FIFA WORLD CUP RUSSIA 2018

More sustainable stadiums

Fourth technical report on the implementation of environmental, energy- and resource-efficient design solutions for the stadiums of the 2018 FIFA World Cup Russia™

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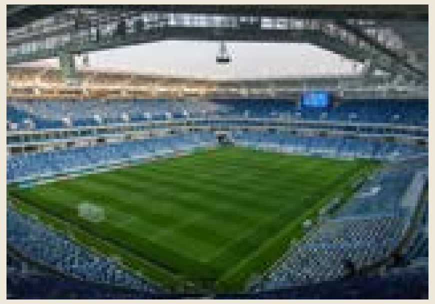
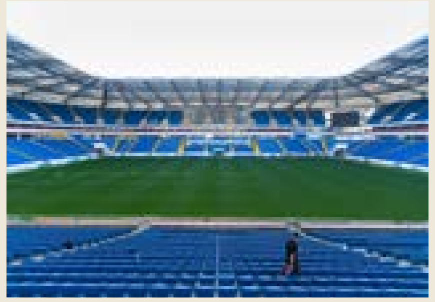


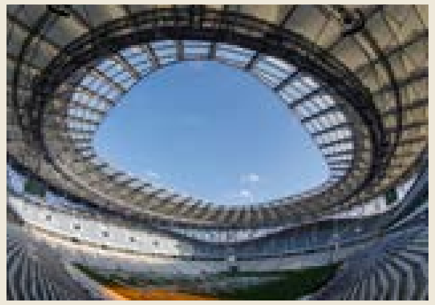
Kaliningrad Stadium

Luzhniki Stadium of Moscow

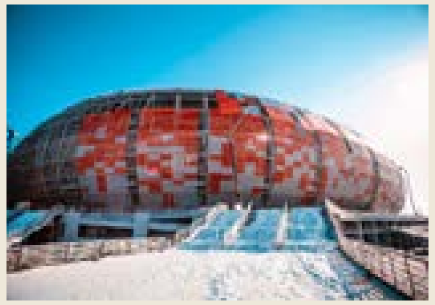


Rostov Arena

Nizhny Novgorod Stadium



Volgograd Stadium



Mordovia Arena Stadium

Samara Arena

Ekaterinburg Arena

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This report was prepared in 2018 for the 2018 FIFA World Cup Local Organising Committee by Geoecology Engineering LLC.

Introduction

The green certification of stadiums is a requirement of FIFA described in Stadium technical requirement and presumes that every stadium shall choose any of “green” standards such as e.g. LEED, BREEAM, RUSO. Football stadiums. Stadium authorities shall achieve minimum level of certification equal to LEED level 40 -49 score. This report covers resource-efficient approaches and engineering solutions made on the stage of design and construction that lead to achievement of required level of certification.

This report includes a description of the green construction activities that have been undertaken or are expected to be undertaken in the Samara Arena, Kaliningrad Stadium, Ekaterinburg Arena, Mordovia Arena, Nizhny Novgorod Stadium, Volgograd Arena, Rostov Arena and the Luzhniki Stadium in Moscow. These stadiums will host the 2018 FIFA World Cup™. In addition to the eight stadiums mentioned, the World Cup will also take place in the Spartak Stadium in Moscow, Saint Petersburg Stadium, Kazan Arena, and Fisht Stadium in Sochi. These four stadiums were individually reviewed in public report no. 3 and are therefore not included in this report.

The information was collected using a methodology approved which included visits to the stadiums, as well as the review of both the general and detailed design documentation. The data was collected during visits to the stadiums and a review of the design documentation. Experts had 2-days visits on each of stadium. The visit was performed based on a check-list and covered interior and exterior areas of stadiums, including office areas, engineering technical points, cooling facilities, ventilation facilities, heating facilities, water supply and metering facilities, control panel rooms, sanitary rooms, waste storage areas, oil and grease collection facilities, dispatching room.

1 Objectives of the public report

The public report is prepared for a wide ranging public and describes the green construction activities implemented in the World Cup stadiums. The report also includes an assessment of the activities undertaken.

2 List of Terms and Abbreviations

BREEAM a green construction standards developed by Building Research Establishment Global (England) used quite widely across the world

FIFA Fédération Internationale de Football Association – the governing body of association football, which ensures the coordination of football as a sport

LOC the organising committee for the preparation and hosting of the 2018 FIFA World Cup™

RUSO the Russian rating system for the certification of football stadiums

3 The strategic vision for the preparation of the FIFA World Cup in the field of green construction

FIFA and the LOC have paid great attention to the implementation of concepts in the Sustainability Strategy of the 2018 FIFA World Cup™.

Compliance with these concepts and mechanisms for their implementation have laid the foundations for the strategy of the 2018 FIFA World Cup™ in Russia in the field of sustainable development. The implementation of this strategy will guarantee the minimisation of negative impacts during the preparation and hosting of the tournaments, and the full realisation of the possible positive impact of the tournaments on society, the economy and the environment.

The key issues covered by the sustainability strategy are shown in Fig. 1. The environment is an integral part of the activities of the LOC and FIFA.

Fig. 1. The key issues covered by the sustainability strategy.

These issues not only reflect the main provisions, including the environmental aspects, of the sustainable development strategy, but are also closely intertwined with the requirements under international and Russian green construction standards, such as BREEAM and RUSO.

Name of stadium	Standard	Certification body	Certification type	Date of certification
Luzhniki stadium	BREEAM Bespoke	BRE Global	Completed construction	January 2018
Nizhny Novgorod stadium	To be determined	To be determined	Completed construction	To be determined
Volgograd Arena	To be determined	To be determined	Completed construction	To be determined
Samara Arena	To be determined	To be determined	Completed construction	To be determined
Mordovia Arena	To be determined	To be determined	Completed construction	To be determined
Rostov Arena	To be determined	To be determined	Completed construction	To be determined
Kaliningrad stadium	To be determined	To be determined	Completed construction	To be determined
Ekaterinburg stadium	To be determined	To be determined	Completed construction	To be determined

4. Description of resource-efficient approaches and engineering solutions in the design and construction of the stadiums

Data to describe resource-efficient and engineering solutions in the design and construction of the stadiums was collected for eight stadiums: Samara Arena, Kaliningrad Stadium, Ekaterinburg Arena, Mordovia Arena in Saransk, Nizhny Novgorod Stadium, Volgograd Arena, Rostov Arena and Luzhniki Stadium in Moscow.

The World Cup stadiums were designed and constructed in line with the requirements for reduced environmental impact. The environmental efficiency of the stadiums will be confirmed by certification under one of the green construction standards. In the time it has taken to prepare the report, some of the stadiums have already obtained a BREEAM certificate, namely Luzhniki Stadium, Nizhny Novgorod Stadium, Volgograd Arena, Samara Arena and Mordovia Arena. The certificates were granted on the basis of the design documentation and the implementation of the green construction activities from the early design stages of these facilities. The majority of stadiums are in the process of selecting a green construction standard. Visits to facilities and the review of the design documentation has made it possible to single out some of the green construction activities that are common to the stadiums:

- state-of-the-art engineering equipment (earns points under the BREEAM In-Use standard)
- the automation of utility systems (certification awarded under “RUSO. The football stadiums”)
- indoor lighting using LED lamps (included under the majority of standards)
- water-saving sanitary equipment (included under the majority of standards)
- public transportation points less than 500m from the stadium (included under the majority of standards)
- landscaping plan and green areas covering over 10% of the construction area (included under the majority of standards)
- the use of safe refrigerants (meets points under the BREEAM In-Use standard)
- the use of grease traps (meets points under the BREEAM In-Use standards)
- the provision and operation of a drainage system and stormwater system (included under the majority of standards)
- the expected implementation of segregated waste collection (included under the majority of standards).

This report also covers accessibility criteria for disabled people and people with limited mobility from the point of view of certification bodies. The assessment of accessibility features here is not according to FIFA´s own requirements for all of the stadiums.

Individual activities relating to green construction and the minimisation of environmental impact were undertaken in a number of stadiums. Improved transportation solutions were implemented in the Luzhniki Stadium (where a wide range of transportation solutions will be used, including a cable car which is being designed), Samara Arena (where a tram line is being built) and Mordovia Arena (where there is a train station in the vicinity). Certain stadiums include bicycle infrastructure in their transport strategy (Luzhniki Stadium, Ekaterinburg Arena and Mordovia Arena).

In the Rostov Arena there is a rainwater collection system to water the football pitch. This will make it possible to reduce the amount of water consumed from the common water supply, and earns the stadiumpoints under the green construction standards.

Additional energy-efficient activities have been implemented in the Ekaterinburg Arena, where historical facades have been preserved and now serve as wind protection.

