SDG Striker
Scoring Goals for Sustainability

SUSTAINABLE DEVELOPMENT GOALS

PRACTICAL GUIDELINE to incorporate and communicate SDGs IN THE SPORTS ORGANISATIONS

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INTRODUCTION

1 INTRODUCTION

SDG Striker aims to increase organizational capacity for good governance in grassroots sports organizations by supporting the implementation and communication of the Sustainable Development Goals (SDGs). It also aims to develop a shared understanding of good practices before, during and after testing and assessing their replication potential in national sports federations - and beyond national borders. Sport itself stands for fairness, adherence to rules, fair conditions, and competition. These aspects should also be characteristic of good association management. In this respect, good governance describes the orientation of association management and association activities according to ethical standards. In addition to integrity and transparency, these standards also include future viability and sustainability. (Dycker 2019)

To this end, relevant research findings of sustainability aspects will be compiled on three focal areas (energy poverty/energy efficiency, photovoltaics, and green turf filler). In addition, a survey of soccer clubs will be conducted to identify their needs and current practices in the three focus areas. Specific pilot projects will be conducted in three countries for later evaluation and validation.

The pilot projects:

PORTUGAL:

Potential and feasibility of photovoltaics

SCOTLAND:

Energy efficiency and energy poverty

NORWAY:

Microplastics in the context of artificial turf infill material

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In order to fulfill the SDG Striker project's goal of **strengthening organizational capacity for good governance in grassroots sports,** two general objectives were developed:

- **General objective (GO) 1:** The project will serve as a support for implementation and also communication towards the SDGs. Ad hoc actions will be provided at the local level to align with European, national, and local public policies.
- **General objective (GO) 2:** To create a common understanding of best practices across national boundaries.

To specify this, further specific objectives (SO) have been developed.

The first objective (SO1) is to develop a best practice guide for the mentioned focus areas energy efficiency/poverty, photovoltaic systems, and lawn fillers. This is based on a literature review and survey and serves as a guide for steps to be implemented. The second objective (SO2) involves implementing the three pilot projects incorporating the SDGs to improve good governance in grassroots sports. The third objective (SO3) is about overcoming possible obstacles in the implementation and recommendations for federations and clubs to support a continuation after the project period. The fourth objective (SO4) is to disseminate the main results, especially to club managers and pitch owners, in order to implement the measures locally and nationally.

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SUSTAINABILITY IN SPORTS & FOOTBALL

Sustainable development plays an important role in almost every area of life. The United Nations General Assembly developed the 2030 Agenda for Sustainable Development and adopted it in September 2015. 17 Sustainable Development Goals (SDGs) and their respective sub-goals include a new understanding of poverty, environmental degradation, inequality and many more and are intended to create a balance between the three dimensions of economic, social and ecological aspects. The fact that sport plays a key role here is explicitly described in the 2030 Agenda. Particularly with regard to further developments and peace, a contribution is attributed to it.

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2.1
The SDGs and the application in sports/ football

The 2030 Agenda for Sustainable Development was adopted by the United Nations in 2015 (United Nations General Assembly 2015). It is a shared concept for peace and prosperity for people and the planet and it includes the 17 Sustainable Development Goals (SDGs). The SDGs are a call for action by all countries. They follow the approach that the targets to end poverty and other deprivations, to improve health and education, to reduce inequality, to boost economic growth, to fight against climate change and to ensure the preservation of forests and ocean must be addressed together. (United Nations n.d.)

The 17 SDGs are shown in Figure 1. In total, they include 169 targets, that are assigned to the different goals.

In recent decades, it has become clear that sport is playing an increasingly important role in society. Sport unites, brings together people from a wide range of social classes and backgrounds and also receives support of a political and financial nature. Through sport, people learn values and norms, and it should not be underestimated as an economic factor either. Internationally, too, there is a growing opinion that sport makes a major contribution to sustainable development.

In order to fulfill the SDGs, it is essential to have a healthy society and physical activity and sports are helpful to achieve these goals. The SDGs contain a wide variety of dimensions that are intended to promote both socioeconomic and ecological developments. However, health promotion is a clear goal in all SDGs. Sport is an important promoter of these goals. Physical activity is essential for improving health and contributes to both the prevention and treatment of disease. People who are physically active and participate in sports benefit on a social, physical and mental level. (United Nations Inter-Agency Task Force on Sport for Development and Peace 2003)

Accordingly, sport is also seen as an important pillar for achieving the SDGs. Sport also shows ways in the field of environmental development, education, and global health development. Thus, sport can impart skills and also knowledge, which are important for an independent and healthy life. Also, an economic participation can be shown. Furthermore, sport can counteract poverty and create a global network. participation can be shown. Furthermore, sport can counteract poverty and create a global network.

2.2
How does sport address the SDGs?

According to the United Nations sports in general is an "important enabler for sustainable development" (United Nations General Assembly 2015). With the overall objective to leave no one behind, the 2030 Agenda represents an opportunity for global change and development all around the world, also including the field of sport, as with sport it is possible to promote peace and development targets very cost-effective. (Lemke n.d.) Furthermore, sports promote tolerance and respect, and it contributes to the empowerment of women and young people, individuals and communities. In addition, sports can address targes regarding health, education and social inclusion. (United Nations General Assembly 2015) The SDG that represents the clearest relation to sports is Goal 3 (Good health and well-being) (SDG Fund 2018).

Concerning the health benefits of sports, sport does not only benefit the physical fitness, but it can also communicate a healthy lifestyle to children. Moreover, physical exercises also have a positive effect on mental health, self-esteem and self-confidence. (Lemke n.d.) Therefore, in order to support the SDGs, sports need to be fully integrated into development programs and policies, on the local, national and global level (SDG Fund 2018). In a certain way, sports can be related to all of the 17 SDGs, whereby for some of the goals a greater contribution is identified, and some are only limited or indirectly addressed, but not less important to deal with. **The SDGs where a direct impact of sports is identified by the *United Nations Office on Sport for Development and Peace* are SDG 3, SDG 4, SDG 5, SDG 8, SDG 11 and SDG 16.** (UNOSDP n.d.)

SDG 3: Ensure healthy lives and promote well-being for all, at all ages

Sports and physical activities can make a contribution to preventative health policy. Health and well-being should be understood as holistic conceptions because regular physical activities can reduce the risk of diseases and show further benefits for psychological and social health. Through an increased participation in sport, it is possible to reduce inactivity of both adults and children. So, the target of SDG 3 is physical and mental health and well-being across people's life cycle. (Lindsay und Chapman 2017) (Dudfield und Dingwall-Smith 2015)

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

A holistic education consists out of different components and physical education, physical activity and sport are part of them. All people should have access to life-long learning opportunities and therefor also to sports. The value of sport as part of education and training cannot and should not be underestimated. The positive effects on health and education through high-quality physical education are equally essential. (Lindsay und Chapman 2017)

SDG 5: Achieving gender equality and empower all women and girls

Not only are gender equality and women's rights part of human rights, but they are also components of sustainable development. In recent years, issues of gender (in)equality have increasingly come to the foreground, also through the use of sport as a kind of instrument for development. Achieving gender equality and introducing women and girls to different sports requires broad legal frameworks for non-discrimination and initiatives that promote women and girls. (Lindsay und Chapman 2017)

8 DECENT WORK AND ECONOMIC GROWTH

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

The sports industry makes an important contribution to the national economy. If we define it very broadly, it includes events, sporting goods, clothing, equipment and many more. Far it can come in the sport by voluntary work to later excellent employment prospects. Furthermore, the relationship between sports, tourism, gastronomy, construction and health should not be underestimated and there can be a great interaction between these industries. (Dudfield und Dingwall-Smith 2015)

11 SUSTAINABLE CITIES AND COMMUNITIES

SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable

The basic message of SDG 11 is that importance must be given to the global urbanization trend. It is recommended that 15 percent of the urban area be used as green space. This includes sports and recreation areas, as these promote social cohesion and make residential areas attractive for residents and also investors. Furthermore, they increase the opportunities for physical activity and can contribute to long-term health promotion. (Lindsay und Chapman 2017)

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

SDG 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

The contribution of sport to reducing violence is larger than one might think at the local and community level. The high value placed on sport can be used to contribute to the pursuit of peace and the reduction of violence. (Dudfield und Dingwall-Smith 2015)

Hence, sports and therefore also football can contribute to the SDGs in different ways and the SDG STRIKER project shows some possibilities for this contribution.

3

SCOTLAND PILOT:

ENERGY EFFICIENCY AND ENERGY POVERTY

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3.1
Energy efficiency

The pilot for the topic energy efficiency and energy poverty is located in Scotland. It includes 6 out of 17 SDGs (see Figure 2). The topic of energy poverty addresses Goal 1 (No poverty) and Goal 10 (Reduced inequalities) and the topic of energy efficiency deals with Goal 7 (Affordable and clean energy), Goal 12 (Responsible consumption and production) and Goal 13 (Climate Action). Furthermore, Goal 17 (Partnership for the goals) is addressed by the Scottish pilot through interlinkage and the variety of activities.

Figure 2: 6 out of 17 UN Sustainable Development Goals
Source: United Nations 2021

Humans have always used energy to be able to survive and develop. Energy moves everything but it comes at a price, and here we are not just talking about the monetary price but also the environmental and social. Sports fields use energy to maintain and use installations and provide services, but where does the energy come from and at what cost? Also, what is the social price that a community faces due to the cost of energy? What implications does it have? All these questions do not have an easy answer, but they show that **energy is more than a technology.**

The current energy system relies by 79,7% on carbon-related fuels (Center for Climate and Energy Solutions 2021). This source of energy produces CO^2, which is the greenhouse gas that has most impact on climate change (European Environment Agency 2022). Other sources of energy such as the Eolic (wind) or Solar which account in 2020 for 10,6% of the world total energy supply, are not only more environmentally friendly, but their economic cost is lower related to levelized cost of energy over plant lifetime. This is important when we talk about a term called energy poverty.

