SCIENTIFIC LIFE

A.H. Arakelyan

FINAL WORKSHOP OF THE PROJECT " SYNERGIA - SYSTEMATIZED AND SUSTAINABLE ENERGY EFFICIENCY IN ARMENIA"

The paper is prepared on the summaries provided by the authors of presentations of the workshop held in Yerevan at the Yerevan State University on September 23rd , 2016.
The Program Committee of the workshop was as follows:
Prof., Dr. Hans Kaminski - Head
Prof., Dr. Areg Grigoryan – member
Prof., Dr. Aram Arakelyan – member
Simona Malz-member
Vitalij Prjadkin -member
This workshop acknowledged the growing number of researchers working in the rapidly expanding area of the energy saving and energy efficiency as well as authorities and Government Officials who are responsible to provide the efficiency behavior of energy sector of the economy.
The seminar sought to bring together researchers, authorities from different Armenian institutions to explore a number of themes that relate to the energy saving development of energy saving large, multifaceted, complex and important Armenian residential area. Topics included relations between energy saving efficient and non - efficient appliances across communities.
We invited expressions of interest from academics, post-graduate students, Government officials and those interested in exploring the energy saving and energy efficiency dimensions of the Armenian residential area. The representativeness of interest was witnessed by the participants from Armenian Government officials, Representatives of High Education Institutes as well as Research Institutes. Thus, workshop gathered:

1. Government officials:
   Deputy Minister of Energy and Natural Resources Hayk Harutyunyan
   Deputy Minister of Education and Science Manuk Mkrtchyan
   Representative of the Committee of State Incomes Armen Safaryan
   Representative of Renewable Energy Department Norair Hayrapetyan
2. Representatives of academic institutions:
   Deputy Director of the National Institute of Education Prof., Dr. Yuri Safaryan
   Vice-Rector of National University of Architecture Prof., Dr. Yuri Safaryan
   President of Engineering Academy of Armenia Prof., Dr. Sergey Minasyan
   Dean of the Faculty of Economics and Management of YSU Prof., Dr. Hayk Sarkisyan
   Representatives from State Pedagogical University:
3. Participants of the project SINERGIA
   Simona Malz and Vitalij Prjadkin from IEE
   Aram Arakelyan, Hayk Adilkhanyan, Sona Sarkisyan, Styopa Tsarukyan, Ani Khalatyan, Vehanush Marukhyan from YSU
   PhD and Master Students form YSU: David Kharatyan and Shushan Indjigulyan
   Areg Grigoryan, Ruben Khachatryan and Mariam Saghatelyan from NPUA
4. Students form YSU

The opening ceremony implemented Dean of the Faculty of Economics and Management of YSU **Prof., Dr. Hayk Sarkisyan**. He welcomed participants of the workshop, noted the significance of the project for Armenia as the country which doesn't have natural energy resources and depends on the gas supply from Russia and during last years from Iran. The project was significant for the research implementing by master and PhD students. They implement dissertations devoted to the study of the problems concerning the efficiency of energy resources and energy saving. Then he passed the presentation to Deputy Minister of Energy and Natural Resources Hayk Harutyunyan.

Mr. Hayk Harutyunyan welcomed participants of the workshop. He presented projects implemented by the Ministry of Energy and Natural Resources of Armenia, noted programs devoted to the study of energy efficiency and saving in Armenia implementing in the cooperation with the World Bank. He expressed hopes that current project could be a valuable contribution to the development of stable basis for the further progress

in the field of energy, architecture, building construction, education and research, providing energy efficiency and saving. **Mr. Manuk Mkrtchyan** welcomed participants of the workshop and noted the significance of the project SYNERGIA for the economic education in Armenian secondary schools and simultaneously for the education of school teachers delivering classes in Economics of Energy.

Prof. Dr. Dr. h. c. Hans Kaminski and Simone Malz[1] presented the **Project "SYNERGIA".** A key challenge for all global energy supply systems will be to provide enough energy in spite of growing demand and limited fossil energy resources. At the same time economic, ecological and social concerns are taking into account - that makes it more difficult. This applies Germany, as well as Armenia. Both countries do not have any significant conventional energy sources. For this reason, the development of renewable energy is the most major component of the transition of energy supply system, but it is not enough. Human behavior has also to change. In order that as many people as possible learn how to conserve energy and use it more efficiently, we need incentive systems and an appropriate political framework. Technical solutions can support human behavior as well.

In 2014 in view of these facts Armenian and German scientists joined together in the project "SYNERGIA"[2] to pursue answers to the question, how energy efficient behavior of private households can be effectively supported. The aim of the cooperation of Yerevan State University (YSU), National Polytechnic University of Armenia (NPUA) and Institute for Economic Education at the Carl von Ossietzky University of Oldenburg is to establish a network with partners from science, policy and economy. This network has to encourage applied research and develop concrete solutions in the field of energy efficiency in the residential area of Armenia and Germany, as well. In this respect the promotion of scientific young researchers is an important concern. This project, which is founded by the German Federal Ministry of Education and Research, is to understand as a first step to build-up a long-term cooperation.

One of the specific features is the bilateral collaboration of different disciplines. The cross-disciplinary approach meets the needs of the underlying complex problem. Every discipline deals with different questions of energy efficiency from its specific point of view. Communication and networking among participants cause holistic understanding of multiplex challenges, which are connected with energy-efficient consumer behavior. This approach helps to open the view onto new solutions.

The focus of the previous work was the development of a conceptual basis for the future research work, expansion of the network and finding junior researchers. The evaluation of energy efficiency in view of unused potentials, available technical options (for example, use of LED, smart technologies and so on), political and legal frameworks, possible financial or legal barriers and already implemented actions in both countries are the fundament for it.

