Interim Report (WP12)
and
Preliminary chapters on WP1 to WP11 of the final report

Economic Analysis to Facilitate the Establishment of a Stable Price for Electricity from Renewable Sources

ME 36_1_2 T54

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March 10th, 2017

This interim report summaries the results of the work on WP1 to WP11, which were scheduled to be completed by the time of the interim report. For detailed information on each work package please look at the full text on each work package in the appendix. These full text are draft versions of the first eleven work package chapters for the final project report.

In addition to summarising the results achieved so far the interim report looks at the work and time plan of the project and suggests necessary adjustments due to substantial delays in the final acceptance of the inception report, which was delivered to the Energy Devision as a draft in November 2016. Due to a lengthy process of approval it has taken until mid February 2017 to receive the final approval of the inception report.

This interim report suggests two additional visits of the consultant to Barbados in April and June 2017 to facilitate the final discussion of the report and the presentation and discussion of the key results.

Summary of the results of WP1 to WP11

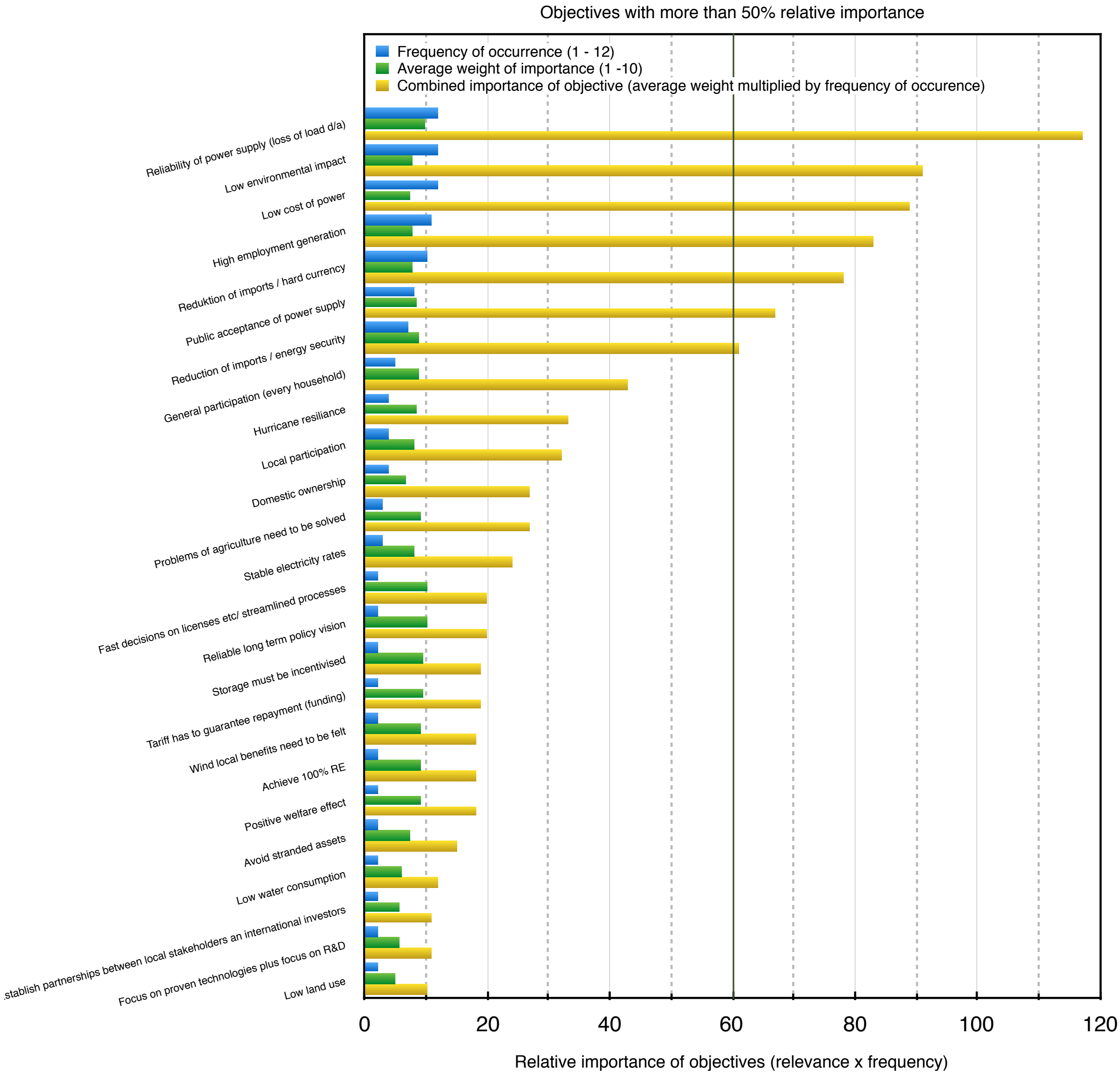
WORK PACKAGE 1: STAKEHOLDER CONSULTATIONS

