

White Paper

Financial Analysis of Utility Scale Variable Renewable Energy Projects

Authors

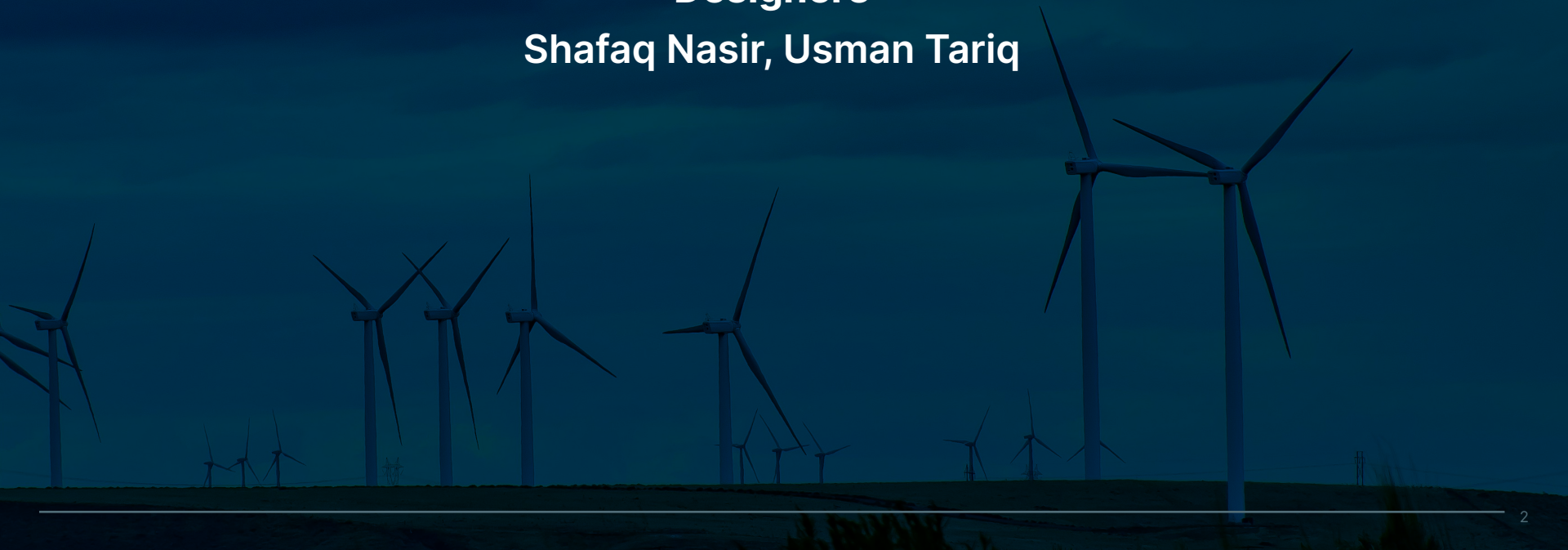
Muqaddas Ashiq Abbasi

Qurratulain

Shaheera Tahir

Designers

Shafaq Nasir, Usman Tariq



Executive Summary

Utility Scale Solar and Wind Power Development in Pakistan is slow

Since the adoption of the 2006 Renewable Energy Policy, approximately 2,500 MW of utility-scale Variable Renewable Energy (VRE) capacity has been installed in Pakistan. However, there are projects whose Commercial Operation Dates (CODs) have been delayed for over a decade..

Trends in Installed Energy Capacity in Pakistan: A decade Overview

Pakistan has witnessed significant milestones in its installed energy capacity, reflecting both progress and challenges in the sector. The country has made strides in diversifying its energy mix, with increased investments in renewable sources, alongside ongoing reliance on traditional fossil fuels. However, capacity expansion has been uneven, with periodic setbacks due to economic and infrastructure constraints with renewables always at the risk.

Levelized Tariff and Cost trends for VRE plants over years

A comparison of solar and wind tariffs in 2015 and 2023 reveals that the tariffs have dropped to about 20% of their initial tariff. This indicates a substantial reduction in the overall EPC (Engineering, Procurement, and Construction) costs (in USD) for these projects which is reflected in the cost analysis performed under this study.

Global cost savings through Variable Renewable Energy (VRE) integration

The overall module costs have reduced worldwide and, since 2000s approximately of USD 500 billion has been saved by the countries after integrating Renewables to their system with China and India leading the race.

Utility scale project development Barriers

Project development faces numerous technical, financial, and regulatory barriers. The rupee-dollar disparity complicates investment for local stakeholders, while challenges in the transmission and distribution network exacerbate the situation. Additionally, authorities often question the credibility of these projects even after these hurdles are overcome.

Strategic Approaches for Pakistan's utility scale Projects Future

- Consistent policies and implementation of developed policies is essential for utility scale VRE development, along with investments in grid modernization.
- Foster the growth of ancillary markets.
- Provide or promote flexible financing mechanism for investors.



Utility scale variable renewable power development in Pakistan needs attention

- Currently, share of renewables stand at approx. 7% in Pakistan's installed generation capacity mix.
- This work – a continuation of our research efforts in promoting VRE in country's power mix - aims to highlight the bottlenecks in utility scale solar and wind power development, and present financial implications of such bottlenecks.
- For this analysis we have dissected the project costs of solar and wind power projects gathered through publicly available data on National Electric Power Regulatory Authority (NEPRA) website, assessed their trends over the years, and identified the project cost heads that need attention
- To engage with policymakers on addressing the causes for inflated project costs for renewable projects.
- To assert the need for implementation of policies and timelines in facilitating the renewable energy projects development



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Evolution of Energy Mix

Historical Overview of Policies

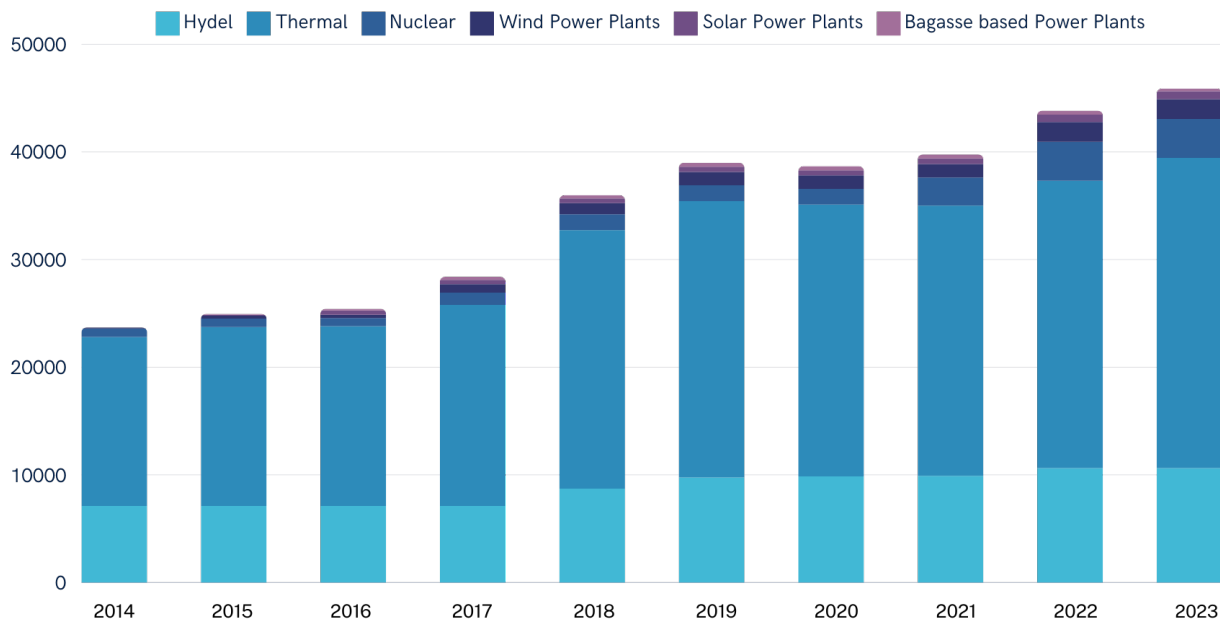
Utility Scale Variable Renewable Energy (VRE) share in energy mix vs Potential in Pakistan

Global and National VRE Cost trends

Barriers: Technical, Financial, Regulatory and Political

Recommendations

Thermal and hydel energy based power plants dominate Pakistan's electricity generation fleet



Source: Author's own analysis of State of Industry Reports (2014-2023)

Variable Renewable Energy (VRE) however has developed slowly in the past decade since its entry in the generation mix

Forty-two megawatts (MW) of solar energy were integrated into the grid in 2023, while no wind energy was added during the same year

Whereas 2.13 GW of non renewables became part of grid in 2023



Evolution of Energy Mix

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Historical Overview of Policies

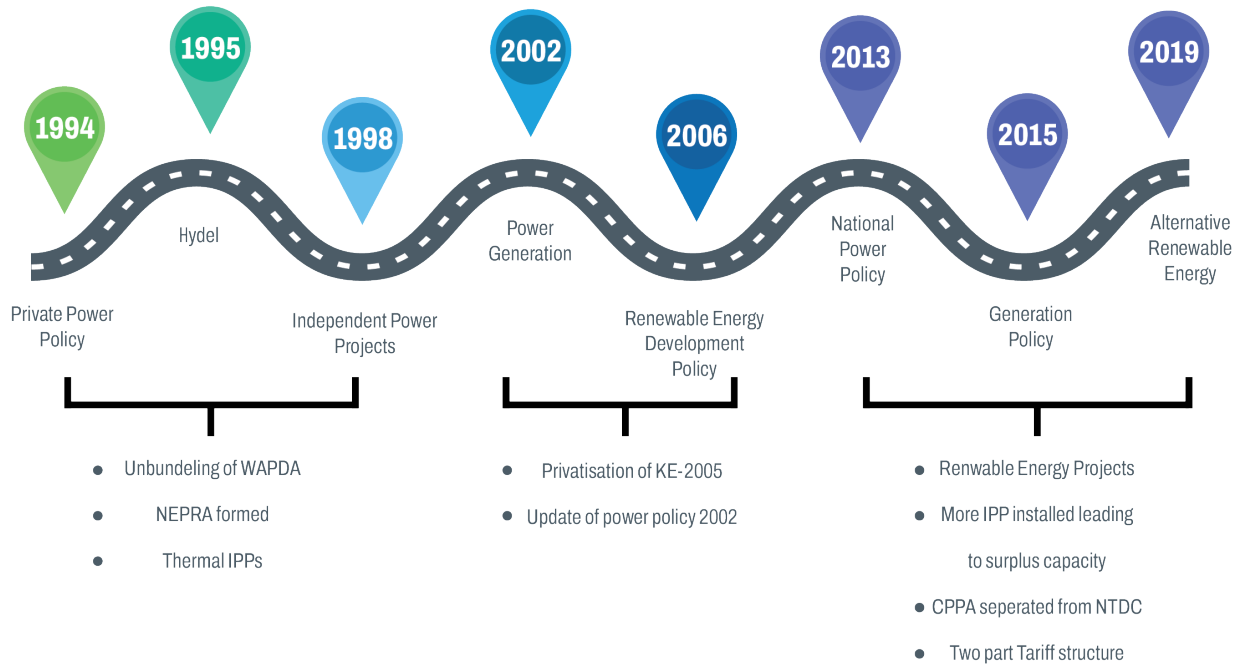
Utility Scale Variable Renewable Energy (VRE) share in energy mix vs Potential in Pakistan

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Barriers: Technical, Financial, Regulatory and Political

Recommendations

Historical policy framework has been skewed towards thermal generation



To date, two renewable energy policies have been formulated.