From the acquired results as far important approaches for promoting of energy-efficient-consumption-behavior can be derived and appropriate pilot projects outlined. Following articles will present results of done research work and drafts of pilot projects. But many important research questions remain unanswered. Because of the importance for society as whole energy-efficient behavior is a future-oriented field of activity for junior researchers. Therefore, an important focus of our future activities is the development of implementation approaches on the level of education (universities, professional education and schools) for more energy-efficient consumer behavior.

The presentation of **Vitalij Prjadkin** was devoted to the study of the **Energy Efficiency in Germany (residential area).** German energy support system is based largely on the use of fossil energy sources as the following figures for primary energy supply in 2015 show: Oil is the most significant source (33,9%) followed by natural gas (21,1%). In the third place is hard coal (12,5%) closely followed by renewable energy sources like wind, sun, biomass, geothermal energy and waste (all together 12,5%). Lignite (11,8%) and nuclear energy (7,5%) come in last[3]. Like Armenia Germany has quite limited fossil energy sources. More than two third - 69,6% - of the total energy needs in Germany are covered by imported energy resources. Lignite and renewable energy are domestic only. In addition to the risks associated with the import dependency, environmental pollution and greenhouse gas emissions caused by using fossil energy sources are a problem. Furthermore, Germany decided to accelerate the phase-out of nuclear power by 2022 following the Fukushima Daiichi nuclear accident in March 2011. In order to meet these challenges, the use of renewable energies is being promoted. At the same time energy efficiency plays an important role. Germany has set a target of 20% reduction in primary energy consumption by 2020 and 50% by 2050. It has also plans to reduce electricity consumption by 10% by 2020 and by 25% by 2050.

Private households play in that regard one of the central parts. Their share in the whole final energy

[1] Prof. Dr. Dr. h.c. Hans Kaminski was absent at the workshop. But he is the coauthor of presentations "Project SYNERGIA" and "Summary and Perspectives", as well.

[2] SYNERGIA = Systematic and sustainable energy efficiency in Armenia.

[3] All the dates which are used in the presentation of Mr. Prjadkin come from reports of the "Working community energy balances" (Arbeitsgemeinschaft Energiebilanzen – AGEB).

consumption in Germany is 26% (2014).

The biggest part of energy use in the residential sector is applied to heat buildings. In 2014 German private households used 444 TWh for it. The second item was water-heating (78 TWh) followed by home appliances and communication (57 TWh). The next one was cooking and washing (39 TWh). Lighting was the smallest item with 12 TWh in 2014 only. Most of the projected energy savings are coming from that sector, where the bulk of potential cost-effective improvements can be found. That is one of the reasons because many experts tell about big potentials to save energy in the building-area. This is especially important related to residential area as well as trade and services sector in Germany. Other important action field is traffic and transportation. German government developed a number of tools to provide and support energy efficiency in different areas. There are three groups of them:

Regulatory law - Bills and rules, standards and obligatory certificates. The government dictates consumers in direct way to do something or not. One of the most important tools of this category in the area of building is the Energy Saving Act. The first amendment originates from 1976. The last version is from 2014. This law regulates requirements on new and existing buildings in the areas of heating/cooling and insulation of building shell.

Financial incentives and market tools - Subsidies and credits, development programs and taxes. It means that consumers, who are saving energy, save money. For example, KfW – a non-profit banking group - has programs in its portfolio which are targeted at private customers - owner of new and existing buildings. The goal of these programs is to help owner of buildings to pay high costs for refurbishment/energy-saving rehabilitation or for constructing new buildings with high energy-saving demands. For these purposes KfW provides specific loans which are cheaper.

Information and education - Promotional campaigns, educational programs for schools and adult education, consulting. All the market players need information to make a decision. Private consumers need information about new technical solutions, development programs for promoting energy efficiency and energy savings, government policy in this specific field and so on. Especially consulting services are very popular in Germany. It could be consulting offer from consumer advice offices for free, which is mostly used by families with a low income. Different way is to get a specific point-of-care-consulting, which is more expensive. But an offer like that is made for special needs of the customer and his/her building. There are many exhibitions in Germany, where private customers can see, who are constructors in the region, what are new trends in the area of energy saving and energy efficiency, what kind of loans or credits are provided by the banks and so on.

All these tools or instruments have the same aim: they have to put private households in a position to exploit unused potentials in the field of energy efficiency in their own impulse.

The presentation of **Aram Arakelyan** was devoted to study of the energy use and energy efficiency in Armenian residential area, as well as he presented methods and research approaches for the implementation of the project SINERGIA. The author presented general concepts and definitions of the energy efficiency existing in the research of advanced economic schools and researchers. Particularly, concepts and definitions of energy efficiency and saving consist of the:

i) efficiency related to the electrical appliances using in the residential area,
ii) efficiency of lighting lamps, refrigerators, water pumps, electrical heating equipment, greenhouse heating equipment which uses woods, gas, electrical energy.
iii) efficiency of the devices, generating, producing and supplying of the electrical energy,
iv) efficiency of the adjustment of air pollution through the providing of the efficiency of electrical energy use.

