



Support for Wind Power Development in Mozambique Economic and Financial Analysis

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ENERGY, CLIMATE
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DEVELOPMENT

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UNEP Risø Centre – Energy Climate and Sustainable Development

International and Danish
research team of 23 economists
and scientists.

Based on agreement between
Risø, UNEP and Danida.
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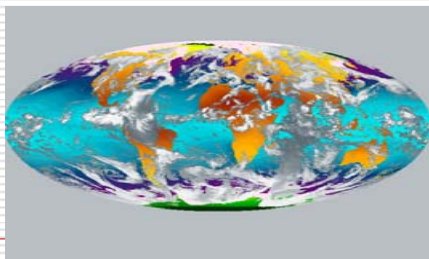
Capacity
Building



Energy for
Sustainable
Development



Emphasis on Africa



Climate
Change

URC Activities

Three Key Themes

- Energy Policy
- Energy and Carbon Finance
- Sustainable Development and Climate Change



Activity areas

- Energy & Poverty
- Energy Efficiency & Renewable Energy
- Energy Sector Reform
- CDM & Carbon markets
- Development & Climate
- National and International Policy Instruments
- Transport
- Capacity Building

Energy Policy in Mozambique

- To promote the development of conversion technologies and environmentally benign energy uses (solar power, wind power and biomass);
- To ensure reliable energy supply, at the lowest possible cost, so as to satisfy current levels of consumption, and the needs of economic development;
- To increase the availability of energy for the domestic sector, particularly coal, kerosene, gas and electricity;
- The IPP participation... ;
 - introducing independent power producers (IPPs) in new generation projects....

Economic and Financial Analysis of Ponta de Ouro Wind Power Project

Background	
Investment 10 MW project (\$2 mill/MW current costs; transmission-\$0.25 mill)	\$20.25 mill. Includes feasibility study, project and site development work, engineering, plant and equipments, installation, and transmission lines (33 KV- 5 Km, and one sub-station)
O & M Costs (increase 3% per year)	2% of the investment per year. Includes land lease, property tax, labour, other operational expenses etc.
Annual Energy Production	18 GWh (net)(From year 1) -5% losses (Transmission)
Plant life	20 years- 10% Salvage Value

Projected power sale rate	US cents 9/kWh (and escalation 3% per year)
Income tax	- No tax
<p>CDM</p> <ul style="list-style-type: none"> - CER prices - Emission red. coeff. (eq. CO₂) <p>Note: CDM revenues assumed for entire plant life</p>	<p>\$15/ ton</p> <p>0.6 t/ MWh</p>

Financial Structuring

- Ownership Structures
 - Private
 - Utility
 - Public (Central or Provincial)
 - PPP

Each has its own costs and financial arrangement possibilities.

Base Case:

Equity 20%

Loan 80%; 15%, 15 Yrs+ 6 Yr (Grace Period)

NPV and IRR Calculations

□ Discount rate

- What is used in Mozambique to examine economic viability? 12% was used
- Hurdle rate for investor?
(based on cost of financing)
- 16.8 (base case)

Hurdle rate

- ❑ Required IRR \geq hurdle rate
- ❑ The hurdle rate is weighted average cost of the capital (wacc) + spread
- ❑ WACC is calculated using the following formula;
- ❑ $WC = (E/TC) * RE + (D/TC) * RD * (1-T)$

Where;

WC is weighted average cost of capital

E is the equity contribution

D is the debt

TC is the total cost (D+E)

RE is the required return on equity

RD is required rate of return on debt (rate of interest + FE risk and guarantee for foreign loans), and

T is the tax rate

Discount rate = Hurdle rate + spread

<p>18 GWh</p> <p>NPV</p> <p>Base Case: Discount rate 12% (Domestic loan at 15% with 15 year term+ 6 yr GP)</p> <p>Hurdle rate 16.8%</p> <p>Which one to choose?</p>	<p>- ve</p> <p>-ve</p>
<p>IRR</p>	<p>4.3% (8.8- 25 GWh)</p>
<p>MIRR</p>	<p>7.4</p>

□ Impact of CDM

CER Prices	\$15/ton
IRR	5.3 (10- 25 GWh)
MIRR	7.9

Is it acceptable now?

-
- What is my acceptable IRR ?
(normally 17-18% private investors, but look at hurdle rate)

 - This is economic IRR, and if tariff and investment and other data is without distortion, it gives a basis for decision making at policy level (although it is not strictly an economic analysis).

 - For an investor, decision criteria will typically be Financial IRR, which depends on financing arrangements.

