

Building Sustainably

ENERGY USE BEST PRACTICES FOR CONSTRUCTION SITES

Case Studies from FIFA World Cup Qatar 2022™ Stadiums



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► March 2023

Developed By:

Gulf Organisation for Research & Development (GORD)

In Collaboration With:

Supreme Committee for Delivery & Legacy (SC)

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اللجنة العليا
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FOREWORD



Dr. Yousef Mohammed Alhorr

Founding Chairman,
Gulf Organisation for Research &
Development

Every year, tons of greenhouse gases are released by construction and the building industry contributing to an irreversible environmental damage. As the urban infrastructure continues to grow, so does the need for future-resilient practices. Understanding this climate emergency, building and construction community across the world has ramped up efforts to make our built environment exist in harmony with the nature.

Over the years, cutting edge green technologies and smart architectural strategies have accelerated the development of low-carbon buildings and cities. From ecologically responsible materials to energy-efficient systems, project owners and stakeholders are increasingly prioritizing sustainability as part of their broader ESG strategies. That said, in considering the environmental performance of a project, carbon emissions linked with construction practices on site are often left out of the equation.

From enabling the heavy equipment to powering site facilities, construction activities consume a tremendous amount of energy. For mega projects, the energy footprint can be even more colossal. Under the wise leadership of HH Sheikh Tamim bin Hamad Al Thani, the State of Qatar has introduced and implemented concrete policies to mitigate its construction-linked emissions from large-scale projects including the facilities developed in preparation of the FIFA World Cup Qatar 2022™.

In response to Article 4.4 of the Paris Agreement, Qatar has committed to reduce 25% of its overall GHG emissions by 2030, with a clear focus on the building and construction industry. To this end, the Global Sustainability Assessment System (GSAS) has

played a pivotal role in meeting the State's national ambitions. As communicated in Qatar's Nationally Determined Contributions (NDC) statement submitted to the United Nations Framework Convention on Climate Change (UNFCCC), "Qatar has been transforming its building standards towards higher sustainability levels through the adoption of the Global Sustainability Assessment System (GSAS) standards."

With firm support from the Supreme Committee for Delivery & Legacy (SC) and its unhindered stance to host a climate-conscious sporting event, GSAS has remained a cornerstone guiding project teams to ensure that every World Cup stadium is environmentally sustainable from design and architecture, through to construction and operations.

As these venues take final shape ahead of the World Cup, this report titled 'Energy Use Best Practices for Construction Sites' sheds light on the important practices adopted on stadium sites to cut down their energy use, and eventually their carbon footprint, during the construction phase. By summarizing 22 best practices throughout the construction period, the report not only highlights the role of GSAS Construction Management in optimizing energy consumption, but also presents effective ways in which any construction site can mitigate its greenhouse emissions. ways in which any construction site can mitigate its greenhouse emissions.

In a nutshell, the report underscores impactful ways that can enhance any site's energy resilience by reducing electricity consumption in facilities, processes and equipment. By consolidating the best practices in this unified document, we hope to empower the industry professionals, educate the wider communities and create more W engagement in pursuit of a sustainable future.

FOREWORD

Sustainability formed a central part of Qatar's bid for the FIFA World Cup Qatar 2022™, helping it stand out among competitors. When we started drawing up plans for the tournament, we had a nearly blank canvas – giving us a huge advantage to ensure that sustainability sat at the heart of all our FIFA World Cup Qatar 2022™ planning and delivery, before we first broke ground on any projects.

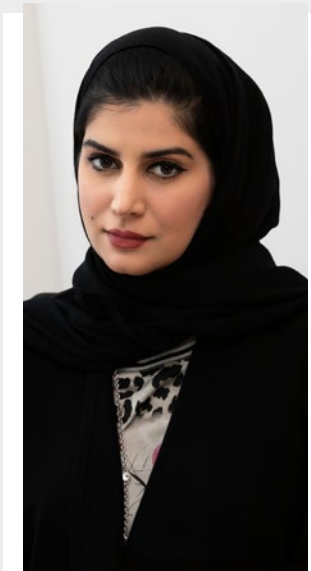
In working with our partners and stakeholders to successfully deliver on our FIFA World Cup Qatar 2022™ sustainability goals, a key aspect was building the infrastructure required for the tournament according to the highest sustainable building and construction standards. On stadium sites, this involved Qatari entities working with international partners to achieve sustainable design and construction – of which efficient energy use and management formed a crucial element.

Our collective efforts have helped minimize the impact that the construction of tournament venues had on the environment and contributed to upscaling environmental consciousness across the industry. Along the way, we have set new benchmarks that we hope the rest of both the construction and mega-event industries locally and internationally can benefit from.

However, despite all of the progress we have made, our work is not done and maintaining this positive momentum will be key to the legacy we are aiming for the tournament to leave after 2022.

The Gulf Organisation for Research & Development (GORD) has been a key partner in helping us achieve the immediate positive environmental impact of the FIFA World Cup Qatar 2022™, guided by the GSAS green building certification system. Our collaboration will continue long after 2022 as we move to deliver our long-term legacy planning aimed at ensuring that sustainable environmental development is maintained for generations to come, and reports such as this one will contribute to this.

We are pleased to share this report on sustainable construction, focused on energy management best practices and case studies from stadium sites across Qatar. We are certain this report will be an invaluable tool to many in the construction industry and look forward to continued cooperation.



Eng. Bodour Al Meer

Executive Director - Sustainability,
Supreme Committee
for Delivery & Legacy (SC)

ACKNOWLEDGEMENTS



This report has been made possible through the continued efforts and support of many dedicated individuals and entities, including the Supreme Committee for Delivery & Legacy, GSAS Certified Green Professionals working at stadiums' construction sites, and the Gulf Organisation for Research & Development's technical and administration support teams.

1.0 INTRODUCTION

The construction of mega projects can last for many years, employing thousands of people, using hundreds of machinery and equipment, and deploying a diversity of technologies. These construction sites become a long-living working place for the construction crew where electric power is required at all times for many purposes.



Saving and optimizing energy consumption are necessary for executing any sustainable construction work. There are several options when it comes to supplying power for construction sites, especially for equipment that consume a heavy amount of electricity. This includes setting up temporary solar grids, hooking up to the power lines, or using generators. In most cases, construction sites opt to use temporary power provided by on-site diesel generators and are rarely connected to the grid. Considering energy efficiency measures along with smart controls can reduce electricity consumption. There are many environmental benefits to reducing electricity consumption, such as achieving better air quality, reducing greenhouse gas emissions, cutting down natural resource consumption, and lessening fuel truck trips.

On construction sites, the electricity is mainly used for supplying temporary on-site buildings and facilitating construction

activities. Electricity supply for temporary buildings involves lights, fans, air-conditioning for rest areas, canteens, offices, warehouses, workshops, etc. At the same time, electrical supply for construction activities involves site lighting, pumps, fans, and electric construction equipment such as tower cranes, cement mixers and handheld tools.

Construction in Qatar and the region encounters some special challenges, such as high temperature and humidity, requiring air conditioning of all buildings and in some cases outdoor spaces to be able to perform certain tasks. With low-lying land, dewatering is also often required, which demands a significant amount of energy for pumping.

In Qatar, with the goals set forth in Qatar National Vision 2030 (QNV2030) (GSDP, 2008) and in Qatar National Development Strategy 2018–2022 (PSA, 2018), significant attention has been placed on greenhouse gas emissions and air quality. The environmental pillar of the FIFA World Cup Qatar 2022™ Sustainability Strategy also includes clear objectives for green building, greenhouse gas emissions and air quality.

As all key stakeholders have the intention to pursue sustainability, substantial activities have been undertaken to reduce the amount of energy used during construction as a way to meet the main objectives of the respective strategies and visions.

1.0 INTRODUCTION



1.1 FIFA Endorsement and SC Commitment

For the FIFA World Cup Qatar 2022™, GSAS Design & Build (GSAS-D&B) certification with 4-Star rating has been endorsed as the required green building rating system for the match venues. The Supreme Committee for Delivery & Legacy (SC) has gone beyond FIFA's minimum requirement by specifying GSAS Construction Management (GSAS-CM) certification for all FIFA World Cup Qatar 2022™ stadium sites. The SC has specified that GSAS-CM certification should be achieved with a minimum rating of Class A for the construction sites of the stadiums. Furthermore, the SC has commenced implementing GSAS Operations (GSAS-OP) certification for the stadiums and head office.

GSAS-CM is applied to assess the processes and practices of contractors to evaluate the sustainability impact of projects over the course of the construction phase (start to end). The FIFA World Cup Qatar 2022™ stadiums have achieved very recognizable GSAS-CM ratings as shown in Table 1.

