



OUTLOOK ON ENERGY AND EMPLOYMENT SCENARIOS IN SELECT SOUTH ASIAN NATIONS: SEVEN-YEAR FORECAST (2023-2030)

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ABSTRACT

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Coal is the primary energy source of countries India, Pakistan, and Sri Lanka. Coal is a fossil fuel and thus is non-renewable. In this study, we are analyzing and forecasting various energy parameters, encompassing total energy generation, consumption, the proportion of renewables in the overall primary energy mix, and socio-economic parameters such as population statistics, unemployment rates, and the percentage of women in the workforce. The objective is to leverage this data to evaluate forthcoming business and employment prospects within the renewable sector, and how it can reduce unemployment rates and improve women's participation in the workforce. Additionally, the existing job opportunities in the renewable energy market are also assessed. The high gap between energy consumption and generation indicates the need for the establishment of renewable energy infrastructure.

KEYWORDS: Renewable Energy, Fossil Fuels, Unemployment rate, Energy consumption

INTRODUCTION

Renewable energy derives from naturally replenishing sources and is sustainable over time. Some of the notable renewable energy sources include Solar Energy, Wind Energy, Geothermal Energy, Hydropower, Ocean Energy, and Bioenergy. In contrast, non-renewable sources, such as fossil fuels, diminish over time and contribute to the release of greenhouse gases like CO₂, posing environmental threats. Due to carbon emissions, we are facing issues such as climate change, rise in sea level, ocean acidification, forest fires, extinction of different species, etc ^[1]. In 2016, global CO₂ emissions totalled approximately 50 billion metric tons, with India contributing 6.6% to this figure ^[1].

The global spotlight is currently on renewable energy. The shift to renewable energy is expected to yield reduced air pollution, improved public health, and diminished greenhouse gas emissions. The International Energy Agency anticipates a surge in job

opportunities in the energy sector, with projections indicating that by 2030, while five million jobs related to fossil fuels may be lost, 14 million new jobs will emerge in clean energy, creating an additional 9 million job opportunities ^[2].

This study analyzes six different energy and socio-economic parameters from 2012 to 2022, forecasting the energy and economic landscapes till 2030 across three South Asian countries – India, Pakistan, and Sri Lanka. The analysis underscores the imperative of transitioning to renewable energy and emphasizes the necessity of creating additional job opportunities with a focus on gender equality. The external factors might influence forecasted values.

Purpose

The objective of this study is to assess the future energy and employment landscapes of India, Pakistan, and Sri Lanka, nations heavily reliant on coal fossil fuels, by the year 2030. Additionally, the escalating

unemployment rates across these countries are a notable concern. In the context of India, the proportion of women in the workforce is also a focal point. The findings of this study aim to provide these countries with insights into their upcoming challenges and opportunities, enabling them to take informed actions to address these issues. The highlighted potential for future job and business prospects serves as a compelling incentive for students to pursue knowledge in renewable energy, a field deemed crucial for the sustainable development of these nations.

DATA COLLECTION

The data of the following till 2022 were collected for the South Asian countries India, Pakistan, and Sri Lanka from the website Our World in Data.

- Energy Generation (in TWh): This represents the electricity generated by a country within a year.
- Energy Consumption (in TWh): This accounts for the overall primary energy

consumption in a country annually, encompassing electricity, transport, and heating.

- Share of Renewable Energy in Total Energy Generation (in Percentage): This indicates the proportion of primary energy consumption derived from renewable technologies, including hydropower, solar, wind, geothermal, wave, tidal, and modern biofuels.
- Population: This refers to the number of people residing in a country in a given year.
- Unemployment Rate (in Percentage): Unemployment signifies the percentage of the labor force actively seeking employment but currently without work.
- Women in the Workforce (in Percentage): This represents the share of women contributing to the country's economy.

Indicator Name/Year	Renewables (% equivalent primary energy)	Electric Generation (in TWh)	Primary Energy Consumption	Population	Female labor force participation rates (% of female population economically active)	Unemployment, total (% of total labor force)
2012	6.8295383	1091.84	6942.567	1274487200	23.099	5.414
2013	7.453715	1146.14	7172.9463	1291132000	22.65	5.424
2014	7.4813643	1262.02	7656.9136	1307246500	22.208	5.436
2015	7.282383	1321.96	7922.4277	1322866600	21.775	5.435
2016	7.096447	1401.63	8278.461	1338636300	21.351	5.423
2017	7.6051965	1471.16	8594.206	1354195700	20.934	5.358
2018	8.068529	1578.98	9081.509	1369003300	20.526	5.33
2019	9.015313	1621.91	9310.841	1383112100	21.179	5.27
2020	9.86443	1562.71	8821.111	1396387100	18.603	7.997
2021	9.653707	1713.75	9584.976	1407563900	19.233	5.978
2022	10.401817	1837.95	10123.443			

