UNDA Project on "Promoting Renewable Energy Investments for Climate Change Mitigation and Sustainable Development"

UNDA Project Closing Workshop:

"Renewable Energy UNDA project conclusions and way forward"

13-14 December 2017, Beirut - Lebanon

Economic And Social Commission For Western Asia / United Nations Economic Commission for Europe

UNITED NATIONS

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ESCWA

UNDA Renewable Energy Pipeline Projects

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The Technical Assistance Process

- Call for RE proposals sent to relevant parties in ESCWA Member Countries (MCs)
- 12 RE project proposals from 6 ESCWA MCs where received with project developers seeking technical assistance
- Project developers were invited to attend the training workshop on RE project development
- A guidebook for project developers, outlining the steps for preparing bankable project proposals, was developed, including generic calculation templates per technology.
- Material used as a basis for the training & technical assistance

ESCWA RE Project Development Portfolio

The Technical Assistance Process

- **A consultant was engaged by ESCWA to provide individual technical assistance to RE project developers that expressed interest in the process**
- **Project developers for 9 RE Projects, from 4 ESCWA MCs, confirmed their interest and completed the technical assistance process:**
  - Libya : 1 RE Project (REAOL)
  - Mauritania : 2 RE Projects (APAUS)
  - Palestine : 3 RE Projects (Hebron Utility / Hebron Municipality)
    1 RE Project (Palestine Red Crescent / Hebron)
  - Sudan : 1 RE Project (HCEURP)
    1 RE Project (ATTS)

Selected analysed UNECE Investment proposals

	Name	Size MW	Cost Euro m	IRR	IRR equity	DSCR min	Tariff E/MWh	LCOE E/MWh
1	Armenia PV	**1.00**	**0.60**	77%	154%	12.63	n/a	n/a
2	Armenia, production of more efficient PV modules							
3	Georgia biomass amaranth	**3.00**	**3.54**	14%	89%	1.71	50.00	42.66
4	Georgia wood pellets, schools	**0.30**	**0.12**	48%	142%	4.14	n/a	n/a
5	Ukraine Bio Gaz Zorg	**4.50**	**18.00**	20%			135	
6	Uzbekistan biomass amaranth	**1.00**	**6.0**	39%			60	
7	Uzbekistan solar	**0.50**	**1.00**	-7%	9%	1.54	n/a	n/a
8	Uzbekistan biomass	**20.00**	**1.00**	165%	276%	16.25	60.00	88.39

*under “Promoting Renewable Energy Investments for Climate Change Mitigation and Sustainable Development’ project by UNESCWA and

Cost of RE technologies

Investment cost of power generation technologies in the UNECE region

Technology	Range ($/kW)	Weighted average ($/kW)	Capacity factor range	Capacity factor range weighted
Biomass	1344 to 7106	1756	0.713 to 0.958	0.831
Hydro	519 to 5416	2945	0.169 to 0.854	0.421
Solar	1545 to 3697	2775	0.117 to 0.127	0.119
Onshore Wind	1550 to 2651	1751	0.272 to 0.350	0.344

Source REN21 2017

Cost of generated energy

Levelised cost of Energy of power generation technologies in the UNECE region (in $/kWh)

Technology	Range	Weighted average
Biomass	0.05 to 0.12	0.05
Hydro	0.03 to 0.27	0.05
Solar	0.17 to 0.25	0.21
Onshore Wind	0.07 to 0.14	0.075

Source: REN21 2017

Renewable projects implemented and in pipeline in the UNECE region 2010-2020

Country	Size (MW)	Price (USD/kWh)	Energy cost (USD/kWh)	CAPEX in USD mln (estimated)
Armenia	1,268	1,185	0.37	480
Azerbaijan	623	2,140	NA	1,040
Georgia	2,185	1,850	NA	4,136
Kazakhstan	2,426	1,710	1.00	4,416
Kyrgyzstan	2,475	2,330	0.45	3,427
Tajikistan	7,808	1,872	0.29	4,101
Ukraine	1307	2,800	NA	2,848
Uzbekistan	2,397	1,607	0.80	700
TOTAL	20,489	1,937	0.58	19,748

ESCWA RE Projects

Project Summary RE 2

Name	Grid connected photovoltaic system of Hoon		
Country	Libya		
Organisation	REA Libya		
Installed capacity	14.00	MWp	
Annual production	27,622	MWh	
	$		**LC**
Project cost	22,120,000		27,650,000
Tariff $/MWh	141.0		176.3
LCOE $/MWh	44.5		55.6
Finance	**scenarios**		
	100% equity 5% discount		50% equity 50% loan 2% interest
Loan interest			2.00%
Loan tenor y			15
IRR on equity	15%		11%
Net Cum disc cash @ year 20	27,586,265		-7,786,214
min DSCR	-		2.27

