Supplementary Information

Impact of Renewable Energy Utilization and Artificial Intelligence in Achieving Sustainable Development Goals

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Supplementary Table 1: Evidence of the Renewable energy (RE) mpact including Artificial intelligence (AI) on the achievement of all 169 targets within the 17 goals defined in the sustainable development agenda 2030.

Targets No.	GOAL AND ITS TARGET IN THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT	*Is there published evidence for RE Utilization and AI-based RE as an enabler or an inhibitor for the Target?*			REASONING	REFERENCES FOUND
		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
GOAL 1: No Poverty..						
1.1	By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day.				We identified in the literature studies suggesting that RE may be has positive impact for this target, due to the potential of RE to play a key role in poverty alleviation which would enable the achievement of this goal (1, 2). Other references identify RE can achieve this goal, in the context of using RE in the poor areas can increase their incomes by working in the RE projects, contact with the rest of world, offer them the opportunity to fight against poverty and to foster international collaboration (3). Beside, some literatures have demonstrated that RE can contribute to poverty alleviation directly by providing the energy needed for creating businesses and jobs, turning locally available resources into productive economic assets and therefore, it can be help in achieving this target (4).	(1) Nissing, Christian, and Harro von Blottnitz. "Renewable energy for sustainable urban development: Redefining the concept of energisation." Energy Policy 38.5 (2010): 2179-2187. (2) Schwerhoff, Gregor, and Mouhamadou Sy. "Financing renewable energy in Africa–Key challenge of the sustainable development goals." Renewable and Sustainable Energy Reviews 75 (2017): 393-401. (3) Raspaud, Laurent. "Sustainable energy and the fight against poverty." Field Actions Science Reports. The journal of field actions Special Issue 6 (2012). (4) Sharma, Pooja. "Role of Rural Electrification and Renewable Energy on Poverty in India: A State Wise Analysis." Asia Pacific Journal of Multidisciplinary Research 6.4 (2018).
1.2	By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions.				Based on the literature, RE such as biomass may has negative impact towards the achievement of this target, since it may lead to increase the time spent, mainly for women and children, in collecting biomass (1). However, as other RE source depend on smart system, may lead to reduce availability of jobs as introduced in (1,2). Nevertheless, alternative views reflect that other types of RE can enable this goal, through the supply of modern energy facilitates the improvement of human living conditions and the productivity of sectors. It also contributes by reducing the time spent, mainly for women and children, in collecting biomass and therefore can provide an opportunity for an increase in the education level of children and for women empowerment (1, 2); the shift from the fossil economy to renewable energy and material based economy add research, manufacturing and construction jobs to the job market until the change is finished (40-90 years) (3).	(1) Thiam, Djiby Racine. "Renewable energy, poverty alleviation and developing nations: Evidence from Senegal." Journal of Energy in Southern Africa 22.3 (2011): 23-34. (2) Zahnd, Alex, and Haddix McKay Kimber. "Benefits from a renewable energy village electrification system." Renewable Energy 34.2 (2009): 362-368. (3) Diachuk, Oleksandr, et al. "Transition of Ukraine to the Renewable Energy by 2050." Transition of Ukraine to the Renewable Energy by 2050 (2018).
1.3	Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable.				We did not find published evidence of RE impact and AI-based RE role on this target.	
1.4	By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms				Some authors indicate that RE would positively impact the achievement of this target in case the government officials, private sector leaders and civil society can take to maximize poverty reduction impacts through micro-finance (1). Other study concluded that women empowerment can be achieved in RE sector through investment readiness, learning towards rural RE project, awareness towards financing rural RE project (2). On the hand, some literature concluded that there are noticeable gender inequity in energy use of many poor areas although the women can play a crucial role in regional renewable energy development (3). As any other sector in the poor	(1) Ayodele, Esan, et al. "Hybrid microgrid for microfinance institutions in rural areas–A field demonstration in West Africa." Sustainable Energy Technologies and Assessments 35 (2019): 89-97. (2) Krishnamurthy, Saravan, et al. "Empowering women of rural India for renewable energy adoption–an exploratory factor analysis." Indian Journal of Science and Technology 10.37 (2017): 1-10.

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	of 13 property, inheritance, natural resources, appropriate new technology and financial services, including micro-finance.				areas, women are excluded in the development and management of local renewable energy which may act as inhibitor toward attaining this target (4).	(3) Ding, Wenguang, et al. "Gender and renewable energy study in Tibetan pastoral areas of China." Renewable Energy 133 (2019): 901-913. (4) Nelson, Sibyl, and Anne T. Kuriakose. "Gender and renewable energy: Entry points for women's livelihoods and employment." Climate Investment Funds (2017).
1.5	By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.				The literature puts forward several published studies on how RE utilization can help toward achieving this goal. RE utilization is identified in the literature as an enabler for this target through several applications: water providing via PV pumping system and its good impact on developing their economic and environmental aspects (1); enhance irrigation system (2); enhance their socio-economic aspects (3), and improved the general health of poor areas with mobile/ constant hospitals or clinics with RE sources which have low environmental impacts (3, 4).	(1) Al-Waeli, Ali HA, et al. "Evaluation of the economic and environmental aspects of using photovoltaic water pumping system." 9th International Conference on Robotic, Vision, Signal Processing and Power Applications. Springer, Singapore, 2017. (2) Wazed, Saeed Mohammed, et al. "Solar driven irrigation systems for remote rural farms." *Energy Procedia* 142 (2017): 184-191. (3) Okkonen, Lasse, and Olli Lehtonen. "Socio-economic impacts of community wind power projects in Northern Scotland." Renewable Energy 85 (2016): 826-833. (4) Hussein, Emadeddin AA. Design of renewable energy system for a mobile office/hospital in an isolated rural area. Diss. Memorial University of Newfoundland, 2017.
1.6	Ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation, in order to provide adequate and predictable means for developing countries, in particular least developed countries, to implement programmes and policies to end poverty in all its dimensions.				The RE may positively impact the achievement of this target through mobilization of different RE resources in which at least one of these sources are exist and available in these areas (i.e, wind, solar, biomass, hydro power, and etc.). The variety of RE can be exploited including through enhanced development cooperation supported by governments or other national or international cooperation to enhance the quality of poor areas (1, 2).	(1) Schwerhoff, Gregor, and Mouhamadou Sy. "Financing renewable energy in Africa–Key challenge of the sustainable development goals." Renewable and Sustainable Energy Reviews 75 (2017): 393-401. (2) Cloke, Jonathan, Alison Mohr, and Ed Brown. "Imagining renewable energy: Towards a Social Energy Systems approach to community renewable energy projects in the Global South." Energy research & social science 31 (2017): 263-272.
1.7	Create sound policy frameworks at the national, regional and international levels, based on pro-poor and gender-sensitive development strategies, to support accelerated investment in poverty eradication actions.				We did not find published evidence of RE impact and AI-based RE role on this target.	
GOAL 2: Zero Hunger.						
2.1	By 2030, end hunger and ensure access by all people, in particular the poor and people in				There is plentiful evidence that RE is working towards issues related to ensure food security and end hunger as it will decrease the dependence on fossil fuel. Some study proved that there is opposite relation between the "food and fuel", so the RE will decrease the reliance on fuel which may	(1) Bryant, Henry L., et al. Long-term Effects of the US Renewable Fuel Standard on World Hunger. No. 320-2016-10189. 2010. (2) Bryant, Henry L., et al. Long-term Effects of the US Renewable Fuel Standard on World Hunger. No. 320-2016-10189. 2010.

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	vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.				contribute toward less hunger (1). Other study conclude that the RE without fuel is enabler for this target, as the increasing use of food commodities for fuel production understandably raises concerns that food prices will increase and additional people will be pushed into hunger (2). Many authors, also, claim that the advent of AI will decrease the dependence on fuel by scheduling especially in micro-grid systems that using RE and non-RE sources by using optimization scheduling and therefore the AI can be considered as an enabler for this target (3, 4, 5).	(3) Gabbar, Hossam A., and Aboelsood Zidan. "Optimal scheduling of interconnected micro energy grids with multiple fuel options." Sustainable Energy, Grids and Networks 7 (2016): 80-89. (4) Koltsaklis, Nikolaos E., Myronas Giannakakis, and Michael C. Georgiadis. "Optimal energy planning and scheduling of microgrids." Chemical Engineering Research and Design 131 (2018): 318-332. (5) Behera, Basanta Kumara, Pramod Kumar Rout, and Shyambhavee Behera. "Water, Energy and Food Security: Pillars for Zero Hunger." Move Towards Zero Hunger. Springer, Singapore, 2019. 37-60.
2.2	By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons				We did not find published evidence of RE impact and AI-based RE role on this target.	
2.3	By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment				There is some evidence that the using of RE can contribute towards achieving this goal by providing pumping water station using biogas, solar or wind energy to help in increasing the agricultural productivity, profitability, and incomes of small-scale food producers and family farmers (1,2,3). For instance, solar energy farming is combined with attractive purchase guarantees in order to encourage farmers to efficiently use solar energy on-farm and sell the energy excess (3). The using of AI for RE which used for agriculture farm can improve the drip irrigation system and smart irrigation systems that tailor watering schedules and run times automatically to meet specific landscape needs which reduce the working hours which reduces working hours that mainly depend on women and children (4). Thus, AI for RE utilization for agriculture farm can act as enabler for this target.	(1) Appel, Franziska, Arlette Ostermeyer-Wiethaup, and Alfons Balmann. "Effects of the German Renewable Energy Act on structural change in agriculture–The case of biogas." Utilities Policy 41 (2016): 172-182. (2) Horvatincic, Karolina, Damir Demonja, and Sanja Tisma. "Green Jobs for Green Food: New Knowledge and Skills for Family Farms in Food Production in Croatia." Calitatea 17.154 (2016): 80. (3) Al-Saidi, Mohammad, and Nisreen Lahham. "Solar energy farming as a development innovation for vulnerable water basins." Development in Practice 29.5 (2019): 619-634. (4) Carroquino, Javier, Rodolfo Dufo-López, and José L. Bernal-Agustín. "Sizing of off-grid renewable energy systems for drip irrigation in Mediterranean crops." Renewable energy 76 (2015): 566-574. (5) Elkadeem, M. R., et al. "Feasibility analysis and techno-economic design of grid-isolated hybrid renewable energy system for electrification of agriculture and irrigation area: A case study in Dongola, Sudan." Energy Conversion and Management 196 (2019): 1453-1478.
2.4	By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for				We did not find published evidence of RE impact and AI-based RE role on this target.	

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	adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality					
2.5	By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed				We did not find published evidence of RE impact and AI-based RE role on this target.	
2.6	Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries				We did not find published evidence of RE impact and AI-based RE role on this target.	
2.7	Correct and prevent trade restrictions and distortions in world agricultural markets, including through the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in				We did not find published evidence of RE impact and AI-based RE role on this target.	

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	accordance with the mandate of the Doha Development Round					
2.8	Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility				There is only weak evidence that RE is responding to this particular sub-goal. Ref. (1) highlight the positive role of RE that use for agricultural purpose such as water pumping which in turn reduce the food price as compare to pumping stations which depend on electricity or fossil fuel. The using of AI for RE which used for agriculture farm can improve the drip irrigation system and smart irrigation systems that tailor watering schedules and run times automatically to meet specific landscape needs which reduce overall cost of the food products (2). Thus, AI for RE utilization for agriculture farm can act as enabler for this target.	(1) Chel, A., and G. Kaushik. "Renewable energy for sustainable agriculture." Agronomy for Sustainable Development 31.1 (2011): 91-118. (2) Carroquino, Javier, Rodolfo Dufo-López, and José L. Bernal-Agustín. "Sizing of off-grid renewable energy systems for drip irrigation in Mediterranean crops." Renewable energy 76 (2015): 566-574.
GOAL 3: Good Health and Well-being.						
3.1	By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births				We did not find published evidence of RE impact and AI-based RE role on this target.	
3.2	By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births				We did not find published evidence of RE impact and AI-based RE role on this target.	
3.3	By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases				We did not find published evidence of RE impact and AI-based RE role on this target.	
3.4	By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being				There is only weak evidence that RE is responding to this particular sub-goal. Ref. (1) discussed that the utilization of RE for electricity service, especially in developing country and areas without power supply can help in building the Clinics which may help increase the people awareness about diseases, as well as treatment and prevention of diseases. In addition, using RE as power supply will definitely enhance the community and well-being (2).	(1) Olatomiwa, Lanre, et al. "Hybrid renewable energy supply for rural healthcare facilities: An approach to quality healthcare delivery." Sustainable Energy Technologies and Assessments 30 (2018): 121-138. (2) Al-faruq, Umar, et al. "Assessment of Renewable Energy Impact to Community Resilience in Sumba Island." Resilience Development Initiative 9 (2016).

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3.5	Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol				We did not find published evidence of RE impact and AI-based RE role on this target.	
3.6	By 2020, halve the number of global deaths and injuries from road traffic accidents				We did not find published evidence of RE impact and AI-based RE role on this target.	
3.7	By 2030, ensure *universal access to sexual and reproductive health-care services*, including for family planning, information and education, and the integration of reproductive health into national strategies and programs				While there are use of RE in clinics and other health aspects, we were unable to find published evidence of RE and/or AI-based RE affecting this target	
3.8	Achieve *universal health coverage*, including financial risk protection, *access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all*				We did not find published evidence of RE impact and AI-based RE role on this target.	
3.9	By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination				The literature puts forward several published studies on how RE (i.e wind, solar and hydropower) will decrease the hazardous chemicals and air, water and soil pollution and contamination that produced by conventional power plant (1,2), and therefore considered as enabler for this target. In addition, These RE sources in its implementation have had a social impact by improving health via reducing pollution (3). However, some studies concluded that although the advantages of biomass as RE source, the use of biomass may act as inhibitor for this target, because it releases carbon monoxide, leading to headaches, nausea, dizziness, and in high concentrations, premature death (4,5). The use of AI and machine learning would act as very important enabler for this target because the it can be used reduce GHG emissions and environmental impact which in turn will help in reduce the number of deaths and illnesses (6,7,8, 9).	(1) Nazir, Muhammad Shahzad, et al. "Environmental impact and pollution-related challenges of renewable wind energy paradigm–A review." Science of the Total Environment 683 (2019): 436-444. (2) Berrill, Peter, et al. "Environmental impacts of high penetration renewable energy scenarios for Europe." Environmental Research Letters 11.1 (2016): 014012. (3) Chilán, Julio Cesar Hernández, et al. "Social impact of renewable energy sources in the province of Loja." International journal of physical sciences and engineering 2.1 (2018): 13-25. (4) Freiberg, Alice, et al. "The use of biomass for electricity generation: A scoping review of health effects on humans in residential and occupational settings." International journal of environmental research and public health 15.2 (2018): 354. (5) Subramanian, Meera. "Deadly dinners." Nature 509.7502 (2014): 548. (6) Boyaghchi, Fateme Ahmadi, Mansoure Chavoshi, and Vajiheh Sabeti. "Multi-generation system incorporated with PEM electrolyzer and dual ORC based on biomass gasification waste heat recovery:

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
						exergetic, economic and environmental impact optimizations." Energy 145 (2018): 38-51. (7) Murphy, Fionnuala, et al. "Life cycle assessment of biomass-to-energy systems in Ireland modelled with biomass supply chain optimisation based on greenhouse gas emission reduction." Energy 109 (2016): 1040-1055. (7) Nie, S., et al. "Optimization of electric power systems with cost minimization and environmental-impact mitigation under multiple uncertainties." Applied Energy 221 (2018): 249-267. (9) Wagh, M. M., and V. V. Kulkarni. "Modeling and optimization of integration of Renewable Energy Resources (RER) for minimum energy cost, minimum CO_2 Emissions and sustainable development, in recent years: A review." Materials Today: Proceedings 5.1 (2018): 11-21.
3.10	Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries, as appropriate				We did not find published evidence of RE impact and AI-based RE role on this target.	
3.11	Support the research and development of vaccines and medicines for the communicable and non-communicable diseases that primarily affect developing countries, provide access to affordable essential medicines and vaccines, in accordance with the Doha Declaration on the TRIPS Agreement and Public Health, which affirms the right of developing countries to use to the full the provisions in the Agreement on Trade Related Aspects of Intellectual Property Rights regarding flexibilities to protect public health, and, in particular, provide access to medicines for all				We did not find published evidence of RE impact and AI-based RE role on this target.	

