

78 MW AKOCAK HYDROELECTRIC POWER PLANT MONITORING REPORT



Document Prepared By GTE Carbon

Ehlibeyt Mahallesi 1259. Sokak No: 7/2

Balgat / Çankaya /Ankara

Phone: +90 312 472 3500 Fax: +90 312 472 3366

www.gtecarbon.com

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Prepared By	GTE Carbon
Contact	Address: Ehlibeyt Mah. 1259.Sok. No:7/2 Balgat/Çankaya/Ankara-Turkey Phone: +90 312 472 3500 Fax: +90 312 472 3366 www.gtecarbon.com

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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

AKOCAK is a run of river type hydroelectric power plant (HEPP) project located on Karadere River, in Trabzon province, in East Black Sea Region of Turkey. The purpose of the project is to generate energy from the running waters of Karadere River. The electricity generation license has been awarded to

AKENERJI Elektrik Uretimi A.Ş. for a period of 49 years by the Turkish licensing authority named as Energy Market Regulatory Authority (EMRA).

The project includes two weirs. The first weir called Erikli weir is built on Alcak Brook, a branch of Karadere, on 1,339 meters riverbed elevation. A sediment pool of 41 meters long and 2.3 meters wide is built along the riverbed. The other weir called Akocak weir is built on Karadere branch of the river, on 1,328 meter riverbed elevation. The sediment pool of Akocak weir is 41 meters long and 4.3 meters wide. The powerhouse is located on Karadere River, at 570 meters riverbed elevation.

The water collected at the Erikli weir is connected with a 3 meter diameter, circular section, derivation tunnel of 3,250 meters long to the upstream of Akocak weir. The Akocak weir shall transmit the collected waters to a surge tank through a 6,150 meters long transmission tunnel of 3 meters cross section. The penstock extending from the surge tank to the powerhouse is 1,842 meters long, with an average diameter of 1.82 meters.

The power house includes two turbines of vertical pelton type, each 40.5 MW. Therefore, the capacity of plant is 81 MW actually; however, the capacity was increased after PDD and Passport documents were approved and market registry. In fact, this capacity increment does not affected the annual electricity generation and additionality of the project. This situation was also recognized in previous verification report. Moreover, capacity increment was also stated in previous monitoring report which was verified and approved in 2012. The design flow rate is 12.30 m³/sec. Net head is 744 meters. There are two generators, each 48.75 MVA. The installed capacity of Akocak HEPP is 81 MWe. The generated electrical energy is connected to Arsin TM grid substation through a double circuit 2 x 477 MCM, 32 km long 154 kV transmission line. The annual estimated (ex-ante) electricity production is 257,440 GWh. Corresponding emission reduction is about 144,681 tCO₂ per year. The annual electricity generation is 133,369 GWh in this crediting period. Corresponding emission reduction is about 74,939 tCO₂ per year in this crediting period.

The project has generated 455,677 GWh for 41 months between August 2012-December 2015 which has avoided 256,043 tonnes of CO₂. The detailed calculations are shown excel monitoring spread sheet.

Milestones of the Project

Milestone	Date
License Issuance	23/11/2005
EIA Approval	17/10/2006
Equipment Purchase Agreement	05/10/2006*
Start of Construction	01/12/2006

License Amendment	17/05/2007
Carbon Agreement	10/06/2008
LSC Meeting	27/10/2008
Provisional Acceptance & Commissioning for Unit 1	29/07/2010
Provisional Acceptance & Commissioning for Unit 2	30/06/2010
Expected Monitoring Frequency	Annual
End of Licensing Period	22/11/2054

Table 1. Akocak HEPP Project Milestones (*Investment Decision Date)

1.2 Sectoral Scope and Project Type

The main goals of the Akocak HEPP project include;

- Using Turkey's hydroelectric potential to meet the increasing demand for electricity and contributing toward the guarantee of Turkey's energy security.
- Increase the share of run of river type HEPPs in the mix of electricity generation in Turkey, reduce dependency on imported fossil fuel and as a consequence provide a tangible reduction in GHG emissions.
- Contribute to economic development by creating direct and indirect job opportunities during the construction and operation phases.

