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Renewable Energy Deployment Potential in Pakistan and China

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Abstract: Environmental concerns like climate change and continuously increasing energy needs have steered sustainable and alternate eco-friendly practices forward. This meta-analysis has investigated the renewable energy deployment potential in Pakistan and China. Analysis of renewable energy deployment revealed the availability of solar, wind, hydro and biofuel energy in both countries. Unlike China, Pakistan has just started developing a favorable environment for investors. However, China is found to have conflicting energy policies promoting both renewable and conventional energy. Statistical analysis unveiled high dependence of primary renewable energy deployment on policy support with Fisher's exact test significance value of 0.013 and Cramer's V value of 0.632 and availability of sources with Fisher's exact test significance of 0.013 and Cramer's V of 0.632. Also, tertiary deployment is found to be dependent on the availability potential of sources in Pakistan with Fisher's exact test significance value of 0.043 along with statistically significant Cramer's V value of 0.553. In China, tertiary RE deployment and presence of reported sources are strongly associated with Fisher's exact test significance value of 0.045 and Cramer's V value is found to be 0.775. Conclusively, both countries have a long way to go in order to achieve sustainable development but, renewable energy deployment represents steps in the right direction.

Keywords: renewable energy; energy policy; deployment; potential; sustainability.

I. INTRODUCTION

Recent environmental concerns and continuously increasing energy needs have steered sustainable and alternate eco-friendly practices forward. The need to reduce Greenhouse Gas emissions and increasing energy requirement of China and Pakistan have enforced the inevitable renewable energy (RE) deployment. There are various renewable energy sources mainly solar, wind, biofuels, and hydro. These sources are becoming more and more prominent as power producers move towards achieving

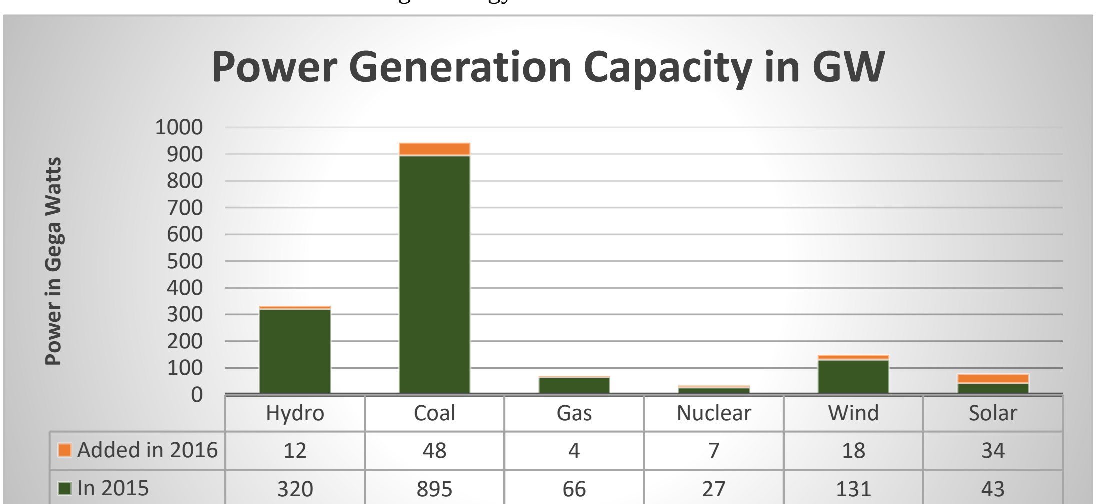

Figure 1: China's power mix in 2016 [2]

a 100% renewable grid [1]. The reason behind the struggle for a national grid that is focused on renewable

Figure 1 China's power mix in 2016 [2] energy is based on the sustainability of the current environment, management of depleting resources and continuously increasing energy demands. With continuously diminishing fossil fuel reserves and excessive fossil fuel dependent global economies, it is high time that energy policies are altered in favor of a system that is free from the exhaustion of its primary source hence, leading to energy independence [3, 4]. This concept has led countries like Norway, Costa Rica, Brazil, and Canada to have a national grid based on hydropower and to have a 97%, 93%, 76% and 62% renewable grid respectively [5]. In addition to hydropower, wind farms and solar parks based on photovoltaic (PV) are also considered to attain a carbon-free energy sector which is becoming more and more attainable [5].

The shift in the energy paradigm of the West has also taken roots in the eastern part of the globe. China, which was considered a carbon-intensive economy, has undergone some adjustments in terms of power policy in recent years. On the other hand, Pakistan has a power crisis on their hands that has proven to be a significant negative influence on its economy. Hence, it can be reflected as a premium opportunity to identify RE deployment potential, the available resources and the type of support that is accessible to power producers in Pakistan and China at the moment. When considering the energy mix of China, the energy powerhouse has previously focused on coal-based energy production. However, an 80% increase in the total share of solar energy in the national power system was observed between 2015 and 2016 [2].

