FIFA WORLD CUP RUSSIA 2018

More sustainable stadiums

Technical report on the environmental, energy and resource-efficient design solutions for the construction and refurbishment of the stadiums for the 2018 FIFA World Cup Russia™


Moscow

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Technical report on the environmental, energy and resource-efficient design solutions for the construction and refurbishment of the stadiums for the 2018 FIFA World Cup Russia™

This report was prepared in 2015 for the 2018 FIFA World Cup Local Organising Committee by a Russian public not-for-profit organisation in the field of sustainable construction, "The Russian Green Building Council" (RuGBC).
The RuGBC is a member of the World Green Building Council (World GBC).

Contents

The official names in English of the stadiums for the 2018 FIFA World Cup™ are as follows:

1. Ekaterinburg Arena – Ekaterinburg
2. Fisht Stadium – Sochi
3. Kazan Arena – Kazan
4. Kaliningrad Stadium – Kaliningrad
5. Luzhniki Stadium; Spartak Stadium – Moscow
6. Mordovia Arena – Saransk
7. Nizhny Novgorod Stadium – Nizhny Novgorod
8. Rostov Arena – Rostov-on-Don
9. Samara Arena – Samara
10. Saint Petersburg Stadium – Saint Petersburg
11. Volgograd Arena – Volgograd

Introduction

The current design and construction practices in Russia, especially for such an important and unique project as the 2018 FIFA World Cup, largely correspond to the best sustainable construction practices and international standards.
However, in order to ensure the highest environmental performance of the stadiums and to meet the sustainable development goals, special obligations have been taken for the preparation stage and during the 2018 FIFA World Cup matches to ensure compliance with FIFA's certification requirements for green building.
Green building compliance covers sustainable development aspects, such as the introduction of energy and resource efficient technologies, minimising the negative environmental and social impact, conservation of biodiversity, ensuring the accessibility of buildings for people with limited mobility as well as providing a safe and comfortable environment for building users.
Certification of the 2018 FIFA World Cup stadiums allows for the improvement and dissemination in Russia of the cutting-edge experience of the international architectural, construction and facilities management communities, leaving a legacy of skills, knowledge and practical examples of the wide implementation of sustainable development principles.
This report prepared by the Russian Green Building Council (RuGBC) describes the principal green building approaches applied during the design and construction of the 2018 FIFA World Cup stadiums in Russia during 2014 and 2015.

Requirements for all stadiums of the 2018 FIFA World Cup

In achieving its mission of "building a better future", FIFA aims to lead by example and work with its partners towards making a positive impact on society and on the environment. Football stadiums are the heart and soul of the FIFA World Cups™ and their environmental sustainability is key to leaving a lasting legacy in the host country.

Environmental sustainability is already taken into account when planning the construction and renovation of football stadiums. It was shown at the FIFA Women's World Cup Germany 2011™ that environmental screening can lead to substantial savings in the long term compared to business-as-usual. An overall investment of an estimated EUR 700,000 in environmental measures for all official football stadiums in Germany led to annual savings of approximately EUR 300,000.

For the 2014 FIFA World Cup™ in Brazil, green building certification was also a condition for obtaining stadium construction funds from the Brazilian Development Bank.

There are various comparable certification systems for green buildings such as LEED, BREEAM or other rating tools that have been adapted to and developed for the local situation by organisations already acquainted with green building principles.

In line with its environmental sustainability commitment, FIFA has made the integration of environmental sustainability into the construction and renovation of all official football stadiums mandatory for all future FIFA World Cups, including the 2018 FIFA World Cup Russia.

1. The strategic vision for sustainable construction during preparations for the 2018 FIFA World Cup

In accordance with the FIFA stadium requirements, all of the 2018 FIFA World Cup stadiums have to be certified according to one of the internationally or nationally recognised green building standards. The requirement for compliance with such standards is enshrined in the Sustainability Strategy for the 2018 FIFA World Cup™ (hereinafter called the Strategy). The implementation of engineering and organisational solutions in compliance with green building standards also contributes to achieving other goals of the Strategy.

For example, in respect to the "Health and Safety" approach, green building standards support the FIFA requirements for the creation of tobacco-free environments and events at the 2018 FIFA World Cup, ensuring the application of technical norms to support healthy environments and the well-being of staff and visitors.

Universal access to the events, including transport planning for people with reduced mobility, is achieved by employing various design solutions as part of the practical introduction of the "Inclusivity and Equality" approach, providing comfort and the ability to move independently and access all areas of the stadiums.