The project contributes to the sustainable development in the region through creating new job opportunities during the construction and operational phases. Approximately 200 people were employed during construction phase. After the commissioning of the plant, the project employs 30 local employees. In addition to direct and indirect job opportunities the project contributes to sustainable development through activities conducted within the framework of corporate social responsibility. In addition to contribution to local economy, project also contributed to the use of local and renewable resources to meet the increasing energy demand of Turkey and reduce dependency on fossil fuels.

According to the research conducted by State Planning Organization(SPO) on socio-economic level of Districts in Turkey, Araklı District is ranked as 475th among 872 Districts in Turkey in terms of development level and classified in third (out of six) group. Unemployment rate of Araklı District has been determined as 6.56% whereas population increase rate is about 11.44%. About 77.7% of the population works on agriculture and 18.1% works on service sector whereas only 4.2% works on industry. In that respect, direct and indirect contribution of project activities to local economy through employment and supply of needs from the region has a significant effect on development in the region.¹ Industrial plants

¹ Socioeconomical Development Index of Districts in Turkey, State Planning Organization, 2004 (page 206)

and agricultural lands are limited in the region (only 25% of land within the province can be used for agriculture) and main products are tea plant, hazelnut, corn and grains.²

Proposed project activity involves electricity generation from renewable sources therefore it is categorized in the sectoral scope 1 “Energy Industry – Renewable -/Non-renewable Sources” according to the UNFCCC definition.

Project consists of two weirs and a powerhouse. Project is not a part of grouped project.

1.3 Project Proponent

Organization name	AKENERJI Elektrik Uretim AS
Contact person	Özlem Sefer Palabıyık
Title	Strategic Planning and Risk Manager at Akenerji
Address	Miralay Sefik Cad. No:15 Zip Code:34437 Taksim/Istanbul
Telephone	Phone: +90 212 249 8282 Fax: +90 212 249 7355
Email	info@akenerji.com.tr opalabiyik@akenerji.com.tr

Table 2. Contact information of project owner

Organization name	GTE Carbon
Contact person	M.Kemal Demirkol
Title	Managing partner
Address	Ehlibeyt Mahallesi 1259 sk 7/2 Balgat Cankaya Ankara TURKEY
Telephone	Phone:90 312 472 35 00 Fax: 90 312 472 33 66
Email	kemal@gtcarbon.com

² EIA Report, Section IV.3, page 126

Table 3. Contact information of project participant who is responsible from development of project documents, managing validation and verification processes for the project.

1.4 Other Entities Involved in the Project

N/A

1.5 Project Start Date

The project has started to feed energy to the grid as of 30/06/2010 after its preliminary acceptance had been realized.

1.6 Project Crediting Period

First crediting period of the project is 10 years between 01/07/2010 and 31/07/2020. Crediting period will be renewed twice.

1.7 Project Location

The Akocak HEPP project is located within the boundaries of Arakli District of Trabzon Province. The nearest settlements to the project site are Kayaici and Gelber Villages. The GPS coordinates of the project is given following table:

	LONGITUDE	LATITUDE
Erikli Weir	E 39° 57' 5.4"	N 40° 36' 23.8"
Akocak Weir	E 39° 54' 54.9"	N 40° 36' 47.5"
Powerhouse	E 39° 54' 12.9"	N 40° 40' 13"

Table 4. Project coordinates

Also the project location represented on the Map of Turkey is shown below.



Figure 1. Project Location

1.8 Title and Reference of Methodology

The United Nations approved consolidated baseline methodology applicable to this project is ACM0002 “Consolidated methodology for grid-connected electricity generation from renewable sources”, Version 10³.

ACM0002 refers to the following tools:

- “Tool for the demonstration and assessment of additionality”, Version 05.2, ⁴and
- “Tool to calculate the emission factor for an electricity system”, Version 02⁵.