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3.12	Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing States				We did not find published evidence of RE impact and AI-based RE role on this target.	
3.13	Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks				Although some authors think that there is indirect effect of RE toward achieving this target, we were unable to find published evidence of RE and/or AI-based RE affecting this target	
GOAL 4: Quality Education.						
4.1	By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and Goal-4 effective learning outcomes				We have identified few areas and indirect evidance where RE can be considered an enabler for this target: use RE to supply schools and its laps especially in developing and rural area where the grid supply is limited or not exist at all (1). The most important benefits are the savings. For instance, a study (2) suggests that if the available space that educational buildings provide for solar panels is used, then up to 75% of their electricity needs could be covered. This saved money could then be used to benefit the students and the administration and thus improves the education in general. In addition, after students back home, the energy produced form RE in the school/institute/university may sell to the grid or homes. The money of sold energy can be used to benefit the students and the education sector (3). There is also some evidence (4,5,6) showing the AI used as energy management optimization, motion sensors, or/and student and staff detector which will auto switch the lights on/off is very important to minimize energy consumption. Therefore, lighting control technologies will save from 20% to 35% and this money can be used for improving the education.	(1) Giday, Zelalem Girma. "Technical and economic assessment of solar PV/diesel hybrid power system for rural school electrification in Ethiopia." International Journal of Renewable Energy Research (IJRER) 3.3 (2014): 735-744. (2) Hanus, Nichole L., et al. "Solar PV as a mitigation strategy for the US education sector." Environmental Research Letters 14.4 (2019): 044004. (3) Juan, Yi-Kai, Peng Gao, and Jie Wang. "A hybrid decision support system for sustainable office building renovation and energy performance improvement." Energy and buildings 42.3 (2010): 290-297. (4) Mauser, Ingo, et al. "Adaptive building energy management with multiple commodities and flexible evolutionary optimization." Renewable Energy 87 (2016): 911-921. (5) Jin, Xiaolong, et al. "Hierarchical microgrid energy management in an office building." Applied Energy 208 (2017): 480-494. (6) Chel, Arvind, and Geetanjali Kaushik. "Renewable energy technologies for sustainable development of energy efficient building." Alexandria Engineering Journal 57.2 (2018): 655-669.
4.2	By 2030, ensure that all girls and boys have access to quality early childhood development, care and preprimary education so that they are ready for primary education				Similar to 4.1.	
4.3	By 2030, ensure equal access for all women and				Similar to 4.1 in general.	

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	men to affordable and quality technical, vocational and tertiary education, including university					
4.4	By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship				The literature reflects a wide range of areas where RE can positively impact the achievement of this target: statistics reveal that, RE provided 26% of electricity worldwide in 2019 (1). Therefore, these percentages mask the absolute growth of the industry and what renewable energy's potential can mean for creating jobs and speed up economic development (1); RE-based remote teaching (schools and institutes electrified by RE) would allow to educate more students in under developed countries with good performance (2); due to the establishing of RE factories and prosperity of RE industry, a numbers of youth and adults can work in this sector as well as direct youth to income generating activities in this sector (3); it will move young people into productive and long-term nation building activities, away from nonproductive pursuits (4); the development of RE can bring positive and tangible effects on employment because this energy is local in nature and can usually be made available without the existence of heavy infrastructure (5). However, some studies highlight the fact that this new technology would require highly skilled professionals, a fact that could result in increased inequalities due to under-prepared professionals (6). On the other hand, as AI and machine learning will increase the efficiency of RE in many areas, will definitely help toward achieving this target (7).	(1) Global Status Report. (2019, 22 June). Renewables 2019 Global Status Report-REN21. Available: https://www.unenvironment.org/resources/report/renewables-2019-global-status-report (2) Del Rio, Pablo, and Mercedes Burguillo. "An empirical analysis of the impact of renewable energy deployment on local sustainability." Renewable and Sustainable Energy Reviews 13.6-7 (2009): 1314-1325. (3) Wei, Max, Shana Patadia, and Daniel M. Kammen. "Putting renewables and energy efficiency to work: How many jobs can the clean energy industry generate in the US?." Energy policy 38.2 (2010): 919-931. (4) Rodríguez-Huerta, Edgar, Martí Rosas-Casals, and Alevgul H. Sorman. "A societal metabolism approach to job creation and renewable energy transitions in Catalonia." Energy Policy 108 (2017): 551-564. (5) Colombo, Emanuela, et al. "An impact evaluation framework based on sustainable livelihoods for energy development projects: an application to Ethiopia." Energy Research & Social Science 39 (2018): 78-92. (6) Lucas, Hugo, Stephanie Pinnington, and Luisa F. Cabeza. "Education and training gaps in the renewable energy sector." Solar Energy 173 (2018): 449-455. (7) Batcha, R. Rahin, and M. Kalaiselvi Geetha. "A Survey on IOT Based on Renewable Energy for Efficient Energy Conservation Using Machine Learning Approaches." 2020 3rd International Conference on Emerging Technologies in Computer Engineering: Machine Learning and Internet of Things (ICETCE). IEEE, 2020.
4.5	By 2030, *eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations*				We did not find published evidence of RE impact and AI-based RE role on this target.	
4.6	By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy				Similar to 8.6.	

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4.7	By 2030, ensure that *all learners acquire the knowledge and skills needed to promote sustainable development*, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and *appreciation of cultural diversity* and of culture's contribution to sustainable development				We did not find published evidence of RE impact and AI-based RE role on this target.	
4.8	*Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, nonviolent, inclusive and effective learning environments for all*				We did not find published evidence of RE impact and AI-based RE role on this target.	
4.9	By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training and information and communications technology, technical, engineering and scientific programs, in developed countries and other developing countries				Based on the literature, the RE may negatively impact the achievement of this goal. In this regard, RE institutions/industry sectors always looking for highly skill and professional engineers to train/study (1). During the writing of this study (2nd half of 2020), and based on Global Education Monitoring Report – UNESCO (published on Nov 26, 2019) mentioned that, the number of scholarships available to developing countries and poor communities still under the excepted level and the report also showed that the world is drastically off track (2).	(2) Lucas, Hugo, Stephanie Pinnington, and Luisa F. Cabeza. "Education and training gaps in the renewable energy sector." Solar Energy 173 (2018): 449-455. (2) UNESCO, "Global Education Monitoring Report", 2019, https://en.unesco.org/gemreport/taxonomy/term/210
4.10	By 2030, substantially increase the supply of qualified teachers, including through				There is only weak evidence that RE is responding to this particular sub-goal. For instance, the authors in (1) discussed that the utilization of RE for training facilities can contribute for achieving goal as most of developing	(1) Adenle, Ademola A. "Assessment of solar energy technologies in Africa-opportunities and challenges in meeting the 2030 agenda and sustainable development goals." Energy Policy 137 (2020): 111180.

Targets No.	GOAL AND ITS TARGET IN THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT	*Is there published evidence for RE Utilization and AI-based RE as an enabler or an inhibitor for the Target?*			REASONING	REFERENCES FOUND
		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	international cooperation for teacher training in developing countries, especially least developed countries and small island developing states				countries, especially least developed countries and small island developing states without electricity cervices.	
GOAL 5: Gender Equality.						
5.1	End all forms of discrimination against all women and girls everywhere				We did not find published evidence of RE impact and AI-based RE role on this target.	
5.2	Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation				We did not find published evidence of RE impact and AI-based RE role on this target.	
5.3	Eliminate all harmful practices, such as child, early and forced marriage and female genital mutilation				We did not find published evidence of RE impact and AI-based RE role on this target.	
5.4	Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate				There is an evidence so far that RE may impact positively toward achieving this particular sub-target. In this regard, Ref. (1,2) discussed that the RE can improve the provision of public services and infrastructure which in turn can improve and the promotion of shared responsibility within the household and the family.	(1) Kirsanova, Natalia Yu, Olga M. Lenkovets, and Anni Yu Nikulina. "Renewable energy sources (RES) as a factor determining the social and economic development of the Arctic zone of the Russian Federation." International Multidisciplinary Scientific GeoConference: SGEM 18.5.3 (2018): 679-686. (2) Amador, Ryan. "Rural Renewable Energy Based Infrastructure of the Philippines." (2017).
5.5	Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision making in political, economic and public life				We did not find published evidence of RE impact and AI-based RE role on this target.	
5.6	Ensure *universal access to sexual and reproductive health and reproductive rights* as agreed in accordance with the				We did not find published evidence of RE impact and AI-based RE role on this target.	

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	Programme of Action of the International Conference on Population and Development and the Beijing Platform for Action and the outcome documents of their review conferences					
5.7	Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws				We did not find published evidence of RE impact and AI-based RE role on this target.	
5.8	Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women				We did not find published evidence of RE impact and AI-based RE role on this target.	
5.9	Adopt and strengthen sound policies and enforceable legislation for the promotion of gender equality and the empowerment of *all women and girls at all levels*				We did not find published evidence of RE impact and AI-based RE role on this target.	
GOAL 6: Clean Water and Sanitation.						
6.1	By 2030,achieve *universal and equitable access to safe and affordable drinking water for all*				We found ample evidence in the literature that RE and AI-based RE acts as enablers for this target. The RE sources have been used widely in the recent years to purify and treat drinking water and shown technical and economic feasibility as proved in (1,2,3,4). According to (5), the World Health Organization estimates that 760 million people worldwide lack access to clean drinking water. The regions with the highest water scarcity are usually off-grid, remote and have high solar insolation. Therefore, the use of solar powered reverse osmosis water treatment systems is a viable solution. A standalone hybrid PV/ wind energy system is used to continuously power a submersible water pump (underground well) to produce drinking water located at the Disi aquifer, South of Jordan (6). It concluded that this project can be considered optimal scenario which is economically and technically feasible. The AI has also big role for the using of RE in treatment,	(1) Phuangpornpitak, N., and T. Katejanekarn. "Suitability analysis for implementing a renewable energy powered water purification system." Energy Procedia 89 (2016): 55-68. (2) Halder, D., Mondal, S., Mukherjee, A., & Ghosh, A. (2016). An overview on the treatment of wastewater using renewable energy. Int J Res Eng Technol, 5(1), 78-83. (3) Kabir, K. M., Matin, M. A., Misran, H., & Amin, N. (2018, September). Solar photovoltaic assisted cost-efficient brackish water purification system. In 2018 4th International Conference on Electrical Engineering and Information & Communication Technology (iCEEiCT) (pp. 510-513). Ieee.

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
					desalination, sterilization and chemical purification of the drinking water such as 3D artificial transpiration device used in (7) which increase the efficiency to 85%. The results also show an additional improvement by a factor of five in the overall economic and environmental performance of the optimized plant when alternative renewable energy resources are included. Optimization of integrating alternative RE resources to drinking water plants proposed by (8), the results also show an additional improvement by a factor of five in the overall economic and environmental performance of the optimized plant when alternative RE resources are included.	(4) Keith, A. E., & French, J. J. (2019). Design and testing of a remote deployable water purification system powered by solar energy. Advances in Technology Innovation, 4(1), 30. (5) Freire-Gormaly, M. (2018). Experimental characterization of membrane fouling under intermittent operation and its application to the optimization of solar photovoltaic powered reverse osmosis drinking water treatment systems (Doctoral dissertation). (6) Abdul-Rahman, S., and A. Badran. "Analysis of an Off-Grid Photovoltaic-Wind Hybrid Power System for Disi Water Pumping Project." Int. J. of Thermal & Environmental Engineering 14.1 (2017): 41-48. (7) Li, Xiuqiang, et al. "Three-dimensional artificial transpiration for efficient solar waste-water treatment." National Science Review 5.1 (2018): 70-77. (8) Ahmadi, Aras, et al. "On the importance of integrating alternative renewable energy resources and their life cycle networks in the eco-design of conventional drinking water plants." Journal of Cleaner Production 135 (2016): 872-883.
6.2	By 2030, achieve *access to adequate and equitable sanitation and hygiene for all* and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations				There is evidence in the literature that RE could have a positive effect on this sub-target in concern with the sanitation. For instance, using the energy comes from solar radiation and is complemented by biogas from the anaerobic sewage treatment is introduced in (1). The results shown that the ability of the system's to transfer heat and, consequently, to sanitize and dry the sludge. Optimization of suitable cost-effective model for hybrid electric renewable sources to provide a hygienic community toilet system for the poor people in Indian village (2). The results shows the eco-techno feasibility for RE while the optimization also enhance the system operation and reduce the cost.	(1) Gontijo, Jéssica Cristine, et al. "Sanitation and drying of sewage sludge on radiant floors using solar energy and biogas: comparison between different thicknesses of deposited mass." Brazilian Archives of Biology and Technology 61.SPE (2018). (2) Goel, Sonali, and Renu Sharma. "Feasibility study of hybrid energy system for off-grid rural water supply and sanitation system in Odisha, India." International Journal of Ambient Energy 37.3 (2016): 314-320.
6.3	By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally				Similar to 6.1, Ref. (1,2,3,4, 7)	
6.4	By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people				There is evidence about the role of solar energy toward achieving this target. For instance, the use of solar energy and/or hybrid RE in pumping the water from the underground wells in the rural and desert areas is contributed toward the reduction of the number of people suffering from water scarcity (1,2,3). The AI can also be used for management the water pumping using RE and used it in efficient way for irrigation systems which will increase the efficiency use of water and reduce water waste (4,5). On the other hand, Ref. (6) addresses the environmental effects of solar panels on an unirrigated pasture that often experiences water stress. The result shown that, after 2	(1) Hassanien, Reda Hassanien Emam, Ming Li, and Wei Dong Lin. "Advanced applications of solar energy in agricultural greenhouses." (2) Barron-Gafford, Greg A., et al. "Agrivoltaics provide mutual benefits across the food–energy–water nexus in drylands." Nature Sustainability 2.9 (2019): 848-855. (3) Khattab, N. M., et al. "Feasibility of hybrid renewable energy water pumping system for a small farm in Egypt." International Journal of Applied Engineering Research 11.11 (2016): 7406-7414. Renewable and Sustainable Energy Reviews 54 (2016): 989-1001.

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	suffering from water scarcity				years the areas under PV solar panels maintained higher soil moisture throughout the period of observation and noticed that the areas under PV panels were significantly more water efficient (328% more efficient).	(4) Bertsiou, M., Feloni, E., Karpouzos, D., & Baltas, E. (2018). Water management and electricity output of a hybrid renewable energy system (HRES) in Fournoi island in Aegean Sea. Renewable Energy, 118, 790-798. (5) Chaouali, Houssem, et al. "Fuzzy logic optimization of a centralized energy management strategy for a hybrid PV/PEMFC system feeding a water pumping station." International Journal of Renewable Energy Research 8.4 (2018): 2190-2198. (6) Hassanpour Adeh, Elnaz, John S. Selker, and Chad W. Higgins. "Remarkable agrivoltaic influence on soil moisture, micrometeorology and water-use efficiency." PloS one 13.11 (2018): e0203256.
6.5	By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate				We did not find published evidence of RE impact and AI-based RE role on this target.	
6.6	By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes				There is very weak or indirect evidence about the negative impact of RE on this target, as the installation of RE farms such as, solar wind, biomass, and hydropower may affect the water-related ecosystems such as forests, wetland, and mountain especially large scale RE farms (1). For instance, cutting the wood for biomass energy operation, using the wetland for farms installation, etc (1,2).	(1) Gasparatos, Alexandros, et al. "Renewable energy and biodiversity: Implications for transitioning to a Green Economy." Renewable and Sustainable Energy Reviews 70 (2017): 161-184. (2) Hodges, Donald G., et al. "Opportunities and attitudes of private forest landowners in supplying woody biomass for renewable energy." Renewable and Sustainable Energy Reviews 113 (2019): 109205.
6.7	By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies				We did not find published evidence of RE impact and AI-based RE role on this target.	
6.8	Support and strengthen the participation of local communities in improving water and sanitation management				We did not find published evidence of RE impact and AI-based RE role on this target.	
GOAL 7: Affordable and Clean Energy.						
7.1	By 2030, ensure *universal access to affordable, reliable and modern energy services*				There are many evidence about the high effect of RE and AI role for RE utilization toward achieving this goal. For instance, many studies confirmed that the dependence on RE sources for power production will highly reduce the electricity cost as it is free available (1,2,3,4), will contribute to organize reliable power supply especially in case of Microgrid systems in which the	(1)Wang, Richard, et al. "Renewable energy microgrids: Economic evaluation and decision making for government policies to contribute to affordable and clean energy." Applied Energy 274 (2020): 115287. (2) Yan, Jinyue, et al. "Clean, efficient and affordable energy for a sustainable future." (2017): 953-962.