In the framework of the "Transport, Carbon, Energy and Waste Management" approach, the objective of environmental impact mitigation and rational use of resources will be achieved by the following means:

- implementation of energy- and water-efficient technologies, including design of efficient engineering systems, constructions, technologies and equipment;
- use of energy-saving and durable materials;
- well-planned organisation of transport flows and use of low emission vehicles or alternative fuel vehicles;
- effective waste management with maximal reuse and recycling.

Preventing risks and promoting environmental protection, regulatory compliance and conservation of biodiversity in accordance with the "Risk Mitigation and Biodiversity" approach are achieved through the activities described above, and through the application of best practices for on-site construction management, landscaping measures, conservation of natural features and conservation of buildings of cultural or historical value.

It should also be noted that the green building requirements to use local labour resources and locally produced materials at the construction stage fully correspond with the "Local Economic Development" approach.

2. Approaches to implementing green building standards

The application of green building standards during the design and construction of stadiums is ensured by the following managerial decisions:

- Public contracts for the design and construction of stadiums specifically include a commitment regarding compliance with green building standards.
- A set of bespoke criteria for green building standards was developed and approved according to which the stadiums can be assessed and certified. This set of criteria is currently being implemented.
- An awareness-raising programme for stadium authorities and state bodies and municipalities has been developed and will be implemented at national and regional level, to be delivered through the development of information materials, provision of training sessions and information-sharing meetings with professionals in the area of green certification.

3. Environmental challenges in the framework of constructing the stadiums for the 2018 FIFA World Cup

3.1 Challenges in building approaches

In total 12 stadiums for the 2018 FIFA World Cup are being built based on three different types of construction approaches (new construction, wide reconstruction of old stadiums and adaptation of modern stadiums). Different types of works require different approaches to sustainable construction including the selection of assessment schemes and certification standards.

Two of the stadiums, Luzhniki in Moscow and Ekaterinburg Arena are the old existing stadiums from the mid-1950s which are being widely reconstructed. In general, the construction works involve preserving the original facades and parts of the interior because these stadiums are listed as architectural monuments. The seating areas and pitches are being rebuilt in accordance with the FIFA requirements. The stadiums are complemented by new constructions, new engineering systems are being installed in the stadiums and at the adjacent areas. As a result, the buildings will become modern sports facilities, harmoniously blending the old recognisable forms with modern technologies.

Seven stadiums are being built from scratch. The new modern stadiums are being built in the cities of Kaliningrad, Nizhny Novgorod, Samara, Saransk, Rostov-on-Don and Volgograd.

The new stadium in the city of Saint Petersburg is being built on the site of the historically existing Kirov stadium, so that the groups of old buildings and other historically valuable architectural elements are preserved and incorporated into the new architectural complex.

Two new stadiums are already complete. They have been in operation for over a year. These are the stadiums in Kazan (built in 2013) and the Spartak Stadium in Moscow (renovated in 2014).

One stadium in Sochi, constructed for the opening and closing ceremonies of the Winter Olympic Games in 2014, is now undergoing engineering and technical reconstruction to comply with FIFA's requirements. In general, the main changes to the stadium are connected with the parameters and dimensions of the football field, and the parameters of the stands, canopies and seats.