The first definition of **energy poverty** promoted in the United Kingdom understood that a person was in a situation of energy poverty when they spent at least 10% of their income on paying energy bills. This definition is questionable and, in fact, has evolved over time. Energy poverty depends on the climate (and weather), the house insulation, the family income and the price of energy. Since there are many variables, there are different ways to mitigate and tackle energy poverty, but in order to do so it is important to first detect the cases. This can be tricky since people may not even be aware of their own energy poverty situation and it may also be attached to stigma. Energy poverty becomes most obvious, when users are not able to pay their energy-bills and get into debt. Other cases would include people not consuming the energy that they actually need, so they can afford their food; or users spending part of their money on energy, while cutting other costs that would be necessary for their well-being. But how does this relate to sports at all? Young people are one of the groups most affected by energy poverty (Liddell 2009). This includes grassroots players. The club can play a role in detecting these cases and helping its community members, sometimes by simply offering a place to spend time during the day.

One option to tackle energy poverty is **increasing energy efficiency** and thus reducing overall energy consumption and energy costs. The term "energy efficiency" probably sounds more familiar to most people than energy poverty. In fact, it can be argued that energy efficiency is something that an "average citizen" is aware of, since it is useful to save on energy bills. This is also true for stadium managers, at a very different level of course. In a sports stadium such as football, there are several factors to take into account when it comes to energy efficiency: from the building material to the light bulbs. It is interesting to point out that the United Nations has two goals that are directly linked with energy efficiency: goal number 7 on affordable and clean energy which has a special target on energy efficiency and goal number 13 on climate change.

This guideline provides information on how sports managers can both: (1) measure energy efficiency and increase it and (2) help tackle energy poverty. Each section is self-explanatory so the reader can take a look at them as individual sections.

3.1.1 What is energy efficiency?

According to the European Energy Efficiency Directive (2012/27/EU) (European Parliament and Council 2012) ***energy efficiency*** is defined as the ***"ratio of output of performance, service, goods or energy, to input of energy"***. Measures to increase energy efficiency for example of an industrial process or of a building, aim at reducing or minimizing the amount of energy required to fulfil the purpose of the process or the building. In order to increase energy efficiency, possible energy losses need to be identified and reduced or eliminated. In case of a building, these could for example be heat losses over a poorly-insulated building envelope or electricity losses due to inefficient electrical equipment, such as old pumps or refrigerators. However, energy losses are not only a consequence of inefficient technical equipment or poor building structures, but can also be caused by human behaviour.

3.1.2 Energy consumption in sports centres

Because of their structural characteristics and use, sports facilities are highly energy-intensive complexes, especially when it comes to their electricity consumption. The following table gives an overview of typical energy consumers in different kinds of sports facilities (Raggi und Tavaroli 2021).

Type of sports facilities	Main energy consumers
Football stadiums (Selectra 2022)	• 38% lighting, scoreboard, advertising screen • 23% heating and cooling • 21% kitchen and refrigerators • 11% broadcasting equipment • 7% others (cleaning, maintenance…) – If in place, the following services can also have a significant impact on energy consumption: • Under-soil heating • Pumps for the irrigation system • Artificial lighting for grass growth
Sports and training centers with a pool (Carbon Trust - UK 2006)	• 39% air conditioning and ventilation • 22% other (irrigation system, electronic gym equipment…) • 16% pumps • 12% heating and hot water • 11% lighting
Club headquarters (U.S. Department of Energy (DOE) 2011)	• 40% space heating and cooling, including ventilation • 20% lighting • 15% other • 12% cooking, refrigeration, water heating • 8% electronics and computers • 5% adjustments to SEDs

Table 1: Energy consumption of sports facilities (Raggi und Tavaroli 2021)

3.1.3 Why does energy efficiency matter for sports clubs?

Next to environmental considerations, energy consumption also is a considerable cost factor, so it is advisable from an economic point of view to use it in an efficient way. In addition, sports centers often play an important role in community life and thus also can serve as role-models and multipliers for energ efficient technologies and the use of renewable ener sources.

A large proportion of sports facilities that are in u today, were built from the 1960s to the 1980s, in a tir when energy efficiency was not a design consideratio In order to reduce their energy consumptio renovation and maintenance is required (Raggi u Tavaroli 2021).

In the framework of the European Life TACKLE proj (Daddi et al. 2021) (2018-2021), a survey was conduct among European football managers on the status improvement measures of their sports facilities. Resu showed that 90% of football clubs and stadiums already started to implement certain environmental practices (including those related to the reduction of energy consumption) but their implementation levels vary greatly as shown by Figure 3 (Raggi und Tavaroli 2021).

Case studies, best practices and EU funded projects point out that energy consumption in these facilities can be reduced by up to 30% in many cases (SPORTE2 - Final Report 2014).

When looking at the large number of sports facilities in Europe (see Figure 4), it becomes clear that there lies a huge potential for energy savings in this sector

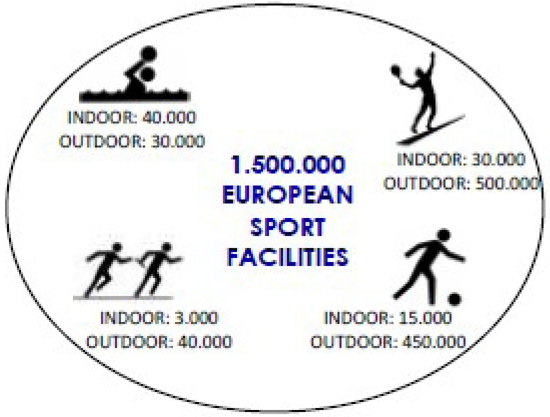


Figure 4: EU dimension of the Sport and Recreation Building Stock
Source: (SPORTE2 - Final Report 2014)

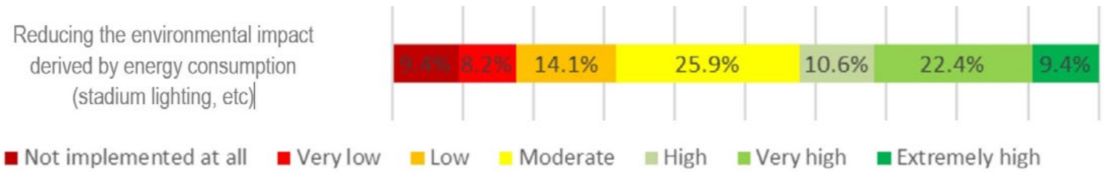


Figure 3: Implementation level of measures to reduce environmental impact of football facilities (Raggi und Tavaroli 2021)

3.2
Energy Poverty

3.2.1 What is energy poverty?

As defined by the European Energy Poverty Observatory (EPOV), energy poor households are those who experience inadequate levels of essential energy services, such as adequate warmth, cooling, lighting and the energy to power appliances, due to a combination of high energy expenditure, low household incomes, inefficient buildings and appliances, and specific household energy needs (EPOV 2022).

The concept of energy poverty was introduced in literature as the condition of a household spending a too high fraction of its income on its energy bills (Boardman 1991). Later on, the term "energy poverty" has been used to represent different conditions of energy deprivation, depending on whether a functioning infrastructure enabling the procurement of those energy services is available or not. Where the infrastructure is unreliable or absent, the concept can be seen as a lack of access to energy. On the contrary, in Europe the term is often replaced by "fuel poverty", which centers on the economic constraints faced by energy poor households. The definition applied at the beginning of the chapter is used here to include all the variety of cases that might suffer a situation of energy deprivation in Europe.

3.2.2 How to measure energy poverty?

Different indicators have been used to measure energy poverty, responding to the multiple effects generated by living in these conditions. This chapter presents the indicators used by the European Energy Poverty Observatory (enclosed by square brackets), focusing more on what they represent on the daily life of households living in energy deprivation than on the technicalities.

Generally, households spending more than 10% of their net income on energy expenses are considered living in energy poverty *['High share of energy expenditure in income (2M)']*, since they will likely accumulate debt *['Arrears on utility bills']* or face a cut of supply. Also, those households might sacrifice other expenses to pay their bills, cutting on groceries for example (a situation described as "heat or eat" dilemma).

Another possibility for those households is to sacrifice their comfort and reduce their use of high-consuming appliances such as the boiler or the washing machine to extremely low levels *['Low absolute energy expenditure (M/2)']*. The heating load can be reduced to very dangerous levels, which can deteriorate the physical and mental health of tenants, mainly worsening cardiovascular and respiratory diseases, but also stress and depression (particularly in young people). These effects intensify for old and poorly insulated dwellings, where people with lower income tend to live, which are difficult to heat up to adequate comfort levels *['Inability to keep home adequately warm']* (EPOV 2019).

The psychological and emotional effects of living in this condition of precarity range from powerlessness and frustration to guilt and shame. Social life may also be affected if, for example, people avoid inviting friends, acquaintances or family home because it is too cold, or they have mold on the wall.

Many other coping mechanisms to minimize the effects of energy deprivation have been developed, some as straightforward as using the heating intermittently, limiting domestic life to one or two rooms, and wrapping up in extra clothes and blankets to stand the cold (Middlemiss und Gillard 2015). Finally, other coping mechanisms may be less intuitive, like spending more time outside in warmed up places (e.g. libraries, friends' houses) or taking hot showers only at the gym.

3.2.2 Energy poverty and sports

As anticipated before, spending time outside one's home is a frequent coping mechanism to deal with energy deprivation. Still, little research has been done on the experience of the energy poor outside the home environment and the reliance that can be placed on 'safe spaces' such as the office, bars or even sport facilities. As an example, young people living in shared flats, either if they study or work precarious jobs, are often unable to afford heating during the day and are inclined to spend more time at work, at the university or at other people's houses (Petrova 2018).