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
					feeding using different RE sources will increase the power system reliability (4), other study concluded that using microgrid generation technologies is very useful in order to establish reliable power supply as the microgrid based on RE is considered as one of the realization forms of the distributed energy paradigm (5). Moreover, the authors in (6) concluded that countries use RE more than non-RE sources is extremely important in terms of making progress towards modern power services sustainability of development. Digital and intelligent energy systems, drawing on the ever increasing data on energy demand and supply, in the future may be able to identify who needs energy and deliver it at the right time, in the right place and at the lowest cost (7,8). This would support access. However a smarter and more digitalized energy system makes it more vulnerable to cyber-attacks (9). Further, AI systems will need significant amounts of electricity - and such additional usage could impact electrical grids in countries where access to electricity is still an issue, potentially increasing blackouts, etc. (7,10). Moreover, AI plays an important role to reduce the cost based on scheduling based on the weather condition, to guarantee continues power supply, and for enabling consumers to respond to load management signals, when operated under the supervision of a scheduling coordinator (11, 12). The optimization technique is also used to increase the system reliability through power balance between supply and demand which is the core criterion for the reliability evaluation	(3) Nelson, David, and Gireesh Shrimali. "Finance mechanisms for lowering the cost of renewable energy in rapidly developing countries." Climate Policy Initiative (2014). (4) Adefarati, Temitope, and Ramesh C. Bansal. "Reliability, economic and environmental analysis of a microgrid system in the presence of renewable energy resources." Applied energy 236 (2019): 1089-1114. (5) Kharchenko, Valeriy, Valentin Gusarov, and Vadim Bolshev. "Reliable Electricity Generation in RES-Based Microgrids." Handbook of Research on Smart Power System Operation and Control. IGI Global, 2019. 162-187. (6) Güney, Taner. "Renewable energy, non-renewable energy and sustainable development." International Journal of Sustainable Development & World Ecology 26.5 (2019): 389-397. (7) International Energy Agency. Digitalization & Energy (2020). (A) (8) Yang, T., Zhao, L., & Wang, C. (2019). Review on application of artificial intelligence in power system and integrated energy system. Automation of Electric Power Systems, 43(1), 2-14. (9) Fleury, T., Khurana, H. & Welch, V., 2008, in IFIP International Federation for Information Processing, Volume 290; Critical Infrastructure Protection II, eds. Papa, M., Shenoi, S., (Boston: Springer), pp. 71–85. (A) (10) Jones, Nicola. "How to Stop Data Centres from Gobbling up the World's Electricity." Nature 2018 561:7722, September 12, 2018. (B) (11) Abdolrasol, Maher GM, et al. "An optimal scheduling controller for virtual power plant and microgrid integration using the binary backtracking search algorithm." IEEE Transactions on Industry Applications 54.3 (2018): 2834-2844. (12) Giuntoli, Marco, and Davide Poli. "Optimized thermal and electrical scheduling of a large scale virtual power plant in the presence of energy storages." IEEE Transactions on Smart Grid 4.2 (2013): 942-955. (13) Ren, Y., Cui, B., Feng, Q., Yang, D., Fan, D., Sun, B., & Li, M. (2020). A reliability evaluation method for radial multi-microgrid systems considering distribution network transmission capacity. Computers & Industrial Engineering, 139, 106145.
7.2	By 2030, increase substantially the share of renewable energy in the global energy mix				There is published evidence that the RE progress is going to achieve this target. In this context, based on the International Energy Agency (1) and Renewables Global Status (REN21) reports (2), the share of RE in the global energy mix was 8.6% in 2010 and increased to 18.2% by the end of 2017, then; in the first quarter of 2020 jumped to nearly 28% from 26% in Q1 2019. Renewable energy has established itself on a global scale. That's expected to rise to 45 percent by 2040. In 2018, more than 90 countries had installed at least 1 GW of generating capacity, while at least 30 countries exceeded 10 GW of capacity across the globe (2,3). These evidence confirmed without doubts the RE utilization will contribute toward achieving this goal. Moreover, AI could support the usage of Smart Grids, that in turn could increase the penetration of renewable energy in the system (1,4). Also, ICT companies have been involved in scaling up the use of renewables (5).	(1) International Energy Agency, Renewables – Global Energy Review 2020 Analysis (2020). (2) Global Status Report. (2019, 22 June). Renewables 2019 Global Status Report-REN21. Available: (3) Al-Shetwi, A. Q., Hannan, M. A., Jern, K. P., Mansur, M., & Mahlia, T. M. I. (2020). Grid-connected renewable energy sources: Review of the recent integration requirements and control methods. Journal of Cleaner Production, 253, 119831. (4) Ramchurn, S. D., Vytelingum, P., Rogers, A. & Jennings, N. R. Putting the 'Smarts' into the Smart Grid: a Grand challenge for artificial intelligence A research agenda for making the smart grid a reality. 55 (2012). (C)

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
					However, AI could be used to identify technically recoverable oil and gas resources, and optimize the coal sector, reducing global fossil fuel prices and therefore reducing the competitiveness of renewable energy sources (1). Furthermore, a smarter and more digitalized energy system makes it more vulnerable to cyber-attacks (1).	(5) Jones, Nicola. "How to Stop Data Centres from Gobbling up the World's Electricity." Nature 2018 561:7722, September 12, 2018. (B)
7.3	By 2030, double the global rate of improvement in energy efficiency				There is evidence that RE has high impact on increasing the energy efficiency as the energy efficiency and RE technologies are so related. For instance, RE can supply two-thirds of the total global energy demand, and contribute to the bulk of the greenhouse gas emissions reduction that is needed between now and 2050 for limiting average global surface temperature increase below 2 °C (1). Based on study introduced by (2) about the impact of RE on energy efficiency in Europe confirmed that the average efficiency of the selected EU countries is increasing via using RE sources and average total factor productivity has increased by 8.4% annually. RE integration will enable data centers and power operators to achieve the desired RE utilization while improving energy efficiency and will allow us to have a better quality of life, less gas emission, reducing greenhouse effect and resulting in a wiser management of the resources available in our cities (3,4). Furthermore, using the RE sources as standalone and grid-connected mode can used during outage or grid faults as backup feeding sources which will increase the energy supply efficiency (5). Regarding the using of AI in RE, there is evidence that AI could support the usage of Smart Grids that in turn could increase the efficiency of local and global energy systems (6, 7). Real-time data in buildings and weather forecast combined with smart systems could predict when heating and cooling is needed, therefore increasing system efficiency (6). "Smart demand response" , for instance, could provide 185 gigawatts (GW) of electricity system flexibility, roughly equivalent to the currently installed electricity supply capacity of Australia and Italy combined (6).	(1) Gielen, D., Boshell, F., Saygin, D., Bazilian, M. D., Wagner, N., & Gorini, R. (2019). The role of renewable energy in the global energy transformation. Energy Strategy Reviews, 24, 38-50. (2) Gökgöz, F., & Güvercin, M. T. (2018). Energy security and renewable energy efficiency in EU. Renewable and Sustainable Energy Reviews, 96, 226-239. (3) Abdelwahab, H., Moussaid, L., Moutaouakkil, F., & Medromi, H. (2018). Energy Efficiency: Improving the renewable energy penetration in a smart and green community. Procedia Computer Science, 134, 352-357. (4) Kwon, S. (2020). Ensuring renewable energy utilization with quality of service guarantee for energy-efficient data center operations. Applied Energy, 276, 115424. (5) Dhakouani, A., Znouda, E., & Bouden, C. (2019). Impacts of energy efficiency policies on the integration of renewable energy. Energy Policy, 133, 110922. (6) International Energy Agency. Digitalization & Energy. (2020). (A) (7) World Economic Forum (WEF). Fourth Industrial Revolution for the Earth Series Harnessing Artificial Intelligence for the Earth (2018). (C)
7.4	By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology				According to the literature, there are wide-range of researches about the role of RE in establishing national/ international cooperation and institute in order to facilitate access to clean energy and energy efficiency while reducing the dependence on fossil fuel (1). Moreover, the RE contribute to build international electric power interconnections that take into account climatic features, seasonal peak load differences and other factors in order to rationally match power demand and supply is getting increasingly more obvious (2). Based on (1, 3, 4), with the emergence of RE, thousands of cooperation, institutes and infrastructure have been established around the world to achieve 100% clean energy in the future. Regarding the using of AI in RE, there is evidence that AI will support the flow of information, capacity building and education outcomes, including in the energy spheres (5). Also, AI can be used to analyze satellite data, with the aim of "tracking/predicting" poverty indicators and to facilitate international collaboration and action plans (6).	(1) Chandel, S. S., Shrivastva, R., Sharma, V., & Ramasamy, P. (2016). Overview of the initiatives in renewable energy sector under the national action plan on climate change in India. Renewable and Sustainable Energy Reviews, 54, 866-873. (2) Batmunkh, S., Stennikov, V., Bat-Erdene, B., & Erdenebaatar, A. (2018). Mongolia's potential in international cooperation in the Asian energy space. In E3S Web of Conferences (Vol. 27, p. 01006). EDP Sciences. (3) Lajqi, S., Meha, D., Berisha, X., Đurin, B., & Baić, L. (2017, January). The infrastructure of Renewable Energy Sources for Sustainable Development in Kosovo. In 12th SDEWES Conference Dubrovnik 2017 (p. 445). (4) Bagheri, M., Shirzadi, N., Bazdar, E., & Kennedy, C. A. (2018). Optimal planning of hybrid renewable energy infrastructure for urban sustainability: Green Vancouver. Renewable and sustainable energy reviews, 95, 254-264. (5) McArthur, D., Lewis, M. & Bishary, M. The Roles of Artificial Intelligence in Education: Current Progress and Future Prospects. J. Educ. Technol. 1, 42–80 (2005). (C) (6) Jean, N., Burke, M., Xie, M., Davis, W. M., Lobell, D. B. &

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
						Ermon, S. Combining satellite imagery and machine learning to predict poverty. Science 353, 790-794 (2016). (A)
7.5	By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support				There is published evidence that the RE act as enabler for this target because of the recent wide share of RE sources in energy mix which reached to 28% in 2020, many manufactural for these sources parts has been established across the world such as solar cells, wind turbines, the combustor, boiler, prime mover, engine, generator, controls, stack, converters, inverters, and etc, along with and developed technical technology and controllers required to enhance the productivity (1,2,3,4). In addition, the prosperity of RE increased the trading and market of this technology in many rural areas around the world especially in developing countries (3, 5). With respect to the impact of using AI in RE utilization toward achieving this target, there is published evidence that AI will enable algorithms to split complex jobs into minor tasks, which can then be distributed and assigned worldwide for instance to workers in developing countries (6). Other benefits of AI include optimization of the electric grid system (7) and improvement of the design and resilience of infrastructure (8).	(1) Steffen, B., Matsuo, T., Steinemann, D., & Schmidt, T. S. (2018). Opening new markets for clean energy: The role of project developers in the global diffusion of renewable energy technologies. Business and Politics, 20(4), 553-587. (2) International Energy Agency, Renewables – Global Energy Review 2020 Analysis (2020). (3) Philibert, C. (2017). Renewable energy for industry. Paris: International Energy Agency. (4) Gandoman, F. H., Ahmadi, A., Sharaf, A. M., Siano, P., Pou, J., Hredzak, B., & Agelidis, V. G. (2018). Review of FACTS technologies and applications for power quality in smart grids with renewable energy systems. Renewable and sustainable energy reviews, 82, 502-514. (5) Hu, H., Xie, N., Fang, D., & Zhang, X. (2018). The role of renewable energy consumption and commercial services trade in carbon dioxide reduction: Evidence from 25 developing countries. Applied energy, 211, 1229-1244. (6) Bissio, R. Vector of hope, source of fear. Spotlight on Sustainable Development 2018, Chapter 3, 77-86 (2018). (C) (7) Kok, K. & Widergren, S. A Society of devices: integrating intelligent distributed resources with transactive energy. IEEE Power and Energy Magazine 14, 34-45 (2016). (B) (8) Adeli, H. & Jiang, X. Intelligent Infrastructure: Neural Networks, Wavelets, and Chaos Theory for Intelligent Transportation Systems and Smart Structures. CRC Press, Taylor & Francis Group (2009). (A)
GOAL 8: Decent Work and Economic Growth.						
8.1	Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries				There is evidence in the literature that the RE has a positive impact toward achieving this target as the results in (1) which studied the economic growth and RE relation for nine developed countries showed that there is a unidirectional causality running from RE consumption to real Gross Domestic Product (GDP) per capita for the whole panel at short run. In addition, investigate on the relationship amongst RE, foreign direct investment and gross domestic product in 31 Chinese provinces from 2000 to 2015 was conducted in (2) The empirical results indicate that there is a long-term and stable equilibrium relationship between gross domestic product per capita and RE consumption per capita (2). The transition to RE may have a positive impact on the Dutch economy and adding almost 1% of gross domestic product (3,4).	(1) Saidi, Kais, and Mounir Ben Mbarek. "Nuclear energy, renewable energy, CO2 emissions, and economic growth for nine developed countries: Evidence from panel Granger causality tests." Progress in Nuclear Energy 88 (2016): 364-374. (2) Fan, Weiyang, and Yu Hao. "An empirical research on the relationship amongst renewable energy consumption, economic growth and foreign direct investment in China." Renewable Energy 146 (2020): 598-609. (3) Bulavskaya, Tatyana, and Frédéric Reynès. "Job creation and economic impact of renewable energy in the Netherlands." Renewable Energy 119 (2018): 528-538. (4) Shen, Wei, et al. "A comprehensive review of variable renewable energy levelized cost of electricity." Renewable and Sustainable Energy Reviews 133 (2020): 110301.
8.2	Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-				In the literature, may the RE has negative impact on economic productivity as the results presented by (1) showed that no remarkable causal link exists between RE consumption and Total Factor Productivity (TFP) growth in the BRICS. On the other hand, the RE has positive effect on this target as the study conducted in (2) provided new empirical evidence that The RE will act as enabler foe income, human capital, energy productivity, energy prices, and eco-innovation (2). The AI, machine learning, and optimization, smart	(1) Tugcu, Can Tansel, and Aviral Kumar Tiwari. "Does renewable and/or non-renewable energy consumption matter for total factor productivity (TFP) growth? Evidence from the BRICS." Renewable and Sustainable Energy Reviews 65 (2016): 610-616. (2) Li, J., Zhang, X., Ali, S., & Khan, Z. (2020). Eco-innovation and energy productivity: New determinants of renewable energy consumption. Journal of Environmental Management, 271, 111028.

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	value added and labour-intensive sectors				communications have positive impact to increase the RE productivity, reducing the cost, introduced innovation toward smart grid, etc (3,4, 5) .	(3) Vyhmeister, E., Muñoz, C. A., Miquel, J. M. B., Moya, J. P., Guerra, C. F., Mayor, L. R., ... & Reyes-Bozo, L. (2017). A combined photovoltaic and novel renewable energy system: An optimized techno-economic analysis for mining industry applications. Journal of cleaner production, 149, 999-1010. (4) Rahbar, Katayoun, Chin Choy Chai, and Rui Zhang. "Energy cooperation optimization in microgrids with renewable energy integration." IEEE Transactions on Smart Grid 9.2 (2016): 1482-1493. (5) Chiu, Te-Chuan, et al. "Optimized day-ahead pricing with renewable energy demand-side management for smart grids." IEEE Internet of Things Journal 4.2 (2016): 374-383.
8.3	Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services				Positive impact of RES to the economic and social dimensions of sustainable development might be significant. Particularly important is employment creation (1). For instance, the RE added around 7.7 million jobs across the globe in 2014 which led by china with around 3,390 jobs, based on IRENA report 2016 (2). According to (3), that transition to RE may have a positive impact on the Dutch economy, creating almost 50 000 new jobs by 2030 and adding almost 1% of gross domestic product. The deployment of RE in the Czech Republic has succeeded to create a significant number of jobs (more than 20 000 employees in 2010) (4). The employment impact of an accelerated uptake of renewable electricity generation that sees the world derive 100% of its electricity from renewable sources by 2050. It is found that the global direct jobs associated with the electricity sector increases from about 21 million in 2015 to nearly 35 million in 2050. Solar PV, batteries and wind power are the major job creating technologies during the energy transition from 2015 to 2050 (5).	(1) Del Rio, Pablo, and Mercedes Burguillo. "An empirical analysis of the impact of renewable energy deployment on local sustainability." Renewable and Sustainable Energy Reviews 13.6-7 (2009): 1314-1325. (2) IRENA, "Renewable Energy Benefits: Measuring the Economics," ed: International Renewable Energy Agency Abu Dhabi, United Arab Emirates, 2016. (3) Bulavskaya, Tatyana, and Frédéric Reynès. "Job creation and economic impact of renewable energy in the Netherlands." Renewable Energy 119 (2018): 528-538. (4) Dvořák, Petr, et al. "Renewable energy investment and job creation; a cross-sectoral assessment for the Czech Republic with reference to EU benchmarks." Renewable and Sustainable Energy Reviews 69 (2017): 360-368. (5) Ram, Manish, Arman Aghahosseini, and Christian Breyer. "Job creation during the global energy transition towards 100% renewable power system by 2050." Technological Forecasting and Social Change 151 (2020): 119682.
8.4	Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production, with developed countries taking the lead				We did not find published evidence of RE impact and AI-based RE role on this target.	
8.5	*By 2030, achieve full and productive employment and decent work for all*				We did not find published evidence of RE impact and AI-based RE role on this target.	