³ http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_YOYKBRCBIK7TSPSB7MQT75SPX75PE8

⁴ http://cdm.unfccc.int/methodologies/PAmethodologies/AdditionalityTools/Additionality_tool.pdf

⁵ See: http://cdm.unfccc.int/methodologies/Tools/EB35_repan12_Tool_grid_emission.pdf

1.9 Other Programs

- Emission Trading Programs and Other Binding Limits: This project registered under VCS program, there is no other registration in the vcs or other GHG program databases with the same name and location.
- Other Forms of Environmental Credit: There is no another GHG-related environmental credit or renewable energy certificates, during this monitoring period for this project.
- Participation under Other GHG Programs: N/A

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

The project has been in operation since 30/06/2010. The crediting period for the project is 10 years between 01/07/2010 and 30/06/2020 and will be renewable for 2 times. The project activities consist of only one site.

No event or situation that may prevent applicability of methodology has occurred during the monitoring period.

In terms of GHG emission reductions, there were time periods consisting less water collection occurred. Therefore, the electricity generation amount and bounded GHG emission reduction values have might been less than the estimated calculations at the beginning of the project. However, if such any situation observed, it could be easily understand that the reason of it was related with the uncontrolled natural hydrological events.

As a result, there was not any change in project proponents and other entities in this monitoring period.

2.2 Deviations

2.2.1 Methodology Deviations

There was not any deviations during the application of methodology during this monitoring period.

2.2.2 Project Description Deviations

In the PDD, only the reservoir area of the Erikli weir has been taken into consideration. Although, the area of the reservoirs both of Erikli and Akocak weirs are small, the calculation of power density for both weirs is provided below. As the power density still remains higher than 10 W/m², project emissions from the reservoirs have been ignored.

Based on the regulations of Electricity Market Balancing and Conciliation, electricity generation is measured and recorded by remote system and records are sent to PYS (Market Management System).

Therefore, Generated electricity is shown only EPIAŞ (PMUM) web site. All the generation records can be gathered in pdf file from 2012 to end of the 2015 for this monitoring period.

Project installed capacity has been increased from 78 MWe to 81 MWe⁶ as it was also stated in the previous monitoring report (2012).

Furthermore, in the PDD, it was stated that the regarding project emissions from diesel generators, bills would be used for quantification.

There is not other project description deviations applied during this monitoring period

2.3 Grouped Project

Project is not a part of grouped project.

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Data / Parameter:	EG_{y, Total}
Data unit:	GWh
Description:	Net Electricity delivered to the grid by power plants in Turkey in years 2005, 2006 and 2007
Source of data used:	TEIAS web page - http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2014/istatistik2014.htm
Justification of choice of data or description of measurement methods and procedures applied	Data is used for OM calculation and value. The remaining calculation and value is from the previous monitoring report and the related date of the PDD, since this is an ex-ante situation for this project.
Value applied:	155,469.1 GWh; 169,543.1 GWh; 183,339.7 GWh
Purpose of the data	Data used for emission reduction calculation(for calculation of OM, Net-to-Gross electricity ratio and share of low-cost must-run sources)
Comments:	N/A

⁶ Akocak HEPP Generation licence.

