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IMPACT ASSESSMENT

IMPLEMENTATION OF INTERNATIONAL BUILDING CODES (IBC)

FINAL

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ABSTRACT

Georgia's current building codes are outdated. They are a mix of Soviet, American, as well as British, German, and other European standards. The most recent are the seismic codes that were last updated in 2009, but they were mainly based on versions of codes from the 1980's and need substantial revision. Soviet Construction Norm and Rules (SNIPs) are the most widely used codes in Georgia. But even SNIPs have not been updated for a decade. Although SNIP structural and seismic codes are used, there are no Mechanical, Electrical, and Plumbing (MEP), fire protection, existing buildings, energy conservation, and accessibility codes. Lack of knowledge; awareness; and importance of building safety, design, construction material use, energy efficiency, water efficiency, and operation and maintenance are contributing to poor quality, inefficient, and unsustainable Georgian building stock. Therefore, new and modern building codes are urgently needed.

Reforming the building codes will have a profound impact on the development of construction sector in Georgia. The implementation requires some initial investments that would be fully compensated due to the gains related to the quality of buildings. The consumers of the buildings will benefit as well because of the reduced expenses related to the heating.

The implementation of International Building Codes (IBC) will have important safety and environmental effects as well. IBC is an important first step towards implementation of green building policies that, based on experts' estimations, will bring energy savings in average of 37%, savings in CO_2 emissions by 72%, savings in water use by 40% and savings in solid waste by 70%.

ABBREVIATIONS

IBC - International Building Codes

SNIP - Russian Abbreviation of Soviet Construction Norm and Rules

MEP- Mechanical, Electrical, and Plumbing

ICC - International Code Council

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MONETIZED BENEFITS FOR CONSTRUCTION BUSINESSES

In the current construction environment, construction businesses do not observe any standards and requirements related to Thermal Resistance (R), resulting in residents of the buildings spending increased operational costs to maintain heating and ventilation of apartments and houses.

The International Building Codes (IBC) will promote internationally recognized standards of Thermal Resistance (R). Thermal Resistance (R) is a factor defining a ratio of building envelope thickness and thermal conductivity of materials used in the structure. If the thermal resistance of a building design is known, it is possible to define the thickness of wall-filling layers and thermal characteristics necessary for preserving of comfortable air temperature inside, i.e. 19-21°C based on the amount of energy consumption (by building)..

The observance of Thermal Resistance (R) would require some additional investments in the construction process, but the investments will be fully recovered and compensated because of:

1. Area gained as a result of decreasing wall thickness;
2. Saving of materials in retaining structure at the expense of lightening (reduction of thickness) of filler materials; and
3. Saving of energy needed for heating.

IBC will have significant positive monetized impact on construction businesses. The positive quantifiable monetized impact is associated with area gain and construction economy. Additional cost is associated with the additional investments required in order to comply with IBC. In case of observing Thermal Resistance (R), additional investment costs will be fully compensated because of the economic gains on the above mentioned factors. Based on the calculations, the monetized annual economic impact on construction businesses will be GEL 18,460,800.

MONETIZED BENEFITS FOR BUILDING CONSUMERS

The implementation of IBC, which will significantly increase Thermal Resistance (R) of the building, will result in huge savings for consumers on heating expenses. Heat loss calculation was implemented for each option to define energy savings from heating, with fuel meant as natural gas.

Assuming that the minimal exploitation period of the building is at least 50 years, the average savings during 50 years on energy for heating per 1 m^2 would be 2.1 GEL*50= GEL 105. The total monetized impact for consumers based on the annually constructed area in Georgia is estimated to be GEL 67,305,000.

II. APPENDICES

A. BACKGROUND

B. METHODOLOGY

C. FINDINGS

A. BACKROUND

CURRENT BUILDING REGULATIONS IN GEORGIA[1]

Georgia's current building codes are outdated. They are a mix of Soviet, American, as well as British, German, and other European standards. The most recent are the seismic codes that were last updated in 2009, but they were mainly based on versions of codes from the 1980's and need substantial revision. Soviet Construction Norm and Rules (SNIPs) are the most widely used codes in Georgia. But even SNIPs have not been updated for a decade. Although SNIP structural and seismic codes are used, there are no Mechanical, Electrical, and Plumbing (MEP), fire protection, existing buildings, energy conservation, and accessibility codes. Lack of knowledge; awareness; and importance of building safety, design, construction material use, energy efficiency, water efficiency, and operation and maintenance are contributing to poor quality, inefficient, and unsustainable Georgian building stock. Therefore, new and modern building codes are urgently needed.