Table 1: Data collected for India ^{[3][4][5][6][7]}

Indicator Name/Year	Renewables (% equivalent primary energy)	Electric Generation (in TWh)	Primary Energy Consumption	Population	Female labor force participation rates (% of female population economically active)	Unemployment, total (% of total labor force)
2012	4.317788	98.1	687.83606	202205860	22.464	1.847
2013	11.522516	104.93	751.7423	205337550	22.745	2.95
2014	11.496396	107.34	775.9353	208251630	22.944	1.83
2015	11.174577	112.32	815.8589	210969300	23.936	3.57
2016	11.014951	123.65	888.98755	213524850	23.112	3.779
2017	9.591863	131.58	940.99817	216379650	22.302	3.916
2018	9.339477	139.9	971.03046	219731490	21.508	4.08
2019	10.928219	136.03	982.51624	223293280	21.418	3.542
2020	11.878904	136.88	977.2168	227196740	20.609	4.303
2021	10.295133	150.17	1083.7887	231402110	20.727	4.352
2022	10.861109	152.17	1000.5467			

Table 2: Data collected for Pakistan ^{[3][4][5][6][7]}

Indicator Name/Year	Renewables (% equivalent primary energy)	Electric Generation (in TWh)	Primary Energy Consumption	Population	Female labor force participation rates (% of female population economically active)	Unemployment, total (% of total labor force)
2012	0.8133145	45.84	294.77423	152090660	31.273	4.119
2013	0.768418	50.04	306.70013	154030140	31.677	4.43
2014	0.6303479	52.59	318.27	155961310	32.086	4.384
2015	0.7730467	55.59	385.2265	157830000	32.503	4.366
2016	0.7727132	64.84	385.9961	159784580	32.931	4.35
2017	0.85236263	68.91	403.53275	161793970	36.109	4.37
2018	0.706803	73.96	430.49335	163683950	36.242	4.413
2019	0.6336403	79.51	482.69788	165516220	36.311	4.438
2020	0.6318109	75.72	457.0722	167420940	34.545	5.413
2021	0.6982034	80.57	479.4749	169356240	34.869	5.229
2022	0.7543987	85.23	498.5029			

Table 3: Data collected for Sri Lanka ^{[3][4][5][6][7]}

In addition to electrical energy, overall energy consumption encompasses transportation and heating, primarily relying on fossil fuels. Across all three countries, coal and natural gas dominate as non-renewable energy sources. In India, 75% of electricity stems from thermal power plants, contributing to CO2 emissions. In 2021, India committed to achieving net-zero emissions by 2070 ^[8]. Long power outages are happening in Pakistan due to their reliance on imported natural gas for energy and the price for the same is increasing ^[9]. Since 2022, Sri Lanka has encountered similar challenges. Embracing renewable energy sources like solar, wind, and tidal power

presents a viable solution for these nations to address and overcome these energy-related issues.

FORECAST OF ENERGY – EMPLOYMENT SCENARIOS

Energy generation, energy consumption, share of renewable energy in total energy generation, population, unemployment rate, and women in the workforce are predicted for next five years, that is till 2028 using SPSS, a time series forecasting software. Following are the prediction results:

India:

Model		2022	2023	2024	2025	2026	2027	2028	2029	2030
ElectricGeneration-Model_1	Forecast	-	1870.43	1940.26	2010.08	2079.9	2149.72	2219.54	2289.36	2359.18
	UCL	-	1976.71	2047.06	2117.41	2187.75	2258.1	2328.44	2398.78	2469.12
	LCL	-	1764.16	1833.45	1902.75	1972.04	2041.34	2110.64	2179.94	2249.24
RenewableEnergy-Model_1	Forecast	-	10.759	11.116	11.473	11.83	12.187	12.545	12.902	13.259
	UCL	-	11.793	12.579	13.265	13.9	14.501	15.08	15.64	16.186
	LCL	-	9.724	9.652	9.681	9.761	9.873	10.01	10.164	10.332
PrimaryEnergyConsumption-Model_1	Forecast	-	10260.92	10557.51	10854.1	11150.69	11447.28	11743.87	12040.46	12337.04
	UCL	-	10838.76	11138.22	11437.66	11737.08	12036.5	12335.9	12635.28	12934.65
	LCL	-	9683.074	9976.799	10270.54	10564.29	10858.06	11151.84	11445.63	11739.44
Population-Model_1	Forecast	1.00E+09	1.00E+09	1.00E+09	1.00E+09	1.00E+09	1.00E+09	1.00E+09	1.00E+09	1.00E+09
	UCL	1.00E+09	1.00E+09	1.00E+09	1.00E+09	1.00E+09	1.00E+09	1.00E+09	1.00E+09	2.00E+09
	LCL	1.00E+09	1.00E+09	1.00E+09	1.00E+09	1.00E+09	1.00E+09	1.00E+09	1.00E+09	1.00E+09
Femalelaborforceparticipationrates-Model_1	Forecast	18.795	18.356	17.917	17.478	17.039	16.6	16.161	15.722	15.283
	UCL	20.129	19.697	19.265	18.833	18.401	17.969	17.536	17.104	16.672
	LCL	17.461	17.015	16.569	16.124	15.678	15.232	14.786	14.34	13.895
Unemploymenttotal-Model_1	Forecast	5.706	5.706	5.706	5.706	5.706	5.706	5.706	5.706	5.706
	UCL	7.579	7.579	7.579	7.579	7.579	7.579	7.579	7.579	7.579
	LCL	3.834	3.834	3.834	3.834	3.834	3.834	3.834	3.834	3.834