- RE Policy 2006
- ARE Policy 2019

ARE policy 2019 is continuation of RE policy 2006

ARE Policy 2019 clearly defined goals for 20% alternate renewable energy (excl. hydro) by 2025, and 30% by 2030

With 2025 around the corner, VRE share stands at a mere 7% in the national grid

Source: Aims vs Priorities: A critique of the National Electricity Plan 2023 PRIED



Evolution of Energy Mix



Historical Overview of Policies



**Utility Scale Variable Renewable Energy (VRE) share in
energy mix vs Potential in Pakistan**



Global and National VRE Cost trends

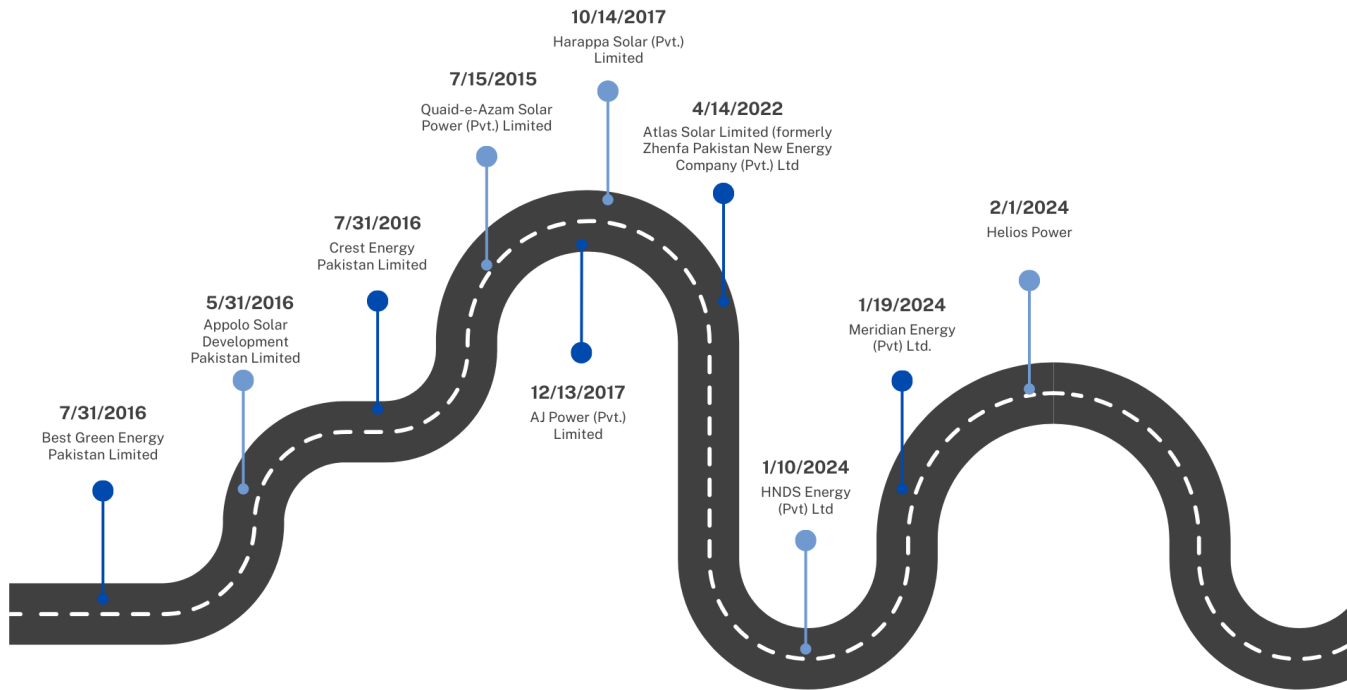


Barriers: Technical, Financial, Regulatory and Political



Recommendations

10 solar plants of 680 MW capacity became part of the national grid in past decade



Commercially operational solar plants in Pakistan with their respective CODs : PPIB

As per PPIB reports a total capacity of 21,123 MW of Thermal Power Plants has been added to the power mix since the private power policy 1994.

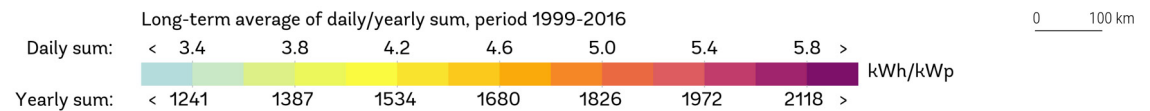
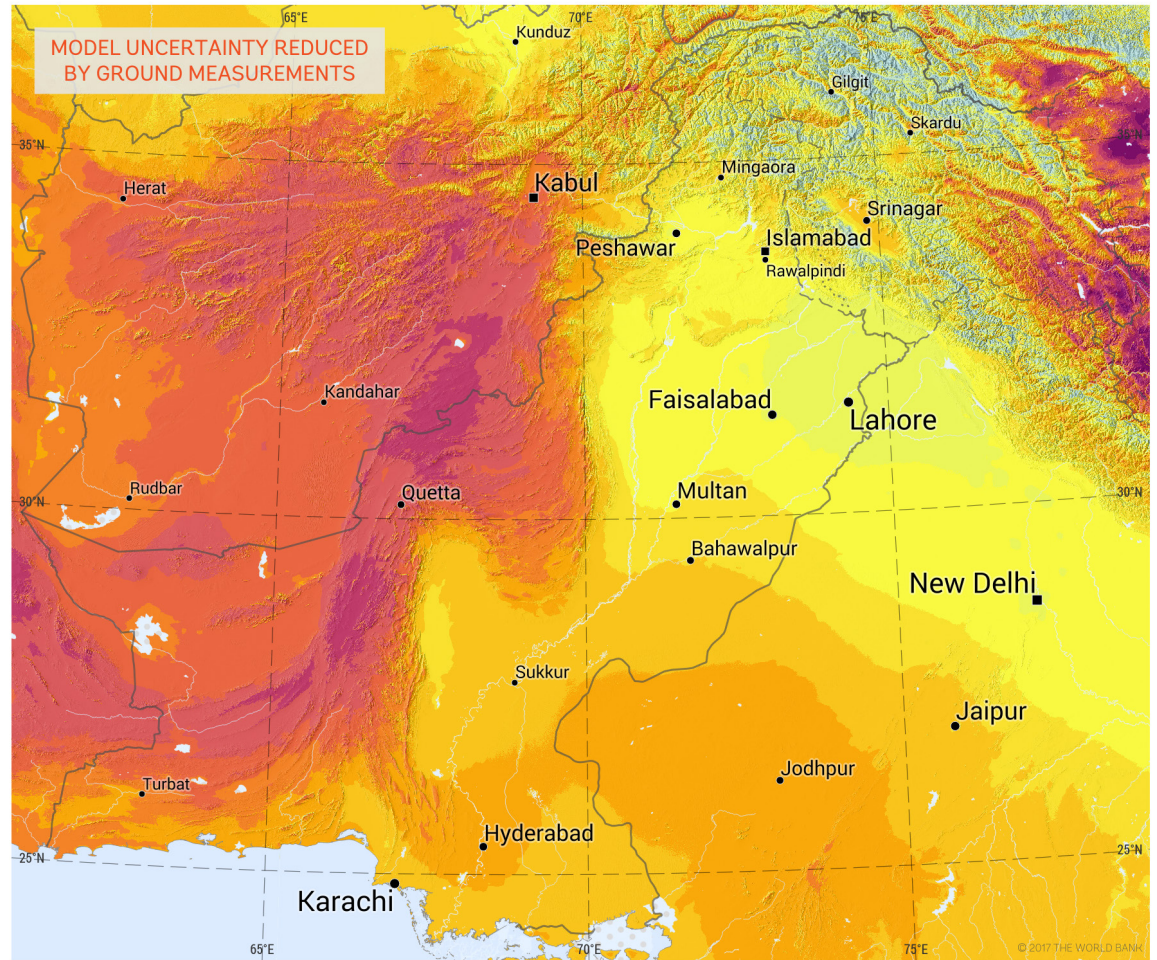
While a total capacity of 680 MW of Solar has been installed since the first solar power project entered Pakistan's national grid in 2014

SOLAR RESOURCE MAP
PHOTOVOLTAIC POWER POTENTIAL



Whereas all across Pakistan, solar potential is abundant

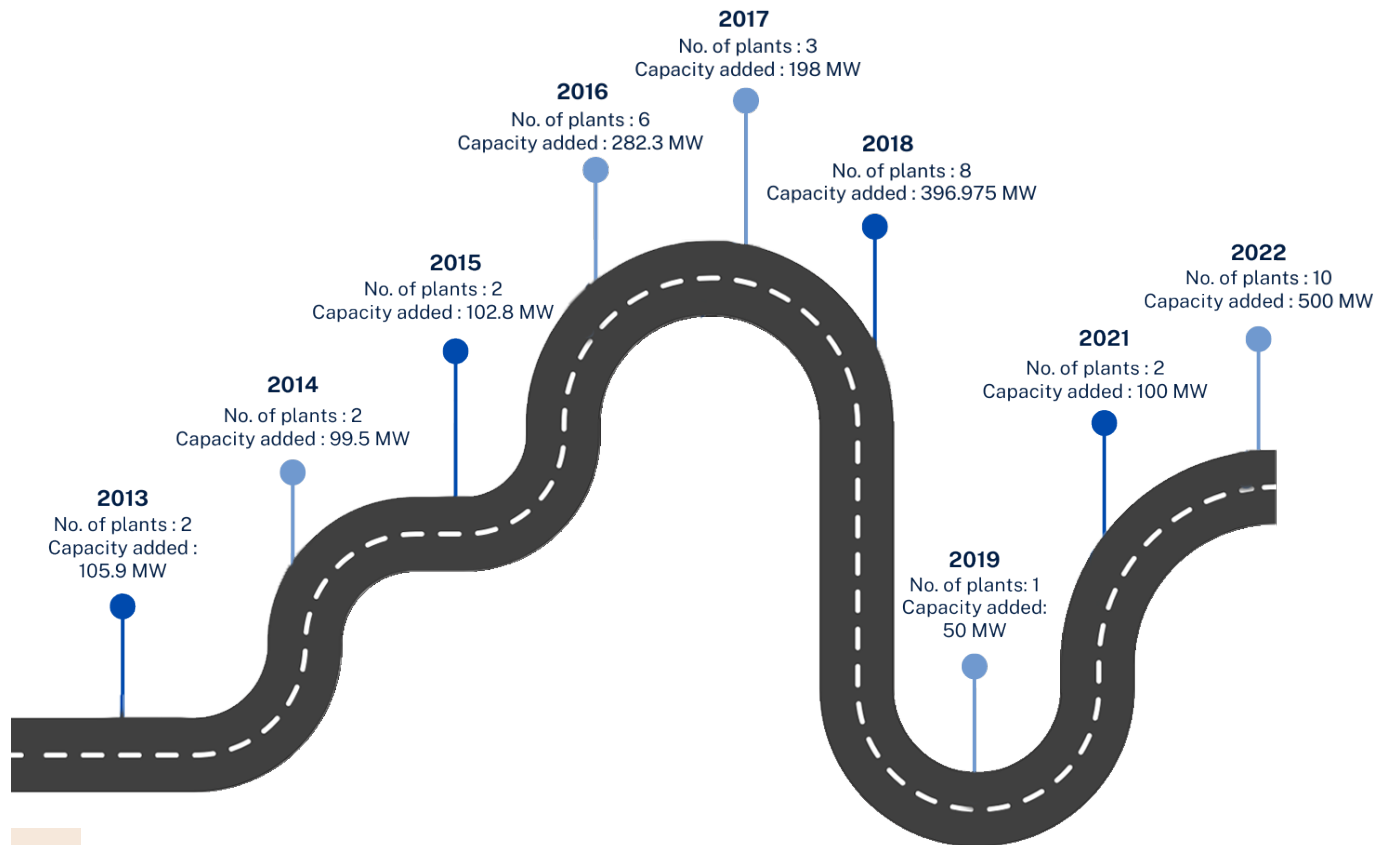
- Over 100,000 MW of electricity from sunlight could be generated, particularly in regions within the Sunny Belt.
- The annual average daily global radiation of Pakistan is:
 - horizontal (GHI) - 16 MJ/m²
 - oblique (GTI) - 13 MJ/m²
- The minimum annual average daily GHI in Pakistan is higher than the world average annual average daily GHI.



