Wind Power as a solution for energy poverty in the Eastern Pamirs

Project Initiation Document (PID)
Project Phases 1 and 2

June 2011

Version 1.0

Contact details:
E: info@etc4ca.com
W: www.etc4ca.com

Contents

Contact details:
E: info@etc4ca.com
W: www.etc4ca.com

1. Introduction

This document sets out the project definition for providing a wind power pilot as demonstration of a potential solution to energy poverty in the Eastern Pamirs region of Tajikistan. This pilot constitutes Phases 1 and 2 of a potential and strategic long-term programme for the installation of wind power as a sustainable source of energy to address the needs of the communities of this region.

This document builds on the following previously published documents:

- "Report on the Opportunities for Renewable Energy Provision for Communities in the Pamir Mountains" – published by etc4CA, October 2010
- "Outline Proposal for Wind Power as a solution for energy poverty in the Eastern Pamirs" – published by etc4CA, December 2010

This document is intended as a 'live' document for the duration of Project Phases 1 and 2.

2. Project Executive Summary

The initial phases of this project require an investment of $30,000 to evaluate the potential of wind power to meet energy poverty issues in the community villages of the Eastern Pamir. There is a clear and urgent issue of energy poverty in these communities and existing energy supplies are becoming cost and environmentally prohibitive. At a micro-level, the pilot phases of this project will provide communities with a ~2kW supply of electricity to power small appliances and provide lighting and heating. At the macro-level, this project has a compelling case for evaluating wind as a renewable energy solution and the project has the potential to become a landmark initiative for remote mountainous regions in the world. Service and maintenance of these assets will provide ongoing local enterprise – a much needed source of employment in the region.

By the end of Phase 2, in Spring 2013, there will be sufficient detailed information to validate wind power as an effective solution to energy poverty in the region. A detailed business case and plan will then be produced to justify, or not, the commencement of Phase 3 for the implementation of a community-wide electricity generating solution.

Contact details:
E: info@etc4ca.com
W: www.etc4ca.com

3. Project Overview

Energy is a critical world issue today and is at the forefront of the global agenda. It is central to the issues of development, global security, environmental protection and achieving the Millennium Development Goals (MDG). Eliminating energy poverty is of paramount importance in eradicating poverty. A third of humanity has no access to modern energy services and half of humanity has to rely on traditional biomass (such as teresken – an over-cropped shrub in the Eastern Pamirs) for meeting their basic needs. Furthermore, the vast potential for energy efficiency improvements across the energy supply and delivery chain remains largely untapped.

As a consequence to the above, the United Nations system and its Member States are called to commit themselves to two complementary goals[1]:

- Ensure universal access to modern energy services by 2030.
- Reduce global energy intensity by 40% by 2030.

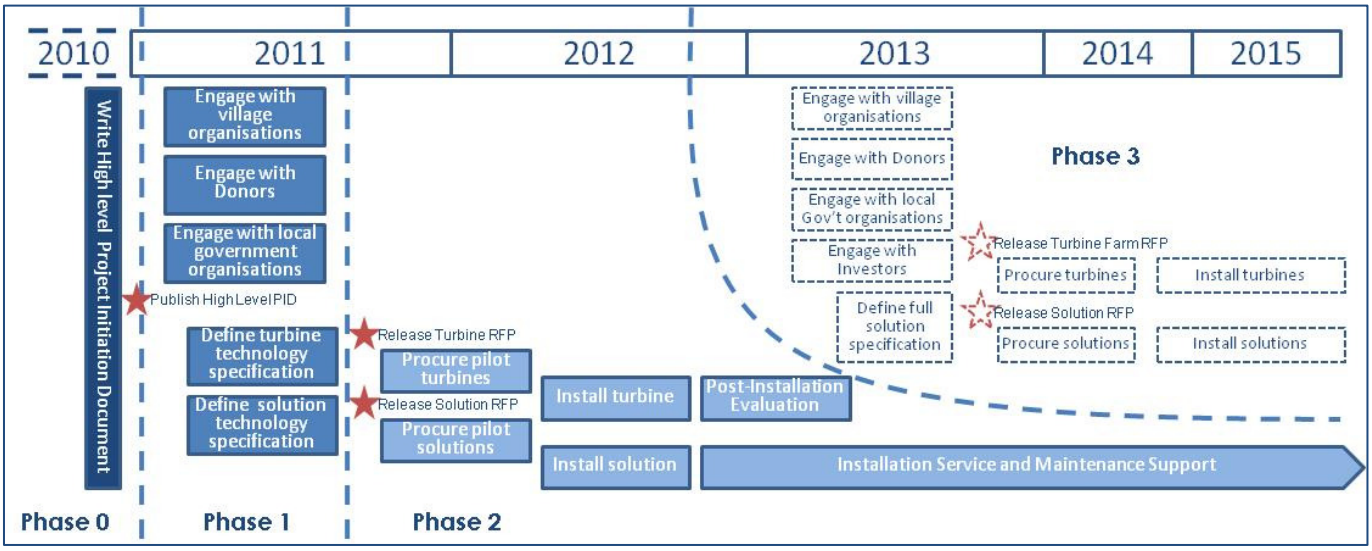
A recent reconnaissance of the Eastern Pamirs[2] has revealed:

