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ENERGY EFFICIENT KINDERGARTENS IN BELGRADE: CRITICAL ANALYSIS OF GOOD PRACTICE OF COMPETITION SOLUTIONS IMPLEMENTATION

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Marija Lalošević[1], Mirko Komatina[2], Marko Miloš[2], Nebojša Stefanović[1]

[1]The Institute of Architecture and Urban & Spatial Planning, Belgrade, Serbia
[2]University of Belgrade, Faculty of Mechanical Engineering, Belgrade, Serbia

Abstract. *The paper critically analyzes the process of realization of energy efficient kindergartens in the City of Belgrade whose designs are obtained in the open public urban architectural competition. The process initiated, financed and realized by the city government of the City of Belgrade is an example of an effort toward meeting the EU directives and achieving the Energy Community objectives in the field of energy efficiency and usage of renewable energy sources, where facilities for public use must lead and be examples of the best practice. The whole process is analyzed, starting from planned conditionality of urban-architectural competition announcement through special conditions concerning energy efficiency and usage of renewable energy sources to construction and use of zero energy kindergartens, with a special analysis of the energy efficiency parameters of one of the kindergartens chosen as a representative of a good practice of competition solutions implementation of energy efficient facilities for the public use.*

Key words: *energy efficiency, kindergartens, renewable energy sources, architectural and urban planning design competition, public concern, the City of Belgrade*

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Corresponding author: Marija Lalošević
Institute of Architecture and Urban & Spatial Planning of Serbia
Kralja Aleksandra Blvd. 73/II, 11000 Belgrade, Serbia
E-mail: marija.lalosevic@urbel.com

1. OBJECTIVE, CONDITIONS, ACTORS, AN INNOVATIVE APPROACH TO THE PROCESS

In accordance with the City of Belgrade Development Strategy [1], the most important strategy document for the city development, and the defined priority development projects in the field of energy efficiency and social protection, the city of Belgrade announced "International, anonymous, one-stage competition for preliminary architectural and urban planning design of the five energy efficient kindergartens in Belgrade, Serbia", in October 2010.

The main objective of the architectural-urban competition was to increase the public choices and offers of optimal quality energy efficient designs through the institution of competition and to obtain professionally verified designs with accurate cost assessment, for all five locations planned for construction of kindergartens in Belgrade.

The design teams are asked to give five designs for the facilities located in the different municipalities of Belgrade (three in New Belgrade and one in the settlement of Stubline near Obrenovac and the other in the settlement of Banjica).

The suggested designs were to be in compliance with the urban conditions, the project terms of reference, the applicable standards for kindergarten facilities as well as all the other applicable standards particularly in the field of safety, applied materials and proposed equipment. At the same time, the modern requirements in the field of energy efficiency were to be met, the environmental awareness and the economy in the construction and service were to be supported, which was highlighted as the primary objective in the competition announcement.

The competition was announced by the Agency for Investment and Housing of the City of Belgrade, the Secretariat for Child Protection of the City of Belgrade, the Serbian Association of Architects and the Belgrade Association of Architects.

The nature of competition: according to type the competition was general and public, according to task it was architectural and urban, according to form it was one stage and according to manner and way of work it was anonymous. All natural and legal persons from the territory of the Republic of Serbia who had at least one engineer of architecture with an authorized designer license in their team had the right to participate in the competition.

Forty-three author teams with over 200 proposed designs participated in the public urban-architectural competition for the five energy efficient kindergartens in the City of Belgrade Belgrade, closed in November 2010.

The eminent jury chose one project for each of the five locations, after which the winners of awards began with the development of kindergarten major projects.

The whole process was transparent, and the exhibition of all the submitted papers was held in December 2010 in the building of the Museum of the City of Belgrade. During the exhibition a public open discussion was held with the participants of the competition, the jury, the city architect, the Mayor and all interested citizens.

This process was performed with great efforts of the City of Belgrade institutions and represents one of the rare activities where the expert public was free to participate and professionally compete, and it is the only urban-architectural competition in which the condition was that the buildings were energy efficient and used renewable energy sources from the site.

Since the announcement of the competition to this day (September 2016), the City of Belgrade has built with its funds from the budget four kindergartens which, as an example of a good practice, use renewable energy sources for their own needs, are integrated into the urban environment and each separately represents a prestigious architectural range in design.