This map is published by the World Bank Group, funded by ESMAP, and prepared by Solargis. For more information and terms of use, please visit <http://globalsolaratlas.info>.

1.8 GW of wind power generation has become part of the national grid in the past decade, a miniscule fraction of its potential in Pakistan's wind corridors.

Commercially operational wind plants in Pakistan with their respective CODs



A total capacity of 1,845.47 MW of wind has been installed since 2013 in Gharo-Jhimpir wind corridor.

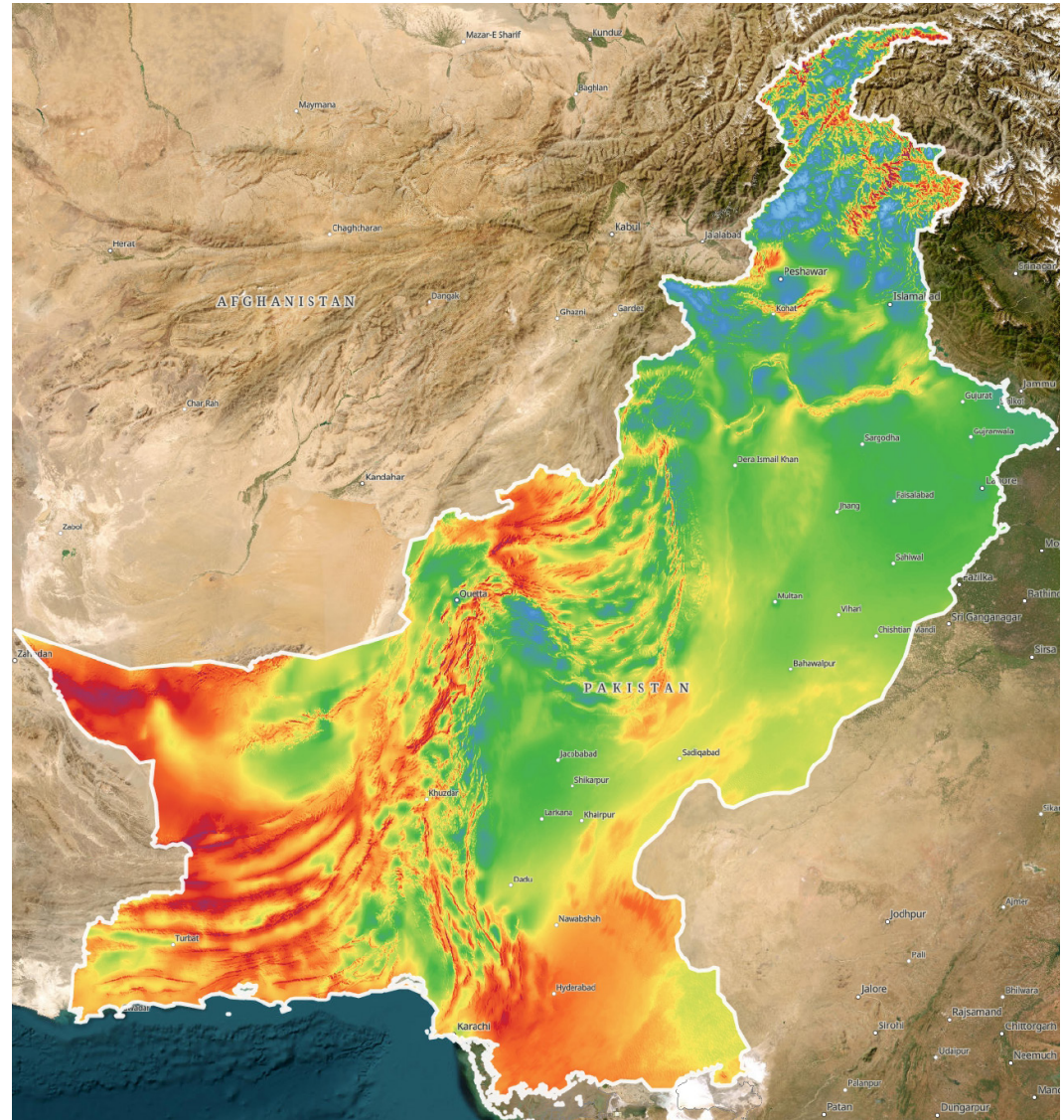
As per longterm power generation plan for 2024 – 2034, only 100MW of wind will be added in the national grid in next 10 years.

Southern provinces have vast potential of harnessing wind for power generation

Wind data, provided by Pakistan's Meteorological Department, measures Pakistan's coastal belt at 60km (Gharo-Keti Bandar) and 180km long. Jhimpir wind corridor, in the Sindh Province in southeast Pakistan has potential to generate more than 11 gigawatts of power.

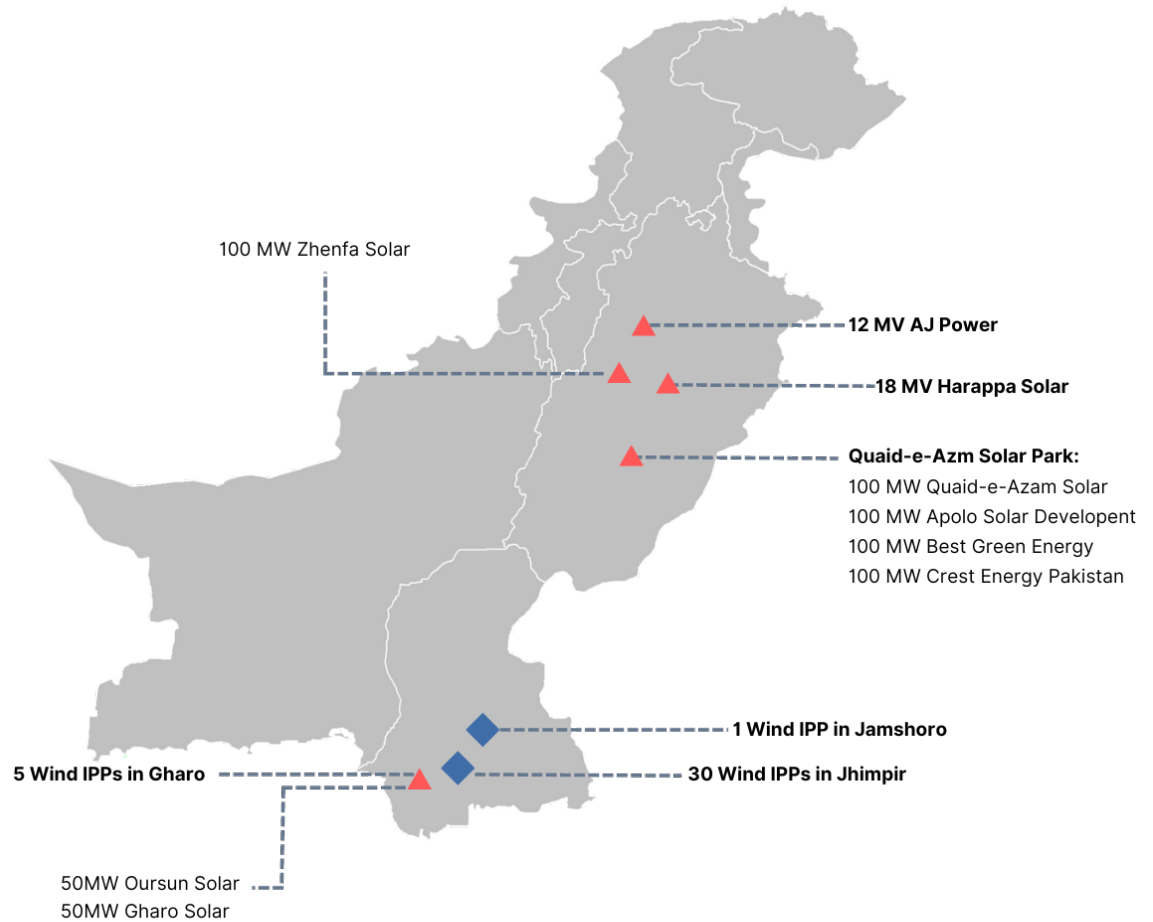
Exploitable potential of electricity generation through wind turbines stands at 50,000MW at this belt.

Currently, 36 private wind projects are operating, producing approximately 1845MW.



Spatial distribution of existing Utility Scale VRE projects in Pakistan

Utility scale solar and wind power plants are concentrated in the provinces of Punjab and Sindh



Source: Author's own analysis



Evolution of Energy Mix

Historical Overview of Policies

Utility Scale Variable Renewable Energy (VRE) share in energy mix vs Potential in Pakistan

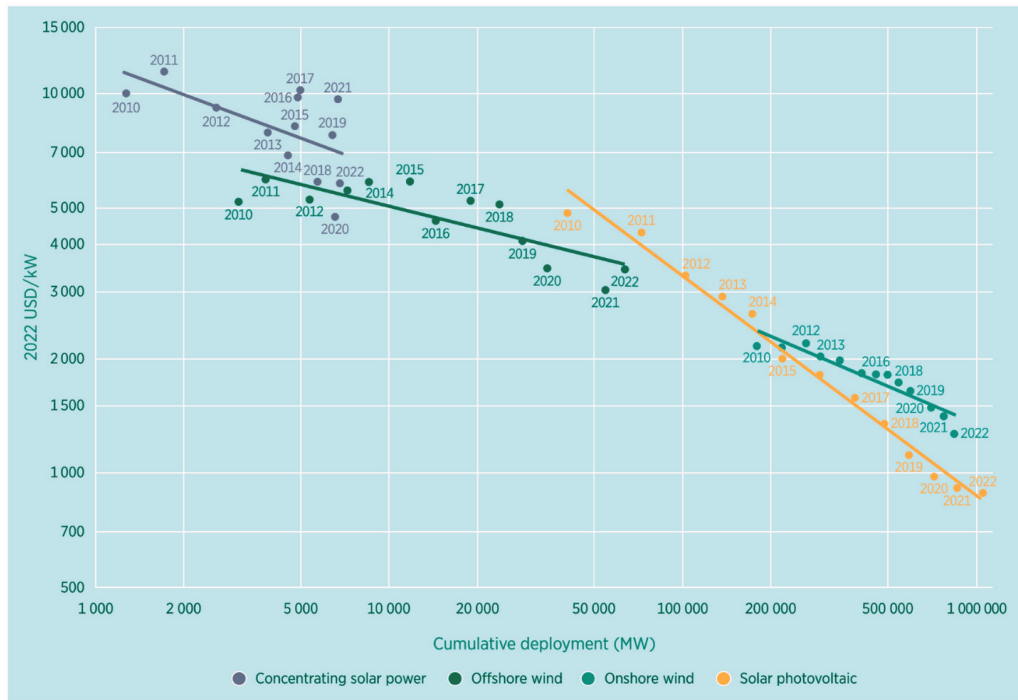
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Global and National VRE Cost trends