It is unclear whether sport facilities play an important role when coping with energy poverty. Gyms, sport centers, swimming pools and locker rooms are generally equipped with hot showers and hair dryers, offering players some crucial energy services. But also, leisure areas and bars in a sports center or even teammates' houses can act as safe spaces, where to spend some hours of comfort.

Moreover, practicing sports improves both physical and mental health, limiting the demeaning effect of living in unhealthy homes. Doing exercise reduces the risk of most major illnesses, such as heart disease and stroke. It also boosts self-esteem, mood and sleep quality, while reducing the risk of stress and depression.

Sports teams, in particular, also favor the social interactions of players, providing skills for cooperation and problem solving. The creation of a safe network is vital to deal with the many inconveniences that arise from living in conditions of inequality. It is common to hear parents with low income talking about "getting their kids busy" to keep them out of trouble and make new friends.

In addition, parents and children of low-income families interviewed by Holt agree that practicing sports help improve confidence and emotional control (Holt et al. 2011), skills which may help to deal with the stress, exclusion and deprivation.

All the above reinforces some research findings, suggesting that good social relations can enable access to energy services (Middlemiss et al. 2019) by overcoming the dynamics of oppression and discrimination someone may face. Let's think of the linguistic barrier faced by new coming migrants struggling to understand their bills and reclaim their rights. Or the hardship of accessing funding to settle a debt or renovate the flat for people without a job and guarantees. Or the impossibility of being hosted at someone's house in case the heating system breaks, or the light gets cut off in winter.

Social relations based on generosity, friendship and trust can help people's morale. Social networks can as well represent a safe space for periods of psychological instability (Berkman 1995; Pollner 1989). In this sense, it can be said that **grassroot sport clubs are already doing a lot to combat energy poverty** when they address the themes of inclusivity of low-income children, who are more prone to suffer conditions of energy deprivation.

But while sports have proved to be a key area to tackle poverty and can arguably prove to be a good area to support the community around the sports clubs who suffer energy poverty; still, many barriers exist to sports participation for people in risk of social exclusion, namely economic, policy and communication wise.

Economically, when clubs do not directly offer grants, low-income families often face financial barriers that limit children's sport participation, with costs rising as they grow and progress in sport. For instance, in 2016, a poll done in the UK found that 49% of people said they would do more exercise if they could find opportunities that were free (UKactive 2016). Similarly, a study conducted by the Housing and Communities Research Team in the Centre for Analysis of Social Exclusion (CASE) at the London School of Economics (LSE) found that cost is an important barrier to sports participation of young people living in disadvantaged areas, with schools playing a major role in getting children involved by providing activities and facilities for free or at very low cost (Edwards et al. 2015).

Policy wise, we put the focus on the reach of social security policies which aim to eradicate energy poverty. On a first instance, surrounding the sports clubs there is a community that may be eligible for grants and that can be easily reached. Secondly, sports can give voice to the invisible energy poverty cases. The problem of invisible, or hidden, energy poverty consists of people who are not, or consider themselves not to be, included in the canonic vulnerable groups of energy poverty, such as elders or low-income households. Those people may still live in precarious dwelling conditions and suffer discomfort in their home but are generally excluded from the support schemes defined by public authorities and NGOs. An example can be offered by the student population, which often live in poorly insulated shared flats and argue on how much time the oven should be used to avoid too high bills (Petrova 2018). In this regard, the sports clubs can use their platforms to make the invisible, visible.

Communication wise, in addition to general communication about economic, social schemes and support available for all citizens, communication should focus on some specific groups such as new coming migrants who may not be fully aware of their rights and therefore avoid the reach of social services and benefits, charities and community initiative.

3.3

Practical guideline for football clubs on energy efficiency and energy poverty

3.3.1 Energy efficiency

Reducing the environmental impact of energy-consuming systems requires two synergistic approaches: First, it is necessary to reduce energy losses and thus the overall energy consumption through implementation of energy efficiency measures, and second, the remaining energy demand can be provided via renewable energy sources. Each case needs to be assessed individually in order to identify the weak points and the most promising optimization potentials (Raggi und Tavaroli 2021).

For football facilities, the following relevant areas of improvement should be considered (Raggi und Tavaroli 2021):

- **Lighting systems**
- **HVAC systems, plant, and equipment (heating, ventilation, air conditioning)**
- **Building automation / Building Management Systems**
- **Building envelope**
- **Electrical equipment and specific technologies**

3.3.1.1 Lighting

For the lighting systems of football buildings, different requirements are of importance, such as aspects of illuminance, uniformity, glare control and chromatic properties of the source used. These requirements vary based on the level of competition of the football club. Regarding to lighting there are simple possibilities to reduce the energy consumption and also the related costs (Raggi und Tavaroli 2021):

- Conversion of existing lighting systems to LED with High-Efficiency LED lights.
- Splitting and adapting the system so that multiple scenarios are allowed for different purposes.
- Implementing an automated lighting management system. This may include the actual monitoring of lighting levels, occupancy and daylight sensors.

The amount of energy and cost savings will be higher the more fixtures are replaced and if hours of use or costs of electricity are higher (Raggi und Tavaroli 2021).

LED lights offer several advantages compared to conventional technologies related not only related to energy efficiency, but regarding service life, costs, color, operating times, focus, light pollution and the environment (Raggi und Tavaroli 2021). In Table 2 those benefits are explained in more detail:

Item	Benefits of LED lights compared to conventional technologies
Service life	Lifespan of LED lights is 4 or 5 times higher than other technologies. They also lose their lumen efficiency much slower over time when compared to MH HID technology, offering better performances for a much longer lifespan. This translates into lower maintenance and material replacement costs, as well as less waste for disposal.
Energy efficiency	LED fixtures offer excellent light performance with low power. Replacing conventional lamps with modern LED floodlights and lamps can lead to up to 35% energy savings.
Costs	LED systems generally cost more than other solutions, but they offer a better return on investment during the lifespan of the system thanks to energy savings and the reduction in maintenance costs and need of replacement.
Color	LED lights offer higher Television Lighting Consistency Index (TLCI) than other technologies. Color rendering is especially important in sports facilities that host HD TV footage and broadcasts.
Operating times	Unlike other technologies, LED solutions emit 100% of the luminous flux, directly upon switching on. They don't take time to warm up.
Focus	HID and other technologies emit omnidirectional light, they tend to illuminate beyond the specific area, even with spotlights, which means that much of the light emitted is scattered and wasted. The LED lights, on the other hand, are very localized, where ~100% of the emitted light can be specifically directed towards the area to be illuminated.
Light pollution	The directional lighting capability of LED lights naturally helps to minimize light pollution. Additionally, the use of reflective visors can further reduce light scattering and its negative impact on the environment around sports facilities.
Environment	In addition to minimizing light pollution, LED solutions require significantly less energy to operate than other technologies. As a result, they create fewer greenhouse gas emissions.

Table 2: LED lights versus conventional technologies (Raggi und Tavaroli 2021)

When adapting lighting solutions, the purpose of the lighting needs to be taken into account and of course, there can be very different requirements, depending on the league of the respective club. For every venue an individual solution has to be evaluated and designed (Raggi und Tavaroli 2021):

- Pitch: precision LED lighting installations with flexible controls.
- Seating: balanced lighting to maximise visibility for spectators.
- Indoor areas: controls and sensors are recommended to avoid energy wasted and fit user needs.
- Outdoor areas: adequate lighting to provide safety.

3.3.1.1.1 Flood lighting

It is advisable to install modular LED floodlights than can be used even in dual or triple configurations, with different power outputs and light distributions (Raggi und Tavaroli 2021).

- Illuminance levels must be configured for each camera position (if needed).
- Artificial light sources should simulate natural daylight.
- Colour rendering greater than 80 and TLCI rating should be above 80.
- Implement a continuous LED light level adaptation.
- Flicker factor under 6% is highly recommended.

Adequate lighting control technologies ensure long-term installation performance and easy maintenance (Raggi und Tavaroli 2021).

3.3.1.1.2 LED technologies for internal lighting

For lighting design of interior spaces, the following points should be taken into consideration (Raggi und Tavaroli 2021):

- Install proper control systems using smart swathes, daylight controls and motion sensors able to avoid the use of lights when not needed.
- Identification of lighting level required by the specific use of the space and according to tasks and human factors and considering the availability of daylighting. Illuminance levels must be configured for each space needs.
- Artificial light sources should simulate natural daylight.
- Considerations on surfaces characteristics and glare control measures.
- Color of the lamps, taking into account CCT (correlated Color Temperature) and CRI (Color Rendering Index) index.

3.3.1.1.3 Lighting controls

Adequate lighting control technologies ensure long-term installation performance and easy maintenance (Raggi und Tavaroli 2021).

Common types of lighting controls (Raggi und Tavaroli 2021):

- Dimmer controls
- Occupancy sensor controls
- Timer controls
- Daylight sensors

Key elements for lighting controls of internal spaces (Raggi und Tavaroli 2021):

- Identification of spaces and relevant lighting levels required.
- Considerations space usage, frequency of use, type of users.
- Analysis of the internal geometry of spaces and daylight levels.

3.3.1.2 HVAC systems, plants and equipment

Heating, cooling, ventilation and domestic hot water (DHW) production represent a consistent area of improvement for any buildings. A complete renovation of the HVAC system, in the case of large and complex buildings, can represent a huge and expensive intervention that should be evaluated carefully. HVAC systems installed in the existing buildings are often difficult to retrofit and an entire system renovation can require a deep refurbishment, as the components are spread through the whole building in different spaces (Raggi und Tavaroli 2021).