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	women and men, including for young people and persons with disabilities, and equal pay for work of equal value					
8.6	By 2020, substantially reduce the proportion of youth not in employment, education or training				As proved in (8.3), the RE has high positive impacts towards achieving this target. The employment patterns in RE manufacturing and distribution of RE are similar to those in other capital investment goods industries (1). Based on (2, 3, 4), with the emergence of RE, thousands of cooperation, institutes and infrastructure have been established around the world for teaching and training to achieve 100% clean energy in the future.	(1) Ram, Manish, Arman Aghahosseini, and Christian Breyer. "Job creation during the global energy transition towards 100% renewable power system by 2050." Technological Forecasting and Social Change 151 (2020): 119682. (1) Chandel, S. S., Shrivastva, R., Sharma, V., & Ramasamy, P. (2016). Overview of the initiatives in renewable energy sector under the national action plan on climate change in India. Renewable and Sustainable Energy Reviews, 54, 866-873. (3) Lajqi, S., Meha, D., Berisha, X., Đurin, B., & Baić, L. (2017, January). The infrastructure of Renewable Energy Sources for Sustainable Development in Kosovo. In 12th SDEWES Conference Dubrovnik 2017 (p. 445). (4) Bagheri, M., Shirzadi, N., Bazdar, E., & Kennedy, C. A. (2018). Optimal planning of hybrid renewable energy infrastructure for urban sustainability: Green Vancouver. Renewable and sustainable energy reviews, 95, 254-264.
8.7	Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms				We did not find published evidence of RE impact and AI-based RE role on this target.	
8.8	Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment				We did not find published evidence of RE impact and AI-based RE role on this target.	
8.9	By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products				There RE has positive impact on sustainable tourism through establishing stations of RE as some of tourism areas are locates in isolated areas, mountains or Jungles. In addition, it can further develop the tourism infrastructure such as hotels the major tourist centres and isolated settlements via renewable power supply (1,2). Therefore, the contribution on the prosperity of the sustainable tourism will create jobs for the local people (1).	(1) Mandryk, O. M., Arkhypova, L. M., Pobigun, O. V., & Maniuk, O. R. (2016, August). Renewable energy sources for sustainable tourism in the Carpathian region. In IOP Publishing. IOP Conf. Series: Materials Science and Engineering (Vol. 144, p. 012007). (2) Petrevska, Biljana, Vlatko Cingoski, and Mimoza Serafimova. "Sustainable tourism and hotel management in Macedonia through the

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
						use of renewable energy sources." UTMS Journal of Economics 7.1 (2016): 123-132.
8.10	Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all				We did not find published evidence of RE impact and AI-based RE role on this target.	
8.11	Increase Aid for Trade support for developing countries, in particular least developed countries, including through the Enhanced Integrated Framework for Trade-Related Technical Assistance to Least Developed Countries				We did not find published evidence of RE impact and AI-based RE role on this target.	
8.12	By 2020, develop and operationalize a global strategy for youth employment and implement the Global Jobs Pact of the International Labour Organization				There is weak evidence about the positive impact of RE toward achieving this target. In this regard, the EU attaches increasingly more importance in green employment in a green economy, especially youth sector. The countries with the best results in this regard were Germany and the Nordic countries, these countries are the ones that have made the biggest progress in correlating the employment policies with the environmental ones, aiming thus creating green jobs and recognizing the potential of the green economy as a source of jobs for the unemployed and have developed vocational training courses in green skills. Active labor market policies focusing on employment planning especially in RE sector have proven to be effective in helping young people find jobs (1). As recently the AI and machine learning starts to widely applied to RE in order to increase its productivity and efficiency the youth can be employed especially information technology experts in this sector (2,3). According to the global tracking framework, decentralized renewable energy (DRE) technologies are fast becoming a popular vehicle for rapid delivery of electricity access, yet reports suggest the sector's expansion is hindered by a labor and skills gap. Thus, there is an opportunity for the growth of decentralized renewables to help tackle both universal energy access (SDG 7) alongside expansion of decent work opportunities (SDG 8) (3).	(1) Aceleanu, Mirela Ionela, Andreea Claudia Serban, and Cristina Burghelea. ""Greening" the Youth Employment—A Chance for Sustainable Development." Sustainability 7.3 (2015): 2623-2643. (2) Halaweh, Mohanad. "Artificial intelligence government (Gov. 3.0): The UAE leading model." Journal of Artificial Intelligence Research 62 (2018): 269-272. (3) Shirley, Rebekah, et al. "Powering Jobs: The Employment Footprint of Decentralized Renewable Energy Technologies in Sub Saharan Africa." Journal of Sustainability Research 2.1 (2019).
GOAL 9: Industry, Innovation and Infrastructure.						
9.1	Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being,				There is evidence about the positive impact of RE on this target. Based on (1), the performance of hybrid renewable systems for the economies impacts scale at neighborhood in Vancouver (Canada) has positive effect of the cities infrastructure. This study recommended that the local governments and planners a framework for integrating neighborhood scales' hybrid renewable energy systems in their jurisdictions. The good impact of hybrid contribution led to interest an advance the integration of hybrid renewable energy systems in involved cities. The studies on (2) develops work based on urban RE (eg. solar/wind/biomass/natural gas) systems at neighborhood scale in Canada and	(1) Bagheri, Mehdi, et al. "Optimal planning of hybrid renewable energy infrastructure for urban sustainability: Green Vancouver." Renewable and sustainable energy reviews 95 (2018): 254-264. (2) Bagheri, Mehdi, et al. "City-integrated renewable energy design for low-carbon and climate-resilient communities." Applied energy 239 (2019): 1212-1225. (3) Kwasinski, Andres, and Alexis Kwasinski. "Increasing sustainability and resiliency of cellular network infrastructure by

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	with a focus on affordable and equitable access for all				their results showed cost-benefits related the integrating natural gas with renewable is assed. The system improve the human well-being, with affordable energy system. In addition, Ref (3) focusses on using harvested RE such as solar and wind energy for sustainable areas which led to an increase in cellular network due to fact of RE do not need lifelines in operation. The RE can increase the sustainability and enhance the services and infrastructure (4). RE can lead to urban transformation. It is built on the most successful of past and present urban sustainability trends and emerging infrastructure directions, presenting renewable energy applications as offering new and inevitable approaches to urban infrastructure planning and the design of cities (4).	harvesting renewable energy." IEEE Communications Magazine 53.4 (2015): 110-116. (4) Droege, Peter. "Renewable city: A comprehensive guide to an urban revolution." (2006).
9.2	Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries				Similar to 8.3 and 7.5.	
9.3	Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets				There is a strong evidence about the ability of RE in achieving this target as proved by (1,2,3). The RE options could significantly improve the performance of rural small- and micro-enterprises. Ref (2, 3) mentioned the using of solar energy emerges in market for rural house, biogas and hydro power for rural entrepreneurship and government programs. This led to greater attention financing involving small-scale market facilitation organizations, private power developer and donor assistance.	(1) Pfeiffer, Birte, and Peter Mulder. "Explaining the diffusion of renewable energy technology in developing countries." Energy Economics 40 (2013): 285-296. (2) Karekezi, Stephen, and Waeni Kithyoma. "Renewable energy strategies for rural Africa: is a PV-led renewable energy strategy the right approach for providing modern energy to the rural poor of sub-Saharan Africa?." Energy policy 30.11-12 (2002): 1071-1086. (2) Martinot, Eric, et al. "Renewable energy markets in developing countries." *Annual review of energy and the environment* 27.1 (2002): 309-348.
9.4	By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities				In the literature, there are various studies proved that the RE can act as an enabler for this target. In addition, the AI using in RE has strong effect toward achieving this target as well. The research (1) present overview HRES based on unit sizing, optimization, energy management and modelling of hybrid for solar photovoltaic. The outcomes of this review support the target role. The research (2) concluded that the combinations wind-PV can lead to increasing in electricity demand, low overall operating and cost for residential home application, as well as for housing development industry. The research (3) approaches the design in pumped hydro storage (PHS) for supporting hybrid solar-wind system which studies applied in Island in Hong Kong. The study contributes ideal solution for100% energy atomy as well as can enhance power supply reliability. There is a creative approach proposed by (4) using HOMER software. The hybrid designed in Sabah, Malaysia includes both conventional and renewable sources as an aim to optimum the system in other variables for supporting continues operation in off/on grid connections.	(1)Bajpai, Prabodh, and Vaishalee Dash. "Hybrid renewable energy systems for power generation in stand-alone applications: A review." *Renewable and Sustainable Energy Reviews* 16.5 (2012): 2926-2939. (2) Wang, Xiaonan, Ahmet Palazoglu, and Nael H. El-Farra. "Operational optimization and demand response of hybrid renewable energy systems." *Applied Energy* 143 (2015): 324-335. (3) Ma, Tao, et al. "Technical feasibility study on a standalone hybrid solar-wind system with pumped hydro storage for a remote island in Hong Kong." *Renewable energy* 69 (2014): 7-15. (4) Halabi, Laith M., and Saad Mekhilef. "Flexible hybrid renewable energy system design for a typical remote village located in tropical climate." *Journal of cleaner production* 177 (2018): 908-924.

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9.5	Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending				The RE can be act as enabler for this target. For instance, The research (1) proposed Electric Vehicle Charging Station (EVCS) based combination solar and biogas using HOMER Prod software in which promotes commercial efficiency and enhance air quality in Bangladesh, as well as increases the socio-economic standard of EV owner, at the same time can increase the workers in this industry. An investigation (2) done for promoting deployment for RE resources in Gujarat, India as can be used for government, policymakers, utilities, stakeholders and researchers to develop country. The research confirmed that the dependence on AI will increase the efficiency of sustainable source. The research (3) concluded that the existing RE technologies in the Nigeria for driving technological innovation (AI) and generate employment for effective energy development in the country. The implementation of an off-grid hybrid RE system in Sri Lanka for 10 years and the grid-connected operation for next years can increase the demand of development worker in this industry (4).	(1) Karmaker, Ashish Kumar, et al. "Feasibility assessment & design of hybrid renewable energy based electric vehicle charging station in Bangladesh." *Sustainable cities and society* 39 (2018): 189-202. (2) Elavarasan, Rajvikram Madurai, et al. "A State-of-the-Art review on the drive of renewables in Gujarat, State of India: Present situation, barriers and future initiatives." *Energies* 13.1 (2020): 40. (3) Mohammed, Y. S., et al. "Existing and recommended renewable and sustainable energy development in Nigeria based on autonomous energy and microgrid technologies." *Renewable and Sustainable Energy Reviews* 75 (2017): 820-838. (4) Kolhe, Mohan L., KM Iromi Udumbara Ranaweera, and AGB Sisara Gunawardana. "Techno-economic sizing of off-grid hybrid renewable energy system for rural electrification in Sri Lanka." *Sustainable Energy Technologies and Assessments* 11 (2015): 53-64.
9.6	Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States 18				There are recently finical support from organizations and governments to support sustainable and resilient infrastructure development for RE in developing countries which may partially contribute toward achieving this target. In this regard, developing countries such as Azerbaijan, Uganda and others have been witnessed sustainable and resilient infrastructure development. Ref (1) reported the success of hybrid-solar-diesel mini grid in Namibia, Africa due to involvement of the people and support from the government resulted to the interested business, long term sustainability of the systems and others. Ref (2) reviewed Azerbaijan government has adopted regulations to enhance attractiveness of RE in market include estimation development technology in RE with high price, adopted with strategic Road Map and natural gas exportation to world markets (AI has a great role). This is lead to Azerbaijan involved a huge energy project Southern Gas Corridor, in which able provide maximum 18 bcm of gas in the future. This is interesting as other countries from Central Asia and Middle East involve to this same project. But, Azerbaijan still remains only country that supply gas to Europe. Uganda is a landlocked country. This research (3) concerns to replace fossil fuels with renewable energy in Uganda and proposed the Ugandan government to deal with ongoing project in long-term (economic, environmental and social) for energy future in 2030.	(1) Azimoh, Chukwuma Leonard, et al. "Replicability and scalability of mini-grid solution to rural electrification programs in sub-Saharan Africa." Renewable Energy 106 (2017): 222-231. (2) Vidadili, Nurtaj, et al. "Transition to renewable energy and sustainable energy development in Azerbaijan." Renewable and Sustainable Energy Reviews 80 (2017): 1153-1161 (3) Fashina, Adebayo, et al. "The drivers and barriers of renewable energy applications and development in Uganda: a review." Clean Technologies 1.1 (2019): 9-39.
9.7	Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities				We did not find published evidence of RE impact and AI-based RE role on this target.	
9.8	Significantly increase access to information and				We did not find published evidence of RE impact and AI-based RE role on this target.	

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020					
	GOAL 10: Reduced Inequality.					
10.1	By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average				We did not find published evidence of RE impact and AI-based RE role on this target.	
10.2	By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status				There are some weak evidences to achieve goal for exploring relationship between political power and RE (1). The authors in (1) mentioned the energy transition related dominant system of energy power includes: exploring relationships between RE and political power, assessing tension with an energy democracy agenda and analysis implication for RE development. This will offer the outcomes in democratic practice: components, stages and end use, sharpening positions and market ideology, unlimited growth of ideology, and the modernist/industrialist agenda. While RE projects have the potential for broad and farreaching benefits, they are found to be more effective (e.g., in relation to improved technology adoption) when gender equality is taken into account (2). However, the need for stable and long-lasting local social structures supporting the implementation and/or on-going operation of the RE power systems must found to be a key element for project survival in Central America (3)	(1) Burke, Matthew J., and Jennie C. Stephens. "Political power and renewable energy futures: A critical review." *Energy Research & Social Science* 35 (2018): 78-93. (2) Nelson, S., & Kuriakose, A. T. (2017). Gender and renewable energy: Entry points for women's livelihoods and employment. Climate Investment Funds.. (3) Madriz-Vargas, Rolando, Anna Bruce, and Muriel Watt. "The future of Community Renewable Energy for electricity access in rural Central America." *Energy research & social science* 35 (2018): 118-131.
10.3	Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and action in this regard				We did not find published evidence of RE impact and AI-based RE role on this target.	
10.4	Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality				There is evidence in the literature showing that RE may be an enabler for this target. The RE can encourage the financial, fiscal, legislative, political, technological and environmental policy-maker in order to make it a reference and a guideline for other energy policies studies (1).	(1) Abdmouleh, Zeineb, Rashid AM Alammari, and Adel Gastli. "Review of policies encouraging renewable energy integration & best practices." *Renewable and Sustainable Energy Reviews* 45 (2015): 249-262.
10.5	Improve the regulation and monitoring of global financial markets and institutions and strengthen				RE may be, according to the literature, an enabler for this target for instance through employs hybrid policies related to Contracts for Difference and Capacity Market (CFD & CM) to address environmental and energy challenges through RE in a low-carbon economy. The policy combines and improves on	(1) Onifade, Temitope Tunbi. "Hybrid renewable energy support policy in the power sector: The contracts for difference and capacity market case study." *Energy Policy* 95 (2016): 390-401.

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	the implementation of such regulations				the elements of feed-in tariff (FIT) and quota obligation (QO) as well as creating a predictable and stable market (1).	
10.6	Ensure enhanced representation and voice for developing countries in decision-making in global international economic and financial institutions in order to deliver more effective, credible, accountable and legitimate institutions				We did not find published evidence of RE impact and AI-based RE role on this target.	
10.7	Facilitate orderly, safe, regular and responsible migration and mobility of people, including through the implementation of planned and well-managed migration policies				We did not find published evidence of RE impact and AI-based RE role on this target.	
10.8	Implement the principle of special and differential treatment for developing countries, in particular least developed countries, in accordance with World Trade Organization agreements				We did not find published evidence of RE impact and AI-based RE role on this target.	
10.9	Encourage official development assistance and financial flows, including foreign direct investment, to States where the need is greatest, in particular least developed countries, African countries, small island developing States and landlocked developing countries, in accordance with their national plans and programmes				We did not find published evidence of RE impact and AI-based RE role on this target.	
10.10	By 2030, reduce to less than 3 per cent the transaction costs of migrant remittances and				We did not find published evidence of RE impact and AI-based RE role on this target.	

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	eliminate remittance corridors with costs higher than 5 per cent					
	GOAL 11: Sustainable Cities and Communities.					
11.1	By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums				Based on the literature, a number of potential positive impacts of RE are expected, including the ensuring of affordable energy and basic services (1). Furthermore, integrating biomass overcomes local municipal solid waste (MSW) disposal issue and at same time provide electricity to the community which in turn will improve the basic services (2). As result, developing of domestic biowaste in hybrid renewable energy system (HRES) for a housing estate which offering stable community-based electricity generation and reduce in disposal costs of local solid waste. The AI based RE can be used for enhancing the waste collection and used it as biomass fuel with intelligent transformation, conversion, and production (4). However, due to the capital cost of RE, its dependency on weather conditions, and bad effect of biomass smoke may will lead RE to be inhibitor toward achieving this goal (2,4).	(1) Sovacool, B. K. (2013). Expanding renewable energy access with pro-poor public private partnerships in the developing world. Energy Strategy Reviews, 1(3), 181-192. (2) Tiwary, Abhishek, Stanislava Spasova, and Ian D. Williams. "A community-scale hybrid energy system integrating biomass for localised solid waste and renewable energy solution: Evaluations in UK and Bulgaria." *Renewable energy* 139 (2019): 960-967. (3) Holmes, Tracey, Brian Baker, and Lewis Shoemaker. "Materials for service in municipal waste-& biomass-fired power generation:a review of recent experience." NACE International Corrosion Conference Proceedings. NACE International, 2016. (4) Situmorang, Y. A., Zhao, Z., Yoshida, A., Abudula, A., & Guan, G. (2020). Small-scale biomass gasification systems for power generation (< 200 kW class): A review. Renewable and Sustainable Energy Reviews, 117, 109486.
11.2	By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons				According to the literature, RE may act as an enabler for this target in a number of areas: development of electric vehicle, electric bus, RE used for charging and discharging of electric bus/vehicle, and development of smart cities with better infrastructure and using renewable resources (1). PV system also used for traffic lights with smart system (AI) (2). The study conducted in (3) support the goal by approaching the power-to-fuel (PTF) in transport sector for an increasing engine efficiency, as well as improve road safety. The research conducted in (4) proposed Smart Energy Systems which is 100% RE in electric vehicles and the system was fuel efficient and cost-effective.	(1) Shaukat, N., Khan, B., Ali, S. M., Mehmood, C. A., Khan, J., Farid, U., ... & Ullah, Z. (2018). A survey on electric vehicle transportation within smart grid system. Renewable and Sustainable Energy Reviews, 81, 1329-1349. (2) Manikandan, P., et al. "Role of Solar Powered Automatic Traffic Light Controller for Energy Conservation." International Research Journal of Engineering and Technology (IRJET) 5.12 (2018): 989-992. (3) Schemme, Steffen, et al. "Power-to-fuel as a key to sustainable transport systems–An analysis of diesel fuels produced from CO2 and renewable electricity." *Fuel* 205 (2017): 198-221. (4) Mathiesen, Brian Vad, et al. "Smart Energy Systems for coherent 100% renewable energy and transport solutions." *Applied Energy* 145 (2015): 139-154.
11.3	By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries				We did not find published evidence of RE impact and AI-based RE role on this target.	
11.4	Strengthen efforts to protect and safeguard the world's cultural and natural heritage				We did not find published evidence of RE impact and AI-based RE role on this target.	
11.5	By 2030, significantly reduce the number of				The RE will contribute toward achieving this target because it will reduce the climate change effect which considered as one of the death causes. According	(1) World Health Organization (WHO), Climate change and health.