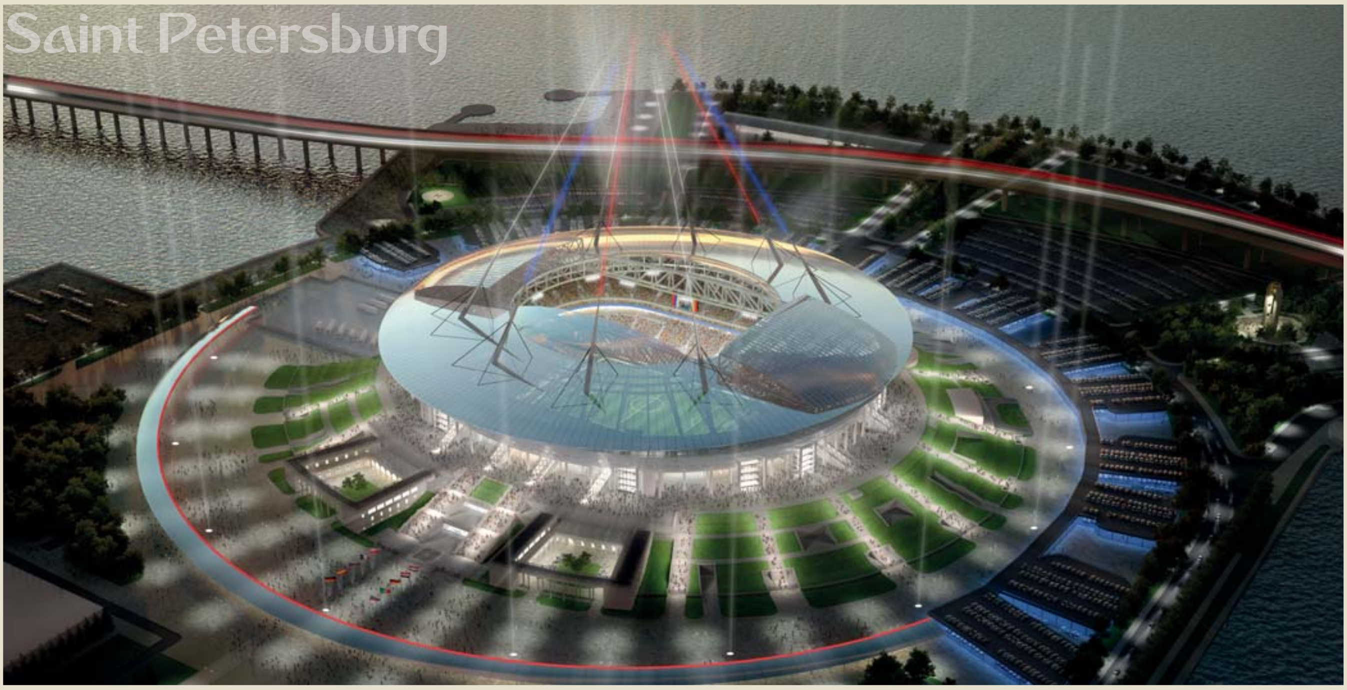
3.2 Climatic challenges for the construction processes

The 12 stadiums are located in 11 different regions of Russia. Those 11 regions are in five different climatic zones (subtropical, moderate, moderate continental, continental, sharply continental). Therefore, the stadiums are being built in climates ranging from humid subtropical in Sochi, with very warm winters and hot summers, to a sharply continental climate in Samara with very cold winters.

The maximum range of average annual temperatures in the different climatic zones varies from +17 to -15°C in winter and from + 27 to +17 in summer. Significant variations in humidity and wind load also occur in different areas. This variation of climatic conditions requires different approaches for building envelopes and planning of heating and cooling systems, constituting a significant challenge for resource-efficiency of the venues.

3.3 Geographical and territorial challenges for the construction processes

Nine of the 12 stadiums are situated within or near the river or coastal water protection zones. Several stadiums are being built on the banks of major urban rivers at a distance of not more than 300-500m from the water. The stadium in Sochi is situated within the coastal protection zone of the Black Sea



in 200m from the shore. The stadium in Kaliningrad is situated in 3km from the Ushakovsky Gulf of the Baltic Sea, on the banks of the Pregolya River, which flows into the gulf. The stadium in Saint Petersburg is on the shore of the Gulf of Finland of the Baltic Sea.

This proximity to natural waterbodies requires special environmental mitigation measures for preventing environmental impact during the construction works and the stadium operation, for example in respect to ensuring collection and removal of drainage or contaminated waste water, and construction of facilities for collection and temporary storage of waste. In some cases (for example in Volgograd), additional coastal fortifications are being built on the Volga River near the stadium as a flood protection measure.

Some of the stadiums are built in close proximity to natural parks and protected areas with vegetation that has to be conserved or requires compensation planting in other locations. For example, Luzhniki Stadium in Moscow is located in a urban green park complex in the centre of Moscow. In the design framework, compensatory planting and transplanting of trees is foreseen, as well as protecting existing trees on the site and soil rehabilitation works.

The stadiums in the cities of Rostov-on-Don and Kaliningrad are developed on urban greenfield sites as the future centrepieces of new urban centres with surrounding neighbourhoods and districts. Such projects require significant preparatory work in terms of planning and infrastructure for future development including:

- Integrated urban master-planning for the overall spatial development (adjacent multifunctional centres and residential development)
- Extensive engineering surveys
- Large-scale earthworks and strengthening of water defences
- Drainage works
- Special foundation surveys and testing
- Development of transport systems including new roads, interchanges, bridges and flyovers
- Development of new utilities (electricity, water supply and sewage, heating mains)

The stadiums in the cities of Saransk, Volgograd, Ekaterinburg and Samara are being built or reconstructed in densely populated areas and introduced into the existing urban landscape. They are surrounded by existing infrastructure, offices and residential areas.

