



Regional Centre for Renewable Energy and Energy Efficiency
Centre Régional pour les Energies Renouvelables et l'Efficacité Energétique
Centro Regional para Energias Renováveis e Eficiência Energética
www.ecreee.org

RE INFRASTRUCTURE PROJECTS APPRAISAL REPORT

PRESENTATION

THURSDAY, 27TH SEPTEMBER 2012
DAKAR, SENEGAL



PRESENTATION OUTLINE



- 1. INTRODUCTION AND SCOPE OF THE REPORT*
- 2. METHODOLOGY*
- 3. PRESENTATION OF EACH PROJECT*





INTRODUCTION



- ECREEE has established the 'ECOWAS Renewable Energy Investment Initiative' (EREI) to facilitate and provide support to medium- and large-scale RE projects in the region
- The overall objective of EREI is to support such projects in development and to facilitate their successful implementation, including the presentation of these projects to sources of capital finance such as commercial and development banks
- EREI has attracted a number of projects that some are currently in development, across all of the ECOWAS countries, and covering a range of RE technologies
- Sinclair Knight Merz Limited (SKM) has been appointed by ECREEE to undertake a high level review of this pipeline of projects to support its engagement with the financing community, and as an input to the EREI Forum, to be held in Senegal in September 2012



METHODOLOGY



- Data collection
 - ECREEE gathered project information directly from project sponsors and government agencies.
 - search for published information on the proposed projects, using sources such as publicly available UN databases. Where data and information on costs and/or performance were not available, SKM established its own best estimates
- Basis of the review
 - basic technical, structural and economic characteristics of the projects
 - the conformance of the projects with generic investment criteria (such as the application of Equator Principles and CDM investments)
 - It has not included consideration of the prospects for any country-specific policy instruments that might exist that could influence the commercial viability of the projects (such as capital support programmes, fiscal (tax) interventions, or revenue support)
 - Where data have been available, we have derived an estimated levelised cost of electricity generation (LCOE). This coupled with the potential for CDM revenue
 - The review has to be set in the context of any policy instruments that may exist and the commercial terms in any PPA that may exist in that particular country, to assess a project's overall potential commercial viability.



METHODOLOGY



- Project Pro-forma design
 - Spreadsheet format to capture key information on the project and to draw broad conclusions about the project against certain criteria using a ‘traffic light’ approach
 - The pro-forma includes:
 - A review of the projects, highlighting key technical and economic characteristics and key risks
 - Where data is available on which to base such a calculation, an estimate of the LCOE generation, based on cost, performance and expected project hurdle rates for that particular type of project/technology
 - A semi-qualitative system for drawing principal conclusions, in which projects are given a ‘traffic-light’ (red, amber, green) marking against the following criteria:



METHODOLOGY



- Project Pro-forma design
 - project categorization according to the level of data detail

	Red	Amber	Green
Resource assessment	very weak basis for resource assessment	some evidence of site-specific resource assessment	robust assessment, based on reasonable site-specific data and appropriate methodology
Technology risk	high level of technology risk	sketchy or incomplete information on technology, or unfamiliar technology provider	proven technology with good information on process design and/or installation/contractor
Environmental concerns	detailed ESIA required but not started or largely incomplete.	ESIA not yet approved but no major problems anticipated. Or, only low level ESIA required.	ESIA approved and environmental permit in place. Or, formal decision that ESIA not needed.
CDM potential	project not additional / project not eligible under CDM	application of CDM doubtful due to poor commercial viability or significant hurdles or barriers to CDM	additional & commercial potential/undergoing CDM review/CDM process begun
Business model	unrealistic business model	optimistic commercial assumptions	robust project model with commercially realistic assumptions
Project status	glint in the eye	early stage development, but project fundamentals established	well advanced project with clear programme/plan for implementation



METHODOLOGY



Project Pro-forma design

- project categorization according to the level of data detail

Project category	Implications	Number of projects
Category '1'	Category 1 projects have a reasonable level of information available. We are able to provide reasonable commentary on all aspects of the project, to provide an estimated LCOE and to provide a full 'traffic light' assessment.	16
Category '2'	Category 2 projects have some information on a project, sufficient to enable us to identify a specific site and consider a particular type of technology, however there is very limited information on cost and performance. In these cases, SKM has provided its own best guess of possible costs and/or performance, based on the limited information available, in order to provide a rough estimated for a LCOE. Because of the limited information, however, we have not provided a full 'traffic light' assessment.	18
Category '3'	Category 3 projects have very limited information, to the extent that it is not possible to identify a site, or understand the technology choice, or consider availability of resource. Given this, we have provided some limited commentary on the project, but have not been able to provide even a very rough estimate for the LCOE, nor have we provided a full 'traffic light' assessment.	7



METHODOLOGY



Financial Review

- to determine a lifetime levelised cost of electricity (LCOE) generation
- LCOE is equivalent to the average price the output of the generating plant would have to be sold at to exactly repay the investor for capital costs (capex), O&M costs (fixed and variable) and any relevant fuel costs, with a rate of return equal to the discount rate, expressed as €/kWh
- LCOE is the minimum price at which energy must be sold for a generation project to break even – and so return a zero NPV. The formula for calculating the LCOE is shown below:

$$LCOE = \frac{\text{total lifetime expenses}}{\text{total lifetime output}} = \frac{\sum_{t=1}^n \frac{I_t + M_t}{(1+r)^t}}{\sum_{t=1}^n \frac{G_t}{(1+r)^t}}$$

Where:

I_t = investment cost (capex) in year t

M_t = operating costs in year t

G_t = generation output in year t

r = discount rate



METHODOLOGY



Financial Review

- the discount rate is a critical parameter in calculating the LCOE and so a key issue to be determined is the assumed value of discount rate adopted
- The different discount rates are intended to reflect the generic hurdle rates that may apply to these investment options based on perceptions of technology risk
- Assumed Discount Rates (representing indicative 'hurdle rates' for investment)

Technology	Risk perception	Discount rate %	
		Low	High
Onshore Wind	Low	7	10
Biomass	Medium	9	13
Solar PV	Low	6	9
Small hydro	Low	6	9



