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A Regional Approach to Developing Multi-Project Baselines for the Power Sector

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Caribbean Participation in the Clean Development Mechanism: A Regional Approach to Developing Multi-Project Baselines for the Power Sector

I. Introduction and Paper Overview

A. Overview of CDM and Potential Opportunity in the Caribbean

The Clean Development Mechanism (CDM) is established under Article 12 of the Kyoto Protocol in order to (1) assist developing countries (non-Annex I countries) in achieving sustainable development, and (2) assist industrialized countries (Annex I countries) in meeting a portion of their emission reduction commitments under the Protocol. The CDM has the potential to attract investments in energy efficiency and renewable energy technologies that will result in local air quality benefits and reduce reliance upon imported fuels in developing countries. In addition, the CDM may have the potential to draw into developing countries needed investments in sustainable land-use and forestry projects.[1] Barriers to investments in such projects often relate to up-front costs and access to capital. Placing a financial value on Certified Emission Reductions (CERs) generated by CDM projects is a way to reduce these barriers and mobilize capital through providing an additional project income stream, thus improving returns on investment.

The size of the CDM market is uncertain, but expert analysts working in the early carbon emissions market estimate that the CDM can provide between $5 and $10 billion dollars of investment per year to developing countries during the first commitment period (2008-2010)[2] (Black, 2000).[3] Preliminary analysis suggests that the CDM potential in the Caribbean power sector alone can generate $114 million dollars in Certified Emission Reductions (CERs).[4]

To participate in the CDM marketplace, Caribbean countries must build the necessary technical and institutional capacity to attract investment to the region. By developing regional baselines and streamlining a process for host country approval, the Caribbean can reduce transaction costs associated with CDM projects, which can be implemented as early as 2000.

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[1] It has not been determined whether carbon sequestration projects will be considered eligible under the CDM.

[2] Assumes the Protocol is ratified and the instrument efficiently designed and operated.

[3] Black (World Bank) estimate is in 1998 dollars. Ellerman, et. al. estimates an emissions market of $26.2 billion dollars per year, assuming no limits on trading and no surcharge, and a price of $9.9 per CER in 1998 dollars, adjusted from a price in 1985 dollars of $6.4 per CER (using the CPI between 1985 and 1998. Source: http://www.westegg.com/inflation).

[4] Based on an estimate of the need for new power generating capacity given the current electricity demand growth rate and the age of older plants which will need to be replaced, 85 million new tons of CO_2 will be emitted in the Caribbean during the 2008-2012 Annex I commitment period under a business-as-usual scenario. If 15% of new electrical capacity are non-fossil-projects and another 15% are BAT diesel engines, 11.5 million tons of CO_2 would be reduced using the "recent additions" baseline of 700 kg CO_2/MWh (see section V of this paper). At $9.9/CER (see footnote 3) this equals a value of $114 million for the CO_2 reductions.

In this paper we examine issues and options for developing regional baselines in the Caribbean power sector. First, we review the development of regional baselines as a tool to reduce transaction costs associated with measuring the "additionality" of CDM projects and quantifying the emission reductions. Second, we discuss options for designing a regional baseline in the Caribbean power sector. Our analysis relies on data collected from regional experts;[5] the methods, assumptions, and data collected are presented in Annex I of this paper.

B. Developing a Regional Approach to CDM Participation

CDM transaction costs will likely be high in the Caribbean because small island states do not have the advantage of economies of scale that larger countries do. Caribbean nations are concerned that investors will focus on larger countries that are likely to have lower costs for institutional design and project evaluation. Developing regional baselines in the Caribbean would address this problem by spreading the costs across all countries. The goals of a regional baseline are to (1) simplify the CDM project review process and reduce transaction costs; (2) attract investment to the region while maintaining the environmental integrity of the Kyoto Protocol, and (3) contribute to the necessary infrastructure to support a multi-country approach to project development (Kelly et al., 2000).

II. Measuring Certified Emission Reductions Under the CDM

A. Purpose of Baselines Under the CDM

According to Article 12.5 of the Kyoto Protocol, emission reductions generated by the CDM must provide "real, measurable, and long term benefits related to the mitigation of climate change." Also, emission reductions must be *additional* to any that would have occurred in the absence of the project activity. Emission reductions that would have happened without the implementation of the CDM should not be considered additional. An emissions baseline is a projection of emissions under a "without project" or "business-as-usual" scenario.

Emission baselines are inherently speculative and uncertain, since they predict events that will not occur if a project is implemented, making it impossible to verify once a CDM project has altered the business-as-usual scenario.

Baseline setting is a necessary step in the CDM process and should be done carefully. Using inflated baselines for CDM projects could undermine the effectiveness of the Kyoto Protocol. Since the emission baseline determines the number of CERs generated by a CDM project, project developers have an incentive to overestimate or inflate the baseline to maximize the number of

[5] A team of energy experts from countries throughout the region was coordinated by Mona Whyte and Byron Smith of the Caribbean Energy Information System of the Scientific Research Council, (CEIS/SRC) in Jamaica. CEIS/SRC also contributed to the data collection.

CERs claimed. If inflated baselines are not detected, and CERs generated by non-additional projects are used by developed countries to meet their emission reduction commitments under the Kyoto Protocol, then developed country emissions will exceed the Kyoto emission reduction target.

B. Multi-Project Baselines

As mentioned above, a baseline is a projection of GHG emissions that would have taken place under business-as-usual conditions, i.e. in the absence of the CDM. There are two approaches to baseline development discussed in this paper.

1. Project-specific baselines – projected business-as-usual emissions for an individual project (e.g. one power plant) based on project-specific data and assumptions regarding fuel use, technology and other relevant factors, over a given period of time.

2. Multi-project baselines (also referred to as "benchmarks") – projected business-as-usual emission rate per unit of output (e.g., tons CO_2/kWh for the power sector, or tons CO_2/ton of cement for the cement industry) based on aggregated data for a region, sector, project type or technology. Groups of similar projects compare their emission rates to the multi-project baseline emission rate (OECD, 1999). The regional baselines for the Caribbean power sector discussed in this paper fall into the multi-project baseline category.

Both project-specific and multi-project baselines are tools that can be used to measure additionality and emission reductions. A project-specific approach requires project developers to prepare and submit baselines for every project and requires the host country and the CDM governance entities (e.g., the designated operational entities and the Executive Board) to conduct an in-depth review of every baseline -- including analysis of a host country's laws, policies, technologies, and management practices -- to verify project additionality. These processes can require a high level of technical capacity and a significant expenditure of time and resources.

Multi-project baselines streamline the project review process and promote consistency and transparency by defining a standardized emissions rate for a sector or project type based on regional, national, or international conditions, so that the process of baseline setting need not be repeated for every project. Once a multi-project baseline is established for a sector, the emissions rate of a group of projects within that sector can be compared to that of the baseline. Any project with an emissions rate lower than the baseline would be considered additional,[6] and CERs can be calculated by subtracting the total emissions associated with a CDM project from the total emissions associated with an equivalent baseline project (Leining and Helme, 2000).