Further, the author presented methods and works of foreign researchers concerning the management of the process of energy use in residential area. He noted that this experience allowed participants of the project SINERGIA to use and implement the project especially for the study of the energy saving processes in Armenian residential area. Taking into consideration research implemented at the Institute of Economic Education of Carl Osetski University and joining this research with the works of different foreign researchers, Armenian participants of the project got an opportunity to develop research plan devoted to the study of the efficiency of the use of energy resources in Armenian residential area. As the first step in this direction the questionnaire allowing the study of energy use and energy saving in residential area has been developed and the questioning of households of communities of the cities of Yerevan and Dilijan has been implemented. Thus, participants of the project got an opportunity to study the state of the energy use and energy saving in residential area, as well as to make an assessment of the energy saving and efficiency of appliances using in residential area. The structure of energy use in residential sector of studied communities has been developed and it allowed to get an assessment of the energy use by different electrical devices using in the residential sector of the city of Yerevan and the city of Dilijan. He noted that main part of the energy is using for the heating needs in residential area. However, the study of Armenian households showed that about 30% of electrical energy is using for lighting needs. This situation is caused by the use of non efficiency lamps used in residential area. In addition he noted that the level of the use of energy saving advanced technologies in

Armenian residential area is needed to be increased.

Further, the author proposed a program for the investments providing to retrofit residential area and replace conventional lighting lamps by energy-saving lamps. Main feature of proposed project is the assumption that investments are to be based on the borrowing, solicited from companies responsible to generate and supply electricity to the population. The author also presented the mechanism for making investments and their use with following up payback. Simultaneously, the author assumed that we should avoid foreign investments.

The study of Armenian residential area showed that the process of its management through the establishment of energy saving appliances could be efficient if we prepare passport of energy appliances using in households. This passport assumes to record electrical appliances using in households by energy saving ones.

Further, the author presented conclusions of the paper as follows:

1. The approach of the energy efficiency assessment based on the study of the process of use of electrical energy is new and allows to assess environment pollution.
2. The analysis of the housing fund and its satisfying to the requirements of energy saving provides the need of retrofitting the residential area and replacement of non- efficient appliances by energy saving ones.
3. The mechanism of the borrowing and implementation of the investments into residential area is new and is targeted to those who are responsible to provide energy efficiency of the economy and particularly the residential area.
4. The mechanism of the development of passports of electrical appliances used in households is new and is a call to those who are responsible for the energy efficiency of the economy.
5. The project SINERGIA has scientific and academic significance because it generated new master dissertations teams and students found it interesting as the basis for future research.

Areg Grigoryan presented a Laboratory Conception on power efficiency which is developed in the frames of the Project of the Federal Ministry of Education and Scientific Investigations of Germany, "SYNERGIA". The goal of the conception is the establishment of a Laboratory at the Institute of Power and Electrical Engineering (IPEE) of National Polytechnic University of Armenia. The representatives of the Institute of Economic Education of the University after Karl von Osetski in Oldenburg (Germany), Yerevan State University, NPUA, the Federal Technological Centre of Electrical Engineering and Information Engineering BFE (Oldenburg, Germany) took part in the discussion on the conception development.

The establishment of the Laboratory at the IPEE is urgent, as that institute trains Bachelors and Masters of Engineering in many specialities of Power and Electrical Engineering. Post-graduate students are also trained at the Institute. The total number of the students of the IPEE is about 800. All the students of the Institute study the issues on power efficiency one way or another. Power efficiency technologies are paid a special attention in the courses taught to the students, studying by the speciality "Power-saving Technologies and Power Management". A new speciality, named "Alternative Energetics" will be introduced at the Institute beginning from the academic year 2017-2018. The issues concerning the power efficiency will occupy a significant part in the disciplinary courses of the students, being trained by that speciality.

The IPEE new laboratory will be used for academic and research purposes. It will be equipped by technological installations, devices, equipment and furniture so that it should be possible to conduct lectures and laboratory works on power efficiency, as well as organize demonstrative practical seminars and carry out investigations.

For academic purposes, in accordance with the curricula and programmes of the University, the following types of lessons will be held for the students at the laboratory: lectures, practical and laboratory lessons, as well as scientific seminars. Lessons for the qualification improvement of both the lecturers of the University and the retraining of the specialists of different enterprises and institutions will be conducted.

At the laboratory the Graduate and Post-graduate students of the University will carry out investigations on the issues of power efficiency and power-saving. In particular, they will study the characteristics and operation modes of the laboratory equipment and installations.

The technological installations, devices and equipment can be conventionally divided into two groups:

1. the equipment, providing the power supply of the laboratory;
2. the equipment, providing the efficient power consumption.

The first group will include the solar photovoltaic plant of small power, the solar thermal plant, the wind generator, the accumulator with an inverter system, the geothermal thermocompressor.

The second group will include the installations and devices, regulating the operation modes of the cooling-heating, illuminating, and other systems, as well as various sensors.

All the equipment, including the operation of the thermocompressor, providing the laboratory with heat energy, will be regulated with the automatic system "smart home".

Hayk Adilkhanyan's presentation was devoted to the analysis of electricity consumption structure in

Armenian private households. Current study is devoted to the analysis of electricity consumption structure in Armenian residential sector. Various methods of economic research are implemented for achieving trustworthy results. An attempt is made to define a picture on average volume of electricity consumption, the volume of electricity consumption by certain appliances and draw conclusions based on respective models. The main problem related to analysis was unavailability of data. Therefore, there was a necessity to compile a credible information from households.

As a method of data collection, a paper-based survey is selected and respective questionnaire is developed. The latter includes questions aimed at revealing information about households' average expenses on electricity, structure of those expenses. Furthermore, specific questions are included in order to get an understanding about respondents' attitude towards energy efficiency and energy efficient technologies.

The survey was conducted in Ajapnyak administrative district of Yerevan. In overall, 600 households representing panel multistorey houses, took part in the survey which were classified into three types, according to the number of rooms (1, 2 and 3-room apartments). An important thing is the fact that selected apartments do not have access to natural gas and therefore electricity is the only source both for heating and cooking. It is also worth mentioning, that survey data covers only January and February.