Table 1: GSAS-CM certification ratings achieved by all FIFA World Cup Qatar 2022™ stadium projects

Stadium	GSAS-CM Rating
Ahmad Bin Ali Stadium	Class A*
Al Bayt Stadium	Class A*
Al Janoub Stadium	Class A*
Al Thumama Stadium	Class A*
Education City Stadium	Class A*
Khalifa International Stadium	Class A
Lusail Stadium	Class A*
Stadium 974	Class A*

2.0 ENERGY USE IN GSAS CONTEXT

The energy used for construction activities is assessed in GSAS-CM v2.1 under the Energy category, which is composed of two criteria “[E.1] Energy Management” and “[E.2] Overall CO₂ Emissions”. [E.1] criterion assesses the measures undertaken to minimize the energy consumption in temporary buildings. [E.2] criterion assesses the implementation of measures to minimize the CO₂ emissions from the generation of electricity for use on-site.

The assessment is performance-based as the Energy Calculator is used to determine the Energy Performance Coefficients (EPCs) based on the equipment specifications and the electricity consumption compared to business as usual. The EPCs determine the awarded criterion level from 0 to 3 as indicated in Table 2:

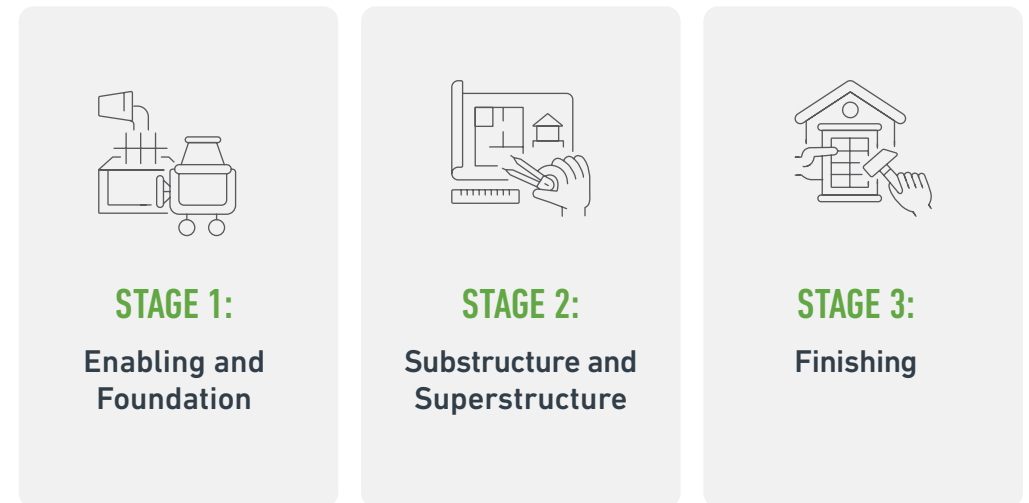
Table 2: Awarded level based on the EPC value

Level	EPC value	
	[E.1] Energy Management	[E.2] Overall CO ₂ Emissions
0	EPC > 1.0	EPC > 1.0
1	0.85 < EPC ≤ 1.0	0.85 < EPC ≤ 1.0
2	0.70 < EPC ≤ 0.85	0.70 < EPC ≤ 0.85
3	EPC ≤ 0.60	EPC ≤ 0.60

An EPC > 1.0 means that no energy saving has been achieved compared to the reference value; therefore, level 0 is assigned. The greater the energy saving, the greater the awarded level reaching up to a maximum of 3.

On-site meters are necessary to be installed to monitor the electricity consumption of temporary buildings and construction activities, hence completing the GSAS Energy Calculator. In addition, equipment and temporary building envelope specifications are required to do the assessment.

The assessment is carried out over the entire construction period, and audits are conducted during three construction stages as follows:



2.0 ENERGY USE IN GSAS CONTEXT

2.1 FIFA World Cup Qatar 2022™ Stadiums

Represents the FIFA World Cup Qatar 2022™ Stadium projects' awarded levels for the Energy criteria [E.1] and [E.2]:

Table 3: Awarded [E.1] and [E.2] levels.

Stadium	Stage 1		Stage 2		Stage 3	
	[E.1]	[E.2]	[E.1]	[E.2]	[E.1]	[E.2]
Ahmad Bin Ali Stadium	2	3	2	3	2	3
Al Bayt Stadium	1	0	1	3	2	2
Al Janoub Stadium	1	2	2	3	2	3
Al Thumama Stadium	3	3	3	3	2	3
Education City Stadium	2	2	2	2	3	3
Khalifa Stadium	2	0	2	0	2	0
Lusail Stadium	2	2	3	3	3	3
Stadium 974	3	3	2	3	2	3



2.0 ENERGY USE IN GSAS CONTEXT

2.2 Scope of the Analysis

This report focuses on the electricity use in the FIFA World Cup Qatar 2022™ stadium construction sites during the entire construction period. It highlights the role of GSAS-CM in optimizing energy consumption. It provides energy use data on construction sites that can be used by future projects as a reference for planning their energy use. However, it is crucial to indicate that the study takes into account the following considerations for a reliable comparison between projects:

1. The scope of the assessment extends to all on-site equipment powered by electricity, supplied by both the main grid and diesel generators. However, the energy consumed by mobile construction equipment has been excluded from the assessment except for light towers powered by their own built-in generators. This means that energy consumed by excavators, mobile cranes, trucks, etc. is not a part of the study.
2. Any building used for the management and operations of the construction site, whether existing or newly constructed/installed, has been considered, including but not limited to site offices, welfare facilities such as mess halls, canteens, sanitary facilities, clinics, rest areas, warehouses and workshops, etc. However, the energy consumed by the on-site workers' accommodation has been excluded from the analysis as it is not a common practice.
3. Khalifa International Stadium was refurbished and not newly constructed; therefore, it has been excluded from the analysis.
4. Al Bayt Stadium and Al Janoub Stadium construction started before the implementation of the electricity consumption monitoring; therefore, they have been excluded from some ratio calculations.
5. Stadium 974 and Education City Stadium required dewatering activities, which demanded significant energy consumption; therefore, the corresponding data have been excluded from some ratio calculations, as explained further in this report.

2.0 ENERGY USE IN GSAS CONTEXT

2.3 Energy Use Data Analysis

Stadium projects can be considered unique buildings as they intend to host instantly a large crowd of people for sports events. However, the construction practices can be considered similar to other typical buildings, despite the fact that some specific arrangements could impact the energy consumption, such as the double shift working schedule (24/7) which was implemented in the stadiums and required extra artificial lighting and cooling demand. Furthermore, due to the hot climate, higher energy demand is required to cool temporary buildings, and fans were required on site to improve the thermal comfort of the workers. Mitigating the heat required a significant amount of energy, especially considering that many of the fans were provided with a cooling system.

The collected data was analyzed, and the following ratios were calculated accordingly

- The ratio of electricity consumption per area.
- Distribution of electricity consumption
 - between temporary buildings and construction activities.
 - within the different temporary buildings' systems (HVAC, lighting, office equipment, and others).
 - within the different construction activities (construction equipment, lighting, pumps, and fans).

- The ratio of temporary buildings' electricity consumption per area per annum.
- Variation of electricity consumption through the construction stages.

2.3.1 Ratio of Electricity Consumption per Built-Up Area

The ratio of consumption per area can be considered a useful parameter in estimating energy use, as both area and energy used are relevant to the size of the construction. Larger construction buildings require more energy for the installation of materials. The duration of such projects is also longer, resulting in higher use of energy for temporary buildings.

This ratio of electricity consumption per stadium's built-up area can serve as a reference for future construction projects, especially when excluding certain activities related to major projects, such as dewatering.

Excluding the dewatering activities, Table 4 shows that an average of 141 kWh of electricity was used per square meter of built-up area. The ratio ranges from 69 kWh in Education City Stadium to 252 kWh in Lusail Stadium.

2.0 ENERGY USE IN GSAS CONTEXT

Table 4: The ratio of electricity consumption per built-up area (dewatering excluded)

Stadium	Ratio of consumption per area (kWh/m ²)
Ahmad Bin Ali Stadium	111
Al Thumama Stadium	105
Education City Stadium	69
Lusail Stadium	252
Stadium 974	170
Average Ratio	141

Table 5 shows the same average, however, when including the dewatering activities. An average of 151 kWh of electricity was used per square meter of built-up area. The ratio ranges from 98 kWh in Education City Stadium to 252 kWh in Lusail Stadium.