All the kindergartens use geothermal energy, have solar connectors for hot water and photovoltaics on the rooftops.

The innovation of the presented process lies in two factors – the use of renewable energy sources in public facilities/kindergartens and the implementation of public urban-architectural competition for the best urban-architectural designs. What is also innovative for the Republic of Serbia is the fact that four out of five planned facilities are constructed and are in use.

The whole process was conducted and financed by the City of Belgrade.

Fig. 1 Illustration: The awarded competition projects for the five locations of energy efficient kindergartens in Belgrade, Serbia [2]

2. CONTEXT – LIABILITIES TO ENERGY COMMUNITY AND EUROPEAN UNION IN THE SECTOR OF PUBLIC BUILDINGS

Signing the Agreement with Energy Community (Decision of the Energy Community Ministry Council from December 2009 - Decision No 2009/05/MC-EnC) and September 2010 - Decision No 2010/02/MC-EnC), the Republic of Serbia assumed the obligation to implement the three European directives into national legislation, including the Directive 2010/31/EU on energy performance of buildings (Directive on the energy performance of buildings-referred to as EPBD) [3].

The Directive 2010/31/EU (Recast EPBD) on energy performance of buildings indicates the need and necessity of making concrete actions aimed at exploiting the great potential for energy savings in buildings. It also draws attention to the insufficient use of renewable and alternative energy sources in buildings and it requires their mandatory consideration for all new buildings regardless of size as well as for existing buildings in major reconstructions. Member states of the European Union are required to prepare national plans for increasing the number of nearly zero energy buildings, as well as to regularly report on it to the European Commission. What is particularly emphasized is that public buildings sector must take a leading role in the field of improving energy efficiency in buildings and must outline more ambitious targets for public buildings.

Due to the increased activity of the Republic of Serbia in joining the European Union, as a society we must become aware that we will have obligations in the near future and that just the same as the other member States we will also have to invest effort for energy savings in the buildings sector and in the field of use of renewable energy sources. We must bear in mind that the Directive to the member States of the European Union imposes the obligation that all new buildings be nearly zero energy buildings until December 31st, 2020, as well as that all new buildings used for public purposes and buildings owned by the government (public sector) be nearly zero energy buildings after December 31st, 2018.

The example of the five Belgrade kindergartens that use renewable energy sources for their own needs is the example of a good way toward the outlined objectives and obligations in the public buildings sector.

3. Terms of Urban-Architectural Competition for Energy Efficient Kindergartens in Belgrade

3.1. Kindergartens locations and general conditions

The task of the competition was the development of architectural and urban design of kindergartens in the following locations:

1) Kindergarten 6, Urban Municipality of New Belgrade, part of the block 12, Grčka bb Street, Bežanijska kosa
2) Kindergarten 11, Urban Municipality of New Belgrade, block 61, Vojvođanska bb Street, Bežanijska kosa
3) Kindergarten in University settlement, Urban Municipality of New Belgrade, block 67, Milutina Milankovića bb Street
4) Kindergarten in the settlement of Stubline, Urban Municipality of Obrenovac
5) Kindergarten in the settlement of Banjica, Urban Municipality of Voždovac, Baštovanska Street.

Author teams were supposed to do the planning design for all five locations.

It was necessary that the design meets all the parameters set in the project task. Free-standing structures were planned at all locations which were supposed to be set up within the given construction lines on the plot, so that the group rooms for children were predominantly southern oriented. It was necessary that the manner of conceiving the dimensions, design and processing of the facade coincides with urban planning documentation and the rules of urban regulations (special urban conditions were given for each location separately). The suggested designs had to meet the general requirements of hygienic comfort – concerning the standards for all kinds of construction and installation materials and structures, ventilation, natural ventilation, as well as to meet the given structure of the facility (rooms for educational work, shared premises, management rooms, supply department rooms, utility rooms). The design was to be with courtyard design, free areas of the complex with underground infrastructure and external lighting.