As the report has to recommend the most appropriate market structure, support mechanisms and policy measures for a sustainable development and stable prices of renewable electricity in Barbados it was necessary to find out the most important objectives of the introduction of renewable energy held by important stakeholders in the energy sector in Barbados. Interviews with twelve key stakeholders in power generation and renewable energy were conducted asking for the important objectives seen and their relative importance. The interviews produced 56 different objectives, out of which 30 objectives were only mentioned by one stakeholder. Combining the results of all interviews (average weight times the frequency at which an objective was mentioned) lead to an ordered set of objectives by relative importance. The results are shown in Figure IR1 below. Besides the *reliability of the power supply* a *low environmental impact, low cost of power, high employment generation,* and *reduction of imports* to reduce *to outflow of hard currency* and to *increase energy security* are objectives of high importance to the interviewed stakeholders. *Local participation* and *domestic ownership were* mentioned as other important objectives. The *public acceptance of the power supply* was an other important objective relating to public involvement. One group of stakeholders with an agricultural background stressed the objective p*roblems of agriculture need to be solved.*
These important objectives can give orientation beyond the often used *low cost of power* and *reliability of power supply* for the design of energy policies and support mechanisms as well as for the discussion on the most appropriate market structure.

WORK PACKAGE 2: UPDATED ESTIMATES ON RENEWABLE ENERGY POTENTIALS AND COSTS

In work package 2 the available information on international cost developments for wind and solar PV were brought together with information on local cost and potentials. As a result it can be concluded that especially in the case of solar PV Barbados has made substantial progress in reducing the cost differences of systems installed in Barbados and in the world market. By early 2017 PV systems were installed at cost as low as 2.13 BBD/Wp. Nevertheless, very expensive systems are being installed at up to 20 BBD/kWp, which strongly influence average investment cost to between 5.9 and 11.4 BBD/Wp depending on system size. At the same time international PV prices are in the range of 2.8 to 5.8 BBD/Wp depending on system size.

Figure IR1: Frequency of occurrence, average weight of importance and relative importance of the twenty five objectives mentioned by at least to key stakeholders



For wind no reliable data exist for Barbados, but experts involved in the first two larger wind development projects suggest that the cost are about 20-25% higher in Barbados as compared to the world market due to market size and transport cost. At the end of 2016 world market prices for wind turbines including all investment and financing cost are in the range of 3,400 BBD/kW, with very similar costs in Europe (Germany as European lead market) and in the US.

Cost for biomass are highly project specific and no cost figures can be quoted from international markets, which could be directly compared to the two major biomass activities in Barbados for which cost estimates are available. The investment costs for the bagasse combustion plant are quoted at 18,400 BBD/kW (230 million USD for 25 MW capacity), while the first estimates for the gasification and power production from King Grass are at 10,000 BBD/kW.

Concerning the potential of of renewable energy resources in Barbados specifically wind seems to be critical. A new assessment by Rogers (2015) shows a good potential of about 450 MW as a result of a detailed study of the local wind resource. The potential of bioenergy depends highly on the agricultural land available and the type of use (energy crops only or energy like King Grass as a byproduct of an other crop utilisation like bagasse). In the case of King Grass 20,000 acres could produce about 400 GWh of electricity per year, while the use of bagasse from 18,000 acres of sugar cane plus river tamarind from additional 5,000 acres could produce about 169 GWh/a (net) in the biomass combustion planned by the cane industry.

WORK PACKAGE 3: UPDATED DISCUSSION OF THE APPLICABILITY OF PUMP STORAGE HYDRO SYSTEMS AND THEIR COSTS IN BARBADOS

Latest studies have shown that pump storage installations in the range of 1 to 5 GWh of storage are feasible in Barbados (Stantec 2016) and that the costs will most likely be in the range of about 3,000 BBD/kW. Pump storage experts visiting the island in late 2016 came to the conclusion that the cost should be close to the average of present pump storage facilities build around the world. As the system will play a central role in controlling the frequency and voltage of the power system the specific technology used will allow a very fast and continuous operation shifting from 100% pumping to 100% generation within less than 180 seconds.

