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PFAN
Accelerating Investment for Climate and Clean Energy

CLEANTECH ECOSYSTEM OF PAKISTAN





UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

REEEP

PREPARED BY

Data Darbar Technologies
E-mail: media@datadarbar.io | Website: https://insights.datadarbar.io

Mutaher Khan
Natasha Uderani
Ahtasam Ahmad
Abdul Rafay
Susheel Kumar

Designed by: Ayla Khan and Ayesha Anwar

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DISCLAIMER

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Global Overview

GLOBAL CLEANTECH LANDSCAPE

Decades of unchecked industrialization, coupled with an ever-growing appetite for consumption, have pushed our planet to the brink of an existential crisis. This relentless pursuit of unsustainable growth has not only exploited natural resources but has also led to a massive accumulation of greenhouse gases in the earth's atmosphere, fundamentally altering our climate and local ecosystems.

As a result, the global average temperature has risen by approximately 0.06° Celsius per decade since 1850, since the pre-industrial era (late 19th century).[1] This seemingly small shift in temperature has set off a chain reaction, manifesting in frequent and severe weather events, rising sea levels, and altered ecosystems.

At the current rate of greenhouse gas emissions, scientists project a temperature rise of 2.5°C to 4.5°C by the end of the 21st century, making large parts of the planet nearly inhabitable.[2] In fact, there have already been early warning signs from raging wildfires to heatwaves across continents. This alarming trajectory underscores the urgency of addressing the root causes of climate change.

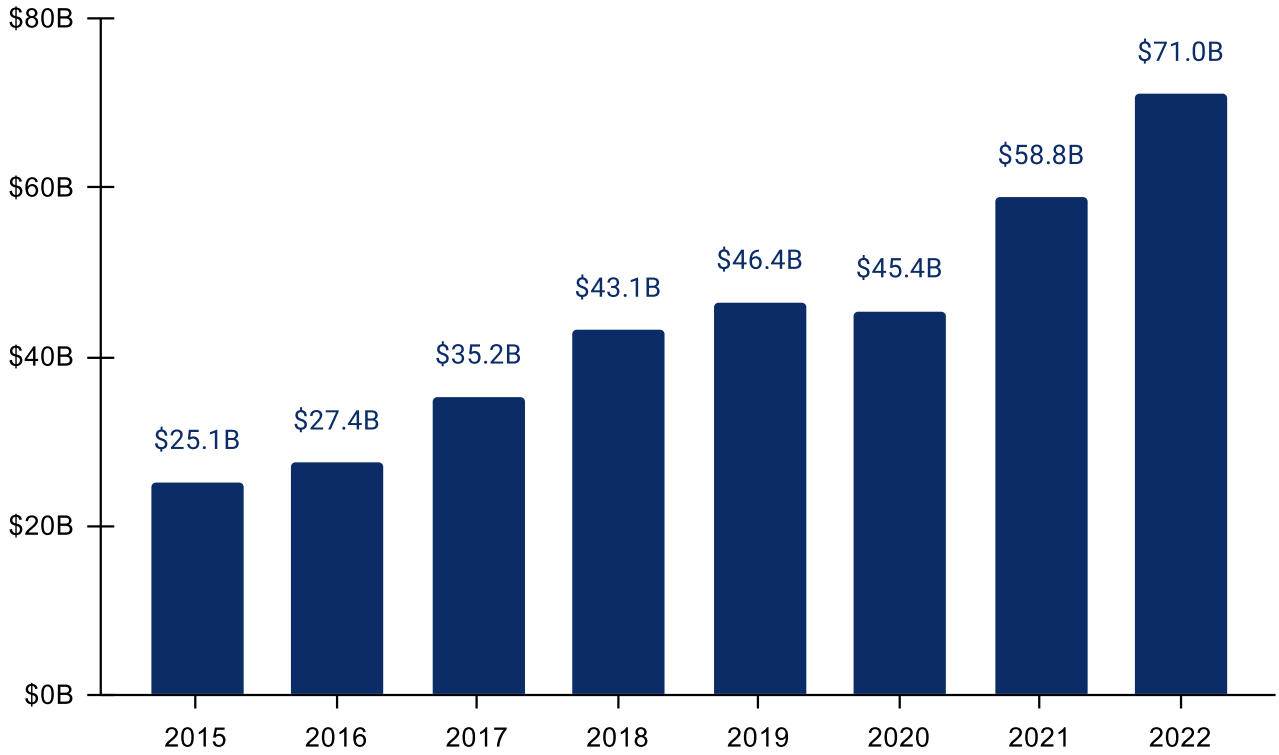
It's a clarion call for a global shift towards sustainable practices and technologies, highlighting the critical role of cleantech in mitigating these impacts and steering our planet away from its current, perilous course. In this regard, the international community banded together in 2015 for the Paris Agreement where 195 signatory countries agreed to restrict the rise in global temperatures to 2°C above pre-industrial levels and ideally to 1.5°C.[3] This included commitments from all countries involved to cut their emissions through a five-year cycle where each state will set forth its own climate action plan, or the Nationally Determined Contributions (NDC).[4]

To help achieve these targets, developed countries agreed to mobilize $100 billion annually by 2020 to help the financial needs of developing nations in their fight against climate change. However, the lofty goal still remains elusive as the developed countries provided and mobilized $89.6 billion for the Global South in 2021 — almost 10% short of the target a year after the initial deadline.[5] Since then, the financial needs of developing states have possibly further amplified in the wake of climate catastrophes such as urban flooding and heat waves.

1. Climate Change: Global Temperature - Climate.gov
2. Is it too late to prevent climate change? - NASA Science
3. List of Parties that signed the Paris Agreement on 22 April
4. Key aspects of the Paris Agreement | UNFCCC
5. Climate Finance and the USD 100 Billion Goal - OECD

Only 16.1% of the climate finance mobilized by developed countries in 2021 was in the form of private finance while the lion's share came as a result of bilateral and multilateral efforts.[4] Particularly, the multilateral development banks have accelerated their efforts and made climate finance commitments of around $71 billion during 2022, with the World Bank Group contributing just under half.[6] By instrument, 61% of the committed climate finance for low- and middle-income countries was in the form of investment loans while another 14% came via policy-based financing and 10% through grants. Additionally, more than two-thirds of the amount was earmarked for mitigation and the rest for adaptation.

Fig. 1: Global Climate Finance commitments from MDBs



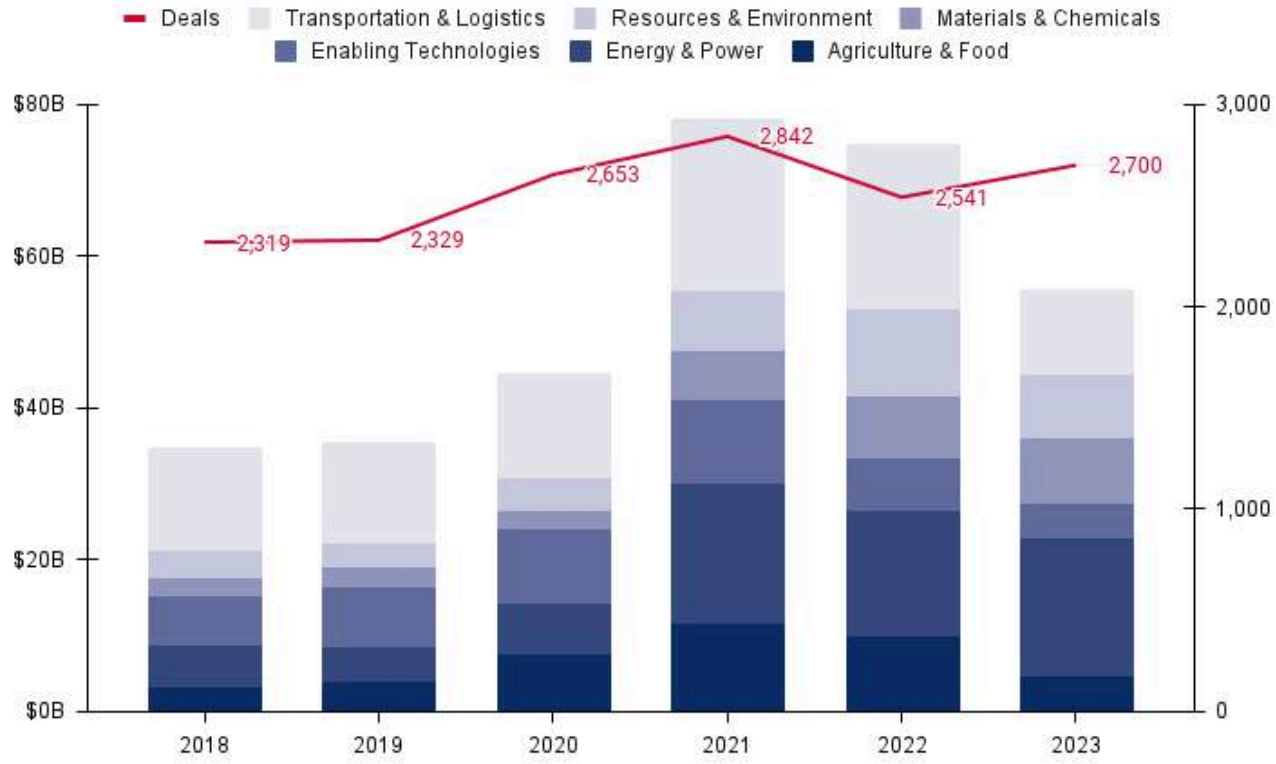
Understandably, climate finance is a rather broad category that primarily concerns itself with funding avenues for proactively and reactively tackling the effects of climate change. In line with the Paris Agreement's NDCs, it becomes the primary responsibility of national governments, and thus the bulk of the climate finance so far has been committed to public sector recipients.

Sniffing opportunity, as well as pressure from civic groups including the ESG movement, private financiers have also increasingly adopted climate as an important thematic area in assessing investments. As a result, both cleantech and climate tech, two related verticals with slight differences in taxonomy, have seen significant uptake in capital deployment compared to five years ago, despite recent recalibration due to the overall market slowdown.

6. 2022 Joint Report on MDB's Climate Finance

Venture and growth investments to cleantech companies clocked in at $55.7 billion across 2,700 deals during 2023.[7] While the amount was down 25.4% year-on-year, this was better than the 34.7% decline seen in the overall VC. Meanwhile, the number of cleantech deals actually bounced back 6.3%, as against a 22.1% dip in the VC ecosystem at large.

Fig. 2: Cleantech Funding Activity

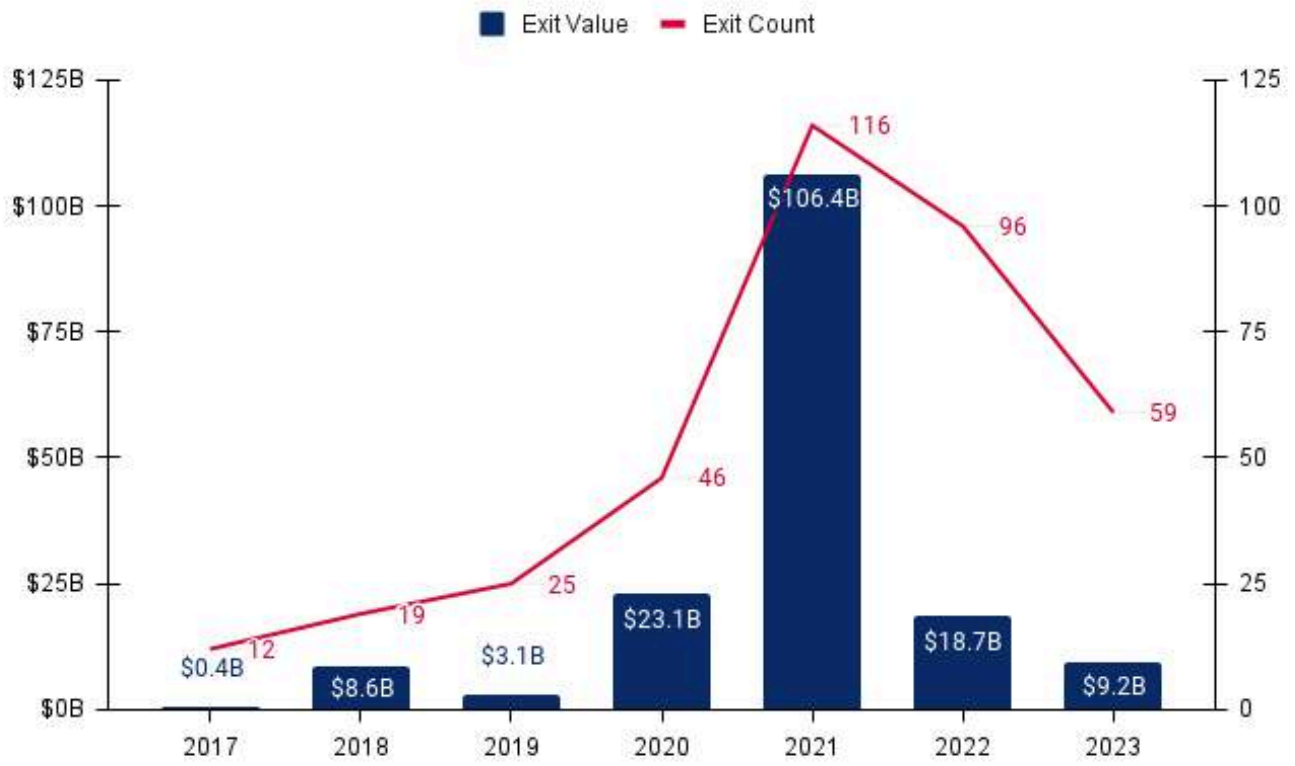


Zooming in at the vertical level, transportation & logistics contributed the largest decline in absolute value as its amount went down by $10.5 billion, or 48.2%, in 2023. This is slightly steeper than the overall trend in mobility where VC funding plunged 38.3% year-on-year to $26.6 billion — down 71.5% compared to the 2021 levels and the lowest figure since 2015. In relative terms, agriculture & food witnessed the sharpest contraction of 53.5%, or $5.3 billion, to $4.6 billion in the outgoing year. On the other hand, energy & power bucked the trend and saw venture funding increase 10.4% to reach $18.1 billion. Materials & chemicals also edged up 6.2% to its highest-ever total of $8.6 billion.

Over the last half decade, one major trend has been the geographical rebalancing where North America's domination in the investment ecosystem has waned significantly. The region's share in total deals and amount stood at 37.5% and 42.0%, respectively, during 2023, a significant decline compared to 55.1% and 61.1% back in 2018. In its stead, Europe & Israel emerged to be the biggest gainers and now account for 40.9% of the volumes and 30.8% of the funding value, up from 30.0%

7. CleanTech Group

Fig. 3: ClimateTech VC Exit Activity



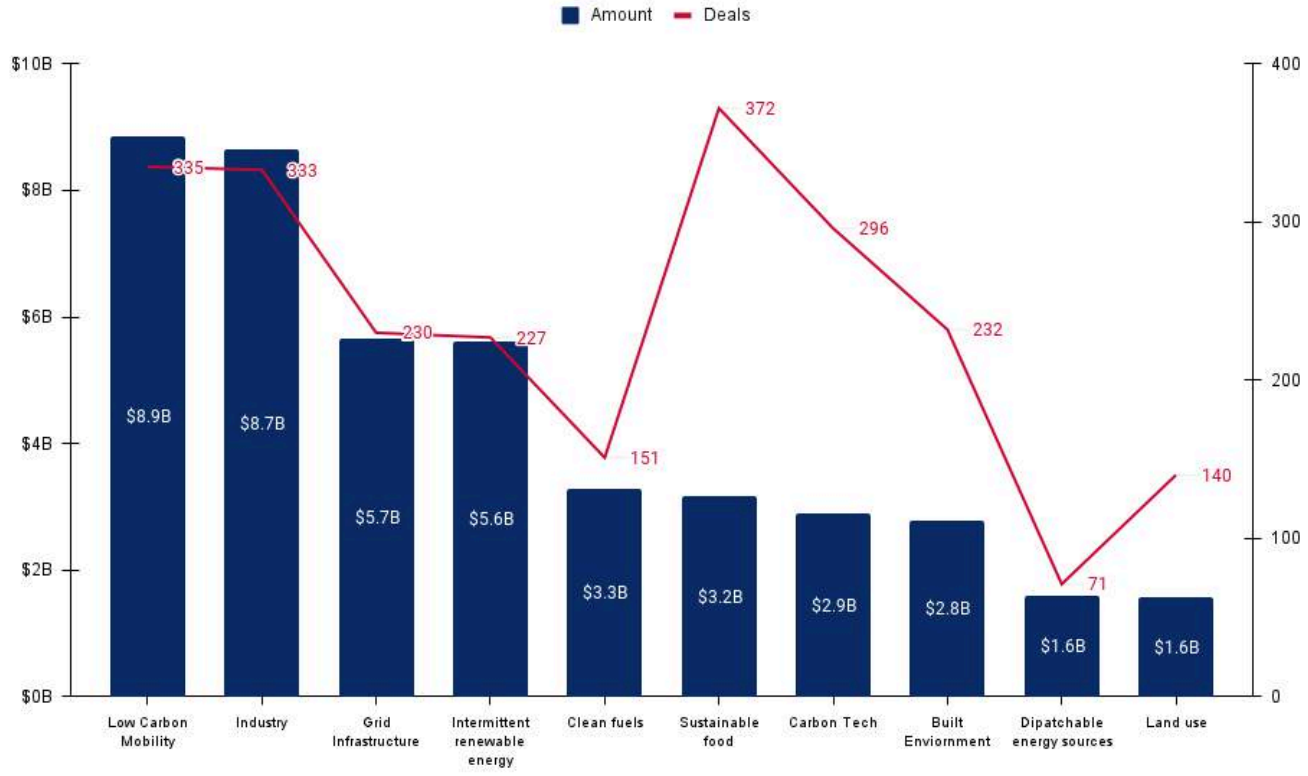
and 19.1% in 2018. Even in absolute terms, the region defied the funding downturn and raised $10.2 billion across 472 deals, up 17.2% and 22.0%, respectively.

However, most leading data providers and analysis platforms, such as PitchBook and NetZero Insights, refer to the industry as ClimateTech with slight differences in taxonomy,[8] which is often the case with any emerging technology vertical where there's no standardization as yet. The former reported that the total VC funding to climate tech companies fell by 14.6% to $41.1 billion in 2023,[9] making it even more resilient than the overall venture ecosystem. The number of deals also edged lower by a modest 1.7% to 2,312.

The slowdown was much more visible on the exit side where the total exit value unlocked by VC-backed climate-tech companies stood at $9.2 billion across 59 unique deals. This represents a 50.8% decline in funding value over the previous year and a massive 91.4% compared to the high of 2021. In contrast, the exit value of the overall venture ecosystem decreased by a relatively better 28.1% during 2023. Segment-wise, low-carbon mobility bagged the highest amount of $8.9 billion across 335 deals. Industry followed right behind with $8.7 billion in dollar value and 333 deals. By volume, sustainable food stood ahead of others with a deal count of 372 though the amount of $3.2 billion was much smaller in comparison.

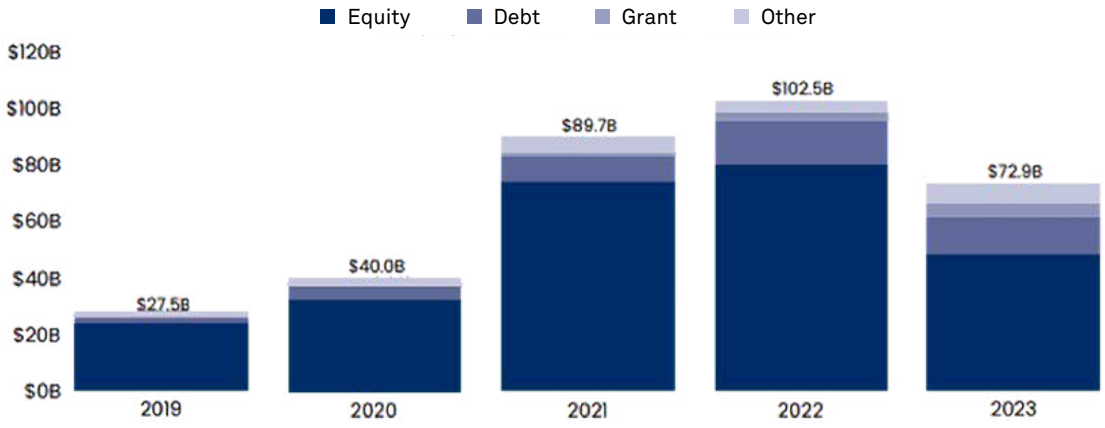
8. "Climate tech" is a broad term, and exact definitions of climate technologies and applications vary. This note combines two analyst-curated verticals—carbon & emissions tech and clean energy—and adds climate-relevant categories from the mobility and foodtech verticals to provide a broad view of the climate tech space. This analyst note is an update to our Q2 2023 Analyst Note: VC Investment in Climate Technology, and as such, we define the climate tech space as technologies that act to mitigate climate change by reducing greenhouse gas emissions. This excludes certain climate-adjacent areas such as land- and water-pollution remediation, water-use reduction, and climate adaptation technologies.
9. VC Investment in Climate Tech 2023 - Pitchbook

Fig. 4: ClimateTech Deal Activity by Segment



NetZero Insights presents an even more detailed overview of the investment trends in the space. According to its State of ClimateTech 2023 report, total funding reached $72.9 billion across 4,010 deals, compared to $102.5 billion and 5,129 the year before.[10] This includes not just equity but non-dilutive sources like debt and grants and thus explains why the figures are significantly higher than other data sources.

Fig. 5: ClimateTech Financing by Instrument



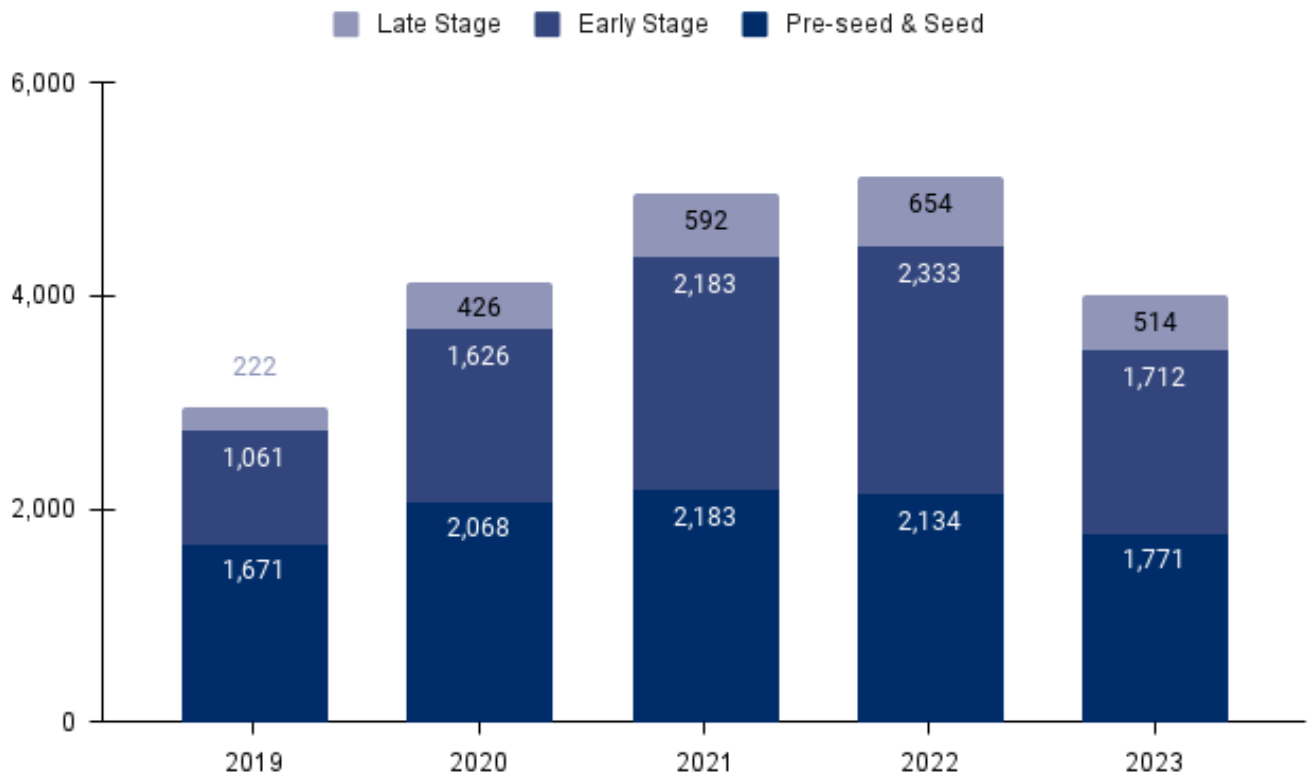
10. State of Climate Tech 2023 - Net Zero Insights

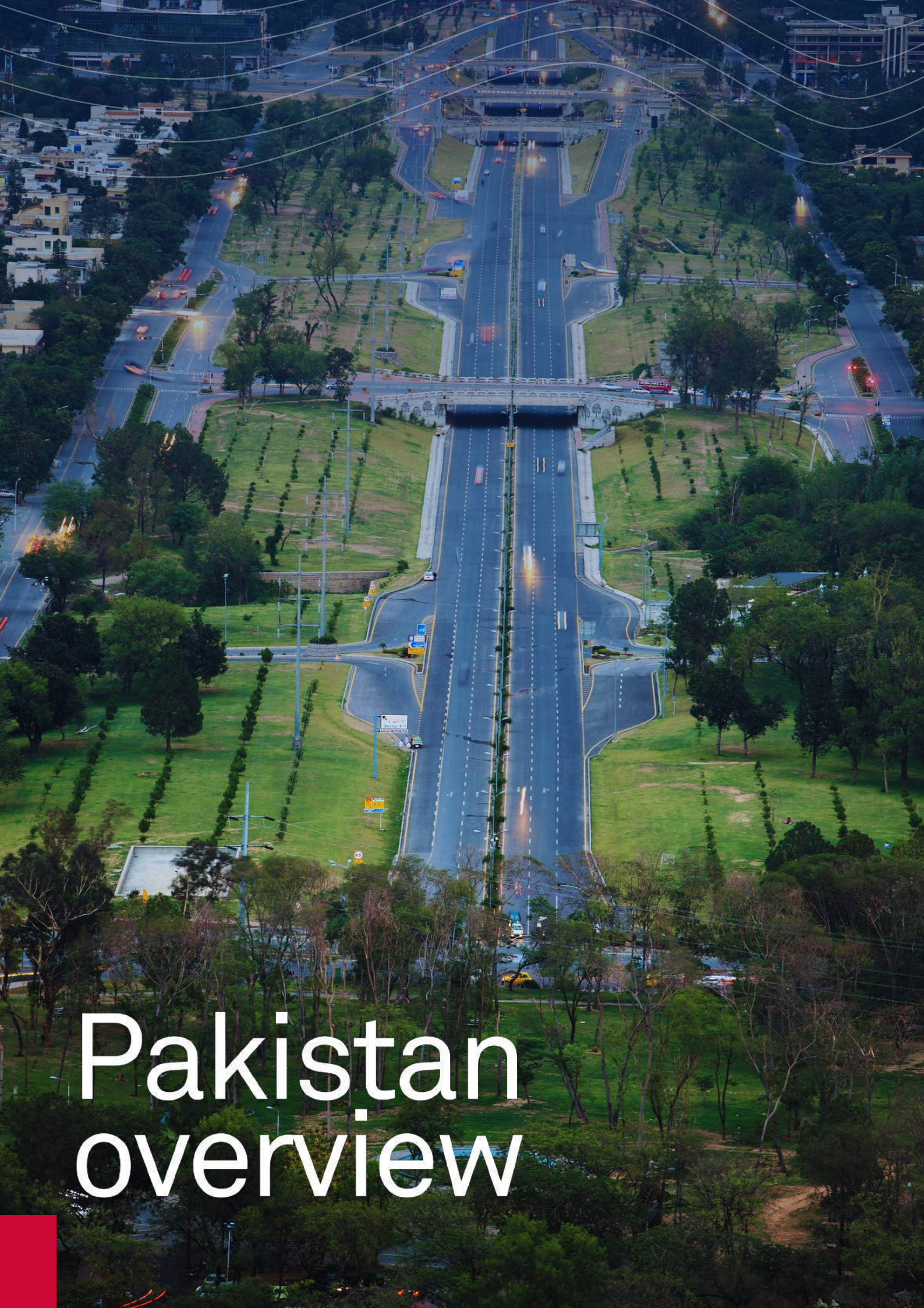
Predictably, equity was the most popular financing type and accounted for 61.6%, or 2,472, of all deals, while also having the largest share in overall amount.

Among regions, Oceania had the highest proportion of equity financing while debt was the dominant instrument in Africa. Globally, one-third of funding in 2023 was non-dilutive, compared to 22.7% the year before, pointing to how alternate avenues of capital helped prevent a sharper decline. Zooming in at the sub-sector level, the highest number of deals were channeled towards energy. Understandably, equity took the lead with volumes of 779, followed by 362 grants and 88 debt financings.

The decline echoed across every stage, with the sharpest contraction seen in early-stage deals, at 26.6%, to 1,712 while late-stage deals also fell 21.4% to 514. This was the first instance of sequential decline for both.At pre-seed & seed, the picture looks a little better on the first look as the volumes dipped by 17.0%.However, not only was this the second straight year of a downward trend but the deal count has receded to the lowest level since 2019. Despite that, the average pre-seed and seed deal sizes edged up to $1.1 million and $2.7 million, respectively.