BUT: Single equipment can be replaced more easily with good results in terms of energy efficiency improvement, e.g. HVAC generators (Raggi und Tavaroli 2021).

The selection of type and capacity of HVAC generators must be carefully evaluated considering the heating and cooling systems, their operating temperatures, the insulation provided to the building envelope and the availability of a suitable heat source (Raggi und Tavaroli 2021).

Possibilities to become more energy efficient (Raggi und Tavaroli 2021):

- High efficiency Heat Pumps
- High efficiency Condensing Boiler
- High efficiency Air Handling Units (AHU)
- Cogeneration systems
- Tri-generation systems

Detailed design of HVAC systems and key components depends on (Raggi und Tavaroli 2021):

- Particular building cases
- Local characteristics
- National codes

To make correct sizing of a new HVAC system, the characteristics and the main parameters of all elements must be correctly calculated and assessed, including for example (Raggi und Tavaroli 2021):

- Maximal airflow of ventilation units
- Maximum capacity of heating and cooling equipment
- Ducts and pipes diameters
- Etc.

3.3.1.3 Building automation / Building management systems

Building management system (BMS) is one of the most powerful tools in building engineering services. It is primarily used to monitor and control electro-mechanical systems, extra low voltage systems, elevators, lighting etc. It ensures efficient utilization of resources, energy efficiency, improved comfort and safety for the users (Raggi und Tavaroli 2021).

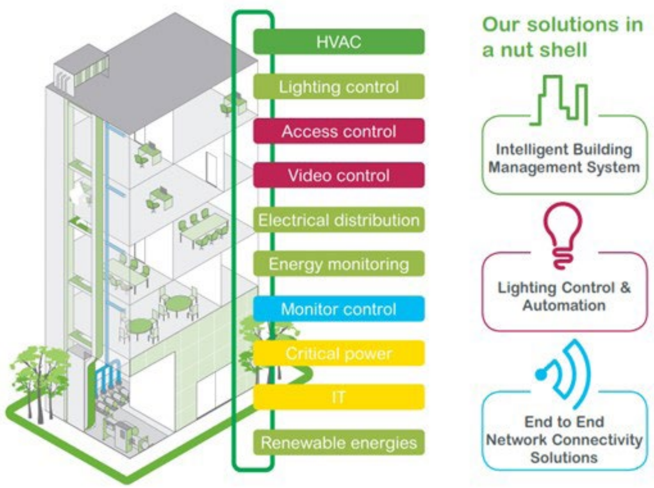


Figure 5: Example of a building automation and management system

Source: (Microtech(bd)system)

A BMS includes subsystems for managing its various components, including (Raggi und Tavaroli 2021):

- System for commercial accounting of heat consumption.
- Automatic equipment for heating and cooling supply systems.
- Water supply and plumbing systems.
- Automatic equipment for lightning and electric power supply systems.
- Smoke removal, fire alarm system and other emergency warning systems.
- Security-burglar signaling system.
- Access monitoring and control system.
- Other low current systems.

Typically, systems linked to a BMS represent 40% of a building's energy usage and up to 70% if lighting is included. Therefore, the potential energy and costs savings may be considerable (Raggi und Tavaroli 2021).

BMS – Recommendations (Raggi und Tavaroli 2021):

- All the coolers and heat pumps will have built-in temperature sensors for monitoring the temperature and hence it is not necessary to add additional temperature sensors.
- Status of pumps also to be taken from mechanical side by installing DP Switches across pumps rather than relying on electrical starters, as starter will always show 'On' status when switched on, but sometimes the pump may not be really running due to some mechanical failure.
- Instead of integrating the Main Fire Alarm Panel fully into BMS, it is better to assign 2 control relays, one for supervisory monitoring and one for fire alarm monitoring in the fire alarm system. By monitoring the status of these control relays, BMS operators could come to know the main 2 status.
- The BMS software should be customized to depict and process the data in a facility management perspective. Some of the specific functions required are:
  - Report energy consumption values from utility meters on a daily cut-off hour.
  - Report trends of parameters and status in HVAC Systems, Hot Water Systems, Ambient Conditions etc.
  - Trip/Fault and Stop status of equipment to be popped up in the BMS workstation with an Audio-Visual Alarm.
  - Automatic printing of alarms and events through a printer attached to BMS Workstation.
  - Preventive maintenance schedule alarms based on the operating hours of the equipment.
  - These functionalities in the software would enable the facility management team to analyse the energy usage patterns, variation of parameters at different operating conditions, and allow for proper planning and efficient utilization of energy and resources.

3.3.1.4 Building envelope

An adequate renovation of the building envelope reduces the energy demand of the building for both heating and cooling. The quality and energy performance of building envelops are the most important factors that affect the energy consumed by heating and cooling equipment. In addition to an improved energy performance, building envelope improvements can also occupant comfort through more stable temperatures and better control of lighting (e.g. glare reduction). Energy loss through the building envelope is highly variable and depends on numerous factors such as building age and type, climate, construction technique, orientation, geographical location and occupant behavior. The solutions to improve performance are also varied and highly dependent on the specific case (Raggi und Tavaroli 2021).

2.5.1.4.1 Thermal insulation

Thermal insulation reduces heat gain/loss through the building envelope and maintains a comfortable indoor environment. There are several common types of insulation: fiberglass, mineral wool, cellulose, polyurethane foam, expanded polystyrene (EPS), rigid foam board, and spray foam, etc. The type and the thickness of insulation needed varies considerably according to the climate zone (Raggi und Tavaroli 2021).

In order to improve energy performance in winter, solar gains should be maximized, and thermal losses minimized mainly using thermal insulation. During summer internal and external gains should be minimized to not overcharge the cooling system using thermal mass, efficient glazing, insulation, shading, reflective surfaces and natural ventilation. Both needs should be carefully balanced based on the actual needs of the building (Raggi und Tavaroli 2021).

For thermal insulation, the following parameters have to be considered (Raggi und Tavaroli 2021):

- Climatic parameters.
- Material properties of the existing envelope.
- Existing thermal bridges and possibilities to solve them.
- Use of the internal spaces.
- Thermal performances of the insulation (e.g. thermal conductivity, heat capacity, density of the material, etc).

Recommendations for thermal insulation (Raggi und Tavaroli 2021):

- Apply external insulation to achieve higher performances reducing thermal bridges with little risk of moisture problems.
- Internal insulation must be installed carefully and must not create a situation where the moisture levels in the wall can rise.
- Complete insulation of walls, roofs and ground slabs is recommended in cold climates.
- For warm climates it may be more efficient to isolate only walls together with the implementation of cool roofs.
- Sustainability: choose insulation materials with high percentage of recycled materials and select products with responsible sourcing certification.
- To choose the right material, it is important to analyze how it responds to moisture, whether it meets fire safe regulations and whether the thickness meets the national standards.

3.3.1.4.2 High-performance windows

High-performance windows help improving thermal insulation of the envelope while ensuring appropriate level of natural lighting and ventilation. A wide range of high-performance windows with different type of frames, glass, glazing and cavity fill is available (Raggi und Tavaroli 2021).

The following parameters should be considered for the selection of appropriate windows (Raggi und Tavaroli 2021):

- Climatic parameters.
- Façade orientation and presence of external shading.
- Inclination of the sun's rays throughout the year.
- Existing thermal bridges and possibilities to solve them.
- Use of the internal spaces.

Choose windows and shading devices based on façade orientation balancing the thermal transmittance (U-value) with the solar heat gain coefficient (SHGC) and the visible transmittance (VT). In general, high U-value are recommended for north-façades while high SHGC are recommended for south-façades (Raggi und Tavaroli 2021).

3.3.1.4.3 Cool roofs

A cool roof is able to reflect solar heat and keep roof surfaces cool under the sun. There are reflective and emissive materials used to reflect solar radiation back into the atmosphere. As the roof stays cooler, the amount of heat transferred to the internal spaces of the building is reduced keeping a cooler and more constant temperature in the interior. When correctly installed with air sealing, each type of insulation can deliver comfort and lower energy bills. To get the biggest savings, the easiest place to add insulation is usually in the attic (Raggi und Tavaroli 2021).

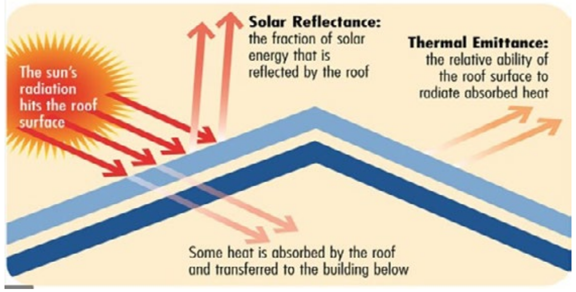


Figure 6: Heat being reflected and absorbed by a roof
Source: Nationaland Kapodestrian University of Athens

3.3.1.4.4 Green roofs

Green roofs incorporate plants into the roof assembly adding insulating value, reducing storm water runoff, cool the building interior and the surrounding area, provide habitats for birds and insect. Several types of green roofs with varying coverings, complexity and scopes can be established on rooftops. Implementing a green roof on an existing building needs to be carefully evaluated under the structural and seismic point (e.g. loadbearing capacity of the building, need for structural modifications) (Raggi und Tavaroli 2021).

In order to choose the correct plants, the following parameters should be considered (Raggi und Tavaroli 2021):

- Weather data: Adequate weather conditions and rainfall support the growth of the plants, so that there is no or littler need for irrigation.
- Slope gradient of the roof: Preferably a flat or relatively flat roof.

- Weight of the whole system: Consider the load-bearing capacity of the construction.
- Water requirement and growing medium of the species: Select locally appropriate native species resistant to climate agents and potential droughts.
- Water retention capacity.
- Adequate protective cover under the trays is required, in order to protect the roof covering.
- Maintenance of green roofs is crucial (especially in the first 5 years).