Battery storage, although becoming cheaper in the last years is still far away from being competitive with pump storage at the necessary scale for Barbados. The concentration on battery storage mislead the authors of the IRENA road map for Barbados to ignoring the potential of their own scenario. As shown in new model simulations including in this report the inclusion of a sizeable pump storage plant (3 GWh storage) instead of the assumed battery storage of 150 MWh would have lead to 94% of renewable energy production with the same installed renewable energy capacity instead of the 84% reached by the battery based scenario.

WORK PACKAGE 4: EXTENSION AND UPDATE OF HOURLY POWER SYSTEM SIMULATION MODEL FOR BARBADOS

The analysis of the most appropriate market structure, support mechanisms and policies for a sustainable development of renewable electricity generation in Barbados needs to be tested against the target to be reached and the transition pathway to the renewable energy based target system. To analyse different possible target systems for a 100% renewable electricity supply for Barbados the existing hourly simulation model developed by the author and applied to 100% renewable energy solutions was extended to accommodate the use of flexible bioenergy from King Grass gasification. This extension allows to model seasonal harvesting and flexible hour of day production based on a day ahead prognosis of the production from wind and solar energy. At the same time the model was extended to handle power production from waste gasification on the same basis.

In addition the model was extended by a discounted cash flow subprogram, which allows to account for the hourly income from residual load dependent feed-in tariffs for example for electricity from King Grass or solid waste gasification. This can be used to assess the impact of load dependent tariffs on flexible production units as a precondition to the setting of such tariffs.

WORK PACKAGE 5: SIMULATION OF ALTERNATIVE 100% RE TARGET SYSTEMS AND ANALYSIS OF THEIR PROSPECTIVE COSTS

A set of 18 different target systems were simulated to analyse all relevant combinations of the renewable power technologies available to Barbados. These technologies are wind turbines, solar PV systems, solid biomass combustion, biomass gasification, solid waste combustion and waste gasification. The comparison of the power costs of all alternative target systems showed that a combination of wind, PV and solid waste combustion can produce 100% renewable power at the lowest cost (0.39 BBD/kWh in a year of low winds).

The target system addressing the agricultural problem still having relatively low costs is the combination of wind, PV, solid waste combustion and the gasification of King Grass from about 6,000 acres leading to costs of 0.4 BBD/kWh. Table IR1 shows the costs of each simulated scenario in the sequence of the cost per kWh.

Table IR1: Electricity cost per kWh of simulated target systems for 100% RE power for Barbados

Scenario		LCOE
No.	**Name**	**BBD/kWh**
11	100% RE / Wind / PV / Solid waste combustion	0,3883
7	100% RE Wind and PV plus storage	0,3999
13	100% RE / Wind / PV / King Grass / WTE combustion	0,4004
6	100% RE Wind and storage alone	0,4013
17	100% RE / Wind / PV / King Grass / Bagasse / WTE combustion	0,4128
14	100% RE / Wind / PV / Bagasse / WTE combustion	0,4143
12	100% RE / Wind / PV / King Grass / WTE gas	0,4209
8	100% RE / Wind / PV / King Grass	0,4212
9	100% RE / Wind / PV / Bagasse	0,4233
10	100% RE / Wind / PV / WTE gas	0,4356
18	100% RE / Wind / PV / King Grass / Bagasse / WTE gasification /WTE combustion	0,4361
13a	100% RE / Wind / PV / King Grass / WTE combustion	0,4386
1	New diesel only (base line)	0,4495
16	100% RE / Wind / PV / King Grass / Bagasse / WTE gasification	0,4584
15	100% RE / Wind / PV / Bagasse / WTE gas	0,4614
2	Bagasse and river tamarind only	0,4810
3	King grass gasification only	0,4886
5	100% RE PV and storage alone	0,5100
4	Waste to energy gasification only	0,5126

WORK PACKAGE 6: DISCUSSION OF THE ALTERNATIVE 100% RE TARGET SYSTEMS WITH THE RELEVANT STAKEHOLDERS AND THE ENERGY DIVISION

As all reasonable alternatives have been covered by the scenarios calculated and as it has become clear that only one option can be dismissed right away, while all other decisions will need to be made by policymakers, it was decided that a stakeholder workshop could not decide on the final technology choices. Only if a decision on the solution of the agricultural problem is taken by policymakers, the decision on the final target system can be made.

