NATSIONALNA ELEKTRICHESKA KOMPANIA

BASELINE STUDY OF JOINT IMPLEMENTATION PROJECTS IN THE BULGARIAN ENERGY SECTOR

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1. Introduction

Bulgaria complies with the requirements of the UN Framework Convention on Climate Changes (UNFCCC) ratified by the Bulgarian Parliament in March 1995. Besides, the Parliament of the country ratified the Kyoto Protocol to the Convention on 17th July 2002. The Protocol was based on the ideas and principles set forth in it and develop them further adding new obligations, larger in scope and detail than those in the Convention.

According to Art. 6 of the Kyoto Protocol, in order to perform its obligations for emission reduction and limitation, each of the countries listed in Annex 1 may transfer to another country on the list, or receive from it, emission reduction limits obtained as a result of projects for reduction of anthropogeneous emissions of greenhouse gases by sources. In practice, such projects are mostly implemented in countries with economies in the process of transition where there are more opportunities for emission reduction, and at a lower cost. The amounts of Emission Reduction Units achieved as a results of the project may be bought by a developed country for the purpose of keeping its obligation under the Protocol.

In Bulgaria, joint implementation of projects is viewed as an economically acceptable way of reducing the emissions of anthropogeneous greenhouse gases and receiving, at the same time, financial, economic, technical assistance and expertise.

In order to start work by the so-called “flexible mechanism” under the Kyoto Protocol – Joint implementation (JP) Projects – a bilateral agreement has to be signed between the Government of Bulgaria and another developed country or an international fund for protection of the environment.

So far, bilateral Memoranda of Understanding and Bilateral Cooperation for implementation of JP Projects have been signed with the Kingdom of Netherlands, the Republic of Austria, the Kingdom of Denmark and EBRD in the latter’s capacity of trustee of a Prototype Carbon Fund.

2. Purpose of the Study

The purpose of the present assignment is to carry out a study in order to define the Baseline scenarios of the Bulgarian Electricity Power System and calculate the annual Basic Carbon Emission Factor (BCEF) of the Baseline in the process of operation of the electric power sector.

3. Introduction to the Baseline Study

The most important part of the preparation for a greenhouse gas reduction project is the Baseline Study. It should define, in a transparent and comprehensive manner, what rate of CO_{2eq} reduction and related financing can be expected. Besides, the Baseline defines and provides the methodology of assessing which of several possible developments is the most probable in the absence of the project and what emissions would be generated by that scenario.

The Marrakesh Accords (the decisions of COP7 in Marrakesh in November 2001) constitute the central guidance as far as documents required by COP for climate protection projects are concerned.

According to the Marrakesh Accords, the Baseline shall meet the following more significant requirements:

1. To be transparent in terms of assumptions, method, project boundary, parameters, data sources, key factors and Additionality;
2. To account of important national and industrial policy measures and circumstances such as sector-related reforms, availability of indigenous fuels, plans for expansion of the electric power sector, and economic situation in the sector;
3. To be formed in such a manner that it would be impossible to generate ERUs and CERs for reduction of activities beyond the project boundary on the basis of Force Majeure events;
4. To be project-based or standard oriented;
5. To take data uncertainty into account. The assumptions shall be selected conservatively.

It means that the assumptions as to calculations in the event of hesitation (data range, data uncertainty, etc.) shall be selected in such a manner that the resulting total Baseline emissions would be low rather than high. As a result of that, the calculated emission reduction is underestimated rather than overestimated and is, therefore, more stable with respect to data status variations or with respect to criticism from outside. That increases the probability for the Baseline to be accepted by the validator and by the stakeholders.

6. Besides, the Baseline selection shall be substantiated.
7. There is a restriction upon the choice of a Baseline composition method for projects under CDM, but not for [3]JI projects. The following three Baseline approaches are possible only:

a) “historical or existing emissions”

That generally well sustained wording probably leaves room for all substantial Baseline methods because, in principle, every method can be supported by the argument that, directly or indirectly, it rests on historical or existing emissions.

b) “emission of a technology that, due to obstacles before investments, is an economically attractive alternative”

Practically, the purpose of that wording could be to extend the investment analysis method – an economically attractive alternative.

c) “the mean percentage of emissions from comparable project activities during the last five years implemented in similar social, economic, environmental and technological conditions, the project activities of which belong to the best 20% in their category”.