The implementation of a green roof strongly depends on the site conditions and has to be planned carefully, in order to prevent damage to the roof or building and to guarantee a long lifetime of the plants.

Figure 7: Example of a green roof (Barclays Center, Brooklyn, NY)
Source: Weston Solutions

3.3.1.5 Electrical equipment and special technologies

Technologies and equipment, with relevant energy consumption could be present in stadiums or training centers. If they are replaced with new advanced technologies this offers challenges and opportunities to improve the energy efficiency of the system. Wherever possible, any features or equipment that require extensive or costly maintenance should be avoided. Severe weather conditions or failure to undertake adequate maintenance could make it necessary to use technologies such as under-soil heating and artificial lighting to growth grass. These are extremely energy intensive systems and represent a field in which to investigate opportunities and solutions for energy improvement and financial savings (Raggi und Tavaroli 2021).

3.3.1.5.1 Under-soil heating

Recommendations for under-soil heating (Raggi und Tavaroli 2021):

- The heating cables should be installed 25-30 cm (up till 35 cm) below the surface to avoid cable damage. Distance between the wires depends on the required W/m², and typically is about 15-25 cm.
- An adequate drainage system is needed. Less water means less heating needs.
- In order to keep the soil warm and moist, the area should be covered with plastic or a similar material when it is not in use.
- To limit energy consumption, it is essential to adopt intelligent control systems that heat the under-soil heating only as long as it is necessary to prevent the soil from freezing.
- A photovoltaic system in combination with battery storage can power the electric under-soil heating system, even at night, without expensive external power.

3.3.1.5.2 Artificial lights for grass growth

Recommendations for articifial lights for grass growth (Raggi und Tavaroli 2021):

- Artificial lights to improve the growth of natural and mixed-synthetic grass in football stadiums.
- It also provides a turf heating that favors the melting of snow and ice.
- A LED-based system allows groundskeepers to adjust the color of light to enhance photosynthesis.
- It is recommended for those climates and building configurations where natural sunlight and temperature are not sufficient to guarantee an adequate grass growth.
- High operating cost that can be reduced using a PV system to provide free electricity.

3.3.2 Energy Poverty

Football clubs can address the topic of energy poverty within their community to create awareness and potentially also reduce energy poverty (Edwards et al. 2015):

- Sometimes spending time outside one's home is a frequent coping mechanism to deal with energy deprivation – football clubs give young people the opportunity to spend time outside their homes.
- Sport facilities provide energy services, such as hot showers, hair dryers, …
- The creation of a safe network is vital to deal with the many inconveniences that arise from living in conditions of inequality.
- Good social relations can enable access to energy services by overcoming the dynamics of oppression and discrimination (e.g. overcoming linguistic barriers to understand the energy bills, …)
- Clubs can offer grants and facilitate the participation of low-income children, as low-income families often face financial barriers that limit children's sport participation – hence more money for energy is available for the families.
- Clubs could also provide workshops or consulting opportunities for their members, on energy bills, energy efficiency in general and low-cost energy efficiency measures, accessing grant schemes or tips for positive behavior change.
- Creating awareness for the topic of energy poverty within the club and also outside (e.g. an awareness campaign). In a first steps, coaches, medical staff and educators could be educated about this and then they could hand-on this information to the players, e.g. via workshops or discussions.

4

PORTUGAL PILOT:

POTENTIAL AND FEASIBILITY OF PHOTOVOLTAICS

SDG Striker
Scoring Goals for Sustainability

Photovoltaic systems (PV systems) use solar panels to convert sunlight into electricity. PV panels installed in football buildings' roofs provide a simple and environmentally friendly means of generating electricity. In a football building, a small PV system may provide energy to a single service or device (e.g. a lamp in outdoor areas or parking) while large grid-connected PV systems can provide the energy needed by multiple and consistent electrical services. The use of PV systems suits well also with the intermittent use of most of the football facilities, such as stadiums, with occupancy ranging between time intervals without use and time intervals with the maximum use. In particular, through an intelligent demand side management it is possible to:

- Dedicate energy to the facility when needed.
- Store energy, through efficient and cost-effective energy storage systems.
- Exchange energy with the grid when it is not needed on site. In this case the energy produced by the PV array can be sold back into the main electricity grid in a net metering agreement.

Allowing a structure such as a stadium, extremely energy-intensive during a sporting event, to become more autonomous from an energy point of view would make the power grid of the whole district more stable by avoiding these peaks in consumption. While solar panels are still an expensive option in the short term, the economic benefits will be realised over a period of time. Additionally, many countries now have grants and subsidies that make them a viable and even attractive proposition over the longer term.

One pilot of the SDG Project addresses PV units. It is located in Portugal, and it deals with photovoltaics potential and feasibility on sports facilities. Therefore, as it can be seen in Figure 8: 4 out of 17 UN SDGs, 4 SDGs are addressed with this pilot, including Goal 7 (Affordable and clean energy), Goal 11 (Sustainable cities and communities), Goal 12 (Responsible consumption and production) and Goal 13 (Climate Action).

Figure 8: 4 out of 17 UN SDGs. **Source:** United Nations 2021

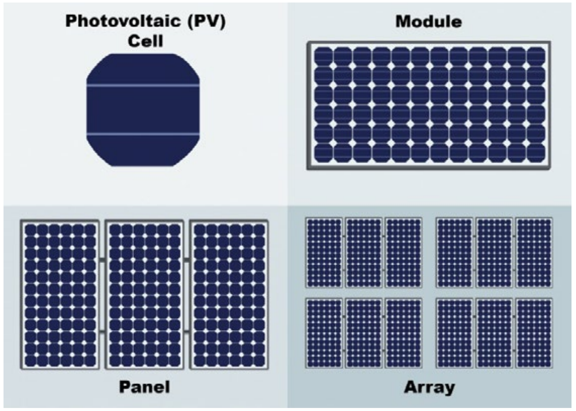
4.1

Photovoltaics for football installations

4.1.1 What photovoltaics are?

- The term "solar collector" is often being used in common speech. But behind this term, there lie two different systems: While photovoltaic systems are directly converting solar radiation into electricity, solar thermal panels are producing heat, typically hot water for example for space heating. The most common types of PV cells are based on silicon, making use of the photovoltaic effect (saena 2021).
- Several cells connected in parallel or in series, in order to generate higher currents, voltages or power, form a module, which is sealed in a protective laminate. One or more connected modules form a panel, which is the "field-installable PV unit". And finally, several connected panels make-up a larger PV array (see Figure 9). [Cells, Modules, Panels and Arrays - FSEC® (ucf.edu)] effect (saena 2021).

Figure 9: From a PV cell to a PV array.
Source: Cells, Modules, Panels and Arrays - FSEC® (ucf.edu)



- A PV system generally consists of PV panels, metering-, control- and protection systems and grid-connection, an DC/AC inverter, power cables, and optionally, a battery system (saena 2021).

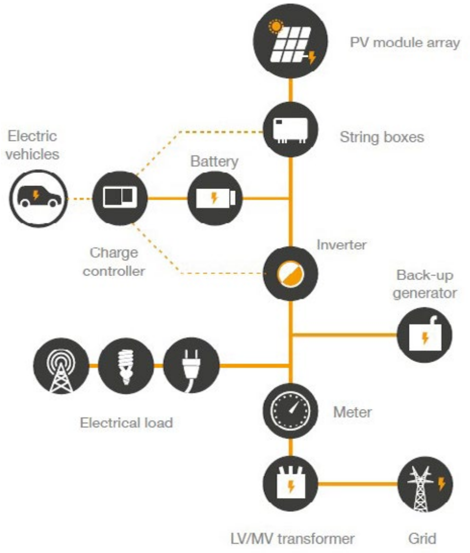


Figure 10: Schematic overview of a hybrid PV system (battery and grid-connection) **Source:** https://www.arup.com/perspectives/publications/promotional-materials/section/five-minute-guide-to-rooftop-solar-pv

- The amount of electricity generated in a PV system is determined by several factors, which have to be taken into account when designing a PV system: solar irradiation (depending on geographical region, see Figure 11), orientation and tilt of the PV modules, clouding etc. (saena 2021).
- PV collectors can be installed on roofs, as part of the façade of a building or set-up on the ground. The electricity that is produced by the collectors can either be directly used for the electricity demand of the building or process or can be fed into the electrical grid (https://www.seai.ie/publications/Best_Practice_Guide_for_PV.pdf).

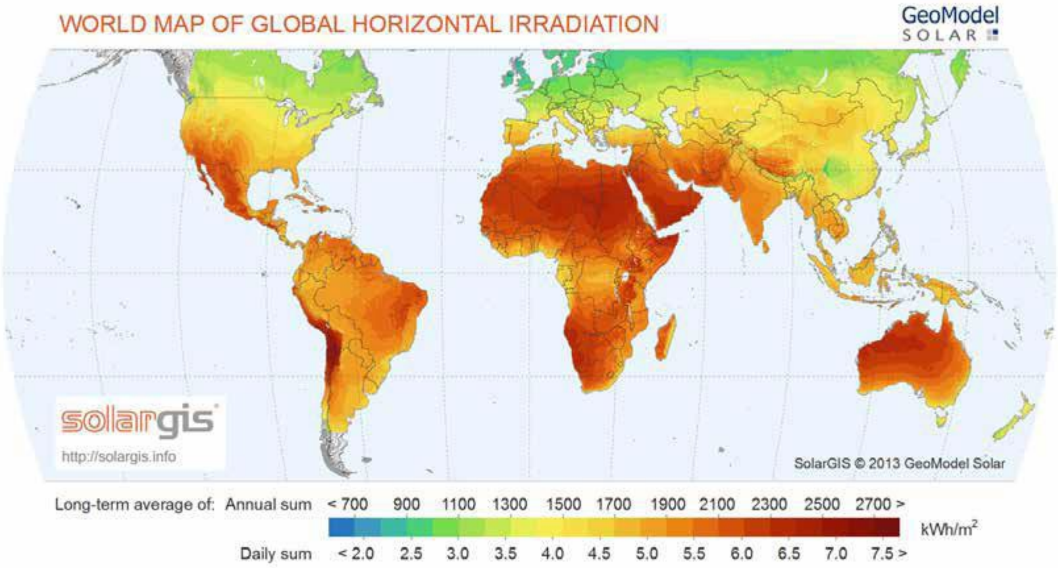


Figure 11: World Map of Global Horizontal Irridiation
Source: https://www.arup.com/perspectives/publications/promotional-materials/section/five-minute-guide-to-rooftop-solar-pv

4.1.2 What is self-consumption?

- Electricity produced by the PV system is fed into the internal grid of the building and directly consumed there, if needed (="self-consumption"). For PV systems that are linked to the public grid, excess energy can be fed into the grid. If more electricity is required than the amount provided by the PV system, this amount is taken from the public grid (saena 2021).
- It is advisable to aim for a high proportion of self-consumption, when planning a PV system, of course always considering the cost-benefit ratio (saena 2021):

Why?