Policymakers will need to decide how to complement the basic mixture of wind, PV and solid waste combustion with a biomass technology for securing the future of intercropping agriculture in Barbados. As the King Grass gasification is right know entering the demonstration phase, it might be wise to postpone this decision until the results of the first demonstration project on Barbados will be available about 2020. In the meantime the expansion of wind and solar PV can be pursued without the need for such a decision for the energy system before 2025.

Instead of holding the planned stakeholder workshop on the modelling results there will be a broader workshop at the end of the project for the discussion of all results of phase one and phase two of the project. From recent discussions it has become clear that, while most stakeholders see the advantages of a differentiated dynamic feed-in tariff system, the first price points to be suggested in the report and the assumptions going into their calculation will meet far greater interest as some details of the final target scenario.

WORK PACKAGE 7: ANALYSIS OF THE PRESENT POWER SUPPLY SYSTEM AS THE STARTING POINT OF THE NECESSARY TRANSITION TO A 100% RE TARGET SYSTEM

The analysis of the present power supply system shows that this is dominated still by oil based power production (96%), although the installation of solar PV has increased significantly during the last years. With respect to the necessary back-up of future renewable power systems the present generating equipment with the exemption of the steam turbines (2 x 20 MW out of 239 MW total generating capacity) can be used as flexible back-up capacity, if the necessary maintenance is done and the generators are kept operating. The target system simulations show a back-up capacity between 160 and 200 MW will be need. Therefore, the flexible part of the present generators of BL&P will be a sufficient back up capacity for the target systems. As the equipment will be fully written off by the time when it will go into back-up operation, these generators will be the cheapest back-up capacity available to the system.

Form the IRP (integrated resource plan) of Barbados Light and Power (2012), filed in 2012 the power demand for 2035 is estimated to be around 1,350 GWh/a in the base case. In a low case it is estimated at about 950 and in a high demand case at about 2,000 GWh/a. For the simulations of the 100% RE target system a demand of 1,350 GWh/a has been assumed based on the numbers of the IRP.

WORK PACKAGE 8: DESIGN OF AN APPROPRIATE TRANSITION PATHWAY FROM THE PRESENT ELECTRICITY SYSTEM TO THE 100% RE TARGET SYSTEM

As a result of the eighteen 100% RE target systems simulated in WP5 four different target scenarios have been selected for the design of four alternative transition pathways. These systems are the combination of wind, PV and solid waste combustion (scenario 11) as the lowest cost alternative. The combination of these three technologies with a modest use of King Grass gasification (scenario 13), or with an extensive use of King Grass (scenario 13a) and with the combustion of solid biomass (scenario 14). All scenarios employ between 200 and 260 MW of wind and PV and 11 MW of solid waste combustion. They only differ in the extent of biomass utilisation and the technology used for the biomass utilisation.

All scenarios start faster on PV, because the ramping up of wind energy requires more preconditions to be set appropriately, while the power cost will benefit substantially from the use of wind energy. A substantial share of renewable energy will decrease cost as compared to the starting system, while power cost will increase again as the full 100% are finally approached. By 2020 the share of RE electricity is between 22% and 41%, where the main difference is due to the assumed commissioning of the solid biomass combustion plant (25 MW) before 2020 in scenario 14 bringing the share of RE in this scenario to 41% in 2020 already. The other scenarios show shares close to 25% (see Table IR3 below). By 2030 the RE share increases to between 59% and 75%, with the lowest share in scenario 13a including a massive use of King Grass gasification, while the scenario 14 still has the highest share of RE due to the operation of the solid biomass combustion. By 2030 all scenarios have shares of RE between 86% and 91% with the shares of RE moving closer together. In 2035 all scenarios reach 96.3% of RE based on the selected renewable technologies. The rest of 4.7% is based on bio fuels used in the back-up units. Tables IR2 and IR3 show the development of the four transition pathways.