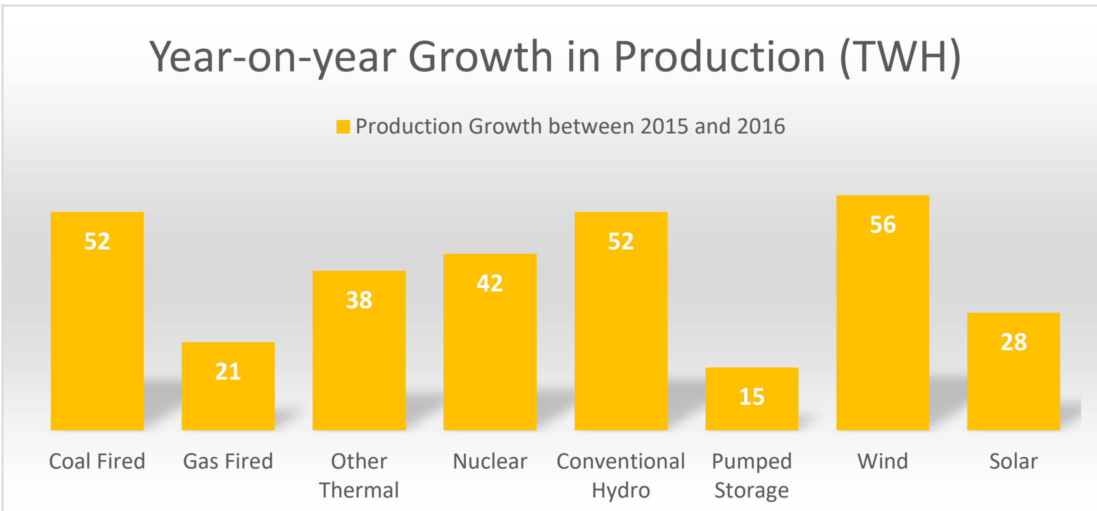

Figure 2: China's coal deployment increase in 2016 [2]

Figure 1 offers a year-on-year analysis between China's energy mix based on a primary source in 2015 against 2016. Figures 1 provide great optimism for RE deployment in China but Figure 2 delivers insight regarding the considerable share of conventional methods being deployed and expanded annually for energy production in China.

Pakistan's energy mix in recent years has faced over-reliance on natural gas and furnace oil resources along with a minor role of hydro, coal and nuclear power sources. A 47% share of natural gas based energy production followed by 33% of furnace oil-based energy with a negligible amount of energy being produced through RE is alarming [6]. This provides a real dilemma for a country that has been importing furnace oil and has burdened its economy with imported resource-based energy production while RE sources are being ignored. Although researchers have proposed a different route through enhanced RE deployment for Pakistan's energy future, its feasibility is yet to be tested in terms of deployment potential. Moreover, Pakistan is further advancing its coal centered energy production with the newly found 175 Billion ton reserve of Thar-coalfield [7].

Combining this with the current cost of electricity production provides even alarming findings. It has been reported by a research article that due to the poor operational condition and high fuel cost of coal power plants in Pakistan, production cost has reached PKR 34.79 per KWh while oil is second costliest with PKR 15.98 per KWh. On the other hand, water reservoir based electricity production cost was in the region of PKR 3.23 per KWh, followed by run-off the river production at PKR 4.63 per kWh and nuclear power at PKR 4.58 per kWh [8]. Also, it is believed that solar-based electricity cost is predicted to be PKR 6-8 per KWh. In case of China, onshore wind-based electricity is reported to cost around 0.4–0.57 Yuan per KWh, offshore wind-based electricity cost at 0.85 Yuan per KWh, solar electricity cost at 0.6–0.8 Yuan per KWh, and coal-fired power costing at around 0.2791–0.502 Yuan per KWh [9]. The price competitiveness in the case of China can be argued however, the environment-related costs of coal-based electricity production cannot be justified. In addition to this, Pakistan is an agricultural country and such environmental issues can affect its crop yield as well [10].

Therefore, it is high time to assess the potential of renewable energy sources in Pakistan and China for a better understanding of the future of energy production in both countries and to guide policymakers and investors in an informed manner. This will assist policymakers, government authorities, private investors, energy strategists, and planners in exploiting the identified potential and advancing exploration of specific renewable sources based on the presented proof through this research. In the following article, research methodology is provided in the next section followed by the review results and analysis in section 3 and conclusion in section 4.

II. DATA COLLECTION AND ANALYSIS

Research design is based on secondary data and review methodology has been selected. A meta-analytic review is conducted and a convenience sampling technique is used for data source selection. This method of review is found to be an effective methodology for the identification of underlying evidence without bias [11, 12]. Data sources have been selected based on the inclusion and exclusion criterion presented below. Analysis of the collected data is conducted utilizing a simple statistical tool that is SPSS version 22.0. A total of 30 data sources have been included in this study.