Fig. 6: Stage-wise breakdown of ClimateTech deals





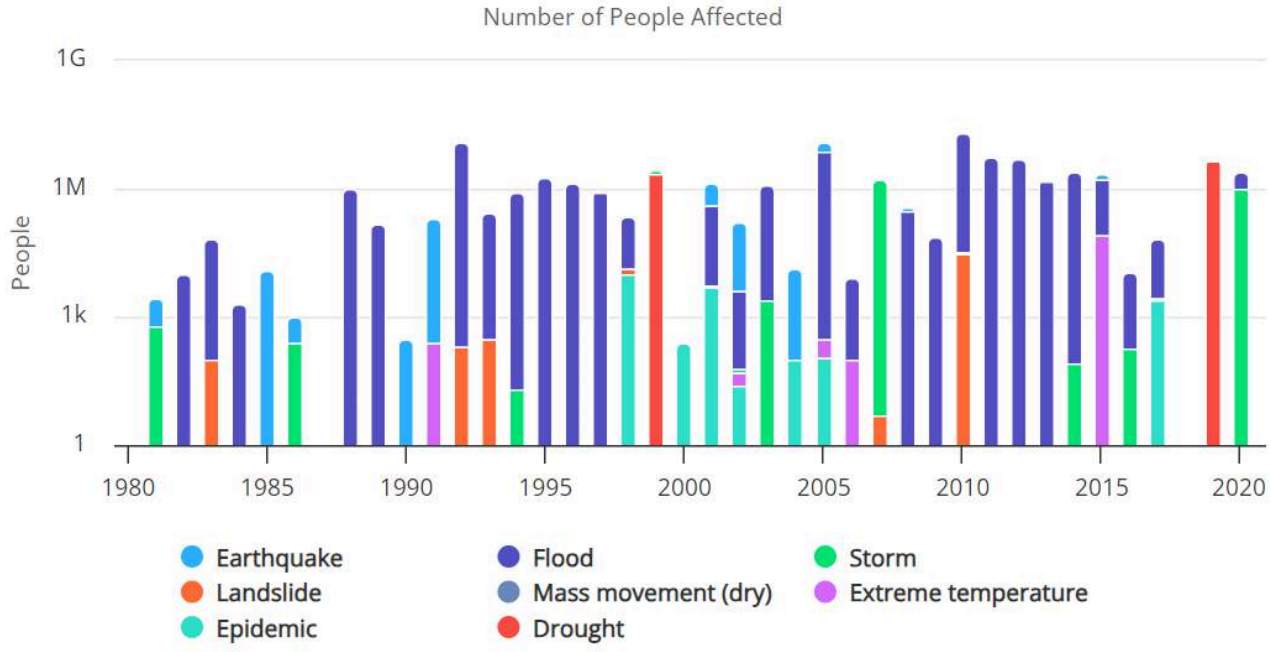
Pakistan overview

PAKISTAN'S CLEANTECH LANDSCAPE

Pakistan's Climate Crisis

As one of the most climate-vulnerable countries in the world, Pakistan is facing an unprecedented environmental crisis that threatens its very existence. The country's average temperature has risen at a rate considerably above the global average, with projections indicating a potential increase of between 1.3°C to 4.9°C by the 2090s,[11] using the 1986-2005 baseline. According to the Climate Risk Index (CRI), which analyzes the extent of damage from weather-related loss events in terms of deaths, economic losses, frequency, and calamity type, the country ranks fifth globally in climate vulnerability.[12] This grim assessment paints a concerning picture of the country's future as it already grapples with the dire consequences of extreme droughts and catastrophic flash floods occurring in rapid succession. Maintaining a consistently high ranking on the Climate Risk Index over the years highlights Pakistan's persistent struggle with climate-induced disasters.

Fig. 7: Key Natural Hazard Statistics for 1980-2020



11. Pakistan Climate Risk Country Profile - Asian Development Bank
12. Climate Risk Index - GermanWatch

This alarming trend has already manifested in a series of devastating climate-related disasters that have wreaked havoc across the nation. In 2010, record-breaking monsoon rains triggered catastrophic floods that submerged one-fifth of Pakistan's total land area, affecting more than 20 million people and causing over $10 billion in economic losses. The crisis reached a new nadir in 2022, when exceptionally heavy monsoon rains once again resulted in catastrophic flooding, inundating a staggering one-third of the country. This disaster affected a staggering 33 million people, claimed over 1,700 lives, and caused an estimated $30 billion in damages[13] — a devastating blow to a nation already grappling with a persistent economic crisis.

Beyond the immediate human toll, these climate-induced calamities have had far-reaching consequences. Water scarcity, already a long-standing challenge in Pakistan, has been exacerbated by the melting of glaciers and changes in precipitation patterns. This, in turn, has led to a decline in agricultural productivity across major crops,[14] heightening the risk of food shortages and threatening the livelihoods of millions who rely on the land. Consequently, the country has lately become a net importer of food as well despite being an agrarian economy, which puts further pressure on the limited foreign exchange reserves and worsens the external account woes.

The climate crisis has also had a profound impact on public health, with the spread of waterborne diseases, the proliferation of vector-borne illnesses, and the emergence of heat-related illnesses posing an ever-growing threat to the well-being of the Pakistani people. Confronted with these existential challenges, Pakistan finds itself at a critical juncture. The country's ability to adapt and build resilience in the face of the climate emergency will determine its very future. Urgent and comprehensive action is needed to address the root causes of this crisis, from reducing greenhouse gas emissions to investing in sustainable infrastructure and implementing robust adaptation strategies. Unfortunately, the current level of preparedness falls well short of both required and desired levels. According to the Notre Dame Global Adaptation Initiative (ND-GAIN) Index, which tracks countries' preparedness and capacity to withstand climate-related challenges, Pakistan ranks a dismal 150th out of the total 185 countries assessed.[15] This puts us behind other regional countries like India (116th) and Sri Lanka (104th) though slightly ahead of Bangladesh (163rd). Specifically on the readiness sub-index, Pakistan stands in the 146th place.

Unfortunately, readying Pakistan for the current and impending impacts of climate change requires significant financial resources. For the flood rehabilitation alone, the economic needs were assessed to be worth $16.3 billion,[16] of which not even 10% had been received from the international community by March 2024.[17] Proactively navigating the country's adjustment to the environmental risks would entail a much more monumental effort. As per its 2021 NDC, Pakistan had set a target of halving the overall emissions by 2030, conditional on getting international financial support for 35% of the $101 billion amount for energy transition alone.[18] Thus far, there have been few signs of progress despite the government rallying for global support and roadshows in the wake of the 2022 floods. In the long term, Pakistan critically needs a comprehensive strategy to accelerate and incentivize its transition towards clean technologies.

13. World Bank Assessment
14. The slide of agri yields - Business Recorder
15. Country Index - Notre Dame Global Adaptation Initiative
16. Pakistan Floods 2022 Impact Assessment - Ministry of Finance
17. Pakistan gets only $1.4bn out of pledged $11bn for flood relief - Profit by Pakistan Today
18. Pakistan Updated NDC 2021

As part of this study, we'll be mapping the state of CleanTech in Pakistan. Given the very nascent ecosystem, the country barely has any clearly defined or available taxonomy at the moment to track progress. Therefore, the classification used hereon would be fundamentally different from those provided by international platforms like PitchBook or Net Zero Insights. We primarily categorize the industry into four areas: Renewable Energy, E-mobility, Circular Economy, and so-called Innovation in ClimateTech, which includes all other verticals and initiatives from industrials to agri. To understand their scope, let us review each in the following section.

In its 2021 international climate pledge, Pakistan says that meeting its emissions targets will require $101bn in climate finance by 2030 and an additional $65bn by 2040. Pakistan's pledge adds that it will need $7-14bn per year to adapt to the impacts of climate change.

This includes:

- $20bn for replacing under-construction coal projects with hydropower
- $50bn for achieving its target of producing 60% of its electricity from renewable including hydropower by 2030.
- $20bn to upgrade the electricity transmission network by 2040.
- $18bn for buying out and closing "relatively new coal projects"
- $13bn for replacing coal projects with solar


Renewable
Energy

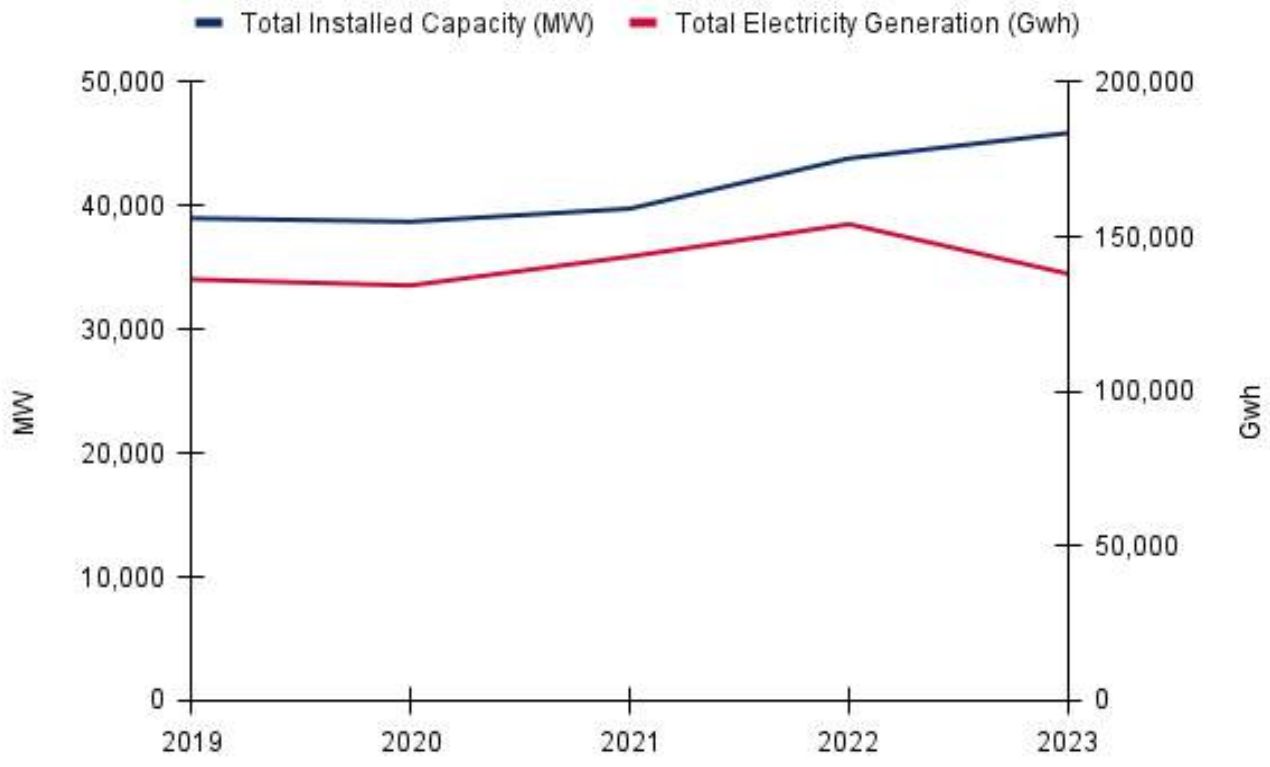
CLEANTECH OVERVIEW

Renewable Energy

The energy sector in Pakistan plays a pivotal role not only in the country's economy but also in fulfilling its National Determined Contributions (NDCs) under the Paris Agreement. The latest pledge indicates that the country aims to optimize its power generation mix, with 60% of the supply expected to come from renewable sources.[19] Post-independence, Pakistan inherited a limited generation capacity in its energy sector. The capacity growth was slow until the 1970s when major hydel projects were added. During the first five decades of its existence, Pakistan heavily relied on renewable energy sources, particularly hydropower, for electricity generation. Projects like the Tarbela and Mangla dams were the main sources of energy production.

Around the early 2010s, the government began to prioritize other sources of renewable energy as well, such as wind, solar, and bagasse. Starting from zero in FY14, the installed capacity of these sources has soared by 384% to 2,700 MW as of June 2023, with wind energy contributing approximately two-thirds of the total.[20]

Fig. 8: Installed Capacity vs. Generation



19. National Determined Contributions 2021 - Government of Pakistan
20. National Electric Power Regulatory Authority

Despite the significant growth in wind, solar, and bagasse capacity, the combined contribution of these sources to the overall energy mix is only 6.3%, a percentage that remains relatively unchanged even after factoring in Karachi Electric's (KE) capacity. However, when hydroelectric power is also considered, as reported separately by the National Electric Power Regulatory Authority, the share of renewables increases to 26.3%. Although the share of renewables in annual electricity generation has averaged around 33% for over a decade, recent changes in the capacity mix have been influenced by the addition of thermal plants fueled by coal and imported gas. In the current renewable generation capacity, the largest single contribution, not surprisingly, comes from hydropower, which reached 38,293 GW/h in 2023, while wind energy produced 4,442 GW/h of electricity.[21]

Fig. 9: Projected Capacity Additions

FY	Local Coal	Hydro	RLNG	Nuclear	Imported Coal	RE	Local Gas	Furnace Oil	Cross Border	Net Yearly Addition	Cumulative Total
Jun-22	1,320	10,593	9,789	3,620	4,020	2,802	2,744	3,633	-	-	38,521
2023	1,980	205	1,263	-	660	630	-	-	-	4,738	43,259
2024	-	314	-420	-	-	1,330	-	-	-	1,224	44,483
2025	-	2,347	-	-	-	5,082	-	-	1,000	8,429	52,912
2026	300	630	-1,300	-	-	3,230	-	-	-	2,860	55,772
2027	990	2,558	-	-	-	1,560	-225	-1,423	-	3,460	59,232
2028	-	545	-	-	-	3,583	-	-	-	4,128	63,360
2029	-	876	-	-	-	1,355	-	-727	-	1,504	64,863
2030	-	1,514	-172	-	-	680	-	-136	-	1,886	66,749
2031	-	2,979	-450	-	-	680	-586	-	-	2,623	69,372
Total	**4,590**	**22,560**	**8,710**	**3,620**	**4,680**	**20,932**	**1,933**	**1,347**	**1,000**	**30,852**	**69,372**

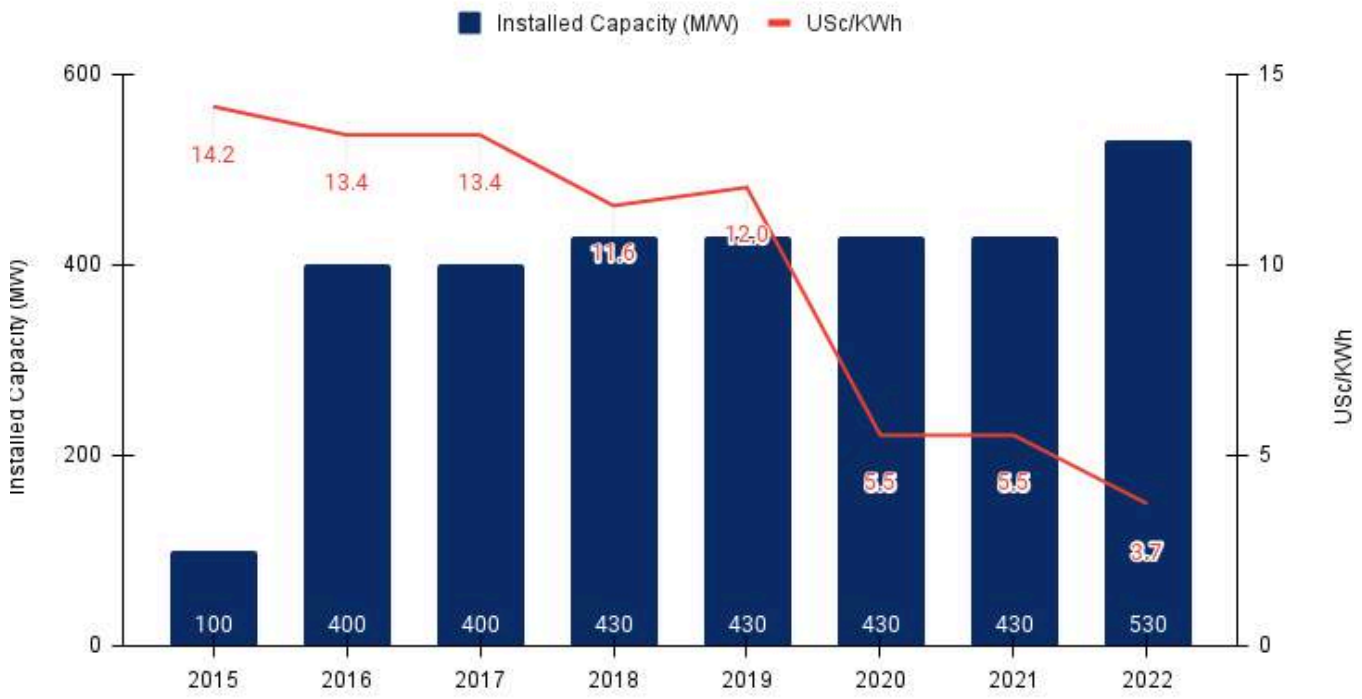
21. National Electric Power Regulatory Authority

Pakistan aims to increase its renewable energy generation capacity to around 63%, as indicated in Nepra's latest Indicative Generation Capacity Expansion Plan (IGCEP). The majority of the additional installations by 2031 are expected to be derived from renewable sources.[22] The motivation behind this is rooted in the government's strategy to indigenize electricity generation. This approach is twofold: firstly, transitioning from imported fuel to Thar coal, and secondly, harnessing the wind and solar energy potential. The latter, specifically, offers a significant cost advantage and a decrease in tariff volatility, contrasting with the circumstances surrounding imported fuel.
Additionally, there is a compelling argument for the Off-Grid integration of renewables. At the provincial level, there is variation in electrification rates. Punjab leads with the highest rate, as 94% of its 17,103,982 households have access to electricity. Sindh follows with an 80% electrification rate among its 8,566,286 households. Khyber Pakhtunkhwa and Balochistan have rates of 85% and 71%, respectively.[23] The data indicates that the southwestern region of the country lags behind in access to electricity, highlighting the substantial potential for the implementation of Mini-Grids (MG) in areas like Balochistan, where traditional grid connectivity is either absent or unreliable.

Solar

While Pakistan was a relatively late entrant to the world of utility-scale solar, with the first plant commissioned in July 2015 in Bahawalpur, it has witnessed some progress since then. Similar to wind power, solar has been installed through upfront and cost-plus tariff models in Pakistan.

Fig. 10: Capacity additions for solar power



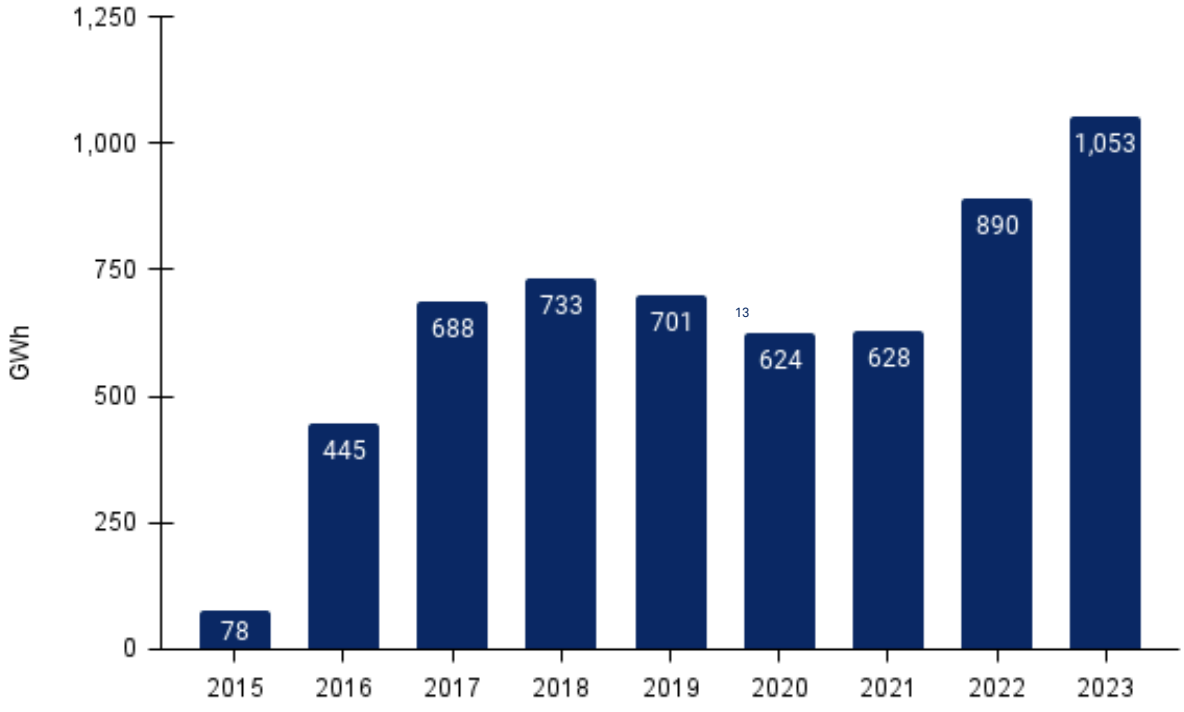
22. Indicative Generation Capacity Expansion Plan 2022-31
23. Renewables First

The upfront regime provides a fixed price over the lifetime of the project at an above-market rate to attract developers or IPPs. It was first employed for solar power projects in 2014 before being discontinued in favor of competitive bidding. While a cost-plus tariff enables the developer to recover the initial project expenses along with a mutually agreed-upon rate of return between the developer and the offtaker.[24] As of FY23 end, there were seven projects live with a total installed capacity of 530MW[25] on the Central Power Purchasing Agreement-Guarantee system while another 202MW belongs to KE. This puts solar's share in the country's total capacity at 1.6%. However, as per the latest IGCEP, the regulator is betting on solar becoming a major source of power in the coming years. It projects that Pakistan's solar capacity will reach 13,670MW by 2031 in the base scenario, second only to hydropower, and account for 19.7% of the country's overall capacity. This includes six new committed plants with a capacity of 400MW, which will be complemented by 4,320MW via net metering by 2030.

On the generation side, solar has been on an upward trajectory and produced 1,053 GWh of electricity in FY23, rising 18.3% over the previous year's 890 GWh.[26] What makes this impressive is how solar defied the wider trend as total generation fell 4.9%, largely led by a 70.7% decline in residual fuel oil. Even beyond that, no other source managed to grow in double digits. Yet, solar's share in aggregate generation remains minute, at just 0.81%, albeit improving by 16 basis points.

Unlike coal, RFO, or RLNG-based plants, where the average tariff has been steeply rising on the back of both rupee devaluation and higher capacity payments, solar offers a much cheaper alternative with virtually no generation cost while tariffs have consistently declined with capacity additions.[27]

Fig. 11: Electricity Generation through Solar



24. IIEEFA
25. Pakistan Economic Survey 2022-23
26. National Electric Power Regulatory Authority
27. IEEFA

While there has been some progress in integrating solar to the energy mix, Pakistan still has significant untapped potential for solar power generation. Based on the March 2017 Solar Resource Report from the Energy Sector Management Assistance Program (ESMAP), the Western region of Pakistan stands out in Global Horizontal Irradiance (GHI) values, surpassing 2,330 kWh/m2 annually (with a daily average of 6.4 kWh/m2). In the Northern areas, GHI scores fluctuate between 1750 to 1300 kWh/m2, with daily averages ranging from 4.8 kWh/m2 to 3.6 kWh/m2.[28]

The annual average PV output in Pakistan ranges from 1240 kWh/kWp to 2100 kWh/kWp, with higher values observed in Baluchistan province. However, terrain shading in the mountainous northern regions significantly reduces PV output by 20% or more. The elevated altitude and cooler temperatures in Baluchistan make it ideal for PV-based generation, showcasing substantial GHI potential due to lower aerosol levels in the atmosphere.[29]

Despite this potential, the economic rationale regarding localization of the energy supply chain and IGCEP's optimistic projections, there's no mention of any upcoming project in the NEPRA State of Industry report. The last attempt at promoting solar generation in Muzaffarabad was met with lukewarm interest as the developers believed the tariffs to not be attractive enough. It was a stark reminder of the problems of pricing and distribution in the energy paradigm.

Using Comtrade, we conducted a broad analysis after identifying components related to solar and related equipment, which include the following three HS codes; 850720 — Lead-acid electric accumulators, except for starting piston engines; 854140 — Photosensitive semiconductor devices, incl. photovoltaic cells whether or not assembled in modules or made up into panels; light-emitting diodes; and 854390 — Parts of electrical machines and apparatus, having individual functions, not specified or included elsewhere in Chapter 85. Since data was available at six digits, it is not possible to pinpoint the exact magnitude of trade and the figures may be a little overstated.

With that disclaimer out of the way, we find that during the decade between FY14 and FY23, Pakistan imported $4.3 billion worth of solar and related equipment.[30] The overall value has ranged widely during the period, starting out with $197.8M and peaking at $842.1M in FY17, just around the time the trade deficit was ballooning on the back of an overvalued rupee. However, the situation changed drastically after mid-2022 when rumors of default and dwindling foreign exchange reserves pushed the government to curb imports. As a result, the import bill for solar and related equipment plunged 96.3% to just $20.8M during FY23, from $557M.4M.

Almost 88%, or $3.8B, of the bill, can be attributed to 854140 — Photosensitive semiconductor devices, incl. photovoltaic cells whether or not assembled in modules or made up into panels; light-emitting diodes. In FY14, the imports for this commodity were $196.1M, a number that swelled to a high $720M by FY17. However, the import bans hit the product hard as the total bill under this HS code dropped to zero in FY23, compared to $530.4M the year before.

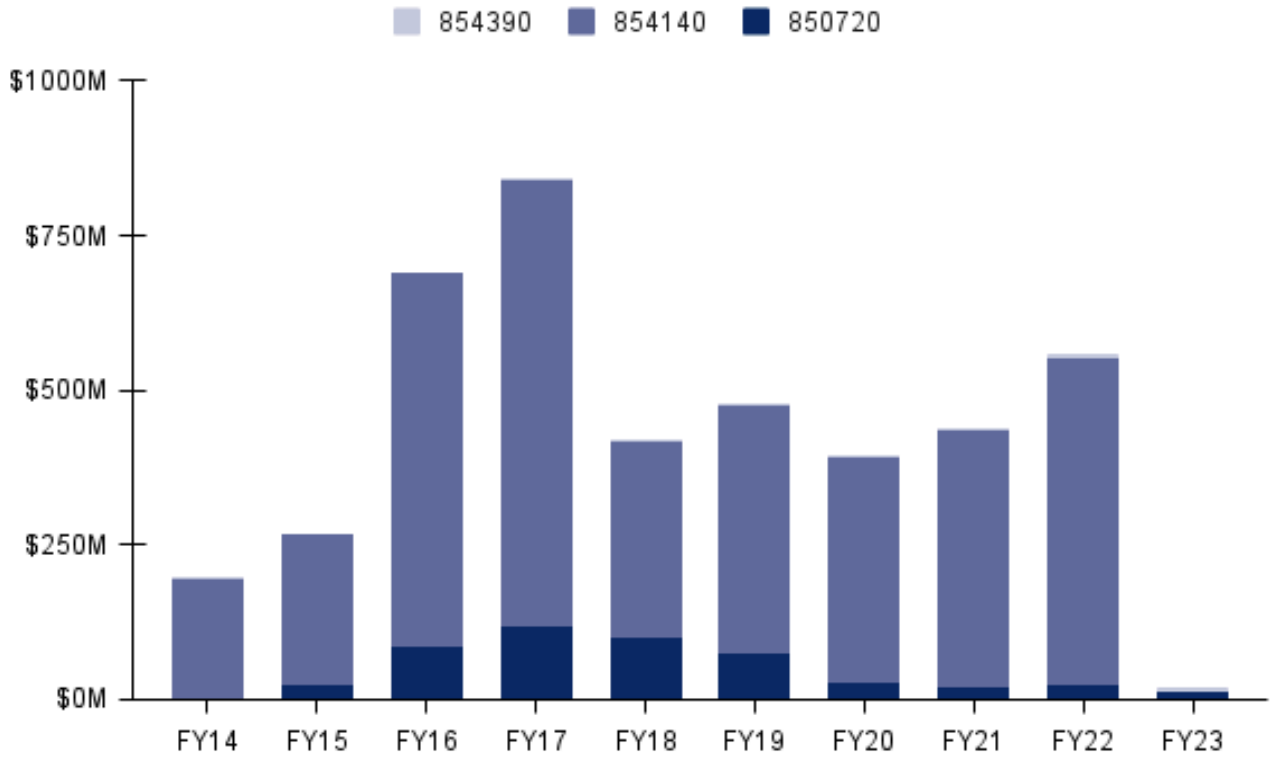
28. https://renewablesfirst.org/wp-content/uploads/2023/05/On-Grid-Guidebook-for-the-website.pdf
29. https://renewablesfirst.org/wp-content/uploads/2023/05/On-Grid-Guidebook-for-the-website.pdf
30. Data Darbar analysis using Comtrade

Under 850720 — Lead-acid electric accumulators, except for starting piston engines, there have been total imports of $485.3M over the past decade. Predictably, the value ballooned to a peak of $119.6M in FY17, followed by another $100.3M the following year. Since then, it has been on a downward trajectory, reaching just $13.5M in FY23, down sequentially from $22.0M.

The smallest contribution is from 854390 — Parts of electrical machines and apparatus, having individual functions, not specified or included elsewhere in Chapter 85 — with cumulative imports of just $36.9M over the period under review. Perhaps because of the low base, this is the only commodity in our broader solar category that has actually witnessed an uptake as the value of imports reached $7.3M in FY23, compared to $5.0M the year before.

Unsurprisingly, China was Pakistan's single largest source of solar and related equipment, accounting for a massive 94.0%, or $4.1B, of the total import bill during the decade under review. However, the share plunged to just 53% in FY23 as imports $11M on the back of the government's restrictions. Vietnam was a distant runner-up, at $33.2M, over the decade. Other major trading partners include Malaysia ($30.1M), United Arab Emirates ($27.9M), South Korea ($25.5M) and United States ($24.2M).

Fig. 12: Pakistan's Solar Panels & Related Equipments Imports



Other opportunities

Beyond utility-scale power generation, solar presents multiple other opportunities that need to be explored. For instance, street lights consumed 521 GWh of electricity in FY23 from the CPPA-G without incorporating the KE system.[31] This is a cost that the government has to bear, and the rise in tariffs, it adds pressure on the fiscal side. Transitioning towards solar for street lights could help reduce that burden and open up new avenues for the existing lighting players. Currently, a couple of players, such as Get Technologies, are already operating in the value chain, including in-house manufacturing for LED.

Similarly, another area of intervention exists in the agricultural sector where Pakistan's traditional flood irrigation system consumes is extremely water-intensive. In this regard, expanding access to solar-powered drip irrigation machinery can help save up to 50% of water in addition to improving crop yields.[32] Currently, players like Jaffer Group and Hajisons have a significant share of the still nascent market. However, their ability to expand is still largely contingent upon capital investments in solar panels.

Wind

The United States Department of Energy and the National Renewable Energy Laboratory (NREL) have recognized Pakistan's potential for generating around 346 GW of energy from Wind. Particularly, the coastal wind zones in Sindh Province experience wind speeds ranging from 5 to 12 m/s, indicating rich wind energy resources in these areas estimated at about 20 GW. This highlights the substantial wind energy potential in the province, which, if harnessed, could play a significant role in resolving the electricity crisis.[33]

The Jhimpir wind corridor, situated in the Sindh Province of southeast Pakistan, is a vast expanse of saline land known for its strong winds that are unsuitable for agriculture. This location was identified as having the capacity to generate over 11 gigawatts of power potential. Now adorned with large wind turbines, this formerly barren area has become a center for Pakistan's clean energy production and is home to the Super Six wind IPPs.