METHODOLOGY



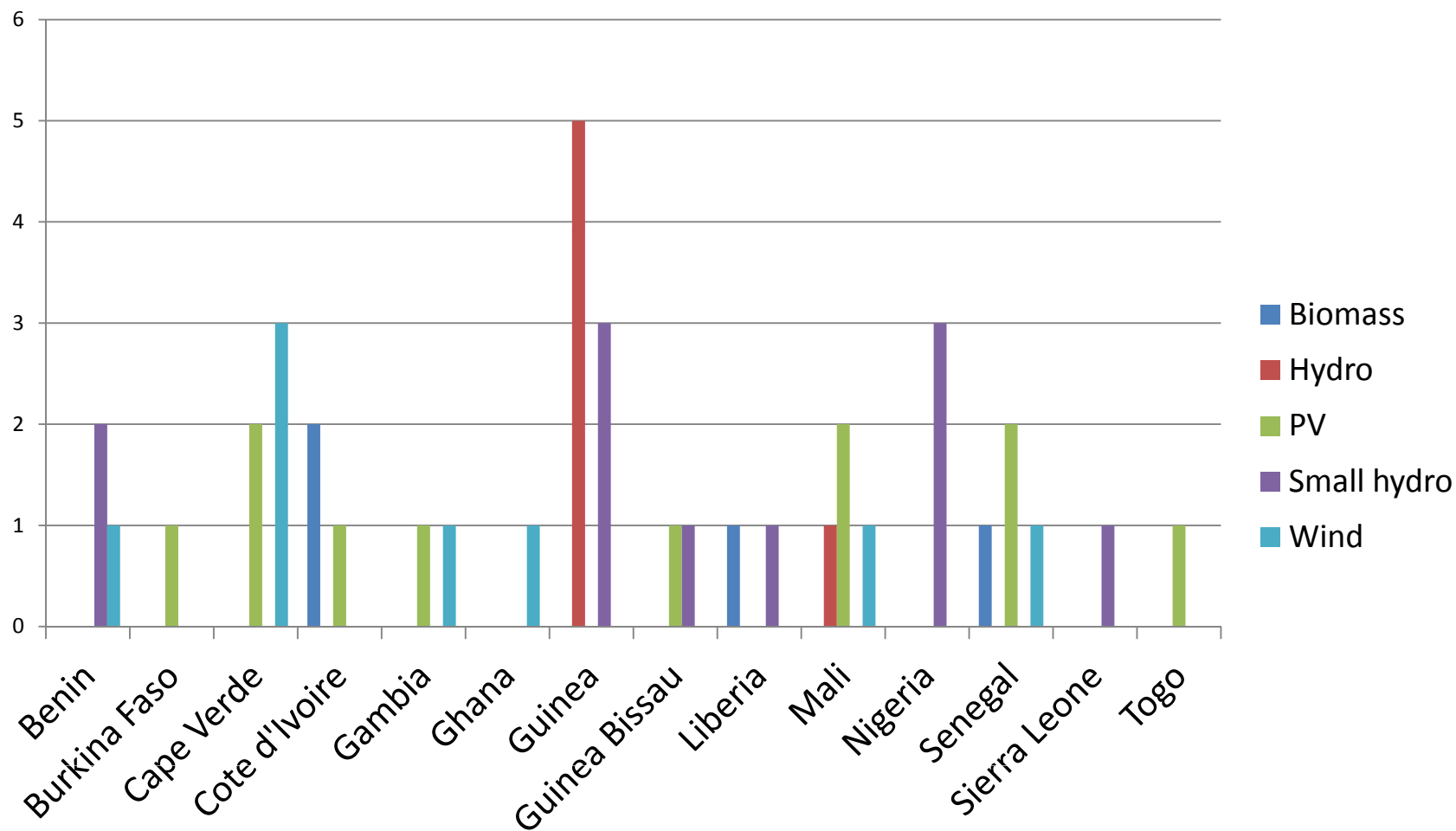
Review of opportunity for CDM revenue

- the projects within the pipeline *may be eligible for revenue from the CDM, which would effectively reduce the price at which electricity needs to be sold*
- Estimated CDM revenues were generated by multiplying the yearly forecasted carbon reductions by a forecasted carbon price for the years to come



SELECTED PROJECTS

BY NUMBER OF PROJECTS PER COUNTRY





SELECTED PROJECTS

BY MW AND TECHNOLOGY PER COUNTRY

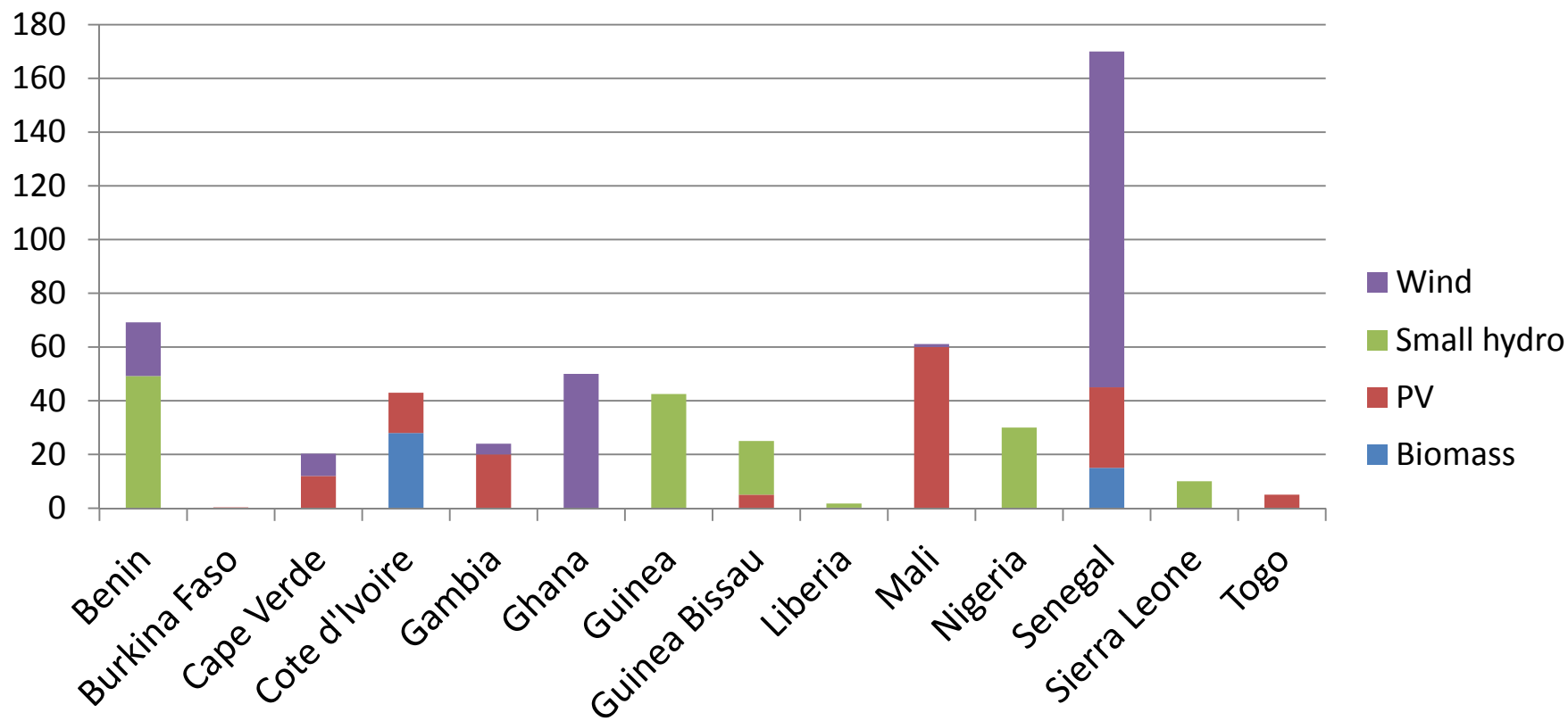


	Biomass	PV	Small hydro	Wind	Grand Total
Benin			49	20	69
Burkina Faso		0			0
Cape Verde		12		8	20
Cote d'Ivoire	28	15			43
Gambia		20		4	24
Ghana				50	50
Guinea			43		43
Guinea Bissau		5	20		25
Liberia	0		2		2
Mali		60		1	61
Nigeria			30		30
Senegal	15	30		125	170
Sierra Leone			10		10
Togo		5			5
Grand Total	43	147	153	208	552



