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DISSOLVED GAS ANALYZERS FOR THE GEORGIA STATE ELECTROSYSTEM

July 19, 2012

This report was produced for review by the United States Agency for International Development. It was prepared by Tetra Tech, Inc.

Foreword

This report was prepared by USAID's Georgia Power and Gas Infrastructure Project (PGIP) under Contract Number AID-EDH-I-00-08-00027-AID-114, Task Order 10-00003. Tetra Tech, Inc. is the prime contractor on PGIP.

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USAID / GEORGIA POWER AND GAS INFRASTRUCTURE PROJECT (PGIP)

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1. Background

The Georgia Power and Gas Infrastructure Project (PGIP) provides resident professional engineering and other technical services to support power and gas transmission improvements that USAID is undertaking on behalf of the Government of Georgia. PGIP's activities support USAID's objectives of promoting energy security through greater access to electricity and natural gas supplies for households in western Georgia, promoting the development of the Poti Free Industrial Zone on the Black Sea, and securing power exports through domestic reliability-related infrastructure improvements. The activities under the PGIP task order support USAID's larger goal of fostering sustainable development.

This report was prepared in support of USAID's third objective of securing power exports through domestic reliability-related infrastructure improvements. It traces the decisions made on the Dissolved Gas Analyzer Project from the summer of 2011 to the present.

The dissolved gas analyzer (DGA) units in the field measure the quantities (expressed in parts per million) of nine gases and water that are dissolved in the oil of large power transformers. The concentrations of these gases and water, and their relative ratios, tell much about the health of the transformers. The early detection of problems in the transformers enables the electric utility to take actions to prevent, or at least lessen, damages to the transforms, power outages, and the curtailment of power exports.

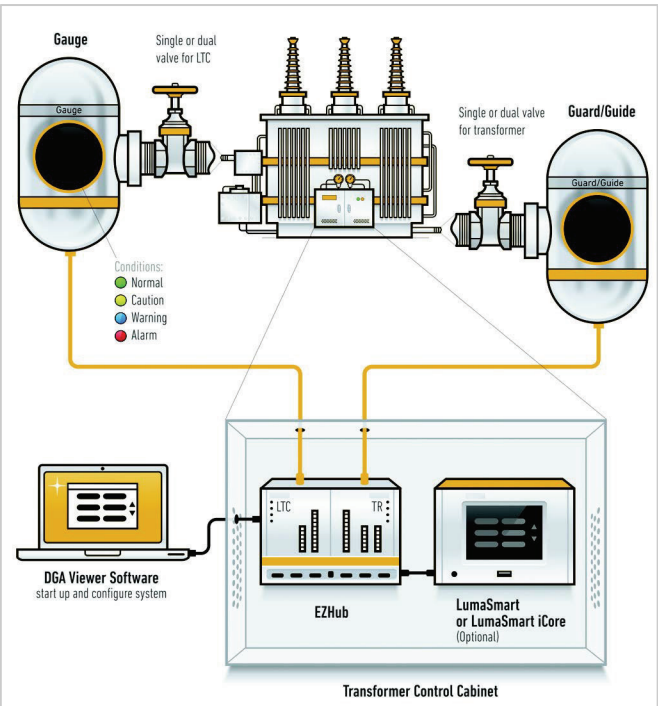


Figure courtesy of LumaSense Technologies web site.

The figure at the left shows how the DGA field units are connected directly to the transformer. There is no piping that transports the oil to a remotely located analyzer, and return piping to take the oil back to the transformer.

When the transformer consists of one three-phase transformer in one tank there will be one DGA field unit connected to the tank. When the transformer bank is made up of three single-phase transformers each in a separate tank, there will be on DGA filed unit connected to each tank. GSE transformers do not have load tap changers as shown in the figure at the left.

2. System Monitoring Sub-component

Page 5 of the PGIP Task Order presents the rationale for the project's monitoring component:

> System monitoring sub-component: USAID intends to provide assistance to GSE on preventive maintenance regimes to optimize the productive life of critical substation equipment through the procurement and installation of sensors and associated computer software and networking equipment. The purpose of this pilot activity is to optimize the service life of electricity transmission assets by monitoring gas concentrations in dielectric transformer fluids in real time across the network and benchmarking those concentrations against industry standards to predict catastrophic failure before it happens. Failure rates for transformers and other critical substation equipment increase dramatically with age, and the increasing presence of certain gas concentrations in dielectric fluids has been shown to be indicative of imminent failure. By identifying and subverting potential failures, explosions that destroy transformers and associated equipment can be substantially avoided, and the productive life of the equipment can be vastly prolonged. Specifically, the intent is to purchase and install dissolved gas analysis technology and associated IT assets in a number of GSE substations to optimize the productive life of critical substation equipment (e.g., transformers).

