ENHANCING CAPACITY FOR LOW EMISSION DEVELOPMENT STRATEGIES (EC-LEDS) CLEAN ENERGY PROGRAM

COOPERATIVE AGREEMENT NO. 114-A-13-00008

Project Proposal

Hybrid Utilization of Biomass and Solar Energy for Heating of Kindergarten Building in Pshaveli Village

August 2016

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Preamble

In May 2016, a project proposal on Hybrid Utilization of Biomass and Solar Energy for Heating of Kindergarten Building in Pshaveli Village was prepared by an independent expert under order of Remissia Project (Agreement No ???). The list of activities implemented is as follows: analysis of existing projects in municipality of Telavi, selection of particular project, technical, economical and resource analysis of project activities and budgeting.

The author of the project would like to thank an Eco Enginee, an Electrical Engineer and an Economist for active involvement into working processes.

1 Project Prerequisites

1.1 Problem Description

Since 2010 the process of undertaking voluntary commitments has been launched in Georgia under the Covenant of Mayors which means that the cities joined this initiative aim to reduce the GHG emissions for their territories by 20% till 2020. Main sectors considered by the EU cities within the frames of this initiative are transport and buildings; however, the cities may include some other sectors as well (street lighting, waste management, landscaping, etc.).

Following Tbilisi, other self-governing cities of Georgia enthusiastically embraced this initiative and started to join it gradually. 13 self-governments have already joined this initiative, including 9 self-governing cities and 4 municipalities.

There have already been developed Sustainable Energy Action Plans (SEAP) for eight self-governing cities and a monitoring report - for Tbilisi. Main sectors considered by the cities of Georgia include transport, buildings, street lighting, waste management and landscaping.

Telavi Municipality is located in Kakheti region. It was declared municipality in 2006. From 2014 city of Telavi became self-governing city and Temi Telavi became independent municipality.

Its population was 38 721 people in 2014. The climate in the municipality is temperate wet, with moderately cold winter and hot summer. Mean annual temperature equals to 12°C and the annual sum of precipitation makes 700-800 mm.

Telavi municipality became a legatee of the signature to the Covenant of Mayors (CoM). Telavi municipality has signed the Covenant of Mayors (CoM) on January 30, 2015 and thus has undertaken an obligation to prepare and implement within its administrative borders the SEAP aimed at the reduction of GHG emissions.

The SEAP for the city of Telavi is currently being prepared and is to include Transportation, Buildings, Street lightning, Greening, Waste sectorsas well Agriculturefor both mitigation and adaptation purposes.

The municipality of Telavi has neither an appropriate experience, nor skills, or enough technical staff to plan or manage sustainable development process of municipality; Particularly, one of strategic sectors of Telavi, under the short-term strategy of sustainable energy development process, is building sector but in order to move smoothly to clean/low emission buildings carrying out of serious steps and planning awareness raising activities for the population are being required, highlighting advantages of energy savings and utilization of local renewable energy resources.

One of the projects considered within the Temi Telavi SEAP to be implemented by Municipality in 2016 involves construction of new energy efficient Kindergarten with renewable heat supply system in village Pshaveli – one of 30 villages of municipality. Specific activities to be carried out include:

- Construction of 750 sq.m. building (Stage 1 – completed)

- Roofing and exterior works (ongoing)
- Establishment of water supply to the building (ongoing)
- Interior works and installation (to be started shortly)

However planned project didn't not involve activities directly aimed at reduction of GHG emissions and energy consumption and increase in sustainability of the village infrastructure. Only activity planned by municipality that aids the energy efficiency was installation of PVC plastic windows.

1.2 Project Goal

Due to the municipalities obligations under the Covenant of Mayorsprocess as well as decrease of operational costs related to increased energy consumption it is necessary for the municipality to implement a project that demonstrates climate friendly approach and reduction of municipality's carbon footprint.

To achieve this goal it is required to replace natural gas heating system that was planned to be installed inthe kindergartenbuilding project with heating system that operates onsustainable renewable energy and provides efficient heat to kindergarten and its ancillary infrastructure.

This pilot project will provide Telavi Municipality with significant statistics, data and other findings to ensure long-term planning of renovation activities for other municipal buildings, support preparation and implementation of new projects and remove knowledge and awareness raising barriers.