- Energy poverty exists in these communities at all times of the year, but particularly during the winter months;
- A latent, although not empirically proven, capacity for wind energy over the majority of the year and, particularly, during the winter months;
- Apparent success to date of the recent wind energy generation trial performed in the village of Alichur, Eastern Pamirs (a project supported by the Mountain Societies Development Support Programme - MSDSP) – see Appendix A;
- A history of wind energy being successfully utilised in the region, even with the old technologies; and
- Limited applicability for hydro-electric or solar solutions during the critical winter months due to below -40C winter temperatures.

All of the above points to wind power as the right alternative energy solution for the Eastern Pamirs. However there is still the need for further investigation of wind energy potential and this pilot project is intended to demonstrate its viability. This pilot will constitute Project Phases 1 and 2 as defined in the diagram following.

[1] Source: The UN Secretary-General's Advisory Group on Energy and Climate Change (AGECC), Summary Report and Recommendations - 28 April 2010

[2] Source: 'Report on the Opportunities for Renewable Energy Provision for Communities in the Pamir Mountains' – etc4CA, October 2010



The following critical success factors[3] need to be validated in the pilot prior to proceeding into a full implementation:

- Donor financing;
- Community co-investment;
- Project expertise;
- Financial sustainability; and
- Support from local government organisations.

Furthermore, there are a number of unanswered questions from the reconnaissance that a pilot implementation will resolve prior to Project Phase 3:

- Necessary Wind Power technology required to meet the harsh climatic conditions (-40°C in the winter to +30°C in the summer);
- Maintenance and support mechanisms, requirements and costs; and
- Reliability of the wind conditions in the villages of the Eastern Pamirs.

[3] Source: 'Best practice model in Central Asia, sustainable energy model for rural communities' – Bank Information Center, April 2010

4. Project Phase 1 & 2 Objectives

- Installation, in summer 2012, of a 2kW wind turbine in each of four villages in the Eastern Pamir;
- To pilot potential solutions for use of 'dump' electricity (i.e. when batteries are fully charged);
- To evaluate the post-implementation performance of the technologies during summer 2013;
- To identify all the critical success factors for the successful implementation of wind energy installations for remote rural regions;
- To clarify a business case and operating model for a full-scale solution (see Phase 3) of wind energy generation for whole communities in the Eastern Pamirs; and
- To identify the through-life support mechanisms and costs for a full-scale solution.

5. Project Phases 1 and 2 Scope

5.1. In Scope

The scope of the project includes the following items:

- Identification of specific sites in the Eastern Pamirs for pilot wind turbine installations;
- Liaison with communities and local government authorities affected by this project;
- Procurement and installation of wind turbine equipment of ~2kW rated power (3.2kW max output) in a maximum of four locations;
- Set up and support of ongoing maintenance/repair regime for installations including a stock holding of essential parts;
- Fund raising for all of the above from local communities/donor agencies;
- Provision of technical specialist resources to support the installation and the training of local maintenance team;
- Investigation into potential utilisation of 'dump' electrical energy from wind turbines (including the potential for sandali and/or bread ovens powered by electricity); and
- The following locations:

- Murghab (alt: 3627m) 38°10'12.83"N; 73°58'20.85"E. This town is the regional centre and, consequently has the highest population and demand for electricity.
- Karakul (alt: 3928m) 39°00'50.18"N; 73°33'27.91"E. This town has the most severe weather conditions of any of the towns in the region.
- Rangkul (alt: 3812m) 38°29'04.23"N; 74°22'48.99"E. The breadth of the Rangkul valley will provide for good wind conditions without turbulence from any direction.
- Tokhtamish (alt: 3804m) 37°49'49.98"N; 74°38'56.79"E. A trial presence here demonstrates that this project will reach remote communities and support the traditional nomadic herders.