To preserve the facades and structures of Kaliningrad Stadium for the future, a system was installed that ensures the stadium remains stable during landslides and shifts.

Activities that have been approved can become the basis for the green construction rating of the stadiums. At the time this report was being prepared, the majority of activities had already been implemented or were being implemented.

4.1. Kaliningrad Stadium

4.1.1. Transport accessibility

Kaliningrad Stadium is located on Oktyabrsky island in Kaliningrad. The current public transport points nearest to the stadium and within walking distance are Rybnaya Derevnya and Naberezhnaya Veteranov (distance of 2 km). Transport comes at 6-minute intervals.

At the time this Report was being prepared, transportation solutions for the Kaliningrad Stadium did not meet the requirements of the main green construction standards due to the remoteness of the bus stops. The introduction of new public transportation points will solve this problem and make visiting the stadium easier with public transport.

The stadium will be accessible for all, including disabled people and people with limited mobility. To that end, the building is fitted with access ramps, dedicated seats in the stadium bowl and suitable sanitary facilities.

Fig. 2. Location of Kaliningrad Stadium

Infrastructure for people with disabilities is required under both national law and the leading green construction standards.

4.1.2. User comfort and safety

The stadium was designed to ensure the comfort of visitors and staff. Workplaces and stadium bowl seats were designed taking into account access to daylight. Access to daylight and windows (for workplaces) are relevant components of users' visual comfort. The glass structures which determine users' access to daylight, is one of the building evaluation parameters under the green standards.

The inside of the stadium is lit by LED lamps. LED lighting is more ecologically friendly, have longer life cycle and LED lamps are easier for recycling. LED lamps consume less energy and does not emit mercury in the environment after utilization (in comparison with luminescent lamps).

Thermal comfort is ensured; users can control the air parameters using the radiators' thermostatic valves and control panels for the heating units.

Green construction standards take into account user comfort solutions, since they not only increase the general user's satisfaction when they are in the building, but also lead to reduced energy consumption (e.g. if it is too hot, it is possible to regulate the air temperature, thereby reducing energy consumption).

Fig. 3. Glass structures of Kaliningrad Stadium

Fig. 4. Radiator with a thermostatic valve

4.1.3. Energy saving

The latest solution to optimise the operation of the building utility system and save energy is automation, which also earns points under the "RUSO. The Football Stadiums" standard.

The rooms are heated by floor-mounted radiators fitted with thermostatic valves, thus allowing users to control the temperature and avoid heat energy losses if the heating is too intense. On average, 10-20% thermal energy can be saved this way, compared to radiators without control valves. Heat curtains are provided at the entrances to the building. These units supply powerful warm air streams that prevent cold outdoor air from entering the room, and the heated air from leaking outside; this is another way of saving energy when heating spaces.

The stadium has an operating forced-air plenum and exhaust ventilation system with heat recovery. The recovery system uses exhaust air to heat entering cool, outdoor air. This considerably reduces the amount of energy consumed – on average saving up to 50%.

The stadium's air conditioning is provided by multi-zonal systems. These systems have an outdoor cooling unit and several indoor units with a shared refrigerant circulation system (in regular systems each indoor unit requires a dedicated refrigerant circulation circuit). The shared system saves the energy that would be lost on the refrigerant transfer in a regular system.

4.1.4. Water saving

Water saving activities are aimed at both minimising the environmental impact of the stadium and reducing utility costs. Monitoring water consumption and installing water-saving equipment pay off in the very first years of the building's operation.

Kaliningrad Stadium has a water meter that monitors water consumption using a UV meter. The model installed demonstrates high precision even when water and energy consumption are low.

It is worth noting that the stadium's water-saving equipment includes mixer taps and flushing devices of toilets. The water-flow rate of the mixer taps is 8.3 l/min. This is considerably lower than the average water-flow rates of regular taps, and lower than basic European water consumption standards (12 l/min). At the time of the visit, toilets with two-button flushing systems (4-6 l) were being installed at the stadium. Bearing in mind that one large flush equals three small flushes (BREEAM International NC 2013, Water 01), a single-button toilet bowl with a 6-litre tank would consume 24 litres of water for every 4 flushes, while a two-button toilet bowl with 4-litre and 6-litre flushes consumes 18 litres. Therefore, 1.5 litres of water are saved per flush, and a total of up to 26,000 litres of water can be saved per match when the stadium is full. The specified water-saving activities are covered by the leading green construction standards.

4.1.5. Use of efficient materials

Kaliningrad Stadium will act to preserve and prevent damage of the property. Some conventional examples include spectator flow management, access of the audience to the stadium through several access points, and the provision of protection elements in loading areas and areas where there is a lot of trolley movement. Metal sheet cladding of corridors, safety stands and other structures in parking lot areas and doorstops will be used to protect those elements. These measures are covered by the BREEAM green construction standard.

4.1.6. Waste management

Segregation and recycling of waste collection considerably reduces the environmental footprint of the facility. Segregated waste collection and recycling done by the LOC Cleaning and Waste Management Team during the FIFA World Cup in the stadium will become a good practice in the implementation

Fig. 5. Water-saving sanitary fittings in Kaliningrad Stadium

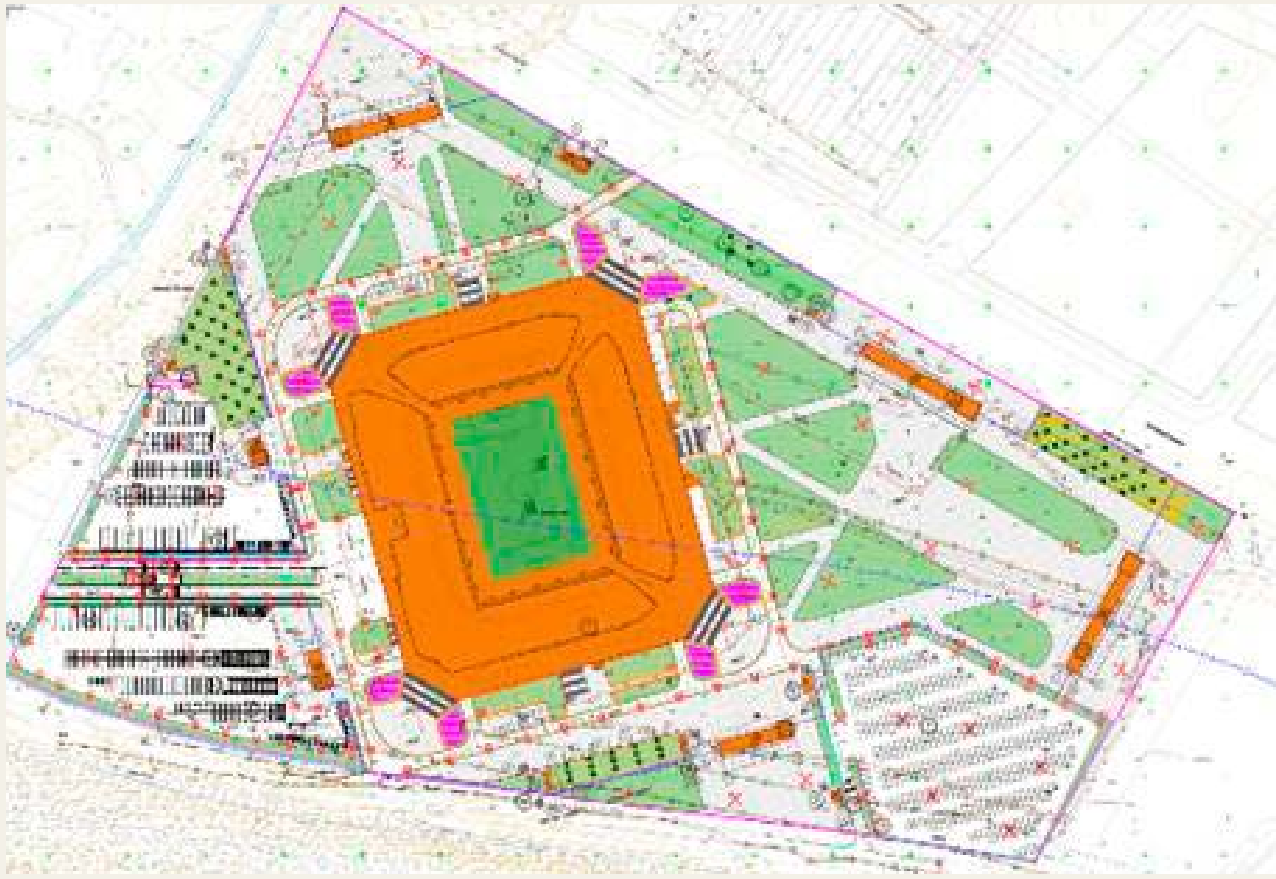


Fig. 6. Kaliningrad Stadium improvement and landscaping scheme

of segregation systems with several flows. To that end, bins with appropriate signage (stickers) will be provided in the building by LOC. Most green construction standards favours the implementation of waste collection in several flows to facilitate recycling and reuse. The stadium will have substantial gains if the sustainable waste collection measures adopted during the FIFA World Cup are continued after the tournament.