Consider a hypothetical example, illustrated in Figure 1 below, wherein the Caribbean's electricity generation is projected to be dominated by diesel-fired reciprocating engines. Based on the carbon content of diesel fuel and the efficiency of an average power plant, the average

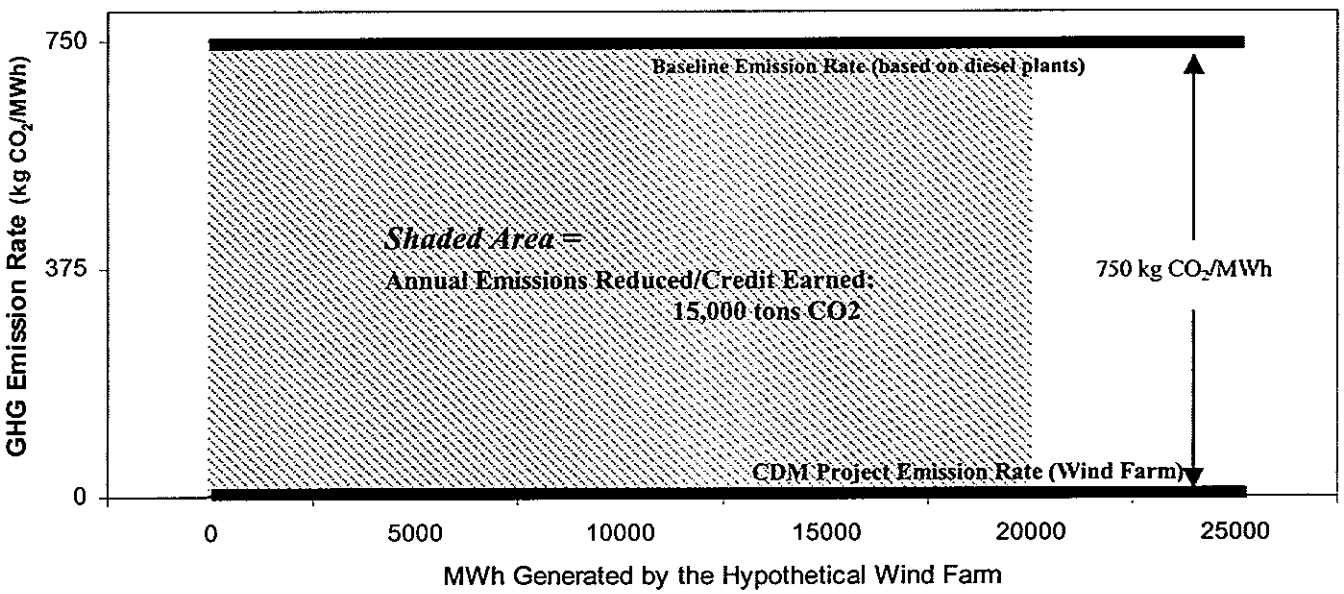
[6] To establish an *annual* emission baseline (total CO_2 per year emitted), the emission rate is multiplied by the number of units of output per year under the project (e.g., kWh of electricity generated or tons of cement produced).

emission rate from these plants is 750 kg of CO_2 for every megawatt-hour (MWh) of electricity produced. This emission rate could be the multi-project baseline with which CDM projects could be compared.

If a CDM project developer wished to install a renewable energy technology, such as a wind turbine, the wind turbine's emission rate of zero would be compared to the multi-project baseline. As illustrated below, the wind project would be additional. Credits would equal the difference of emission rates (750 - 0 = 750 kg CO_2/MWh) multiplied by the electricity output of the wind project. If the wind turbine had 9 MW of capacity,[7] and operated for 30% of the year, it would produce roughly 20,000 MWh of electricity per year. Thus, the amount reduced per year would be:

$$750 \text{ kg } CO_2/\text{MWh} * 20{,}000 \text{ MWh} = 15{,}000 \text{ tons of } CO_2$$

Figure 1: Measuring Emissions Reductions Using a Multi-Project Baseline



Because multi-project baselines do not evaluate additionality using project specific data, multi-project baselines have the potential to credit projects that are not additional. If multi-project baselines are not sufficiently stringent, the risk of awarding non-additional credits increases with the number of projects under the baseline. For this reason, multi-project baselines should be set more stringently (i.e., conservatively) than similar project-specific baselines. For project developers, the reduced transaction costs and greater certainty of multi-project baselines compensates for the greater stringency (Lawson and Helme, 2000).

[7] Represents a real proposal by the Barbados Light and Power Company Ltd to install 9 MW of wind capacity.

C. Status of Negotiations on Baselines

International policy makers have not yet reached consensus on the approaches and methods for establishing baselines. The types of baselines used to evaluate CDM projects can affect the number of projects that can be evaluated annually, the stringency of project review, the consistency of project evaluation and approval, and the transparency of the process. These issues will be the focus of discussions among Parties to the UNFCCC during the sixth session of the Conference of the Parties (COP 6) in November 2000, when decisions are required on rules, guidelines and procedures for implementing CDM projects.

The current negotiating text (UNFCCC, 2000) describes baseline methodologies, capacity building, and the approval process. Negotiators outline both project-specific and multi-project baselines as potential baseline methodologies, with the stipulation that multi-project baselines be set at a better than average rate. Most likely, the CDM Executive Board must evaluate and certify all new baseline methodologies, and an accredited Operational Entity must approve all baselines (including multi-project baselines) before project developers can use the baselines to evaluate CDM projects. International negotiators are considering the Intergovernmental Panel on Climate Change (IPCC)[8] or an Executive Board Panel for a role in guiding baseline methodologies, documentation, and approval criteria. Policy makers recognize that the technical capacity and data systems for developing baselines vary considerably among developing countries, and that capacity building may be needed in order to support the development of baselines and CDM projects.

III. Regional Baselines for the Caribbean Power Sector

A. Characterization of the Caribbean Power Sector

As discussed above, a multi-project baseline would simplify the CDM project review process and reduce transaction costs for investors. Multi-project baselines are only appropriate when sector output, technologies, fuel use, and trends are fairly homogenous and centralized across the region. The power sector has an advantage over other sectors in setting multi-project baselines because the output of electricity is essentially uniform.[9] The power sector in the Caribbean is a particularly good candidate for setting and using regional baselines because most Caribbean countries rely on electricity generated from oil-fired reciprocating engines, which have relatively high CO_2 emission rates. Diesel reciprocating engines are expected to dominate the Caribbean power sector for the foreseeable future under business-as-usual conditions.

[8] The Umbrella Group is not in favor of using the IPCC in this capacity.

[9] As discussed later, kWh generated during peak operating hours may be considered a separate product or output than kWh generated during off-peak hours.