Table 5: The ratio of electricity consumption per built-up area (dewatering included)

Stadium	Ratio of consumption per area (kWh/m ²)
Ahmad Bin Ali Stadium	111
Al Thumama Stadium	105
Education City Stadium	98
Lusail Stadium	252
Stadium 974	188
Average Ratio	151

It is noticeable that Lusail Stadium’s electricity consumption is very high compared to the others. The reason behind it is that Lusail is a much larger stadium, its capacity doubles the others (80,000 compared to 40,000), and its construction required a longer duration.

2.0 ENERGY USE IN GSAS CONTEXT

Another factor considered in calculations is the continuous dewatering carried out for both stadiums, Education City Stadium and Stadium 974, which required a significant amount of energy. 42% of the total electricity consumption in Education City Stadium and 11% in Stadium 974 is attributed to dewatering activities. Dewatering activities were required only for 23 months, almost half of Stadium 974’s construction duration, which would explain why the consumption percentage is lower than in Education City Stadium, where dewatering was carried out during the whole construction phase (35 months).

2.3.2 Distribution of the Electricity Consumption

Knowing the detailed distribution of the electricity consumption on site between temporary buildings and construction activities can be of interest to future projects when planning their site logistics. The assessment considers energy consumption for both, the on-site temporary buildings and the construction activities.

Any building used for the management and operations of the construction site, whether existing or newly constructed/installed, is considered under the ‘Temporary Buildings’ category. These include, but are not limited to, site offices, welfare facilities such as mess halls, canteens, toilets, clinics, rest areas, warehouses and workshops, excluding on-site workers’ accommodation.

Any construction activity running with electricity is considered under the Construction Activities category, whether using power from the main grid or generated on site. These include, but are not limited to, lighting of the construction site, pumps, fans, and construction equipment including tower

cranes, compressors, concrete mixers, welding equipment and all pieces of equipment powered by electricity, excluding any on-site batching plant and equipment that runs on standalone fossil-fueled engines.

Table 6 shows that 56% of the electricity was consumed on construction activities and 44% on temporary buildings without dewatering. The percentages were changed when dewatering was included.

Table 6: Electricity consumption distribution between construction activities and temporary buildings

Stadium	Electricity consumption percentages (Dewatering excluded)		Electricity consumption percentages (Dewatering included)	
	Temporary buildings	Construction activities	Temporary buildings	Construction activities
Al Bayt Stadium	29%	71%	29%	71%
Al Janoub Stadium	53%	47%	53%	47%
Ahmad Bin Ali Stadium	58%	42%	58%	42%
Al Thumama Stadium	54%	46%	54%	46%
Education City Stadium	41%	59%	29%	71%
Lusail Stadium	22%	78%	22%	78%
Stadium 974	53%	47%	48%	52%
Average Ratio	44%	56%	42%	58%

2.0 ENERGY USE IN GSAS CONTEXT

It is noteworthy that the percentage of temporary buildings' electricity consumption is lower in the larger stadiums, Al Bayt (29%) and Lusail (22%), than in the rest of the stadiums. Larger stadiums require more temporary buildings with more energy consumption than the others. However, they also require much more energy for the electrical equipment on site which results in a higher percentage of electricity consumption for construction activities than in the rest of the stadiums.

Also, it is noticeable the impact of dewatering in the high percentage of construction activities consumption in Education City Stadium (71%), compared to the lower percentage in other stadiums of similar size. Once the dewatering consumption is excluded, this percentage decreases to 59%, which is in line with the rest of the stadiums.

2.3.2.1 Distribution of Temporary Buildings Consumption

Electricity consumption in temporary buildings is quite significant, so, it is important to know how it is distributed. GSAS-CM assessment requires monitoring of the following activities within the temporary buildings:

- HVAC equipment.
- Lighting in temporary buildings.
- Office equipment, including computers, servers, monitors, printers, etc.
- Other powered fixtures, such as pumps, fans, and water heaters.

Figure 1 shows all stadiums average distribution of energy consumption for these activities within the temporary buildings.

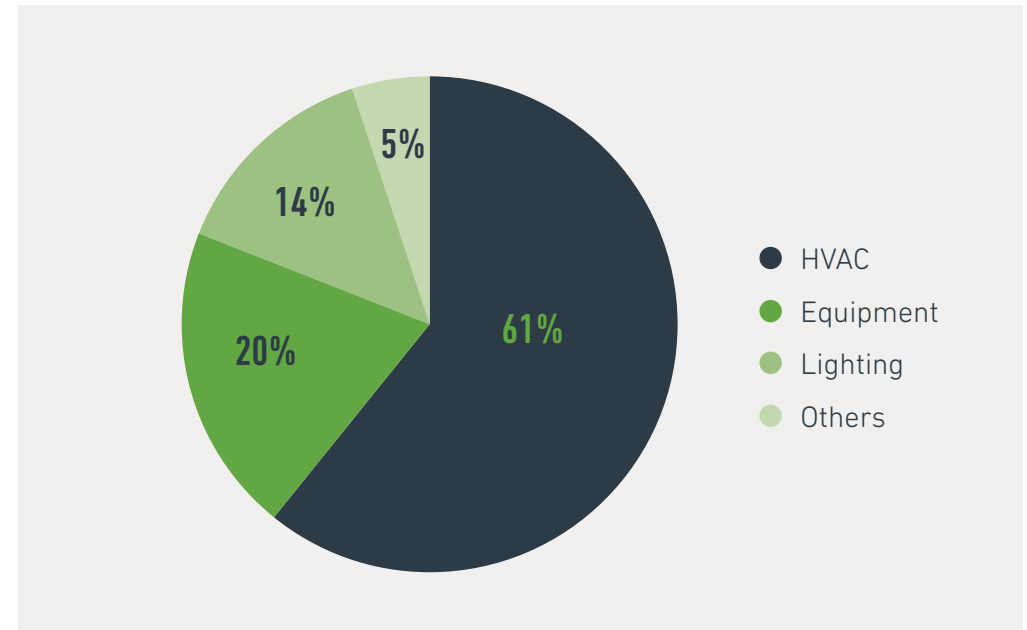


Figure 1: Average energy consumption distribution of stadiums temporary buildings

As mentioned earlier, exceptional conditions in the construction of the FIFA World Cup Qatar 2022™ stadiums were effective. The hot climate in Qatar requires higher energy consumption compared to milder climates for cooling temporary buildings. Also, the continuous construction schedule (24/7) significantly increased the need for artificial lighting as well as cooling, in the hot months, in the temporary buildings.

2.0 ENERGY USE IN GSAS CONTEXT

2.3.2.2 Distribution of Construction Activities Consumption

Electricity consumption in construction activities is also quite significant; so, it is important to know how it is distributed. GSAS-CM assessment requires monitoring of the following construction activities:

- Lighting on the construction site.
- Construction equipment, including all pieces of equipment powered by electricity.
- Pumps, including dewatering pumps.
- Fans used for cooling working spaces and rest areas.

Figure 2 shows all stadiums average distribution of energy consumption for these construction activities.

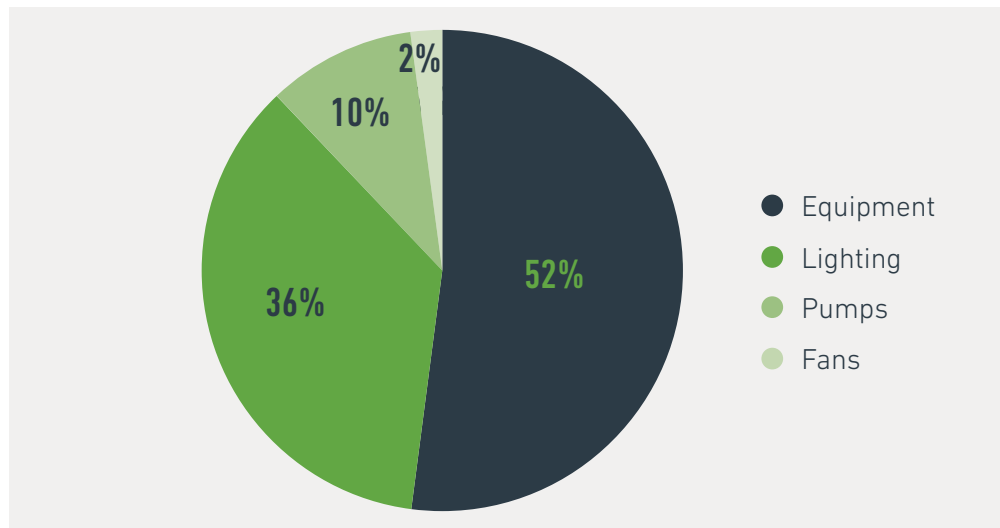


Figure 2: Average energy consumption of stadiums construction activities

2.3.3 Ratio of Temporary Buildings Electricity Consumption Per Area Per Annum

It is interesting for a future project to know the expected consumption per area of temporary buildings on site for:

- dimensioning the generator’s capacity to optimize efficiency.
- having a reference benchmark to identify excessive consumption, since issues like oversized AC systems are common in construction sites and can be easily identified through energy monitoring and benchmark comparison.

