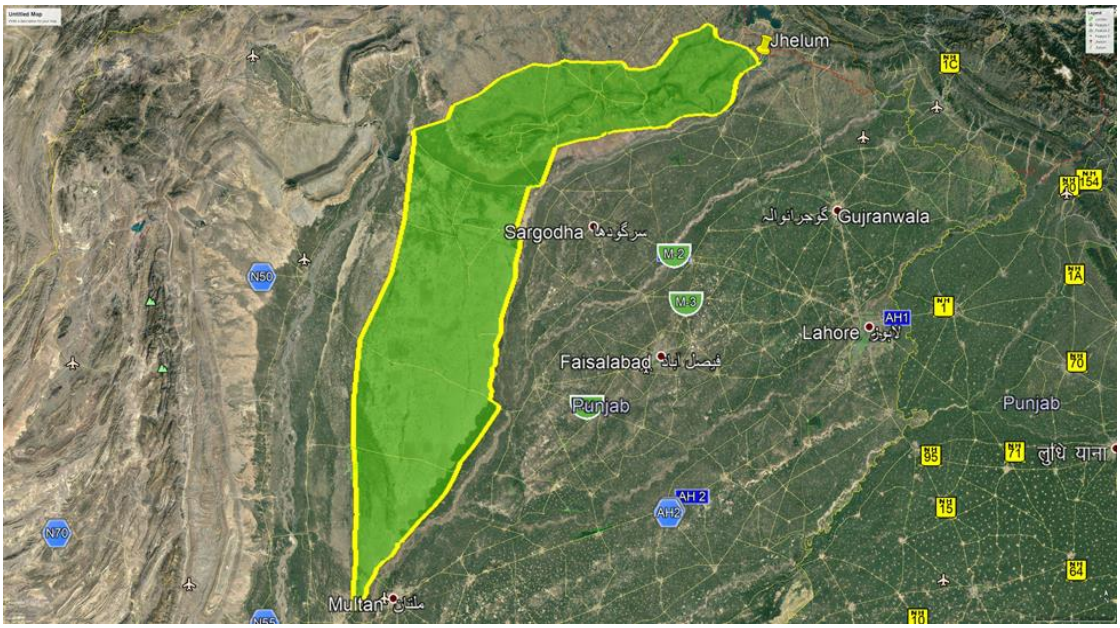
7000 MW Mid Country Hybrid Renewable Energy Project

Mangla to Muzaffar Garh Corridor

(Jhelum - Kallar Kahar - Sakaiser - Noor Pur Thal - Mankera - Chaubara – Mzaffar garh)



Index

Sponsor of the Project

Super Asia Electric and Solar Power Private Limited was incorporated in 2017 with objective to meet the needs of electricity with Green or Renewable Energy at the lowest cost in the country. In that regard Super Asia Power had support of its vast international linkage for Finical and Technical cooperation.

The Project

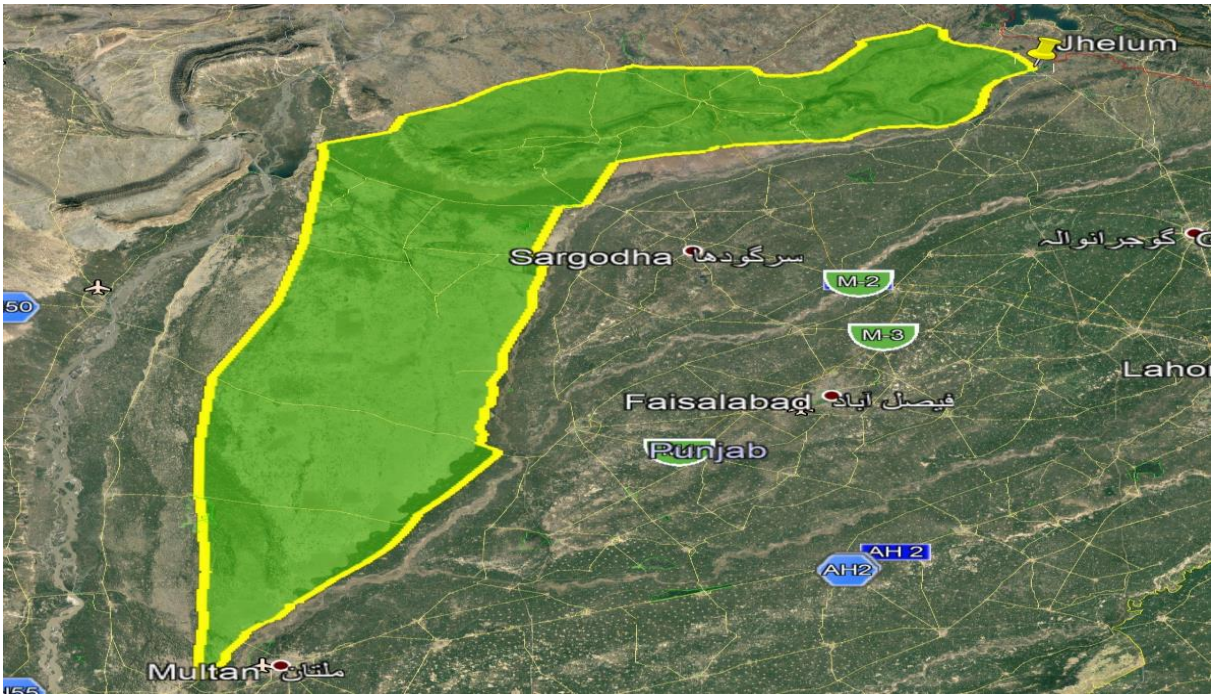
This project will produce the lowest cost green electricity to the tune of lesser than 5 Cent per Unit. This will be Environmentally Friendly Project and will Yield Carbon Credits. This project will be first of its kind in World with Integration of Solar, Wind and Small Hydropower and lands will be fully utilized for Floriculture, Low Height Vegetables, Precious Herbs, Field Grazed Chicken, Goats and Cows.

This corridor has potential of replacing all fossil fuel or thermal power which is around 60% of current production. It has10 Hi Tension Transmission Lines for easy and cost efficient up linking as IPP and it has dozens of LT Lines for Net Metering. This area has best sun hours of the country and more than 10 Km/Hour Wind Velocity. Half of the corridor has potential of micro and small hydropower plants.

Since NTDC is and independent body, this project first of its type, will pay rent to NTDC to carry its produced energy at point of use. SPV will make it own grid stations at point of use. User will pay half od the price of current monopolized retail by WAPDA. It will be beginning of an alternative option against monopoly of WAPDA.

Geographical Location

Location of projects is Mangla to Muzaffar Garh Corridor which includes Jhelum - Kallar Kahar - Sakaiser - Noor Pur Thal - Mankera - Chaubara – Mzaffar garh). Major Area falls from National Highway N5 Sohawa-Jhelum to Chok Munda - Rangpur Road.



Advantages of This Geographical Location

This area is one of the best in Pakistan for Integrated Solar Wind Power Project. It has potentials of Hydro Energy by constructing small dams. It can be augmented with mouth of the mine coal power plants.

It has Good Sunshine Hours for Solar Power (6 Projects already in area) and required Wind Velocity for Wind Power.

Integration will ensure the steady power generation year-round and 24 hours a day.

For Solar & Wind Power Projects, after Sunshine hours and Wind Velocity, there are only three factors;

1. Availability of Vast Land

2. Road Connectivity.

3. Linking up with National Grid

Though in mid of the country, this area has the lowest land cost being barren since centuries.

It has good road access.

It has several HT Lines to operate as IPP and hundreds of LT Lines for Net Metering.

Several HT electric lines of 500 KV are passing through area thus saving huge cost of transmission and dispatching as IPP Model. Dozens of LT Lines are passing for Net Metering Model.

Transmission Lines of the following Power Plants are Crossing the Area reducing cost of unlinking significantly

Power Plant	Capacity (MW)
Trabela	4,888
Ghazi Barotha	1,450
Neelum Jhelum	969
Mangla	1150
CHASNUPP	2,200
Chashma Hydropower	184
Taunsa Barrage	120
Lalpir Power	362
Kot Addu Power	1600
Muzaffargarh GENCO-III	1,350
	14,273

Pilot Project Area
Police Station Domeli, Tehsil Sohawa, District Jhelum

Pilot Project will be located in valley having size of 30km by 20 km surrounded by hills of Diljabba-Domeli on north and hills of Rohtas- Tilla Jogian on south. N5 Sohawa-Dina on East and Hills of Ara on West.

Three Hi Tension 500,000 Volts Transmission Lines pass through this area which will make Up Linking cost negligible. Lands acquired are within 0 to 2 KM from those HT Lines.

Pilot Project Area has 4 options of Power Generation.

1. Solar
2. Wind
3. Hydro
4. Mouth of the Mine Coal

4th Option is not under consideration due to probability of GHG emissions. While other Three options are being considered being eco-friendly.

Financials of the Project

This Project will Cost USD 5,000.00 million with Yield of 7,000 MW of Electricity. Costing USD 0.71 million per 1 MW and it is very reasonable for Green Energy Projects. Hydro Power projects are costing USD 2.0 million per 1 MW.

Project will be financed at 30:70 Equity: Debt Ratio.

100,000.00 acres of Land will be purchased with owner's equity in the name of the company/SPV. This land will constitute 30 % of cost component. 70% debt will be borrowed from international banks at low mark up.