- Usually, the price for electricity from the energy-supplier is considerably higher than the price of self-produced PV electricity and also as the compensation that an owner of a PV system gets from the energy-supplier for electricity fed into the grid.
- By directly using self-produced PV electricity, the public grid can be relieved in times of high solar electricity production (peak-loads).
- When electricity is consumed near to its production site, transmission losses in power supply lines can be reduced.

How?

- Design of PV system and collector size adapted to individual needs and actual consumption patterns. So first, it is mandatory to gather information about the current electricity demand and load profiles and also to take into account if the electricity demand will change in the future (planned electric cars, heat-pump etc.).
- Matching of times of consumption to times of production, either manually or automatically.
- Storage of PV energy in battery systems (stationary or mobile) or heat storage systems, in order to use it in times of no production.
- Up to 30% of the yearly electricity demand of a building can be covered by a PV system; and up to 80% are possible with a good energy management system and storage solution in place (saena 2021).

Appearances and aesthetics play a big role in building design. How will the PV panels "look" on the roof or façade? There are various architectural options for that. (https://www.seai.ie/publications/Best_Practice_Guide_for_PV.pdf).

4.1.3 Why photovoltaics for football facilities?

Football buildings that are currently in use, usually are run with fossil energy sources or grid-electricity. As opposed to renewables, such as sun, wind or geothermal heat, fossil fuels are finite resources, largely contribute to climate change and can also be subject to geopolitical conflicts. As football facilities are high electricity consumers and usually offer large unused roof areas, the integration of photovoltaics can be a promising solution (Raggi und Tavaroli 2021).

Large sports facilities usually have a high electricity demand during sports events and thus cause peaks in the public electricity grid. Use of self-produced PV electricity can help stabilizing the local grid (Raggi und Tavaroli 2021).

Apart from that, football clubs play an important role in social life and can act as role-models and multipliers in promoting new sustainable technologies.

As already mentioned in chapter 3.3.1, energy efficiency and integration of renewable energy sources should go hand-in-hand: First it is advisable to reduce possible energy-losses and thus increase energy-efficiency and then, the remaining energy demand can be provided via renewable sources (Raggi und Tavaroli 2021).

4.2
Practical guideline for football clubs on photovoltaics installation

4.2.1 Key facts on PV technology

Photovoltaic systems produce DC, which needs to be converted to AC in order to be able to feed the electricity into the public grid, this is done in the inverter unit. PV systems can utilize direct and diffuse solar radiation, but of course, the output is better when the sun is shining onto the panels. PV systems are able to reach efficiencies of about 5-15%, this means that 5-15% of the incoming solar radiation is being converted to electricity. PV is an established technology, with some facilities already in operation for over 15 years. Modules can have different shapes and sizes, and while PV cells are opaque, modules can also be designed with some transparent areas. PV systems reach highest efficiencies when the array is installed under uniform conditions.[1]

The amount of electricity generated in a PV system is determined by the following factors, which have to be considered in the design phase (saena 2021):

> **Geographical location:** The available global horizontal irradiation (kWh/m^{2}a), the sum of direct and diffuse solar radiation that horizontally meets the earth's surface, depends on the geographic region, where the PV system is set-up (see Figure 1). For Lisbon the global horizontal irradiation comes up to around 1.700 kWh/m^{2}a.

1 • https://www.seai.ie/publications/Best_Practice_Guide_for_PV.pdf

> **Orientation and tilt:** A PV system generates the highest output, when the solar radiation meets the collector at an angle of 90° and when the collector area is directed to the South (solar orientation, "Azimuth"). Even if this exact orientation and tilt often is not possible, there are a range of options giving up to 95% of maximum output (https://www.seai.ie/publications/Best_Practice_Guide_for_PV.pdf).

> **Clouding:** Trees or other objects can cast shadows on the collector area and thus reduce the electricity yield of the system and in the worst case even cause damages due to hot spots. So, it is necessary to investigate the planned site for possible shadows during all times of the day and the year. Also, possible future problems (e.g. growing trees) should be taken into consideration.

> **Dirt:** Dust, tree-leaves and other dirt can accumulate on the collector area over time. This can lead to a reduced yield or even damage of the system.

> **Weather conditions:** Solar collectors can be covered by snow for several weeks in winter; however, the effort to remove the snow usually does not equal the benefit, because the yield is lower in winter anyway. Too hot weather conditions can also have a certain negative effect on the yield, therefore a ventilation-space behind the collectors makes sense; however, also in this case the costs have to be considered as opposed to the benefits. Inverters automatically reduce their capacity when they get too hot.

> **Ageing:** Construction materials that are permanently exposed to sunlight will degrade faster. PV Suppliers provide information about component lifetimes in their datasheets. This information must be considered when calculating the economic efficiency of a PV project. Inverters should be installed in a weather-protected location and have a lifetime of around 10-15 years. PV cells can have a lifetime of up to 30 years. Current-carrying cables must be protected from sun and water.

> **Dimensioning:** The dimensioning of the system should be done according to the current or planned future electricity demand or planned scenario. Oversizing has a negative impact on cost-benefit ratio.

4.2.2 How to succeed installing PV

This chapter gives a basic overview of the steps necessary when designing and installing a PV system. For more specific information see the following Literature:

- https://www.nrdc.org/sites/default/files/stadium-solar-guide.pdf
- https://www.arup.com/perspectives/publications/promotional-materials/section/five-minute-guide-to-rooftop-solar-pv
- https://www.seai.ie/publications/Best_Practice_Guide_for_PV.pdf

1) In order to achieve a good cost-benefit ratio, the design of the PV system should be done according to the energy demand pattern of the building or facility.

So, the first step is the investigation of the current energy consumption pattern and also planned future demands (planned e-cars, heat pumps etc.): consumption data usually is available from the energy supplier and can be measured in order to get more details. It is advisable to get support from professionals already in this step, either from the energy supplier, the PV supplier or an independent energy consultant.

2) It is also necessary to get into contact with authorities and the grid operator at an early stage of the project, i.a. to clarify issues concerning construction permits or the possibility of grid-feeding of the planned PV electricity.

3) Definition of project goal: Which goals are pursued with the installation of a PV system? This could be:

a) PV as primary electricity source: Is a high degree of self-consumption intended? (see chapter 4.1.2)

b) PV as supporting electricity source or supply for a single installation (e.g. lighting)

c) PV as a well-visible symbol for a club's attitude towards sustainability

d) PV as a means of community engagement:
- Public events to mark the project's completion
- Stadium tours
- Educational signage
- Educational tool for local schools

Activities for public engagement can already be planned at this stage.

4) Which sites and areas are available for setting up PV panels? Roof, façade, ground, cover of parking areas etc.? Is a beneficial orientation and tilt possible? Is shading prevented, also in the future (see chapter 4.2.1)?

5) A financial plan needs to be developed:

a) Are public funds or incentives available for the project (e.g. for investment or grid-feeding, taxes)? If yes, how do these influence the cost-benefit ratio of the project? When does the application have to be done (before start or after completion)?

b) Are there possibilities for corporate sponsoring or partnerships with local companies or communities and energy or PV suppliers?

c) Are contracting models an option? For example: Roof area is leased to a third party, which then constructs their own PV system there. PV electricity could be sold to the building owner or fed into the grid. Various models are possible here.

6) Releasing a request for proposals: This depends on the selected financial and ownership model and can be done directly by the building owner or by a project manager.

7) Detail planning and installation by the selected supplier.