Table IR2: Four target scenarios for 100% RE power supply in 2035 and transition pathways to these target scenarios

Scenario / Wind year 2011		**Year**	**Annual power demand**	**LCOE**	**Installed capacities and annual generation**									
					Wind		**PV**		**King Grass**		**Bagasse and river tamarind combustion**		**Solid wate combustion**	
No.	**Name**			**BBD/ kWh**	**MW**	**GWh/ a**	**MW**	**GWh/ a**	**MW**	**GWh/ a**	**MW**	**GWh/ a**	**MW**	**GWh/a**
11	100% RE / Wind / PV / WTE combustion	2015	950		0		10	19					0	
		2020	1050	0,3664	25	114	55	113					5	34
		2025	1150	0,3002	105	481	125	258					11	74
		2030	1250	0,3123	185	847	195	403					11	74
		2035	1350	0,3883	265	1213	265	547					11	74
13	100% RE / Wind / PV / King Grass / WTE combustion	2015	950		0	0	10	19	0	0			0	0
		2020	1050	0,3696	20	92	65	134	2	5			5	34
		2025	1150	0,3253	90	412	120	248	10	30			11	74
		2030	1250	0,3161	160	733	175	361	18	75			11	74
		2035	1350	0,4004	232	1062	232	479	26	120			11	74
13 a	100% RE / Wind / PV / King Grass / WTE combustion	2015	950		0		10	19	0	0			0	
		2020	1050	0,3749	20	92	50	103	2	5			5	34
		2025	1150	0,3354	80	366	100	206	14	45			11	74
		2030	1250	0,3451	140	641	150	310	27	150			11	74
		2035	1350	0,4331	200	916	200	413	40	300			11	74
14	100% RE / Wind / PV / Bagasse / WTE combustion	2015	950		0	0	10	19			0	0	0	0
		2020	1050	0,3807	20	92	65	134			25	169	5	34
		2025	1150	0,3452	85	389	120	248			25	169	11	74
		2030	1250	0,3609	170	778	175	361			25	169	11	74
		2035	1350	0,4143	219	1003	219	452			25	169	11	74

Table IR3: Four target scenarios for 100% RE power supply in 2035 and transition pathways to these target scenarios. The development of the need for storage during the transition period.

Scenario / Wind year 2011		Year	Annual power demand	LCOE	Installed capacities and annual generation: Diesel/ Biodiesel		Storage volume	Storage generation		Storage pumping		Share of RE	Total overproduction
No.	Name			BBD/ kWh	MW	GWh/ a	MWh	MW	GWh/ a	MW	GWh/ a	%	GWh/a
11	100% RE / Wind / PV / WTE combustion	2015	950		239	950							
		2020	1050	0,3664	140,9	789						24,9 %	0
		2025	1150	0,3002	148,8	354	3000	150,5	60	90	80	69,2 %	17
		2030	1250	0,3123	162,2	118	5000	186,3	176	220,7	202	90,6 %	192
		2035	1350	0,3883	166,7	50	5000	196,8	205	307	238	96,3 %	400
13	100% RE / Wind / PV / King Grass / WTE combustion	2015	950		239	950	0	0	0	0	0	0,0 %	0
		2020	1050	0,3696	140,2	785						25,2 %	0
		2025	1150	0,3253	148	422						63,3 %	36
		2030	1250	0,3161	155,6	164,4	5000	178	142	162,8	163	86,8 %	157,4
		2035	1350	0,4004	144,8	50	5000	172,9	163	253,4	190	96,3 %	435
13 a	100% RE / Wind / PV / King Grass / WTE combustion	2015	950		239	950						0,0 %	
		2020	1050	0,3749	140,2	816						22,3 %	0
		2025	1150	0,3354	140,5	469						59,2 %	10
		2030	1250	0,3451	135,3	168	5000	156	97	131,5	110	86,6 %	93
		2035	1350	0,4331	131,6	50	5000	156,8	129	199,8	151	96,3 %	403
14	100% RE / Wind / PV / Bagasse / WTE combustion	2015	950		239	950	0	0	0	0	0	0,0 %	0
		2020	1050	0,3807	121,7	621						40,9 %	0
		2025	1150	0,3452	129,9	286	5000	138,4	56	85,3	75	75,1 %	16
		2030	1250	0,3609	139,4	133	5000	165	157	181,4	181	89,4 %	265
		2035	1350	0,4143	151,9	50	5000	180,6	176	248,3	205	96,3 %	398

WORK PACKAGE 9: DISCUSSION OF POSSIBLE MARKET MECHANISMS AND POLICIES FOR THE SUCCESSFUL INTRODUCTION OF RENEWABLES IN BARBADOS