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations				to the world health organization (WHO), between 2030 and 2050, climate change is expected to cause approximately 250000 additional deaths per year, from malnutrition, malaria, diarrhea and heat stress (1). As climate change cause thousands of deaths. Hence this goal supported by (2) and (3) (based on Iran country) that deployment of renewable energy technologies needed for decreasing in climate change, hence reduce the percentage of death. There are also some advantages creating employment for people in better health. To reduce GHG, many optimization methods have been used for RE based electricity and shown high reduction especially in biomass case (5). Moreover, As described in 8.1 & 8.3, the RE will definitely enhance the direct economic losses relative to global gross domestic product which will contribute toward achieving this target.	https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health (2) Heidari, Negin, and Joshua M. Pearce. "A review of greenhouse gas emission liabilities as the value of renewable energy for mitigating lawsuits for climate change related damages." *Renewable and sustainable energy reviews* 55 (2016): 899-908. (3)Afsharzade, Nashmil, et al. "Renewable energy development in rural areas of Iran." *Renewable and Sustainable Energy Reviews* 65 (2016): 743-755. (4)Aviso, K. B., et al. "Fuzzy optimization of carbon management networks based on direct and indirect biomass co-firing." Renewable and Sustainable Energy Reviews 132 (2020): 110035. (5) Murty, Vallem Veera Venkata Satya Narayana, and Ashwani Kumar. "Optimal DG integration and network reconfiguration in microgrid system with realistic time varying load model using hybrid optimisation." IET Smart Grid 2.2 (2019): 192-202.
11.6	By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management				There is evidence that the RE has positive impact toward achieving this target, due to the RE ability to reduce the environmental impact in general and the increase of the use of RE per capita reduce CO_2 emission per capita. Moreover, the use of RE in general, such as wind affect in decreasing CO_2 emission per capita (1). Climate change from CO_2 can risk to human activities and life which cause air pollution and extreme weather conditions that seriously threatened human health (1). The goals strongly achieved by ref (2) that showing RE reveal China's provincial air quality pollution by helping control NOx and PM10 emissions. This also supported by Ref (3) that confirmed the important role of RE can lower CO_2 reduction. The AI has high effect to reduce the CO_2 in MG-based RE or virtual power plant such as the using of backtracking search algorithm and particle swarm optimization of Microgrid consist of RE sources which reduced the emissions by 8.1% and 8.4, respectively (4,5).	(1) Nachrowi, N. D. (2012). The Impact of Renewable Energy and GDP Per Capita on Carbon Dioxide Emission in the G-20 Countries. Economics and Finance in Indonesia, 60, 145-174. (2) Zhu, Yongfeng, et al. "Does renewable energy technological innovation control China's air pollution? A spatial analysis." *Journal of Cleaner Production* 250 (2020): 119515. (3) Lin, Boqiang, and Junpeng Zhu. "The role of renewable energy technological innovation on climate change: empirical evidence from China." *Science of the Total Environment* 659 (2019): 1505-1512. (4) Hannan, M. A., et al. "Binary particle swarm optimization for scheduling MG integrated virtual power plant toward energy saving." IEEE Access 7 (2019): 107937-107951. (5) Abdolrasol, Maher GM, et al. "An optimal scheduling controller for virtual power plant and microgrid integration using the binary backtracking search algorithm." IEEE Transactions on Industry Applications 54.3 (2018): 2834-2844.
11.7	By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities				We did not find published evidence of RE impact and AI-based RE role on this target.	
11.8	Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning				The literature reflects a positive impact of RE on this particular goal such as study conducted by (1) concluded that the RE source will be the best option for minimizing pollution, increasing economy, energy security, and job opportunities; also, poverty will be reduced because mostly poor people rely on the natural resources. The using of RE has shown its ability to link the rural areas resident and city dwellers more than before using the RE (2). In addition, the RE has improved the technical, economic, and socioeconomic aspects for rural development in resource-poor population-rich developing countries (3). the RE can achieve energy security and energy access for social and economic development in the urban and rural areas (in sub-Saharan	(1) Kumar, M. (2020). Social, Economic, and Environmental Impacts of Renewable Energy Resources. In Wind Solar Hybrid Renewable Energy System. IntechOpen. (2) Benedek, J., Sebestyén, T. T., & Bartók, B. (2018). Evaluation of renewable energy sources in peripheral areas and renewable energy-based rural development. Renewable and Sustainable Energy Reviews, 90, 516-535. (3) Ramakumar, R., and William L. Hughes. "Renewable energy sources and rural development in developing countries." IEEE Transactions on Education 24.3 (1981): 242-251.

Targets No.	GOAL AND ITS TARGET IN THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT	*Is there published evidence for RE Utilization and AI-based RE as an enabler or an inhibitor for the Target?*			REASONING	REFERENCES FOUND
		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
					Africa and South Asian region), as discussed in (4). It was supported by Ref (5) as well, whose reveal that RE can decreases CO_2 emission in urbanization across China regions. Hence, it leads to the increase in economic growth and can cause higher level of social development. The AI contribute in developing the planning, design, and implementation of RE to support the positive the link between urban, peri-urban and rural areas in term of economic, social and environmental (6). AI-based RE has an evident potential, but only if utilized responsibly-to provide a positive change in our cities, societies, and businesses by promoting a more efficient, effective and sustainable transition/transformation (6). However, RE may has minor effect on this target due its known uncertainty (7).	(4) Owusu, Phebe Asantewaa, and Samuel Asumadu-Sarkodie. "A review of renewable energy sources, sustainability issues and climate change mitigation." *Cogent Engineering* 3.1 (2016): 1167990. (5) Wang, Qiang, Yue-E. Zeng, and Bo-wei Wu. "Exploring the relationship between urbanization, energy consumption, and CO2 emissions in different provinces of China." *Renewable and sustainable energy reviews* 54 (2016): 1563-1579. (6) Yigitcanlar, Tan, et al. "Contributions and risks of artificial intelligence (AI) in building smarter cities: Insights from a systematic review of the literature." Energies 13.6 (2020): 1473. (7) Zakaria, A., et al. "Uncertainty models for stochastic optimization in renewable energy applications." Renewable Energy 145 (2020): 1543-1571.
11.9	By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels				We did not find published evidence of RE impact and AI-based RE role on this target.	There is evidence about the role of RE toward achieving this target. For instance, some organization/countries started to support the developing countries to use the RE which in turn will contribute in climate mitigation. For instance, UN development program (UNDP) has funded many renewable project in developing countries such as Afghanistan, Chile, Dominican Republic, Ghana, Guatemala, Iraq and Yemen (1). As an example, UNDP funded about 30 projects of PV solar power stations in Yemen (2). These projects already saved the CO approximately USD $73,000 per year and 149 tons of carbon dioxide emissions per year.
11.10	Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials				There are many examples in the literature where RE projects have been supported by many governments, international organization, and UN development program (UNDP) for least developed countries in Africa and Asia towards sustainable building/cites (1,2). There is an evidence from ref (2) that showed technical advance of RE had applied for solar installation for total land area of India, hence resultant increase in power density of photovoltaic and led to the high demand of energy and building sector. The high demand for global energy also increased for space and domestic water heating especially for solar technical interest area. The ref (2) showed Hybrid RE system (HRES) has been widely utilized on building for stability of the energy supply. For an example Residential building complexes, HOMER was used in the study of residential applications of PV systems in China, Queensland and Ireland. PV hybrid system of an off-grid house in Jordan, residential building in Dhahran and so on. The integration of RE technologies and building renovation are the two main procedures for improving energy sustainability of buildings at neighborhood scale, as introduced in (5)	(1) United Nations Development Program, UNDP Energy Projects. (2) United.Nations. United Nations Development Programme (UNDP), Greening the blue (3) Kammen, Daniel M., and Deborah A. Sunter. "City-integrated renewable energy for urban sustainability." *Science* 352.6288 (2016): 922-928. (4) Ma, Weiwu, Xinpei Xue, and Gang Liu. "Techno-economic evaluation for hybrid renewable energy system: Application and merits." *Energy* 159 (2018): 385-409. (5) Le Guen, M., Mosca, L., Perera, A. T. D., Coccolo, S., Mohajeri, N., & Scartezzini, J. L. (2018). Improving the energy sustainability of a Swiss village through building renovation and renewable energy integration. Energy and Buildings, 158, 906-923.
GOAL 12: Responsible Consumption and Production.						

Targets No.	GOAL AND ITS TARGET IN THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT	*Is there published evidence for RE Utilization and AI-based RE as an enabler or an inhibitor for the Target?*			REASONING	REFERENCES FOUND
		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
12.1	Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries				We did not find published evidence of RE impact and AI-based RE role on this target.	
12.2	By 2030, achieve the sustainable management and efficient use of natural resources				Evidence in the literature suggests that this target could be supported by RE, if systematic transition to RE power sector are supplemented policy and financial support. Up to date, the utilization of RE in power sector which reached recently to 28% is an evidence of the efficient use of natural resources (1). Moreover, the using of AI and machine learning has high positive impact to manage the RE sustainability such as prediction, scheduling, cost reduction, emission reduction, efficient energy management, etc (2,3,4,5). The report conducted in (6) recognized some countries had achieving sustainable development for providing and maintain energy in short-, medium-, and long-term economic development of the country. The related companies such as China provided total RE more than 20% of the country's electricity generation, European Union provided 72%, United States is 12.2% and India is about 17%. Turkey had achieved sustainable energy development by increasing indigenous RE as much as possible. Hence, Turkey has an obvious target for RE power capacity generation including wind, solar and geothermal. There are reports also for national and global strategic involving by many countries related to sustainable economic market growth supported by RE investments (5,7).	(1) International Energy Agency, Renewables – Global Energy Review 2020 Analysis (2020). (2) Banos, Raul, et al. "Optimization methods applied to renewable and sustainable energy: A review." Renewable and sustainable energy reviews 15.4 (2011): 1753-1766. (3) Zakaria, A., Ismail, F. B., Lipu, M. H., & Hannan, M. A. (2020). Uncertainty models for stochastic optimization in renewable energy applications. Renewable Energy, 145, 1543-1571. (4) Muis, Zarina A., et al. "Optimal planning of renewable energy-integrated electricity generation schemes with CO2 reduction target." Renewable energy 35.11 (2010): 2562-2570. (5) Olatomiwa, L., Mekhilef, S., Ismail, M. S., & Moghavvemi, M. (2016). Energy management strategies in hybrid renewable energy systems: A review. Renewable and Sustainable Energy Reviews, 62, 821-835. (6) Elum, ZA and, and A. S. Momodu. "Climate change mitigation and renewable energy for sustainable development in Nigeria: A discourse approach." *Renewable and Sustainable Energy Reviews* 76 (2017): 72-80. (7) Simsek, Hayal Ayca, and Nevzat Simsek. "Recent incentives for renewable energy in Turkey." *Energy Policy* 63 (2013): 521-530.
12.3	By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses				We did not find published evidence of RE impact and AI-based RE role on this target.	
12.4	By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce				The RE utilization may positively affect the achievement of this target. In this regard, the study conducted in (1) supported the goal which addressed the material recovery from waste management composting (bio-waste) and incineration (residual waste). The waste treatment processes such as anaerobic digestion to produce biogas and electric energy can reduce the waste impact and produce electricity either via biogas or biomass. The anaerobic digestion the energy is produced by a renewable source. Hence, avoiding the production of energy from conventional sources.	(1) Cremiato, Raffaele, et al. "Environmental impact of municipal solid waste management using Life Cycle Assessment: The effect of anaerobic digestion, materials recovery and secondary fuels production." *Renewable Energy* 124 (2018): 180-188. (2) Arena, Umberto, Filomena Ardolino, and Fabrizio Di Gregorio. "A life cycle assessment of environmental performances of two combustion-and gasification-based waste-to-energy technologies." *Waste management* 41 (2015): 60-74.

Targets No.	GOAL AND ITS TARGET IN THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT	*Is there published evidence for RE Utilization and AI-based RE as an enabler or an inhibitor for the Target?*			REASONING	REFERENCES FOUND
		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	their release to air, water and soil in order to minimize their adverse impacts on human health and the environment				The report (2) focused on attributional life cycle of gasification Waste to energy (WtE) can utilize of renewable biomass coke: which strongly reduce the "Global Warming" impact and amount of residues in landfill. These (1) and (2) report help to mitigate the burdens release of air, water and soil that impacts on human health and the environment. However, the marine renewable energy could have negative environmental impacts, resulting from habitat loss, collision risks, noise and electromagnetic fields of the RE devices (3). Regarding the using of AI, some studies concluded that the using of AI can be enabler for this target, because the optimization of WtE technologies for treatment of different waste fractions in a medium term future energy system taking into account their dynamic properties and optimizing both production and investments. It recommended that to incinerate mixed waste primarily in dedicated waste incineration plants producing CHP at high efficiencies (4). Therefore, routes which include waste components (i.e food and yard wastes, non-biodegradable components, plastic, rubber, leather, textile and wood r) are the optimized WtE routes for maximum power generation potential by biochemical and thermochemical treatments of MSW (5).	(3) Shields, Mark A., et al. "Marine renewable energy: The ecological implications of altering the hydrodynamics of the marine environment." Ocean & coastal management 54.1 (2011): 2-9. (4) Münster, M., & Meibom, P. (2011). Optimization of use of waste in the future energy system. Energy, 36(3), 1612-1622. (5) Korai, M. S., Mahar, R. B., & Uqaili, M. A. (2016). Optimization of waste to energy routes through biochemical and thermochemical treatment options of municipal solid waste in Hyderabad, Pakistan. Energy Conversion and Management, 124, 333-343.
12.5	By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse				The RE has high impact toward achieving this target. For instance, the study conducted in Makkah to convert waste into RE concluded that: (A) Total revenue of 758 million SAR can be achieved from waste biorefinery, (B) 1.95 million barrels of oil and 11.2 million MCF of natural gas can be saved, and (C) Reduction in global warming potential of 1.15 million Mt.CO2 eq. can be achieved (1). The article (2) proved that the biomass energy production project in Jordon for power/heat generation and biogas production increased the sustainability and recycling. The biomass based RE share to the energy mix in which resources come from agricultural residues, animal manure and municipal solid waste. The article (3) is also shown that RE recovery which biogas production from disposal waste is by using WTE-T has high impact on waste recycling. The paper (4) concluded that the policies on RE followed by the emphasis on solid waste management policies towards effective implementation of biogas in Malaysia generation from municipal solid waste encouraged the sustainability and recycling. The biomass projects lead to reduce of energy consumption, reduction of environmental impact and support for private households to produce their own RE (1,4). Regarding the role of AI, it is similar to 12.4.	(1) Nizami, A. S., et al. "Developing waste biorefinery in Makkah: a way forward to convert urban waste into renewable energy." Applied Energy 186 (2017): 189-196. (2) Al-Hamamre, Zayed, et al. "Wastes and biomass materials as sustainable-renewable energy resources for Jordan." *Renewable and Sustainable Energy Reviews* 67 (2017): 295-314. (3) Moya, Diego, et al. "Municipal solid waste as a valuable renewable energy resource: a worldwide opportunity of energy recovery by using Waste-To-Energy Technologies." *Energy Procedia* 134 (2017): 286-295. (4) Bong, Cassendra Phun Chien, et al. "Review on the renewable energy and solid waste management policies towards biogas development in Malaysia." *Renewable and Sustainable Energy Reviews* 70 (2017): 988-998.
12.6	Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle				We did not find published evidence of RE impact and AI-based RE role on this target.	
12.7	Promote public procurement practices that are sustainable, in				We did not find published evidence of RE impact and AI-based RE role on this target.	