Table 1 shows the fuel mix of all existing generation capacity in 16 Caribbean countries.[10] Five out of the sixteen countries use non-oil fired plants for more than 25 percent of their electricity generation. Note that Trinidad and Tobago and Barbados are the only countries that have natural gas in their fuel mix. For the other countries, natural gas is not a domestic resource and cannot be transported economically to the region now.[11] A number of countries including Belize, Cuba, Dominica, Jamaica, St. Vincent, and Suriname have hydro power capacity. Additionally, Belize imports roughly 16 percent of its power from neighboring countries.

Table 1. Power Generation Mix in the Caribbean in 1998

Country	*Total Generation (GWH)*	*Percent by Fuel*			
		L/HFO[a]	*N. Gas*	*Hydro*	*Other*
Antigua	185	100	0	0	0
Bahamas	1130	100	0	0	0
Barbados	747	95[b]	5[c]	0	0
Belize	203	51	0	33	16[2]
B.V.I.	95	100	0	0	0
Cuba	13060	98	0	2	0
Dominica	70	52	0	48	0
Grenada	113	100	0	0	0
Guyana	411	100	0	0	0
Jamaica	2950	97	0	3	0
St. Kitts	86	100	0	0	0
St. Lucia	236	100	0	0	0
St. Vincent	85	74	0	26	0
Suriname	1561	43	0	57	0
Trinidad & Tobago	5228	29	71	0	0
Turks & Caicos	45	100	0	0	0

[a] Light or Heavy Fuel Oil
[b] Approximate
[c] Imported

B. Possible CDM Projects Suitable for Power Sector Multi-Project Baseline Applications

Economic growth in the Caribbean is driving increases in energy and electricity consumption. Between 1993 and 1998, electricity consumption grew, on average, 6 percent per year in the Caribbean (excluding Cuba).[12] This suggests the potential for a large number of CDM projects in the power sector to meet the growth in electricity demand. A power sector multi-project baseline for the region can be used to assess additionality and measure emission reductions for a variety of

[10] These figures do not include self supply or power sold to the grid from independent power producers. Data on these sources was not available.
[11] Caribbean countries are continuing to explore options to improve the economic plausibility of natural gas transport.
[12] Based on analysis of data collected by CEIS/SRC

project types, including new and retrofit projects (e.g. efficiency improvements at existing facilities) on both the energy supply- and demand-side.

New supply-side projects may include fossil technologies – efficient oil or gas plants – and renewable technologies – photovoltaic (PV), wind, or biomass. Qualifying retrofit projects improve the emissions intensity of electricity generation (i.e., lower emissions per kWh) at an existing power plant. Replacing inefficient boilers in a steam generator plant is an example of a retrofit project. For new and retrofit projects alike, a power sector multi-project baseline could be used to determine project additionality and measure greenhouse gas emission reductions.

Demand-side projects include all types of energy efficiency improvements in applications such as lighting or air conditioning. Developers that implement projects to reduce electricity consumption, offsetting new power generation capacity, could use the power sector multi-project baseline to measure greenhouse gas emission reductions. However, the details of how multi-project baselines can measure additionality and emission reductions for demand-side projects need further exploration.

IV. Key Issues to Consider when Establishing Regional Baselines

This section discusses several key issues associated with establishing regional baselines, including which Caribbean countries could be eligible to participate in a regional baseline, differences between peak and baseload plants, and considerations for new and retrofit projects.

A. Selecting an Appropriate Data Set

The key objective in setting a multi-project baseline is to represent what would have happened in the absence of the CDM. Based on this principle, the preferred data for multi-project baseline development are planned future capacity additions, since theoretically, these data best reflect "what would have otherwise occurred." However, in practice, reliable data on planned new additions are often unavailable in developing countries. Detailed and reliable planned capacity data was not available for the region at the time of this study, and thus was not used for the regional baseline analysis presented below.

Data from least-cost expansion models can also be used to develop baselines for the power sector. These models are often the primary tool in determining what technology and fuel will be selected for expanding capacity. The recommendations from the model are determined mostly by what option is the least costly to build and run, but also include factors such as environmental regulations and fuel availability. These models can be used to determine what would have happened anyway and could, thus, be used to estimate the multi-project baseline. But often times the least-cost option is not selected, which calls into question the ability of these models to account for all factors that influence investment decisions. Also, model input data is often limited or not available. While a least-cost expansion model was not used in the regional baseline

analysis in this paper, it should be considered as a potential tool for setting multi-project baselines in other regions with accurate and available data.

Recent capacity additions also suggest business-as-usual trends. This information is objective, reliable, and in most cases available. Recent capacity additions best reflect what would have otherwise occurred, assuming the factors that led to the choice of technologies in recent additions do not change significantly (Bosi, 2000). The data can be measured and monitored so that the multi-project baseline would be updated each year, or every few years, with the newest additions. Changing conditions, such as oil prices, equipment costs, resource availability, and the CDM itself, could be captured in each new multi-project baseline, ensuring that new projects always be compared to the best estimate of business-as-usual.

For this analysis, recent capacity additions are used to establish the multi-project baseline for the Caribbean power sector. Data on the last three capacity additions in each country were collected from the team of regional experts. In most cases the last three additions were installed within the last five years (see Annex I, table A-1). Table 2 shows the recent capacity additions by fuel type for the thirteen countries for which data were available.

Table 2: Recent Capacity Additions [a]

Country	*Recent Additions as % of Total Capacity*	*Recent Additions by Fuel (%)*			
		L/HFO [b]	*N. Gas*	*Hydro*	*Other*
Antigua	34%	100%	0%	0%	0%
Bahamas	10%	100%	0%	0%	0%
Barbados	29%	100%	0%	0%	0%
Belize	27%	38%	0%	62%	0%
B.V.I.	47%	100%	0%	0%	0%
Cuba	n/a				
Dominica	17%	100%	0%	0%	0%
Grenada	41%	100%	0%	0%	0%
Guyana	3%	100%	0%	0%	0%
Jamaica	15%	100%	0%	0%	0%
St. Kitts	n/a				
St. Lucia	47%	100%	0%	0%	0%
St. Vincent	13%				
Suriname	n/a	100%			
Trinidad & Tobago	10%	1%	99%	0%	0%
Turks & Caicos	36%	100%			

[a] Recent capacity additions include the last 3 additions in each country.
[b] Light or Heavy Fuel Oil

B. Accounting for Countries with Atypical Trends

As discussed previously, the regional multi-project baseline should include countries that have power sector trends that are similar to the rest of the region. Countries that significantly deviate from the regional norm should establish their own national baselines. Recent capacity additions in the various countries show a fuel mix that in most cases resembles the region's average fuel mix (Tables 1 and 2). For the thirteen countries for which data were available, all but Belize and Trinidad and Tobago have installed all oil-fired generating plants to meet the growing power demand. Belize recently installed a hydro plant, and Trinidad and Tobago installed a large natural gas plant.

Trinidad and Tobago has domestic resources of natural gas, unlike other countries in the region[13], and has recently installed gas power plants. Trinidad and Tobago will likely develop future generation similar to its recent additions, which are atypical for the region. Therefore, Trinidad and Tobago *should not* be included in the regional power sector multi-project baseline and should develop its own national power sector baseline. Caribbean countries that do not have indigenous natural gas resources may import natural gas in the future. If so, future regional baselines should reflect this availability and Trinidad and Tobago may be eligible to participate in the regional multi-project baseline.