Basically four main market or support mechanisms for the introduction of renewable energy sources into electricity production are used world wide. These are net metering, feed-in tariffs (FIT), renewable portfolio standards (RPS) and auctioning. All are used widely throughout the world, while net metering is seen only as an early mechanism of limited applicability, as it shifts the other power system costs to the customers not producing renewable electricity, which can become overwhelming, if large shares of RE are produced based on net metering. Like net metering FITs approach the target of inducing higher RE shares from the side of the pricing of energy and the quantity installed is determined by the market players, while RPS and auctioning set quantity targets and the final price for the quantity of RE installed is set by market processes.

While pay-as-bid auctions allow to approximate the cost curve for the supply of renewable power RPS combined with the trading of green certificates price according to the last unit of RE supplied. Thus, all other producers with lower costs can benefit from a substantial producer surplus. Therefore, by tendency the cost of renewable electricity supplied under RPS will be higher than under an auctioning system. Both approaches have the serious disadvantage that they require sophisticated well informed market players in sufficient numbers for a competitive market. Thus, most likely they are either not applicable to small island states or may require a substantial number of international investors to reach the necessary level of competition.

FITs rely heavily on an informed administration and well informed policy makers setting differentiated tariffs according to the cost structure of the different RE technologies. If FITs are differentiated for different system sizes and different conditions under which the RE are deployed (e.g. the quality of a wind site) it is possible to approximate the cost curve of a technology similar to the auction process. If FITs are applied in a dynamic way, reducing the rates for new installations every year according to the cost digression of a technology seen in the market, they can result in lower RE cost than auctioning and RPS, as historic experience shows in the comparison between the cost development of RE in Germany (FIT), the UK (auctioning and RPS) and the USA (RPS). At the same time FITs don't need competitive markets to find the tariff to be paid. As RE technologies are traded internationally national FITs can be informed by the international cost structures and developments as long as the local specifics are taken into account.

Empirical evidence has shown that specifically a wide participation of all citizens in RE investments is best accommodated by FITs and that these can induce a very rapid market diffusion of RE.

WORK PACKAGE 10: ANALYSIS OF THE PRESENT MARKET SITUATION OF RENEWABLES IN BARBADOS

Presently only solar PV has been installed in sizeable numbers as RE electricity technology in Barbados. As Table IR4 shows the installation of PV capacity has started in significant numbers in 2012 with 910 kW of capacity installed and annual installation has been increasing ever since. The main driver of the installation of PV has been the renewable energy rider (RER) first introduced in 2010 for a trial period of two years and allowed as a permanent support mechanism in August 2013. The RER was directly linked to the fuel cost adjustment clause and thereby to the world market price of oil. In 2016 the variable rates of the RER based on the Fuel Clause Adjustment was temporarily converted to a fixed feed in tariff of 0.416 BBD/kWh for PV and 0.315 BBD/kWh for wind energy. This change was due to the fact that the world market crude oil price had gone down to below 40 USD/bbl while it was at more than 100 USD/bbl in the years when the RER was originally designed. This massive drop in oil prices led to many solar installations becoming economically endangered. As the 2016 RER ruling, is only temporary investors are waiting for the further development of the Barbados support mechanism.

As the RER initially only applied to installations up to 150 kW, a limit that was later raised to 250 and then to 500 kW, larger installations are not seen in Barbados except the 10 MW PV plant built by BL&P, which does not come under the support mechanisms applied to all other investors

Besides the unclear future of the renewable energy support mechanism the development of RE is slowed down by relatively unclear and lengthy licensing and permitting processes. The new requirement of an ELPA license and the financial burdens posed by it on investors is seen by many as one of the main obstacles to a faster development of RE. The situation that every project over 500 kW is treated as an independent power producer (IPP) under the Electric Light and Power Act (ELPA) puts investors into a very difficult negotiating position with the vertically integrated monopoly of BL&P, as this is a totally asymmetrical negotiating position.

Table IR4: Development of PV capacity in Barbados since 2010 (sources: UNDP no year, p.19, IDB 2016, p. 12 and application data for ELPA licenses)

Year	No. of PV Systems	Annually Installed Capacity (kW)	Cumulative Installed Capacity (kW)
2010	4	7	7
2011	8	7	14
2012	63	896	910
2013	350	1990	2900
2014	710	2600	5500
2015		4900	10400
2016	850	12455	22855

In addition the frequent demand for additional information from investors in unclear licensing and permitting processes are a main obstacle to substantial RE investments in Barbados. Some wind energy projects have been in the licensing and permitting process for more than five years with the end of the process still pending. As compared to international standards this is absolutely not acceptable.