The Super Six initiative is an effort focused on developing six wind power projects in Pakistan. This initiative aims to provide cost-effective and eco-friendly electricity, addressing the country's pressing energy requirements and reducing its reliance on expensive imported fossil fuels. With a combined capacity of 310MW, the Super Six installations are expected to generate more than 1,000 gigawatt-hours of electricity annually, potentially resulting in a decrease of approximately 650,000 tons of carbon dioxide emissions per year.[34]

31. Pakistan Economic Survey 2022-23
32. Saving water, one drip at a time - Business - DAWN.COM
33. A Research on Electricity Generation from Wind Corridors of Pakistan
34. Understanding barriers to financing solar and wind energy projects in Asia | EY Singapore

Fig. 13: Installed Capacity of Wind

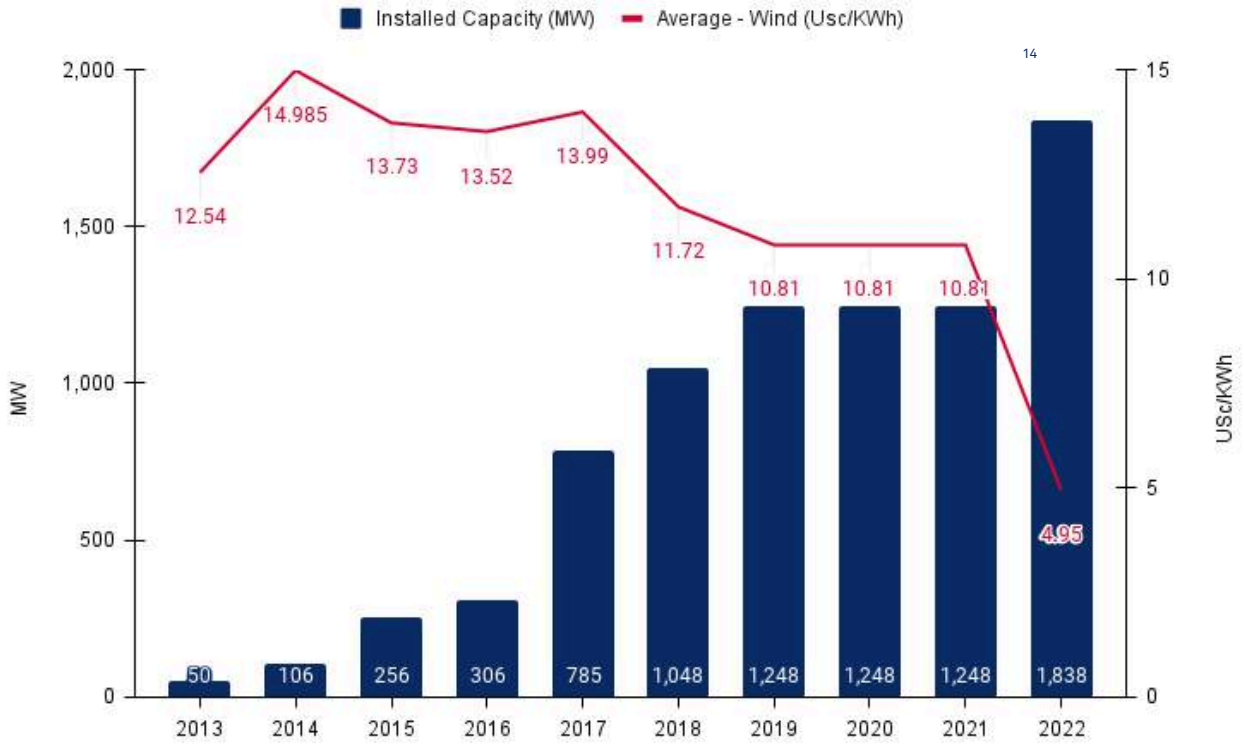
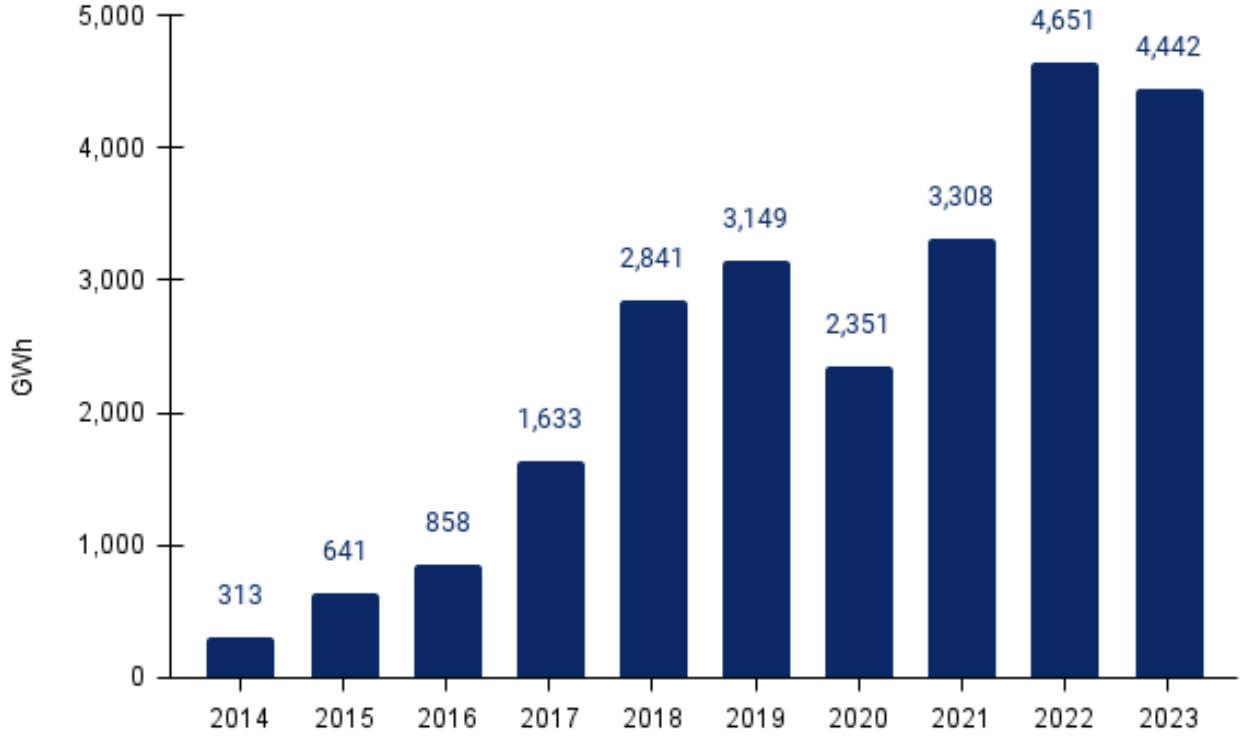
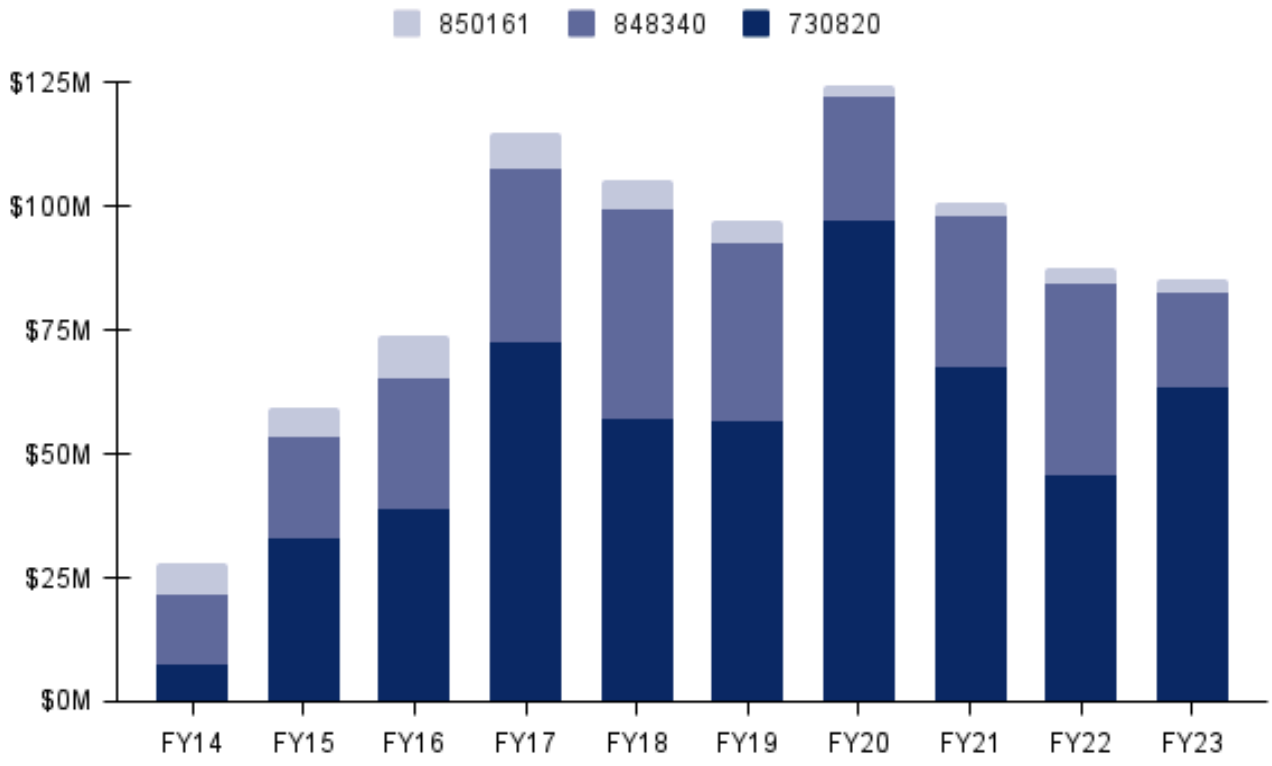


Fig. 14: Electricity Generation through Wind



The uptake and variation in wind technology can be tracked by analyzing import data. For wind turbines and components, we identified relevant products to fall under the following HS6 codes; 730820 — Towers and lattice masts, of iron or steel; 848340 — Gears and gearing, other Than toothed wheels, chain sprockets, and other transmission elements presented separately; ball or roller screws; gear boxes and other speed changers, incl. torque converters; and 850161— AC generators "alternators", of an output <= 75 kVA. Under these, Pakistan has imported a cumulative $876.7M over the past decade.[35] Looking at the annual data, total value spiked in FY20 at $124.4M but has since receded from those highs. Meanwhile, in FY23, the import clocked in at $85.3M, edging lower by 2.5% compared to $87.5M the year before. Unlike the plunge in solar and related equipment, this category doesn't seem to be impacted as much by the import bans, likely due to their relatively smaller size.

Fig. 15: Pakistan's Wind Turbines & Components Imports



At HS-code level, 730820 — Towers and lattice masts, of iron or steel — account for the largest proportion of 61.6%, or $540.0M, during the period under review. Unlike the broader wind category, imports under this HS6 saw growth as they jumped 38.1% to $63.3M in FY23, up from $45.8M, but are still considerably below the peak of $97.3M seen in FY20. On the other hand, 848340 — Gears and gearing, other than toothed wheels, chain sprockets, and other transmission elements presented separately — imports almost halved to $19.4M in the outgoing fiscal year, compared to $38.7M in FY22. Over the decade, the contribution to wind turbines and components imports stood at $287.3, or 32.7%.

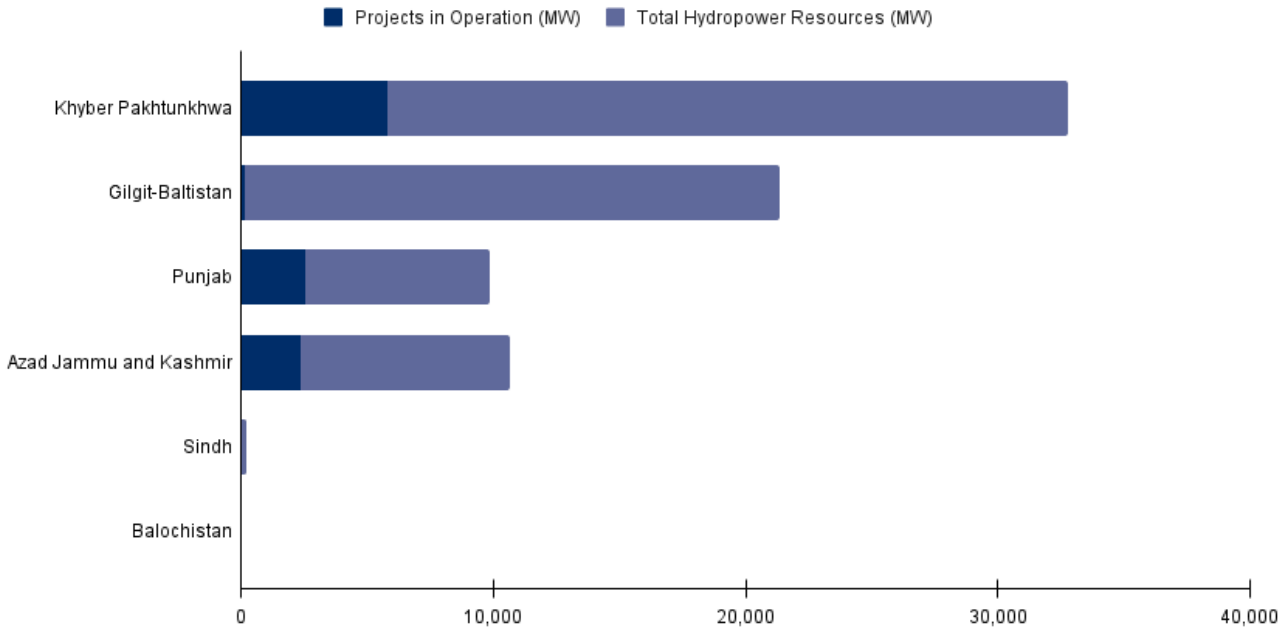
35. Data Darbar analysis using Comtrade

The lowest share came from 850161 — AC generators "alternators", of an output <= 75 kVA — with total imports of $49.4M. For the last four years, the imports for this commodity have hovered around $2-3M and stood at $2.6M in FY23. Expectedly, China was the largest source of wind turbines and components with imports of $659.3M, translating into 75.2% of the overall bill. While imports from Beijing peaked at $95.7M in FY20, they have recently shown some signs of recovery and bounced back to $69.4M in FY23, up 6.7% compared to the year before. Turkiye has also been a major partner, with Pakistan buying $52.3M of equipment from it. Annual data shows that the country only became a sizable source in FY20 when imports surged to $16.1M, but have since receded to just $4.2M by FY24. Germany emerges as the third most important trading partner for wind turbines and components, accounting for imports of $28.1M during the past decade. Vietnam follows right behind at $27.6M.

Hydel

Pakistan has historically relied on hydropower to fulfill its energy requirements, leveraging its extensive network of rivers fed by glaciers and snowmelt from the Himalayan region and seasonal monsoons. The country's hydropower journey began in 1925 with the construction of the 1 MW Renala Khurd project in Punjab, initially intended for irrigation purposes. Over time, Pakistan expanded its hydropower capacity significantly by constructing large-scale dams such as the 1,150 MW Mangla and 3,500 MW Tarbela dams, offering vital services like water management, electricity generation, and irrigation.[36] The northern region, particularly in Khyber Pakhtunkhwa province, Gilgit Baltistan autonomous territory, and Azad Jammu and Kashmir districts, holds the major portion of Pakistan's hydropower potential.

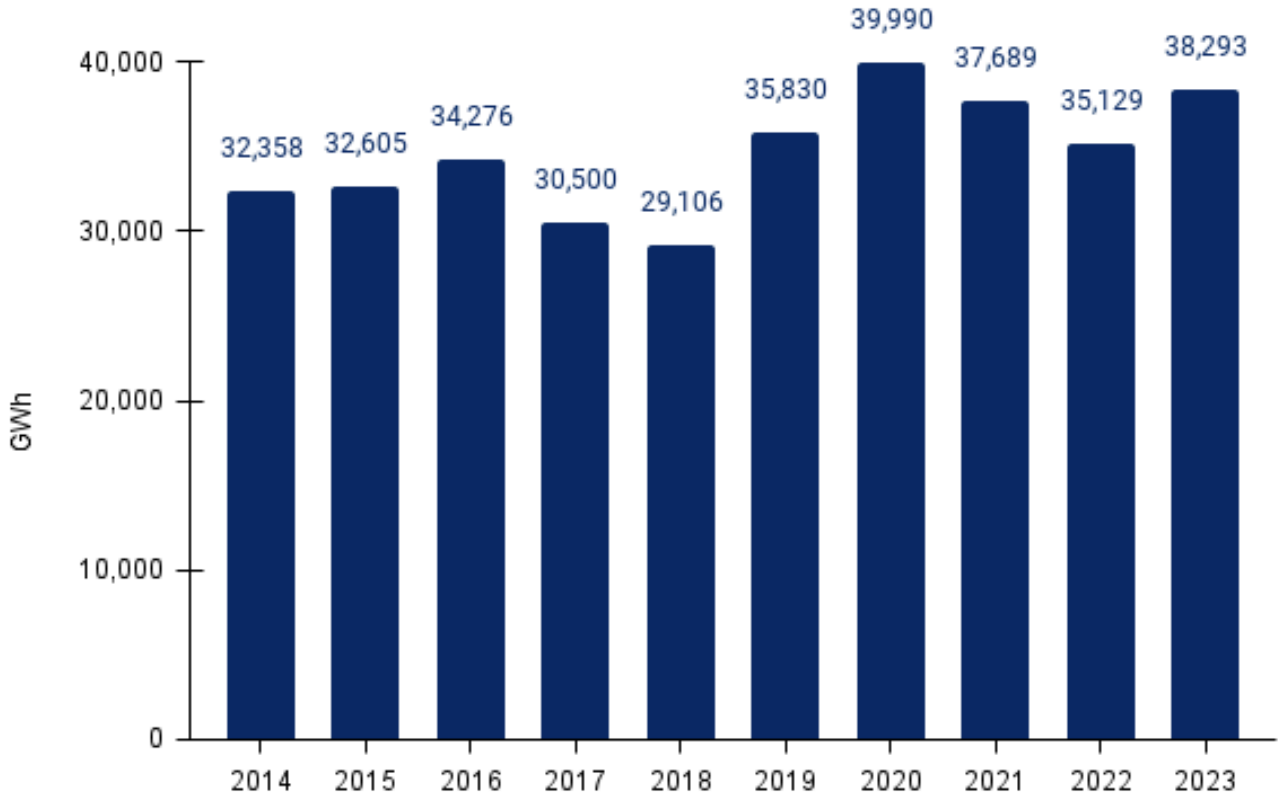
Fig. 16: Hydropower resources of Pakistan



36. IEEFA

Unsurprisingly, hydel has also historically retained the lion's share in terms of electricity generation, averaging at more than 28% over the last two decades. In FY23, hydel produced 32,529 Gwh of electricity, declining by 0.5% compared to the year before. On the other hand, overall electricity generation plunged by 10.4% to 135,652 during the same period. While hydel remains the single largest source of all electricity produced in the country, its contribution to the national grid has witnessed a sharp recalibration, standing at just under 24% in the outgoing year. This is well below the recent peak of 33.6% seen in FY11 as scales have been tipped in the favour of thermal sources amid new additions. Since then, the imported RLNG has become the second biggest source of energy generation, adding to the country's import bill.

Fig. 17: Electricity Generation through Hydel



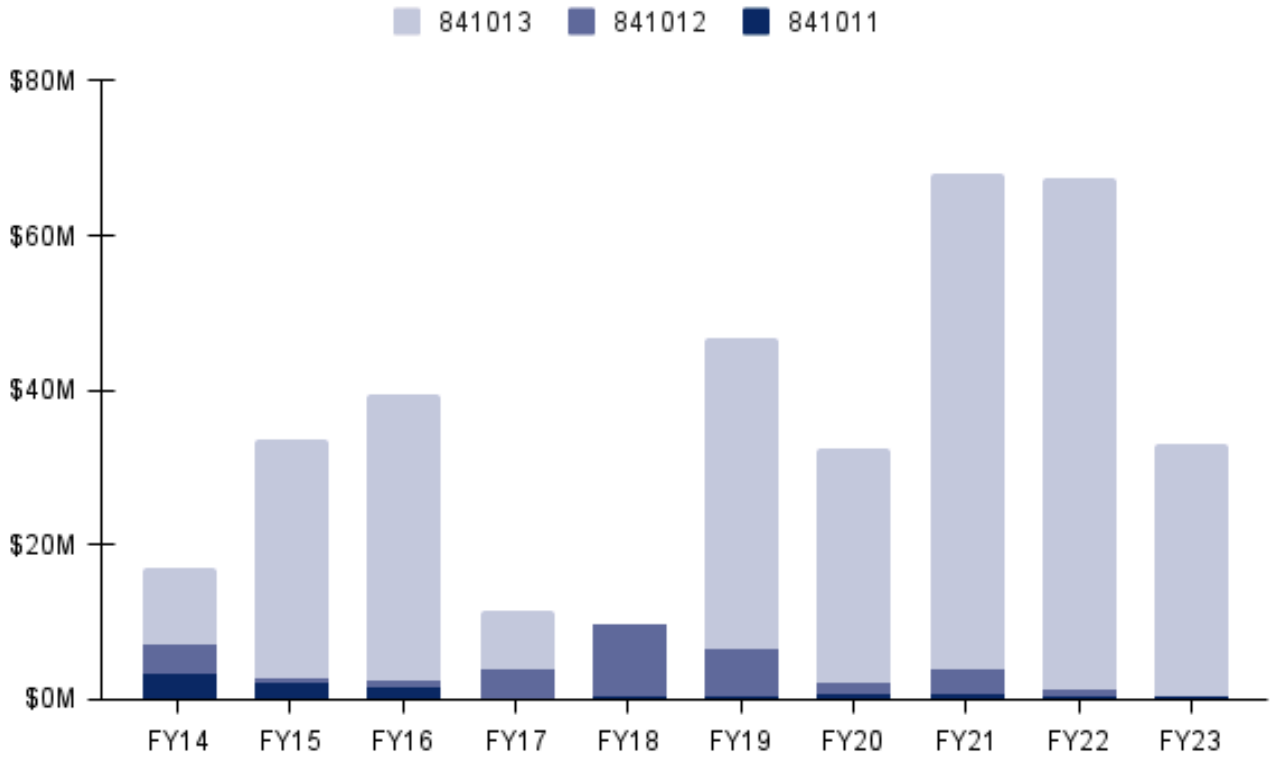
We identified the following three broad commodity groups relevant to hydropower and small hydro equipment; 841011 — Hydraulic turbines and water wheels, of a power <= 1.000 kW; 841012 — Hydraulic turbines and water wheels, of a power > 1.000 kW but <= 10.000 kW; and 841013 — Hydraulic turbines and water wheels, of a power > 10.000 kW. Under these, Pakistan has imported a cumulative $359.1M of equipment during the past decade.[37] For the first half, the imports were relatively low and averaged just over $22.2M annually but picked up pace and almost doubled during the second phase. However, in FY23, there was a drastic decline as value plunged to $33.0M, compared to $67.4M the year before.

37. Data Darbar analysis using Comtrade

Almost 89% of the imports were concentrated in 841013 — Hydraulic turbines and water wheels, of a power > 10.000 kW — with an aggregate value of $319.1M during the period under review. Particularly in FY23, Its share was even more elevated at a massive 98.7%, or $32.5M, in line with the past year but much higher than the historical levels. Meanwhile, 841012 — Hydraulic turbines and water wheels, of a power > 1.000 kW but <= 10.000 kW — imports were almost $30.0M, with no purchase in FY23. For this commodity group, value peaked all the way back in FY18 at $9.8M and hasn't approached similar levels since then. Meanwhile, 841011 — Hydraulic turbines and water wheels, of a power <= 1.000 kW — had a rather insignificant contribution of $10.0M with the value not touching even $700,000 in the last seven years.

For FY23, the import bill was a meager $427,260, as per analysis using Comtrade data. Unlike solar and wind, Pakistan relied on far fewer trading partners for purchases, though China once again dominated the list and had an 86.9% share, or $311.9M, in the import bill. In FY23, this share shot up to 97.6%. Beyond Beijing, no single country sold even $10M during the period, with Germany coming in a distant second at a bare $5.2M, followed by the United Arab Emirates at $4.5M and Italy $4.5M.

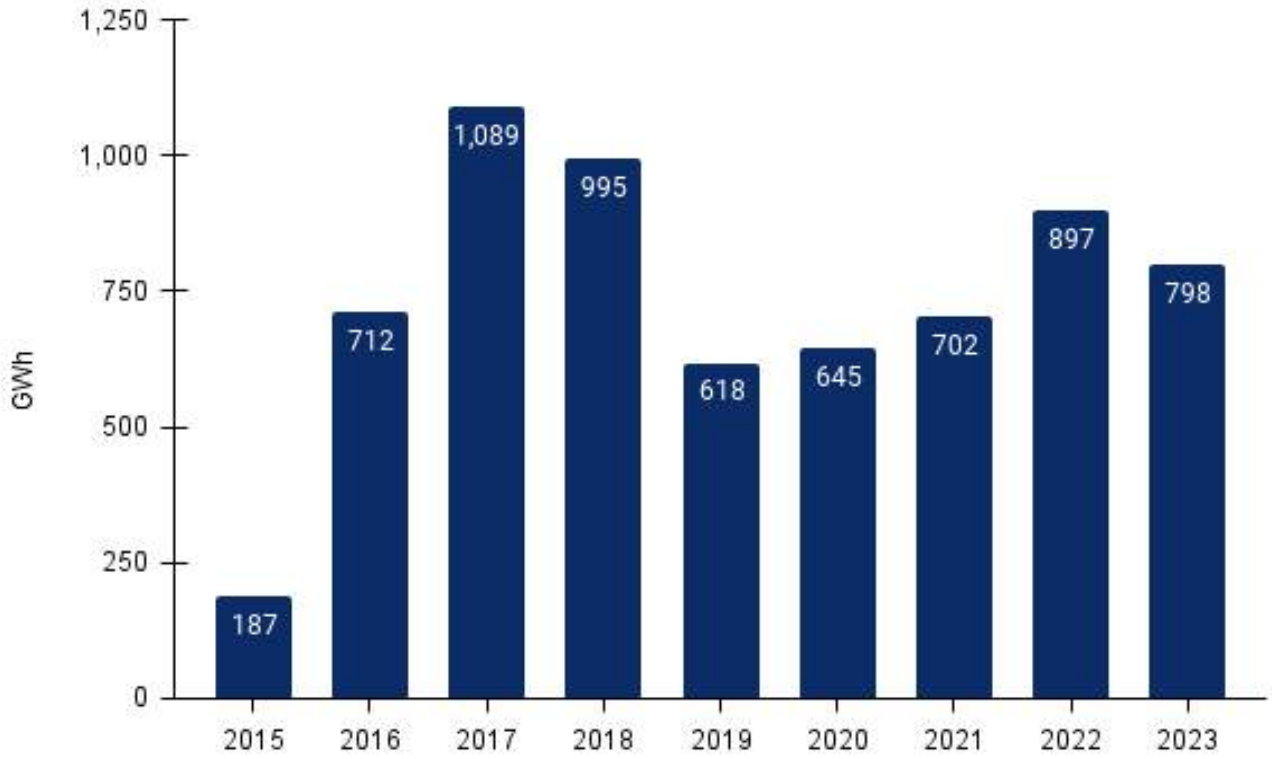
Fig. 18: HydroPower & Small Hydel Equipment Imports



Biogas

Pakistan possesses significant potential for electricity generation using biogas. Its livestock population, growing at a rate of approximately 4% annually, includes cattle, buffalo, sheep, goats, camels, horses, ass, and mules. By collecting manure from buffalo and cattle alone, 92.54 million tons can be obtained, comprising 30% of total manure content and capable of producing 4.63 billion m3 of biogas. Despite a 70% biogas loss during filling, the remaining gas can be used for electricity production and cooking, generating around 19.79 TWh of electricity. In 2021, Pakistan produced 102.742 TWh of electricity, with biogas contributing only 0.98%, equivalent to 1 TWh. Leveraging the livestock population, Pakistan has the potential to generate 19.79 TWh of electricity solely from cattle and buffalo manure, which is more easily collected compared to other livestock waste.[38]

Fig. 19: Electricity Generation through Bagasse

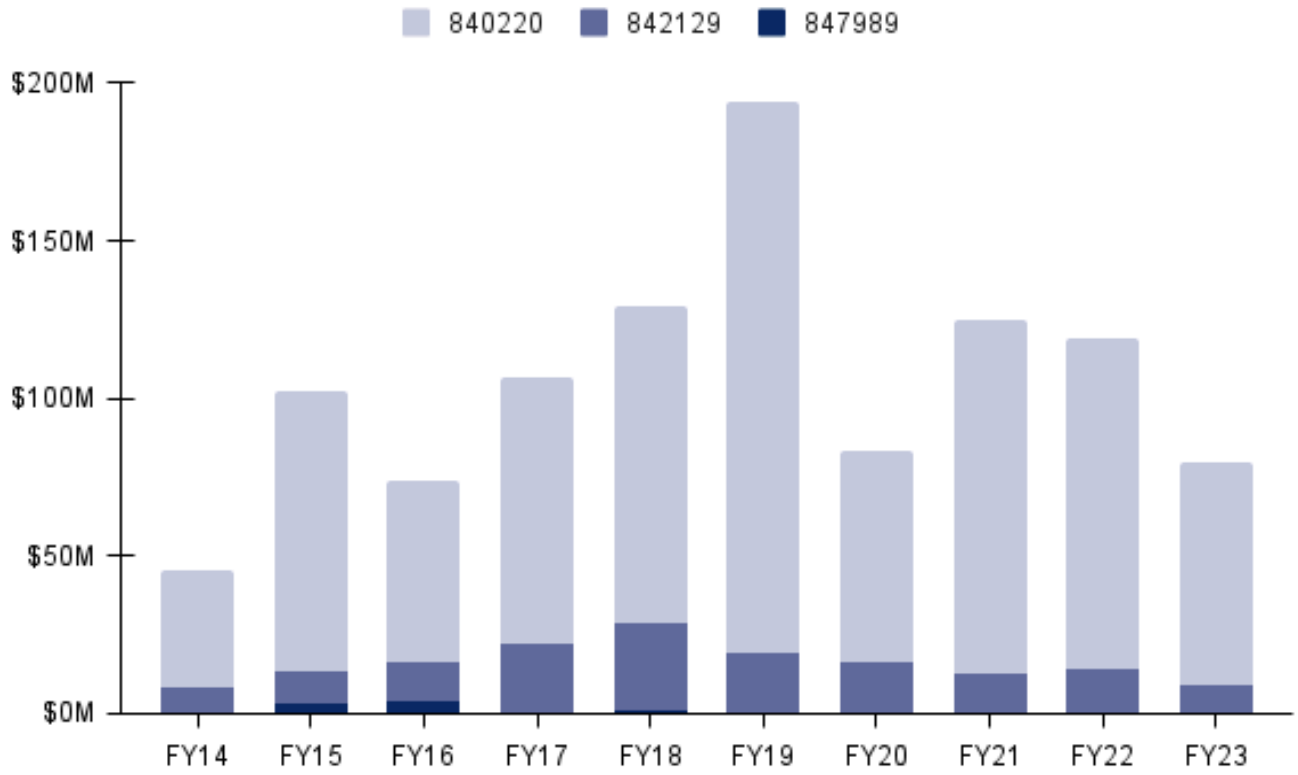


For this section, we found the following commodity groups relevant; 840220 — Superheated water boilers; 842129 — Filtering or purifying machinery and apparatus for gases, other than intake air filters for internal combustion engines; 847989 — Machines and mechanical appliances having individual functions, not specified or included elsewhere in Chapter 84. To reiterate, the data was available at HS6 level, the values may not relate to bagasse uptake in its entirety. Overall imports[39] under these three codes were $1.1B between FY14 and FY23 and peaked back in FY19 at $193.9M.

38. Green electricity generation from biogas of cattle manure
39. Data Darbar analysis using Comtrade

In six out of the 10 years, Pakistan has imported equipment in excess of $100M under this category. However, the value plunged 33.1% to $79.4M — the lowest since FY17. The overwhelming share of 84.8% came from 847989 — Machines and mechanical appliances having individual functions, not specified or included elsewhere in Chapter 84 — with imports at $897.0M during the last decade. Mirroring, or better driving, the overall category trend, total value of imports dipped to $70.0M in the outgoing year, from $104.3M in FY23.