Although Belize, unlike other countries in the region, recently installed a hydro plant, Belize *is* included in the regional multi-project baseline because several Caribbean countries have hydro potential and will likely develop it in the future. For example, a smelting company in Suriname is expected to install an additional hydro-electric plant on the order of 75 to 300 MW (CEIS/SRC).

C. Distinguishing Between Baseload and Peak Plants

Because the demand for electricity (electrical load) varies throughout the day and by season, different types of power plants are generally used to satisfy this changing demand. In Barbados, for example, the minimum baseload demand is about 70 MWh of electricity. During the day, the demand peaks at around 120 MWh as hotel guests turn up their air conditioners, businesses become active, and homeowners use appliances and heat water. This daytime peak lasts for 12 to 14 hours until people retire in the evening, and demand slowly decreases back to the baseload 70 MWh (Williams, 2000). This cycle is fairly smooth and predictable.

Baseload plants tend to be large, have high up-front costs and low operating costs. These characteristics mean that baseload plants must run most of the time to be economical. Thus baseload plants tend to have higher capacity factors (e.g. 80% or higher). If demand were constant and predictable, only baseload plants would be needed.

Peaking plants are generally small and have low capital costs and high operating costs. These characteristics mean that peaking plants are economical when they have relatively low capacity

[13] Barbados also has access to natural gas, although less than 25% of power in Barbados is generated using this fuel.

factors (5% to 20%). Because of the differences in demand and the capacity needed to meet that demand, electricity markets differentiate between baseload and peaking generation, treating them as separate products. Because baseload plants are much more efficient than peaking plants, average baseload CO_2 emission rates are much lower than peaking emission rates. For these reasons, different baselines should be established for baseload and peaking capacity.

Baseload v. Peak Multi-Project Baselines for Power Plant Projects

Most new power plants installed in the Caribbean will be baseload plants and, thus, will be required to use the lower baseload multi-project baseline. Since the peak multi-project baseline is considerably higher than the baseload multi-project baseline, project developers may try to qualify for the peak baseline in order to earn more CERs. Therefore, clear and stringent evaluation criteria must be established to ensure that the proper multi-project baseline is applied. For example, the evaluation criteria may include the capacity factor and the time of day when the plant operates. If the project is operated differently during the monitoring and verification period than was originally proposed, the multi-project baseline must be reevaluated. Strict criteria along with monitoring and evaluation, will dissuade potential investors from characterizing their baseload power plants as peaking plants. Monitoring and verification may be particularly important in the Caribbean where many plants designed as peaking plants are forced to operate as base-load plants to meet the increasing electricity demand.

Baseload v. Peak Multi-Project Baselines for DSM/Energy Saving Projects

Determining whether DSM projects offset base or peak power is not straightforward. For most DSM projects, a combination of both peak and baseload power will be avoided. Without detailed monitoring and accounting, project developers cannot know how much of each type of power is avoided. Thus, it will be difficult to determine whether DSM projects should be measured against the baseload or peak multi-project baseline.

One solution to this problem would be to require all DSM projects to use the lower baseload baseline. Another solution would be to select the baseline according to the type of DSM project. Projects operating during peak hours of production should use the peak baseline, and projects operating during off-peak hours should use the baseload baseline. Projects that operate during both peak and baseload hours should use an appropriate mix of the two baselines. For example, a DSM project in which a very efficient refrigerator is installed can be assumed to operate all the time. Therefore, this project would apply both multi-project baselines in proportion to the mix of baseload and peaking generation in the system.

D. Distinguishing Between New and Retrofit CDM Projects

Power supply projects can be *new* plant installations or *retrofit* projects at existing plants. The CDM rules will likely require more stringent baselines for new plant installations than for retrofit

projects because developers of new plants can choose from the best available technologies[14], while developers of retrofit projects are limited by the type of existing installation. The gap between the emissions intensity at new facilities and existing facilities widens as new technologies and practices are introduced. For example, even if an existing plant implemented all applicable and reasonable greenhouse gas emission reduction measures, it may not be able to reduce its emission intensity to that of a new plant.

In the Caribbean, projects that replace old engines with new ones are often referred to as retrofits. However, they should be treated as new projects and evaluated against a multi-project baseline developed for *new* power sector projects because engine replacement is the equivalent of installing new generation capacity. Most energy efficiency improvements in the Caribbean power sector are limited to routine maintenance and upkeep and, thus, would likely not qualify as CDM projects. Therefore, this paper does attempt to construct a multi-project baseline for retrofit projects and instead focuses on resolving issues associated with multi-project baselines for new plant installations. For other countries or regions where more power generation options are available, more retrofit opportunities are likely to exist and a separate multi-project baseline for retrofit projects may be appropriate.

V. Case Study Multi-Project Baseline Options

This study presents a methodology for developing a regional power sector baseline in the Caribbean and expands upon the analysis prepared for the March 2000 Regional Capacity Building Workshop in Barbados, *Caribbean Benchmarks: A Regional Approach to Establishing Baselines under the CDM*, (Kelly, et. al 2000). The March 2000 study provided a preliminary assessment of the key issues that arise in establishing a regional baseline for the power sector. Four sample regional baselines for the power sector were developed using readily available data on existing generation capacity provided by the Caribbean Energy Information Systems (CEIS).

The current analysis uses technology and fuel consumption data on recent power plant capacity additions as the basis for the regional multi-project baseline. These data[15] were gathered by regional experts under the regional capacity building project and are expected to represent business-as-usual development trends more accurately than an average of recent capacity. Three regional baselines were developed for the power sector, as well as a reference emissions case. These proposed multi-project baselines could be used to determine the additionality of CDM projects as well as the number of CERs to be credited to the CDM activity. Each of the regional baseline options is discussed and summarized in Table 3.

Setting a baseline involves a trade-off between maximizing CERs and minimizing non-additional projects (e.g., preventing diesel reciprocating engines from receiving credits). Higher multi-project baselines create more opportunities to earn CERs *and* to credit non-additional projects, which may lead the CDM Executive Board to deny baseline certification. To maintain the

[14] Best available technology and practices may vary from country to country depending on the national circumstances of the host country (e.g., available resources, capacity).
[15] Data include power generating capacity, generation, and fuel consumption by fuels and plant type.

environmental integrity of the CDM, the emission baseline must be set to best reflect emissions under a business-as-usual scenario.

