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Hydropower Investment Promotion Project (HIPP)

CONFERENCE – YOUNG ENGINEERS IN GEORGIAN ENERGY SECTOR

April 17, 2013, GTU Conference Hall

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Post Workshop Report

USAID Hydropower Investment Promotion Project (HIPP) organized a Conference, "Young Engineers in Georgian Energy Sector" for Georgian energy sector representatives on 17 April, 2013 in Georgian Technical University (GTU) Administrative Building Conference Hall.

The goal of this conference was to strengthen and promote young engineers' role in Georgian energy sector, stimulate open discussion and exchange of information on recent developments in hydropower investment issues that will facilitate coordination among all energy stakeholders.

The Conference brought together representatives of the MENR, MESD, and other energy stakeholders: Electricity System Commercial Operator, Georgian State Electricity System as well as the university students from economic and power engineering departments.

Themes

Kakha Kaladze , Minister of Energy and Natural Resources of Georgia, Sukru Bogut**,** USAID Senior Energy Advisor and a Professional Energy Engineer, and Archil Prangishvili, GTU Rector addressed an audience with the introductory speeches.

Presentations were made by HIPP's Chief of Party, Jake Delphia, GTU Irakli Darchiashvili & Givi Shovnadze (MENR scholarship Holders); PHD students Tengiz Magradze, Nino Magradze; Tata Pillipidici, Nino Kikabidze: David Dgebuadze; Giorgi Ketelauri; Nikoloz Kvrivishvili, Alexander Petrosyan, Nikoloz Javshanashvili, Archil Artilakhva, 3rd student Lado Gugushvili, HIPP representatives Zviad Gachechiladze and Nick Sumbadze;

Presentations were followed by intense discussions.

Below are the photos of the Workshop:


USAID
HIPP
and
GEMM 2015

Outcomes and Next Steps

All Workshop participants acknowledged the importance of such workshops for the energy sector development and highly appreciated USAID/ HIPP's efforts in building capacity of Tbilisi State Technical University. For more than five years, USAID have made strong effort to strengthen technical and scientific base of the GTU through two significant projects: NATELI and AEAI. Now USAID/HIPP initiated capacity building activity through networking GTU's distinguished students as well as the graduates and the energy sector officials including the representatives from the Ministry and Georgian State Electricity System.

Professors as well as the participating students underlined that the Conference "Young Engineers in Georgian Energy Sector" was the first large conference stimulating research and scientific works of the GTU students, and asked HIPP representatives to give it a regular form .

The Conference highlighted great opportunities in the energy sector for graduating engineers from GTU and again confirmed several pre-existing concepts, which will underpin both HIPP's work as well as the continued evolution of Georgian energy sector:

- The importance of idea sharing in a diverse and open public setting;
- The need for capacity building within the academic and professional energy sectors;
- The importance of networking and building relationships across energy stakeholders; and,
- The pressing need to continue engaging an increasingly broad collection of stakeholders through workshops and conferences.

Below are the Resumes of the Presentations made by Conference participants:

1. Jake Delphia, CoP of HIPP: "Hydropower Investment Promotion Project (HIPP) and Georgian Electricity Market Model 2015 (GEM 2015)"

Main goals of HIPP are to: identify Georgian HPP sites and cluster of sites. Reach out to 500 potential investors, Complete 20 HPP pre-feasibility studies, at least 400 MW of new HPPs with signed development contracts with the GoG, attract USD 5-600 million, reduce winter dependence on foreign oil improve Georgia's balance of trade.

Georgian Electricity Market Model (GEMM) in 2015 is envisaged as a mechanism that: Increases investments in electricity sector, enables electricity trading on the regional competitive power markets while increasing power sector security; and Benefits Georgian domestic Tariff customers via improved quality service and long-term reasonable price of electricity.

GEMM 2015 is consistent with regional competitive power markets, carrying necessary minimal technical and legal requirements to benefit from the energy trade.

Driving forces of GEMM 2015: new Electricity Transmission Interconnection to Turkey will become commercially available in 2013, loan payments to IFIs to be reimbursed from trading across the new interconnection, Black Sea Transmission Project Loans' Covenants, Cross Border Electricity Trading Agreement, harmonization with the Turkish Electricity Market, GoG Decision for all Electricity Consumers to be able to choose their own Electricity Supplier by 2017, input from potential HPP developers and lenders, negotiations on Energy Community Accession.
The changing landscape for Engineers**:**

2. Givi Shovnadze, GTU Postgraduate Student: "Impact of Nonlinear Loads on Capacity Factor and Consumed Capacity"

Recently Impact of nonlinear consumers (computers, climate controls UPSs and other office equipment) on capacity factor and consumed capacity has been significantly increased.