Barriers: Technical, Financial, Regulatory and Political

Recommendations

Globally the cost of utility scale solar and wind power projects have been on a declining trend



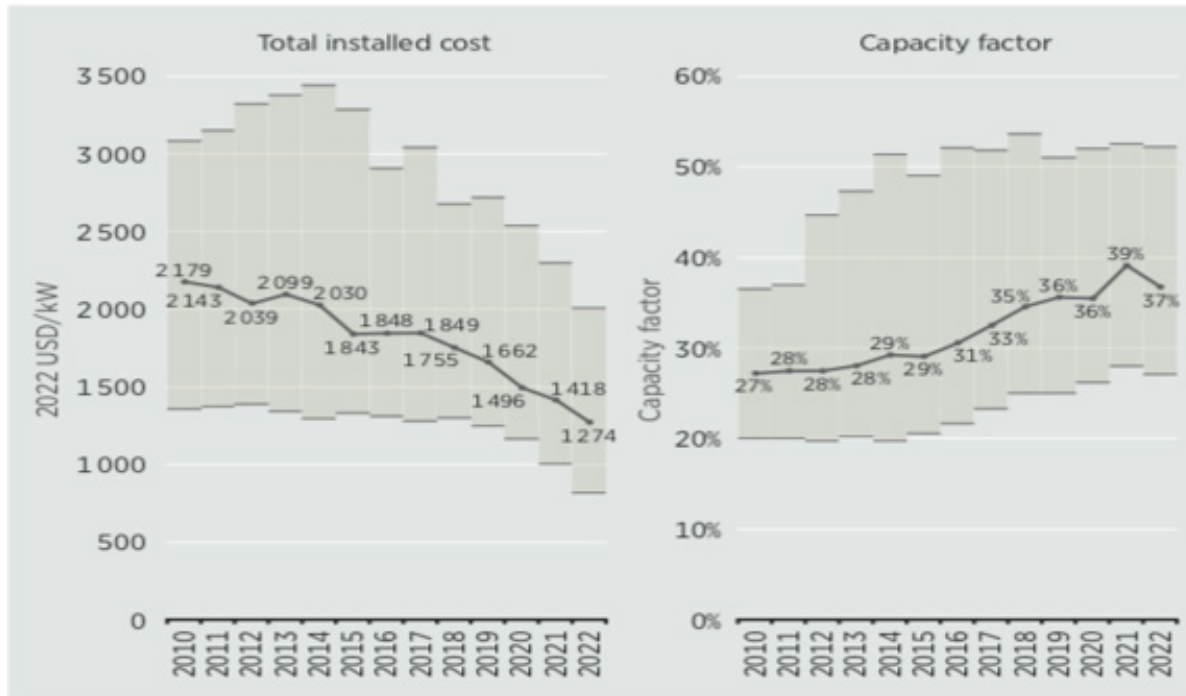
Source: IRENA Renewable power generation costs_in_2022

The global weighted average levelized cost of electricity (LCOE) of newly commissioned utility-scale solar PV projects fell by 88% between 2010 and 2021.

The LCOE of utility scale onshore and offshore wind fell by 68% and 60% respectively.

Economies of scale, increased competitiveness, and maturity in this sector, are primary sources of decline in these prices. Evolving supply chains have also contributed to declining prices of utility scale projects

Alongside steep cost declines, technology improvements have also resulted in better capacity factors for wind projects

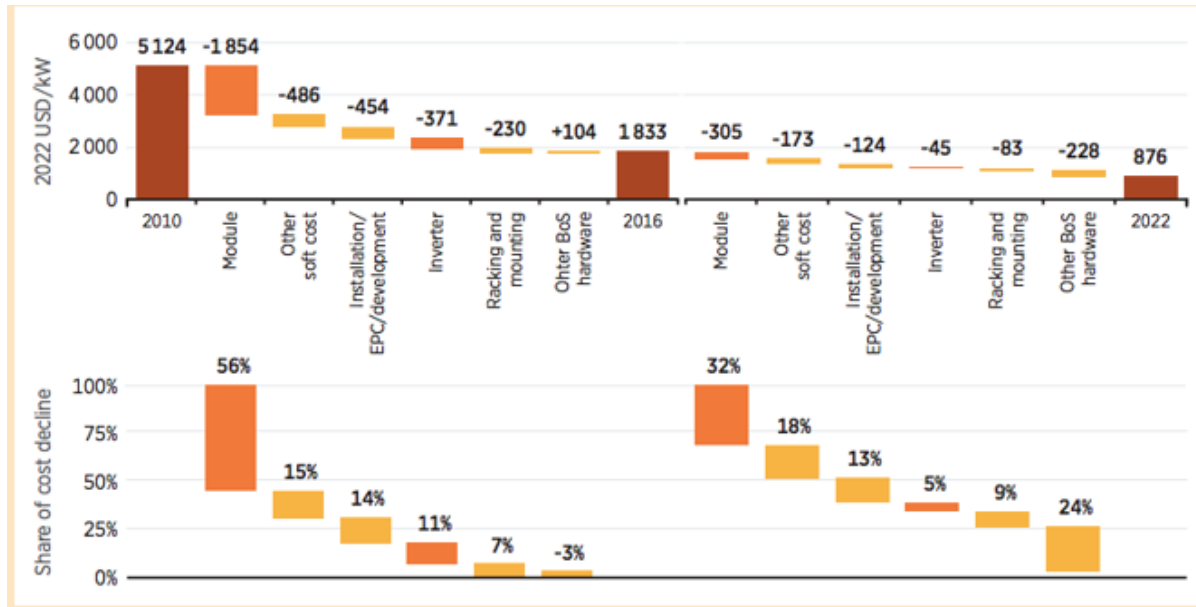


Source: IRENA Renewable power generation costs_in_2022

The global weighted average levelized cost of electricity (LCOE) of newly commissioned utility-scale solar PV projects fell by 88% between 2010 and 2021.

Prior to 2016, the decline in utility scale solar projects was majorly attributed to decline in modules prices, whereas after 2016 improvements have been witnessed in Balance of System costs contributing to 24% decline in project costs.

Globally, decline in PV modules cost has been the primary driver in reducing installation cost of utility scale solar projects.



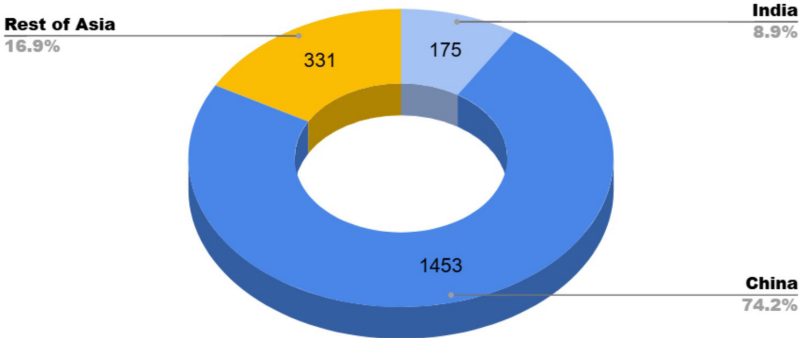
Source: IRENA Renewable power generation costs_in_2022

The global weighted average levelized cost of electricity (LCOE) of newly commissioned utility-scale solar PV projects fell by 88% between 2010 and 2021.

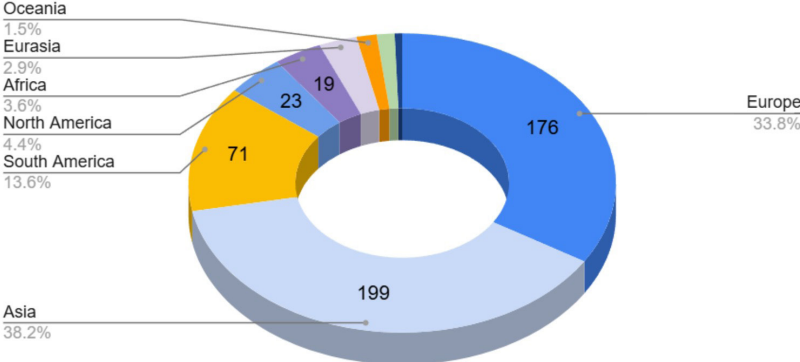
Prior to 2016, the decline in utility scale solar projects was majorly attributed to decline in modules prices, whereas after 2016 improvements have been witnessed in Balance of System costs contributing to 24% decline in project costs.

In past two decades, billions of dollars of global savings have been experienced by displacing fossil fuels and integrating renewables

Asia RE Installed capacity/GW 2023



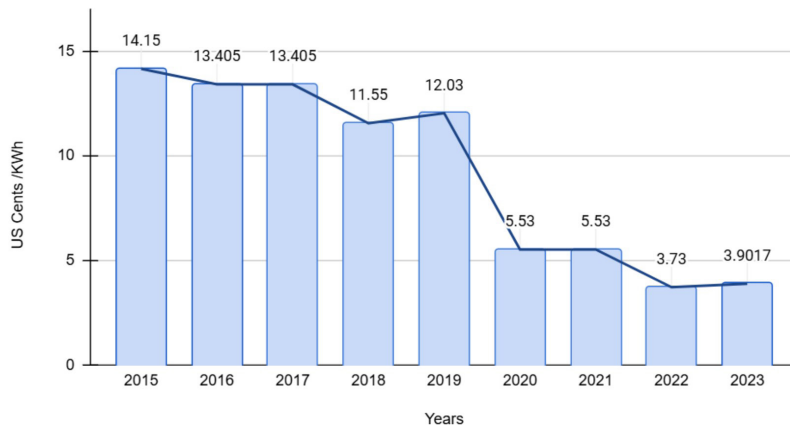
Global Savings billion USD 2022



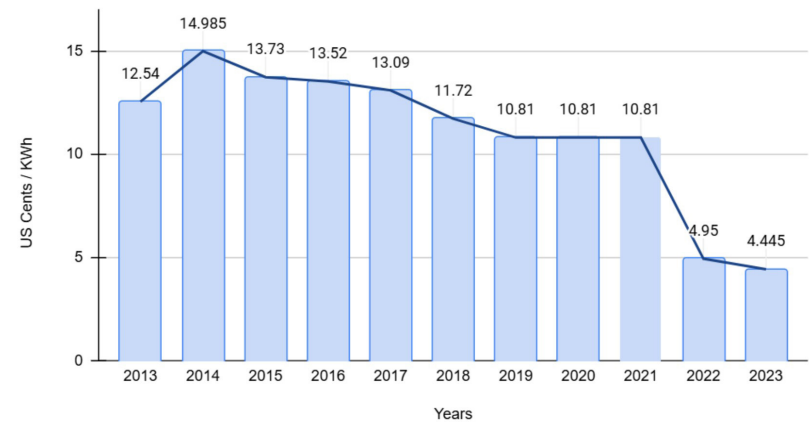
Source: IRENA RENEWABLE CAPACITY STATISTICS 2024