Table 4: India – Forecasted values

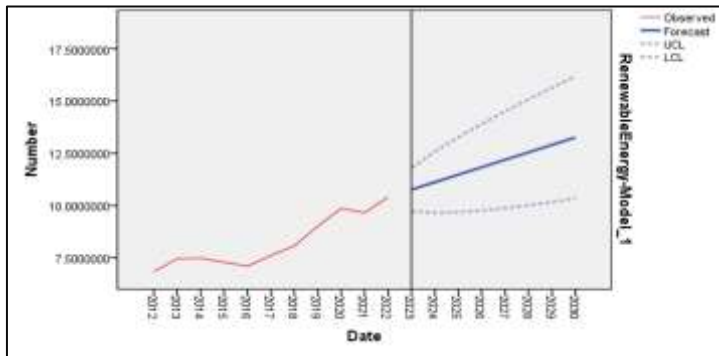


Image 1: India – Renewable Energy Share Forecast

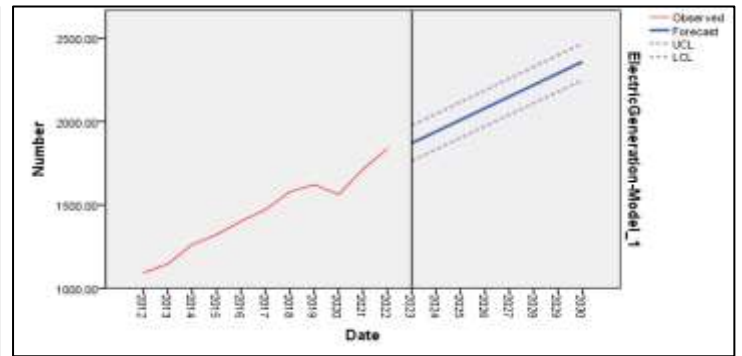


Image 2: India – Electricity Generation Forecast

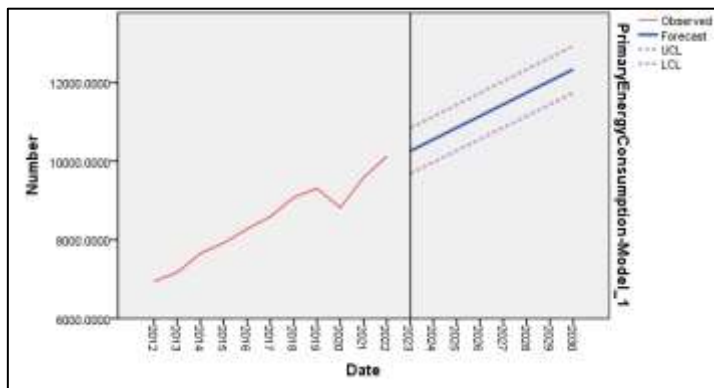


Image 3: India – Energy Consumption Forecast

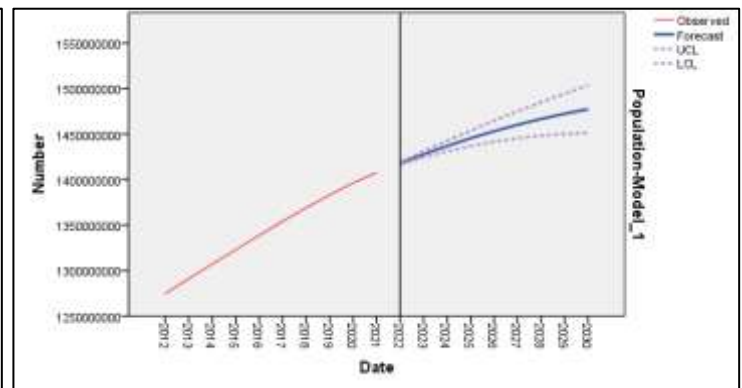


Image 4: India – Population Forecast

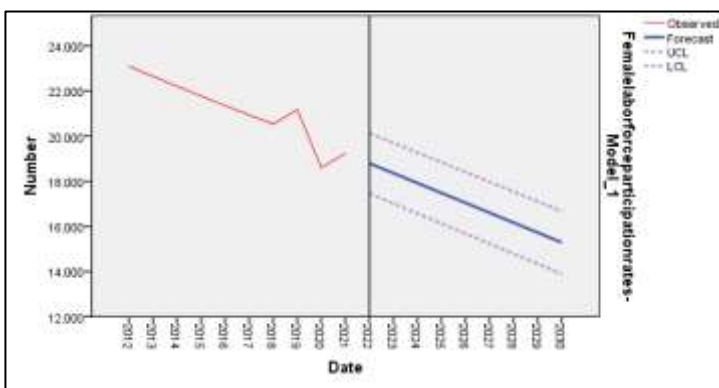
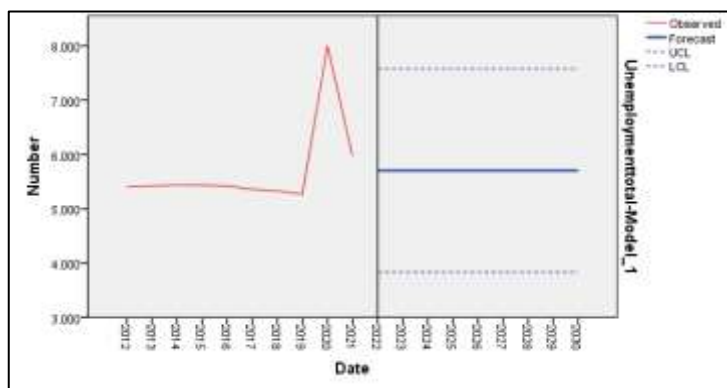


Image 5: India – Unemployment Rate Forecast
Pakistan:

Image 6: India – Female Labor Force Participation Rate

			2023	2024	2025	2026	2027	2028	2029	2030
Electric Generation-Model_1	Forecast		159.25	164.73	170.22	175.71	181.19	186.68	192.17	197.66
	UCL		169.59	175.27	180.95	186.63	192.3	197.97	203.64	209.31
	LCL		148.9	154.19	159.49	164.78	170.09	175.39	180.7	186
Renewable Energy-Model_1	Forecast		10.220085	10.220085	10.220085	10.220085	10.220085	10.220085	10.220085	10.220085
	UCL		14.922729	14.922729	14.922729	14.922729	14.922729	14.922729	14.922729	14.922729