The results indicate that for all three types of apartments both in January and February the major part of consumed electricity (85-90%) pertained to four types of appliances – heating devices, water heaters, electrical stoves and lighting equipment. The only difference is the order of appliances. In January, for all cases the largest share in electricity consumption belonged to heating appliances, while in February, electrical stoves and water heater took the first place.

According to respondents' answers to specific questions, it becomes clear that mostly they are aware of energy efficient appliances and technologies. Moreover, the vast majority of participants emphasized the importance of informing population about such technologies and mentioned TV as the most appropriate source of receiving such information. However, they pointed as well, that there was no practice of spreading information about energy efficiency among private households.

Further, based on the results obtained with help of survey, mathematical modelling techniques are applied and respective models are estimated. At first, for each type of apartment and each month a single OLS regression is evaluated in order to assess possible impact that heating devices, stoves, water heaters and lighting appliances exert on the overall volume of consumed electricity. The results show, that out of the mentioned four appliances the strongest influence belongs to heaters (in January) and water heaters (in February).

Besides OLS regressions, a panel analysis is conducted as well. In total six panels are included in the analysis – a panel for each type of apartment and each month. Pooled OLS, fixed effect and random effect models are estimated and show that again, the strongest impacts come from heating equipment and water heaters.

At the final part of study, possible benefits from using efficient lighting equipment instead of inefficient ones are calculated. This stage is reasoned by the fact, that according to the results of survey, lighting accounts for a quite large part of total electricity consumption which is mostly due to the fact that Armenian households use inefficient lighting appliances from electricity consumption perspective. Calculations are done for all three types of apartments and show that on average LED lamps consume 85-90% less electricity compared with their traditional counterparts. In monetary terms it means to save annually 25,000 AMD for 1-room apartments, 29,000 AMD for 2-room apartments and 37,000 AMD for 3-room ones (or 521 kWh per year, 603 kWh per year and 753 kWh per year respectively).

Sona Sargsyan's presentation was devoted to the solution of the models of optimality of mechanisms of clean development. The models of the optimality of mechanisms of clean developement are studied. As case study the economy of the Republic of Armenia is considered. The numerical method of the solution of studied models is given. It's applied to the empirical data describing economic indicators of the Republic of Armenia.

Models including specific targets and restrictions may be applied in the electricity production and consumption area. The structure of the generated amount of electricity which is given below, allows us to formulate the problem of maximizing summary income on the basis of these costs and planned targets. For each organization producing electricity the revenue structure can be represented in the following table.

Model: Consider n organizations producing electricity. Let's say e_j, $j = 1,2,...,n$ is the number of harmful emissions into the atmosphere as a result of the operation of organization j. In particular it is possible to put the model for determining the optimal taxation, taking into account the quota restrictions on pollution.

It is required to maximize the total income of the organization

$$\max_{\{e_j\}_{j=1,\dots,n}} \sum_{j=1}^{n} A_j B_j^{\alpha_j} C_j^{\beta_j} \exp((\alpha_j \gamma_j + \beta_j \delta_j) e_j) - \sum_j d_j e_j. \quad (1)$$

Revenue			
Cost price		Profit	
material inputs	salary	Net profit	Taxes

Suggestions:1. In the field of renewable energy needs to implement diversified financial and credit stimulation.

2. Mechanical and obsolescence of machinery and equipment in the power system contributes to the high level of pollution. Actual problem is the renovation of stations producing electricity.

3. Reduction of taxes on import of renewable energy production equipment is necessary.

Styopa Tsarukyan[4] presented the paper "An assessment of the efficiency of the electrical energy use and the improvement of social norm" which was devoted to the study of the approaches providing the increase of electrical energy use efficiency in different countries. Particularly he noted the approach used in the Russian Federation which was based on the intention of the limited size of electrical energy for each household and the establishment of the tariff according to this limited size. The tariff is increasing if the household uses the electrical energy extended this size. Similar approach was used in Armenia. However, the author argued that the approach used in the Russian Federation didn't get the acceptance from households and different layers of the population. Reviewing approaches on the increase of electrical energy use in different countries the author concluded the need for the inclusion of additional steps targeted to the improvement of the efficiency of the use of natural resources. Taking into consideration this argument he studies the structural identification schemes allowing an increase of the efficiency of electrical energy use in household sector. As the main conclusion made by the author is the suggestion that the constraint of the size of the use of electrical energy is not an efficient approach because it causes the decrease of the quality of life. The improvement of this approach should be based on the technology development and establishment of energy efficiency equipment and facilities for household use. As a case study the author considers assessments of the size of the power used by different electrical facilities. He concludes that the main part (30%) of the power Armenian households are using for the apartments is lighting.

He offers the proposal based on the replacement of 60 Wt.H. lighting lamp by 7 Wt.H. LED lamps having the same lighting qualities. For the sample of apartments he considers apartments of Yerevan and proposes to replace these apartments by 60 Wt.H. lighting lamps by 7 Wt.H. LED lamps. He calculates the profit tax of 73 major taxpayers of Armenia and proposes to:

i) borrow money from the Armenian energy producers and supplyers, ii) purchase 7 Wt.H LED lamps,

iii) replace 60 Wt.H. lighting lamps by 7 Wt.H. LED lamps,

iv) continue counting the costs of electricity calculated for lamps 60 Wt.H.

This approach could allow to repay the debt taken for the purchase of LED 7. This will repay the debt taken for the purchase of 7 Wt.H. LED during 8 months. After this period the population will pay for the use of electricity counted for the 7 Wt.H. LED. The author suggests that the use of 7 Wt.H. LED lamps allows the improvement of social rate of the electricity use based on the constraint of the size of used electricity and increasing of the tariff for the use of extra size electricity. The approach proposed in this paper allows to maintain the quality of life.