Site offices make up most of the temporary buildings on a construction site. Their use in terms of electrical equipment is very similar regardless of the type of construction. Therefore, a separate ratio for this type of building is deemed useful.

The rest of the buildings are very different and include stores, workshops, mess halls, canteens, mosques, etc. Therefore, the calculation of separate ratios would not provide reliable information. However, a ratio including all the temporary buildings on site can be of interest for planning purposes.

2.3.3.1 Temporary Buildings’ Electricity Consumption Per Area Per Annum

Table 7 shows the electricity consumption per meter square per annum of all temporary buildings. The average consumption is 205 kWh per square meter per annum. The ratio ranges from 167 kWh/m² at Education City Stadium to 290 kWh/m² at Ahmad Bin Ali Stadium.

2.0 ENERGY USE IN GSAS CONTEXT

Table 7: Electricity consumption per square meter per annum (all temporary buildings)

Stadium	Duration (months)	kWh/m ² per year
Ahmad Bin Ali Stadium	42	290
Al Thumama Stadium	46	172
Education City Stadium	35	167
Lusail Stadium	52	213
Stadium 974	43	182
Average Ratio	44	205

2.3.3.2 Site Offices' Electricity Consumption Per Area Per Annum

Site office arrangements on site differed from one stadium to another, as some typical portacabins were used as temporary site offices, and the others added existing buildings as offices.

Table 8 shows the electricity consumption per square meter per annum of the portacabin site offices. The average consumption is 233 kWh per square meter per annum. As expected, this ratio is higher than the one considering all temporary buildings, as the load in the offices is higher than in other buildings using little or no equipment, such as mess halls and stores. The ratio ranges from 183 kWh/m² at Al Thumama Stadium to 297 kWh/m² at Ahmad Bin Ali Stadium. The ratio is not calculated for Stadium 974 as all site offices were located in the existing buildings.

The same table shows the electricity consumption per square meter per year of the site offices located in the existing buildings. The average consumption is 147 kWh/m² per annum. As expected, this ratio is lower than a typical portacabin office, due to the higher insulation of the building envelope and in the case of Al Thumama Stadium the use of a centralized air conditioning system. This proves the positive outcome of reusing the existing buildings as an office instead of portacabins in all those stadiums where it was possible. The ratio ranges from 70 kWh/m² at Al Thumama Stadium to 202 kWh/m² at Ahmad Bin Ali Stadium.

Table 8: Electricity consumption per square meter per annum

Stadium	Duration (months)	kWh/m ² per annum	
		Portacabin site offices	Existing buildings site offices
Ahmad Bin Ali Stadium	42	297	202
Al Thumama Stadium	46	183	70
Education City Stadium	35	219	N/A
Lusail Stadium	52	233	N/A
Stadium 974	43	N/A	170
Average Ratio		233	147

2.0 ENERGY USE IN GSAS CONTEXT

2.3.4 Variation of Electricity Consumption Through the Construction Stages

As GSAS-CM assessment is conducted three times during the whole construction period, subsequently, the electricity consumption is continuously monitored during the three stages; therefore, data is available to analyze the variation of electricity consumption through the construction phase. As not all the construction stages have the same duration in every stadium, the time variation of the consumption is analyzed per month. Table 9 and Figure 3 illustrate the percentage increase of energy consumption through the three construction stages compared to Stage 1.

Table 9: Increment to Stage 1 of the overall electricity consumption through the construction stages

Stadium	Stage 2	Stage 3
Ahmad Bin Ali Stadium	75%	65%
Al Thumama Stadium	6%	52%
Education City Stadium	22%	133%
Lusail Stadium	0%	147%
Stadium 974	84%	244%
Average Ratio	37%	128%

A high increase in electricity consumption among the stadiums was noticed in Stadium 974 during Stage 3. The reason might be attributed to the fact that the stadium has a different design than the others, the foundations are shallow, the structure is made of steel, and the blockwork and façade are formed from shipping containers. Therefore, the tower cranes were not needed during Stage 1 and were installed halfway through Stage 2. Most of the containers were lifted during Stage 3, increasing the energy demand of the tower cranes.

On the other hand, there is a decrease in consumption during Stage 3 at Ahmad Bin Ali Stadium. The main reason is that the tower cranes were dismantled at the end of Stage 2.

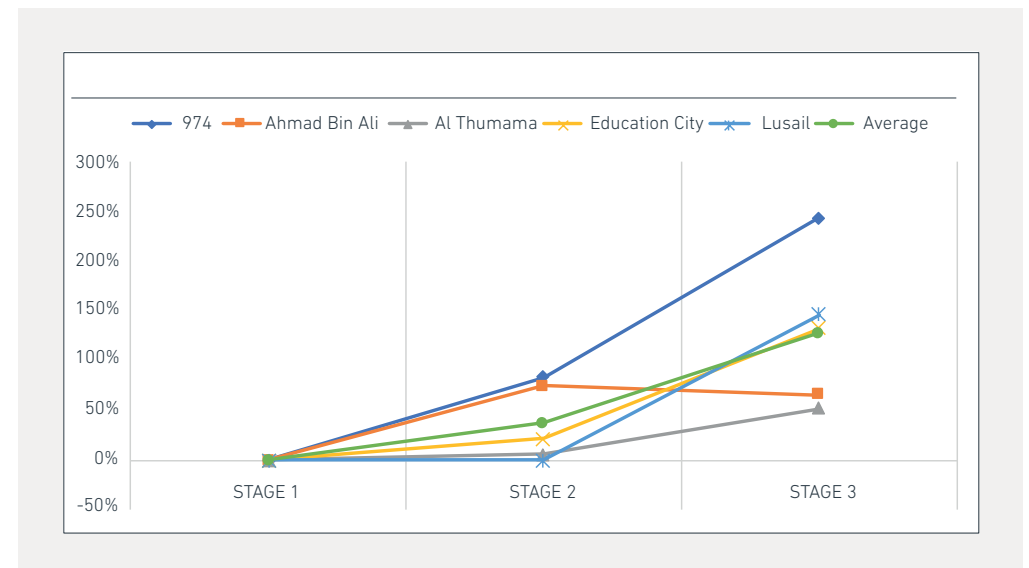


Figure 3: Energy consumption variation through the three construction stages

2.0 ENERGY USE IN GSAS CONTEXT

There is a clear trend of higher electricity demand with time. The consumption per month in Stage 2 is 37% higher than that in Stage 1, and the Stage 3 consumption per month more than doubles (128%) compared to Stage 1. Following are some reasons behind this trend:

- Increase in manpower. The construction activities carried out during Stage 1, mainly earthworks and foundations, require less manpower than the structural and block works during Stage 2. The manpower during Stage 3 is significantly increased for the MEP and finishing works. Also, more temporary buildings are required to enhance welfare facilities and to accommodate new subcontractors' offices, which results in higher energy demand.
- More electricity-powered equipment are required for MEP and finishing works compared to earthworks and structural works, thereby demanding more diesel-powered machinery.
- Increase in lighting demand on site. As the stadium blockwork and façade are being constructed, lighting is required even during the day in the indoor areas. Figure 4 shows the overall number of lighting fixtures installed on the stadium sites through the three construction stages. The data shows an increase of 238% and 347% in Stages 2 and 3 compared to Stage 1.

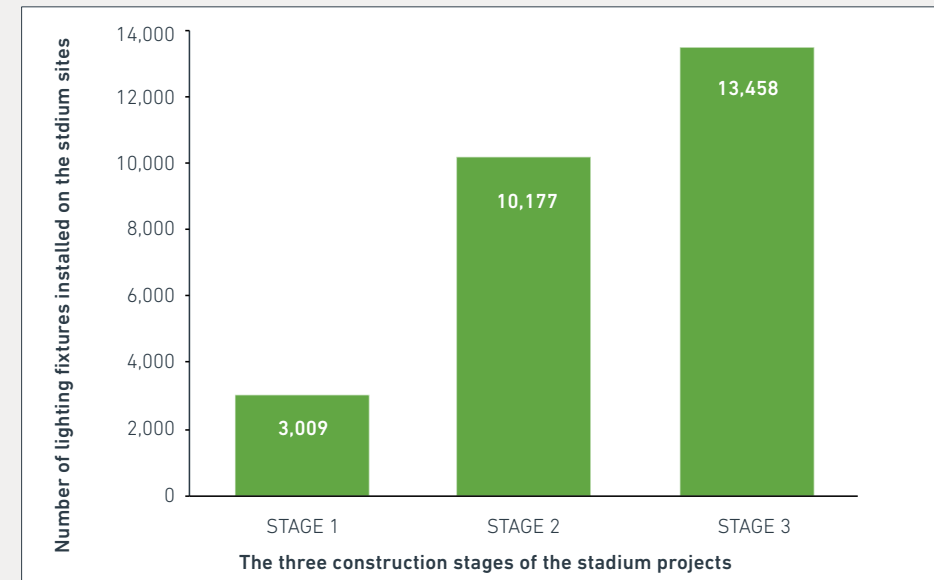


Figure 4: Lighting fixtures installed through the three construction stages

3.0 IMPLEMENTED METHODS AND MEASURES

3.1 Best Practices

Best Practice 1: Adopting Principles for Effective Energy Management

Key decisions can be taken at a management level to promote energy conservation on construction sites. Most of these decisions should be taken at the early stages of the project and involve the management teams of the client, designer and contractor.