5.2. Out of scope

The scope of the project excludes the following items:

- Provision of full wind energy generation solution to meet whole community needs (to be addressed in prospective Phase 3);
- Other renewable energy solutions (including biogas, biomass, solar, hydro);
- Locations other than those defined in scope; and
- Improvements to heat insulation of the buildings involved.

5.3. Deliverables to be produced

- Project Initiation Document (PID) – Phase 1.
- Specification documents – Phase 1.
- Stakeholder Alignment document – Phase 1.
- Turbine Request For Procurement (RFP) – Phase 1.
- Solution RFP – Phase 1.
- Procurement of turbines (turbine equipment) – Phase 2.
- Procurement of solutions (installation equipment including building materials, guys, cabling, batteries, sandal/bread oven) – Phase 2.
- Installation of turbines and solutions – Phase 2.
- Post Implementation Review (PIR) – Phase 2.

5.4. Organisations affected

The impact of this project on other organisations or elements of the partner organisations needs to be determined to ensure that the right people and functional areas are involved and communication is directed appropriately.

ORGANISATION	How are they affected, or how are they participating?
Mountain Societies Development Support Programme (MSDSP)	To provide local project management support, transportation, equipment storage and liaison for involved parties using their local knowledge and experience.
Agency for Technical Cooperation and Development (ACTED)	To provide translation and project accounting services for funds and payments and internet facilities in Murghab.
etc4CA	etc4CA will act as key resource to address project activities and provide coordination and consulting support for those organisations involved.
Tajik local and national Government (including Ministry of Industry and Energy)	To be made aware of the project and its progress in relation to potential future projects in other areas of Tajikistan. Projects should also be considered in the context of Tajikistan's strategic renewable energy programme.
Technical Wind Specialist (Peter Flower & Pamir Wind forum)	Resourced by etc4CA, this specialist support will provide the technical input into decisions, particularly relating to the turbine site, selection, procurement and installation.
Donor Agency (to be determined)	To be engaged as a critical stakeholder of the project and kept updated regarding progress in terms of time, quality, and budget.
Murghab EcoTourism Association (META)	To provide accommodation services for the installation team members whilst in the Eastern Pamirs.
University of Central Asia (UCA)	To identify potential candidates for ongoing service and maintenance roles.
Village Organisations (client).	To be engaged in project to establish ongoing community co-investment and ensure client needs are met.

6. Project Team/Resources

6.1. Team

The project team is compact and reflects the early and preparatory work already undertaken. However the resources deployed are considered to be the minimum needed to achieve the deliverables within the timeframe defined.

Project team: -

Phase 0	Phase 1	Phase 2	Phase 3
Project Manager (Part-time) (MSDSP)		**Resources to be defined**	
Project Accounting (Part-time) (ACTED)			
Project Consultants (Part-time) (etc4CA)			
Technical Consultant (Part-time) (etc4CA)			
Quality Assurance (Part-time) (Chinese resource)			
Technical consultant (Part-time) (Tajik resource)			
Service support engineer (Part time) (Local community resource)			
Stakeholders (Part time) (Village Organisations; local government; Donors; Investors)			

The name of individual stakeholders is to be defined during Phase 1.

6.2. Estimated Costs

The average price for large, modern wind farms is currently around $1000 per kilowatt of electrical power installed. However, rough calculation for the pilot small installations is currently estimated[4] at $6,000 per installation.

It is assumed that all local government support will be provided free of charge. Total indicative estimate for Project (Phase 1 and 2) x4 installations and x1 service parts is $30,000 (see Appendix B for breakdown of indicative estimates).

It is recommended that each community provides $1000 (i.e. 20% of each site cost) towards their solution procurement and installation. There will also be an ongoing annual service and maintenance charge to the communities (yet to be defined).

[4] Source: 'Micro Wind Generation – A Case Study from Kyrgyzstan' – published by etc4CA in August 2010

6.3. Project Plan and Key Milestones

A detailed project plan has been developed in Microsoft Project, including key milestones. The plan has also been resource profiled.