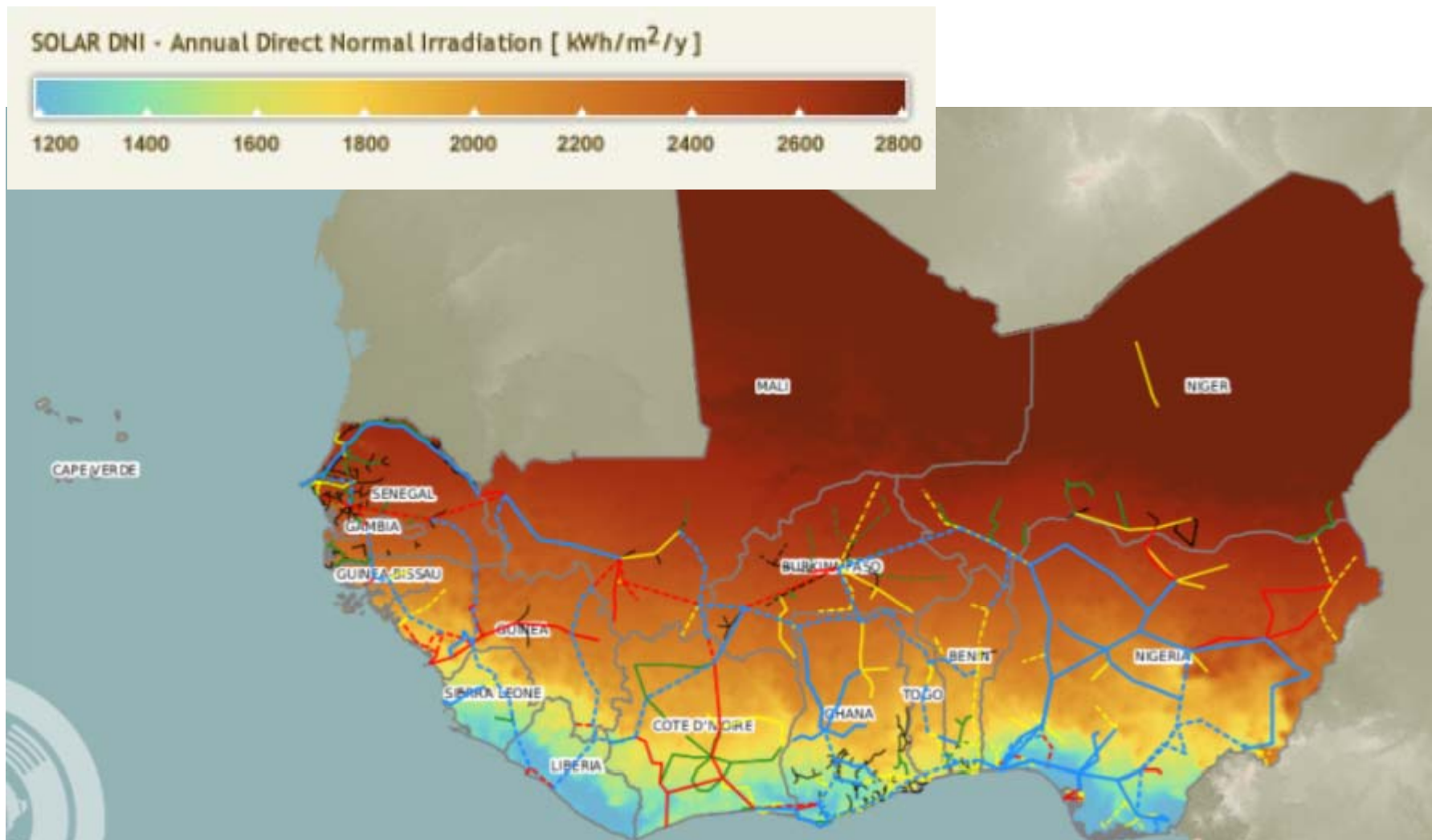
SELECTED PROJECTS

BY MW AND TECHNOLOGY PER COUNTRY



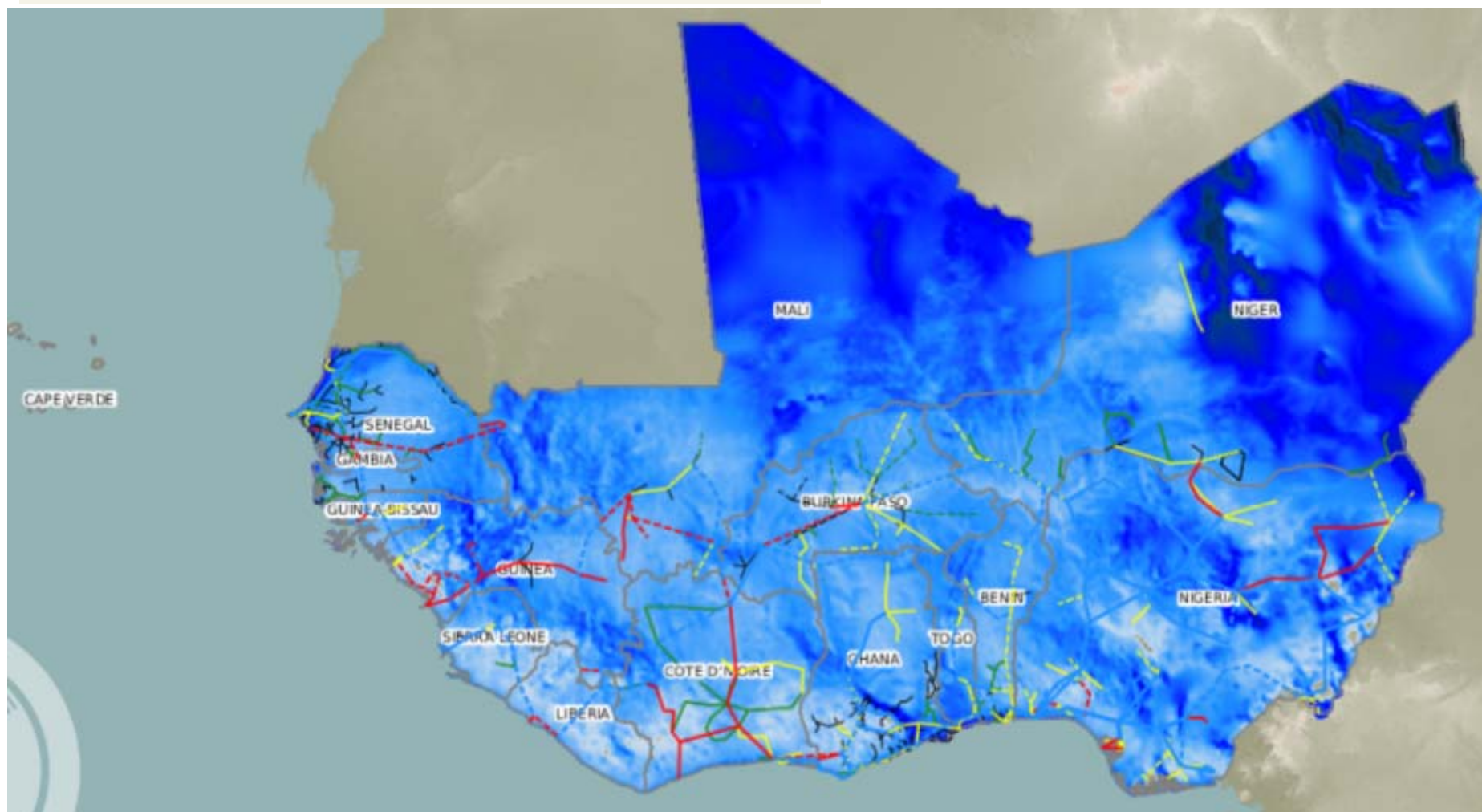


SOLAR RESOURCE ASSESSMENT





WIND RESOURCE ASSESSMENT





BENIN WIND FARM



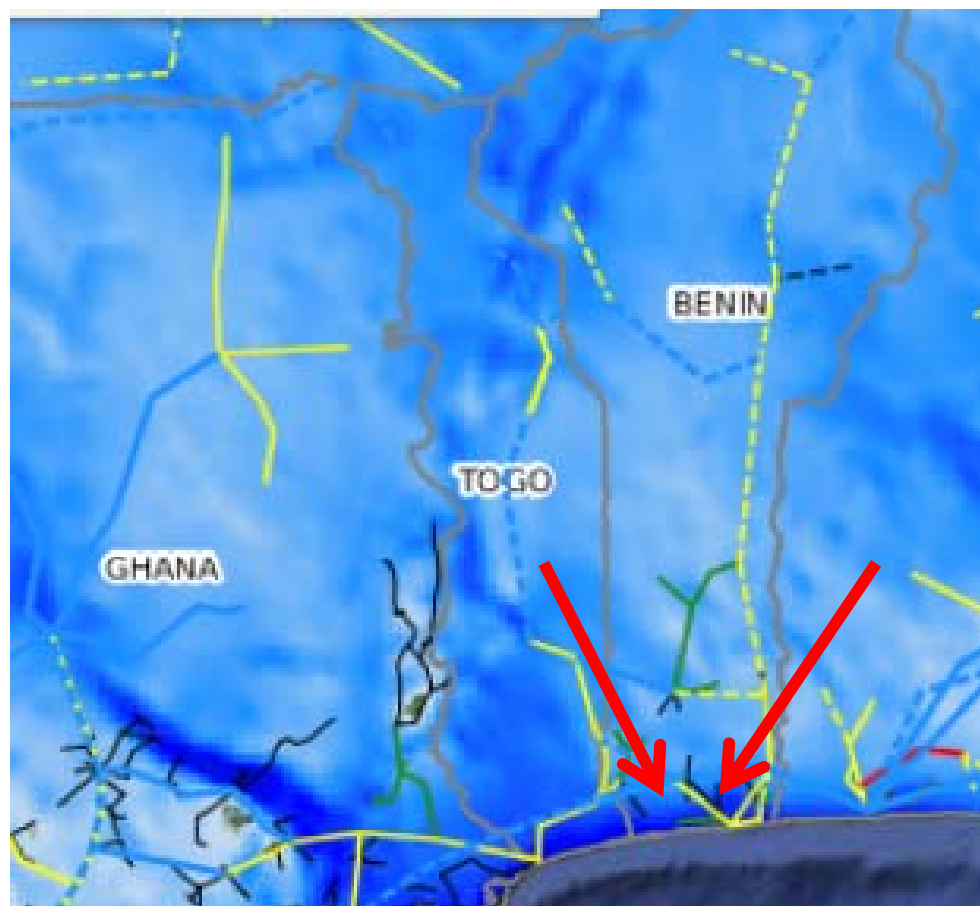
Technology	Capacity	Promoter	Status
Wind	20 MW	CEB	Feasibility study planned

