

# KOROGLU HYDROELECTRIC POWER PLANT

Document Prepared By Kilittasi Engineering Consulting & Construction Co. Ltd.

|                      |                                                                                                                                                                                                                                                                                             |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Project Title</b> | <b>Koroglu Hydroelectric Power Plant</b>                                                                                                                                                                                                                                                    |
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## Abbreviations

|       |                                                                           |
|-------|---------------------------------------------------------------------------|
| BE    | Baseline Emission                                                         |
| BM    | Build Margin                                                              |
| CDM   | Clean Development Mechanism                                               |
| CO    | Combined Margin                                                           |
| DSI   | General Directorate of State Hydraulics Works of the Government of Turkey |
| EF    | Emission Factor                                                           |
| EG    | Energy Generation                                                         |
| EIA   | Environmental Impact Assessment                                           |
| EMRA  | Energy Market Regulatory Authority                                        |
| EUAS  | Electricity Generation Incorporation                                      |
| FC    | Fuel Consumption                                                          |
| GHG   | Greenhouse Gas                                                            |
| HEPP  | Hydroelectric Power Plant                                                 |
| IRR   | Internal Rate of Return                                                   |
| OM    | Operating Margin                                                          |
| HEPP  | Hydroelectric Power Plant                                                 |
| IPCC  | Intergovernmental Panel on Climate Change                                 |
| J     | Joule                                                                     |
| LSC   | Local Stakeholder Consultation                                            |
| NCV   | Net Calorific Value                                                       |
| PE    | Project Emission                                                          |
| UNFCC | United Nations Framework on Climate Change                                |
| T     | Ton                                                                       |
| TEIAS | Turkish Electricity Transmission Incorporation                            |
| VER   | Voluntary Emission Reduction                                              |
| WEPM  | Wind Energy Potential Map                                                 |

## 1 PROJECT DETAILS

### 1.1 Summary Description of the Project

Koroglu Hydroelectric Power Plant (HEPP) (from now called Project and/or Koroglu HEPP) is a run-of river type power plant that will be constructed on the Savrun River between the elevations of 875 m and 747 m. Project site is located in Province of Osmaniye, Kadirli district in the Mediterranean Region. Project investor is a private enterprise, ETKEN Elektrik Enerji Uretim Ltd.Sti.<sup>1</sup>

Koroglu HEPP project received a 49-year production license from the Energy Market Regulatory Authority of Turkey (EMRA)<sup>2</sup> on 25 Dec 2008. Water use agreement was signed between ETKEN Ltd. Sti. and the Directorate of Hydraulic Resources (DSİ)<sup>3</sup> of the Government of Turkey on 29 Januray 2008 and it is revised on 13 February 2012. On 13 Sep 2011, project received an “Environmental Impact Assessment Not Required” statement from the Ministry of Forestry and Environment<sup>4</sup> following the preparation of a “Project Introduction File” in compliance with the Turkish Environmental Impact Assessment Law.

There will be three weirs in the project. One is the Main Weir located on the Savrun River, and the other two small tyrolean type weirs are located on the Kurbağalı Creek which is a side branch of the Savrun River. Main Weir is on the 875.0 m crest elevation on the Savrun River. Weir body height is 5 m from the thalweg. Catchment basin area of the main weir is 149 km<sup>2</sup>. Intake structure is placed on the right side bank of the river. Access to the main weir is very difficult due to the rough geography of the region. Therefore, an access tunnel is designed to be able to reach easily to the Main Weir. Due to the geographic difficulties, settling basin is placed 900 m away from the water intake. There is a conveyance tunnel between the water intake and the settling basin.<sup>5</sup>

Water will be taken from the Kurbagali Creek by two small Tyrolean type weirs. Each of Tyrolean weir’s catchment basin area is 8 km<sup>2</sup>. Diverted water by Tyrolean weirs is conveyed to the settling basin by a pipeline. Suspended material inside the water (bigger than 0.3 mm) will be settled by a settling basin. Water leaving the settling basin will be conveyed to a headpond. Penstock length is 998 m and its diameter is 1.8 m. Powerhouse is placed on the right side bank of the Savrun River at the tailwater elevation of 747.0 m. Water will be turbined by three units of horizontal axis Francis turbines.<sup>6</sup>

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<sup>1</sup> Koroglu HEPP Feasibility Report, October 2010 (In Turkish). Section 1, pp.3

<sup>2</sup> Enerji Piyasası Düzenleme Kurulu –EPDK (in Turkish). <http://www.epdk.gov.tr>

<sup>3</sup> Devlet Su İşleri-DSİ (in Turkish). <http://www.dsi.gov.tr/>

<sup>4</sup> Title of the Ministry of Forestry and Environment changed to Ministry of Environment and Urbanization in 2012.

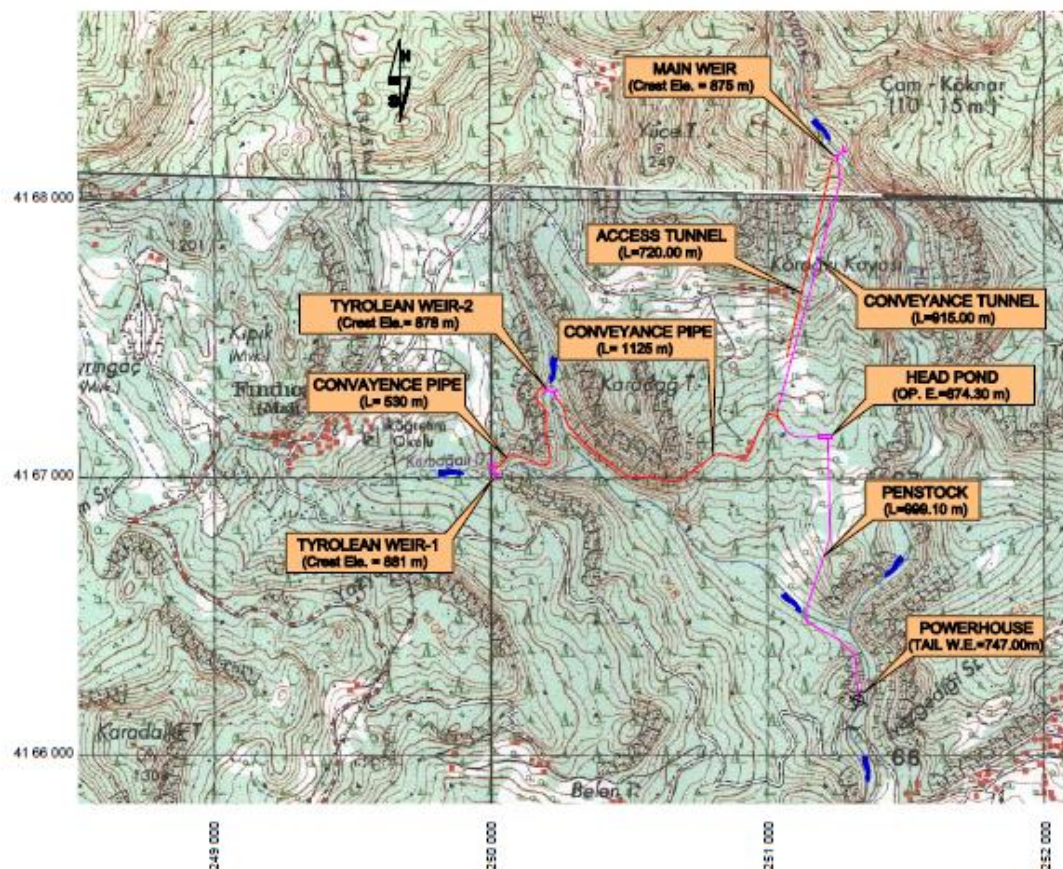
<sup>5</sup> Koroglu HEPP Feasibility Report, October 2010 (In Turkish). Section 1, pp.3-4

<sup>6</sup> Koroglu HEPP Feasibility Report, October 2010 (In Turkish). Section 1, pp.3-4

Each turbine will have an installed capacity of 3.02 MWe and total installed capacity of the project will be 9.06 MWe<sup>7</sup>; (3.177 MWm x 3 = 9.53 MWm). Generator nominal output is 3400 kVA, power factor is 0.9, therefore  $3400 \text{ kVA} \times 0.9 \times 3 = 9.18 \text{ MW}$ <sup>8</sup>.

CDM Project standard v.5, par. 82 (a) requires “the installed capacity for renewable electricity generating units that involve turbine-generator systems shall be based on the installed/rated capacity of the generator” for small scale projects. Accordingly, the project’s output capacity is calculated as 9.18 MW.

Generated energy will be transmitted to the Sayan HEPP via a 2 km transmission line. Sayan HEPP, located at the downstream of the project activity, will be the connection point of the Koroglu HEPP to the Turkish National Grid System.<sup>9</sup> Project is expected to generate 26.13 GWh amount of energy per year.<sup>10</sup>



**Figure 1: Koroglu HEPP Project Formulation**

<sup>7</sup> Koroglu HEPP Electricity Generation License, authorized by the EMRA with the number of EU/1904-3/1351, dated as of 25 Dec 2008.

<sup>8</sup> Please see the Turbine Generation Agreement between Wasserkraft GmbH&Co KG and Etken Elektrik Uretim Ltd. Sti. pp.10.

<sup>9</sup> Koroglu HEPP Feasibility Report, October 2010 (In Turkish). Section 1, pp.10

<sup>10</sup> Koroglu HEPP Feasibility Report, October 2010 (In Turkish). Section 1, pp.2

Koroglu HEPP, as a renewable type energy generation project, will contribute to global CO2 emission reductions efforts. Project will replace the same amount of CO2 emissions which would have been, otherwise, released by fossil fired power plants. Koroglu HEPP is expected to generate 13846.28 tCO2 amount of emission reduction annually.

In addition to being environmentally friendly, project will have social benefits to local life, creating direct and indirect employment opportunities in the region. Temporary jobs will be available for the local people living in the nearest villages. In addition to that, some materials will be purchased from local market providing an income for the community as well.

## 1.2 Sectoral Scope and Project Type

According to UNFCCC sectoral scopes definition for Clean Development Mechanism (CDM) projects, Koroglu HEPP falls under the category of Sectoral Scope 1, Energy Industries (renewable - / non-renewable sources).

Project is a single greenfield investment, not a part of a project group or bundle.

No public funding and no Official Development Aid finance are used for the Project.

## 1.3 Project Proponent

Project proponent of the Koroglu HEPP: ETKEN Elektrik Enerji Uretim Ltd.Sti.

Contact Person:

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Mr. Baskan coordinates the construction and operation of the Koroglu HEPP project. He is also responsible for the implementation of the Koroglu HEPP Monitoring Plan for Verified Carbon Standard (VCS) verification.

ETKEN Elektrik Enerji Uretim Ltd.Sti. is the owner of the carbon credits.

## 1.4 Other Entities Involved in the Project

Kilitasi Engineering Consulting and Construction Co. Ltd. is providing consulting services for the development of the carbon asset for the Koroglu HEPP.

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### 1.5 Project Start Date

20 June 2014 - Commissioning date.

### 1.6 Project Crediting Period

- Crediting period start date : 20 June 2014
- Crediting period end date : 20 June 2024
- VCS project crediting period : 10 years 0 month, renewable twice.

### 1.7 Project Scale and Estimated GHG Emission Reductions or Removals

Koroglu HEPP is a small-scale renewable type energy generation project with an installed capacity of 9.06 MWe (9.53 MWm) ; and it will, in the future, remain below the eligibility limit of 15 MW for renewable type small-scale CDM projects as well. Project's annual electricity generation is expected to be 26.13 GWh.<sup>11</sup>

|              |   |
|--------------|---|
| Project      | X |
| Mega-project |   |

| Years                      | Estimated GHG emission reductions or removals (tCO <sub>2</sub> e) |
|----------------------------|--------------------------------------------------------------------|
| 20.06.2014 – 31.12.2014    | 6448.95                                                            |
| 2015                       | 13846.28                                                           |
| 2016                       | 13846.28                                                           |
| 2017                       | 13846.28                                                           |
| 2018                       | 13846.28                                                           |
| 2019                       | 13846.28                                                           |
| 2020                       | 13846.28                                                           |
| 2021                       | 13846.28                                                           |
| 2022                       | 13846.28                                                           |
| 2023                       | 13846.28                                                           |
| 01.01.2024 – 20.06.2024    | 7397.33                                                            |
| <b>Total estimated ERs</b> | <b>138462.80</b>                                                   |

<sup>11</sup> Koroglu HEPP Feasibility Report, October 2010 (In Turkish). Section 1, pp.2

|                                 |          |
|---------------------------------|----------|
| Total number of crediting years | 10       |
| Average annual ERs              | 13846.28 |

## 1.8 Description of the Project Activity

Koroglu HEPP is a run-of-river type hydropower project with an installed capacity of 9.06 MWe (9.53 MWm) with an expected electricity generation of 26.13 GWh annually. Project will be implemented on the Savrun River in Kadirli district in Province of Osmaniye.

Legally project lifetime is 49 years.<sup>12</sup> In other words, Koroglu HEPP investor can operate this project for 49 years; beyond this time period, investor has to make a new agreement with the government to be able to continue to operate the plant.<sup>13</sup> However, from the technical point of view, project life time can be referred to the lifetime of turbine. All construction elements have a lifetime of 45 years according to the DSI Report.<sup>14</sup> The only element having shortest lifetime is turbine which is defined as 150 000 in UNFCC CDM EB50-Annex 15<sup>15</sup>.

So the technical lifetime of the Koroglu HEPP Project is 150 000 hr (approximately 17 years). However, since turbines will not operate continuously, this value can be accepted as 20 years which is equal to the time period to which it is being applied for carbon certification to VCS (2 times 10 year. Please see Section 1.6 of this report).

Koroglu HEPP will generate green electricity from a renewable resource; therefore, it will replace electricity from Turkish grid which is dominated by fossil fuel fired power plants.

Project will generate GHG emission free, clean electricity, feeding into the national Turkish grid where all Turkish power plants are connected and are dispatched centrally by the Turkish grid operator, Turkish Electricity Transmission Incorporation. Electricity supplied to the national grid is dominated by thermal power plants.<sup>16</sup> Electricity generated by the Koroglu HEPP project will displace power generation by thermal power plants, which leads to savings in fuel combustion and thus to the reduction of GHG emissions, as specified and explained in detail in Section 3 below.

Following table provides a summary of the technical specifications of the project facilities.

**Table 1: Technical Characteristics of Koroglu HEPP<sup>17</sup>**

<sup>12</sup> Koroglu HEPP Water Usage and Operation Agreement dated 5 Nov 2008.

<sup>13</sup> Koroglu HEPP Water Usage and Operation Agreement dated 5 Nov 2008.

<sup>14</sup> DSI.Yatirim Projelerinin Ekonomik Analizi. 1985. In Turkey, all projects implement for and/or in cooperation with DSI, use the technical lifetime values defined in this report. Similarly, Koroglu Feasibility Report, 2010 also based on these data provided in this report. [http://cdm.unfccc.int/EB/050/eb50\\_repan15.pdf](http://cdm.unfccc.int/EB/050/eb50_repan15.pdf)

<sup>15</sup> UNFCC CDM, EB50-Annex 15, pp.4.. Visited on 11 Sep 2013.

<sup>16</sup> See Section 2.4 below.

<sup>17</sup> Koroglu HEPP Feasibility Report, October 2010 (In Turkish). Section 1, pp.4-10

| Project Main Characteristics                   |                        | Headpond                  |                         |
|------------------------------------------------|------------------------|---------------------------|-------------------------|
| Type                                           | Run-of-river           | Headpond Width            | 21.5 m                  |
| Gross Head                                     | 127.28 <sup>18</sup> m | Headpond Length           | 22.0 m                  |
| Design Discharge                               | 8.35 m <sup>3</sup> /s | Headpond Height           | 4.5 m                   |
| Total Installed Power                          | 9.06 MWe               | Headpond Operation Elev.  | 874.28 m                |
| Power Generation                               | 26.13 GWh/year         | Headpond Min Water Elev.  | 870.00 m                |
| Weir, Water Intake Structure (Kurbagali Creek) |                        | Penstock                  |                         |
| Type                                           | Tyrolean               | Type                      | Steel                   |
| Elevation at Crest                             | 881.0 m                | Diameter                  | 1.8 m                   |
| Thailweg Elevation                             | 878.0 m                | Length                    | 998 m                   |
| Height from River Bed                          | 3.0 m                  | Branch                    | 3                       |
| Length of Weir                                 | 12.5 m                 | Branch Diameter           | 1.0 m                   |
| Water Intake                                   | Left Side              |                           |                         |
| Water Intake Length                            | 10 m                   |                           |                         |
| Conveyance Channel (Between Tyrolean Weirs)    |                        | Powerhouse                |                         |
| Type                                           | Box                    | Type                      | Above Ground            |
| Gradient                                       | 0.002                  | Width                     | 16.0 m                  |
| Bottom Width                                   | 1.5 m                  | Length                    | 34.6 m                  |
| Length                                         | 530.0 m                | Tailwater Elevation       | 747.0 m                 |
|                                                |                        |                           |                         |
| Weir, Water Intake Structure (Kurbagali Creek) |                        | Generator                 |                         |
| Type                                           | Tyrolean               | Number of Generators      | 3                       |
| Elevation at Crest                             | 878.0 m                | Nominal Voltage           | 6.3 kV (+/- 5%)         |
| Thailweg Elevation                             | 875.0 m                | Frequency                 | 50 hz                   |
| Height from River Bed                          | 3.0 m                  | Synchronic Rotation Freq. | 750 rpm                 |
| Length of Weir                                 | 15.0 m                 |                           |                         |
| Water Intake                                   | Left Side              |                           |                         |
| Water Intake Length                            | 10 m                   |                           |                         |
| Conveyance Channel (Tyrolean Weir to Headpond) |                        | Turbine                   |                         |
| Type                                           | Box                    | Type                      | Horizontal Axis Francis |
| Gradient                                       | 0.002                  | Installed Power           | 3 x 3.02 MWe            |
| Bottom Width                                   | 1.5 m                  | Rotation Frequency        | 750 rpm                 |
| Length                                         | 1125.0 m               |                           |                         |
|                                                |                        |                           |                         |
| Main Weir                                      |                        | Transmission Line         |                         |
| Type                                           | Concrete Body          | Voltage                   | 36 kV                   |
| Elevation at Crest                             | 875.0 m                | Connection Point          | Sayan HEPP              |
| Thailweg Elevation                             | 870.0 m                | Length                    | 2.0 km                  |
| Height from River Bed                          | 5.0 m                  |                           |                         |
| Length of Weir                                 | 36.0 m                 |                           |                         |
| Water Intake                                   | Right Side             |                           |                         |

<sup>18</sup> Koroglu HEPP Feasibility Report, October 2010 (In Turkish). Section 1, pp.2

| Conveyance Tunnel |            | Weir Access Tunnel |                     |
|-------------------|------------|--------------------|---------------------|
| Type              | Horse Shoe | Type               | Modified Horse Shoe |
| Length            | 865 m      | Length             | 650 m               |
| Diameter          | 4.3 m      | Dimensions         | 4.3 m               |
| Slope             | 0.0005     |                    |                     |

As a run-of-river type project, Koroglu HEPP applies environmentally safe and sound technologies, having no harm to environment. Turbines and generators that will be used in the project will be manufactured abroad and then delivered to the project site. By the time of writing this report, Austrian Wasser Kraft Craft Company was chosen by the project owner to transfer these technology and equipment to the project. Chosen technology is a grid friendly one with low maintenance needs as well as low noise and low environmental impacts.

## 1.9 Project Location

Koroglu HEPP is located in the Marmara Region in Turkey. Project is in the boundary of Kadirli District in Province of Osmaniye.

Figure 2 and Figure 3 show its location in Turkey and Province of Osmaniye respectively.

Geographical coordinates of the project site<sup>19</sup>:

| Project Facilities                   | Latitude (6° UTM) | Longitude (6° UTM) |
|--------------------------------------|-------------------|--------------------|
| Koroglu Main Weir                    | 41 68 185(N)      | 251 255(E)         |
| Koroglu Side Weir (Kurbagali Weir)-1 | 41 67 020 (N)     | 250 028(E)         |
| Koroglu Side Weir (Kurbagali Weir)-2 | 41 67 275 (N)     | 250 220(E)         |
| Powerhouse                           | 41 66 175(N)      | 251 310 (E)        |

<sup>19</sup> Koroglu HEPP Feasibility Report, October 2010 (In Turkish). Section 1, pp.3



Figure 2: Project Location in Turkey

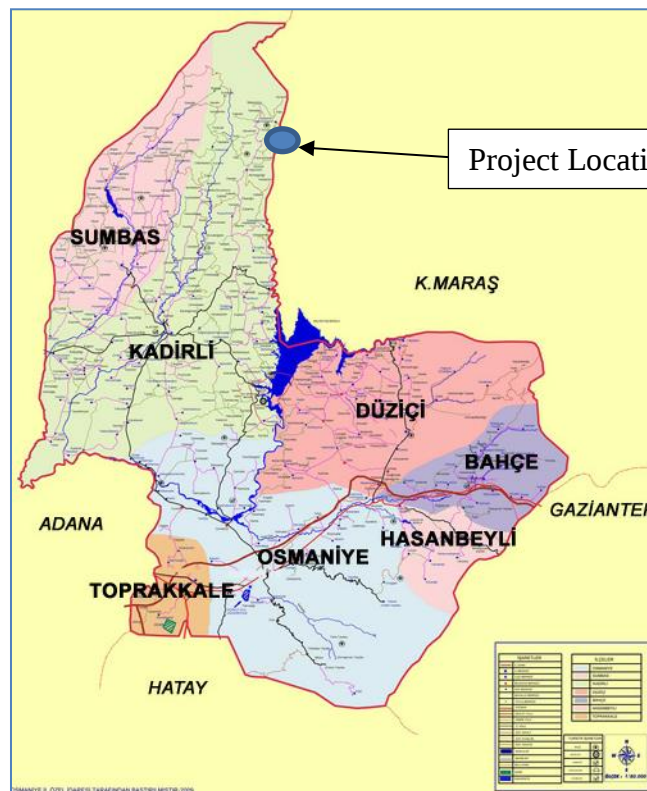


Figure 3: Project Location in Province of Osmaniye

### 1.10 Conditions Prior to Project Initiation

Koroglu HEPP project site is located on the Savrun river, about 35 km of Kadirli district in Province of Osmaniye.