One special problem of the permitting of wind power installations are the distance rulings applied by Town and Country Planning. As different from the international standard rules Town and Country Planning requires minimum distances from the perimeter of the property on which a wind turbine is placed, while the international standard is based on the distance to an object to be protected from the direct impact of wind energy. As the Barbados ruling does not allow to locate wind turbines in the middle of uninhabited agricultural land owned by a several land owners it only allows a small fraction of the wind energy capacity which could be placed on such land as compared to the international standards. If Barbados wants to benefit of its superb wind energy resource and the low cost of wind energy this rule has to be brought up to international standards.

WORK PACKAGE 11: COMPARISON OF PRESENT MARKET SITUATION AND INSTRUMENTS TO POSSIBLE ALTERNATIVE CHOICES

In WP11 the present support situation and the alternative support mechanisms discussed in WP9 are analysed with respect to the important objectives that they should fulfil according to the interviews with key stakeholders (see WP1). In addition to the 13 most important objectives two additional criteria were introduced into the discussion, the *applicability of* such *a support mechanism* and the *necessary administrative effort* to handle a support mechanism. Table IR5 shows the results of the comparison of the support mechanisms with the objectives. Plus signs (+) showing that a support mechanism can fulfil an objective and a minus (-) showing that it does not fulfil the objective. As this can be more or less the case, a scale from (+++) to (- - -) has been used.

As pointed out before, net metering should not be applied at a large scale, as it drives up the cost for the poorest customers and benefits richer investors. The same applies to the original renewable energy riders system, which in times of high oil prices prohibits that power prices are stabilised by the extensive use of cheaper renewables. Thus, both systems have to be ruled out for a large scale application in Barbados.

Renewable portfolio standards (RPS) require functioning markets for green certificates based on the production of renewable electricity. In addition they require spot and futures markets for electricity to fully function. Both types of large anonymous markets can not be established with the small number of market participants in Barbados and with the monopoly generator of conventional electricity. Thus, RPS are not applicable for Barbados and are therefore dismissed.

The final discussion boils down to a comparison of auctioning and feed-in tariffs (FITs) with respect to the important objectives. As measured against all thirteen objectives and the two additional criteria FITs do well on all of them. ***There is not a single objective which could not be met by a well set differentiated dynamic FIT system***.

While auctioning does best on *low cost of electricity* and by tendency even better than an FIT system, if there is enough competition in the auctions, it does badly on *high employment generation, reduction of imports/hard currency, public acceptance of power supply, general participation, local participation* and *domestic ownership*, while it necessitates a large *administrative effort* for the regular auctions and the setting of multiple quantity targets at short intervals. It can do well on *reduction of imports/energy security* and *solving agricultural problems*.

The detailed discussion of all different aspects in WP11 has shown that ***a differentiated dynamic FIT system tailored to the needs of Barbados is by far the most adequate support mechanism for the sustainable long term diffusion and stable prices of renewable energy in Barbados***.

Table IR5: Summary of the scores of all support mechanisms on thirteen objectives for the renewable energy policy of Barbados and two additional criteria

Priority objectives	Relative importance of objective (Score, max. 120)	Support mechanisms						
		Barbados today			Options for the future			
		RER	FTC fixed tariffs	Individual PPAs	Net metering	FIT	RPS	Auctioning
Reliability of power supply (loss of load d/a)	117,0	-	+	+ + +	-	+	+ + +	+ + +
Low environmental impact	91,0	+ +	+ +	+ +	+ +	+ + +	+ +	+
Low cost of power	89,0	-	-	+ +	-	+ +	+	+ + +
High employment generation	83,0	+ + +	+ + +	+	+ + +	+ + +	-	- -
Reduktion of imports / hard currency	78,0	+ +	+ +	+	+ +	+ + +	- -	- -
Public acceptance of power supply	67,0	+ +	+ +	+	+ +	+ + +	- -	- - -
Reduction of imports / energy security	61,0	++	++	++	++	+ + +	+ + +	+ + +
General participation (every household)	43,0	+	+	- - -	+	+ + +	- - -	- - -
Hurricane resiliance	33,0	0	0	0	0	0	0	0
Local participation	32,0	++	++	-	++	+ + +	- - -	- - -
Domestic ownership	27,0	+ + +	+ + +	+	+ + +	+ + +	- - -	- - -
Problems of agriculture need to be solved	27,0	- - -	- - -	+	+	+ + +	- - -	+ + +
Applicable to Barbados	Additional criterion	Yes	Yes	Yes	Yes	Yes	No	Yes
Administrative effort necessary	Additional criterion	+ +	+ +	+ +	+ +	+	- -	- -

