ADB ENERGY FOR ALL WORKSHOP

BEIJING, MAR.12, 2010

Proposal for Distributed Small Wind Turbines System Deployed in Poor Rural Area of China

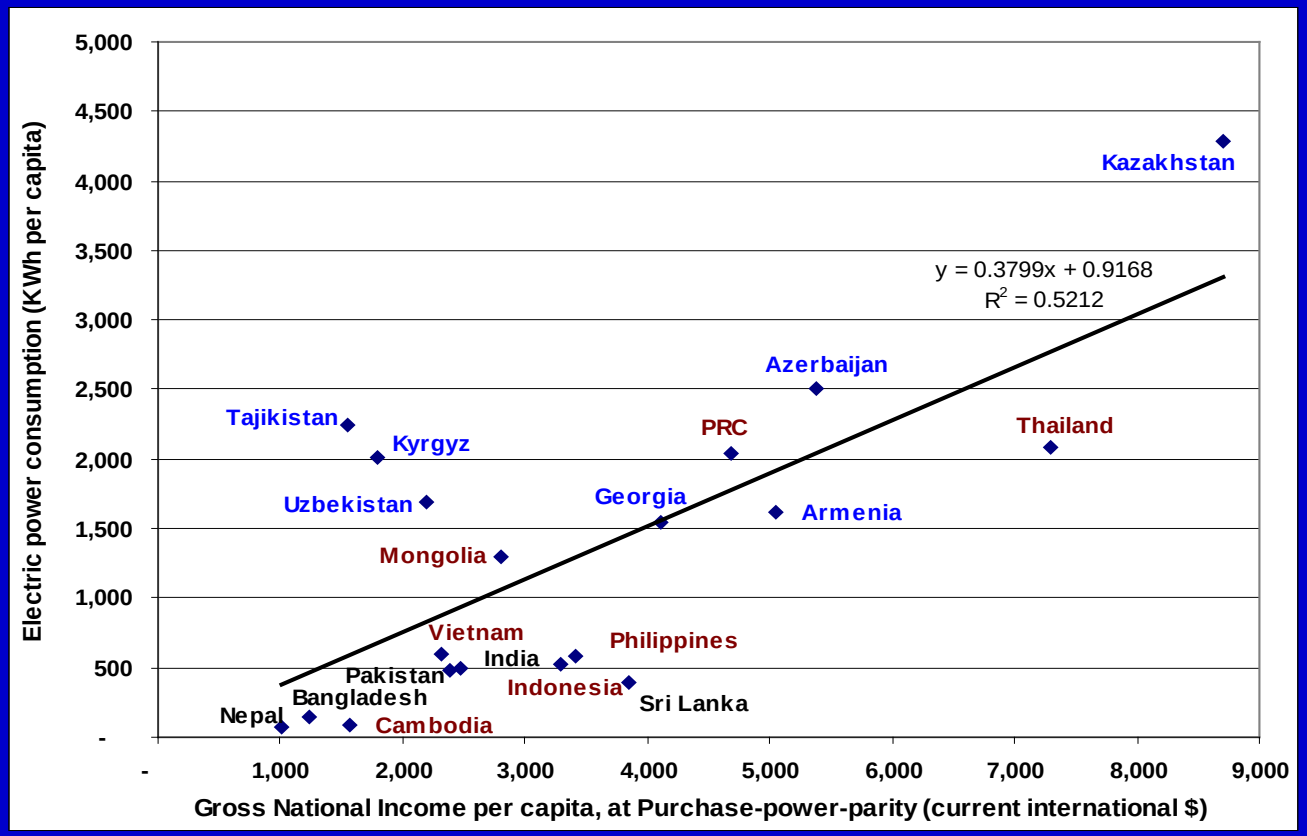
Haofeng Fei

Contents

- Electricity Demand of Poor Rural Area
- Available Solution: SWT System
- Cost Estimate
- Financial Feasibility
- Risk Management

Electricity Demand (1)

Income and Electricity Consumption per capita in Selected Asia Pacific Developing Countries: 2006



Source: World Bank, 2009, World Development Indicators

Electricity Demand (2)

Electricity Demand Estimate

Village Status			Electricity Consumption		Bill Payable			
Population	Family	Per Capita Income US$/y	Nominal Per Capita KWh	Whole Village MWh	Per Capita US$/y	As % of Net Income Per Capita	Whole Village US$/y	Nominal Tariff US$/KWh
500	100	365	200	100	22	6.03%	11,000	0. 11

Note: 1. Per Capita Income lower than 1 dollar per day is the poor line defined by UN.

