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Energy Storage in the C&I Sector in Pakistan

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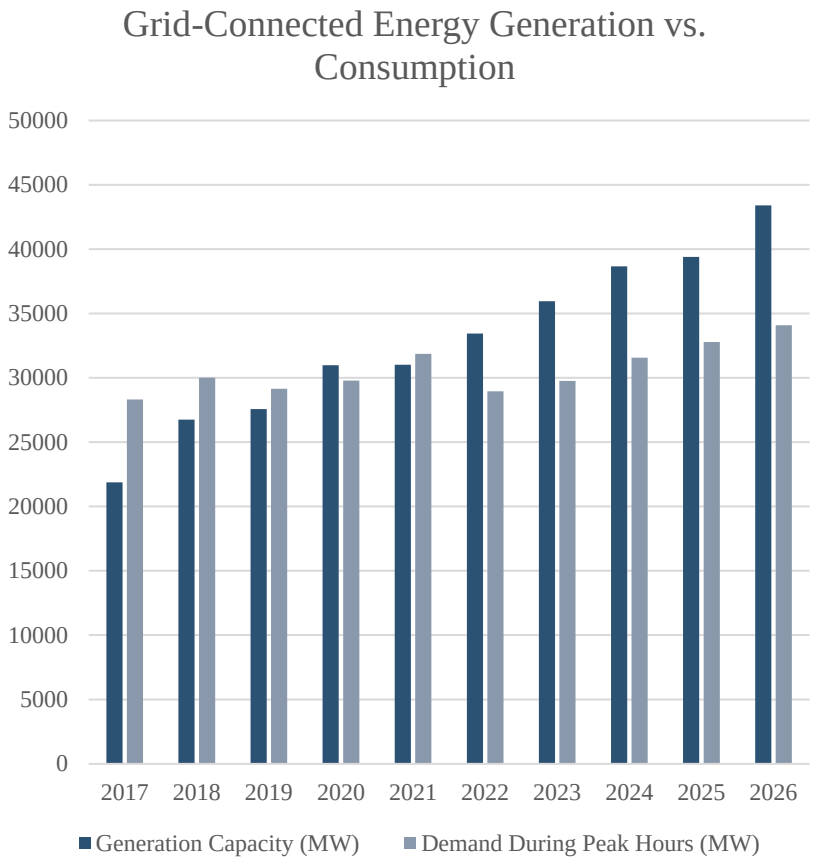
Context – Electricity Sector and Energy Crisis

- Context
  - Electricity Sector and Energy Crisis
  - C&I Sector
- Legal Framework
  - Relevant Ministries and Agencies
  - Regulations
- Energy Storage
  - Potential Use Cases
  - Technologies
  - Pilot Project
- Market potential and potential partners
  - Textile and Garment Sector
  - Cement Sector
- Potential Use Cases
- Market Barriers and Risks
- Recommendations for Market Entry
- SWOT-Analysis

Context – Electricity Sector and Energy Crisis



- Longstanding energy crisis
  - Peak demand surpassed generation capacities
  - Daily load-shedding of 8-12h even in urban centers
  - Grid becoming a bottleneck
  - Recently: Rising prices on the global energy markets and currency devaluation
- Electricity market projections
  - Total generation capacity
    - 2021: 39,772 MW – Share of Renewables: 5.4%
    - 2030: 61,112 MW – Share of Renewables: 22,3%
  - Peak demand
    - 2021: 23,792 MW
    - 2030: 37,129 MW