The DGA Project represents the implementation of this sub-component of the Task Order.

3. Expansion of the DGA

The installation of *additional* DGA units was one of the items considered in the July 12, 2011, meeting of GSE and PGIP staff (see Annex A, item 6). However, item 6 was not selected for implementation because the initial Dissolved Gas Analyzer Project will not be completed until the end of October 2012. The meeting participants considered it premature to expand the use of DGA field units until the basic system is operational.

4. Initial DGA

The decision was made to proceed with the initial DGA project. This is reported in item 1 of Annex B, which contains the notes of the Steering Committee meeting of November 21, 2011.

5. Benefits to GSE and Georgia

The DGA will enable GSE to quickly detect problems developing in large power transformers, which can result in a catastrophic failure of the transformer.

The failure of a transformer in the transmission system would have major impacts on Georgia.

a) Outages for some customers in Georgia

The average capacity of the transformer banks being monitored in the DGA Project is 337.8 MVA. At a residential peak demand of 3 kVA per household and a residential distribution diversity factor of 4, the loss of a 337.8 MVA transformer could result in the loss of electric supply to about 450,000 customers.[1] The actual number of customers without power will depend upon which transformer failed, where in the network it is located, the time of day, season, weather, and other factors.

b) Reduced net inflow of money to Georgia because of reduced exports of power out of Georgia

Georgia exports power at the 500 kV transmission level. However, most of the hydro plants (Enguri is the exception) generate electricity and inject the power into the transmission system at 220 kV and below. The 550/220 kV and the 220/110 kV transformers are important avenues for energy to flow from the hydro plants to the 500 kV level for export. The loss of the 500/220 kV and 220/110 kV transformers can, depending upon system conditions, reduce the export of power.

The average size (in MVA) of the transformers to be monitored is 337.8 MVA. Assuming an export power cost of USD 50.00 per MWH and a 0.9 power factor at the interconnection delivery point, the value of the transferred energy is USD 15,201.00 per hour. Transformer failure and repair scenarios can be complicated, but two scenarios would demonstrate the value of on-line DGA.

Scenario 1: This scenario entails the loss of a 337.8 MVA transformer, 0.9 power factor at the interconnection delivery point, no indications ahead of time of the failure, no spare transformer at the site or anywhere in the country, able to repair the transformer on-site in three months, exports are reduced by 337.8 MVA for the three months. Estimated lost revenue from exports: USD 33.2 million.

Scenario 2: This scenario entails the loss of a 337.8 MVA transformer, 0.9 power factor at the interconnection delivery point, no indications a head of time of the failure, no spare transformer at the site or anywhere in the country, total destruction of the transformer, two years to buy a new transformer (specify, approve funds, tender, award contract, fabricate, factory test, ship, install, field test, and commission), exports

[1] See Cell R40 in the spreadsheet in Annex D, Tabulation of GSE Network Facilities involved in DGA.

are reduced by 337.8 MVA for the two years. Estimated lost revenue from exports: USD 226.3 million plus the cost of buying a whole new transformer.

There may be lost revenue when a transformer with a pending fault is removed from service (say, four hours of switching time, USD 60,800 using the above assumptions), but this lost revenue will be minor compared to the lost revenue of a three-month or two-year outage.

6. Portions of the GSE Transmission Network Covered

Table D-1

Please refer to the figure in Annex C, and [redacted]. of Annex D, Tabulation of GSE Network Facilities involved in DGA.

When the tender was developed, it was planned to measure all 500/220 kV, 330/220 kV, and 220/110 kV transformers in the GSE system:

- 28 transformer tanks
- 17 transformer banks
- 7 substations.

Transformers at the hydro and thermal generating stations (for example, Enguri, Lajanuri, Khrami, Gardabani, and Jinvali) were not included because those transformers are the property of the generating companies and not GSE.