Data / Parameter:	EF_{CO₂, i, y}																
Data unit:	tCO ₂ /TJ																
Description:	CO ₂ emission factor of fossil fuel type “i” in year “y”																
Source of data used:	-For EF of fossil fuels, IPCC values at the lower limit have been used.																
Justification of choice of data or description of measurement methods and procedures applied	According to ACM0002, IPCC default values at lower limit of 95% confidence interval can be used. Although, the actual emission reduction is expected to be higher due to high EF of fuels consumed in existing power plants, IPCC values have been used for conservativeness as requested by the methodology.																
Value applied:	<table> <thead> <tr> <th>Fuel Source</th><th>EF(tCO₂/Tj)</th></tr> </thead> <tbody> <tr> <td>Coal</td><td>89.5</td></tr> <tr> <td>Lignite</td><td>90.9</td></tr> <tr> <td>Fuel Oil</td><td>75.5</td></tr> <tr> <td>Diesel</td><td>72.6</td></tr> <tr> <td>LPG</td><td>61.6</td></tr> <tr> <td>Naphta</td><td>69.3</td></tr> <tr> <td>Natural Gas</td><td>54.3</td></tr> </tbody> </table>	Fuel Source	EF(tCO ₂ /Tj)	Coal	89.5	Lignite	90.9	Fuel Oil	75.5	Diesel	72.6	LPG	61.6	Naphta	69.3	Natural Gas	54.3
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Natural Gas	54.3																
Purpose of the data	Data is used for baseline/project emission calculations.																
Comments:	N/A																

Data / Parameter:	FC_{i, y}
Data unit:	Tons or 1000m ³ for gases
Description:	Amount of fuels consumed by thermal power plants for electricity generation in terms of fossil fuel type “i” in year “y”
Source of data used:	TEIAS web page http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2014/istatistik2014.htm
Justification of choice of data or description of measurement methods	Data is chosen for the country specific calculation for the OM value.

and procedures applied	
Value applied:	See Annex 3
Purpose of the data	Data is used for OM calculation
Comments:	N/A

Data / Parameter:	GE
Data unit:	%
Description:	Generation efficiency of thermal power plants
Source of data used:	Annex I- Tool to calculate the emission factor for an electricity system
Justification of choice of data or description of measurement methods and procedures applied	Data is chosen for the country specific calculation for the BM value.
Value applied:	See Annex 3
Purpose of the data	Data is used for BM calculation
Comments:	N/A

Data / Parameter:	NCV
Data unit:	Tj/kt
Description:	Net Calorific Values of Fuel combusted in power plants.
Source of data used:	TEIAS web page http://www.teias.gov.tr/T%C3%BCrkiyeElektrik%C4%B0statistikleri/istatistik2014/istatistik2014.htm
Justification of choice of data or description of measurement methods and procedures applied	Data is chosen to exact calculation of the project emission caused by the specific combustion features of fuel type in this project.
Value applied:	See Annex 3
Purpose of the data	Data is used for OM and BM calculation
Comments:	N/A

3.2 Data and Parameters Monitored

Data / Parameter:	EG_{facility, y}
Data unit:	GWh
Description:	Net Electricity generated and delivered to the grid by Akocak HEPP in year “y”
Source of data:	EPIAŞ (PMUM) records are used for main calculation where “Monthly Facility Reports” (signed by the project owner) are used for cross-check.
Description of measurement methods and procedures to be applied:	Measurement of electricity is done with calibrated and TEİAŞ approved meters regularly
Frequency of monitoring/recording:	Continuous measurement at the site and daily and monthly recording were applied. The plant manager and the staff extracted the records regularly every day. The monthly records gathered by TEİAŞ remotely.
Value monitored:	455,677 GWh during monitoring period.
Monitoring equipment:	Four calibrated ammeters (two of them are spare). Meters used are in compliance with the regulation ⁷ on meters issued by relevant government agencies and have 0.5S accuracy class ⁸ .
QA/QC procedures to be applied:	Maintenance test and calibration of the metering devices will be made by accredited laboratory and TEİAŞ periodically at the project site. Test of the devices were done at 08/12/2012, 11/12/2013, 10/10/2014 and 16/10/2015 during this monitoring period. Moreover, calibration of the meters were done in 27/05/2010 and it will be valid till the 2020. If there is a significant difference between the readings of two devices, maintenance and tests of the metering devices and the associated equipment will be done before waiting for the periodical maintenance.