Fig. 20: Pakistan's Bioenergy and Biogas Imports



Meanwhile, 842129 — Filtering or purifying machinery and apparatus for gases, other than intake air filters for internal combustion engines — also added $156.6M to Pakistan's forex bill during the decade under review. Ever since peaking at $27.9M in FY18, imports have been on a downward trajectory and reached $9.4M in FY23, down 35% year-on-year. On the other hand, 842129 — Filtering or purifying machinery and apparatus for gases, other than intake air filters for internal combustion engines — contributed just $9.6M, with the FY23 amount not even in six digits.

At the country-level, while China did account for 45.6%, or $481.4M, of the overall imports, this share is much smaller in comparison to other categories where it's typically above 80%. Total value imported from Beijing fell by 38.8% to $45.1M in FY23, from $73.7M the year before. Germany was the second largest partner, contributing 8.5% or $89.9M to the bill. However, annual breakdown shows a little under half of it was in FY18 and FY19. In fact, the imports of $3.8M for FY23 were the lowest in eight years.

Off- Grid

Micro/Mini Grids can play a crucial role in improving energy access to underserved areas and bridging the electrification gap. According to NERPA's Microgrid Regulation 2022,[40] a Microgrid is defined as a localized energy system that meets the following criteria:

- It is a self-contained distribution system operating at a voltage not exceeding 33 kV for the distribution of electric power with a peak distribution load not exceeding five megawatts;
- It is intended to serve an unserved market; and
- It is not connected directly or indirectly to the national grid;

In the realm of micro/mini grids, two technologies have immense potential, Solar and Hydel.

Fig. 21: Off-Grid Potential by Province

No of mini-grids sites	185	331	340	159	1,015
Avg. PV capacity (kW_p)	75	214	153	148	158
Avg. Number of connections	191	445	220	323	304
Avg. Cost per connection (USD/connection)	1,343	1,165	1,531	1,097	1,310
Avg. CAPEX Cost per mini-grid (USD/cluster)	233,213	467,972	317,404	343,365	355,227
Total Estimated CAPEX Cost (millions of USD)	43.1	154.9	107.9	54.6	360.5
Total population covered	219,108	880,515	429,470	318,157	1,847,250
Total demand (kWh/day)	45,265	191,187	140,586	70,955	447,993

Furthermore, a streamlined licensing regime under NEPRA's unified license makes setting up a microgrid feasible. This license is open to a wide range of entities, including individuals, companies, cooperative societies, partnerships, and social welfare organizations. With this non-exclusive license, the applicant is authorized to perform various microgrid-related activities, such as connection, metering, billing, collection, and disconnection in cases of payment defaults by consumers.

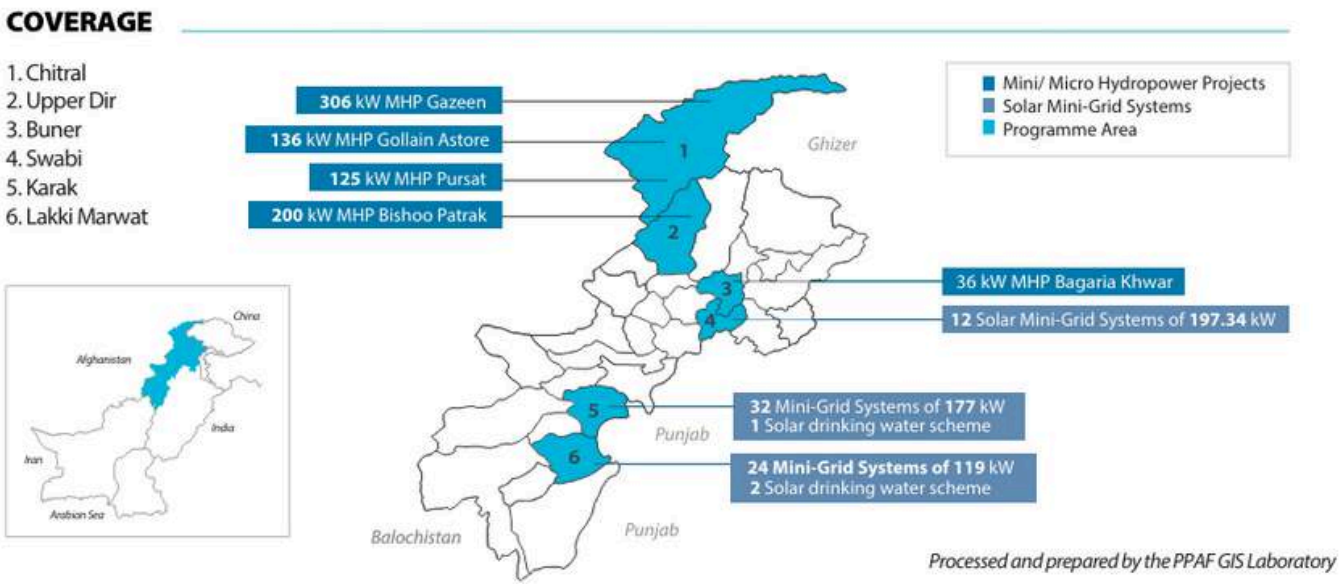
40. NEPRA

As of September 2023, NEPRA has granted micro-grid project licenses to Quaid-e-Azam Solar (Private) Limited (QASPPL). A total of eleven licenses have been issued, divided among six and five locations, with each location having a combined capacity of 700 kilowatts and 600 kilowatts, respectively.[41]

Moreover, Mini/Micro Hydropower offers an additional solution for electrifying households on the outskirts. They represent a highly efficient decentralized renewable energy option for delivering dependable and cost-effective electricity to remote and isolated areas of Pakistan.

The province of Khyber Pakhtunkhwa (KP) encounters challenges in accessing reliable energy sources due to its secluded geographical locations, rendering certain areas inaccessible to existing power grid networks. These regions have population densities ranging from 50 to 100 individuals per square kilometer and are inhabited by remote communities lacking access to electricity. Nevertheless, with its considerable hydropower potential, KP can utilize the deployment of mini/micro hydropower to bridge the electrification gap.[42]

Amongst the key players involved in the development of micro hydropower in Pakistan, the Pakistan Poverty Alleviation Fund (PPAF) stands out. Supported by the Federal Republic of Germany through KfW and overseen by the Pakistan Poverty Alleviation Fund (PPAF), the Hydro and Renewable Energy Project began in 2013. The project primarily includes two components: Mini/Micro Hydropower Projects and Solar Mini Grid Systems.

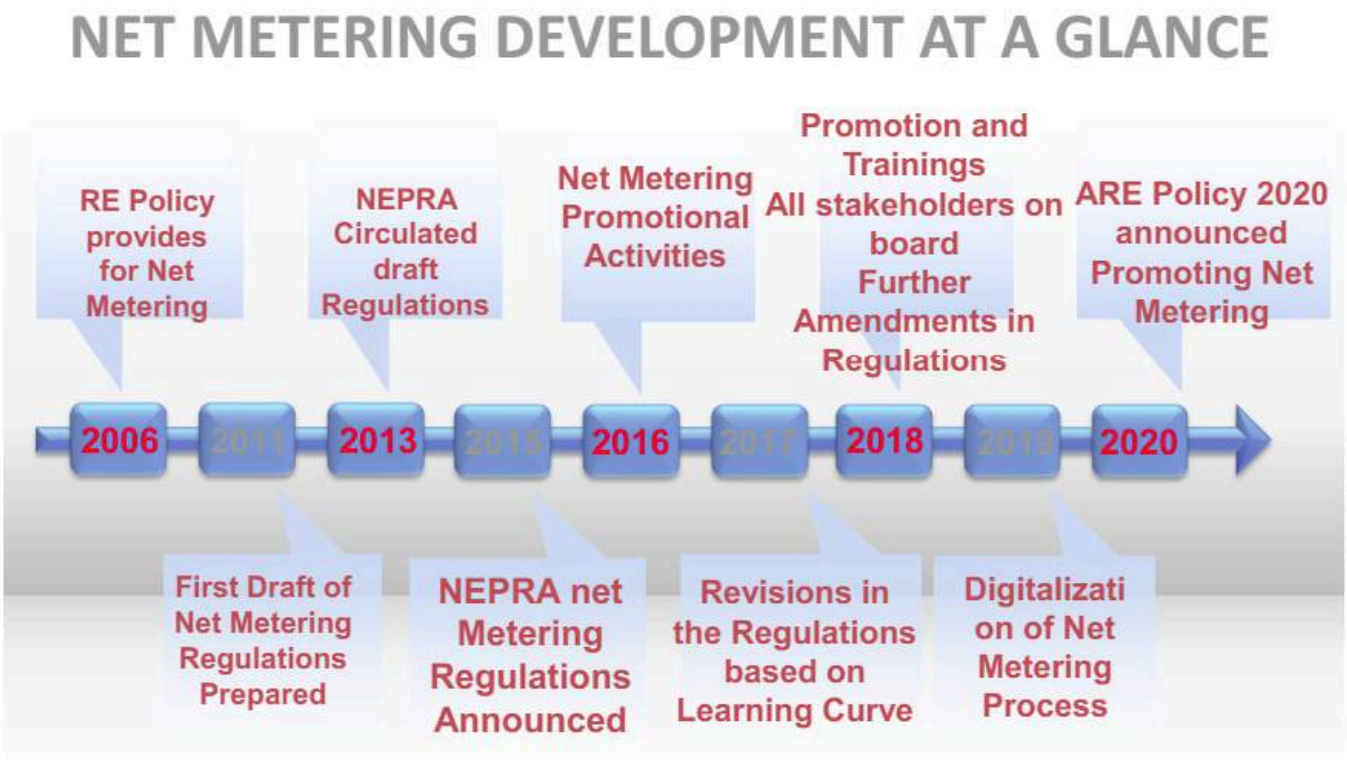


Five mini/micro hydropower plants with a combined installed capacity of over 800 kW have been established in Chitral, Upper Dir, and Buner Districts of Khyber Pakhtunkhwa under the program. The generated electricity adequately addresses the lighting, cooking, and heating needs of the community, in addition to fulfilling the energy requirements of small and mini enterprises.[43]

41. Off-Grid Renewable Energy Guidebook - Renewables First
42. Sustainable Mini-grid Solutions for Off-grid electrification in Pakistan - IPS
43. PPAF

Net Metering

NEPRA, assisted by PPIB (formerly AEDB), introduced the National Electric Power Regulatory Authority (Alternative & Renewable Energy) Distributed Generation and Net Metering Regulations in 2015, facilitating the implementation of net-metering installations for solar and wind generation up to 1 MW capacity. By June 2023, the total number of net-metering solar installations had reached 63,703, with a combined capacity of 1055.03 MW, and the certified installers had reached 325.[44] This is substantially higher than the combined existing solar capacity on the CPPA-G and KE systems. In 2022-23 alone, 596 net-metering licenses were issued nationwide, totaling 221.05 MW. These licenses were distributed among consumers under nine different utility companies, with K-Electric (458), Lahore Electric Supply Company (331), and Faisalabad Electric Supply Company (183) having the highest number of granted licenses.[45]



The net metering market is primarily urban-focused, catering mainly to residential demand. Similar to the pattern observed in other emerging markets like Brazil,he adoption of DG products and services in Pakistan is influenced by factors such as income levels, population, and electricity tariff structures. In Pakistan, various small and medium PV system integrators, known as installers or solar companies, operate using a service-provision model to design and install net metering systems. Higher-end companies provide comprehensive Engineering, Procurement, and Construction (EPC) services, along with post-installation operation & maintenance (O&M) support.

44. Brief on Net-Metering – Private Power & Infrastructure Board - PPIB
45. Pakistan's net-metering approvals hit 221.05 MW in fiscal 2022-23 – pv magazine International

Conversely, lower-end service providers offer limited services, including system-sizing, equipment installation, and short-term after-sales support. Local solar equipment manufacturing is restricted to solar-panel assembly and AGM battery production by industrial groups such as Daewoo, Treet, Eco Star (DWP and Gree), and Homage. Solar companies and installers heavily rely on imports for fulfilling orders, with a supply chain involving equipment importers, wholesalers, and retailers supplying solar panels, inverters, batteries, and charge controllers to the installation companies.

Regulatory Overview and Government Initiatives

Over the last couple of years, the short-sightedness of Pakistan's energy policy has become crystal clear. A dependence on imported residual furnace oil and gas has led to heavy imports of petroleum products, averaging $1.1B[46] a month between 2014 and 2023. In June 2022, the figure had shot up to a high of $2.9B as the global commodity super cycle had pushed energy prices to elevated levels. While the subsequent import curbs have brought down the bill to a relatively manageable range, it has come at a cost where monthly power generation has been on a consistent decline.[47] This leads to higher capacity charges that end consumers have to pay, making electricity increasingly unaffordable. In fact, the average electricity consumption per connection now stands at its lowest in two decades at least.[48]

Therefore, the need for renewables cannot be overstated in making Pakistan's future energy secure. From a macroeconomic perspective, it would not only provide fiscal space but also ease up pressure on the external account by reducing the demand for imported fuels. For consumers, it would mean cheaper electricity and help increase their disposable incomes. However, getting there requires a concerted effort from the policymakers in streamlining both the demand and supply sides. Even though its share in the national grid is still quite modest, solar energy has attracted a lot of attention from the government and till date, a series of initiatives have been introduced to encourage its uptake. In 2022, the government introduced a framework for Fast Track Solar Initiatives,[49] under which it intends to add over 10,000 MW of solar power. This is based on a three-prong approach, of which 6,000 MW is supposed to come from utility-scale solar as a substitute for imported fuel. However, the plan suffered a setback when the flagship 600 MW project at Muzaffargarh for the former failed to attract even a single bid despite incentives like the provision of land, guaranteed off-take for 25 years, tax breaks, and a 70% dollar-index tariff.

Another 2,000 MW of solar power is envisioned to be added through a decentralized, medium-scale PV network into 11 KV feeders. This solution aims to address the issues of power quality, as outages and voltage drops are a frequent occurrence. Pakistan currently has to install a lot more electricity than peak demand requires because of the high transmission and despatch losses. Not only are they directly passed onto consumers, but idle generation also results in higher capacity payments, which further increase the tariffs. In this regard, a medium-scale solar PV around the 1kV feeder can help increase its capacity and improve the power quality without requiring large-scale additional capacity.

46. State Bank of Pakistan
47. Power generation: The rut continues - BR Research - Business Recorder
48. Pakistan's extreme energy poverty - BR Research - Business Recorder
49. Fast Track Solar Initiatives - Private Power & Infrastructure Board

A pilot project at one of the biggest feeder systems on the CPPA-G system showed that in the case of maximum load (August daytime), the losses along the MV line are as high as 1.3 MW or 29%. However, by integrating three 1 MWp solar PV plants, these losses declined to just 4%.[50] "At the same time, the maximum voltage drop (at the end of the line) decreased from more than 30% to less than 10% (10% being an acceptable voltage range for a country like Pakistan)."

Finally, the last component of the program entails the installation of 1,000MW of capacity through solarization of public sector buildings.[51] The goal is to save on electricity bills and relieve utilities from long-term dues by installing solar net metering-based systems at various public office premises on both lease (based on a 10-year build, own, operate, and transfer mechanism) and own-cost models. The vendor will have to guarantee a certain minimum annual energy yield and all power generated will become property of that department. In this regard, the erstwhile Alternate Energy Development Board, which was merged into the Private Power & Infrastructure Board, floated tenders for the first phase of this project, wherein as many as 50 buildings across eight public sector employers under the lease model.[52] This included buildings of high-profile organizations like the Islamabad Police, Pakistan Post Office, and Pakistan Rangers Punjab among others.

In addition, another 19 buildings of nine employers, including the National Database and Registration Authority and National Insurance Company Limited, were advertised for solarization bids on their own cost model.[53] The Punjab government undertook a similar initiative under which five public institutes, including Lahore General Hospital and Danish School campuses, have been solarized.[54] However, early results point to a mixed picture with the Evaluation & Monitoring report grading the project as "partially successful" amid a time overrun of seven months and costs exceeding the original approved sum by 22%.[55] The ongoing Sindh Solar Energy project, supported by $100M financing from the World Bank, also had a distributed solar component where PV systems and associated energy management systems will be installed on rooftops and other available space on and around public sector buildings.[56] As of October 6, 2023, 16.39MW of capacity was added under this program, on track to meet the target of 20MW by the end of 2024.[57]

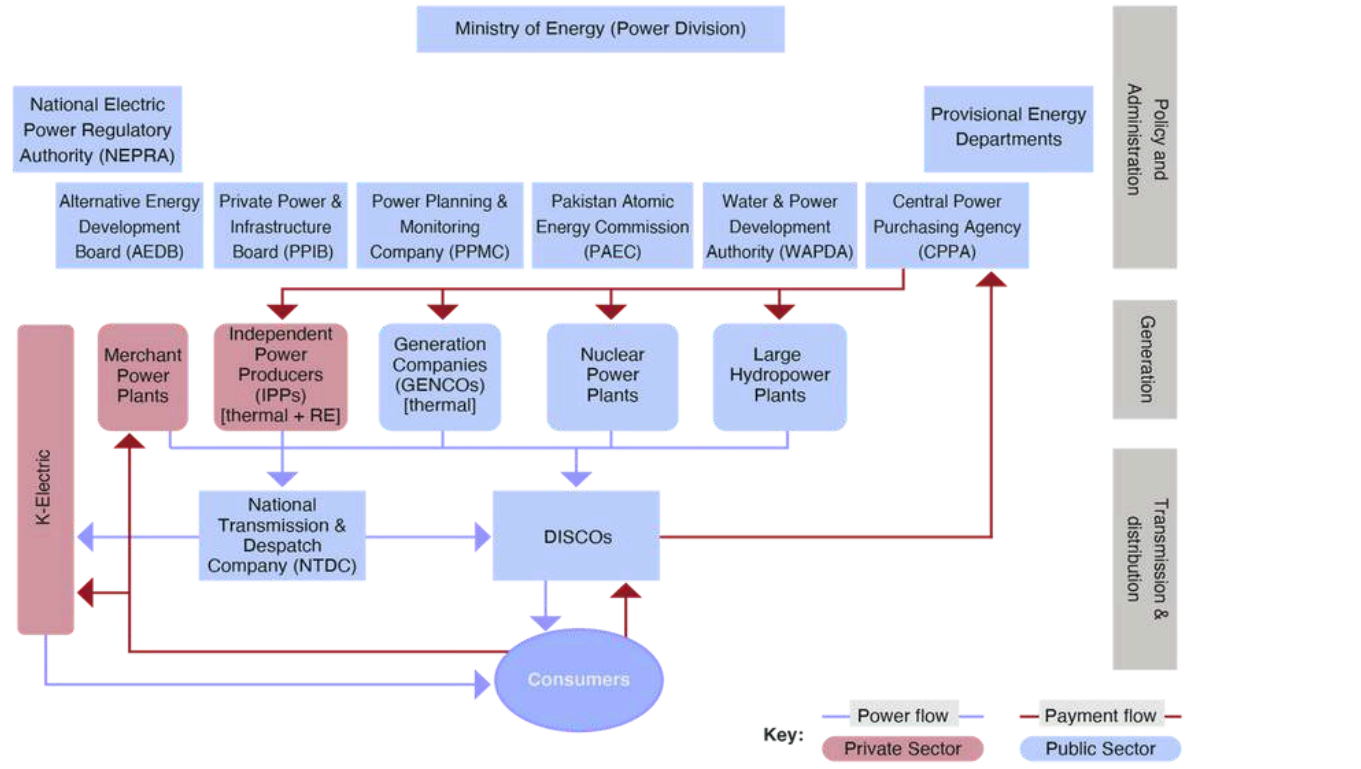
On the demand side, rising electricity tariffs coupled with reforms in the net metering regime have led to a steady uptake of rooftop solar panels. Amid advancements in technology, the cost of solar PV systems has consistently declined over the years, even after accounting for the rupee depreciation, thus making it a long-term capital investment for many households. Consequently, 145 new installers received certifications in July–March FY23, bringing the total number of active AEDB-certified installers to 307. Furthermore, net metering-based systems of 355.3 MW total capacity were installed by different consumer segments during the same period, while 50,656 installations totaled 863.4 MW as of March 2023.[58] For context, this is 25% higher than the combined solar capacity of CPPA-G and KE.

50. Decentralized Feed-in of Solar PV into MV Grids in Pakistan (Draft) - PGREF
51. Choosing the right incentive for Pakistan's renewable energy industry | Institute for Energy Economics and Financial Analysis
52. Invitation of Bids-Solarization of Public Sector Buildings (20-April-2023) - PPIB
53. Solarization of Public Sector Buildings on Own Cost Model (13-Jun-2023) – Private Power & Infrastructure Board
54. 2nd Monitoring Report on the project of solarization of Public Institutes | Planning & Development Board, Government of Punjab
55. Evaluation Report "Solarization of Public Institutes" | Planning & Development Board, Government of Punjab
56. Sindh Solar Energy Project - SSEP
57. Development Projects: Sindh Solar Energy Project - P159712 - WB
58. Pakistan Economic Survey 2022-23 | Ministry of Finance

Further, a solar manufacturing policy is also in the works aimed at promoting the local manufacturing of solar panels and allied equipment while discouraging dependency on imports. These features include tariff and tax exemptions on raw materials and machinery used in local production, alongside increased tariffs on imported finished solar panels. Additionally, the policy outlines a 10-year plan with escalating targets for investment, production capacity, exports, and localization, supported by bank guarantees. To qualify for exemptions, manufacturers must meet specific criteria over the course of the policy period. Incentives are contingent upon achieving localization and export targets, with provisions for withdrawal or recovery if targets are not met. Implementation of the policy will involve the extension of incentives through the Fifth Schedule of the Customs Act to qualifying manufacturers recommended by the EDB. Quota allocation will be determined by the IOCO of the FBR. Some salient features of the policy include:

- Manufacturers must increase capacity from 01 GW to 10 GW starting from the sixth year .
- The export sales to local sales ratio should be as follows: 50:50 in the first year, 60:40 in the second year, 70:30 in the third year, 80:20 in the fourth year, 90:10 in the fifth year, and maintained for the following years.
- Localization targets start at zero in the first year, increasing to 30% in the second year, 40% in the third year, and reaching 50% from the fourth year onwards.
- The required investment amounts are as follows: $10 million in the first year, $20 million in the second year, $30 million in the third year, $40 million in the fourth year, $50 million in the fifth year, and $60 million from the sixth year till the tenth year.

Fig. 22: Key Regulatory Stakeholders in Energy



Pakistan's CleanTech Policies

Policy	Salient Features
Power Policy 1994	The policy aimed to address the country's power shortage by encouraging private sector involvement in power generation. It offered incentives to attract investors and played a crucial role in shaping the energy landscape during that period.
Hydel Power Policy 1995	The policy offered tax exemptions for private power generation companies and facilitated equipment imports for plant and equipment related to hydropower projects. It played a crucial role in shaping Pakistan's energy landscape by promoting investment in indigenous hydel resources.
Power Policy Generation Projects 2002	It focused on hydel and indigenous fuel-based projects, emphasizing a favorable regulatory environment and institutional arrangements. The policy provided procedures for soliciting proposals, negotiations on tariff, and project implementation.
Renewable Energy for Power Generation Policy 2006	The policy covered wind, solar, and small hydro projects (less than 50 MW). It served as the country's initial roadmap for renewable energy development. Additionally, the policy introduced requirements such as the Letter of Intent (LOI) and Implementation Agreements (IA). These agreements included a Sovereign guarantee from the Government of Pakistan to attract investment in the Independent Power Producer (IPP) model
National Power Policy 2013	The policy aimed to address the challenges faced by the power sector and achieve long-term sustainability. Its vision was to develop the most efficient and consumer-centric power generation, transmission, and distribution system. The policy focused on supply, demand, affordability, and sustainability, aiming to meet energy needs while boosting the economy
Power Generation Policy 2015	The policy objective revolved around achieving sufficient power generation capacity at the least cost, encouraging the exploitation of indigenous resources, considering stakeholders, and ensuring affordability, sustainability, environmental protection, and energy security.

ARE Policy 2019	The policy aims to achieve 20% of generation capacity from ARE technologies by 2025 and 30% by 2030. It lays out a plan for harnessing the full potential of ARE while ensuring competitive pricing through mandatory competitive bidding for renewable energy projects, with exceptions for new technology and strategic projects. The policy also promotes local content and indigenisation.
National Electricity Policy, 2021	The policy's main objectives are affordable energy access, energy security, and sustainability. It targets electricity for all households in five years, ensures affordability for everyone, emphasizes uninterrupted power supply, enhances grid reliability, encourages sustainable energy practices, and promotes renewable and local fuel use to reduce environmental impact.
Fast Track Solar PV Initiatives 2022	The policy aims to add 10,000 MW of solar projects, with 6,000 MW allocated to utility-scale solar projects acquired through competitive bidding. These large-scale projects will be procured through a competitive bidding regime on a Build, Own, Operate, and Transfer (BOOT) basis. The remaining 4,000 MW will include solar projects at existing 11 kV feeders with surplus distribution capacity, procured through auctions, and the solarization of government buildings.
IGCEP 2022-2031	It outlines the country’s strategy for meeting its energy needs while transitioning towards cleaner and more sustainable sources. The plan includes ambitious targets for solar and wind capacity, net-metering, and reducing reliance on imported fuels. Under the solar initiatives for 2022, the government aims to promote local renewable energy sources, particularly solar photovoltaic (PV) energy. By 2031, Pakistan plans to add approximately 6,000 MW of solar PV capacity and 4,928 MW of wind capacity. Net-metering will allow consumers to generate their own electricity, further encouraging the adoption of distributed renewables.

Innovation

Nizam Energy

Location: Karachi

Founded In: 2012

Sector: Renewable Energy

What problem is it solving:

It aims to address the challenges in adoption of solar technology speiafically in the areas of engineering and procurement.

How is it solving that problem?

By offering comprehensive services in designing, procuring, and building solar power plants at competitive rates, with a focus on selecting the most suitable hardware based on location and site-specific conditions.

Ghulam Rasool & Company (GRC)

Location: Multan

Founded In: 1965

Sector: Renewable Energy

What problem is it solving:

It aims to address the challenges in mainstreaming commercial and industrial scale distributed power generation technologies.

How is it solving that problem?

By developing a portfolio of distributed solar power projects of up to 8MW under the Build Own Operate & Transfer ("BOOT") model.

Ningbo Green Light Energy

Location: Lahore

Founded In: 2020

Sector: Renewable Energy

What problem is it solving:

Rest stops along Pakistan's motorways currently rely on grid-powered electricity, leading to high operational costs. Transitioning these facilities to solar energy could result in substantial cost efficiencies.

How is it solving that problem?

By entering into a 10-year Build, Own, Operate, and Transfer (BOOT) agreement with Motorway Operations & Rehabilitation Engineering (MORE) to install 4.4MW solar panels at 10 rest stops along the M2 motorway to ensure cost-effective and uninterrupted electricity supply to the rest stops.

Ray Data Environments

Location: Karachi

Founded In: 2022

Sector: Renewable Energy

What problem is it solving:

It aims to address the challenge of high energy consumption in data processing.

How is it solving that problem?

By establishing a renewable-powered data center in Southern Pakistan, integrating a 7.5 MW wind farm and a 340-rack data center.

E-mobility

ELECTRIC VEHICLES

The Air Quality Life Index ranked Pakistan as the World's fourth most polluted country, with all of Pakistan's population living in areas where the annual average particulate pollution level exceeds the WHO guideline[59] while a more recent ranking by IQAir placed Pakistan on the second spot.[60] Deemed as the greatest threat to human health in Pakistan, taking 3.9 years off the life of an average Pakistan, air pollution has increased by 49.9% from 1998 to 2021. While the reasons for this vary from waste incineration and electricity generation to crop burning and heating fuel, the burning of fossil fuels for transportation is a major contributor to the deteriorating air quality in the country.

Fig. 23: 2023 Air Quality Index Ranking

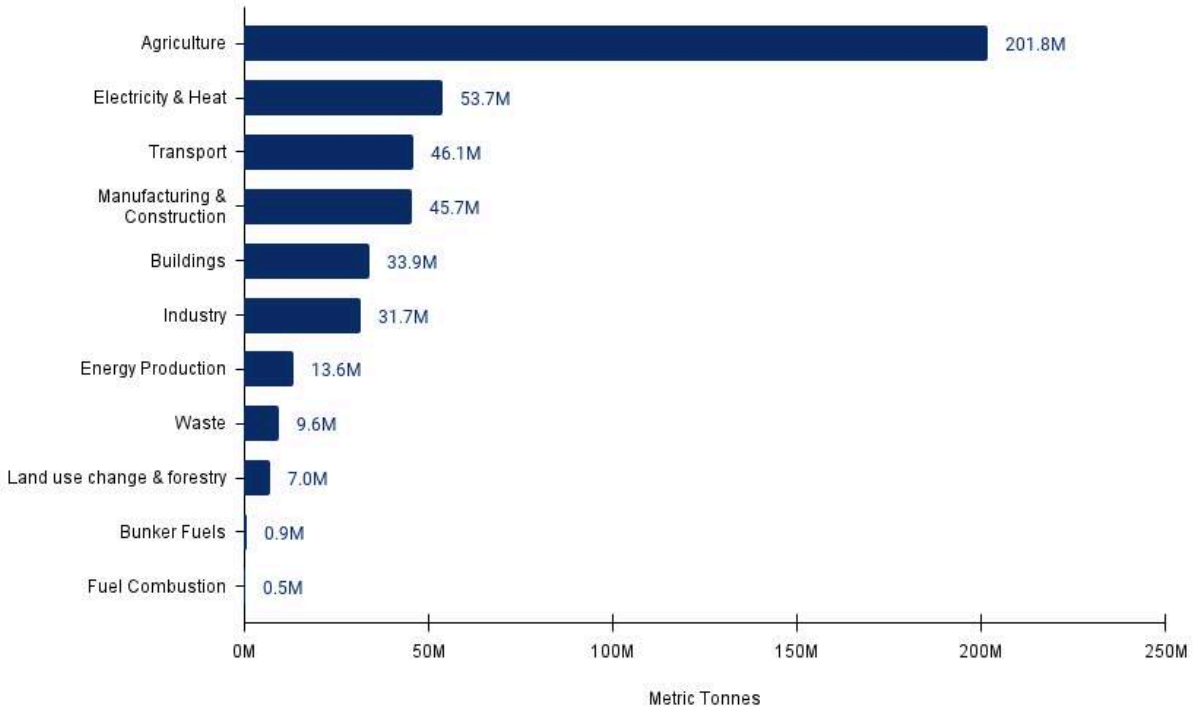
#	COUNTRY	POPULATION	AVG. US
1	Bangladesh	169,356,251	164
2	Pakistan	231,402,117	160
3	India	1,407,563,842	147
4	Tajikistan	9,750,064	134
5	Burkina Faso	22,100,683	128
6	Iraq	43,533,592	121
7	United Arab Emirates	9,365,145	119
8	Nepal	30,034,989	118
9	Egypt	109,262,178	118
10	Democratic Republic of Congo	95,894,118	114

59. Pakistan - AQLI
60. Pakistan Air Quality Index (AQI) and Air Pollution information | IQAir

Fig. 24: How polluted is Pakistan?