When the bids were received and evaluated the cost of the above planned transformers exceeded the USAID threshold. Therefore, the quantity of DGA field units was reduced. The following criteria were used:

- 330 / 220 kV transformer remains (Gardabani)
- 500 / 220 kV transformers remain (Gardabani, Ksani, and Zestaponi)
- 220 / 110 kV transformers remain (Kutaisi and Batumi)

This resulted in the following inventory of monitored transformers. These are the quantities in proposed system. See Columns C and Columns P through T of Table D-1 in Annex D for a tabulation of the transformer banks, transformer tanks, and substations that are to be monitored.

- 19 transformer tanks
- 8 transformer banks
- 5 substations.

The quantities of transformers that are not monitored at this time are as follows. See Column C and Columns J through N of Table D-1 in Annex D for a tabulation of the transformer banks, transformer tanks, and substations whose monitoring is deferred.

- 9 transformer tanks
- 9 transformer banks
- 5 substations.

The three tabulations above add up for the number of tanks (28 = 19 + 9) and for the number of banks (17=8+9). However, the number of substations do not add up because there are several transformer banks and tanks at each substation, some of which are to be purchased now and some of which are deferred. See Table D-1 for the details.

A consideration is to reduce the number of DGA field units from 19 to 11 in order to fund the EECS project. Additional DGA field units can be added to the system later without affecting the central station equipment in the GSE headquarters in Tbilisi.

These transformers could be monitored in future projects by the purchase and installation of additional DGA field units. The central station equipment at GSE headquarters will handle the incorporation of these additional units without additional cost.

The transformers associated with the HVDC system are not included in this DGA project because they are under Siemens' warranty and Siemens has not been approached about installing GSE DGAs on Siemen's transformers. However, there is no technical reason that DGA field units could not be installed on the Siemens transformers at Akhaltsikhe at a later time.

The order is to include one portable gas analyzer with a portable printer.

Annex A
July 12, 2011 GSE-PGIP Meeting Minutes

This annex contains the notes of the GSE - PGIP meeting of July 12, 2011. The minutes were published on July 14, 2011.

Possible Smart Grid Projects

Consensus points from meeting of July 12, 2011

- The dissolved gas analyzer project should proceed independent of the Senaki I and II 220 kV line project.
- The team of GSE and Tt sees the advantages of installing monitoring points on the existing transformers when the transformers are out of service for schedule or unscheduled maintenance.
- The funds available for the project will limit the scope and extent of what smart grid work can be done at this time.

The second and third columns report possible smart grid projects which were identified at the GSE – Tt meeting of July 12, 2011. The four right hand columns indicate the benefits and were added by Tt after the July 12 meeting.

Nr.	Title	Description	Benefits			
			Reduce Technical Losses	Increased Efficiency	Increase Revenue (reduce commercial losses)	Improve Customer Satisfaction
1	Circuit switchers (also known as disconnectors)	Replace circuit switchers (disconnectors) at substations so that they status (open or closed) of the circuit switchers is reported via the SCADA system; and to control (open or close) the disconnector remotely via the SCADA system.		Yes, by decreasing the amount of substation operator involvement in system restorations.	Yes, by enabling rapid restoration of the system after an outage.	Yes, by enabling rapid restoration of the system after an outage.
2	Emergency Control System	Expand the emergency control system recently installed on the backbone 500 kV lines from west to east Georgia to adjacent lines.		Yes, be decreasing the amount of manpower required in system restoration.	Yes, by minimizing the extent of load shedding when there is outage.	Yes, by minimizing the extent of load shedding when there is outage.

Possible Smart Grid Projects

Nr.	Title	Description	Benefits			
			Reduce Technical Losses	Increased Efficiency	Increase Revenue (reduce commercial losses)	Improve Customer Satisfaction
3	Under Frequency Relays	Replace the existing under frequency relays with fixed thresholds with new relays that allow such features as (a) trip on *rate of frequency change*, (b) remotely programmable threshold, and (c) changeable daily schedules (so that the same district or feeder is not affected each time).		Yes, initiating load shedding based on rate of frequency change should reduce the magnitude of large system outages.	Yes, by avoiding system failure due to potential large system outage	Yes, since the same districts will not be subject to load shedding time after time.
4	Voltage Angle Measurements across the system.	Install measurement devices in substations that measure the voltage angle across the transmission system (say, Batumi to Gardabani). This angle is a measure of the stress on the transmission system.			Yes, fewer system wide outages, that is, increased sales.	Yes, fewer system wide outages.
5	Digital Projection and Control Equipment	Replace the existing electro mechanical relays in a substation with modern digital relays, measurement and control systems.		Yes, more reliable operation of relay protection systems and subsequently less damage to substation equipment and lines.	Yes, fewer system wide outages, that is, increased sales.	Yes, few outage, and outages of less magnitude.