1. The Client

The SC has considered energy conservation as one of the key practices to achieve sustainability during the construction of stadiums. The SC included contractual requirements to develop and implement a Construction Environmental Management Plan (CEMP) and to achieve GSAS-CM certification, with at least A Class rating. The provisions included hiring professionals with GSAS-CM expertise by the contractor, project management and construction supervision teams.

All stadium projects report to the SC on a weekly and monthly basis, with energy conservation evidence as part of the reporting. The SC additionally organizes bimonthly knowledge-sharing meetings across all the projects and ensures dissemination of best practices reports to share lessons learned on energy conservation practices.

2. The Designer

The design of a building can affect its construction activities. Some construction activities are more energy-demanding than others; therefore, this is an aspect that can be considered during the design stage.

For example, the initial design of Lusail Stadium had the stadium's foundations reaching the water level, which required huge dewatering during the construction process. As explained earlier, dewatering is an energy-intense activity that entails 30% of the energy consumption as in the case of the Education City Stadium. The design of the foundation of Lusail Stadium project was changed and made shallower to avoid the water table and therefore the need for dewatering during the construction phase. This resulted in significant energy savings and avoided a significant amount of CO₂ emissions associated with the dewatering processes.

3. The Contractor

Contractors have a leading role in the implementation of energy conservation measures as they oversee the deployment of necessary resources. Success in achieving the goal requires an integrated approach from several departments within the contractor's organization. Therefore, full commitment from the project manager is paramount throughout the construction phase as shown in Figure 5.

3.0 IMPLEMENTED METHODS AND MEASURES

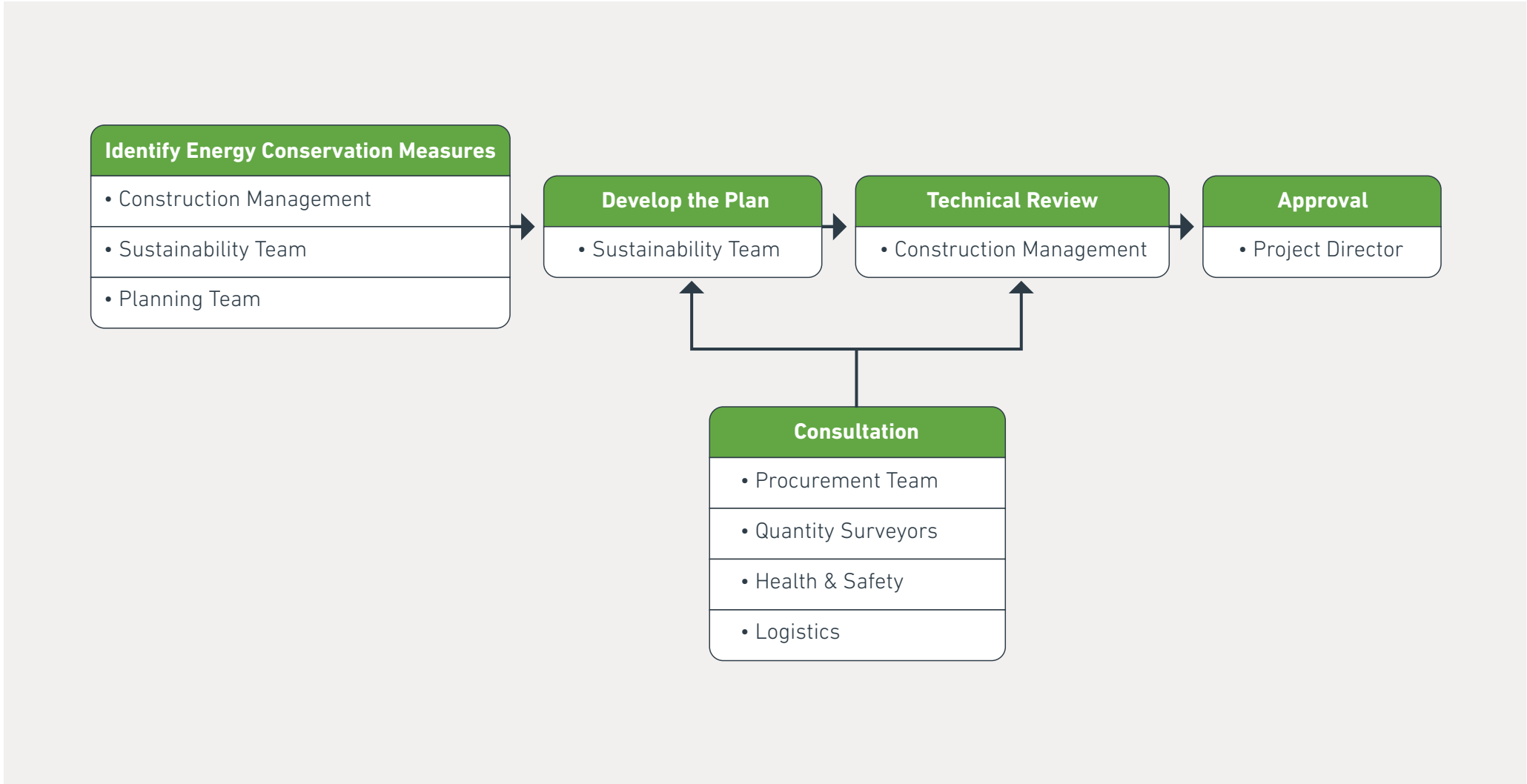


Figure 5: Workflow for Energy Conservation Plan

3.0 IMPLEMENTED METHODS AND MEASURES

► Planning

At the commencement of the construction phase, the contractor's sustainability team should take the lead in developing the plan, which should identify the opportunities for reducing energy consumption. This plan includes:

- Renting or buying temporary buildings with high-insulation envelopes, and efficient lighting and equipment.
- Arranging an energy metering system to monitor the electricity consumption in the temporary buildings.
- Arranging the generators according to the expected demand. The generators must be as efficient as possible.
- Exploring opportunities in the market for:
 - LED lighting fixtures for installation in the temporary buildings and the construction site.
 - Highly efficient construction equipment and generators for on-site use.
 - Renewable energy sources.
- Training and awareness program for the staff and workers.

► Procurement and Subcontracting

The Contractor must include the necessary provisions in the contracts to ensure that the subcontractors comply with the GSAS-CM requirements

for energy management. The contractor and subcontractors must procure and rent efficient electrical equipment, generators, and well-insulated temporary buildings. Furthermore, they must ensure that all equipment and machinery are powered by electricity or other energy-efficient sources with less CO₂ emissions. The use of standalone fuel-powered machinery and equipment must always be limited as much as possible.

► Construction Phase

During the construction phase, the contractor is in charge of deploying the resources to execute and supervise the implementation of energy conservation practices. Key activities of the sustainability team include:

- Monitoring the energy consumption. This practice includes the monitoring of electricity sources from the grid and on-site diesel generators.
- Tracking the diesel consumption on site for each activity. The practice includes documenting the receipts, invoices and logs.
- Training the workforce on energy conservation practices. The training includes regular presentations, toolbox talks (TBTs), regular knowledge-sharing sessions, etc.
- Supervising and auditing the implementation of sustainable measures by conducting regular internal inspections and audits.
- Reporting regularly to the project management on the energy consumption and implementation of sustainable measures.

3.0 IMPLEMENTED METHODS AND MEASURES

3.1.1.4 Site Audits

GSAS Trust conducts four site audits per stadium. The site audit looks into the implementation of methods and measures stipulated in GSAS-CM guidelines for all targeted criteria. One of the main subjects for audit is energy conservation measures. Audits help project teams to stay focused and perform continuous supervision of mitigation measures. The stages of the auditing system result in the improvement of best practices including energy conservation throughout the project life.