Pakistan's transport sector is heavily reliant on internal combustion engine (ICE) vehicles which are powered by imported fossil fuels. These vehicles not only emit a significant amount of greenhouse gases but the health & economic costs of exposure to transport-related pollutants are too massive to ignore. Fair Finance Pakistan found that air pollution in Pakistan leads to at least 128,000 deaths per year, with the actual figure to be likely higher.[61] A study conducted to assess the air quality index (AQI) of the main urban areas of Pakistan based on pre-and post-lockdown effects and mortality rates due to coronavirus disease found that AQI greatly improved in all the main cities of Pakistan during the lockdown when the number of vehicles on the road greatly decreased.[62]

Fig. 25: Emissions by Sector



61. Pakistan's Air Pollution Shortens Lives | Human Rights Watch.
62. The effect of COVID-19 on the air pollution in urban areas of Pakistan | Environmental Health Engineering and Management Journal

In 2021, Pakistan was ranked as the eighth most climate-vulnerable country in the world by Germanwatch.[63] The threats posed by climate change make Pakistan's transition to clean mobility solutions a necessity as the country bears the brunt of extreme weather patterns, rising temperatures & environmental degradation. In contrast to conventional ICE vehicles, electric vehicles produce no direct emissions of greenhouse gases or other air pollutants. When charged using Pakistan's rapidly expanding renewable energy capacity like solar, wind, and hydropower, the lifecycle emissions of EVs are a small fraction compared to gasoline/diesel counterparts. Transitioning to EVs would not only make a dramatic increase in the mortality rates caused by air pollution but they can also slash Pakistan's reliance on importing expensive fossil fuels by making Pakistan's transport sector dependent on domestically-produced electricity. To understand the potential of electric mobility in Pakistan, we first need to look at the existing market for ICE vehicles.

2-Wheelers

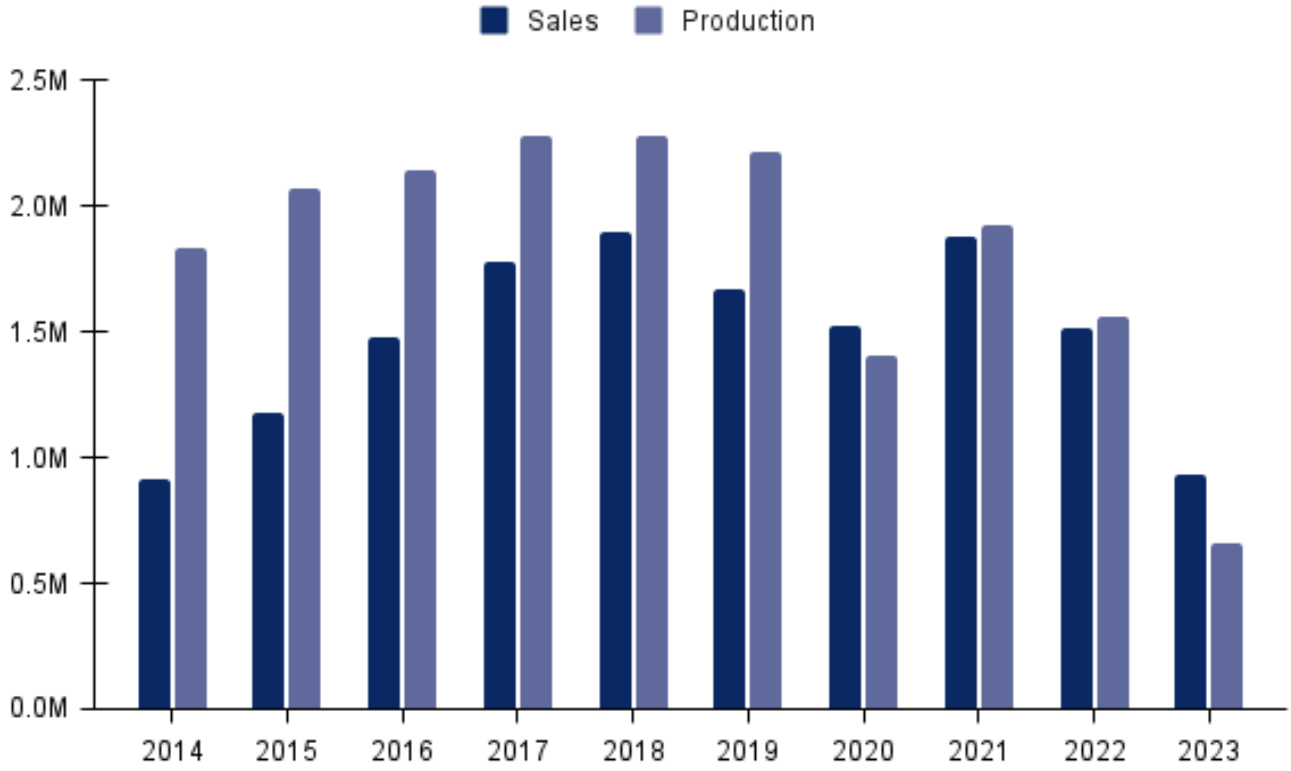
As a low-middle income country, two-wheelers are the most popular segment in Pakistan with almost 27.6M registered motorcycles as of 2023 — more than three times as much as all other types combined. Other than the relatively low price point, the lack of proper urban transport options make 2-wheelers a suitable choice of mobility. Over the last decade, the industry has produced an average of 1.8M vehicles every year, though the number contracted in 2023 to just 657K — the lowest since 2009. Similarly, while inflationary pressures spoiled the demand, domestic two-wheeler sales have averaged around 1.5M annually during the period under review. The emergence of gig economy platforms like Bykea and Foodpanda have further pushed the uptake of two-wheelers in the country.

Given their volumes as well as the prevalence of relatively less fuel-efficient two-stroke engines, motorcycles are actually the largest source of greenhouse gases among vehicles, accounting for 82% of all emissions from the transport sector.[64] Therefore, in order to meet Pakistan's NDC targets, it's of utmost importance to transition the industry towards cleaner technologies where electric vehicles can help achieve the goal. Secondly, the rise in fuel prices has strained the pockets of millions of Pakistanis who rely on this mode of transport.

Sniffing the opportunity, the EV two-wheeler space has heated up with 31 assemblers now having obtained the license from the Engineering Development Board.[65] Currently, the product offerings mirror that of their ICE counterparts with most of the players adopting similar frames due to the widespread availability of relevant parts. However, the core components of electric vehicles, i.e. batteries, electric motors, and motor control units, are still dependent on imports, which makes those units a lot more expensive.[66] As a result, electric bikes are significantly costlier than ICE models, where the industry claims to have achieved 95% localization levels. For instance, United, the second largest player in the segment, has a delta of almost more than 2x between its base ICE and electric variants.[67]

63. 10 of the countries most affected by climate change | Concern Worldwide
64. Bajwa AU, Sheikh HA. Contribution of Road Transport to Pakistan's Air Pollution in the Urban Environment.
65. Engineering Development Board
66. Pakistan: Electric Vehicles and Batteries Market Assessment - USAID
67. Bike Prices in Pakistan - Latest Motorcycles Price list | PakWheels

Fig. 26: Production and sales of motorcyles



While local assemblers of electric two-wheelers also have reportedly up to 80% of parts localization,[68] a more meaningful way to look at it from a cost perspective. Since the largest input costs for EVs are attributable to motors and batteries, only around 30% of the costs are localized. On top of higher upfront pricing, EV bikes also have ample room to cover technology-wise as the maximum speeds on average are still lower than their ICE counterparts.

However, around the world and across segments, electric wheelers are typically more expensive than their ICE counterparts due to the higher costs of battery, technology, and other capital investments. On the other hand, operation expenditure is generally lower and makes the transition to EVs beneficial in the longer term. For example, a 70cc bike — the most popular engine in Pakistan — does on average 53km per liter, which translates into a per kilometer cost of PKR 5.2. In contrast, which are still in the very early stages of sophistication, offer PKR 1.5-2.5, making them far more cost-effective to operate daily.[69] Therefore, a better metric for comparison is the total cost of ownership (TCO), which incorporates not only the upfront price but also the operation expenses over the life of the vehicle. In this respect, two-wheeler EVs lead comfortably over 5 years. According to an analysis published by the United Nations Development Program and National Energy Efficiency and Conservation Authority in October 2021, Honda 70cc, one of the most fuel-efficient models in the market, had a TCO of PKR 351,000 while Jolta's base variant cost PKR 197,000.[70]

68. Interview | Hassan Khan, Founder of Zyp Technologies
69. Top Locally Assembled Electric Bikes and Scooters - A List - PakWheels Blog
70. Scaling up Electric Mobility in Pakistan - UNDP, NEECA

On a per-kilometer basis, Honda 70cc stood at PKR 3.9 versus Jolta's PKR 2.16. Since then, fuel prices have more than doubled, thus making ICE motorcycles even more expensive to use for maintenance. Regardless of the long-term savings, upfront pricing plays a massive role in the purchasing behavior of average consumers. Nonetheless, the business segment can be a potential market for EV assemblers. Particularly, courier companies and gig economy platforms are almost entirely dependent on motorcycles for their daily operations with a combined fleet of hundreds of thousands. For these organizations, a transition towards electric could help reduce the electronic, and their ability to get better credit terms from financial institutions might be possible.

Pakistan's current electric two-wheeler landscape features both incumbents and new entrants, slightly tilting towards the former. As per the EDB, 18 of the 31 listed players also produce ICE while the remaining are startups. Geographically, there's a healthy mix of companies from 11 different cities. Lahore comfortably dominates in the space with 12 assemblers of which a third are startups while Karachi is the distant second with five players in total.

Fig. 27: Registered 2W Assemblers

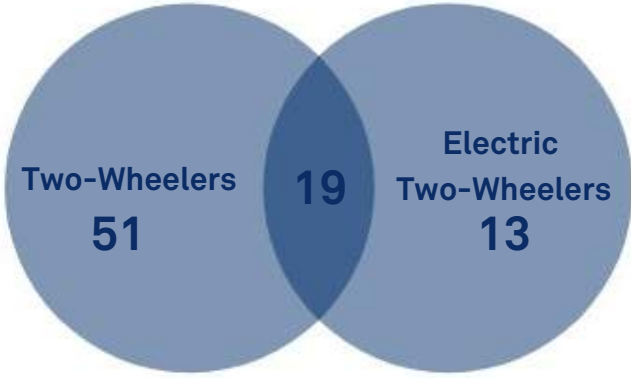
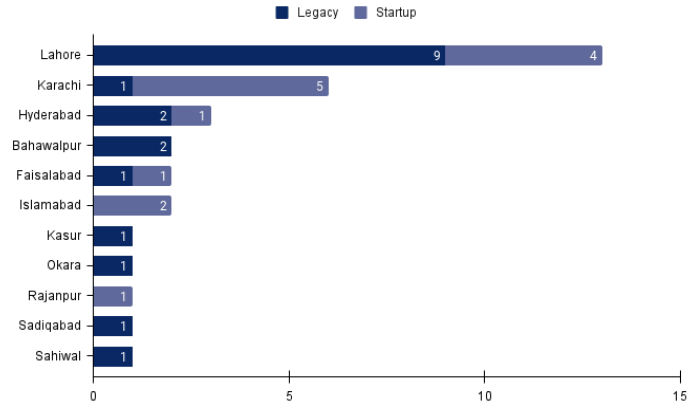


Fig. 28: 2W EVs by City

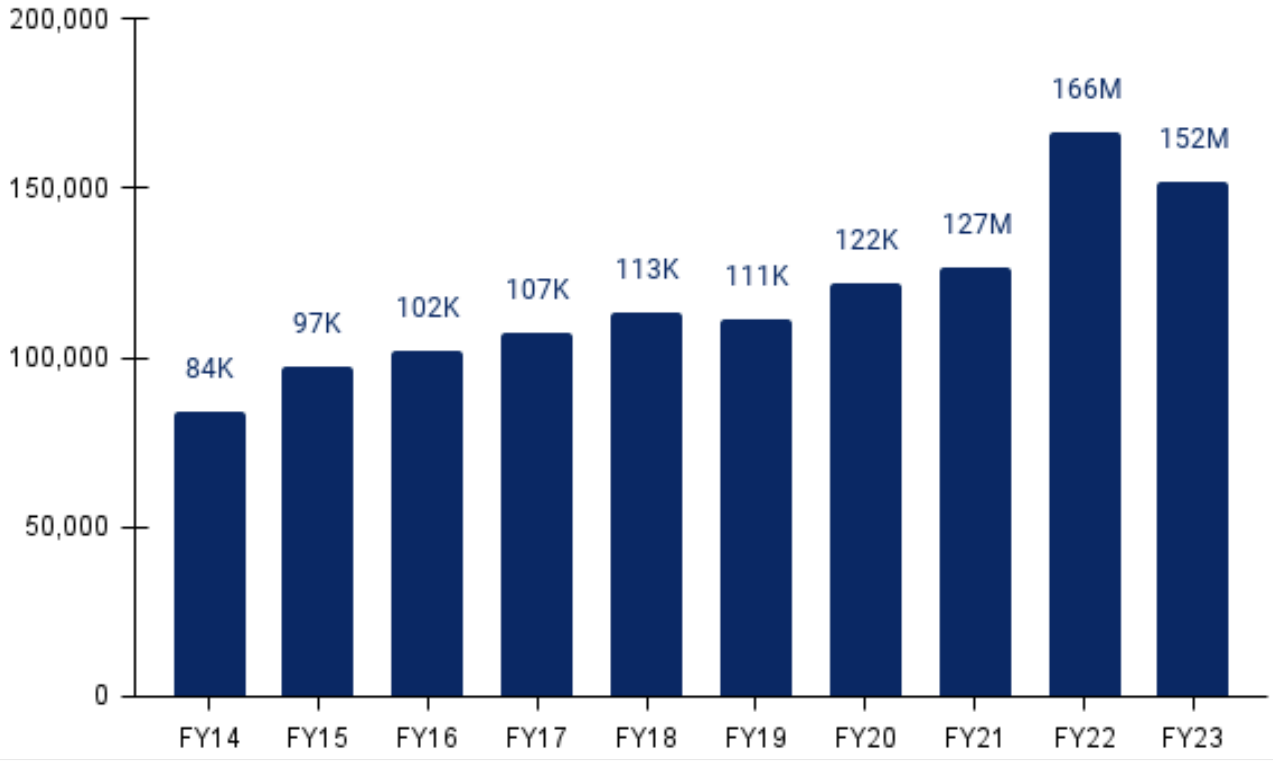


We further analyzed 17 players with available product-level details to understand the underlying business models and technological specifications. According to their reported data, the average top speed stands at 66kph while the range peaks at 150km, indicating the industry's nascency. This has major implications from a business model perspective as the range is presently not suitable for the B2B segment. It should be no surprise then that all but one player is focused on the consumer market where daily running is comparatively lower. Similarly, the average charging time across our sample is 4.2 hours, which further renders the commercial use case quite limited. To address this, three assemblers have adopted a battery-swapping model where they are working on building centers across major hubs that'd allow them to replace batteries and make the transition more convenient. For batteries, there is a wide variety available right now with at least four variants using lead-acid-based batteries. From a localization viewpoint, this can be feasible as Pakistan produced more than 150,000 storage batteries in FY23.[71] However, for both lithium-ion and LiPo options, the assemblers have to turn towards foreign markets. According to our analysis of Comtrade data, Pakistan imported batteries worth $228.6M between FY19 and FY23 under HS code 850760, with the average unit price rising over the years amid spike in demand for lithium-based batteries after Covid-19.

71. Pakistan Bureau of Statistics

Fig. 29: Pakistan's Import of Lithium-ion Batteries

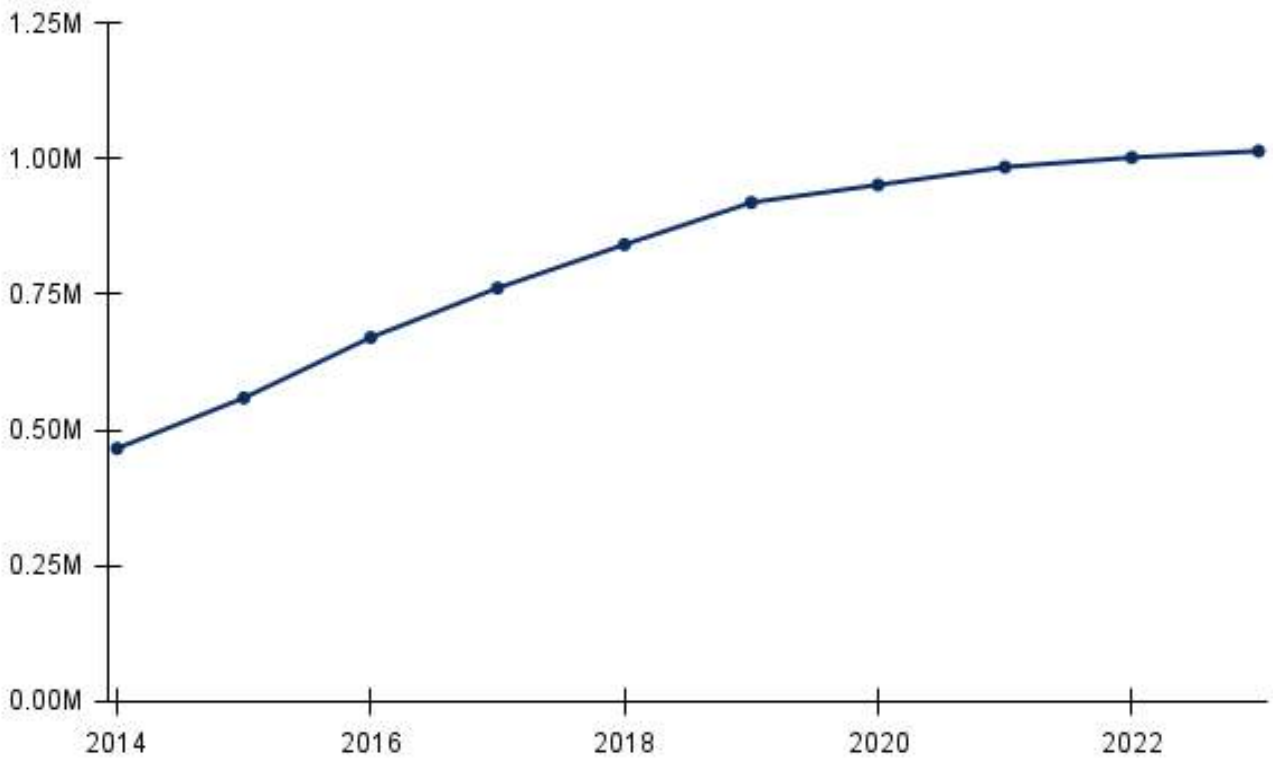
Fig. 30: Storage batteries produced in Pakistan



3-Wheelers

Three-wheelers enjoy significant popularity in Pakistan and have traditionally been the vehicle of choice for public mobility in the absence of reliable mass transit options. In addition, they are also used as loaders and quite prevalent in the logistics industry. As of 2023, there were 1,013,798 registered three-wheelers in the country,[72] making them the third largest type of vehicle. However, in the last two years, new registrations have slowed down considerably compared to pre-Covid levels and the 2023 figure stood at just 11,936.

Fig. 31: Total Registered Three-wheelers



This extends to the EVs as well where unlike two-wheelers, activity in local three-wheelers is quite sparse with only players focusing on the segment. In this space, Sazgar Engineering has been one of the first movers, further capitalizing on its leading market position in the segment and became the first local company to obtain licence for electric rickshaw manufacturing in January 2024.[73] The remaining three — i.e. Nova Mobility, Ms AlhMmdAli EPC Co and La He Trading International — are focusing on cargo loaders.

72. Pakistan Economic Survey
73. Govt grants first electric rickshaw license to Sazgar - Mettis Global Link

Expectedly, the electric three-wheelers are costlier than ICE models, with a delta of around 1.8x. However given the commercial nature of rickshaws and cargo loaders, the daily running is much higher at around 200-250km, and therefore, operational expenses can be a key deciding factor for buyers and can be significant in the long run. Sazgar's own product brochure claims to save PKR 292,000 in the form of fuel efficiencies and maintenance requirements.[74] According to the above-mentioned UNDP and NEECA study, the differences are massive where an electric rickshaw had an opex of PKR 237,000 compared to PKR 923,000 for ICE. As a result, the TCO of ICE rickshaws stood at PKR 1.2 million compared to Electric's 737,000.

While the long-term cost savings make great economic sense, both to the owners and the end consumers in terms of lower fares, the uptake of electric three-wheelers is contingent upon the availability of charging infrastructure. Typically, a rickshaw runs 200-250km daily, which is almost twice the range available in Sazgar's model. In such a scenario, a battery-swapping model might be suitable, though there doesn't exist any such network.

4-Wheelers

Amid the depreciation of the rupee, Pakistan's four-wheeler market has been hit extremely hard as total car sales fell to just 65,843 in 2023, plunging by 69.5% compared to 215,581 the year before. This is the lowest figure in two decades, indicating the severity of the underlying crisis in the industry. With a total of 4,567,300 cars on the road,[75] Pakistan has 20 cars per 1,000 people[76] which are predominantly owned by high-income populations. However, due to unprecedented inflation[77] and increases in fuel costs, even the traditionally affluent strata are feeling the pinch.

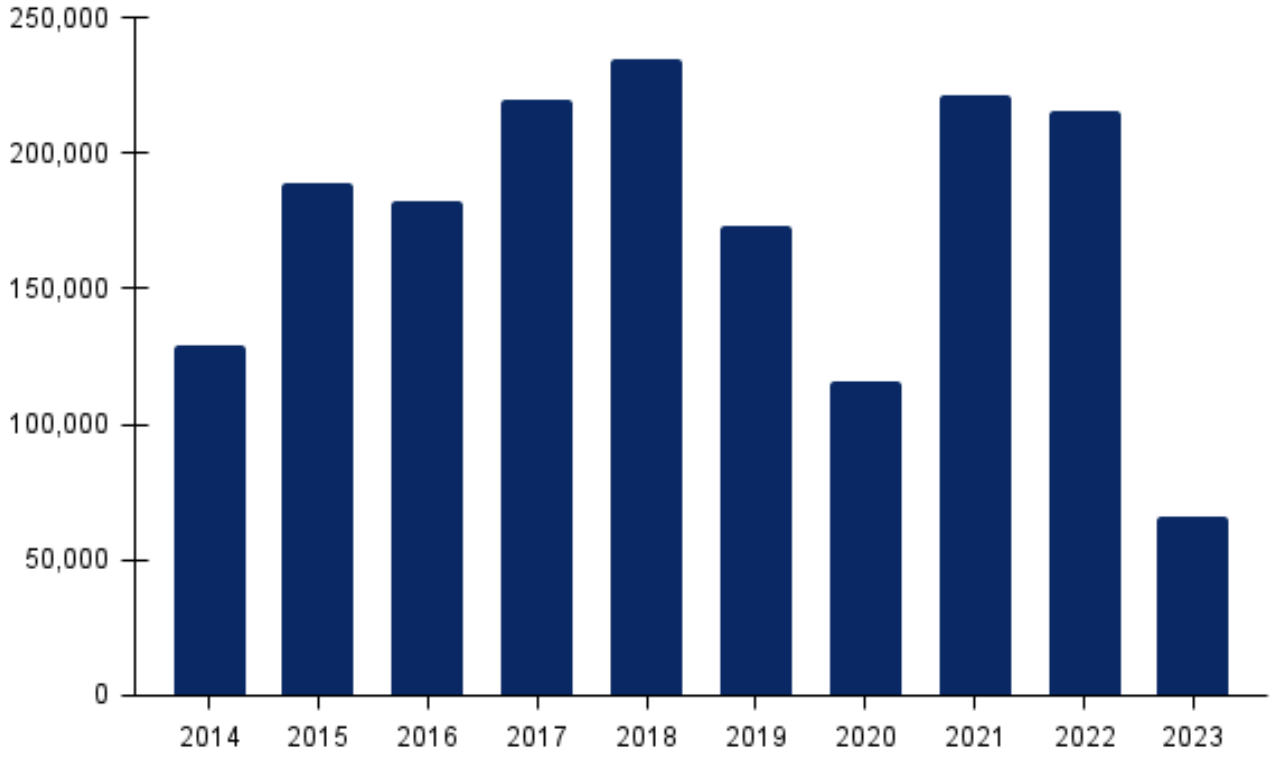
Despite being in the market for decades, the legacy auto manufacturers still remain heavily import-dependent, which results in continuous jacking up of prices. As a result, even the existing ICE models remain well beyond the reach of average consumers. Consequently, four-wheelers have the least attractive economics. As of October 2021, the TCO of MG's ICE variant of ZS (PKR 6.55 million) was higher than the ICE model (PKR 6.48 million). Notwithstanding these pressures, Pakistan's EV space has seen some traction with the launch of new models from a number of assemblers.

The flurry of interest by the government in developing a functioning EV ecosystem in Pakistan led to a lot of international players wanting to enter the market. The first player to get the coveted spot for a locally manufactured HEV was Sazgar with the launch of their Haval H6 HEV.[78] Sazgar Engineering (PSX: SAZEW), is known for being one of the biggest manufacturers of rickshaws in Pakistan.

This was followed by Toyota who announced an infusion of $100M in the country for the development of Hybrid electric vehicles through Indus Motor Company in 2021.[79] After many delays in production, their first locally manufactured cross-hybrid electric vehicle was launched in December 2023.[80]

74. eVe: First Fully Electric Rickshaw in Pakistan - Aik Charge Mae 100 Km
75. Pakistan Economic Survey 2022-23
76. Who Owns the Most Vehicles per Capita, by Country? - Visual Capitalist
77. Pakistan's headline inflation hits new record at 38% in May 2023 - Business Recorder
78. Indus Motor Company inaugurates its hybrid electric vehicle assembly line - Profit by Pakistan Today
79. Toyota to inject $100m into hybrid vehicle production - Express Tribune
80. Indus Motor launches first locally made hybrid electric vehicle in Pakistan

Fig. 32: Sales of Cars and Jeeps



Years before this, right on the heels of the launch of the EV policy, Pakistan and China collaborated to form Topsun Motors to launch the 1st electric car in the country.[81] Though the showroom for Topsun was inaugurated with much fanfare in 2020, the electric variant of their Z100 car was to be launched after the implementation of the National Electric Vehicle Policy but no such variant has been launched since then. In the last few years, new entrants like Changan, MG, and Hyundai have also introduced their all-electric models. On top of it, there's also some import of high-end brands like Audi and BMW.

Overall, the four-wheeler electric industry remains skewed towards the SUV segment, indicating that the offerings are still very much catered towards the niche customer groups. However, the recent announcement by China's BYD, the largest EV manufacturer in the world, to enter Pakistan in partnership with the local Mega Conglomerate is a positive development.[82]

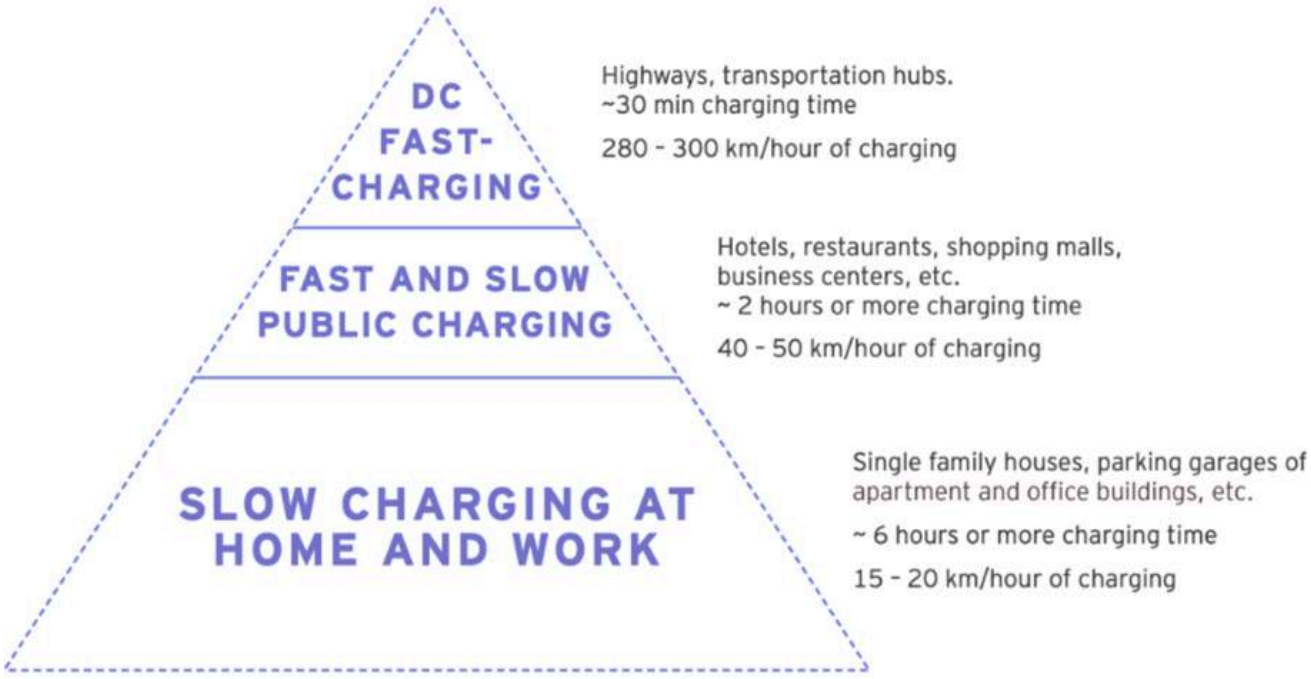
Charging Infrastructure

Arguably more than the upfront price and the product specifications, the uptake of electric vehicles depends on the charging infrastructure. Currently, it's a chicken and egg problem where customers shy away from making the transition to EV due to the lack of charging options. For instance, in urban areas, the lack of personal parking spaces and security concerns attach a risk to home charging where the average duration is 4.2 hours for two-wheelers and higher for other segments.

81. Topsun Motors Officially Launched in Pakistan as First Electric Car Company
82. BYD enters Pakistan's EV market - The News

Establishing charging infrastructure is essential for driving EV adoption, as it boosts consumer confidence and alleviates range anxiety concerns. In Pakistan, facilitating home charging access is a critical factor in encouraging consumers to transition to EVs. Industry experts note that a significant portion of charging occurs at home using Level 1 chargers overnight, typically with power ratings below 3.3 KW. Workplaces offer another viable recharging option, employing Level 2 AC chargers ranging from 3.3 to 22 KW, often initially set at 7–11 kW.[83]

Fig. 33: Charging Infrastructure



To address the time-consuming charging process, battery swapping emerges as a potential solution due to its quick nature, enabling battery exchange within minutes and reducing wait times. While previously recommended for addressing extended charging durations, the capital-intensive nature of battery swapping has led companies like Tesla to prioritize establishing supercharger networks over battery swap stations. Standardisation is crucial for clarity, safety compliance, and scaling up EV charging infrastructure.

Encouraging EV charging interoperability allows drivers to recharge using preferred authorization and payment methods at any charging point. The Pakistan Standards and Quality Control Authority (PSQCA) leads efforts to set and enforce EV charging station standards in the country.

Effective charger utilization is critical, influenced by factors like charging behavior, driving patterns, housing types, charging station proximity to commercial areas, and user accessibility. Strategic location selection based on various considerations is key to efficiently meeting charging demands. In the context of Pakistan's energy landscape, there is excess power generation capacity, primarily from cleaner sources like nuclear, hydel, renewables, and efficient RLNG plants.