To accomplish these specific objectives of the project it is planned to:

- Design and installationofheat and powergenerating energymodulethat will provide electricity and heat energy generated from sustainable renewable sources (solar, biomass) to the street lightning system and heating systemtokindergarten building
- Showcase to residents and guests of the village integrated system of energy generation and utilization to gain support of wider public and backing replicability in other areas of the Telavi well as other municipalities of Georgia

To accomplish reduction of potential energy consumption and GHG emissions it is planned to:

- Replace consumption of fossil fuels (natural gas) for heating purposes in kindergarten building by installation of biomass boiler. According to the project design NG based heating system was planned to be established in this building. As far as NG is provided to whole municipality of Telavi the most kindergartens, in particular buildings rehabilitated recently use NG for heating.
- Reduce consumption of electricity for lighting purposes by installation of 4 units of LED lighting on the street leading to the kindergarten building. As incandescent lighting is used throughout the municipality without this particular activity of the project incandescent lighting would be installed.

– Reduce the consumption of thermal energy for heating of the kindergarten building through increase of insulation levels of building. This will be achieved by addition of insulation layer (total of 650 sq.m.) in the garret of the building and installation of PVC windows with higher energy-efficiency than conventional windows installed in Telavi's municipal buildings

1.3 Partners and Beneficiaries

1.3.1 Partners

- **Telavi Municipality Government** – the major partner and main implementer of the project. Temi Telavi local government is ready to allocate co-financing tocarry out all the rest worksrequired for full construction of the kindergarten building. In addition the Municipality is ready to bear the expenses for such EE measures as insulation of the building garret, installation of EE windows and walls satisfying the high standards of thermal resistance;

- **Telavi Municipality/Community** – Community leaders will support the project in attracting qualified local staff, raising awareness and spreading obtained results on other buildings;

- **Ministry of Environment and Natural Resources Protection of Georgia (As a coordinator of the Covenant of Mayors in Georgia)** – the Ministry is responsible for implementing Climate Change Convention Principles throughout Georgia. Moreover, it coordinates the Covenant of Mayors initiative, supporting the participating cities and municipalities through methodologies and available data. Therefore, it may play significant role in attracting additional funding for such pilot projects.

- **Ministry of Energy (As a coordinator of the Covenant of Mayors in Georgia)** – the Ministry of Energy also coordinates the Covenant of Mayors initiative for the country in cooperation with the Ministry of Environment and Natural Resources Protection of Georgia. Processes, strategies or action plans of the country, scheduled by the Ministry, are directly reflected in the SEAPs of the Covenant of Mayors signatory cities and municipalities. Plans are particularly important for sustainability of heat supply and energy efficiency improvements. The Ministry actively cooperates with municipalities and cities throughout the NEEAP (National Energy Efficiency Action Plan) preparation processes, supplying them with parameters, preliminary evaluated at national level. (GDP, Population growth, elasticity coefficients of various sectors, etc.);

- **Ministry of Regional Development and Infrastructure of Georgia** – The Ministry is directly linked to the implementation of the SEAPs and large part of activities related to the development of infrastructure and social building sector are being planned in cooperation with them as well as partially funded by them;

- **NALA (National Association of Local Authorities)** – NALA can make special contribution to local staff training initiatives. Along with additional investments, awareness

raising programs on climate change, sustainable development etc. prepared by them for municipalities are able to significantly contribute to these processes.

1.3.2 Beneficiaries

- **TelaviMunicipal Government** – will benefit from reduced expenses and energy efficient, low emission building;
- **TelaviMunicipality/Community** – it will receive a benefit in terms of workplaces causing by spreading the innovation to other buildings,they acquire certain skills increasing their chances of employment;
- **Local population of Telavi municipality and its Community** – children from this community will get new energy efficient kindergarten with heating and hot water supply, standard temperature in the rooms which is not the case in most of kindergartens;
- **Ministry of Environment and Natural Resources of Georgia –** as a body directly responsible for implementing the GHG emission-reduction measures across the country and developing appropriate strategies and action plans, also coordinating CoM municipalities;
- **Ministry of Energy** –being responsible for the preparation and implementation of NEEAP (National Energy Efficiency Action Plan) and being coordinator of CoM process.
- **Government of Georgia** – having overall responsibility for implementation climate change convention, EU association agreement and supporting the sustainable **decentralization process through strengthening local governments.**Strong regions would be useful while fulfilling their obligations under the Climate Change Convention.