Project site is in a rocky area where there was no settlement before the project. The closest residential area is Inci village which is horizontally about 500 m away from the project's power house. Since project site is rocky where few trees exist, mostly covered with small plants like *maki*, there was no activity within the site. There is also no fish farming activity both at downstream and upstream.

Project has expropriation, and land owners are paid for the lands covered by the project activity. Project owner also compensated the Ministry for Environment and Forest for the value of trees to be planted somewhere.

Project is a newly implemented renewable energy project. Main purpose is utilization of hydraulic potential of Turkey to meet its increasing demand for energy.

Project activity is not implemented for subsequent reduction of GHG. Project is a hydro power plant implemented to generate electricity from renewable resources (please see the expropriation records).

### 1.11 Compliance with Laws, Statutes and Other Regulatory Frameworks

Koroglu HEPP project received all necessary authorizations and/or approvals from the relevant entities of the Government of Turkey, showing that project is in compliance with all relevant laws and regulations of Turkey. Following table summarizes these laws and regulations.

**Table 2: Laws and Regulations Applicable to the Project and the Alternatives**

| Relevant Laws                                             | Number / Enactment Date | Aim and Scope                                                                                                                                                                                                          |
|-----------------------------------------------------------|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Environmental Law <sup>20</sup>                           | Nr. 2872 / 11.08.1983   | According to the Electricity License Regulation, all energy generation projects have to receive approval from the Ministry of Environment and Urbanization. Energy projects have to comply with the Environmental Law. |
| *Environmental Impact Assessment Regulation <sup>21</sup> | Nr. 26939 / 17.07.2008  |                                                                                                                                                                                                                        |
| Electricity Market Law <sup>22</sup>                      | Nr. 4628 / 20.02.2001   | Regulating procedures for electricity generation, transmission, distribution, wholesale and retail for legal entities. Two regulations issued under the                                                                |

<sup>20</sup> Available at <http://www.mevzuat.adalet.gov.tr/html/631.html>. Accessed on 2 April 2012.

<sup>21</sup> Available at <http://www.epdk.org.tr/index.php/elektrik-piyasasi/mevzuat?id=73>. Click on the "Çevresel Etki Değerlendirmesi Yönetmeliği" link. Accessed on 28 Dec 2012.

<sup>22</sup> Available at <http://www.epdk.org.tr/index.php/elektrik-piyasasi/mevzuat?id=143>. Click on the "Elektrik Piyasası Kanunu" link. Accessed on 28 Dec 2012.

|                                                                                                                |                        |                                                                                                                                                                                                                                                                                             |
|----------------------------------------------------------------------------------------------------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| *Electricity License Regulation <sup>23</sup>                                                                  | Nr. 24836 / 04.08.2002 | law; one for generation license and the other for market price balancing and conciliation.                                                                                                                                                                                                  |
| *Electricity Market Balancing and Conciliation Regulation <sup>24</sup>                                        | Nr. 27200 / 14.04.2009 |                                                                                                                                                                                                                                                                                             |
| Law on Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy <sup>25</sup> | Nr. 5346 / 18.05.2005  | Aims to extend the utilization of renewable energy for electricity generation, and identifies methods and principles for power generation from renewable resources in an economical and conservative manner as well as certification of the electricity generated from renewable resources. |
| Energy Efficiency Law <sup>26</sup>                                                                            | Nr. 5627 / 02.05.2007  | Identifies method and principles for industry, power plants, residential buildings and transport to implement necessary measures for energy efficiency during electricity generation, transmission, distribution and consumption                                                            |

## 1.12 Ownership and Other Programs

### 1.12.1 Right of Use

Ownership of the plant, equipment and electricity generation license (EU/1904-3/1351) belongs to ETKEN Elektrik Enerji Uretim Ltd. Sti., to whom all emission reductions/removals will be granted.<sup>27</sup>

### 1.12.2 Emissions Trading Programs and Other Binding Limits

Koroglu HEPP project will not be used for compliance with an emissions trading program or to meet binding limits on greenhouse gas (GHG) emissions.

### 1.12.3 Participation under Other GHG Programs

Koroglu HEPP has not been registered and/or is seeking registration under any other GHG programs.

<sup>23</sup> Available at <http://www.epdk.org.tr/index.php/elektrik-piyasasi/mevzuat?id=167>. Click on the "Lisans Yönetmeliği" link. Accessed on 28 Dec 2012.

<sup>24</sup> Available at <http://www.epdk.org.tr/index.php/elektrik-piyasasi/mevzuat?id=167>. Click on the "Dengeleme ve Uzlaştırma Yönetmeliği İlgili Mevzuatı" link. Accessed on 28 Dec 2012.

<sup>25</sup> Available at <http://www.epdk.org.tr/index.php/elektrik-piyasasi/mevzuat?id=73>. Click on the "Law on Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy" link. Accessed on 28 Dec 2012.

<sup>26</sup> Available at <http://www.epdk.org.tr/index.php/elektrik-piyasasi/mevzuat?id=73>. Click on the "Enerji Verimliliği Kanunu" link. Accessed on 28 Dec 2012.

<sup>27</sup> Koroglu HEPP Electricity Generation License, authorized by the EMRA with the number of EU/1904-3/1351, dated as of 25 Dec 2008.

## 1.12.4 Other Forms of Environmental Credit

Koroglu HEPP project has not created another form of environmental credit or renewable energy certificate.

## 1.12.5 Projects Rejected by Other GHG Programs

Koroglu HEPP did not receive any rejection from any other GHG programs.

## 1.13 Additional Information Relevant to the Project

### Eligibility Criteria

Koroglu HEPP is not a part of grouped projects.

### Leakage Management

According to the AMS-I.D. Version 17.0, if the energy generating equipment is transferred from another activity, leakage is to be considered. In Koroglu HEPP project, energy generation equipments will be brand new, which are not used previously in any other activity. Therefore, leakage will not be considered in emission reduction calculations.

### Commercially Sensitive Information

The whole content of all the contracts signed with other parties for construction, purchase of electromechanical equipment, maintenance and services, board decisions and financial data are commercially sensitive information. However all required information from these documents including copies of cover pages, and/or various pages as per the requested information, will be provided to the Auditors to meet the following criteria as stated by the VCS standard v.3.3, 3.18.

“Information in the project documents related to the determination of the baseline scenario, demonstration of additionality, and estimation and monitoring of GHG emission reductions and removals shall not be considered to be commercially sensitive and shall be provided in the public versions of the project documents.”

### Further Information

-

## 2 APPLICATION OF METHODOLOGY

### 2.1 Title and Reference of Methodology

Emission reductions of the project have been calculated in accordance with the approved small scale CDM-methodology AMS-I.D.: “Grid connected renewable electricity generation”, Version 17.0.<sup>28</sup>

For baseline calculations, AMS-I.D refers to the “Tool to calculate the emission factor for an electricity system” Version 4.0.0.<sup>29</sup> This methodological tool determines the CO<sub>2</sub> emission factor for the displacement of electricity generated by power plants in an electricity system, by calculating the Combined Margin emission factor (CM) of the electricity system. The CM is the result of a weighted average of two emission factors pertaining to the electricity system: the Operating Margin (OM) and the Build Margin (BM).

For the demonstration of additionality, “Tool for the demonstration and assessment of additionality”, version 7.0.0 is used.<sup>30</sup>

### 2.2 Applicability of Methodology

The applicability criteria of CDM-methodology AMS-I.D. are listed and justified below:

| No | Applicability criteria listed in the AMS-I.D. methodology                                                                                                                                                                                                                                                                                         | Justification                                                                                                                                                                       |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | This methodology comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal and renewable biomass: Supplying electricity to a national or a regional grid; or supplying electricity to an identified consumer facility via national/regional grid through a contractual arrangement such as wheeling. | Koroglu HEPP project is a grid connected renewable energy generation project, utilizing hydraulic power to generate electricity.                                                    |
| 2  | This methodology is applicable to project activities that: (a) Install a new power plant at a site where there was no renewable energy power plant operating prior to the implementation of the project activity (Greenfield plant); (b) Involve a capacity addition;                                                                             | Koroglu HEPP project installs a new power plant at a site where there was no renewable energy generating power plant operating prior to the implementation of the project activity. |

<sup>28</sup> Available at <http://cdm.unfccc.int/methodologies/DB/RSCTZ8SKT4F7N1CFDXCSA7BDQ7FU1X/view.html>. Accessed on 6 April 2012.

<sup>29</sup> Available at <http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v4.0.pdf>. Accessed on 15 Jan 2014.

<sup>30</sup> Available at <http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v7.0.0.pdf> Accessed on 15 Jan 2014.

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   | (c) Involve a retrofit of (an) existing plant(s); or (d) Involve a replacement of (an) existing plant(s).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 3 | <p>Hydro power plants with reservoirs that satisfy at least one of the following conditions are eligible to apply this methodology:</p> <p>The project activity is implemented in an existing reservoir with no change in the volume of reservoir;</p> <p>The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the Project Emissions section, is greater than 10 W/m<sup>2</sup>;</p> <p>The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the Project Emissions section, is greater than 10 W/m<sup>2</sup>.</p> | <p>Koroglu HEPP is a run-of-river type project; therefore it has only a tiny reservoir to regulate water flow. Power density of the reservoir is higher than the threshold value, 10 W/m<sup>2</sup>.</p> <p>AMS-I.D Version 17.0 methodology refers to the ACM002 for calculating project emission where the Power Density (EW/m2) of the project activity is calculated by using the following formula:</p> $PD = \frac{Cap_{PJ} - Cap_{BL}}{A_{PJ} - A_{BL}}$ <p>Where</p> <p>PD = Power density of the project activity (W/m2)</p> <p>Cap<sub>PJ</sub> = Installed capacity of the hydro power plant after the implementation of the project activity (W)</p> <p>Cap<sub>BL</sub> = Installed capacity of the hydro power plant before the implementation of the project activity (W). For new hydro power plants, this value is zero</p> <p>A<sub>PJ</sub> = Area of the single or multiple reservoirs measured in the surface of the water, after the implementation of the project activity, when the reservoir is full (m2)</p> <p>A<sub>BL</sub> = Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m2). For new reservoirs, this value is zero.</p> |

|   |                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                        |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   |                                                                                                                                                                                                                                                                                                                                   | Reservoir area of the project activity is “1450 m <sup>2</sup> ” <sup>31</sup> and total installed capacity is 9.06x10 <sup>6</sup> W, resulting with a power density of 6248 W/m <sup>2</sup> that is far larger than the 10 W/m <sup>2</sup> threshold value provided in the ACM002. |
| 4 | If the new unit has both renewable and non-renewable components (e.g. a wind/diesel unit), the eligibility limit of 15 MW for a small-scale CDM project activity applies only to the renewable component. If the new unit co-fires fossil fuel, <sup>8</sup> the capacity of the entire unit shall not exceed the limit of 15 MW. | Koroglu HEPP project has only renewable component, utilizing hydraulic power. Its installed capacity is 9.53 MW which is less than the 15 MW limit value for small scale renewable type projects.                                                                                      |
| 5 | Combined heat and power (co-generation) systems are not eligible under this category                                                                                                                                                                                                                                              | Koroglu HEPP project is not a combined heat and power system.                                                                                                                                                                                                                          |
| 6 | In the case of project activities that involve the addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the project should be lower than 15 MW and should be physically distinct <sup>9</sup> from the existing units.                      | Project is not an additional to an existing renewable power generation facility.                                                                                                                                                                                                       |
| 7 | In the case of retrofit or replacement, to qualify as a small-scale project, the total output of the retrofitted or replacement unit shall not exceed the limit of 15 MW.                                                                                                                                                         | Koroglu HEPP project is not a retrofit or modification of an existing facility.                                                                                                                                                                                                        |

In addition, CDM-methodology AMS-I.D refers to the following tools for additionality analysis and project emission calculations.

- “Tool to calculate the emission factor for an electricity system” Version 4.0.0.
- “Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion” Version 02.
- “Tool for the demonstration and assessment of additionality”, version 7.0.0.

Koroglu HEPP meets the applicability conditions of the following tools; and here are the justifications:

<sup>31</sup> Koroglu HEPP Weir Layout drawing with the number of KRG-UY-RG-02.

“Tool to calculate the emission factor for an electricity system” Version 4.0.0. This methodological tool is used for baseline calculations. It determines the CO<sub>2</sub> emission factor for the displacement of electricity generated by power plants in an electricity system, by calculating the Combined Margin emission factor (CM) of the electricity system. The CM is the result of a weighted average of two emission factors pertaining to the electricity system: the Operating Margin (OM) and the Build Margin (BM).

The CO<sub>2</sub> emission due to diesel generators of Koroglu HEPP neglected according to methodology of ACM0002. ACM0002 says CO<sub>2</sub> emissions due to diesel emergency generator can be neglected.

For the demonstration of additionality, “Tool for the demonstration and assessment of additionality”, version 7.0.0 is used.

## 2.3 Project Boundary

Koroglu HEPP is will be constructed on the Savrun River between the elevations of 875 m and 747 m. Project site is located in Province of Osmaniye, Kadirli district in the Mediterranean Region.

| Source   |                                                                                                                                                                   | Gas              | Included? | Justification/Explanation                                                                                                                                                                                                                                                                                                                                                  |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Baseline | CO <sub>2</sub> emissions that are displaced due to the Project Activity from electricity generation in fossil fuel fired power plants connected to national grid | CO <sub>2</sub>  | Yes       | Main emission source. The dominant emissions from power plants are in the form of CO <sub>2</sub> ; therefore CO <sub>2</sub> emissions from fossil fuel fired power plants connected to the grid will be accounted in baseline calculations.                                                                                                                              |
|          |                                                                                                                                                                   | CH <sub>4</sub>  | No        | Minor emission sources.                                                                                                                                                                                                                                                                                                                                                    |
|          |                                                                                                                                                                   | N <sub>2</sub> O | No        |                                                                                                                                                                                                                                                                                                                                                                            |
|          |                                                                                                                                                                   | Other            | No        |                                                                                                                                                                                                                                                                                                                                                                            |
| Project  | Emissions as a result of Project Activity                                                                                                                         | CO <sub>2</sub>  | No        | Minor emission source. ACM002, Section 5.4.3 CH <sub>4</sub> emission is accepted as zero given that power density of the Koroglu HEPP is far larger than 10 W/m <sup>2</sup> threshold value (please see Section 2.2). Diesel generator is the only source of CO <sub>2</sub> emission due to only source of diesel generators neglected according to ACM0002 version 15. |
|          |                                                                                                                                                                   | CH <sub>4</sub>  | No        |                                                                                                                                                                                                                                                                                                                                                                            |
|          |                                                                                                                                                                   | N <sub>2</sub> O | No        |                                                                                                                                                                                                                                                                                                                                                                            |
|          |                                                                                                                                                                   | Other            | No        |                                                                                                                                                                                                                                                                                                                                                                            |

## 2.4 Baseline Scenario

According to AMS I.D. (Version 17), if the project activity is an installation of a new grid-connected renewable power plant, the baseline scenario is the electricity delivered to the grid by

the project activity that otherwise would have been generated by the operation of grid-connected power plants which are mainly fired by fossil fuel.

The baseline scenario has been developed by the assumption that the energy generation profile of Turkey will not change, and the weight of fossil fired power plants will remain the same during the crediting period.

In Koroglu HEPP Project, baseline scenario covers the national electricity grid which is mainly dominated by the fossil fuel fired power plants. According to the annual electricity statistical data published by the Turkish Electricity Transmission Incorporation (TEIAS),<sup>32</sup> approximately 73.57% of the total electricity generation is based on fossil fuels which are natural gas, lignite, hard coal, imported coal and liquid fuels. Share of hydroelectric power plants in generation of electricity only remains at 24.52% (Table 3 and Figure 4).<sup>33</sup>

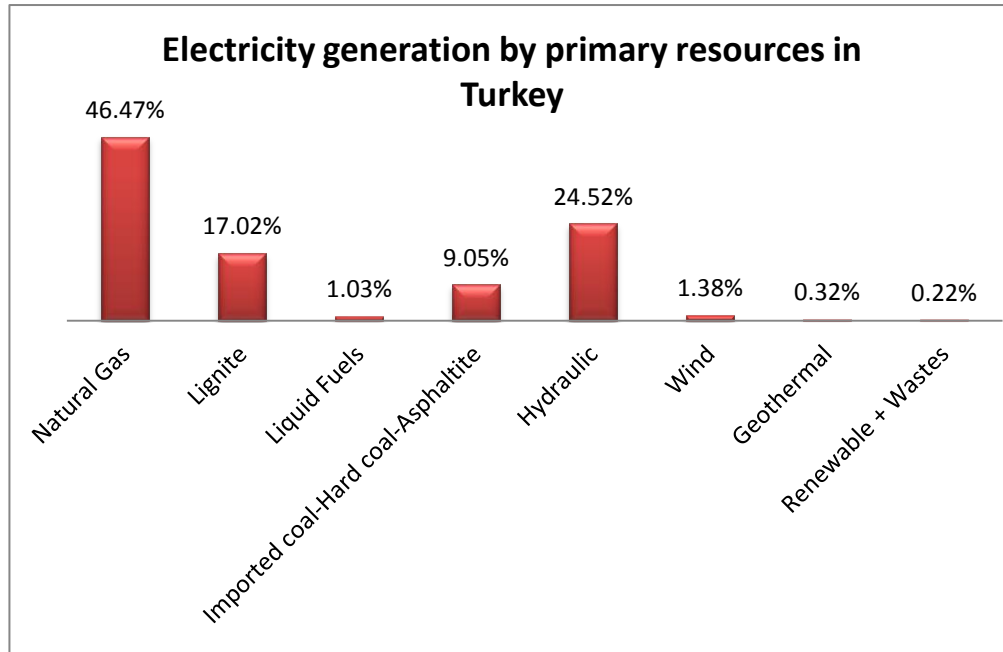
**Table 3: Electricity Generation by Primary Resources in Turkey-2010<sup>34</sup>**

| Electricity Generation Sources     | Electricity Generation GWh | Percentages |
|------------------------------------|----------------------------|-------------|
| Natural Gas                        | 98143.7                    | 46.47%      |
| Lignite                            | 35942.1                    | 17.02%      |
| Liquid Fuels                       | 2180.0                     | 1.03%       |
| Imported coal-Hard coal-Asphaltite | 19104.3                    | 9.05%       |
| Hydraulic                          | 51795.5                    | 24.52%      |
| Wind                               | 2916.4                     | 1.38%       |
| Geothermal                         | 668.2                      | 0.32%       |
| Renewable + Wastes                 | 457.5                      | 0.22%       |

<sup>32</sup> A government-owned company providing the electricity generation data of Turkey available to public.

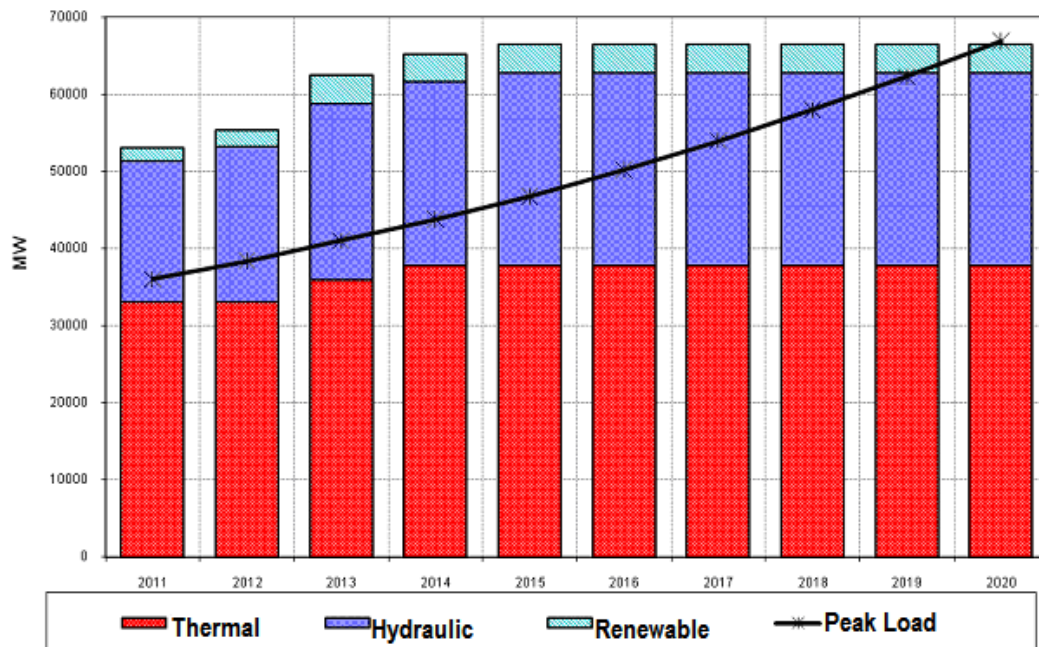
<sup>33</sup> Electricity Generation Incorporation (EUAS), *Annual Report*, 2010. p.21. Available at [http://www.euas.gov.tr/apk%20daire%20baskanligi%20kitapligi/YILLIK\\_RAPOR\\_2010.pdf](http://www.euas.gov.tr/apk%20daire%20baskanligi%20kitapligi/YILLIK_RAPOR_2010.pdf)

<sup>34</sup> EUAS, *Annual Report*, 2010. p.21. Available at [http://www.euas.gov.tr/apk%20daire%20baskanligi%20kitapligi/YILLIK\\_RAPOR\\_2010.pdf](http://www.euas.gov.tr/apk%20daire%20baskanligi%20kitapligi/YILLIK_RAPOR_2010.pdf)



**Figure 4: Share of Resources for Electricity Generation in Turkey-2010.**

Figure 5 and Table 4 show the expected share of resources in energy generating capacity between 2011- 2020 based on corresponding operational, under construction and licensed power plants. The data shows that fossil fuels will remain dominant in the electricity generation mix in Turkey, at least over the midterm period with an expected share of 57 % in 2020. Hydro power plants will hold approximately 38% of the total share.