The declining cost trend for solar and wind is also prominent in Pakistan despite the recurring economic and political instability, and existence of regulatory barriers

Levelized Tariff Trends (Solar)



Levelized Tariff trends (Wind)



- Despite steep decline in solar and wind levelized tariffs, their share in the energy mix remains significantly low at 7%.
- A review of tariff determinations of operational projects and projects in pipeline depicts the potential for savings in project costs that have escalated because of various regulatory delays and barriers, and political instability.
- Source: Author' own analysis from NEPRA Solar and Wind IPPs Generation Tariffs



Evolution of Energy Mix



Historical Overview of Policies



Utility Scale Variable Renewable Energy (VRE) share in energy mix vs Potential in Pakistan



Global and National VRE Cost trends



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Barriers: Technical, Financial, Regulatory and Political



Recommendations

Grid Constraints need to be addressed to enhance VRE share in the national grid

Inadequate Reactive Power Support and Voltage Stability:	Absence of Ancillary Services Market:	Inadequate Grid Monitoring ,and Outdated Technology used by System Operator
<p>Long transmission lines and increased capacitance amplifies voltage leading to network stability</p>	<p>Current structure does not support the procurement of power system stability services at competitive rates.</p> <p>All thermal power is engaged on take or pay basis, rather than take and pay to care for baseload</p>	<p>Current system is not capable f real-time monitoring with over 60% of network not being monitored in real-time and relies on old methods of fax and phone.</p> <p>Until Jan 2024, SCADA had not been fully implemented at NTDC, and it covered only 20% of the grid</p>

Even projects which are operational face frequent curtailment (particularly wind IPPs)

Excessive curtailments: Wind power projects accuse NPCC of discrimination

Mushtaq Ghuman Published February 24, 2023

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ISLAMABAD: The country's three dozen Wind Power Projects (WPPs) have reportedly accused National Power Control Centre (NPCC) of discriminating against them through excessive curtailments, well-informed sources told *Business Recorder*.

Curtailment in high wind season: Minister seeks report on UEPW accusations

Mushtaq Ghuman Published July 9, 2023

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Money Matters

Brownouts and blackouts

By Shahid Sattar & Asim Riaz | Mon, 01, 24

Alarm mounts as wind power turbines halt after govt stops purchases

Seasonal grid instability challenges in Pakistan—II

Shahid Sattar | Asim Riaz Published January 24, 2024

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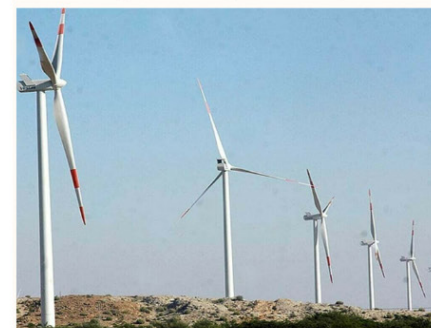


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Wind power projects face curtailment issues as NEPRA set to hold hearing

BR Web Desk Published February 21, 2023

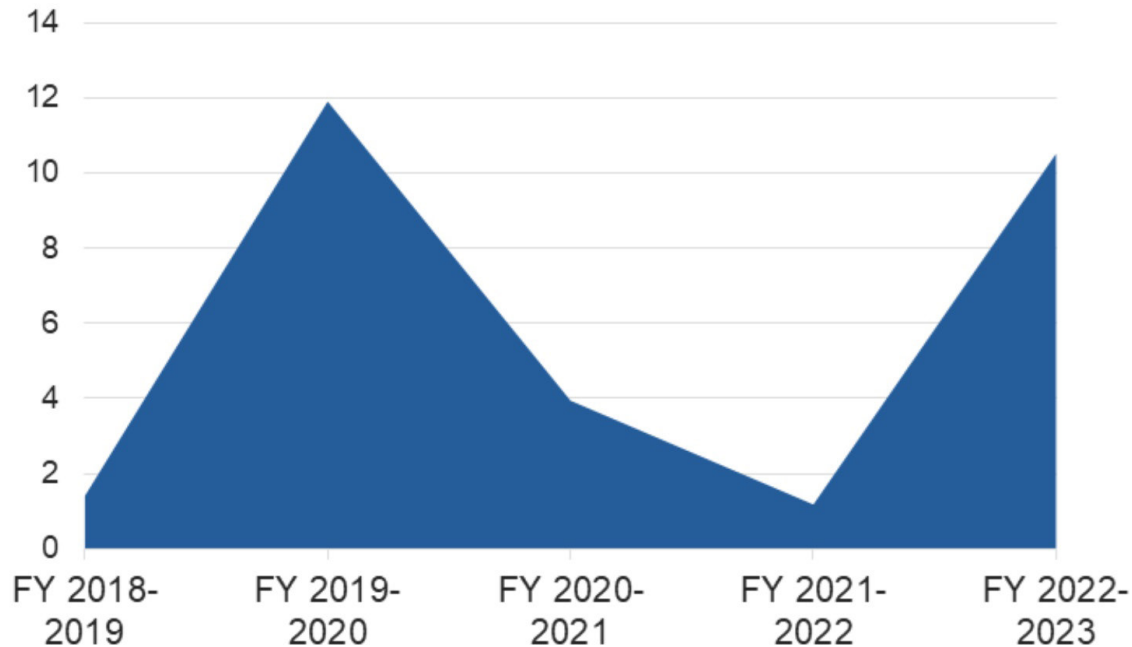
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Renewable plants are always considered an easy target of curtailment since thermal power plants incur higher losses if their operations are halted. This leads to severe generation capacity losses hence undermining the financial feasibility of the project.

VRE plants curtailment has resulted in 28.95 billion PKR in NPMV in the last 5 years

Non-Project Missed Volume (Billion Rupees)



Source: NEPRA State of Industry Report 2023

Curtailed plants in 2023 comprise of 6 solar power plants and 35 wind power plants in FY 2022-2023.

Power purchaser (CPPA-G) is obligated to pay VRE plants for non-project based missed volume such as transmission constraints and scheduled outages, as they engage with the grid on a 'Must Run' status.

Unlike thermal power plants which are paid capacity payments for their full capacity, VRE plants are paid NPMV based on their capacity factors (17-22% for solar, 33-37% for wind)

VRE is discriminately curtailed as a first choice despite it being the least costly source of power generation. At times of low demand, power is continued to generate from costly and environmentally damaging fossil fuels.



Evolution of Energy Mix

Historical Overview of Policies

Utility Scale Variable Renewable Energy (VRE) share in energy mix vs Potential in Pakistan

Global and National VRE Cost trends

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Barriers: Technical, Financial, Regulatory and Political

Recommendations

Majority financing for renewable projects has been foreign, with foreign financing under CPEC taking the lion's share

Foreign vs Local Financing (Operational Solar Projects)



Mostly solar projects have been installed by Chinese investors as part of the CPEC, or financing from Chinese banks.

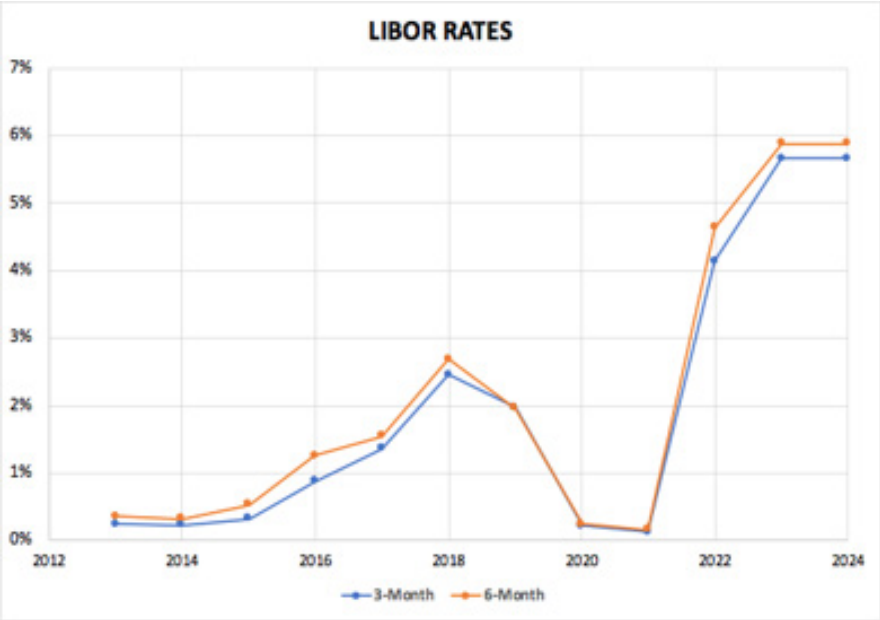
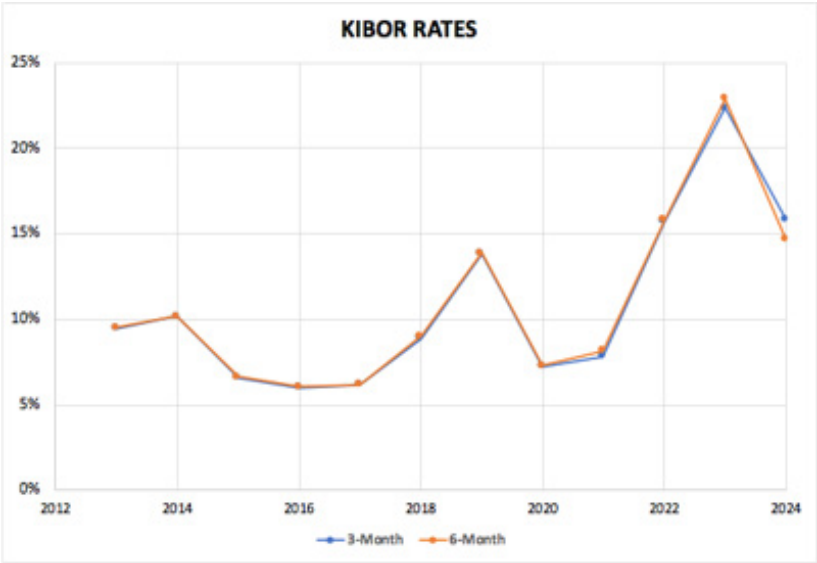
A handful of local banks have been involved in local financing including Bank of Punjab, United Bank Limited, Bank Alfalah, MCB Bank

Most local financing transactions were refinanced at 6% under the State Bank of Pakistan's (SBP's) Refinancing Scheme for Renewable Energy launched in 2016

However, for the period of transition to SBP refinancing scheme, interest was changed at KIBOR + pre-defined spread (usually around 4-5%), highlighting that the interest costs could have been lower for interest during construction cost head