Possible Smart Grid Projects

Nr.	Title	Description	Benefits			
			Reduce Technical Losses	Increased Efficiency	Increase Revenue (reduce commercial losses)	Improve Customer Satisfaction
6	Dissolved Gas Analyzers	Install more real-time Dissolved Gas Analyzers (DGA) on major system power transformers than is presently planned and funded in the companion DGA Project.			Avoid potential long term outages due to transformer failures.	Yes, fewer outages, and smaller outages.

Annex B
November 21, 2011 Steering Committee Meeting Minutes

This annex contains the minutes of the November 21, 2011 GSE/USAID/Tetra Tech Steering Committee meeting. The minutes were published on November 25, 2011.

Meeting Notes for Discussion Topics
Meeting of Monday, November 21, 2011; 15:00 hours

Attendees:

GSE	*USAID*	*Tetra Tech*
[redacted]		

Location: At GSE

Topics below are listed randomly; there is no significance to the order or sequence of the topics below.

The table begins on the next page.

Meeting Note for Discussion Topics
Meeting of Monday, November 21, 2011; 15:00 hours

Discussion Leader	Nr.	Component of PGIP	Issue or Update for this Meeting	Expected Outcome from this Meeting.	Results of Meeting (filled in after the meeting)
Hajny	**1**	Smart Grid	1. Did the trip to SEL go well? 2. Deciding what technology GSE wishes to pursue (that is, emergency response system / SEL, dissolved gas monitoring, a mix of both, etc.). 3. Outline the scope of work in general terms and a schedule. 4. Confirmation / buy-in from USAID of the way forward.	1. Identify which technologies / project GSE wishes to pursue for the smart grid component. 2. Oral outline of the work to be done (scope, budget, schedule). 3. USAID support to proceed with the scope of work budget, and schedule.	1. Two technologies will be pursued: a) Emergency control system, with phasor measurements; and, b) Dissolved gas in transformer oil analysis capability. 2. Tt and GSE technical members to meet at 2:30 PM on Tuesday, 22 November, 2011 at GSE. Plan is to send EOIs or RFPs to bidders by end of December 2011 for their response at end of January 2012. 3. USAID indicated that they are supportive of the above plans.
Hajny	**2**	Senaki 1 and 2 transmission lines	Tetra Tech requests for a short description of the land resettlement and compensation *methodology* for the environmental assessment document being prepared for the US Government.	GSE to describe / summarize the methodology and Tt will take notes. Draft text will be sent by Tt to GSE for review before the text goes into the EA.	1. Tetra Tech provided draft text at the meeting. 2. GSE to respond with edits on Tuesday. 3. Tt to submit EA document to USAID by COB Tuesday.
	3	Etc.	Other topics as may be discussed at the meeting.		USAID invites GSE's comments on whether one or two contracts; see item 3 on the page 3.

Meeting Note for Discussion Topics
Meeting of Monday, November 21, 2011; 15:00 hours

Discussion Leader	Nr.	Component of PGIP	Issue or Update for this Meeting	Expected Outcome from this Meeting.	Results of Meeting (filled in after the meeting)
	4	Next meeting	Next meeting.	Set the date and time for the next meeting.	Friday, December 2, 2011, at 15:00 hours at GSE.

Text below expands upon the summary table above.

1 Smart Grid

Two technologies will be pursued in parallel.

a) Expansion of the existing emergency control system including phasor measurements (ExpECS); funding of about USD 1.2 million; and,
b) Dissolved gas in transformer oil analysis capability (DGOA); funding of about USD 1 million.

Tt and GSE technical members to meet at 2:30 PM on Tuesday, 22 November, 2011 at GSE. (Comment: the meeting was held on Tuesday as planned. Meeting notes will be issued for that meeting.)