Figure 6: GSAS-CM site audit at Lusail Stadium

Best Practice 2: Monitoring Electricity Consumption

Measuring the electricity consumption is part of the GSAS-CM requirements; therefore, energy meters were installed on the SC stadium sites.

The collected data must be entered into the GSAS-CM Energy Calculator to compute the energy performance coefficients (EPCs) and determine the energy criteria levels. Therefore, the energy monitoring system must be configured to obtain data matching the Energy Calculator structure as follows:

- Temporary Buildings' electricity consumption includes:
 - Heating and air conditioning
 - Lighting fixtures
 - Office equipment
 - Domestic water pumps
 - Exhaust fans
 - Water heaters
- Construction activities' electricity consumption includes:
 - Construction machinery and equipment
 - Lighting
 - Water pumps
 - Fans

3.0 IMPLEMENTED METHODS AND MEASURES

It is to be noted that the electrical circuit arrangements on site were designed to cater to a monitoring system meeting GSAS-CM requirements. For example, the use of single generators feeding both temporary buildings and construction activities was avoided unless energy is metered for each type of use. As construction site arrangements change with time, some generators and meters need to be relocated along the process.

Following the principle “You can’t manage what you can’t measure”, the project teams analyzed the collected data for decision-making that led to energy savings. For example, some installed generators were found to be working at a low load factor. Therefore, they were replaced by smaller generators, saving both energy and diesel, and mitigating CO₂ emissions. As an example, Figure 7 and Figure 8 show excerpts of an energy management report developed for Education City Stadium.

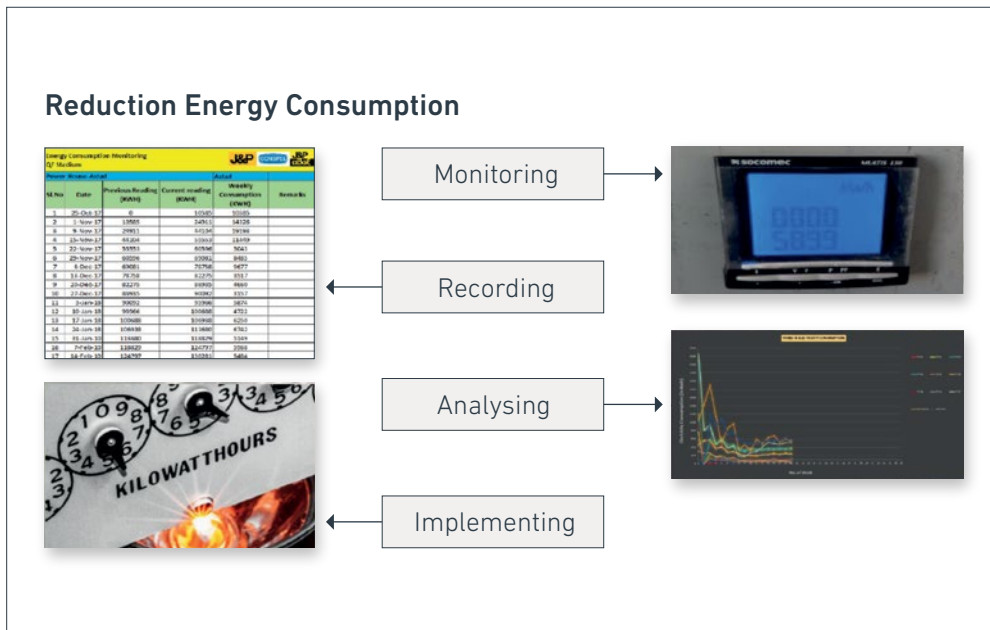


Figure 7: Strategy on sustainability implementation in energy at Education City Stadium

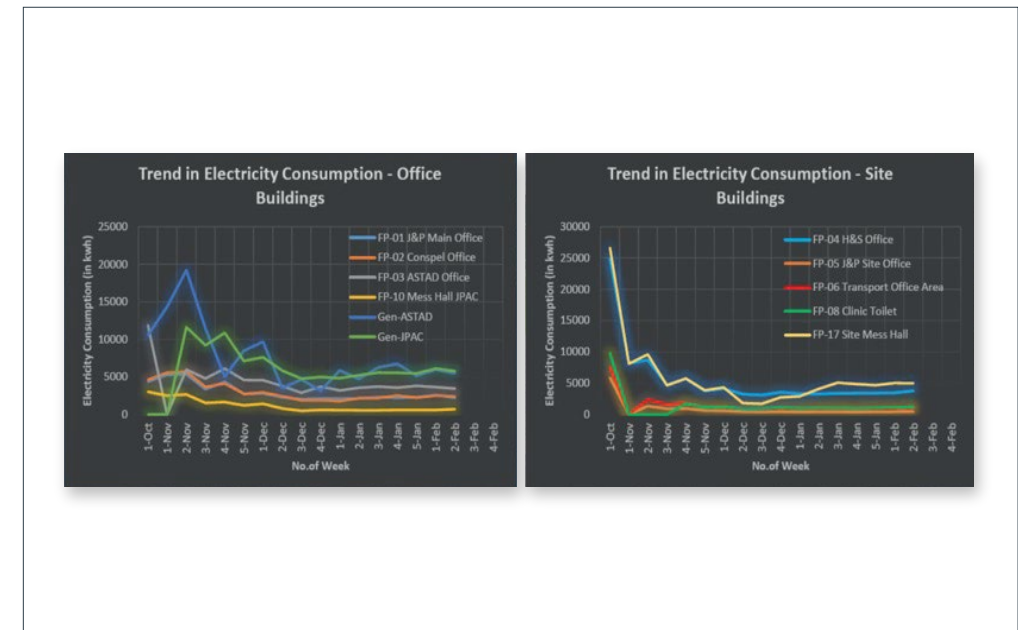


Figure 8: Electricity consumption data analysis of Education City Stadium

3.0 IMPLEMENTED METHODS AND MEASURES

Best Practice 3: Using High-Quality Offices Envelope

During many months of the year in Qatar, the difference between the desired indoor temperature (24°C) and the outdoor temperature is very high. As the gradient of temperature is large, it is very important to have well-insulated temporary buildings to reduce the power demand for cooling.

The SC stadium projects installed temporary offices and buildings provided with a high-insulation envelope, built with low U-value materials. U-value measures the heat transmission of material in watts per square meter degree Kelvin ($W/m^2 \cdot K$). Therefore, the lower the value, the higher the insulation. The average wall U-value of portacabins installed in SC stadiums was 0.60. Figure 9 and Figure 10 depict site offices at Al Bayt Stadium and Lusail Stadium.



Figure 9: Al Bayt Stadiums' site office



Figure 10: Lusail Stadiums' site office

3.0 IMPLEMENTED METHODS AND MEASURES

Best Practice 4: Reusing Existing Buildings as Site Offices and Welfare Facilities

Construction sites require the installation of on-site facilities, including offices, workshops, stores, and mess halls, among others. Typically, prefabricated portacabins serve as site offices, and they are usually built with materials that do not provide high-quality thermal insulation, resulting in high energy demand for cooling.

At some of the SC stadium sites, existing buildings were used as site offices and welfare facilities during the construction phase. The existing buildings' thermal insulation is better than the portacabins, reducing the energy required for cooling. The average wall U-value of the reused existing buildings was 0.40 W/m²K, compared to the average 0.60 W/m²K of the portacabins.

Ahmad Bin Ali Stadium site contained existing buildings belonging to the Al Rayyan Sports Club (ARSC) in usable condition. Such buildings or portions could be used permanently. ARSC building was used as the client and project management site office. The use of the existing primary structure did not require significant strengthening or alterations to make it structurally viable. However, some associated systems and components were upgraded to be more energy and water efficient, including the HVAC and sanitary facilities. Following the completion of the stadium, the building was refurbished to be used as an office space again during stadium operations.



Figure 11: Ahmad Bin Ali Stadium's usage of existing buildings

At Stadium 974 site, eleven existing buildings, accounting for nearly 7,000 m² of built-up area, were used by different parties, including the client, contractor, consultants and others. The buildings were used as offices to accommodate the staff working on site, mess halls for workers, and one mosque for prayer.



Figure 12: Stadium 974's usage of existing buildings

3.0 IMPLEMENTED METHODS AND MEASURES

Some existing buildings at Al Thumama Stadium's construction site were kept to be used for other purposes. For example, an existing building currently serves as an office for the client and consultants for the entire construction period. Meanwhile, the chillers and pumps from the existing energy center serve the client's office AC system. Another building has been occupied by the MEP subcontractor.