⁷ <http://www.epdk.gov.tr/web/elektrik-piyasasi-dairesi/44>

⁸ http://www.aktifenerji.com.tr/pdf/sl7000_brosur.pdf

Purpose of the data:	Data is used for baseline emission calculation
Calculation method:	N/A
Comments:	N/A

Data / Parameter:	Cap _{PJ}
Data unit:	W
Description:	Installed capacity of the hydro power plant after the implementation of the project activity
Source of data:	Project site.
Description of measurement methods and procedures to be applied:	The parameter were determined from the labels on the equipment and letter for approval of commissioning issued by Ministry of energy and Natural Resources
Frequency of monitoring/recording:	Yearly
Value monitored:	81,000,000 W ⁹
Monitoring equipment:	N/A
QA/QC procedures to be applied:	N/A
Purpose of the data	Power density calculation of the plant
Calculation method:	N/A
Comments:	N/A

Data / Parameter:	A _{PJ}
Data unit:	m ²
Description:	Area of the reservoir measured on the surface of the water, after the implementation of the project activity, when the reservoir is full
Source of data:	Project site
Description of measurement methods and procedures to be applied:	Measured from topographical surveys or maps
Frequency of monitoring/recording:	Yearly

⁹ Project Generation License

Value monitored:	38,543.722 (Akocak Weir) and 33,877.016 (Erikli Weir) ¹⁰ m ²
Monitoring equipment:	N/A
QA/QC procedures to be applied:	N/A
Purpose of the data	Power density calculation of the plant
Calculation method:	N/A
Comments:	Maximum area is given in Reservoir Map and considered in calculations. Annual measurements are not higher than baseline value.

Data / Parameter:	FC _{i,j,y}
Data unit:	Mass or Volume unit per year (e.g. ton/yr or m ³ /yr)
Description:	Quantity of fuel type i combusted in Diesel power generator during the year y
Source of data:	Project site
Description of measurement methods and procedures to be applied:	Fuel Invoices
Frequency of monitoring/recording:	Continuous monitoring, annual recording.
Value monitored:	17,644 liters of diesel oil
Monitoring equipment:	N/A
QA/QC procedures to be applied:	N/A
Purpose of the data	Project emission calculation
Calculation method:	N/A
Comments:	The calculation for the project emissions has been carried out through the total working hours of the generators. To be conservative, maximum fuel consumption rate (l/hr) is obtained from the generators' manual. The working hours are obtained from the meekly maintenance reports dated in September.

3.3 Monitoring Plan

Monitoring is a key procedure to verify the real and measurable emission reductions from the proposed project. To guarantee the proposed project's real, measurable and long-term GHG emission reductions, the monitoring plan is established.

¹⁰ Akocak HEPP Reservoir map

In order to demonstrate the emission reduction, only the required data is the net electricity delivered to the grid by the project activity.

Net electricity generation is measured and recorded by both EPIAŞ and project owners for billing purposes therefore no new additional protocol is needed for monitoring emission reduction. Power Plant Manager, is responsible for the electricity generated, gathering all relevant data and keeping the records. He is informed about VER concepts and mechanisms and how to monitor and collect the data which is used for emission reduction calculations.

Generation data collected during crediting period is submitted to GTE Carbon who is responsible for calculating the emission reduction subject to verification: Generation data is used to prepare monitoring reports which is used to determine the vintage from the project activity. These reports are submitted to the duly authorized and appointed Designated Operational Entity 'DOE' before each verification period.

The monitoring system organization chart is shown in Figure 2 below, in which the authority and responsibility of project management are defined.