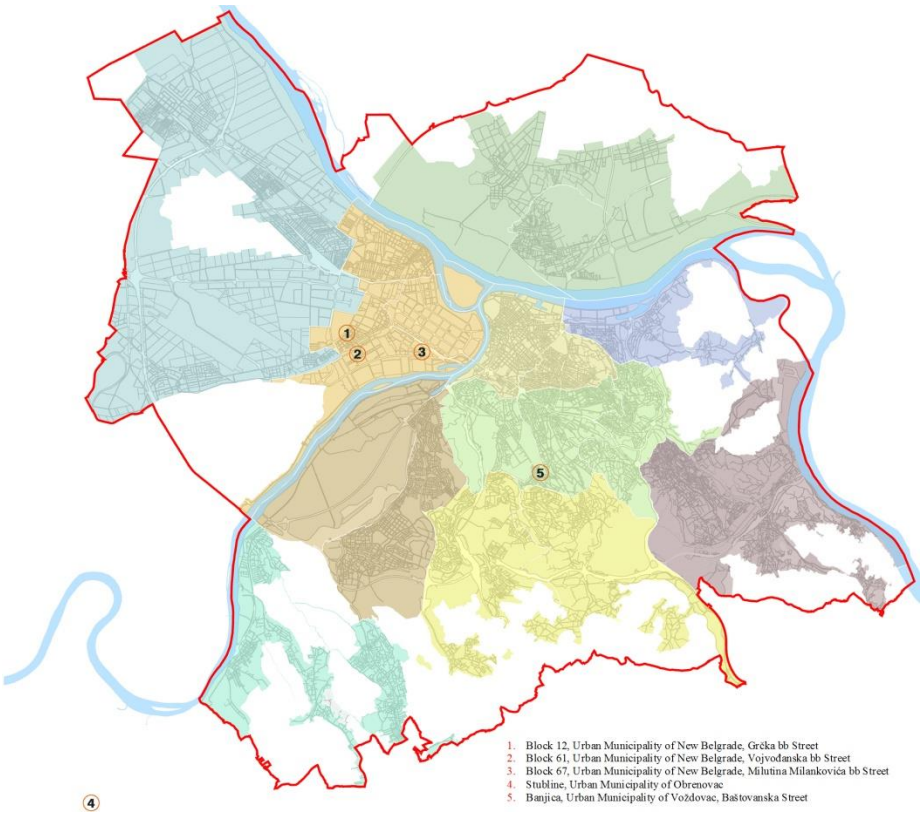

Fig. 2 Plan of the location of the kindergarten related with the City of Belgrade

3.2. Special conditions concerning energy efficiency and the use of renewable energy sources

Special conditions concerning energy efficiency and the use of renewable energy sources for energy efficient kindergartens:

- *Thermal comfort* – use idle/efficient architecture and other necessary means to ensure the temperature in the facility is maintained as close to the limits of comfort as possible, without turning the HVAC (air conditioning, heating, cooling) installations on.
- *Visual comfort* – implement measures necessary for the introduction of maximum daylight into rooms and minimal use of artificial lighting; allow the maximum daylight by using the correct position and dimension of windows; maximize the diffuse daylight while minimize the direct daylight; introduce natural light through the ceiling whenever it is possible; ensure the effective control of glare using modern methods; for artificial classroom lighting use lamps with an optimal direct and diffuse lighting components; design damping of artificial lighting with continuous damping and adequate guidance of the level of brightness; design the artificial lighting in a way as to be compatible with the natural light; design the artificial lighting with the possibility to power on/off based on occupancy.

- *Facility* – it should be designed so that it provides maximum solar radiation during winter and minimal during summer, child's rooms orientation for the given location should be the most convenient (South, possibly East); take into consideration that the specific local conditions (wind, etc.) can have impact on deviation on south orientation; the facility should be as of compact design as possible, preferably without separate blades, a stack or cantilever elements; the facility should have an optimal ratio of nontransparent and transparent areas; the facade layer must have a high tightness; the designed thermal mass should increase the thermal inertia of the facility.
- *Heating and ventilation systems* – analyze the possibility of applying independent heating system from renewable sources, using a heat pump, water/water with ground probes for energy use of the ground or sub geothermal waters, as well as using the low-temperature heating by means of radiation; design artificial ventilation using two-speed fans; recover waste energy with plate heat exchangers; design elements of heating and ventilation system with the highest degree of efficiency of equipment and distribution of energy medium, under full and partial load; design the system measuring heat consumption.
- *Energy savings* – ensure maximum use of natural resources to increase energy efficiency of the facility by means of idle architecture elements; ensure the use of all forms of waste energy in the facility; preparation of hot water usage by alternative energy sources – solar or heat pump; take all necessary measures of saving energy in the system of electrical installations.
- *Plumbing and sewage* – design measures and equipment for efficient use of water installations; design efficient preparation of hot water; design efficient faucets with adjustable spring for turning off; design the use of dual-flush toilets.