2. Assume average a family has 5 members.

3. Because of intermittence of wind and cost limitation of energy storage, per capita 200 KWh/y electricity consumption is the target, the real number is setted as about 70% of this target.

4. Althrouth the real electricity consumption per capita may not reach to 200 KWh, the bill payable per capita is fixed as 22 dollars per year.

Electricity Demand (3)

Electricity Distribution Assumption

Electric Appliances	Rated Power	Loading Time	Electric Appliance per Family	Electric Appliance for Whole Village	Electricity Consumption per Day for Whole Village	Percentage
	W	Hours/d			KWh/d	
Lighting	20	5	3	300	30	15. 5%
TV	100	4	1	100	40	20. 66%
Electric Fan	50	3	2	200	30	15. 5%
Refrigerator	150	8	0.5	50	60	30. 99%
Washer	120	1	0.8	80	9.6	4. 96%
Bump	5,000	2	-	2	20	10. 33%
Flour Mill Machine, etc.	4,000	1	-	1	4	2. 07%
Total	57. 1KW	3. 39	0. 571KW		193.6	100%

Note: 1. Red marked 5 applications (lighting, TV, fan, refrigerator and washer) is defined as basic demand and need to be satisfied priority.

2. Load rate on the same time is about 70% by effective end user management.

Solution: Autonomous SWT Systems(1)

Wind Resource Assumption

Avg. Loading Hours per year Hours/y	Turbine Rated Power KW	Installed Turbines per Village	Electricity Generation per Year MWh/y	Electricity Generation per Day KWh/d	Nominal Power Service Coverage Ratio	CER Ton/y
2,500	10	4	100	274.0	1. 42	90

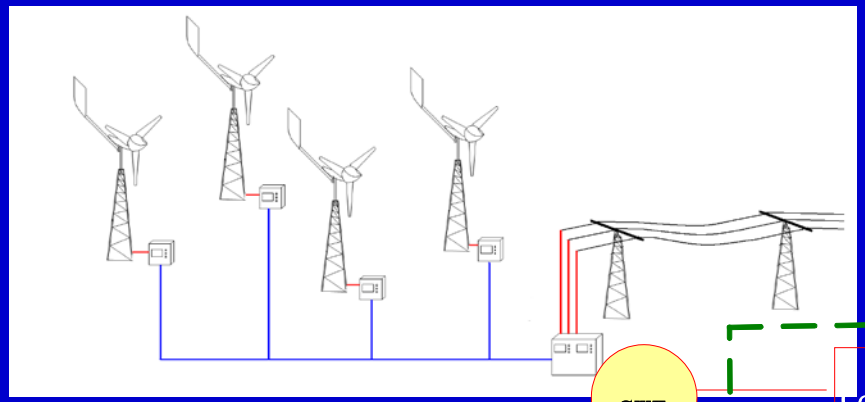
Note: 1. Assume the average wind speed is 6.4 m/s at 20 meters high over ground, the real power output for a 10KW turbine is about 2.85KW at this wind speed, annual generation is about 25000KWh, so the average loading hours is 2500 hours.