Table 3. Power Sector Multi-Project Baseline Options

Multi-Project Baseline Option	Metric	Sample Population	*Emission Rate (kg CO_2/MWh)*
Reference Case	Weighted-average	All generation [a]	859
Baseline Option 1	Weighted-average	Last three additions in each country [b]	752
Baseline Option 2	Weighted-average	Last three base-load plants [b]	700
Baseline Option 3	Top performer	Best available (BAT) diesel engines	627

[a] For all countries
[b] For all countries except Trinidad and Tobago

Reference Case Emissions: Average of All Capacity

The reference case emissions rate is a weighted average of all existing generation in the Caribbean and is estimated at 859 kg CO_2/kWh. This option is presented only as an indicator of current generating mix in the region and includes both base and peak plants. This option is not recommended as a baseline since it does not account for trends in the business-as-usual scenario for the region and includes power generation technology that is old and inefficient. While the data are relatively easy to collect and the costs of developing a multi-project baseline based on existing capacity are relatively low, such a baseline has greater potential for crediting non-additional projects than other options presented below. As discussed above, the CDM Executive Board is unlikely to certify a regional multi-project baseline based on all generation because such a baseline is likely to jeopardize the environmental integrity of the Kyoto Protocol.

Option 1: Average of Recent Additions

Option 1 is more restrictive than the reference case because it is based on a weighted-average of *recent capacity additions* rather than all existing capacity. This baseline, estimated at 752 kg CO_2/kWh, is roughly 12 percent lower than the weighted-average of all capacity. This decrease suggests that technology and efficiency have been improving over time, and that newer plants run more efficiently than older plants. Recent capacity additions may provide a reasonable basis for estimating future trends, assuming the technical and economic conditions for choosing capacity do not change significantly.

The data on recent capacity additions include the last three additions to the power generating capacity in each country and include both baseload and peaking plants. In most cases, the most recent plants in the region were built within the last five years. In all but two countries – Belize installed hydro and Trinidad and Tobago installed natural gas – each new plant is fueled by oil. While recent additions suggest a trend toward oil-based reciprocating engines, the market may change, making future installations different from recent ones. Factors that may change the

market include the price of fuels (including transport costs), costs of new technologies, retirement of existing capacity and electricity deregulation.

Option 2: Separate Multi-Project Baselines for Baseload and Peaking Plants

Option 2 uses the same data set as Option 1 – recent capacity additions – but distinguishes between base-load and peaking plants. The baseload and peaking plants have markedly different emission rates due to the difference in efficiencies as discussed above.

The multi-project baseline of 700 kg CO_2/MWh is the weighted average of the recently installed baseload power plants in the region. The baseload emission rate is lower than both the Reference Case and Option 1 because (1) it is based on recent capacity additions and it does not include older power plants, and (2) peaking plants, which generally have higher emission rates, are also excluded. This baseload multi-project baseline shows that recently installed baseload power plants are better performers than the average technology in the region, though still not as good as the best available technology.

The question remains whether and how a separate multi-project baseline for peaking plants should be established, given that the creation of a separate peak baseline may provide an incentive for projects offsetting baseload power to try to use the peak baseline in order to maximize their CERs. A separate peak baseline could also allow many inefficient and highly polluting technologies to qualify as additional and to earn CERs. This issue needs further investigation and research.

Option 3: Technology Standard

The emissions rate of the best available technology (BAT) can serve as a technology standard baseline. In order to qualify under the CDM and earn credit, a project must implement a technology with a lower emission rate than that of the BAT technology. The BAT multi-project baseline in the Caribbean would be based on the emission rate of the best available oil-fired technology on the market, i.e. diesel-fired reciprocating engines. Since the market for diesel-fired engines is international, this multi-project baseline for the Caribbean reflects international best available technology that has an emission rate of 627 kg CO_2/MWh (see Annex 1). Since natural gas is not available, this baseline would effectively prevent all fossil fuel technologies from earning CERs under the CDM, including BAT diesel projects that would qualify under the multi-project baselines discussed above.

While this option does not have the data uncertainty problem associated with some of the other options, there are drawbacks. The major difficulty is choosing the technology that will be used to represent what would have happened anyway. Because the technology standard assumes a given fuel type, it may not reflect development trends in the region (i.e., what has recently been implemented or will be implemented in the future). In the Caribbean, diesel-fired reciprocating engines are selected as the BAT since they dominate the region. However, regions with other available natural resources, such as gas or coal, might base their BAT standard differently.

Other Options

In order to encourage cleaner CDM projects that will reduce the potential for non-additionality, multi-project baselines with greater stringency could be implemented. One simple, though arbitrary, approach is to reduce the multi-project baseline by 5% or 10%. Unfortunately, this reduced baseline may be too low for any projects to qualify under the CDM or not low enough to prevent non-additional projects from qualifying. The following option is an example of a stringent *and* context-sensitive multi-project baseline.

Hybrid "recent additions" and "best available technology" multi-project baselines. A properly set best available technology emission rate will never be higher than the recent additions emission rate. Averaging the two rates will result in a baseline that is strict, yet guaranteed not to exceed the stringency of the best available technology baseline. As the BAT changes over time, even if recent additions remain the same, a hybrid multi-project baseline will become more stringent. Under a hybrid multi-project baseline, only renewable projects and the lowest emitting fossil technologies would likely qualify for CERs. CERs can be quantified based on the hybrid baseline – for maximum environmental credibility – or on the recent additions baseline – for the most accurate accounting of project-level emissions reduction, assuming non-additional projects are successfully disqualified by the hybrid baseline.

VI. CDM Project Eligibility and Earning Potential

A. Potential CDM Technology

Depending on the CO_2 emission rate at which the multi-project baseline is set, different power plant technology and fuel combinations will be eligible CDM projects.

Table 4 lists CDM projects[16] that would be eligible under the three multi-project baseline options developed in this paper. Emission rates from potential new power plants were compared to the emissions rate of the multi-project baseline options identified above to determine which technologies would be eligible to earn CERs. With each subsequent baseline option the number of eligible technologies declines. The last option effectively disqualifies all fossil-fueled power plant projects from earning CERs, since the applicability of gas-fired combined cycle technology is limited to two countries in the region.

[16] While coal is not economically available source of power generation for most Caribbean regions, coal technology is included in the analysis to illustrate the stringency of the multi-project baseline options.

Table 4. Technologies Eligible as CDM Projects

	Technologies eligible for CERs	*Technologies ineligible for CERs*
Option 1	• All non-fossil • Biomass • BAT diesel engines • Oil-fired combined cycle • Gas-fired simple cycle[a] • Gas-fired combined cycle	• All coal-fired technologies • Average diesel engines • LFO/HFO steam turbine • Oil-fired simple cycle
Option 2	• All non-fossil • Biomass • BAT Diesel engines • Oil-fired combined cycle • Gas-fired simple cycle • Gas-fired combined cycle	• All coal-fired technologies • Average diesel engines • LFO/HFO steam turbine • Oil-fired simple cycle
Option 3	• All non-fossil • Biomass • Gas-fired combined cycle	• All coal-fired technologies • BAT diesel engines • LFO/HFO steam turbine • Oil-fired simple cycle • Gas-fired simple cycle • Oil-fired combined cycle

[a] Dependent on load factor and particular turbine efficiency.