A. *Inclusion and Exclusion Criteria*

Inclusion and exclusion of data sources and literature is based on the following points.

- The data source must be directly associated with the energy sector of Pakistan or China.
- The data source must be a published research article or doctoral thesis with a clear conclusion.
- The data source must be published by a credible source like public institution and/or locally or globally renowned and respected organization.

B. *Ethical Aspects and Reliability Considerations*

This research does not involve any primary data collection hence there are no data privacy and confidentiality issues associated with the study [13]. Standardized statistical review of selected literature ensures eradication of any opinionated bias that might exist at the part of the researcher. In addition to this, convenience sampling encourages random result inclusion in the study and research articles are selected on the basis of inclusion and exclusion criterion [12]. These steps warrant reliability of the research method and hence, certifying the validity of the research outcome.

III. RESULTS AND DISCUSSION

An extensive review of 30 data sources has been conducted for the recognition of a number of aspects associated with the potential of RE deployment. The investigated aspects in this research are: RE sources emphasized in the selected literature, the level of RE deployment and proposed or suggested share in the country's energy mix in the near future. The level of RE deployment is evaluated on the scale of primary or as the main source to tertiary being equal to or less than 5% share. In addition to this, the evidence presented by the data source regarding RE source' availability, policy-related aspect or economic provisions is also included in the analysis.

A. *In Pakistan*

The above-offered elements are examined in the light of RE deployment potential in Pakistan and Table 1 presents a detailed result of the evaluated data based on analysis of each data source.

Table 1: Potential of RE Deployment in Pakistan

Potential of RE Deployment in Pakistan										
Data Source	**RE Deployment**			**Type of Resource**				**Type of Support**		
	Primary	Secondary	Tertiary	Solar	Wind	Hydro	Biofuel	Availability	Policy	Economic
Raheem et al., [14]	✓			✓	✓	✓	✓	✓		
Baloch, Kaloi, and Memon [15]		✓		✓	✓			✓		
Ghafoor et al., [16]				✓	✓	✓	✓	✓		
APCTT-UN ESCAP Report [17]	✓			✓	✓	✓	✓	✓		
Rafique and Rehman [18]	✓			✓	✓		✓	✓		
Mirza and Khalil [19]	✓			✓	✓	✓	✓	✓		
World Bank Private Investment Report [20]		✓			✓	✓	✓			✓
Khalil, Khan, and Mirza [21]			✓	✓	✓			✓		
Awan [22]		✓		✓	✓			✓	✓	

Kamran [23]	✓			✓	✓	✓	✓	✓		
LEAD Pakistan Report [24]		✓		✓	✓		✓	✓	✓	✓
AEDB Bio-Energy Framework 2013 [25]			✓				✓		✓	
AEDB Provincial Policy 2015 [26]			✓	✓	✓		✓		✓	
State Bank of Pakistan Green Policy [27]			✓	✓	✓	✓	✓		✓	✓
AEDB RE Policy 2006 [28]		✓		✓	✓	✓	✓		✓	
PPIB Commissioned Project [29]			✓	✓	✓	✓	✓			✓
Power Policy 2013 [30]		✓		✓	✓	✓	✓		✓	
Planning Commission's Vision 2030 [31]			✓	✓	✓		✓		✓	

Statistical evaluation of the above provided reviewed data sheds light on a number of features that play a significant role in the deployment of RE in Pakistan. It has been found that the 18 data sources studied and presented in the above table have been uniformly distributed when considering the level of RE deployment that is 33.33% each. One-third of the literature has suggested that Pakistan can develop its RE sector to a level where it holds a majority share in Pakistan's energy mix. Similarly, another one-third have suggested that RE deployment can be enhanced significantly to a level where it plays a considerable role in the energy frame of the country. It must be mentioned that 70% of all the studies, that have included hydropower in the discussion and have suggested that RE deployment can be increased to secondary or even primary level. Here, it must be highlighted that this can be very intriguing finding for energy strategists and investors as a heavy investment under the flagship project of China-Pakistan Economic Corridor (CPEC) is being spent on the energy sector [32]. This upcoming investment can be channeled towards RE deployment through the formulation of a policy structure that supports resource potential identification along with its optimum exploitation. Moreover, this is vital as hydro energy already contributes 11% to Pakistan's national power production paradigm and stands at the 3rd position already in terms of energy share [6]. Lastly, 8 data sources have suggested that it will play a tertiary role in the future. Over 90% of these 8 sources are government published data sources. Hence, it can be suggested that the government authorities still assume RE as an outsider in Pakistan's energy frame while private and academic segments have suggested a starring role for RE in Pakistan.