4. The application of green building standards during the construction of the stadiums

4.1 Green building in Russia

Green building standards have been used for the past seven years in the Russian construction industry, including in projects across all the main Russian regions within the developed urban centres. By the end of 2015, the number of buildings certified to international standards will be over 50. However, the number of completed buildings built using innovative energy- and resource-efficient decisions is over 230. They comprise a large variety of buildings and real estate projects including office buildings, multi-functional complexes, manufacturing facilities and logistical centres, universities, residential complexes, integrated urban development projects, private households, train stations, and depots.

The effectiveness of green building standards has been successfully tested on a number of major public projects, including sports facilities built for the Winter Olympic Games in Sochi in 2014, such as the Bolshoi Ice Palace and a number of infrastructure projects (hotels, railway stations, a university).

The next international sporting event that is the driving force behind the sustainable construction industry in Russia is the 2018 FIFA World Cup. All the stadiums being built for the 2018 FIFA World Cup must comply with environmental standards and have to be certified to one of the recognised standards.

Thanks to the 2018 FIFA World Cup in Russia, new stadiums will be built in accordance with best practice construction requirements for environmental protection and resource efficiency.

4.2 BREEAM standard

The BREEAM international standard was developed in the United Kingdom and is managed by the UK-based Building Research Establishment (BRE). Nowadays, this standard is used worldwide for certification of buildings and constructions and has a proven track record in Russia. The application of BREEAM's "bespoke" approach enables the assessment methodology to be adapted for each project to take into account compliance with national norms and rules while applying international environmental and energy efficiency building codes for construction.

The project team submits special forms under the BREEAM "International Bespoke" process, noting the presence of local regulatory guidance documents and accounting tools that are suitable to prove compliance with the requirements of the certified project criteria developed by BREEAM, which uses them as the compliance criteria alongside with the international requirements.

Designers and developers of several stadiums have chosen BREEAM due to the fact that the standard has already has a proven track record in Russia, including for the certification of sports facilities. It is also popular due to the flexibility of the BREEAM "International Bespoke" scheme, which in each case is adapted to a specific project.

4.3 Special Russian standard

A special Russian standard has been developed for the purpose of certifying the 2018 FIFA World Cup stadiums. The standard takes into account the requirements of internationally recognised standards. It was developed by experts from the Russian professional engineers' association (AVOK) with the support of the Russian Federation's Ministry

of Natural Resources and the 2018 FIFA World Cup Local Organising Committee.
The development of this standard aims to consider the baseline requirements of sustainable development during the certification of newly designed and reconstructed 2018 FIFA World Cup stadiums.
The criteria of the standard are based on sustainability principles balancing three factors:

- Socio-cultural
- Environmental
- Economic

The standard takes into account the best international practices and approaches in the field of green building whilst complying with Russian regulations and Russian construction practice. The standard regulates not only compliance with minimum requirements but also stimulates improvements.
The standard includes basic criteria in areas such as environmental protection and environmental safety, energy efficiency, efficient water management, environmental characteristics of materials, waste management, quality of architectural design and land planning, and user comfort.

4.4 The certification status of the stadiums

By the end of 2015, the design of five stadiums gained interim certification under the BREEAM "International Bespoke" standard. They are:

- Luzhniki Stadium in Moscow
- Samara Arena
- Nizhny Novgorod Stadium
- Volgograd Arena
- Mordovia Arena in Saransk

Practical assessment for the Russian standard has started. It is expected that all twelve stadiums will be certified by the final stage of construction either according to an international standard or the special Russian standard.

5. Implementation of resource-efficient approaches and environmental decisions at the stadiums

The use of green building standards has a direct impact on the selection of resource-efficiency measures and environmental construction solutions to be implemented – including the selection of appropriate engineering technologies and equipment. This section describes the main approaches used in implementing the required "green" standards within the design and construction of the stadium.