The presentation of Mariam Saghatelyan was devoted to the study of the technical and economic efficiency of applying different hydroaggregates in small hydroenergetics in Armenia. The development of small hydroenergetics in Armenia gives an opportunity to supply electricity to remotely populated areas which are located nearby some water source. The correct selection of constructive solutions of the main units of the SHPP gives an opportunity to obtain relatively high power efficiency and power safety of the whole system. Besides, the correct technical and economic analysis of SHPP gives an idea about the anticipated expenses and the payback period. The correct choice of the hydroturbine and the electric generator is of special importance. In order to substantiate the efficiency of SHPP of Armenia the water resources of the Republic of Armenia

[4] Styopa Tsarukyan was absent at the workshop, but has presented a summary of the presentation. Current text is the summary he provided.

(RA) and 41 of the existing SHPPs of a power of 1…5 *MW* are analyzed. These SHPPs belong to the basins of different rivers. The technical and economic indications for applying of hydro-turbines in SHPPs in RA are also given.

The location of the water resource has an important role in the solution of expediency of the SHPP use as an alternative source of electricity. The remoteness of the source from the consumer more than 5 *km* is a determining factor at evaluating the profitability of using the SHPP, because there is a need of great expenses for building and exploitation of electricity transmission overhead lines.

When a water source is far from the consumer up to 5 *km* the cost of the project realization is determined by the value of hydroaggregate and construction and secondary equipment, reconstruction of hydromechanical structures and installation of equipment.

In the water resource selection process, for installing a SHPP it is necessary to know the head of water and water discharge, which are the main parameters at selecting the aggregate type and its determined capacity.

Thus, knowing the parameters of the reservoir, the hydrotechnical structures, as well as by selecting the type of the aggregate to be installed (according to its determined capacity) the end-user of electricity and the profitability of the project realization can be determined. Similarly, by having the value of the required electricity production, the parameters of the hydroaggregate can be determined (for an individual consumer) and compare the possibility of its installation in the given water source [1].

The selection of a consumer is one of the decisive factors for the hydroturbine selection, because its parameters may fail to satisfy the required needs.

There are two types of hydroturbines by principle of operation: active, which operate from the free jet at normal atmospheric pressure due to the kinetic energy of water and are used only at high heads of water, from 40 to 800 *m,* and reactive, which operate due to the potential energy of water at heads of water from 1,5…2 to 350 *m.* The main working body where the energy is converted is the runner.

By the regulation method of the power, the reactive hydroturbines can be of single and double regulation. By the shaft location of the runner, the hydro-turbines can be vertical, horizontal and inclined.

There are different types of hydroturbines which differ by the power and head of water. The most common hydroturbine types which are used in the SHPP systems are the axial-flow propeller Kaplan turbine, the radial-flow Francis turbine, the diagonal turbine, the Pelton turbine, the Turgo turbine and the cross-flow Banki-Michele turbine. Due to their several advantages the Turgo turbine and the Banki-Michelle turbine are widely used in SHPPs in recent years.

The head of water of the considered SHPP ranges 51.2…575 *m,* the water discharge ranges 0.45…6 m^3/s. The average annual values of SHPP of RA are: head of water – 167 *m*, water discharge – 2 m^3/s, the SHPP capacity – 2200 *kW*, the produced electricity per year – 8.15 *mln. kW per hour*.

There are a lot of SHPPs in RA which have 100…5000 *kW* of the set capacities. Thus, an efficiency varies little at 30…100% of load. It allows to design hydroaggregates with the set capacity in accordance with the river water energy in spring. It allows to use the SHPPs effectively for the entire year of operation.

It is possible to increase the profitability of SHPPs and decrease the economic expenses during its realization by selecting the optimal velocity of hydroaggregate units in accordance with energetic parameters of the river.

Ruben Khachatryan presented "Programs and perspectives of development of energy sector of Armenia and the role of energy saving in households". Energy consumption growth is observed in Armenia since 1995. According to the IEA in Armenia on average is produced 32.4% of its total primary energy supply. At the current level and if the growth rate of the energy consumption remains constant for sustainable development of Armenia's economy, where there are no own resources of fossil fuels it is necessary to increase the energy efficiency of the economy as a whole, as well as the development of local renewable energy sources.

The main purpose of the *National Program on Energy Saving and Renewable Energy* adopted in 2007 is to set targets for the energy saving and renewable energy development in Armenia and to determine the means for their realization. Among the program indicators of energy saving measures, the total energy saving potential from the use of energy efficient light bulbs by population was estimated to be roughly 303 GWh. According to the program it is economically advantageous to reduce the consumption of thermal energy for heating with improved thermal insulation in buildings at least by 30%. In this case, annual savings will amount to 335 KTOE, and in public buildings to 67 KTOE (which corresponds to a reduction of CO2 emissions by 2300 tons).

The World Bank study carried out in 2008 determined that Armenia can save as much as 132 AMD billion per year in energy expenditure by investing in energy efficiency. Equal to saving annually 1 210 KTOE energy. One of the priority measures of the *National Energy Efficiency Action Plan* was the implementation of the national energy statistics and the drafting of the first detailed energy balance for 2008-2010. In this regard, it provided that a gradual approach will be applied, and new action plans will be adopted in the coming years.

The total energy saving target by 2020 will be about 22.3%.

In the document "*Ways of long-term (to 2036) development of the energy system of Armenia*" various scenarios of development energy system of Armenia are considered and the activities are grouped in three areas: market reforms, development of infrastructure, development of electricity production capacities.