Estimated cost	LCOE
40.000.000 EUR	

Project at an early stage. No site identified but government engaged

The process is to be phased over a period of 4 years:

- the first 2 years to be wind resource analysis and financial assessment
- years 3 & 4 would be for actual project implementation





BENIN SMALL HYDRO LE FLEUVE



Technology	Capacity	Promoter	Status
Small Hydro	26 MW	Government	Feasibility study planned

Estimated cost	LCOE
61.000.000 EUR	91 EUR/MWh



Resource Assessment		No clear been de	e has
Technical Risk		Size of d represe	likely to
ESIA Assessment			
CDM Potential		The only and ther LCOE (w	ivity Wh.
Business Model			
Project Status			



BENIN BIOMASS UNIT



Technology	Capacity	Promoter	Status
Biomass	23,2 MW	Government	Feasibility study planned

Estimated cost	LCOE
81.200.000 EUR	118 EUR/MWh



Resource Assessment		
Technical Risk		The technology type has not yet been defined . SKM would note that agricultural residue biomass plants of this scale are most commonly of the grate fired steam boiler and steam turbine type.
ESIA Assessment		
CDM Potential		Only concern is inexperience of CDM DNA - no CDM in Benin at present. CDM revenue of €14.86/MWh LCOE (with CDM) = 106 EUR/MWh
Business Model		Capex assessment low
Project Status		



BURKINA FASO YAHO PV/DIESEL HYBRID



Technology	Capacity	Promoter	Status
PV	0,3 MW	Fonds Electrification Rurale	Funds mobilization

Estimated cost	LCOE
1.050.000 EUR	308 EUR/MWh

Resource Assessment	 	2000 Wh/m ² /day.
Technical Risk	 	The technology type has not yet been defined
ESIA Assessment	 	No major environmental impact has been identified during EIA investigation
CDM Potential	 	Probability of eligibility and additionality is good .Only concern is inexperience of CDM DNA
Business Model	 	Very high level business model
Project Status	 	The project investigation has been done. Looking for partners to go further on this project

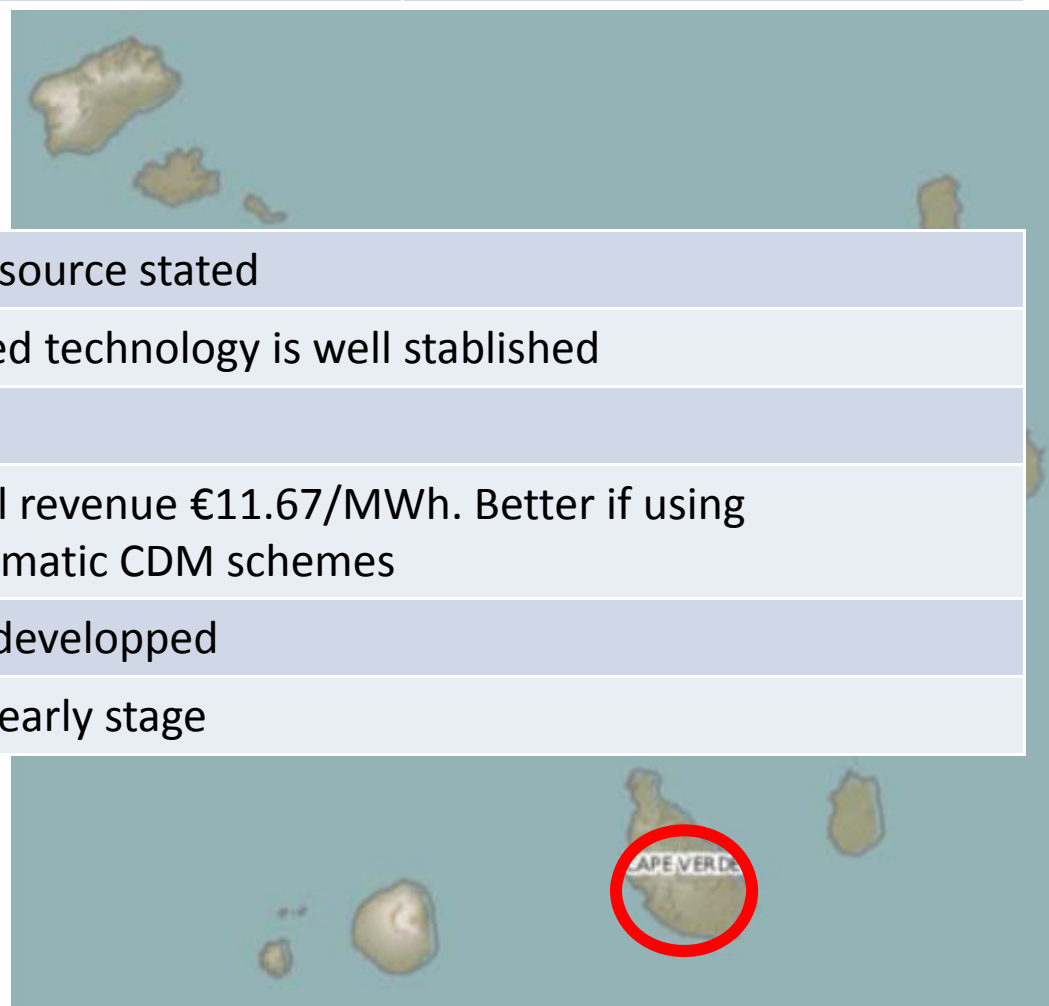


CAPE VERDE WIND IN SANTIAGO



Technology	Capacity	Promoter	Status
Wind	6,8 MW	Government	Feasibility study planned

Estimated cost	LCOE
16.354.000 EUR	102 EUR/MWh



Resource Assessment	Red	No data source stated
Technical Risk	Yellow	Suggested technology is well established
ESIA Assessment	Yellow	
CDM Potential	Green	Potential revenue €11.67/MWh. Better if using programmatic CDM schemes
Business Model	Red	Not yet developed
Project Status	Red	Still in a early stage