General engineering approaches and solutions
Measures foreseen as part of the design and construction of the stadium to reduce the consumption of energy and material resources and achieve compliance with environmental requirements while maintaining or improving the quality of the stadiums and the comfort of their internal environment include the following general measures and design solutions:

- Planning the buildings to be energy efficient and save resources (for example, compact allocation of constructions and facilities on master-plans)
- Natural lighting strategies which optimise the window-to-wall area ratio depending on the orientation of the building
- The use of "buffer" areas (curtain walls) and "thermal protection zones" between the outer and inner walls and fencing structures
- Effective thermal insulation of the building envelopes
- The use of sun protection/shading systems and louvres in the office areas of a stadium
- Roof covering with selection of light colours to reflect the sun light
- The use of environmentally friendly materials in construction, including non-combustible materials without phenol-containing binders
- Easy-to-install prefabricated structures
- Where possible, the use of regional materials manufactured in proximity to the construction site
- Multi-sectional and low-inertia engineering systems with a wide range of adjustment possibilities
- Controlling of alternating air flow for indoor-space heating for various premises and with seasonal and time mode settings
- The application of measures to reduce sound and vibration levels from ventilation equipment
- Heat recovery of exhaust air in air-handling units of the building utilising highly efficient heat exchangers
- The use of cold accumulator recharging at night
- The use of water-saving plumbing systems: lock valves, sensors and water- flow shut-off systems, water filters, dual-mode device flush toilets, individual automatic flushing urinals
- The separation of "technical" and drinking water supplies
- Installation of the central and individual controls for central water heating;
- The use of automatic systems to maintain optimal parameters in engineering systems
- Installation of measuring devices for heat metering
- Development of permeable surfaces for parking lots at the rate of 20% of total parking area

The building management systems (BMSs) in the stadiums
All of the stadiums are equipped with modern automatic control systems, utilising special hardware and software. Such building management systems reduce the use of resources for a building maintenance, by controlling and monitoring them

across all areas of the stadiums. Additionally BMSs control and monitor other important environmental indicators such as CO_2 levels and detect leaks in pipelines.
The following stadium engineering systems are monitored and controlled by BMSs: heating, cooling, ventilation, air conditioning, lighting, water supply, sewerage, electricity supply, fire protection systems, security and communication systems.

5.1 Energy-saving and energy-efficient engineering equipment in the stadiums

Electric power supply

The electric power supply for all of the stadiums is provided using load distribution calculated according to the anticipated operation periods of the stadiums. The calculation of electrical loads for each stadium was conducted taking into account the seasonal factors and use profiles depending on the operating mode for peak electrical consumption.
Internal electricity distribution is carried out by radial circuits depending on the various consumption patterns created according to the functionality and placement within each building and demand locations. Thereby power losses in the networks are minimised.

Cooling and air conditioning

In order to supply the stadiums with sufficient cooling capacity, each of them is equipped with one or more modern high-efficiency cooling centres with a centralised cooling and conditioning system. The chillers with water-cooled condensers and dry coolers are selected from leading manufacturers. Cooling centres consist of two circuits: one operating in summer mode, producing cooling and another one operating in winter mode producing both heating and cooling as required.
In winter, under normal conditions, the cooling machines are turned off and cooling is provided by heat exchangers in winter mode. Air conditioning fan coil units are cooled by means of chilled water supplied by the cooling centre. Each room with air conditioning has its own individual controls.

Kalininigrad Stadium's heating, ventilation and air conditioning (HVAC)

The air conditioning system in Kaliningrad is designed using multi-zone virtual routing and forwarding (VRF) systems. Outdoor units are installed in the technical area, whilst warm and cooled air is piped directly to the rooms, each of which has individual controls. The VRF system is a new direction in the development of central air conditioning systems. The VRF is an intelligent and complex system with all the functionality of traditional central air conditioning systems but with smart operation.
There are numerous advantages of the VRF over traditional central air conditioning systems, the most important of them being:
- High level of consumer comfort
- Very low electricity consumption
- Convenient operation
- Reliability

Heat supply and distribution

Heating is provided with external district heating networks. An individual heating unit is used as a local source of heat for the heat supply network, ventilation system and hot water preparation. This approach is considered to be the most efficient technological solution for heat supply at the stadiums.
In order to maintain the required indoor environmental parameters, part of the air handling units are designed to pre-heat the outside air using

water-based air heaters. Designs also provide for the use of thermal vestibules – infrared heating situated between the open galleries of spectators and blocks of warm rooms (kiosks, coffee shops, etc.). Heat curtains are also considered at the outer openings (lobbies including in office areas, loading and unloading areas). Electric under-floor heating is planned in the team locker rooms and in the medical examination rooms.
Individual heating controls are installed in the most of the premises. Installation of heat meters are considered for various functional areas for measuring the heat consumption.

