

# GRID EMISSION FACTOR FOR ARMENIA

2014-2016

Version 01.0

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## CONTENT

<b>Steps of grid emission factor calculation .....</b>	<b>2</b>
<i>Step 1: Identify the relevant electricity systems .....</i>	<i>2</i>
<i>Step 2: Choose whether to include off-grid power plants in the project electricity system .....</i>	<i>2</i>
<i>Step 3: Select a method to determine the operating margin (OM) .....</i>	<i>2</i>
<i>Step 4: Calculate the operating margin emission factor according to the selected method .....</i>	<i>2</i>
<i>Step 5: Calculate the build margin emission factor .....</i>	<i>4</i>
<i>Step 6: Calculate the combined margin emissions factor .....</i>	<i>7</i>
<b>Results of calculation: Combined Margin for 2016 .....</b>	<b>7</b>
<b>Annex I: Combine Margin Emission Factor for 2016 (ex-ante) .....</b>	<b>8</b>
<b>Annex II: Combine Margin Emission Factor for 2016 (ex-post) .....</b>	<b>9</b>
<b>Annex III: Load duration curve for 2016 .....</b>	<b>10</b>
<b>Annex IV: Combine Margin Emission Factor for 2015 (ex-post) .....</b>	<b>11</b>
<b>Annex V: Load duration curve for 2015 .....</b>	<b>12</b>
<b>Annex VI: Combine Margin Emission Factor for 2014 (ex-post) .....</b>	<b>13</b>
<b>Annex VII: Load duration curve for 2014 .....</b>	<b>14</b>

## Steps of grid emission factor calculation

The grid emission factor for the electricity system of the Republic of Armenia (Armenia) for 2016 has been calculated in line with provisions and recommendations provided in the version 5.0 of the “Tool to calculate the emission factor for an electricity system” (Tool) and based on information and data obtained by DNA from public sources and respective state authorities of Armenia.

### *Step 1: Identify the relevant electricity systems*

The national power distribution grid of Armenia covers all the country and is identified as the project electricity system for the purpose of grid emission factor calculation. The Armenian power system maintains power exchange with the national electricity grid of Iran and Georgia. In such a way, Iranian and Georgian national grids are considered as the connected electricity systems. For the purpose of determining the operating margin emission factor the Tool proposes four options to determine the CO<sub>2</sub> emission factor(s) for net electricity imports from a connected electricity system. Within the scopes of this study option (a) i.e. 0 tones CO<sub>2</sub> per MWh is selected.

### *Step 2: Choose whether to include off-grid power plants in the project electricity system*

Option I of the Tool i.e. “Only grid power plants are included in the calculation” is selected; hence, off-grid power plants are not included in the project electricity system.

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

According to the definition used in the Tool, low-cost/must-run resources are defined as power plants with low marginal generation costs or dispatched independently of the daily or seasonal load of the grid. They include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. In accordance with this definition, within the scope of this study, all power plants except for four large thermal power plants (Yerevan TPP, Hrazdan TPP, Hrazdan TPP Unit N5 and CCGT Unit at Yerevan TPP) are selected as low-cost / must-run power plants.

Based on the statistic information provided by the Ministry of Energy Infrastructures and Natural Resources of RA during the period of 2012-2016, low-cost/must-run (LCMR) resources constituted more than 50% of the total grid generation in average of the five most recent years. Additionally, based on information on hourly load data provided by the Ministry, it was identified that averages load by LCMR resources is higher than average lowest annual system load (LASL) over the three years. Hence, following the procedure for application of operational margin methods provided in the Tool, “Simple adjusted OM” was selected for calculation of the operating margin emission factor.

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

In order to evaluate Operational Margin, net quantity of electricity (mln kWh) generated and delivered to the grid by all power units serving the system need to be identified as well as CO<sub>2</sub> emission factor (tCO<sub>2</sub>/MWh) of power units operated on fossil fuels need to be calculated. Information on net generation of electricity by all power plants (both LCMR and no LCMR) the Armenia power system in 2014-2016 is presented in the table below. According to the Tool, electricity import is also considered in calculation of Simple adjusted OM.

POWER PLANT	Delivered electricity (MWh)			Type of fuel
	2014	2015	2016	
No LCMR <sup>1</sup>				
Hrazdan Thermal Power Plant	905226.6	507854.7	409255.2	natural gas
Unit 5 of Hrazdan Thermal Power Plant	827590.2	615732.6	668631.8	natural gas
Yerevan Thermal Power Plant	-	-	-	natural gas
CCGT Unit at Yerevan TPP	1398771.7	1541259.7	1380764.4	natural gas
LCMR <sup>2</sup>				
Metzamor NPP	2265639.0	2571098.1	2194847.1	nuclear
Sevan-Hrazdan CHPPs (IEC)	465328.9	444311.1	395599.4	hydro
ContourGlobal Hydro Cascade	826596.3	909566.5	981804.0	hydro
Small Hydro Power Plants <sup>3</sup>	670561.8	818676.3	940108.2	hydro
Lori-1 Wind Power Plant	3701.8	3384.1	1612.8	wind
Qajaran Wind Power Plant (Arats LLC)	-	13.6	49.9	wind
Energy Center at YSMU – CHP Unit	14540.4	12334.4	6327.7	natural gas
ArmRoscogeneration CJSC – CHP Unit	11469	9030.6	11594.7	natural gas
Import	204849.5	172822.0	263526.8	
TOTAL with Import	7594275.2	7606083.7	7254122	
LCMR Plants	4257837.2	4768414.7	4531943.8	
Low-cost/must-run plants + import	4462686.7	4941236.7	4795470.6	

In the table below results of calculation of emission factors for no LCMR power plants for 2014-2016 is presented.

POWER PLANT	Year	Fuel consumption FC <sub>i,m,y</sub>	Net calorific value of fuel NCV <sub>i,y</sub>	Emission factor EF <sub>CO<sub>2</sub>,i,y</sub>	Emission factor
		1000m <sup>3</sup>	GJ/1000m <sup>3</sup>	tCO <sub>2</sub> /GJ	tCO <sub>2</sub> /MWh
Hrazdan TPP	2014	275583	34.710	0.054	0.57
	2015	162509	34.773	0.054	0.6
	2016	129544	34.278	0.054	0.59
Unit N5 at Hrazdan TPP	2014	210883	34.759	0.054	0.48
	2015	148592	35.165	0.054	0.46

<sup>1</sup> There is no publicly available information demonstrating that any of four large fossil fuel plants serving the system is dispatched by the grid operator independently of the daily or seasonal load of the grid. Hence there are no strong arguments for consideration of that plant as low-cost/must-run resources.