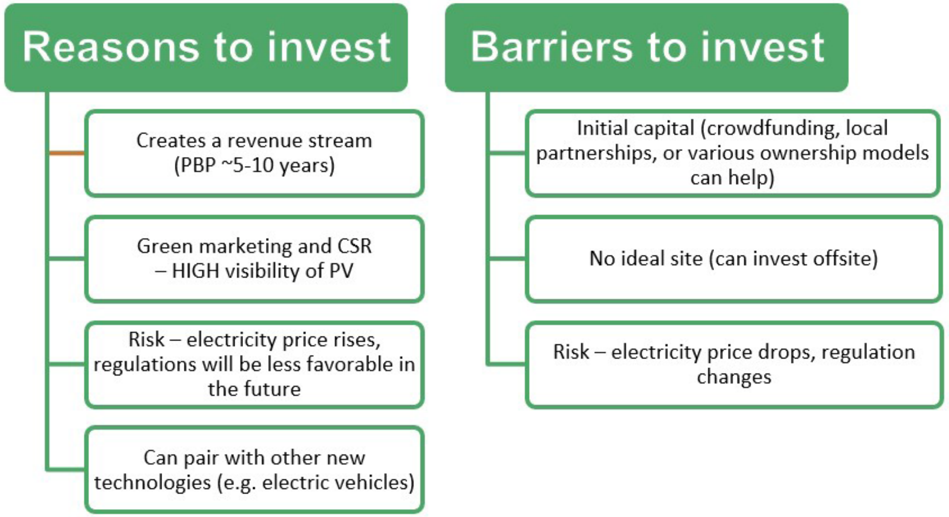


Figure 12: Reasons and barriers to invest into a PV system

5

NORWAY PILOT:

MICROPLASTICS IN THE CONTEXT OF ARTIFICIAL TURF INFILL MATERIAL

SDG Striker
Scoring Goals for Sustainability

5.1
Artificial turf and turf filler

The third topic related to the sustainability in football is related to the microplastic concern of artificial turf and turf filler that are used for the football pitches. Therefore, the pilot located in Norway deals with this issue and aims at finding greener alternatives to microplastic in the context of turf filler materials. With this pilot four SDGs are addressed, including Goal 9 (Industry, innovation and infrastructure), Goal 11 (Sustainable cities and communities), Goal 12 (Responsible consumption and production), Goal 13 (Climate Action).

Figure 13: 4 out of 17 UN Sustainable Development Goals.
Source: United Nations 2021

In Norway football is the most popular sport and therefore also provides a great benefit for the health not only for children, but also for adults (Magnusson 2020). Hence, the use of artificial turf pitches is required to meet the large demand. But not only in Norway, but in general artificial sport pitches all over Europe play a very relevant role. ECHA (European Chemicals Agency) states that every day, sports pitches with infill material out of plastic or rubber granules are used by millions of Europeans. These infill materials are used very often as they provide several advantages. With such filler material the pitches are more durable and weather-proof and in addition it brings more shock absorption and traction. (ECHA n.d.)

However, with artificial turf pitches which use plastic and rubber material as infill the problem of microplastic and the related environmental impacts and the potential human health risks need to be considered (ECHA n.d.).

Further advantages and disadvantages of the use of SBR tires are discussed in 5.1.4.

5.1.1 Structure of artificial turf

(Fleming et al. 2015), Hann et al. 2018, p. 37 (CEN 2020) Magnusson 2020:

Artificial turf consists of plastic fibres such as polypropylene and polyethylene attached to a backing. The backing consists of a non-woven fabric to which the plastic fibres are sewn and a backing made of latex or polyurethane, for example, which makes the fibres stick tightly and gives the carpet stability. 3G systems contain sand to stabilise the carpet on the ground and elastic infill to soften the artificial turf mat. Infill can consist of, for example, tyre granules or newly manufactured rubber/plastic such as EPDM or TPE. There are also bio-based infill materials such as cork and plastic-coated sand where infill sand and elastic material are integrated.

Granule-free artificial turf has an increased amount of fibre instead of elastic infill to provide corresponding softness. Moreover, inorganics such as sand can be used as infill, thus substituting plastics. A pad can be laid underneath the artificial turf, which provides additional swelling and thus reduces the need for swelling in the artificial turf system. For example, the pad can be made from plastic material in a factory or from recycled tyre granules that are laid in place and mixed with a hardener. Underneath the pad is gravel material in different layers.

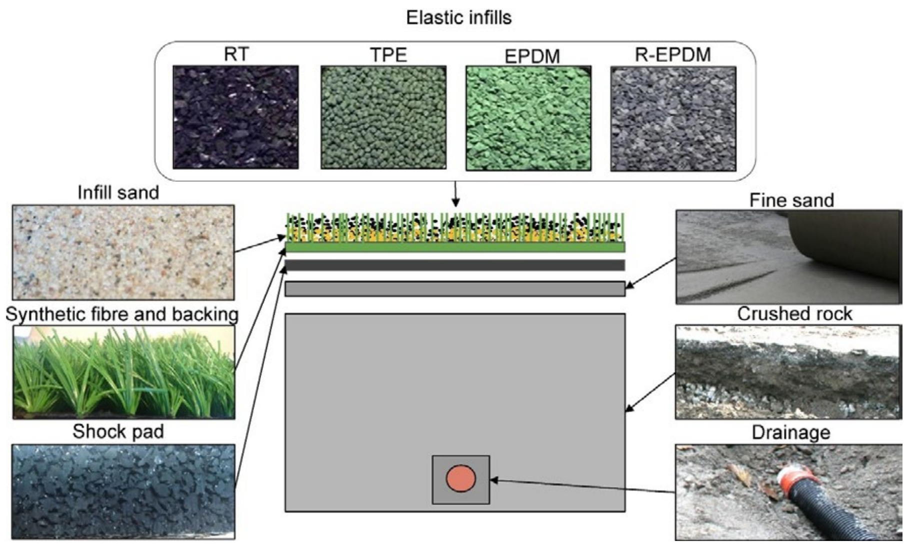


Figure 14: Components of the construction of an artificial turf pitch with 3G system with tyre granules or a granule-free system.
Source: Magnusson,S., Mácsik, J. (2017) Analysis of energy use and emissions of greenhouse gases, metals and organic substances from construction materials used for artificial turf, Resources, Conservation and Recycling, Volume 122, pp 362-372.

Structure of artificial turf

- An artificial turf system is built up in layers that interact in a complex manner.
- Brushing, stripaping, cleaning, and watering is usually done by volunteers or full-time employees. In addition, the refilling of infill is also part of the maintenance.
- The lifetime of an artificial turf pitch depends on the artificial turf carpet and is generally around 12 to 15 years.

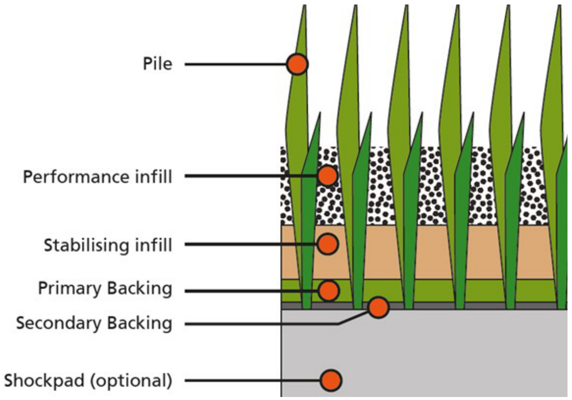


Figure 15: Structure of artificial turf.
Source: Eunomia Research & Consulting Ltd for FIFA 2017, https://publica.fraunhofer.de/eprints/urn_nbn_de_0011-n-6403908.pdf

Infill loss and potential microplastic release

- **Release of microplastic in the environment** through **wear and tear of the artificial grass fibers and spreading the infill material.**
- Considering different **release pathways.** Release to:

– **Surrounding soil area**

– Paved areas around the fields and subsequently **release to sewerage systems via grates** (releases from **shoes and clothes of the players)**

– **Indoor environment through particles in sports bags, shoes and clothes** (removed by vacuum cleaning or released to sewerage systems via washing machines)

– **Drainage via drainage water:** downward seepage, release to sewerage system or release to nearby streams due to rainfalls

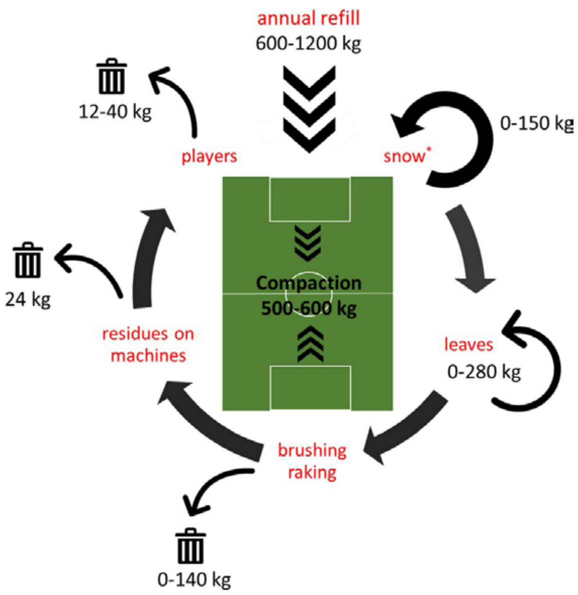


Figure 16: Approximated annual input and output of End-of-life tires (ELT) granulate on artificial turf
Source: Verschoor, A.J., van Gelderen, A. & Hofstra, U. (2021) Fate of recycled tyre granulate used on artificial turf. Environ Sci Eur 33, 27 https://doi.org/10.1186/s12302-021-00459-1

5.1.2 The problem of microplastic in general

There is not one definition of microplastic, but according to ECHA when speaking of microplastic "small, usually microscopic and solid particles made of a synthetic polymer" (ECHA 2019, S. 7) are meant. Microplastic particles can lead to challenges due to several reasons:

> **Size:** Typically, the microplastic particles are microscopic and can therefore be easily ingested and then transmitted up the food chain.

> **Resistance to environmental (bio)degradation:** Due to its high resistance to environmental degradation after their release the microplastic particles are in the environment for a very long time.

> **(Bio)degradation into continuously smaller particles:** Via fragmentation the particles are (bio) degrading in the environment in particles that are getting smaller and smaller.

> **Impossible to be moved from the environment:** Once the microplastic particles have been released to the environment it is not possible to remove them again. (ECHA 2019

Microplastic continuously pollutes the ecosystem and have been found in freshwater, marine as well as terrestrial ecosystems. This arise concerns not only for the environment, but also regarding human health. (ECHA n.d.)

Microplastic can be either unintentionally formed, but they are also manufactured on purpose and added to certain products. There are several products which contain intentionally added microplastics, such as for example fertilizers, cosmetics, detergents, cleaning products and paints. For many consumer products, microplastic particles are used because they are abrasives and are therefore used for instance for exfoliating in cosmetics. Furthermore, they are used for controlling the thickness and can have a positive influence on the stability of the product. (ECHA n.d.)