The expansion of the present ECS around the functionality of the present Schweitzer Engineering Laboratories (SEL) ECS system will be the model for the scope of work for this ExpECS work. Competitive bids will be sought; the basis of award should be "best evaluated cost" and not "lowest price".

GSE's present oil analysis laboratory, along with the purchase of some portable field dissolved gas oil analysers will be the focus of this component. At this time it appears that on-line, real-time dissolved gas oil analysers using gas chromatographs installed at the transformers or at the substations may not be pursued. (Comment, the Technical Department of GSE was not present at the meeting, and their views will be sought.)

Plan is to send EOIs or RFPs to bidders by end of December 2011 for their response at end of January 2012.

USAID indicated that they are supportive of the above plans.

2 Senaki 1 and 2 Transmission Line Project Land Issues

Tetra Tech needs text that describes the land settlement methodology for the Environmental Assessment being developed for the US Government. Draft text was provided by Tetra Tech to GSE; GSE is to respond with edits to the draft text on Tuesday. The plan is for Tt to submit the EA with the finalized text to USAID by the end of the day, Tuesday. (Comment: GSE provided the text at the close of the day on Tuesday, and Tt submitted the revised EA document to USAID late Wednesday.)

3 One or Two Contracts

USAID solicited GSE's view on whether to have one or two contracts for the Senaki project.

1. The "one contract" approach would be for the combined substation and transmission line works.
2. The "two contracts" approach would be for (a) one contract for the substation work, and (b) anther contract for the transmission line works.

Additional bids and insight would be obtained by obtaining bids from all countries (not just the US and CIS), except for the sanctioned countries.

GSE was supportive of whichever way gets the new lines into service as quickly as possible, consistent with law and regulations.

The suggested way forward it to have one RFP with three "lots"; bidders could choose to bid on as many of the lots as they want. The one RFP would then generate either one or two contracts, depending upon the outcome of the bid evaluation process. This produces bone fide bids for the three options, and avoids future discussion of "what would have happened if….".

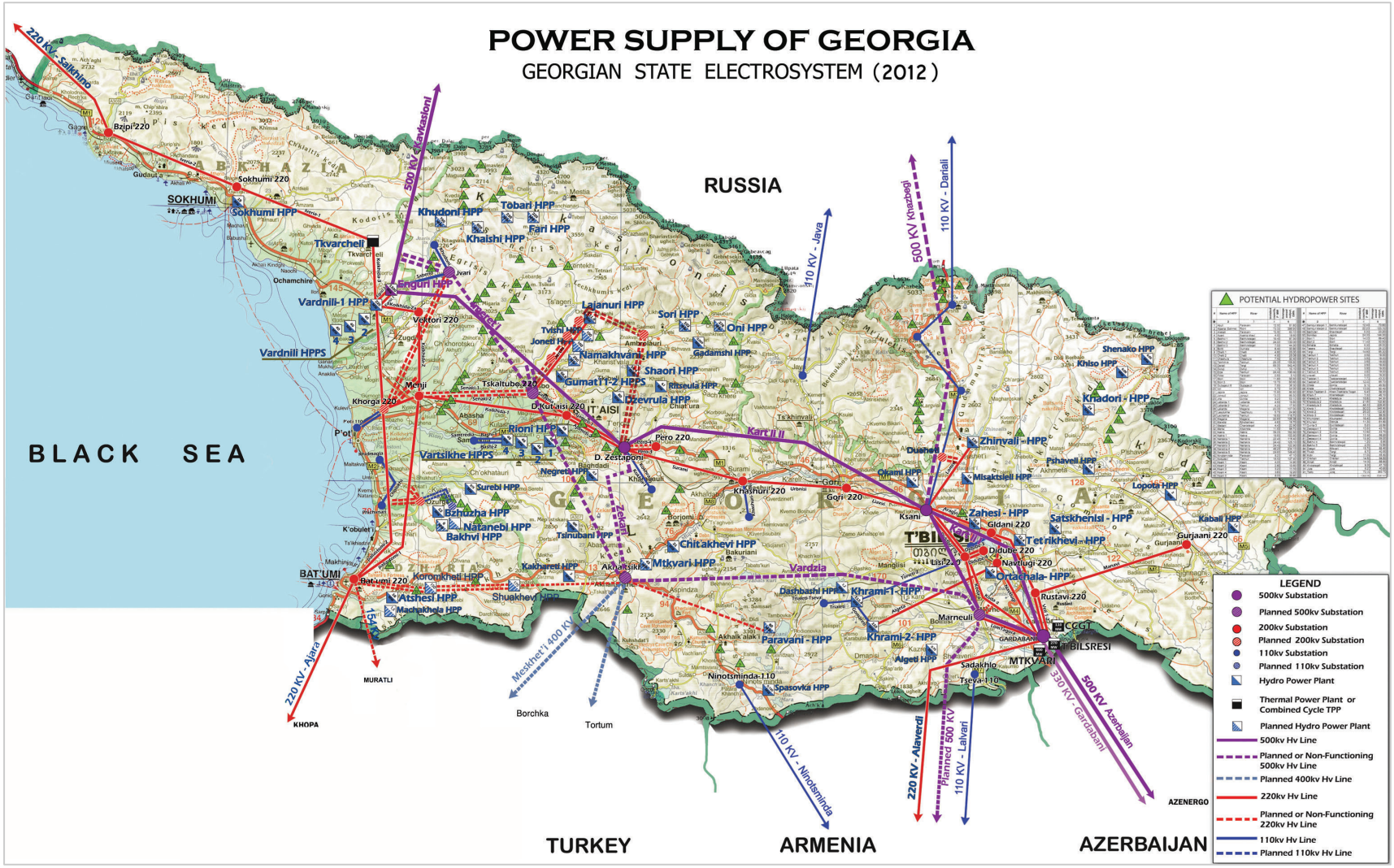
Lot 1	Combined transmission line and substation works
Lot 2	Just the transmission line works
Lot 3	Just the substations works