<sup>2</sup> Small CHP units are included in low-cost/must-run plants list because these plants are dispatched by the grid operator independently based on power purchase agreements. According to decision of the Public Services regulatory Commission of RA, national grid is obliged to purchase electricity produced by such plants base on the tariff approved by the Commission. Moreover, CHP units are operated in heating seasons to produce thermal energy that is consumed for uninterruptable heating of consumers (e.g. residential and university building). Hence, these units shall be considered as must-run.

<sup>3</sup> The list of small hydropower plants included in “Small Hydro Power Plants” category is provided in the Annex VIII.

	2016	164951	34.503	0.054	0.46
CCGT at Yerevan TPP	2014	305644	34.583	0.054	0.41
	2015	336813	34.554	0.054	0.41
	2016	303887	34.378	0.054	0.41

*Note: The measurement of natural gas is made under the following conditions: temperature – 15°C, pressure – 1 atm.*

In the table below results of calculation of emission factors for LCMR power plants for 2014-2016 is presented.

POWER PLANT	Year	Fuel consumption FC <sub>i,m,y</sub>	Net calorific value of fuel NCV <sub>i,y</sub>	Emission factor EF <sub>CO<sub>2</sub>,i,y</sub>	Emission factor
		1000m <sup>3</sup>	GJ/1000m <sup>3</sup>	tCO <sub>2</sub> /GJ	tCO <sub>2</sub> /MWh
Metzamor NPP, Large and Small HPPs, Lori-1 WPP	2014	0	0	0	0
	2015	0	0	0	0
	2016	0	0	0	0
Energy Center at YSMU – CHP Unit	2014	4309	34.790	0.054	0.56
	2015	3878	34.823	0.054	0.59
	2016	2116	34.272	0.054	0.62
ArmRosco generation CJSC – CHP Unit	2014	3125	34.869	0.054	0.52
	2015	2576	34.620	0.054	0.54
	2016	3227	34.290	0.054	0.52

Calculation of lambda factor is performed in accordance with the procedure set by the Tool and based on chronological (hourly) power generation data for each plant/unit provided by the Ministry.

In the table below results of calculation of lambda factor and respective Simple adjusted OM for 2014-2016 are presented.

The number of hours for which low-cost/must-run sources are on the margin (hours)	2014	2015	2016
	17	12	24
Lambda factor	0.0019406	0.0013699	0.0027322
Simple adjusted OM emission factor (tCO <sub>2</sub> /MWh)	<b>0.475</b>	<b>0.458</b>	<b>0.452</b>

#### *Step 5: Calculate the build margin emission factor*

Following the procedure for selection of power units m used to calculate the build margin described in the Tool, the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently (SET5-units) has been identified along with their annual electricity generation (AEGSET-5-units, in MWh).

In the table below information on installed capacities and cumulative share of power generation of these plants is given for 2014-2016.

The set of five power units (excluding power units registered as CDM project activities) that started to supply electricity to the grid most recently (SET5-units) for 2014-2016

Year	N	POWER PLANT	First year in service	Power generation in 2014, MWh	Cumulative share, %
2014	1	Yegheg SHPP	2014	746.5	0.01
	2	Spitak Jur SHPP	2014	13.6	0.00
	3	Mane SHPP	2014	896.4	0.01
	4	Khachaghbyur-2 SHPP (Megaenergy LLC)	2014	8056.7	0.11
	5	Khachi Qar SHPP	2014	3878.6	0.05
<b>TOTAL</b>				<b>13591.9</b>	<b>0.18</b>
Year	N	POWER PLANT	First year in service	Power generation in 2015, MWh	Cumulative share, %
2015	1	Daranak SHPP	2015	955.7	0.014
	2	Arevis-1 SHPP	2015	477.6	0.007
	3	Nigava SHPP	2015	5351.3	0.080
	4	Gndevanq SHPP	2015	190.5	0.003
	5	Qajaran Wind Power Plant	2015	13.6	0.0002
<b>TOTAL</b>				<b>6988.8</b>	<b>0.104</b>
Year	N	POWER PLANT	First year in service	Power generation in 2015, MWh	Cumulative share, %
2016	1	Seca SHPP	2016	1071.2	0.02
	2	Anapat-1 SHPP	2016	1573.1	0.02
	3	Amberd-3 SHPP	2016	11234.8	0.16
	4	Meghri-1 SHPP	2016	2512.7	0.04
	5	Her-Her SHPP	2016	1351.6	0.02
<b>TOTAL</b>				<b>17743.3</b>	<b>0.25</b>

As it is seen from the above table the total power generation of the 5 recently commissioned power plants is much lower than 20% of total power generation of the system.

The next step requires determining the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEG<sub>total</sub>, in MWh), and to identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEG<sub>total</sub> (SET<sub>≥20%</sub>) and determine their annual electricity generation (AEG<sub>SET-≥20%</sub>, in MWh);

In the table below information on annual electricity generation as well as share of electricity generation of the plants included in SET<sub>≥20%</sub> is given.

The set of power units (excluding power units registered as CDM project activities) that started to supply electricity to the grid most recently and that comprise 20% of the system generation (SET<sub>≥20%</sub>) for 2014-2016

Year	POWER PLANT	First year in service	Fuel	Power generation, MWh	Share of AEG <sub>total</sub> (%)
2014	Hrazdan TPP Unit N5	2011	NG	857490	11.6
	85 small WPPs and HPPs	2010-2014	HY	301689	4.08
	CCGT Unit at YTPP	2010	NG	1447860	19.59
	<b>TOTAL</b>			<b>2607041.4</b>	<b>35.27</b>
2015	Hrazdan TPP Unit N5	2011	NG	638368	9.52
	94 small WPPs and HPPs	2010-2015	HY	415337	6.19
	CCGT Unit at YTPP	2010	NG	1594592	23.78
	<b>TOTAL</b>			<b>2634155.2</b>	<b>39.49</b>
2016	Hrazdan TPP Unit N5	2011	NG	694823	9.93
	105 small WPPs and HPPs	2010-2016	HY	490324	7.01
	CCGT Unit at YTPP	2010	NG	1427313	20.41
	<b>TOTAL</b>			<b>2612466.8</b>	<b>37.35</b>

As it is seen from the above two tables the group of power units included in SET<sub>≥20%</sub> comprises the larger annual electricity generation than power plants included in SET<sub>5-units</sub> in 2014-2016 period.