Pay Back Period: 5 years (2 Years to reach COD stage, 3 Years after COD)

Salvage Value: Salvage Value will be 2 times of the investment after 25 years life of the project.

Typical Prevailing Tariff for End Users

As On February 2021

ISLAMABAD ELECTRIC SUPPLY COMPANY (IESCO)				
SRO 185 (I)/2021	February 12, 2021			
A-1 GENERAL SUPPLY TARIFF - RESIDENTIAL				
Sr. No.	TARIFF CATEGORY / PARTICULARS	FIXED CHARGES Rs/kW/M	APPLICABLE VARIABLE CHARGES Rs./kWh	
a)	For Sanctioned load up to 5 kW		-	-
i	Up to 50 Units	-	-	3.95
	For Consumption exceeding 50 Units		-	-

ii	1- 100 Units	-	-	7.74
iii	101- 200 Units	-	-	10.06
iv	201- 300 Units	-	-	12.15
v	301- 700 Units	-	-	19.55
vi	Above 700 Units	-	-	22.65
b)	For Sanctioned load 5 kW & above	-		
	Time Of Use		Peak	Off-Peak
		-	22.65	16.33
As per the Authority's decision residential consumers will be given the benifits of only one previous slab.				
Under tariff A-1, there shall be minimum monthly customer charge at the following rates even if no energy is consumed.				
a) Single Phase Connections:		Rs. 75/- per consumer per month		
b) Three Phase Connections:		Rs. 150 /- per consumer per month		
A-2 GENERAL SUPPLY TARIFF - COMMERCIAL				
a)	For Sanctioned load up to 5 kW		-	19.95
b)	For Sanctioned load 5 kW & above	440	-	21.63
			Peak	Off-Peak
c)	Time Of Use	440	23.55	17.58
Under tariff A-2, there shall be minimum monthly charges at the following rates even if no energy is consumed.				
a) Single Phase Connections:		Rs. 175/- per consumer per month		
b) Three Phase Connections:		Rs. 350 /- per consumer per month		
A-3 GENERAL SERVICES				
a)	General Services	-	-	19.51
Under tariff A-3, there shall be minimum monthly charges at the following rates even if no energy is consumed.				
a) Single Phase Connections:		Rs. 175/- per consumer per month		
b) Three Phase Connections:		Rs. 350 /- per consumer per month		

B - INDUSTRIAL				
B1	Up To 25 kW (at 400/230 Volts)	-	-	17.23
B2(a)	Exceeding 25-500 kW (at 400 Volts)	440	-	16.73
	Time Of Use		Peak	Off-Peak
B1(b)	Up to 25 kW	-	20.79	15.23
B2(b)	Exceeding 25-500 kW (at 400 Volts)	440	20.73	15.02
B3	For All Loads up to 5000 kW (at 11,33 kV)	420	20.73	14.93
B4	For All Loads (at 66,132 kV & above)	400	20.73	14.83
For B1 consumers there shall be a fixed minimum charge of Rs. 350 per month.				
For B2 consumers there shall be a fixed minimum charge of Rs. 2,000 per month.				
For B3 consumers there shall be a fixed minimum charge of Rs. 50,000 per month.				
For B4 consumers there shall be a fixed minimum charge of Rs. 500,000 per month.				
C - SINGLE-POINT SUPPLY				
C -1	For supply at 400/230 Volts		-	-
a)	Sanctioned load less than 5 kW	-	-	20.63
b)	Sanctioned load above 5 kW & up to 500 kW	440	-	20.13
C -2(a)	For supply at 11,33 kV up to and including 5000 kW	420	-	19.93
C -3(a)	For supply at 66 kV & above and sanctioned load above 5000 kW	400	-	19.83
	Time Of Use (Optional)		Peak	Off-Peak
C -1(c)	For supply at 400/230 Volts above 5 kW & up to 500 kW	440	23.55	16.95
C -2(b)	For supply at 11,33 kV up to and including 5000 kW	420	23.55	16.75
C -3(b)	For supply at 66 kV & above and sanctioned load above 5000 kW	400	23.55	16.65
D - AGRICULTURE TARIFF				
D-1(a)	SCARP less than 5 kW	-	-	17.63
D-2(a)	Agricultural Tube Wells	200	-	7.3
			Peak	Off-Peak
D-1(b)	SCARP 5 kW & above	200	20.55	13.3
D-2(b)	Agricultural 5 kW & above	200	7.3	7.3

Under this tariff, there shall be minimum monthly charges of Rs.2000/- per consumer per month, even if no energy is consumed.				
Note: - The consumers having sanctioned load less than 5 kW can opt for TOU metering.				
E - TEMPORARY SUPPLY TARIFFS				
E-1(i)	Residential Supply	-	-	22.79
E-1(ii)	Commercial Supply	-	-	20.34
E-2	Industrial Supply	-	-	18.31
For the categories of E-1(I & ii) above, the minimum bill of the consumers shall be Rs. 50/- per day subject to a minimum of Rs.500/- for the entire period of supply, even if no energy is consumed.				
F - SEASONAL INDUSTRIAL SUPPLY TARIFF				
	125% of relevant industrial tariff			
Note:	Tariff-F consumers will have the option to convert to Regular Tariff and vice versa. This option can be exercised at the time of a new connection or at the beginning of the season. Once exercised, the option remains in force for at least one year.			
G- PUBLIC LIGHTING				
G	Street Lighting	-	-	20.63
Under Tariff G, there shall be a minimum monthly charge of Rs.500/- per month per kW of lamp capacity installed.				
H - RESIDENTIAL COLONIES ATTACHED TO INDUSTRIAL PREMISES				
H	Residential Colonies attached to industrial premises	-	-	20.63
I - RAILWAY TRACTION				
I	Railway Traction	-	-	20.63
K - SPECIAL CONTRACTS				
1	Azad Jammu & Kashmir (AJK)	400		17.85
	Time Of Use		Peak	Off-Peak
		400	23.55	16.65
2	Rawat Lab		-	20.63

Steps Achieved

The most difficult part is procurement of lands at required places.

Locations with Road Access and Power Lines for Up linking has been not only been identified but also documents of owners has been verified and at most places agreements with land sellers has been inked and Tokin/Advances has already been paid to 20,000.00 acres of land.

Stake Holders for Electricity Generation, Transmission and Retail in Pakistan

NEPRA (National Electric Power Regulatory Authority) is the Regulatory Body.

National Transmission & Dispatch Company (NTDC) is autonomous power transmission company under ministry of Energy (Power Division). It was separated from Water & Power Development Authority (WAPDA) in 1998 and owns all 220 KV and 500KV grid stations and transmission lines in Pakistan. The company operates fourteen 500 KV and forty-three 220 KV grid stations, 5,893 km of 500 KV transmission lines, and 10,963 km of 220 KV transmission lines in Pakistan.

Electricity in Pakistan is generated, transmitted, distributed, and retail supplied by two vertically integrated public sector companies, Water and Power Development Authority (WAPDA) for all of Pakistan except Karachi. WAPDA owns 10 reginal Electric Supply Companies.

1. Faisalabad Electric Supply Company (FESCO)
2. Gujranwala Electric Power Company (GEPCO)
3. Hyderabad Electric Supply Company (HESCO)
4. Sukkur Electric Power Company (SEPCO)
5. Islamabad Electric Supply Company (IESCO)
6. Lahore Electric Supply Company (LESCO)
7. Multan Electric Power Company (MEPCO)
8. Peshawar Electric Power Company (PESCO)
9. Quetta Electric Supply Company (QESCO)
10. Tribal Electric Supply Company (TESCO)

Karachi Electric (K-Electric formerly KESC) operates for the city of Karachi and its surrounding areas.

There are around 42 Independent Power Producers (IPPs) that contribute significantly in electricity generation in Pakistan.

Current Electricity Generation capacity is134,745.70 GWh.

The Alternative Energy Development Board (AEDB) is the sole representing agency of the Federal Government that was established in May 2003 with the main objective to facilitate, promote and encourage development of Renewable Energy in Pakistan and with a mission to introduce Alternative and Renewable Energies (AREs) at an accelerated rate. The administrative control of AEDB was transferred to Ministry of Water and Power in 2006.

Introduction of Net Metering has enhanced opportunity of micro level power generation to manifold and it is not fully exploited yet to its full extent.

Ministry of Climate Change is stake holder for environmental and ecological issues.