That last requirement may be interpreted to mean that JI/CDM projects should not lead to implementation of outdated technologies or used equipment, but to technological and social progress, that is, to sustainable development in the countries where they are implemented.

Beside these official requirements of the Marrakesh Accords, theoretically there are no other substantial directions restricting the Baseline development. This is to emphasize that, in the development of a Baseline, the question “What would happen to the system and its emissions if no financial resources came from Carbon Credit sales” has priority over adherence to preset criteria.

Although, in principle, individual routes may be chosen to the implementation of that task, the previous experience offers several already proven methodological approaches that should be favored. Other routes should be chosen only where there are special reasons for that and where they are, respectively, adduced intelligibly by the author of the Baseline. Method selection depends on the type of project, the data status, the preferences of Carbon Credit buyers, resp. the parties to the Contract, the Baseline author’s experience, etc.

4. Methodological Approaches to Baseline Determination

The Baseline Determination Methodologies fall into two broad categories – project-specific approaches and multi-project approaches.

1) Project-Specific Baseline

a) Reference Group

From the point of view of a project specific Baseline, it is often emphasized that the type of project, its size and availability of data are the main factors that determine the choice of Baseline methodology.

The Reference Group approach requires finding of a similar country, region or project with conditions comparable to the particular project for the purpose of studying a development that does not include the Joint Implementation Project. The definition of a reference group in a similar situation in the electric power industry, would be difficult due to different circumstances with respect to fuels used, technologies implemented, economic aspects, electricity market liberalization status and policy, etc.

b) Investment Analyses

In these analyses, all probable and realistic possibilities are determined taking into account the technical, economic, political, social and environmental aspects graded by economic benefit, for example through determination of the Internal Rate of Return. The highest-return alternative is defined as Baseline Alternative. Due to the fact that economic aspects are the determining factors for that aspect, such approach requires a solution model guided mainly by economic considerations and the clear comparability of different options.

The potential for use of investment analysis in the electric power sector is quite limited because, in principle, the new projects compete with a variety of generation units in the electric power sector. It is very seldom that a new project competes directly with an existing unit. For that reason the investment approach is not considered very useful in the electric power sector.

b) Scenario analysis

Risk-based analyses deal with the possible development scenarios in the absence of a project taking into consideration various influencing factors such as technologies, policies and market restrictions. Possibilities leading to high risk are dismissed and the most probable scenario is selected as baseline. The main challenge in this approach is selecting the main influencing factors and to determine the best and most reliable data sources for the study.

2) Standard-oriented, or Multi-project Baseline

There are a number of different approaches to Multi-project Baselines. They can vary from average-emission specific emissions for a sector to technological standards of broad modeling within the frameworks of the particular sector such as, for example, merit order dispatch analysis in the electric power sector. In spite of the variety of approaches, the main point is to provide a set of standard data that shall be used as a baseline for a number of different projects. That can be also bases for comparison with respect to the baselines specific to a project and could be expressed in specific emissions per unit of electricity output (i.e., Basic Carbon Emission Factor /BCEF/ determined in tons of CO_2/GWh).

The multi-project approach is launched because, through the use of such methods, the transaction costs of Joint-Implementation Projects will be significantly reduced. In other words, the baseline development costs in Joint-Implementation Projects will be much lower than those developed in countries that already have a Multi-project Baseline and, therefore, the project developers' and investors' costs will be significantly reduced. Therefore the present study will also launch a number of projects that will be implemented by means of these mechanisms, as it will launch implementation of smaller but environmentally friendly and stable energy projects as well. Besides, there will be better predictability to the project developer in terms of number of emission reduction units that will be achieved through a project.

More particularly, in the power plant case, the multi-project approach to a Baseline seems to be a reliable and efficient solution.

5. Multi-Project Baseline for the Electric Power Sector

Considering the electric power sector, Multi-project Baselines find wide application in Joint-Implementation Projects and in Clean Development Mechanism Projects. The reason is that, in most cases, implementation of a project with capacity exceeding 20MWe, there is a marginal impact on the whole electric power sector. Therefore, project-specific Baselines are not suitable and multi-project approaches are preferred.

In the next section, an analysis of different Baseline methodologies based on multi-project approaches is made, and their compatibility with the subject of discussion is examined. Institutional conditions, available data and specificity of the Bulgarian electric power sector should also be taken into account when the most appropriate Baseline methodology is finally selected.