Since all power units included in the selected group (SET<sub>≥20%</sub>) started to supply electricity to the grid no more than 10 years ago, the set of power plants in the latter table is used for calculation of the Build Margin.

In the below emission factors for plants included in Build Margin as well as Build Margin emission factor for the system 2014-2016 are given.

Year	POWER PLANT	Emission factor of power plants included in BM (tCO <sub>2</sub> /MWh)	Build Margin emission factor (tCO <sub>2</sub> /MWh)
2014	Hrazdan TPP Unit N5	0.48	0.3854
	85 small HPPs	0	
	CCGT Unit at YTPP	0.41	
2015	Hrazdan TPP Unit N5	0.46	0.3591
	94 small HPPs	0	
	CCGT Unit at YTPP	0.41	
2016	Hrazdan TPP Unit N5	0.46	0.3456
	105 small HPPs	0	
	CCGT Unit at YTPP	0.41	

### *Step 6: Calculate the combined margin emissions factor*

For the purpose of this study the weighted average Combined Margin (CM) method (Option a) has been used as the preferred option.

As the result of the performed calculations the following CM emission factors have been received for ex post approach for 2014-2016.

Year	EX POST (tCO <sub>2</sub> /MWh)	
2014	Simple Adjusted Operating Margin	0.4753
	Build Margin	0.3854
	CM for wind and solar	0.4528
	CM for all other projects	0.4303
2015	Simple Adjusted Operating Margin	0.4581
	Build Margin	0.3456
	CM for wind and solar	0.4333
	CM for all other projects	0.4086
2016	Simple Adjusted Operating Margin	0.4525
	Build Margin	0.3456
	CM for wind and solar	0.4258
	CM for all other projects	0.3991

### **Results of calculation: Combined Margin for 2016**

As the result of the performed calculations the following CM emission factors have been received for ex ante approach for 2016.

Year	EX ANTE (tCO <sub>2</sub> /MWh)	
2016	Simple Adjusted Operating Margin	0.4620
	Build Margin	0.3456
	CM for wind and solar	0.4329
	CM for all other projects (1 <sup>st</sup> CP)	0.4038
	CM for all other projects (2 <sup>nd</sup> and 3 <sup>rd</sup> CP)	0.3748

## Annex I: Combine Margin Emission Factor for 2016 (ex-ante)

### The simple adjusted operating margin

	2014	2015	2016	Average	
<b>EF<sub>grid,OM-adj,y</sub></b> =	<b>0.4753183</b>	<b>0.458135</b>	<b>0.4525609</b>	<b>0.4620047</b>	<b>tCO2/MWh</b>

<b>EG</b>	7 594 275	7 606 084	7 254 127	(MWh) Net quantity of electricity generated and delivered to the grid
<b>EG<sub>m,y</sub></b>	3 131 588	2 664 847	2 458 651	(MWh) Net quantity of electricity generated and delivered to the grid by not low-cost/must-run power units
<b>EG<sub>k,y</sub></b>	4 462 687	4 941 237	4 795 475	(MWh) Net quantity of electricity generated and delivered to the grid by low-cost/must-run power units

<b>MWh (plot line)</b> =	<b>510.25632</b>	<b>565.55916</b>	<b>549.91134</b>
<b>y</b> =	<b>8743</b>	<b>8748</b>	<b>8760</b>
<b>X</b> =	<b>17</b>	<b>12</b>	<b>24</b>

<b>λ</b> =	<b>0.0019406</b>	<b>0.0013699</b>	<b>0.0027322</b>
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### The build margin 2016

<b>EF<sub>grid,BM,y</sub></b> =	<b>0.3456902</b>	<b>tCO2/MWh</b>
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### The combined margin 2016

<b>EF<sub>grid,CM,y</sub></b> =	<b>0.4329261</b>	<b>tCO2/MWh</b>	<b>For Wind and Solar projects</b>
<b>EF<sub>grid,CM,y</sub></b> =	<b>0.4038475</b>	<b>tCO2/MWh</b>	<b>For other projects</b>

	<b>W<sub>OM</sub></b>	<b>W<sub>BM</sub></b>
<b>For Wind and Solar projects</b>	<b>0.75</b>	<b>0.25</b>
<b>For other projects</b>	<b>0.5</b>	<b>0.5</b>



## Annex II: Combine Margin Emission Factor for 2016 (ex-post)

### The simple adjusted operating margin

$EF_{\text{grid,OM-adj,y}}$	=	<b>0.4525609</b>	tCO <sub>2</sub> /MWh
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<b>EG</b>	7 254 127	(MWh) Net quantity of electricity generated and delivered to the grid
<b>EG<sub>m,y</sub></b>	2 458 651	(MWh) Net quantity of electricity generated and delivered to the grid by not low-cost/must-run power units
<b>EG<sub>k,y</sub></b>	4 795 475	(MWh) Net quantity of electricity generated and delivered to the grid by low-cost/must-run power units

<b>MWh (plot line)</b>	=	<b>549.91134</b>
<b>y</b>	=	<b>8760</b>
<b>X</b>	=	<b>24</b>

$\lambda$	=	<b>0.0027322</b>
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### The build margin