Forecast, Electricity Consumption Per Capita, Current Installed Capacity of Electricity Generation

Electricity Consumption Per Capita – Global Snapshot & Ranking of Pakistan

Country wise Electricity consumption per capita (kWh per person)			
	Country	kWh per person	Year of Data
1	Iceland	50,409	2020
2	Norway	22,351	2020
3	Kuwait	19,300	2020
4	Bahrain	17,349	2020
5	Qatar	15,236	2020
6	Finland	14,859	2020
7	Canada	13,854	2020
8	Sweden	13,085	2020
9	United States	11,730	2020
10	United Arab Emirates	11,329	2019
11	Luxembourg	10,304	2020
12	Taiwan	10,058	2020
13	Liechtenstein	10,057	2020
14	Cayman Islands	9,880	2020
15	Korea, South	9,793	2020
16	New Caledonia	9,445	2020
17	Australia	9,008	2020
18	Saudi Arabia	8,668	2020
19	Macau	8,263	2020
20	Trinidad and Tobago	8,163	2020
21	Greenland	8,123	2020
22	Brunei	8,119	2020
23	New Zealand	8,020	2020
24	Oman	7,957	2020
25	Singapore	7,680	2020
26	Japan	7,519	2020
27	Austria	7,292	2020
28	Estonia	7,158	2020
29	Belgium	7,010	2020
30	Switzerland	6,956	2020
31	Germany	6,693	2020
32	France	6,644	2020
33	Russia	6,418	2020
34	Slovenia	6,373	2020
35	Israel	6,340	2020

36	Netherlands	6,296	2020
37	Puerto Rico	6,108	2020
38	Czech Republic	5,825	2020
39	Hong Kong	5,771	2020
40	Denmark	5,626	2020
41	Falkland Islands (Islas Malvinas)	5,525	2016
42	Greece	5,363	2020
43	Ireland	4,961	2020
44	Kazakhstan	4,936	2020
45	Bahamas	4,898	2020
46	Slovakia	4,897	2020
47	Spain	4,788	2020
48	Italy	4,703	2020
49	United Kingdom	4,702	2020
50	Bulgaria	4,642	2020
51	Malta	4,641	2020
52	Montenegro	4,604	2020
53	Portugal	4,556	2020
54	Serbia	4,251	2020
55	Malaysia	4,193	2020
56	Hungary	4,029	2020
57	Chile	4,026	2020
58	China	3,991	2020
59	Libya	3,962	2020
60	Poland	3,903	2020
61	Lithuania	3,844	2020
62	Croatia	3,768	2020
63	South Africa	3,668	2020
64	Latvia	3,614	2020
65	Saint Kitts and Nevis	3,593	2020
66	Seychelles	3,391	2020
67	Barbados	3,361	2020
68	Belarus	3,347	2020
69	Uruguay	3,179	2020
70	Antigua and Barbuda	3,135	2020
71	Bosnia and Herzegovina	3,095	2020
72	Ukraine	3,033	2020
73	Macedonia	3,020	2020
74	Lebanon	2,872	2020
75	Suriname	2,871	2020
76	Turkey	2,818	2020

77	Bhutan	2,792	2020
78	Iran	2,783	2020
79	Turkmenistan	2,729	2020
80	Thailand	2,721	2020
81	Argentina	2,661	2020
82	Andorra	2,588	2020
83	Venezuela	2,512	2020
84	Georgia	2,509	2020
85	Brazil	2,405	2020
86	Romania	2,330	2020
87	Nauru	2,281	2020
88	Panama	2,236	2020
89	Saint Lucia	2,061	2020
90	Mexico	2,011	2020
91	Azerbaijan	1,983	2020
92	Mauritius	1,976	2020
93	Costa Rica	1,925	2020
94	Mongolia	1,872	2020
95	Kyrgyzstan	1,764	2020
96	Armenia	1,751	2020
97	Albania	1,662	2020
98	Grenada	1,637	2020
99	Uzbekistan	1,605	2020
100	Botswana	1,569	2020
101	Jordan	1,554	2020
102	Egypt	1,534	2020
103	Paraguay	1,516	2020
104	Dominican Republic	1,490	2020
105	Namibia	1,479	2020
106	Cuba	1,461	2020
107	Tajikistan	1,461	2020
108	Vietnam	1,451	2020
109	Saint Vincent and the Grenadines	1,440	2020
110	Peru	1,398	2020
111	Dominica	1,395	2020
112	Colombia	1,390	2020
113	Ecuador	1,342	2020
114	Moldova	1,308	2020
115	Tunisia	1,303	2020
116	Algeria	1,302	2020
117	Swaziland	1,296	2020

118	Belize	1,134	2020
119	Guyana	1,053	2020
120	Jamaica	1,014	2020
121	Iraq	989	2020
122	Gabon	928	2020
123	El Salvador	915	2020
124	Fiji	908	2020
125	India	857	2020
126	Indonesia	799	2020
127	Morocco	794	2020
128	Honduras	782	2020
129	Laos	735	2020
130	Syria	730	2020
131	Philippines	717	2020
132	Bolivia	669	2020
133	Zambia	634	2020
134	Cape Verde	630	2020
135	Samoa	603	2020
136	Guatemala	589	2020
137	Nicaragua	579	2020
138	Equatorial Guinea	556	2020
139	Sri Lanka	554	2020
140	Korea, North	542	2020
141	Zimbabwe	489	2020
142	Tonga	456	2020
	As per NEPRA, Pakistan Falls Here	**529**	
143	Papua New Guinea	446	2020
144	Lesotho	430	2020
145	Djibouti	409	2020
146	**As per International Bodies, Pakistan Falls here**	**395**	
147	Mozambique	384	2020

As per "State of Industry Report 2019 by NEPRA", Electricity Consumption per Capita = 529 kWh/Capita on PEPCO and 892 on KE system.

Forecast for Demand of Electricity in Coming Years

Pakistan falls under 600 kWh per person while world Median and Mode is between 2,000 to 3,000 kWh per person. It means Pakistan will grow 5 to 6 times from its current capacity. The forecast total demand will reach to 200,000 MW by 2035 while by 2020 the installed electricity generation capacity is only 37,402 MW according to the Pakistan Economic Survey 2019–20.

Pakistan electricity sector is a developing market with huge potential. For years, the matter of balancing the country's supply against the demand for electricity had remained a largely unresolved matter. The country faced significant challenges in revamping its network responsible for the supply of electricity. Electricity generators were seeking a parity in returns for both domestic and foreign investors indicating it to be one of the key issues in overseeing a surge in electricity generation when the country was facing growing shortages. Other problems included lack of efficiency, rising demands for energy, and political instability.

At one point electricity generation had shrunk by up to 50% due to an over-reliance on fossil fuels. The country was hit by its worst power crisis in 2007 when production fell by 6000 Megawatts and massive blackouts were faced.

The forecast total demand will reach to 200,000 MW by 2035 while by 2020 the installed electricity generation capacity has reached 37,402 MW according to the Pakistan Economic Survey 2019–20.

Current Electricity Generation

134,745.70 GWh

Electricity Generation by Source

Natural gas:	31% of total
Coal:	16% of total
Furnace oil:	14% of total
Hydroelectric:	29% of total
Nuclear:	4% of total
Renewable (solar & wind):	5% of total
Others (Bagasse, Waste Heat Recovery etc.):	1% of total

State of Renewable Energy in Pakistan

Renewable energy in Pakistan is a relatively underdeveloped sector; however, in recent years, there has been some interest by environmentalist groups and from the authorities to explore renewable energy resources for energy production. Currently lesser than 35% of energy comes from Renewable source and most of Pakistan's renewable energy comes from hydroelectricity. Other sources are Solar and Wind.

Support and Facilitation by Government of Pakistan for Renewable Energy Projects

Government of Pakistan is fully in support for promotion of Green or Renewable Energy projects. It has eased the approvals, financing, Tax Exemptions, Ease in Import and several other incentives.

Notifications of State Bank of Pakistan, FBR and Power Division are affixed on next pages.

STATE BANK OF PAKISTAN
Infrastructure, Housing & SME Finance Department
I. I. Chundrigar Road
Karachi

IH&SMEFD Circular No. 03

June 20, 2016

The Presidents/Chief Executives,
All Banks/DFIs

Dear Sir /Madam,

Revised SBP Financing Scheme for Renewable Energy

1. Background

State Bank of Pakistan announced the scheme for Financing Power Plants using Renewable Energy in 2009, with a view to promote renewable energy projects in the country. Keeping the low utilization of the scheme in view, the scope and financial mechanism have been revised to make it more attractive to borrowers and financing banks/DFIs.

2. Objective

Pakistan's economy is currently facing the dual challenge of energy shortage and climate change. The inadequate supply of energy has severely impacted the growth of industries/businesses and the welfare of public in general. Similarly, the effects of climate change have been observed in the form of devastating floods, droughts, heat waves and changing weather patterns. These changes essentially inhibit our ability to develop sustainably.

In order to overcome these challenges, SBP decided to promote green banking i.e. use of indigenous resources especially renewable energy in order to ensure sustainable banking and development. For this purpose, the scheme has been amended based on the feedback received from various stakeholders. The scheme will provide concessionary financing for large renewable energy power projects as well as for small scale renewable energy solutions.

3. Scope

The scheme shall be available for power generated by using alternative / renewable energy sources (solar, wind, hydro, biogas, bio-fuels, bagasse cogeneration, and geothermal as fuel). Scheme is available under two categories, as given below:

I. Prospective sponsors, desirous of setting up renewable energy power projects with a capacity ranging from more than 1 MW and up-to 50 MW[1], who have completed

[1] Subject to maximum refinance from SBP of Rs 6 billion per project. Banks/DFIs may structure loan as per their own terms & conditions for any amount exceeding this limit.

TIMELINE FOR ISSUANCE OF SALES TAX EXEMPTION CERTIFICATE ON IMPORT OF RENEWABLE ENERGY EQUIPMENT

S. No.	Task/Activity	Timeline
1.	Request of company received and forwarded to PV Off-Grid section	1 – 2 days
2.	Scrutiny of company's documents	1 – 2 days
3.	Processing of Case	2 – 3 days

4.	Approval of Case	2 – 3 days
5.	Issuance of Exemption Certificate	1 – 2 days
Total Number of Days		7 – 12 days

Reference:

1. Sales Tax Exemption Certificate is issued to the importers of Renewable Energy Equipment under the provision of serial no. 110 of Table-I of the 6th Schedule of Sales Tax Act 1990.
2. In case if there are shortcomings, they are communicated to the company for addressing and submitting in 2-3 days.
3. Days mean working days.