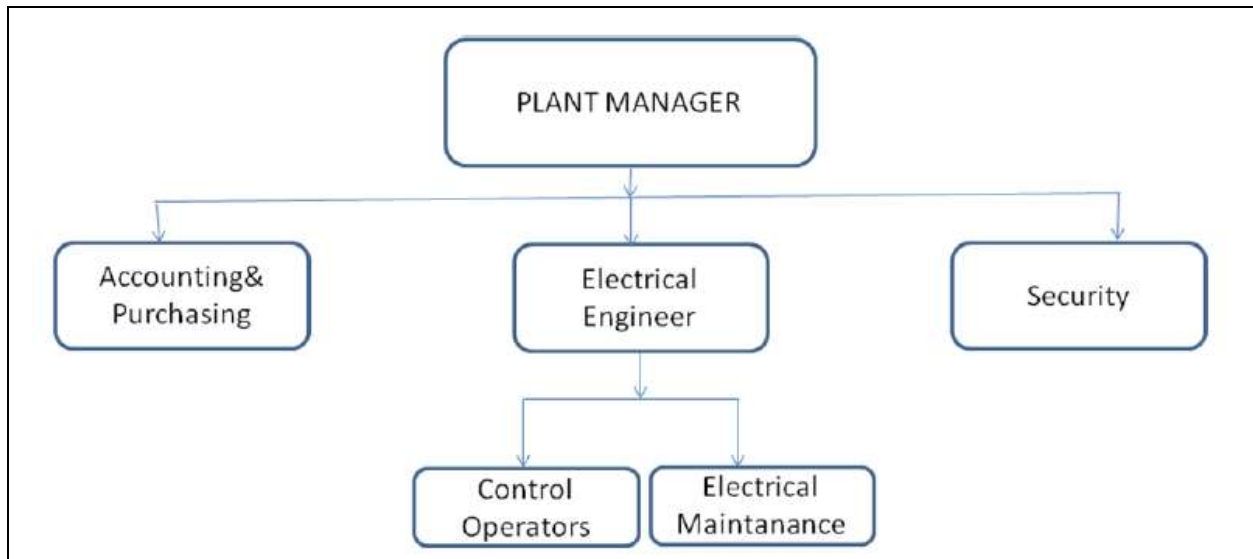


Figure 2. Operational structure of Akocak HEPP

VER Team Members are;

Plant Manager: Overall responsibility of compliance with VER monitoring plan

Electrical Engineer: Responsible for day to day running of plant, recording and monitoring of relevant data and periodic reporting

Accounting Manager: Responsible for keeping data about power sales, invoicing and purchasing.

Control Operators & Electrical Maintenance: Staff is responsible for day to day operation and maintenance of the plant and equipment. All staffs were trained and had certificate for working with high voltage equipment.

GTE Carbon: Responsible for emission reduction calculations, preparing monitoring report and periodical verification process.

Installation of meter and data monitoring are carried out according to the regulations by EPIAŞ. Four metering devices (two of them used as control) are used for monitoring the electricity generated by the

power plant. Readings are done using main metering devices and spare metering device is used for comparison only. Data from metering devices is recorded by EPIAŞ monthly. In addition to the two metering devices, generation of the Akocak HEPP can be cross checked from EPIAŞ web site (<https://www.epias.com.tr/>) which is accessible using a password provided to electricity generation companies. Both the EPIAŞ data and the facility/TEAIS records are taken into account for comparison and to identify any abnormalities.

Technical information of the meters is tabulated below:

Brand	Type	Serial Number
Actaris	SL761A071	53064405 (main- unit 1)
Actaris	SL761A071	53064406 (spare- unit 1)
Actaris	SL761A071	53064407 (main- unit 2)
Actaris	SL761A071	53064408 (spare- unit 1)

Every year between 2012-2015 (this monitoring period) calibration and control of the metering devices were done by TEİAŞ regularly, as it can be understood from the technical and governmental documents provided.

In case of a major failure at both metering at the same time, electricity generation by the plant since the last measurement is able to be monitored by another metering device at the inlet of the main substation operated by TEİAŞ where the electricity is fed to the grid. Electricity generated by the power plant is also available at the SCADA (supervisory control and data acquisition system) of the grid operator TEİAŞ, through the RTU (remote terminal unit) installed at the power plant and supervised by the Load Dispatch Centre of TEİAŞ.

The net electricity fed to the grid is measured continuously and recorded monthly by the EPIAŞ and plant staff. For consistency, recorded data are compared with electricity sale receipts.

All data collected are recorded daily and archived both as electronically and as hard copy for at least two years.

The maximum area of the reservoir is provided in Akocak, Reservoir Map , the level of water was also checked from topographical surveys and maps and didn't exceed the limit value.