83. Scaling-Up-Electric-Mobility-in-Pakistan - UNDP

Fig. 34: Electric vehicle charging & batteries standards (PSQCA)

1	PS IEC:61851-1	Electrical appliances and accessories (TC-3)	Electric vehicle conductive charging system - Part 1: General Requirements
2	PS IEC:61851-23	Electrical appliances and accessories (TC-3)	Electric vehicle conductive charging system - Part 23: DC electric vehicle charging station
3	IEC:62840-1	Dry cells batteries and accumulators (TC-6)	Electric vehicle battery swap system - Part 1: General and guidance
4	IEC:62840-2	Dry cells batteries and accumulators (TC-6)	Electric vehicle battery swap system - Part 2: Safety requirements
5	PS:206-1	Dry cells batteries and accumulators (TC-6)	Lead acid starter batteries - Part 1: Dimension of batteries and marking of terminals
6	PS:206-2	Dry cells batteries and accumulators (TC-6)	Lead acid starter batteries - Part 2: General requirement and method of test
7	PS IEC:62133-1	Dry cells batteries and accumulators (TC-6)	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for portable sealed secondary cells and for batteries made from them, for use in portable applications - Part 1: Nickel Systems
8	PS IEC:62133-2	Dry cells batteries and accumulators (TC-6)	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for portable sealed secondary lithium cells and for batteries made from them, for use in portable applications - Part 2: Lithium Systems
9	PS IEC:61960-3	Dry cells batteries and accumulators (TC-6)	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Secondary lithium cells and batteries for portable applications - Part 3: Prismatic and cylindrical lithium secondary cells and batteries made from them
10	PS IEC:60622	Dry cells batteries and accumulators (TC-6)	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Sealed nickel cadmium prelatic rechargeable single cells
11	PS IEC:61951-1	Dry cells batteries and accumulators (TC-6)	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Portable sealed rechargeable single cells - Part 1: Nickel cadmium
12	PS IEC:61951-2	Dry cells batteries and accumulators (TC-6)	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Portable sealed rechargeable single cells - Part 2: Nickel-Metal-Hydride

13	PS IEC:61982	Dry cells batteries and accumulators (TC-6)	Secondary batteries (except lithium) for the propulsion of electric road vehicles - Performance and endurance tests
14	PS IEC:60086-4	Dry cells batteries and accumulators (TC-6)	Primary batteries - Part 3: Safety of lithium batteries
15	PS IEC:62620	Dry cells batteries and accumulators (TC-6)	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Secondary lithium cells and batteries for use in industrial applications

Effective charger utilization is critical, influenced by factors like charging behavior, driving patterns, housing types, charging station proximity to commercial areas, and user accessibility. Strategic location selection based on various considerations is key to efficiently meeting charging demands. In the context of Pakistan's energy landscape, there is excess power generation capacity, primarily from cleaner sources like nuclear, hydel, renewables, and efficient RLNG plants.

However, limited demand for electricity from traditional sources, driven by higher pricing, has prompted a need for transitioning transportation to electric vehicles (EVs). This transition could enhance power grid utilization and optimize solar panel capacity, with economic rationale supporting consumer-level conversion to EVs. Challenges hindering EV adoption, such as economic uncertainty impeding investment, highlight the potential benefits of government intervention in promoting EV adoption.

Incorporating 0.5 million EVs into the transportation grid by 2025, as recommended by studies, could mitigate carbon dioxide emissions by 1.47 billion kg/year and alleviate industrial and household power affordability strains. However, the surge in EV distribution may pose challenges in electricity network congestion and voltage irregularities, necessitating investments at the Distribution Companies (Discos) level. KE's proactive measures and potential privatization of Discos under the NTDC system could drive further improvements in this regard.[84]

EEV charging stations involve two key cost elements: capital costs and operating costs. Capital costs encompass equipment, installation, site preparation, and grid connectivity expenses, representing fixed costs incurred during station setup. Operating costs, on the other hand, comprise variable expenses related to station operation, including electricity supply, maintenance, land lease, and financing costs for loan interest and equity investor returns.

Limited availability of data on cost components, such as equipment and site preparation, coupled with a reluctance among value chain players to share insights, has necessitated relying on existing information and making educated estimates. According to a UNDP study, “Scaling-Up-Electric-Mobility-in-Pakistan” the following is the estimated capital cost of deploying an EV charging station. It comprises the expenses for the charging equipment or EVSE, installation costs, including site preparation, and utility system upgrades like new transformers, wires, and switches.

84. Rising capacity payments: EVs to the rescue - Business Recorder

Fig. 35: Commercial Charging

Make-ready Cost Estimates for Commercial Charging Station (PKR)				
	Level 2 7 kW AC	Level 3 DCFC 50 KW	Level 4 DCFC 150 KW	Level 5 DCFC 350 KW
Site preparation (per charger)	40,000	480,000	480,000	480,000
Installation (per charger)	16,000	50,000	50,000	50,000
Transformer (per station)	0	2,880,000	4,800,000	4,800,000
Distribution Box & Cabling (per station)	0	1,040,000	1,040,000	1,040,000

EV Charger Equipment Cost Estimates (PKR)				
	Level 2 7 kW AC	Level 3 DCFC 50 KW	Level 4 DCFC 150 KW	Level 5 DCFC 350 KW
ABB Pakistan	320,000	4,960,000	11,200,000	19,200,000
SZS Group - Pakistan	225,000	3,000,000	5,500,000	-
Chinese EVSE Supplier	140,000	2,300,000	3,900,000	14,000,000

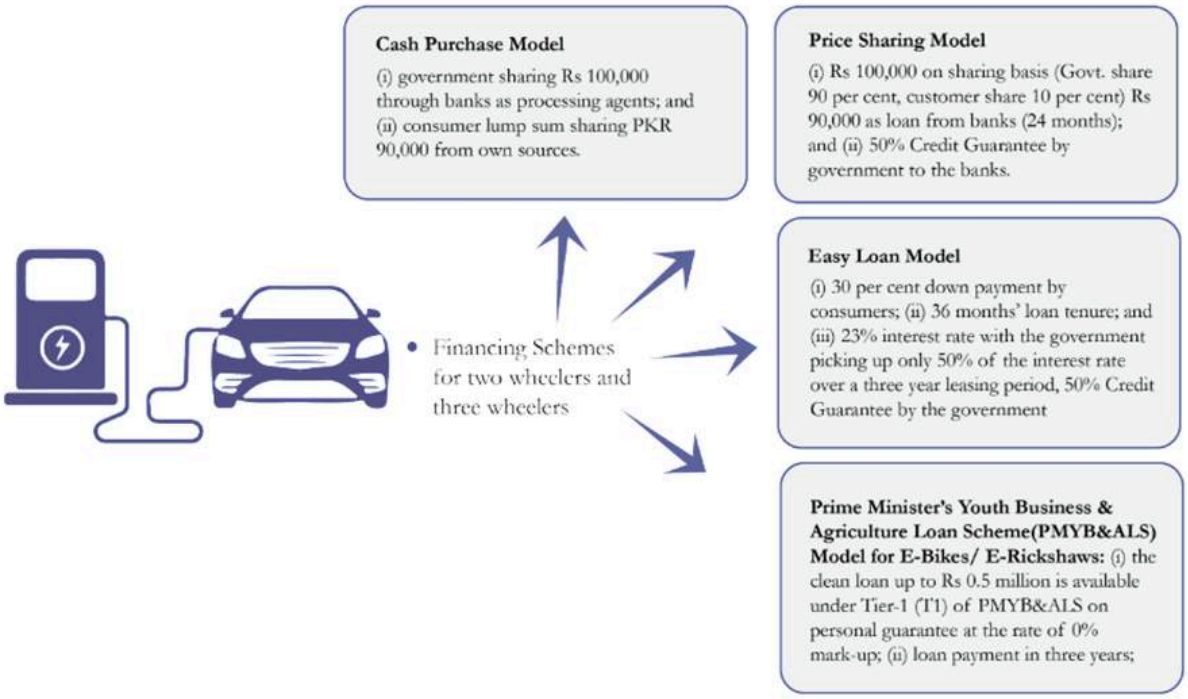
Financing Overview

When faced with situations where purchasing decisions entail significant investments, consumers frequently turn to subsidized or alternative financing options to rationalize their investment choices. Unfortunately, due to the financial institutions' risk averse nature and a high interest environment, Pakistan's credit markets are quite small with just PKR 251 billion of total auto finance as of December 2023. This hinders the potential scalability of electric mobility in the mass market.

Currently, only a few financial institutions offer loans for EVs in Pakistan. An analysis by the Policy Research Institute of Equitable Development (PRIED) reveals that merely 4% of banks actively engage in financing EVs, indicating a significant gap in banking sector support for renewable energy projects, with 96% of banks refraining from EV lending. Despite the Ministry of Industries and Production introducing a financing scheme for electric two-wheeler bikes based on subsidy models, its implementation has not yet taken place.[85]

85. Situation-Brief-Greening-Pakistans-Future-2024

Fig. 36: EV Financing Models



The issues related to narrow scope and the necessity for separate facilities for different products pose taxonomy-related challenges, further complicating regulatory limitations. Alongside these hurdles, the absence of a robust monitoring or evaluation mechanism hinders the effective tracking and assessment of financing progress under the scheme, resulting in a lack of understanding of the challenges surrounding green lending.

As the scheme was gradually gaining momentum, the State Bank of Pakistan (SBP) discontinued allocations under the program, leading to its complete termination. Currently, the government is exploring potential solutions for EVs, including the introduction of a credit guarantee scheme through the SBP and the consideration of a software battery management system to address issues like non-payment of loans.[86]

Pakistan's EV Policy

To encourage the use of EVs in the country, Pakistan launched its first EV policy in 2019.[87] Some of the key targets of the policy included seeing electric vehicles capture 30% of the total passenger vehicle and heavy-duty truck market by 2030 and 90% of the market by 2040. The goals were even more ambitious for buses and two & three-wheelers whereas 50% of all new sales by 2030 should be of electric alternatives. The policy also specified the installation of charging infrastructure in every major city with Lahore being chosen for the roll-out of this plan.

86. Credit guarantee schemes for EVs on the cards - Business Recorder
87. PAKISTAN: National Electric Vehicle Policy (2019)

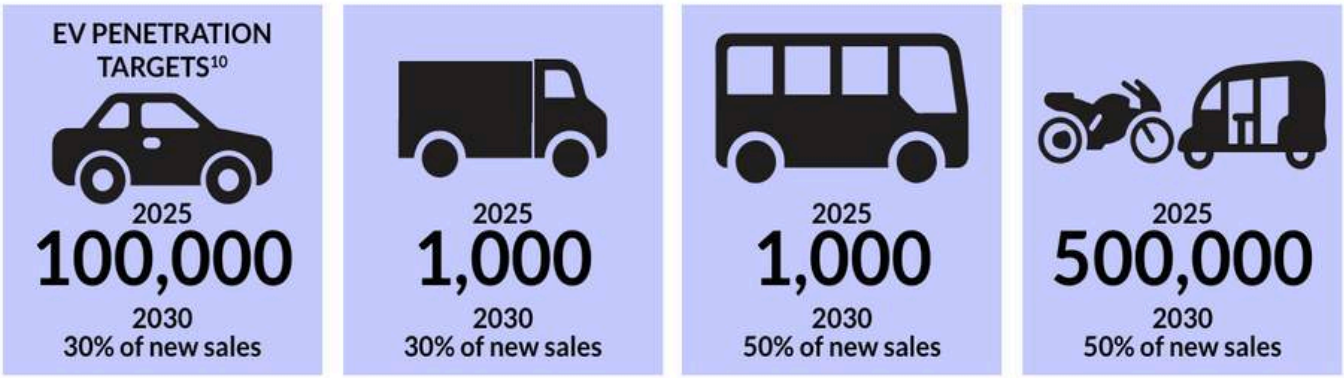
Fig. 37: Regulatory incentives for EVs

Description	Vehicle Type	Customs Duty (CD)	General Sales Tax	Additional Incentives
Completely Knocked Down (CKD) - EV Specific Parts Localized CD 25% Non-Localized CD 10%	Buses & Trucks	1%	1%	• 0% VAT at import stage • 0% Additional Customs Duty • 0% Regulatory Duty
	4W - Vehicles & SUVs	1%	1%	
	2W Motor Bikes & 3W Auto Rickshaw	1%	1%	
Completely Built Unit (CBU)	Buses & Trucks	1%	1%	• 0% VAT at import 0% Additional Customs Duty • 0% Regulatory Duty
	Passenger Vehicles & SUVs	10% till June 2022 & it would increase to 25% till June 2026.	1%	
	2W Motor Bikes & 3W Auto Rickshaw	50% of prevailing CD	1%	
Duty- and Tax-Free Import of Plant Machinery of EV Assembly and Manufacturing		0% CD 0% ACD 0% ACD		• Income tax exemption for auto part manufacturers for setting up manufacturing facility for EV related equipment
Import of EV Charging Equipment		1%		• 0% ACD • 0% RD

Table 3: EV Policy Incentives for Electric Vehicles, Source: EDB MoIP compiled by Author

CD = Customs Duty | GST = General Sale Tax | Source: EDB, MOIP - Author's compilation

Fig. 38: E-mobility Targets



In 2020, an amended policy by the name of "Electric Vehicle and New Technology Policy 2020-2025" was launched which included incentives for both local manufacturing and import of EVs with another amendment called the "New Auto Industry Development and Export Policy" launched in 2021. The new policy revised the previous sales tax of 17% on EVs to 1% while the customs duty on imports was amended to 10% from the previous 25%.

As of April 2024, the Engineering Development Board of Pakistan had granted manufacturing licenses to thirty-four EV companies with all of them being two and three-wheeler manufacturers.[88] While adoption has been slow, EVs have slowly and gradually made their way to showrooms and local markets. 2023 also saw the launch of fourteen electric vehicles and hybrid electric vehicles. Moreover, in February 2024 it was announced that the government would likely introduce a credit guarantee scheme for Electric Vehicles through the State Bank of Pakistan.[89] The interest rate for this scheme would be fixed and equal to KIBOR. The inter-ministerial with representatives from the Ministry of Energy, NEECA, Commerce, Ministry of Science and Technology Ministry of Finance, etc also took the following decisions.

- The Engineering Development Board of Pakistan will take the lead role in the implementation of the Electric Vehicle Policy in compliance with the Special Investment Facilitation Council (SIFC).
- The application procedure for applying for an EV manufacturing license is to be simplified with no open-ended procedures for approval.
- There should be coordination between the EDB and Provincial Registration Authorities as well as the Punjab Transport Authority so there can be a reduction in the fee structure[7] applicable to different variants of EVs.
- The SBP should introduce a credit guarantee scheme and options for that might be explored with the World Bank.
- Possibilities shall be explored for the introduction of a software battery management system that can enforce the stoppage of electric batteries on the non-payment of loans.

Challenges to EV adoption in Pakistan

- High Upfront Costs: While owning an EV saves you money in the long run, the initial purchase price of these vehicles is steeper as compared to their traditional counterparts. The high price point is mostly attributed to the cost of batteries which run on the high side. This cost discrepancy places EVs out of the reach of a substantial portion of the population.
- Lack of Charging Infrastructure: Pakistan is at a very nascent stage of EV adoption and hence the charging infrastructure for EVs is not very widespread. This deters many customers from considering EVs as an option due to fears that the vehicle will run out of battery before reaching a charging station which is not as evenly spread out as gas stations for traditional vehicles.

88. EDB grants 34 licences to boost electric vehicle production - Profit by Pakistan Today
89. Credit guarantee schemes for EVs on the cards - Business Recorder

- Electricity Shortfall: Pakistan's electricity shortfall problem is another deterrent for potential EV owners. Even if ample charging stations are established, the availability of uninterrupted electricity at these stations is still a question mark given Pakistan's frequent power outages. Revenue-based load management in many areas also makes it difficult for the establishment of charging stations since EVs have a long charging time.

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- Lack of Skilled Workforce for EV Maintenance: Pakistan lacks the skilled workforce that is needed to operate and maintain electric vehicles. These vehicles and their charging stations require specialised maintenance.

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Other Opportunities

While the success of local assemblers is critical to the development of the EV ecosystem in the country, there are many other sectors in the value chain that need to be developed in parallel. Among them is the localization of electric motors, of which there are few options available presently. In this regard, the 150-member strong Pakistan Pumps & Electric Motors Manufacturers Association could play an important role by looking beyond its traditional segments of fans and expanding towards the growing EV market.

Similarly, the entry of specialised charging and battery infrastructure is crucial. As of December 2023, there were only eight charging stations in the country,[90] of which three are located in Islamabad and two in Lahore. This opens up the need for players of all sizes for setting up both commercial stations and providing turnkey solutions to households. While the space has seen the entry of power producers like Reon Energy and engineering specialists like AEPL, there is still massive room for more. In particular, executive office real estate developers and restaurants across highways could possibly be suited to enter the market by leveraging their existing use cases and offering value-added service to their customers.

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Moreover, the existence of both EV assemblers and new charging providers opens up the market for core software players to build localized solutions. Presently, many assemblers are either trying to build either in-house technology related to monitoring and fleet management or buying international products. Hearteningly, a local startup, Orko, has already entered the space and is working with Vlektra and Ecodost, having raised funding from Singapore's Accelerating Asia.

Finally, there's a need for financial solutions catered to the EV market. While lending is certainly the most critical component, other service offerings must be developed too. Particularly, insurance providers need to underwrite products catered for the electric segment, where many of the ICE-based terms and conditions don't work. The status quo is such that damage to the battery is typically not insured for gasoline-powered vehicles, unless the vehicle is damaged. In that case, there is a mandatory 50% deduction on replacement and thus adds a major risk element to the maintenance of EVs.

90. EV charging stations incurring 'high cost', insiders say - Technology - Business Recorder

Innovation

ezBike
Location: Islamabad Founded In: 2020 Sector: E-mobility
What problem is it solving:
It aims to bridge the affordability and technology gap that has hindered the adoption of electric two-wheelers.
How is it solving that problem?
By building and selling affordable electric two-wheelers tailored for the local market and deploying the country's first network of battery swap stations, where customers can rent fully charged lithium-ion batteries.

Mode Mobility
Location: Karachi Founded In: 2020 Sector: E-mobility
What problem is it solving:
Addressing the challenges in providing sustainable and inclusive travel and transport options for everyday citizens.
How is it solving that problem?
By manufacturing cost-effective electric motorcycles & scooters, developed in-house to meet the specific requirements of niche market segments, ensuring they are equally user-friendly and accessible for both genders.

Innovation

Orko
Location: Lahore Founded In: 2022 Sector: E-mobility
What problem is it solving:
Addresses the need for a comprehensive platform that streamlines operations for different stakeholders in the EV supply chain.
How is it solving that problem?
By offering A platform for electric vehicle industry entities to streamline operations, facilitate communication with stakeholders, track EVs, monitor performance, and leverage data insights for service enhancement.

Zyp Technologies
Location: Karachi Founded In: 2022 Sector: E-mobility
What problem is it solving:
It aims to address the issues of high upfront cost, range anxiety, and lengthy charging times.
How is it solving that problem?
Through an indigenously-developed product portfolio that includes purpose-built electric motorcycles, innovative battery swap stations, proprietary and patent pending battery architecture, cloud software and mobile apps.

Circular Economy

CIRCULAR ECONOMY

Pakistan generates almost 50 million tons of solid waste annually, with the number increasing by 2.4% with every passing year.[91] Poor waste management has led to overflowing landfills that contaminate air and water resources. According to the World Bank, out of the total market of $1.2B of plastic waste, only 15% of $144M is being utilized,[92] representing a massive loss of valuable resources. With 87,000 tons of solid waste being produced every week, the current wasteful model puts a strain on Pakistan's limited natural resource base.

Fig. 39: Estimated waste characterisation percentages

Waste Fraction	Abbottabad	Faisalabad	Sahiwal	Lahore	Rawalpindi	Mirpur	Sialkot	Muzaffarabad	Marden	Gujranwala	Peshawar	Islamabad	Kohat	Sahiwal	Mingora	Average
Kitchen green waste	66.74	72.67	34.21	56.32	54.70	62.33	38.14	68.24	62.96	62.50	53.74	59.95	55.82	56.90	49.21	56.96
Paper	11.86	1.59	8.90	3.20	2.40	4.46	12.95	4.95	3.91	15.30	7.32	7.26	8.2	5.219	13.1	7.37
Textile	1.78	3.87	2.21	9.21	6.05	3.05	3.54	2.71	3.71	3.87	2.35	1.81	2.75	3.71	3.53	3.61
Dry grass and wood	1.47	8.38	12.33	6.05	3.66	1.43	3.93	1.32	1.05	1.63	10.29	0.00	0.15	1.70	4.66	3.87
Plastic	9.46	4.16	9.67	10.64	10.51	12.52	10.22	10.22	7.36	7.70	9.34	7.49	12.00	9.54	14.69	9.71
Leather and rubber	1.07	0.08	0.54	1.00	1.20	0.84	3.20	1.09	0.61	0.77	0.63	0.00	0.723	0.88	0.33	0.86
Metal	0.08	0.38	0.58	0.06	0.03	0.31	3.20	0.26	0.20	0.23	0.72	0.68	0.025	0.375	0.46	0.51
Bottle and glass	0.75	0.21	1.96	0.69	0.64	1.03	7.13	1.31	0.87	1.16	2.32	2.79	9.73	0.75	0.74	2.14
Ceramic, stone, and soil, etc.	1.15	7.37	1.59	6.40	11.13	0.59	2.00	0.24	3.09	1.10	12.32	0.00	0.90	2.51	1.30	3.45
Domestic hazardous wastes	0.20	0.05	0.43	1.36	1.49	0.37	5.39	0.47	0.45	0.60	0.00	0.82	0.40	1.03	0.50	0.90
Sieve Remaining>6mm	0.05	0.00	5.39	2.00	0.00	1.61	2.00	0.78	0.00	3.23	0.00	0.00	0.76	3.06	2.86	1.45
Miscellaneous	5.39	1.24	22.25	3.07	8.28	13.47	6.00	8.41	15.79	1.91	0.97	19.20	8.54	14.33	8.62	9.16

91. Pakistan - Waste Management - Trade.gov
92. 'Circular economy': Country can generate $1.2bn by utilising plastic waste - Business & Finance - Business Recorder

The current solid waste management system in Pakistan relies on local and municipal governments for collecting waste. In cities, handcarts and donkey pull carts are used for primary collection while open trucks and tractors are used for secondary collection. These collection methods are augmented by sanitary workers to ensure smooth collection and storage of waste in formal or informal depots until it is collected.

Fig. 40: Estimated Waste Generation, Treatment & Disposal

Settlement Area	Waste Quantity					
	Generated		Collected	Transported	Treated	Disposed of
	Daily (kg per capita per day)			Yearly (million metric tons per year)		(% of waste generated)
Large cities (11)	0.55	9.44	80	80	20	80–100[a]
Medium-sized and small cities[b]	0.42	4.44	50–70	50–70	10	90–100
Rural communities	0.33	13.72	20	20	20	80–100
Total		27.58				

kg = kilogram.

Note: Pakistan's large cities had a total population of 52 million in 2017; medium-sized and small cities, 32 million; and rural areas, 126 million. Large cities and most medium-sized and small cities dispose of waste in uncontrolled dumpsites, away from the cities. In rural areas, waste is scattered or burned in the outskirts of villages.

[a] Recovery rates have been reduced following the closure or partial operation of refuse-derived fuel (RDF) plants in Lahore, Multan, and Wah Cantonment, and the composting facility in Lahore.

[b] A few intermediate-sized cities like Bahawalpur and Sialkot are exceptions, with collection rates of more than 80%.

Sources: Batool, Chaudhry, and Majeed (2008); Government of Pakistan (2017); authors' compilation from waste analysis and characterization studies over the past decade, in around 15 cities in Pakistan; assessment of data collected in 2015–2020 from waste management/utility companies in Faisalabad, Gujranwala, Lahore, Multan, Peshawar, and Rawalpindi; and analysis of available data from the cities of Dera Ghazi Khan (2018), Hafizabad (2015), Okara (2015), and Sahiwal (2016–2017).

Currently Karachi has three sanitary landfill sites with Lahore having two and plans to construct landfills in other major cities where currently waste is disposed outside the boundaries of urban areas. With only two landfill sites, Lahore is still the only city with a proper solid waste management, treatment and disposal system which has been outsourced to Turkish companies Albayrak and OzPak.[93]

93. Waste management company says Turkish government on board as Lahore cleanup deal gets dirty | Arab News PK

Besides municipal waste, other types of waste include industrial waste [All waste that results from construction and demolition, manufacturing, agricultural operations, wholesale trade, and mining], electronic waste, and healthcare waste. As per a UN report, Pakistan produced 433 kilotons of e-waste in 2021 and was among the 15 countries where e-waste dismantling and recycling is considered a major health hazard.[94] On top of that Pakistan imports about 80,000 tons of hazardous waste from countries like the United Kingdom, Iran, the United Arab Emirates, Saudi Arabia, the United States of America, Belgium, Germany, Spain, Canada, and Italy.[95] [96]

To combat the growing mountain of waste in the country, the Ministry of Climate Change came up with the National Hazardous Waste Management Policy 2022.[97] The objective of the policy was to facilitate the implementation of the Stockholm Convention,[98] the Basel Convention[99] and the Minamata Convention[100] to prevent, minimize, and control hazardous waste. A key point of the policy was that in order to effectively manage hazardous waste, sustainable financial instruments need to be developed with the involvement of the government and autonomous institutions. This is to be done by encouraging financial institutions to provide low-interest loans to the private sector for the development of businesses that are focused on the Environmentally Sound Management of Hazardous Waste. Other key points included:

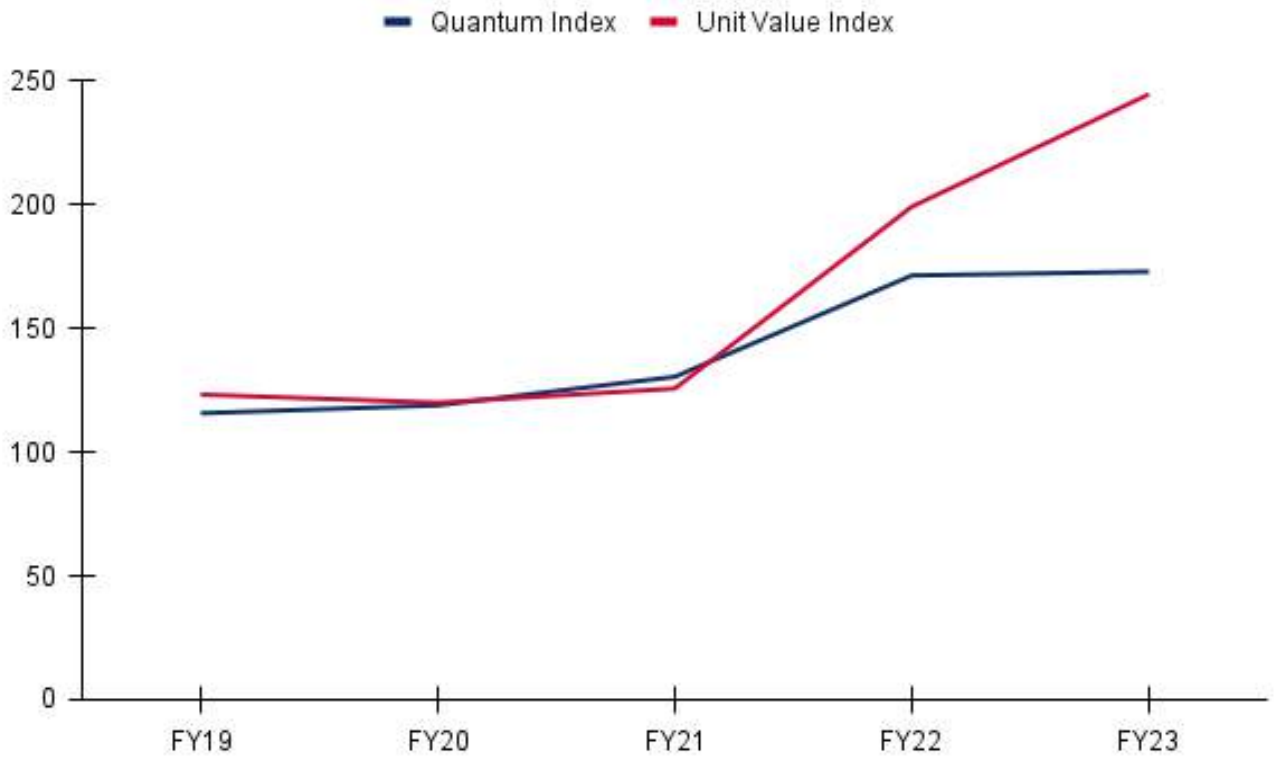
- Inviting the private sector to launch joint ventures for waste management.
- Encouraging voluntary measures by the private sector to manage hazardous waste by offering them incentives in the form of green credits or other similar schemes.[76]
- Offering special credits/subsidies/low-interest loans for the establishment of hazardous waste management systems and industrial upgradation of green technology.
- Removal of trade barriers for the import of clean and green technology.
- Application of discharge fees for the discharge of hazardous effluent based on the type, volume and loading of the effluent in accordance with the existing NEQS/PEQS and any new standards established.
- Penalization of industries that generate hazardous waste in excess of the quantity declared through the Environmental Audit Statement each year
- Introduction of environmental taxes for the industry to promote hazardous waste management in order to enhance the baseline of the environmental financial framework.
- Encouraging industries to develop an incineration facility for their waste through incentives like investment allowance or depreciation allowance.
- Offering incentives to the private sector to help them restructure their processes in a manner that produces minimal hazardous waste.

94. E-waste poses health threat to Pakistanis, says UN study - BAN
95. Pakistan top destination of waste import - Express Tribune
96. E waste scrap Imports in Pakistan - Import data with price, buyer, supplier, HSN code
97. National Hazardous Waste Management Policy 2022 - Drug Regulatory Authority
98. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes | UNEP - UN Environment Programme
99. Stockholm Convention | UNIDO
100. Minamata Convention on Mercury | US EPA

More than 3.3 million tons of plastic is wasted in Pakistan each year, with estimates of 12 million tons being wasted annually by 2040.[101] The country also has one of the highest percentages of mismanaged plastic in South Asia.[102] The most imminent threat of Pakistan's mountain of plastic waste is to the Indus Delta with 11,977 tons of waste reaching the mouth of the Indus annually, threatening coastal and marine life as well as entire communities that rely on them. To combat plastic waste, the government of Pakistan joined the World Economic Forum's Global Plastic Waste Action Partnership (GPAP) which aims to end plastic waste. As a result, Pakistan's Environment Protection Agency banned single-use plastics in Islamabad starting from August 2023[103] under the Single-Use Plastics (Prohibition) Regulations 2023 which "prohibits the use, import, manufacture, distribution, supply, sale, purchase, stocking and trade of single-use items, such as polythene bags, and plastic crockery such as cups, glasses, plates and bowls."