Upon receipt of the application along with listed documents complete in all respect, AEDB will review the documents and will check the quantities stated in the application for issuance of certificate within seven (07) working days.

The importers of the solar PV system/ equipment are requested to apply to AEDB for issuance of certificate immediately after the receipt of copy of bill of lading / air way bill to avoid delay / demurrages upon arrival of the shipments.

ISSUANCE OF CERTIFICATE FOR IMPORT OF RENEWABLE ENERGY EQUIPMENT STANDARD OPERATING PROCEDURE

As per the Sr. No. 110 of Table I of the Sixth Schedule of The Sales Tax Act 1990 Alternative Energy Development Board (AEDB) is required to issue a certificate for dedicated use of renewable source of energy.

Importers of the solar equipment are required to apply to AEDB for issuance of certificate. The application shall accompany the documents outlined in this list. Please scroll down and select the import items applicable to your application and submit the documents accordingly.


حکومت پاکستان کا ایک اور انقلابی قدم
متبادل توانائی کے شعبے میں حکومت کی سال 20-2019ء میں اُٹھائے گئے اہم اقدامات
نئی متبادل توانائی پالیسی 2019ء:۔
متبادل توانائی کو ایک بالکل نئی سمت مہیا کر دی گئی ہے۔
2025ء تک مُلک کی بجلی کی پیداوار میں متبادل توانائی کا حصہ موجودہ 5 فیصد سے بڑھا کر 20 فیصد کیا جائے گا۔
2030ء تک متبادل توانائی سے 30 فیصد بجلی پیدا کی جائے گی۔
مُلک میں متبادل توانائی کی وجہ سے بجلی کی قیمتیں کم ہونگی۔
مُلکی وسائل کا استعمال، متبادل توانائی سے متعلقہ مارکیٹیں، صنعتیں اور ملازمت و کاروبار کے وسیع تر مواقع۔
1730.2 میگاواٹ کے 41 متبادل توانائی کے منصوبوں کو اجازت۔
104 مزید متبادل توانائی کے موجودہ منصوبوں کو مسابقتی بولی کے ذریعے اپنے منصوبے لگانے کی اجازت۔
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Annex-I

PROCESSING SCHEDULE FOR UNSOLICTED PROJECTS

In view of provision of ARE Policy 2019 and Section 8.7.1.1 (Exhibit 3) of RE Policy 2006, the processing schedule for unsolicited grid-connected RE IPPs is given under:

Activity	Typical Allowance (Days)
a. Submission of proposal on raw site by sponsors	-
b. Review of proposal and qualification of sponsors by AEDB	30
c. Posting of Bank Guarantee by sponsors	15
d. Issuance of Letter of Intent (LoI) by AEDB	7
e. Initial time allowed to carry out feasibility study and term of the LoI.	Based on schedule submitted by IPP, subject to maximum of 18 months.
f. Tariff negotiations with power purchaser and approval of tariff by NEPRA (the time can be significantly reduced if up-front tariff is accepted by IPP)	90
g. Submission of Performance Guarantee by sponsors upon approval of tariff by NEPRA	15
h. Issuance of LoS by AEDB	7

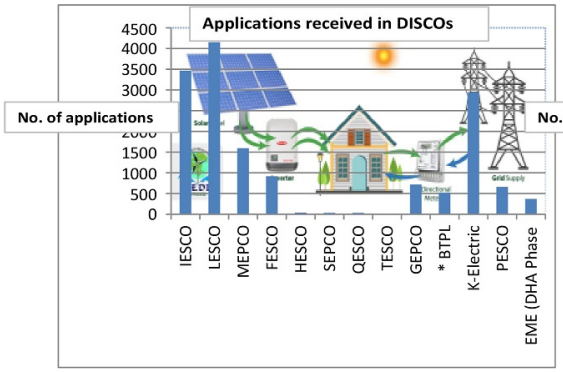

متبادل توانائی کے شعبے میں حکومت کی سال 20-2019ء میں اُٹھائے گئے اہم اقدامات
1730.2 میگاواٹ کے 41 متبادل توانائی کے منصوبوں کو اجازت۔
104 مزید متبادل توانائی کے موجودہ منصوبوں کو مسابقتی بولی کے ذریعے اپنے منصوبے لگانے کی اجازت۔
مُلک میں پہلی بار متبادل توانائی کی موزوں ترین جگہوں کی انٹرنیشنل اور سائنسی طریقوں سے نشاندہی:۔
مُلک میں پہلی بار عالمی بینک اور متبادل توانائی ڈویلپمنٹ بورڈ مل کر مسابقتی بولی پر نئے پراجیکٹس لگانے کیلئے بنیادی دستاویزات کی تیاری۔
مُلک میں نیٹ میٹرنگ کا باقاعدہ اور بڑے پیمانے پر فروغ۔
گھریلو صارفین اس وقت 60 میگاواٹ بجلی نیٹ میٹرنگ سے پیدا کر رہے ہیں۔
متبادل توانائی بورڈ کا آن لائن نیٹ میٹرنگ موڈیول کا آغاز۔
تمام بجلی تقسیم کار کمپنیوں میں نیٹ میٹرنگ پر باقاعدہ ٹریننگ۔

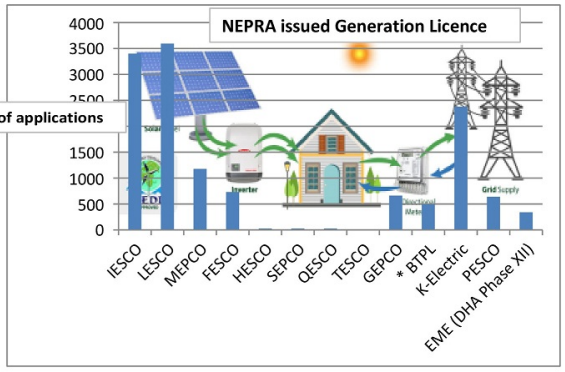
Progress of Net-Metering in Pakistan up to June 30, 2021

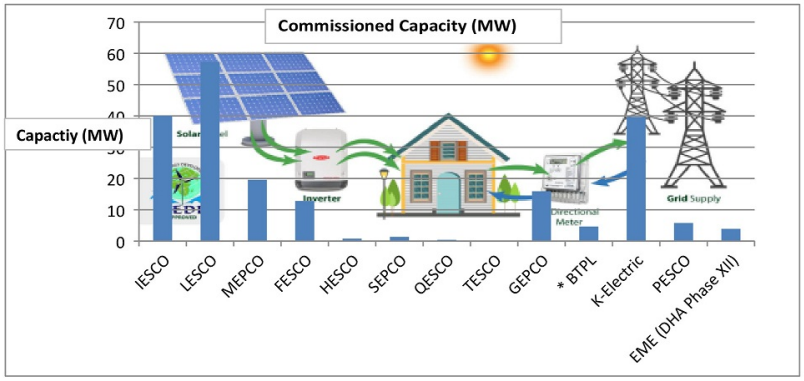
S.No	Name of DISCO	Application received in DISCOs		Applied to NEPRA	Generation License issued by NEPRA		Commissioned Systems	
		Nos.	Capacity (KW)	Nos.	Nos.	Capacity (MW)	Nos.	Capacity (MW)
1	IESCO	3465	42510.0	3435	3400	42	3256	40
2	LESCO	4150	80872.4	3956	3594	67.26	3149	57.26
3	MEPCO	1593	43415.0	1411	1178	24.88	951	19.59
4	FESCO	917	23741.5	850	731	16.21	553	12.79
5	HESCO	37	2495.7	21	19	1.26	11	0.76
6	SEPCO	27	3263.8	13	10	1.57	10	1.35
7	QESCO	8	615.1	6	5	0.34	5	0.34
8	TESCO	0	0.0	0	0	0.00	0	0.00
9	GEPCO	716	20810.0	716	662	19.11	533	15.89
10	* BTPL	519	4864.0	519	492	4.63	492	4.63
11	K-Electric	2941	51998.4	2617	2376	41	2337	40
12	PESCO	659	9627.4	645	640	9.151	514	5.771
13	EME (DHA	370	4232.9	370	340	3.89	340	3.89
Total:		15402	288446	14559	13447	231.08	12151	201.97

*BTPL progress was upto Oct 16, 2020 due to suspection /cancellation of License of BTPL by NEPRA from Oct 16, 2020, vide its letter dated Oct 20, 2020

Graphical view of Net-Metering progress in Pakistan up to June 30, 2021







Alternative Energy - Investment Opportunities (Targets, Incentives, Proposed Areas of Collaboration)

As part of Energy Security Action plan 2006, the Honorable President and the Prime Minister of Pakistan have tasked the Alternative Energy Development Board to have share of at least 5% of total National On-Grid Power generation capacity through wind energy by year 2030. AEDB is developing investment friendly opportunities and several fast-track regimes for wind power project to meet the targets. In order to harness the wind potential in Pakistan, AEDB is working to explore the wind power projects in other parts of the country.

Proposed Areas of Collaboration for Investment in Pakistan

Direct Foreign Investment (DFI): Participation of companies in development of ARE Power Projects through DFI. Government of Pakistan shall provide full facilitation through AEDB.

Financing / Lending for Commercial Wind Power Projects: Banks and financing institutions may finance the commercial projects through debt and equity sharing.

Export Credit: To promote equipment Governments may give export credit to its OEMs.