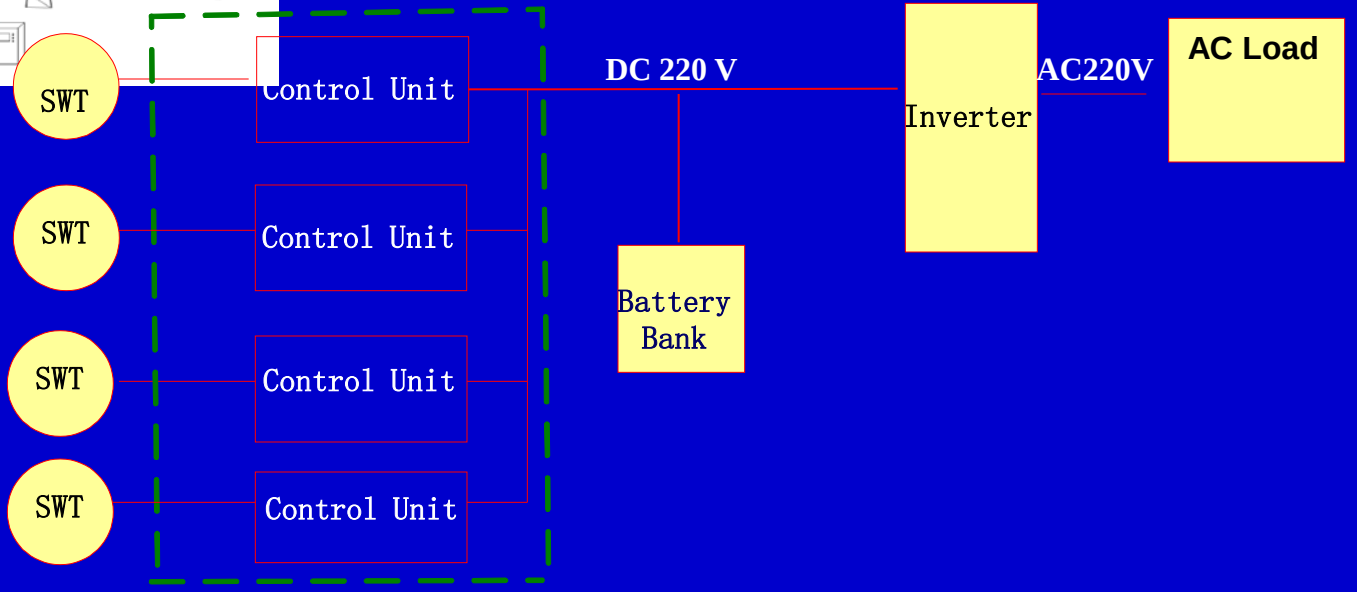
2. The nominal power service coverage ratio is canculated as Electricity Generation per Day divided by Electricity Consumption per Day for Whole Village.

3. Assume the CO2 emission reduction using the eletricity generated by wind turbine is 0.9kg/KWh.

Solution: Autonomous SWT Systems(2)

Village Scale Off-Grid Small Wind Turbine System





Cost Estimates(1)

Installed 4X10KW Turbines Cost Estimate

	Wind Turbine		Other Components					Civil Engineering			Misc.	Total
	Nancelle	Blades	Tower	Control System	Battery Bank	Inverter	Cable	Foundation	Hoisting	Installation		
Unit	US$/KW	US$/KG	US$/m	US$/KW	US$/KVAh	US$/KVA	US$/m	US$/m3	US$/day	US$/personal day	US$/KW	US$/KW
	1,200	15	200	280	140	320	4	300	200	80	232	3, 211
Quantity	40	300	80	40	113.22	40	1,000	20	1	4	40	40
Amount	48,000	4,800	16,000	11,200	15,850	12,800	4,000	6,000	200	320	9,280	128,450.3
As%of Total Turbine Cost	42.61%	4.26%	14.20 %	9.94%	14.07%	11.36 %	3.55%					
As%of Total Cost	37.37%	3.74%	12.46 %	8.72%	12.34%	9.96%	3.11%	4.67%	0.16%	0.25 %	7.22 %	100.00%

Note: 1. Assume all of the price is based on FOB price.

2. Misc. will include shipment fee, local transportation fee, insurance, clear custom fee, project preparation cost, civil engineering management fee, etc.

3. Battery bank is deploied as 70%+ of basic eletricity demand to save cost.

4. Cable is not including the distribution network into family houses.

Cost Estimates(2)

System O&M Cost Estimates

	O&M Fee		Personnel Cost	Misc.	Total
	Parts	Battery	US$/y	US$/KWh	
	US$/KWh	US$/y			US$/y
Unit	0.01	2, 642	1,500	0.002	
Amount per year	1,000	2, 642	750	200	4,592

Note: 1. Battery life cycle is 6 years under 50% discharge depth.
2. Misc. will include transportation fee, etc.
3. A technician can take care 8 turbines, or take care 4 turbines by parttime.