4.1.7. Green areas

Landscaping the vast territory surrounding the stadium is included in the design plans. Green areas will cover 16,403.8 m², or 40% of the construction area. This is a high percentage compared to other FIFA World Cup stadiums. The provision of green areas is part of the green construction requirements. The high percentage of green areas means the stadium earns high points under both BREEAM In-Use and the "RUSO. The Football Stadiums" standards.

4.1.8. Environmental protection

Impacts from the construction and operation of the stadium are reduced by activities to reduce negative impacts throughout the life cycle of the building.

The stadium's air-conditioning systems use an ozone-friendly refrigerant (R-410A). This refrigerant is free of chlorine which is the main cause of the destruction of the earth's ozone layer. The use of R-410A refrigerant is safe and is in line with international environmental law, specifically, the Montreal Protocol which governs the use of chlorine and other substances that deplete the ozone layer. The use of safe refrigerants is encouraged under the majority of green construction standards.

Fig. 7. Bicycle lanes next to the stadium grounds

4.1.9. Conclusions

Kaliningrad Stadium can be considered to be an environmentally-efficient building, since it meets a number of the requirements of green construction standards:

1. Systems to regulate temperature, air and water run on equipment with a high degree of automation.
2. Strategies to ensure the thermal and visual comfort of users have been implemented.
3. LED lighting indoor areas has been provided.
4. A high percentage (40%) of green area compared to other stadiums.
5. Water-saving measures can help save up to 113,000 l of water per match when the stadium is full.

Therefore, the strongest advantages of the stadium in terms of environmental efficiency include energy efficiency and its landscaping design.

4.2. Luzhniki Stadium of Moscow

4.2.1. Transport accessibility

Luzhniki Stadium boasts excellent transport accessibility. Users have many transportation options. This increases the general accessibility of the facility and is encouraged under the green construction standards. Within 1 km of the Stadium there are:

- two stations of the Sokolnicheskaya metro line – Sportivnaya and Vorobyevy Gory;
- bus and trolleybus stops with routes connecting the stadium to the city centre and various districts;
- Luzhniki station on the Moscow Central Circle line;
- a number of bicycle parking spots and bicycle lanes, which allow cyclists to cycle along the embankment and further to the city centre. The following route can be taken using bicycle lanes: Nagatinskaya Embankment, Red Square, Grand Kremlin Public Garden, Kremlin Embankment, Cathedral of Christ the Saviour, Luzhniki, Alley of Fame, Krasnaya Presnya park, Moscow City centre. The route is about 29 km long.

There are also plans to have a cable car before the World Cup starts in order to connect the Luzhniki complex to the opposite Moscow river bank and the observation platform on Sparrow Hills.
A convenient navigation system is provided in the stadium for user convenience.

The excellent transport accessibility of the stadium will mean it receives a high evaluation during the green construction certification of the building.

Fig. 8. Navigation panels on the Luzhniki grounds

Fig. 9. Location of Luzhniki Stadium

4.2.2. User comfort and safety

The Luzhniki Stadium's interior and grounds are designed to ensure the comfort of its users.

Visual comfort is provided by access to daylight in the administrative rooms and lobbies of the building. This increases user satisfaction when in the building and saves electricity that would be used for artificial lighting in the daytime.

Heating and air conditioning devices have been fitted with controls to ensure thermal comfort. The thermostatic valves on radiators and the control panels of fan-coil units mean the air parameters in specific rooms can be changed according to user needs.

Fig. 10. Thermostatic valve and fan-coil unit in Luzhniki Stadium

The Stadium employees have permanent access to clean drinking water, as water cooler dispensers have been installed in the building.

Fig. 11. Water cooler dispenser in an office area in Luzhniki Stadium

All stadium users, including visitors, can use the outdoor recreational areas. Spaces with benches and fountains are located in the central alley of the stadium. This area is illuminated at night and is safe.

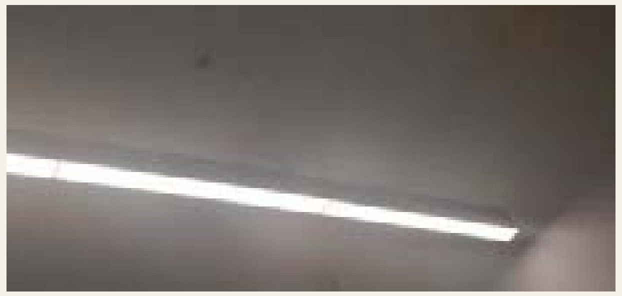
Fig. 12. Recreational area in the central alley of Luzhniki Stadium

The activities undertaken to ensure the comfort of users in the building are the basis of the stadium's rating under the corresponding section of the BREEAM standard, a green construction standard. Luzhniki Stadium was awarded a "pass" under that standard.

4.2.3. Energy saving

Energy saving in Luzhniki Stadium is achieved by:

- the use of state-of-the-art equipment for heating, ventilation and air-conditioning systems, lighting systems, etc.
- combining the systems regulating temperature, air and water into a single automated system. This system enables the complete monitoring of and control over the energy consumption of the building
- the use of LED lamps instead of fluorescent lamps saves up to 70% electricity.



Outdoor lighting of the Stadium is also designed in view of saving electricity. It is controlled automatically and provides for four-mode operation (celebration, match, daily, night). The automatic control of outdoor lighting has made it possible to earn points for energy under the BREEAM bespoke process.

Fig. 14. Lighting control in Luzhniki Stadium on the dispatcher panel

4.2.4. Water saving

Sanitary fixtures with low water-flow rates are installed in Luzhniki Stadium. These include manual taps with a flow rate of not more than 5 l/min. Most modern devices have flow rates of 9-12 l/min, therefore the value of 5 l/min is 1.5-2 times lower than the average.

Shower facilities have been installed in the team changing rooms. The showers have a maximum water-flow rate of 6 l/min. European green construction standards consider 14 l/min to be the basic flow rate for showers, therefore Luzhniki Stadium's water consumption is less than half.

In addition, the flushing devices of the toilets in the stadium's sanitary facilities have a flushing volume of 6 l/min or less. During events, reducing the flushing volume by 1-2 litres can lower water consumption

Fig. 13. LED fixtures in the Luzhniki Stadium

without compromising user comfort. This measure can save up to 160,000 litres of water per match.

Water consumption is metered at the main inlet by a water meter. Individual meters are installed for watering the pitch, green areas and etc and kitchens water supply. Detailed metering of water consumption means it is possible to analyse the needs of major consumers, make adjustments and plan a reduction in water consumption in the long run. The installation of individual water meters is the measure that was considered in the certification of the stadium under the BREEAM bespoke process.

Water consumption levels of the stadium's sanitary fixtures meet European water-consumption standards. The water consumption levels of the taps does not exceed 4 l/min, showers 6 l/min, and flushing devices of toilets 6 l/min. This has allowed Luzhniki Stadium to be recognised under the water section of the BREEAM standard. Water-saving measures in the stadium allows up to 490,000 l of water to be saved per match when the stadium is full.

4.2.5. Use of efficient materials

The provision of protection elements for the building structures will make it possible to use building spaces for as long as possible without repair or replacement. The corridors walls are protected with metal sheets in areas with high traffic of cargo.

Office doors are fitted with stops to avoid breaking the adjacent walls.

4.2.6. Waste management

Segregated waste collection and recycling will be implemented in Luzhniki Stadium by the LOC Cleaning and Waste Management Team during the FIFA World Cup. In addition, two press compactors have already been installed for cardboard waste and packaging. By pressing this type of waste, the press compactors will reduce the volume of general waste and frequency of waste removal. The segregation of cardboard in an individual flow is a justified measure since recycling it is common practice, while sorting it from the common flow is an extremely complex goal.

Dedicated bins will be provided for the recyclable and general waste. A waste compound and interim waste collection points were included in the stadium design. All recyclable waste will be sent to a waste treatment facility.

Fig. 17. Press compactor in Luzhniki Stadium

Fig. 15. Metal sheets on corridor walls

Fig. 16. Doorstops

Fig. 18. Landscaping around Luzhniki Stadium

4.2.7. Green areas

There are vast spaces around Luzhniki Stadium. A considerable green area and many trees were retained during the redevelopment. The redevelopment design also provided for additional landscaping. 1,050 trees and shrubs, such as maple, linden, apple, shadbush, lilac, etc., were planted and 15,700 m^2 of flower gardens were arranged.