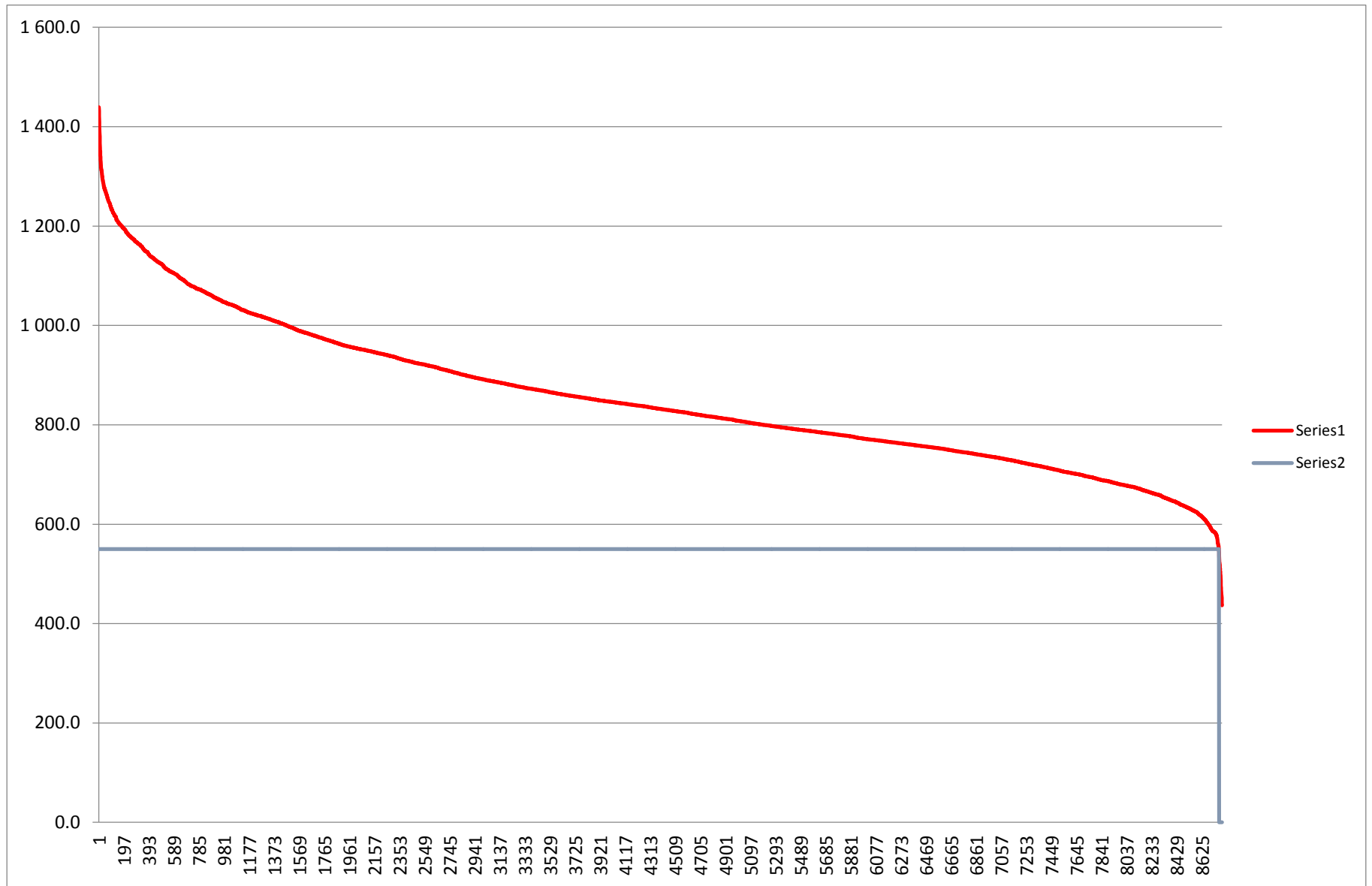
$EF_{\text{grid,BM,y}}$	=	<b>0.3456902</b>	tCO <sub>2</sub> /MWh
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### The combined margin

$EF_{\text{grid,CM,y}}$	=	<b>0.3991256</b>	tCO <sub>2</sub> /MWh
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<b>W<sub>OM</sub></b>	=	<b>0.5</b>
<b>W<sub>BM</sub></b>	=	<b>0.5</b>

Annex III: Load duration curve for 2016



## Annex IV: Combine Margin Emission Factor for 2015 (ex-post)

### The simple adjusted operating margin

$EF_{\text{grid,OM-adj},y}$	=	<b>0.45813499</b>	tCO <sub>2</sub> /MWh
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<b>EG</b>	7 606 084	(MWh) Net quantity of electricity generated and delivered to the grid
<b>EG<sub>m,y</sub></b>	2 664 847	(MWh) Net quantity of electricity generated and delivered to the grid by not low-cost/must-run power units
<b>EG<sub>k,y</sub></b>	4 941 237	(MWh) Net quantity of electricity generated and delivered to the grid by low-cost/must-run power units

<b>MWh (plot line)</b>	=	<b>565.559157</b>
<b>y</b>	=	<b>8748</b>
<b>X</b>	=	<b>12</b>

$\lambda$	=	<b>0.00136986</b>
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### The build margin