1) Mean specific emissions will all plants participating

At present, this is the most simplified methodology for Baseline determination. It assumes that the project will displace part of the integral electricity generation mix. The problem with that method is that it encompasses all plants with low operating costs that usually operate as baseload plants, inclusive of hydro- and nuclear power plants. There is, however, almost no chance for a new investment to replace the output of these plants; it is much more probable for an investment to replace plants with higher operating costs such as plants fired with fossil fuel. Therefore, that methodology may be rejected by the investor countries because the share of nuclear generation added to that of hydro-power (about 50%) is large within the power system of Bulgaria.

2) Mean specific emissions less Nuclear, Pumped-Storage and Hydro-Power Plants

In principle, there will be technologies that will continue to work irrespective of the adoption of a Joint-Implementation Project. The best example of that are the Chaira Pumped-Storage Hydro-Power Plant and the four large existing hydro-power cascades with hydro-power plants built downstream of the dams that have extremely flexible load-following capacity and can operate in peak-load periods. That is not due to the high operating costs but rather to the opportunity offered by them to choose the time of electricity generation in the event of unexpected need for generation capacity in the system.

There is also a current trend in Baseline determination to eliminate the output of all nuclear and hydro-power plants because the low operating costs mean that their output will not be affected by new plants in the network. If NPP and HPP are eliminated from the Baseline, such assumption shall be supported by clear written records and justified.

Therefore, this approach attempts to consider matters related only to consideration of mean values in the system; however, precision here still remains questionable. The benefit of that approach is that it will yield the variety of all loads that will be replaced by the project; however, it will not yield the mean weighted value against the current (operating) costs.

3) Mean emissions for each Load Category

That involves load curve grouping into different load categories such as seasonal, peak, shoulder, and base loads. After determining the load profile of a project, a direct comparison to the same load category in the Baseline forecasts can be made.

4) Consideration of Solely Marginal Plants (Merit order dispatch Analysis)

The Least-Cost Method assumes that plants operating at the margin (at highest costs and, most probably, with highest emissions) will be the first to be replaced. The method should indicate the generation from each plant for every hour (or group of hours) within one year. The assumption is that commissioning of the new capacity will displace plants that currently operate at the end limit of the load curve. That analysis will require evaluation of the last unit(s) that should be connected, for every hour or group of hours in a year and, in that manner, the specific emissions per hour. That type of approach proves to be the most precise with respect to determining which unit actually stops generating electricity. The negative aspect is the quality and quantity of data needed for that method.

5) Operating Margin/Build Margin Methodology of IEA and OECD

OECD recommends to use the weighted mean between the operating margin and build margin for determination of the Baseline. That is based on the assumption that a Joint Implementation Project will very likely have an impact on the operation of an existing and new plant in the short term (marginal operating costs) as well as delay the implementation of a new plant in the longer term (marginal build costs). It will be possible to use a power sector model for forecasting of the build margin as well as of the operating margin.

6. Baseline Determination and Computation of the Carbon Emission Factor (CEF) Common to the Bulgarian Power Sector

6.1. Mean specific emissions (all plants included)

The study enables determination of the mean specific emissions and the corresponding CEF for every plant and system-total. That analysis encompasses all power plants, inclusive of nuclear power plants and hydro-power plants that release no emissions but contribute power generation to the system. This approach is too imprecise to analyze CEF and, respectively, reduction of CO_2 emissions in a Joint-Implementation Project, because the operation of nuclear power plants and, to less extent, the operation of the four large hydro-power cascades of the power system are not influenced by the implementation of such projects.

6.2. Mean Specific Emissions (less NPP and HPP)

The study calculates and determines the mean specific emissions and the corresponding CEF for every plant and system-total, only excluding NPP and HPP from the calculation of Baseline emissions because they have low operating costs and, for that reason, there is not probability of their replacement. An option with starting up of the hydro-power cascades with HPP participating in the regulation of the system according to the above-mentioned calculations was developed for the event that a JP project hypothetically replaces peak-load hydro-power capacities of the system (HPP or gas-fired combined-cycle power plant over 20 MW).

That methodology can have quite extensive application in projects but still it remains a less refined methodology and is recommended only in cases of smaller-volume emission reductions in the sector. For example, when integration of JI projects with less than 200 MW installed capacity into the system is considered.