This is an interesting finding considering that the Pakistani energy sector is a heavily government-influenced sector. Until recently, private investors had to go through a considerable number of approvals and licensing work for investment in the private sector. However, major private investment from local investors and the Chinese government under the flagship project of China Pakistan Economic Corridor (CPEC) has modified the situation for good [33]. Still, it is significant that the government emphasis on conventional non-renewable sources is managed or diminished to achieve this impressive RE deployment potential. This importance is based on the evidence presented in a number of research studies that have stressed on the influence of government policies and government-led initiatives on the dissemination of energy sources' acceptability, development and private investor interest [34, 35].

In addition to this, high support has been provided to solar, wind and biofuel energy sources by the reviewed data sources. Solar energy has been supported by 16 out of 18 sources (88.89%), wind energy with even higher 17 out of 18 sources (94.44%) and bio-fuel being suggested as a possible RE source for electricity production in Pakistan by 16 sources (83.33%). Hydro energy was not reinforced at the same level as other debated sources mainly because of the notion that it has been a part of the national energy mix for numerous years now. Hydro energy is currently being utilized at 15% of the total available capacity in Pakistan [17, 20]. Therefore, it can be advised to the policymakers and energy strategists that a larger share of hydropower in the national energy mix must be a priority given the rich availability of hydro source in northern regions of the country. Hydro energy source, unlike oil fuel, is free of cost and renewable and therefore, can decrease Pakistan's energy dependence on imported fossil fuels [36]. This is not only true for Pakistan but is also applicable in the case of other Southeast Asian countries like Bangladesh and India [36]. This sums up the lack of resource exploitation and inability in achieving the potential of the existing resources. These findings offer a comprehensive view of the current situation with ample scientific support for the decision makers to rethink the prevailing energy management and production mechanism.

Furthermore, the nature of support and provision that has been provided in the data source has also been analyzed in this study. Availability of RE source in varying geographical locations of the country gained highest support (55.5%) followed by policy provisions and backing at 44.4% and only 22.2% of the studies focused on economic assistance in regards to RE deployment in Pakistan. These findings are an appropriate reflection of the actual problems surrounding RE deployment in Pakistan. Availability of RE sources is first and foremost requirement for its deployment but to further the deployment process, researchers and strategists have to step forward and present policy proposals and identify financial opportunities for the government as well as the private sector.

Therefore, it can be suggested that comparable situation might persist in the local energy sector of the country, which is lack of policy framework and financial backing at the ground level while a deficiency in research evidence complicates the matters further. Combining this outcome of missing policy structure and financial assistance from government authorities along with the discussed auxiliary perception of government bodies regarding RE sources, the current state of RE deployment in Pakistan must be considered as a correct reflection of the ground reality. Figure 3 is a pictorial representation of the above-illustrated assessment.

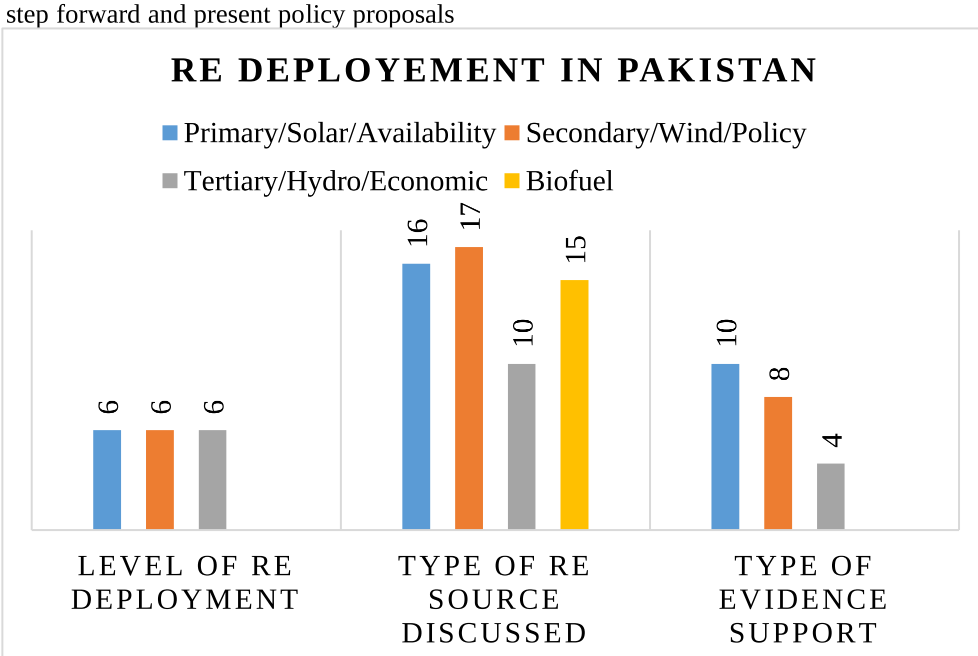

Figure 3: RE deployment potential in Pakistan

1) Primary RE Deployment and Policy Support

In addition to the above-presented results and discussion, the Chi-square test has been utilized for the identification of any association between the aspects that have been recorded and displayed in Table 1. Based on the findings of the Chi-square test in relation to primary RE deployment and policy support in Pakistan, a very intriguing association has been found. Table 2 presents the Fisher's exact test significance value of 0.013. This suggests that the primary RE deployment in Pakistan is dependent on policy support significantly with a confidence level of over 98%. In order to understand the strength of this dependence or association, Phi and Cramer's V test is conducted and the output presented in Table 3. It clearly identifies a strong positive association with a Cramer's V value of 0.632 at a significance level of 0.007.