4. AWARDED DESIGNS OF ENERGY EFFICIENT KINDERGARTENS – FROM DESIGN TO IMPLEMENTATION

4.1. Site No1 – Bezanijska Kosa, New Belgrade, Serbia – Kindergarten "Stardust"

Special competition conditions for location of "Stardust" kindergarten: plot area 6138m²; terrain of the complex is flat with a mild decline toward Nede Spasojević Street; planned number of floors P+1; gross floor area of the facility 1890m²; the facility capacity is 252 children.

Authors of the awarded design: architects Ana Nastić, Miloš Paunović, Marko Petrović, Uroš Kovačević and Petar Bojović

Fig. 3 and **Fig. 4** Awarded project – Spatial representation

Fig. 5 North-east appearance

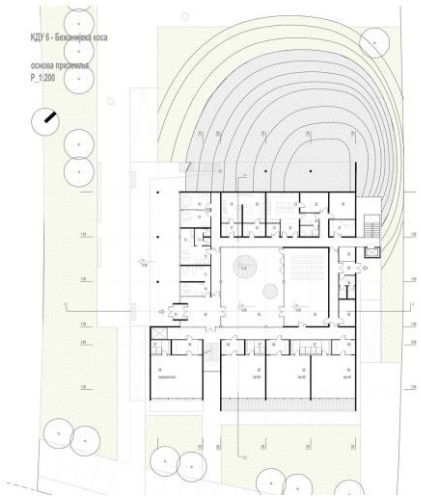

Fig. 6 Ground floor base

Fig. 7 and **Fig. 8** Constructed facility of "Stardust" kindergarten

4.2. Site No2 – Block 61, New Belgrade, Serbia – Kindergarten "Dragan Lakovic"

Special competition conditions for the location of "Dragan Laković" kindergarten: plot area 6311m²; the complex terrain is mostly flat; planned number of floors P+1; gross floor area of the facility 2100m², the facility capacity is 315 children.

Authors of the awarded design: architects Borislav Petrović, Ivan Rašković, Aleksandar Tomić, Nada Jelić, Nikola Stojković, Luka Ostojić and Anđelka Munić. Associate: Boris Petrović. Consultants: Milica Jovanović Popović, Martin Elezović, Milenko Marić, Zoran Šipetić, Vladan Lutrov and Nikola Paunović

Fig. 9 Spatial representation of "Dragan Laković" kindergarten

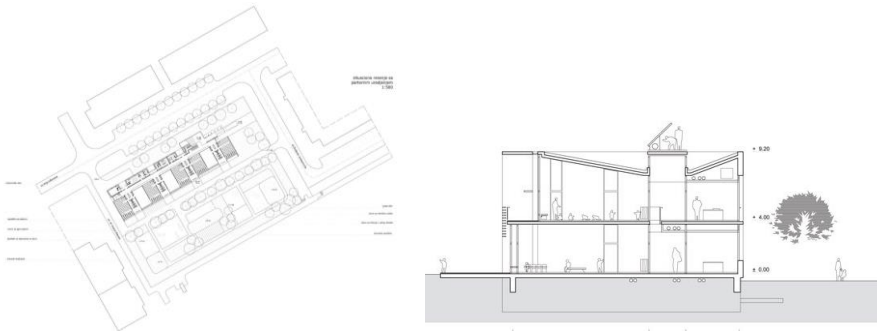

Fig. 10 and **Fig. 11** Situational presentation and cross-section through the facility

Fig. 12 and Fig. 13 Constructed facility of "Dragan Lakovic" kindergarten

4.3. Site No3 – Block 67, New Belgrade, Serbia – Kindergarten "Nikola Tesla"

Special competition conditions for the location of "Nikola Tesla" kindergarten: plot area 6138m²; planned numbers of floors P+1; gross floor area of the facility 1600m², the facility capacity is to accommodate 230 children. Construction index is 0.5, the degree of occupancy is up to 30%.