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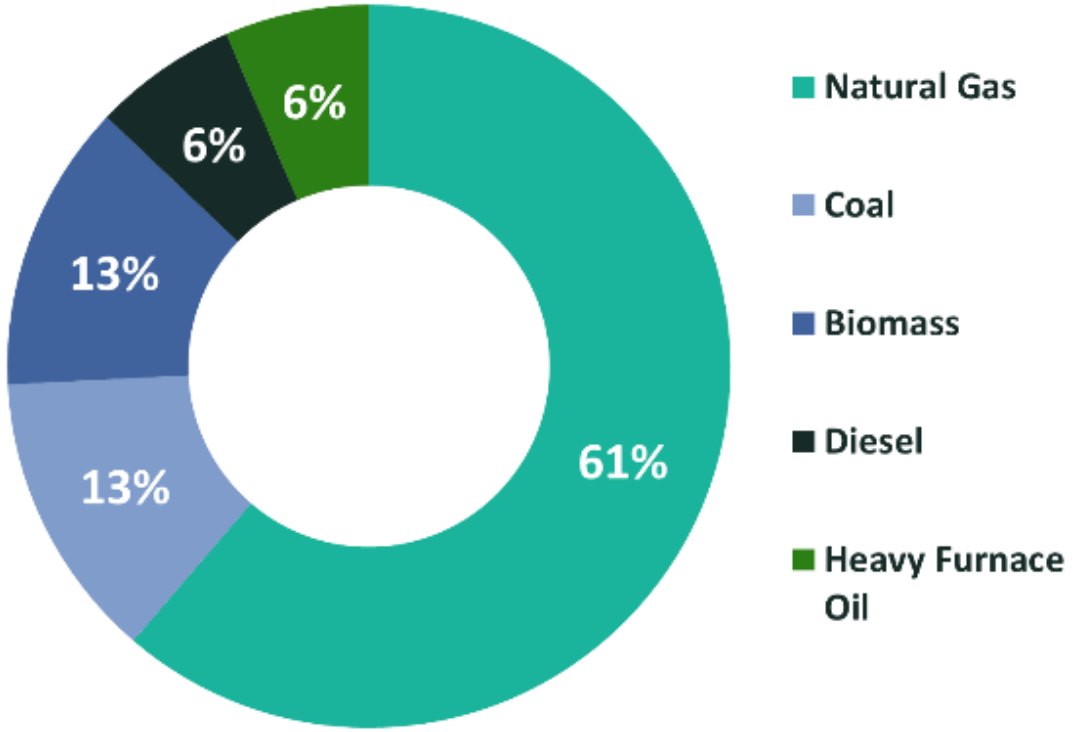
Context – C&I Sector

- Many production facilities in Pakistan are grid connected but also rely on Captive Power Plants (CPP)
- Volatile prices for fossil fuels are becoming a burden for the Pakistani C&I Sector

Fuels used for captive power generation



Source: Ul Haq 2022, p. 15.

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Relevant Ministries and Agencies

- **National Electric Power Regulatory Authority (NEPRA):**

Responsible for issuing power generation, transmission and distribution licences, defining and reviewing safety standards in the electricity sector, and setting electricity prices

- **Alternative Energy Development Board (AEDB)**

Issues permits/licenses to independent power producers (IPPs), examines feasibility studies for newly planned power plant, implementation partner of IPPs during planning and construction phase