B. Earning Potential of CDM Power Sector Projects

In addition to determining which technologies are eligible as CDM projects, the multi-project baseline will also measure the amount of CERs that a given CDM project will receive. Table 5 shows the revenue from CERs earned under the three baseline options. The CER earning potential is based on the emission reductions the project attains compared with the baseline and the value of the CER. For this analysis, the market price of a CER is estimated at \$10/ton CO_2 (Black, 2000).[17]

The difference in earning potential highlights the stringency of each multi-project baseline option. Baseline Option 1, based on the average of recent capacity additions, awards the most CERs to baseload CDM projects. Option 2, based on recently added base-load power plants, awards fewer CERs to baseload CDM projects than Option 1. Peaking power plants earn no CERs under Option 1 or Option 2, highlighting the need to consider a separate multi-project baseline for peaking power plants. Although we do not recommend developing a separate peak power baseline based

[17] Black uses a range from \$3 to \$19 per CER. Our use of \$10/CER reflects a adjusted median of this range.

on recent additions, we do recommend further analysis to determine if and how a peaking baseline should be established.[18]

Table 5. Income Potential for Various Technologies Using the Case Study Multi-Project Baseline Options

	Technology Emission Rate	Baseline 1 752 kg CO_2/MWh	Baseline 2 700 kg CO_2/MWh	Baseline 3 627 kg CO_2/MWh
Technology		US c/kWh	US c/kWh	US c/kWh
Diesel reciprocating engine (old)	952	0.00	0.00	0.00
Diesel reciprocating engine (average)	784	0.00	0.00	0.00
Diesel reciprocating engine (BAT)	627	0.12	0.07	0.00
Oil boiler/steam turbine LFO	808	0.00	0.00	0.00
Oil boiler/steam turbine HFO	844	0.00	0.00	0.00
Oil turbine/simple cycle	952	0.00	0.00	0.00
Oil turbine/combined cycle	556	0.20	0.14	0.07
Gas turbine/simple cycle	721	0.03	0.00	0.00
Gas turbine/combined cycle (BAT)	367	0.39	0.33	0.26
Hydro	0	0.75	0.70	0.63
Solar	0	0.75	0.70	0.63
Biomass (bagase)	0	0.75	0.70	0.63
Wind	0	0.75	0.70	0.63
Other non fossil	0	0.75	0.70	0.63

Note: Market price of $10/CER assumed.

Option 3, based on the best available technology, is the most stringent, allowing only oil and gas combined cycle plants and renewable projects to receive credit. Please note that under all three multi-project baseline scenarios, older combined cycle plants are awarded credits.

C. Competitiveness of Caribbean CERs in CDM Marketplace

Power sector CDM projects in the Caribbean will face competition on two fronts: (1) Competing in the global CDM market, and (2) competing at home with business-as-usual technologies in the power sector

(1) Competing in the global CDM marketplace. Various analyses show that the potential demand for CDM emission reductions is on the order of 5 billion tons during the first commitment period (2008-2012).[19] At a price of $10/CER the CDM market is on the order of $50 billion for the first commitment period ($10 billion per year between 2008 and 2012). Countries such as China and India will likely claim the largest shares of this market; however, as small as the Caribbean is compared to these countries, it can still compete.

[18] Given the fact the peak power in the Caribbean is generated using mostly two technologies—simple cycle gas turbines fired by oil, and reciprocating engines also fired by oil—it may be possible to develop a technology standard multi-project baseline for peak power production. A separate multi-project baseline for each technology could be established using the BAT option.

[19] See section I-A of this paper.

Based on preliminary analysis, the Caribbean CERs will likely be competitive in the global marketplace; the cost of reducing a ton of CO_2 in the Caribbean power sector is at or below the estimated CER market price.[20]

(2) Caribbean CDM projects will also compete at home, with business-as-usual power sector technologies. Our preliminary analysis shows that at $10/CER, technologies such as biomass, wind, and BAT diesel engines may receive adequate incentive—through the sale of CERs—to make them competitive with business-as-usual power technologies in the Caribbean (Williams, 2000).[21]

VII. Conclusions

A regional power sector baseline developed using data on recent capacity additions may be the best approach, given data availability, for representing what would have happened anyway in the Caribbean power sector. All countries in the Caribbean, with the exception of Trinidad and Tobago, would be eligible to use the regional power sector multi-project baseline. Due to significantly different development trends based on the availability of natural gas, Trinidad and Tobago should develop its own national multi-project baseline at this time. We recommend that the baseline be updated annually to account for recent trends and that Trinidad and Tobago be included if other countries gain economic access to natural gas.

The regional power sector baseline must be environmentally credible and must be certified by the CDM Executive Board. While the evaluation criteria for baselines have not yet been determined, policy makers have expressed the need for multi-project baselines to be set more stringently than project specific baselines since a far greater number of projects will be eligible to use them. Once a regional multi-project baseline is established and certified for those countries that have similar development trends, countries should not be allowed to opt out. Nevertheless, participating countries can always decide not to host CDM projects.

With a regional power sector multi-project baseline in place, the Caribbean will be able to maximize opportunities offered by the CDM. Initial analysis using the regional baseline options developed in this paper show that Caribbean power sector projects will likely be cost competitive in the international CDM market; however, further analysis is required to more accurately characterize the competitiveness of potential CDM project options.

Issues for Further Study

This analysis only includes power plants operated by electric utilities in determining the various multi-project baseline options. However, private power generators operate in some countries. In

[20] Assumes a CER price of $10. Based on Black, 2000; Ellerman, 1998.

[21] Based on a comparison of the costs of equipment, fuel, and operation and maintenance of several technology options as well as a comparison of the revenues generated by each, using electricity prices and operating hours.

addition, large manufacturing companies in many cases generate electricity for self-supply (e.g., off-grid generation) using bagasse or other renewables. This trend is prevalent throughout some countries in the region, particularly in the bauxite and sugar industries.

Better data on independent power producers and self-generation is necessary for their inclusion in the analysis. If these electricity sources are not accounted for, there is significant potential for non-additional projects to earn credit under the CDM.

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IX. Annex I: Methodology and Assumptions

Method: The analysis accounts for only CO_2 emissions from fossil fuel combustion at the generating units. The combustion of fossil fuel also emits other greenhouse gases including methane (CH_4) and nitrous oxide (N_2O). These emissions, in general, account for roughly 1 percent of the total CO_2 equivalent emissions, and therefore, were not included in this analysis.

The following calculations were used:

1. CO_2 Emissions for each plant: the fuel consumption in GJ was multiplied by the carbon content of the fuel.
2. Emission rate per MWh for each plant: (1) divided by electricity production
3. CO_2 emissions by country: country total (1) divided by country total (2)
4. CO_2 emission by the region: regional total (1) divided by regional total (2)
5. Best Available Technology (BAT) calculation:
   Best conversion efficiency quoted by manufacturers (CAT, Wartsila) — 46%
   Allowance for wear and tear (time factor)—2%
   Allowance for engine size (small engines are less efficient)—1.5%
   Resulting applicable BAT—diesel reciprocating engines—42.5%
   Corresponding heat rate—8471
   Corresponding emission rate for LFO—627kg/MWh
6. Calculations for the last three additions, total, peak, and base-load were done using the same methodology as (1)-(4) above.