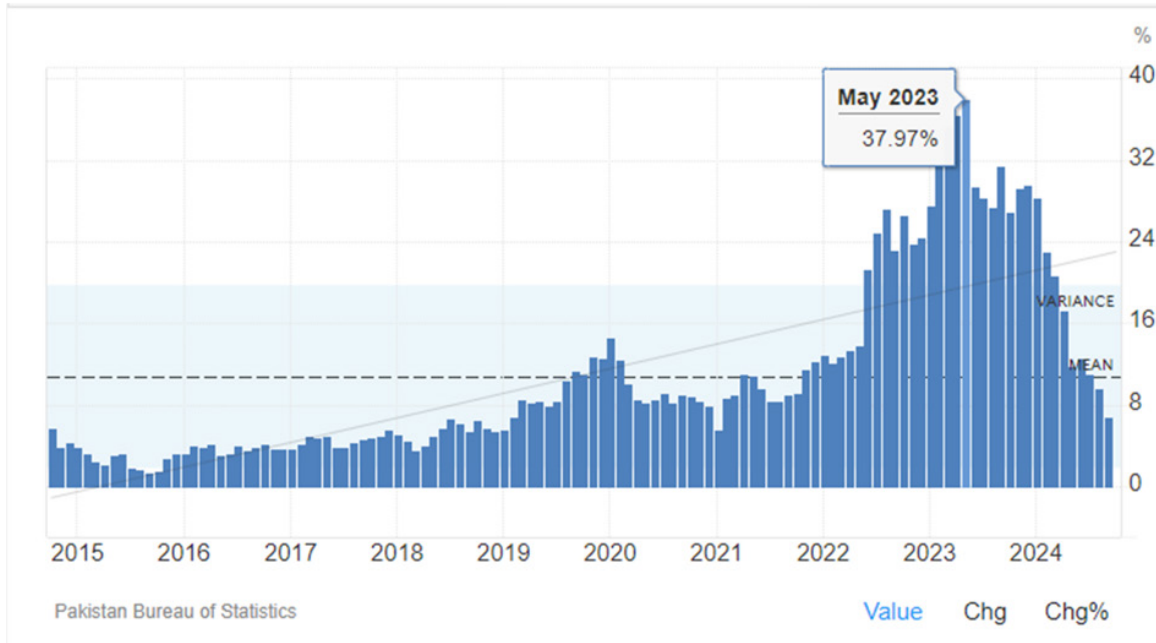
While number of solar and wind project receiving local financing have been low, there is no pledge/commitments by the banking institutions to limit their financing for fossil fuel projects

Interest rate markets have been highly volatile, decreasing the prospects of investments in renewables



Source: How High Interest Rates Harm Innovation By Gina Potthoff Kacik

High inflation as a result of economic crisis has escalated the project costs of Installed VRE projects by having an impact on borrowing costs

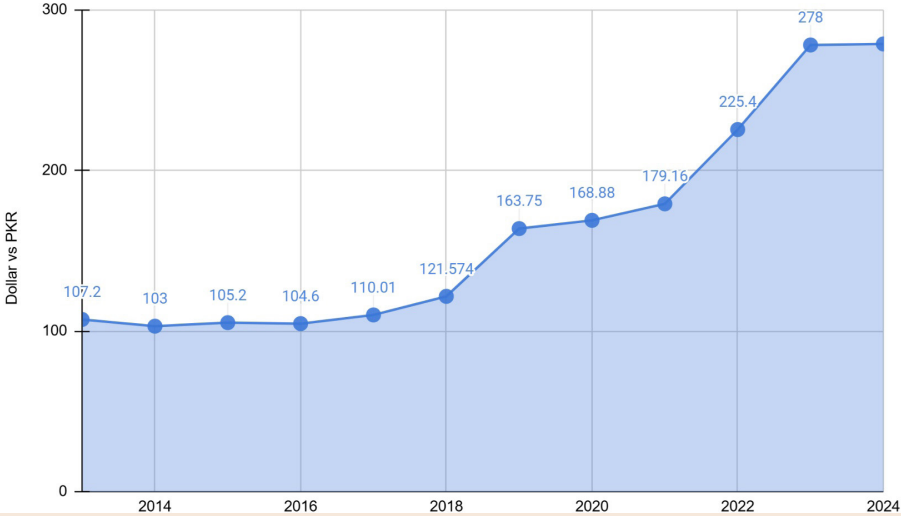


2024	Moody's	positive
2023	Moody's	stable
2022	S&P	stable
2022	Moody's	negative
2022	S&P	negative
2022	Moody's	negative
2020	Moody's	stable
2020	Moody's	under review
2019	Moody's	stable
2019	S&P	stable
2018	Moody's	negative
2016	S&P	stable
2015	Moody's	stable
2015	S&P	positive
2015	Moody's	positive
2014	Moody's	stable
2012	Moody's	negative

Increased Financing Costs
Increased Tariffs
Lowers Investor Confidence

Economic instability has escalated the project costs of Installed VRE projects in PKR terms

Dollar vs PKR vs. Year

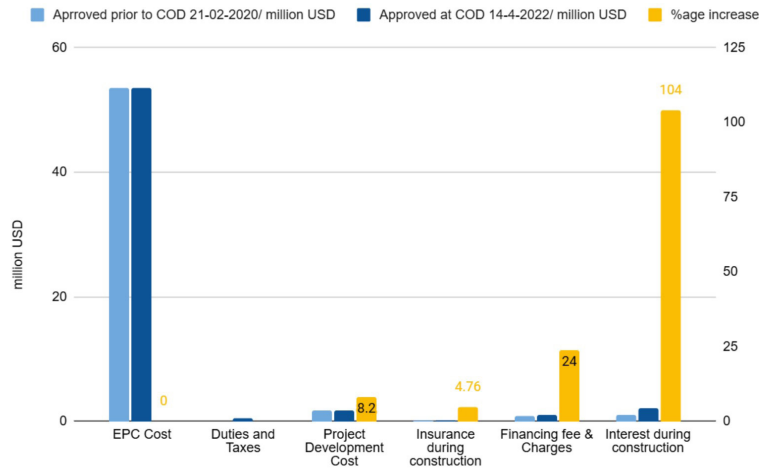


Description	Total Project Cost/ million USD	Total Project Cost/ Million Rupees (1USD = PKR 104.786 (16-12-15))	Total Project Cost/ Million Rupees (1USD = PKR279.93(8/6/2024))
>50MW ≤100MW	1.194	125	334
>20MW ≤50MW	1.2	127	338
≥1MW ≤20MW	1.23	129	344

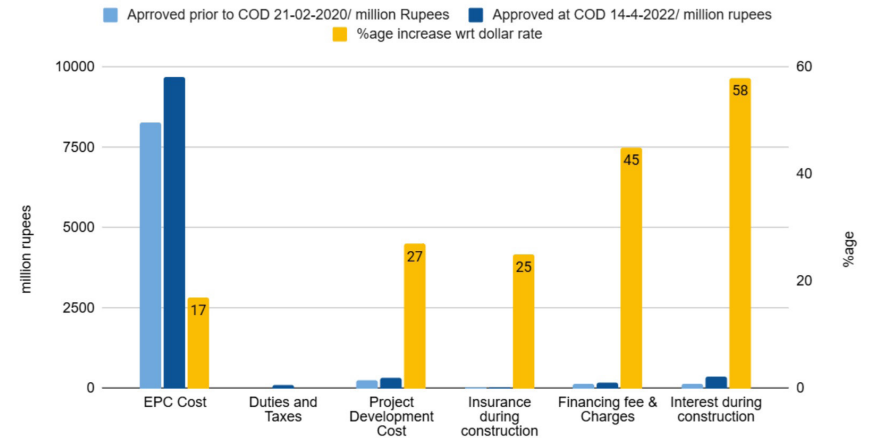
Between 2013 and 2024, PKR/USD exchange rate has inflated 1.67 times
 In upfront tariff determination for solar projects, PKR/USD exchange rate was set at 105
 Project costs such as Engineering, Procurement and Construction (EPC) costs, Financing costs, Consultants’ cost, and other costs which were dollar denominated therefore increased by a factor 1.67 on average

Project cost heads dependent on interest rates, and project development costs have seen increase at the time of commercial operations from the initially determined costs – A case study of Atlas Solar

Approved Costs prior to COD 21-02-2020 million USD vs Approved costs at COD 14-4-2022 million USD



Approved costs prior to COD (21-02-2020) million Rupees vs Approved costs at COD (14-4-2022) million rupees



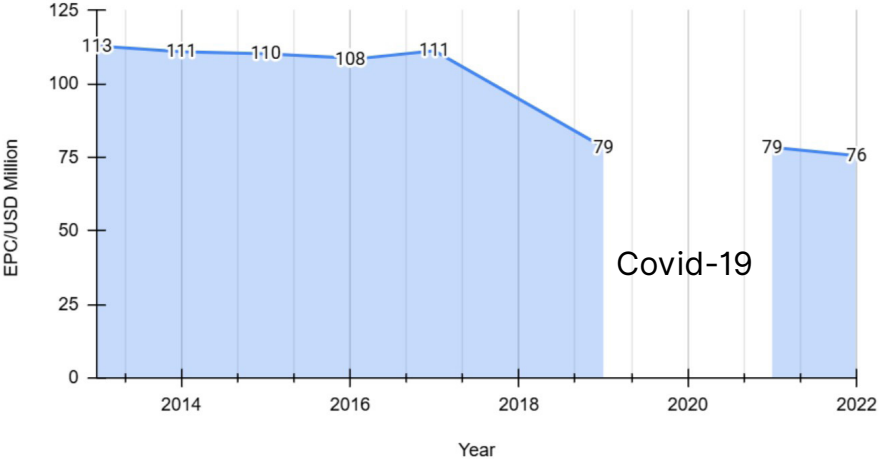
With respect to rupee dollar exchange rate variation, at the time of COD of Atlas solar, we see a 17.2% increase in the overall cost.

Actual project cost in rupees at the time of commercial operations is generally higher than the costs determined in the upfront tariff determinations.