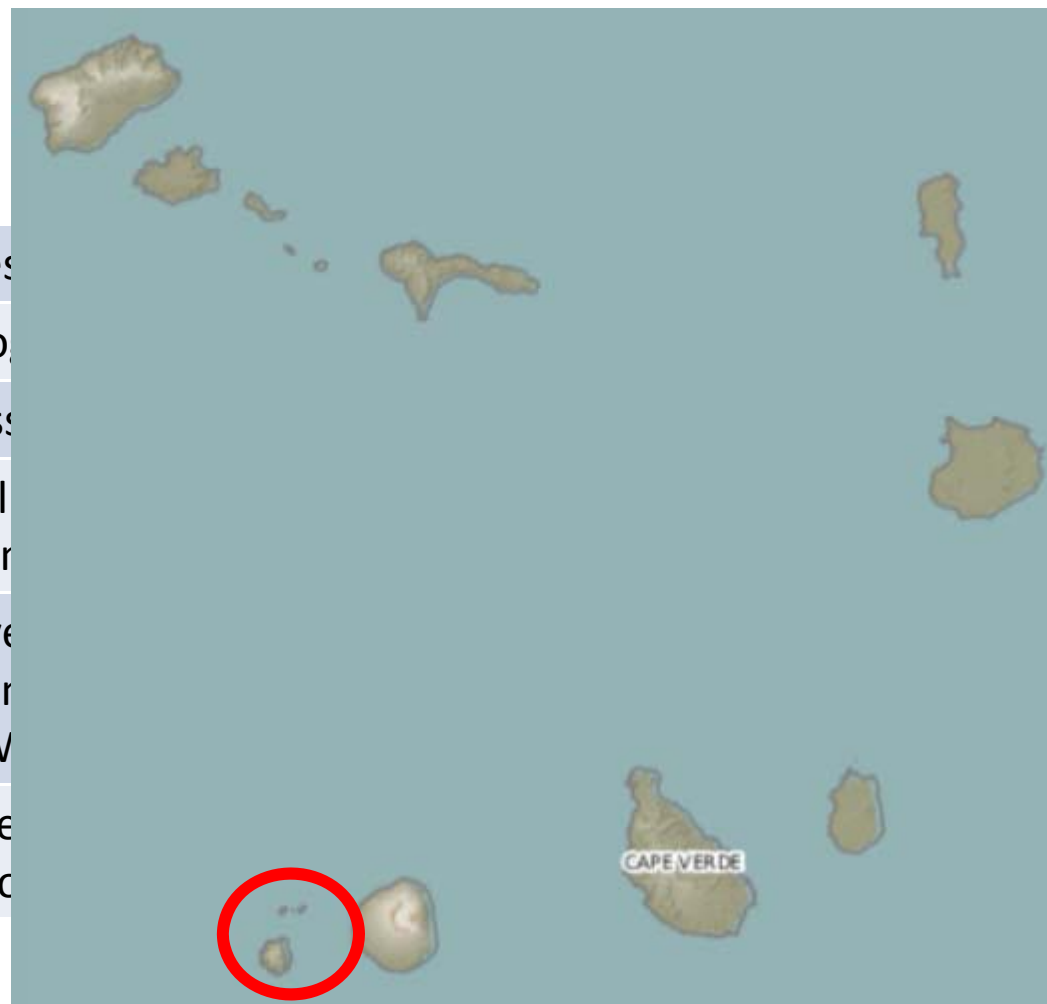
CAPE VERDE WIND FOR WATER SUPPLY



Technology	Capacity	Promoter	Status
Wind	0,5 MW	Agua Brava - GEF	Funds mobilization

Estimated cost	LCOE
875.000 EUR	117 EUR/MWh

Resource Assessment	Red	Estimates
Technical Risk	Yellow	Technolo
ESIA Assessment	Red	No assess
CDM Potential	Yellow	Potential Program
Business Model	Green	Well deve lower wir €130/MV
Project Status	Yellow	A wind re viability c



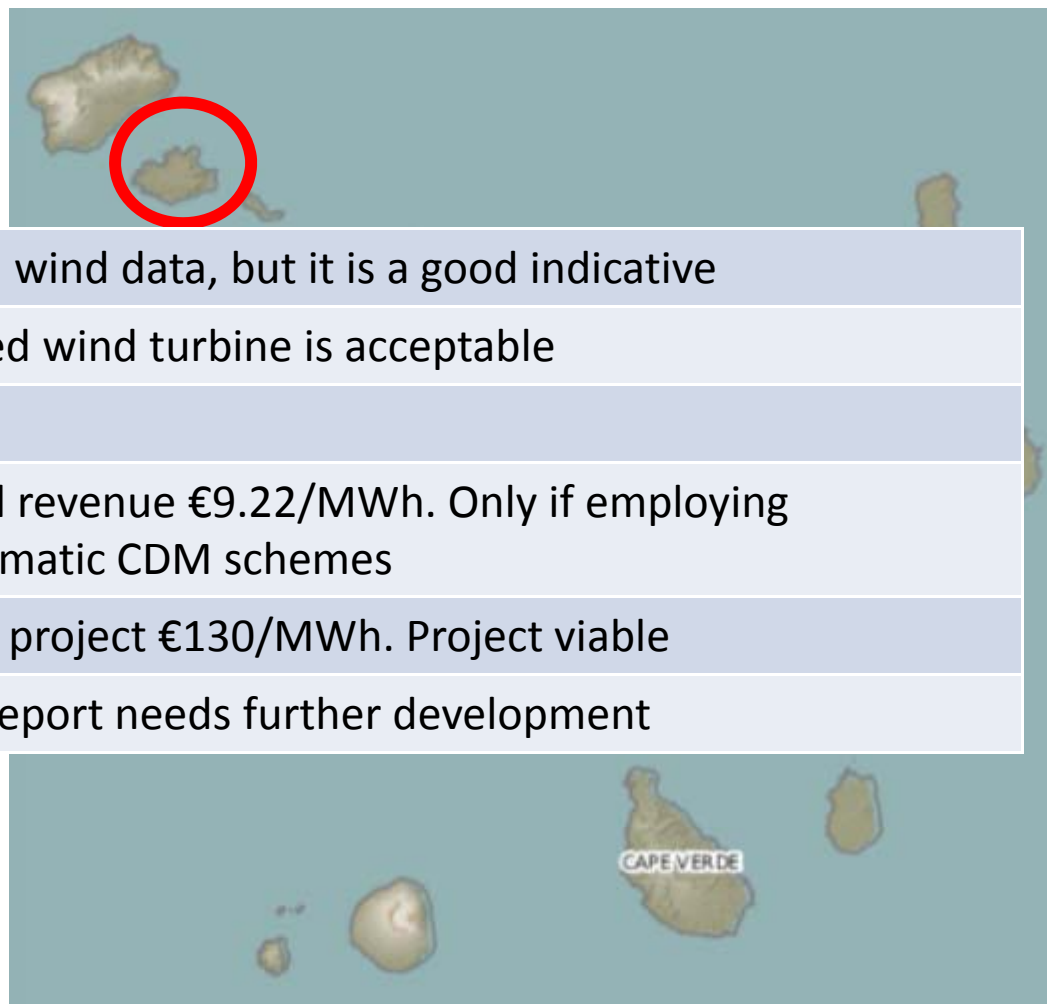


CAPE VERDE WIND FARM IN MINDELO



Technology	Capacity	Promoter	Status
Wind	0,99 MW	ELECTRA - GEF	Funds mobilization

Estimated cost	LCOE
3.000.000 EUR	108 EUR/MWh



Resource Assessment	Yellow	Used old wind data, but it is a good indicative
Technical Risk	Yellow	Suggested wind turbine is acceptable
ESIA Assessment	Yellow	
CDM Potential	Yellow	Potential revenue €9.22/MWh. Only if employing Programmatic CDM schemes
Business Model	Green	Tariff for project €130/MWh. Project viable
Project Status	Yellow	Project report needs further development