In the medium term, implementation of activities aimed at stimulating interstate trade includes gradual (until 2019) liberalization of the Armenian electric energy market. In total, the implementation of medium-term measures for the development of infrastructures will create an additional burden of about 5.5 AMD / kWh on the tariff of electricity in 2020-2021. As a result of the analysis of examined scenarios we can conclude that in the period from 2018 to 2036 because of renovation and development of generating capacities of Armenia the power system weighted average cost of electricity production most likely will grow to $ 66-77 per MWh. Whereas the stimulation of energy efficiency may result in fuel savings and economy of financial resources, and it can reduce the amount of new thermal power required.

In *Scaling Up Renewable Energy Program (SREP)* for Armenia three investment priorities that would lead to scale-up emerged from the analysis and discussions with stakeholders are geothermal power, utility-scale PV, geothermal heat pumps and solar heating.

Today already 11 Armenian cities are signatories of the agreement "Covenant of Mayors" (2009), while 7 of them, including the capital Yerevan, have a "*Sustainable Energy Action Plan*" (SEAP). A number of international financial institutions offer mechanisms of financial support for residential and private programs, that include soft loans for energy efficiency programs. In recent years several demonstration projects have been carried out in residential and public sectors such as "Municipal Heating", "Improving Energy Efficiency in Buildings", "Green Urban Lighting", etc.

Why is it necessary to promote energy efficiency and incentives in the residential sector?

1. In the Republic the percentage of consumption of primary energy resources by population is high. According to statistics (IEA) almost one-third of TPES (2101 KTOE in 2013) accounted for the residential sector and was 662 KTOE.

2. In winter about 10-30% of the average household budget is spent on its energy costs. The rising cost of energy affects not only the reduction in demand, but also leads to restriction of comfort and creates a solvency problem for low income households. At the same time the cost of electrical energy sold to the final consumer, as it was already mentioned, in the next decade will continue to grow.

3. In RA about 11% of the total greenhouse gas emissions are produced as a result of the energy consumption in buildings. For accelerating efficiency in the housing sector it is necessary to reduce the emission volumes and contribute to the solution of environmental problems.

Much has been done to improve energy efficiency in the country, especially during the recent years, but it is still necessary to implement actions to inform the population and stimulate energy-efficient behavior.

Aram Arakelyan, Sona Sargsyan, Ani Khalatyan and Vehanush Marukhyam presented the textbook in Energy Economics for secondary schools. The results of a sociological survey of different sectors of the population showed a low level of awareness of people about the energy efficiency projects, the impact of different energy resources consumption on the environment. This fact, as well as the experience of our colleagues in "SYNERGIA" project became the basis for the submission of the project on creation of this guide. The manual is intended to be submitted to the school discipline on the economy, as a source of knowledge on energy economics.

The content of the manual must be complied with the curriculum on the subject of the economy, however, it could be focused on the general public, it can include recommendations to improve energy efficiency projects.

To preview the presentation of the brochure it had been chosen two themes from the overall subject of the economy.

Theme 1: The subject, the problem, the production factors and the economic system of the economy.

Theme 2: Supply and demand. Pricing in the market.

Here in parallel with the basic concepts of economic theory it had been given the definitions of the electricity market, electricity as a commodity, which has a number of features that significantly influence on the formation of the cost in its production, and that the differences in costs sometimes underlie the differences in fees for its use (tariffs).

It have been observed the features of electric power from a consumer perspective. In contrast to other goods the consumer gets it exactly at the point in time when there is a need for it. The examples explain the behavior of supply and demand of electricity as a commodity. In the guide simple questions are posed, such as:

- where does the electricity emerge?
- how and by what do people warm up?
- what are the energy efficiency and conservation?

It had been listed the relevant answers.

After the completion of the energy economy course different sectors of the population will increase the level of knowledge of the energy efficiency projects which will bring to significant savings in energy use.

Knowing that, for example, the replacement of light bulbs in the entrances of apartment buildings with more energy saving ones or installing solar panels on the roofs of houses, will bring to the significant financial savings for all the residents of these homes and which will be one of the visible results of this guide. It is very important to give knowledge on energy-efficient use of appliances that you need to know for insulating homes that efficiently - central or individual heat supply since the school age and answers to these questions must be substantiated by specific examples and calculations.

Plan - Contents

1. Energy Alphabet
   Answers to the questions-what? WHERE? FOR WHAT?
   1.1 Where does the electricity supply begin?
   1.2 How do people warm up?
   1.3 What are the energy efficiency and conservation?
2. Energy efficiency projects
   2.1 What is the energy efficiency project?
   2.2 What should we know about the warming of the house?
   2.3 Central or individual energy supply?
   2.4 Where is the heat lost?
3. The maintenance and management of multistory buildings (New solutions for the old problems).
   3.1 The lightening of the porches and courtyards.
   3.2 The installation of solar panels on the roofs of multistory buildings.
4. The advice for the energy efficiency for using household appliances.

Arev Sahakyan presented the paper "Assessment of quality of life based on electricity usage". Among the most urgent problems are the level and the quality of life. One of the reasons is the financial economic crisis of 2008-2010, which brought a deep decline in the population's level and quality of life. Moreover, currently, one of the main reasons is the energy consumption costs. Our well-being depends on the correct social policy, which, in turn, depends on whether the information is sufficient, and whether it fully shows the problems in today's society. The direction and pace of further reform in the country and therefore ultimately political and, consequently, economic and social stability depend on solving the life's level and quality problems. These problems' solving requires specific policies worked out by the state, the central point of which is a man, his well-being, physical and social health. That is why all the transformations that can cause changes in living standards, have great interest in population.