ESCWA RE Projects

RE-P3 MAURITANIA

Name	PV 10 rural localities in the country			
Country	Mauritania			
Organisation	Universal access to Basic Services Agency (APAUS)			
Installed capacity	1	MWp	of which 78%	
Annual production	1973	MWh		
	$	LC		
Project cost	6,300,000	2,250,000,000		
Tariff $/MWh	400	142,857		
LCOE $/MWh	671	239,534		
Finance	**scenarios**			
	0	10% equity 90% IDA loan	10% equity 18% loan 72% grant	
Loan interest	1.25%	1.25%		
Loan tenor	15	15		
IRR on equity	#NUM!	3%		
Net Cum disc cash @ year 20 in	-1,314,390,409	-50,329,785		
min DSCR	0.25	1.23		

ESCWA RE Projects

RE-P4 MAURITANIA

Name	PV, Wind, Hydro180 isolated rural villages		
Country	Mauritania		
Organisation	APAUS		
Installed capacity	1.00	MWp	
Annual production	676	MWh	
	$		**LC**
Project cost	12,000,000		4,285,714,286
Tariff $/MWh	420		150,000
LCOE $/MWh	761		271,904

Finance	scenarios		
	0 10% equity	90% ADFD loan	10% equity 50% loan 40% grant
Loan interest		1.00%	1.00%
Loan tenor		20	20
IRR on equity		#NUM!	#NUM!
Cum disc cash @ year 20 in LC		-2,428,343,713	-1,213,162,658
min DSCR		0.26	0.47
	Government guarantee		

ESCWA RE Projects

RE-P4 MAURITANIA

Name	PV, Wind, Hydro180 isolated rural villages		
Country	Mauritania		
Organisation	APAUS		
Installed capacity	1.00	MWp	
Annual production	676	MWh	
	$		**LC**
Project cost	12,000,000		4,285,714,286
Tariff $/MWh	420		150,000
LCOE $/MWh	761		271,904

Finance	scenarios		
	0 10% equity	90% ADFD loan	10% equity 50% loan 40% grant
Loan interest		1.00%	1.00%
Loan tenor		20	20
IRR on equity		#NUM!	#NUM!
Cum disc cash @ year 20 in LC		-2,428,343,713	-1,213,162,658
min DSCR		0.26	0.47
	Government guarantee		

ESCWA RE Projects

RE-P4 MAURITANIA

Name	PV, Wind, Hydro180 isolated rural villages		
Country	Mauritania		
Organisation	APAUS		
Installed capacity	1.00	MWp	
Annual production	676	MWh	
	$		**LC**
Project cost	12,000,000		4,285,714,286
Tariff $/MWh	420		150,000
LCOE $/MWh	761		271,904

Finance	scenarios		
	0 10% equity	90% ADFD loan	10% equity 50% loan 40% grant
Loan interest		1.00%	1.00%
Loan tenor		20	20
IRR on equity		#NUM!	#NUM!
Cum disc cash @ year 20 in LC		-2,428,343,713	-1,213,162,658
min DSCR		0.26	0.47
	Government guarantee		

ESCWA RE Projects

RE-P6 PALESTINE

Name	PV rooftop Hebron	
Country	Palestine	
Organisation	Hebron Electric Power Company	
Installed capacity	1	MWp
Annual production	1500	MWh
	$	LC
Project cost	1,500,000	5,357,143
Tariff $/MWh	110.00	392.86
LCOE $/MWh	33.65	120.17
Finance	**scenarios**	
	5% equity 95% grant	5% equity 25% loan 70% grant
Loan interest	1.25%	1.25%
Loan tenor	15	15
IRR on equity	137%	62%
Cum disc cash @ year 20 in LC	3,182,745	1,608,277
min DSCR		1.83

ESCWA RE Projects

RE-P7 PALESTINE

Name	PV Solar Power, 1MW ground mounted			
Country	Palestine			
Organisation	Hebron Electric Power Company			
Installed capacity		1	MWp	
Annual production		1500	MWh	
	$		LC	
Project cost		1500000		5357142.857
Tariff $/MWh		110		392.8571429
LCOE $/MWh		126.4216844		451.5060157
Finance	scenarios			
	5% equity 95% grant		5% equity 25% loan 70% grant	
Loan interest				1.25%
Loan tenor				15
IRR on equity		137%		95%
Cum disc cash @ year 20 in LC		3,182,745		2,308,041
min DSCR				3.29

ESCWA RE Projects

RE-P7 PALESTINE

Name	PV Solar Power, 1MW ground mounted			
Country	Palestine			
Organisation	Hebron Electric Power Company			
Installed capacity		1	MWp	
Annual production		1500	MWh	
	$		LC	
Project cost		1500000		5357142.857
Tariff $/MWh		110		392.8571429
LCOE $/MWh		126.4216844		451.5060157
Finance	scenarios			
	5% equity 95% grant		5% equity 25% loan 70% grant	
Loan interest				1.25%
Loan tenor				15
IRR on equity		137%		95%
Cum disc cash @ year 20 in LC		3,182,745		2,308,041
min DSCR				3.29