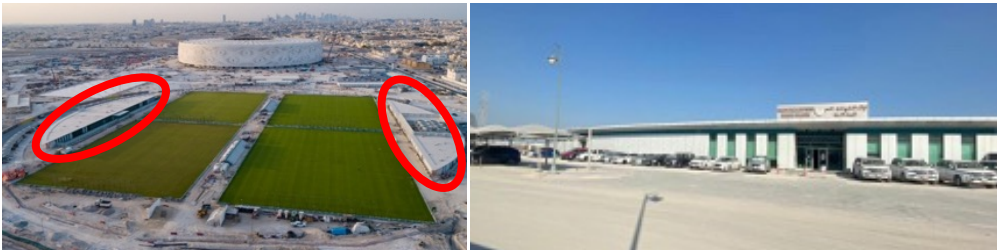


Figure 13: Al Thumama Stadium's usage of existing buildings

Best Practice 5: Using Indoor Space for Welfare Facilities

As mentioned earlier, some temporary buildings used for welfare facilities such as mess halls, rest areas, etc. do not provide as good thermal insulation as permanent buildings, resulting in high energy demand for cooling. Some stadium projects managed to reduce the energy consumption by relocating some of the facilities inside the stadium as the construction advanced and some spaces could be made available. This way, the energy consumption for cooling the welfare facilities was reduced.

In Education City Stadium, for instance, initially, provisional air-conditioned tents served as mess halls, but as soon as it was possible, the mess hall was moved to the stadium's ground floor, including washing and toilet facilities. The yearly power consumption ratio was reduced to less than a third, from 164 kWh/m² of the tents to 52 kWh/m² inside the stadium. Other indoor spaces were allocated for site offices and air-conditioned chemicals stores.



Figure 14: Education City Stadium's mess hall



Figure 15: Education City Stadium's chemicals store within the permanent structure

3.0 IMPLEMENTED METHODS AND MEASURES

Best Practice 6: Installing Highly Efficient AC Equipment

Cooling is the most energy-intensive activity in the site's temporary buildings, accounting for 61% of the electricity consumption. Efforts have been made to conserve energy while providing the necessary thermal comfort to the workers in the harsh climate of Qatar.

The SC stadium projects procured and installed highly efficient equipment capable to provide a cool environment with the minimum possible consumption. As seen in Figure 16, AC equipment rated as high as 7 stars were installed in many temporary buildings.



Figure 16: Seven-star-rated AC unit

Best Practice 7: Shading Windows and Façade

Indoor spaces exposed to direct sunlight gain more heat and demand more energy for cooling. Therefore, ensuring shaded windows, even façades, is a good practice to mitigate electricity consumption. This practice is especially important in Qatar where sun radiation is not only high but frequent; there are on average 343 sunny days per year.

In Education City Stadium for example, the car parking shading structure was installed right next to the site office façade, providing shading for both cars and the building windows and façade using the same material, which makes the practice even more sustainable.



Figure 17: Shading of temporary buildings' windows and façades

3.0 IMPLEMENTED METHODS AND MEASURES

Best Practice 8: Using Solar Window-Coatings

Another measure to reduce the exposure to direct sunlight in indoor spaces is to reduce the solar transmittance of the window's glazing. Solar-window coatings were installed in most of the temporary buildings at the SC stadium projects, reducing the solar gain by up to 60% in some cases. This type of glazing not only reduces the electricity consumption required for cooling but also mitigates the glaring, making the indoor space visually more comfortable for the occupants.

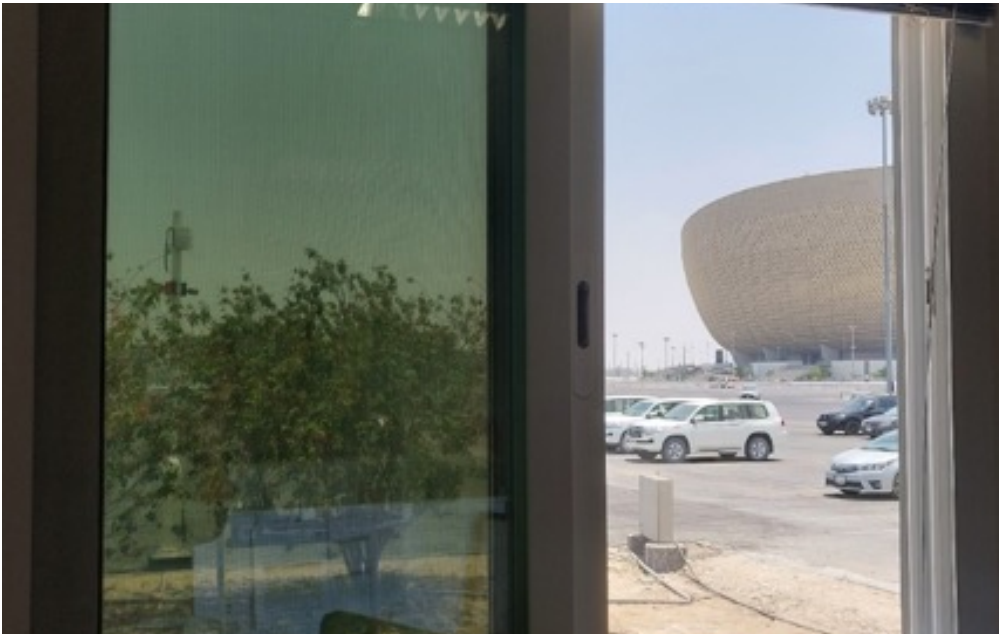


Figure 18: Solar-coated window

Best Practice 9: Connecting to the Main Grid

Energy conservation is not the only purpose of the GSAS-CM assessment, as GSAS also targets reduction in the associated CO₂ emissions that drive climate change and improve air quality. Emissions associated with diesel generators are higher than those from the main grid in Qatar; therefore, whenever possible, it is advisable to secure a connection to the main grid.

Construction sites are not typically allowed to connect to the grid due to the wide consumption variations through time caused by their dynamic nature. However, with efforts from the SC management, all the stadium projects except one were partially connected to the grid. Overall, 27% of the stadium projects' electricity was sourced from the main grid, which resulted in a significant reduction in CO₂ emissions.

Best Practice 10: Installing Centralized Generators Management

As explained earlier in this report, generators can save fuel if they work at an optimal load, which also reduces CO₂ emissions.

At Al Janoub Stadium, a comprehensive synchronizer was installed to control the main generators. The system controls the engine speed of the generators based on the load demand to reach optimum efficiency. It can synchronize the load of different generators through the electronic control unit of their engines.

3.0 IMPLEMENTED METHODS AND MEASURES



Figure 19: *Generators Synchronizing System at Al Janoub Stadium*

Best Practice 11: Ensuring Energy-Efficient Dewatering

The following measures were implemented to improve the efficiency of the dewatering system and therefore reduce the associated energy consumption:

- Providing a comprehensive site investigation data prior to preparing the dewatering design to avoid trial and error on site. This will also help decrease unnecessary delays, and therefore, reduce the project's fuel use.
- Use of energy-efficient pumps to reduce energy consumption and save fuel costs.
- Good maintenance of pumps and generators because when the pumps are in the best condition, their performance can be maximized. Small additional flow on site can be managed without installing additional

pumps. Good maintenance requires that the generators are serviced, carbon deposits are removed, overload and underload are avoided, and the correct coolant temperature is maintained to avoid excessive consumption of fuel.

- Use of trench and sump pumping system which allows using gravity to move the water to the sump pump or deep well location. Using trenching can eliminate the need for unnecessary pumps, thereby reducing energy consumption.



Figure 20: *Energy-efficient dewatering arrangement on site*

3.0 IMPLEMENTED METHODS AND MEASURES

Best Practice 12: Shading and Insulating the Water Tanks

Water tanks are typically installed on construction sites to store water for both domestic use and construction activities. Cool drinking water was available all the time for the workers on the stadium sites to prevent heat stress. The water coolers were installed on site for water cooling purposes, which are energy-intensive equipment. To reduce the energy consumption of the coolers, the water tanks were shaded and insulated with rock wool sheets to reduce the temperature of the stored water, as seen in Figure 21.



Figure 21: *Shading and insulating of water tanks*

Best Practice 13: Organizing Awareness Trainings and Competitions

Staff and workers are the end users of the electrical appliances and equipment on site. Therefore, raising awareness on energy conservation can help to significantly reduce electricity consumption.

SC stadium projects implemented comprehensive training programs for all staff and workers on site. Special training was provided to machinery operators on the efficient running of their equipment. Staff attention was brought to the responsible use of AC, lighting and office equipment in the temporary buildings. In Education City Stadium, a competition was organized between the consultant and the contractor to see who would have lower power consumption in their respective offices.