The regulation also included bans on plastic cutlery as well as any single-use packaging for serving/transporting food as well as a fine of up to PKR 1M on producers of single-use plastic and up to Rs.10,000 on local suppliers, shopkeepers, stall holders, and hawkers. The EPA administration imposed 725,000 PKR in fines from Sep 2021 to 2022 with 12,000 kg in plastic bags confiscated during that time period. Similar bans have been placed on plastic bags throughout Pakistan's history but have not always been followed, with the earliest dating back to 1994.[104] For Islamabad, this is their second chance to enforce the ban with an earlier attempt in 2019 not yielding fruitful results. Following Islamabad's example, Lahore too announced a similar ban from June 2024.[105]

Fig. 41: Pakistan's Plastic Exports



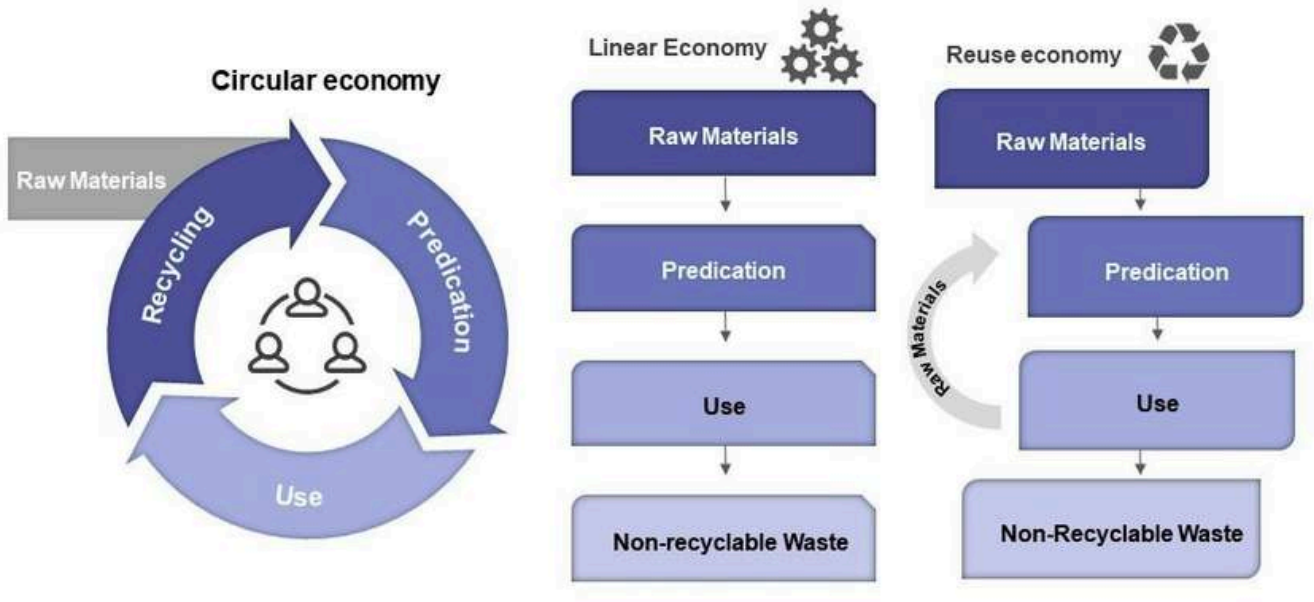
101. Pakistan's Plastic Waste Management Crisis - The Friday Times
102. Plastic Pollution - Our World in Data
103. PAKISTAN: Import and Use of Single-use Plastics Banned in Islamabad | HKTDC Research
104. How to stop plastic bag use | Political Economy | thenews.com.pk
105. Punjab to ban plastic bags from June 6 - Pakistan Observer

While other provinces have also announced their plans to introduce similar bans, experts have often argued that the solution does not lie in just banning plastic but rather eradicating it through a comprehensive plastic management plan. Plastic Industry is one of the fastest emerging industries in Pakistan with 11,000 plastic manufacturing units operating in both the formal and informal sectors.[106] According to the Pakistan Bureau of Statistics, Plastic exports grew by 53.79% in FY24 with material worth $215.161B being exported from July-January (2023-24) as compared to the export of $139.909 million from July-January (2022-23).[107]

According to the World Wildlife Fund, Pakistan has 19 plastic recycling plants across the country which are recycling only a fraction of the 250 million tons of existing garbage in Pakistan which primarily consists of plastic bags, PET bottles, and food scraps.[108]

Beyond the environmental damage, Pakistan's wasteful linear model imposes major economic costs through import dependence, health impacts, missed business opportunities, and insufficient resource productivity. Estimates suggest that environmental degradation costs Pakistan over 365B PKR annually, with the amount expected to go up to 450B in the coming years.[109]

Fig. 42: From a linear to circular economy



To tackle these challenges, Pakistan is pursuing a national transition towards a more circular economic model that maximises resource reuse, recycling, and recovery. The Circularity Gap Report 2022 which maps how far the economy of any country is from their circularity potential,[110] put Pakistan in the “far” category which means that Pakistan must do a lot more to exploit its circularity potential. The current linear model of production and consumption that has been put in place since the Industrial Revolution uses a TAKE-MAKE-USE-DISPOSE approach while a circular economy focuses on reducing, recycling and reusing. This not only helps reduce resource dependency but also extends product life cycles while ensuring that there is minimum waste at the end of the life cycle.

106. Plastic Industry of Pakistan: Prospects and Challenges amid Coronavirus Crisis
107. Plastic material export increases 53.79pc to $215 million in 7 months - The Nation
108. The deportation of Afghan refugees from Pakistan is damaging the country's economy | Qantara.de.
109. The cost of environmental degradation in Pakistan - WB
110. Circularity-Gap-Report-2022.pdf

Innovation

Concept Loop

Location: Karachi

Founded In: 2021

Sector: Circular Economy

What problem is it solving:

It aims to address Pakistan's growing mountain of plastic waste which is not being adequately managed or recycled.

How is it solving that problem?

By transforming plastic waste into high-quality, negative carbon footprint products such as building materials and lifestyle items, while advocating for sustainable practices.

Farm Loop Technologies

Location: Karachi

Founded In: 2024

Sector: Circular Economy

What problem is it solving:

The overlooked potential of Pakistan's agricultural waste that can be used in producing renewable energy.

How is it solving that problem?

By connecting agri-waste processors to farmers for procurement of agricultural waste which is then used to create sustainable green products like biofuel and bio-fertilizers.

Innovation in carbon tech

LOW CARBON TECHNOLOGY

Pakistan's cleantech ecosystem is still extremely nascent with most of the local commercial solutions centered around either renewables, EV assembly, and limited initiatives related to the circular economy. However, in order to tackle the country's climate crisis, a concerted effort is required across other verticals such as green construction, carbon capture, and sustainable industrial manufacturing. Though local solutions are few and far between, Pakistan currently has meaningful trade flows for low carbon technology (LTC) products, as classified by the International Monetary Fund.[111] This includes 124 HS codes ranging from Water filtering or purifying machinery and apparatus to Heat exchange units. Using Comtrade, we analyzed the data and found that Pakistan imported LCT goods worth $11.1 billion between FY19 and FY23. This translates into 3.8% of Pakistan's overall imports during the same period.

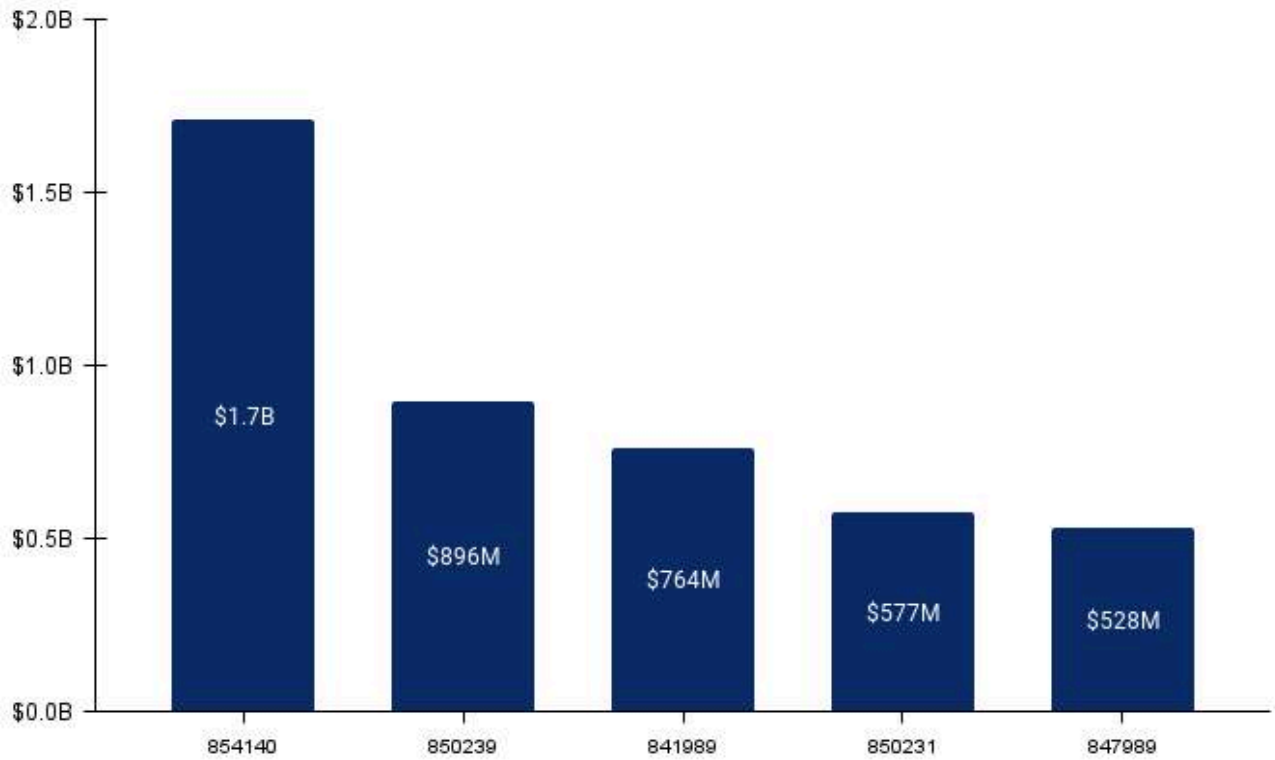
Fig. 43: Pakistan's Low-Carbon Technology Imports

111. Low Carbon Technology Harmonized System Codes | Climate Change Indicators Dashboard

However, the annual trend shows that Pakistan's imports of LCT goods plunged 58.7% to $1.08B in FY23, from $2.61B the year before. While the underlying reason was the government's restrictions in an attempt to save on scarce foreign exchange, the decline was significantly steeper than the 30.5% dip seen in the country's overall import bill during the same period. In relative terms, the share of LCT in total imports peaked at 5.4% in FY20 and has been sliding ever since, reaching 1.9% by FY23.

At the HS code level, the largest contribution came from "Photosensitive semiconductor devices, incl. photovoltaic cells whether or not assembled in modules or made up into panels; light-emitting diodes", with imports of $1.7B between FY19 and FY23. This was distantly followed by "Electric generating sets; (excluding those with spark-ignition or compression-ignition internal combustion piston engines), other than wind powered" at $896M. Other leading categories included; "Other machinery. for treatment of materials by change of temperature" at $764M; "Electric generating sets; wind-powered, (excluding those with spark-ignition or compression-ignition internal combustion piston engines)" $577M; and "Machines and mechanical appliances having individual functions, not specified or included elsewhere in Chapter 84" $528M. Country-wise, China was by far the largest source with Pakistan importing almost $7.5B from there between FY and FY23. The United States was a distant second at $498M, followed by Japan $474M and Germany $452M.

Fig. 44: Most imported LCT goods (FY19-FY23)



The other side of the equation was considerably modest as Pakistan's LCT exports stood at $632M between FY19 and FY23, translating into just 0.5% of all exports over the same period. However, the annual trend shows that exports surged 88.3% to almost $147M in FY23, up from $78M. Afghanistan was the largest destination with Pakistan's exports to the country at $172M, of which $51M came in the outgoing fiscal year. Turkiye was the second biggest market though it was marked by a one-off spike of $94M in FY20 and flatlining since then.[82]

Fig. 45: Pakistan's Low-carbon Technology Exports

At the HS code level, over a fifth of Pakistan's exports were of "Electric accumulators; lead-acid, of a kind used for starting piston engines, including separators, whether or not rectangular (including square)" at $130M. This was followed by Turbines; parts of gas turbines (excluding turbo-jets and turbo-propellers) at $118M, Electric generating sets; (excluding those with spark-ignition or compression-ignition internal combustion piston engines), other than wind-powered at $96M, and Aluminium; casks, drums, cans, boxes and the like for any material (not compressed or liquefied gas), 300l capacity or less, whether or not lined or heat-insulated, no mechanical or thermal equipment at $95M. The substantial gap between Pakistan's exports and imports of LCT goods isn't in the least bit surprising, considering that the country has had a perpetual trade balance. However, this is part of the cycle as initially, companies in the Global South lack the human, physical, and financial capital to produce such products. The gap can be plugged through imports from more developed markets and is the first step in the technology-transfer staircase.

Fig. 46: Most Exported LCT Goods (FY19-FY23)

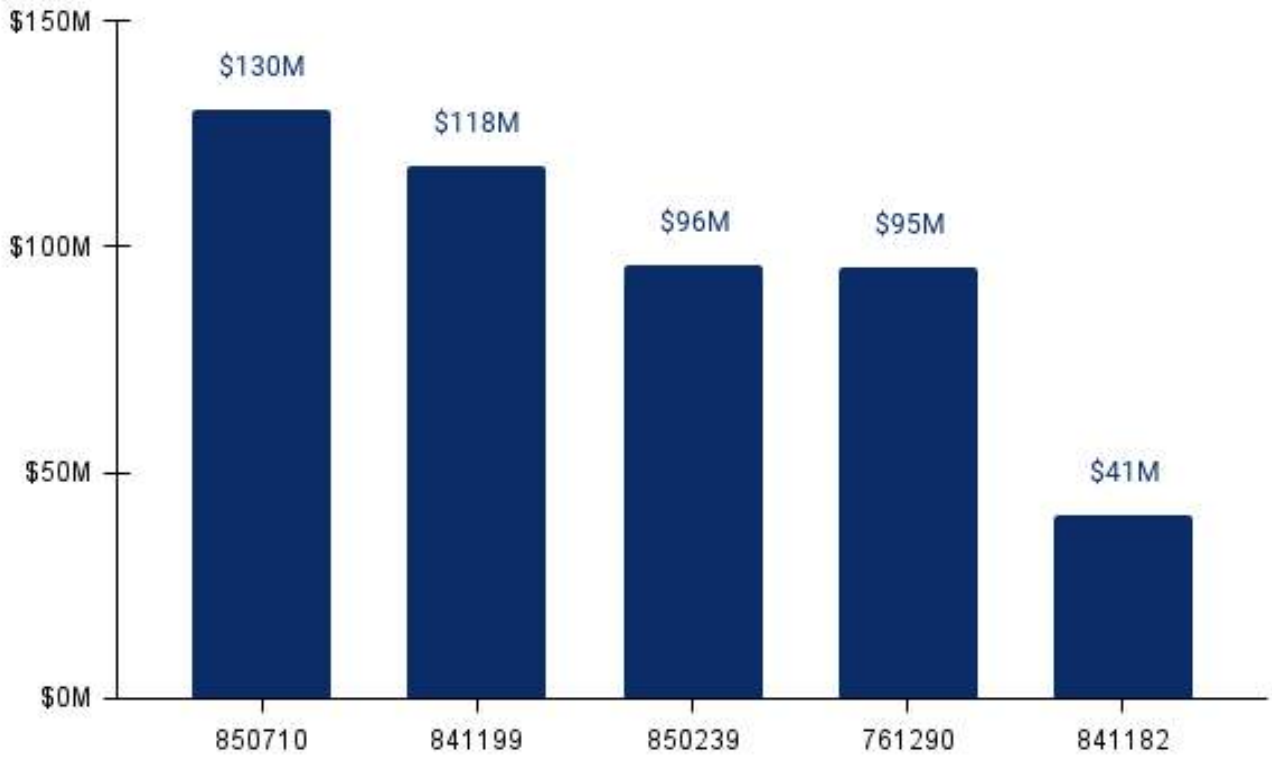
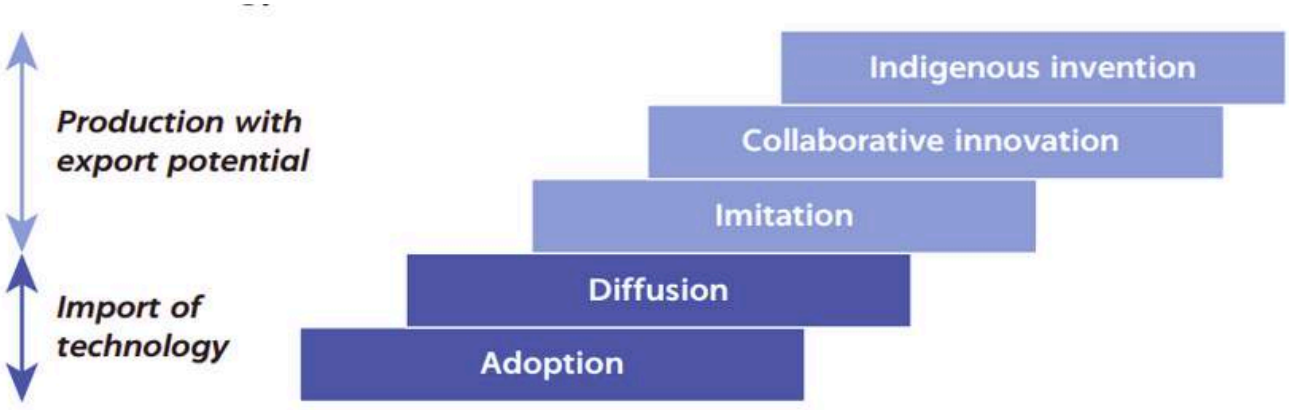


Fig. 47: The Technology Transfer Staircase



"Firms and households benefit from imported technology, but local firms initially lack the ability to significantly modify or reproduce it. As domestic capabilities develop, countries become able to diffuse imported technology more widely across economic sectors. Eventually, domestic firms acquire the capacity to imitate foreign products and production methods, but they still rely on intellectual property developed and owned abroad. Collaborative innovation between domestic and foreign firms (for example, through joint ventures) begins to create the domestic capacity to develop original technologies, conferring some degree of local control and ownership over the technological upgrading process. Ultimately, the country's domestic research and development capacity evolves to the point that it can produce, commercialize, and potentially export technologies based largely or entirely on locally owned intellectual property. However, progression up the technology staircase is not automatic, and countries can languish for years or even decades at the lower steps."

The same study notes that human capital is the strongest predictor of high performance in LCT trade and innovation, ahead of both institutional and physical capital. Unfortunately, Pakistan's performance in this regard remains lacking, particularly when it comes to research and development. Reaching the last step of the staircase presents significant challenges for both the public and private sectors. This report finds that, across countries, human capital is the strongest predictor of high performance in LCT trade and innovation, followed by institutional and physical capital.

While building an export-oriented manufacturing base should be the north star for Pakistan, the focus in the medium term should be to transition towards cleaner technologies that can help meet the country's NDC targets and alleviate the underlying climate crisis. In this regard, a number of sectors warrant immediate attention.

Agriculture, in particular, is marred by inefficiencies and contributes more than two-fifths to Pakistan's carbon emissions.[112] The sector is infamous for not only burning crops, which is responsible for around 20% of all air pollution[113] but also consumes more than 90% of available water.[114] Therefore, addressing these problems is critical to the country's climate and water security. Currently, the country predominantly relies on the extremely water-intensive flood irrigation system, leading to serious wastage. One effective, yet simple, solution is the use of drip irrigation as it helps save approximately 50% of the water while improving yields through a more precise approach. Unfortunately, only between 70,000 and 100,000 acres, or 0.2% of the cropped area,[115] in Pakistan have drip sites. This is significantly lower than other developing economies, such as India where 11% of the irrigated area is covered by micro irrigation systems.[116]

The biggest impediment behind the slow uptake of micro irrigation in Pakistan is the high initial capital investment, which continues to increase amid the rupee's depreciation. In this regard, the Punjab government has taken a lead by subsidising 60-75% of the upfront cost, depending on the

112. Greenhouse Gas Mitigation Options for Pakistan: Agriculture Sector - CDKN
113. Crop residue burning in Pakistan: A systems approach towards sustainability
114. Impact of water insecurity amidst endemic and pandemic in Pakistan: Two tales unsolved.
115. Saving water one drip at a time - Dawn
116. Pradhan Mantri Krishi Sinchayee Yojana, Ministry of Agriculture & Farmers Welfare, India

size of farm ownership. While that has helped put the province relatively ahead of others, the progress remains rather slow. The underlying gap presents an opportunity for local businesses to make such technology more accessible, either through indigenizing manufacturing or through better financing models. Currently, the leading names in micro irrigation systems are Jaffer Brothers and Hajisons, each of whom relies on imports.

Another sector that warrants timely attention is industry, both large- and small-scale manufacturing. Cement, for instance, accounts for around 5% of Pakistan's carbon dioxide emissions and largely relies on dirty coal,[117] which not only is harmful to the environment but has traditionally put strain on the external account. Similarly, construction, which includes a host of allied industries, also needs quick intervention. Similarly, the use of greener technology in brick kilns presents another possible opportunity where the existing market is both mature and large, estimated to be contributing around 1.5% of the gross domestic product.[118] The use of zigzag technology reduces the amount of coal required and alleviates the adverse environmental effects.[119]

117. Haroon M, Ayub A. Role of the Pakistan Cement Industry towards the Achievement of Net Zero Goal by Mid-Century: A Review from a Waste Heat Recovery Perspective. Engineering Proceedings. 2023; 45(1):45.
118. A big push for climate-friendly brick production in Pakistan - International Centre for Integrated Mountain Development
119. Improved Kiln Technology Delivers Environmental Benefits and Drives Generational Change in Pakistan's Brick Sector

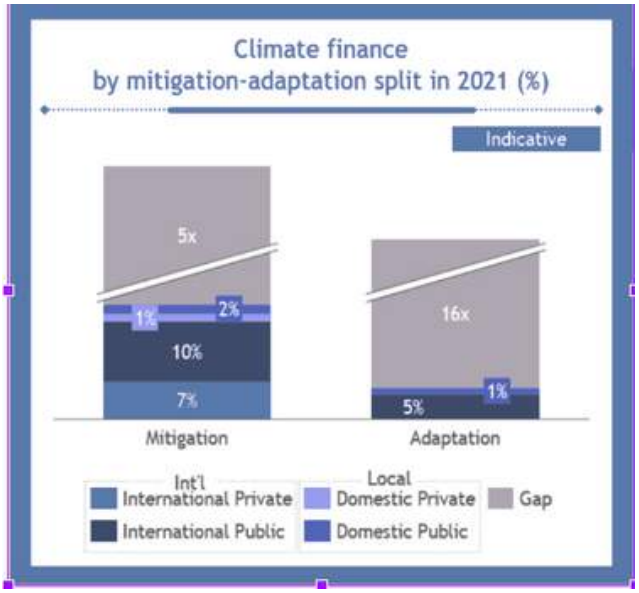
Cleantech Financing

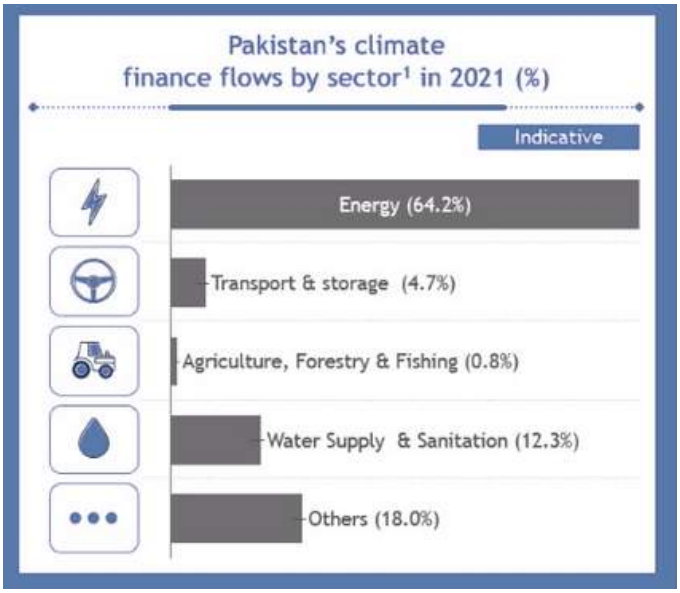
CLEANTECH FINANCING

Pakistan has set a target for a 50% reduction in projected carbon emissions from 2015 to 2030, with 15% relying on Pakistan's resources and 35% on international financial aid. A comprehensive approach to Pakistan's climate challenges from 2023 to 2030 requires an estimated $348 billion investment, with $152 billion for adaptation and resilience and $196 billion for decarbonization. In 2021, $4 billion in climate-related investments were made in Pakistan, with the public sector leading at 69% and private sector contributions at 31%. The breakdown includes $650 million from local sources, with public and private sectors contributing $450 million and $200 million, respectively. International actors have played a significant role, providing 84% of the total climate finance, with Development Partners contributing 58% and international private sector investors and project developers contributing 26%. However, there remains a disproportionate focus on mitigation rather than adaptation financing in Pakistan.

Mitigation efforts received 79% of the financing, with substantial investments in renewable energy generation, notably facilitated through the State Bank of Pakistan's initiative. The limited domestic financing stems from the evolving green finance market in Pakistan, where traditional financial institutions lack the expertise to evaluate climate projects effectively. Perception of high risks deters local financiers from climate investments, while lack of public awareness and tailored financial products hinder financial support for climate initiatives. Challenges in accessing affordable long-term capital and the absence of specialized financial products further restrict local funding options in the country.[120]

Fig. 48: Climate Finance Flows to Pakistan





120. Acumen Pakistan secures $28m anchor funding for a new $90m Climate Fund. How will this help agribusinesses?

In January of 2023, the country rallied for support from the international community for flood rehabilitation and managed to get pledges of over $10 billion.[121] Islamic Development Bank was the largest donor at $4.2B, followed by the World Bank at $2B and Saudi Arabia committing $1B. Instrument-wise, almost the entire financing, or $10.33B out of $10.953B, was in the form of loans while the remaining $550.4M was pledged as grants.

However, the details present a rather disappointing picture. According to a report published in the Brookings Institution: "A preliminary analysis of the World Bank pledge shows that $650 million is re-purposed from previous commitments, $1.3 billion from the overall IDA commitment (part of $3.9 billion, 7 percent of total IDA Performance Based Allocation to Pakistan), and $700 million in additional money from the crisis response window. Similarly, the Islamic Development Bank's $4.2 billion is largely ($3.6 billion) normal trade finance. ADB financing structure is a similar mix of re-purposing and upfronting previously committed allocation and some fresh money.[122] Perhaps even more concerningly, pledges haven't necessarily translated into receipts. A year after the initial announcement, total multilateral and bilateral disbursements to Pakistan stand at just $1.4 billion, or a little over 10% of the pledged amount.[123]

Notwithstanding the fundraising for flood rehabilitation, Pakistan has somewhat successfully mobilized funding through multilateral development banks, which are by far the largest providers of climate finance to the country with commitments of $10.1 billion between 2015 and 2022. Put another way, Pakistan accounts for 2.8% of the global commitments by MDBs over this period. As a result, it is also the biggest beneficiary of MDB commitments among peer markets and stands ahead of Bangladesh ($9.1B), the Philippines ($8.4B), Vietnam ($4.5B), and Thailand ($1.7B). However, in 2022 — the last year of available data — total climate finance commitments to Pakistan by MDBs plunged to just over $1B, from the peak of $2.7B the year before.

Similarly, initiatives like the Green Climate Fund (GCF) and the Global Environment Facility (GEF) have provided crucial funding for several renewable energy and energy efficiency projects across Pakistan. However, the demand for such financing far outstrips the available supply of capital, underscoring the need for increased commitments from international climate finance mechanisms. Under the GCF, Pakistan has received financing of $249M for seven projects[124] worth a total of $1.64B.[125] Additionally, there are an equal number of readiness activities with $5.2M approved, of which $2.4M has been disbursed so far.

Among peer countries, Bangladesh has mobilized the highest amount of financing at $441.2M from the GCF for nine projects while Vietnam ($146M, 3), the Philippines ($137.7M, 8), and Thailand ($58.5M, 2) follow behind. Further details show that two of the seven projects are for mitigation while the remaining are for adaptation, with an identical split between public and private sectors. Among the Pakistan-specific projects, Green BRT Karachi is unsurprisingly the biggest with a lifespan of 20 years and a project value of $583.5M. Out of this, GCF will foot $49M in total, with $37.2M through loans and $11.8M in the form of grants.