4.2.8. Environmental protection

The design provides for the installation of a grease trap. This prevents the discharge of waste kitchen water containing a considerable amount of grease and oil from ending up in the common sewage system. The grease trap not only reduces the contamination of waste water, but also prolongs the service life of the pipes of the water discharge system. The grease trap is a plastic tank with a specific design which lets water through and retains the majority of animal and vegetable fat. The design of grease traps depends on the physical properties of the fat, specifically the fat density. Since fat is less dense than water, it floats up to surface and accumulates in a special grease trap chamber.

A rainwater collection system is provided in the area surrounding the Stadium to prevent the accumulation and infiltration of rainwater into the ground, as urban rainwater is often contaminated and unsuitable for watering green areas.

The air-conditioning system is made up of chillers, which use the refrigerant R-134A with zero potential for ozone layer destruction.

4.2.9. Conclusions

Luzhniki Stadium will become the central venue of the 2018 FIFA World Cup™. Green construction and environmental solutions were implemented in its design at the very early stages. The green construction standard, used in the certification (BREEAM Bespoke), specified certain requirements not only for the design solutions, but also for the construction processes, which were also implemented with a view to minimising the environmental impact. The fact that the stadium has been granted the BREEAMcertificate for design documentation confirms the early elaboration of the adopted solutions. Among all the FIFA World Cup stadiums, today Luzhniki is the only stadium that has passed the complete certification cycle – from design to construction under the same standard. At the time the report was being drawn up, the stadium was in the process of obtaining the final pass-level certificate. The certification includes an evaluation of the following: health and wellbeing, energy, water, waste, transport, pollution, land use and environment. Therefore, the stadium meets the requirements of the majority of the BREEAM categories.

4.3. Rostov Arena

4.3.1. Transport accessibility

Rostov Arena is located on the left bank of the River Don. There are shops, cafeterias and a city residential area within walking distance.

Fig. 19. Location of Rostov Arena

Transport accessibility of Rostov Arena:

- bus routes stop at the nearest public transportation points (within 1,000 m of the stadium there are three bus stops; any city district can be reached on the buses that stop at these).
- areas for personal vehicles and taxis (a secured parking lot and convenient unloading areas)
- shuttles for the period of the World Cup will run on the following routes: Yuzhnyi airport — centre, Yuzhnyi airport — stadium, main railway station — centre, main railway station — stadium and centre — stadium.

The stadium is fitted with the required infrastructure to ensure access for people with low mobility: sloped lifts to the stadium concourse, lifts with wide doors and low control panels, equipped sanitary facilities, etc. The requirements for accessibility for disabled people and people with limited mobility under the green construction standards have been met and can be included in the certification of the stadium.

4.3.2. User comfort and safety

Solutions for the users' thermal and visual comfort allows the stadium to claim recognition under the

Fig. 20. Above-ground city transport stop Gorodskoy Plyazh

corresponding categories of the green construction standards. Access to daylight is ensured by a large area of glass structures. Certain rooms without access to daylight are equipped with hollow tubular light guides. The light guide comprises three main parts: a collector to collect daylight, a diffusor to distribute light and the light guide itself between them. They redirect daylight to the rooms which lack it, and therefore ensure illumination and ensure visual comfort.

The thermal comfort of users is achieved through widely used solutions – there is the possibility of controlling the temperature, rate and direction of indoor air in the rooms. Users can adjust these parameters using the control panels of fan-coil units or the thermostatic valves of radiators.

Fig. 21. Fan-coil unit control panel in Rostov Arena

4.3.3. Energy saving

The energy efficiency of the football stadium is achieved by using state-of-the-art energy-efficient equipment in the utility systems of the building, the automation of the system operation, metering thermal energy resources and implementing control systems and energy-saving methods in the operation of the utility systems of the building.

The metering system for power consumption uses power meters installed for each sector. Power consumption can thus be monitored with the required accuracy and activities can be scheduled to reduce consumption. Measuring the power consumption at a detailed level is one of the evaluation criteria of BREEAM and "RUSO. The Football Stadiums" standards.

Indoors, the stadium is illuminated by LED lamps. This type of lamp saves up to 70% electricity, and their use is encouraged under the energy-saving categories of the green construction standards.

Fig. 22. LED lighting in Rostov Arena

Some of the spaces (utility rooms) are illuminated by fluorescent lamps with electronic start control devices (ESCD). The use of ESCD reduces the noise level, prolongs the lamps' service life and increases light quality. ESCDs are encouraged by BREEAM.

Lighting of public spaces is controlled in a centralised manner.

Automation makes it possible to control the air-heating power in the plenum ventilation systems based on the outdoor air temperature and save thermal energy that would be wasted when heating unnecessarily. The ventilation system is also controlled automatically with a preset time schedule.

The motors of the ventilation units are fitted with frequency converters, which allows them to change the rotation of the fan and, therefore, the air capacity of the unit in cold and warm seasons in order to avoid unnecessary energy expenses when the ventilation units heat spaces.

All heating devices in the building are fitted with capacity controllers to change temperature locally and avoid overheating spaces and heat losses by aerating.

Energy efficient solutions of the cold supply system provide for the automatic selection of the operation mode, which saves up to 25% electricity.

4.3.4. Water saving

Water in the stadium is saved in three ways: the prevention of major leakages, the use of efficient sanitary fixtures and the monitoring of resource consumption.

There are electric valves on the stadium's water inlets, which can cut off the water supply in the event of an accident or unforeseen, uncontrolled flow rate. Water consumption is metered at the building inlet. The model installed is a fully fledged measuring complex which can both meter water consumption and process, store and transmit information in combination with the unified building management system.

Efficient sanitary fixtures in the stadium include manual taps and toilet flushing systems.

The taps installed have a built-in cartridge to control the water-flow rate. The lower limit of the flow is 2 l/min compared to regular taps with a water-flow rate of up to 20 l/min, saving about 90% resource. The water flow rate in the stadium exceeds the European norms of 12 l/min or by 80%. As a result the stadium can receive a high evaluation in its green standard certification. During one match, 200,000 l can be saved when the stadium is full.

The water volume of each flush is controlled by the toilet flushing systems. The lower flow-rate limit of the two-button system is 2 l (small flush) and 4 l (large flush), the single-button systems have a minimum flushing volume of at least 4 l. This helps to avoid abrupt increases in the water-flow rate during matches and other events. The average volume of flushing saves up to 58% water compared with European norms (6 l). For one match, up to 45,000 l of water can saved.

The stadium has a functioning system of rainwater collection from the roof and stadium concourse. The collected water enters the waste water treatment system of the stadium and is then used to water the football pitch. Surface rainwater is collected using concrete and plastic trays, i.e. rain collectors, and is discharged via site rainwater networks to local treatment facilities. Treated water is used to water the football pitch. Waste water is collected in three tanks with capacities of 710.5 m^3, 333.4 m^3 and 715.9 m^3. If it rains enough this measure will make it possible to water the entire pitch (average watering demand of the pitch - 60-80m^3 a day).

Fig. 23. Metering and computing complex in Rostov Arena

Fig. 24. Rainwater collection tank

4.3.5. Use of efficient materials
A number of activities to protect the building structures are provided for, including spectators' flow management, managing of entering the stadium via several access groups and equipping of the building with protective elements, such as doorstops and fencing structures in the delivery area.

It is worth noting that among the materials used is a modern, high-tech roofing material that is very strong, durable and highly translucent.

4.3.6. Waste management
Special waste storage areas and collection rooms are provided within the stadium building. There will be bins for the segregated collection of waste as follows: recyclable and non-recyclable waste.The removal and further treatment of waste will be performed by a licensed contractor. The stadium will have substantial gains if the sustainable waste collection measures adopted during the FIFA World Cup by the LOC Cleaning and Waste Management Team are continued after the tournament.

4.3.7. Green areas
The area surrounding the stadium will be improved and become a fully functional urban recreational area. The green area in the design will occupy 13,071.8 m^2. The green area will take about 15% of the total construction area of 89,422m^2. As the green area exceeds 10% of the construction area, the stadium earns points under the green construction standards, specifically BREEAM In-Use.

Various plants, which naturally grow in Rostov-on-Don area, will be planted including trees such as maple, tilia platyphyllos and silver birch; shrubs such as laburnum, lycium and acacia; and flower gardens with annual plants. The creation of a habitat with species that naturally grow in Rostov Oblast will allow it to become a part of the natural green spaces of the city and surroundings.