Based on the results presented here, it can be evidently suggested that in order to enhance the RE deployment facet in Pakistan to a level where it can be considered for primary utilization, strong policy backing can be considered as one of the most vital factors. Importance of policy framework to include RE in the energy mix of Pakistan as a chief contributor is now statistically evident. This provides robust evidence to the government authorities, energy strategists and policymakers to evaluate the current energy scenario and what future holds for Pakistan in terms of sustainable development given the rich availability of RE sources. Thus, it is high time to act on these findings to ensure Pakistan's energy security and sustainable development as well as to control environmental degradation.

Table 2 Association between primary RE deployment and policy support

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7.200[a]	1	.007		
Continuity Correction [b]	4.753	1	.029		
Likelihood Ratio	9.454	1	.002		
Fisher's Exact Test				.013	.011
Linear-by-Linear Association	6.800	1	.009		
N of Valid Cases	18				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.67.

b. Computed only for a 2x2 table

Table 3: Result of Phi and Cramer's V test for primary RE deployment and policy support

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.632	.007
	Cramer's V	.632	.007
N of Valid Cases		18	

2) RE Deployment and Availability

Now, considering the facet of availability of RE sources in Pakistan and its association with RE deployment, a mouth-watering prospect has been identified. This has been discussed earlier as a vital factor but, here a detailed statistical evaluation is conducted leading to a conclusive remark on this matter. A statistically significant and strong dependence has been unearthed based on Fisher's exact test and Cramer's V test. Fisher's exact significance value of 0.043 has been established along with statistically significant Cramer's V value of 0.553 with 0.019 significance value has been achieved. Both these results are tabulated in Table 4 and Table 5.

Table 4: Relationship between tertiary RE deployment and availability in Pakistan

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.513[a]	1	.019		
Continuity Correction [b]	3.403	1	.065		
Likelihood Ratio	5.828	1	.016		
Fisher's Exact Test				.043	.032
Linear-by-Linear Association	5.206	1	.023		
N of Valid Cases	18				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.67.

b. Computed only for a 2x2 table

Table 5 Phi and Cramer's V test results of dependence between tertiary RE deployment and availability in Pakistan

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.553	.019
	Cramer's V	.553	.019
N of Valid Cases		18	

Additionally, specific evaluation of the relationship between primary RE deployment in Pakistan and the availability potential of RE in the country led to another important revelation. The outcome of the Chi-Square test provided in Table 6. This additionally cements the claim that RE deployment and availability potential are associated statistically. The government authorities, policy makers and private investors can utilize such findings for the formulation of a framework that boosts RE deployment at all levels that is national, provincial and regional off-grid. Fischer's exact test significance value of 0.013 has been found. The Cramer's V value delivered in Table 7 further asserts the above statement with a value of 0.632 having a statistical significance of 0.007.

Table 6: Association between primary RE deployment and availability potential in Pakistan

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7.200[a]	1	.007		
Continuity Correction [b]	4.753	1	.029		
Likelihood Ratio	9.454	1	.002		
Fisher's Exact Test				.013	.011
Linear-by-Linear Association	6.800	1	.009		
N of Valid Cases	18				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.67.
b. Computed only for a 2x2 table

Table 7: Phi and Cramer's V test result of dependence between primary RE deployment and availability potential

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.632	.007
	Cramer's V	.632	.007
N of Valid Cases		18	

All these findings point towards the prominence of recognition of RE sources' availability in these data sources and is a cause of great optimism when looking forward to RE deployment in the country. This research advances the existing status of various reports on RE availability and assessments in terms of RE deployment at a primary, secondary or tertiary level. The importance of availability has been discussed by many but this analysis offers comprehensive evidence which should eradicate any doubts that still persists in the minds of the readers regarding the importance of acknowledging RE source availability and then extending the discussion to its deployment in the same breath. This can be vital when focusing on foreign involvement for sustainable power development and can result in greater funding from global energy players considering the high energy demands [37].

Addressing the above-presented aspect with the earlier discussed notion of policy backing, this combination can prove to be the turning point in the successful deployment of RE in the Southeast Asian region. Sustainable energy development in developing countries, energy resource availability, policies and interactions between various associated factors is vital to answer impending questions in the minds of policymakers, energy strategists, investors, researchers, and numerous other government and non-government actors. Hence, documentation, assessment, and recognition of all the offered factors in this section identified through evaluation of selected data sources is of extreme importance and represents foundational work towards creating an environment that is feasible for RE deployment.