6.3. Mean Specific Emissions for Each Load Category

This approach is not considered in detail because it requires CEF determination for the overall power system. The approach does not add much to the two previous methodologies and it can be said again that it is a less refined approach and it does not reach far in determining what will actually be replaced by the new capacity.

6.4. Integrated Resource Planning (Least-Cost Planning Analysis)

Merit order dispatch analysis for the power sector indicates, in economic terms, what technologies or which particular generating units can be possibly replaced by a new generation in the network. That can provide a realistic picture of replacement, more specifically in the open electricity markets.

This method requires detailed information on the generating capacities and evaluation of the marginal units that shall be started up from a cold reserve state for every hour of the year. The power plants with guaranteed supply contracts shall be taken into consideration.

6.5. Operation Margin/Build Margin Methodology

This approach is a combination of marginal operating costs and marginal construction costs. It can be applied in countries where the power system capacities are expanding. The problem with this methodology is that it is difficult to determine the weighted mean between the Operation Margin and the Build Margin.

7. Selection of Baseline Study Methodology

Following the argumentation here above, the methodology used for Baseline Determination was developed on the basis of merit order dispatch analysis. This type of approach is considered the most precise for analysis which unit will be replaced by a new capacity.

The merit order dispatch approach analyses the electric power sector on the basis of electricity demand forecasts – minimum and maximum; fuel prices, new capacities and envisaged rehabilitation projects; and cost estimates. For these analyses NEK uses the IRP Manager computer model (Integrated Resource Planning Model).

The US software company Electric Power Software in Minneapolis has developed the software called IRP Manager for US institute EPRI. Since 1995 the model is implemented in the Bulgarian National Electricity Company for the least cost expansion planning of the power sector development.

The IRP-Manager model provides comprehensive management of demand, supply, financial and rate data needed for long-term integrated resource planning of the power sector. It coordinates an expansive “Tool Box” of capabilities including: chronological simulation of demand and resources, automated resource strategy development, decision analysis and complete forecasts of impacts from all perspectives.

The forecast power balances obtained by merit order dispatching are used to develop the Baseline study. The basis study itself was developed using the ACM0002 Methodology, “Consolidated Baseline Methodology for Grid-Connected Electricity Generation from Renewable Sources” of UNFCCC CDM – Executive Board.

In order that the study can be as complete as possible and applied to the widest possible range of JP projects in the Bulgarian power sector, all methods offered in the power plant operation margin determination methodology are applied. The relation between operation margin and build margin is assumed everywhere as 50/50 % for BCEF determination.