**Figure 5: Electricity Generation Forecast (2011-2020)**

Table 4: Capacity Development of Thermal, Hydro and Renewable Sources (2011 – 2020)<sup>35</sup>

| Year | Thermal |    | Hydro  |    | Renewable |   | Total  |
|------|---------|----|--------|----|-----------|---|--------|
|      | MW      | %  | MW     | %  | MW        | % | MW     |
| 2011 | 32,999  | 62 | 18,333 | 35 | 1,704     | 3 | 53,035 |
| 2012 | 33,083  | 60 | 20,027 | 36 | 2,211     | 4 | 55,321 |
| 2013 | 35,855  | 57 | 22,841 | 37 | 3,683     | 6 | 62,379 |
| 2014 | 37,797  | 58 | 23,726 | 36 | 3,683     | 6 | 65,207 |
| 2015 | 37,797  | 57 | 24,926 | 38 | 3,683     | 6 | 66,407 |
| 2016 | 37,797  | 57 | 24,926 | 38 | 3,683     | 6 | 66,407 |
| 2017 | 37,797  | 57 | 24,926 | 38 | 3,683     | 6 | 66,407 |
| 2018 | 37,797  | 57 | 24,926 | 38 | 3,683     | 6 | 66,407 |
| 2019 | 37,797  | 57 | 24,926 | 38 | 3,683     | 6 | 66,407 |
| 2020 | 37,797  | 57 | 24,926 | 38 | 3,683     | 6 | 66,407 |

According to the *10 Year Energy Generation Capacity Projection Report 2011* prepared by TEIAS,<sup>36</sup> demand for energy was always high in the last ten years,<sup>37</sup> changing between 6.3% and 8.8%.<sup>38</sup> Over the next 10 year period, from 2011 to 2019, demand for electricity will continue to increase from 227 000 GWh in 2010 to 398 160 in 2019 GWh in low demand scenario, to 433 900 GWh in high demand scenario.<sup>39</sup>

Furthermore, the same report has found that demand for energy in Turkey will not be met by 2016 and onwards in case of high demand scenario. Similarly, in case of low demand scenario, it will not be met by 2017 and onwards. It means that even if all power plants (operational, under construction and licensed) are taken into account, there is still a projected lack of supply in the near future. And, in the face of the upcoming electricity shortage, it is clear that the most likely installation alternative would be conventional fossil-fuelled power plants.

In Turkey, greatest source of GHG emissions is fossil fuel-based power generation. According to the *National Experience on Carbon Market and Future Perspectives* report published in 2011 by the Ministry of Environment and Urbanization, GHG emission share of thermal power generation

<sup>35</sup> TEIAS, “10 Year Energy Generation Capacity Projection Report”, 2011 (In Turkish). pp.50. Available at <http://www.teias.gov.tr/KapasiteProjeksiyonu.aspx>. Click on the “2011” link.

<sup>36</sup> Capacity Generation reports are published annually by TEIAS since 2003.

<sup>37</sup> With the exception of years of economic recession.

<sup>38</sup> TEIAS, “10 Year Energy Generation Capacity Projection Report”, 2011 (In Turkish). pp.4. Available at <http://www.teias.gov.tr/KapasiteProjeksiyonu.aspx>. Click on the “2011” link.

<sup>39</sup> TEIAS, “10 Year Energy Generation Capacity Projection Report”, 2011 (In Turkish). pp.12-13. Available at <http://www.teias.gov.tr/KapasiteProjeksiyonu.aspx>. Click on the “2011” link.

is 82.5% in 2008 (366.5 Million Ton CO<sub>2</sub>).<sup>40</sup> The continuing reliance on fossil fuels in the power sector will further rise the GHG emissions in the coming years.

Koroglu HEPP will supply electricity to national grid which is dominated by fossil-fired power plants. Therefore; it is an additional alternative to the baseline scenario.

## 2.5 Additionality

The additionality of the project is assessed according to the “Tool to for the Demonstration and Assessment of Additionality Version 7.0.0.” Project timeline of Koroglu HEPP is given below:

**Table 5: Koroglu HEPP Project Timeline**

| Milestone                                          | Date            | Documentary Proof                                     |
|----------------------------------------------------|-----------------|-------------------------------------------------------|
| Signing water usage agreement with DSI.            | 5 Nov 2008      | Koroglu HEPP Water Usage and Operation Agreement      |
| Acquisition of energy generation license from EPDK | 25 Dec 2008     | EPDK-Koroglu HEPP Energy Production License.          |
| Preparing Feasibility Report                       | Oct 2010        | Koroglu Feasibility Report (In Turkish), October 2011 |
| EIA Decision                                       | 13 Sep 2011     | EIA Decision Letter                                   |
| Investment Decision by Board of Directors          | 30 Sep 2011     | Board of Directors decision record.                   |
| Turbine Agreement                                  | 11 October 2011 | Turbine Agreement Document                            |
| Construction start                                 | 22 October 2011 | Landuse Permission from the Ministry of Forestry      |
| Commissioning                                      | 20 June 2014    | Provisional Acceptance Protocol                       |
| Starting date of crediting period                  | 20 June 2014    | Provisional Acceptance Protocol                       |

### Step 1- Identification of alternatives to the project activity consistent with current laws and regulations

#### Sub-step 1a: Define alternatives to the project activity:

As per the tool, following alternatives will be analyzed:

- 1) Proposed project activity undertaken without being registered as a CDM project activity;
- 2) Other realistic and credible alternative scenario(s) to the proposed CDM project activity scenario that deliver outputs or services with comparable quality, properties and application areas;

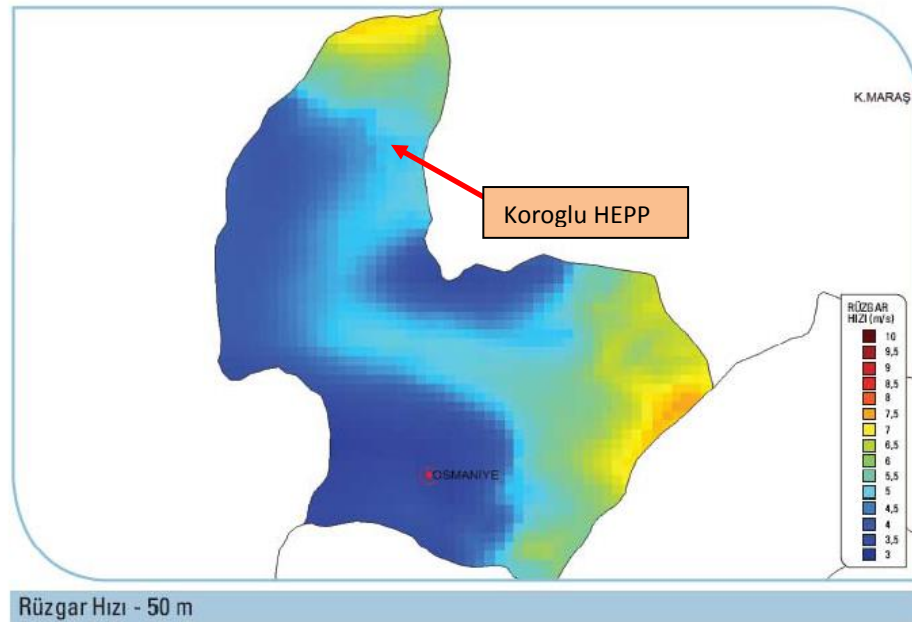
<sup>40</sup> Directorate of Environment, *Karbon Piyasalarında Ulusal Deneyim ve Geleceğe Bakış*, 2012. Ministry of Environment and Urbanization (Report is in Turkish). pp.83. Available at <http://www.karbonkayit.cob.gov.tr/Karbon/Files/Karbon%20Piyasalar%C4%B1nda%20Ulusal%20Deneyim%20ve%20Gelece%C4%9Fe%20Bak%C4%B1%C5%9F.pdf>.

3) Continuation of the current situation (no project activity or other alternatives undertaken).

First alternative, as per the statement of the tool under this category, is the implementation of the Koroglu HEPP project without being registered to a VER program. However, this is not a realistic scenario due to that project IRR is below the benchmark IRR value (16%) without having carbon revenue.

Second alternative could be the implementation of a new power plant utilizing renewable resources, which will produce similar services with the project activity. These alternatives are wind, solar and geothermal power generations. However, implementing any of these alternatives is not realistic although the Electricity Market License Regulation gives priority to these types of renewable projects, which utilize local resources with low environmental impact.<sup>41</sup>

For example, project region technically is not an eligible location for wind power generation. According to the Wind Energy Potential Map (WEPM) of Turkey, developed by the Directorate of Renewable Energy Resources of the Government of Turkey,<sup>42</sup> the speed of the wind should be higher than 7 m/sec for an economically feasible power generation. Figure 6 shows the wind power map of Province of Osmaniye. Gray colored regions in the Map shows the locations which are not suitable for power generation. It shows that wind speed is lower than 5 m/sec at the project site, showing that it is not suitable for wind power projects. Hence, wind power is not an alternative to the Koroglu HEPP Project.<sup>43</sup>



<sup>41</sup> Electricity Market License Regulation, Sub-clause (5) of Article.9. Available at the EPDK web site. <http://www.epdk.org.tr/index.php/elektrik-piyasasi/mevzuat?id=167>. Click on the “Lisans Yönetmeliği” link. Accessed on 28 Dec 2012.

<sup>42</sup> EIE Homepage. <http://www.eie.gov.tr>

<sup>43</sup> EIE Homepage. <http://www.eie.gov.tr>

**Figure 6: Wind Energy Potential Map of Province of Osmaniye<sup>44</sup>**

Geothermal resources eligible for electricity generation are located on the western part of Turkey. At the project location there is no geothermal resource. Using solar power or biomass for electricity generation is still in the infancy state in Turkey. Therefore, utilizing other renewable resources is not a realistic and credible alternative scenario to the proposed project activity.

In case no project activity is taken, that is the third alternative as suggested by the Tool, the same amount of electricity will be generated by the existing grid to supply the increasing demand of Turkey. However, this alternative is the same with the baseline scenario.

**Outcome of Step 1a:** The only realistic and credible scenario is the third alternative, which is the same amount of electricity generation by the existing grid.

Existing grid mostly dominated by the thermal power plants which would have lead more CO<sub>2</sub> emission to the atmosphere. Therefore, as per the *EB 63, Annex 24: Attachment A of Appendix B*, there is an investment barrier to this project.

**Sub-step 1b: Consistency with Mandatory Laws and Regulations:**

All alternatives to the project activity are in compliance with the existing laws and regulations which are described in Section 1.11, Table 2.

**Outcome of Step1:** The only realistic and credible scenario is the third alternative, which is the supply of the same amount of electricity from the existing grid that is in compliance with the relevant mandatory laws and regulations.

**Step 2 - Investment Analysis**

Since there is no realistic alternative to the Koroglu HEPP project, the investment analysis will only analyze the financial attractiveness of the project without carbon revenue.

Investment analysis includes the application of the following steps:

- Determining the appropriate analysis method;
- Calculation and comparison of financial indicators;
- Sensitivity analysis.

**Sub-step 2a - Determine Appropriate Analysis Method**

The “Tool for the Demonstration and Assessment of Additionality, Version 7.0.0”, offers three alternative methods for financial analysis:

- Option I: Simple cost analysis
- Option II: Investment comparison analysis

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<sup>44</sup>General Directorate of Electrical Power Resources Web Site.Osmaniye *Wind Power Resource Information*. Available at [http://www.eie.gov.tr/YEKrepa/REPA-duyuru\\_01.html](http://www.eie.gov.tr/YEKrepa/REPA-duyuru_01.html). Click on the “ICEL” link.

- Option III: Benchmark analysis.

Option I is only applicable if the project activity does not receive any revenue other than the sale of carbon credits. Koroglu HEPP project will generate revenue from the sale of electricity. Therefore, this option is not applicable.

Option II is applicable if there are alternatives to the project activity. In this case, Koroglu HEPP does not have alternatives. Only viable alternative is the 'No Activity'. Therefore, investment analysis is not applicable to this alternative.

As a result Option III (Benchmark Analysis) is applicable to the Koroglu HEPP project.

#### **Sub-step 2b - Option III-Apply Benchmark Analysis**

There are no benchmarks specified by national authorities for hydropower projects in Turkey.

According to the "Tool for the demonstration and assessment of additionality" version 7.0.0, benchmark rate can be derived from commercial lending rates.

Ministry of Development publishes "Main Economic Indicators" on a monthly basis. As the project is a mid-term investment (exceeding a year), lending rate for medium term investment has been selected as the benchmark. The lending rate for the medium term investment as estimated by the Turkish Development Bank is 16% for the last quarter of the year.<sup>45</sup> This 16% is taken as the benchmark value.

#### **Sub-step 2c - Calculation and Comparison of Financial Indicators**

The IRR is calculated on the basis of expected cash flows (investment, maintenance and operating costs, and revenues from electricity sale), as used in the financial analysis for the feasibility assessment of the project.

Plant Load Factor of Koroglu HEPP is 0.313.

Plant Load Factor is determined by dividing the plant actual output with the maximum possible output.

$$PLF = \frac{26,130 \text{ MW/h}}{(365 \text{ day}) \times (24 \text{ hr/day}) \times (9.06 \text{ MWe})}$$

$$PLF = 0.329$$

$$PLF = 32.9\%$$

**Table 6: Financial Parameters Used in Financial Analysis**

<sup>45</sup> Republic of Turkey, Ministry of Development Website. Main Economic Indicators. Section 7, 13<sup>th</sup> Excel Sheet. Table 7.13- Lending and Deposit Interest Rates. Accessed on 26 March 2015.

[http://www.kalkinma.gov.tr/Lists/Temel%20Ekonomik%20Gstergeler/Attachments/13404/13-faiz\\_orani.xls](http://www.kalkinma.gov.tr/Lists/Temel%20Ekonomik%20Gstergeler/Attachments/13404/13-faiz_orani.xls)

| Parameters                      | Unit     | Value      | Source                                                                                                          |
|---------------------------------|----------|------------|-----------------------------------------------------------------------------------------------------------------|
| Expected Electricity Generation | GWh      | 26.13      | Koroglu HEPP Feasibility Report, October 2010 (In Turkish). Section 1, pp.2                                     |
| Total Investment Cost           | USD      | 10 795 265 | Koroglu HEPP Feasibility Report, October 2010 (In Turkish). Section 9, pp.9                                     |
| Operational Cost                | USD      | 413 531    | Koroglu HEPP Feasibility Report, October 2010 (In Turkish). Section 9, pp.6 (Table 9.2, 17061+396470=413531USD) |
| Revenues                        | USD/Year | 2 613 056  | Koroglu HEPP Feasibility Report, October 2010 (In Turkish). Section 9, pp.11                                    |
| Exchange Rate                   | USD/TL   | 1.6147     | Koroglu HEPP Feasibility Report, October 2010 (In Turkish). Section 1, pp.2                                     |

*Note: Please see IRR Input Excel Sheet for details*

The IRR before taxation for the project is calculated as 13.99 % without the VER revenue. That is much lower than benchmark IRR, which is 16%. Including carbon revenue with assuming VER price will be 1.5 USD/tCO<sub>2</sub>e, project IRR become 14.21% which is still lower than the benchmark value.

As a result, the revenue acquired from the operation of the power plant is not financially attractive to do the investment.

## Sub-step 2d - Sensitivity Analysis

The sensitivity analysis is applied in order to show that investment decision, financially, is not the most attractive alternative.

For a range of ±10% fluctuations in Investment Cost, Operating Cost and Electricity Sales revenue, following table shows the results of the sensitivity analysis.

**Table 7: Sensitivity analysis for the Project IRR**

| Variation | Investment Cost (IRR %) | Operating Cost (IRR %) | Electricity Sales Revenue (IRR %) |
|-----------|-------------------------|------------------------|-----------------------------------|
| -10%      | 15.73                   | 14.29                  | 12.04                             |
| -5%       | 14.83                   | 14.14                  | 13.03                             |
| 0%        | 13.99                   | 13.99                  | 13.99                             |
| 5%        | 13.22                   | 13.84                  | 14.93                             |
| 10%       | 12.51                   | 13.69                  | 15.85                             |

The best case scenario in sensitivity analysis is the rise in revenue, and decrease in investment and operational costs. In such cases, project IRR becomes

- 15.85 % with a 10% rise in revenue,
- 15.73 % with a 10% decrease in investment cost
- 13.69 % with a 10% decrease in operational cost

## *Possible cases hitting the benchmark value*

To hit the IRR benchmark values, electricity price should be at least 10.5 USD cents and investment cost should drop 6% (10,147,549 USD).

However, change in the electricity price was not expected by the time of the investment decision. The Renewable Energy Law, enacted in 2005 with the number of 25956, states that the price of the electricity to be purchased under the Renewable Energy Law should be the country average of the electricity wholesale price of the previous year to be determined by the EMRA. In any case, the price cannot be less than the Turkish Lira equivalent of 5 Euro Cent/kWh and more than 5.5 Euro Cent/kWh. The law also provides a purchase guarantee of maximum 10 years.

In 2010, an Amending Law<sup>46</sup> to the Renewable Energy Law was enacted, and this new amendment did not change the electricity price for hydropower plants. It rather converted the unit price of electricity from Euro to USD, which is determined as 7.3 Cent/kWh.

By all account, the probably rise in electricity price was already taken into account at the time of the investment decision by taking the electricity price as 10 cent/kWh. The electricity price should at least be 10.5 USD cent/kWh to hit the benchmark of 16 %; which is not likely to occur. The investment cost is not likely to decrease but may increase due to the financial constraints faced by the project. It should be 6% lower than the actual value to hit the benchmark of 16%. In IRR analysis, 30 % reduced financial inputs are already used to stay on the safe side<sup>47</sup>; therefore there is no way to reduce investment cost furthermore.

The operational cost will be approximately be the same regarding to the personnel expenses, periodic maintenance and other administrative costs as the installed capacity and the number of personnel would not change. In order to hit an IRR equal to the benchmark, the operational cost should be zero and there should be extra income as much as 14% folds of the original value. And, this scenario is clearly impossible to occur, because an already higher value (10 cents/kWh) is used to calculate income stay on the safe side.

It should also be noted that other risks, such as drought and decrease in rainfall in the region; which would reduce the yearly electricity generation, are not included in the financial analysis. This potentially results in decrease in project revenue, further reducing the IRR.

**Outcome of Step 2:** Investment analysis confirms that the proposed project is not attractive for investment. Even the maximum IRR values calculated for the best-case scenario is considerably below the 16% benchmark. Thus, there is a strong need for additional revenues from carbon credits to implement the project.

## **Step 3: Barrier Analysis**

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<sup>46</sup> Published by the Official Gazette with the number of 27809 dated 8 Jan 2011.

<sup>47</sup> Please see Table 9.5 and Table 9.6 in

The sensitivity analysis has shown that the project is not financially attractive; therefore, as per the Tool, this step is not implemented.

#### Step 4: Common Practice Analysis

Based on the requirement given in the CDM Validation and Verification Manual Version 1.2, paragraph 119, page 23, common practice analysis is not applied to the project given that it is a small scale project.

CDM Validation and Verification Manual Version 1.2, paragraph 119, page 23 states that

“For proposed **large-scale project activities**, unless the proposed project type is first-of-its kind as determined in accordance with the relevant guidelines, the DOE shall assess whether the project participants have conducted a common practice analysis.”

Statement only concerns about the large scale projects, not small ones.

#### Sub-step 4a - Analyze other Activities Similar to the Proposed Project Activity

N/A

#### Sub-step 4b - Discuss any Similar Options that Occurring

N/A

#### Outcome of Sub 4:

N/A

## 2.6 Methodology Deviations

There are no deviations in methodologies used in this report.

## 3 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

### 3.1 Baseline Emissions

AMS-I.D. methodology defines the baseline scenario as the electricity delivered to the grid by the project activity that would have otherwise been generated by the operation of grid-connected power plants and addition of new generation sources into the grid.

$$BE_y = EG_{BL,y} * EF_{CO2,grid,y}$$

Where:

$BE_y$  Baseline Emissions in year y (t CO<sub>2</sub>)

|                    |                                                                                                                                  |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------|
| $EG_{BL,y}$        | Quantity of net electricity supplied to the grid as a result of the implementation of the CDM project activity in year $y$ (MWh) |
| $EF_{CO_2,grid,y}$ | $CO_2$ emission factor of the grid in year $y$ (t $CO_2$ /MWh)                                                                   |

According to the AMS-I.D., the emission factor ( $EF_{CO_2,grid,y}$ ) can be calculated in a transparent and conservative manner in the following two ways:

- A) A combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the “Tool to calculate the Emission Factor for an electricity system”;

or

- B) The weighted average emissions (in t  $CO_2$ /MWh) of the current generation mix. The data of the year in which project generation occurs must be used.

Methodology further clarifies that calculations shall be based on data from a publicly available official source. Among these options, Option A is used to calculate the emission factor ( $EF_{CO_2,grid,y}$ ).” Using Option B was not an applicable option due to that weighted average emissions data are not available.

The tool that will be used to calculate the emission factor is “Tool to calculate the emission factor for an electricity system, Version 4.0.0. This tool determines the  $CO_2$  emission factor for the displacement of electricity generated by power plants in an electricity system by calculating the “combined margin” emission factor (CM) of the electricity system. The CM is the result of a weighted average of two emission factors pertaining to the electricity system: the “operating margin” (OM) and the “build margin” (BM). The operating margin is the emission factor that refers to the group of existing power plants whose current electricity generation would be affected by the proposed CDM project activity. The build margin is the emission factor that refers to the group of prospective power plants whose construction and future operation would be affected by the proposed CDM project activity.

Following steps, as per tool, are applied to determine the CM emission factor:

- 1) STEP 1: Identify the relevant electricity systems;
- 2) STEP 2: Choose whether to include off-grid power plants in the project electricity system (optional);
- 3) STEP 3: Select a method to determine the operating margin (OM);
- 4) STEP 4: Calculate the operating margin emission factor according to the selected method;
- 5) STEP 5: Calculate the build margin (BM) emission factor;
- 6) STEP 6: Calculate the combined margin (CM) emission factor

**STEP 1: Identify the relevant electricity system**

**Project electricity system** is the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity (e.g. the renewable power plant location or the consumers where electricity is being saved) and that can be dispatched without significant transmission constraints.