The weaknesses of Georgian building codes are presented below:

- Georgian building codes have not been updated for over a decade.
- Inconsistency in building codes and standards exist; a mix of Soviet, American, as well as British, German, and other European standards are used.
- Current Georgian building codes are mainly based on SNIPs.
- No MEP, fire safety, and accessibility codes exist.
- Designers, architects, and engineers use any codes they desire.
- No licensing is required to practice design, engineering, and construction.
- Contractors are at loss. They often build using inconsistent design and sometimes they build based on the owner's direction in materials, means and methods selection.
- Lack of unified and consistent standards, such as standards for concrete, steel, and other building materials,

INTERNATIONAL BUILDING CODES

A building code is a set of rules that specify the minimum acceptable level of safety for constructed objects such as buildings. The International Building Code (IBC) is a model building code developed by the International Code Council (ICC). A model building code has no legal status until it is adopted or adapted by government regulation. The IBC provides minimum standards to insure the public safety, health and welfare insofar as they are affected by building construction and to secure safety of life and property from all hazards incident to the occupancy of buildings, structures or premises.

Before the creation of IBC there were several different building codes used, depending on where one decided to construct a building. The IBC was developed to consolidate existing

[1] EPI Building Codes Assessment

building codes into one uniform code that could be used nationally and internationally to construct buildings. The purpose of IBC is to protect public health, safety and general welfare as they relate to the construction of buildings. Therefore, it is used to regulate building construction through use of standards and is a reference for architects and engineers to use when designing buildings or building systems.

It has been proven that buildings contribute to the environmental degradation and CO2 emission more than industry and transportation. For example buildings in the United States consume 40% energy, 73% electricity, 14% potable water, and 39% CO2 emission. It is apparent that the building environment in Georgia has impact on natural resources and environment. Reforming building codes will have a profound impact on the development of the construction sector in Georgia. Key benefits of this project are outlined below.

- Introducing new and internationally recognized codes such as the 2009 International Code is a step in the right direction to establish sustainable design and construction for Georgia's current and future development. The adoption of the new codes will establish a baseline for Georgia's new development and construction;
- Compliance with and enforcement of the codes will contribute to sustainable design, construction, and operation practices compared to the current practices;
- With new code implementation, a baseline for energy and water conservation can be established, and green practices can be added to maximize building performance.
- Building-related CO2 emission can be calculated and reported, and strategies can be developed to further optimize building performance and decrease buildings' and ultimately Georgia's CO2 footprint;
- With code implementation, sustainable site, water efficiency, and energy conservation practices will be followed that are far better and more advanced than what Georgia currently uses;
- The new codes will establish buildings' minimum energy performance and will introduce new types of building materials, including envelope insulation and efficient glazing. This will contribute to the discovery and use of local materials in construction, which will contribute to Georgia's economy;
- Storm water management, flood plains, and light pollution baselines will be established with new code implementation;
- With the baselines established, optimized building performance will follow when integrating new approaches and practices for heat island effect, hazardous material handling, transportation, open space management, water and energy conservation, and local and healthy materials used in construction.

B. METHODOLOGY

The following impact assessment was designed to analyze the qualitative and quantitative effects of IBC implementation in Georgia. The consultant used qualitative research methods such as interviews, survey results and secondary reports. The consultant also relied on two previous EPI reports titled *EPI Building Codes Assessment* and *Assessment of the Costs and Thermal Performance of Construction Materials.*

The EPI consultant relied on an analytical method that assessed the impacts of IBC implementation based on the utilization of new construction materials and techniques in order to comply with internationally recognized standards for Thermal Resistance (R). The assessment disaggregates among the economic benefits expected to affect the construction businesses and consumers.