Activity Data: Experts from the region collected information on the last three capacity additions installed in 16 countries in the Caribbean. These are data for the years 1993-1998, and include national capacity (MW), production (MWh), technology type, fuel type and fuel consumption. The regional multi-project baselines are based on data collected from Dominica, Barbados, Jamaica, St. Lucia, BVI, and the Bahamas as shown in Table A-1. This data included plant name, capacity (MW), production (MWh), technology type, fuel type and fuel consumption. Accurate data were not available from St. Vincent, Guyana, Grenada, Montserrat, Antigua, and Turks and Caicos. Data on Trinadad and Tobago and Belize were collected (Table A-1), but were not used to develop the regional multi-project baseline as their new capacity additions did not fit the profile of the region.

Emissions and Conversion Factors: Fuel consumption data were provided in either energy units or volumetric units. All fuel consumption figures were converted into GJ using low heating value energy content taken from various sources. (Table A-2). Carbon content of fuel was taken from the IPCC (Table A-3).

Calculating BAT diesel emission rates: In calculating the emission rate of the best available technology we contacted several manufacturers (Caterpillar and Wartsila) of reciprocating engines, as well as local dealers (Plantrac Engineering Ltd) that are active in selling this equipment in the Caribbean. The manufacturers quoted conversion efficiency figures for their

best equipment at 46%, corresponding to a heat rate of 7826 GJ/MWh. However, the manufactures noted that this figure is typically guaranteed only for the start-up and a short trial period. Thereafter, the conversion efficiency declines. The extent of the decline is a function of maintenance. If the daily maintenance is good, the conversion efficiency may decline by 2% over the life-time of the equipment. Furthermore, the highest efficiencies were quoted for the largest engines, which are not always suitable for all situations and all countries. Power requirements in some countries in the region are too small for such large equipment. For the best available technology reference, therefore, we elected to use a compromise figure of 42.5% conversion efficiency, corresponding to a heat rate of 8471, and an emission rate of 627 kg/MWh when using light fuel oil. This emission rate reflects both the decline of efficiency with age of the equipment, and the fact that smaller engines have lower efficiency to begin with. We believe this is a good compromise.

TABLE A-1: Data Samples Used for Developing Multi-Project Baseline Options 1, 2, and the Reference Case.

Country	Plant	Capacity	Production	Technology	Fuel Type	Fuel Consumption	units given	Conversion	unit	Plant Type	On-line
		MW	MWh								
Dominica	Sugar Loaf 1	1.35	7500.0	reciprocating	LFO	0.0589	Imp.gal./kwh	83319	GJ	Base Load	1999
	Sugar Loaf 3	1.35	5600.0	reciprocating	LFO	0.0600	Imp.gal./kwh	63374	GJ	Base Load	1998
	Fond Cole 5	2.84	13300.0	reciprocating	LFO	0.0576	Imp.gal./kwh	144492	GJ	Base Load	1996
St. Vincent	BEQUIA	0.64	2500.0	reciprocating	Diesel	217.1000	grams/kwh	23519	GJ	Base Load	2000
	CANE HALL POWER STATION	4.20	17800.0	reciprocating	Diesel	201.0000	grams/kwh	155038	GJ	Base Load	2000
	CANOUAN	2.40	9600.0	reciprocating	Diesel	205.0000	grams/kwh	85280	GJ	Base Load	2000
Barbados	Seawell Gas Turbine Plant – GT03 & GT04	33.00	62656.0	Av.Jet - gas turbine	Av. Jet	885351.5000	TJ	885352	GJ	Peaking Plant	1996/1999
	GT02 Gas Turbine	13.00	41625.2	Liquid fueled gas turbine	Diesel	616913.0000	TJ	616913	GJ	Peaking Plant	1990
	Spring Garden Low Speed Diesel Station	50.00	307077.1	Low speed Diesel Engines with waste heat	Residual Fuel Oil	3006827.3000	TJ	3006827	GJ	Base Load	1982/1987/1990
Jamaica	Jamaica	12.10	64000.0	reciprocating	Bunker 'C'	13.5000	kWh/gal	749511	GJ	Base	1998
	JPPC	60.50	394379.0	reciprocating	Bunker 'C'	504300.0000	bbl	3527248	GJ	Base	1996
	JEP	74.16	336326.0	reciprocating	Bunker 'C'	480000.0000	bbl	3357285	GJ	Base	1995
	Hunts Bay unit 10	32.50	81000.0	gas turbine	Diesel	180000.0000	bbl	1258982	GJ	Peaking Plant	1993
St. Lucia	Cul de Sac Power Station (CDSPS 7)	9.30	0.0	reciprocating	Diesel			0		Base Load	2000
	Cul de Sac Power Station (Station B)	27.90	167497.0	reciprocating	Diesel	1527.0000	TJ	1527000	GJ	Base Load	1998
	Cul de Sac Power Station (Station A)	19.60	81366.9	reciprocating	Diesel	795.2100	TJ	795210	GJ	Base Load	1989
BVI	Pockwood Pond Station	15.00	84051.0	reciprocating	Diesel (LFO)		Gals/Kwh	894520	GJ	Base Load	1995
	BVI Electricity Corp	13.10	19640.0	reciprocating	Diesel (LFO)		Gals/Kwh	209020	GJ	Base Load	1969

Table A-1 Continued:

Country	Plant	Capacity	Production Technology	Fuel Type		Fuel Consumption	units given	Conversion	unit	Plant Type	On-line
Guyana	Wartsilla 2	5.50	39000.0 reciprocating	#6 fuel, 380 cst. at 50 deg.C		15.5000	kwh/a.g	397800	GJ	Base Load	1997
	Wartsilla 3	5.50	39000.0 reciprocating	#6 fuel, 380 cst. at 50 deg.C		15.5000	kwh/a.g	397800	GJ	Base Load	1998
	Wartsilla 4	5.50	39000.0 reciprocating	#6 fuel, 380 cst. at 50 deg.C		15.5000	kwh/a.g	397800	GJ	Base Load	1998
Trinidad and Tobago	Inncogen Limited	225.00	1110330.0 natural gas - gas turbine	Natural gas		14535.0000	TJ	14535000	GJ	Base Load	1999
	Scarborough Power Station	11.00	11105.0 reciprocating	Diesel Oil		100.0000	TJ	100000	GJ	Peaking Plant	1999
	Scarborough Power Station	2.70	1665.0 reciprocating	Diesel Oil		19.0000	TJ	19000	GJ	Peaking Plant	1985
Grenada	Prototpes (2) Caterpillar	2.80	17795.6 reciprocating	Distillate No. 2	?		us. Gals	0.00		Base Load	1998
	Power Modules	6.25	25046.3 reciprocating	Distillate No. 2	?		us. Gals	0		Peaking Plant	1996
	Wartstila (1)	5.00	32233.4 reciprocating	Distillate No. 2	?		us. Gals	0		Base Load	1996
Belize	Mollejon Hydro Plant	25.20	67000.0 Hydro					0		Both	1995
	Ladyville 3	3.00	21000.0 4 stroke Combustion Engine	#2 Diesel		14.9000	kwh/a.g	221340	GJ	Base Load	1994
	Belize 3	3.00	21000.0 4 stroke Combustion Engine	#2 Diesel		14.5500	kwh/a.g	226664	GJ	Base Load	1989
Bahamas	D./A 11 (Diesel Alternator)	32.00	67093.7 reciprocating	Heavy Fuel Oil		555.9570	TJ	555957	GJ	Base Load	1999
	G.T. 1R (Gas Turbine)	20.00	2748.0 gas turbine	Automotive Diesel Oil		50.6680	TJ	50668	GJ	Peaking Plant	1999
	G.T. 10	22.00	109219.0 gas turbine	Automotive Diesel Oil		1734.8800	TJ	1734880	GJ	Peaking Plant	1997
Montserrat	#1 gen set (Caterpillar	1.00	2012.0 reciprocating	Distillate Diesel		16.0000	kwh/imp gal	23718	GJ	Base Load	1992
	#2 gen set (Caterpillar	1.00	1165.0 reciprocating	Distillate Diesel		15.6000	kwh/imp gal	14085	GJ	Base Load	1992
	#3 gen set (Cummins KTA50-G3)	1.00	5230.0 reciprocating	Distillate Diesel		16.5000	kwh/imp gal	59784	GJ	Base Load	1997
Antigua	KPB Services	5.80	6759.5 Caterpillar, reciprocating	Diesel Fuel	?		TJ	0		Peaking Plant	1998
	Wartsilla (APC)	12.86	42563.0 18V32 (Watr:) Diesel Oil- recip: Engine 2 X T/G - fuel	Diesel Fuel and Heavy Fuel Oil	?		TJ	0		Base Load	1996
	Tango	18.20	34958.0 oil - Steam	HFO	?		TJ	0		Base Load	1986
Turks and Caicos	Providenciales	4.40	30000.0 reciprocating	Diesel Fuel	?		TJ	0		Base Load	1998
	Providenciales	4.40	30000.0 reciprocating	Diesel Fuel	?		TJ	0		Base Load	1995
	Providenciales	4.40	30000.0 reciprocating	Diesel Fuel	?		TJ	0		Base Load	1989
Suriname	Di Nil 2&3	4.20	33205.2 reciprocating	Diesel Fuel		9.9000	MJ/kWh	328731	GJ	Base Load	1999
	Cor 1	0.38	2696.5 Marine Diesel	Diesel Fuel		12.2500	MJ/kWh	33032	GJ	Base Load	1999
	Di A14 & A15	15.20	107524.8 Marine Diesel	Diesel Fuel		9.8300	MJ/kWh	1056969	GJ	Base Load	1995

Table A-2: Energy Content by Fuel Type

Fuel	Energy Content	
Diesel/LFO/No.2	5.83	GJ/barrel
HFO/No.6/Bunker C	6.22	GJ/barrel
Av Jet Fuel	5.68	GJ/barrel
Jet A-1	5.68	GJ/barrel
Natural Gas	35	GJ/1000m^3

Source: US DOE, IEA

Table A-3: Carbon Content by Fuel Type

Fuel	Carbon Content
Av Jet Fuel/Kerosene	19.5 tC/TJ
Diesel/LFO/No.2	20.2 tC/TJ
HFO/No.6/Bunker C	21.1 tC/TJ
Natural Gas	15.3 tC/TJ

Source: IPCC, 1997

X. ANNEX 2: Fuel Definitions[22]

Automotive Diesel: see Distillate fuel oil

Aviation Gasoline: A complex mixture of relatively volatile hydrocarbons with or without small quantities of additives, blended to form a fuel suitable for use in aviation reciprocating engines.

Bunkers: Fuels supplied to ships and aircraft in international transportation, irrespective of the flag of the carrier, consisting primarily of residual, distillate, and jet fuel oils.

Bunker "C" Fuel: see Residual fuel oil.

Distillate Fuel Oil: A general classification for one of the petroleum fractions produced in conventional distillation operations. It includes diesel fuels and fuel oils. Products known as No. 1, No. 2, and No. 4 diesel fuel are used in on-highway diesel engines, such as those in trucks and automobiles, as well as off-highway engines, such as those in railroad locomotives and agricultural machinery. Products known as No. 1, No. 2, and No. 4 fuel oils are used primarily for space heating and electric power generation.

Heavy Fuel Oil: see Residual fuel oil

Heavy Heating Oil: see Residual fuel oil

[22] US DOE Energy Information Agency Webpage. 2000 http://www.eia.doe.gov/emeu/efficiency/mecs_glossary.htm

Kerosene: A light petroleum distillate that is used in space heaters, cook stoves, and water heaters and is suitable for use as a light source when burned in wick-fed lamps. See Kerosene-Type Jet Fuel.

Kerosene-Type Jet Fuel: A kerosene-based product having a maximum distillation temperature of 400 degrees Fahrenheit at the 10-percent recovery point and a final maximum boiling point of 572 degrees Fahrenheit. It is used for commercial and military turbojet and turboprop aircraft engines.

Light Fuel Oil: see Distillate fuel oil

Liquefied Petroleum Gases (LPG): Ethane, ethylene, propane, propylene, normal butane, butylene, ethane-propane mixtures, propane-butane mixtures, and isobutane produced at refineries or natural gas processing plants, including plants that fractionate raw natural gas plant liquids.

Low Sulfur No. 2 Diesel Fuel: No. 2 diesel fuel that has a sulfur level no higher than 0.05 percent by weight. It is used primarily in motor vehicle diesel engines for on-highway use.

Natural Gas Liquids (NGL): Those portions of reservoir gas that are liquefied at the surface in field facility or gas processing plants. Some examples are ethane, propane, butanes, pentanes, natural gasoline, and condensate.

No. 2 Diesel Fuel: A fuel that has distillation temperatures of 500 degrees Fahrenheit at the 10-percent recovery point and 640 degrees Fahrenheit at the 90-percent recovery point. It is used in high- speed diesel engines that are generally operated under uniform speed and load conditions, such as those in railroad locomotives, trucks, and automobiles.

No. 2 Fuel Oil (Heating Oil): A distillate fuel oil that has distillation temperatures of 400 degrees Fahrenheit at the 10-percent recovery point and 640 degrees Fahrenheit at the 90-percent recovery point. It is used in atomizing-type burners for domestic heating or for moderate capacity commercial/industrial burner units.

Residual Fuel Oil: The general classification for the heavier oils that remain after the distillate fuel oils and lighter hydrocarbons are distilled away in refinery operations. The classification includes No. 5 (light and heavy), No. 6 (including heavy-grade, so called Bunker C oil), and Navy Special fuel oil. It is used for the production of electric power, space heating, vessel bunkering, and various industrial purposes.