Fig. 25. Areas reserved for flower gardens in Rostov Arena

4.3.8. Environmental protection
The establishment of a fully functioning drainage system will avoid rainwater and meltwater from stagnating in the area surrounding the stadium and the football pitch. It will protect structures and prevent excess infiltration of atmospheric water into the ground. Surface drains for water intake are arranged along the perimeter of the pitch and in the service territory.

To treat the stadium's kitchen waste water there is a grease trap which prevents grease and oil-contaminated water from entering the general sewerage system.

Fig. 26. Drainage system elements at the stadium

There are LG air-conditioning systems in the facility, which use R-410A refrigerant. The advantage of R-410A over obsolete refrigerants (R-21, R-22, etc.) is that it does not contribute to ozone depletion at high, specific cooling capacity. The use of safe refrigerants is encouraged under BREEAM In-Use.

4.3.9. Conclusions
Rostov Arena has implemented certain widespread solutions for efficient resource consumption and environmental stability, including up-to-date utility systems and their automation, LED lighting, the use of safe refrigerants and green areas. The stadium stands out with its water consumption solutions. Sanitary fixtures mean that water-flow rates can be adjusted to meet strict international standards, and that the collection of rainwater reduces the consumption of clean water from the common water pipeline, while the quality treatment systems make it possible to use it safely for watering. Both activities specified are encouraged under the green construction standards and can be included in the stadium's certification.

4.4. Nizhny Novgorod Stadium

4.4.1. Transport accessibility
The stadium building is located in the Kanavinsky district of Nizhny Novgorod.

There is a public transport stop, Sedmoye Nebo, within 500 m of the stadium. Transport comes at 10-minute intervals. The World Cup has entailed considerable changes to the city transportation system and 23 new routes will be introduced to improve the transport situation in the entire city and to the stadium. The distance to the public transportation points is acceptable under green construction standards, and an increased number of routes after the introduction of new trips will allow the stadium to earn additional points under the transport accessibility category of the green construction standards.

The stadium's location in the district, which will be served by well-developed infrastructure, will mean residents will no longer need to use motor vehicles to do shopping, or visit malls, drug stores, banks and other facilities. All of which are located within walking distance of the stadium building. The fact that the above-mentioned facilities are close by means the stadium earns points under BREEAM In-Use.

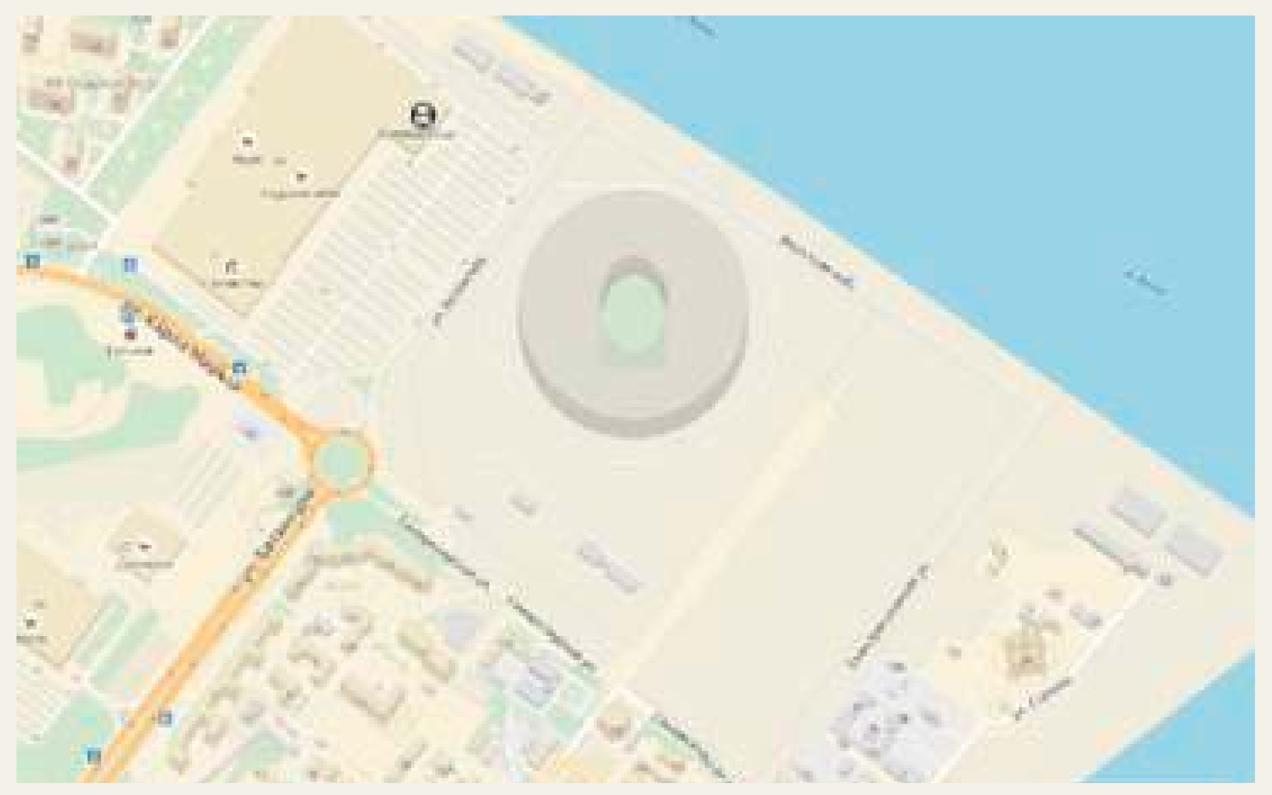


Fig. 27. Location of Nizhny Novgorod Stadium

4.4.2. User comfort and safety

The stadium's interior and grounds are designed to ensure the comfort of its users. The visual comfort of the stadium's users is ensured by access to daylight in the working areas. The building's public areas are also made of glass structures; this solution makes it possible to reduce the electricity consumption in the daytime.

Fig. 28. Glass structures of Nizhny Novgorod Stadium

Up-to-date LED equipment is used to light inside the stadium and ensures visual comfort.

The users of the stadium can independently set the temperature according to their needs. Fan-coil units and radiators ensure thermal comfort. The radiators are fitted with thermostatic valves, and fan-coil units control air supply and temperature locally through control panels.

4.4.3. Energy saving

The main energy-saving solutions in Nizhny Novgorod Stadium include the installation of up-to-date utility systems, their combination into an automated network and indoor lighting using LED fixtures.

The operation algorithms of smart systems are designed so as to minimise energy consumption without compromising comfort. Up to 30% of resources for the heating of buildings, water supply and power supply are saved as a result.

LED lighting is provided in all rooms occupied by people. Compared to fluorescent lighting, LED fixtures can save up to 70% electricity.

4.4.4. Water saving

There is a flow-rate meter to monitor water consumption in the building of the Nizhny Novgorod Stadium. Its design makes it able to measure the impulse output, which in future will be integrated into the common building management system and monitor the water-flow rate in real time.

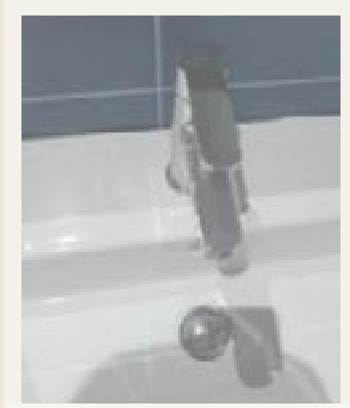


Fig. 29. Water-saving sanitary fixtures in Nizhny Novgorod Stadium

Water-saving equipment in the stadium will help save water without compromising user comfort. There are single-lever mixer taps with a flow-rate limit of up to 5 l/min. This value is less than half the average values set out in European standards (12 l/min), thus making it possible to save up to 58% water. This parameter is the equivalent of 211,500 l of water per match when the stadium is full. Taps with single-lever controls also have the advantage, compared to regular valve taps, that the same handle can control both water temperature and flow intensity at the same time. Flush panels of toilets in the stadium are fitted with double flushing systems - small flush (3 l) and large flush (6 l). Having two flushing volumes means up to 2,25 l of water per flush are saved, which amounts to 101,250 l per match when the stadium is full.

4.4.5. Use of efficient materials

A number of activities to protect the building structures are provided for, including spectators' flow management, managing of entering the stadium via several access groups and equipping of the building with protective elements, such as doorstops and fencing structures in the delivery area.

4.4.6. Waste management

In order to reduce the amount of waste sent to a landfill, a segregated waste collection system and the installation of a multi-bin system at Nizhny Novgorod Stadium will be performed by the LOC Cleaning and Waste Management Team during the FIFA World Cup. Further handling and recycling will be conducted by licensed contractors. Segregated waste collection is highly rated in the green construction standards; the segregation of several waste streams allow the stadium to get the highest possible points under BREEAM In-Use. In the stadium, two main streams will be organised for spectator and operational areas. The stadium will have substantial gains if the sustainable waste collection measures adopted during the FIFA World Cup are continued after the tournament.