Capacity Building/Technical Assistance: Support in capacity building and technical assistance of public entities /organizations of Pakistan associated with Renewable energy sector.

Collaboration in Wind Turbine Manufacturing: Collaboration with Pakistani engineering industries for manufacturing/assembling of ARE equipment/components in Pakistan.

Government Recommendations for Private Sector Business Models in Solar Energy Sector Other Than IPP Model

Energy Services Companies for Setting Up Domestic & Commercial Solar Energy Plants

Under this model, the private sector companies are encouraged to provide services to the customers to set up solar energy plants as per following models:

As service provider install equipment, operate it after sale services period (e.g. for one year), train the project team of client and after one year hand over the equipment to client. In this model, the client has to bear the capital and operational costs upfront.

As energy services provider, offer a package deal to the customer for installing equipment operating it for after sale services period at its own cost and get the return of investment in installments.

Involve banks for providing loans to the clients to set up such plants with a pre-condition to use their product. The client then pay backs the price / loan to the bank in installments.

Industrial and commercial sector enterprises use solar energy to meet energy needs

The solar energy can be used to generate heat required for running boilers of the industrial units. Solar systems can also be installed to supplement heat requirements of large industries. The industrialists are promoted to use solar energy to meet their energy demands. This may include using solar energy for water heating, space heating and cooling, steam production for the plant etc. This contributes in improving economics, promote using solar energy instead of fossil fuels to generate heat and electricity, and improve overall economics, reduce the production costs, making heat and electricity available as and when it is required by the entities.

Domestic sector promoted to use solar energy applications to meet their energy needs

The domestic sector is promoted to install captive units for heating and cooling of their houses. Solar water heating systems can be installed to:

Meet water heating requirements of the households

Supplement existing heating systems by pre-heating water

This helps in reducing their fossil fuel consumption and reducing their domestic energy bills.

The domestic sector is also promoted to install solar PV systems at their roof tops for captive as well as for net metering purposes. In captive systems, the domestic sector installs solar PV systems to meet large share of their electricity needs. In net metering, the customers are encouraged to use equipment that helps the system connected to the distribution grid. The electricity generated through installed solar PV systems is used to meet electricity needs and surplus is dispatched to the distribution grid. The consumer is billed for the net of electricity consumed from the grid and dispatched to the grid.

State of Solar Energy in Pakistan

Solar Resource Mapping

The World Bank and Alternative Energy Development Board (AEDB)-Government of Pakistan are implementing a Renewable Energy Resource Mapping activity covering all of Pakistan. The project is funded by World Bank's Energy Sector Management Assistance Program (ESMAP) and focuses on the assessment of wind, solar and biomass resources, including ground-based data collection, GIS analysis, and geospatial planning.

For solar data collection, nine ground-based solar measurement stations have already been installed at following locations. The geographical locations of the sites are distributed all over Pakistan covering different solar and climatic regimes, with several universities:

1. QA Solar Park, Bahawalpur
2. National University of Science and Technology (NUST), Islamabad
3. Kala Shah Kaku (KSK) Campus of UET Lahore, KSK
4. MNS Campus of UET Lahore, Multan
5. University of Engineering and Technology (UET), Peshawar
6. NED University, Karachi
7. Mehran University, Jamshoro
8. Balochistan University of Information Technology (BUITEMS), Quetta
9. Balochistan Univeristy of Engineering and Technology (BUET), Khuzdar

During the two-year measurement campaign, which started in October 2014, high quality measurements of the global horizontal, direct normal irradiance, and diffuse radiation has so far been collected. Each has a different purpose: Global horizontal is useful for solar photovoltaic installations, whilst direct normal irradiance is needed for understanding the potential power output from a concentrated solar power plant. This project component is being led by DLR, the German space agency, and other partners.

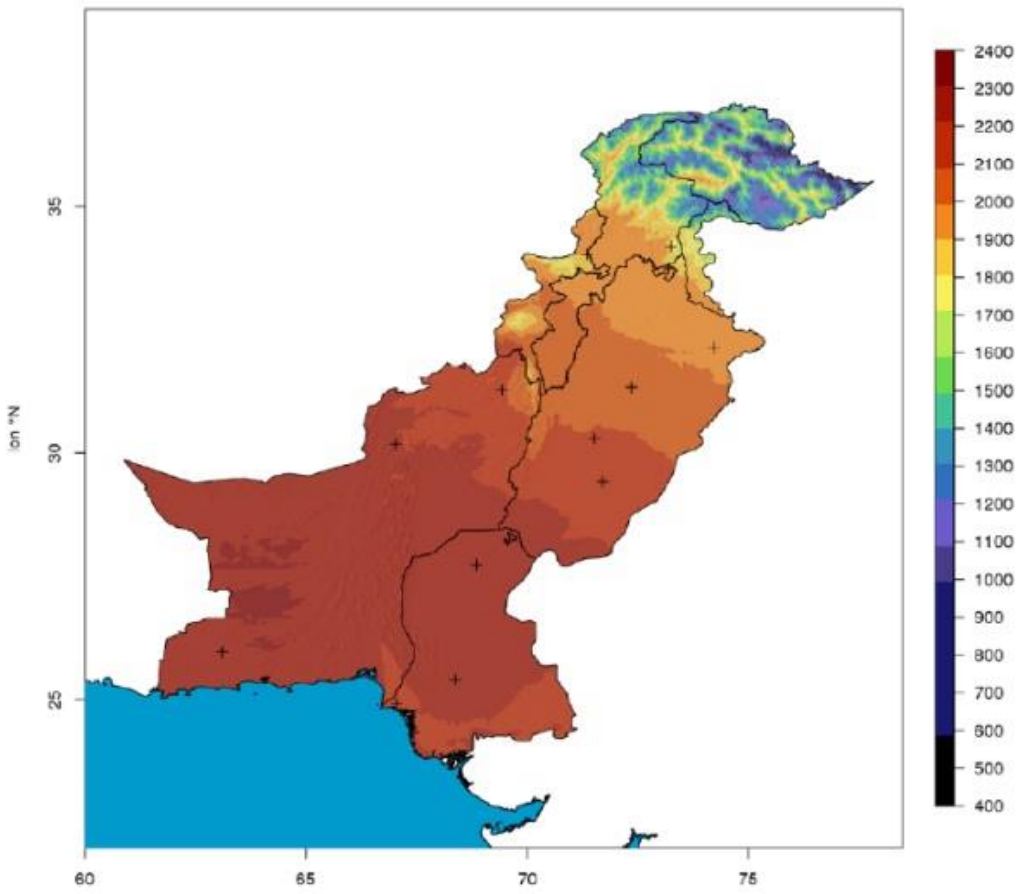


Figure: Multi-year mean (2000-2012) of annual Global Horizontal Irradiance (GHI) for Pakistan in kWh/m²

Once two years of solar measurements are obtained, these will be used this highly accurate data to produce solar atlas for Pakistan. The World Bank will publish the maps, resource database, and ground-based measurement data online, providing a public resource that can be utilized by government and commercial developers. The data will also be shared with the IRENA Global Atlas for Renewable Energy, which collects and shares data from multiple countries and studies.

Pakistan has some of the highest values of radiation in the world with eight to nine hours of sunshine per day, ideal climatic conditions for solar power generation. However, the country has been slow to adopt the technology.

The country has solar plants in Pakistani Kashmir, Punjab, Sindh and Balochistan. Initiatives are under development by the International Renewable Energy Agency, the Japan International Cooperation Agency, Chinese companies, and Pakistani private sector energy companies. The country aims to build the world's largest solar power park, the Quaid-e-Azam Solar Power Park (QASP) in the Cholistan Desert, Punjab with a 1 GW capacity.

Current Status of Solar PV Power Projects in Pakistan

AEDB is pursuing 22 solar PV power projects of cumulative capacity of approximately 890.80 MW

The following Six (06) solar power projects of 430 MW capacity are operational.

	Name of Project	Capacity (MW)	Location	Date of Completion
1	M/s QA Solar Pvt. Ltd.	100	Quaid e Azam Solar Park, Bahawalpur	15-Jul-15
2	M/s Appolo Solar Pakistan Ltd.	100	Quaid-e-Azam Solar Park, Bahawalpur	31-May-16
3	M/s Crest Energy Pakistan Ltd.	100	Quaid-e-Azam Solar Park, Bahawalpur	31-Jul-16
4	M/s Best Green Energy Pakistan Ltd.	100	Quaid-e-Azam Solar Park, Bahawalpur	31-Jul-16
5	Harappa Solar Pvt. Ltd	18	Sahiwal	14-Oct-17
6	*AJ Power Pvt. Ltd.*	*12*	*Pind Dadan Khan*	*13-Dec-17*

Four (04) IPPs with a cumulative capacity of 41.80 MW have obtained Letter of Support (LOS) from AEDB and are in the process of achieving Financial Closing of their projects

Sr. #	Name of Project	Capacity (MW)	Location
1	*M/s Access Electric Pvt. Ltd.*	*10*	*Pind Dadan Khan*
2	M/s Bukhsh Solar (Pvt.) Ltd.	10	Lodhran
3	M/s Safe Solar Power Pvt. Ltd	10.28	Bahawalnagar
4	*M/s Access Solar Pvt. Ltd.*	*11.52*	*Pind Dadan Khan*

Twelve (12) Solar Power projects of 419 MW cumulative capacity have obtained LOI from AEDB and are at different stages of project development.