1.3.3 Contributing Factors to Project Implementation

- International obligations taken by the Country and self-governing cities on EE and GHGs mitigation (the EU Association Agreement; the Covenant of Mayors,future commitments under the Climate Change Agreement);
- Municipality's and it's management's interest to implement EE and RE pilot projects reducing their annual expenses;
- Availability of sufficient solar potential in this region;
- Abundance of easily available, sustainableagricultural biomass waste resources;
- Availability of grant resources for co-financing the additional costs raised by EE measures;

1.4 Project Implementation Barriers

- Procurement gaps. Procurement law is currently based on the principle of the lowest price that has seriously damaged the quality of a number of implemented projects. This problem should be solved and the law should be improved through joint efforts of the municipalities and cooperation with the central government; a bidding document shall contain material and equipment specifications and necessity of submission certificates of origin and quality assurance to avoid delivery of low-quality products.

- Lack of awareness of local decision makers on EE and Renewable technologies. Special awareness raising and knowledge getting programmes should be organized by the project;

- Lack of relevant technical staff for preparing bidding/project document for such type of activities. On job training of local staff should be done by the project but government also have to think about outsourcing of such specific tasks;

- Insufficient budgetary resources and local staff to prepare grant application. Closer cooperation with private sector seeking support from them;

- Lack/absence of qualified construction/ESCO companies providing relevant service at Georgian market and in particular at local markets. This small project couldn't do large contribution to this direction but government should organized programmes (with the support of donors) for training of construction/ESCO firms in order to ensure the relevant market for implementation of EE measures and supply.

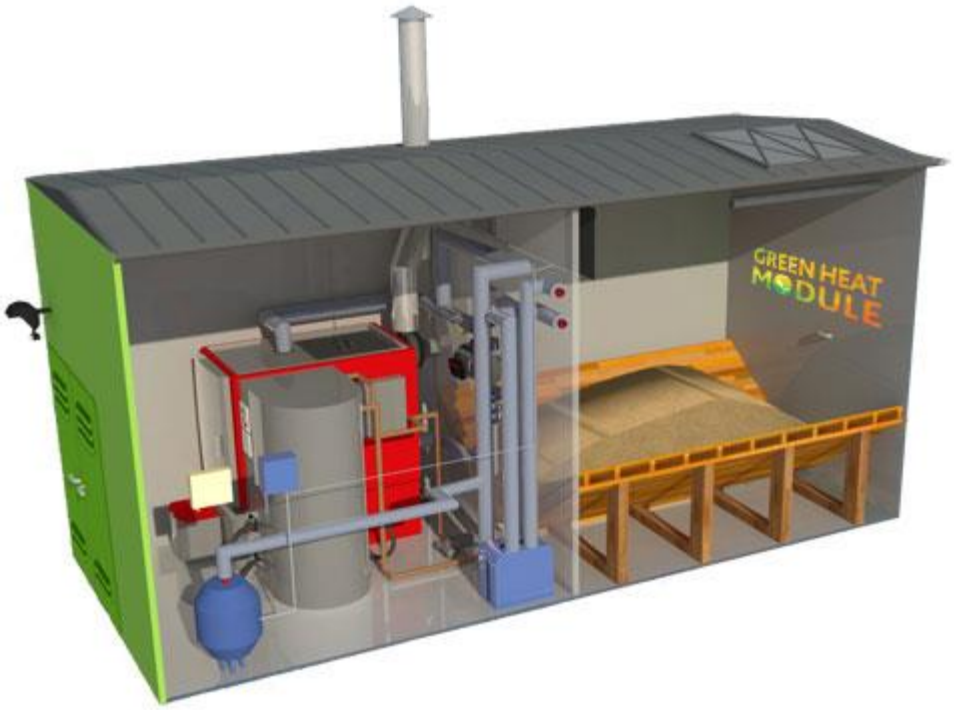
2 Recommendations on Activities to Be Implemented

Based on the study and analysis of existing building plans and economic and social circumstances of Pshaveli village and Telavi municipality it is recommended,in general, to design, engineer and install a system of hybrid utilization of solar and biomass sourced energy. The project includes:

- Installation of so called green heating module (see picture #1, sample model) which consists of shredder for biomass, small size biomass chips' storage, biomass boiler, hot water storage tank, control and monitoring system and photovoltaics that will supply system with required electricity

- Addition of extra insulation to the garretof the building

- Installation of LED lighting on the street leading to the kindergarten and powered by solar electricity generated through photovoltaics



Picture 1. Illustration of green heating module that represents container consisting of 2 sections.