Quality of life is the degree of satisfaction of the material, spiritual and social needs of the person. It is the most important social category, which characterizes the structure of human needs and capabilities to meet them. Some researchers, in the definition of "quality of life", oriented a lot of attention on the economic side: the material security of the population's lives. It is true, as the assessment and measurement of quality of life is a necessary component of the socio-economic monitoring, assessment of the state and nature of the development of social processes in any country.

People's quality of life and the degree of economic development are determined also by the level of electricity consumption. Electricity consumption plays really a life support role. Because of a constant increase in energy prices the majority of consumers have a desire not only to save electricity, but also to meet the consumption volume of low-cost electricity. This can be done in many ways. In this work we analyze those which create minimal discomfort for consumer trying to save the energy that is spent in vain. In one word, energy saving and energy efficiency are direct methods of current problem.

In order to have streamlined and efficient savings, people must focus on energy-consuming appliances in the house. To do this, they must analyze a table, which shows the averaged power consumption for some devices. Of course, consumption will greatly vary depending on the individual preferences of each resident, but in general people can have an idea of what devices are consuming a lot of electricity in particular. Moreover, some household appliances (such as: TV, audio equipment, microwave, etc.) after switching off, are not disconnected from the mains at all, but being in standby mode always have a power consumption. By minimizing the use of electricity in the house with energy saving and with substituting items, people can enhance the electricity usage efficiency almost 25-30%.

Shushan Indjigulyan presented the paper "Assessment of energy efficiency in individual greenhouse farms of the Republic of Armenia". The purpose of this work is research of individual greenhouses , the assessment efficiency of energy consumption and identifying existing problems.

Greenhouses are divided into different types according to several criteria. Depending on the operation and design features for the classification of greenhouses, the following criteria apply: seasonality, cultivation technology, design, etc.

Depending on the kind of fuel Armenia has the following types of greenhouses heated fuel or materials, performing the role of fuel: gas, electricity, firewood, fuel oil, diesel fuel, etc.

During the operation and analyzed visits were conducted 5 greenhouses. Greenhouses are at one and the same area and all greenhouses have almost identical structure. This factor makes the study more productive as the external conditions (ambient air temperature, lighting) are the same for all the greenhouses.

During the investigation it became clear that in most greenhouses are used improvised stoves. Efficiency of heating depends largely on the structure of the heating system as a whole. The efficiency depends largely on the heating pipe installation location. In one case, the pipe is installed on the side wall and on the other case-directly on the ground. The number of tubes used and the amount of water in two cases are almost the same, but studies suggest, that second type is more effective. In the latter case while using the same amount of fuel the temperature in the greenhouse is recorded at 2-3 degrees above.

In contrast to natural gas heating, wood-burning heating system requires additional financial costs. It is necessary to divide the respective parts of the wood, store it correctly and to monitor the heating boiler during the work. At the very least, for all this you need an extra worker.

Wood heating systems are not automated, therefore they do not provide the ability to provide a fixed temperature. These conditions, especially in case of such plants, which do not need a very high temperature, increases the risk of frostbite. In addition, it is not always possible to buy high-quality wood, which leads to a decrease in the proportion of energy derived from burning wood.

Studies and surveys conducted among greenhouse owners show, that at the present time the most efficient is considered to be natural gas heating.

Comparative evaluations conducted between 1, 2 and 3 greenhouses will not be exact, since the average temperature in the greenhouse was different and in a greenhouse number 3 there was no polyethylene coating. At the same time the greenhouse number 4 and 5 coincide both in terms of average temperature, and form a polyethylene coating. We study the cost of heating greenhouses number 4 and 5. Wood heating costs amounted to 1260000 dram. Taking into account the results of studies conducted in the greenhouse room 5 we see that the cost of natural gas heating of greenhouse No. 4 amounted to 1007800 drams.

Studies and surveys conducted among the owners of hothouses, show that at the present time natural gas heating is considered to be the most efficient both in terms of maintenance, and in parts of heat.

Now, based on studies and findings let's define existing problems. Often the introduction of natural gas heating system is complicated by several factors. Gasification of some villages have not yet been completed, so the owners of the greenhouses are forced to use alternative fuels. In addition, heating greenhouses, you need high-pressure gas, which must be delivered from the central highway. This is costly. It is also necessary to take into account the fact that often the greenhouses are located far away from residential areas, and it is worth a few times more.

Among the urgent problems worrying the owners of greenhouses is the problem schedule of payments for the consumed gas. Heating is carried out during the months from November to March. Monthly bill for the used gas must be paid before the 20th of the following month. While the income obtained much later. As a result, owners of the greenhouses often arise financial problems, in particular, they do not have the opportunity to continue the further heating of greenhouses.

The main purpose of **David Kharatyan's** article is to analyze the financial performance of Vorotan complex of hydroelectric power plant for the period of 2011-2014 by using the DuPont model. It has been found out that plant's financial performance was stable in 2011 with positive ROE return on equity and profit margin values. However, the plant's performance started to worsen in 2012 with negative profit margin and return on equity values. The plant incurred significant losses in 2013 which resulted in negative profit margin and return on equity and high financial leverage values. It was able to recover in 2014 as the plant improved its performance significantly with large return on equity and profit margin values.

Further **Prof. Dr. Dr. h. c. Hans Kaminski and Simone Malz** presented the summary and perspectives of the project SINERGIA. The results of the research work done so far show on the one hand, that many measures to encourage energy-efficient consumer behavior are implemented. On the other hand, much unused potential can be found as the research findings of the survey about the consumption of electricity and natural gas in private households in Armenia show. This result indicated existing barriers, which hamper to exploit energy-efficiency potentials to the full extent.