Sr. #	Name	Capacity (MW)	Location
1	IPS Solar Park- IPS 22 Pvt. Ltd.	50	Nooriabad, Sindh
2	IPS Solar Park- JA 23 Pvt. Ltd.	50	Nooriabad, Sindh
3	IPS Solar Park – SB 24 Pvt. Ltd.	50	Nooriabad, Sindh
4	R.E. Solar I Pvt. Ltd.	20	Dadu, Sindh
5	R.E. Solar II Pvt. Ltd.	20	Dadu, Sindh
6	ET Solar (Pvt.) Ltd.	25	Thatta, Sindh
7	ACT Solar (Pvt.) Ltd.	50	Thatta, Sindh
8	Janpur Energy Limited	12	Sultanabad, Rahim Yar Khan
9	*Lalpir Solar Limited*	*12*	*Mehmood Kot, Muzafar garh*

10	*Siddiq sons Solar Ltd*	*50*	*Kalar Kahar, Chakwal*
11	*ET Solar (Pvt.) Ltd.*	*50*	*Fateh Jang, Attock*
12	Asia Petroleum Limited	30	Bahawalnagar, Punjab

Ongoing Solar Power Projects in Pilot Project Area

Sr. #	Name	Capacity (MW)	Location
1	AJ Power Pvt. Ltd.	12	Pind Dadan Khan, Jhelum
2	M/s Access Electric Pvt. Ltd.	10	Pind Dadan Khan, Jhelum
3	M/s Access Solar Pvt. Ltd.	11.52	Pind Dadan Khan, Jhelum
4	Siddiq Sons Solar Ltd	50	Kalar Kahar, Chakwal

Lithium-Ion batteries

Solar Energy has one huge draw back, it can not be stored and cannot be available at demand peak hours of early morning and early night. Now this drawback can be offset by storage devices like batteries.

The new age of cleaner energy will be led by advanced battery technologies becoming available for much cheaper prices and Lithium-Ion battery or Li-ion battery has been proven the best till date. In 2019, The Nobel Prize in Chemistry was given to John Goodenough, Stanley Whittingham and Akira Yoshino "for the development of Lithium-Ion batteries

Lithium-Ion battery or Li-ion battery is a type of rechargeable battery. Lithium-ion batteries are commonly used for portable electronics and electric vehicles and are growing in popularity for military and aerospace applications. A prototype Li-ion battery was developed by Akira Yoshino in 1985, based on earlier research by John Goodenough, M. Stanley Whittingham, Rachid Yazami and Koichi Mizushima during the 1970s–1980s, and then a commercial Li-ion battery was developed by a Sony and Asahi Kasei team led by Yoshio Nishi in 1991.

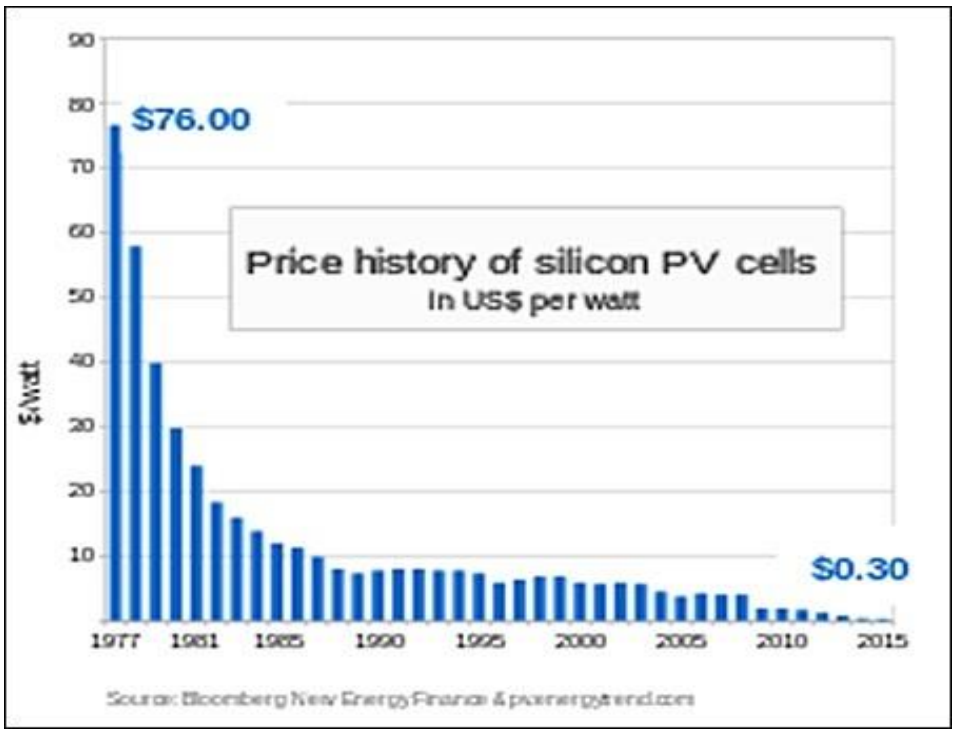
Industry produced about 660 million cylindrical lithium-ion cells in 2012; the 18650 size is by far the most popular for cylindrical cells. If Tesla were to have met its goal of shipping 40,000 Model S electric cars in 2014 and if the 85-kWh battery, which uses 7,104 of these cells, had proved as popular overseas as it was in the United States, a 2014 study projected that the Model S alone would use almost 40 percent of estimated global cylindrical battery production during 2014. As of 2013, production was gradually shifting to higher-capacity 3,000+ mAh cells. Annual flat polymer cell demand was expected to exceed 700 million in 2013.

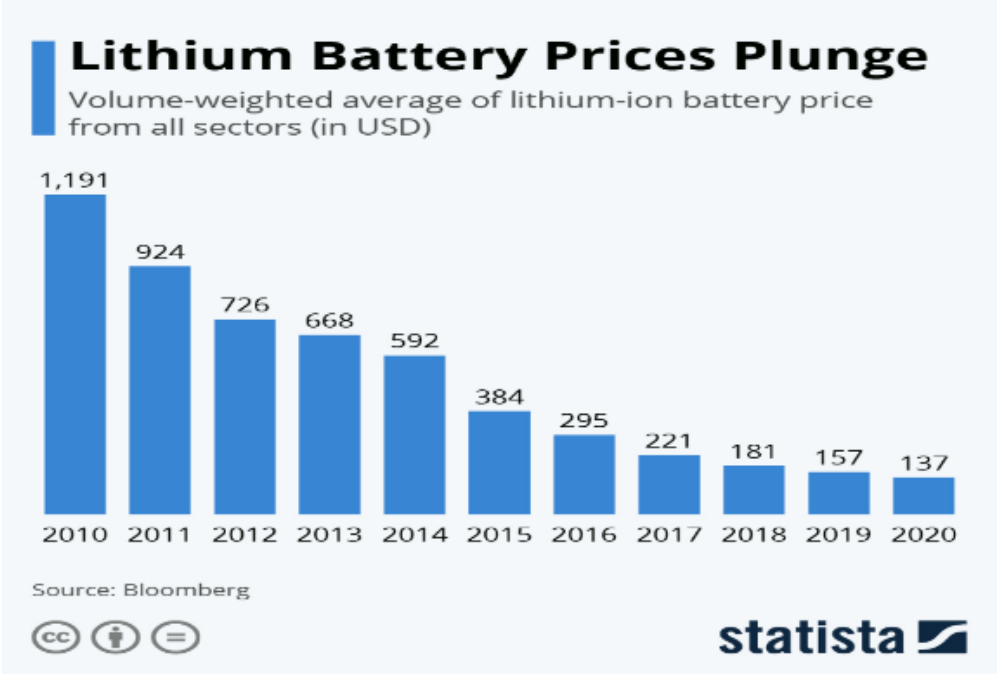
In 2015, cost estimates ranged from $300–500/kWh. In 2016 GM revealed they would be paying US$145/kWh for the batteries in the Chevy Bolt EV. In 2017, the average residential energy storage systems installation cost was expected to drop from 1600 $/kWh in 2015 to 250 $/kWh by 2040 and to see the price with 70% reduction by 2030. In 2019, some electric vehicle battery pack costs were estimated at $150–200,[86] and VW noted it was paying US$100/kWh for its next generation of electric vehicles.

Batteries are used for grid energy storage and ancillary services. For a Li-ion storage coupled with photovoltaics and an anaerobic digestion biogas power plant, Li-ion will generate a higher profit if it is cycled more frequently (hence a higher lifetime electricity output) although the lifetime is reduced due to degradation.

Lithium nickel manganese cobalt oxide (NMC) cells come in several commercial types, specified by the ratio of component metals. NMC 111 (or NMC 333) have equal parts of nickel, manganese and cobalt, whereas NMC 532 has 5 parts nickel, 3 parts manganese and 2 parts cobalt. As of 2019, NMC 532 and NMC 622 were the preferred low-cobalt types for electric vehicles, with NMC 811 and even lower cobalt ratios seeing increasing use, mitigating cobalt dependency. However, cobalt for electric vehicles increased 81% from the first half of 2018 to 7,200 tons in the first half of 2019, for a battery capacity of 46.3 GWh.

In 2010, global lithium-ion battery production capacity was 20 gigawatt-hours. By 2016, it was 28 GWh, with 16.4 GWh in China. Production in 2021 is estimated by various sources to be between 200 and 600 GWh, and predictions for 2023 range from 400 to 1,100 GWh.