**Connected electricity system**, e.g. national or international, is an electricity system that is connected by transmission lines to the project electricity system. Power plants within the connected electricity system can be dispatched without significant transmission constraints but transmission to the project electricity system has significant transmission constraint.

The electricity system in Turkey is interconnected. There is no an independent regional grid system neither in Province of Osmaniye nor in the Mediterranean Region where the project site is located. Therefore “the project electricity system” and “the connected system” are the same for Koroglu HEPP.

In addition to this, In Turkey there is no DNA to delineate the project electricity system; therefore, following suggested criteria as per the Tool is used:

- 1. In case of electricity systems with spot markets for electricity: there are differences in electricity prices (without transmission and distribution costs) of more than 5 percent between the systems during 60 percent or more of the hours of the year;*

There is no spot electricity market available in Turkey, therefore this criteria can not be applied.

- 2. The transmission line is operated at 90% or more of its rated capacity during 90% percent or more of the hours of the year.*

There is no capacity usage figure for transmission line published, therefore this criteria can not be applied.

If none of these criteria do not result in a clear grid boundary, the Tool suggests to use a regional grid definition in the case of large countries with layered dispatch systems (e.g. provincial / regional / national). However, there are no layered dispatch systems in Turkey.

As a result, national grid system is used as the project electricity system. Hence, the estimation of OM and BM emission factors are based on the definition of the Turkish electricity network as one single interconnected system.

Interconnected electricity transmission grid of Turkey is shown below:



Electricity generated by the power plants is transmitted to the national grid from where it is distributed to consumers via the local distribution companies. Turkey is divided into 21 regions in distributing electricity. Figure 9 shows the physical boundaries of these regions; Table 8 provides the list of these distribution companies.

☐ Private



<sup>49</sup> Privatization of Turkey's Electricity Distribution Industry.pp.2. Available at [http://www.oib.gov.tr/tedas/teaser\\_english.pdf](http://www.oib.gov.tr/tedas/teaser_english.pdf)

Table 8: List of Turkey's Electricity Distribution Companies

| Region No | Provinces Included in the Region                                  | Region Centre           | Region Name                                                       |
|-----------|-------------------------------------------------------------------|-------------------------|-------------------------------------------------------------------|
| 1         | Batman, Diyarbakır, Mardin, Siirt, Şanlıurfa, Şırnak              | Diyarbakır              | Dicle Electricity Distribution Company (Dicle EDAS)               |
| 2         | Bitlis, Hakkari, Muş, Van                                         | Van                     | Vangölü Electricity Distribution Company (Vangölü EDAS)           |
| 3         | Ağrı, Ardahan, Bayburt, Erzincan, Erzurum, Iğdır, Kars            | Erzurum                 | Aras Electricity Distribution Company (Aras EDAS)                 |
| 4         | Artvin, Giresun, Gümüşhane, Rize, Trabzon                         | Trabzon                 | Çoruh Electricity Distribution Company (Coruh EDAS)               |
| 5         | Bingöl, Elazığ, Malatya, Tunceli                                  | Elazığ                  | Fırat Electricity Distribution Company (Firat EDAS)               |
| 6         | Sivas, Tokat, Yozgat                                              | Sivas                   | Çamlıbel Electricity Distribution Company (Camlibel EDAS)         |
| 7         | Adana, Gaziantep, Hatay, Kilis, Mersin, Osmaniye                  | Adana                   | Toroslar Electricity Distribution Company (Toroslar EDAS)         |
| 8         | Konya, Karaman, Kırşehir, Nevşehir, Niğde, Aksaray                | Konya                   | Meram Electricity Distribution Company (Meram EDAS)               |
| 9         | Ankara, Bartın, Çankırı, Karabük, Kastamonu, Kırıkkale, Zonguldak | Ankara                  | Başkent Electricity Distribution Company (Baskent EDAS)           |
| 10        | Antalya, Burdur, Isparta                                          | Antalya                 | Akdeniz Electricity Distribution Company (Akdeniz EDAS)           |
| 11        | İzmir, Manisa                                                     | İzmir                   | Gediz Electricity Distribution Company (Gediz EDAS)               |
| 12        | Balıkesir, Bursa, Çanakkale, Yalova                               | Bursa                   | Uludağ Electricity Distribution Company (Uludag EDAS)             |
| 13        | Edirne, Kırklareli, Tekirdağ                                      | Tekirdağ                | Trakya Electricity Distribution Company (Trakya EDAS)             |
| 14        | İstanbul Anadolu Yakası                                           | İstanbul Anatolian Side | İstanbul Anadolu Yakası Electricity Distribution Company (AYEDAS) |
| 15        | Bolu, Düzce, Kocaeli, Sakarya                                     | Sakarya                 | Sakarya Electricity Distribution Company (Sakarya EDAS)           |
| 16        | Afyon, Bilecik, Eskişehir, Kütahya, Uşak                          | Eskişehir               | Osmangazi Electricity Distribution Company (Osmangazi EDAS)       |
| 17        | İstanbul Avrupa Yakası                                            | İstanbul European Side  | Boğaziçi Electricity Distribution Company (BEDAS)                 |
| 19        | Aydın, Denizli, Muğla                                             | Denizli                 | Menderes Electricity Distribution Company (Menderes EDAS)         |
| 20        | Adıyaman, Kahramanmaraş                                           | Kahramanmaraş           | Göksu Electricity Distribution Company (Goksu EDAS)               |
| 21        | Amasya, Çorum, Ordu, Samsun, Sinop                                | Samsun                  | Yeşilirmak Electricity Distribution Company (Yesilirmak EDAS)     |

The tool states that electricity transfers from connected electricity systems to the project electricity system are defined as *electricity imports*, and electricity transfers to connected electricity systems are defined as *electricity exports*.

The tool further states that for the purpose of determining the BM emission factor, the spatial extend is limited to the project electricity system, except where recent or likely future additions to transmission capacity enable significant increases in imported electricity.

The national grid of Turkey is connected to the electricity systems of neighbour countries. As per the tool, complying with the rules of the tool, the emission factor for imports from neighbour countries is considered 0 (zero) tCO<sub>2</sub>/MWh for determining the OM emission factor.

**STEP 2: Choose whether to include off-grid power plants in the project electricity system (optional)**

As per the “Tool to calculate the emission factor for an electricity system, Version 4.0.0”, project developers may choose between the following two options in emission factor calculations:

Option I: Only grid power plants are included in the calculation

Option II: Both grid power plants and off-grid power plants are included in the calculation.

**Option I** is chosen.

**STEP 3: Select a method to determine the operating margin (OM)**

As per the Tool, to calculate the OM emission factor, project developers can choose one of the following options depending on the data availability:

- (a) Simple OM, or
- (b) Simple adjusted OM, or
- (c) Dispatch Data Analysis OM, or
- (d) Average OM

Options (b) and (c) are not preferred due to data scarcity. Option (d) is not preferred since low-cost/must-run resources do not constitute more than 50% of total grid generation. As described in the Tool, the Simple OM (a) can only be used if low-cost/must-run resources constitute less than 50% of total grid generation in: 1) average of the five most recent years, or 2) based on long-term averages for hydroelectricity production.

Low-cost/must-run resources consist of hydro, geothermal, wind, low-cost biomass, nuclear and solar which are used for power plants with low marginal generation costs or power plants and dispatched independently of the daily or the seasonal load of grid. There is no indication that coal is used as a must-run and no nuclear energy plants are located in Turkey.

Following table shows the share of low-cost/must-run production for the last five years. The low-cost/must-run resources should constitute less than 50% of total grid generation in average of the five most recent years, which is 21,43% in Turkey (Table 9). Therefore the requirements for the use of the Option a (Simple OM) are satisfied.

**Table 9: Total Electricity Generation (2006-2010)<sup>50</sup>**

<sup>50</sup> TEIAS Web Site, Electricity Generation and Transmission Statistics of Turkey. Available at <http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2011/istatistik%202011.htm>. Click on the following link: “Annual Development of Turkey’s Gross Electricity Generation by Primary Energy Resources and The Electricity Utilities (2006-2011).” Accessed on 28 Dec 2012.

| Electricity Generation (GWh) / Year   | 2006             | 2007             | 2008             | 2009             | 2010             |
|---------------------------------------|------------------|------------------|------------------|------------------|------------------|
| Thermal Total                         | 131,835.1        | 155,196.2        | 164,139.3        | 156,923.4        | 155,827.6        |
| Hydro+Geothermal+Wind Total           | 44,464.7         | 36,361.9         | 34,278.7         | 37,889.5         | 55,380.1         |
| <b>Turkey's Total</b>                 | <b>176,299.8</b> | <b>191,558.1</b> | <b>198,418.0</b> | <b>194,812.9</b> | <b>211,207.7</b> |
| Share of low-cost/must-run production | 25.22            | 18.98            | 17.28            | 19.45            | 26.22            |
| <b>Average share (%)</b>              | <b>21.43</b>     |                  |                  |                  |                  |

The Tool allows choosing one of the options below based on the data availability;

**Ex ante option:** If the ex-ante option is chosen, the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emission factor during the crediting period is required. For grid power plants, a 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emissions factor during the crediting period.

**Ex post option:** For ex post option, the emission factor is determined for the year in which the project activity displaces grid electricity, requiring the emission factor to be updated annually during monitoring. The year, in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring.

Based on the most recent data available, ex- ante option is chosen for Simple OM method, with the most recent data for the baseline calculation stemming from the years 2008 to 2010.

## Step 4. Calculate the operating margin emission factor according to the selected method

The Simple OM can be calculated by one of the following two options:

- Based on the net electricity generation and a CO<sub>2</sub> emission factor of each power unit (Option A);
- Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system (Option B).

Option B can only be used if:

- The necessary data for Option A is not available,
- Only nuclear and renewable power generation are considered as low-cost/must-run power sources and the quantity of electricity supplied to the grid by these sources is known, and
- Off-grid power plants are not included in the calculation.

For simple OM calculations, **Option B** is chosen due to following justifications;

- Electricity generation and CO<sub>2</sub> data for individual power units are not available.

- Only renewable power generation plants are considered as low cost/must-run resources.
- Off-grid power plants are not included in calculations.
- The fuel consumption of different fuel type data for power plants/ units is available in the official source, TEIAS.

In Option B, Simple OM emission factor is calculated based on the net electricity supplied to the grid by all power plants serving the system, not including low-cost/must-run power plants/units, and based on the fuel type(s) and total fuel consumption of the project electricity system, as follows:

$$EF_{grid,OMsimple,y} = \frac{\sum_i (FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y})}{EG_y}$$

Where:

|                        |                                                                                                                                                                      |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $EF_{grid,OMsimple,y}$ | Simple operating margin CO <sub>2</sub> emission factor in year y (tCO <sub>2</sub> /MWh)                                                                            |
| $FC_{i,y}$             | Amount of fossil fuel type i consumed in the project electricity system in year y (mass or volume unit)                                                              |
| $NCV_{i,y}$            | Net calorific value (energy content) of fossil fuel type i in year y (GJ / mass or volume unit)                                                                      |
| $EF_{CO2,i,y}$         | CO <sub>2</sub> emission factor of fossil fuel type i in year y (tCO <sub>2</sub> /GJ)                                                                               |
| $EG_y$                 | Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost / must-run power plants / units, in year y (MWh) |
| i                      | All fossil fuel types combusted in power sources in the project electricity system in year y                                                                         |
| y                      | The three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex ante option)                          |

OM emission factor calculations are provided in Annex II.

#### STEP 5: Calculate the build margin (BM) emission factor

In this step, a generation-weighted average emission factor is calculated based on a sample of power plants, which have been taken into operation recently. According to the “Tool to calculate the emission factor for an electricity system, ver.4.0.0,” the sample group of power units m used to calculate the build margin consists of either:

- a) The set of five power units that have been built most recently, or
- b) The set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

Among these choices, **Option b** is selected due to that it produces larger annual electricity generation than “option a.”

In terms of vintage, two options are defined in the tool:

**Option 1:** For the first crediting period, calculate the build margin emission factor ex-ante based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

**Option 2:** For the first crediting period, the build margin emission factor shall be updated annually, ex post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor shall be calculated ex ante, as described in Option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

**Option 1** is selected for the data vintage due to that at the time of the document submission for registration to a carbon certification program, most recent information is not available on units already built for sample group m. Most recent data available, which is announced by TEIAS, belongs to 2010.

The build margin emission factor will be calculated by using the following formula;

$$EF_{grid,BM,y} = \frac{\sum_{i,m} EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

|                    |   |                                                                                                 |
|--------------------|---|-------------------------------------------------------------------------------------------------|
| $EF_{grid, BM, y}$ | : | Build margin CO <sub>2</sub> emission factor in year y (tCO <sub>2</sub> /MWh)                  |
| $EG_{m,y}$         | : | Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh) |
| $EF_{EL,m,y}$      | : | CO <sub>2</sub> emission factor of power unit m in year y (tCO <sub>2</sub> /MWh)               |

- m : Power units included in the Build margin
- y : Most recent historical year for which power generation data is available

For the power units in Turkey, only electricity generation and fuel type data are available. Therefore, Option A2 (Step 4, Simple OM approach) is used and the emission factor is determined based on the CO<sub>2</sub> emission factor of the fuel type used and the efficiency of the power unit.

$$EF_{EL,m,y} = \frac{EF_{CO_2,m,i,y} * 3,6}{\eta_{m,y}}$$

Where:

- EF<sub>EL,m,y</sub> : CO<sub>2</sub> emission factor of power unit m in year y (tCO<sub>2</sub>/MWh)
- EF<sub>CO<sub>2</sub>, m,i,y</sub> : Average CO<sub>2</sub> emission factor of fuel type i used in power unit m in year y (tCO<sub>2</sub>/GJ)
- η<sub>m,y</sub> : Average net energy conversion efficiency of power unit m in year y (ratio)
- m : All power units serving the grid in year y except low-cost/must-run power units
- y : The relevant year

η<sub>m,y</sub> data for power plants m in Turkey are not available, therefore these values are taken from the Tool (Appendix-1: Default Efficiency Factors for Power Plants). Following table show these values.

**Table 10: Default Efficiency Factors for Power Plants (Appendix 1 of the Tool)**

| Grid Power Plants     |                                   |                           |
|-----------------------|-----------------------------------|---------------------------|
| Generation Technology | Old Units<br>(before and in 2000) | New Units<br>(after 2000) |
| Coal                  | -                                 | -                         |
| Subcritical           | 37%                               | 39%                       |
| Supercritical         | -                                 | 45%                       |
| Ultra-Supercritical   | -                                 | 50%                       |
| IGCC                  | -                                 | 50%                       |
| FBS                   | 35,5%                             | -                         |
| CFBS                  | 36,5%                             | 40,0%                     |

|                |       |        |
|----------------|-------|--------|
| PFBS           | -     | -41,5% |
| Oil            | -     | -      |
| Steam turbine  | 37,5% | 39%    |
| Open cycle     | 30%   | 39,5%  |
| Combined cycle | 46%   | 46%    |
| Natural Gas    | -     | -      |
| Steam turbine  | 37,5% | 37,5%  |
| Open cycle     | 30%   | 39,5%  |
| Combined cycle | 46%   | 60%    |

In Turkey, the generation technologies for natural gas and oil are “Combined cycle”, and for coal it is “Subcritical”. Since the default values for lpg and naphta are not given in the tool, the efficiency factors of these fuel types are assumed to be 60% (equal to the efficiency figure for Natural Gas-Combined Cycle). In summary, efficiency factors of each fuel type, which are used in BM Emission Factor Calculations, are given in the following table.

**Table 11: Efficiency Factors of Fuel Types Used in BM Calculations.**

| Fuel Type   | Generation Technology      | Efficiency Factor |
|-------------|----------------------------|-------------------|
| Hard Coal   | Coal-Subcritical           | 39%               |
| Lignite     | Coal-Subcritical           | 39%               |
| Fuel Oil    | Oil-Combine Cycle          | 46%               |
| Diesel Oil  | Oil-Combine Cycle          | 46%               |
| Natural Gas | Natural Gas- Combine Cycle | 60%               |
| LPG         | Natural Gas- Combine Cycle | 60%               |
| Naphta      | Natural Gas- Combine Cycle | 60%               |

For CO<sub>2</sub> emission factor, Default Emission Factors for Stationary Combustion in the Energy Industries (kg GHG/GJ on a Net Calorific Basis)<sup>51</sup> which are provided in Table 12, are used. In calculations, lower CO<sub>2</sub> emission factors are used to be on the conservative side.

<sup>51</sup> IPCC 2006, 2006 *IPCC Guidelines for National Greenhouse Gas Inventories*, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan. Volume 2, Chapter 1: Introduction. Available at [http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2\\_Volume2/V2\\_1\\_Ch1\\_Introduction.pdf](http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf)

**Table 12: Default Emission Factors for Stationary Combustion in the Energy Industries (kg GHG/GJ on a Net Calorific Basis)<sup>52</sup>**

| Fuel Type                 | CO <sub>2</sub>         |             |       |
|---------------------------|-------------------------|-------------|-------|
|                           | Default Emission Factor | Lower       | Upper |
| Residual Fuel Oil         | 77.4                    | <b>75.5</b> | 78.8  |
| Gas/Diesel Oil            | 74.1                    | <b>72.6</b> | 74.8  |
| Sub-Bituminous Coal       | 96.1                    | <b>92.8</b> | 100.0 |
| Liquefied Petroleum Gases | 63.1                    | <b>61.6</b> | 65.6  |
| Naptha                    | 73.3                    | <b>69.3</b> | 76.3  |
| Anthracite                | 98.3                    | <b>94.6</b> | 101.0 |
| Lignite                   | 101.0                   | <b>90.9</b> | 115.0 |
| Natural Gas               | 56.1                    | <b>54.3</b> | 58.3  |
| Naptha                    |                         | <b>63.1</b> |       |

The tool further states that “Power plant registered as CDM project activities should be excluded from the sample group m.” Based on this statement, projects registered as a CDM project activity between 01.01.2009-31.12.2010 are excluded from the list. Following table provides the list of these projects.

**Table 13: Projects Registered to a Carbon Certification Program (2009-2010)<sup>53</sup>**

| Power Plant         | Installation Capacity MW | Capacity Taken Into Operation in 2009/2010 <sup>54</sup> (MW) | Energy Generation GW <sup>55</sup> | VER     | Commissioning Date |
|---------------------|--------------------------|---------------------------------------------------------------|------------------------------------|---------|--------------------|
| Darica –I HEPP      | 99.0                     | 99.0                                                          | 328                                | VCS506  | 2009               |
| Sebenoba Wind Power | 30.0                     | 10.                                                           | 36.7                               | VCS 553 | 2010               |
| Sirma HEPP          | 5.9                      | 5.9                                                           | 23                                 | VCS 603 | 2009               |
| Erkenek HEPP        | 12.0                     | 12.0                                                          | 50                                 | VCS 693 | 2009               |
| Lamas III-IV HEPP   | 37.3                     | 37.3                                                          | 150                                | VCS 726 | 2009               |
| Uzuncayir HEPP      | 82.0                     | 82.0                                                          | 319.6                              | VCS 762 | 2009-2010          |

<sup>52</sup> IPCC 2006, 2006 *IPCC Guidelines for National Greenhouse Gas Inventories*, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan. Volume 2, Chapter 1: Introduction. Available at [http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2\\_Volume2/V2\\_1\\_Ch1\\_Introduction.pdf](http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf)

<sup>53</sup> Projects receiving a VER certification are derived from the VCS and CDM Gold Standard websites. VCS web site: <http://www.vcsprojectdatabase.org/>, CDM Gold Standard: <http://www.cdmgoldstandard.org/>

<sup>54</sup> Only the amount of the installed capacity taken into the operation in 2009 and 2010 are used in emission reduction calculations. For example, Sebenoba wind farm project received VER certification in 2010 for its total installed capacity, 30 MW. However, this 30 MW capacity did not start operation in 2010; 20 MW started operation before 2009, and remaining 10 MW started to operation in 2010. Therefore, only 10 MW of this total installed capacity is taken into account in emission reduction calculations.

<sup>55</sup> Energy generation data represents the amount of the installed capacity taken into operation in 2009 and 2010. For example energy generation data for Sebenoba wind farm represents the 10 MW installed capacity, not the total installed capacity of the plant, which is 30 MW.

|                                 |       |       |                 |       |           |
|---------------------------------|-------|-------|-----------------|-------|-----------|
| Sayalar Wind Farm               | 34.2  | 3.6   | 11.36           | GS369 | 2009      |
| Soma Polat Wind Farm            | 140.1 | 79.20 | 264             | GS398 | 2010      |
| Alize Camseki Wind Farm         | 20.8  | 20.8  | 82              | GS399 | 2009      |
| Akbuk Wind Farm                 | 31.5  | 16.80 | 123             | GS436 | 2009      |
| Keltepe Wind Farm               | 20.7  | 20.7  | 71.4            | GS437 | 2009      |
| Dares Datca Wind Farm           | 29.6  | 21.5  | 61.01           | GS438 | 2009      |
| Mamak Landfill Waste Management | 19.8  | 2.8   | 21.1            | GS440 | 2009      |
| Dora II Geothermal              | 9.5   | 9.5   | 73              | GS445 | 2010      |
| Osmaniye Wind Farm              | 135.0 | 112.5 | 425.8           | GS474 | 2009-2010 |
| Kuyucak Wind Farm               | 25.6  | 25.6  | 110             | GS576 | 2010      |
| Sarıkaya Wind Farm              | 28.8  | 28.8  | 96              | GS577 | 2009      |
| Kores Kocadag Wind Farm         | 15.0  | 15.0  | 56              | GS601 | 2009      |
| Ay Yıldız Wind Farm             | 15.0  | 15.0  | 51              | GS634 | 2009      |
| Duzova Wind Power               | 30.0  | 30.0  | 96              | GS672 | 2009-2010 |
| Senbuk Wind Farm                | 15.0  | 15.0  | 47              | GS733 | 2010      |
| <b>TOTAL</b>                    |       |       | <b>2588 GWh</b> |       |           |

BM emission factor calculations are provided in Annex III.