	LCL		5.5174404	5.5174404	5.5174404	5.5174404	5.5174404	5.5174404	5.5174404	5.5174404
Primary Energy Consumption-Model_1	Forecast		1105.4902	1141.0436	1176.597	1212.1504	1247.7037	1283.2571	1318.8105	1354.3639
	UCL		1201.8875	1239.3148	1276.7071	1314.0662	1351.394	1388.6918	1425.9614	1463.2038
	LCL		1009.0929	1042.7724	1076.4868	1110.2345	1144.0135	1177.8224	1211.6596	1245.5239
Population-Model_1	Forecast	2.00E+08	2.00E+08	2.00E+08	2.00E+08	3.00E+08	3.00E+08	3.00E+08	3.00E+08	3.00E+08
	UCL	2.00E+08	2.00E+08	2.00E+08	3.00E+08	3.00E+08	3.00E+08	3.00E+08	3.00E+08	3.00E+08
	LCL	2.00E+08	2.00E+08	2.00E+08	2.00E+08	2.00E+08	3.00E+08	3.00E+08	3.00E+08	3.00E+08
Female labor force participation rates-Model_1	Forecast	20.727	20.727	20.727	20.727	20.727	20.727	20.727	20.727	20.727
	UCL	22.186	22.791	23.254	23.645	23.99	24.301	24.588	24.854	25.104
	LCL	19.268	18.663	18.2	17.809	17.464	17.153	16.866	16.6	16.35
Unemployment total-Model_1	Forecast	4.761	5.017	5.273	5.529	5.785	6.041	6.297	6.553	6.809
	UCL	6.092	6.355	6.617	6.88	7.143	7.405	7.668	7.93	8.193
	LCL	3.43	3.679	3.929	4.178	4.428	4.677	4.927	5.176	5.426