$76.00
Price history of silicon PV cells
In US$ per watt
$/watt
$0.30
1977
1981
1985
1990
1995
2000
2005
2010
2015


Lithium Battery Prices Plunge
Volume-weighted average of lithium-ion battery price from all sectors (in USD)
1,191
924
726
668
592
384
295
221
181
157
137
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Source: Bloomberg
statista

State of Wind Energy in Pakistan

Pakistan is blessed with tremendous wind resource. World Bank and AEDB are implementing Renewable Energy Mapping Project. Based on analysis of satellite data for the period 2000-2010 and existing ground data, initial results indicate good wind regime in the country as shown in graph below;

Detailed set of initial results are available on following web link;

http://esmap.org/re_mapping_pakistan

https://databox.worldbank.org/initiative/renewable-resource

During Phase-2 of the RE Mapping Project which is currently under implementation, ground based wind data will be collected. For this purpose, initially 12 sites across the country have been identified for installation of 80-meter-high wind masts. Most of the masts have been installed and on-ground raw wind resource data is being collected.

Once two years of solar and wind measurements are obtained, this highly accurate data will be used to produce solar and wind atlases for Pakistan. The World Bank will publish the maps, resource database, and ground-based measurement data online, providing a public resource that can be utilized by government and commercial developers. The data will also be shared with the IRENA Global Atlas for Renewable Energy, which collects and shares data from multiple countries and studies.

In 2007, USAID in collaboration with Pakistan Meteorological Department (PMD) and AEDB, developed solar and wind atlases of Pakistan. Most of wind projects are located in Gharo-Keti Bandur Wind Corridor within an area of roughly 60 Km x 170 Km.

After completion of World Bank funded Renewable Energy Mapping Project, high resolution (5 Km x5 Km) wind and solar atlases will be available and will not only help in long term planning and development of renewable energy projects but also help in attracting further investment in the country.

Incentive by Government for Wind Power Project Development in Pakistan

Government of Pakistan's "Policy for Development of Renewable Energy for Power Generation" offers the following incentives for setting up Wind IPPs:

Wind Risk (risk of variability of wind speed).

Guaranteed Electricity Purchase.

Grid provision is the responsibility of the purchaser

Protection against political risk.

Attractive Tariff (Cost plus 17% ROE), indexed to inflation & exchange rate variation (Rupee / Dollar).

Euro / Dollar Parity allowed.

Carbon Credits available.

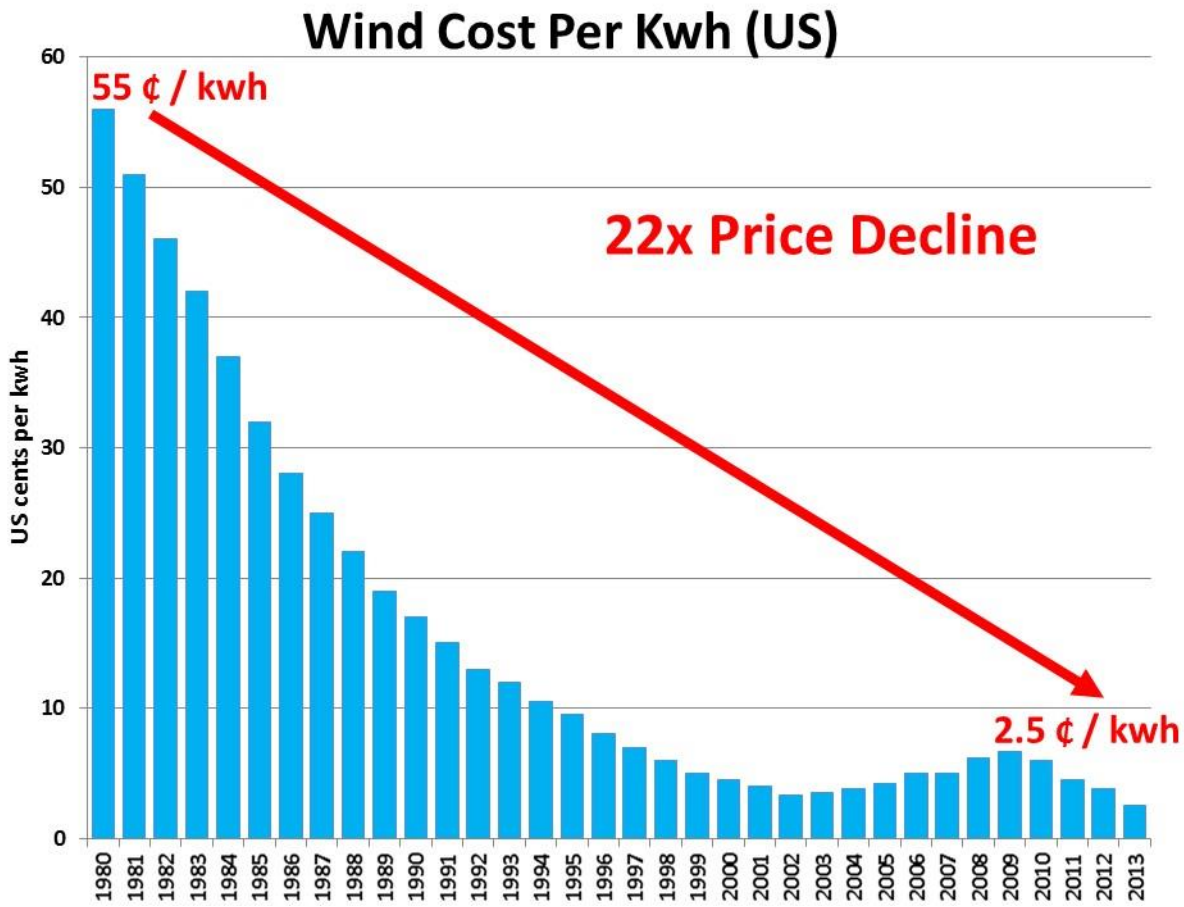
No Import Duties on Equipment.

Exemption on Income Tax / Withholding Tax and Sales Tax.

Repatriation of Equity along with dividends freely allowed.

Permission to issue corporate registered bonds.

NEPRA has announced an upfront tariff of US Cents 13.52 per kWh (levelized) dated April 24, 2013 for Wind Power Projects. Details are available on NEPRA's Website.



Proposed Wind Turbine Technology for This project

We will not go for high mast turbines due several adverse factors. We propose following types of turbines for low wind velocity, low noise, low hazard to birds and low cost.


ICEWIND

Potential of Augmentation with Hydro Power in Pilot Project Area

Solar Energy has one huge draw back, it cannot be stored and cannot be available at demand peak hours of early morning and early night. Now this drawback can be offset by a novel solution that we produce electricity by water. It needs two reservoirs. Solar power will be used only to shift back the water used for hydropower. Our selected area for pilot project is unique in this way.

Pilot Project will be located in valley having size of 30km by 20 km surrounded by hills of Domeli on north and hills of Tilla on south. N5 Sohawa to Dina on East and Hills of Ara on West.

Three 500,000 Volts Hi Tension transmission lines pass through this area. Which will make up linking cost negligible. Lands acquired are within 0 to 2 KM from those lines.

There is potential of construction more than a dozen micro and small dams.

Five (5) Small Dams already exist with potential of storage of water to 4 times. Dams are owned by Irrigation Department of Sub National Government of the Province of Punjab. Pre 18th amendment, height of dams was kept lower as power production was federal subject and provinces were under compulsion to keep the height of dam to 50 ft.

Domeli Dam

Location	Situated at about 3 Km North West of Domeli, Tehsil Sohawa District Jhelum
Completion Date	2008
N.P.L.	1175.00 Ft
Dead Storage Level	1153.00 Ft
Top of Dam	1194.00 Ft
N.S.L.	1084.00 Ft
Top Width	30 Ft
Height of Dam	120.00 Ft
Length of Dam	1100.00 Ft
Live Storage	3735 Aft
Capacity of Channel	30.0 Cfs
Length of Channel	29200 Ft
Command Area (CCA)	3000 Acres
Beneficiaries Villages:	Domeli, Bagwala, Jhang, Chanjlot, Dhok Kalial
Potential	Current Storage capacity can be increased to 4 times. Pre 18th amendment, height of dams was kept lower as power production was federal subject

Gurha Utam Singh Dam

Location	Situated at about 25 Km South West of Domeli village, 75 KM from Jhelum Tehsil Sohawa District Jhelum
Completion Date	2009
N.P.L.	1391.00 Ft
Dead Storage Level	1371.00 Ft
Top of Dam	1406.00 Ft
N.S.L.	1312.00 Ft
Top Width	20 Ft
Height of Dam	94.00 Ft
Length of Dam	500.00 Ft
Capacity of Channel	12.25 Cfs
Length of Channel	30000 Ft
Command Area (CCA)	1500 Acres
Beneficiaries Villages:	Hayal, Gangial, Malia Mohra, Bidder, Dhok Laman, Dhok Shera, Dhok Raja Dewan

Potential	Current Storage capacity can be increased to 4 times. Pre 18th amendment, height of dams was kept lower as power production was federal subject