7. High Level Project Assumptions

To identify and estimate the required tasks and timing for the project, certain assumptions need to be made. Based on current knowledge, the project assumptions are detailed below. If assumptions are invalidated at a later stage, then the activities and estimates within the project plan will be adjusted accordingly.

Assumptions
All participating organisations provide resources/inputs, as defined, in a timely manner and to the required quality/value.
The Alichur turbines continue to work successfully and there are no major issues revealed regarding their installation or ongoing operations.
Chinese turbine manufacturers can be identified and they can reliably provide quality defined to indicative costs within the budget, turbine specifications and RFP requirements.
Turbines can be transported from China overland via Kulma pass and directly to Murghab without excessive delivery costs.
All solution materials (cement, guidelines, cabling, etc) can be sourced locally.
etc4CA and MSDSP project management, transport, accommodation and planning activities are excluded from the above costs.

8. High Level Project Risks.

Project risks are characteristics, circumstances, or features of the project environment that may have an adverse effect on the project or the quality of its outcomes and outputs. Known project risks have been identified below. A plan will be put into place to minimize or eliminate the impact of each risk to the project plan.

Risk Area	Level H/M/L	Mitigation Plan
The funding from donor/investor agencies is not forthcoming.	Medium	etc4CA, ACTED and MSDSP have agreed a list of potential sources to secure funding. All sources to be exhaustively investigated.
Insufficient resources in terms of project officers.	Medium	Monthly update meetings and regular email communication between organisations involved in activities.
Piloting indicates that the strategic project (i.e. phase 3) will not deliver benefits	Low	
External resource becomes too busy to adequately support project	Medium	Ensure some contingency exists within project team to cover this.
Project timeline slips behind schedule	High	etc4CA to track and adjust project plan based on feedback.
Safety of installation team and electricity users	Medium	A full safety compliance document will be produced and strict safety procedures will trained-in and maintained throughout installation and use.

9. Project Reporting and Communications.

The project will provide updates on progress to the organisations and stakeholders involved at intervals as defined in the project plan. Regular public communications regarding project progress will also be published through MSDSP, ACTED and etc4CA.

Appendix A – Alichur Implementation

In December 2009 2 x 300W wind turbines were installed in Alichur town, Murghab Region as part of the MSDSP Pamir Allied Land Management (PALM) project together with the local village organisation. This project was funded 80% by MSDSP and 20% by the Village Organisation at a cost of approximately $3-4,000 per installation.

Alichur is located on the Pamir Highway, 4 hours / 207 km by road from Khorog and 2 hours / 104 km from Murghab at an altitude of 3863m. It has a population of approximately 1500 people (150 families). It is on the broad plateau between the northern (highest peak 5880m) and southern Alichur mountain ranges (highest peak 5500m) which both run east to west.

Alichur does not have a local grid and is hundred/s of km from the nearest network grid (Khorog/Murghab). There is no water suitable for a hydro electric installation. There are some solar panels placed on the rooves of houses. Petrol generators are the only other possible source of electricity and the cost of petrol is high and rising (US$1.5 per litre).

The installation was carried out by the villagers themselves over the course of 2 days. One of the turbines is located by the school building and provides electricity to power the headmaster's computer for a few hours a day. The mast is supported by 4 guy ropes attached to footings (bent at an angle at the base) which are sunk in 50-80cm of concrete. The second turbine is located next to some houses to support some of the poorest people in the village.

The head of the Village Organisation explained that there is most wind from March-May and September – November and less in the mid summer and mid winter. The wind mostly comes from the South around to the North West.

The wind turbines continue to work and generate electricity and there have been no breakdowns or need for replacement parts over the past 18 months.

There was enormous pride from those we met at the school and members of the VO in having the turbines and ownership was clearly very high which would ensure continued operation / maintenance of the turbines.

Four issues were identified:

- The wind turbine is located too close to the school building, approximately halving the potential power that could be generated. The current location was chosen so that only a short cable was needed and avoiding any interference with the area the children played in, so minimising the risk of damage. If the turbine is located further from the school, wind turbulence would be minimised and performance improved. Locating the turbine on the roof was considered, however, such installations are not recommended as they tend to create instability in the roof structure.

- The VO in Alichur is concerned that the mast moves at high wind speed. This can be resolved by additional guy ropes. They also asked about a tower mast, which would

improve stability. However, this would also slow the turbine as the blades go through the wind shadow of the mast - this solution is not recommended.