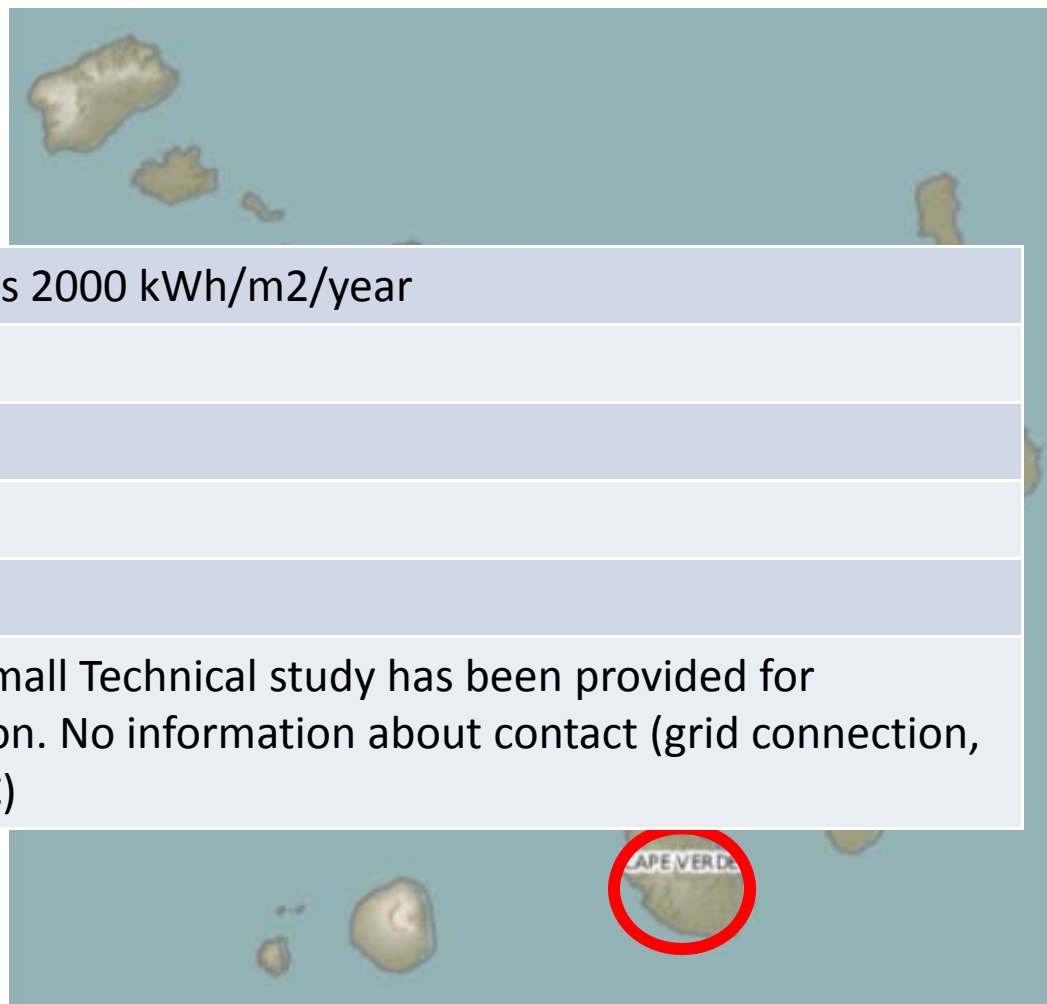


CAPE VERDE PV CIDADE VELHA



Technology	Capacity	Promoter	Status
PV	9 MW	Government	Feasibility study planned

Estimated cost	LCOE
29.565.000 EUR	268 EUR/MWh



Resource Assessment		Estimates 2000 kWh/m ² /year
Technical Risk		
ESIA Assessment		
CDM Potential		
Business Model		
Project Status		Only a small Technical study has been provided for evaluation. No information about contact (grid connection, PPA, EPC)

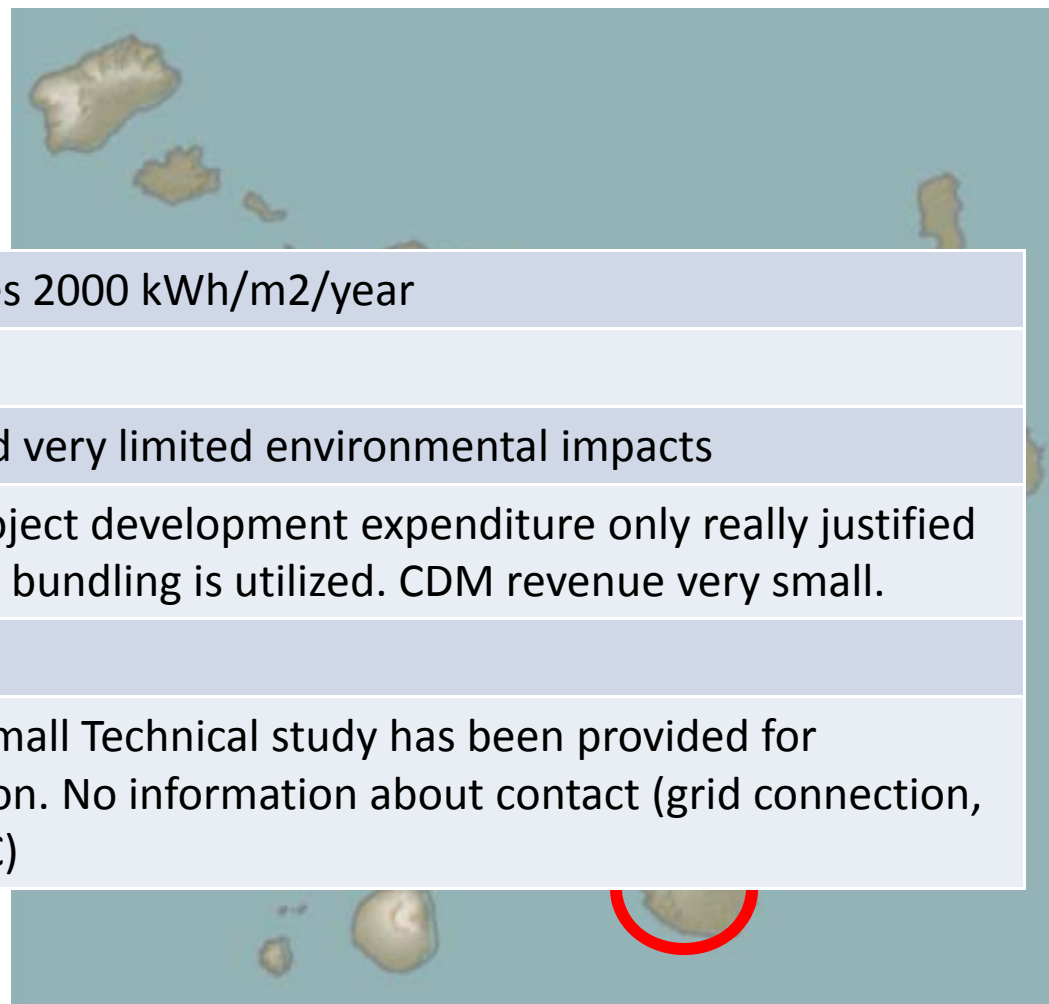


CAPE VERDE PV SALAMANSA



Technology	Capacity	Promoter	Status
PV	3 MW	Government	Feasibility study planned

Estimated cost	LCOE
9.750.000 EUR	225 EUR/MWh



Resource Assessment	Yellow	Estimates 2000 kWh/m ² /year
Technical Risk	Light Blue	
ESIA Assessment	Yellow	Expected very limited environmental impacts
CDM Potential	Yellow	CDM project development expenditure only really justified if PoA or bundling is utilized. CDM revenue very small.
Business Model	Light Blue	
Project Status	Red	Only a small Technical study has been provided for evaluation. No information about contact (grid connection, PPA, EPC)

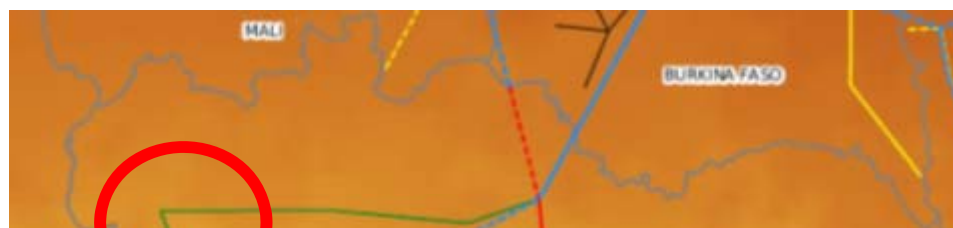


COTE D'IVOIRE PV ODIENNE



Technology	Capacity	Promoter	Status
PV	15 MW	TD Continental	Feasibility study planned

Estimated cost	LCOE
24.00.000 EUR	121 EUR/MWh



Resource Assessment	■	
Technical Risk	■	
ESIA Assessment	■	Expected very limited environmental impacts
CDM Potential	■	Additionality and eligibility expected. Revenues low, Programmatic/bundling may want to be considered
Business Model	■	Technical study (with costs) identified but full business plan and financial assessments not available
Project Status	■	Site location still in purchase. No contracts (EPC, grid connection, PPA) at this stage





COTE D'IVOIRE BIOMASS AKOUEDO



Technology	Capacity	Promoter	Status
Biomass	8,49 MW	Groupe EOULEE	Funds mobilization

Estimated cost	LCOE
31.837.000 EUR	114 EUR/MWh



Resource Assessment	Yellow	Recommended to verify projected biogas yields
Technical Risk	Yellow	
ESIA Assessment	Yellow	Unknown if it exists ESIA
CDM Potential	Green	
Business Model	Green	Technical study (with costs) identified but full business plan and financial assessments not available
Project Status	Yellow	Project reliant on accord with Government and on success with EIA approval





COTE D'IVOIRE BIOMASS BIOKALA



Technology	Capacity	Promoter	Status
Biomass	18,3 MW	BIOKALA	Feasibility study planned