Figure 22: *On-site training session*

3.0 IMPLEMENTED METHODS AND MEASURES

Best Practice 14: Providing Knowledge-Sharing Sessions

Energy conservation practices in construction sites are still not very common in this region. Some of the construction personnel at stadium sites were still not used to energy conservation practices on site. Therefore, it was crucial for them to gain knowledge on the subject and to witness implementation on other sites.

The SC organized a series of regular knowledge-sharing sessions. All the stadiums project teams regularly gathered in one stadium site where they were briefed by the host team about the implementation of energy conservation measures and challenges encountered. These sessions were particularly useful for SC stadium projects that started construction later, as they could benefit from the lessons learned from the earlier projects.



Figure 23: Knowledge-sharing session

3.2 Common Practices

Common Practice 1: Using LED Lighting Fixtures

Night shifts were implemented on the stadiums construction sites, which increases the demand for lighting during construction activities. The energy demand for lighting entails 21% of the total electricity consumption.

Therefore, the SC stadium projects implemented measures to reduce the lighting energy demand. Replacing halide lighting fixtures with LED fixtures proved to be highly effective, as the power consumption of LED lights is 25% compared to a halide light for the same amount of emitted light.

At the beginning of the projects, the availability of LED lights in the market was not high enough to meet the demand; so, halide lights were more commonly used. However, the situation changed rapidly with time, and more and more halide lights were replaced with LEDs as the construction progressed. Figure 24 illustrates the percentage of LED lights used in the stadiums through the years of construction. In 2017, 36% of the fixtures lighting construction activities were LEDs, the percentage raised and it eventually reached 79% by the end of the construction in 2021.

3.0 IMPLEMENTED METHODS AND MEASURES

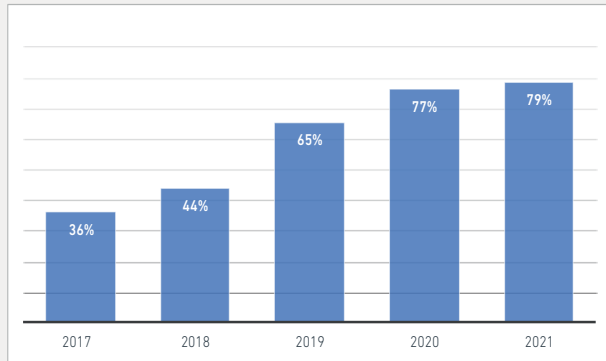


Figure 24: Percentage of LED lights used on construction sites



Figure 25: LED lighting fixtures on construction sites

LED fixtures were not only used to light the construction areas, but also temporary buildings including site offices. In the early stages of the program, these lighting fixtures were hardly available in the market but the LED share in the market increased and the SC stadium projects could partially replace the lighting fixtures in the temporary buildings.



Figure 26: LED lighting fixtures in temporary buildings

3.0 IMPLEMENTED METHODS AND MEASURES

Common Practice 2: Zoning Lighting Circuits

It is not so uncommon on construction sites to find lights unnecessarily switched on in areas with enough sunlight to proceed with the work safely. This mostly happens because there are indoor and outdoor lighting fixtures connected to the same circuit. During the day, the circuit is powered to light the indoor spaces, but the fixtures in areas with enough daylight remain unnecessarily on. To avoid this, separate lighting circuits were installed in indoor areas where artificial lighting was required during the day, and in outdoor/indoor areas with enough daylight.

Common Practice 3: Using Highly Efficient Construction Equipment, Pumps and Fans

The energy consumption of construction equipment, pumps and fans combined entail 37% of the overall consumption on site. Therefore, reducing the consumption of this equipment is of major significance. Using highly efficient equipment results in lower consumption, especially for energy-intensive equipment such as tower cranes, air compressors, pumps, fans and water coolers. A desired 60% efficiency rate was considered for air compressors, pumps and motors in general, while 80% efficiency was considered for water coolers used on stadium sites.



Figure 27: Examples of electrical equipment on site

Common Practice 4: Using Highly Efficient Generators

Energy conservation strategies for construction sites should consider reducing both energy demand as well as fuel consumption and CO₂ emissions associated with the generation of energy on site, mainly through diesel generators.

To achieve high efficiency in a generator, the alternator must be efficient and capable to run at an optimal load, which means it must be sized according to the expected energy demand. A 50% efficiency was considered as high for the diesel generators in the SC stadiums.



Figure 28: Example of diesel generator used on site

3.0 IMPLEMENTED METHODS AND MEASURES

Common Practice 5: Setting AC Temperature to 24/25°C

HVAC energy consumption entails 26% of the overall consumption; therefore, reducing the energy demanded by the HVAC equipment is very important.

An effective and simple measure to achieve it is by increasing the set temperature of AC units. Increasing one single degree can result in 6% energy saving. The SC stadium offices and temporary buildings' AC temperature was set to 24°C or 25°C, which is considered a temperature cool enough to provide thermal comfort to the building occupants while reducing the electricity consumption.



Figure 29: AC temperature set to 25°C

Common Practice 6: Switching Off Devices When Not in Use

The simplest way to reduce energy is to turn off the devices when not in use. On construction sites, most of the office staff spend part of their time in the field. During this time, AC units, lights and office equipment are not required to be left on.

A training program was implemented in the SC stadium projects to raise awareness on this matter and ensure that staff would switch off the devices when not in use. Figure 30 shows one of the stickers placed in the site offices as a reminder for the staff.



Figure 30: Staff reminder to turn off electrical systems

3.0 IMPLEMENTED METHODS AND MEASURES

Common Practice 7: Using Photo Voltaic Panels (PVs)

As mentioned earlier, most of the energy on site is sourced by diesel generators, emitting CO₂ into the atmosphere and polluting the air. To mitigate the CO₂ emissions, renewable energy sources should be used in construction. Unfortunately, there were just a few alternatives in the market in this region at the time the stadiums were constructed. However, the SC stadium projects have made use of renewable energy to power dust monitoring equipment, weather stations, CCTV cameras and external lighting fixtures.

Fortunately, the market is evolving rapidly and currently construction projects may find solar-powered portacabins, light towers or even install PV panels on the parking covers to power the site offices.



Figure 31: Example of PV panels used on construction sites

4.0 CONCLUSION



Construction sites are dynamic places with different natures that host complicated activities executed by workforces from different cultures. They are a hive of activity, ingenuity and a second home for many people. The comfort and safety of all those who enter the site are essential. Efficient equipment and tools are also essential to carry out the construction works.

Electricity is required to power many of the construction tools and equipment used, and to keep buildings and the site, in general, comfortable and well-lit. The electricity on site is generally provided by temporary diesel generators on site. Generators like these provide reliable temporary power, but with relatively high carbon emissions and local air emissions.

Measuring and reducing electricity on construction sites saves money and helps the environment, both locally and globally. Hence, significant progress should be made on construction sites, through a focus on measuring energy consumption to understand where to make the changes with the best impact.

Data from FIFA World Cup Qatar 2022™ stadiums construction sites shows that simple changes to the temporary buildings supporting the construction works can have a big impact on the overall site electricity usage. These changes include efficient AC units, LED lighting, better insulation and the reuse of any existing permanent buildings that may be available on site. Likewise for construction activities, LED construction lights, avoidance or optimization of dewatering, and efficient operations of temporary power generators can make a significant impact.

This report highlights some of the best practices adopted on SC stadium project sites to contribute to a growing body of knowledge, legacy, and experience in the construction sector. The publication of this report is an effort to create a legacy of knowledge and to make it available to a wider audience within the construction sector. We encourage the concerned professionals to consider these best practices as well as the GSAS-CM certification to measure and reduce energy consumption on construction sites.

5.0 BIBLIOGRAPHY

1. GSAS 2019 Construction Management Assessment Manual for Buildings & Infrastructure. Gulf Organisation for Research and Development (GORD), 2019, <https://www.gord.qa/admin/Content/GSAS-2019-Construction-Management-Assessment-Manual.pdf>
2. GSAS 2019 Construction Management Guidelines Manual for Buildings & Infrastructure. Gulf Organisation for Research and Development (GORD), 2019, <https://www.gord.qa/admin/Content/Link2611201914490.pdf>
3. GSAS Technical Guide 2019. Gulf Organisation for Research and Development (GORD), 2019, <https://www.gord.qa/admin/Content/Link2722020122828.pdf>
4. Weather Stats forecast, statistics and analysis. (2022). Doha Average Annual Weather / Weather Averages for Doha. <https://weather-stats.com/qatar/doha/monthly>
5. General Secretariat for Development Planning. (2008). Qatar National Vision 2030 (Issue July). www.planning.gov.qa
6. Planning and Statistics Authority. (2018). Qatar Second National Development Strategy 2018~2022. In Planning and Statistics Authority, Qatar (p. 337). Gulf Publishing and Printing Company, Doha.



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