Ventilation
Modern mechanical ventilation systems with variable speed drives are included in the stadium design for greater comfort. The ventilation system is equipped with filters at the air intakes to clean the outdoor air. Combined extract and input ventilation is designed for all of the indoor premises.
For each group of premises in the stadium the ventilation system is split into blocks so that each area can be separately ventilated. Air is supplied to the groups of premises on a need-only basis, saving energy and resources. The main playing field and the stands are normally designed to be ventilated passively by outdoor air.

Lighting
Energy-efficient metal-halide lamps will be used for artificial lighting of the sports stadiums. According to the FIFA requirements, these are the only type of lamps that meet the required quality of light in terms of brightness and frequency.
In the surrounding areas and in the architectural exterior lighting, the stadiums mainly apply efficient and energy-saving, environmentally friendly systems based on LED lamps. Interior lighting in offices and technical rooms is mostly provided by metal-halide and LED lamps.
All the stadiums are designed to allow natural daylight into the main arena in the daytime. This is achieved through the architecture design and the extensive use of translucent materials.

Internal and external lighting conditions
At a number of the stadiums such as those in the cities of Samara and Nizhny Novgorod, a special study was carried out calculating internal and external lighting conditions. Such calculations took into account the different aspects of lighting operations during a particular period of time: by the hour, by the day, by the week, and by the season. They also take into account the characteristics and lighting requirements of the illuminated area under consideration.

Lighting technical calculations are an inherent requirement for a number of internationally recognised green building standards. The calculations are performed by a computer simulation that provides high-precision data and a methodology for energy-efficient lighting modes within and adjacent to the stadiums. Lighting calculations allow the required number of outside lights, their optimum capacity and allocation on the site plan to be determined with a high degree of accuracy at the design stage.

Usually, all the stadiums have two modes of lighting: everyday and sport. Outdoor lighting switches on and off automatically and is controlled by sensors that determine the time of day and condition of the ambient light. In some of the stadiums, motion sensors will be installed for indoor lighting of technical rooms that are rarely occupied. Such systems will switch on and off automatically, will save energy and can prolong bulb lives. All the electrical lighting in all of the stadiums is in turn controlled by a common automatic control system (i.e. the Building Management System) that also controls energy consumption and provides power saving.

Use of hollow tubular skylights
Some rooms and spaces in the stadiums in the cities of Rostov-on-Don and Kaliningrad use hollow tubular skylights to bring natural daylight into some working premises such as public catering areas.

Hollow tubular skylights supply passive daylight by redirecting sunlight through special fibre tubes. The hollow fibre tubes consist of the collection dome section, on the outer end of which there is an optical system to collect the natural light, and at the inner end of which there is a diffuser to direct the light into the interior of the room.

The design uses the daylight entering rooms via vertically arranged prismatic optical fibres. The vertical light pipes (made of optical fibres) of various diameters pass through the ceiling on the ground floor and are then fed through the area of the suspended ceilings. "Lightway" light tubes are designed for such use in stadiums.

5.2 Measures for rational water use in the stadiums

Water supply and sewerage

The existing municipal water supply network is the source of water in all the stadiums.
The following systems are designed for the stadiums in order to meet the highest standards of efficiency:

- Domestic drinking cold water supply
- Domestic hot water supply
- Internal water supply for fire protection needs (combined with automatic fire extinguishing)
- Automatic fire extinguishing system
- Domestic sewage
- Technical sewage with grease catchers (from catering)
- Drainage (including internal drainage and storm water drainage)
- Sewage treatment plant (in some stadiums)

In order to monitor water consumption, water meters are located at the entrance of the water supply system to the building and at the entrance to the sanitary facilities.

Water-saving sanitary equipment

All washbasins and showers at the stadiums are provided with contactless automatic (sensor) mixer taps and aeration nozzles. The urinals will be installed with sensors for the flush. "Dual flush" toilets are designed as standard as well as other sanitary water-saving appliances. Toilets will be also equipped with a vacuum flushing water system flowing at 1-2 litres per flush.
Drinking and technical (non-potable) water supplies are separated. These types of measures significantly decrease the water consumption for domestic needs. In order to reduce the hot water consumption, a centralised engineering system is designed with hot water circulation in the main pipelines and standpipes with insulation.