Financial barriers are in the leading position. Large energy-saving potentials in domestic sphere can result from the rehabilitation of the building shell, modernization of heating or cooling systems and in the field of electric appliances. Usually modernization or rehabilitation activities are expensive and these costs could be covered by equity capital only in rare cases. Experience shows, that the accession to financial resources and offers do not generate demand automatically. There are several explanatory approaches: effects of discounting, risk aversion or investor-user dilemma. Another important question is what role is played by information or information deficit. The evaluated results obtained so far show that the detailed reflection delivers important advices for developing effective and target-group-specific measures or adjustment of existing offers and

programs. Especially relating to expensive activities some people tell about “too much” information. As a result of this “too much” people become uncertain about their decisions (for example, recording to the choice of materials or electric appliances) and at the end they quit. At least performer or executer, for example, worker, who install new windows or air conditioning systems have to be necessary professionally qualified for consulting or giving advices. These and more barriers add to the fact, that not all the economic potentials to save energy or to use it efficiently are used to their full extent. This finding applies for Armenia and in a similar way for Germany, as well.

The findings of the scientific cooperation can make important contributions to the design of sociopolitical framework to promote energy efficiency, to design and development of new technical solutions and to the configuration of education offers with long-term effects, going well beyond simple information transfer. First connecting factors have been identified and concretized in the frame of SYNERGIA. For example, it is the laboratory on the base of the National Polytechnic University of Armenia, where professionals and employees will be taught to install new energy efficient housing technologies or electric appliances. Another example is the design and development of teaching materials for general education schools. In this way, all the young citizens can be equipped systematically and extensively with the most important knowledge- perception- and valuation-competencies related to the energy-efficient consumer behavior.

At the same time these project ideas offer an opportunity to relate the intensive practically-orientated development work to fundamental empirical research. Stakeholder from policy and economy can benefit from it. Especially to junior researchers from different disciplines energy efficiency is not only a fascinating but also increasingly important research area.

Ա.Հ. Առաքելյան

«ՀԱՄԱԿԱՐԳՎԱԾ ԵՎ ԿԱՅՈՒՆ ԷՆԵՐԳԱԱՐԴՅՈՒՆԱՎԵՏՈՒԹՅՈՒՆ ՀԱՅԱՍՏԱՆՈՒՄ – ՍԻՆԵՐԳԻԱ» ՆԱԽԱԳԾԻ ԵԶՐԱՓԱԿԻՉ ՍԵՄԻՆԱՐ

Ներկայացվում է «Համակարգված և կայուն էներգաարդյունավետություն Հայաստանում - ՍԻՆԵՐԳԻԱ» նախագծի եզրափակիչ սեմինարի համառոտ տեղեկատվություն: Սեմինարը տեղի է ունեցել Երևանի պետական համալսարանի Տնտեսագիտության և կառավարման ֆակուլտետում: Նախագիծը ֆինանսավորվել էր Գերմանիայի կրթության և գիտության նախարարության կողմից և կատարվել էր Կարլ ֆոն Օսեցկու համալսարանի Տնտեսագիտական կրթության ինստիտուտի, Երևանի պետական համալսարանի Տնտեսագիտության և կառավարման ֆակուլտետի և Հայաստանի ազգային պոլիտեխնիկական համալսարանի կողմից: Մասնակիցների զեկուցումները նվիրված էին էներգաարդյունավետությանը և էներգախնայողությանը վերաբերող զանազան հարցերի ուսումնասիրությանը, ինչպես նաև էներգետիկայի տնտեսագիտությանը վերաբերող հիմնախնդիրներին: Սեմինարը հետաքրքրություն առաջացրեց Հայաստանի էներգետիկայի նախարարությունում, Հայաստանի Կրթության և գիտության նախարարությունում, ինչպես նաև մի շարք համալսարաններում, որտեղ էներգաարդյունավետության և էներգախնայողության հարցերի ուսումնասիրությունը ընդգրկված է ուսումնական պլանով դասավանդվող առարկաներում: Սեմինարում ներկայացված զեկուցումները ցույց տվեցին, որ ՍԻՆԵՐԳԻԱ ծրագրի շրջանակում կատարված է նշանակալի հետազոտական աշխատանք Հայաստանում՝ էներգախնայողության և էներգաարդյունավետության բնագավառում:

А.А. Аракелян

ЗАКЛЮЧИТЕЛЬНЫЙ СЕМИНАР ПРОЕКТА “SYNERGIA” – СИСТЕМАТИЗИРОВАННАЯ И УСТОЙЧИВАЯ ЭНЕРГОЭФФЕКТИВНОСТЬ В АРМЕНИИ”

Приводится краткая информация о заключительном семинаре проекта “SYNERGIA” – систематизированная и устойчивая энергоэффективность в Армении”, состоявшегося на Факультете экономики и управления Ереванского государственного университета. Проект финансировался Министерством высшего образования и науки Германии. Исполнителями проекта выступили Институт экономического образования Университета им. Карла фон Осецкого (Ольденбург, Германия), Факультет экономики и управления Ереванского государственного университета и Национальный политехнический университет Армении. Доклады участников семинара посвящены широкому кругу вопросов, касающихся проблем энергоэффективности и энергосбережения в Армении. Работа семинара вызвала интерес в Министерстве энергетики и природных ресурсов, Министерстве образования и науки Армении, у широкого круга специалистов, занятых решением проблем энергоэффективности, а также представителей сферы образования в области экономики. Результаты работы семинара показали, что в рамках проекта “SYNERGIA” проделана значительная работа, позволившая продвинуть исследования в области энергоэффективности и экономического образования в сфере экономики энергетики.

Arakelyan Aram H. - Prof. Dr., Head, Department of Mathematical Modeling in Economics, Yerevan State University