#### STEP 6: Calculate the combined margin (CM) emission factor

For Koroglu HEPP project, the applicable method to calculate the CM emission factor is the Weighted Average CM;

$$EF_{\text{grid,CM,y}} = EF_{\text{grid,OM,y}} \times w_{\text{OM}} + EF_{\text{grid,BM,y}} \times w_{\text{BM}}$$

where:

$EF_{\text{grid,BM,y}}$  = Build margin CO<sub>2</sub> emission factor in year y (tCO<sub>2</sub>/MWh)

$EF_{\text{grid,OM,y}}$  = Operating margin CO<sub>2</sub> emission factor in year y (tCO<sub>2</sub>/MWh)

$w_{\text{OM}}$  = Weighting of operating margin emissions factor (%)

$w_{\text{BM}}$  = Weighting of build margin emissions factor (%)

As per the Tool, following default values should be used for the Koroglu HEPP project:  $w_{\text{OM}} = 0.5$  and  $w_{\text{BM}} = 0.5$  for the first crediting period.

$$EF_{\text{grid,CM,y}} = 0.6555 \times 0.5 + 0.4043 \times 0.5$$

|                                      |                              |
|--------------------------------------|------------------------------|
| Koroglu HEPP EF <sub>grid,CM,y</sub> | 0.5299 tCO <sub>2</sub> /MWh |
|--------------------------------------|------------------------------|

### 3.2 Project Emissions

AMS-I.D Version 17.0 methodology refers to the ACM002 for calculating project emission where the Power Density (EW/m<sup>2</sup>) of the project activity is calculated by using the following formula:

$$PD = \frac{Cap_{PJ} - Cap_{BL}}{A_{PJ} - A_{BL}}$$

Where

- PD = Power density of the project activity (W/m<sup>2</sup>)
- Cap<sub>PJ</sub> = Installed capacity of the hydro power plant after the implementation of the project activity (W)
- Cap<sub>BL</sub> = Installed capacity of the hydro power plant before the implementation of the project activity (W). For new hydro power plants, this value is zero
- A<sub>PJ</sub> = Area of the single or multiple reservoirs measured in the surface of the water, after the implementation of the project activity, when the reservoir is full (m<sup>2</sup>)
- A<sub>BL</sub> = Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m<sup>2</sup>). For new reservoirs, this value is zero.

Reservoir area of the project activity is “1450 m<sup>2</sup>”<sup>56</sup> and total installed capacity is 9.06 x10<sup>6</sup> W, resulting with a power density of 6248 W/m<sup>2</sup> that is far larger than the 4 W/m<sup>2</sup> threshold value provided in the ACM002.

$$PD = \frac{9.06 \times 10^6 \text{ W} - 0 \text{ W}}{1450 \text{ m}^2 - 0 \text{ m}^2} = 6248 \text{ W/m}^2$$

Therefore, Koroglu HEPP project emission value is taken as zero in emission reduction calculations.

Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion” Version 02” requires the calculation of CO<sub>2</sub> emission from internal fossil fuel combustion. At Koroglu HEPP, the only source of fuel consumption will be diesel generators. Their emission is neglected according to ACM0002 version 15.

<sup>56</sup> Koroglu HEPP Weir Layout drawing with the number of KRG-UY-RG-02.

## 3.3 Leakage

According to the AMS-I.D Version 17.0, leakage should be considered if the energy generating equipment is transferred from another activity. The proposed project is a new power plant and therefore the leakage is taken as zero.

## 3.4 Summary of GHG Emission Reductions and Removals

GHG Emission reduction calculation of Koroglu HEPP is done in accordance with the following formula:

$$ER_y = BE_y - PE_y - LE_y$$

Where

$ER_y$  : Project Emission Reduction in year  $y$  (t CO<sub>2</sub>)

$BE_y$  : Baseline Emissions in year  $y$  (t CO<sub>2</sub>)

$PE_y$  : Project Emission in year  $y$  (t CO<sub>2</sub>)

$LE_y$  : Leakage Emission in year  $y$  (t CO<sub>2</sub>)

Following table provides a summary of the GHG emission reduction of Koroglu HEPP Project since its commissioning date, 20 June 2014.

| Years                   | Estimated baseline emissions or removals (tCO <sub>2</sub> e) | Estimated project emissions or removals (tCO <sub>2</sub> e) | Estimated leakage emissions (tCO <sub>2</sub> e) | Estimated net GHG emission reductions or removals (tCO <sub>2</sub> e) |
|-------------------------|---------------------------------------------------------------|--------------------------------------------------------------|--------------------------------------------------|------------------------------------------------------------------------|
| 20/06/2014 – 31/12/2014 | 6448.95                                                       | 0                                                            | 0                                                | 6448.95                                                                |
| 2015                    | 13846.28                                                      | 0                                                            | 0                                                | 13846.28                                                               |
| 2016                    | 13846.28                                                      | 0                                                            | 0                                                | 13846.28                                                               |
| 2017                    | 13846.28                                                      | 0                                                            | 0                                                | 13846.28                                                               |
| 2018                    | 13846.28                                                      | 0                                                            | 0                                                | 13846.28                                                               |
| 2019                    | 13846.28                                                      | 0                                                            | 0                                                | 13846.28                                                               |
| 2020                    | 13846.28                                                      | 0                                                            | 0                                                | 13846.28                                                               |
| 2021                    | 13846.28                                                      | 0                                                            | 0                                                | 13846.28                                                               |
| 2022                    | 13846.28                                                      | 0                                                            | 0                                                | 13846.28                                                               |
| 2023                    | 13846.28                                                      | 10                                                           | 0                                                | 13846.28                                                               |

|                         |                  |          |          |                  |
|-------------------------|------------------|----------|----------|------------------|
| 01.01.2024 – 20.06.2024 | 7397.33          | 0        | 0        | 7397.33          |
| <b>Total</b>            | <b>138462.80</b> | <b>0</b> | <b>0</b> | <b>138462.80</b> |

## 4 MONITORING

### 4.1 Data and Parameters Available at Validation

|                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Data Unit / Parameter:                                                                        | <b>Gross EG<sub>y</sub></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Data unit:                                                                                    | GWh                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Description:                                                                                  | Annual Gross Electricity Generation of Turkey in year y. y: 2008,2009 and 2010.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Source of data:                                                                               | <p>EIAS Web Site, Turkish Electricity Statistics, Year 2010.</p> <p>File name:<br/> <i>Annual Development of Electricity Generation-Consumption and Losses in Turkey (1984-2010)</i><br/> <i>Türkiye Elektrik Enerjisi Üretim Tüketim ve Kayıplarının Yıllar İtibariyle Gelişimi (1984-2010)</i></p> <p>Available at :<br/> <a href="http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2011/istatistik%202011.htm">http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2011/istatistik%202011.htm</a></p> |
| Value applied:                                                                                | Annex II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Justification of choice of data or description of measurement methods and procedures applied: | TEIAS is the only government organization in Turkey which makes the electricity generation and transmission statistics available to the public. <a href="http://www.teias.gov.tr/">http://www.teias.gov.tr/</a>                                                                                                                                                                                                                                                                                                                                         |
| Any comment:                                                                                  | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

|                        |                                                                                                                                                                                                                                                                                                       |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Data Unit / Parameter: | <b>Net EG<sub>y</sub></b>                                                                                                                                                                                                                                                                             |
| Data unit:             | GWh                                                                                                                                                                                                                                                                                                   |
| Description:           | Annual Net Electricity Generation of Turkey in year y. y: 2008,2009 and 2010.                                                                                                                                                                                                                         |
| Source of data:        | <p>TEIAS Web Site, Turkish Electricity Statistics, Year 2010.</p> <p>File name:<br/> <i>Annual Development of Electricity Generation-Consumption and Losses in Turkey (1984-2010)</i><br/> <i>Türkiye Elektrik Enerjisi Üretim Tüketim ve Kayıplarının Yıllar İtibariyle Gelişimi (1984-2010)</i></p> |

|                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                               | Available at :<br><a href="http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2011/istatistik%202011.htm">http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2011/istatistik%202011.htm</a>                                                                                                                                                                                                                                                                                                                                  |
| Value applied:                                                                                | Annex II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Justification of choice of data or description of measurement methods and procedures applied: | TEIAS is the only government organization in Turkey which makes the electricity generation and transmission statistics available to the public. <a href="http://www.teias.gov.tr/">http://www.teias.gov.tr/</a>                                                                                                                                                                                                                                                                                                                                                            |
| Any comment:                                                                                  | This data is used to find out the ratio of the gross to net electricity generation which is later used to calculate the net electricity generation of thermal power plants. TEIAS does not provide the net electricity generation data of thermal power plants. However, it is essential to note that this is a conservative approach, since thermal power plants, in general, consume more electricity internally than hydro, wind power, geothermal and other similar power plants. This approach leads to higher net electricity amounts and lower emission reductions. |

|                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Data Unit / Parameter:                                                                        | El <sub>y</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Data unit:                                                                                    | GWh                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Description:                                                                                  | Net electricity imported to the grid in year y.<br>y: 2008,2009 and 2010.                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Source of data:                                                                               | TEIAS Web Site, Turkish Electricity Statistics, Year 2010.<br>File name:<br><i>Annual Development of Electricity Generation-Consumption and Losses in Turkey (1984-2010)</i><br><i>Türkiye Elektrik Enerjisi Üretim Tüketim ve Kayıplarının Yıllar İtibariyle Gelişimi (1984-2010)</i><br>Available at :<br><a href="http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2011/istatistik%202011.htm">http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2011/istatistik%202011.htm</a> |
| Value applied:                                                                                | Annex II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Justification of choice of data or description of measurement methods and procedures applied: | TEIAS is the only government organization in Turkey which makes the electricity generation and transmission statistics available to the public. <a href="http://www.teias.gov.tr/">http://www.teias.gov.tr/</a>                                                                                                                                                                                                                                                                                                                     |
| Any comment:                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

|                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Data Unit / Parameter:                                                                        | <b>FC<sub>i,y</sub></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Data unit:                                                                                    | Tonnes or 1000 m <sup>3</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Description:                                                                                  | Annual Fuel Consumption by fuel type in year y.<br>y: 2008,2009 and 2010.                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Source of data:                                                                               | TEIAS Web Site, Turkish Electricity Statistics, Year 2010.<br>File name:<br><i>Fuels Consumed In Thermal P.Ps In Turkey By The Electricity Utilities (2006-2010)</i><br><i>Türkiye Termik Santrallerinde Kullanılan Yakıt Miktarlarının Üretici Kuruluşlara Dağılımı (2006-2010)</i><br><br>Available at :<br><a href="http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2011/istatistik%202011.htm">http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2011/istatistik%202011.htm</a> |
| Value applied:                                                                                | Annex II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Justification of choice of data or description of measurement methods and procedures applied: | TEIAS is the only government organization in Turkey which makes the electricity generation and transmission statistics available to the public. <a href="http://www.teias.gov.tr/">http://www.teias.gov.tr/</a>                                                                                                                                                                                                                                                                                                                       |
| Any comment:                                                                                  | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Data Unit / Parameter: | <b>HV<sub>i,y</sub></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Data unit:             | TCal/Mass or TCal/Volume                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Description:           | Heating Values of fuels consumed for electricity generation by fuel type in year y.<br>y: 2008,2009 and 2010.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Source of data:        | TEIAS Web Site, Turkish Electricity Statistics, Year 2010.<br>File name:<br><i>Heating Values Of Fuels Consumed In Thermal P.Ps In Turkey By The Electricity Utilities ((2006-2010)</i><br><i>Türkiye Termik Santrallerinde Kullanılan Yakıtların Isı Değerlerinin Üretici Kuruluşlara Dağılımı (2006-2010)</i><br><br>Available at :<br><a href="http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2011/istatistik%202011.htm">http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2011/istatistik%202011.htm</a> |
| Value applied:         | Annex II<br><br>There is no national NCV data in Turkey. However, TEIAS announces Heating values of fuels. This data is used to calculate the annual NCVs for each fuel type via dividing it with the FC <sub>i,y</sub> .                                                                                                                                                                                                                                                                                                                                        |

|                                                                                               |                                                                                                                                                                                                                 |
|-----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Justification of choice of data or description of measurement methods and procedures applied: | TEIAS is the only government organization in Turkey which makes the electricity generation and transmission statistics available to the public. <a href="http://www.teias.gov.tr/">http://www.teias.gov.tr/</a> |
| Any comment:                                                                                  | -                                                                                                                                                                                                               |

|                                                                                               |                                                                                                                                                                                                                                         |
|-----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Data Unit / Parameter:                                                                        | <b>NCV<sub>i,y</sub></b>                                                                                                                                                                                                                |
| Data unit:                                                                                    | TJ/kton, TJ/million m <sup>3</sup>                                                                                                                                                                                                      |
| Description:                                                                                  | Net Calorific Values of fuels consumed for electricity generation by fuel type in year y                                                                                                                                                |
| Source of data:                                                                               | NCV data is not available; therefore, NCV is calculated by dividing the Heating Value by the Fuel Consumption. Both data (HV <sub>i,y</sub> and FC <sub>i,y</sub> ) are provided by the TEIAS.<br><br>$NCV = \frac{HV_{i,y}}{FC_{i,y}}$ |
| Value applied:                                                                                | Annex II                                                                                                                                                                                                                                |
| Justification of choice of data or description of measurement methods and procedures applied: | TEIAS is the only government organization in Turkey which makes the electricity generation and transmission statistics available to the public. <a href="http://www.teias.gov.tr/">http://www.teias.gov.tr/</a>                         |
| Any comment:                                                                                  | -                                                                                                                                                                                                                                       |

|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Data Unit / Parameter: | <b>Electricity Capacity Additions</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Data unit:             | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Description:           | Capacity addition to the national grid between 2009-2010, which comprises the 20% of the total electricity generation in 2010.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Source of data:        | TEIAS, "10 Year Energy Generation Capacity Projection Report", 2011 (In Turkish). pp.88-106. Available at <a href="http://www.teias.gov.tr/KapasiteProjeksiyonu.aspx">http://www.teias.gov.tr/KapasiteProjeksiyonu.aspx</a> (Click on the "2011" link).<br><br>TEIAS, "10 Year Energy Generation Capacity Projection Report", 2010 (In Turkish). pp.85-100. Available at <a href="http://www.teias.gov.tr/KapasiteProjeksiyonu.aspx">http://www.teias.gov.tr/KapasiteProjeksiyonu.aspx</a> (Click on the 2010 link). However, this source does not provide the commissioning date of the capacity additions in terms of day/month/year. Therefore, this missing data is completed |

|                                                                                               |                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                               | by requesting it from TEIAS through the Bilgi Edinme Yasasi (Information Requesting Law) which provides individuals to request any data, which are okay to be publicly available, from government agencies. As per this Law, missing data is obtained from TEIAS. |
| Value applied:                                                                                | Annex III                                                                                                                                                                                                                                                         |
| Justification of choice of data or description of measurement methods and procedures applied: | TEIAS is the only government organization in Turkey which makes the electricity generation and transmission statistics available to the public. <a href="http://www.teias.gov.tr/">http://www.teias.gov.tr/</a>                                                   |
| Any comment:                                                                                  | -                                                                                                                                                                                                                                                                 |

|                                                                                               |                                                                                                                                                                                                            |
|-----------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Data Unit / Parameter:                                                                        | $EF_{grid,CM,y}$                                                                                                                                                                                           |
| Data unit:                                                                                    | tCO <sub>2</sub> /MWh                                                                                                                                                                                      |
| Description:                                                                                  | Combined margin CO <sub>2</sub> emission factor for grid connected power generation in year y calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" |
| Source of data:                                                                               | Koroglu HEPP VCS PD-Baseline Calculations                                                                                                                                                                  |
| Value applied:                                                                                | 0.5299 tCO <sub>2</sub> /MWh                                                                                                                                                                               |
| Justification of choice of data or description of measurement methods and procedures applied: | "Tool to calculate the emission factor for an electricity system"                                                                                                                                          |
| Purpose of Data                                                                               | Calculation of baseline emission                                                                                                                                                                           |
| Any comment:                                                                                  | "Tool to calculate the emission factor for an electricity system"                                                                                                                                          |

## 4.2 Data and Parameters Monitored

|                        |                                                                                                                                                           |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Data Unit / Parameter: | Electricity Generated by the Koroglu HEPP ( $EG_{Facility,y}$ )                                                                                           |
| Data unit:             | MWh/y                                                                                                                                                     |
| Description:           | Net electricity supplied to the national grid by the Koroglu HEPP in year y.<br>Electricity generation will be continuously measured by the power meters. |
| Source of data:        | Monthly official TEIAS invoices.                                                                                                                          |

|                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description of measurement methods and procedures to be applied: | <p>Continuously measured by TEIAS-approved power meters located at the grid interface (TEIAS substation). Measured data is stored at the PMUM web site, which is operated by the TEIAS.</p> <p>Monthly official TEIAS invoices will be used for calculating EG<sub>y</sub>.</p> <p>As a note, monthly settlement notifications of PMUM consist of electricity production and withdrawn from the grid on an hourly basis. PMUM data will be used to calculate net amount of electricity generated which will be equal to the electricity supplied to the grid minus electricity withdrawn from the grid.</p>              |
| Frequency of monitoring/recording:                               | Measurement will be continuous                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Value applied:                                                   | 26 130 MWh /year (expected)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Monitoring equipment:                                            | <p>Monitoring equipment is the power meters located at the TEIAS substation. They will measure the amount of electricity supplied to the grid and withdrawn from the grid. One power meter will be the main one, and the other will serve as the backup. Power meters will be sealed by the TEIAS to prevent any possible interventions. Power meters will measure data continuously; however, readings will be on a monthly basis. Collected data will be stored at the PUMM by the TEIAS.</p> <p>Brand of power meter is ELSTER and main power meter number is 00484541 and backup power meter number is 00484542.</p> |
| QA/QC procedures to be applied:                                  | PMUM settlement data will be used for crosschecking monthly TEIAS invoices.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Purpose of Data                                                  | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Calculation method:                                              | The difference between the amount of electricity supplied to the national grid and electricity drawn from the national grid to be used by the Koroglu facility will be provide the "net electricity generation".                                                                                                                                                                                                                                                                                                                                                                                                         |
| Any comment:                                                     | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

|                            |                                                                                             |
|----------------------------|---------------------------------------------------------------------------------------------|
| Data Unit / Parameter:     | <b>CAPpj</b>                                                                                |
| Data unit:                 | MWe                                                                                         |
| Description:               | Installed capacity of the hydropower plant after the implementation of the project activity |
| Source of data:            | Nameplates of the project turbines                                                          |
| Description of measurement |                                                                                             |

|                                       |                                                |
|---------------------------------------|------------------------------------------------|
| methods and procedures to be applied: | Reading the nameplates of the project turbines |
| Frequency of monitoring/recording:    | Annually                                       |
| Value applied:                        | 9.06 MWe                                       |
| Monitoring equipment:                 | N/A                                            |
| QA/QC procedures to be applied:       | N/A                                            |
| Purpose of Data                       | Calculation of project emissions               |
| Calculation method:                   | N/A                                            |
| Any comment:                          | -                                              |

|                                                                  |                                                                                                                                                   |
|------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Data Unit / Parameter:                                           | <b>APpj</b>                                                                                                                                       |
| Data unit:                                                       | m <sup>2</sup>                                                                                                                                    |
| Description:                                                     | Area of the Project reservoir measured on the surface of the water, after the implementation of the Project activity, when the reservoir is full. |
| Source of data:                                                  | Project Final Design drawings (Official detailed design document of the project)<br>Koroglu HEPP Weir Layout KRG-UY-RG-02.pdf                     |
| Description of measurement methods and procedures to be applied: | Koroglu HEPP Weir Layout KRG-UY-RG-02.pdf                                                                                                         |
| Frequency of monitoring/recording:                               | Annually                                                                                                                                          |
| Value applied:                                                   | 1450 m <sup>2</sup>                                                                                                                               |
| Monitoring equipment:                                            | N/A                                                                                                                                               |
| QA/QC procedures to be applied:                                  | N/A                                                                                                                                               |
| Purpose of Data                                                  | Calculation of project emissions                                                                                                                  |
| Calculation method:                                              | N/A                                                                                                                                               |
| Any comment:                                                     | -                                                                                                                                                 |

### 4.3 Description of the Monitoring Plan

The purpose of Koroglu HEPP Monitoring Plan is to ensure a complete and accurate measurement of the net electricity generation by the project activity. Net electricity generation can be defined as the amount of electrical energy, referring to the difference between gross electricity generation and project's own internal electricity consumption. Multiplying the annual net electricity generation data with the CM emission factor provides the Koroglu HEPP's annual CO<sub>2</sub> emission reduction.

At the project facility, there will be two power meters to measure the electricity supplied to the grid and drawn from the grid. Among these two power meters, one will serve as a main one, the other will be the backup of the main meter. Power meters will be installed by the project owner, but checked and approved by TEIAS before the commissioning. Technical specifications of the power meters should comply with the Communiqué for Power Meters<sup>57</sup> as announced by the EMRA for energy investors to comply with.

As per the Communiqué for Power Meters regulations (Section II, Article 11), the minimum accuracy requirement that the metering devices have to fulfill are categorized according to the installed capacity. As the rated output of the Project Activity is between 10 MW and 100 MW, the accuracy of the power meters that will be installed at the project facility will be at least 0.5%. Both power meters will be installed into the powerhouse and sealed by the TEIAS to prevent any possible intervention. Only TEIAS officers have access to them.

Calibration and maintenance of these two power meters are performed by the TEIAS once in a year as per the TEIAS System Usage Agreement rules.<sup>58</sup>

Besides that if one of the parties of the agreement feels that power meters are not working appropriately, power meters will be tested by the presence of both parties anytime. If test results show that the power meter is not working properly, then measurements of backup meter will be used, beginning from the last measurement value when both meters are reading the same data (page 3, 2-c). In case of the main meter has a breakdown, the readings of the back-up meter will be used. If both meters failed, the internal Supervisory Control and Data Acquisition System (SCADA) data will be used.

Power meters provide two types of data on an hourly basis. These are gross electricity generated and electricity consumed by the power plant. The difference between these two parameters provides the net electricity data.