Also, bids would be invited from all countries (except the sanctioned five), with the RFP stating that bids from the US (Code 000) and the former CIS (Code 110) were preferred, but that USAID could at its discretion award the contract to other countries if the pricing was appropriate and a 'source – origin' waiver was granted to the project.

4 Next Meeting

The next meeting of the steering committee is scheduled for Friday, December 2, 2011, at 15:00 hours at GSE.

Annex C
GSE Transmission Network


POWER SUPPLY OF GEORGIA
GEORGIAN STATE ELECTROSYSTEM (2012)
RUSSIA
BLACK SEA
TURKEY
ARMENIA
AZERBAIJAN
ABKHAZIA
SOKHUMI
Sokhumi 220
Sokhumi HPP
Bzipi 220
Gudauta
220 KV - Salkhino
500 KV Kavkasioni
Khudoni HPP
Khaishi HPP
Tobari HPP
Fari HPP
Tkvarcheli
Ochamchire
Enguri HPP
Vardnili-1 HPP
Vardnili HPPs
Vektori 220
Lajanuri HPP
Sori HPP
Oni HPP
Tvishi HPP
Jonati HPP
Namakhvani HPP
Gadamshi HPP
Shaori HPP
Gumati I-2 HPPs
Rioseula HPP
Czevrula HPP
Tskaltubo 220
D.Kutaisi 220
KUTAISI
Khorga 220
Menji
Rioni HPP
Vartsikhe HPPs
Negreti HPP
Surebi HPP
Bzhuzha HPP
Natanebi HPP
Bakhvi HPP
Tsinubani HPP
Chitakhevi HPP
Mtkvari HPP
Akhaltsikhe
Vardzia
Khrami-1 HPP
Khrami-2 HPP
Paravani - HPP
Ninotsminda-110
Spasovka HPP
Akhalk'alak'i
Borjomi
Khashuri 220
Gori 220
Karl'i II
Pero 220
D. Zestaponi
Khresili
Ksani
T'BILISI
Didube 220
Navtlugi-220
Ortachala- HPP
Rustavi 220
Marneuli
CCGT
T'BILSRESI
MTKVARI
Gardabani
Sadakhlo
Tseva-110
Algeti HPP
Zahesi - HPP
Gldani 220
Tetrikhevi HPP
Satskhenisi - HPP
Gurjaani 220
Kabali HPP
Lopota HPP
Pshavela HPP
Misaktsieli HPP
Zhinvali - HPP
Dusheti
Khadori - HPP
Khiso HPP
Shenako HPP
Dami HPP
BAT'UMI
Batumi 220
Koromkheli HPP
Atsheli HPP
Machakhela HPP
Shuakhevi HPP
MURATLI
KHOPA
220 KV - Algara
Meskhet'i 400 KV
Borchka
Tortum
110 KV - Ninotsminda
110 KV - Java
500 KV Khazbegi
110 KV - Dariali
220 KV - Alaverdi
Planned 500 KV
110 KV - Lalvari
330 KV - Gardabani
500 KV Azerbaijan
AZENERGO
POTENTIAL HYDROPOWER SITES
LEGEND
500kv Substation
Planned 500kv Substation
200kv Substation
Planned 200kv Substation
110kv Substation
Planned 110kv Substation
Hydro Power Plant
Thermal Power Plant or Combined Cycle TPP
Planned Hydro Power Plant
500kv Hv Line
Planned or Non-Functioning 500kv Hv Line
Planned 400kv Hv Line
220kv Hv Line
Planned or Non-Functioning 220kv Hv Line
110kv Hv Line
Planned 110kv Hv Line