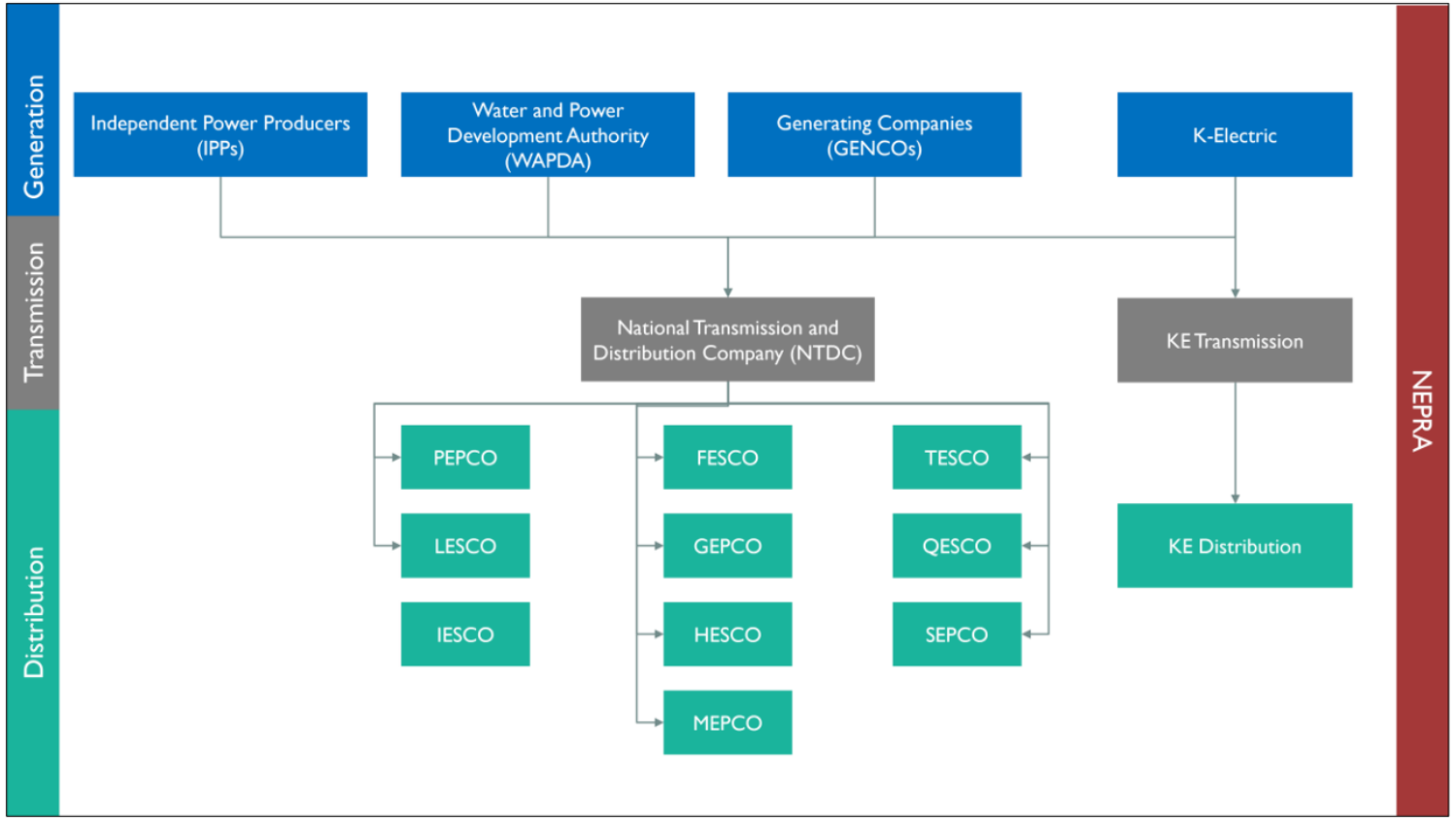
- **National Transmission and Despatch Company (NTDC)**

Responsible for the operation of the national power grid with 90% of national grid-connected generation capacities

- **K-Electric (KE)**

Responsible for the operation of the Karachi region power grid with 10% of national grid-connected generation capacities

Simplified Schematic Diagram of Pakistan's Electricity Sector



Source: Ul Haq 2022, p. 9.

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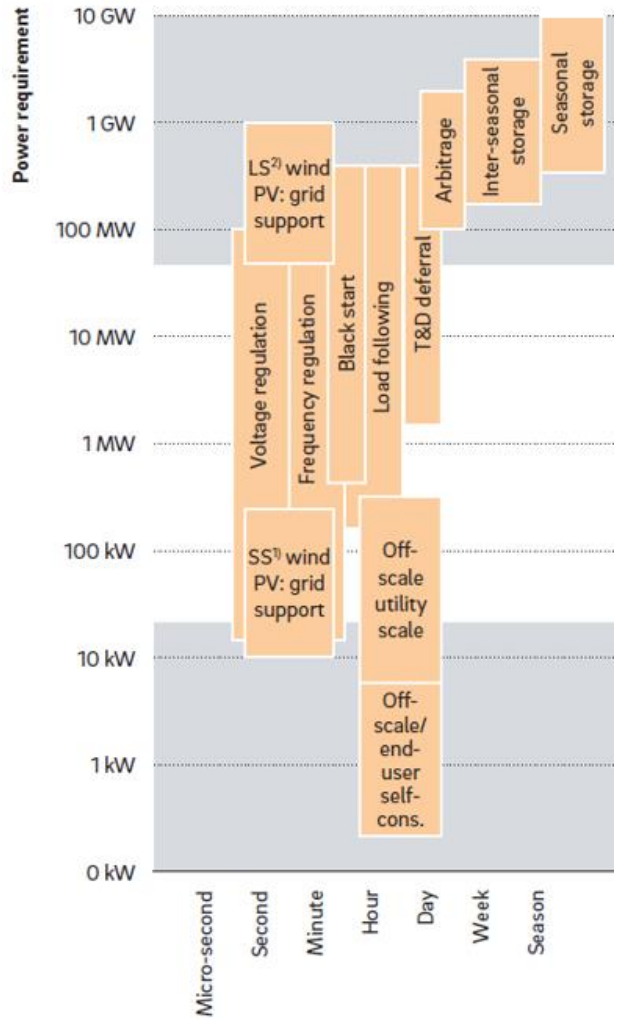
Regulations