First section (on the right) is used for placing of biomass shredder and biomass chips (storage). Automatic feeder delivers wood chips from first section into second section where biomass boiler, hot water storage tank and other components of the system (battery, inverter and controller for photovoltaic system, pump group and control and monitoring system) are installed. Photovoltaic panels (with surface area of 6.5 sq.m) are installed on the roof of the heating module.

Project will showcase the mixed use of the following renewable energy sources:

- Solar for electricity production
- Agricultural biomass waste for thermal energy production

The energy will be produced and stored with the following equipment

- Photovoltaic panels (with surface area of 6.5 sq.m) with total capacity of 1.5 kW for generation of electricity required to operate various equipment inside the heating module
- Power battery of 0.5 kW, to store energy required to operate various equipment inside the heating module when solar energy (after the dawn) is not sufficient
- Buffer tank of 1 ton (for storage of heated water for efficient operation of heating system)
- Shredder (with capacity of 100 kg per hour to provide conversion of agricultural woody residue – prunings from vineyards and gardens into biomass chips)
- 60 kW Biomass boiler with automatic delivery system

- LED street lighting (4 LED's on the street leading to kindergarten building)

As for sufficiency of each of renewable energy source justification is given below:

- Sun: According to Technical Regulations "Building Climatology" of Georgia (http://gov.ge/files/382_40062_363410_71-5.pdf) direct and constant radiation in Telavi is following:

Constant[1]: January – 57 kWh/m2, April – 130 kWh/m2, July – 199 kWh/m2, October – 92 kWh/m2

Direct: January – 28 kWh/m2, April – 65 kWh/m2, July – 119 kWh/m2, October – 52 kWh/m2

These amounts of radiation will provide sufficient energy for operation of Photovoltaic.

Energy produced by photovoltaic will be supplied to the control unit and LED lighting on the street.

- Biomass: Pshaveli village community has around 700 ha of vineyards and 30 ha of fruit gardens. According to research conducted by representative of Temi Telavi Municipality biomass that is annually produced by pruning and then disposed of (by burning in the field) by community amounts to 180 tons from vineyards and 10 tons from fruit gardens. An average calorific value per ton of this type biomass is estimated at 4200 kWh. In addition other biomass resources include waste biomass from corn and other agricultures. Total biomass resources in the area amount to 1260 tons.

Annual consumption of biomass boiler is estimated at only 17-18tons (1.3-1.4% of total biomass sources).Calorific value of this amount of biomass is estimated at 71,400-75,600 kWh.

Above mentioned activities will result in generation of the following energy:

- Electric power produced annually by Photovoltaics estimated at 849 kWh per year (1.53kWX8hX365daysX19%, where 1.53kW is total capacity of photovoltaic system, 8h is daily operation time, 365 days is annual amount of days in operation and 19% is efficiency rate of Photovoltaic system used to calculate working capacity of total capacity)

- Thermal energy produced by biomass boiler is estimated at 71,997 kWh per year(745sq.mX151daysX8hX0.08kW/sq.m. where 745 sq. m. is heated area of kindergarten building, 0.08 kW/sq.m is consumption of specific heat after improvement of building insulation, 8 is daily duration of heating operation in hours and 151 is length of heating season per year in days.)

[1] Only these four months data are available at this stage. However, this information is sufficient for assessment of resource required by the system.

3 Expenditure Estimated for Energy Efficiency and Renewable Energy Measures

Major cost of the project is covered by Telavi Municipality to finance the following tasks:

- Construction of 750 sq. m. building structure (Stage 1 – completed)
- Roofing and exterior works (ongoing)
- Establishment of water supply to the building (ongoing)
- Interior works and installation (to be started shortly)

Expected budget for activities assigned by Telavi Municipality in the boundaries of project amount to GEL 520,000. Assuming exchange rate of GEL 2.15 to 1 USD the budget equals to USD 241,860.