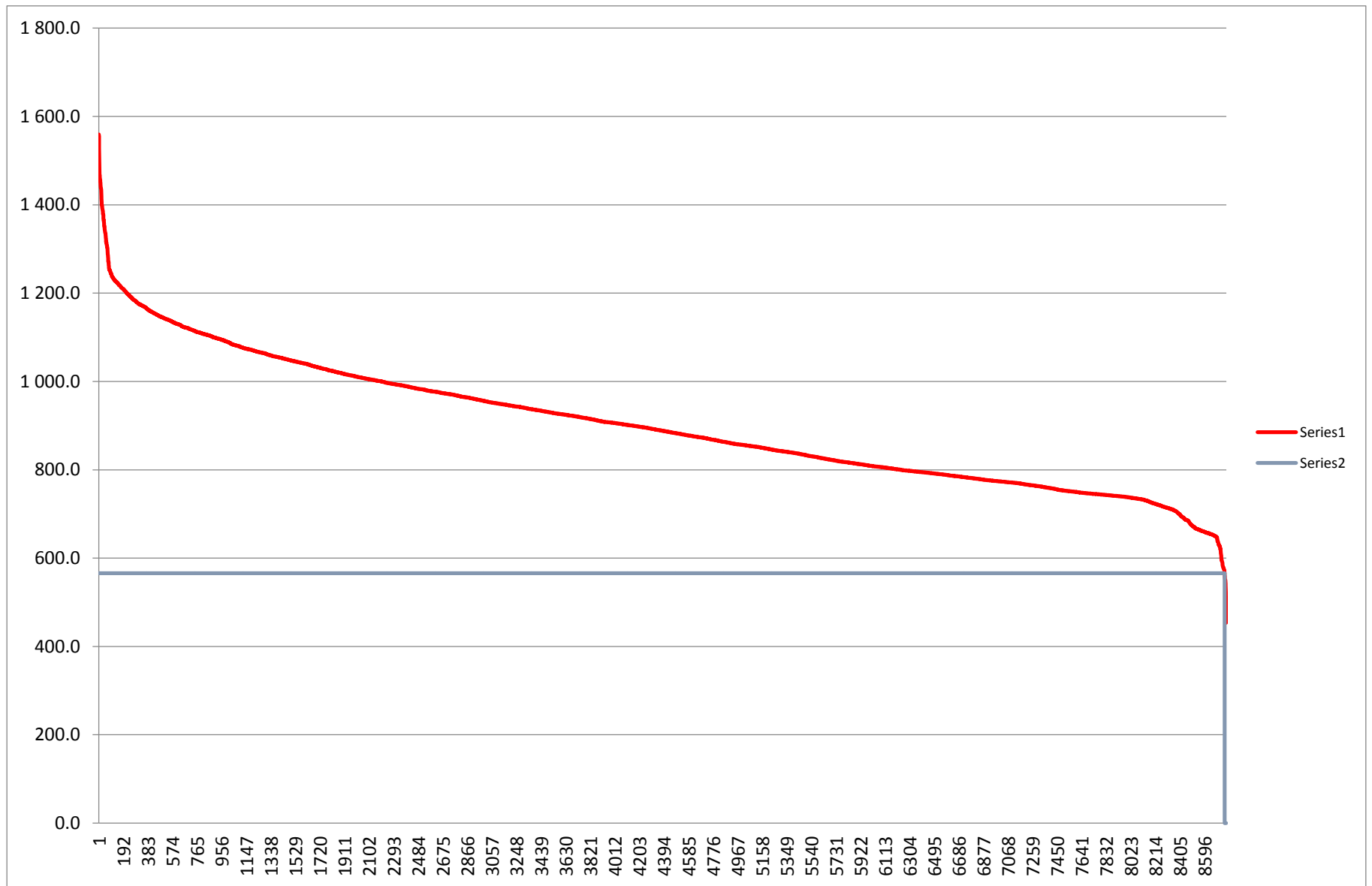
$EF_{\text{grid,BM},y}$	=	<b>0.35909381</b>	tCO <sub>2</sub> /MWh
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### The combined margin

$EF_{\text{grid,CM},y}$	=	<b>0.4086144</b>	tCO <sub>2</sub> /MWh
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<b>W<sub>OM</sub></b>	=	<b>0.5</b>
<b>W<sub>BM</sub></b>	=	<b>0.5</b>

Annex V: Load duration curve for 2015



## Annex VI: Combine Margin Emission Factor for 2014 (ex-post)

### The simple adjusted operating margin

$EF_{\text{grid,OM-adj,y}}$	=	<b>0.4753183</b>	tCO <sub>2</sub> /MWh
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<b>EG</b>	7 594 275	(MWh) Net quantity of electricity generated and delivered to the grid
<b>EG<sub>m,y</sub></b>	3 131 588	(MWh) Net quantity of electricity generated and delivered to the grid by not low-cost/must-run power units
<b>EG<sub>k,y</sub></b>	4 462 687	(MWh) Net quantity of electricity generated and delivered to the grid by low-cost/must-run power units

<b>MWh (plot line)</b>	=	<b>510.25632</b>
<b>y</b>	=	<b>8743</b>
<b>X</b>	=	<b>17</b>

$\lambda$	=	<b>0.0019406</b>
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### The build margin

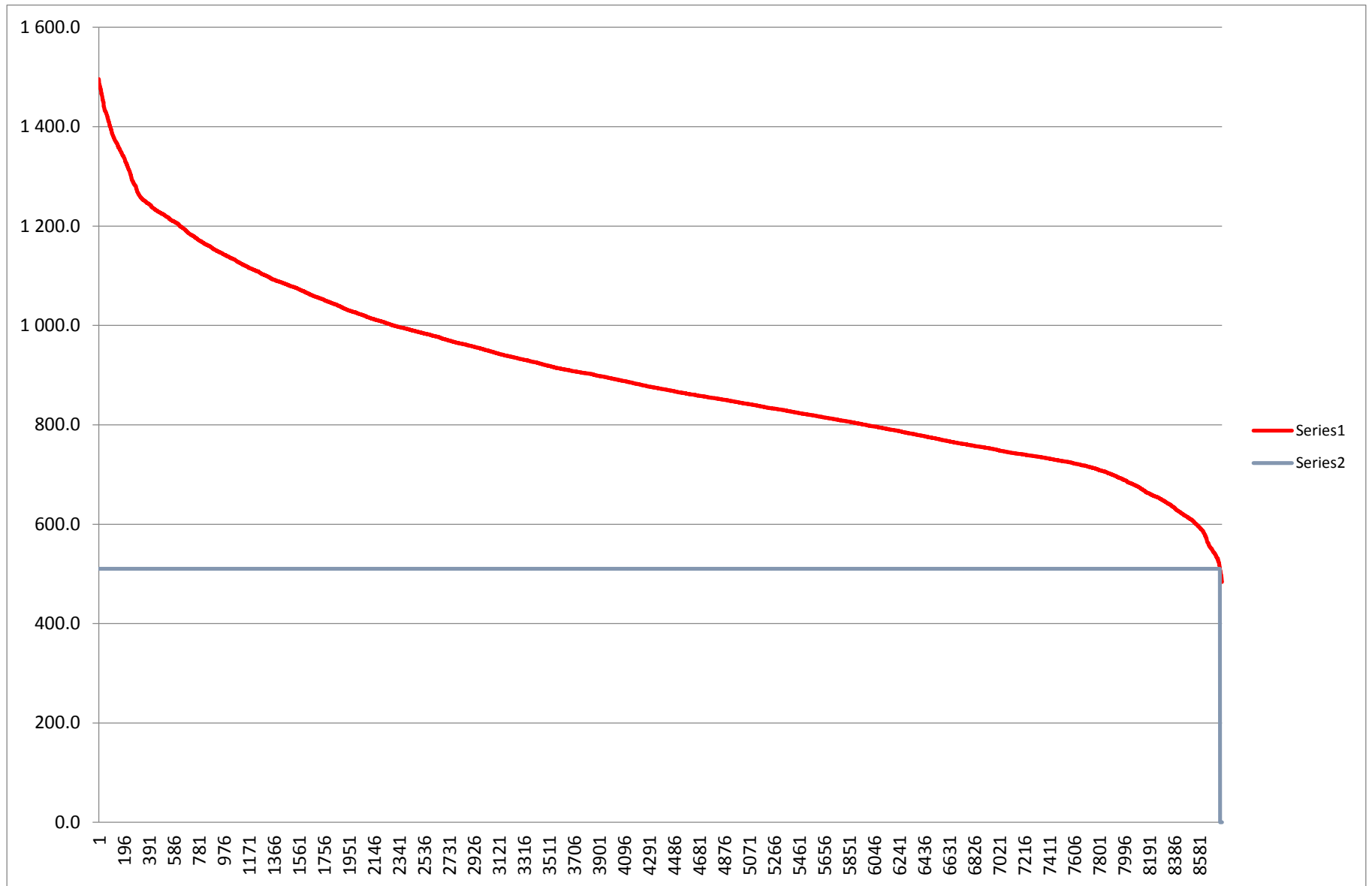
$EF_{\text{grid,BM,y}}$	=	<b>0.3854739</b>	tCO <sub>2</sub> /MWh
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### The combined margin