4.4.7. Green areas

The construction of the stadium provides for the improvement of the surrounding area and the provision of a fully functioning recreational area. The total construction area covers 51,495m², of which 15,000 m² will be used for landscaping. Therefore, the green area will cover about 29% of the site´s area. This value is above average among the FIFA World Cup stadiums and will earn points for landscaping under both the BREEAM In-Use and "RUSO. The Football Stadiums" standards. At the time of the visit, the stadium had already started the implementation of the landscaping programme; young plants were being planted.

Fig. 30. Planting young trees in Nizhny Novgorod Stadium

4.4.8. Environmental protection
Measures have been taken to minimise the environmental impact of the stadium's operation.

Kitchen waste water enters the general sewage system only after being treated in a grease trap, a device which separates water from grease and oil. Therefore, the level of waste-water contamination is reduced and the service life of the sewage pipes is prolonged. This activity is encouraged under BREEAM In-Use.

There is a drainage system to prevent the infiltration of rainwater into the ground. Precipitations in cities are often polluted, and their infiltration into ground can harm green areas. The availability of a stormwater control plan is evaluated under "RUSO. The Football Stadiums" and BREEAM In-Use.

4.4.9. Conclusions
Green construction solutions have been adopted at Nizhny Novgorod Stadium and will allow it to be recognised under one of the green construction standards in the future. The stadium has the chance to get at least entry-level recognition under each category of the green construction standards, as it has energy-efficient solutions, user-comfort solutions, an operating public transportation points nearby, water-saving sanitary equipment and one of the largest green areas among the FIFA World Cup stadiums.

4.5. Volgograd Stadium

4.5.1. Transport accessibility
Volgograd Arena is located in the Central District of Volgograd.

Within 200 m of the stadium, there are two public transport stops named Central Stadium. One of them is a premetro stop (the premetro is the high-speed line of underground streetcars).

Fig. 31. Tramway along Lenin Avenue

The second stop is served by trolleybuses and other buses. Transport comes at 5 minute intervals. The stadium can also be reached by railway and getting off at Mamaev Kurgan.

The stadium can be attended by people with low mobility without obstruction. For their comfort, there are special lifts. The stadium is also fitted with ramps, special sanitary facilities and handrails in the required locations. The disabled people and people with limited mobility access strategy is in line with the green construction standards; the stadium infrastructure fully meets the requirements of the standards.

Within walking distance of the stadium, there are ATMs, hotels, drug stores, and other amenities which can be accessed by stadium users without needing to resort to personal vehicles or public transport, thus reducing potential MM^2 and exhaust gas emissions.

4.5.2. User comfort and safety
The use of up-to-date stained glass systems ensures access to daylight and window views for stadium users. Paint on the reverse side of the window glass has been used in work areas where intensive daylight can cause inconvenience, e.g. glare on screens. In addition, window blinds have been installed to reduce glare in VIP stands and mass media area.

Fig. 32. Glass structures of the stadium

Certain rooms in the stadium that are expected to be permanently occupied by people do not have access to daylight. For those rooms, a decision to compensate that fact was made; they are illuminated by additional light sources to one level above the standard national level.

Plans for the lighting of indoor and outdoor working areas are based on energy-efficient and LED fixtures.

LEDs are safer for the personnel's and visitors' health due to their easy disposal, strength and the lack of mercury. The use of LEDs is covered by green construction standards both under energy categories and health categories. For example, under "RUSO. The Football Stadiums" standard, extra points can be earned for the elimination of mercury lamps.

Thermal comfort is achieved by controlling indoor air parameters according to individual user needs.

4.5.3. Energy saving
Energy in Volgograd Arena is saved by using a wide-ranging solution, namely the automation and supervisory control of the building's support systems regulating temperature, air and water.

The automation of the outdoor lighting equipment makes it possible to control lighting modes, including by selecting weekdays or celebration modes. This type of automation is encouraged under the BREEAM green construction standard.

Controlling the operation of the ventilation equipment remotely saves energy by zoning the building, i.e. by switching off the units that are not required at that particular moment. The automation of the ventilation system makes it possible to monitor the air and heat-transfer fluid parameters of the air heaters to set optimum ratios to ensure energy saving.

An original solution is the use of excess heat emitted during the cooling of the condensers of the stadium's refrigerating units. The heat is used to heat the cold water of the hot water supply system. The excess heat of the refrigerating units, which in conventional systems is lost on heating air, will be used to heat water in order to reduce energy consumption for additional heating.

The heating system uses two pipes and thermostats in radiators to ensure the proper thermal comfort in addition to saving energy.

The described energy-efficient solutions will allow the stadium to get above average recognition under the green construction standards.

4.5.4. Water saving

Water saving in the stadium takes two forms: the quality monitoring of water consumption and the installation of water-saving sanitary fixtures.

Consumption is monitored at the water inlet of the building where a water meter with impulse output is installed. This option allows for the automatic display and the collection of data when the meter is connected to the building management system.

Fig. 33. Water meter in Volgograd Stadium

Water-saving sanitary fixtures will have the following flow rates: sink taps – maximum of 6 l/min, double-button flush panels – 4.5 l. Urinals will have programmable flushing levels, and the factory setting of 0.7 l per flush fully conforms with the green construction standards.

4.5.5. Use of efficient materials

A number of activities to protect the building structures are provided for, including protective elements of the building, such as doorstops and fencing structures in the delivery area.

4.5.6. Waste management

A segregated waste collection system and recycling will be implemented by the LOC Cleaning and Waste Management Team during the FIFA World Cup.

In order to avoid mixing flows the waste management infrastructure will be equipped with appropriate signage. All types of recyclable waste collected at the stadium will be sent for further recycling. The stadium will have substantial gains if the sustainable waste collection measures adopted during the FIFA World Cup are continued after the tournament.

4.5.7. Green areas

The landscaping design of the territory around the stadium provides for the planting of over 135 species of plants, including conifers and broad-leaved trees, shrubs and herbaceous plant.

4.5.8. Environmental protection

The design includes several grease traps to prevent large amounts of water containing oil and grease from entering the sewerage system.

To avoid the infiltration of contaminants into ground water there is a drainage system that ensures the discharge into a stormwater sewage, which will allow the stadium to get points under the "RUSO. The Football Stadiums" standard.

The air-conditioning system of the stadium uses an ozone-friendly refrigerant that does not contribute to the depletion of the Earth's ozone layer.

Fig. 34. Drainage system element and a grease trap

4.5.9. Conclusions

Certain solutions, which taken into account in the certification under green construction standards, have been implemented at the Volgograd Stadium. Entry-level recognition can be obtained for energy efficiency, water saving, user comfort and the reduction of environmental impact. The strength of the design is the stadium's accessibility by public transport, the proximity of the transport hub the frequency of transport, which will allow it to earn more recognition points.

4.6. Mordovia Arena Stadium

4.6.1. Transport accessibility

Mordovia Arena is located adjacent to the right bank of the River Insar. The stadium is located within 5 km of the airport, 2.4 km of the railway station and 4.8 km of the bus station.

In addition to the fact that the stadium is on many of city bus routes, there are other transportation options:

Railway: Mordovia Arena can be reached by suburban trains that stop at "Posop" station. An important advantage of this solution is the high reliability of railway transportation and the exact timetable. The distance from the stop to the stadium is about 800m. The fact that the railway station is so close to the stadium is unique among the regional FIFA World Cup stadiums.

Fig. 40. Distance from Posop railway station to Mordovia Arena

4.6.2. User comfort and safety

The comfort of both permanent and temporary visitors of the stadium is ensured by:

- access to daylight in working areas and public spaces. The translucent capacity of stained glass and windows in the stadium is at least 80%;

Fig. 36. Glass structures of the Mordovia Arena

Fig. 35. Distance from Posop railway station to Mordovia Arena

- users are able to set indoor air parameters by adjusting the thermostatic valves on radiators and control panels of fan-coil units. It is possible to vent office rooms by opening the flaps manually.

Fig.37. (1) Radiator (thermostatic valves are being installed). (2) The installed fan-coil unit

4.6.3. Energy saving

State-of-the-art engineering equipment and its automation, and LED lighting indoors help save heat and electric energy.

Energy from the Saransk-2 power plant is used to heat the stadium. This plant uses natural gas as its main fuel, which is preferable from an environmental point of view as it creates less pollution than coal and other fossil fuel types. The use of an environmentally friendly fuel is considered by BREEAM In-Use and will allow the stadium to earn points under the energy category.