TEIAS officers read power meters on a monthly basis, then transmit the data electronically to the TEIAS network to be stored at the PMUM<sup>59</sup>, which is an electronic medium operated by the TEIAS where electricity is purchased and sold by free market rules. Based on this reading, a

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<sup>57</sup> Elektrik Piyasasında Kullanılacak Sayaçlar Hakkında Tebliğ (in Turkish), enacted on 22.4.2011 with the number of 27913. <http://www.epdk.gov.tr/web/elektrik-piyasasi-dairesi/44>.

<sup>58</sup> TEIAS System Usage Agreement (Sistem Kullanım Antlaşması -in Turkish), Attachment 2-Section 3.3. pp.13. Available at <http://mid.teias.gov.tr/SKAM/SKAornek.pdf>

<sup>59</sup> PMUM Web Site. <http://www.teias.gov.tr/mali/maliuz.htm>

protocol form is printed out, which lists in detail the energy generation and consumption values in a similar way the PMUM web site lists them. Then, it is then signed by the site manager and the TEIAS officers.

Project owners can access its own consumption and generation data at PMUM web site by using their assigned ID and password, and can derive a variety of actual and historical data. These data are used by TEIAS for invoicing. At the PMUM web site, electricity data is available in terms of gross electricity generation and self-electricity consumption with a breakdown into three time periods (T1 for 06:00-17:00, T2 for 17:00-22:00, T3 for 22:00-06:00). However, it does not show the net electricity generation separately. Therefore, this data has to be calculated by using the gross electricity generation and self-electricity consumption for each month. The annual total net electricity generation is then found by summing up monthly net electricity generation values.

#### *Origin of Monitoring Data*

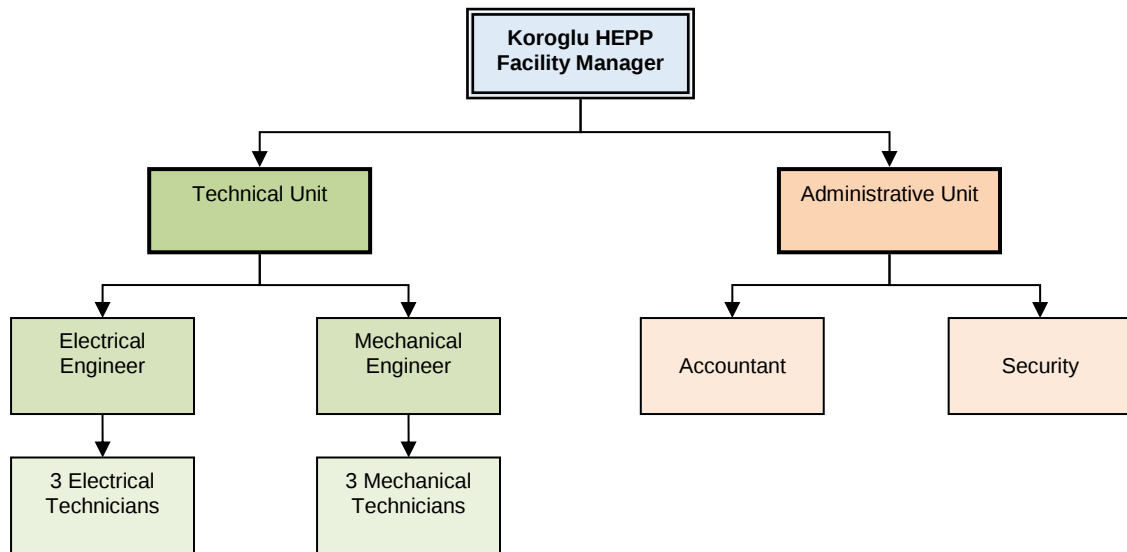
TEIAS invoices will be used for monitoring to determine the Koroglu HEPP annual emission reductions. PMUM settlement web site data will be used for cross-checking.

No additional protocol between project owner and TEIAS will be required for VER crediting.

#### *Roles and Responsibilities*

Koroglu HEPP Plant Manager will be responsible for the implementation of the monitoring plan and preparation of the monitoring report. This task includes the archiving of TEIAS invoices, calculation of annual emission reduction for determining VCS VCUs, and crosschecking the TEIAS invoices data with the PMUM settlement web site for quality control purposes.

All relevant data is recorded and kept by the project owner and will be presented to the DOE during verification. Data will be kept for two years following the completion of the crediting period.



**Figure 10: Proposed Line Diagram of the Koroglu HEPP Facility Personnel**

*Procedures for handling internal auditing and non-conformities*

As above mentioned, the data acquisition and management, and quality assurance procedures are in place as per the agreements with TEIAS and related regulations; therefore there is no need to establish additional procedures for the monitoring plan.

As a note, the two power meters are installed in a redundant manner will keep the uncertainty level of the monitoring parameter (net electricity generated) as low. Higher quality of this data is not only in the interest of the emission reduction monitoring, but also paramount for the business relation between the plant operator and the electricity buyers.

## 5 ENVIRONMENTAL IMPACT

The Environmental Impact Assessment (EIA) study for Koroglu HEPP was conducted in 2010, and Koroglu HEPP Project Description Report was prepared and submitted to the Ministry of Environment and Urbanization<sup>60</sup> in accordance with the Annex II of the Regulation on Environmental Impact Assessment in Turkey that is issued on 17 July 2008 and published in the Official Gazette numbered 26939. The report analyzes the potential environmental impacts of the project and the preventive measures that will be taken to eliminate and/or minimize those impacts

Project received EIA exemption on 13 September 2011 2011 from the Ministry of Environment and Forestry due to that its environmental impact is minimal. The exemption letter indicates that

<sup>60</sup> Its title was Ministry of Environment and Forestry at that time.

“EIA is not Required” for Koroglu HEPP project. This official letter will be available to DOE during the validation process. The exemption letter states that the preventive measures described in the Koroglu HEPP Project Description Report are sufficient.

Per related environmental regulations, two more reports were prepared for the project. One is the Ecosystem Report which analyses the impact of the project on local ecosystem, and the other is the Water Use Rights Report which finds out the local water needs in the project site, such as irrigating farm land, fish farms, drinking water etc. The purpose of this report is to ensure that implementation of the project will not negatively affect the local people life in terms of meeting their water needs.

In general, Koroglu HEPP project will produce benefits in many ways. First of all it is a renewable type; therefore, its impact on the environment is very limited as compared with the traditional thermal power plants which mainly dominate the Turkish grid system. Besides that, in the design of the project, special efforts spent to make the project consistent with the sustainable development of the region. In other words, besides being environmentally friendly, project also will improve local people life through providing job opportunities.

As a renewable energy generation project, Koroglu HEPP does not affect the environment in a way that fossil fuelled power plants do. In other words, project will not emit waste heat and gases that is common with fossil fuel driven thermal power plants, which are major contributor to air pollution, global warming and acid rain. Mining and drilling required to acquire fossil fuels for power plants have also significant negative environmental impacts.

Project will support Turkey in stimulating and commercializing the use of grid connected renewable energy technologies and markets, which are far more environmentally friendly than thermal power plants. This will lead a diversification of Turkish electricity generation mix which is currently dominated by the fossil fueled power plants.

Project will contribute to the air quality by indirectly reducing the airborne pollutants that would otherwise be released by the thermal power plants in the national grid.

Mitigation measures will be taken to minimize possible negative environmental impacts, such as fish migration and sustaining the local habitat. Project will have a fish way, and will release a minimum amount of water to the river bed to sustain the existing aquatic life.

At global scale, project will contribute to the mitigation efforts of global climate change problem.

## 6 STAKEHOLDER COMMENTS

Project owner contacted with local stakeholders to receive their comments about the project. First of all, face to face communication were realized with the local people living in the surrounding villages. Village people were informed about the project; and in return they stated their support to the project, believing that project will not deteriorate the environment and most importantly will contribute to the local economy. Village heads, called Muhktars, also stated their support the project. In general, project is welcomed by the local people.

ANNEX I : PRIVATELY-OWNED HYDROPOWER PROJECTS BY THE END OF 2010<sup>61</sup>

| POWER PLANT                    | INSTALLED<br>CAPACITY<br>(MW) | PROJECT<br>ENERGY<br>GENERATION<br>CAPACITY (GWh) | RELIABLE<br>ENERGY<br>GENERATION<br>CAPACITY (GWh) |
|--------------------------------|-------------------------------|---------------------------------------------------|----------------------------------------------------|
| BEREKET (DENİZLİ)              | 3,7                           | 12                                                | 12                                                 |
| AKÇAY                          | 28,8                          | 95                                                | 45                                                 |
| AKIM (CEVİZLİK HES)            | 91,4                          | 330                                               | 187                                                |
| ANADOLU ÇAKIRLAR               | 16,2                          | 60                                                | 28                                                 |
| ASA EN.(KALE REG.)             | 9,6                           | 32                                                | 18                                                 |
| BAYBURT HES                    | 14,6                          | 51                                                | 24                                                 |
| CEYKAR BAĞIŞLI                 | 29,6                          | 99                                                | 47                                                 |
| BEREKET (DALAMAN)              | 37,5                          | 179                                               | 179                                                |
| BEREKET (FESLEK)               | 9,5                           | 41                                                | 25                                                 |
| BEREKET (GÖKYAR)               | 11,6                          | 43                                                | 23                                                 |
| BEREKET (MENTAŞ)               | 39,9                          | 163                                               | 140                                                |
| BEREKET (KOYULHİSAR)           | 42,0                          | 329                                               | 155                                                |
| BEYOBASI (SIRMA)               | 5,9                           | 23                                                | 11                                                 |
| AKUA KAYALIK                   | 5,8                           | 39                                                | 20                                                 |
| AKKÖY ENERJİ (AKKÖY HES)       | 101,9                         | 408                                               | 263                                                |
| ALAKIR (YURT EN.)              | 2,1                           | 6                                                 | 4                                                  |
| ALP ELEKTRİK (TINAZTEPE)       | 7,7                           | 29                                                | 17                                                 |
| BEYTEK(ÇATALOLUK HES)          | 9,5                           | 31                                                | 17                                                 |
| BİRİM (ERFELEK HES)            | 6,5                           | 19                                                | 11                                                 |
| BULAM                          | 7,0                           | 33                                                | 19                                                 |
| BURÇBENDİ (AKKUR EN.)          | 27,3                          | 113                                               | 64                                                 |
| CANSU ELEKTRİK (ARTVİN)        | 9,2                           | 47                                                | 31                                                 |
| CEYHAN HES (BERKMAN HES-ENOV)  | 25,2                          | 103                                               | 58                                                 |
| CEYHAN HES (OŞKAN HES-ENOV)    | 23,9                          | 98                                                | 55                                                 |
| CİNDERE DENİZLİ                | 28,2                          | 88                                                | 50                                                 |
| ÇAKIT HES                      | 20,2                          | 96                                                | 54                                                 |
| ÇALDERE ELEKTRİK DALAMAN MUĞLA | 8,7                           | 35                                                | 25                                                 |
| ÇAMLIKAYA                      | 5,6                           | 19                                                | 11                                                 |
| DAMLAPINAR(CENAY ELEK.)        | 16,4                          | 92                                                | 52                                                 |
| DAREN HES (SEYRANTEPE BARAJI)  | 49,7                          | 182                                               | 161                                                |
| DEĞİRMENÜSTÜ (KAHRAMANMARAŞ)   | 38,6                          | 106                                               | 52                                                 |
| DENİZLİ EGE 1                  | 0,9                           | 4                                                 | 2                                                  |
| DİM HES (DİLER ELEK.)          | 38,3                          | 123                                               | 70                                                 |
| DİNAR HES (ELDA ELEK.)         | 4,4                           | 15                                                | 9                                                  |

<sup>61</sup> TEIAS, "10 Year Energy Generation Capacity Projection Report", 2011 (In Turkish). pp.98-100. Available at <http://www.teias.gov.tr/KapasiteProjeksiyonu.aspx>. Click on the "2011" link.

|                                     |      |     |     |
|-------------------------------------|------|-----|-----|
| DOĞUBAY ELEK.(SARIMEHMET HES)       | 3,1  | 10  | 6   |
| EGEMEN 1 HES (ENERSİS ELEK.)        | 19,9 | 72  | 41  |
| EKİN ENERJİ (BAŞARAN HES)           | 0,6  | 5   | 0   |
| ELESTAŞ YAYLABEL                    | 5,1  | 20  | 10  |
| ELESTAŞ YAZI                        | 1,1  | 6   | 3   |
| ENERJİ-SA BİRKAPILI                 | 48,5 | 171 | 17  |
| ENERJİ-SA-AKSU-ŞAHMALLAR            | 14,0 | 45  | 7   |
| ENERJİ SA-SUGÖZÜ-KIZILDÜZ           | 15,4 | 55  | 8   |
| ERENLER REG.(BME BİRLEŞİK EN.)      | 45,0 | 85  | 48  |
| ERENKÖY REG.(TÜRKERLER)             | 21,5 | 87  | 49  |
| ERİKLİ-AKOC AK REG.(AK EN.)         | 82,5 | 257 | 146 |
| EŞEN-II (GÖLTAŞ)                    | 43,4 | 170 | 80  |
| ELTA (DODURGA)                      | 4,1  | 12  | 12  |
| ERVA KABACA HES                     | 8,5  | 33  | 15  |
| FEKE 2 (AKKUR EN.)                  | 69,3 | 223 | 126 |
| FIRTINA ELEK.(SÜMER HES)            | 21,6 | 70  | 39  |
| FİLYOS YALNIZCA HES                 | 14,4 | 67  | 33  |
| GÖK HES                             | 10,0 | 43  | 24  |
| GÜDÜL I (YAŞAM EN.)                 | 2,4  | 14  | 8   |
| GÜZELÇAY-I HES(İLK EN.)             | 8,1  | 43  | 24  |
| HAMZALI HES (TURKON MNG ELEK.)      | 16,7 | 117 | 66  |
| H.G.M.ENER.(KEKLİCEK HES)           | 8,7  | 18  | 11  |
| HETAŞ HACISALİHOĞLU (YILDIZLI HES)  | 1,2  | 5   | 3   |
| HİDRO KONTROL YUKARI MANAHOZ        | 22,4 | 79  | 45  |
| HİDRO KONTROL (SELİMOĞLU HES)       | 8,8  | 35  | 20  |
| İÇ-EN ELEK. ÇALKIŞLA                | 7,7  | 18  | 11  |
| İÇTAŞ YUKARI MERCAN                 | 14,2 | 44  | 20  |
| İŞKUR (SÜLEYMANLI HES)              | 4,6  | 18  | 4   |
| KAHRAMAN REG.(KATIRCIOĞLU ELEK.)    | 1,4  | 6   | 3   |
| KAHTA I HES(ERDEMYILDIZ ELEK.)      | 7,1  | 35  | 20  |
| KALE HES                            | 34,1 | 116 | 66  |
| KALEN ENER. (KALEN I-II)            | 31,3 | 104 | 47  |
| KALKANDERE-YOKUŞLU HES(AKIM EN.)    | 14,5 | 63  | 36  |
| KARADENİZ ELEK.(UZUNDERE I HES)     | 62,2 | 165 | 93  |
| KAREL (PAMUKOVA)                    | 9,3  | 55  | 55  |
| KAR-EN KARADENİZ ELEK.(ARALIK HES)  | 12,4 | 56  | 32  |
| KARŞIYAKA HES (AKUA EN.)            | 1,6  | 8   | 5   |
| KAYABÜKÜ HES (ELİTE ELEK.)          | 14,6 | 49  | 28  |
| KAYEN ALFA EN.KALETEPE HES (tortum) | 10,2 | 37  | 17  |
| KİRPİLİK HES (ÖZGÜR ELEK.)          | 6,2  | 22  | 13  |
| KOZAN HES (SER-ER EN.)              | 4,0  | 9   | 5   |
| KULP IV HES (YILDIZLAR EN.)         | 12,3 | 41  | 23  |

|                                        |       |     |     |
|----------------------------------------|-------|-----|-----|
| KURTEKS (Karasu Andırın HES)           | 2,4   | 19  | 19  |
| TGT EN. LAMAS III-IV                   | 35,7  | 150 | 71  |
| MARAŞ ENERJİ (FIRNİS)                  | 7,2   | 36  | 23  |
| MOLU ENERJİ (BAHÇELİK HES)             | 4,2   | 30  | 30  |
| MURGUL BAKIR                           | 24,2  | 50  | 39  |
| NARINKALE HES (EBD EN.)                | 3,1   | 10  | 6   |
| NİSAN EN.(BAŞAK HES)                   | 6,9   | 22  | 12  |
| NURYOL EN.(DEFNE HES)                  | 7,2   | 22  | 13  |
| ÖZGÜR ELEKTR.K.Maraş Tahta HES         | 12,5  | 54  | 54  |
| ÖZGÜR ELEKTR.AZMAK I                   | 11,8  | 43  | 24  |
| ÖZGÜR ELEKTR.AZMAK II                  | 6,3   | 20  | 11  |
| ÖZTAY GÜNAYŞE                          | 8,3   | 29  | 14  |
| ÖZYAKUT GÜNEŞLİ HES                    | 1,8   | 8   | 4   |
| PAMUK (Toroşlar)                       | 23,3  | 112 | 28  |
| PAŞA HES(ÖZGÜR EL.)                    | 8,7   | 34  | 19  |
| PETA EN. (MURSAL II HES)               | 4,5   | 19  | 11  |
| REŞADİYE I HES(TURKON MNG EL.)         | 15,7  | 126 | 71  |
| REŞADİYE II HES(TURKON MNG EL.)        | 26,1  | 210 | 119 |
| SABUNSUYU II HES (ANG EN.)             | 7,4   | 21  | 12  |
| SARMAŞIK I HES (FETAŞ FETHİYE ENERJİ)  | 21,0  | 96  | 54  |
| SARMAŞIK II HES (FETAŞ FETHİYE ENERJİ) | 21,6  | 108 | 61  |
| SARITEPE HES DİNAMİK SİSTEMLER         | 4,9   | 20  | 9   |
| SELEN EL.(KEPEZKAYA HES)               | 28,0  | 124 | 70  |
| SU ENERJİ (ÇAYGÖREN HES)               | 4,6   | 19  | 4   |
| ŞİRİKÇİOĞLU KOZAK                      | 4,4   | 15  | 7   |
| TAŞOVA YENİDEREKÖY                     | 2,0   | 10  | 6   |
| TEMSA ELEKTRİK (GÖZEDE HES)            | 2,4   | 10  | 6   |
| TEKTUĞ-KARGILIK                        | 23,9  | 83  | 19  |
| TEKTUĞ-ANDIRIN                         | 40,5  | 106 | 60  |
| TEKTUĞ-KALEALTI HES                    | 15,0  | 52  | 11  |
| TEKTUĞ-KEBENDERESİ                     | 5,0   | 32  | 20  |
| TEKTUĞ-ERKENEK                         | 12,5  | 50  | 30  |
| TURKON MNG REŞADİYE III                | 22,3  | 175 | 88  |
| UMUT III HES(NİSAN EL.)                | 12,0  | 26  | 15  |
| UZUNÇAYIR                              | 82,0  | 322 | 182 |
| YEDİGÖZE HES                           | 155,3 | 474 | 268 |
| YEŞİL ENERJİ (TAYFUN HES)              | 0,8   | 5   | 4   |
| YEŞİLBAŞ                               | 14,0  | 56  | 26  |
| YAPISAN HACILAR DARENDE                | 13,3  | 90  | 54  |
| YAPISAN KARICA DARICA                  | 97,0  | 328 | 154 |
| YAVUZ HES (MASAT EN.)                  | 22,5  | 83  | 47  |
| YPM ALTINTEPE SUŞEHRİ HES              | 4,0   | 18  | 10  |

|                                |      |     |     |
|--------------------------------|------|-----|-----|
| YPM BEYPINAR HES               | 3,6  | 18  | 9   |
| YPM KONAK HES (SUŞEHİRİ/SİVAS) | 4,0  | 19  | 10  |
| YPM GÖLOVA                     | 1,1  | 3   | 2   |
| YPM SEVİNDİK                   | 5,7  | 36  | 18  |
| YURT EN. TOCAK I               | 4,8  | 13  | 6   |
| TÜM EN. PINAR                  | 30,1 | 138 | 65  |
| ULUBAT KUVVET TÜN.(AK EN.)     | 97,0 | 372 | 210 |
| BEYKÖY ZORLU                   | 16,8 | 87  | 87  |
| KUZGUN ZORLU                   | 20,9 | 36  | 0   |
| TERCAN ZORLU                   | 15,0 | 51  | 28  |
| ATAKÖY ZORLU                   | 5,5  | 8   | 8   |
| ÇILDIR ZORLU                   | 15,4 | 30  | 20  |
| İKİZDERE ZORLU                 | 18,6 | 110 | 100 |
| MERCAN ZORLU                   | 20,4 | 78  | 48  |

## ANNEX II: OM CALCULATIONS

**Table 14: Fossil Fuel Consumed in Thermal Power Plants in Turkey (ton /gas 10<sup>3</sup> m<sup>3</sup>)<sup>62</sup>**

| Fuel Type                          | 2008       | 2009       | 2010       |
|------------------------------------|------------|------------|------------|
| Hard Coal+Imported Coal+Asphaltite | 6,270,008  | 6,621,177  | 7,419,703  |
| Lignite                            | 66,374,120 | 63,620,518 | 56,689,392 |
| Fuel Oil                           | 2,173,371  | 1,594,321  | 891,782    |
| Diesel Oil                         | 131,206    | 180,857    | 20,354     |
| LPG                                | 0          | 111        | 0          |
| Naphta                             | 10,606     | 8,077      | 13,140     |
| Natural Gas                        | 21,607,635 | 20,978,040 | 21,783,414 |

Net Calorific Values (NCV) data in Turkey is not publicly available. However, TEIAS announces Heating values of fuels which can be used to calculate the annual NCVs for each fuel type through dividing by the Fuel Consumption.