$EF_{\text{grid,CM,y}}$	=	<b>0.4303961</b>	tCO <sub>2</sub> /MWh
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<b>W<sub>OM</sub></b>	=	<b>0.5</b>
<b>W<sub>BM</sub></b>	=	<b>0.5</b>

Annex VII: Load duration curve for 2014



## Annex VIII: List of small hydropower plants (SHPPs)

N	POWER PLANT	Delivery (MWh)		
		2014	2015	2016
1	Dzora HPP	68111.7	89110.8	83903.1
2	Salenergo LLC	14719.8	15466.3	16646.6
3	Gyumri SHPP	10876.1	16388.7	15087.5
4	Areni HPP (Erenerg CJSC)	3463.0	3736.7	4289.6
5	Kapan-Energy CJSC	32120.7	33937.4	43157.5
6	Hakobjanyani-Galstyani SHPP LLC	4729.8	5082.3	4793.9
7	Q-H LLC	2406.6	2541.2	2764.7
8	Agarak SHPP	2104.8	2110.2	2248.3
9	Armavir-Luys CJSC	2835.7	4432.5	4174.1
10	Mushegh SHPP LLC	2667.2	2412.4	2582.3
11	Ijevan SHPP	3926.9	5711.8	7017.0
12	Hydroenergia LLC (Yerevan)	2501.5	2224.5	2605.2
13	Energia LLC (Avan HPP)	1089.0	1063.5	987.4
14	Energia LLC (Aparan)	14262.3	14445.5	14018.6
15	Hydroenergia LLC (Kotayk)	2698.9	2393.9	2564.4
16	Ararat JEG CJSC (Kamenka)	0.0	0.0	0.0
17	G.Tatevosyan LLC (Ani HPP)	137.6	67.5	0.0
18	Energotekhnika LLC	302.2	297.3	566.6
19	Ler-Jur LLC (Atchut1)	1210.6	1157.2	1417.7
20	Energatsantsshin OJSC (Narek HPP)	0.2	55.2	0.0
21	Zovashen SHPP LLC	2348.4	2271.8	3603.3
22	Elegis SHPP LLC (Elegis)	5410.8	5422.3	5426.8
23	Atlas Energo LLC	0.0	0.0	0.0
24	Elgia LLC	0.0	0.0	0.0
25	Narenerg LLC	4603.0	4819.6	5205.6
26	Bazenq CJSC	24925.2	25022.8	28772.4
27	Ler-Jur LLC (Atchut2)	3045.0	3588.3	3802.2
28	H-G HPP LLC	9086.8	8905.1	9050.6
29	G.G.V. LLC	3513.1	4497.3	5500.0
30	Aking CJSC	1622.2	1692.8	2290.4
31	H.A.G.Eryak CJSC	1995.5	2174.1	2408.0
32	Zangezur-95 SHPP	6357.0	6107.5	5984.7
33	Benzar Energy LLC	958.7	888.3	920.0
34	Loraget SHPP LLC	1292.4	1678.1	2423.1
35	Astghik-Hovhannes LLC (Hoktember HPP)	0.0	0.0	0.0