Status of the work on the project and planing of the remaining tasks

With the submission of the interim report the first 12 work packages of the project (see Figure IR2) have been completed.

Due to the results from the extensive target system simulations the stakeholder workshop (WP6) has been postponed to the second project phase, as the results of the project will benefit far more from a more comprehensive discussion of all aspects of the project than just a discussion of the target system.

Figure IR2: Detailed project plan taken from the inception report of the project

WP	Name of work package	Person days	Project duration in weeks																
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
WP0	Inception Report	10																	
WP1	Stakeholder interviews	3																	
WP2	Resource potentials and costs	3																	
WP3	Pump storage	3																	
WP4	Model extension	10																	
WP5	Simulation target system	2																	
WP6	Stakeholder discussion	5																	
WP7	Present system	3																	
WP8	Transition pathway	3																	
WP9	Possible market mechanisms	3																	
WP10	Present RE market situation	3																	
WP11	Comparison of market mechanisms	5																	
WP12	Intererim report	5																	
WP13	New market design	3																	
WP14	Price points	3																	
WP15	Grid and grid service pricing	3																	
WP16	Supply model	3																	
WP17	Market strukture	5																	
WP18	Policy recommentdations	3																	
WP19	Liberalisation discussion	3																	
WP20	Liberalisation suggestions																		
WP21	Final recommendations	6																	
WP22	Final report	10																	

It became obvious that by analysing four alternative target systems and the four transition pathways towards them, all relevant target systems could be covered. Thus, a choice between different target system to select just one for the further work(the original task of the stakeholder workshop) proved not to be necessary.

The work on the project has suffered serious delays as compared to the very ambitious original project plan, which was based on the assumption that the inception plan handed in at the end of November 2016 could be modified and finally accepted within two weeks as implied by the TORs for the project. In reality it took from the submission of the draft inception report at the end of November 2016 to the middle of February 2017 to get final approval on the inception report and by this virtue on the final shaping of the work to be done under the contract. This has delayed the completion of the work substantially.

In addition the administrative effort necessary to shift the contract to a Barbados based consultancy company, started for the purpose of keeping the project income in the Barbados economy, had been far underestimated by the consultant used to other return times in administrative procedures. This has taken massive time out of the available time budget of the consultant, being tied down with administrative procedures instead of being able to concentrate fully on the work for the project. These circumstances had a massive impact on the work on the project, as the planning was extremely tight from the beginning based on a request by the Energy Division to supply the results of the project as fast as possible.

In total the work on the project has been delayed by approximately two month, as the interim report is handed in on March 10th instead of the planned submission on January 20th, 2017. The planned time for the remaining work packages was roughly two month. At the moment it seems that most administrative obstacles have been overcome and that the second phase of the project can be done in the timespan originally planned. Thus, it is assumed that the draft final report can be completed in the last week of April and that it will be submitted between April 24th and 28th. If a reasonable response time is kept by the Energy Division it should be possible to finalise the report no later than by the end of May 2017.

In addition to the three visits of the consultant to Barbados in November 2016 (tree weeks), January 2017 (two weeks) and February/March 2017 (four weeks) the consultant is planning to visit Barbados in the second half of April 2017 for two weeks around the submission of the draft final report and in the second half of June for another two weeks to enable the public presentation of the results of the report and to facilitate the public discussion on the suggested support mechanisms, first price points and policy recommendations. These two journeys were not planned for in the project budget, but will be accommodated in the existing budget, if the payments on the contract are not seriously delayed be the Energy Division due to delayed approval of the reports.

During the planned stay in Barbados in the second half of April it is suggested to have an intensive internal discussion of the results with the Division of Energy and a stakeholder workshop for a first presentation of the results and a first stakeholder discussion of the proposed support mechanisms and policy measures (instead of the workshop originally planned for in WP6).

Barbados, March 10th, 2017

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