- No specific regulations, administrative procedures or standards for battery energy storage systems implemented yet
- Trade Barriers
  - 100% cash margin on Li-ion batteries and lead-acid batteries

Policy for Development of Renewable Energy for Power Generation 2006	National Power Policy 2013	Alternative and Renewable Energy Policy 2019	Integrated Generation Capacity Expansion Plan (IGCEP) 2021-30
First law passed in Pakistan solely for the purpose of promoting the development of renewable energy	Plan for the massive expansion of power generation capacities	Replaced the 2006 Policy	Projects long-term electricity demand and derives the necessary generation capacity expansion and dispatch optimisation plans
Expired in 2018	Main goal was to completely overcome the supply bottlenecks and the resulting load shutdowns	Sets the target to reach an on-grid capacity of RE of at least 20% by 2025 and at least 30% by 2030	Next issue supposed to explicitly include battery energy storage systems

Common Potential Use Cases

- **Energy Arbitrage**
  - The act of absorbing low-cost, off-peak power and selling it during peak demand periods
  - Not possible in Pakistan due to lack of regulation
- **Frequency Regulation and Voltage Support**
  - Services provided to stabilize the power grid
  - Grid in Pakistan operates on 230V and 50hz
  - Currently the most interesting use case for NTDC
- **Back-up Solution**
  - Ensuring uninterrupted power supply (UPS)
  - More likely to be seen on household level



Source: Asian Development Bank 2018, p. 2.

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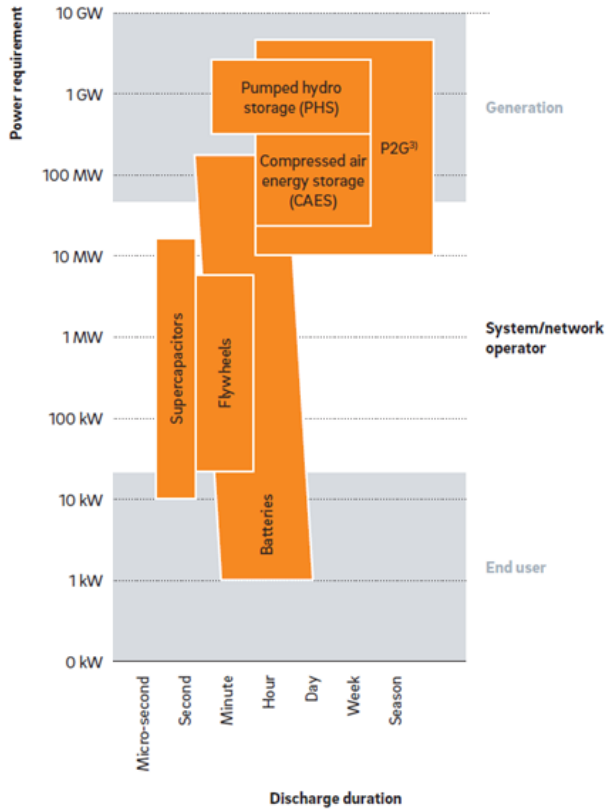
Energy Storage Technologies in Pakistan