Fatehpur Dam

Location	Situated at about 34 Km South West of Domeli Town, 84 KM from Jhelum Tehsil Sohawa District Jhelum
Completion Date	2008
N.P.L.	1550.00 Ft
Dead Storage Level	1545.00 Ft
Top of Dam	1561.50 Ft
N.S.L.	1475.00 Ft
Top Width	20 Ft
Height of Dam	86.50 Ft
Length of Dam	375 Ft
Live Storage	441 Aft
Capacity of Channel	3.0 Cfs
Length of Channel	22000 Ft
Command Area (CCA)	315 Acres
Beneficiaries Villages:	Fatehpur, Dhok Mughalabad, Alipur
Potential	Current Storage capacity can be increased to 4 times. Pre 18th amendment, height of dams was kept lower as power production was federal subject

Salhal Dam

Location	Situated at about 40 Km South West of Dina, Tehsil Sohawa District Jhelum
Completion Date	2006
N.P.L.	1020.00 Ft
Dead Storage Level	1118.75 Ft
Top of Dam	1156.00 Ft
N.S.L.	1088.00 Ft
Top Width	18 Ft
Height of Dam	68.00 Ft
Length of Dam	350.00 Ft
Live Storage	417 Aft

Capacity of Channel	4.0 Cfs
Length of Channel	8550 Ft
Command Area (CCA)	372 Acres
Beneficiaries Villages:	Salial, Nagial, Gujar
Potential	Current Storage capacity can be increased to 4 times. Pre 18th amendment, height of dams was kept lower as power production was federal subject

Garat Dam

Location	Situated at about 14 Km West of Dina, Tehsil Dina District Jhelum
Completion Date	1982
N.P.L.	950.0 Ft
Dead Storage Level	922.50 Ft
Top of Dam	960.0 Ft
N.S.L.	894.0 Ft
Top Width	20 Ft
Height of Dam	66 Ft
Length of Dam	360 Ft
Live Storage	1763 Aft
Capacity of Channel	6.0 Cfs
Length of Channel	15600 Ft
Command Area (CCA)	638 Acres
Beneficiaries Villages:	Khojki, Natain, Gagar Khurd, Gagar Kalan, Mota Gharbi.
Potential	Current Storage capacity can be increased to 4 times. Pre 18th amendment, height of dams was kept lower as power production was federal subject

Technology Proposed for Low Velocity, Low Hydraulic Head-Kinetic Water Turbine and Gravitation Vortex Water Turbine

Kinetic Water Turbine

Kinetic energy turbines, also called free-flow turbines, generate electricity from the kinetic energy present in flowing water rather than the potential energy from the head. The systems may operate in rivers, man-made channels, tidal waters, or ocean currents. Kinetic systems utilize the water stream's natural pathway. They do not require the diversion of water through manmade channels, riverbeds, or pipes, although they might have applications in such conduits. Kinetic systems do not require large civil works; however, they can use existing structures such as bridges, tailraces and channels.

The rotor and the stator create in a quiescent state a symmetrical coaxial diffuser. However, this state is unstable and as a consequence of the instability of the flow through the gap between the rotor and the stator it changes to an asymmetrical one. The shape of the rotor and stator can be variable i.e. it might be improved or optimized. In practice the most common rotors are hemispheres, but what really matters is the diffusion angle of the gap between the rotor and the stator.

One tip of the rotor's shaft is fixed, so that the rotor can roll along the inner side of the confuser. When the fluid flows along the rotor, then due to the flow field instability, the fluid starts to rotate and vorticity is generated. The direct consequence of the vorticity generation is the onset of velocity circulation and the force interaction between the fluid and the rotor. This fluid structure interaction results in the rotation of the shaft on which the rotor is placed.

In principle it does not matter if it is hanging or supported. The rotor with the shaft then performs a precession movement and rotates (circulates) around its direct axis. The amount of rotation depends on the ratio between the inner and outer radii. When this ratio is close to one, i.e. when the gap between the cylinder is small, the number of precessions needed for one rotation of the rotor around its axis increases as the width of the gap decreases. The number of precessions can be simply changed by changing the width of the gap. In the case of a conical stator this can be done by changing the vertical position of the rotor.

The first embodiment of rolling turbines used a rotor hanging from the entry part of an outlet nozzle. The diameter of the rotor for example can be just several centimeters or millimeters. Water flow rates can change usually from single liters to hundreds of liters per second.

The advantage of such turbine lies especially in its simplicity, environmental safety and ability to operate in ultra-low sources of water. The turbine design allows easy adjustments as might be required by specific applications.

In practice more complicated shapes of the rotor and stator have been developed but this figure shows the most important feature of the turbine, the diverging non-symmetrical gap crucial for the appearance of volume forces responsible for the rotation.

Eco-friendly Bladeless Hydraulic Turbine harnesses energy of low velocity / low hydraulic head water sources as ocean currents, tidal streams, rivers, canals and other sources of hydrokinetic energy.

Turbine uses vortex phenomenon to generate energy. It can be cost-effectively used either as a standalone self-contained system or within a multi-unit hydro power farm.

Several modifications of turbine have been successfully tested over the years and we now its most advanced versions are available widely.

The KINETIC-Turbine uses a combination of an efficient axial flow propeller and advanced controls to deliver efficient power at economically viable rates.

EASY TO INSTALL

The Kinetic-Turbine uses a set of compact, modular designs to support fast, easy installation with no civil work.

LOW IMPACT

The low-speed design and open blade minimize adverse environmental impact.

COST-EFFECTIVE

The combination of the efficient turbine, advanced controls, and a flexible mooring system create a cost-effective system.

FLOAT SYSTEM

Maintains a safe and efficient water level for the system while submerging during periods of high debris flow.

ROTOR

Curved blades deliver efficiency and improve performance against debris.

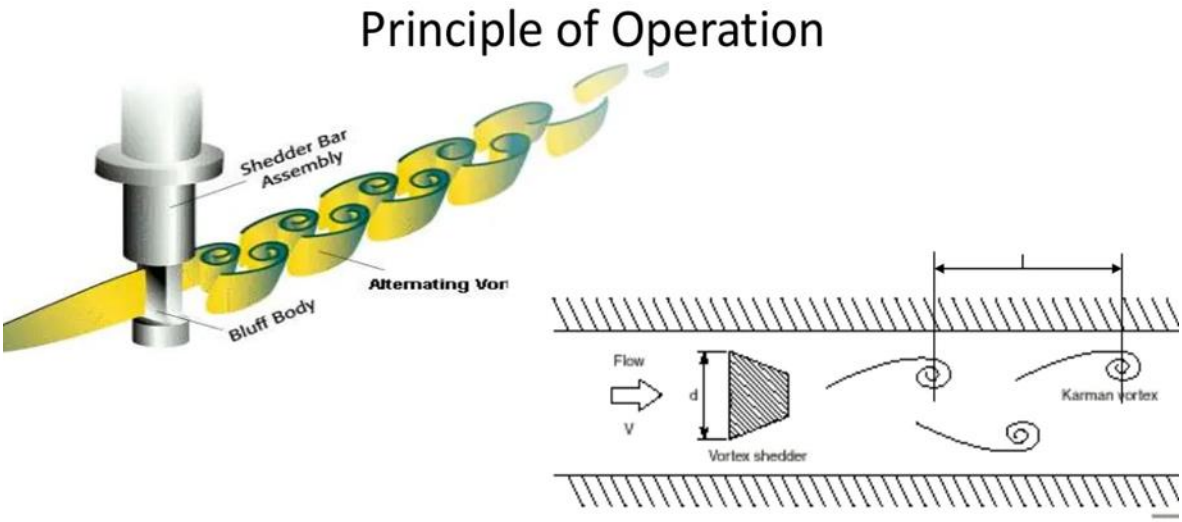
GENERATOR

Submersible permanent magnet generator and rectifier provides grid sync

Cross float Turbine: The cross float turbine captures energy by using the attached flotation rafts to stay on the water surface where deployed. The turbine runner closely resembles that of a crossflow turbine and spins with forces provided by natural flow velocity in the water way. Currently these units come in

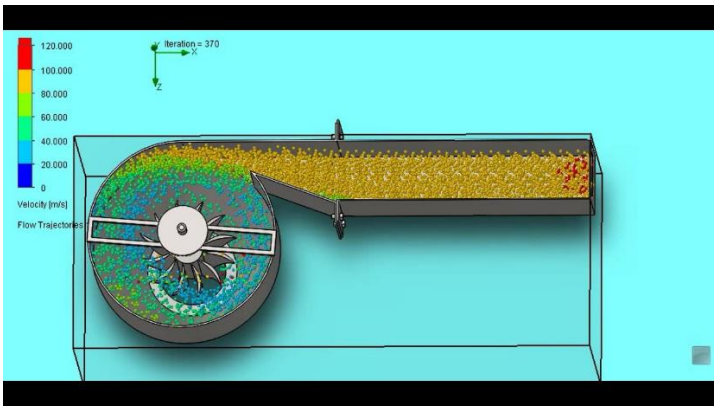
1-kW and 2-kW power sizes with scalable potential topping out at 5 kW per unit. Each unit comes equipped with the Permanent Magnet Generator (PMG) and Variable Frequency Drive (VFD) concept for optimal efficiency.

Vortex Turbine



When a flowing medium strikes a non-streamlined bluff object, it separates, moves around the object and passes downstream. At the point of contact with the object, vortex swirls separate from the body on alternating sides. This separation causes a local increase in pressure and a decrease in velocity on one side and a decrease in pressure and an increase in velocity on the opposite side. The alternating velocities generate alternating pressure forces on either side of the bluff body. The frequency of these pressure changes is proportional to velocity.

Kinetic Turbine



Vortex Turbine