Table 5: Pakistan – Forecasted values

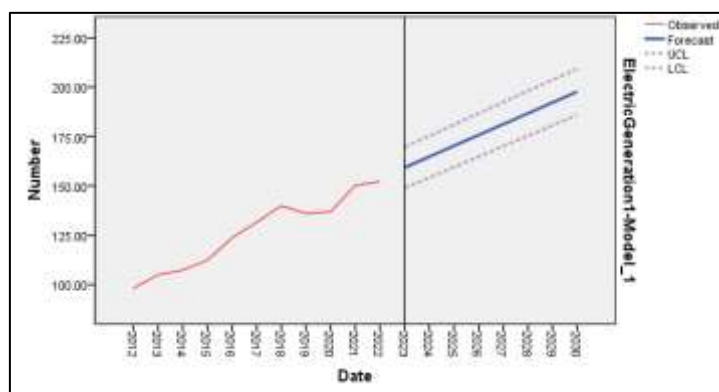
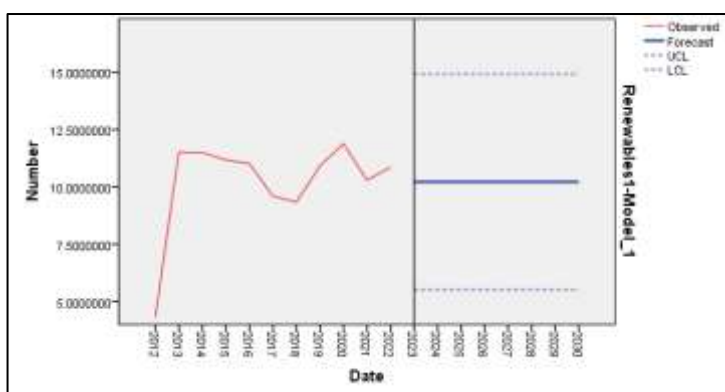