**Table 15: Heating Values of Fuels Consumed in Thermal Power Plants in Turkey (Tcal)<sup>63</sup>**

| Fuel Type                          | 2008    | 2009    | 2010    |
|------------------------------------|---------|---------|---------|
| Hard Coal+Imported Coal+Asphaltite | 33,310  | 35,130  | 39,546  |
| Lignite                            | 108,227 | 97,652  | 96,551  |
| Fuel Oil                           | 20,607  | 15,160  | 8,569   |
| Diesel Oil                         | 1,328   | 1,830   | 209     |
| LPG                                | 0       | 1       | 0       |
| Naphta                             | 113     | 84      | 105     |
| Natural Gas                        |         | 186,266 | 194,487 |

<sup>63</sup> TEIAS Web Site, Electricity Generation and Transmission Statistics of Turkey, "Fuels Consumed in Thermal Power Plants in Turkey (2006-2010)." Available at <http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2010/%C4%B0statistik%202010.htm>. Click on the following link: "Fuels Consumed In Thermal P.Ps In Turkey By The Electricity Utilities (2006-2010)." Accessed on 12 April 2012.

<sup>64</sup> TEIAS Web Site, Electricity Generation and Transmission Statistics of Turkey, "Heating Values of Fuels Consumed in Thermal Power Plants in Turkey by the Electric Utilities." <http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2010/%C4%B0statistik%202010.htm>. Click on the following link: "Heating Values Of Fuels Consumed In Thermal P.Ps In Turkey By The Electricity Utilities ((2006-2010))." Accessed on 12 April 2012.

**Table 16: Heating Values of Fuels Consumed in Thermal Power Plants in Turkey (GJ)<sup>64</sup>**

| Fuel Type                          | 2008    | 2009    | 2010    |
|------------------------------------|---------|---------|---------|
| Hard Coal+Imported Coal+Asphaltite | 139,462 | 147,082 | 165,571 |
| Lignite                            | 453,125 | 408,849 | 404,240 |
| Fuel Oil                           | 86,277  | 63,472  | 35,877  |
| Diesel Oil                         | 5,560   | 7,662   | 875     |
| LPG                                | 0       | 4       | 0       |
| Naphta                             | 473     | 352     | 440     |
| Natural Gas                        | 791,544 | 779,858 | 814,278 |

**Table 17: NCV of Fuels Consumed in 2008, 2009 and 2010 (GJ/Kg)**

| Fuel Type                          | 2008    | 2009    | 2010    |
|------------------------------------|---------|---------|---------|
| Hard Coal+Imported Coal+Asphaltite | 0.02224 | 0.02221 | 0.02232 |
| Lignite                            | 0.00683 | 0.00643 | 0.00713 |
| Fuel Oil                           | 0.03970 | 0.03981 | 0.04023 |
| Diesel Oil                         | 0.04238 | 0.04236 | 0.04299 |
| LPG                                |         | 0.03604 |         |
| Naphta                             | 0.04460 | 0.04358 | 0.03349 |
| Natural Gas                        | 0.03663 | 0,03717 | 0,03738 |

**Table 18: Summary Table: FC, Heat Values, NCV and EF<sub>CO2</sub> Values for 2008**

| Fuel Type                                             | FC (tonnes) | Heat Value (GJ) | NCV (GJ/Kg) | EFCO2 (Kg/GJ) | CO2 Emission (Tonnes) |
|-------------------------------------------------------|-------------|-----------------|-------------|---------------|-----------------------|
| Hard Coal+Imported Coal + Asphaltite                  | 6,270,008   | 139,462         | 0.02224     | 92.8          | 12,942,102            |
| Lignite                                               | 66,374,120  | 453,125         | 0.00683     | 90.9          | 41,189,045            |
| Fuel Oil                                              | 2,173,371   | 86,277          | 0.03970     | 75.5          | 6,513,943             |
| Diesel Oil                                            | 131,206     | 5,560           | 0.04238     | 72.6          | 403,661               |
| LPG                                                   | 0           | 0               |             | 61.6          | 0                     |
| Naphta                                                | 10,606      | 473             | 0.04460     | 69.3          | 32,786                |
| Natural Gas                                           | 21,607,635  | 791,544         | 0.03663     | 54.3          | 42,980,831            |
| <b>CO<sub>2</sub> Emission (Tonnes) for year 2008</b> |             |                 |             |               | <b>104,062,368</b>    |

<sup>64</sup> Conversion factor of 4.1868 Joules/Cal is used

**Table 19: Summary Table: FC, Heat Values, NCV and EF<sub>CO2</sub> Values for 2009**

| Fuel Type                                             | FC (tonnes) | Heat Value (GJ) | NCV (GJ/Kg) | EFCO2 (Kg/GJ) | CO2 Emission (Tonnes) |
|-------------------------------------------------------|-------------|-----------------|-------------|---------------|-----------------------|
| Hard Coal+Imported Coal + Asphaltite                  | 6,621,177   | 147,082         | 0.02221     | 92.8          | 13,649,236            |
| Lignite                                               | 63,620,518  | 408,849         | 0.00643     | 90.9          | 37,164,410            |
| Fuel Oil                                              | 1,594,321   | 63,472          | 0.03981     | 75.5          | 4,792,128             |
| Diesel Oil                                            | 180,857     | 7,662           | 0.04236     | 72.6          | 556,250               |
| LPG                                                   | 111         | 4               | 0.03604     | 61.6          | 258                   |
| Naphta                                                | 8,077       | 352             | 0.04358     | 69.3          | 24,372                |
| Natural Gas                                           | 20,978,040  | 186,266         | 0.03717     | 54.3          | 42,346,316            |
| <b>CO<sub>2</sub> Emission (Tonnes) for year 2009</b> |             |                 |             |               | <b>98,532,969</b>     |

**Table 20: Summary Table: FC, Heat Values, NCV and EF<sub>CO2</sub> Values for 2010**

| Fuel Type                                             | FC (tonnes) | Heat Value (GJ) | NCV (GJ/Kg) | EFCO2 (Kg/GJ) | CO2 Emission (Tonnes) |
|-------------------------------------------------------|-------------|-----------------|-------------|---------------|-----------------------|
| Hard Coal+Imported Coal + Asphaltite                  | 7,419,703   | 165,571         | 0.02232     | 92.8          | 15,365,007            |
| Lignite                                               | 56,689,392  | 404,240         | 0.00713     | 90.9          | 36,745,391            |
| Fuel Oil                                              | 891,782     | 35,877          | 0.04023     | 75.5          | 2,680,472             |
| Diesel Oil                                            | 20,354      | 875             | 0.04299     | 72.6          | 62,601                |
| LPG                                                   | 0           | 0               |             | 61.6          | 0                     |
| Naphta                                                | 13,140      | 440             | 0.03349     | 69.3          | 39,650                |
| Natural Gas                                           | 21,783,414  | 194,487         | 0.03738     | 54.3          | 43,972,046            |
| <b>CO<sub>2</sub> Emission (Tonnes) for year 2010</b> |             |                 |             |               | <b>98,865,167</b>     |

The calculation of net electricity production is demonstrated below. As the efficiency factor from gross to net electricity for thermal resources is not known, the overall relation between gross and net electricity production is assumed to be the same for thermal production. Following table shows the overall gross/net relation where the estimated net electricity production from thermal resources were calculated by using the same relation.

Table 21: Net Electricity Production from Thermal Power Plants (GWh)<sup>65</sup>

|                                                             | 2008    | 2009    | 2010      |
|-------------------------------------------------------------|---------|---------|-----------|
| Gross Electricity Production [GWh] (a)                      | 198,418 | 194,813 | 211,207.7 |
| Net Electricity Production [GWh] (b)                        | 189,762 | 186,619 | 203,046   |
| Net/Gross (c= a/b)                                          | 0.956   | 0.958   | 0.961     |
| Gross Electricity Production from thermal sources [GWh] (d) | 164,139 | 156,923 | 155,827   |
| Net Electricity Production from thermal sources [GWh] (c*d) | 156,978 | 150,323 | 149,806   |

Table 22: Electricity imported to the Grid from Other Countries<sup>66</sup> (GWh)

| Countries    | 2008         | 2009         | 2010           |
|--------------|--------------|--------------|----------------|
| Georgia      | 215.5        | 182.1        | 303.2          |
| Iran         | 450.0        | 504.5        | 684.6          |
| Nahcievan    | 94.0         | 125.3        | 156.0          |
| Greece       | 29.9         | -            | -              |
| <b>TOTAL</b> | <b>789.4</b> | <b>812.0</b> | <b>1,143.8</b> |

<sup>65</sup> Gross electricity generation and net electricity generation data are from the following reference: TEIAS Web Site, Electricity Generation and Transmission Statistics of Turkey. "Annual Development of Electricity Generation- Consumption and Losses in Turkey (1984-2010)." Available at <http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2010/%C4%B0statistik%202010.htm>. Click on the following link: Annual Development of Electricity Generation- Consumption and Losses in Turkey (1984-2010). Accessed on 28 Nov 2012.

Data for electricity generation from thermal resources is from the following reference:

TEIAS Web Site, Electricity Generation and Transmission Statistics of Turkey. "Annual Development of Turkey's Gross Electricity Generation-Imports-Exports and Demand (1975-2010)." Available at <http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2010/%C4%B0statistik%202010.htm>. Click on the following link: "Annual Development of Turkey's Gross Electricity Generation-Imports-Exports and Demand (1975-2010)." Accessed on 28 Nov 2012.

<sup>66</sup> Gross electricity generation and net electricity generation data are from the following reference: TEIAS Web Site, Electricity Generation and Transmission Statistics of Turkey. "Annual Development of Electricity Generation- Consumption and Losses in Turkey (1984-2010)." Available at <http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2010/%C4%B0statistik%202010.htm>. Click on the following link: Annual Development of Electricity Generation- Consumption and Losses in Turkey (1984-2010). Visited on 28 Nov 2012.

Data for electricity generation from thermal resources is from the following reference:

TEIAS Web Site, Electricity Generation and Transmission Statistics of Turkey. "Annual Development of Turkey's Gross Electricity Generation-Imports-Exports and Demand (1975-2010)." Available at <http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2010/%C4%B0statistik%202010.htm>. Click on the following link: "Annual Development of Turkey's Gross Electricity Generation-Imports-Exports and Demand (1975-2010)." Accessed on 28 Nov 2012.

Table 23: EGy - Net Electricity Supply to the Grid by Thermal Plants and Imports<sup>67</sup>

| [GWh]                                             | 2008    | 2009    | 2010      |
|---------------------------------------------------|---------|---------|-----------|
| Gross Generation                                  | 198,418 | 194,813 | 211,207.7 |
| Net Generation                                    | 189,762 | 186,619 | 203,046   |
| Net/Gross                                         | 0.956   | 0.958   | 0.961     |
| Gross Electricity Production from Thermal Sources | 164,139 | 156,923 | 155,827   |
| Net Electricity Production from Thermal Sources   | 156,978 | 150,323 | 149,806   |
| Imports                                           | 789     | 812     | 1,144     |
| Net Generated + Imports                           | 157,768 | 151,135 | 150,949   |

The last part of Step 4 is calculating the ratio of emissions and generation:

$$OM\ EF_{Grid,y}\ [tCO_2/MWh] = \frac{(104,062,368 + 98,532,969 + 98,865,167)}{(157,768 + 151,135 + 150,949) \times 1000}$$

$$OM\ EF_{Grid,y}\ [tCO_2/MWh] = 0.6555$$

<sup>67</sup> TEIAS Web Site, Electricity Generation and Transmission Statistics of Turkey, "Annual Development of Turkey's Gross Electricity Generation-Imports-Exports and Demand (1975-2010)". Available at <http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2010/%C4%B0statistik%202010.htm>. Click on the following link: "Annual Development of Turkey's Gross Electricity Generation-Imports-Exports and Demand (1975-2010)". Accessed on 28 Nov 2012.

## ANNEX III: BM CALCULATIONS

Table 24: Generation of Recent Capacity Additions

|                                                               | GWh         |
|---------------------------------------------------------------|-------------|
| System Generation in 2010 (GWh) <sup>68</sup>                 | 211,207.727 |
| System Generation 2010 excluding CDM Project activities       | 208619.757  |
| Minimum Threshold (20%)                                       | 41723.9514  |
| Total of selected power plants [2009 + 2010] [GWh]            | 41930.37    |
| Annual Generation of Capacity Additions in 2010 <sup>69</sup> | 29,337.44   |
| Annual Generation of Capacity Additions in 2009 <sup>70</sup> | 12592.93    |

The final list of the power plants in the Sample Set is available in the following table.

Table 25: Recent Capacity Additions (2009-2010)<sup>71</sup>

| POWER PLANT                         | INSTALLED CAPACITY (MW) | PROJECT ENERGY GENERATION (GWh) | PLANT TYPE   | COMMISSIONING DATE |
|-------------------------------------|-------------------------|---------------------------------|--------------|--------------------|
| INTERNATIONAL HOSPITAL İSTANBUL AŞ. | 0.77                    | 6.0                             | Natural Gas  | 31.12.2010         |
| KALKANDERE REG. VE YOKUŞLU HES      | 14.54                   | 63.0                            | Hydro        | 30.12.2010         |
| TURGUTTEPE RES (SABAŞ ELEKTRİK ÜR.) | 22.00                   | 64.0                            | Wind         | 30.12.2010         |
| KAHRAMAN REG. VE HES (KATIRCIOĞLU)  | 1.42                    | 6.0                             | Hydro        | 30.09.2010         |
| NARİNKALE REG. VE HES (EBD ENERJİ)  | 3.10                    | 10.0                            | Hydro        | 30.09.2010         |
| ERİKLİ-AKOC AK REG. ve AKOC AK HES  | 82.50                   | 257.0                           | Hydro        | 30.06.2010         |
| ÇAMLIKAYA REG. VE HES               | 5.65                    | 19.0                            | Hydro        | 30.06.2010         |
| BORASKO ENERJİ (BANDIRMA RES)       | 12.00                   | 47.8                            | Wind         | 30.06.2010         |
| ITC-KA ENERJİ (SİNCAN)              | 1.42                    | 11.1                            | Renew+Wastes | 30.04.2010         |

<sup>68</sup> TEIAS Web Site, Electricity Generation and Transmission Statistics of Turkey, "Annual Development of Turkey's Gross Electricity Generation of Primary Energy Resources (1975-2010)." Available at <http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2010/%C4%B0statistik%202010.htm>. Click on the following link: "Annual Development of Turkey's Gross Electricity Generation of Primary Energy Resources (1975-2010)." Accessed on 28 Nov 2012.

<sup>69</sup> TEIAS Web Site, Electricity Generation and Transmission Statistics of Turkey, "Generation Units Put into Operation in 2010." Available at <http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2010/%C4%B0statistik%202010.htm>. Click on the following link: "Generation Units Put into Operation in 2010". Accessed on 28 Nov 2012.

<sup>70</sup> TEIAS Web Site, Electricity Generation and Transmission Statistics of Turkey, "Generation Units Put into Operation in 2009." Available at <http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2009/index.htm>. Accessed on 28 Nov 2012.

<sup>71</sup> 2010 year data is derived from the TEIAS, "10 Year Energy Generation Capacity Projection Report", 2011 (In Turkish). pp.102-106. Available at <http://www.teias.gov.tr/KapasiteProjeksiyonu.aspx>. Click on the "2011" link. 2009 year data is derived from the excel table obtained from the TEIAS (2009 Yılı Kurulu Güç Yeni Giren Santraller.xls).

|                                              |        |        |               |            |
|----------------------------------------------|--------|--------|---------------|------------|
| KAR-EN KARADENİZ EL.A.Ş. ARALIK HES          | 12.41  | 56.0   | Hydro         | 30.04.2010 |
| RASA ENERJİ (VAN) (İlave)                    | 10.12  | 64.9   | Natural Gas   | 29.12.2010 |
| EREN ENERJİ ELEKTRİK ÜR. A.Ş. (İlave)        | 600.00 | 4006.0 | Imported Coal | 29.12.2010 |
| KIRKA BORAKS(Kırka) (Eti Maden İşl.) (İlave) | 10.00  | 65.9   | Natural Gas   | 29.09.2010 |
| ALAKIR HES (YURT ENERJİ ÜRETİM)              | 2.06   | 6.0    | Hydro         | 29.01.2010 |
| SABUNSUYU II HES (ANG ENERJİ ELK.)           | 7.35   | 21.0   | Hydro         | 28.10.2010 |
| KARŞIYAKA HES (AKUA ENERJİ ÜRET.)            | 1.59   | 8.0    | Hydro         | 28.08.2010 |
| CENGİZ ENERJİ SAN. VE TİC. A.Ş. (Tekkeköy)   | 101.95 | 801.0  | Natural Gas   | 31.07.2010 |
| AKIM ENERJİ (CEVİZLİK REG. VE HES)           | 91.40  | 330.0  | Hydro         | 28.05.2010 |
| ALİZE ENERJİ (KELTEPE RES)                   | 1.80   | 6.4    | Wind          | 28.04.2010 |
| CAN TEKSTİL (Çorlu/TEKİRDAĞ)                 | 7.83   | 60.2   | Natural Gas   | 28.01.2010 |
| ALTINMARKA                                   | 4.60   | 37.0   | Natural Gas   | 28.01.2010 |
| BAYBURT HES (BAYBURT ENERJİ ÜRET.)           | 14.63  | 51.0   | Hydro         | 28.01.2010 |
| UZUNÇAYIR HES (Tunceli) (İlave)              | 54.60  | 214.6  | Hydro         | 28.01.2010 |
| ULUABAT KUVVET TÜNELİ VE HES                 | 97.00  | 372.0  | Hydro         | 27.10.2010 |
| KARADENİZ EL.ÜRET. (UZUNDERE-1 HES)          | 62.20  | 165.0  | Hydro         | 27.05.2010 |
| FRİTOLAY GIDA SAN.VE TİC A.Ş. (İlave)        | 0.33   | 2.5    | Renew+Wastes  | 26.11.2010 |
| ALİAĞA ÇAKMAKTEPE ENERJİ (İlave)             | 69.84  | 557.9  | Natural Gas   | 26.11.2010 |
| REŞADİYE 1 HES (TURKON MNG ELEKT.)           | 15.68  | 126.0  | Hydro         | 26.11.2010 |
| EGEMEN 1 ve 1B HES (ENERSİS ELEKTRİK)        | 19.90  | 72.0   | Hydro         | 26.11.2010 |
| SÖNMEZ ENERJİ ÜRETİM (UŞAK)                  | 33.24  | 256.3  | Natural Gas   | 26.08.2010 |
| NURYOL ENERJİ (DEFNE REG. VE HES)            | 7.23   | 22.0   | Hydro         | 26.03.2010 |
| MENDERES GEOTERMAL DORA-2                    | 9.50   | 73.0   | Geothermal    | 26.03.2010 |
| GLOBAL ENERJİ (PELİTLİK)                     | 3.54   | 27.1   | Natural Gas   | 26.02.2010 |
| KONYA ŞEKER SAN. VE TİC. A.Ş.                | 6.00   | Yok    | Lignite       | 26.02.2010 |
| ASMAKİNSAN (BANDIRMA 3 RES)                  | 24.00  | 85.0   | Wind          | 26.02.2010 |
| MARMARA PAMUKLU MENSUCAT (İlave)             | 26.19  | 203.5  | Natural Gas   | 25.11.2010 |
| GÜDÜL I REG. VE HES (YAŞAM ENERJİ)           | 2.36   | 14.0   | Hydro         | 25.08.2010 |
| FEKE 2 BARAJI VE HES (AKKUR ENERJİ)          | 69.34  | 223.0  | Hydro         | 24.12.2010 |
| ORTADOĞU ENERJİ (ODA YERİ) (Eyüp/İST.)       | 4.25   | 32.9   | Renew+Wastes  | 24.02.2010 |
| RB KARESİ İTHALAT İHRACAT TEKSTİL            | 8.60   | 65.0   | Natural Gas   | 23.07.2010 |
| HETAŞ HACISALİHOĞLU (YILDIZLI HES)           | 1.20   | 5.0    | Hydro         | 23.02.2010 |
| SARES RES (GARET ENERJİ ÜRETİM)              | 15.00  | 60.0   | Wind          | 22.12.2010 |
| CENGİZ ENERJİ SAN. VE TİC. A.Ş. (Tekkeköy)   | 101.95 | 801.0  | Natural Gas   | 22.05.2010 |
| YILDIZ ENTEGRE AĞAÇ (Kocaeli)                | 12.37  | 79.8   | Natural Gas   | 22.04.2010 |
| BAKRAS EN. ELKT.ÜR. A.Ş. ŞENBÜK RES          | 15.00  | 47.0   | Wind          | 22.04.2010 |
| ETİ SODA ÜRE.PAZ.NAK.VE ELK.ÜRE.SAN.         | 24.00  | 144.0  | Lignite       | 22.01.2010 |
| KOZAN HES (SER-ER ENERJİ)                    | 4.00   | 9.0    | Hydro         | 21.09.2010 |
| KAYABÜKÜ REG. VE HES (ELİTE ELEKT.)          | 14.58  | 49.0   | Hydro         | 21.07.2010 |
| UĞUR ENERJİ ÜRETİM TİC. VE SAN. A.Ş.         | 48.20  | 405.1  | Natural Gas   | 21.06.2010 |
| FRİTOLAY GIDA SAN.VE TİC A.Ş.                | 0.07   | 0.5    | Renew+Wastes  | 21.04.2010 |
| CİNDERE HES (İlave)                          | 9.07   | 28.5   | Hydro         | 21.01.2010 |
| CEYHAN HES (BERKMAN HES)(ENOVA EN.)          | 25.20  | 103.0  | Hydro         | 20.08.2010 |
| AKSA ENERJİ (ANTALYA)                        | 25.00  | 192.5  | Natural Gas   | 20.03.2010 |
| ALİZE ENERJİ (SARIKAYA RES) (Şarköy)         | 28.800 | 96.00  | Wind          | 19.10.2009 |
| CAN ENERJİ ELEKTRİK ÜR. A.Ş.(Tekirdağ)       | 29.10  | 203.0  | Natural Gas   | 19.08.2010 |
| KURTOĞLU BAKIR KURŞUN SAN. A.Ş.              | 1.59   | 12.0   | Natural Gas   | 19.08.2010 |
| AKDENİZ ELEKTRİK (MERSİN RES)                | 33.00  | 100.0  | Wind          | 19.03.2010 |