ESCWA RE Projects

RE-P8 PALESTINE

Name	MSW Gas Generation of 1000 kW			
Country	Palestine			
Organisation	Hebron Electric Power Company			
Installed capacity		1	MW	
Annual production		3000	MWh	
		$		LC
Project cost		2,250,000		8,035,714
Tariff $/MWh		110.00		392.86
LCOE $/MWh		91.56		327.01
Finance	scenarios			
	16% equity 84% grant		16% equity 84% loan	
Loan interest				2.00%
Loan tenor				15
IRR on total investment		10%		2%
IRR on equity		75%		55%
Cum disc cash @ year 20 in LC		7,950,942		3,766,561
min DSCR		-		1.16

ESCWA RE Projects

RE-P9 PALESTINE

Name	Hebron Red Crescent	
Country	Palestine	
Organisation	Hebron Red Crescent	
Installed capacity	0.08	MWp
Annual production	72	MWh

	$	LC
Project cost	89,600	320,000
Tariff $/MWh	110.00	392.86
LCOE $/MWh	157.32	561.87

Finance scenarios	10% equity 90% grant	10% equity 40% loan 50% grant
Loan interest		2.00%
Loan tenor		15
IRR on total investment	1%	-4%
IRR on equity	58%	23%
Cum disc cash @ year 20 in LC	141,933	53,402
min DSCR		1.60

ESCWA RE Projects

RE-P11 SUDAN Waste PP

Name	Combined Heat and Power Plants on waste	
Country	Sudan	
Organisation	Sudan University of Science and Technology	
Installed capacity	52	MWe
Annual production	374,711	MWhe
Annual production heat	435,000	MWht
	$	LC
Project cost	260,000,000	260,000,000
Tariff $/MWhe	100.00	100.00
LCOE $/MWh	151.37	151.37
Tariff $/MWht	20.00	20.00

Finance	scenarios	
	0 20% equity 80% loan 2% i	20% equity 80% loan 10% int
Loan interest	2.00%	10.00%
Loan tenor	20	20
IRR on total investment	3%	-2%
IRR on equity	32%	11%
Net cum disc cash @ year 20 in LC	78,369,806	-6,539,612
min DSCR	2.06	0.98

ESCWA RE Projects

P12 Sudan

Name	1000 bio digesters			
Country	Sudan			
Organisation	ATTS			
Installed number digesters		1,000	units	
Annual production		2.689	MWh/annum (2m3 biogas day)/unit	
		$	**SDG**	
Project cost		754,000	18,096,000	
Tariff $/unit/year		96.00	2,304.00	
Operation cost/ year		11	271	
Finance	**scenarios**			
	35% equity 65% loan 7y		35% equity 65% loan 15 y 2%	
IRR on equity		#NUM!	40%	15%
Cum disc cash @ year 20 in		-8,028,601	8,825,047	
min DSCR		0.83	2.18	

Summary ESCWA RE Projects

Summary of projects submitted by UNESCWA

	Country	Project	Size MW	Cost $	Equity %	IRR equity	DSCR min	Tariff $/MW	LCOE $/MW	Comments
P2	Libya	PV	4.00	22.12	100%	15%	-	141.00	144.46	grant funded
P3	Mauritania	PV	1.00	6.30	10%	3%	0.25	400.00	670.69	80% desalination
P4	Mauritania	PV, W, H	1.00	12.00	10%	-	0.26	420.00	761.33	180 villages
P6	Palestina	PV	1.00	1.50	5%	137%	-	110.00	126.42	rooftop
P7	Palestina	PV	1.00	1.50	5%	137%	-	110.00	126.42	ground
P8	Palestina	Biogas	1.00	2.25	16%	75%	-	110.00	191.56	
P9	Palestina	PV	0.08	0.09	10%	58%	-	110.00	157.32	rooftop
P11	Sudan	Waste	62.00	260.00	20%	32%	2.06	100.00	151.37	waste to energy
P12	Sudan	Biogas	0.31	0.48	35%	-	0.50	n/a	n/a	1000 biodigesters
	TOTAL		71.39	306.24						