- A 300W turbine was considered underpowered for their needs as it could only power one computer and not the printer at the same time. There are three other computers in the school which they still have to power by diesel generator.
- The turbine has no dump loading facility and switches itself off when the batteries are fully charged. As a result a considerable amount of available generating potential is lost. Extra batteries were considered too expensive. A heating element (Sandali?) dump load may be a future option.

Turbine installation at Alichur school.

Contact details:
E: info@etc4ca.com
W: www.etc4ca.com

Appendix B – Indicative estimates

Indicative estimates have been derived from those actual costs incurred in a similar 2Kw installation in Kyrgyzstan in 2010 (Source: 'Micro Wind Generation – A Case Study from Kyrgyzstan' – published by etc4CA in August 2010). This actual installation was in a similarly remote mountainous region but was for only one turbine from Anhui Hummer Dynamo Co. Ltd. It is expected that there will be economies of scale for the purchase of five equivalent units.

Item	Cost Estimate ($ equivalent)
5 Turbines (Each 2kW – Chinese manufacturer) including: Generator; Inverter; Rotor blades; Tower; Pedestal. Delivery included.	15,500
Building materials & miscellaneous items	800
Steel, bolts & fencing	500
Guys, shackles and anchors	500
Batteries and clamps	7,300
Cabling	500
Sandali / Oven pilot 'dump' facility	3,000
Labour for installation	400
Team transport & accommodation	1,500
Total	$30,000

etc4CA, ACTED and MSDSP project management and planning activities are excluded from the above cost estimates.

Contact details:
E: info@etc4ca.com
W: www.etc4ca.com

Appendix C – Village Reports

During Spring 2011, etc4CA visited each of the prospective villages identified for pilot installations. These visits were coordinated through MSDSP and ACTED who provided transportation to/from the villages and introductions to the village leaders and the Village Organisations (VOs). To provide additional professional competency to our visiting team, etc4CA had also recruited a wind turbine specialist with extensive experience of implementations in remote rural regions. Peter Flower's professional profile is outlined below.

Experience

Currently employed by **Dong Energy**, one of Europe's leading wind power generators.

Previously employed by:

- **Vestas** - the largest wind turbine manufacturer in the world, as team manager for blade composite design, Vestas Blades R&D, Denmark.
- **Vergnet** in construction of wind farms, including manufacturing facility in Mekele, Ethiopia.
- **Relief Aid Worker** on developing a Renewable Wind/Solar solution for rural communities of developing countries, including Haiti .
- **8.2 Consulting AG** performing due diligence and feasibility studies for international wind energy projects, including site assessment, turbine analysis and selection.

Education & Qualifications:

MSc Wind Energy Risoe/ DTU Denmark
BSc Mech./Elec. Systems Engineering
HND Mech Eng

Technical skills & Competencies:

Wind energy engineering: WAsP · HAWC2 · GIS mapping, Composite Blade manufacturing, loads and measurements.

Mech. eng: Matlab · Ansys

Elec. eng: Power Factory · LabView

NASA data for 10 year average wind speeds has also been sourced for the village locations and this data can be seen to correlate with local anecdotal evidence.

The meetings were all semi-formal and utilised Participatory Rural Appraisal (PRT) techniques to stimulate discussion and consensus and overcome any individual perceptions or bias. Three main questions were presented to the meeting attendees:

- Indicate the strength and direction of the wind in your village, by month
- Indicate the preferred locations for the pilot installation in the village. Options included:
  - Hospital
  - Government building
  - Community Centre
  - Poor People's house
  - School
  - Other?

Contact details:
E: info@etc4ca.com
W: www.etc4ca.com

- Indicate the preferred usage of the electricity from the pilot installation in the village. Options included:
    - Television
    - Computer
    - Mobile phone charging
    - Lighting
    - Refrigerator
    - Other?

Cards and tooth picks were used for the exercise with the cards being written in Russian and the items were also pictorially represented on the cards to overcome any literacy issues. ACTED and MSDSP translators were present throughout the meetings.