Authors of the awarded design: architects Milka Gnjato, Marko Radenković, Milan Đurić, Aleksandru Vuja and Jelena Živančević

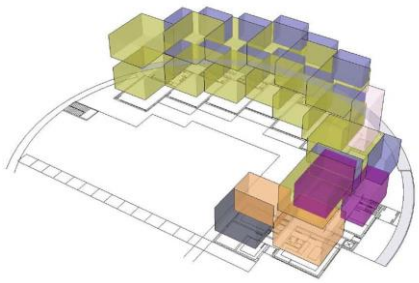

Fig. 14 and **Fig. 15** The ground floor base and spatial representation

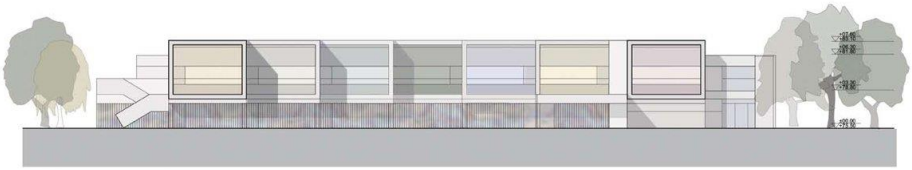

Fig. 16 South-east appearance

Fig. 17 and **Fig. 18** Constructed facility of "Nikola Tesla" kindergarten

4.4. Site No4 – Obrenovac, settlement Stubline, Belgrade, Serbia – Kindergarten "Bellflower"

General competition conditions for the location of "Bellflower" kindergarten: the complex area is 1.09.89 ha; the complex terrain is flat, with a mild decline from West to East; planned numbers of floors P+1; gross floor area 6,5-7,5m²/per child, capacity of the facility is to accommodate 270 children.

Authors of the awarded design: architects Aleksandra Raonić, Branislav Ristović, Miloš Raonić and Danilo Furundžić. Consultants for Energy Efficiency: EN PLUS

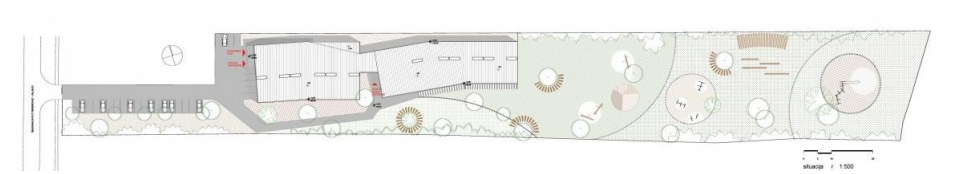

Fig. 19 Situation plan

Fig. 20 The ground floor base

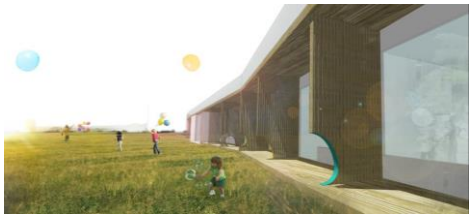

Fig. 21 and **Fig. 22** Spatial representations

Fig. 23 Constructed facility of "Bellflower" kindergarten[1]

4.5. Site No5 – Vozdovac, settlement Banjica, Belgrade, Serbia

General competition conditions for the location of the kindergarten: plot area is 4173m²; the complex terrain is flat with a mild decline toward Baštovanska Street; planned numbers of floors is P+1; gross floor area of the facility 2025,00 m², the facility capacity is to accommodate 264 children. Maximum construction index is 0,5. The degree of occupancy is 41%. Minimum 30% of green areas on the plot, playgrounds for children are not included in the percentage of green areas.

[1] http://www.novosti.rs/vesti/beograd.74.html:539091-Uz-novi-vrtic-i-skolska-sala (Retrieved August 2016)

Authors of the awarded design: architects Jelena Miletić and Dejan Miletić.