Baseline Carbon Emission Factor of
Bulgarian Electricity and Heat Power System

		Unit	2000	2001	2002	2003	2004		
1.	**Total system power generation**	**GWh**	**41 805**	**44 785**	**41 943**	**41 990**	**43 621**		
2.	**Total system heat generation**	**$MW_{th}h$**	**14 398 244**	**17 092 947**	**17 104 183**	**18 945 487**	**15 622 107**		
3.	**Total CO2 emissions of power generation**	**kt/a**	**20 686,07**	**24 186,09**	**21 130,37**	**23 502,96**	**26 141,93**		
4.	**Total CO2 emissions of energy transformation**	**kt/a**	**25 364,83**	**29 868,93**	**27 206,40**	**29 968,99**	**31 566,24**		
	Baseline Emission Factor - BEF								
	Fossil Fuels								
1.	**Dispatch Data_OM_EF**	**tonne/MWh**	1,215	1,287	1,214	1,226	1,199		
2.	**Dispatch Data Adjusted_OM_EF**	**tonne/MWh**	1,159	1,222	1,150	1,160	1,138		
3.	**Average Dispatch Data_OM_EF**	**tonne/MWh**	1,269	1,307	1,231	1,237	1,239		
	HPP included								
1.	**Dispatch Data_OM_EF**	**tonne/MWh**	1,144	1,184	1,106	1,160	1,165		
2.	**Dispatch Data Adjusted_OM_EF**	**tonne/MWh**	1,065	1,106	1,032	1,067	1,078		
3.	**Average Dispatch Data_OM_EF**	**tonne/MWh**	1,101	1,149	1,040	1,073	1,108		
	Fossil Fuels								
1.	**Dispatch Data_OM_EF**	**kg/GJ**	106,38	109,57	110,86	111,24	110,03		
2.	**Dispatch Data Adjusted_OM_EF**	**kg/GJ**	106,93	109,05	110,68	111,09	109,91		
3.	**Average Dispatch Data_OM_EF**	**kg/GJ**	109,43	108,79	109,00	109,47	110,63		
	Forecast								
	Minimum demand	**Unit**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
1.	**Total system power generation**	**GWh**	45 051	43 115	44 156	47 490	48 212	51 139	52 291
2.	**Total system heat generation**	**$MW_{th}h$**	17 875 519	18 057 503	18 320 175	18 746 936	19 028 565	19 744 974	19 358 651
3.	**Total CO2 emissions of power generation**	**kt/a**	28 035,37	31 810,38	31 245,76	33 538,31	33 547,47	33 863,20	31 248,73
4.	**Total CO2 emissions of energy transformation**	**kt/a**	34 447,38	38 304,71	37 832,72	40 154,36	40 358,39	40 560,20	37 758,36
	Baseline Emission Factor - BEF								
	Fossil Fuels								
1.	**Dispatch Data_OM_EF**	**tonne/MWh**	1,215	1,158	1,144	1,022	0,984	0,963	0,953
2.	**Dispatch Data Adjusted_OM_EF**	**tonne/MWh**	1,154	1,100	1,078	0,956	0,917	0,902	0,899
3.	**Average Dispatch Data_OM_EF**	**tonne/MWh**	1,243	1,190	1,146	1,026	0,986	0,974	0,983
	HPP included								
1.	**Dispatch Data_OM_EF**	**tonne/MWh**	1,176	1,175	1,110	0,995	0,959	0,940	0,918
2.	**Dispatch Data Adjusted_OM_EF**	**tonne/MWh**	1,111	1,102	1,017	0,894	0,858	0,849	0,838
3.	**Average Dispatch Data_OM_EF**	**tonne/MWh**	1,138	1,153	1,057	0,947	0,909	0,898	0,889
	Fossil Fuels								
1.	**Dispatch Data_OM_EF**	**kg/GJ**	111,997	106,693	106,484	100,340	97,288	95,088	96,152
2.	**Dispatch Data Adjusted_OM_EF**	**kg/GJ**	111,976	106,621	106,402	100,566	97,871	95,946	96,570
3.	**Average Dispatch Data_OM_EF**	**kg/GJ**	111,622	106,175	106,640	100,646	98,217	96,578	97,026
	Forecast								
	Maximum demand	**Unit**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
1.	**Total system power generation**	**GWh**	46 739	43 572	46 588	48 351	49 455	51 368	53 194
2.	**Total system heat generation**	**$MW_{th}h$**	20 360 486	19 909 333	20 240 498	21 206 857	22 170 354	23 026 991	23 407 576
3.	**Total CO2 emissions of power generation**	**kt/a**	27 152,04	31 508,75	32 821,32	33 044,62	33 387,00	32 807,31	30 531,04
4.	**Total CO2 emissions of energy transformation**	**kt/a**	34 405,23	38 713,17	40 181,87	40 770,13	41 342,14	40 706,37	38 615,88
	Baseline Emission Factor - BEF								
	Fossil Fuels								
1.	**Dispatch Data_OM_EF**	**tCO2/MWh**	1,204	1,215	1,124	1,014	0,973	0,947	0,884
2.	**Dispatch Data Adjusted_OM_EF**	**tCO2/MWh**	1,143	1,156	1,059	0,947	0,908	0,884	0,833
3.	**Average Dispatch Data_OM_EF**	**tCO2/MWh**	1,233	1,252	1,127	1,018	0,977	0,953	0,917
	HPP included								
1.	**Dispatch Data_OM_EF**	**tCO2/MWh**	1,158	1,168	1,101	0,990	0,947	0,928	0,865
2.	**Dispatch Data Adjusted_OM_EF**	**tCO2/MWh**	1,091	1,095	1,006	0,888	0,850	0,834	0,791
3.	**Average Dispatch Data_OM_EF**	**tCO2/MWh**	1,118	1,144	1,052	0,940	0,899	0,879	0,840
	Fossil Fuels								
1.	**Dispatch Data_OM_EF**	**kg/GJ**	109,651	111,991	105,315	100,011	95,929	94,604	93,043
2.	**Dispatch Data Adjusted_OM_EF**	**kg/GJ**	109,571	111,876	105,263	100,226	96,498	95,130	93,524
3.	**Average Dispatch Data_OM_EF**	**kg/GJ**	109,126	111,908	105,550	100,273	96,821	95,676	94,056