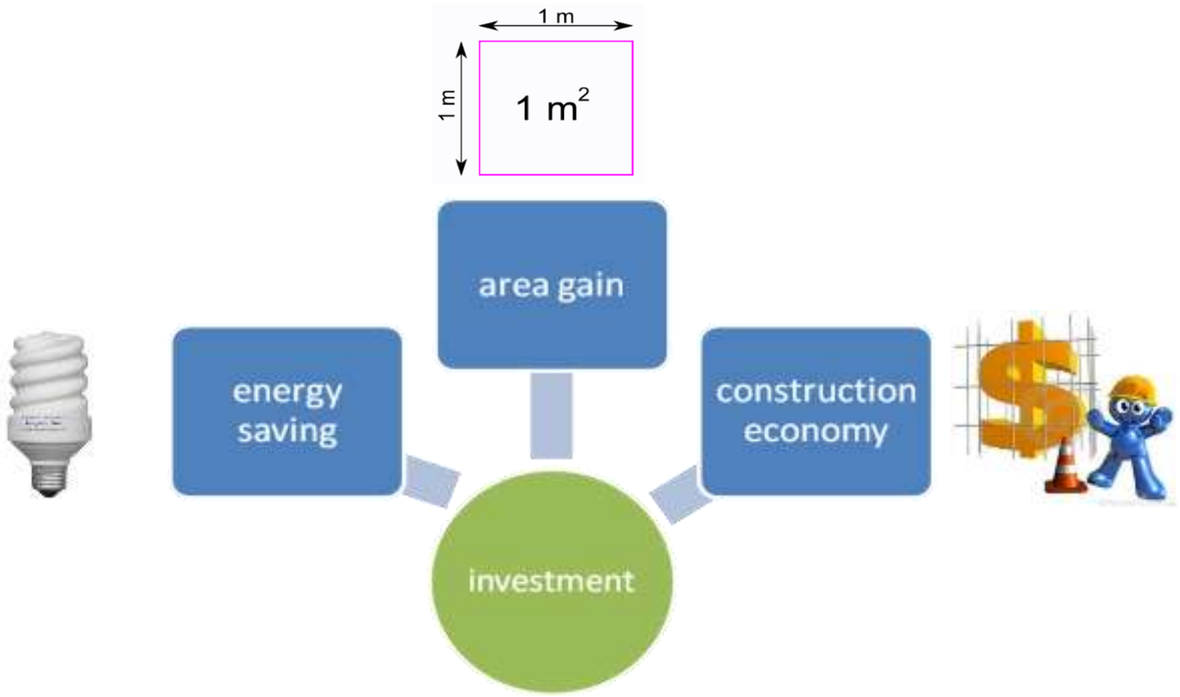
While performing this assessment, the consultant’s priority was to determine the quantifiable economic impact of IBC implementation; in cases where quantifiable impacts were not assessable, the report elaborates qualitative impacts, for example environmental and human safety impacts of IBC.

C. FINDINGS

TOTAL BENEGITS RELATED TO INCREASED THERMAL RESISTANCE[2]

IBC will have significant and positive qualitative and quantitative impacts on construction businesses and consumers in Georgia. The positive quantifiable monetized impact regards to energy savings, area gain and construction economy. Additional costs are associated with additional investments required to comply with IBC regarding Thermal Resistance (R) – however, these costs will be fully compensated because of the economic gains mentioned above. These economic gains will benefit construction companies and consumers.

Figure 1



In the current Georgian construction environment, construction businesses do not observe any standards and requirements related to Thermal Resistance (R), which results in residents spending increased operational costs to maintain heating and ventilation of the buildings.

IBC will promote internationally recognized standards of Thermal Resistance (R), which is a factor defining the ratio of building envelope thickness and thermal conductivity of materials

[2]EPI report on Assessment of the Costs and Thermal Performance of Construction Materials.

used in the structure. If the thermal resistance of a building design is known, it is possible to define the thickness of wall-filling layers and thermal characteristics necessary for preserving of comfortable air temperature inside, i.e. 19-21°C based on the amount of energy consumption (by building).

The observance of Thermal Resistance (R) would require some additional investments in the construction process, but the investments will be fully recovered and compensated because of the following factors:

1. Area gained as a result of decreasing wall thickness;
2. Saving of materials in retaining structure at the expense of lightening (reduction of thickness) of filler materials; and
3. Saving of energy needed for heating,

This analysis considers five types of wall – Options 1, 2, 3, 3a and 4.