EE and RE Measures to be implemented by the project include:

- Installation of so called green heating module which consists of shredder for biomass, small size biomass chips' storage, biomass boiler, hot water storage, control and monitoring system and photovoltaics that will supply system with required electricity
- Addition of extra insulation to the garretof the building(PVC windowinstallation is implemented by municipality)
- Installation of LED lighting and its connection to photovoltaics on the street leading to the kindergarten
- Providing training of local human resource allocated by municipality on maintenance and operation of the equipment installed in the boundaries of the project.
- Handing over executed works to Bolnisi Municipality: project monitoring and service of installed equipment will be conducted by Infrastructure Department of Telavi municipality. Data will be collected on energy generation and consumption, operation service and maintenance frequency. Municipality will allocate transport for biomass collection and staff (1 person full-time employed by Pshaveli kindergarten administration) for maintenance and operation of installed equipment.

Total cost of the above is estimated at USD 50,000.

Project considers the following budget items:

I. Project Management

Project management that involves design of heating module; Mechanical, Electrical and Plumbing engineering of infrastructure; mechanical design and engineering of infrastructural solutions; managingthe implementation of the project, financial and economic aspects and coordination oftasks with different

parties and successful and smooth implementation of all tasks of project, timely fulfillment of the project and supervisionof implementation will be accomplished by the team of Project Director, Project Manager, Architect, MEP Engineer and Mechanical Engineer.

II. Travel and Per Diem

A. Travel of project stuff will be required for site visits for pre-installation phase, meetings with municipality representatives, supervision, etc. Total number of visits 30 (2-4 managers per visit).Cost per visit $30. Total travel costs - $900.

III. Procurement

Execution of equipment purchase, construction, production and assembly of components and installation works is estimated at USD 39 274.

IV. Other Direct Costs

Office/Communication expenses - will cover costs of office supplies needed to complete the project such as printer paper cartridge, telephone bills, bid announcement.

Price/month- $175 Total (3 months) - $300

Total Budget

#	Item	Unit	Quantity	Unit Price incl. installation (USD)	Total Price incl. installation (USD)
1	Green heating module (with smoke pipe, Automatic delivery system – 4700, Buffer tank 1000l, Pump group, Photovoltaic, Controller, inverter, meter, boiler, control and monitoring system, shredder, bunker, battery etc)	PC	1	4950	35664
2	Led Lighting	PC	4	350	1400
3	Insulation	Sq.m.	650	3.4	2210
4	Project management (including salaries, per diem and other direct costs)				10726
	Total				50000

4 Sustainability, Environmental and Economic analysis

The sustainability of the project is a direct outcome of obligations of municipality's joining to the Covenant of Mayors. Another important factor that backs the project fulfillment and guarantees its growth beyond the phase is reduction of operation costs due to reduced consumption and therefore economy of the budget for municipal utility bills. Therefore it is in the municipal authority's interest to sustain project and take on maintenance and operation of the project after it is handed-over.

It is vital to note that sustainability of the project and that the kindergarten does not go to the use of the firewood in future is ensured by costs related to buying firewood and ease of collection of biomass from local farmers. Municipality representative has interviewed biggest of local farmers (30 farmers) that are ready to supply the biomass free of charge. Considering the firewood is priced GEL 120 per m^3(with 550kg/m^3 price of ton is GEL 218) and the costs related collection of biomass given below municipality is interested in providing truck for collection of biomass and its delivery to Pshaveli Kindergarten heating module.

Transportation of biomass will be made from maximum 10 km from Pshaveli kindergarten building. According to Valuer'sUnion's price collection for second quarter of 2016 (table #15) transportation of 1 ton of goods is estimated at 5.12 GEL including salaries. This case is based on used of own transportation vehicle. In case municipality announces a tender for transportation services maximal tendering prices is GEL 6.96 (GEL 5.12+10% overhead costs+8% planned accumulation+18% VAT). Given price is updated quarterly and tendered cannot offer higher price.

As for the price of biomass, it is currently disposed of by burning in the fields and only additional cost of loading and unloading is required. This cost based on interviews in Pshaveli village is estimated at GEL 10.5 per ton. Therefore delivery of 1 ton of biomass equals GEL 17.46.

In addition to achieve high level of sustainability New Technology Center will provide training of local human resource allocated by municipal authority on maintenance and operation of the equipment installed in the boundaries of the project.In future this staff could serve several kindergartens located not far from each other.