Targets No.	GOAL AND ITS TARGET IN THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT	*Is there published evidence for RE Utilization and AI-based RE as an enabler or an inhibitor for the Target?*			REASONING	REFERENCES FOUND
		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	accordance with national policies and priorities					
12.8	By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature				We did not find published evidence of RE impact and AI-based RE role on this target.	
12.9	Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production				There are a few evidence of the RE indirect role toward achieving this target. For instance, article (1) agreed with this relevant goals. The study suggested measures and policy recommendation to support develop country towards the accessibility of RE and avoid change mitigation. Many organizations and developed countries started to support the developing countries via the training, scientists, share their plans and policies of RE to help and encourage RE sectors (2,3).	(1) Owusu, Phebe Asantewaa, and Samuel Asumadu-Sarkodie. "A review of renewable energy sources, sustainability issues and climate change mitigation." *Cogent Engineering* 3.1 (2016): 1167990. (2) Kristoferson, L. A., & Bokalders, V. (2013). Renewable energy technologies: their applications in developing countries. Elsevier. (3) Khan, K. A., & Reza, S. Z. (2019). The Situation of Renewable Energy Policy and Planning in Developing Countries. IJARIIE, 5(4), 557-565.
12.10	Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products				Similar to 8.9. Moreover, the study introduced in (1) mentioned that the use of RE in sustainable tourism development such as wind power station, solar electricity technologies and small hydroelectric power stations in the Carpathian can provide more investment and increase tourist development. Article (2) showed that The Green Tourism Association of Taiwan as green tourism in which minimize the environmental impacts, reduce on carbon emission and as enjoying in ecology-humanity-culture integrity. All references (1-2) supporting the goals. A successful tourism can create and increase green jobs and also provide another source of income to develop countries by promoting local culture and products. The optimization of RE source in tourism areas especially energy management of lighting for hotels and tourism locations which depend completely in RE (i.e mountains, deserts, and rural areas) would play indirect role as proved in (3).	(1) Mandryk, O. M., et al. "Renewable energy sources for sustainable tourism in the Carpathian region." *IOP Publishing. IOP Conf. Series: Materials Science and Engineering*. Vol. 144. 2016. (2) Pan, Shu-Yuan, et al. "Advances and challenges in sustainable tourism toward a green economy." *Science of the Total Environment* 635 (2018): 452-469. (3) Dalton, G. J., Lockington, D. A., & Baldock, T. E. (2008). Feasibility analysis of stand-alone renewable energy supply options for a large hotel. Renewable energy, 33(7), 1475-1490.
12.11	Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse				There is strong relation between the increasing of RE use, improvement and optimization (using AI) of its efficiency and production toward achieving this target. Moreover, the gradual decreasing of RE prices and exempt RE from Taxes will reduce fossil-fuel subsidies (1, 2, 3,4). The study conducted in (5) describeed to phase out fossil fuel subsidies by adding the policies that required to stimulate the RE substitution and adequate R&d funding to the technologies.	(1) Ellabban, Omar, Haitham Abu-Rub, and Frede Blaabjerg. "Renewable energy resources: Current status, future prospects and their enabling technology." Renewable and Sustainable Energy Reviews 39 (2014): 748-764. (2) Jha, Sunil Kr, et al. "Renewable energy: Present research and future scope of Artificial Intelligence." Renewable and Sustainable Energy Reviews 77 (2017): 297-317. (3) Østergaard, P. A., Duic, N., Noorollahi, Y., Mikulcic, H., & Kalogirou, S. (2020). Sustainable development using renewable energy technology. (4) Rahbar, Katayoun, Chin Choy Chai, and Rui Zhang. "Energy cooperation optimization in microgrids with renewable energy integration." IEEE Transactions on Smart Grid 9.2 (2016): 1482-1493. (5) Li, Jianglong, and Chuanwang Sun. "Towards a low carbon economy by removing fossil fuel subsidies?." *China Economic Review* 50 (2018): 17-33.

Targets No.	GOAL AND ITS TARGET IN THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT	*Is there published evidence for RE Utilization and AI-based RE as an enabler or an inhibitor for the Target?*			REASONING	REFERENCES FOUND
		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	impacts on their development in a manner that protects the poor and the affected communities					
					GOAL 13: Climate Action.	
13.1	Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries				There are many evidence which prove that RE will play the main role to reduce the climate change. In this regard, RE is one of the most effective tools we have in the fight against climate change, and there is every reason to believe it will succeed (1). This is because, replacing fossil fuels as an energy source with green power is the most important action we can take to address the impacts of climate change on health and to reduce pollutants that can lead to disease (2). RE usually tops the list of changes the world can implement to stave off the worst effects of rising temperatures. That's because renewable energy sources such as solar and wind don't emit carbon dioxide (CO_2) and other greenhouse gases that contribute to global warming (3). The study has been conducted about the ability of RE to reduce CO_2 emission concluded that increasing the share of renewable energy consumption has positive effects on CO_2 reduction (4). However, other RE sources such as biomass can be inhibiter for this target because wood or other residuals smoke contains harmful pollutants such as carbon monoxide (5). With respect to the impact of using AI in RE utilization toward achieving this target, there is published evidence that AI will enable to reduce the CO_2 emissions using backtracking search algorithm and particle swarm optimization of Microgrid consist of RE sources by 8.1% and 8.4, respectively (6,7,8).	(1) Solaun, Kepa, and Emilio Cerdá. "Climate change impacts on renewable energy generation. A review of quantitative projections." Renewable and sustainable energy Reviews 116 (2019): 109415. (2) Alvarez-Herranz, A., Balsalobre-Lorente, D., Shahbaz, M., & Cantos, J. M. (2017). Energy innovation and renewable energy consumption in the correction of air pollution levels. Energy Policy, 105, 386-397. (3) Rahman, Farahiyah Abdul, et al. "Pollution to solution: Capture and sequestration of carbon dioxide (CO_2) and its utilization as a renewable energy source for a sustainable future." Renewable and Sustainable Energy Reviews 71 (2017): 112-126. (4) Nathaniel, S. P., & Iheonu, C. O. (2019). Carbon dioxide abatement in Africa: The role of renewable and non-renewable energy consumption. Science of the Total Environment, 679, 337-345. (5) Pino, M., Abarzúa, A. M., Astorga, G., Martel-Cea, A., Cossio-Montecinos, N., Navarro, R. X., ... & Moore, C. R. (2019). Sedimentary record from Patagonia, southern Chile supports cosmic-impact triggering of biomass burning, climate change, and megafaunal extinctions at 12.8 ka. Scientific reports, 9(1), 1-27. (6) Hannan, M. A., et al. "Binary particle swarm optimization for scheduling MG integrated virtual power plant toward energy saving." IEEE Access 7 (2019): 107937-107951. (7) Abdolrasol, Maher GM, et al. "An optimal scheduling controller for virtual power plant and microgrid integration using the binary backtracking search algorithm." IEEE Transactions on Industry Applications 54.3 (2018): 2834-2844. (8) Hannan, Mahammad Abdul, et al. "toward enhanced State of charge estimation of Lithium-ion Batteries Using optimized Machine Learning techniques." Scientific reports 10.1 (2020): 1-15.
13.2	Integrate climate change measures into national policies, strategies and planning				As 7.2 and 7.3. In addition, the RE has a role towards achieving this target as it is the main contributor to replace the energy-based fossil fuel production. In this context, there are many evidence that many countries around the worlds have plane to depend on 100% renewable power generation in the future. For instance, Germany has plan to transmit its energy system to 100% renewable energy in 2050 (1). Other countries also have the same strategic plan to reduce climate change such as Europe plan (1), Japan strategic plane toward 100% RE (3), and Nigeria (4). Regarding the role of the implementation of AI in RE toward achieving this target it is same target 13.1. Further, as for targets 7.2 and 7.3, AI will support low-carbon energy systems with high integration of renewable energy and energy efficiency, which are all needed to address climate change (5-7). However, AI will need significant amount of electricity to work properly. If that electricity will be obtained from non-carbon-free sources, it might have implications on	(1) Hansen, Kenneth, Brian Vad Mathiesen, and Iva Ridjan Skov. "Full energy system transition towards 100% renewable energy in Germany in 2050." Renewable and Sustainable Energy Reviews 102 (2019): 1-13. (2) Child, Michael, Dmitrii Bogdanov, and Christian Breyer. "The role of storage technologies for the transition to a 100% renewable energy system in Europe." Energy Procedia 155 (2018): 44-60. (3) Esteban, Miguel, et al. "100% renewable energy system in Japan: Smoothening and ancillary services." Applied energy 224 (2018): 698-707. (4) Akuru, Udochukwu B., et al. "Towards 100% renewable energy in Nigeria." Renewable and Sustainable Energy Reviews 71 (2017): 943-953.

Targets No.	GOAL AND ITS TARGET IN THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT	*Is there published evidence for RE Utilization and AI-based RE as an enabler or an inhibitor for the Target?*			REASONING	REFERENCES FOUND
		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
					greenhouse gases emissions and the integration of climate change measures into national planning (5).	(5) Tripathi, S., Srinivas, V. V & Nanjundiah, R. S. Downscaling of precipitation for climate change scenarios: A support vector machine approach. Journal of Hydrology 330, 621-640 (2006). (A) (6) International Energy Agency. Digitalization & Energy (2017). (A) (7) World Economic Forum (WEF). Fourth Industrial Revolution for the Earth Series Harnessing Artificial Intelligence for the Earth (2018).
13.3	Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning				We did not find published evidence of RE impact and AI-based RE role on this target.	
13.4	Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible				There is evidence about the role of RE toward achieving this target. For instance, some organization/countries started to support the developing countries to use the RE which in turn will contribute in climate mitigation. For instance, UN development program (UNDP) has funded many renewable project in developing countries such as Afghanistan, Chile, Dominican Republic, Ghana, Guatemala, Iraq and Yemen (1). As an example, UNDP funded about 30 projects of PV solar power stations in Yemen (2). These projects already saved the CO approximately USD $73,000 per year and 149 tons of carbon dioxide emissions per year.	(1) United Nations Development Program, UNDP Energy Projects. (2) United.Nations. United Nations Development Programme (UNDP), Greening the blue -UNDP Yemen |. Available: https://yemen.un.org/en/17377-undp-yemen-greening-blue
13.5	Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities				There is a weak evidence about the ability of RE in achieving this target partially as the using of RE to solve the energy poverty in developing countries and small island developing States will encourage the planning of establishing RE stations which have potential role in the mitigation of greenhouse gas emissions (1,2). AI can play important role in RE optimization toward achieving this target (2, 3).	(1) Kim, Kyeongseok, Hyoungbae Park, and Hyoungkwan Kim. "Real options analysis for renewable energy investment decisions in developing countries." Renewable and Sustainable Energy Reviews 75 (2017): 918-926. (2) Owusu, Phebe Asantewaa, and Samuel Asumadu-Sarkodie. "A review of renewable energy sources, sustainability issues and climate change mitigation." Cogent Engineering 3.1 (2016): 1167990. (3) Harkouss, Fatima, Farouk Fardoun, and Pascal Henry Biwole. "Optimal design of renewable energy solution sets for net zero energy buildings." Energy 179 (2019): 1155-1175.
GOAL 14: Life Below Water.						

Targets No.	GOAL AND ITS TARGET IN THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT	*Is there published evidence for RE Utilization and AI-based RE as an enabler or an inhibitor for the Target?*			REASONING	REFERENCES FOUND
		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
14.1	By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution				Although the RE has positive impact on this target. For instance, the study proposed in (1) supported this goal by reporting the solution to reduce the CO_2 and PM10 emissions by the ships in the port. The ship activity based on berthing and maneuvering. The solution can be figured out by providing electricity to the ship from hybrid RE (combination with wind turbine and PV) which are connected to the grid. Article (2) also showed PV system had been installed on the ships can reduce amount of fuel consumption. The similar report also done by (3) which develop the hybrid PV/diesel/ESS in ship power system as an aimed to reduce fuel cost and the CO_2 emissions. The article (4) addresses the global issue which is related the carbon dioxide (CO_2) emission from fuel combustion or other related sector (industrial or land-use) that can make negative impact to the Ocean. This effect of CO_2 will change the hydrogen ion concentration (pH), and may affect the marine's life. To reduce the marine pollution, It was suggested to use a sustainable method which combining carbon capture and sequestration (CCS) and biofuel (renewable) technology, by using a feedstock which is CO_2. However, the marine RE could have negative environmental impacts, resulting from habitat loss, collision risks, noise and electromagnetic fields of the RE devices (5, 6).	(1) Kotrikla, Anna Maria, Theodoros Lilas, and Nikitas Nikitakos. "Abatement of air pollution at an aegean island port utilizing shore side electricity and renewable energy." *Marine Policy* 75 (2017): 238-248. (2) Diab, Fahd, Hai Lan, and Salwa Ali. "Novel comparison study between the hybrid renewable energy systems on land and on ship." *Renewable and Sustainable Energy Reviews* 63 (2016): 452-463. (3) Lan, Hai, et al. "Optimal sizing of hybrid PV/diesel/battery in ship power system." *Applied energy* 158 (2015): 26-34. (4) Rahman, Farahiyah Abdul, et al. "Pollution to solution: Capture and sequestration of carbon dioxide (CO2) and its utilization as a renewable energy source for a sustainable future." *Renewable and Sustainable Energy Reviews* 71 (2017): 112-126. (5) Inger, Richard, et al. "Marine renewable energy: potential benefits to biodiversity? An urgent call for research." Journal of applied ecology 46.6 (2009): 1145-1153. (6) Shields, Mark A., et al. "Marine renewable energy: The ecological implications of altering the hydrodynamics of the marine environment." Ocean & coastal management 54.1 (2011): 2-9.
14.2	By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans				A potential positive impact on this target as introduced in (1) would be the use of RE to protect, conserve marine's system sustainably marine environment by introducing of Marine renewable energy developments (MRED) together with cumulative effects and cumulative effects assessment (CEA) conduction. The concept of cumulative environmental related to identify, manage and mitigate the continuum of human activities effects regard the health environment. For MREDs, the effect of existing MRED had been aware, such as what is happening for human activities in environment related to disposal at sea, recreational fishing and others. These attributes will provide a reference to protect sea environmental change and achieve productive oceans (1). However, some studies reach to that the marine RE has adverse effect on marine and coastal ecosystems through (A) Actual or potential environmental impact can occur during construction, operation and/or decommissioning of ORED; (B) Construction and decommissioning are likely to cause significant physical disturbance to the local environment. There are both short- and long-term implications for the local biological communities. The significance of any effects is likely to depend on the natural disturbance regime and the stability and resilience of the communities; (C) increased underwater noise and collision risk; and (D) During day-to-day operation, underwater noise, emission of electromagnetic fields and collision or avoidance with the energy structures represent further potential impacts on coastal species, particularly large predators. The wider ecological implications of any direct and indirect effects are discussed (2-6).	(1) Willsteed, Edward, et al. "Assessing the cumulative environmental effects of marine renewable energy developments: Establishing common ground." *Science of the Total Environment* 577 (2017): 19-32. (2) Gill, Andrew B. "Offshore renewable energy: ecological implications of generating electricity in the coastal zone." Journal of Applied Ecology (2005): 605-615. (3) Willsteed, E., Gill, A. B., Birchenough, S. N., & Jude, S. (2017). Assessing the cumulative environmental effects of marine renewable energy developments: Establishing common ground. Science of the Total Environment, 577, 19-32. (4) Gasparatos, A., Doll, C. N., Esteban, M., Ahmed, A., & Olang, T. A. (2017). Renewable energy and biodiversity: Implications for transitioning to a Green Economy. Renewable and Sustainable Energy Reviews, 70, 161-184. (5) Frid, C., Andonegi, E., Depestele, J., Judd, A., Rihan, D., Rogers, S. I., & Kenchington, E. (2012). The environmental interactions of tidal and wave energy generation devices. Environmental Impact Assessment Review, 32(1), 133-139. (6) Bonar, P. A., Bryden, I. G., & Borthwick, A. G. (2015). Social and ecological impacts of marine energy development. Renewable and Sustainable Energy Reviews, 47, 486-495.
14.3	Minimize and address the impacts of ocean acidification, including through enhanced				Ocean acidification may happen due to increase in atmospheric carbon dioxide (CO_2) (1). In this regard, the RE will contribute toward achieving this goal because its ability to reduce the CO_2 emission (1, 2). The article (2) also supports the goal that the maximum effectiveness for reducing acidification (on the marine environment) is RE. The use RE for the fossil fuels	(1) Clements, Jeff C., and Thierry Chopin. "Ocean acidification and marine aquaculture in North America: potential impacts and mitigation strategies." *Reviews in Aquaculture* 9.4 (2017): 326-341.

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	scientific cooperation at all levels				replacement and also eliminate the excess of CO_2 in atmospheric and reduced CO_2 emission. The approach RE must be consistent with the conventional policy (3). This is also supported by (4) that showed the ocean's surface PH for Representative Concentration Pathway strongly mitigates with alternative RE sources. However, some RE produce emission such as biomass as proved in (5) which may act as inhibitor for this target (5). In addition, offshore wind energy and tidal energy may cause a small amount of acidification during the construction, operation and/or decommissioning (6). On other hand, the AI represented by optimization techniques for marine RE can reduce the acidification of oceans and indirectly through the increasing of RE efficiency which in turn reduce the GHG emission (7, 8).	(2) Hu, Hui, et al. "The role of renewable energy consumption and commercial services trade in carbon dioxide reduction: Evidence from 25 developing countries." Applied energy 211 (2018): 1229-1244. (3) Gattuso, Jean-Pierre, et al. "Ocean solutions to address climate change and its effects on marine ecosystems." *Frontiers in Marine Science* 5 (2018): 337. (4) Gattuso, J-P., et al. "Contrasting futures for ocean and society from different anthropogenic CO2 emissions scenarios." *Science* 349.6243 (2015). (4) Anthony, Kenneth RN. "Coral reefs under climate change and ocean acidification: challenges and opportunities for management and policy." *Annual Review of Environment and Resources* 41 (2016): 59-81. (5) Budzianowski, Wojciech M. "Negative carbon intensity of renewable energy technologies involving biomass or carbon dioxide as inputs." Renewable and Sustainable Energy Reviews 16.9 (2012): 6507-6521. (6) Gill, Andrew B. "Offshore renewable energy: ecological implications of generating electricity in the coastal zone." Journal of Applied Ecology (2005): 605-615. (7) Algunaibet, Ibrahim M., et al. "Reply to the 'Comment on "Powering sustainable development within planetary boundaries"'by Y. Yang, Energy Environ. Sci., 2020, 13." Energy & Environmental Science 13.1 (2020): 313-316. (8) Wagh, M. M., and V. V. Kulkarni. "Modeling and optimization of integration of Renewable Energy Resources (RER) for minimum energy cost, minimum CO2 Emissions and sustainable development, in recent years: A review." Materials Today: Proceedings 5.1 (2018): 11-21.
14.4	By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics				There is evidence that the marine RE can effect positively and negatively on this target. For instance, Offshore energy installations also have the positive side effect as they are a sanctuary area for trawled organisms. Higher survival of fish and bigger fish is an expected outcome that can contribute to a spillover to outer areas. One negative side effect is that invasive species can find new habitats in artificial reefs and thus influence the native habitats and their associated environment negatively (1). Despite the fact wind energy is low-polluting, it implies spatial conflicts, and may have wildlife impacts, including fish, marine mammals and birds (2).	(1) Langhamer, O. (2012). Artificial reef effect in relation to offshore renewable energy conversion: state of the art. The Scientific World Journal, 2012. (2) Hagos, Kifle W. "Impact of Offshore Wind Energy on Marine Fisheries in Rhode Island." White Paper in Integrated Coastal Science: RI Department of Environmental Management, Division of Fish and Wildlife (2007).
14.5	By 2020, conserve at least 10 per cent of coastal and marine areas, consistent				We did not find published evidence of RE impact and AI-based RE role on this target.	