Image 7: Pakistan – Renewable Energy Share Forecast

Image 8: Pakistan – Electricity Generation Forecast

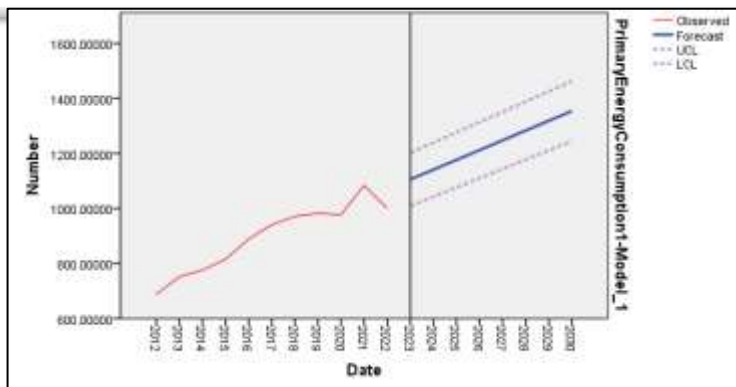


Image 9: Pakistan – Energy Consumption Forecast

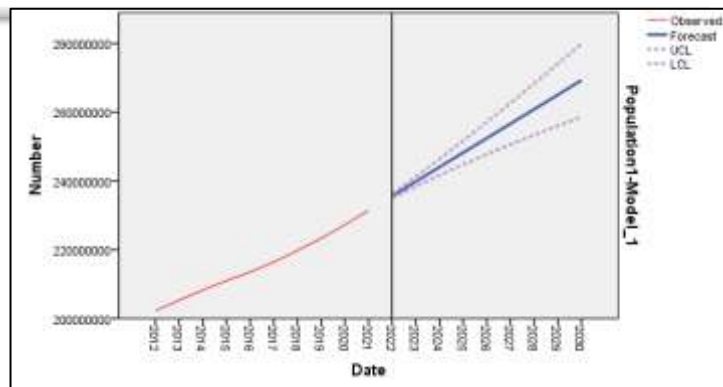


Image 10: Pakistan – Population Forecast

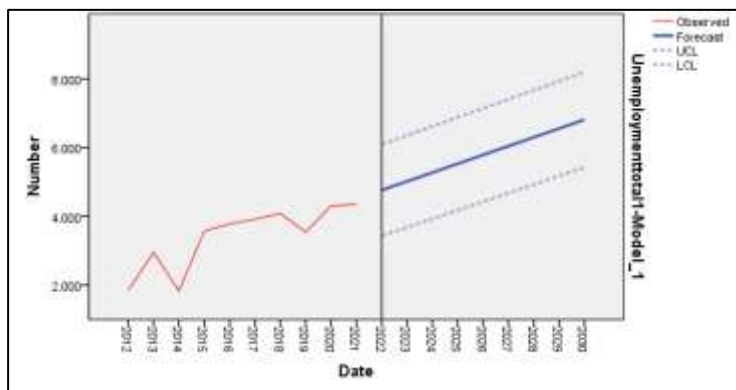


Image 11: Pakistan – Unemployment Rate Forecast

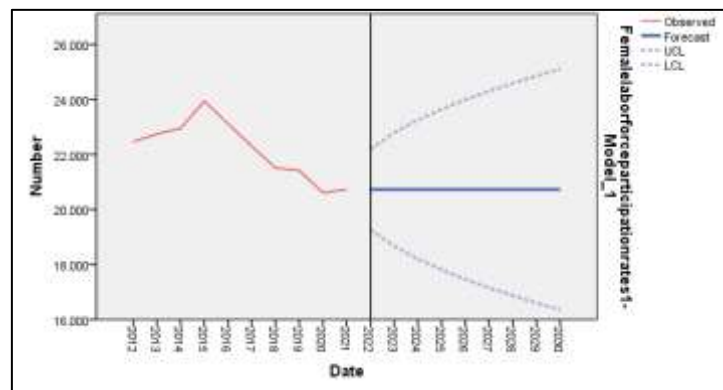


Image 12: Pakistan – Female Labor Force Participation Rate

Sri Lanka:

Model			2023	2024	2025	2026	2027	2028	2029	2030
Electric Generation-Model_1	Forecast		89.17	93.11	97.05	100.99	104.92	108.86	112.8	116.74
	UCL		96.56	103.56	109.85	115.76	121.45	126.96	132.35	137.64
	LCL		81.78	82.66	84.25	86.21	88.4	90.76	93.25	95.84
Renewable Energy-Model_1	Forecast		0.7304599	0.7304599	0.7304599	0.7304599	0.7304599	0.7304599	0.7304599	0.7304599
	UCL		0.9002468	0.9002468	0.9002468	0.9002468	0.9002468	0.9002468	0.9002468	0.9002468
	LCL		0.5606731	0.5606731	0.5606731	0.5606731	0.5606731	0.5606731	0.5606731	0.5606731
Primary Energy Consumption-Model_1	Forecast		531.14955	552.65489	574.16024	595.66558	617.17093	638.67627	660.18162	681.68696
	UCL		575.34015	597.66037	619.9661	642.25809	664.53701	686.8035	709.05813	731.30146
	LCL		486.95895	507.64941	528.35437	549.07308	569.80485	590.54905	611.3051	632.07247
Population-Model_1	Forecast	2.00E+08	2.00E+08	2.00E+08	2.00E+08	2.00E+08	2.00E+08	2.00E+08	2.00E+08	2.00E+08
	UCL	2.00E+08	2.00E+08	2.00E+08	2.00E+08	2.00E+08	2.00E+08	2.00E+08	2.00E+08	2.00E+08
	LCL	2.00E+08	2.00E+08	2.00E+08	2.00E+08	2.00E+08	2.00E+08	2.00E+08	2.00E+08	2.00E+08
Female labor force participation rates-Model_1	Forecast	34.869	34.869	34.869	34.869	34.869	34.869	34.869	34.869	34.869
	UCL	37.694	38.864	39.762	40.519	41.185	41.788	42.343	42.859	43.343
	LCL	32.044	30.874	29.976	29.219	28.553	27.95	27.395	26.879	26.395
Unemployment total-Model_1	Forecast	5.146	5.251	5.356	5.46	5.565	5.67	5.775	5.88	5.985
	UCL	5.843	5.951	6.059	6.167	6.276	6.384	6.492	6.6	6.709
	LCL	4.449	4.551	4.652	4.753	4.855	4.956	5.058	5.159	5.261