Setting the temperature using the thermostatic valves is possible on all heating devices in the stadium. This helps to avoid unreasonable energy consumption for excess heating of spaces when users open windows and vent the rooms letting the heat out.

Indoors, LED lighting of the stadium saves up to 70% electricity compared to fluorescent lamps.

4.6.4. Water saving

Water saving in Mordovia Arena is ensured through:

- Efficient sanitary fixtures. Infrared manual taps consume 5.7 litres of water per minute; the average flow rate of regular taps is 9-12 litres per minute or more. Infrared control also saves water, since the flow switches on and off instantaneously, and situations when the user forgets to close the tap are avoided. Infrared control has been installed in the stadium urinals as well.

Fig.38. (1) Radiator (thermostatic valves are being installed). (2) The installed fan-coil unit

- Detailed metering of water consumption. Water meters have been installed at the water inlet of the building. The meter shows the water consumption of the entire stadium and by each sub-lessee individually. Water consumption can thus be reviewed, limits set and future reductions in water consumption planned according to the needs of each major consumer.

4.6.5. Use of efficient materials

The design provides for activities to protect the stadium structures during its operation, for example the flow streams of constituent groups, the protection of walls in areas where there is load trolley movement. Vandal-proof panels are used in the facade finish. The concourse to funnel the audience and open staircases have concrete floors with polymer anti-skid coating.

4.6.6. Waste management

The stadium with the help of waste management division of Local Organising Committee will implement segregated waste collection and recycling during the FIFA World Cup. To that end, there will be a multi-bin system and a waste management area installed. The removal of waste to landfills or recycling facilities will be conducted by a licensed contractor. The stadium will have substantial gains if the sustainable waste collection measures adopted during the FIFA World Cup are continued after the tournament.

4.6.7. Green Areas

The design provides for the improvement and landscaping of the surrounding area. Trees and shrubs – including common juniper, savin juniper, common lilac and acer ginnala – and lawns and flower gardens will be planted.

4.6.8. Environmental protection

Wide-ranging solutions to reduce the environmental impact of the stadium have been implemented: a grease trap for the sewage system, a drainage system for the surrounding area and the use of a safe refrigerant. All these measures can earn the stadium points under the green construction standards.

4.6.9. Conclusions

Mordovia Arena is able to meet green construction standards. This is made possible thanks to the activities set out in the stadium design and implemented during its construction. It should be noted that the stadium design documentation was awarded a "pass" under the BREEAM green construction standard. For the final certification of the design upon completion of construction, the design's strongest points are transport accessibility and energy efficiency (use of LED fixtures).

4.7. Samara Arena

4.7.1 Transport accessibility

Samara Arena is located in the Kirovsky District of Samara.

Within 500 m of the stadium, there is a bus stop called Pioneerlager im Gagarina. The stop is served by eight public transport routes with transport comes at 5-minutes interval.

Fig.39. Location of Samara Arena

Additional routes and transportation hubs will be arranged during the upgrade of the city transportation system by the time the World Cup starts.

People with low mobility can access all stadium areas provided for visitors. The building's passages are all over 2.2 metres wide, which meets the requirements for wheelchair users. Horizontal surfaces are sloped at not more than 5% for comfortable movement of disabled people and people with limited mobility. There are ramps at the northern end of the stadium. Dedicated people with limited mobility's sanitary facilities are provided on all floors. Infrastructure for people with limited mobility will allow the stadium to claim points under the green construction standards.

4.7.2. User comfort and safety

In rooms that will be in constant use, visual comfort is ensured by stained glass windows. These enable permanent access to natural light and reduce energy that would be used for artificial lighting in the daytime.

The stadium indoors are illuminated by LED equipment to allow the users to stay in the room for a long time without visual discomfort thanks to the low pulsing ratio of LED lamps.

The heat sources of rooms are fan-coil units and radiators. Depending on user preferences, the temperature of the air from fan-coil units can be adjusted by changing the parameters on the control panel. The radiators are fitted with thermostatic valves to adjust the temperature in the room.

Fig.40. The installed fan-coil unit

4.7.3. Energy saving

The automation of the utility system operation processes is one of the energy-saving activities undertaken at the Samara Arena. LED lighting especially contribute to saving energy.

There is a heating system with panel-type radiators with thermostatic valves to control it according to the needs of the user. Temperature control prevents unnecessarily using energy and overheating areas. On average, reducing the temperature by 1°C can reduce heat consumption by 6%.

Air conditioning in the stadium also uses the fan-coil unit system. The peculiarity of this system is that there is water, rather than a refrigerant, circulating between outdoor and indoor units. This makes this system more environmentally friendly than air-conditioning systems that use a refrigerant. Depending on the heat load per chiller, the compressor is incrementally loaded to 25%, 50%, 75% or 100%, thereby saving additional power by reducing the drive speed. This functional specification can also prolong the service life of the costly compressor.

Up to 70% electricity is saved by using LED lighting instead of fluorescent lamps in the stadium.

Fig.41. LED fixtures in the stadium

Outside the stadium, lighting is controlled automatically. This means that excessive consumption of electricity during the daytime is avoided. Automatic control is also encouraged under the green construction standards, specifically BREEAM.

4.7.4. Water saving

Water consumption is monitored using a meter at the inlet of the building. The gauge has an impulse output, which allows for further integration in the building management system.

Fig.42. Water meter in Samara Arena

Single-lever taps are provided in the sanitary facilities. Flow is limited to 9 l/min. Under Russian regulations, the standard water-flow rate in mixer taps is 12 l/min. Therefore the stadium's mixer taps are water efficient. There are flush panels with a volume of 6 l. The flush panel can control the flushing volume to reduce water consumption when the stadium is full. This is the equivalent of at least 44,000 litres per match depending on the settings for the water-flow rate.

4.7.5. Use of efficient materials

Measures will be taken at the Samara Arena to preserve and prevent breakage of structural elements. Classic examples include the arrangement of flow streams, access people to the stadium through several points, and the provision of protection elements in loading areas and areas where there is trolley movement.

4.7.6. Waste management

For the purpose of segregated waste collection and recycling, there will be a two bin system and a waste compound organised by the LOC Cleaning and Waste Management Team during the FIFA World Cup. The waste will be removed and additionally segregated further and recycled by a licensed contractor. The introduction of segregated collection will become an example of best practice in waste management for the entire region. Segregated waste collection with further obligatory recycling is also taken into account in the green standards. This activity can be used to earn points for the certification of the stadium . The stadium will have substantial gains if the sustainable waste collection measures adopted during the FIFA World Cup are continued after the tournament.

4.7.7. Green areas

The design to improve the surrounding area includes green areas. The green areas will occupy 20% of the site area, i.e. 10,695m^2 of 49,346 m^2. The specified percentage will make it possible to earn points under BREEAM In-Use,

4.7.8. Environmental protection

The design provides for the installation of an external grease trap, which prevents the discharge of waste

Fig.43. Water collection channels

kitchen water containing a considerable amount of grease and oil in the common sewage system.

The chillers that make up the cold supply system of the stadium operate with R-134A, a refrigerant that does not contribute to the depletion of the ozone layer.

There is a stormwater drainage system in the stadium's surrounding territory in order to prevent the accumulation of water and infiltration into the ground.

4.7.9. Conclusions

Samara Arena has met the requirements under the green construction standards, as the design implements solutions which allow the stadium to save resources in the operation of the building and compensate for its adverse environmental impact. The most notable are the solutions concerning transport accessibility, landscaping.

4.8. Ekaterinburg Arena

4.8.1 Transport accessibility

Ekaterinburg Arena boasts excellent transport accessibility. The building is located between Repina, Pirogova and Tatischeva streets. The nearest public transport stop is 120 m from the stadium, and is served by bus and trolleybus routes. Transport comes at 5-minutes interval.

Visitors on bicycles can reach the stadium from other city districts by taking a dedicated bicycle lane that runs along the whole of Lenin avenue.

The stadium building is fully ready to host people with low mobility. They can access all audience levels of the facility in lifts with handrails and call buttons at the appropriate height for wheelchair users. The main access ways are fitted with ramps with good adhesion and sloped at 5% maximum. All floors have sanitary facilities for people with low mobility and disabilities. This can be taken into account in the certification under the green construction standards.

4.8.2. User comfort and safety

The visual comfort of employees and visitors is ensured by access to daylight and window views. Stained glass systems are also an energy-saving activity in the daytime. Window blinds have been suggested for certain rooms to control daylight and fight glare. The use of anti-glare measures is encouraged under the green construction standards.

Indoor and outdoor working areas will be lighted mostly by LED fixtures. LEDs are safer for the personnel's and visitor's health due to their easy disposal, strength and lack of mercury.