B. In China

Now, assessment of data sources on the topic of RE deployment potential in China is carried out and it sheds light on some stimulating features. The outcome of the analysis of each data source is revealed in a presentable format in Table 8.

Table 8: RE deployment potential in China

Potential of RE Deployment in China										
Data Source	**RE Deployment**			**Type of Resource**				**Type of Support**		
	Primary	Secondary	Tertiary	Solar	Wind	Hydro	Biofuel	Availability	Policy	Economic
Zhang et al., [38]	✓			✓	✓	✓	✓		✓	
Lo [39]	✓			✓	✓	✓	✓		✓	
Brunekreeft et al., [40]		✓		✓	✓	✓	✓		✓	
Dai et al., [41]	✓			✓	✓	✓	✓			✓

China's RE Law 2005 [42]	✓			✓	✓	✓	✓		✓	✓
Ni [43]			✓		✓			✓	✓	✓
Zhang et al., [44]		✓		✓				✓		
Lin [45]		✓		✓	✓	✓			✓	
RE Roadmap for 2030 [46]		✓		✓	✓	✓	✓	✓	✓	✓
Dai, Xei, and Zhang [47]		✓		✓	✓	✓	✓			✓
Shen and Luo [48]		✓		✓	✓	✓	✓		✓	
Li et al., [49]			✓	✓						✓

Increased demand for sustainable and less energy intensive growth has induced political and economic shifts globally. In China, firm support for RE deployment as an established secondary energy source in the coming years with 50% backing from reviewed data sources has been found. The need for sustainable, low carbon economy and enhanced environmental awareness has led to strong financial assistance from government and investors for RE deployment in China. In addition, deployment of RE in China has a strong policy foundation with the introduction of the RE law in 2005 followed by the RE roadmap provided in vision 2030 to create a sustainable and green energy economy. On the other hand, minimal backing of 33.3% has been found for RE as a primary energy source as even China's vision 2030 RE roadmap suggests a maximum share of RE at 26.7% by 2030. Although coal cap placed by the government provides a glimmer of hope, the current ground situation suggests that RE would remain a secondary player in coal-fired energy producing China. Here, it must be kept in mind that China has seen a huge increment in energy demand and has successfully overseen a power crisis during the early 2000s. This can be an influential factor given RE's weather dependence and other concerns that are presented in this article in later stages. Figure 4 provides a comprehensive outlook of the unearthed information.

Focusing on RE source availability, data sources have provided considerable backing to all the four discussed sources with solar energy being mentioned by most of the sources (91.66%) followed by wind, hydro and biofuel in the descending order with 83.33%, 75%, and 66.66% respectively. One reason behind this high support for all analyzed RE sources might be grounded in the notion that RE sources have been found in abundance in China and that China is already past the RE availability recognition phase which is evident as only 25% of the studies are found to be focused on RE availability. Furthermore, 66.7% of the reviewed sources focused on policy issues while 50% also highlighted financial matters. This represents growth in RE deployment that China has achieved during the last decade with policy and financial support is the center of attention after availability considerations. This is in complete contrast to the outcomes of data sources focusing on Pakistan as