Cost of the installations was discussed with each of the VOs. The VOs collect and hold funds for community development initiatives that they have deemed a priority. It is recognised that best practice implementations of this kind require a financial commitment from the community involved, to ensure that the value of the asset is recognised. At Alichur, 20% of the actual cost was contributed by the VO and it had been previously agreed that a similar % contribution should be sought from the VOs involved with these installations (approximately $1000). During discussions, each VO confirmed their willingness to contribute such a value – particularly as they would have ~12 months to collect funds from the communities before the implementation.

At the end of the meeting, installation site surveys were performed, identifying preferred installation sites in light of the information obtained from the meeting. In all of the villages, ideal installation sites were identified.

Along with the village participants, the following individuals' contributions are gratefully acknowledged: Peter Flower (etc4CA wind turbine specialist); Suhrob (MSDSP – Murghab coordinator); Jamilla (ACTED); Suyuntbek Tadjidinov (ACTED); Januzak Turdukul (META); Miralesho Mamadshoev (MSDSP engineer); Murzabai Jambasov (Governor of Murghab District); Altenbek Mamadiev (META); Ubaidulla Mamadiev (META).

Toktamish – Thursday 5th May 2011

(alt: 3804m; pop: ~2000 [200 families]) 37°49'49.98"N; 74°38'56.79"E

Monthly Averaged Wind Speed At 10 m Above The Surface Of The Earth For Terrain Similar To Airports (m/s)

Lat 37 Lon 74	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
10-year Average	6.87	6.51	6.22	5.50	5.09	4.97	5.23	5.26	5.48	6.16	6.60	6.82	5.89

Meeting held with Guniev Rusbek (Chief of VO, Director of school, Deputy of Toktamish village) along with four other villagers.

PRA Findings:

Month	Strength
January	1
February	3
March	4
April	3
May	2
June	2
July	1
August	3
September	3
October	4
November	2
December	2

Wind direction: Westerly to South-Westerly

Preferred usage locations:
1/ School
2/ Community Centre
3/ School camp

Preferred electrical usage:
1/ Lighting
2/ Computer
3/ Television

Contact details:
E: info@etc4ca.com
W: www.etc4ca.com

Rangkul – Friday 6th May 2011

(alt: 3812m; pop ~1170 [200 families]) 38°29'04.23"N; 74°22'48.99"E

Monthly Averaged Wind Speed At 10 m Above The Surface Of The Earth For Terrain Similar To Airports (m/s)

Lat 38 Lon 74	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
10-year Average	7.07	6.57	6.21	5.47	5.05	4.80	4.91	4.95	5.22	6.08	6.84	7.04	5.84

Meeting held with Kurbonbiy (Chief of VO), Kenish (Manager of VO) along with six other villagers.

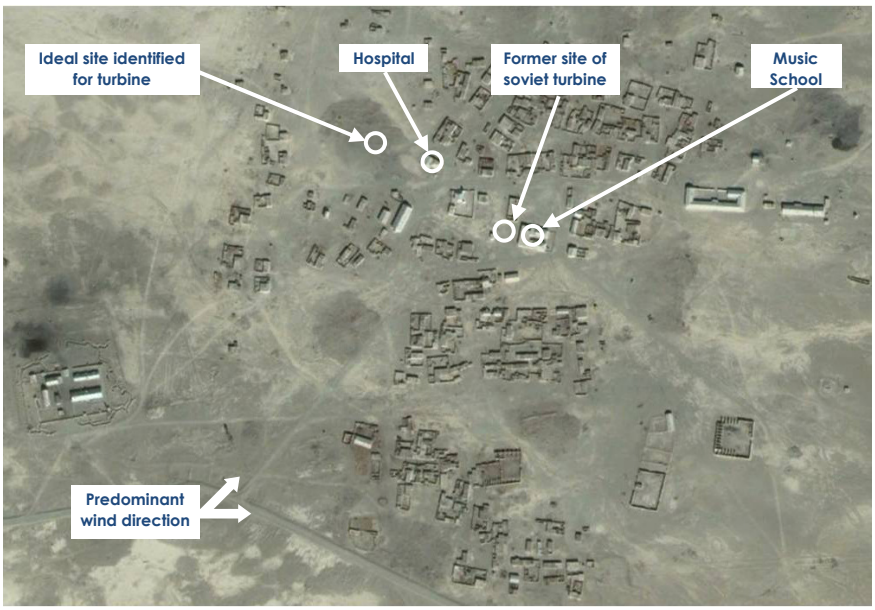
PRA Findings:

Month	Strength
January	1
February	2
March	2
April	2
May	2
June	1
July	0
August	0
September	1
October	2
November	2
December	1

Wind direction: Westerly to South-Westerly

Preferred usage locations:
1/ Community Centre (music school)
2/ Club (next to music school)

Preferred electrical usage:
1/ Lighting
2/ Computer
3/ Musical instruments (including amplifier and keyboard)



Contact details:
E: info@etc4ca.com
W: www.etc4ca.com

Karakul - Tuesday 10th May 2011

(alt: 3928m; pop: 786 [100 families]) 39°00'50.18"N; 73°33'27.91"E

Monthly Averaged Wind Speed At 10 m Above The Surface Of The Earth For Terrain Similar To Airports (m/s)

Lat 39 Lon 73	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
10-year Average	4.71	4.51	4.50	4.16	4.04	3.85	3.82	3.78	3.93	4.28	4.65	4.61	4.23

Meeting held with Mubajad Abdilbaieva (Chief of village), Abdibait Adilbekov (Manager of VO) along with five other villagers.

PRA Findings:

Month	Strength	Direction
January	4	WNW – WSW
February	4	WNW – WSW
March	3	WSW
April	3	WSW
May	2	WSW
June	2	WSW
July	0	-
August	0	-
September	2	WNW
October	3	WNW
November	3	WNW – WSW
December	4	WNW – WSW

Preferred usage locations:
1/ Hospital
2/ Government Building
3/ Mosque

Preferred electrical usage:
1/ Lighting
2/ Computer
3/ Television

At night, the wind direction changes to easterly ('from China').

Contact details:
E: info@etc4ca.com
W: www.etc4ca.com

Murghab – Thursday 5th & Friday 6th May 2011

(alt: 3627m; pop: 5000 [500 families]) 38°10'12.83"N; 73°58'20.85"E

Monthly Averaged Wind Speed At 10 m Above The Surface Of The Earth For Terrain Similar To Airports (m/s)

Lat 38 Lon 73	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
10-year Average	6.27	5.92	5.83	5.16	4.76	4.38	4.54	4.59	4.76	5.43	5.96	6.15	5.31

Meetings held with Murzabai Jambasov (Governor of Murghab District) and Suyuntbek Tadjidinov (ACTED, Murghab representative).

Murghab is much larger than the other three villages and it has substantial local and regional governmental structures. The town has grown around the main public buildings and most are a long way from any good locations for the 2kW turbine installation. The exception is Murghab House – a purpose built resource centre for social, economic and environmental development – situated at the most easterly end of the town. Murghab House serves the local communities in demonstrating new technologies (e.g. solar, internet) and it is an ideal location for the Murghab pilot wind turbine as it is fully exposed to the predominant winds in the valley.

Murghab also does have an existing renewable energy source. The hydro power plant on the south side of the valley operated by Pamir Energy is approximately 60 years old. The plant is extremely unreliable and unable to meet the needs of the town, particularly in winter when the water from the river freezes. A new project is envisaged to completely rebuild the hydro plant and an international consultant is about to commence a feasibility study to be completed by the end of 2011. Piloting wind energy in Murghab is still recommended as it will retain this option and potentially complement any hydro solution that may be found.

Meetings with Murzabai and Suyuntbek confirmed the desire for Murghab to proceed with an installation of a 2kW pilot turbine.

The westerly end of Murghab town is protected from the main force of the wind by a southerly spur from the mountain range to the north. At the eastern end of the town, wind direction was predominantly SW – W at the Murghab House location (note that Murghab House is elevated on a rise approximately 40m above the river flood plain). Wind measurements are now being conducted daily at Murghab House and a wind monitoring station (MetMast) has also been installed near the valley floor at the eastern end of town. Thanks go to Peter Flower for his donation of this equipment and Januzak Turdukul for the use of his roof!
(Both pictured).

Contact details:
E: info@etc4ca.com
W: www.etc4ca.com

PRA Findings:

Month	Strength
January	4
February	4
March	3
April	2
May	1
June	0
July	0
August	1
September	2
October	3
November	3
December	3

Wind direction: Westerly to South Westerly

Preferred usage locations:
1/ Hospital (not considered viable)
2/ Murghab House

Preferred electrical usage:
1/ Computers
2/ Lighting
3/ Heating

Contact details:
E: info@etc4ca.com
W: www.etc4ca.com