Option 1 is a wall type that is most widely used in Georgian construction and is characterized by concrete block masonry, 40cm thick and plastered with sand-cement mortar from both sides. The other options that follow are modern options, one of which would be required to utilize upon enforcement of IBC. This analysis presents the economic impacts of utilizing Options 2, 3, 3a and 4 type of walls compared to Option 1, which is currently used in Georgia.

Option 2 is perlite block masonry, 20cm thick and plastered with perlite-cement mortar from both sides.

Option 3 is concrete block masonry, 20cm thick and plastered with sand-cement mortar from inside and insulated with 5cm heat insulation layer, with rock wool, (made on the basis of basalt fiber) plastered appropriately from outside.

Option 3a is similar to Option 3 but with one difference – in this case, two layers of basalt fiber mat (8mm each) are used for insulation. This insulation material is produced in Georgia, namely in the city of Rustavi.

Option 4 is perlite block masonry, 20cm thick with a 5cm rock wool heat insulation layer, also plastered appropriately from outside.

Each wall option is considered for II, III and IV class building (defined according to current Georgian legislation):

- II Class Building - 2 Floors, 300m^2;
- III Class Building - 8 Floors, 3015m^2
- IV Class Building -18 Floors, 14 040m^2

ADDITIONAL INVESTMENTS

Some additional investments are required to construct buildings according to the requirements of IBC compared to current construction practice.

Table 1

	Investment amount in GEL (price difference in comparison with Option 1)		
	2nd cl. Build, 2 Floors, 300m^2	3rd cl. Build 8 Floors, 3015m^2	4th cl. Build 18 Floors, 14040m^2
Option 1	0	0	0
Option 2	1312	12285	29889
Option 3	10388	92430	215578
Option 3a	5483	47205	106888
Option 4	16681	153990	370451
Average additional investments needed in compared to OPTION 1	8466	76478	180702
Average additional investments needed for each class of buildings per m^2 in compared to OPTION 1	28	25	13
For all the types of buildings average total additional investment per m^2 would be GEL 22			

Additional investment present the price difference in comparison with Option 1, which is needed for insulation of 1 m^2 of wall for certain options (2, 3, 3a, 4). In order to define capital investment, the consultant calculated the average market cost of wall-filling layers for each type of wall. The final amount of investment was obtained by multiplication of this cost to particular areas of appropriate class building.

ENERGY SAVING

The significant savings for consumers based on the IBC derives from the resulting decreased cost in heating. The implementation of IBC, which will significantly increase Thermal Resistance (R) of the building, will cause huge savings for consumers in building heating expenses.

Heat loss calculation was implemented for each option to define energy savings from heating. Fuel was defined as natural gas. The tables below show gas consumption and savings in comparison with Option 1, per heating season, which consists of the five coldest months during the year in Tbilisi.

Table 2

	2 class	3 class	4 class
	gas consumption per season m^3		
Option 1	**4971,2**	**28180,1**	**85793,6**
Option 2	3310,7	16717,8	49273,9

Option 3	2888,1	13800,098	39978,0
Option 3a	4337,2	23803,6	71849,7
Option 4	2435,2	10674,0	30018,1

Table 3

	2 class building, 2 Floors, 300m^2	3 class building, 8 Floors, 3015m^2	4 class Building, 18 Floors, 14 040m^2
	Gas cost saving per season (GEL)[3]		
Option 1	**0**	**0**	**0**
Option 2	847	5846	18625
Option 3	1062	7334	23366
Option 3a	323	2232	7111
Option 4	1293	8928	28446
Average cost savings in gas consumption per building during the season compared to Option 1	881	6085	19387
Average cost savings in heating gas consumption per 1 m^2 during the season compared to Option 1	3	2	1.4
For all the type of buildings average total cost saving on gas consumption for heating during the season per 1 m^2 would be GEL 2.1			

Assuming that the minimal exploitation period of the building is at least 50 years, average energy savings during 50 years for heating per 1 m^2 would be GEL 2.1 *50= GEL 105.

ADDITIONAL AREA GAIN

To implement the requirements of IBC regarding the insulation of buildings and the use of modern construction techniques means that the thickness of the external wall will be decreased, resulting in significant gain in the construction area – 1 running meter of the external wall gives 0.2 m^2 of additional area.