- **Lead-Acid Batteries**
  - Most common type of batteries for UPS on household level
- **Lithium-ion Batteries**
  - Most well-known and looked at type of battery in Pakistan for application in the C&I sector and for grid-scale applications at the moment
- **Flow Batteries (Vanadium/Organic)**
  - Receive little to no attention and are not well known
- **Flywheel / Compressed Air Energy Storage**
  - There is awareness but no interest from interviewed companies



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Pilot Projects – Lucky Cement and REON Energy in Pezu

Source: https://www.aboutpakistan.com/news/lucky-cement-to-install-25-3mw-captive-solar-power-project-in-karachi/

- 34MW PV with 5.589MWh BESS
- PV plant is expected to produce 48GWh annually
- Cement require stable heat and electricity supply for the production process
- CPP energy mix so far 25% waste heat recovery and 75% gas turbines
- BESS is expected to increase the overall CPPs efficiency by balancing variable energy output from waste heat recovery and PV plant

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Pilot Projects – NTDC in Jhimpir

- 20 MW wind energy with 20 MWh BESS
- Funding provided by the Asian Development Bank (ADB)
- Public tender (16.09.2021-28.10.2021)
  - Won by consortium ZTT-ZEST-JSPDI (China)
- Planned to be operational in 2023
- Key applications: frequency regulation and grid supportive services
- First and major learning project
  - No other public projects planned as of now

https://www.energy-storage.news/tender-opens-for-pakistans-first-grid-scale-battery-storage-project/

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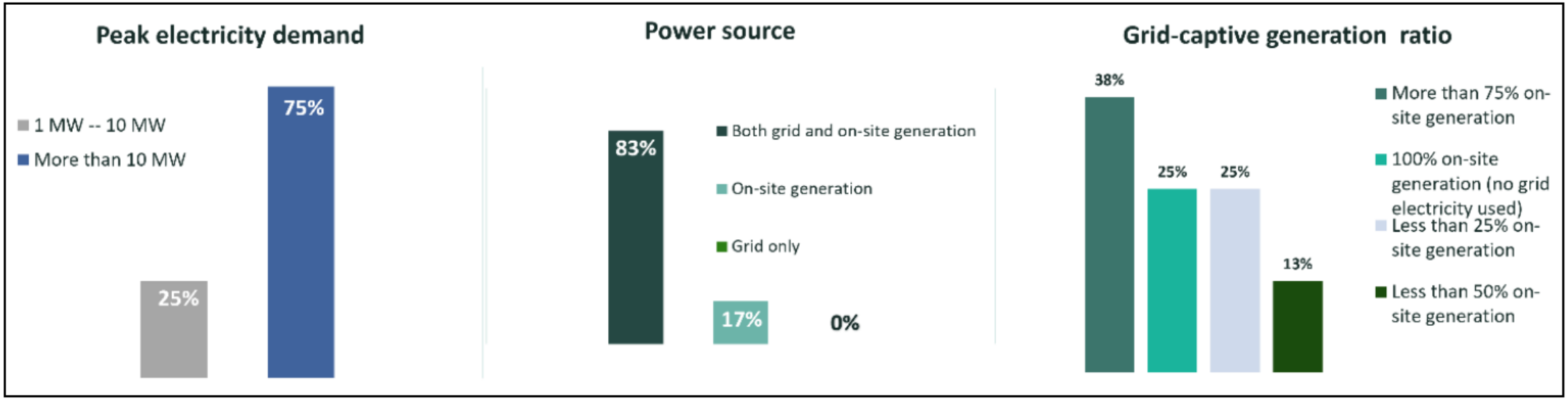
C&I Sector – Potential Partners – Textile and Garment

Pakistan‘s most important industrial sector

Export volume reached USD19.33 billionin 2021 (→ 61% of the country‘s total export volume)	400 textile mills are in business	Pressure from international clients to meet certain sustainability goals and to decarbonize



Captive Power Generation in the Textile Sector – Source: Ul Haq 2022, p. 14.