Annex D
Tabulation of GSE Transformers Involved in DGA

This annex lists the GSE transformers that are involved in DGA.

The left-hand portion of the table on the next page lists the transformers included in the invitation for proposals:

- 28 transformer tanks
- 17 transformer banks
- 7 substations

The middle portion of the table lists the transformers that were not included in the project in order to keep the cost below the USAID threshold:

- 9 transformer tanks
- 9 transformer banks
- 5 substations

The right-hand portion of the table lists the transformers that are now included in the project:

- 19 transformer tanks
- 8 transformer banks
- 5 substations

The DGA field units are all the same and can be assigned to other transformers any time before their installation by the selected vendor, and can be moved by GSE from transformer to transformer after their installation by the selected vendor.

Table D-1. Substations and Transformers Included and Deferred

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
3	Seq.	Nr.	In Tender	Bank	Region	Capacity	Model and		Deferred	DGA		Count			Retained	DGA		Count	
4		Tank	S/S			MVA	Voltages (kV)		S/S	Xfrmrs	MVA	Sub/Sta	Bank		S/S	Xfrmrs	MVA	Sub/Sta	Bank
5	1	1	Gardabani	AT-1	Kvemo Kartli	125	АТДЦТН-220/110-У1		Gardabani	1	125		AT-1						
6	2	2a	Gardabani	AT-3	Kvemo Kartli	133	АОДЦТН-330/220-74У1								Gardabani	1	133	1	AT-3
7	3	2b	Gardabani	AT-3	Kvemo Kartli	133	АОДЦТН-330/220-74У1								Gardabani	1	133		AT-3
8	4	2c	Gardabani	AT-3	Kvemo Kartli	133	АОДЦТН-330/220-74У1								Gardabani	1	133		AT-3
9	5	3a	Gardabani	AT-4	Kvemo Kartli	267	АОДЦТН-500/220-У1								Gardabani	1	267		AT-4
10	6	3b	Gardabani	AT-4	Kvemo Kartli	267	АОДЦТН-500/220-У1								Gardabani	1	267		AT-4
11	7	3c	Gardabani	AT-4	Kvemo Kartli	267	АОДЦТН-500/220-У1								Gardabani	1	267		AT-4
12	8	3r	Gardabani	AT-4	Kvemo Kartli	267	АОДЦТН-500/220-У1								Gardabani	1	267		AT-4
13	9	4	Ksani	AT-1	Mtskheta-Mtianeti	125	АТДЦТН-220/110-У1		Ksani	1	125		AT-1						
14	10	5	Ksani	AT-2	Mtskheta-Mtianeti	125	АТДЦТН-220/110-У1		Ksani	1	125		AT-2						
15	11	6a	Ksani	AT-3	Mtskheta-Mtianeti	167	АОДЦТН-500/220-У1								Ksani	1	167	1	AT-3
16	12	6b	Ksani	AT-3	Mtskheta-Mtianeti	167	АОДЦТН-500/220-У1								Ksani	1	167		AT-3
17	13	6c	Ksani	AT-3	Mtskheta-Mtianeti	167	АОДЦТН-500/220-У1								Ksani	1	167		AT-3
18	14	6r	Ksani	AT-3	Mtskheta-Mtianeti	167	АОДЦТН-500/220-У1								Ksani	1	167		AT-3
19	15	7	Zestaponi	AT-1	Imereti	200	5ARZ-245		Zestaponi	1	200		AT-1						
20	16	8	Zestaponi	AT-2	Imereti	200	АТДЦТН-220/110-68У1		Zestaponi	1	200		AT-2						
21	17	9a	Zestaponi	AT-3	Imereti	167	АОДЦТН-500/220/10								Zestaponi	1	167	1	AT-3
22	18	9b	Zestaponi	AT-3	Imereti	167	АОДЦТН-500/220/10								Zestaponi	1	167		AT-3
23	19	9c	Zestaponi	AT-3	Imereti	167	АОДЦТН-500/220/10								Zestaponi	1	167		AT-3
24	20	9r	Zestaponi	AT-3	Imereti	167	АОДЦТН-500/220/10								Zestaponi	1	167		AT-3
25	21	10	Kutaisi	AT-1	Imereti	125	АТДЦТН-220/110-У1								Kutaisi	1	125	1	AT-1