The additional area obtained as a result of reduced wall thickness was calculated for each type of buildings in the table below. The cost of 1m^2 is defined on the basis of minimal realty price in Tbilisi, which totals GEL 700.

[3] The calculation is based on the natural gas price in Tbilisi which is about 0.51 GEL.

Table 4

	2 class building, 2 Floors, 300m^2	3 class building, 8 Floors, 3015m^2	4 class Building, 18 Floors, 14 040m^2
	Gained Additional Area (in m^2)[4]		
Option 1	**0**	**0**	**0**
Option 2	42	423	725
Option 3	42	423	725
Option 3a	42	423	725
Option 4	42	423	725
For all the types of buildings, the average area gain per 1 m^2 of every new constructed area would be 0.07 m^2 *For all the types of buildings, the average value gain per 1 m^2 of every new constructed area would be 0.07m^2* GEL 700 = GEL 49*			

As it can be seen from the above analysis, insulation of the building can be quite profitable for investors. Even if it is not investor's direct commercial interest to save energy, the profit gained as a result of increased area exceeds investment several times. In some cases, savings made during construction also provides additional benefits. In the end, energy efficient building is the best advertisement for selling areas.

CONSTRUCTION ECONOMY

Savings will also result from the weight reduction of buildings through savings related to building skeletons. Based on the *EPI Assessment of the Costs and Thermal Performance of Construction Materials,* the construction of 3rd and the 4th class buildings will result in significant construction economy because of savings in building skeletons.

Table 5

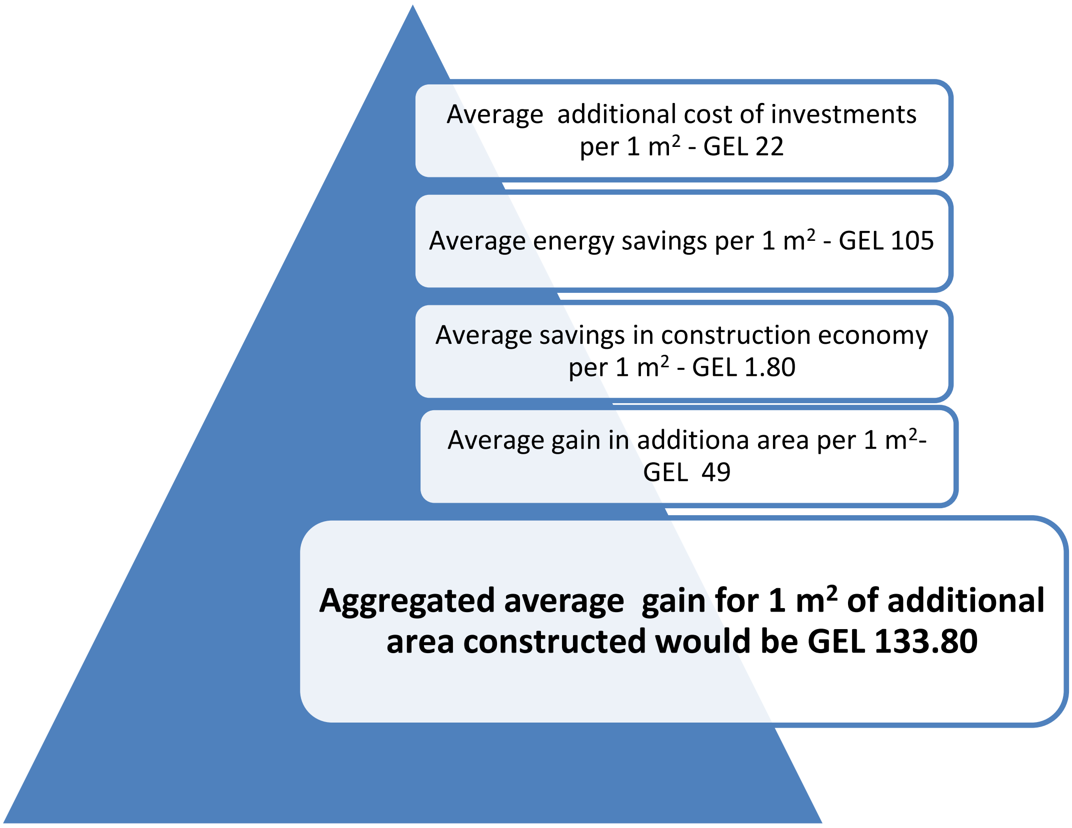
	2 class building, 2 Floors, 300m^2	3 class building, 8 Floors, 3015m^2	4 class Building, 18 Floors, 14 040m^2
	Saving from construction economy (in GEL)		