Table 6: Sri Lanka – Forecasted Values

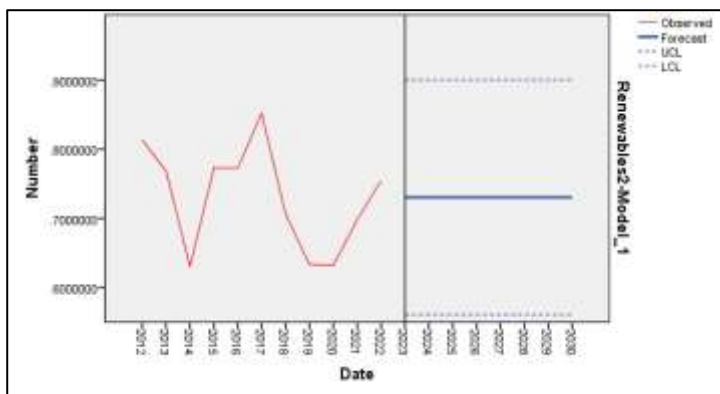


Image 13: Sri Lanka – Renewable Energy Share Forecast

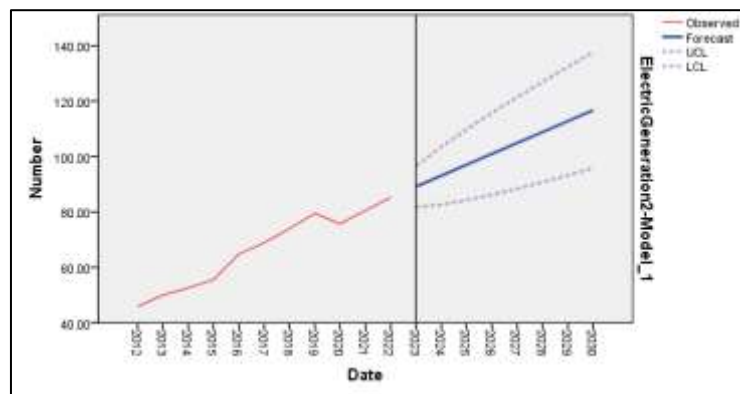


Image 14: Sri Lanka – Electricity Generation Forecast

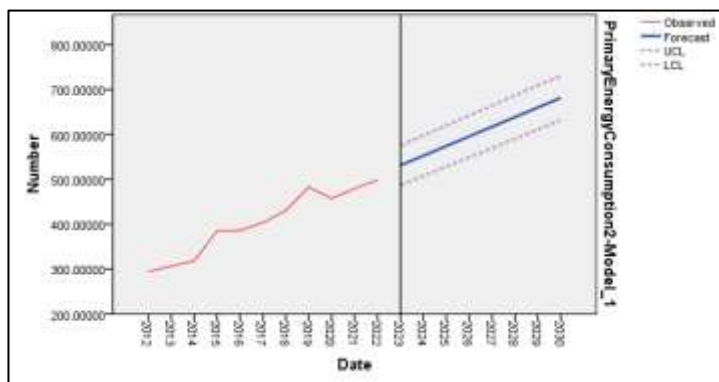


Image 15: Sri Lanka – Energy Consumption Forecast

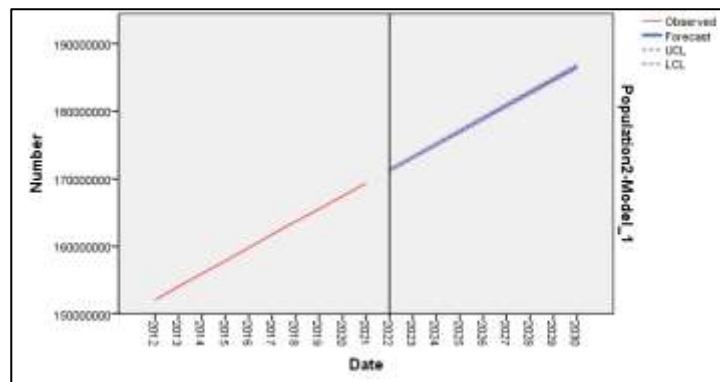


Image 16: Sri Lanka – Population Forecast

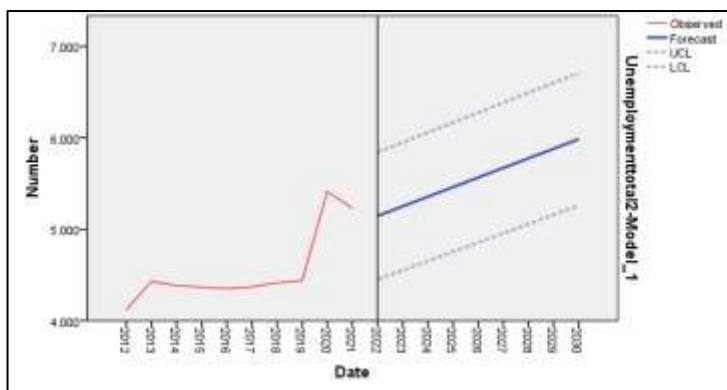


Image 17: Sri Lanka – Unemployment Rate Forecast

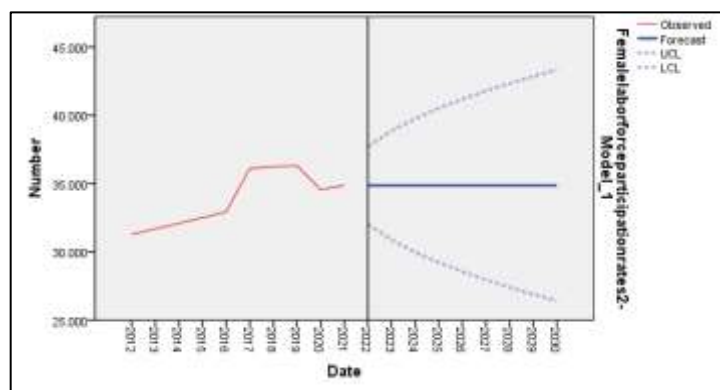


Image 18: Sri Lanka – Female Labor Force Participation Rate Forecast

FORECAST ANALYSIS

In India, a substantial population growth is anticipated which is a contributing factor to the anticipated rise in energy consumption. According to forecasts, by the year 2030, primary energy consumption in India is slated to increase by 21.38%. The electric generation is expected to reach 2359 TWh, with 13.259% of this capacity generated through renewable sources. India has a commitment to achieving zero carbon emissions by 2070 and given that almost 80% of the country's electricity is currently derived from thermal plants, a shift to renewable energy sources becomes imperative. Therefore, there will be lot of business, job, and research opportunities in the field of renewable energy in the future. However, this transition may potentially result in unemployment within communities reliant

on fossil fuel-based livelihoods. Simultaneously, the impact of climate change adds another layer of complexity to the situation [10]. While the unemployment rate is expected to remain stable, there is a forecasted reduction in the percentage of women in the workforce. Despite the anticipated job losses due to the shift to green energy, the transition is poised to create approximately 1 million employment opportunities in the renewable sector, with the majority originating from small-scale renewable energy projects [11]. Additionally, the shift to electric vehicles is important due to the potential depletion of petroleum products in the future.

In Pakistan, there is an anticipated rise in both population and energy consumption by the year 2030, amplifying the existing energy-related challenges the country is currently dealing with.

Despite an expected increase in electricity generation, the share of renewable energy within the primary energy mix is forecasted to remain consistent. According to a report by Infinity Renewables Group, fossil fuel reserves are projected to be depleted by 2060, with no coal reserves expected by 2168^[12]. Thus, it is very important that Pakistan invest in the renewable energy sector. Given the projected increase in the unemployment rate, coupled with a constant rate of women in the workforce, the transition to green energy also holds the potential to boost employment opportunities in Pakistan.