26	22	11	Kutaisi	AT-2	Imereti	125	АТДЦТН-220/110-У1								Kutaisi	1	125		AT-2
27	23	12	Batumi	AT-1	Adjara	125	АТДЦТН-220/110-68У1								Batumi	1	125	1	AT-1
28	24	13	Batumi	AT-2	Adjara	125	АТДЦТН-220/110-68У1								Batumi	1	125		AT-2
29	25	14	Zugdidi	AT-1	Samegrelo	63	АТДЦТН-220/110-78У1		Zugdidi	1	63	1	AT-1						
30	26	15	Zugdidi	AT-2	Samegrelo	63	АТДЦТН-220/110-78У1		Zugdidi	1	63		AT-2						
31	27	16	Menji AT-1	AT-1	Samegrelo	63	АТДЦТН-220/110-10У1		Menji AT-1	1	63	1	AT-1						
32	28	17	Menji AT-2	AT-2	Samegrelo	63	АТДЦТН-220/110-10У1		Menji AT-2	1	63		AT-2						
33	Totals			28					Totals	9	1027	2			Totals	19	2702	5	
34									Count (tanks)		9				Count		19		
35	Ratios (proposed vs. tender)			100.0%					Count (banks)		9				Count (banks)		8		
36									% or Avg.	32.1%	114.1				% or Avg.	67.9%	337.8	MVA	
37											114,111.11	kVA					337,750.00	kVA	
38									Avg KVA / Cust		3	kVA			pead demand / Cust		3	kVA	
39									Diversity Factor		4				Diversity Factor		4		
40									Affected customers		152,148.15	Count			Affected customers		450,333.33	Count	

The Georgia Power and Gas Infrastructure Project ('PGIP' or 'Project') provides in-country professional engineering and other technical services to support power and gas transmission improvements being undertaken by USAID on behalf of the Government of Georgia. Activities performed under the PGIP will complement and reinforce the activities, project management, and engineering expertise of USAID/Caucasus.
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USAID will be undertaking work from 2010 to 2013 in the energy sector in collaboration with the Georgian Oil and Gas Company ('GOGC') and the Georgia State Electrosystem ('GSE') to upgrade, replace, and install critical selected gas and power transmission infrastructure. These companies are state-owned entities charged with the import and transit, and in the case of GSE, dispatch of electricity throughout the country.

The activities under this Project will support USAID's objective of promoting energy security through greater access to electricity and natural gas supplies households in Western Georgia, promote the development of the Poti Free Industrial Zone (FIZ) on the Black Sea, and secure power exports through in-country reliability related infrastructure improvements. The activities assigned are managed by Tetra Tech and support USAID's objective of fostering sustainable development.

The PGIP project includes the following infrastructure projects:

- Construction of a new 31 kilometer, 700 mm gas pipeline from Senaki to the Poti FIZ;
- Construction of a new 76 kilometer, 700 mm gas pipeline from Kutaisi to Senaki;
- Replacement of 58 kilometers of 220 kV transmission lines (referred to as Senaki I and II) which were dismantled in 1992 during Georgia's civil war; and,
- Restoration of the power substations in Tskaltubo and Menji to support the Senaki I and II 220 kV transmission lines.

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