It is also important to note that sustainability is aided by Georgia-EU association agreement, which included Georgia's responsibility to adapt the environmentally friendly and energy efficient technologies.

As for the replicability of the project its' feasibility is based on the demonstrational qualities of the project. Use of biomass and solar energy in the region with abundance of both resources makes it possible to replicate these technologies and approaches not only in kindergartens in other villages of Telavi municipality but a number of other municipal, state and residential buildings.

As for GHG's reduction and energy savings these will be obtained from installation of PVC windows and garretinsulation that will provide reduction of building specific heat consumption from 150 W/sq.m. to 80 W/sq.m. As a result this will decrease energy consumption forheating by 62,997 kWh (745sq.mX(0.15-0.08)X8X151where 745 sq.m. is heated area of kindergarten building, 0.15 kW/sq.m is specific heat consumption before windows renovation and insulation of garret, 0.08 kW/sq.m is specific heat consumption after windows renovation and insulation of garret. , 8 is dailyduration of heating

operation in hours and 151 is length heating season per year (in days). To generate thisamount of energy (62,997 kWh/yr) by burning the natural gas, it's demanded volume will be 62,997 / 9.72 = 6481m^3 costing 6702X 0.98 = 6568GEL (price of natural gas per cubic meter is 0.98 GEL).In case of using firewood to generate this amount of energy it is required to utilize 14,999 kg (62,997kWh/4.2kWh/kg). With firewood price per ton of GEL 218 costs would be GEL 3,270. While in case of biomass the cost is GEL 262 (15tX17.46).

This reduction is providing in decrease of 12.73 tons/annually GHG emissions (0.202kg/kWh).

Additional source of GHG's reduction is obtained from LED lighting. This activity will result in the following:

	Amount of lamps	**Capacity (W)**	**Daily operation hours**	**Daily consumption in kWh**	**Annual consumption in kWh**	**Emission factor kg CO2/kWh**
Base Lighting	4	250	12	12	4 380	0.104
After installation of LED lighting	4	70	12	3.36	1 226	0.104
Reduction of Consumption					3 154	
Reduction of GHG						328

Annual reduction of consumption – 3154 kWh,

Annual reduction of GHG emissions – 0.33 t

Total emission reductions from the project activities are 27.60 tons per year.

Total emission reduction from all project activities is based on life-time of each activity and is as follows:

#	Activity	Annual Saving in kWh	Lifetime (years in operation)	Total savings in kWh	Emission Factor kg per kWh	Total emission reduction in Tons
1	Windows and garret insulation improvement	62,997	8	503,976	0.202	101.8
2	Biomass heating system installation	71,997	15	1,079,955	0.202	218.2
3	LED lighting installation	3,154	15	47,304	0.104	4.9
	Total					324.9

Monitoring and Evaluation

Project monitoring and evaluation will be conducted by Infrastructure Department of Telavi municipality. Major source of data collection on energy generation and consumption will be accomplished through software tools that are incorporated into the monitoring system of the energy cabin. Monitoring system will be connected to heating module (boiler, hot water storage system) and inverter connected to Photovoltaic panels. Monitoring system features special software that can be accessed through Bluetooth® and Speedwire/Webconnecttechnology as standard.Comprehensive calculations for all essential technical criteria in a heating and power generating system help optimize configuration.Integrated tool tips explain the calculated values and indicate when values have not yet reached the optimal range. This prevents bad planning that would consequently be a lot of hassle to correct in the actual system.

Project data regarding the configured system is all compiled into a detailed overview at the end.This overview can be saved as a PDF and sent by e-mail.

In addition to the above collected data (energy generation by boiler and consumption separate overviews with detailed information on generated kWh, and distribution among consumers – Kindergarten and LED lighting) annual sum of utility bills on heating and electricity one year after the launch of the project will be compared to baseline consumption (savings are determined by measuring energy use at the utility meter level):

- Electricity

1. Kindergarten – with projected electricity consumption of 10,752 kWh/y
2. LED lighting – projected baseline consumption of 4,380kWh/y

- Heating

1. Kindergarten – projected baseline consumption of 134,994 kWh/y

This type of verification compared to data from inverter may not be as accurate due to possibility of increased or decreased consumption independent from generation (ex. Hotter or cooler winter that results in change of heating demand, increase or decrease of inhabitants, visitors or other beneficiaries of building, etc).