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	with national and international law and based on the best available scientific information					
14.6	By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation				We did not find published evidence of RE impact and AI-based RE role on this target.	
14.7	By 2030, increase the economic benefits to Small Island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism				We did not find published evidence of RE impact and AI-based RE role on this target.	
14.8	Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the				There is only weak evidence so far that AI is tackling this specific SDG. Ref (1) discussed the future research regarding the marine renewable energy (MRE) seascape include advanced materials, energy storage and so on. This perspective possible benefits to fulfill the Intergovernmental Oceanographic Commission (IOC) outlined for the development of marine biodiversity in term of health and developing countries. In addition, some countries, standards and researchers have been discussed the regulation in this regard such as European regulation (2) and Colombia (3). Many research have been done in marine RE to improve ocean health and to enhance the contribution of marine biodiversity such as (4,5)	(1) Borthwick, Alistair GL. "Marine renewable energy seascape." Engineering 2.1 (2016): 69-78. (2) Wright, Alyssa. "Regulating Offshore Energy: Europe as a Model for Regulation." North Carolina Journal of International Law 45.4 (2019): 69. (3) Rueda-Bayona, Juan Gabriel, et al. "Renewables energies in Colombia and the opportunity for the offshore wind technology." Journal of Cleaner Production 220 (2019): 529-543. (4) Zvezdov, Ivelin M. "The EU Legal and Regulatory Framework for Measuring Damage Risks to the Biodiversity of the Marine Environment." Environmental Policy: An Economic Perspective (2020): 121-137.

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries					(5) Want, A., Crawford, R., Kakkonen, J., Kiddie, G., Miller, S., Harris, R. E., & Porter, J. S. (2017). Biodiversity characterisation and hydrodynamic consequences of marine fouling communities on marine renewable energy infrastructure in the Orkney Islands Archipelago, Scotland, UK. Biofouling, 33(7), 567-579.
14.9	Provide access for small-scale artisanal fishers to marine resources and markets				We did not find published evidence of RE impact and AI-based RE role on this target.	
14.10	Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in UNCLOS, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of The Future We Want				We did not find published evidence of RE impact and AI-based RE role on this target.	
GOAL 15: Life on Land.						
15.1	By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements				While the higher penetration of renewable energy is currently the backbone of environmental efforts, an emerging body of literature demonstrates that the RE sector can affect ecosystems and biodiversity. This study concluded that RE has bad effect on forests, wetlands, mountains and drylands, the current evidence base is stronger for some pathways (e.g. bioenergy, hydropower) than others (e.g. solar, wind, ocean, geothermal), the fact remains that the large-scale deployment of renewable energy can have some biodiversity tradeoffs (1). The large-scale wind farm and solar energy in some countries take large space which lead to cut the trees (2,3). The installation of wind farms can affect the wildlife (3) Tidal barrages have the potential to cause significant ecological impacts particularly on bird feeding areas when they are constructed at coastal estuaries or bays. Offshore tidal stream energy and wave energy collectors offer the scope for developments at varying scales. They also have the potential to alter habitats. A diversity of designs exist, including floating, mid-water column and seabed mounted devices, with a variety of moving-part configurations resulting in a unique complex of potential environmental effects for each device type (4).	(1) Gasparatos, Alexandros, et al. "Renewable energy and biodiversity: Implications for transitioning to a Green Economy." Renewable and Sustainable Energy Reviews 70 (2017): 161-184. (2) Turney, Damon, and Vasilis Fthenakis. "Environmental impacts from the installation and operation of large-scale solar power plants." Renewable and Sustainable Energy Reviews 15.6 (2011): 3261-3270. (3) Schuster, Eva, Lea Bulling, and Johann Köppel. "Consolidating the state of knowledge: a synoptical review of wind energy's wildlife effects." Environmental management 56.2 (2015): 300-331. (4) Frid, Chris, et al. "The environmental interactions of tidal and wave energy generation devices." Environmental Impact Assessment Review 32.1 (2012): 133-139.
15.2	By 2020, promote the implementation of sustainable management of all types of forests, halt				There is evidence in the literature that the installation of large-scales of RE sources (i.e., solar and wind) may be act as inhibiter towards achieving this target especially that installed in agriculture and forest (1). The large-scale wind farm and solar energy in some countries take large space which lead to	(1) Poggi, Francesca, Ana Firmino, and Miguel Amado. "Planning renewable energy in rural areas: Impacts on occupation and land use." Energy 155 (2018): 630-640.

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	deforestation, restore degraded forests and substantially increase afforestation and reforestation globally				cut the trees (2,3). The installation of wind farms can affect the wildlife (3). In the main time, may be this type of energy may contribute to the prosperity of agricultural areas and wildlife and help in the irrigation system and pumping water from underground wells (4,5). In (6), the author's assumed as the main hypothesis, the possibility of developing a complex and integrated evaluation methodology for renewable energy potential. Accordingly, they employed evaluation methods based on mapping techniques AI, GIS, simulation software for wind farms, and the analytical tools offered by the Geographical Information System. The results showed that the renewable energy potential maps, combined with a multidimensional index expressing the development level of localities, are good predictors of appropriate locations for the development of renewable energy source-based facilities and land protection.	(2) Turney, Damon, and Vasilis Fthenakis. "Environmental impacts from the installation and operation of large-scale solar power plants." Renewable and Sustainable Energy Reviews 15.6 (2011): 3261-3270. (3) Schuster, Eva, Lea Bulling, and Johann Köppel. "Consolidating the state of knowledge: a synoptical review of wind energy's wildlife effects." Environmental management 56.2 (2015): 300-331. (4) Rathore, Pushpendra Kumar Singh, Shyam Sunder Das, and Durg Singh Chauhan. "Perspectives of solar photovoltaic water pumping for irrigation in India." Energy strategy reviews 22 (2018): 385-395. (5) Babatunde, Olubayo Moses, et al. "Harnessing renewable energy for sustainable agricultural applications." International Journal of Energy Economics and Policy 9.5 (2019): 308-315. (6) Benedek, József, Tihamér-Tibor Sebestyén, and Blanka Bartók. "Evaluation of renewable energy sources in peripheral areas and renewable energy-based rural development." Renewable and Sustainable Energy Reviews 90 (2018): 516-535.
15.3	By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world				We did not find published evidence of RE impact and AI-based RE role on this target.	
15.4	By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development				We did not find published evidence of RE impact and AI-based RE role on this target.	
15.5	Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species				We did not find published evidence of RE impact and AI-based RE role on this target.	
15.6	Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate				We did not find published evidence of RE impact and AI-based RE role on this target.	

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	access to such resources, as internationally agreed					
15.7	Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products				We did not find published evidence of RE impact and AI-based RE role on this target.	
15.8	By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species				There is indirect relation between the RE and the achievement of this target as it has the ability to reduce the carbon emission and greenhouses gases (1). Lot of agriculture companies moved toward the RE development especially PV farms to retrieve certain revenue, thanks to legislative and fiscal policies encouraging PV development. Therefore to reduce the bad effect of RE on land and water ecosystems and control or eradicate the priority species a win-win situation is requested (2). In (3), the authors propose a methodology to harmonize energy production, agriculture and the enhancement of ecosystem services, looking for a synergy between different economic activities and stakeholders. Areas occupied by PV system can be used for other purposes, as grazing or cultivation or educational activities. Naturalization activities can give back these spaces to pollinator populations notwithstanding the presence of PV panels, enhancing the pollination ecosystem service without affecting other agricultural areas.	(1) Poggi, Francesca, Ana Firmino, and Miguel Amado. "Planning renewable energy in rural areas: Impacts on occupation and land use." Energy 155 (2018): 630-640. (2) Bukhary, Saria, Sajjad Ahmad, and Jacimaria Batista. "Analyzing land and water requirements for solar deployment in the Southwestern United States." Renewable and Sustainable Energy Reviews 82 (2018): 3288-3305. (3) Semeraro, T., Pomes, A., Del Giudice, C., Negro, D., & Aretano, R. (2018). Planning ground based utility scale solar energy as green infrastructure to enhance ecosystem services. Energy Policy, 117, 218-227.
15.9	By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts				As discussed above (see target 15.1), we found ample evidence that RE is an inhibiter of this target as the current RE pathways are associated (directly or indirectly) with all five Millennium Ecosystem Assessment drivers (i.e. habitat loss/change, pollution, overexploitation, climate change and introduction of invasive species) of ecosystem change and biodiversity loss (1). The study introduced in (2) concluded that some RE technologies have considerable potential to impact on the biodiversity of the environments in which they are placed. In addition, the RE sources have the potential to make important energy contributions but might conflict with biodiversity conservation objectives which included field-scale solar, bioenergy crops, wind energy (both onshore and offshore), wave and tidal stream energy (2). On the other hand, the AI may solve the bad effect of RE toward achieving this target. For instance, numerical Genetic Algorithm (GA) is proposed for wind farming optimization to determine both the sitting of wind turbines and the Levelised Cost of Energy (LCOE) in (3). Optimal sites were identified in the small island of Mauritius and the model was applied on a complex terrain around an airport to identify optimal sites for the sitting of wind turbines while analyzing the energy offset in terms of demand and supply of the area to encourage decentralized and more stable energy networks. Based on a set of parameters including local regulations and guidelines, 3 scenarios with a layout of 12, 24 and 36 wind farming sitting arrangements were proposed with a minimal impact on the fauna and flora; including the pathways of migratory birds (3).	(1) Gasparatos, A., Doll, C. N., Esteban, M., Ahmed, A., & Olang, T. A. (2017). Renewable energy and biodiversity: Implications for transitioning to a Green Economy. Renewable and Sustainable Energy Reviews, 70, 161-184. (2) Gove, B., Williams, L. J., Beresford, A. E., Roddis, P., Campbell, C., Teuten, E., ... & Bradbury, R. B. (2016). Reconciling biodiversity conservation and widespread deployment of renewable energy technologies in the UK. PloS one, 11(5), e0150956. (3) Dhunny, A. Z., Allam, Z., Lobine, D., & Lollchund, M. R. (2019). Sustainable renewable energy planning and wind farming optimization from a biodiversity perspective. Energy, 185, 1282-1297.
15.10	Mobilize and significantly increase financial resources from all sources				We did not find published evidence of RE impact and AI-based RE role on this target.	

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	to conserve and sustainably use biodiversity and ecosystems					
15.11	Mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation				Similar to 15.1.	
15.12	Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities				We did not find published evidence of RE impact and AI-based RE role on this target.	
GOAL 16: Peace, Justice, and Strong Institutions.						
16.1	Significantly reduce all forms of violence and related death rates everywhere.				We did not find published evidence of RE impact and AI-based RE role on this target.	
16.2	End abuse, exploitation, trafficking and all forms of violence against and torture of children.				There is weak evidence about the role of RE toward achieving this target either positively or negatively. Based on the literature, RE such as biomass may has negative impact towards the achievement of this target, since it may lead to an increase the time spent, mainly for women and children, in collecting biomass (1). Nevertheless, alternative views reflect that other types of RE can enable this goal, through the supply of modern energy facilitates the improvement of human living conditions and the productivity of sectors (2).	(1) Thiam, Djiby Racine. "Renewable energy, poverty alleviation and developing nations: Evidence from Senegal." Journal of Energy in Southern Africa 22.3 (2011): 23-34. (2) Zahnd, Alex, and Haddix McKay Kimber. "Benefits from a renewable energy village electrification system." Renewable Energy 34.2 (2009): 362-368.
16.3	Promote the rule of law at the national and international levels and ensure equal access to justice for all.				We did not find published evidence of RE impact and AI-based RE role on this target.	
16.4	By 2030, significantly reduce illicit financial and arms flows, strengthen the				We did not find published evidence of RE impact and AI-based RE role on this target.	

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	recovery and return of stolen assets and combat all forms of organised crime.					
16.5	Substantially reduce corruption and bribery in all their forms.				We did not find published evidence of RE impact and AI-based RE role on this target.	
16.6	Develop effective, accountable and transparent institutions at all levels.				We did not find published evidence of RE impact and AI-based RE role on this target.	
16.7	Ensure responsive, inclusive, participatory and representative decision-making at all levels.				We did not find published evidence of RE impact and AI-based RE role on this target.	
16.8	Broaden and strengthen the participation of developing countries in the institutions of global governance.				We did not find published evidence of RE impact and AI-based RE role on this target.	
16.9	By 2030, provide legal identity for all, including birth registration.				We did not find published evidence of RE impact and AI-based RE role on this target.	
16.10	Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements.				We did not find published evidence of RE impact and AI-based RE role on this target.	
16.11	Strengthen relevant national institutions, including through international cooperation, for building capacity at all levels, in particular in developing countries, to prevent violence and combat terrorism and crime.				We did not find published evidence of RE impact and AI-based RE role on this target.	
16.12	Promote and enforce non-discriminatory laws and				We did not find published evidence of RE impact and AI-based RE role on this target.	

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	policies for sustainable development.					
	GOAL 17: Partnerships to achieve the Goal.					
17.1	Strengthen domestic resource mobilization, including through international support to developing countries, to improve domestic capacity for tax and other revenue collection				There is evidence that RE can contribute and strengthen domestic resource mobilization as RE diversity of sources started to apply everywhere including developing countries (1,2). Some countries has strategic plan to use the RE as main demotic mobilization in electricity and agriculture. For instance, Philippine started to invest in RE power plants instead of fossil fuel plant reduce the importing tax and other costs (3). Some countries on the other hand starts to produce the RE components such as solar cells and wind turbine to reduce the tax and increase the demotic industry (4). Indeed, it is based on the mobilization of developing countries own national resources will enable the establishment of a diversified energy mix and will be optimized (AI) around specific technology choices, both reliable and competitive. In developing countries subsidy has played a big role in RE program marketing and whether this will lead to sustainable development is yet to be determined (Negative impact) (5).	(1) Martinot, E., Chaurey, A., Lew, D., Moreira, J. R., & Wamukonya, N. (2002). Renewable energy markets in developing countries. Annual review of energy and the environment, 27(1), 309-348. (2) Surana, Kavita, and Laura Diaz Anadon. "Public policy and financial resource mobilization for wind energy in developing countries: a comparison of approaches and outcomes in China and India." Global Environmental Change 35 (2015): 340-359. (3) Koebrich, Samuel, and Bethany K. Speer. Hot Topic Brief: Emerging Policies for Mobilizing Private Sector Investment into Clean Energy in the Philippines. No. NREL/TP-6A20-74877. National Renewable Energy Lab.(NREL), Golden, CO (United States), 2019. (4)Ragosa, Giulia, and Peter Warren. "Unpacking the determinants of cross-border private investment in renewable energy in developing countries." Journal of Cleaner Production 235 (2019): 854-865. (5) Atabi, Farideh. "Renewable energy in Iran: Challenges and opportunities for sustainable development." International Journal of Environmental Science & Technology 1.1 (2004): 69-80.
17.2	Developed countries to implement fully their official development assistance commitments, including the commitment by many developed countries to achieve the target of 0.7 per cent of ODA/GNI to developing countries and 0.15 to 0.20 per cent of ODA/GNI to least developed countries ODA providers are encouraged to consider setting a target to provide at least 0.20 per cent of ODA/GNI to least developed countries				We did not find published evidence of RE impact and AI-based RE role on this target.	
17.3	Mobilize additional financial resources for developing countries from multiple sources				The RE may act positively toward achieving this target as RE consider one of the main sources used in rural and remote areas especially in developing countries as additional financial resources (1,2).	(1) Gabriel, Cle-Anne, and Jodyanne Kirkwood. "Business models for model businesses: Lessons from renewable energy entrepreneurs in developing countries." Energy Policy 95 (2016): 336-349. (2) Surana, Kavita, and Laura Diaz Anadon. "Public policy and financial resource mobilization for wind energy in developing countries: a comparison of approaches and outcomes in China and India." Global Environmental Change 35 (2015): 340-359.
17.4	Assist developing countries in attaining long-				We did not find published evidence of RE impact and AI-based RE role on this target.	