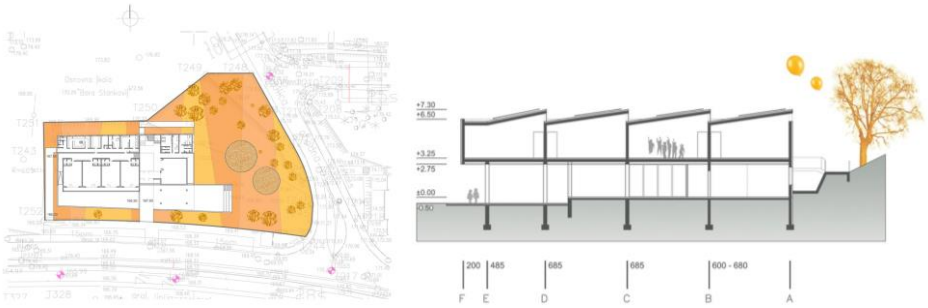

Fig. 24 and **Fig. 25** The ground floor base and cross-section through the facility

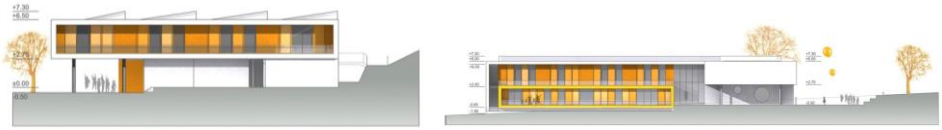

Fig. 26 and **Fig. 27** Facades

Fig. 28 and **Fig. 29** Spatial representations

The facility is not constructed.

5. Parameters of Energy Efficiency of the Constructed "Stardust" Kindergarten

This paper presents parameters for the first constructed of the facilities, "Stardust" kindergarten in Bežanijska kosa which, as well as other kindergartens, intensively uses renewable energy sources. There are the most valid data for this facility.

The building of "Stardust" kindergarten has been in operation for five years. There are continuous measurements of typical energy values. In the kindergarten facility there is a display that shows the total electricity produced.

The main source of heat for thermo-technical installations is geothermal energy of ground water. Photovoltaics and solar collectors are installed.

The main data and parameters are the following:

- *Renewable energy sources – geothermal energy::*
  - Groundwater energy is used by means of heat pump of water/water type;
  - Groundwaters are reached by pumping well;
  - Pumping well depth is 61 m and yield is 5 l/s;
  - The water temperature during winter is 15 °C;
  - Two heat pumps heat water in winter to 50 °C;
  - Heat pump heating capacity is 123 kW at a temperature regime 50/45 °C;
  - Heat pump cooling capacity is 88 kW at a temperature regime 7/12 °C.
- *Renewable energy sources – solar energy / solar collectors:*
  - Solar collectors are used forpreparing hot water for the kitchen and other purposes;
  - Solar collectors are set on the roof at an angle of 45°;
  - 7 receivers of 2,6 m² area are installed.
- *Renewable energy sources – solar energy / photovoltaics:*
  - 14 photovoltaic cells of 1668x1000mm size, and with 225 W electric power are installed;
  - Total installed power is 3,2 kW.

The building has a central system for monitoring and control, which monitors and collects the key information concerning facility operation/service in terms of thermo-technical and electrical installations. Automatic control and monitoring system of the facility includes a certain number of analogue and digital inputs for data reading from a device in the facility, analogue and digital outputs for the facility devices control, applications for managing the processes, interfaces for displaying the status of the process and certain physical parameters, as well as the part for storing the collected data in a given period of time.

Data reading shows that the geothermal source provides up to 80% of the heat energy required for heating the building during winter time, which is an extremely important component in the energy balance of the building. In the summer, the geothermal source owns a several times greater capacity for heat removal than that required for cooling the building. The results show the justification of the heat pump usage compared to conventional methods of conversion of electrical energy or fossil fuel energy into heat energy, in terms of energy efficiency of the building. The energy invested in the work of heat pump results in multiple gain of thermal energy which is used in the building.

The building solar collectors are used for heating the domestic hot water. The data shows that 65% of solar energy is used annually to achieve the desired parameters of domestic hot water which certainly justifies the use of solar collectors for heating the domestic hot water. Solar collectors significantly contribute to the building energy balance using renewable and affordable solar energy as a source.