At a certain stage of concentration of computer and office equipment almost every country faces similar problems. Problems related to the top level harmonic deteriorates quality of electricity, set under the international standards, therefore several negative impacts occur that in its tern causes increase of electricity losses in the electricity networks.

3. David Dgebuadze, Chief of GSE's Metering Department: "Electricity Transmission and Dispatch Services"

Presentation of Electricity Transmission and Dispatch Services stipulates the roles of Transmission and Dispatch Licensees within Georgia's Wholesale Electricity Market. Namely, it describes functions and activities carried out by Transmission and Dispatch Licensees, in line with effective legislation of Georgia, such as, including but not limited to: Planning, Real-Time Balancing and Settlement of Georgia's Electricity Market. Presentation gives general information on: (i) who are effective or applicant Transmission and Dispatching Licensees, (ii) who grants the relevant Licensees, (iii) which undertakings own Transmission and Dispatching License holder Companies, (iv) ownership information, (v) clients of Transmission and Dispatching License holder Companies, (vi) service fees to be paid to Transmission and Dispatching Licensees and etc. The presentation also highlights some of statistical data on power transmission losses determined by the effective legislation of Georgia, which shows the minimizing trend of the losses. The presentation also shows the role of Dispatch Licensee in Metered Data Aggregation and Validation for purposes of wholesale settlement of electricity among market participants in line with effective legislation of Georgia, for daily and monthly activities.

4. Zviad Gachechiladze, Head of TSO Team, HIPP: "Distribution of Active Capacity Losses on the High Voltage Transmission Network"

Transmission loss allocation is important in restructured electricity markets. Since generators and demands are all connected to the same network, actions by one participant can have significant effects on others making it difficult to investigate the cost, each participant is responsible for. It is difficult to achieve an efficient transmission loss allocation scheme that could fit all market structures in different locations. In practice, each restructuring model has chosen a method that is based on a particular characteristic of its network. This research proposes a flow based

method to find the loss allocation that was first proposed by J. Bailek in 1996. The methodology is based on simple circuit laws and does not involve any assumptions. Considering the real power injection and real power loss contribution factors loss allocation can be done. Due to the fact that no unique or ideal procedure exists, any loss allocation algorithm should have most of the desirable properties stated below: to be consistent with the results of a power flow; to depend on the amount of energy either produced or consumed; to depend on the relative location in the transmission network; to avoid volatility; to provide appropriate economic marginal signals; to be easy to understand; to be simple to implement. The flow based methods use the proportional sharing principle, which implies that any active power flow leaving a bus is proportionally made up of the flows entering that bus, such that Kirchhoff's current law is satisfied. For the loss allocation, the share of generators and demands must be specified such as 50% loss among generators and 50% loss among loads. This method use a topological approach to determine the contribution of individual generator to every line flow based on the calculation of distribution factor. This method is applicable both DC power flows and AC power flows (both active and reactive). This method follows both the upstream looking (load to generators) and downstream looking (generators to loads) algorithms. The development process of proposed method is illustrated with a small test power network with AC power solution described in the research. To apply this concept, at first the test power network must be constructed into lossless system, which is by removing the loss at each line and that particular loss is attributed to the sending end bus as a virtual load. Then, according to proportional sharing upstream and downstream algorithms virtual loads are assigned to each generator and load, correspondingly, based on their contribution to formation of loss structure. As of analysis done in the research, the proposed transmission loss allocation methodology satisfies all requirements applied to loss allocation methodology.

5. Nikoloz Sumbadze, HIPP Economic Analyst: Information Exchange Framework for Competitive Electricity Trading

Purpose of this presentation is to introduce audience competitive electricity market and principles of its operation. First, it describes all benefits caused by restructuring and liberalizing electricity market as well as roles and relationships among market participants and newly established institutions necessary for competitive electricity market functioning and trading. At the same time, presentation examines interaction of different types of competitive markets within the different time frameworks and their operation on the market participants' point of view. After describing principles and concept of competitive electricity trading, presentation emphasizes importance of IT and its usage in the process of electricity trading. Presentation introduces one of the beneficial IT technologies, Extensible Markup Language (XML), highly used for information exchange in electricity sector and how market participants, market operator and transmission system operator can coordinate among each other using XML technology, communication protocols and other IT hardware required for information exchange via Internet. Finally, presentation describes Italian and Spanish power exchanges and IT platforms applied for information exchange.

5. Giorgi Ketelauri, GTU Ph.D. Student: "Heat Generators Efficiency Assessment"

The presentation includes an overview of heat generators thermal technical testing classification, methods, organization and information on conduct experiment.