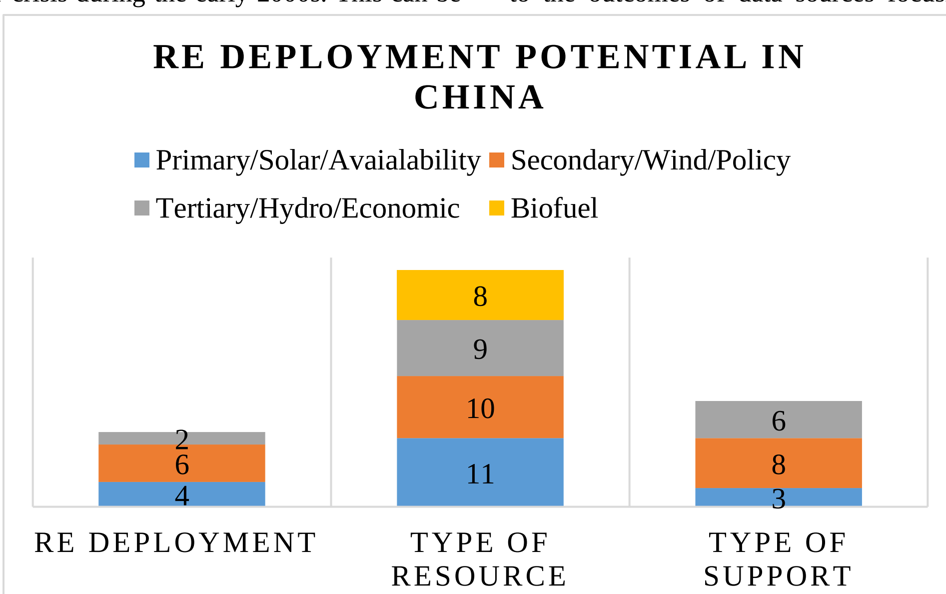

Figure 4: China's RE deployment potential

higher support for solar, wind and biofuel was recorded over a hydro and much larger share of studies focused on availability aspects along with policy elements. This is an intriguing prospect as it points out the current standing of researchers working on facets associated with RE deployment in China and Pakistan. This difference is primarily due to variations in the attitude of government authorities towards RE deployment opportunities. In the case of China, it is evident that the country as initiated RE deployment but it is still at an early stage given the high energy demand. Although China is one of the leading investors in RE deployment and utilization, the Chinese government needs to promote sustainable use of energy sources in order to ensure energy conservation [50]. Leading coal power producing and Green House Gas (GHG) emitting China is moving in the right direction to achieve sustainable development but, RE deployment at a much larger scale will be required to accomplish these motives. Unlike Pakistan, China has set a direction for sustainable development but, increased coal production and year-on-year analysis presented in Figure 4 which provides enough food for thought for environmentalists, energy strategists and policymakers to identify the mixed policies that China has adopted to fuel its development [51].

Nonetheless, it can be suggested that although there is a serious deployment potential in both countries it does not necessarily guarantee their harvesting ability. This is also the case with Argentina who despite having great RE potential, has failed to achieve the set target of 8% renewable energy grid [52]. Therefore, understanding the available potential is vital to ensure RE deployment and harnessing the untapped potential. One attention-grabbing feature that has been noted in this study is the association between tertiary RE deployment and number of RE sources documented by the analyzed studies.

1) Tertiary RE Deployment and Present RE sources

Assessment of RE deployment in China has led to the debate that whether there is any specific association between RE deployment and the identified factors in this research that have been covered in details in Table 8.

. This assessment has exposed a mystifying association between the presence of RE sources with the tertiary deployment of RE sources in China. Unlike the availability potential aspect, the presence of RE sources focuses on the variety of sources that are available to be exploited whom potential can then be examined in later stages. Out of the 4 covered RE sources in this study which are solar, wind, biofuel, and hydro at least 3 sources must be regarded as available or present in the analyzed study for positive inclusion. Otherwise, it is established that the major presence of varying RE sources cannot be established in that data source. This practice is conducted only for this evaluation and Chi-Square Test and Cramer's V test are utilized to test the interaction between the two variables.

The examination of this relationship unveiled a Fisher's exact test significance value of 0.045. In addition to the outcome of the Chi-Square test, Phi and Cramer's V test promoted the notion of a strong association between tertiary deployment and presence of reported RE sources in China through the identification of high strength of dependence of tertiary deployment on the presence of RE sources. The Cramer's V value is found to be 0.775 with a significance level of 0.007. The outcomes of these statistical evaluations are tabularized in Table 9 and Table 10.

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Table 9: Linkage between tertiary RE deployment and present RE sources in China

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7.200[a]	1	.007		
Continuity Correction [b]	3.200	1	.074		
Likelihood Ratio	6.994	1	.008		
Fisher's Exact Test				.045	.045
Linear-by-Linear Association	6.600	1	.010		
N of Valid Cases	12				

a. 3 cells (75.0%) have expected count less than 5. The minimum expected count is .50.

b. Computed only for a 2x2 table

Table 10: Phi and Cramer's V test results of linkage between tertiary RE deployment and present RE sources in China

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.775	.007
	Cramer's V	.775	.007
N of Valid Cases		12	

Discoveries offered in this section, are of prime status in terms of RE deployment in China, especially when considering the high backing presented to RE as a secondary option in the country's energy mix in future by the selected data sources. Bearing in mind the proposed secondary role and the essential nature of the presence of a variety of RE sources in China, it can be evidently anticipated that the future of RE in China is bright. This is suggested on the basis of the high level of the proposed role by researchers and scholars, prominent discussion on policy matters in the analyzed studies and the variety of sources available for exploration and exploitation.

Conclusively, the recipe for success is ready in case of China but the potential needs to be tapped with conviction to ensure it reaches the desired stature. Also, clear policy route needs to be paved with unsustainable practices like increased coal-based energy production needs to be diminished. This is important considering that sustainable development is only possible when all the energy sectors are moving in the same direction. Otherwise, much effort could be lost through conflicting policies and lack of clarity among the government stakeholders. Government authorities, policy makers and energy planners must place sustainable RE development over rapid growth based on the findings presented in this article. Here, it is clear that a policy structure based on the discussed findings of this research work can lead to new horizons in terms of RE deployment in China. These policy enhancements need to be incorporated in the existing RE law and policy framework as such an approach based on continuous improvement can pay dividends in the long run.