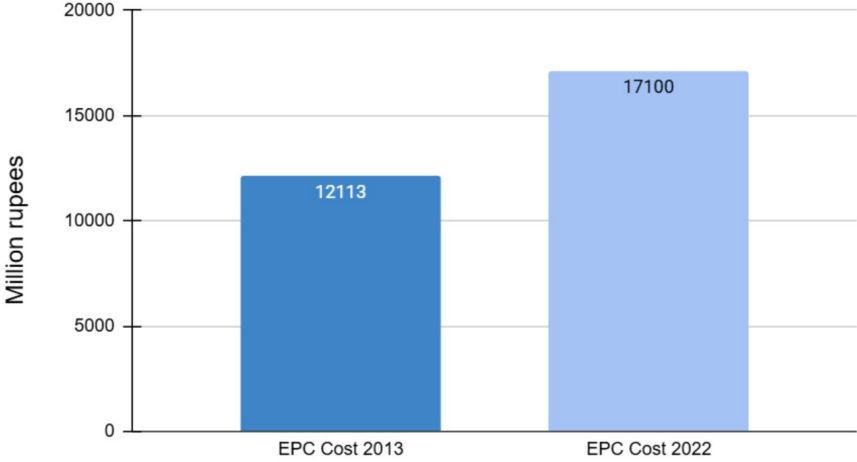
Sources: Author's own analysis of Atlas Solar Tariff Petitions NEPRA

Reviewing Annual Trends: While EPC Costs for Wind Power Projects have Declined in Dollar Terms Over the Years, an Increase Is Observed When Considered in Rupees

EPC cost USD Million vs. Year



EPC Cost Comparison in Rupees for 50 MW



Reviewing Annual Trends: While EPC Costs for Wind Power Projects have Declined in Dollar Terms Over the Years, an Increase Is Observed When Considered in Rupees



Evolution of Energy Mix



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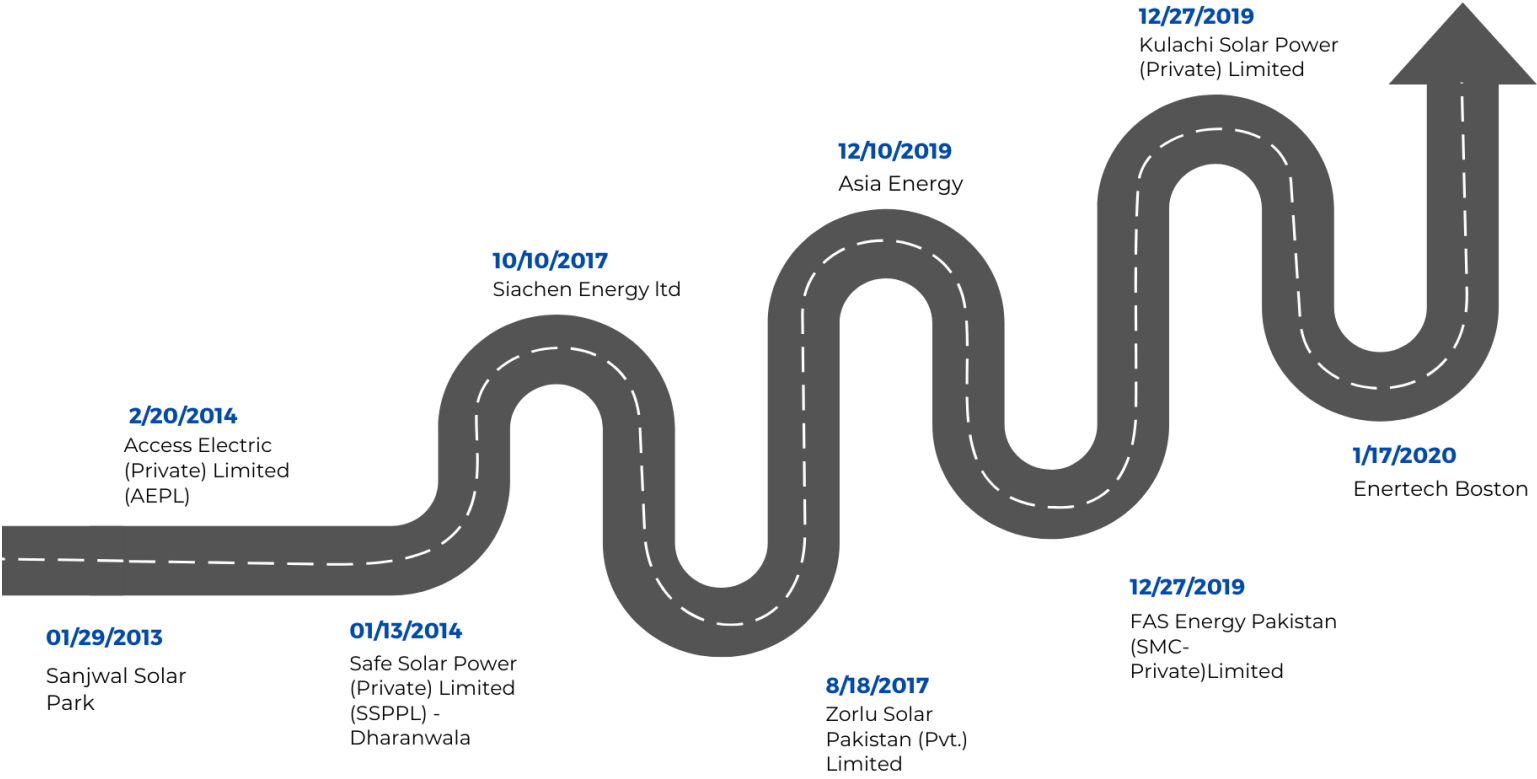
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Barriers: Technical, Financial, Regulatory and Political



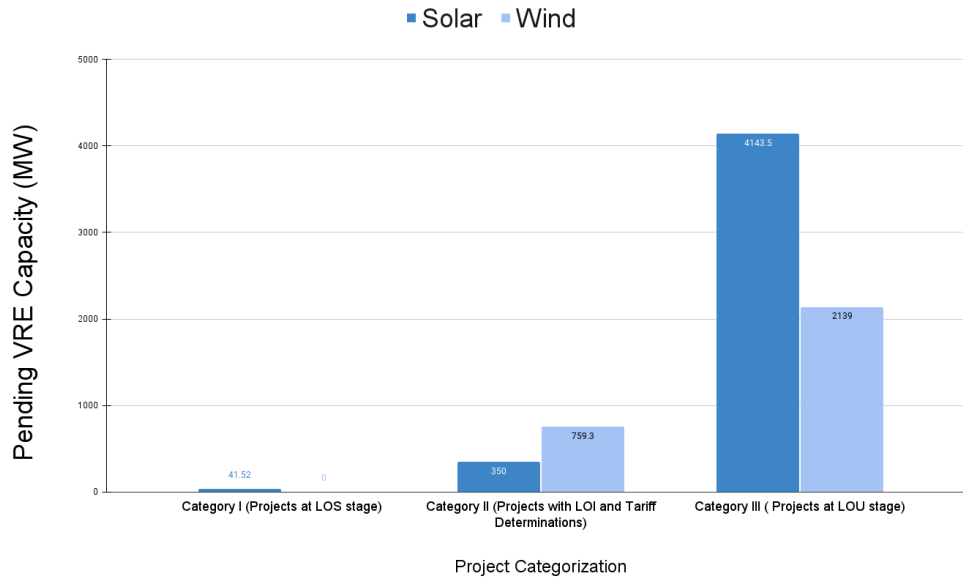
Recommendations

Meanwhile, many VRE projects that showed interest in developing utility scale VRE based power generation plants have not been realized



Solar Plants victim of regulatory and institutional delays with either pending CODs, or unknown development status

Projects in pipeline under RE Policy 2006, after its expiry, were categorized to determine their way forward



Category I Projects:

Projects which have received Letter of Support by the government (i.e. their initial feasibility studies have been approved, they have received tariff and generation licenses, and submitted performance guarantees and now working on their financial close)

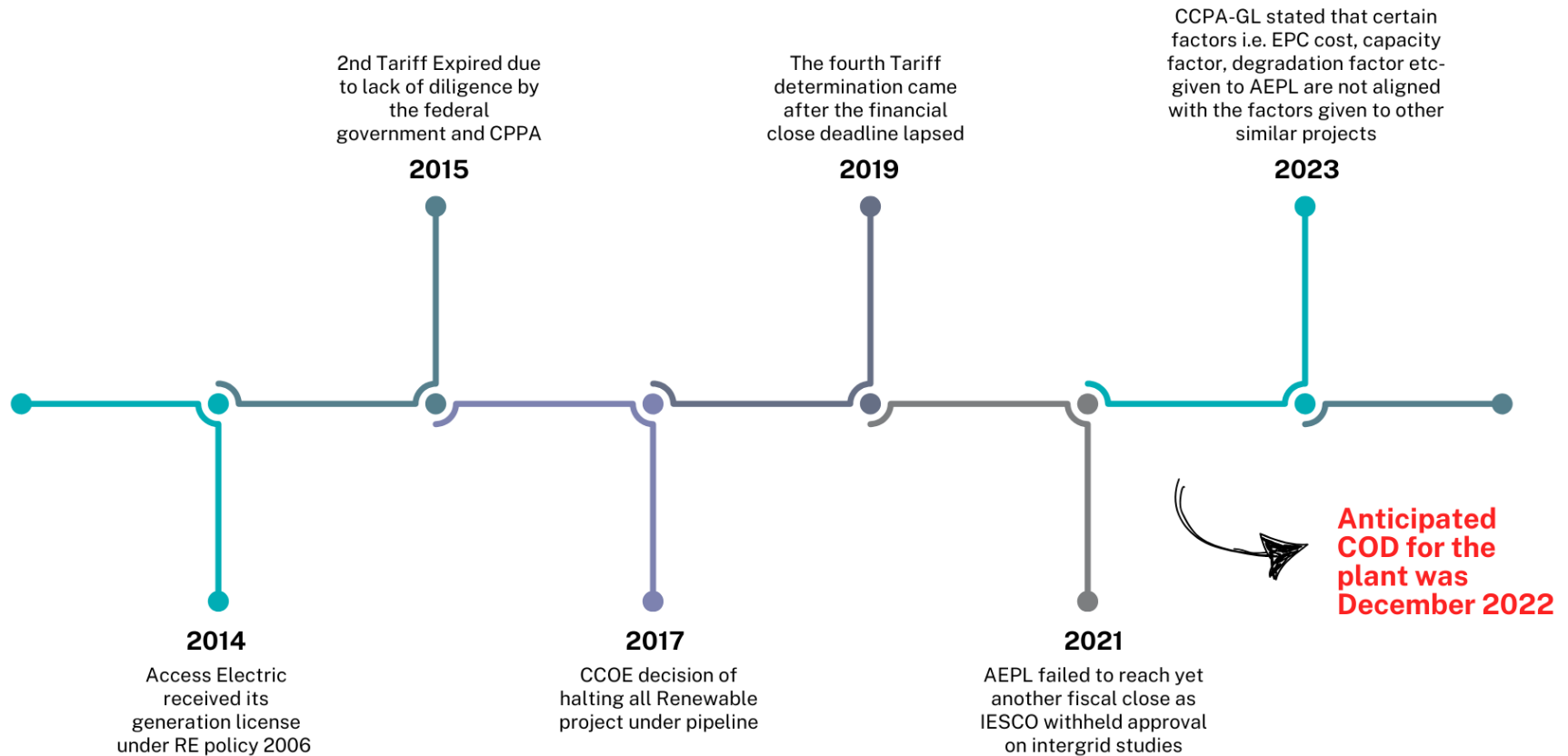
Category II Projects:

Projects which have received Letter of Intent, Tariff Determination and Generation License

Category III Projects:

Projects which have received Letter of Intent prior to RE Policy 2006 expiry, they will proceed under competitive bidding if qualified