The experimental part represents water heating boiler's thermal technical exploitation testing results by using express method, which aims at revealing separate heat loss of aggregate, minimizing of mentioned loss and energy efficiency increase of the work. The method is based on the use of certain constraints, those that slightly change by burnt fuel mass elemental composition as well as by its content of ash and humidity.

Objects of study are two water heating consumer boilers (type - Ecoflam NC -420) of Georgian Technical University building # 8 heating system. Boilers thermal technical examinations were carried out using a flue gas analyzer – "Testo 335". It was ascertained that the boilers are working under profusion of high coefficient of air, which is reflected on their energy efficiency. After elimination of detected malfunction repeated measurement showed 4-5% increase of energy efficiency indicators.

6. Nino Maghradze, GTU Ph.D. Student: "Assessment of the effectiveness of Direct Contracts on electricity purchase and its expansion prospects in competitive electricity market"

The paper discusses types of contracts for electricity trading expanded in the world practice; electricity contracts established on Georgian market after implementing existing "Electricity (Capacity) Market Rules"; contractual relationships between customers and suppliers and the benefits of Direct Contracts and its development prospects.

Studies have shown that competitive electricity markets are highly effective, with bilateral Direct Contracts. It provides strengthening of market forces and reduces risks related to the increase in prices and demand. Direct contracts stipulate investment expansion in the field, by providing fixed-term contracts with fixed prices.

Analysis determined that the allowable margin of at least 1 million kWh of electricity consumption, makes a huge economic benefit to consumers. Expansion of electricity trade with this kind of contracts is one of the effective ways to reduce electricity tariffs and provide reliable supply to the consumers.

7. Nikoloz Kvrivishvili, GTU Ph.D. Student: "Direct current motor microcontroller system design"

In this presentation practically useful objectives are reached, those are involved in a problem of finding out of some kind of specific(not normally available to user) technical data for the initial design of direct current microcontroller system that can be used with low capacity direct current motors with mechanical commuter.

Motor normally unavailable parameters experimental evaluation those are armature resistance and inductance, electrical and electromechanical constants, stall shaft torque, inertia torque, torque of friction. Motor mathematical model compilation through the practically important stages is listed in this presentation.

Ford 1BB-42 direct current motor static (spin speed to torque) graphical representation.

Motor transfer function and characteristic equation compilation.

Amplitude to frequency graphical representation. Transient function referred to control.

Motor inrush acceleration transient curve.

Transfer function referred to disturbance (mechanical burden).

FORD 1BB - 42 motor transient modes when armature gets connected to rated voltage source. Motor differential equation with mechanical load.

FORD 1BB – 42 DC motor **MCU ATMega 88** system design and further exploration possibility.

Reprogrammable device that makes system flexible

- Proportional, integrate and derivative PID regulation possibility.
- Motor and highly energized circuits protection of over currents.
- Shaft's RPM feedback establishment with hall sensors.

Modern MOSFET' s SUD 50 N 04 layout with 1988 year manufactured КТ 805 *И*М bipolar one.

DC brushed motor MCU control system pattern diagram.

Software Multisim is partially used for the DC motor MCU system design for further use as an evaluation kit. The content of this presentation may be useful for individuals who are encountered with such machinery, but suffering with lack of needful data.

8. Tengiz Maghradze, GTU Ph.D Student: "Optimal planning of operative reserve of active power in power system under conditions of uncertainty"

The necessity of optimal planning of operative reserve of active power in power system and corresponding world experience are proved and studied. A general probabilistic assessment algorithm of the active power delay is developed. Based on fuzzy logic method an assessment methodology and two levels model of overall required reliability and acceptable risk level of reliability of individual load nodes and power system are worked out. The algorithm for determining the amount of the hourly operative reserve of active power in power system is developed. Distribution of optimal operative reserve on parallel working generators and hourly power flow calculation in normal and emergency modes are done.

It is created corrective algorithm and optimization function with constraints, which in power system at certain time interval in normal or emergency modes in case of overloaded transmission line/lines, distributes and recalculates power flow in a way that in normal and emergency modes overloaded transmission line/lines will be unloaded. Practical testing of above created new method is done on a simple power system and results are got.

9. Lado Gugushvili, GTU Ph.D. Student "Photovoltaic Transformer Modules for Solar Power and Small-Voltage Systems"

From the non-traditional renewable sources of energy, solar power is available and convenient for everybody. It represents an eco-friendly as well as the free source of energy. Nevertheless, it holds a modest position in the energetic system of countries around the world. However, this position has a tendency to develop and grow. The major task, the challenge facing the scientists is to utilize the solar power to the fullest and increase its share in the energetic of the state. Using the photovoltaic

(PV) systems, major part of which are the (PV) modules, can be considered as one of the ways to solve this problem. The following work discusses: Structure of the smaller-voltage mobile photovoltaic solar systems with universal capacity is worked on and analyzed. This project was made by me at my university to develop renewable energy sources in my country. It was important to make independent source of energy during the camping or in fields' conditions.