The system of photovoltaic cells in the building gave poorer results in operation than the projected ones. Manufacturer's guaranteed cell capacity is 90% of the nominal in the first 10 years of exploitation and 80% of the nominal for the first 25 years of exploitation. The coefficient of conversion is in the theoretical domain 4 times lower in comparison with the conversion through solar collectors. In the operation of the "Stardust" facility, this coefficient is lower than expected, with a number of other parameters which further adversely affect the period of profitability (the cost of installation maintenance, the decline in the efficiency of photovoltaic cells over the years, the loss of electric power inverter, variable yield of electric energy using the above mentioned system) leading to a conclusion

that the energy performance of photovoltaic cells is such that from the standpoint of quantity of used energy, the solar collectors provide significantly greater efficiency.

Based on the overall parameters in operation of the facility it can be concluded that renewable energy sources contribute to energy efficiency of the facility. The required amount of heat generated by application of electricity is minimized by using solar radiation and geothermal sources.

The aim to achieve high levels of energy efficiency of the facility has not compromised comfort in the building, which is one of the important parameters in assessing the performance of the facility, considering the maximum comfort achieved in all the premises of the kindergarten.

The "Stardust" kindergarten is a facility where most of its energy needs is realized by using renewable energy sources from the site. The use of renewable energy sources to a significant extent for their needs, with a compact volume of the facility and the used structural materials that provide energy savings in regular service, in the total balance of energy production from renewable sources and energy consumption the "Stardust" kindergarten is considered to be in the category of facilities "Nearly zero energy building".

"Stardust" kindergarten is one of the best examples that as a society and community we are able to design and construct in a way that meets the EU quality standards and this type of facilities should be strived for.

6. General Conclusion – the Competition Objective is Fulfilled

The main objective was to obtain the best designs for energy efficient kindergartens on the five specific locations in Belgrade through repressed and forgotten institution of competition, and that all the interested experts be allowed to participate in the competition for the best facilities. The number of experts who participated in providing the competition designs was remarkable, which indicates not only the interest of the profession, but also the quality of the project and urban task set by the City of Belgrade. The selected designs, as it was specified in the competition announcement, served as the basis for issuing the location permit and announcing the public procurement for the development of major projects and construction works.

The nominated and selected designs are completely in accordance with the urban requirements, the terms of reference, the applicable standards for the facilities of kindergartens in the Republic of Serbia (in particular the Regulations on detailed conditions for the startup and performance of activities of institutions for children [4] and the Decision on the adoption of norms for planning, construction and equipping of preschool institutions [5]), as well as other applicable standards particularly in the field of safety, applied materials and equipment proposed. At the same time, they met the modern requirement from the field of energy efficiency, in accordance with the Law on Planning and Construction [6] regulated terms of energy efficiency (by the Rulebook on energy efficiency of buildings [7] and the Rulebook on conditions, content and manner of issuing certificates on energy performance of buildings [8]), they support environmental awareness and economic moment and the possibilities of our society, as well as the economy in construction and operation. They are an outstanding example a good practice of meeting the standards for the public buildings imposed the European Union directives, that buildings be close to nZEB concept using renewable energy sources from the site for their own needs.

The competition objectives are met.