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C&I Sector – Potential Partners – Cement Sector

- Pakistan is the 7th biggest exporter of cement worldwide
- 16 operational companies
- Electricity requirement estimated at 720 MW in 2016
- Typical energy mix of cement plant
  - 25% waste heat recovery
  - 75% multi-fuel burners (gas, coal, furnace oil, refuse derived fuels)

Cost Break Up Cement Production 2021

Sr.#	Company	Raw Material	Packaging	Fuel	Power	Others
1	Attock Cement	12%	6%	38%	17%	27%
2	Bestway cement	9%	12%	44%	21%	14%
3	Cherat Cement	9%	11%	36%	17%	27%
4	DG Khan Cement	2%	8%	35%	17%	38%
5	Dewan Cement	5%	7%	44%	21%	24%
6	FAUJI CEMENT	10%	7%	39%	16%	28%
7	Flying Cement	3%	9%	39%	29%	19%
8	FECTO Cement	6%	8%	48%	24%	13%
9	Gharibwal Cement	5%	7%	49%	12%	26%
10	Kohat Cement	7%	10%	42%	22%	19%
11	Pioneer Cement	9%	11%	46%	22%	11%
12	Maple Leaf Cement	8%	10%	36%	22%	23%
13	Power Cement	9%	8%	44%	21%	19%
14	Thatta Cement	6%	10%	44%	21%	20%
15	Lucky Cement	6%	11%	41%	19%	23%
	Industry	**7%**	**9%**	**40%**	**19%**	**26%**

Source: PACRA 2022a, p. 12.

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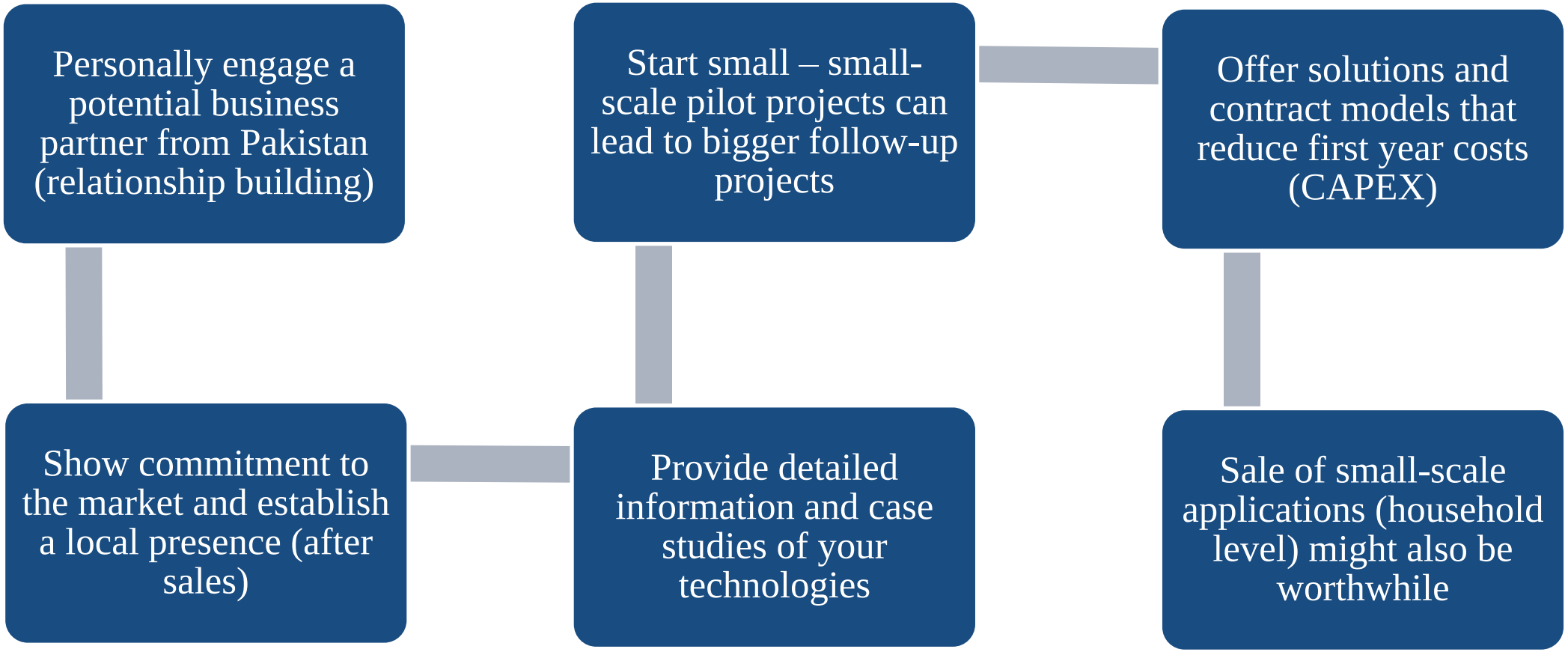
Market Barriers and Risks