IV. Conclusion

Analysis of RE deployment potential in both countries has led to the consideration of a number of aspects ranging from availability of RE sources to the type of support identified by the data sources. All these factors are considered as crucial in the development of an environment which can facilitate government and non-government actors in the identification of essential requirements to ensure achievement of RE deployment potential in China and Pakistan. The findings and gaps unearthed in this study present an opportunity to policy makers, decision makers, investors, and investment planners, energy strategists and researchers. These government and non-government players can utilize these findings and direct their efforts and focus towards the extermination of the discussed concerns to improve sustainable practices and to create a policy structure that is synchronized with the existing energy policies to reduce conflict. Now, the outcome of this study is summarized along with some recommendations which are based on the issues pointed out in this study.

First and foremost, it is apparent that the availability of RE sources in Pakistan and China is well researched and supported by the examined data sources. But, it is the difficult task of exploiting this available RE potential and utilization of these sources to the utmost level has been questioned by many. The findings presented in this article suggest that the development of appropriate policies and secure financial structure can result in enhancement of RE deployment. China has been working extensively on policy development facet and in creating an investor-suited financial environment. Yet, there is a serious policy conflict among China's energy policies with some supporting conventional energy sources like increased coal production and enhanced investment in coal-fired energy production and some policies backing RE deployment. This forms the first recommendation for Chinese government think tanks, policymakers, and energy strategists to identify conflicting areas in the existing energy policy framework and to eradicate any such issues which are causing hindrance in the implementation of sustainable practices and consequently, sustainable development in the region.

On the other hand, Pakistan has just recently moved on to substantial policymaking and attractive venture introduction for investors from the initial availability assessment stage. This means that Pakistan is way behind China in terms of RE deployment. However, energy infrastructure development under CPEC and economic growth provide Pakistan the chance to grow its RE sector exponentially if the opportunity is utilized adequately. Hence, Pakistani government officials and policymakers are advised to enhance RE penetration in the national grid through creating investor-suited policies, favorable financial platform and involvement of international bodies to gain investor trust.

Detailed statistical examination of the underlying factors and association between the recognized aspects unveiled additional discoveries in regards to RE deployment in Pakistan and China. Fisher's exact test significance value of 0.013 has been unearthed shedding light on the notion that primary RE deployment in Pakistan is dependent on policy support significantly. In order to understand the strength of this association, Phi and Cramer's V test is conducted and the output clearly identifies a strong positive association with Cramer's V value of 0.632 at a significance level of 0.007. These results further stem the above-presented conclusion. Furthermore, availability of RE sources in Pakistan and its association with tertiary RE deployment is also estimated and strong dependence has been found based on Chi-Square test and Phi and Cramer's V test results. Fisher's exact test significance value of 0.043 has been established along with statistically significant Cramer's V value of 0.553.

Intensified investigation of these findings revealed that primary level RE deployment and availability potential in Pakistan are similarly associated. This is an exceedingly important outcome as many researchers, investors and policymakers tend to emphasize on these facets but are unable to report any significant statistical evidence to support this claim. Therefore, government authorities can utilize such findings for the formulation of an evidence-based framework which can boosts RE deployment at all levels that is national, provincial and off-grid. The Fisher's exact test significance value of 0.013 and the Cramer's V value additionally affirm the above statement with a value of 0.632 having a statistical significance of 0.007. It is advocated with ample statistical evidence that in order to facilitate RE exploitation, Pakistan must form a robust policy structure which safeguards investor interest, ensures long term investment security and enhance investor trust through RE policy clarity, unidirectional energy policy, and financial subsidies.

Moving on to China, a Fisher's exact test significance value of 0.045 is established which promotes the notion that a strong association between tertiary deployment and presence of reported RE sources is considerably related. The Cramer's V value is found to be 0.775 with a significance level of 0.007 which states the high strength of dependence of tertiary deployment on the presence of RE sources in the Chinese context. These novel findings can be of great advantage if utilized for the development of a framework that can incorporate the acknowledged potential while removing the recorded barriers and concerns. High energy demand and continuously increasing domestic energy need can be handled actively if off-grid RE deployment is promoted in the rural and suburban region of the country. This can be beneficial to the government as it would decrease the load on the national grid and will also give confidence to small scale local investment into the RE sector. Hence, this is highly recommended based on the discovered outcomes in case of China.

Given the vast RE potential that both poses, one-window operations for potential investors and the introduction of a clear pathway for any prospective policies at the regional and provincial level can assist in the exploitation of these resources. This will ensure a hassle-free opportunity for investors and provincial or regional policy support will confirm policy longevity. Based on this meta-analysis, it can be concluded with sufficient evidence that Pakistan and China have great potential to harness electrical energy from renewable energy sources. But, in order to achieve this potential, findings of this study must be considered as a stepping stone for new policies, decision making and further research on RE deployment and related matters. Finally, it is recommended to increase research collaboration opportunities in the RE sector with industry-led research and investor suited policies to enhance of RE deployment in both countries to enhance RE exploration and exploitation

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