Financial Plan(1)

Financial Feasibility Analysis

	Investment Cost US$	O&M Cost US$/y	Financial Cost US$/y	Revenue US$/y		EBITDA US$/y	EBTDA (After Interest) US$/y	Principal Repayment per year US$/y	Debt Service Coverage Ratio
				Bill	Carbon Credit				
Amount	128,450	4,592	3,367	11,000	1,170	7,578	4,211	4,209	1.00
As%of Bill	1,167.73 %	41.74%	30.61%	100.0%	10.64%	68.89%	38.29%	38.26 %	

Note: 1. Assume CER price is 13 dollars.
2. Assume ADB loan rate is 2%, commercial loan is 6%, tenure is 20 years.
3. Assume no tax or charges

Financial Plan(2)

Funding Plan

Source	Government Grant	Carbon Credit Prepay	ADB Loan(20 years)	Commercial Bank Loan(20 years)	Total
Percentage	30%	4.47%	32.76%	32.76%	100%
Amount	38,535	5,744	42,086	42,086	128, 450

Note: 1. Assume ADB can prepay the carbon credit at 50% of 20 years after 8% discounted.

Financial Plan(3)

5 Year 5000 Village Program Financial Plan

	Population	Investment US$	Government Grants US$	Carbon Credit Prepay US$	ADB Loan US$	Commercial Bank Loan US$	Total US$
Unit Village	500	128,450	38,535	5,744	42,086	42,086	128, 450
5000 Village	2,500,000	642,251,462	192,675,439	28,718,081	210,428,971	210,428,971	642, 251, 462

Financial Plan(4)

Sensitivity Analysis

	Baseline	Turbine Cost				Other Components Cost			
		20%	10%	-10%	-20%	20%	10%	-10%	-20%
DSCR	1.0	0.92	0.96	1.05	1.11	0.85	0.92	1.09	1.19
Bill Payable per Capita	22	23.30	22.7	21.3	20.7	24.5	23.4	20.7	19.4
	Baseline	Battery Cost				Exchange Rate			
		20%	10%	-10%	-20%	20%	10%	-10%	-20%
DSCR	1.0	0.83	0.92	1.08	1.16	0.77	0.87	1.16	1.36
Bill Payable per Capita	22	24.7	23.3	20.8	19.7	26.3	24.2	19.9	17.7
	Baseline	Wind Speed				Misc.			
		20%	10%	-10%	-20%	20%	10%	-10%	-20%
DSCR	1.0	1.29	1.29	0.81	0.56	0.98	0.99	1.01	1.02
Bill Payable per Capita	22	18.5	18.5	25.6	32.6	22.3	22.1	21.9	21.8

Note: 1. Battery cost variation comes from both battery unit price and KVAh.

2.If wind speed rises 10-20%, it means just 3X10KW turbine can provide more than or same power with 4X10KW turbine, so the investment cost can save about 25%. If wind speed falls by 10%, there needs 5 turbine to provide same electricity. If wind speed falls by 20%, needs 7 turbine.

3. Exchange rate infloation is only concerned to influence the investment cost on the buildup stage, but not including in the 20 years repayment period.

Risk Management

- Wind Resource : Avg.6.4+m/s @ 20m (5+m/s@10m) , days (more than 50% of 365 days) and hours(more than 4300 hours) per year
- Battery Bank: priority use other cost-effective energy storage methods to avoid deployment of expensive battery, e.g. ice storage, irrigation-water storage
- Exchange Rate: advanced, mass purchasement; exchange rate swop
- Turbine with components: mass procurement, customization and optimization (rated speed, blade shape, ease installation, etc), higher quanlity and lower cost
- Miscellaneous Fee: Cost under term of DDP(Delivered Duty Paid) , engineering management fee
- Affordability: priority select those villages of which net income per capita per day should be more than 1 dollar, and can make more earning with electricity.
- End User Management: electric appliances, loading frequence, bill collection,

Thanks for your attention

hffei00@yahoo.com.cn