Summary UNECE projects

Summary of projects submitted by UNECE

	Name	Project	Size MW	Cost	IRR	IRR equity	DSCR min	Tariff $/MV	LCOE $/MV	Comments
	Albania hydro	H	20.50	24.98	8%	21%	1.28	60.71	21.03	cost water 153'366 ALL/kW?, degradation 5%/y?
	Albania solar	PV	2.50	3.52	0%	8%	1.16	140.00	101.57	Low DSCR
	Armenia production	PV	1.00	0.60	77%	154%	2.63	n/a	n/a	sales margin very high, cost of materials low?
	Belarus biomass	B	0.92	11.00	-7%	-4%	0.36	170.00	199.67	waiting info
	Bosnia biomass CHP	B	1.00	0.65	62%	464%	7.77	119.50	47.51	very profitable, cost of fuel? Very low equity!
	Bosnia Hydro 1	H	3.00	4.13	11%	20%	2.16	63.30	26.86	good project, environmental studies?
	Bosnia Hydro Livno	H	0.59	0.94	7%	20%	1.30	63.50	26.60	good project, environmental studies?
	Croatia Solar PV Kor	PV	1.29	1.50	2%	10%	2.28	200.00	111.03	IRR on 15y (invertor replacement?)
	Georgia biomass ha	B	0.30	0.28	-7%	0%	1.15	n/a	n/a	fuel substitution, for demonstration
	Georgia biomass an	B	3.00	3.54	14%	89%	1.71	60.00	42.66	supply of fuel? Cost of fuel?
	Kyrgistan hydro	H	2.40	2.50	13%	31%	1.31	67.00	38.21	efficiency on high side?
	Kazakhstan wind	W	41.00	51.25	5%	17%	1.25	75.62	31.31	industrial size
	Macedonia wind	W	36.80	54.50	2%	17%	1.09	89.00	52.21	financed by KfW, sovereign guarantee, concessional?
	Montenegro Solar h	S	0.01	0.07	-16%	-15%	0.25	495.00	658.55	demonstration, too expensive
	Ukraine biomass Ch	B	5.00	14.40	13%	26%	1.45	123.90	90.16	fuel supply, radioactive emissions
	Uzbekistan heat pu	H	0.01	0.10	-3%	2%	0.55	n/a	n/a	high fixed cost, demonstration project
	Croatia biogas	B	1.00	6.17	-5%	0%	2.74	164.34	337.51	high fixed costs
	Montenegro solar	PV	1.00	1.20	10%	10%	-	150.00	82.16	10% if sold, 1% if substitute own consumption
	Uzbekistan solar	PV	500.00	1.00	-7%	9%	1.54	n/a	n/a	waiting info
	Uzbekistan bio	B	20.00	1.00	165%	276%	6.25	60.00	38.39	cost of fuel? Unrealistic high return
	Georgia wood pelle	B	3,000.00	0.12	48%	142%	4.14	n/a	n/a	supply and cost of wood?
	Turkmenistan produ	PV	400.00	0.15	15%	24%	1.39	n/a	n/a	assuming annual increase of sale price 2.5%
	TOTAL		641.31	183.61						

Example RE Project in Libya

Project Summary RE 2 PV Libya

A 14 MWp solar PV project in the city of Hoon, Libya, to be implemented by the Renewable Energy Authority of Libya (REAOL). The project is to be financed by the Government of Libya with the aim to: Apply feed-in electricity to the grid using PV technology, which supports the grid to demonstrate the demand of electrical energy for costumers; Increase the availability of the grid; Save fuel; Convince off-takers with PV technology; Make use of high radiation intensities in the region. Preliminary feasibility study on the radiation has been conducted and indicates 1970 MWh/MW. The land and grid connection is provided by the government. The project is intended to by financed by the government. The main risks include political instability, weak legal framework, vandalism and low energy prices (1,41 $c/kWh).

Example RE Project in Libya

Name	Grid connected photovoltaic system of Hoon	
Country	Libya	
Organisation	REA Libya	
Installed capacity	14.00	MWp
Annual production	27,622	MWh
	$	**LC**
Project cost	22,120,000	27,650,000
Tariff $/MWh	141.0	176.3
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Finance	**scenarios**	
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Loan tenor y		15
IRR on equity	15%	11%
Net Cum disc cash @ year 20	27,586,265	-7,786,214
min DSCR	-	2.27

ESCWA RE Project Development Portfolio
The Technical Assistance Process

In conclusion

- **Specific tools are available to carry out RE economic feasibility studies**
- **Economic pre-feasibility studies for 9 RE projects have been carried out, and can be used to start preparing bankable proposals for projects with promising profitability indicators**
- **For these projects, need to proceed with verification of technical details and confirmation of the economic inputs**
- **The confirmed/verified data would be used in a new evaluation to confirm the conclusions of the pre-feasibility studies and proceed with the preparation of the bankable proposals**

Next Steps

- Internal analysis and decision making
- Selection of investment strategy and approach
- Identification of investment sources
- Completion of application documents – business plan, grant application
- Implementation – responsibilities, governance, supervision, reporting

***Link to UN DA project*: https://www.unescwa.org/node/94046**

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THANK YOU FOR YOUR ATTENTION

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