Price sensitive and highly competitive market	Close geographical and political proximity to China (CPEC)	Relationship building required	After sales services and warranty issues

Recommendations for Action for Market Entry



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SWOT-Analysis

Strengths	Weaknesses
Pakistan • Developed a relatively resilient Democratic system since overcoming military rule in 2008 • Good GDP growth rates • Good geographic preconditions for RE	**Pakistan** • Lack of skilled workers • High dependency on fossil fuels and imports of such • Strong focus on short-term gains • Long-lasting energy crisis and load shedding • Inefficient utilization of domestic resources
Market for Energy Storage	**Market for Energy Storage** • Insufficient regulatory framework • No ancillary services • Lack of attractive financing mechanism for BESS • Lack of awareness and knowledge on technologies and use cases in the public sector and C&I sector
Opportunities	**Threats**
Pakistan • Low labor costs • High growth rates in electricity-intensive industry sectors (cement, fertilizers, sugar)	**Pakistan** • Domestic Security situation • Conflict with India • Political partnership with China • Volatile currency • High public debts • Inflation • High perceived corruption • Very high climate change related risks
Market for Energy Storage • Increase of RE capacities • No established major supplier of BESS in Pakistan yet • Increased interest by customers in energy storage and/or hybrid solutions • Unreliable power supply via national grid requires captive powerplants (e.g. hybrid solutions), backup systems etc. • Cheaper and quicker alternative to grid extension in some areas • High costs for fossil fuels and derivates	**Market for Energy Storage** • Chinese-Pakistan Economic Corridor • Dominance of Chinese companies in the Pakistani PV sector • Traditionally very price-sensitive and competitive

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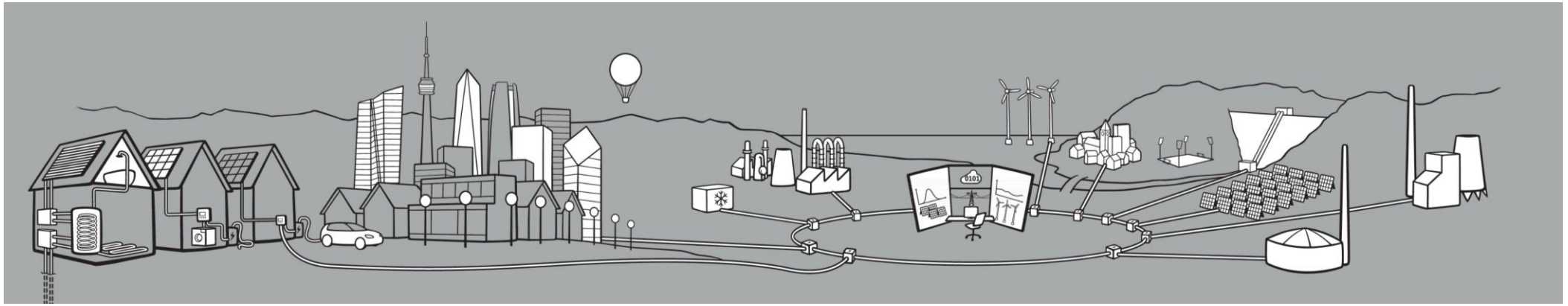

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