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		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	term debt sustainability through coordinated policies aimed at fostering debt financing, debt relief and debt restructuring, as appropriate, and address the external debt of highly indebted poor countries to reduce debt distress					
17.5	Adopt and implement investment promotion regimes for least developed countries				As many countries around world has its own plan to encourage and support penetration of RE especially in developing countries can impact positively toward achieving this target (1). In addition some governments are offering a new policy of taxes with respect RE technology to encourage investment by citizens/individual or companies, and many organizations have started to many RE projects such as PV power plant for rural and remote areas in the developing countries country (2,3, 4). The using of AI and machine learning also has high effect in this target due its ability to reduce the cost and increase the efficiency which will help in the investment of RE sector toward smart grid (4,5).	(1) Kaygusuz, Kamil. "Energy for sustainable development: A case of developing countries." Renewable and Sustainable Energy Reviews 16.2 (2012): 1116-1126. (2) Ragosa, Giulia, and Peter Warren. "Unpacking the determinants of cross-border private investment in renewable energy in developing countries." Journal of Cleaner Production 235 (2019): 854-865. (3) Freire-González, Jaume, and Ignasi Puig-Ventosa. "Reformulating taxes for an energy transition." Energy Economics 78 (2019): 312-323. (4) Tabanjat, Abdulkader, et al. "Energy management hypothesis for hybrid power system of H2/WT/PV/GMT via AI techniques." International Journal of Hydrogen Energy 43.6 (2018): 3527-3541. (5) Abu-Rumman, Ghaida, Adnan I. Khdair, and Sawsan I. Khdair. "Current status and future investment potential in renewable energy in Jordan: An overview." Heliyon 6.2 (2020): e03346.
17.6	Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism				There is weak evidence about the role of RE toward achieving this goal. As the interconnection requirements concerning the integration of RE differ between countries and power system operators across the globe (1 2,3). Therefore, some researchers and organizations such as the European Renewable Energy Council (EREC) (2) and European Wind Energy Association (EWEA) (3) started to organize an international taskforce, including researchers, developers, manufacturers, and operators to universally harmonize the integration requirements based on penetration expansions and the cost-benefit ratio. In addition, the AI, machine learning, and smart communication can be used to success this harmonization to have unique standard concerning RE integration (1,2).	(1) Al-Shetwi, A. Q., Hannan, M. A., Jern, K. P., Mansur, M., & Mahlia, T. M. I. (2020). Grid-connected renewable energy sources: Review of the recent integration requirements and control methods. Journal of Cleaner Production, 253, 119831. (2) Re-thinking 2050, "A 100% renewable energy vision for European Union," European Renewable Energy Council, 2015. (3) European Wind Energy Association. (2018). EWEA Working Group on Grid Code Requirements, Position Paper, European Grid Code Requirements for Wind Power Generation. Available: http://www.ewea.org/
17.7	Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and				As one of the main environmentally sound technologies, RE can be enabler toward achieving this target as described in the literature (1). For instance, the role of official development assistance in the evolution of technological innovation systems especially for RE. This support from countries like Netherlands, and Germany for poor communities is important factor for achieving this targets (2). Some organizations such as UN development program (UNDP) which has funded many renewable project in developing countries such as Afghanistan, Chile, Dominican Republic, Ghana, Guatemala, and Iraq(1). As an example, UNDP funded about 30 projects of	(1) United Nations Development Program, UNDP Energy Projects. (2) Dóci, Gabriella, and Boris Gotchev. "When energy policy meets community: rethinking risk perceptions of renewable energy in Germany and the Netherlands." Energy research & social science 22 (2016): 26-35. (3) United.Nations. United Nations Development Programme (UNDP), Greening the blue -UNDP Yemen |. Available: https://yemen.un.org/en/17377-undp-yemen-greening-blue

Targets No.	GOAL AND ITS TARGET IN THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT	*Is there published evidence for RE Utilization and AI-based RE as an enabler or an inhibitor for the Target?*			REASONING	REFERENCES FOUND
		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	preferential terms, as mutually agreed				PV solar power stations in Yemen (3). Around the globe, developing countries have reported different cases of successfully implemented Renewable Energy (RE) program supported by bilateral or multilateral funding (4).	(4) Atabi, Farideh. "Renewable energy in Iran: Challenges and opportunities for sustainable development." International Journal of Environmental Science & Technology 1.1 (2004): 69-80.
17.8	Fully operationalize the technology bank and science, technology and innovation capacity-building mechanism for least developed countries by 2017 and enhance the use of enabling technology, in particular information and communications technology				We did not find published evidence of RE impact and AI-based RE role on this target.	
17.9	Enhance international support for implementing effective and targeted capacity-building in developing countries to support national plans to implement all the sustainable development goals, including through North-South, South-South and triangular cooperation				We did not find published evidence of RE impact and AI-based RE role on this target.	
17.10	Promote a universal, rules-based, open, non-discriminatory and equitable multilateral trading system under the World Trade Organization, including through the conclusion of negotiations under its Doha Development Agenda				We did not find published evidence of RE impact and AI-based RE role on this target.	
17.11	Significantly increase the exports of developing countries, in particular with a view to doubling the least developed countries' share of global exports by 2020				We did not find published evidence of RE impact and AI-based RE role on this target.	

Targets No.	GOAL AND ITS TARGET IN THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT	*Is there published evidence for RE Utilization and AI-based RE as an enabler or an inhibitor for the Target?*			REASONING	REFERENCES FOUND
		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
17.12	Realize timely implementation of duty-free and quota-free market access on a lasting basis for all least developed countries, consistent with World Trade Organization decisions, including by ensuring that preferential rules of origin applicable to imports from least developed countries are transparent and simple, and contribute to facilitating market access				Based on the literature, RE has a positive effect towards achieving this goal, as many countries have changed their policy and tax system because of the high integration of RE. In this regard, as an example countries such Pakistan (1), Latin America and the Caribbean (2), US, and Turkey (4) have been reduced the taxes regarding importing and installing of RE sources.	(1) Zafar, Usman, et al. "An overview of implemented renewable energy policy of Pakistan." Renewable and Sustainable Energy Reviews 82 (2018): 654-665. (2) Griffith-Jones, Stephany, et al. "Investment in renewable energy, fossil fuel prices and policy implications for Latin America and the Caribbean." (2017). (3) Hymel, Mona. "United States' Experience with Energy-Based Tax Incentives: The Evidence Supporting Tax Incentives for Renewable Energy, the." Loy. U. Chi. LJ 38 (2006): 43. (4) Simsek, Hayal Ayca, and Nevzat Simsek. "Recent incentives for renewable energy in Turkey." Energy Policy 63 (2013): 521-530.
17.13	Enhance global macroeconomic stability, including through policy coordination and policy coherence				We did not find published evidence of RE impact and AI-based RE role on this target.	
17.14	Enhance policy coherence for sustainable development				There is evidence about the role of RE toward achieving this goal. As the interconnection requirements and standards concerning the integration of RE to the electrical grid differ from country to other across the globe (1 2,3, 4, 5), some researchers and organizations such as the European Renewable Energy Council (EREC) (4) and European Wind Energy Association (EWEA) (5) started to organize an international taskforce, including researchers, developers, manufacturers, and operators to universally coherence the integration requirements based on penetration expansions and the cost-benefit ratio. In addition, the AI, machine learning, and smart communication can be used to success this harmonization to have unique standards and requirements concerning RE integration (1, 2, 3).	(1) Fraundorfer, Markus, and Florian Rabitz. "The Brazilian renewable energy policy framework: instrument design and coherence." Climate Policy 20.5 (2020): 652-660. (2) Collste, David, Matteo Pedercini, and Sarah E. Cornell. "Policy coherence to achieve the SDGs: using integrated simulation models to assess effective policies." Sustainability Science 12.6 (2017): 921-931. (3) Al-Shetwi, A. Q., Hannan, M. A., Jern, K. P., Mansur, M., & Mahlia, T. M. I. (2020). Grid-connected renewable energy sources: Review of the recent integration requirements and control methods. Journal of Cleaner Production, 253, 119831. (4) Re-thinking 2050, "A 100% renewable energy vision for European Union," European Renewable Energy Council, 2015. (5) European Wind Energy Association. (2018). EWEA Working Group on Grid Code Requirements, Position Paper, European Grid Code Requirements for Wind Power Generation. Available: http://www.ewea.org/
17.15	Respect each country's policy space and leadership to establish and implement policies for poverty eradication and sustainable development				We did not find published evidence of RE impact and AI-based RE role on this target.	
17.16	Enhance the global partnership for sustainable development, complemented by multi-stakeholder partnerships				There is an evidence so far that the RE may affect positively toward achieving this target especially regarding the improvement of global partnership for sustainable development as the RE sector witnessed global collaboration in term of research, financial support, and economic aspect (1). However, study proposed by (2) concluded that, Around the globe,	(1) Bugaje, Idris Muhammad. "Renewable energy for sustainable development in Africa: a review." Renewable and sustainable energy reviews 10.6 (2006): 603-612.

Targets No.	GOAL AND ITS TARGET IN THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT	*Is there published evidence for RE Utilization and AI-based RE as an enabler or an inhibitor for the Target?*			REASONING	REFERENCES FOUND
		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
	that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the sustainable development goals in all countries, in particular developing countries				developing countries have reported different cases of successfully implemented Renewable Energy (RE) program supported by bilateral or multilateral funding. In developing countries subsidy has played a big role in RE program marketing and whether this will lead to sustainable development is yet to be determined. In developing countries subsidy has played a big role in RE program marketing and whether this will lead to sustainable development is yet to be determined (Negative impact) (2). But, some literature suggested that setting-up international collaborative business ventures between local industry developed countries and RE companies in the advanced countries as an implementation strategy that will appropriate diffusion of RE in the developing countries (2, 3). The authors in (3) explore eight case studies throughout the world of where pro-poor public private partnerships for renewable energy have expanded access to energy services for those most in need of them.	(2) Atabi, Farideh. "Renewable energy in Iran: Challenges and opportunities for sustainable development." International Journal of Environmental Science & Technology 1.1 (2004): 69-80. (3) Eitan, A., Herman, L., Fischhendler, I., & Rosen, G. (2019). Community–private sector partnerships in renewable energy. Renewable and Sustainable Energy Reviews, 105, 95-104..
17.17	Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships				There is some evidence suggesting that RE is an enabler for this target. For example, some literature confirmed that partnership between public administration and private companies for implementing regional RE projects is very important factor for sustainability development (1). the study proposed in (2) concluded that there is a great need for mobilizing financial resources to expand local energy services delivery in the developing world. Pro-poor public–private partnerships are one of the best mechanisms to supplement and overcome government budgetary constraints for widening access to energy services, especially to the poor, as they can allocate project-risks between the public and private sector. This article explores eight case studies throughout the world of where pro-poor public private partnerships for renewable energy have expanded access to energy services for those most in need of them (2). Another study conducted for Iran as case study concluded that Setting-up international collaborative business ventures between local industry in Iran and RE companies in developed countries is proposed as an implementation strategy that will appropriate diffusion of RE in the country (3).	(1) Zamfir, Andreea. "Implementing regional renewable energy projects through public-private partnerships." Business Excellence and Management 2.3 (2012): 77-84. (2) Sovacool, Benjamin K. "Expanding renewable energy access with pro-poor public private partnerships in the developing world." Energy Strategy Reviews 1.3 (2013): 181-192. (3) Atabi, Farideh. "Renewable energy in Iran: Challenges and opportunities for sustainable development." International Journal of Environmental Science & Technology 1.1 (2004): 69-80.
17.18	By 2020, enhance capacity-building support to developing countries, including for least developed countries and small island developing States, to increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts				We did not find published evidence of RE impact and AI-based RE role on this target.	

Targets No.	GOAL AND ITS TARGET IN THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT	*Is there published evidence for RE Utilization and AI-based RE as an enabler or an inhibitor for the Target?*			REASONING	REFERENCES FOUND
		Positive Impact	***Negative Impact***	***Is there any role for AI?***		
17.19	By 2030, build on existing initiatives to develop measurements of progress on sustainable development that complement gross domestic product, and support statistical capacity-building in developing countries				We did not find published evidence of RE impact and AI-based RE role on this target.	
	Total	***75***	***27***	***42***		

Supplementary Table 2: SDG's target results analyzed

No.	The Goal	No of Targets	Positive Impact	Negative Impact	Is there any role for AI?	No evidence found for specific Target
1	**No poverty**	7	5	2	0	2
2	**Zero Hunger**	8	3	1	2	5
3	**Good Health and Well-being**	13	2	1	1	11
4	**Quality Education**	10	6	2	5	3
5	**Gender Equality**	9	1	0	0	8
6	**Clean Water and Sanitation**	8	4	1	4	3
7	**Affordable and Clean Energy**	5	5	0	5	0
8	**Decent Work and Economic Growth**	12	6	1	2	6
9	**Industry, Innovation and Infrastructure**	8	6	1	3	2
10	**Reducing Inequality**	10	3	0	0	7
11	**Sustainable Cities and Communities**	10	6	3	6	4
12	**Responsible Consumption and Production**	11	6	1	4	5
13	**Climate Action**	5	4	1	3	1
14	**Life Below Water**	10	5	4	1	5
15	**Life On Land**	12	3	5	2	7
16	**Peace, Justice, and Strong Institutions**	12	1	1	0	11
17	**Partnerships for the Goals**	19	9	3	4	10
Total		**169**	**75**	**27**	**42**	**90**

Supplementary Table 3: SDG's target analysis results with percentage (%)

No.	The Goal	No of Targets	Positive Impact	%	Negative Impact	%	Is there any role for AI?	%	No evidence found for specific Target	%
1	**No poverty**	7	5	71.42	2	28.5	0	0	2	28.57
2	**Zero Hunger**	8	3	37.50	1	12.5	2	25	5	62.5
3	**Good Health and Well-being**	13	2	15.38	1	7.69	1	7.69	11	84.61
4	**Quality Education**	10	6	60	2	20	5	50	3	30
5	**Gender Equality**	9	1	11.11	0	0	0	0	8	88.88
6	**Clean Water and Sanitation**	8	4	50	1	12.5	4	50	3	37.5
7	**Affordable and Clean Energy**	5	5	100	0	0	5	100	0	0
8	**Decent Work and Economic Growth**	12	6	50	1	8.33	2	16.66	6	50
9	**Industry, Innovation and Infrastructure**	8	6	75	1	12.5	3	37.5	2	25
10	**Reducing Inequality**	10	3	30	0	0	0	0	7	70
11	**Sustainable Cities and Communities**	10	6	60	3	30	6	60	4	40
12	**Responsible Consumption and Production**	11	6	54.54	1	9.09	4	36.36	5	45.45
13	**Climate Action**	5	4	80	1	20	3	60	1	20
14	**Life Below Water**	10	5	50	4	40	1	10	5	50
15	**Life On Land**	12	3	25	5	41.66	2	16.66	7	58.33
16	**Peace, Justice, and Strong Institutions**	12	1	8.33	1	8.33	0	0	11	91.66
17	**Partnerships for the Goals**	19	9	47.36	3	15.78	4	21.05	10	52.63
Total		**169**	**75**	**44.3 %**	**27**	**15.9 7%**	**42**	**24.8 5%**	**90**	**53.2 %**

Classification

Supplementary Table 3: Results within the Environment group of SDGs

Environment				
Goal	**13**	**14**	**15**	
No of Targets	5 (100%)	10 (100%)	12 (100%)	T=27 (100%)
Positive impact	4 (80%)	5 (50%)	3 (25%)	T=12 (45%)
Negative impact	1 (20%)	4 (40%)	5 (41%)	T= 10 (37%)
AI role	3 (60%)	1 (10%)	2 (17%)	T=6 (23%)

T= Total

Supplementary Table 4: Results within the Society group of SDGs

Society										
Goal	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**11**	**16**	
No of Targets	7 (100%)	8 (100%)	13 (16%)	10 (100%)	9 (100%)	8 (100%)	5 (100%)	10 (100%)	12 (100%)	T=82 (100%)
Positive impact	5 (72%)	3 (38%)	2 (25%)	6 (60%)	1 (11%)	4 (50%)	5 (100%)	6 (60%)	1 (9%)	T=33 (41%)
Negative impact	2 (28%)	1 (13%)	1 (8%)	2 (20%)	0 (0%)	1 (13%)	0 (0%)	2 (20%)	1 (9%)	T= 11 (14%)
AI role	0 (0%)	2 (25%)	1 (8%)	5 (50%)	0 (0%)	4 (50%)	5 (100%)	6 (60%)	0 (0%)	T=23 (28%)

T= Total

Supplementary Table 6: Results within the Economy group of SDGs

Economy						
Goal	**8**	**9**	**10**	**12**	**17**	
No of Targets	12 (100%)	8 (100%)	10 (100%)	11 (100%)	19 (100%)	T=60 (100%)
Positive impact	6 (50%)	6 (75%)	3 (30%)	6 (55%)	9 (48%)	T=30 (50%)
Negative impact	1 (8.5%)	1 (13%)	0 (0)	1 (9%)	3 (16%)	T= 6 (10%)
AI role	2 (17%)	3 (38%)	0 (0%)	4 (37%)	4 (21%)	T=13 (22%)