Similarly to Pakistan, Sri Lanka will encounter challenges in the future. The lack of progress in renewable energy generation will cause potential energy crisis for the country. Furthermore, there is an expected rise in the unemployment rate. If the current trajectory persists, the people in Sri Lanka will face elevated costs in electricity and petroleum, heightened unemployment rates, and more pronounced impacts of climate change.

It is imperative for India, Pakistan, and Sri Lanka to transition towards sustainable energy sources. These three countries have a favourable climate for the adoption of solar energy. Implementing initiatives such as installing rooftop solar panels on households, establishing solar parks, promoting solar cooking, and integrating solar energy into transportation can significantly reduce dependency on non-renewable energy and contribute to carbon emission reduction. In addition to solar energy, wind, tidal, and biomass energies present viable alternatives. Switching to renewable energy not only addresses environmental concerns but also creates numerous job opportunities. In the technical and management field, there will be job openings for project managers, software engineers, human resources (HR), sales, and construction engineers^[13]. Apart from that there will be job opportunities for skilled labours as well. In India, a joint program called Powering Livelihoods (PL) was initiated by the Council on Energy, Environment, and Water (CEEW) and Villgro. This program provided technical and financial support to individuals, particularly women in rural areas, fostering social impact enterprises powered by Renewable Energy. Impact assessment surveys revealed an average 33% increase in salaries. Extrapolating from this success, it is projected that by 2030, approximately 30 million Micro, Small, and Medium Enterprises (MSMEs) owned by women could significantly contribute to India's GDP growth^[14]. Expanding such programs could bring multifaceted benefits, including GDP growth, increased renewable energy generation, higher female participation in the workforce, and a reduction in carbon emissions. Pakistan imports crude oil and petroleum products worth \$15-\$16 billion annually^[15]. Sri Lanka is importing oil and coal worth \$3.7 billion^[16]. Notably, Pakistan and Sri Lanka could strategically invest in improving renewable energy generation for long-term economic and environmental gains.

CONCLUSION

Based on the forecast, even though an increase in electricity generation is observed, the renewable energy share in the primary mix remained same for Pakistan and Sri Lanka. Forecasts indicate an anticipated rise in the unemployment rate across all three countries, with India specifically facing a

projected 3% decline in the participation of women in the workforce. The anticipated surge in energy consumption is likely influenced, in part, by population growth. Therefore, it is very important for India, Pakistan, and Sri Lanka to increase the renewable energy generation. Simultaneously, concerted efforts are required to enhance employment opportunities in the renewable energy sector, ensuring equal opportunities for women.

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