[4] EPI report on 'Assessment of the Costs and Thermal Performance of Construction Materials' identifies how many additional m^2 will be constructed because of 'Additional Area Gain' effect in the each class of buildings utilizing all 5 options. The EPI Building Codes Assessment Report then presents the findings related to the impacts for the entire buildings constructions (for each class and options) in its sub-chapter 'Investment Regain Diagrams', pages: 27-32.

Option 1	**0**	**0**	**0**
Option 2	0	3200	33600
Option 3	0	9600	36800
Option 3a	0	9600	36800
Option 4	0	9600	36800
Average cost savings in construction economy per building compared to Option 1	0	8000	36000
Average cost savings in construction economy per m^2 compared to Option 1	0	2.7	2.6
For all the types of buildings, the average cost savings in construction economy per 1 m^2 of every new constructed area would be GEL 1.8			

SUMMARIZING THE TOTAL BENEFITS

Figure 2



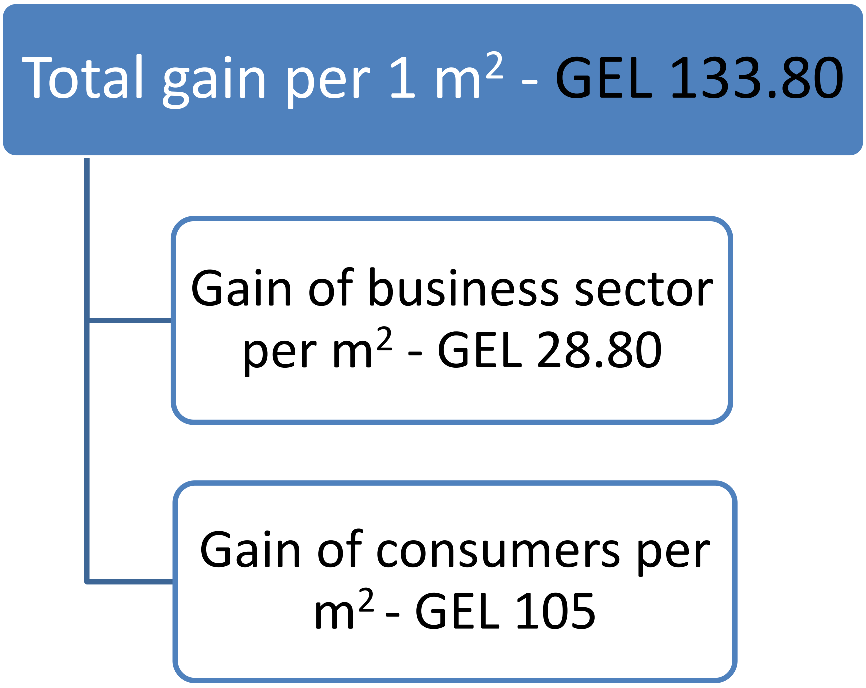
Out of the total gain for 1 m^2 of new construction that is GEL 133.80, the benefit to construction businesses would be equal to:

(average gain in additional area)+ (average saving on construction economy) - (average additional cost of investments)