A_{BL} value was takes as zero and there was no reservoir area before the project is released, thus, as per the methodology.

All data collected as part of monitoring will be archived electronically and be kept between 2012-2015 period or in other words, after the end of the last crediting period.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

Emission reductions (ER_y) are calculated as follows:

$$ERy = BEy - PEy - LEy$$

Where:

ERy = Emission reductions in year y (tCO₂)

BEy = Baseline emissions in year y (tCO₂)

PEy = Project Emissions in year y (tCO₂)

LEy = Leakage emissions in year y (tCO₂)

4.1 Baseline Emissions

Baseline emission is calculated according to the formula

$$BEy = EGy \times EFy$$

Where:

EGy = Net electricity delivered to the grid by the project activity in year y excluding transmission losses of the grid.

EFy = Emission factor calculated according to selected methodology

EGy	Net Generation(MWh)	455,677
EFy	Emission Factor (tCO₂/GWh)	562¹¹
BEy	Baseline emissions in year y (tCO₂)	256,090

Table5. Baseline emissions

4.2 Project Emissions

The proposed project activity involves two small reservoirs which are Akocak Weir and Erikli Weir. The power density is higher than 10 MW/m², so, the project emissions of the project is ignored.

¹¹ Akocak Hepp, Project Description Document, page 29

The power density of the project activity (PD) is calculated as follows:

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

Where:

PD = Power density of the project activity (W/m²)

CapPJ = Installed capacity of the hydro power plant after the implementation of the project activity (W)

CapBL = Installed capacity of the hydro power plant before the implementation of the project activity (W). For new hydro power plants, this value is zero

APJ = Area of the reservoir measured in the surface of the water, after the implementation of the project activity, when the reservoir is full (m²)

ABL = Area of the reservoir 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

For proposed project HEPP,

$$CapPJ = 81.000\ 000\ W$$

$$CapBL = 0.0\ W$$

$$APJ = 38,543.722 + 33,877.016\ (m^2)^{12}$$

$$ABL = 0.0\ (m^2)$$

Therefore PD is calculated as ;

$$PD = \frac{81000000 - 0}{72420.738 - 0}$$

$$PD = 1,118.46\ W/m^2$$

As the calculation per the methodology also indicates, the project emissions from the reservoir is higher than 4W/m² and thus the emissions from water reservoir is ignored in the calculations.

Emissions from Diesel Generator

Diesel generators are utilized at the powerhouse and the regulators as auxiliary power source when there is no electricity generation in the plant or supply by the grid. For the proposed project, there are 4 diesel generators that are used as auxiliary power source when there is no electricity generation in the plant or

¹² Akocak, Reservoir Map

supply by the grid. The locations of these generators and type, their fuel consumption at maximum load and their working hours are provided in the table below:

For the proposed project, to be conservative the calculation of the project emissions is based on the working hours and the diesel consumption of the diesel generators. The working hours of the generators are obtained from the maintenance reports recorded by the project owner. The maximum fuel consumption at ¾ load are obtained from the generator manuals. Accordingly, 17,644 litres of diesel oil is calculated to be consumed by all of the generators.

According to the “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” CO₂ emissions from fossil fuel combustion for process are calculated based on the quantity of fuels combusted and the CO₂ emission coefficient of those fuels, as follows:

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y}$$

Where:

- $PE_{FC,j,y}$ = Are the CO₂ emissions from fossil fuel combustion in process j during the year y (tCO₂/yr);
- $FC_{i,j,y}$ = Is the quantity of fuel type i combusted in process j during the year y (mass or volume unit/yr);
- $COEF_{i,y}$ = Is the CO₂ emission coefficient of fuel type i in year y (tCO₂/mass or volume unit)
- i = Are the fuel types combusted in process j during the year y

For calculating the COEF _{i,y} option B has been used which is given as;

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO_2,i,y} \quad (4)$$

Where:

- $COEF_{i,y}$ = Is the CO₂ emission coefficient of fuel type i in year y (tCO₂/mass or volume unit)
- $NCV_{i,y}$ = Is the weighted average net calorific value of the fuel type i in year y (GJ/mass or volume unit)
- $EF_{CO_2,i,y}$ = Is the weighted average CO₂ emission factor of fuel type i in year y (tCO₂/GJ)
- i = Are the fuel types combusted in process j during the year y

COEF for diesel fuel has been calculated and based on these parameters, PE due to diesel generator has been calculated for the monitoring period. Calculations and references are indicated in excel sheet.