Can wind energy be viable? Some Scenarios

- Tariff 16 cents/kWh
- Capital cost of plant decline by 40%
(reach 1.20 mill \$/MW)
- 0% interest rate loan
- 25% of capital costs as grant and 0%
interest rate loan

Scenario Results

Scenario	Base	Tariff 16 cents/Kwh	Cap. cost 40% less	0 % interest	25% grant + 0% int
NPV 12%	- ve	+ve (marg)	-ve (marg)		
NPV (HR), HR	-ve (HR 16.8)	-ve (HR 16.8)	-ve (HR 16.8)	(HR 4.8)	+ ve (HR 4.8)
IRR %	4.3	12.7 (15% at 18 cents/kWh)	11.5		
IRR-CDM %	5.3	13.5	12.9		
IRR-Investor %	-	9.4	6.9	16.2	30.4
IRR-INV-CDM %	-	11.2	9.7	21.5	36.9

□ At 25 GWh:

- 12 cents/kWh- IRR 13.4 (+ve NPV)
- 14.5 (CDM)
- So viable economically
- What about investor? IRR 11 (13.6 CDM), HR 16.8
- 0 interest (1.5% Mgt fee): IRR-INV 31.2 (37.6 CDM)

Should the wind energy considered as an option in Mozambique ?

- If tariff can be expected to be > 9 cents / kWh (Imports, exports and cost of alt. generation)
- Future SAPP prices??
- Capital costs decreasing
- Environmental Issues
- Energy security?
- Isolated systems (hybrid?)

NOTE: With 25 GWh it makes sense to start **NOW!**

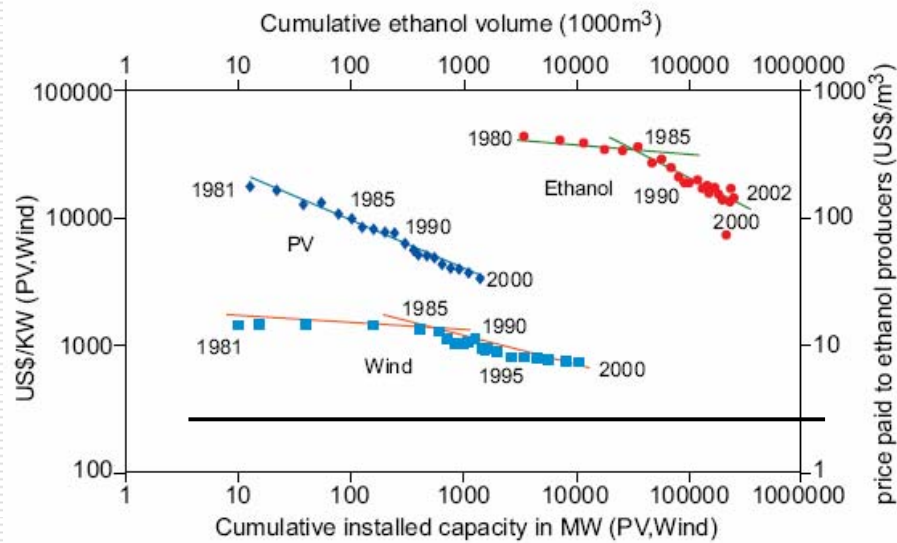


Figure : Cost reductions from learning for PV, Wind^[1] and Bio-ethanol
Source: IPCC, 2007.

Learning curves for PV and Wind separately can be found at <http://www.recabs.org/>.

At What Price?

SI No.	Plant and size	Investment (mill. \$)	Mill. \$ / MW	Remarks
1	49.5 MW Goldwind Damao Wind Farm Project in China (under validation Dec. 2007)	60 (October 2007)	1.2	From project design document (PDD) of the CDM project
2	Ningxia Yinyi 49.50MW Wind-farm Project, China (registration Dec.2007)	53 (Sept. 2006)	1.07	From PDD of the of the CDM project
3	56.25 MW bundled wind energy project in Tamilnadu, India. (Registered Sept 2006)	47 (April 2006) (INR 2095 million)	0.84	From PDD of the of the CDM project
4	NSL 27.65 MW Wind Power Project in Karnataka, India (Registered May 2007)	25 (Feb 2007) (INR 1085 million)	0.90	From PDD of the of the CDM project
5	33 MW NorthWind Bangui Bay Project, Philippines (Registered Sept. 2006.)	51 (Dec. 2005)	1.5	From PDD of the of the CDM project
6	30 MW project in At. Ana in Philippines	52 (2006)	1.7	From preliminary feasibility study
7	40 MW in Mauritius (proposed)	Nov. 2007	2.6 to 2.9	Indicated prices (for cyclone prone areas)

THANK YOU

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