GEL 49 + GEL 1.80 - GEL 22= GEL 28.80

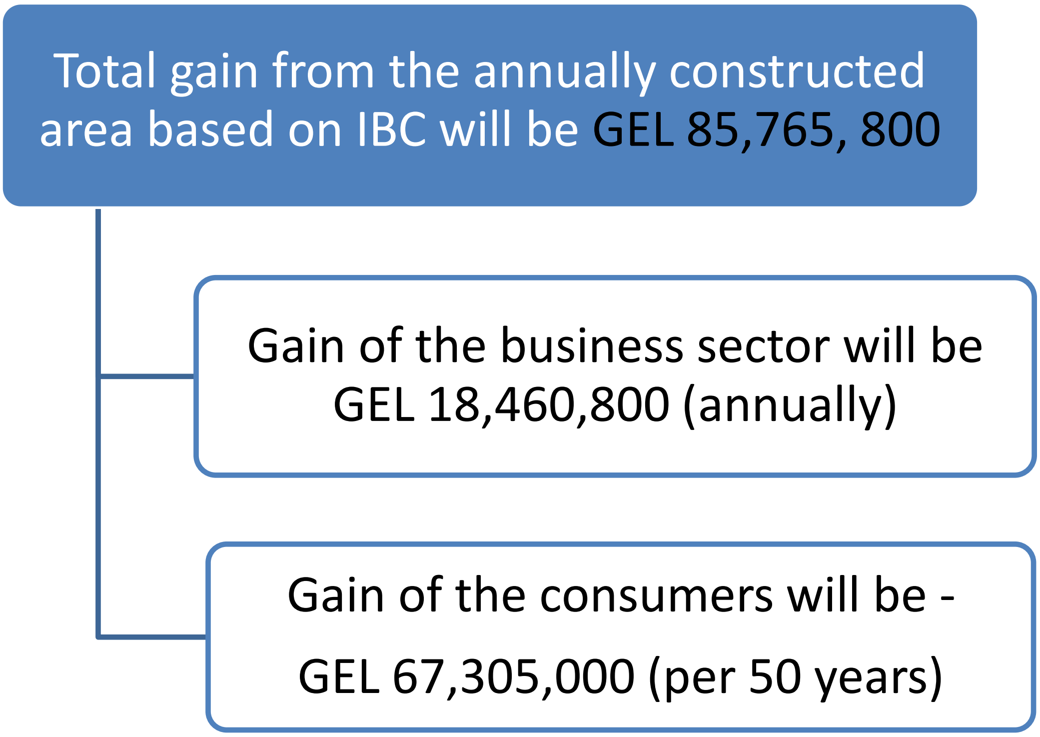
Out of the total gain on 1 m^2 of new construction that is GEL 133.80, the benefit of consumers will be an average energy savings of 105 GEL, as illustrated below.

Figure 3



Initially for some significant time period, the implementation of IBC will not be observed for 2 floor, 2nd class buildings; therefore, at this stage, 2nd class buildings should be excluded from the final economic benefits calculations. In 2011, 801,353 m^2 were constructed in Georgia – out of this amount, approximately 80% of the new constructed area included 3rd and 4th class buildings. Based on these numbers, it is calculated that Georgia would receive benefits for approximately 641,000 m^2 of new constructed area annually from implementation of IBC.

Figure 4



ADMINISTRATIVE COST RELATED TO INTERNTATIONAL BUILDING CODES IMPLEMENTATION

Implementation of IBC will be accompanied by some administrative costs in order to oversee its compliance. Based on the current legislation, the Technical and Construction Inspection Agency is responsible for checking documentation for compliance and private inspections are responsible for spot checking of compliance.

Generally, inspection of building code compliance includes two phases: a) inspection during the building projection phase and b) technical oversight of the construction process. While the costs related to the technical oversight of the construction process would not change significantly after IBC enactment, some additional resources will be required to implement inspection during the building projection phase.

The existing practice for the inspection of building projects is limited to construction structures and geological expertise, but not expertise in construction planning. Implementation of IBC will require construction planning expertise – based on independent experts' assessments, this will increase expertise workload and cost approximately by twice as much.

Currently the average cost to conduct construction project expertise for III and IV class buildings (III Class Building - 8 Floors, 3015m^2, IV Class Building -18 Floors, 14 040m^2) is approximately GEL 2000. In 2011, approximately 250 III and IV class buildings were constructed in Georgia – based on this number, the annual approximate additional cost under IBC implementation would be GEL 500,000.

SOME OTHER QUALITATIVE AND QUANTITATIVE BENEFITS OF IBC

IBC protects public health, safety and welfare

IBC provides protection from tragedy caused by fire, structural collapse and general deterioration in homes, schools, stores and manufacturing facilities. Safe buildings are achieved through proper design and construction practices and a code administration program that ensures compliance. Home and business owners have a substantial investment that is protected through complete code enforcement.

Economy of scale

IBC provides uniformity in the construction industry. This uniformity permits building and materials manufacturers to do business on a larger scale — statewide, regionally, nationally or internationally. Larger scale allows cost savings to be passed on to the consumer.