10. Filippidis Tata, GTU Ph.D Student: "Improvement of electricity tariff structure"

The paper reviews the organizational and economic conditions of forming the electricity tariff after the reforms in the power sector. The industry represents itself as a natural monopoly, where competition is somewhat limited. Under such circumstances economic regulation replaces competition. Such regulation is more full-featured, when it becomes similar to the almighty "invisible" hand of the free market.

The tariff should objectively consider mandatory expenses of the power outage. It must match the state of the industry and public policy in the power sector, as well as be exempted from additional social pressures.

12. Kikabidze Nino, GTU Ph.D. Student: "The optimal planning of long-term consumption tariffs"

Electricity distribution optimal tariff is analyzed for the long-term period in Georgia. In order to resolve this problem, multi-factor economical-mathematic model was worked out. The factors, affecting tariffs are established by using correlation analysis. Medium-term forecast is done for these factors. Regression coefficients are calculated by the parameters obtained from the forecasting.

A simplified economic-mathematical model is formulated for planning the weighted average tariff for electricity consumers. The results are compared with existing tariffs, which indicates how unfair the consumer tariff of electricity is established nowadays.

13. Alexander Pertosyan, GTU Ph.D. Student: "Management System Processing of Smooth Regulation of Reactive Power Compensation Equipment"

On the modern stage, under the conditions of the existing energy crisis, energy efficiency is the main issue. This problem is especially sharp related to the industrial equipment including asynchronous electric drives consuming reactive power that causes electricity losses. The task identified increase of energy data of electro technological equipment through complete compensation of reactive power consumed from the network by management system processing of smooth regulation of reactive power compensation equipment. For dealing with this problem reactive power smooth regulation unit was developed.

14. Nikoloz Javshanashvili, GTU Ph.D. Student: "Perspectives of Stirling Engine Utilization in Renewable Energy Sources"

The first Stirling engine was patented by the Scottish clergyman, Robert Stirling. The influx of warmth could be controlled well, and the relative low pressure in the machine could not lead to serious accidents. Other than the bettered safety

conditions, the engine was found to have lower fuel consumption, compared to the steam engine, which played a role in the development of this new technology.

At the beginning of the 20th century, about 250,000 Stirling engines were in use world-wide as table-top fans, water pumps and engines for small apparatus like sewing machines. Thus, the private house hold and small manual labor operations were supplied with mechanical energy.

In recent times, Stirling engines have a novel use in solar thermal units, e.g. in the Spanish Almeria, where a dish/Stirling was put into use in tandem with the German Center for Air and Space Travel (DLR). Even in warm parts of Germany, the summer sun in the afternoon provided a performance of 1000W per m2.

Dish/Stirling systems are made of a parabolic concentrator, a receiver, and a Stirling engine with a coupled generator. In comparison to large units like solar towers and parabolic rim fields (50 to 200 MWe), dish/Stirling systems are designated for decentralized uses of quite a few kW up to a few MW of electrical performance. The modular size is between 5 kWe and 25 kWe in present systems. Through very high concentration factors and temperatures, dish/Stirling units reached a 29-30 % of the highest conversion level of the best solar thermal unit.

Dish/Stirling systems can be ideally used in regions without electricity for supplying electric energy, water, desalination etc. or as a supplement to existing electrical supply. When individual modules are linked to form the size of a park, they produce 5-10 MW.

The Maricopa Solar power plant is the first commercial project for the SunCatcher CSP technology designed and manufactured by SES. The facility uses 60 SunCatcher Stirling dishes. Each 25-kW SunCatcher consists of a 38-foot mirrored parabolic dish combined with an automatic tracking system to collect and focus the sun’s energy onto a Stirling engine to convert the solar thermal energy into electricity.

Focused energy. The 1.5-MW Maricopa Solar power plant is the first to use Stirling Energy Systems’ Stirling dish technology, which will be deployed at 1,500-MW plants in California and Texas.

SES says that SunCatcher has a number of advantages, including the highest solar-to-grid electric efficiency, zero water use for power production, a modular and scalable design, low capital cost, and minimal land disturbance.

Stirling engine combined with solar dish are really effective and clean way to produce electricity out of solar power and Stirling dishes are good method to slow global warming.

15. Archil Artilakva, “Prediction models using of the net income forecast of the Energy Company”

In this work on specific example of (JSC Telasi) calculated net profit forecast for the years 2012-2015. Neural networks and multivariate predictive models are used in the calculation of net income. Calculated prediction proved the effectiveness of the company's activities.

USAID Hydropower Investment Promotion Project (USAID-HIPP)

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