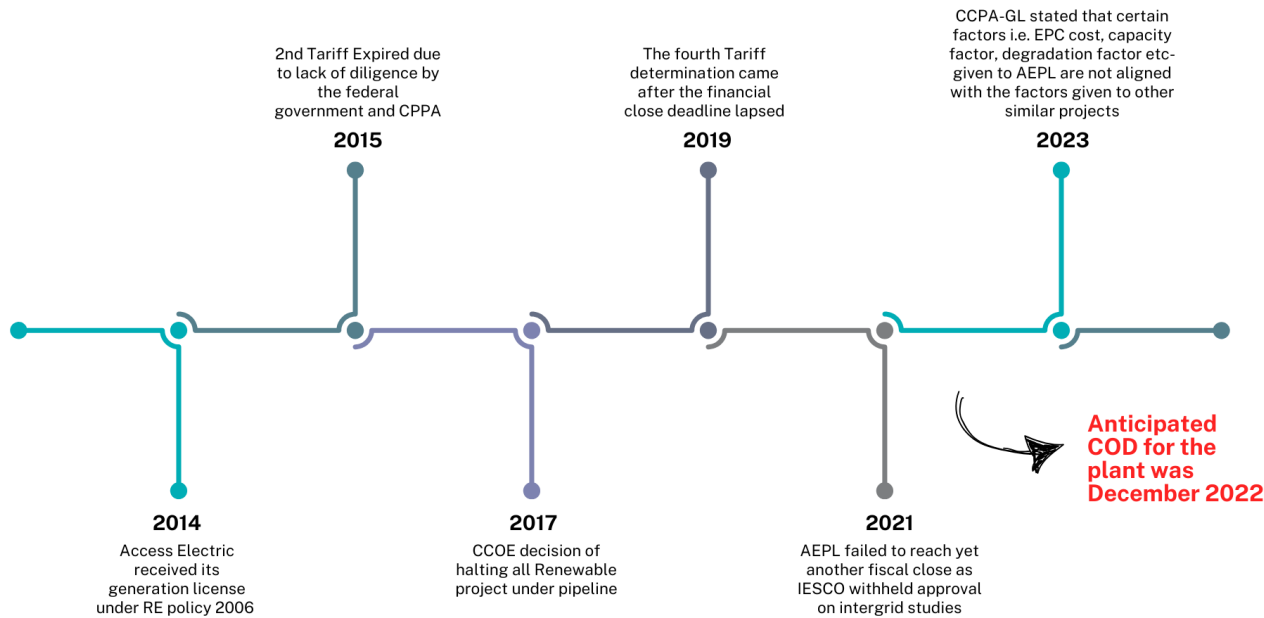
Case Study of Access Solar Pvt. Limited – a project lost in time



The plant is now considered as a category 1 project and is expected to be commissioned in March 2025.

Sources: Author's own analysis of Access Solar Tariff Petitions NEPRA

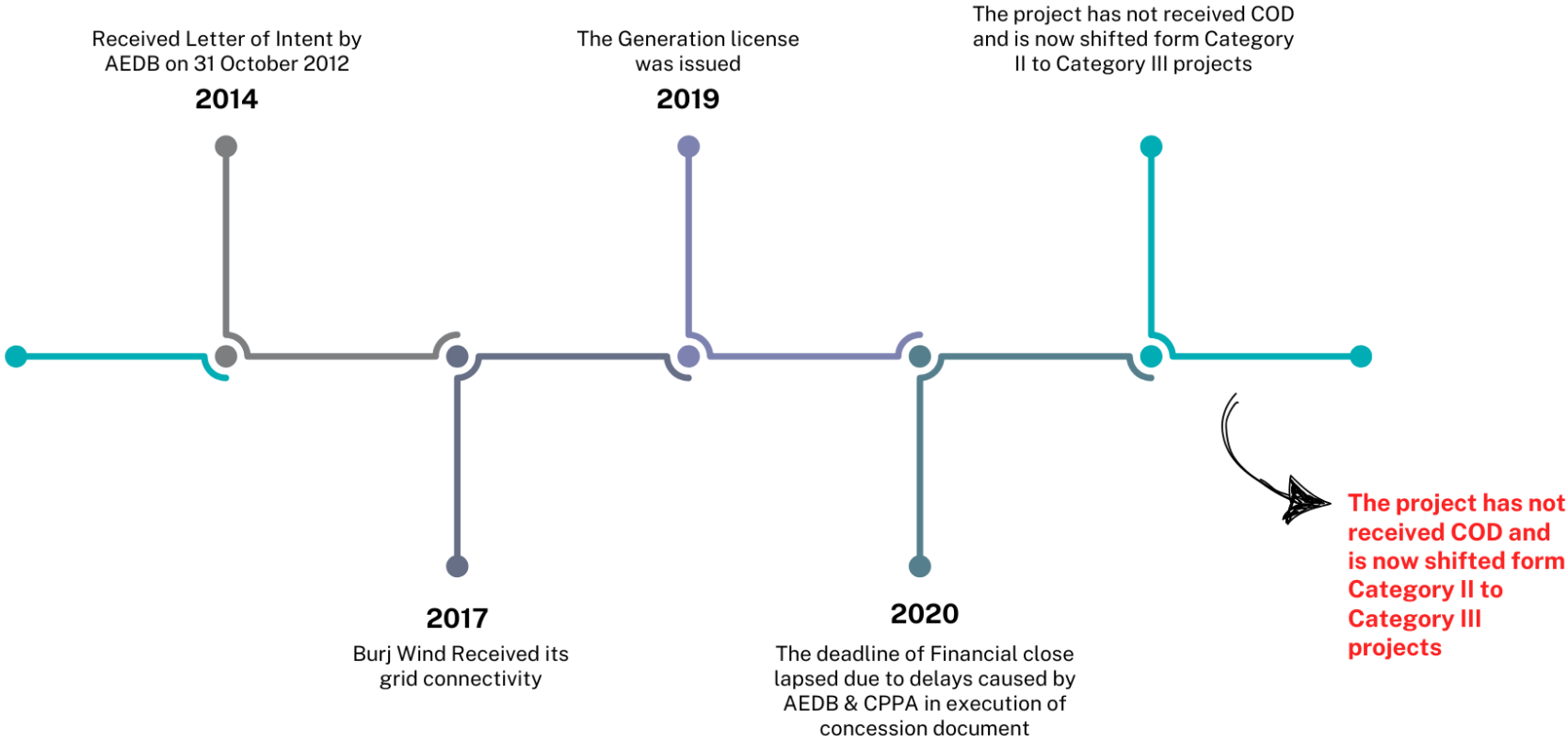
Case Study of Enertech Bostan Pvt. Limited – a project lost to regulatory delay



Although receiving LOI in 2016, 2 years prior to RE Policy 2006 expiry, and completing all the milestones to be eligible for LOS, except for the ones in which NEPRA delayed their tariff determination despite availability of tariff petition, the project that could have installed in Balochistan, now holds an unknown status.

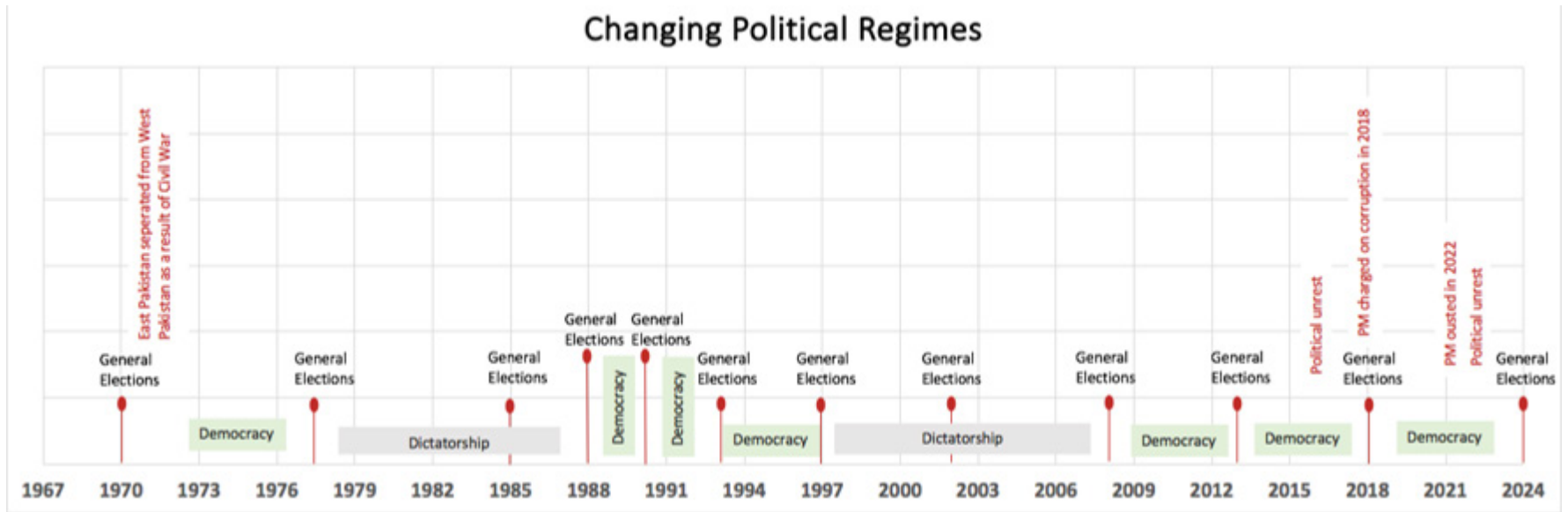
Sources: Author's own analysis of Enertech Bostan Tariff Petitions NEPRA

Case Study of Burj Wind – a project lost to institutional delays



Sources: Author's own analysis of Burj Wind Tariff Petitions NEPRA

Political instability has contagiously affected Pakistan's progress for most period of its existence



Military dictatorships have been long-lived and recurrent whereas periods of democracy have been short-lived
Last decade is marked with significant incidences of political unrest, prolonged protests, overturning governments

Trust Deficit: Government's efforts to attract local and foreign investors for its 600MWp Solar project at Muzzargarh has been in vain

dawn.com/news/1805138

Govt fails to woo a single investor for solar project

Khaleeq Kiani | Published January 12, 2024



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ISLAMABAD: In a major setback, no bid was received for setting up a 600-megawatt solar power project at Muzaffargarh despite multiple revisions in incentives and extensions in deadlines given by the Private Power & Infrastructure Board (PPIB) — a one-window power sector entity of the federal government.

While K electric 220 MW hybrid solar/wind project in Dhabeji, Sindh, received several bids when auctioned and has now achieved a record low tariff of Rupees 8.9189 per unit.

VRE project costs have mainly amplified because of political, economic, and regulatory barriers

Our policies and regulatory frameworks still benefit Thermal and Hydel technologies

Infrastructure enhancement for thermal generation are faced with no resistance (e.g. spreading railway lines to transport coal) whereas grid enhancement to incorporate more VRE share has never been prioritized



Evolution of Energy Mix

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Global and National VRE Cost trends

Barriers: Technical, Financial, Regulatory and Political

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Recommendations

Recommendations

1. Develop Implementable Policies, in which meeting the targets is linked to accountability measures as well

4. Introduce or promote green bonds and climate bonds to raise capital specifically for renewable energy projects. These can be attractive to both domestic and international investors.

7. Build capacity of local persons working in energy space so that they begin to look at VRE as an opportunity to innovate the outdated systems rather than a problematic technology

2. Approvals and permits required by investors from government entities should be provided within the defined timelines under policies

5. Foster a stable investment environment by creating policy consistency and market predictability. Ensure transparency in market operations, including pricing and regulatory changes, to build investor confidence.

8. A shift to ecological sustainability would seek to go beyond “business-as-usual” capitalist finance system approaches. (Going beyond the risk and return logic which are the fundamental determinants for private investors)

3. Advanced financial risk management tools must be introduced by the banking institutions to shield against volatile interest rates, or currency movements

6. Incentivise Local Investments by mandating local banks to green their financing mix, lowering their reserve requirements, or providing concessionary lending rates for VRE projects.

9. Engage in public awareness and advocacy about economic and environmental benefits of VRE projects to build public and political support. Highlight and publicize successful VRE projects in Pakistan to demonstrate the sector’s potential and attract additional investment.