The NCV (0.043 GJ/tonnes) is obtained from the IPCC 2006 Guidelines.¹³ The density of diesel is obtained from TUPRAS website.¹⁴

¹³ IPCC 2006. Vol.2, Ch.1, pg.1.18-1.19

¹⁴ <http://www.tupras.com.tr/detailpage.tr.php?strProductKey=403&lRedirectPageID=145>

The EF is calculated based on the carbon conversion unit (20 t C/TJ) given in the Turkey's National Inventory Report.¹⁵

$$\text{COEF}_{i,y} = [0.043 * (20 * (44/12)) * 1000] / ((1/845) * 1,000,000)$$

$$\text{COEF}_{i,y} = 2.66 \text{ kg CO}_2/\text{lt}$$

Thus, the project emission from the diesel generator is calculated as:

$$\text{PE}_{\text{FC},j,y} = \sum_i \text{FC}_{i,j,y} \times \text{COEF}_{i,y}$$

$$\text{PE}_{\text{FC},j,y} = 17,644(\text{litres}) * 0.00266(\text{t CO}_2) = 47.000 \text{ tonnes CO}_2$$

4.3 Leakage

The energy generating equipment is not transferred from or to another activity. Therefore leakage is also considered as "0".¹⁶

$$\text{LE}_y = 0$$

4.4 Net GHG Emission Reductions and Removals

Total Emission Reduction has been determined as;

$$\text{ER}_y = \text{BE}_y - \text{PE}_y - \text{LE}_y$$

Where;

ER_y = Emission reductions in year y (tCO₂)

BE_y = Baseline emissions in year y (tCO₂)

PE_y = Project Emissions in year y (tCO₂)

LE_y = Leakage emissions in year y (tCO₂)

The proposed project activity involves a small reservoir area. Project's power density is above 4 W/m², project emissions are ignored as per the methodology.

The energy generating equipment is not transferred from or to another activity. Therefore leakage is also considered as "0".

¹⁵ UNFCCC Turkey National Inventory Report 2015 (Table 1A(b)). Value given in t C per TJ. Converted to kg CO₂e per kWh. Then converted to kg CO₂e per L using NCV.
http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8812.php

¹⁶ PDD page 30

Thus, $ER_y = BE_y - PE_y$

Baseline Emissions

$$BE_y = E_{GBL,y} \times EF_{CO_2}$$

Where:

BE_y : Baseline emissions in year y ($tCO_2/year$)

$E_{GBL,y}$: Energy baseline in year (kWh)

EF_{CO_2} : Combined Margin CO_2 emission factor (tCO_2/MWh), which is $0.562tCO_2/MWh$ in the validated PD.

Thus, the emission reduction for August 2012 – December 2015 is calculated as given in table below

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)
2012 (01/08/2012-31/12/2012)	2,719	4.6	0	2,715
2013 (01/01/2013-31/12/2013)	90,799	19.9	0	90,779
2014 (01/01/2014-31/12/2014)	69,175	9.4	0	69,165
2015 (01/01/2015-31/12/2015)	93,396	13	0	93,383
Total (01/08/2012-31/12/2015) (tCO_2e)	256,090	47.000	0	256,043

Table 6. Summary of Emission Reductions

During the monitoring period, project has generated less electricity than expected due to low rate of flow and downtimes which are expected in first years of operation. No event or situation that may prevent applicability of methodology has occurred during the monitoring period.