Rainwater harvesting

The design of the stadiums in Saransk, Kaliningrad and Rostov-on-Don provides for the construction of a local waste-water treatment plant for storm water treatment. This is provided for the purpose of collection, storage and reuse of rainwater to irrigate grass on the pitch. It is assumed that treated water will be accumulated in a special storage tank with a capacity of up to 1800m^3. Treated rainwater is used for watering the pitch. It is also possible to retrofit a special tank for the accumulation of rainwater for subsequent use on the other stadiums where necessary. Such an approach to the water use for irrigation needs using recycled water enables potable water obtained from the city water supply network to be saved.

5.3 Construction materials

The stadium designs reflects the technical solutions using modern, energy-efficient and environmentally friendly insulating materials from the best Russian and international manufacturers which are widely available in the Russian Federation and are of competitive price and quality. For example, floors, facade and interior walls, piles, sandwich panels, all reinforced concrete structures, stands, lobbies and interior partitions – all of them are insulated with energy-efficient materials from internationally recognised suppliers. The following materials are used: mineral wool, a variety of insulation and waterproofing materials. All of them are high-quality products with high-performance thermal and waterproofing qualities.

The rooves of the stadiums generally consists of two basic elements:

- Transparent polycarbonate that protects against rain and snow in all seasons and provides the arena and stands with natural lighting in the daytime
- Metal prefabricated robust structures

The window systems use energy-efficient triplex glass windows in aluminium frames and are specified to only use materials widely available on the territory of the Russian Federation and found at competitive prices and quality.

Highlighted solution – the Sochi Fisht Stadium's unique roof

During the creation of the awning for the Fisht Olympic Stadium, innovative ETFE (ethylene tetrafluoroethylene) material was used; this consists of a transparent film membrane, which is resistant to moisture and which lets in light.

In the framework of the application of complex Texlon technology, the pneumatic membrane units is made of ETFE material in the form of "cushions" which are enclosed in aluminium profiles and supported by a light metallic structure. In order to ensure an adequate level of thermal insulation and resistance to external loads, air is pumped periodically at low pressure into the cushion-type membrane. Pressure control of incoming air enables the adjustments of the whole construction in terms of the light permeability.

The environmental efficiency of ETFE material is characterised by the following characteristics:

- the high transparency of the ETFE material for the daylight including the ultraviolet spectrum makes it possible to reach a high level of natural light for the venue;
- the high resistance to ultraviolet radiation exposure in natural conditions is more than 100 years;
- low thermal conductivity which contributes to the effective thermoregulation within the stadium;
- ETFE material is inflame resistant, and it does not spread flames over the surface;
- ETFE material is approved for use in areas with a high probability of powerful hurricanes, and it has a high resistance to hail and can withstand significant snow loads.

The Texlon technological solution has the third type of eco-labelling for the international environmental declaration of products developed according to the international standard ISO 14025: 2006.

5.4 Transport accessibility

Provision has been made for a sufficient number of parking places in the surroundings of all the stadiums for private and special vehicles of all categories as well as parking for various types of public transport vehicles required to take spectators to the stadiums. Additionally, all the stadiums are equipped with pedestrian access from the adjacent streets. The pedestrian pathways are organised and technologically designed with convenient underground and over ground passages, ramps, stairs, escalators and travellators.

To access the stadiums, visitors have three choices:

- By public transport
- From designated car parks for personal cars
- From the pedestrian traffic routes adjacent to the stadiums

The provision of existing and planned public transport drop-off and pick-up points at all of the stadiums are to be located no further away than 500m according to the green building standards and FIFA requirements. In all Host Cities where the stadiums are newly built, urban transport planning solutions are being implemented, providing visitors with sufficient transport accessibility by public transport. New subway stations and bus stops, tram connections and updated railway stations are being built adjacent to the stadiums. Furthermore, large-scale infrastructure projects are underway offering convenient levels of accessibility and increasing passenger flows, these include the building of new interchanges, overpasses and roads connecting the future stadium to the surrounding areas of the city, airports and railway stations.

5.5 Access for people with limited mobility, inclusiveness

The projects of all stadiums provide a full range of measures for people with limited mobility of all types, ensuring they enjoy the same access to and conditions at the stadium as others, such as:

- Thoughtfully placed sectors and specially equipped places for people with limited mobility in the stands
- Providing barrier-free access to the stadium, including zones of different services and places of public use
- Placing special labels and signs for easy navigation by people with limited mobility

5.6 Mitigation of the environmental impact

Monitoring of air pollution emissions at the construction sites

Construction works are done in stages at all of the stadiums. At every stage there are different air emissions sources. Therefore, during the development of design documentation, special design contractors estimate the impact of construction work in terms of air pollution, including calculations of anticipated pollutant dispersion. These include calculations for selected periods associated with the simultaneous use of the largest number construction vehicles emitting pollutants into the atmosphere. This peak period occurs during the construction of large structures.