7. CONCLUDING REMARKS AND RECOMMENDATIONS

- Realization and putting into use the four out of five planned energy efficient facilities of kindergartens whose designs are obtained in the public urban architectural competition is an enormous success of the City of Belgrade and its institutions and an excellent example of the ability of society to implement the public sector facilities that meet the quality standards of the EU.
- All four implemented facilities are good designs and they represent a high range in architecture. Also, the concepts of interior space organization provide optimal conditions of thermal, visual, sound organizational and educational comfort.
- "Physical structures designed for preschool children upbringing and education, i.e. exterior and interior environment, have a multiple influence on cognitive, social and emotional development of the children. Preschool children, as especially sensitive and vulnerable social group, within lots of development-essential needs and demands, require interior environment that is the product of careful and precise design process, in other words - the environment that will provide comfortable, healthy and stimulating stay." [9]
- Energy efficiency covers an extremely wide area, from construction and transport to distribution of energy and potable water, in a broad sector from households to public buildings and industry. Since this field is very complex and demanding, it is important to establish a proper strategy for the implementation of energy efficiency measures. General measures of improving energy efficiency and using the renewable energy sources include research, educational and promotional measures that have a social benefit. One of the main barriers in implementation of energy efficiency measure and use of renewable energy sources is a lack of information, ignorance, as well as insufficient awareness of the need for environmental protection and sustainable development. Since the rational use and energy management is the basic assumption of sustainable development, it is extremely important to include the area of energy efficiency and use of renewable energy sources in educational programs and professional trainings, as well as to encourage research in this area. Raising the level of knowledge is one of the most important ways to remove the barriers of implementation of energy efficiency measures and use of renewable energy sources.
- In the facility of "Stardust" kindergarten in Bežanijska kosa there is a display that shows the total electricity produced. It primarily has an educational effect on children, who already learn at this age what it means to produce energy, how to save the environment, how to take care of the future of the planet and what a sustainable development is.
- Unfortunately, in the kindergartens of "Dragan Lakovic", "Nikola Tesla" and "Bellflower", which are also an example of approaching the concept of "Near zero energy building", there is no such a transparent approach in reading the parameters of energy production for their own needs from the location and the data is hard to obtain, which is a bad example of finalization of the project itself after an extensive and serious commitment of all participants in the process, from announcing the urban architectural competition to finalization itself and the use of the facilities, and could have been a very good both educational and marketing example for the public sector.

- "The causal relations of architectonic design – ambience quality factors in the preschool facilities, are an important starting point in defining the physical environment where the children stay, and which is significant for the development of children at all." [10]
- It is of invaluable importance that the facilities in which children reside be the best solutions of both physical structures and conditions of comfort. The solutions obtained in the public urban architectural competition and implemented in compliance with authors projects and all applicable regulations are excellent examples of good practice of ways of ensuring the optimal conditions of growth and education of children.
- The law did not oblige stakeholders to announce the public urban architectural competition for the best designs that rely on the use of renewable energy sources and in this respect the described process is completely innovative.
- Farsightedness of the City of Belgrade government and the desire to shift from standard procedures resulted in the announcement of the competition, the public presentation of works, involving the competition winners in the development of major projects and subsequent education of children and parents about the importance of sustainable development.
- When the kindergartens began to be used, "EKO workshops" were organized for the children and their parents in order to highlight the importance of using the renewable energy sources, protecting the environment and the awareness of the importance of rational use. It was explained to children through play what energy means, what renewable sources are and how to grow up into people who behave sustainably toward the environment.
- The presented process starting from the initial idea to the implementation of energy efficient kindergartens in the City of Belgrade should be a prominent example to the other city governments and decision-makers in the Republic of Serbia, to join the efforts so that the facilities in the public sector, above all, be "Nearly zero energy building".

Note: Author of photographs of the constructed kindergartens "Stardust","Dragan Lakovic" and "Nikola Tesla" - Marija Lalošević.

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ENERGETSKI EFIKASNE PREDŠKOLSKE USTANOVE U BEOGRADU: KRITIČKA ANALIZA DOBRE PRAKSE REALIZACIJE KONKURSNIH REŠENJA

U radu je kritički analiziran proces realizacije pet energetski efikasnih vrtića u Gradu Beogradu čija su rešenja dobijena na javnom otvorenom urbanističko-arhitektonskom konkursu. Proces iniciran, finansiran i realizovan od strane gradske uprave Grada Beograda primer je napora ka ispunjenju direktiva EU i dostizanju ciljeva Energetske Zajednice u oblasti energetske efikasnosti i korišćenja obnovljivih izvora energije, u kojima objekti javne namene moraju da prednjače i budu primeri najbolje prakse. Analiziran je celokupan proces, od planskih uslovljenosti raspisa urbanističko-arhitektonskog konkursa preko posebnih uslova vezanih za energetsku efikasnost i korišćenje obnovljivih izvora energije do izgradnje i upotrebe dečijih ustanova niske potrošnje energije, sa posebnim analizom parametara energetske efikasnosti jednog od vrtića koji je izabran kao reprezent dobre prakse realizacije konkursnih rešenja energetski efikasnih objekata javne namene.

Ključne reči: *energetska efikasnost, predškolske ustanove, obnovljivi izvori energije, arhitektonsko-urbanistički konkurs, javni interes, Grad Beograd*