The thermal comfort of visitors and employees is ensured by radiators whose temperature can be controlled by thermostatic valves. The air temperature and volume can also be controlled by fan-coil units.

4.8.3. Energy saving

Ekaterinburg Arena has implemented not only general energy-saving solutions (e.g. the automation of support systems regulating the temperature, air and water, and the use of LED lighting) but also solutions used in a limited number of projects (e.g. the preservation of historical facades).

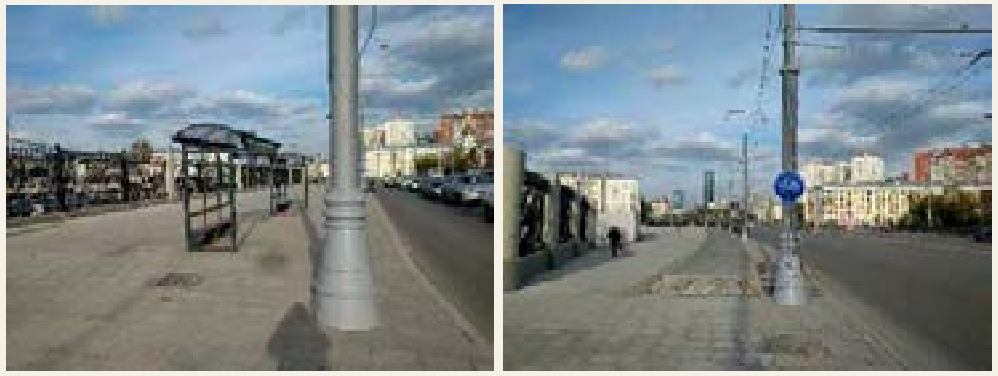


Fig.44. Tsentralny Stadion public transport stop and a dedicated bicycle lane

Fig.45. Preserved cast-iron fencing and view of the historical facades

The retained historical facade structures do not directly save energy, but serve as a wind protection for the new structures ensuring comfort and reduced heat loss.

Energy has been saved by using the stadium's historical facades and fencing, which would have been required to manufacture new materials had the decision to demolish the historical building and dispose of waste had been taken.

Another solution that ensures energy efficiency and comfort is the wind protection system of the stadium, which encircles areas. The wind protection system will provide an additional thermal comfort for the stadium users, reduce energy losses for space heating and ensure the preservation of the building structures.

The air-conditioning system in the stadium has variable flows. This system uses long air ducting so as to use less machinery and, therefore, save electricity. Certain areas are supplied with cold air from local air conditioners. The control systems of the installed machinery have inverter motor capacity, saving up to 30% energy compared to analogue counterparts.

The heating system uses two pipes and thermostats in radiators to ensure the proper thermal comfort in addition to saving energy.

LED lighting in the stadium saves up to 70% electricity compared to fluorescent lamps. The use of LED is encouraged under the main green construction standards. Points for LED lighting can be received under the BREEAM In-Use and "RUSO. The Football Stadiums" standards.

4.8.4. Water saving

UV water meters installed at the stadium's water inlet ensures the monitoring of water consumption.

The stadium's taps, toilet, urinals and showers conform to low and efficient water-flow rates.

Fig.46. Taps and shower in Ekaterinburg Arena

Most mixer taps have sensor control, which stops the water flow automatically when it is no longer being used. This prevents water losses from dripping or when users forget to close the taps. The water-flow rate of the taps is 9 l/min. This is considerably lower than the flow rate of regular taps (at least 12 l/min).

The installation of shut-off valves for certain devices in order to facilitate repair and locate leakages quickly was an additional solution that was implemented for most of the water fixtures.

Toilets in the stadium mainly have one button. The factory flush setting is 6 litres, which corresponds to average water efficiency levels.

Urinals also have a programmable flush volume. The factory setting is 0.7 l per flush, which is highly

Fig.47. Toilet bowl and flush panel

efficient. This value is also sufficient to earn points under the green construction standards.

4.8.5. Use of efficient materials

Measures will be taken at Ekaterinburg Arena to preserve and prevent breakage of structural elements. Classic examples include the arrangement of flow streams, the access of people to the stadium through several points, and the provision of protection elements in loading areas and areas where there is trolley movement.

4.8.6. Waste management

Segregated waste collection and recycling will be organised by the LOC Cleaning and Waste Management Team during the FIFA World Cup. There will be specific containers for different waste flows. Cardboard will be processed in a press compactor in order to reduce its volume and facilitate transportation. Further waste management and recycling will be handled by a licensed contractor on the basis of their ability to sell the sorted waste. The stadium will have substantial gains if the sustainable waste collection measures adopted during the FIFA World Cup are continued after the tournament.

4.8.7. Green Areas

At the time of the inspection, landscaping work was being undertaken in the area surrounding the stadium.

The green areas in the stadium will occupy at least 10% of the site area, which allows the stadium to earn points under BREEAM In-Use.

4.8.8. Environmental protection

There are grease traps installed in the stadium to prevent contaminated kitchen water from entering the common sewage system. They contribute to both the reduction of the contamination level of the discharged water, and the prolongation of the service life of the sewage piping, since it prevents dissolved fat, which can settle on pipe walls, from entering them.

The air conditioning system of the stadium uses an ozone-friendly refrigerant that does not contribute to the depletion of the ozone.

4.8.9. Conclusions

Ekaterinburg Arena has the potential to be recognised under the green construction standards. The stadium has implemented energy-efficient activities, including state-of-the-art equipment, maximum automation level, and the possibility of being able to vary capacities according to load. Other advantages include the excellent transport accessibility of the stadium and accessibility for various visitor groups, including disabled people and people with limited mobility.

Overall conclusions

All of the 2018 FIFA World Cup™ stadiums have the potential to be recognised under the green

Fig.48. Landscaped areas in Ekaterinburg Arena

construction standards. The activities that have been undertaken in the stadiums meet not only national requirements, but also international ones. These will contribute to the stadiums receiving certification under both the Russian green construction standards and international standards. The strongest points for the stadiums' certification will include transport, and landscaping of the surrounding areas. Energy-efficient solutions contribute considerably to the rating. The utility systems of all stadiums are automated, which is taken into account under the "RUSO. The Football Stadiums" standards, and LED indoor lighting which is included in both the national and international standards. Developing thermal and visual comfort is also evaluated under the specified standards; in that category, points will be granted to the stadiums depending on the level of detail involved in the user-comfort solutions.

Average distance to the nearest transportation stop is 640 m or 8-10 minutes for pedestrians. Almost all stadiums have public transport points within at least 500m from the main access to the building, for which points can be earned under "RUSO. The Football Stadiums". The close proximity of public transport points to the Luzhniki Stadium, Volgograd Arena and Samara Arena and the transport comes at 5-minute intervals will allow these stadiums to earn maximum points under BREEAM NC.

All stadiums have a high potential to receive a high score under the waste management category of the green standards if they plan to continue to implement the recycling systems that will be implemented by the waste management function of Local organising committee during the FIFA World Cup.

Landscaping of over 10% of the construction area is sufficient to get points under BREEAM In-Use. According to the landscaping plans, the majority of stadiums have the potential to get this point.

Landscaping of over 25% is recognised by "RUSO. The Football Stadiums". Kaliningrad Stadium will be able to earn the highest points under both the green construction standards with regard to the implementation of landscaping design. The total area of landscaping of all stadiums is over 70,000 m^2.

Points may also be awarded under the energy efficiency category. The high level of automation of the facilities' systems saves up to 30% electricity. The advantage of LED lamps compared to fluorescent ones means 70% of energy is saved.

Points may also be awarded under the water-saving category. Water consumption in the majority of stadiums can be adjusted to the minimum values. Installed water consumption devices will save up to 1,600,000 l of water per match when the stadiums are full. The implementation of a rainwater collection system in the Rostov Arena may add points to the general certification rating under the main standards. When reservoirs are full, their maximum volume can be used to water the football pitch for 20 days.

In addition, all stadiums may be recognised under the category on the reduction of environmental impact, since they use grease traps and ozone-friendly refrigerants.

The listed solutions will form the basis for the green construction rating of the stadiums. This set of solutions is sufficient to grant at least the minimum rating to each stadium. It should be noted that Luzhniki Stadium has already received the final certificate under BREEAM Bespoke with a "pass", and Mordovia Arena, Nizhny Novgorod Stadium, Volgograd Arena and Samara Arena have received the certificate of this standard for their design documentation. The receipt of the certificates will be the final confirmation of the environmental efficiency of the design, construction and operation of the stadiums.

Impressum

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E-mail: contact@fifa.org
Internet: FIFA.com/sustainability
Layout: FIFA Productions
Date: December 2017

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