The preservation of life and safety, as well as the maintenance of property values over time, are a direct result of the application and enforcement of IBC.

The conservation of energy contributes to intelligent use of resources and provides the consumer with cost savings.

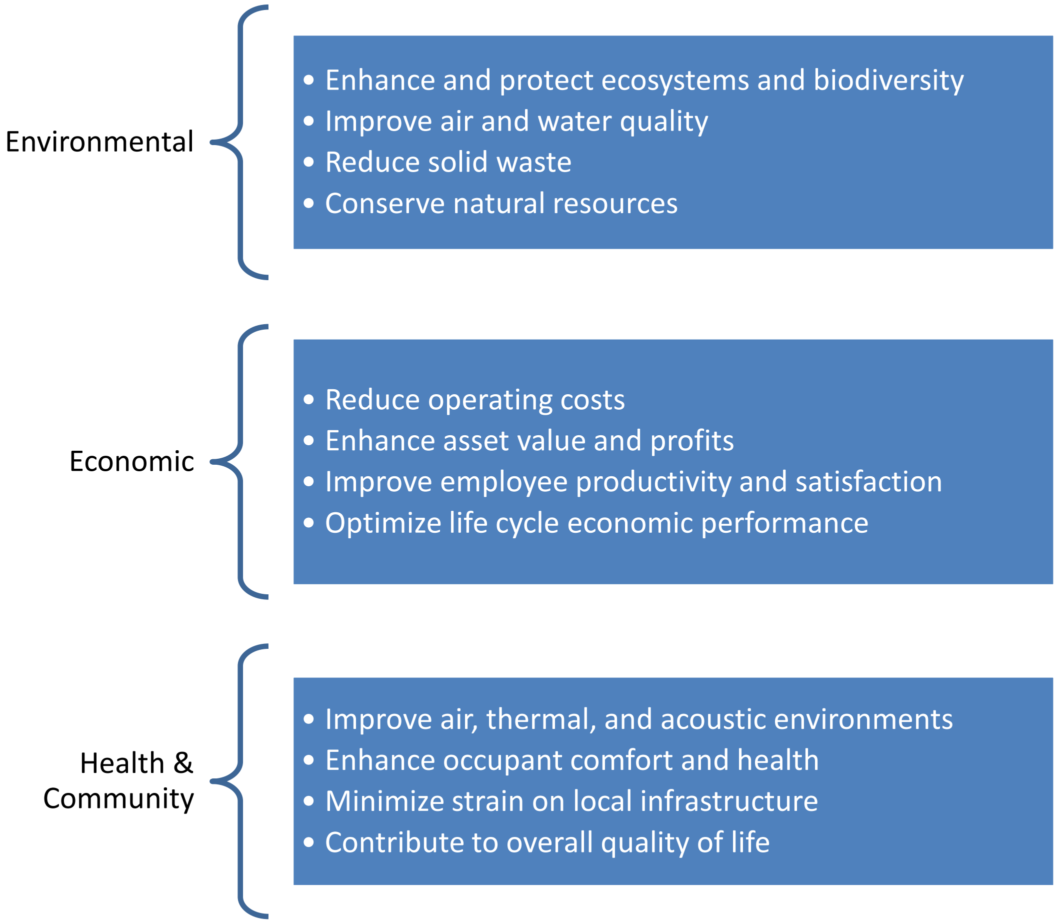
Starting phase towards the implementation of Green Building Policy

IBC is an important first steps towards the implementation of a green building policy, that based on experts' estimations will increase energy savings in average by 37 %, savings in CO_2 emissions by 72%, savings in water used by 40% and savings in solid waste by 70%.

The diagram below summarizes the benefits of green buildings[5]:

[5] EPI Building Codes Assessment;

Figure 5


Environmental
• Enhance and protect ecosystems and biodiversity
• Improve air and water quality
• Reduce solid waste
• Conserve natural resources
Economic
• Reduce operating costs
• Enhance asset value and profits
• Improve employee productivity and satisfaction
• Optimize life cycle economic performance
Health & Community
• Improve air, thermal, and acoustic environments
• Enhance occupant comfort and health
• Minimize strain on local infrastructure
• Contribute to overall quality of life

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