|                                            |        |        |               |            |
|--------------------------------------------|--------|--------|---------------|------------|
| PETA MÜHENDİSLİK EN. (MURSAL II HES)       | 4.50   | 19.0   | Hydro         | 19.02.2010 |
| ASA ENERJİ (KALE REG.ve HES)               | 9.57   | 32.0   | Hydro         | 19.02.2010 |
| ALTEK ALARKO ELEKTRİK SANTRALLARI          | 21.89  | 151.4  | Natural Gas   | 18.12.2010 |
| MAZI-3 RES ELEKTRİK (MAZI-3 RES)           | 7.50   | 26.5   | Wind          | 18.06.2010 |
| AKBAŞLAR (İlave)                           | 1.54   | 12.1   | Natural Gas   | 18.02.2010 |
| REŞADİYE 2 HES (TURKON MNG ELEKT.)         | 26.14  | 210.0  | Hydro         | 17.09.2010 |
| BİNATOM ELEKTRİK ÜRETİM A.Ş.               | 2.00   | 13.0   | Natural Gas   | 17.08.2010 |
| FLOKSER TEKSTİL (Çerkezköy/TEKİRDAĞ)       | 5.17   | 42.0   | Natural Gas   | 17.07.2010 |
| POLYPLEX EUROPA POLYESTER FİLM             | 7.81   | 61.0   | Natural Gas   | 16.12.2010 |
| BORASKO ENERJİ (BANDIRMA RES)              | 21.000 | 85.30  | Wind          | 16.10.2009 |
| KALE REG. VE HES (KALE ENERJİ ÜR.)         | 34.14  | 116.0  | Hydro         | 16.06.2010 |
| FIRTINA ELEKTRİK ÜR. A.Ş. (SÜMER HES)      | 21.60  | 70.0   | Hydro         | 16.04.2010 |
| TÜPRAŞ RAFİNERİ (İZMİT) (İlave)            | 40.00  | 258.8  | Natural Gas   | 15.12.2010 |
| EREN ENERJİ ELEKTRİK ÜRETİM A.Ş.           | 160.00 | 1068.0 | Imported Coal | 15.07.2010 |
| ZİYARET RES (ZİYARET RES ELEKTRİK)         | 35.00  | 140.0  | Wind          | 15.07.2010 |
| GÜZELÇAY-I ve II HES (İLK ELEKTRİK ENERJİ) | 8.10   | 43.0   | Hydro         | 15.06.2010 |
| KAHTA I HES (ERDEMYILDIZ ELEK. ÜRT.)       | 7.12   | 35.0   | Hydro         | 14.10.2010 |
| YAVUZ REG. VE HES (MASAT ENERJİ)           | 22.50  | 83.0   | Hydro         | 14.07.2010 |
| ROTOR ELEKTRİK (OSMANİYE RES)              | 55.00  | 207.8  | Wind          | 14.01.2010 |
| UMUT III REG. VE HES (NİSAN ELEKTR.)       | 12.00  | 26.0   | Hydro         | 13.12.2010 |
| SOMA RES (BİLGİN RÜZGAR SAN. EN.ÜR.)       | 90.00  | 307.0  | Wind          | 13.08.2010 |
| KULP IV HES (YILDIZLAR EN.ELK.ÜR.AŞ.)      | 12.30  | 41.0   | Hydro         | 13.01.2010 |
| TUZLA JEOTERMAL                            | 7.50   | 55.0   | Geothermal    | 13.01.2010 |
| DENİZ ELEKTRİK (SEBENOBA RES)              | 10.00  | 36.7   | Wind          | 12.03.2010 |
| MURGUL BAKIR (Ç.Kaya) (İlave)              | 19.60  | 40.5   | Hydro         | 11.11.2010 |
| KESKİNOĞLU TAVUKÇULUK VE DAM. İŞL.         | 3.50   | 25.0   | Natural Gas   | 11.08.2010 |
| KİRPİLİK REG. VE HES (ÖZGÜR ELEKTRİK)      | 6.24   | 22.0   | Hydro         | 11.07.2010 |
| PAŞA REG. VE HES (ÖZGÜR ELEKTRİK)          | 8.68   | 34.0   | Hydro         | 11.06.2010 |
| DOĞUBAY ELEKTRİK (SARİMEHMET HES)          | 3.10   | 10.0   | Hydro         | 11.03.2010 |
| BULAM REG. VE HES (MEM ENERJİ ELK.)        | 7.03   | 33.0   | Hydro         | 10.08.2010 |
| ALTEK ALARKO ELEKTRİK SANTRALLARI          | 60.10  | 415.6  | Natural Gas   | 10.07.2010 |
| SOMA ENERJİ ÜRETİM (SOMA RES)              | 34.20  | 114.0  | Wind          | 10.03.2010 |
| KUYUCAK RES (ALİZE ENERJİ ÜR.) (İlave)     | 25.60  | 110.0  | Wind          | 09.12.2010 |
| NİSAN E.MEKANİK EN. (BAŞAK REG. HES)       | 6.85   | 22.0   | Hydro         | 09.04.2010 |
| BOREAS ENERJİ (BOREAS I ENEZ RES)          | 15.00  | 49.0   | Wind          | 09.04.2010 |
| BERGAMA RES EN. ÜR. A.Ş. ALİAĞA RES        | 90.00  | 355.0  | Wind          | 09.04.2010 |
| DAMLAPINAR HES (CENAY ELEKTRİK ÜR.)        | 16.42  | 92.0   | Hydro         | 08.07.2010 |
| DİM HES (DİLER ELEKTRİK ÜRETİM)            | 38.25  | 123.0  | Hydro         | 08.07.2010 |
| SÖNMEZ ENERJİ ÜRETİM (UŞAK) (İlave)        | 2.56   | 17.9   | Natural Gas   | 07.12.2010 |
| ENERJİ-SA (BANDIRMA)                       | 930.80 | 7540.0 | Natural Gas   | 07.10.2010 |
| UĞUR ENERJİ ÜR. TİC.VE SAN. A.Ş. (İlave)   | 12.00  | 100.9  | Natural Gas   | 07.10.2010 |
| ERENKÖY REG. VE HES (TÜRKERLER)            | 21.46  | 87.0   | Hydro         | 07.10.2010 |
| BEYTEK EL. ÜR. A.Ş. (ÇATALOLUK HES)        | 9.54   | 31.0   | Hydro         | 07.04.2010 |
| SELİMOĞLU REG. VE HES                      | 8.80   | 35.0   | Hydro         | 07.01.2010 |
| SELEN ELEKTRİK (KEPEZKAYA HES)             | 28.00  | 124.0  | Hydro         | 06.09.2010 |
| GÖK REG. ve HES (GÖK ENERJİ EL. SAN.)      | 10.01  | 43.0   | Hydro         | 06.08.2010 |
| ROTOR ELEKTRİK (GÖKÇEDAĞ RES)              | 22.50  | 85.0   | Wind          | 05.06.2010 |
| ATAER ENERJİ ELEKTRİK ÜRETİM A.Ş.          | 49.00  | 277.9  | Natural Gas   | 05.05.2010 |

|                                            |         |         |               |            |
|--------------------------------------------|---------|---------|---------------|------------|
| BURÇ BENDİ VE HES (AKKUR ENERJİ)           | 27.33   | 113.0   | Hydro         | 04.11.2010 |
| ERENLER REG. ve HES (BME BİR.MÜT.EN.)      | 45.00   | 85.0    | Hydro         | 04.06.2010 |
| TEKTÜĞ ELEKTRİK (ANDIRIN HES)              | 40.50   | 106.0   | Hydro         | 03.09.2010 |
| ÜTOPIYA ELEKTRİK (DÜZOVA RES) (İlave)      | 15.00   | 45.0    | Wind          | 03.09.2010 |
| DİNAR HES (ELDA ELEKTRİK ÜRETİM)           | 4.44    | 15.0    | Hydro         | 03.07.2010 |
| CEYHAN HES (OŞKAN HES) (ENOVA EN.)         | 23.89   | 98.0    | Hydro         | 03.06.2010 |
| BİRİM HİDR. ÜRETİM AŞ. (ERFELEK HES)       | 6.50    | 19.0    | Hydro         | 03.04.2010 |
| RASA ENERJİ (VAN)                          | 26.19   | 166.5   | Natural Gas   | 03.03.2010 |
| YEDİGÖZE HES (YEDİGÖZE ELEKTRİK)           | 155.33  | 474.0   | Hydro         | 02.12.2010 |
| ITC ADANA BİOKÜTLE SANT.                   | 9.90    | 80.0    | Renew+Wastes  | 02.09.2010 |
| BELEN ELEKTRİK (BELEN RES) (İlave)         | 6.00    | 19.0    | Wind          | 02.09.2010 |
| EREN ENERJİ ELEKTRİK ÜR. A.Ş. (İlave)      | 600.00  | 4006.0  | Imported Coal | 01.11.2010 |
| AKSA ENERJİ (ANTALYA)                      | 25.00   | 192.5   | Natural Gas   | 01.07.2010 |
| ÇAKIT HES (ÇAKIT ENERJİ A.Ş.)              | 20.18   | 96.0    | Hydro         | 01.06.2010 |
| ÖZGÜR ELEKTRİK (AZMAK I REG.VE HES)        | 11.80   | 43.0    | Hydro         | 01.04.2010 |
| CEV ENERJİ ÜRETİM (GAZİANTEP ÇÖP BİOGAZI)  | 1.13    | 8.6     | Renew+Wastes  | 01.02.2010 |
| BİL ENERJİ (DG+M)(Balgat)                  | 36.587  | 229.00  | Natural Gas   | 12/31/2009 |
| E.ŞEHİR END. ENERJİ (DG+M)(Eskişehir-2)    | 59.025  | 452.00  | Natural Gas   | 12/31/2009 |
| EGE BİRLEŞİK ENERJİ (LPG+DG+M)(Aliağa)     | 12.825  | 107.00  | Natural Gas   | 12/31/2009 |
| HABAŞ ALİAĞA                               | 224.460 | 1796.00 | Natural Gas   | 12/31/2009 |
| HABAŞ(BİLECİK)(Paşalar)                    | 18.000  | 144.00  | Fuel Oil      | 12/31/2009 |
| HABAŞ(İZMİR)(Habaş)                        | 36.000  | 288.00  | Fuel Oil      | 12/31/2009 |
| HAYAT KAĞIT                                | 7.531   | 56.00   | Natural Gas   | 12/31/2009 |
| KAREL ENERJİ (Pamukova)                    | 9.300   | 55.00   | Hydro         | 12/31/2009 |
| KEN KİPAŞ ELEKTRİK ÜRETİM (KAREN)          | 41.800  | 180.00  | Natural Gas   | 12/31/2009 |
| MODERN ENERJİ (B.Karıştiran)               | 96.780  | 680.00  | Natural Gas   | 12/31/2009 |
| PETKİM ALİAĞA(Aliağa)                      | 222.040 | 1554.00 | Fuel Oil      | 12/31/2009 |
| SİLOPI ELEKTRİK ÜRETİM A.Ş.(ESENBOĞA)      | 44.784  | 315.00  | Fuel Oil      | 12/31/2009 |
| SÜPER FİLM (G.antepe)                      | 25.320  | 203.00  | Fuel Oil      | 12/31/2009 |
| TİRE-KUTSAN(Tire)                          | 8.000   | 37.00   | Fuel Oil      | 12/31/2009 |
| ÖZGÜR ELEKTRİK (AZMAK II REG.VE HES)       | 24.407  | 91.00   | Hydro         | 12/25/2009 |
| TÜPRAŞ O.A.RAFİNERİ(Kırıkkale)(Düzeltilme) | 10.000  | 70.00   | Fuel Oil      | 12/25/2009 |
| DATÇA RES (Datça)                          | 0.800   | 2.27    | Wind          | 12/24/2009 |
| SARITEPE HES (GENEL DİNAMİK SIS.EL.)       | 2.450   | 10.00   | Hydro         | 12/24/2009 |
| KORES KOCADAĞ RES (Urla/İZMİR)             | 15.000  | 56.00   | Wind          | 12/23/2009 |
| YAPISAN (KARICA REG. ve DARICA I HES)      | 48.500  | 164.00  | Hydro         | 12/23/2009 |
| AKSA ENERJİ (MANİSA) (İlave)               | 10.500  | 83.10   | Natural Gas   | 12/18/2009 |
| FALEZ ELEKTRİK ÜRETİMİ A.Ş.                | 11.748  | 88.00   | Natural Gas   | 12/16/2009 |
| ÇELİKLER TAAH. İNŞ. (RİXOX GRAND)          | 2.000   | 58.00   | Natural Gas   | 12/15/2009 |
| TAV İSTANBUL TERMİNAL İŞLETME. A.Ş.        | 3.260   | 27.60   | Natural Gas   | 12/12/2009 |
| SOMA ENERJİ ÜRETİM (SOMA RES)(İlave)       | 10.800  | 36      | Wind          | 12/8/2009  |
| ROTOR ELEKTRİK (OSMANIYE RES)              | 22.500  | 85.3    | Wind          | 12/4/2009  |
| YEŞİLBAŞ ENERJİ (YEŞİLBAŞ HES)             | 14.001  | 56.00   | Hydro         | 12/4/2009  |
| UZUNÇAYIR HES (Tunceli)                    | 27.330  | 105.00  | Hydro         | 12/2/2009  |
| SARITEPE HES (GENEL DİNAMİK SIS.EL.)       | 2.450   | 10.00   | Hydro         | 11/19/2009 |
| ÖZYAKUT ELEK. ÜR.A.Ş. (GÜNEŞLİ HES)        | 0.600   | 2.70    | Hydro         | 11/13/2009 |
| REŞADİYE 3 HES (TURKON MNG ELEKT.)         | 22.300  | 175.00  | Hydro         | 11/11/2009 |
| SELKASAN KAĞIT PAKETLEME MALZ. İM.         | 9.900   | 73.00   | Natural Gas   | 11/11/2009 |

|                                          |                 |         |               |            |
|------------------------------------------|-----------------|---------|---------------|------------|
| TEKTUĞ (Erkenek) (İlave)                 | 6.514           | 26.00   | Hydro         | 11/10/2009 |
| TÜM ENERJİ (PINAR REG. VE HES)           | 30.090          | 138.00  | Hydro         | 11/6/2009  |
| ERVA ENERJİ (KABACA REG. VE HES)         | 4.240           | 16.30   | Hydro         | 10/29/2009 |
| SOMA ENERJİ ÜRETİM (SOMA RES)(İlave)     | 16.200          | 54      | Wind          | 10/28/2009 |
| BELEN ELEKTRİK BELEN RÜZGAR-HATAY        | 15.000          | 42.5    | Wind          | 10/23/2009 |
| CAM İŞ ELEKTRİK (Mersin) (İlave)         | 126.100         | 1008.00 | Natural Gas   | 10/19/2009 |
| AK GIDA SAN. VE TİC. A.Ş. (Pamukova)     | 7.500           | 61.00   | Natural Gas   | 10/17/2009 |
| MAURİ MAYA SAN. A.Ş.                     | 0.330           | 2.50    | Renew+Wastes  | 10/16/2009 |
| DALSAN ALÇI SAN. VE TİC. A.Ş.            | 1.165           | 9.00    | Natural Gas   | 10/14/2009 |
| İÇDAŞ ÇELİK (İlave)                      | 135.000         | 961.70  | Imported Coal | 10/13/2009 |
| YAPISAN (KARICA REG. ve DARICA I HES)    | 48.500          | 164.00  | Hydro         | 10/10/2009 |
| BELEN ELEKTRİK BELEN RÜZGAR-HATAY        | 15.000          | 42.5    | Wind          | 10/2/2009  |
| ELESTAŞ ELEKTRİK (YAZI HES)              | 1.109           | 6.00    | Hydro         | 10/2/2009  |
| ERVA ENERJİ (KABACA REG. VE HES)         | 4.240           | 16.30   | Hydro         | 9/23/2009  |
| BORASKO ENERJİ (BANDIRMA RES)            | 24.000          | 93.7    | Wind          | 9/18/2009  |
| DELTA ENERJİ ÜRETİM VE TİC.A.Ş. (İlave)  | 13.000          | 101.20  | Natural Gas   | 9/17/2009  |
| FİLYOS ENERJİ (YALNIZCA REG. VE HES)     | 14.430          | 67.00   | Hydro         | 9/16/2009  |
| MAZI-3 RES ELEKT.ÜR. A.Ş. (MAZI-3 RES)   | 10.000          | 35.1    | Wind          | 9/16/2009  |
| BAKİ ELEKTRİK ŞAMLI RÜZGAR               | 33.000          | 161.30  | Wind          | 9/11/2009  |
| ROTOR ELEKTRİK (OSMANİYE RES)            | 17.500          | 66.35   | Wind          | 9/11/2009  |
| MAZI-3 RES ELEKT.ÜR. A.Ş. (MAZI-3 RES)   | 12.500          | 43.9    | Wind          | 9/9/2009   |
| ELESTAŞ ELEKTRİK (YAYLABEL HES)          | 5.100           | 20.00   | Hydro         | 9/7/2009   |
| SAYALAR RÜZGAR (Doğal Enerji)            | 3.600           | 11.36   | Wind          | 9/6/2009   |
| AK ENERJİ (AYYILDIZ RES)                 | 15.000          | 51.00   | Wind          | 9/5/2009   |
| SOMA ENERJİ ÜRETİM (SOMA RES)            | 18.000          | 60      | Wind          | 9/5/2009   |
| PETKİM ALİAĞA(Aliağa) (Düzeltilme-İlave) | 52.040          | 364.00  | Fuel Oil      | 8/28/2009  |
| DENİZLİ ELEKTRİK (EGE I HES)             | 0.920           | 4.00    | Hydro         | 8/27/2009  |
| ENTEK KÖSEKÖY(İztek) (Düzeltilme)        | 0.760           | 6.40    | Natural Gas   | 8/27/2009  |
| AKÇAY HES ELEKTRİK ÜR. (AKÇAY HES)       | 28.780          | 95.00   | Hydro         | 8/14/2009  |
| ORTADOĞU ENERJİ (ODA YERİ) (İlave)       | 5.660           | 44.90   | Renew+Wastes  | 8/14/2009  |
| ANADOLU ELEKTRİK (ÇAKIRLAR HES)          | 16.158          | 60.00   | Hydro         | 8/13/2009  |
| ÖZTAY ENERJİ (GÜNAYŞE REG.VE HES)        | 8.300           | 29.00   | Hydro         | 8/13/2009  |
| ÜTOPIYA ELEKTRİK (DÜZOVA RES)            | 15.000          | 46.00   | Wind          | 8/11/2009  |
| ROTOR ELEKTRİK (OSMANİYE RES)            | 17.500          | 66.35   | Wind          | 8/7/2009   |
| ENTEK KÖSEKÖY(İztek) (Düzeltilme)        | 36.295          | 288.90  | Natural Gas   | 8/6/2009   |
| GLOBAL ENERJİ (PELİTLİK)                 | 8.553           | 65.70   | Natural Gas   | 7/31/2009  |
| RASA ENERJİ (VAN)                        | 78.570          | 500.00  | Natural Gas   | 7/31/2009  |
| OBRUK HES                                | 212.400         | 473.00  | Hydro         | 7/29/2009  |
| <b>TOTAL</b>                             | <b>41930.37</b> |         |               |            |

Table 26: Electricity Generation of Selected Recent Capacity Additions by Fuel Type

| Capacity Additions<br>by Fuel Type | Electricity Generation (GWh) |                    |                 |
|------------------------------------|------------------------------|--------------------|-----------------|
|                                    | 2009 <sup>72</sup>           | 2010 <sup>73</sup> | Total           |
| Coal                               | 1961.70                      | 9080.00            | 10041.7         |
| Lignite                            | 0                            | 144.00             | 144.00          |
| Fuel Oil                           | 2975.00                      | 0                  | 2975.00         |
| Diesel Oil                         | 0                            | 0                  | 0               |
| LPG                                | 0                            | 0                  | 0               |
| Naphta                             | 0                            | 0                  | 0               |
| Natural Gas                        | 5869.9                       | 13112.8            | 18982.7         |
| Renewables and wastes              | 49.40                        | 135.6              | 185.0           |
| Hydro                              | 1783.30                      | 4650.6             | 6433.90         |
| Geothermal & Wind                  | 953.63                       | 2214.44            | 3168.07         |
| <b>TOTAL</b>                       |                              |                    | <b>41930.37</b> |

Electricity generation of selected set of sample m is 41930.37 GWh which is larger than the 41723.95 as determined in Table 24.

Table 27: CO<sub>2</sub> Emission Factor (EF<sub>EL,m,y</sub>) of Capacity Additions by Fuel Type (tCO<sub>2</sub>/MWh)

| Fuel Type             | EF <sub>EL,m,y</sub><br>(tCO <sub>2</sub> /MWh) |
|-----------------------|-------------------------------------------------|
| Coal                  | 8601.87                                         |
| Lignite               | 120.83                                          |
| Fuel Oil              | 2047.10                                         |
| Diesel Oil            | 0.00                                            |
| LPG                   | 0.00                                            |
| Naphta                | 0.00                                            |
| Natural Gas           | 6184.56                                         |
| Renewables and wastes | 0.00                                            |
| Hydro                 | 0.00                                            |
| Geothermal & Wind     | 0.00                                            |
| <b>TOTAL</b>          | <b>16954.37</b>                                 |

<sup>72</sup> TEIAS, "10 Year Energy Generation Capacity Projection Report", 2010 (In Turkish). pp.85-100. Available at <http://www.teias.gov.tr/projeksiyon/KAPASITE%20PROJEKSIYONU%202010.pdf>

<sup>73</sup> TEIAS, "10 Year Energy Generation Capacity Projection Report", 2011 (In Turkish). pp.88-106. Available at <http://www.teias.gov.tr/projeksiyon/KAPASITE%20PROJEKSIYONU%202011.pdf>

$EF_{\text{grid,BM,y}} = 16954.37 / 401937.37$

$EF_{\text{grid,BM,y}} = 0.404345 \text{ ktCO}_2/\text{GWh}$  (or  $40.43 \text{ tCO}_2/\text{MWh}$ )