36	Tirakal LLC (Kurtan HPP)	7342.7	10709.7	11481.4
37	Singl Gor LLC (Sandaghbyur HPP)	1721.6	1677.2	1770.4
38	Bitlis Men LLC (Aygezard HPP)	2010.8	1983.3	1937.3
39	Ler Eks Energia LLC (2)	1669.3	1724.3	1726.0
40	Ler-Jur LLC (Chichkhan)	2408.0	3621.4	4052.1
41	RINE LLC	564.6	552.3	560.8
42	Elegis SHPP LLC (Hermon)	3575.7	3844.4	4675.1
43	Pargev-Vardan LLC	1155.7	1164.6	1147.3
44	Mavr LLC (Chanakhchi)	1780.3	2377.0	2852.5
45	Engels Tumanyan LLC (Gevorgavan HPP)	0.0	40.4	8.5
46	Izodrom LLC (Jaghdan HPP)	9918.0	10071.7	11331.9
47	Tezh SHPP (Tezh Waterflow LLC)	3355.4	4258.4	4579.0
48	Smbul LLC	961.5	935.8	931.1
49	Ost-EI LLC (Haghat1)	0.0	396.2	483.6
50	Ost-EI LLC (Haghat2)	2130.3	2309.8	3357.8
51	Firma G.A.K. LLC (Getap HPP)	471.9	267.0	652.8
52	Ler Eks Energia LLC (4)	1696.9	1640.6	1672.2
53	Ararat JEGC JSC (Hnevank-1 and 2)	2246.6	0.0	0.0
54	Shaghat LLC	151.5	89.8	189.0
55	Hosk LLC (Bovadzor HPP)	2056.4	2283.3	2046.0
56	Qurkik Jalal LLC	357.1	455.6	566.0
57	Ler Eks Energia LLC (6)	1850.0	1848.1	2086.3
58	Lernapati Kantegh LLC	544.4	1007.9	1043.0
59	THS LLC	7158.1	8337.9	11264.3
60	Zorakar LLC (Ajri HPP)	2032.9	2141.6	3020.3
61	Atlas Energo LLC (Aygedzor-2 HPP)	2356.4	3410.4	4984.7
62	Gosghek LLC	291.0	715.2	874.8
63	Syunik LLC (Apres HPP)	9201.4	9097.9	8770.3
64	Hak Hek LLC (Karakaya HPP)	4526.6	4989.4	5780.8
65	Ler Eks Energia LLC (3)	1663.4	1630.7	1852.1
66	Sektor Qvant LLC (Dzoragyugh-1)	3755.7	3531.0	3806.2
67	A.A.Khachatrayn LLC (Shushanik HPP)	4789.7	5013.0	5091.8
68	Hermon MAD LLC (Qaraglukh HPP)	1422.7	1559.8	2067.4
69	Ani OJSC (Jradzor HPP) (CDM - Ref. 1835)	21020.0	24844.3	24271.5
70	Surb Aghbyur LLC	2054.0	2257.8	2989.7
71	Arnavar LLC (Heghnajur HPP)	2002.6	2596.3	3006.2
72	Qarevard LLC (Khachaghbyur-1 HPP)	3812.0	4576.1	5852.8
73	Eliza Farm LLC (Spitak-1 HPP)	2200.9	2729.2	2858.8
74	Vakuflo LLC (Aragats-1 HPP)	2447.9	1782.3	3169.4



75	Firma G.A.K. LLC (Her-Her1)	1898.0	2610.2	1931.6
76	Sektor Qvant LLC (Dzoragyugh3)	4556.1	4352.3	4585.1
77	Gosh SHPP LLC (Khachardzan HPP)	844.7	1135.5	1467.7
78	Sanrayz Electric CJSC	1440.7	1555.2	2026.1
79	EI-Kas LLC (Gegharot HPP)	6551.6	6883.0	8377.7
80	Amberd SHPP (1)	3832.7	4385.4	4887.2
81	VICI GROUP LLC (Hakhunm)	506.7	638.0	932.6
82	Loraget HEK LLC (Sisakan-1)	1755.6	1978.1	2306.2
83	MINA-MAYA LLC (Eghegnadzor)	3548.8	3895.6	4439.3
84	VG ev Vordiner (Her-Her-1)	2862.1	2929.2	3357.4
85	Jaghayi Dzor (Goght-1)	3630.8	3354.4	3912.6
86	Jaghayi Dzor (Goght-2)	3177.5	2867.2	6363.7
87	Lusakunq LLC (Ayrq HPP-1)	630.2	698.6	774.4
88	Kh & M Ynkerner (Vararakn HPP)	3419.6	4007.5	4625.2
89	Qanar CJSC (Sarnakunq HPP)	1742.7	1734.2	1851.0
90	ERIK SHPP LLC (Erik)	3351.5	4242.3	6482.6
91	Tsav HPP (Energatsantsshin OJSC)	5601.7	5694.6	8160.1
92	Tigran & Ashkhen LLC (T&A SHPP)	2300.9	2280.5	2321.9
93	Azatek HEK CJSC (Azatek HPP)	1810.2	1824.2	1871.1
94	Jahuk LLC (Artavan-1)	4633.2	4744.2	5381.6
95	Apahov Taniq LLC (Vahagni)	5975.6	6081.5	6105.8
96	Lusakunq LLC (Ayrq HEK-2)	1405.5	1348.3	1714.4
97	EI-En-Eks LLC (Aghstev-1)	7919.7	9052.4	10306.4
98	Lusakunk LLC (Avazan SHPP)	544.6	440.5	0.0
99	H.A.G. Eryak (Voskepar SHPP)	2990.0	3049.2	3974.6
100	ZH ev H LLC (Angeghakot SHPP)	494.4	458.0	456.4
101	MKSHG Energia LLC (Martuni SHPP)	3100.0	3416.4	4356.8
102	Elbist LLC (Marmashen SHPP)	2271.8	5778.9	4348.4
103	Masfish LLC (Vardanants SHPP)	2533.0	3854.0	4072.4
104	Karbi Jrhos HPP (Karbi Jrhos HPP LLC)	1247.6	2217.5	2404.1
105	Sirarpi HPP (Sirarpi AH LLC)	3036.6	2990.6	1702.8
106	Firma G.A.K. LLC (Saravan)	2189.7	2301.2	3378.2
107	Jermuk Hidrotekh LLC (Jermuk HPP-2)	8808.5	8631.6	9112.8
108	Afamia LLC (Darbas SHPP-2)	1850.8	1794.0	1916.6
109	Mina-Maya LLC (Eghegnadzor SHPP-1)	5370.1	6139.5	5345.6
110	Khum HPP (Khum LLC)	1372.8	1355.6	1464.0
111	Martsiget-2 SHPP (Argishti-1 LLC)	7653.6	8947.8	10675.7
112	Sanuk HPP (Smbul LLC)	20.4	19.1	18.4
113	Gevorgavan HPP-1 (Engels Tumanyan LLC)	2747.6	4320.7	5208.2