121. At Geneva conference, Pakistan secures pledges of over $10bn
122. Responding to Pakistan Floods - Brookings Institution
123. Of $11bn pledged to Pakistan after floods, only $1.4bn disbursed so far - The News
124. Pakistan | Green Climate Fund
125. Financing Climate Action | Transparency International Pakistan

By type of financing, GCF has made the biggest proportion of commitments via grants worth $253.75M, including the $100M earmarked for the multi-country "Community Resilience Partnership Program", which also contains a $20M loan component. Moreover, it has also committed $25M in equity funding for the $90M Acumen Climate Action Pakistan Fund and $9M via guarantee in "Recharge Pakistan: Building Pakistan's resilience to climate change through Ecosystem-based Adaptation (EbA) and Green Infrastructure for integrated flood risk management". The latter also included co-financing of $5 million from USAID; $5 million from The Coca-Cola Foundation, and $1.8 million from WWF.[126]

Fig. 49: Global Climate Fund Projects in Pakistan

Project Name	GCF financing	Co-financing
Green BRT Karachi	$49M	$534.5M
Acumen Climate Action Pakistan Fund	$28M	$62M
Community Resilience Partnership Program	$120M	$630M
Recharge Pakistan: Building Pakistan's resilience to climate change through Ecosystem-based Adaptation (EbA) and Green Infrastructure for integrated flood risk management	$66M	$11.8M
Pakistan Distributed Solar Project	$10M	$440M
Transforming the Indus Basin with Climate Resilient Agriculture and Water Management	$34.9M	$12.69M
Scaling-up of Glacial Lake Outburst Flood (GLOF) risk reduction in Northern Pakistan	$36.9M	$0.5M
Total	**$344.9M**	**$1.69B**

126. COP28 Post Visit Report - Ministry of Climate Change

Fig. 50: Global Environmental Facility Projects in Pakistan

Sr.No	Projects	Agencies	GEF Grant ($)	GEF Equity ($)
1	Combating Climate Change through the Promotion and Application of Sustainable Biomass Energy Technologies in Pakistan (PASBET)	UNDP	3,439,041	21,150,446
2	GEF UNIDO Cleantech Program for SMEs	UNIDO	1,575,500	5,786,700
3	Delivering the Transition to Energy Efficient Lighting in Residential, Commercial, Industrial, and Outdoor Sectors	UNEP	1,369,863	4,000,000
4	Sustainable Energy Initiative for Industries	UNIDO	3,550,000	31,200,000
5	Promoting Sustainable Energy Production and Use from Biomass in Pakistan	UNIDO	1,820,000	31,200,000
6	Pakistan Sustainable Transport Project	UNDP	4,800,000	73,220,000

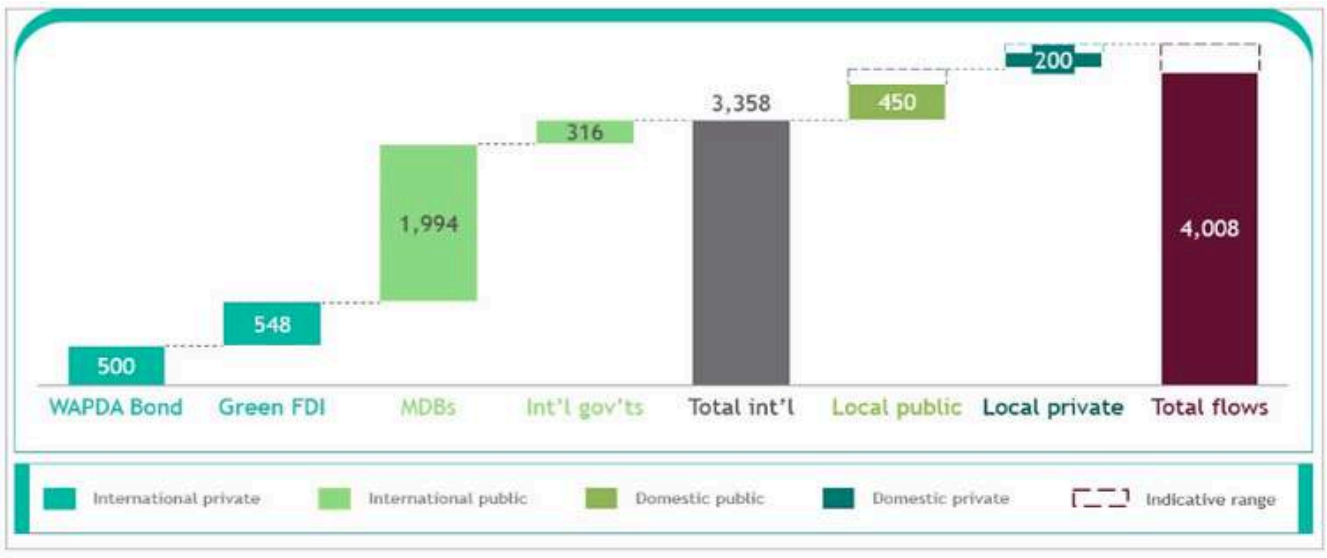
7	Barrier Removal to the Cost-Effective Development and Implementation of Energy Standards and Labeling Project (BRESL)	UNDP	7,800,000 [82]	28,080,900
8	Productive Uses of Renewable Energy in Chitral District, Pakistan (PURE-Chitral)	UNDP	950,000	4,700,000
9	Promotion of Energy Efficient Cooking, Heating and Housing Technologies (PEECH)	UNDP	975,000	1,488,500
10	Mainstreaming Biodiversity Conservation into Production Systems in the Juniper Forest Ecosystem	UNDP	975,000	1,543,737
11	Sustainable Development of Utility-Scale Wind Power Production (Phase 1)	UNDP	3,100,000	720,000
12	Waste-to-Energy: Lahore Landfill Gas Recovery and Use	WB	10,000,000	-

Additionally, Pakistan has accessed $36.5M through GEF grants for 13 approved projects, with another $199.6M via co-financing. Just under half of them are for climate change, accounting for grants worth $15.7M. In addition to these, 23 projects have already been completed in the past, 3 concepts greenlighted, one at the concept proposal stage, and two canceled. Furthermore, there are 26 multi-country projects of which Pakistan is also a part, representing GEF grants of $366.2M.[127]

Outside multilaterals, financing activity remains minimal and is symptomatic of a banking system that is heavily exposed to risk-free government securities, as evidenced by the investment-to-deposit ratio of 92.8%[128] as of March 2024. Consequently, advances as a percentage of deposits have been consistently declining and stood at just 42.4%[129] — the lowest in at least more than two decades — amid the policy rate at a record high.[130] Unsurprisingly, Pakistan's private sector credit to GDP of 14.8% is not even half of Bangladesh's 39% and less than a third of India's 50.4%.[131]

Given both the macroeconomic situation and a risk-averse banking culture, financing for green ventures has been rather scarce. Moreover, due to a lack of standard taxonomy to identify what sectors come under clean technologies, it's difficult to pinpoint the magnitude. Based on our analysis of the State Bank of Pakistan's existing classification, two categories seem to make the cut. First, is "Electricity, gas, steam, and air conditioning supply", which includes a breakdown of loans to hydel, wind, and solar companies, while the second is "Water supply; sewerage, waste management, and remediation activities".

Fig. 50: Climate Finance Flows by Sources

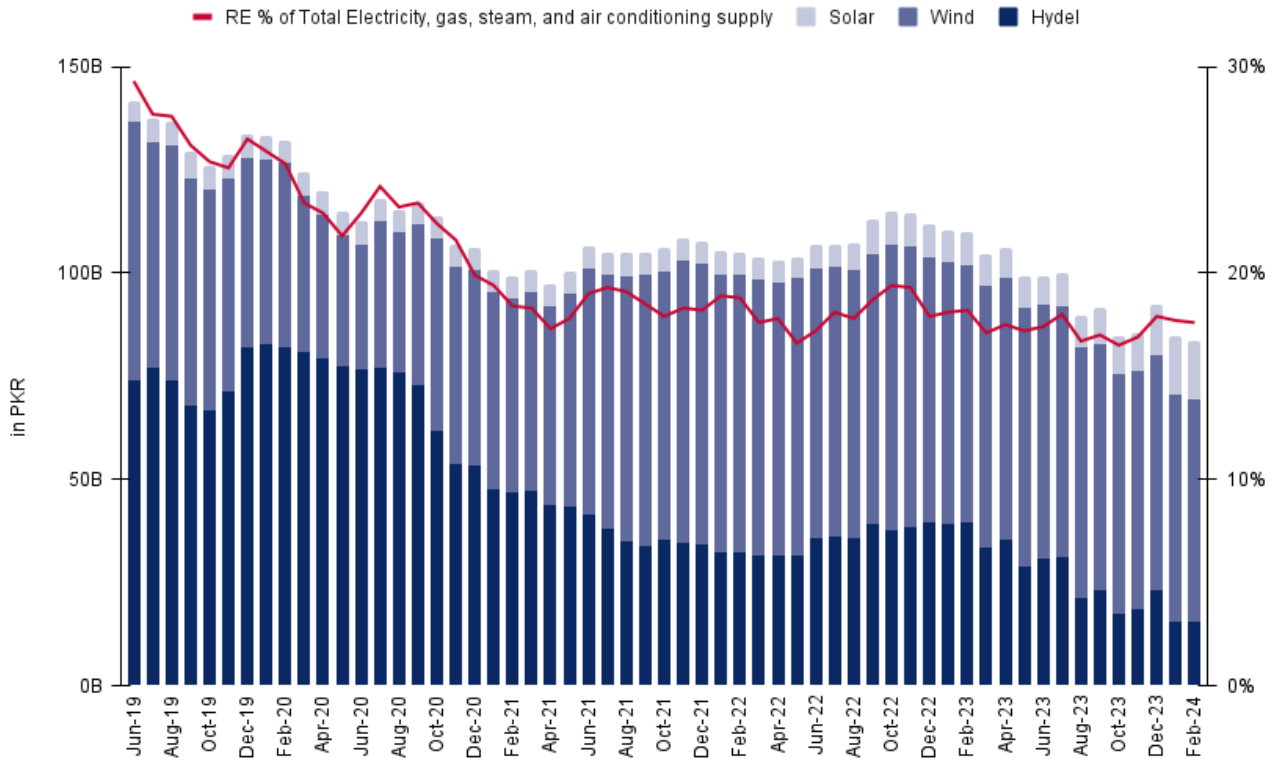


127. GEF Projects Database | Accessed on April 23rd, 2024
128. Total Investments of Scheduled Banks (Stock), State Bank of Pakistan
129. Total Advances of Scheduled Banks (Stock), State Bank of Pakistan
130. Trading Economics
131. World Bank

In the first category, the cumulative outstanding credit to renewable energy players was PKR 83.5B as of February 2024, having shrunk by a noticeable 41.1% compared to PKR 141.7B in June 2019. Even in relative terms, the share of RE in "Electricity, gas, steam and air conditioning supply" has slipped from 29.3% to 17.6% over the same period. The real impact on the figures would be even more, considering the depreciation in the rupee and the erosion of purchasing power amid historically high levels of inflation.

[82]

Fig. 51: Outstanding Bank Financing for Renewable Energy



Most of this decline can be attributed to hydel, where outstanding loans plunged from PKR 74B in June 2019 to just PKR 15.3B by February of 2024. Credit to wind players also fell from PKR 62.8B to PKR 54.1B over the same period. Only solar saw an increase in financing, albeit from a low base of PKR 4.8B, to reach PKR 14.1B. Under the second category, the aggregate amount is much smaller in comparison and stood at just PKR 24.5B at the end of February 2024, edging up from PKR 20.3B in June 2019. This is a fraction compared to the peak of PKR 36.3B seen in October 2021 on the back of an almost 18-month long expansionary monetary policy triggered by the Covid-19. While the current figure is just two-thirds of that, the last nine months have seen a near-doubling of financing value. Despite the crests and troughs in troughs, what has remained rather consistent is the share of in "Waste Collection, treatment and disposal activities", averaging at more than 98%. Cumulatively, the share of clean technologies in the overall private sector was just 1.5% by February 2024, less than half of 3.1% prevailing back in June 2019. Predictably, financing through microfinance banks for renewable energy is even smaller and stood at PKR 4B for hydel and another PKR 1.1B for solar. Under water supply, sewerage, waste management and remediation activities, the credit amount almost negligible at PKR 226M as of 2023 end.

Fig. 52: Outstanding Bank financing for water supply, sewage etc

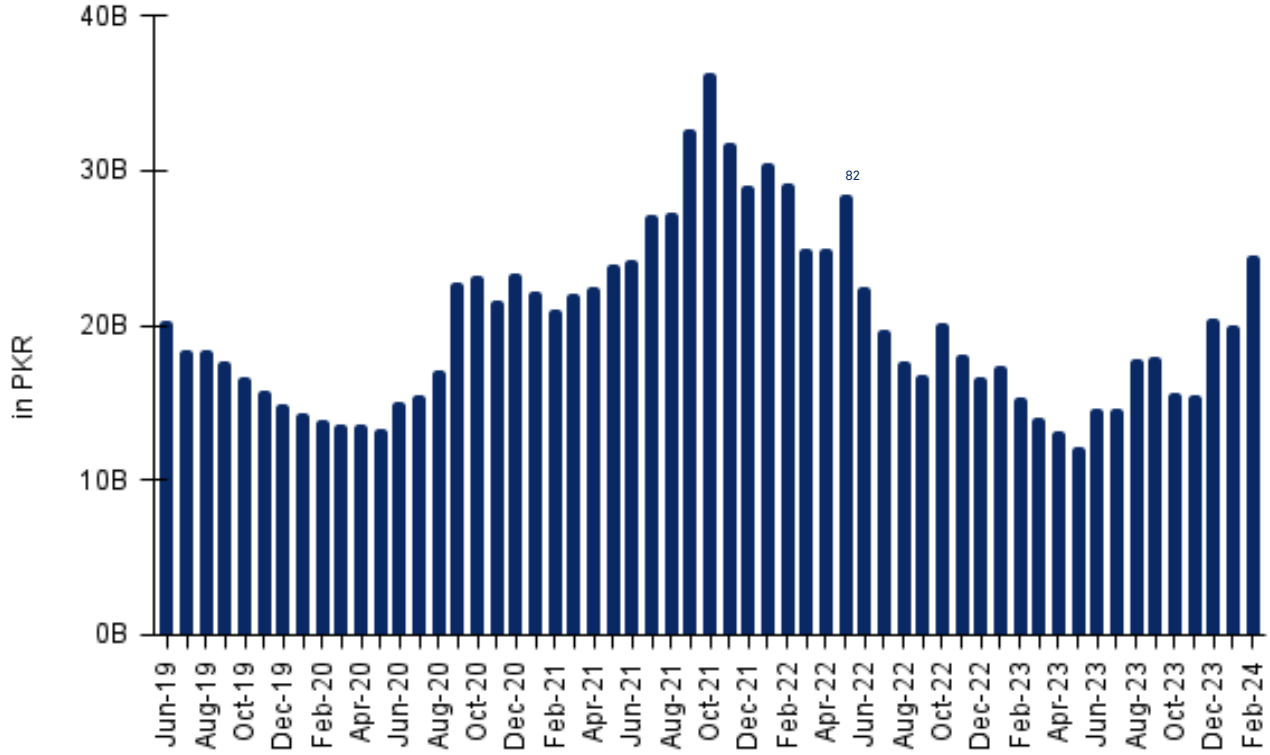
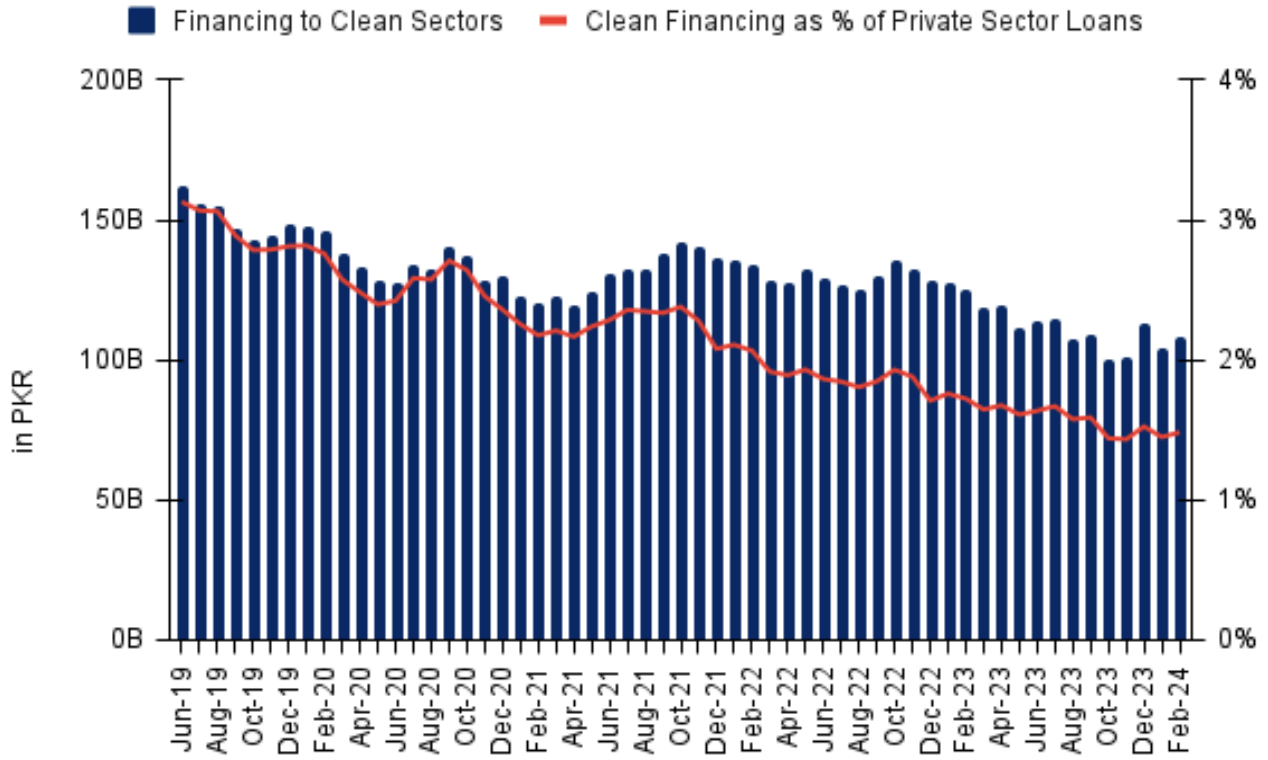


Fig. 53: Banking Credit to Clean Sectors



Entrepreneurial Finance

Despite a tough macroeconomic environment over the last few years, the country has seen healthy entrepreneurial activity. Particularly, incorporations with the Securities and Exchange Commission Pakistan have continued as 27,746 new entities came online in FY23 — the highest-ever, edging out the preceding year's 26,502. A notable feature beneath the headline numbers is the focus on innovation, with the information and communication sector accounting for 14.6% of all companies coming live. Similarly, local startups experimenting with unique business models have also come into the mainstream of late and are major players in both the employment and innovation landscape.

However, access to entrepreneurial finance still remains limited. Given the banks' hesitation, multiple governments have intervened and provided subsidized financing under various programs. Under the latest Prime Minister's Youth Business & Agriculture Loan Scheme (PMYB&ALS), a cumulative 107,813 loans worth PKR 66.3B have been disbursed in 2023.[132] On the equity side, venture capital has become the largest, and arguably only, major source of funding for innovative startups in the country, having deployed a total of $858.2M across 259 unique deals between 2019 and 2023. The funding trends have neatly mirrored the global VC, with the amount peaking in 2021 at $347M on account of expansionary monetary and fiscal policies.

Since then, the asset class has witnessed a sharp calibration across the world, with total funding amount nosediving 34.9% YoY to $345.7B in 2023[133] — the lowest since 2019. Funding to Pakistani startups fell even harder by 77% to just $75.8M while the number of deals dipped by 41.8% to 39. However, cleantech space has only managed to attract $15.04M in VC funding across 16 deals in eight companies, translating into around 1.5% of the aggregate during the period under review.

Three of these startups operate in the electric mobility space, with two assembling their own motorcycles while the third helps EV players with fleet management software. This translates into just $2.3M of investment, considering the extremely early stage of the vertical. Meanwhile, the most funded company is Ricult, having raised almost $8M since inception and operating in both Pakistan and Thailand. In renewables, Eco Energy is the only notable player, working towards expanding electricity to off-grid communities through a rental distribution model. Half of the funded companies are serving the consumer segment while the remaining have adopted a mix of B2B or hybrid models.

Despite the lackluster deal flow, the supply side of capital features some notable names from both impact-focused multilateral and market-based investors. The former includes the likes of Islamic Development Bank, Bill & Melinda Gates Foundation, and Karandaaz Pakistan. On the VC side, leading local investors such as Indus Valley Capital, i2i Ventures, Walled City, and Deosai Ventures are invested in the cleantech space. Among international firms, SOSV — one of the biggest accelerators globally by number of investments with a dedicated climate fund — also features along with Accelerating Asia, Wavemaker Partners, Bualuang Ventures, and The Community Fund.

132. PMKJ YES Quarterly Data | State Bank of Pakistan
133. Pitchbook Venture Monitor

Incubators and Accelerators Overview

INCUBATOR AND ACCELERATOR OVERVIEW

Pakistan boasts a vibrant incubation and acceleration ecosystem with various key players contributing to its growth and success. Following is a brief overview of some of the key entities involved:

National Incubation Centers (NICs): Established in Islamabad, Lahore, Karachi, Peshawar, Quetta, Faisalabad, and Hyderabad by private sector organizations and universities, these NICs are funded by Ignite. They offer a range of support services such as incubation, mentorship, networking, investor summits, co-working spaces, hackathons, workshops, and community events. NIC Peshawar also provides pre-incubation programs for startups.

National Expansion Plan: Set up by the Ministry of Information Technology and Telecommunication (MoITT) and Punjab Information Technology Board (PITB), these incubation centers collaborate with public universities across various regions in Pakistan to provide incubation, mentorship, networking, co-working space, stipends, business development guidance, and legal assistance.

Durshal: KPITB's initiative, Durshal aims to facilitate digital transformation in Khyber Pakhtunkhwa by establishing incubators in multiple locations, offering incubation, mentorship, networking, co-working space, and stipends.

University Incubation Centers: Across Pakistan, universities host 29 incubation centers, providing support for final-year projects, business plan competitions, incubation, mentorship, and networking opportunities.

NSPIRE: Operated by NETSOL Technologies, NSPIRE features a five-month program offering mentorship, office space, industry connections, and investment opportunities for startups.

TiE Islamabad, Lahore: As part of the global TiE organization, these chapters conduct initiatives like the Pakistan Startup Cup, the Startup Academy for women entrepreneurs, the WECREATE Center for women entrepreneurs, and various accelerator programs.

Founder Institute: With chapters in Islamabad, Karachi, and Lahore, the Founder Institute offers a four-month program for founders to learn from experienced startup CEOs and receive structured training and feedback.

Invest2Innovate (i2i): A pioneer of impact accelerators in Pakistan, i2i supports startups in raising capital and creating jobs through programs like WeRaise and producing insights on fundraising through the Dealflow Tracker.

CaterpillHer: Providing free 16-week accelerator programs for women entrepreneurs and professionals, CaterpillHer focuses on leadership development, mentorship, business curriculum, and investment readiness training.

Katalyst Labs: Offering acceleration programs, mentorship, access to investors, and networking opportunities, Katalyst Labs helps startups scale up and connect with relevant professionals.
Epiphany: Through pre-acceleration and acceleration programs, Epiphany supports startups in various industries and offers training, investment preparedness, and leadership development opportunities.

Telenor Velocity: A digital startup accelerator, Telenor Velocity collaborates with tech startups in Pakistan to develop new digital products and services, particularly in agritech, edtech, and gaming sectors.

Accelerating Cleantech

The cleantech sector is highly diverse, encompassing various subsectors such as renewable energy, waste management, and sustainable agriculture. Each of these areas has unique challenges, technologies, and market dynamics. Therefore, a uniform approach would overlook these nuances and fail to address the specific needs of cleantech startups. Customized support, specialized incubators, and mentors with a deep understanding of cleantech markets are essential.

Unfortunately, Pakistan does not have a well-developed dedicated ESO cluster. However, there is a significant amount of activity with incubators and accelerators collaborating with startups from various sectors including cleantech. Despite this, there have been notable advancements in establishing support pipelines for cleantech startups. These developments include the following:

The Climate Finance Accelerator (CFA) is a capacity-building program valued at £10 million, funded by International Climate Finance via the UK Government's Department for Energy Security and Net Zero (DESNZ). Operating across eight emerging economy countries, including Pakistan, the CFA aims to help Pakistan develop a sustainable pipeline of financially viable, low-carbon projects while exploring appropriate funding avenues for these initiatives. It is envisioned that the program will establish a long-term CFA mechanism in Pakistan to continually secure financing for low-carbon projects, supporting the country in meeting its Nationally Determined Contributions (NDC) and bolstering its climate ambitions.

The PFAN SME Accelerator in Pakistan offers a distinctive opportunity to access advanced entrepreneurship training, business coaching, and tailored support from both international and local clean energy specialists. This accelerator program is facilitated by the Network for Global Innovation (NGIN), an experienced international organization that has assisted numerous clean energy entrepreneurs in more than 22 countries, including Pakistan. The accelerator program consists of 4 months of intensive online training and group mentoring followed by 6 months of customized support and 1:1 coaching by clean energy experts for selected ventures. Accelerator graduates with the greatest potential may be eligible for international investment facilitation support from PFAN. Since 2006, PFAN has leveraged over $2B of investment for 155 clean energy projects and ventures.

Notwithstanding developments such as PFAN or CFA's program, dedicated cleantech incubation is still a relatively new concept in Pakistan and most programs remain sector-agnostic. Understandably, this is a function of the ecosystem's nascency and weak startup pipeline, which leaves few tailored options for companies in the space. That said, a number of incubators and accelerators have lately expanded their focus towards cleantech verticals. In this regard, Ignite's National Incubation Centers and Plan9's National Expansion Plan have played a major role so far. According to our analysis, the former has inducted at least 75 startups, with Karachi standing on top with 23 startups. Similarly, the latter has had 34 companies in cleantech. Among the development sector-supported initiatives, Accelerate Prosperity has proactively focused on cleantech through both organizational and financial support.

That said, any comprehensive analysis of support organizations' cleantech performance is limited for multiple reasons. First of all, the availability of data remains a challenge, not only with respect to core operating or financial metrics but even at the cohort induction and graduation level. Secondly, there's no standard taxonomy followed across the board that can enable peer comparison, a problem further amplified by greenwashing certain companies. Thirdly, the phenomenon of incubator-hopping is commonplace wherein a particular company would be part of multiple organizations, indicating the lack of pipeline depth.

To further promote the cleantech sector, Pakistan needs to enhance its efforts by establishing dedicated cleantech incubators and accelerators, providing targeted support and incentives for startups, and fostering collaborations with international cleantech ecosystems to leverage best practices and resources. Most importantly, in the absence of other sources of capital, such as bank financing or VC, accelerators need to play a more active role as not only arrangers but also providers of capital, possibly through structured cohort-based programs or various thematic challenges. Thus far, there's almost negligible involvement of capital provision by ESOs, and this should be an urgent area of intervention. With respect to the latter, while Ignite has in the past taken such initiatives, their frequency and regularity remain lacking.

Global Examples

Climate Collective is the largest private climate tech startup support organization in South Asia. Their primary focus is on empowering startups working in the climate technology space. Through various programs and initiatives, Climate Collective supports startups at different stages of development. They aim to create a thriving ecosystem for climate-focused entrepreneurs, helping them raise capital and create jobs

EnergyLab is Australia's largest climate tech startup accelerator and innovation ecosystem. Their mission is to reach net-zero emissions by supporting talented founders who are addressing the global climate crisis. EnergyLab connects startups with mentors, advisors, partners, peers, and investors to help them succeed. They offer several programs, including Climate Tech Ignite, Women in Climate and Energy Fellowship, Climate Tech Charge, Climate Solutions Accelerator, and the Energy Scaleup Program.

Cleantech Hub is a pioneering hybrid hub located in Abuja, Nigeria. Founded in 2016, it focuses on research, development, demonstration, and incubation of clean and green ideas and technologies in Africa. CTH provides strategic support to idea and early-stage energy entrepreneurs, helping them prove the viability of their businesses and access funding. Their work spans areas such as environment, climate action, energy access, and enterprise development.

Recommendations

RECOMMENDATIONS

In this report, we have identified significant barriers that currently impede the progress of the cleantech ecosystem. Implementing the following interventions could help overcome these obstacles.

Enhanced Reporting Standards and Clear Taxonomy

Developing and implementing standardized reporting frameworks tailored to cleantech verticals, accompanied by well-defined industry categories. This can simplify evaluation processes, enhance transparency, and facilitate comparisons within the cleantech sector.

Demand-Side Policies and Procurement Alignment

Establishing consistent demand-side policies and procurement regulations across the country. This unified approach is essential to stimulate market growth, foster innovation, and create a level playing field for cleantech businesses.

Patient Capital and Funding Linkages

Creating synergies between venture investors, climate-driven foundations, and governmental financing mechanisms to ensure adequate patient capital is accessible to cleantech ventures at different developmental stages. This will provide sustainable financial backing and support the long-term growth of cleantech initiatives.

Executive Mentorship and Scaling Skills

Specialized programs connecting cleantech entrepreneurs with seasoned tech executives renowned for their global scalability expertise. By leveraging the knowledge and experience of these mentors, cleantech innovators can sharpen their scaling skills, navigate challenges, and accelerate their business growth effectively.

Support for Local Innovation in Low-Carbon Solutions

Encouraging the creation and adoption of low-carbon, resilient solutions rooted in technological advancements across diverse sectors. This strategic push towards innovation seeks to address local challenges effectively, drive sustainable development, and meet the evolving needs of the community.

Diversified Stakeholder Engagement

Promoting a collaborative and inclusive approach to stakeholder engagement within the cleantech ecosystem. By involving a wide array of entities such as industry associations, policymakers, financial institutions, and impact investors, diverse perspectives can be integrated, fostering a supportive environment for cleantech advancement and growth.

Resolution of Regulatory Barriers and Taxation Issues

Engage with policymakers[41] and industry stakeholders to advocate for the development and implementation of tailored regulations and policies. Including a thorough review and update of existing regulations in sectors such as renewable energy, waste management, and sustainable agriculture to ensure alignment with cleantech advancements. Streamlining bureaucratic processes and approval mechanisms for cleantech projects can help reduce delays and enhance competitiveness by expediting time-to-market for innovative solutions. .

Curriculum and Mentoring

Developing a comprehensive curriculum at accelerators and incubators focused on cleantech-specific topics, such as sustainable business models, cleantech regulations, and technical aspects of clean technologiesAdditionally, providing mentors with relevant industry experience and expertise in cleantech can greatly benefit the startups.

Investing in Human Capital

Collaborating with industry experts, academia, and vocational institutions to design and offer targeted courses can bridge the skill gap and cultivate a skilled workforce proficient in cleantech innovations. Investing in comprehensive training and education initiatives will play a pivotal role in nurturing a talent pool capable of driving sustainable development in cleantech sectors.

Infrastructure and Facilities

Creating dedicated cleantech innovation centers with testing labs and pilot plants, in collaboration with government agencies, academic institutions, and private sector partners, can support startups in developing and validating their technologies. Access to reliable and affordable clean energy, especially renewable solutions, can be enhanced through incentives and partnerships with energy providers. Investing in infrastructure and sustainable energy sources can create a favorable environment for cleantech startups to flourish.

Case study

SPOTLIGHT: MODULUS TECH

ModulusTech functions as both a developer and supplier to completely disrupt and revolutionise Pakistan's housing sector. Before becoming operational, the company delved into extensive research and development on climate-smart homes and materials to ensure that its product offerings were tailored to Pakistan's climate vulnerabilities and responsive to the needs of target consumers. ModulusTech stands out from other developers by employing unique construction technologies not previously used in low-income housing in Pakistan and achieving EDGE Advance certification for its homes.

The company's product lineup comprises affordable, prefabricated/flat-pack carbon-neutral housing, tiny houses/backyard homes, and climate-friendly tourist chalets targeted at higher-income households. Its flat-packed homes, which can be assembled in one to three days, boast features such as relocatability, fire, and earthquake safety, compliance with international building codes, and self-sustainability through integrated solar systems. These homes adhere to modular design principles, offer significant energy and water consumption savings (up to 95%), and are either carbon neutral or incorporate substantial reductions in embodied carbon.

All ModulusTech homes prioritize energy efficiency by incorporating passive and active design techniques. Unlike other developers discussed in the report, ModulusTech strictly adheres to passive design principles, utilizing unique construction materials and employing strategies like white-painted roofs and walls, north-facing windows, airtight structures, and large window overhangs for solar heat management.

As part of its development initiatives, ModulusTech launched the Karachi Net-Zero Project in 2023, aiming to provide climate-smart homes for lower- and middle-income families in Karachi. This project, partially funded by Reall Ltd., involved the assembly of ten homes in a gated housing society in Gadap Town within a short timeframe. The homes were then made available to eligible households through partnerships with stakeholders like Trellis.

SPOTLIGHT: MODULUS TECH

Typically single-story with a 650 sq. ft. floor area, ModulusTech homes are priced at PKR 1.7 million and come equipped with electrical and plumbing systems. These homes require 72–100 hours for assembly, have a lifespan of about 50 years, and are designed without labor- or resource-intensive materials. The company's active design techniques focus on high insulation and the inclusion of solar systems in the sale price to enhance the quality of life for inhabitants.

ModulusTech's cost-effective approach in rural areas, where construction costs are higher due to limited infrastructure, makes its homes attractive to corporate clients seeking sustainable housing solutions. The company’s off-site manufacturing process further contributes to competitive pricing. Additionally, ModulusTech’s climate-resilient and self-sustaining homes are highly appealing in remote regions that lack essential services like electricity.

To promote net-zero emissions and solar system integration, ModulusTech includes the cost of solar systems in the mortgage packages offered to end-users, without the subsidies commonly available to higher-income groups.