Estimated cost	LCOE
30.145.000 EUR	84 EUR/MWh



Resource Assessment	Yellow	Needs further due diligence
Technical Risk	Yellow	Technology concept for cogeneration plant seems good practice. Details of fuel drying should be investigated
ESIA Assessment	Yellow	NO EIA provided but environmental and social impacts probably not significant
CDM Potential	Green	Currently undergoing CDM cycle (at validation phase)
Business Model	Red	Business model not developed. Capex estimate may be optimistic for this type of plant. Fuel prices need verification. Likely tariff insufficient to cover LCOE
Project Status	Yellow	





GAMBIA WIND FARM



Technology	Capacity	Promoter	Status
Wind	4 MW	Government	Feasibility study planned

Estimated cost	LCOE
60.000.000 EUR	133 EUR/MWh

Resource Assessment		Very low average wind speed, capacity factor of 10%
Technical Risk		Use of 'repowered' V47 technology needs further investigation, due to warranty issues and spare parts
ESIA Assessment		No EIA has been completed, potential affection to birds
CDM Potential		Potential revenue of €12.5/MWh may be available. CDM revenues are low, possibility of being developed as part of CDM PoA
Business Model		Very low project capacity factor leads to high LCOE, less than €110/MWh tariff
Project Status		Low average site wind speed extrapolated. No actual hub height measurements available



GAMBIA PV BIRKAMA



Technology	Capacity	Promoter	Status
Solar	20 MW	NAWEC	Feasibility study planned

Estimated cost	LCOE
60.000.000 EUR	238 EUR/MWh

Resource Assessment		Average irradiation is about 2100 kWh/m ² /year
Technical Risk		
ESIA Assessment		No EIA has been undertaken
CDM Potential		Additionality and CDM revenue supportive. Obstacles will be DNA inexperience.
Business Model		Insufficient information provided
Project Status		Project still at the prospection stage



GUINEE SMALL HYDRO SINGUEGA

(REPRESENTING 3 SHP + 5 HP)



Technology	Capacity	Promoter	Status
Small Hydro	18 MW	Government	Feasibility study planned

Estimated cost	LCOE
45.900.000 EUR	52 EUR/MWh

Resource Assessment		
Technical Risk		
ESIA Assessment		
CDM Potential		Only concern is lack of DNA experience which can be a key hurdle. Good CDM revenue and emissions reduction forecasts as standalone or PoA
Business Model		
Project Status		





GUINEA BISSAU PV

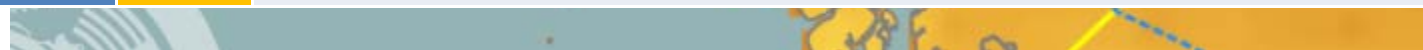


Technology	Capacity	Promoter	Status
PV	9 MW	Government	Funds mobilization

Estimated cost	LCOE
29.547.000 EUR	218 EUR/MWh



Resource Assessment		
Technical Risk	Green	
ESIA Assessment	Yellow	No EIA but not considered to be a high risk due to size and location
CDM Potential	Green	Project passes additionality tests and CDM revenue supportive of small scale development
Business Model	Yellow	Business model not developed. As far as can be seen, only cost of installing plant available - further work required to understand financial viability and potential
Project Status	Yellow	Unclear on land status





GUINEA BISSAU SMALL HYDRO SALTINHO



Technology	Capacity	Promoter	Status
Small Hydro	18 MW	Government	Feasibility study planned

Estimated cost	LCOE
60.300.000 EUR	50 EUR/MWh

Resource Assessment	Yellow	Good catchment; but significant flow seasonal variation
Technical Risk	Yellow	Technology is tried and tested; however construction of a new dam may be complex in some contexts and grid connection may be long
ESIA Assessment	Red	EIA and RAP for resettlement of people will be needed. Also flood risk and possible effects on water resources availability by climate change should be assessed
CDM Potential	Yellow	Positive. Inexperience of Guinea-Bissau DNA is a concern however project screening should be undertaken
Business Model	Red	figures/costs are is considerably out of date. They should be re-visited
Project Status	Yellow	



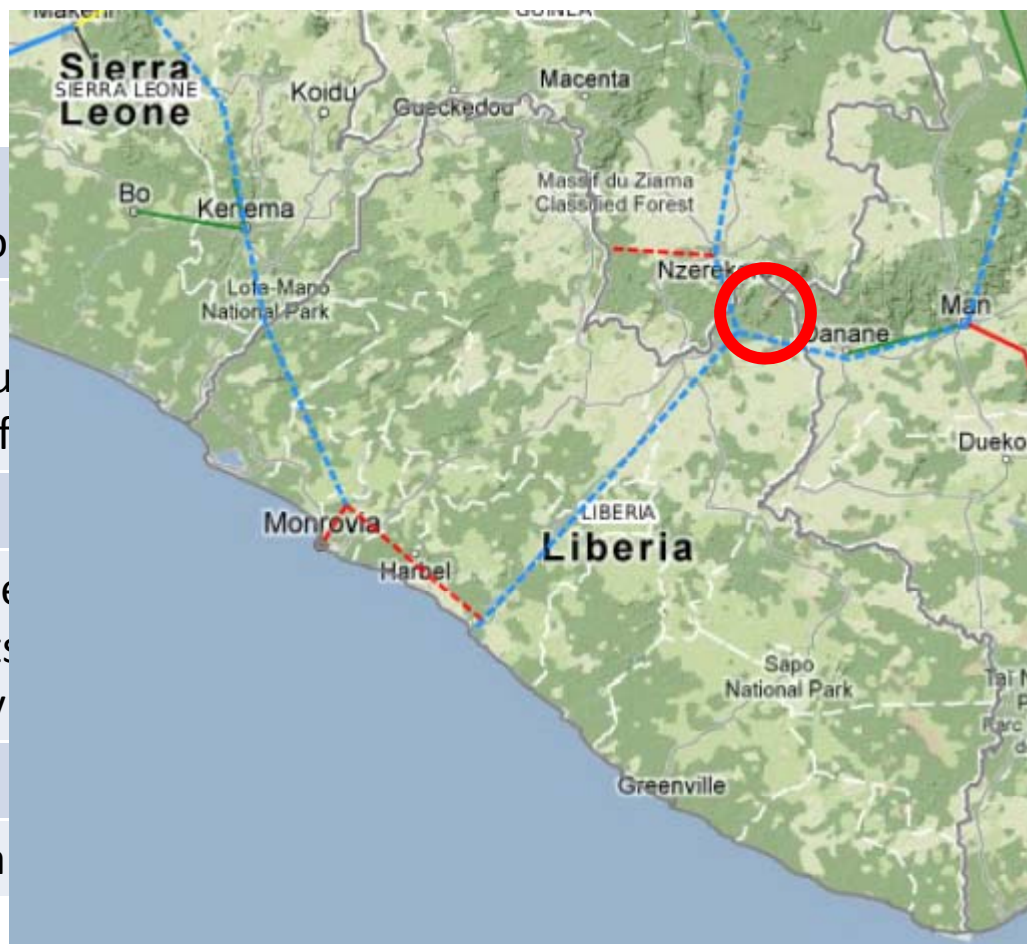
LIBERIA COCOPA BIOMASS



Technology	Capacity	Promoter	Status
Biomass	0,21 MW	Winrock	Funds mobilization

Estimated cost	LCOE
770.832 EUR	198 EUR/MWh

Resource Assessment		Due reco	
Technical Risk		Due requ gasif	
ESIA Assessment			
CDM Potential		Proje costs only	
Business Model			
Project Status		Sma	





LIBERIA SMALL HYDRO MEIN

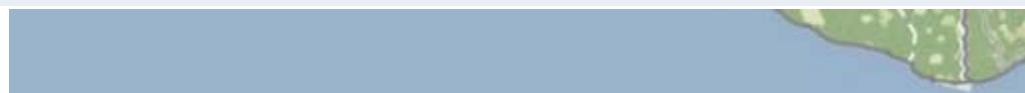


Technology	Capacity	Promoter	Status
Small Hydro	1,5 MW	Winrock	Funds mobilization

Estimated cost	LCOE
3.600.000 EUR	106 EUR/MWh



Resource Assessment	Green	
Technical Risk	Green	Some environmental and flood risk information incomplete
ESIA Assessment	Yellow	
CDM Potential	Green	Project does fit additionality and eligibility criteria but CDM costs would probably prevent consideration. PoA approach only option at this stage. Revenue €7.58/MWh
Business Model	Green	
Project Status	Yellow	No indication that project has proceeded beyond detailed feasibility assessment