114	Tashir HPP-1 (Alezi LLC)	426.6	604.9	576.2
115	Jotaghbyur-4 (Hov - Khach LLC)	1316.0	1461.9	1537.9
116	Jotaghbyur-5 HPP (Hov - Khach LLC)	978.7	1054.6	1066.0
117	Qarahunj HPP (Qarahunj HPP LLC)	8211.9	8529.7	8825.2
118	Tsovak HPP (Armarson - Energy LLC)	945.3	1063.1	1034.3
119	Arjadzor HPP (Arjadzor LLC)	689.9	1147.2	1258.0
120	Jotaghbiur-3 SHPP (Hov-Khach LLC)	1981.5	2182.0	2136.5
121	Pozitron SHPP (Aiuda-Los LLC)	3573.5	4119.6	5118.1
122	Jotaghbiur-2 SHPP (Hov-Khach LLC)	1780.0	1939.0	1884.9
123	Vahan SHPP (ERIK SHPP LLC)	1066.9	1638.8	2001.0
124	Getik-1 SHPP (Ariuo-Energy LLC)	6329.1	8131.1	12830.8
125	Vardahovit SHPP (Vardahovit LLC)	5521.4	5356.4	6555.1
126	Kechut SHPP (Vou Din LLC)	27092.2	29687.2	29479.8
127	Katnarat SHPP (Vanshain LLC)	2967.2	5730.4	5659.6
128	Pharos SHPP (Laitex LLC)	889.5	4069.0	2881.4
129	Jotaghbiur-1 SHPP (Hov-Khach LLC)	1992.9	2156.6	2051.8
130	Oshenergo SHPP (Eghvard artadrakan baza LLC)	0.0	0.0	0.0
131	Njdegh SHPP (Sar-Rob LLC)	6180.9	6642.8	7480.2
132	Amberd-2 SHPP (Amberd SHPP LLC)	5829.8	7666.7	8362.2
133	V.A.L.SHPP (V.A.L.Energo LLC)	239.2	417.1	438.3
134	Goghtanik SHPP (HHNMS LLC)	4455.0	4085.5	3709.9
135	Dzor-Dzor-2 HPP (Energodzor LLC)	539.6	538.9	555.5
136	Yeghegis-3 HPP (Syunyats Water LLC)	6265.4	5797.6	5377.8
137	Vardenik SHPP (Jrasahq LLC)	12372.6	13089.1	16248.5
138	Eghegis-2 SHPP (Rael LLC)	7564.3	6954.8	6492.4
139	Vorotan-7 SHPP (HGNQ Group LLC)	2616.6	2545.9	2475.9
140	Lernashen-1 SHPP (Gurgen-Mher LLC)	1404.3	1506.5	1468.7
141	Lor HEK-1 SHPP (Veh Loren LLC)	1168.6	1208.6	1414.2
142	Arpa SHPP (Arpa-Energia LLC)	11080.8	12300.2	13285.5
143	Ishkhanasar SHPP (Miezerq LLC)	14867.9	14452.5	14892.1
144	Artik-1 SHPP (Artik SHPP LLC)	2321.2	2633.4	2831.6
145	Kantegh SHPP (Gelieguzan LLC)	6784.8	7116.8	7939.1
146	Amasia SHPP (Ersted LLC)	584.1	3946.7	2681.4
147	Dzoraget-5 SHPP (Hazar u mek LLC)	2641.7	3965.8	3860.7
148	Dzoraget-6 SHPP (VRB Concern LLC)	2595.5	4630.9	4952.3
149	Argichi SHPP (Hydro Corporation LLC)	14360.2	26233.8	27512.0
150	Khachaghbyur-2 SHPP (Megaenergy LLC)	899.5	11593.1	1774.3
151	Geghi-2 SHPP (Eremirenergi LLC)	1461.5	1055.4	1954.9
152	Nane SHPP (Arates Energy LLC)	3235.8	6248.7	8266.6

153	Martsiget-1 SHPP (Marts Energy LLC)	328.6	4298.7	5637.5
154	Gndasar SHPP (Gndasar LLC)	346.0	919.6	947.3
155	Her-Her SHPP (Vorotan HEKH LLC)	1318.7	972.7	2604.0
156	Kachachkut SHPP (Van Al En K LLC)	793.6	1172.6	1156.4
157	Vayots SHPP (Surb Aghbyur LLC)	3622.3	3643.3	4141.5
158	Brnakot-1 SHPP (AG Hayrapetyanner LLC)	495.1	816.5	1020.9
159	Brnakot-2 SHPP (AG Hayrapetyanner LLC)	158.7	369.9	467.9
160	Getik-4 SHPP (ANDG Style LLC)	758.0	4451.2	9732.3
161	Dastakert SHPP (Basa Shin LLC)	394.4	1202.6	1149.6
162	Yegheg SHPP (Yegheghek LLC)	746.4	5715.2	6352.0
163	Spitak Jur SHPP (AEG Service)	13.6	192.0	0.0
164	Mane SHPP (Kayur HEK LLC)	893.4	3620.1	2161.3
165	Khachaghbyur SHPP (Energy Kok)	7936.1	1223.5	127.0
166	Khachi Qar SHPP (BSB LLC)	3870.9	3419.9	1653.0
167	Tigran Mets SHPP (Rus and Har LLC)		5183.4	10088.6
168	Dzagedzor-2 SHPP (Qajaran Montazh LLC)		1831.2	2636.0
169	Varantsov SHPP (Varantsov LLC)		841.5	5346.1
170	Voghji-1 SHPP (Kapan Energy CJSC)		10682.5	14968.2
171	Kosh SHPP (AKAG LLC)		1613.1	2625.8
172	Daranak SHPP (Agrospasarkum MC OJSC)		925.2	1387.9
173	Arevis-1 SHPP (Aqsati LLC)		470.7	2658.9
174	Nigava SHPP (Nigava LLC)		5236.4	11702.3
175	Gndevanq SHPP (BSB LLC)		190.5	1613.5
176	Khachaghbyur-2 SHPP (Megaenergy LLC)			15122.8
177	Key Energy SHPP (Qarevard LLC)			779.4
178	Gomq SHPP (Natenergy 68 LLC)			142.5
179	Sahakyan-1 SHPP (Stek Energo CJSC)			1625.9
180	Dali SHPP (Khachatryan Eghbayrner LLC)			551.4
181	Seca SHPP (Karalevas LLC)			1071.0
182	Anapat-1 SHPP (Tetevi Anapat LLC)			1571.0
183	Amberd-3 SHPP (Amberd HEK LLC)			10787.5
184	Meghri-1 SHPP (Grin Power LLC)			2421.9
185	Her-Her SHPP (Arm-Aero CJSC)			1346.9
		<b>670561.8</b>	<b>818676.3</b>	<b>940108.2</b>