Based on dispersion modelling produced by the assigned companies for each of the stadiums, calculations demonstrate that the estimated concentration of polluting substances emitted by sources at the construction site do not exceed the maximum allowable concentrations, taking into account the existing background air quality. The mitigation measures are foreseen in the design documentation in order to reduce the air impact.

Waste-water treatment at the construction stage
All stadium construction sites are provided with efficient measures for collection and treatment of waste water, including water polluted with oil products and storm water. Control of discharges into waterbodies is organised on-site. Technical waste water from canteens, bars and cafeterias is to be sent to a special technical sewage network. Grease catchers are provided at the network exit points of the buildings. After treatment in grease catchers, waste water is directed first to the on-site sewage system, then it flows into the municipal sewage network.

Washing the truck wheels on the construction sites
All of the stadium construction sites are equipped with closed-cycle water wheel washing systems, equipped with water treatment systems. This measure prevents the transfer of soil and cement dust being transported on vehicle wheels to adjacent areas.

Construction waste management
The waste generated in the construction process at all of the stadiums is temporarily stored (accumulated) in closed reservoirs or containers in specially designated areas. The special removal procedure is employed on sites for regular waste removal, transportation and disposal by specialised contractors.

5.7 Landscaping, planting and biodiversity conservation

The environmental impact generated during the construction works is mitigated by the following measures:

- Control of ground mass movement
- Stabilisation of the construction area which is not in current use and seeding it with grass for fixing
- Washing the wheels of construction vehicles
- Maximum possible conservation of existing adjacent areas
- Restoration of areas damaged during the construction

After the completion of main construction activities at the stadiums, works will be carried out for to landscape and plant the sites with appropriate vegetation, including the following actions:

- Construction of hard-surface roads, pavements and paved areas
- Creation of vegetation areas
- Introduction of lawns and flower beds
- Installation of small architectural forms (benches, urns, flower pots)

At the stadiums where introduction of vegetation is foreseen, the landscaping will be done by planting shrubs, trees and grass (creation of lawns) while considering the access requirements for maintenance of the underground engineering communications. The areas on which planting is planned will be covered with fertile topsoil.
Thus, before the operation stage, the former construction areas of the stadiums will be covered with:

- Paved areas (roads, pavements and paved areas)
- Artificial ground (transformed soil) which will be performed by the fertile soil layered on top of the structured surface constructed by backfill material

Key conclusions from the technical report

Structural and engineering solutions recommended at the design stage for newly constructed or renovated stadiums are aimed at encouraging the use of cutting-edge technologies and efficient materials, reducing the consumption of electricity, water and, accordingly, the operating costs during the operational phase of stadiums.

Using best practices of works and waste management during the construction phase can significantly reduce the negative impact on the environment and reduce environmental risks which is especially important for natural and cultural sites located in the vicinity of the stadiums.

The design stage of 2018 FIFA World Cup stadiums under construction or reconstruction allows for green certification to be implemented. Five of the stadiums are certified using this assessment method at the design stage according to the BREEAM "International Bespoke" standard. Currently, decisions are being made about whether to certify the stadiums according to the specially developed Russian standard or to have them undergo BREEAM certification.

To ensure compliance with the certification requirements, experts from the Russian professional engineers' association AVOK (Association of Heating, Cooling and Ventilation Engineers), with the support of the Russian Ministry of Natural Resources and the 2018 FIFA World Cup Local Organising Committee, have developed a bespoke green building certification system for stadiums.

The applicable green building standards are the best ones to take into account the international practices and approaches in the field of design and construction, on the one hand, and on the other hand to assure compliance with Russian building regulations and legislation. This ensures not only the fulfilment of the necessary requirements, but also contributes to improving environmental performance in the construction management, increased operational efficiency in the stadiums and providing additional levels of comfort for spectators.

The certification process for the 2018 FIFA World Cup stadiums promotes the use of cutting-edge solutions and best practices from the international community in the design, construction and operation of technically complex buildings and structures, as well as the adaptation accordingly to Russian conditions and the regulatory framework. This creates a unique opportunity to learn from the experience of large-scale use of sustainable construction principles, enabling a wide range of specialists to develop the necessary skills and knowledge – designers, builders, engineers and consultants – thereby enhancing the country's skillset.

Impressum

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