MALI PV BAMAKO

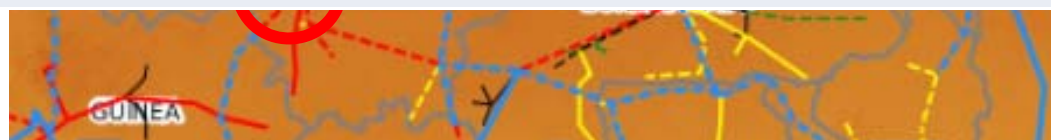


Technology	Capacity	Promoter	Status
PV	40 MW	Government	Feasibility study under way

Estimated cost	LCOE
124.300.000 EUR	269 EUR/MWh



Resource Assessment	■	Average irradiation is about 2100 kWh/m ² /year
Technical Risk	■	Some environmental and flood risk information incomplete
ESIA Assessment	■	
CDM Potential	■	Project to be considered for CDM project development, good revenue and additionality on several grounds
Business Model	■	
Project Status	■	Project at the prospection stage. ESIA, feasibility study, business plan have to be done





MALI PV GAO



Technology	Capacity	Promoter	Status
PV	2 MW	Government	Feasibility study planned

Estimated cost	LCOE
61.700.000 EUR	254 EUR/MWh



Resource Assessment	■	Average irradiation is about 2000 kWh/m ² /year
Technical Risk	■	
ESIA Assessment	■	
CDM Potential	■	Project to be considered for CDM project development, good revenue and additionality on several grounds
Business Model	■	
Project Status	■	Project at the prospection stage. ESIA, feasibility study, business plan have to be done





MALI WIND TOMBUCTU



Technology	Capacity	Promoter	Status
Wind	1,1 MW	Government	Feasibility study planned

Estimated cost	LCOE
3.000.000 EUR	



Resource Assessment		Not enough information available
Technical Risk		Not enough specific information provided. Suggested WTG size may be appropriate
ESIA Assessment		No information
CDM Potential		CDM revenues very small, only really possible through PoA approach
Business Model		No business plan - high level view acknowledging that a financial evaluation is required.
Project Status		This project does not give a sufficient measure of detail to allow for an appropriate assessment





MALI SHP PROJECTS



Technology	Capacity	Promoter	Status
Small Hydro	21,6 MW	Government	Feasibility study planned

Estimated cost	LCOE
14.904.000 EUR	269 EUR/MWh

Resource Assessment		
Technical Risk		
ESIA Assessment		
CDM Potential		
Business Model		
Project Status		appears to be very early state



NIGERIA SHP IKERE

(REPRESENTING 3 SHP)



Technology	Capacity	Promoter	Status
Small Hydro	8 MW	Government	Feasibility study planned

Estimated cost	LCOE

Resource Assessment		
Technical Risk		
ESIA Assessment		
CDM Potential		Nigerian DNA experienced, healthy CDM revenue and financial forecasts, additionality is likely on several grounds
Business Model		
Project Status		



SENEGAL BIOMASS ROSS BETHIO



Technology	Capacity	Promoter	Status
Biomass	15 MW	SGI	Feasibility study planned

Estimated cost	LCOE
57.000.000 EUR	119 EUR/MWh



Resource Assessment		Work needed to confirm biomass feedstock supply costs and harvesting methods
Technical Risk		Gasification technology using engines is not proven at large scale, but would appear proven for combustion in a boiler feeding a steam turbine
ESIA Assessment		
CDM Potential		Eligibility and additionality tests are positive. CDM cycle underway
Business Model		
Project Status		Project is at the feasibility stage. To reach financial close, considerable project development required



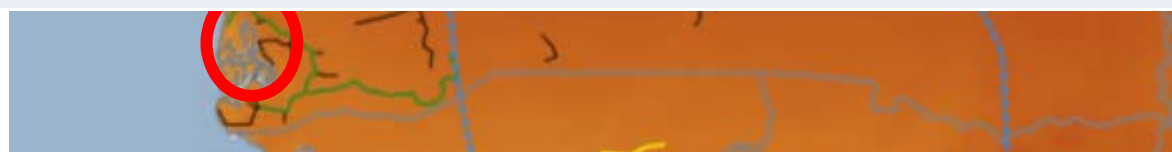
SENEGAL PV ZIGUINCHOR



Technology	Capacity	Promoter	Status
PV	10 MW	Government	Fund mobilization

Estimated cost	LCOE
23.000.000 EUR	189 EUR/MWh

Resource Assessment	■	Good Irradiation study available
Technical Risk	■	
ESIA Assessment	■	Not EIA done yet
CDM Potential	■	Eligibility and additionality ensured. Annual CDM revenue very good at around €117,400/year, eligible for PoA however positive outlook as a small-scale standalone project. No CDM development as yet.
Business Model	■	
Project Status	■	Project is at the feasibility stage





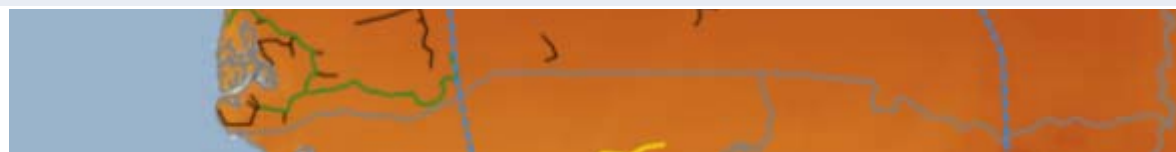
SENEGAL PV SAKAL/DAGANA



Technology	Capacity	Promoter	Status
PV	20 MW	Government	Fund mobilization

Estimated cost	LCOE
58.500.000 EUR	220 EUR/MWh

Resource Assessment	■	Information about Solar irradiation and yield is adequate
Technical Risk	■	The main components for project are known (modules, inverter, tracking system), other component are not known.
ESIA Assessment	■	No ESIA prepared but possibly no significant impacts except during construction
CDM Potential	■	Additionality positive
Business Model	■	Further financial evaluation required, including sale price of electricity
Project Status	■	Project at the designing stage





SENEGAL TAIBA NDIAYE WIND FARM

(75 MW + 50 MW)



Technology	Capacity	Promoter	Status
Wind	125	SARREOL	Fund mobilization

Estimated cost	LCOE
245.000.000 EUR	150 EUR/MWh



Resource Assessment	Yellow	Long term correlation performed, but no actual evidence cited on mean wind speed
Technical Risk	Yellow	Little detail on the transport infrastructure risks given
ESIA Assessment	Yellow	EIA has been carried out and approved but may not be up to international standards. There could potentially be red triggers for project financing .
CDM Potential	Green	Project requested registration, CDM cycle in full flow, emissions reductions and CDM revenues very positive
Business Model	Green	Further financial evaluation required, including sale price of electricity
Project Status	Red	Documentation is a little ambiguous on wind farm size and hence installation layouts



SIERRA LEONA SMALL HYDRO



Technology	Capacity	Promoter	Status
Small Hydro	10 MW	GEF	Fund mobilization

Estimated cost	LCOE
23.400.000 EUR	77 EUR/MWh



Resource Assessment	Yellow	Yield estimate not based on actual flow data
Technical Risk	Green	
ESIA Assessment	Yellow	EIA has been carried out and approved but may not be up to international standards. There could potentially be red triggers for project financing .
CDM Potential	Green	No ESIA completed but adverse environmental and/or social effects not likely to be significant. However, climate change effects could affect the hydrological regime
Business Model	Yellow	Further project specific financial evaluation required
Project Status	Green	Documentation is a little ambiguous on wind farm size and hence installation layouts



TOGO PV PARK



Technology	Capacity	Promoter	Status
PV	5 MW	CEB	Feasibility study planned

Estimated cost	LCOE
15.000.000 EUR	

Resource Assessment		
Technical Risk		
ESIA Assessment		
CDM Potential		Bundling/PoA development - otherwise low CDM revenue. Challenge will be lack of DNA capacity.
Business Model		
Project Status		Project at the prospection stage



Thank you! Merci! Muito Obrigado!

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