According to a report prepared by Boucher et al., both forms, primary microplastics intentionally added and secondary microplastics produced by abrasion and the likes are both responsible for losses in the Megaton range, with secondary microplastics being more important. 12.7 vs 5.0 Mt/a in the pessimistic case. (Boucher und Friot 2017)

In addition, the definition for intentionally added microplastic also applies for granular infill material made out of end-of-life tyres that is used for most of the artificial turf pitches. In 2017, ECHA published a proposal for a restriction of intentionally added microplastic, that would also affect these turf filler materials. According to ECHA, annually 42 kilotons of microplastics are annually released annually, with artificial turf pitches being the largest contributor with 16 kilotons. In comparison, releases via abrasion and mechanical degradation in general contribute 176 kilotons per year. (ECHA)

5.1.3 The proposed ECHA ban

After having analysed different hazardous substances and components in microplastics and microplastics itself, the ECHA proposed a restriction of a full ban of intentionally added microplastics, such as in artificial pitches. Subsequently, the SEAC (Committee for Socio-economic Analysis) and RAC (Committee for Risk Assessment) agreed to the proposal in December 2020. (Committee for Risk Assessment (RAC) & Committee for Socio-economic Analysis (SEAC) 2020) However, the SEAC did not fully endorse the notion to include the filling materials in artificial turf pitches, as they reckoned it was a policy decision, if emission reduction or microplastics are the main area of interest. According to ECHA's website a discussion with member states and a decision are expected for 2022. (ECHA)

5.1.4 Advantages and disadvantages of the use of ELT granulates as turf filler

As already mentioned before, granulate from End-of-life tires (ELT) is very often used as filler in sports pitches, for several reasons. The granulate is not only elastic and durable, it also provides an economic advantage as it is relatively cheap. Furthermore, these artificial turf pitches are more weather-resistant than natural grass pitches and it is possible to use them the whole year. As artificial turfs allow intense playing, less pitches and therefore also less land is needed for outdoor sports. (Verschoor et al. 2021)

Furthermore, the ELT used for granulates in artificial pitches give an end-of-life product a secondary use. Verschoor et al. (2021) show how the ELT pathway is split up in 2017 relying on data from the "End-of-life Tyre Report" (ETRMA 2015). According to them, most of the ELT end up as rubber granulate and powders, with 43% of the total ELT from the EU27 and UK, Norway, Switzerland, Turkey and Serbia. As it can be seen in Figure 17, 21% of these are used as infill material for sports pitches. With the use of recycling and reuse of ELT the virgin resources are saved and therefore, also emissions can be avoided. According to Verschoor et al. (2021), the 21% ELT that are reused as infill for sports pitches imply 600 million kg of CO^2 emissions, relying on data from Merlin und Vogt (2020). (Verschoor et al. 2021)

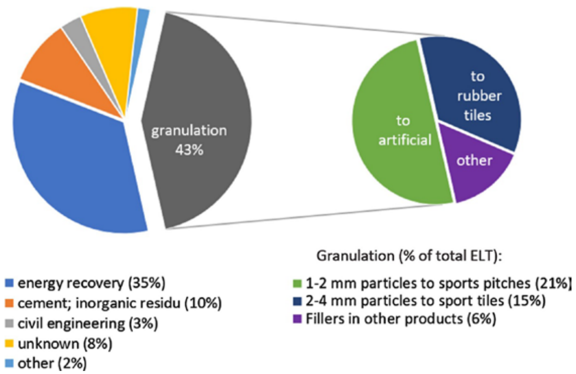


Figure 17: Use of ELT in EU27, (+UK, Norway, Switzerland and Turkey) **2017.**
Source: Verschoor, A.J., van Gelderen, A. & Hofstra, U. (2021) Fate of recycled tyre granulate used on artificial turf. Environ Sci Eur 33, 27 https://doi.org/10.1186/s12302-021-00459-1

However, as already mentioned before, the use of ELT granulates as infill material also provides several concerns and disadvantages related to microplastic that is released to the environment due to the use on sports pitches (ECHA n.d.).

Microplastic is released to the environment through wear and tear of artificial grass fibers and through spreading the granular infill material. There are different pathways how the infill material can be released to the environment. One way where it could find its way to the environment is its release to surrounding soil area. Furthermore, the infill material could also find its way to paved areas that are surrounding the field and are then released to the sewerage system through grates. This could also happen with the material that is released from shoes or clothes of the players. Additionally, infill material could get stuck in the shoes or clothes and then are released to the indoor environment. From there on it is possible that through the washing machines it again finds its way to the sewerage system. The last pathway mentioned is the release through drainage water, which then seep away, also ends in the sewerage system or is released to surrounding streams when it comes to heavy rainfalls. (Lassen et al. 2015)

It can be quite challenging to find out about the amount of infill granulates that is released to the environment. The assessment can either rely on analysis of the use of infill material and the related assumptions about the routes of dispersal or it relies on measurements in the environment. Both of these assessment routes imply certain uncertainties. For the first assessment, it mainly depends on the information available on sales inquiries and the dispersal routes that are assumed. In the latter one, where it relies on measurements in the environment, it has to be considered that impacts such as the field constructions, weather conditions or the field age have an influence on the assessment. (Verschoor et al. 2021)

According to a study by Hann et al., most of the microplastics produced by artificial turf ends up in soil, meaning they do not make it to surface water and entering the water cycle with all the known consequences such as uptake by marine organisms with subsequent rising to the food chain and the inevitably ingestion by men. (Hann et al. 2018)

For a football field using ELT granular infill, during the construction 100-120 thousand kg ELT is put on the field. In the use phase of the field, a certain amount of infill material needs to be replaced every year. (Verschoor et al. 2021) Whereby conventional assumptions suggest that about 3% of infill is lost per year, making up 3000-5000 kg of infill needed to be replaced for a full-size pitch, (Verschoor et al. 2021) recent studies contested these assumptions, suggesting that only 600-1200 kg of infill needs to be replaced by year. Verschoor et al. (2021) shows where the infill material is lost and how much needs to be refilled per year (Figure 16). Furthermore, it is shown that a majority of this refill, needs to be done due to compaction. (Verschoor et al. 2021) There are different reasons for compaction, including natural weathering, the agitation caused by players or gravitation (Verschoor et al. 2021; Fleming et al. 2015). However, there are also some measures to deal best with compaction, including different maintenance measures and treatments concerning the weather conditions (Verschoor et al. 2021).

Although the major amount of infill loss occurs because of compaction, there also occur other infill losses, that needs to be considered, as they could lead to granulates ending up in the environment.

As already mentioned before, one possible route of infill loss takes place by the players, when the granulates are in their shoes and socks. In this context Verschoor et al. (2021) compared three different studies (Norges forskningsråd 2017; Regnell 2019; Weijer et al. 2017). Each of them relies on different methods, characteristics and assumptions and therefore also the results vary between 12-40 kg per field per year, whereby not only the humidity of the pitches, but also the climate condition have an impact on the granulates that are dispersed by the players. (Verschoor et al. 2021)

Furthermore, during different maintenance measures of the pitches, it also comes to dispersal of infill material. One of those measures brushing, which is done in order to level the pitches and it is expected that 0-140 kg filler granulate is collected per pitch every year due to brushing. Therefore, it is essential what is done with the material collected by brushing. Another important point regarding the release of infill granulates to the environment concerns the snow clearance that is needed on the pitches, especially in Nordic countries. If the snow is dumped on soil or ditches nearby the fields, the infill particles can end up in the environment. However, it has to be mentioned that there are already newer machineries for snow clearance that can either leave the infill material on the pitch or it is returned to the pitches. The amount of infill related to snow clearance, as well as how frequently snow clearance measures become relevant, largely depends on different factors, including local climate conditions, maintenance measures and snow storage methods. Another maintenance measure that could lead to infill loss is leaf blowing. Here, the potential release of infill material to the environment also strongly depends on the equipment that is used. As on the one hand, for instance with a simple hand-held leaf blower, it is possible that the granulate is blown together with the field to areas outside the pitches. On the other hand, there is already newer equipment available, that allows to sieve the leaves and the infill material and so nearly all of the granulate can be reused on the pitches. In addition, the granulates may find its way to the natural environment due to the cleaning of maintenance equipment. (Verschoor et al. 2021)

Therefore, the amount of infill material to the environment depends on different factors, including the construction of the field, maintenance measures, as well as the frequency of maintenance, and the awareness of the people involved (e.g. players). (Verschoor et al. 2021)

Possible infill mitigation routes are thus: (CEN 2020)

- Being carried by players
- Snow removal
- Being carried by maintenance equipment
- Inappropriate maintenance procedures
- Inappropriate installation procedures
- Poor storage of spare material
- Surface water run-off from the field

5.2
Practical guideline for football clubs on artificial turf and turf filler

With the objective to prevent the dispersal of microplastic infill material to the natural environment, there are two different options for the football clubs. The first one is to consider the use of alternative infill materials instead of infill from ELT. The second possibility is to take measures to prevent the dispersal of infill material to the natural environment.

5.2.1 Consideration of alternative infill materials

As the concern about microplastic becomes more and more relevant, it definitely makes sense to think about alternative infill materials to the rubber turf filler. However, as already mentioned before, all the currently available alternatives provide its own advantages and disadvantages. Therefore, before an alternative infill material is implemented, several points should be considered:

- **Size:** Typically, the microplastic particles are microscopic
- **Economic dimension:** The price of the material? Is it economically feasible?
- **Technical dimension:** Quality and durability of the alternative material; How often does it need be replaced or refilled?
- **Environmental dimension:** What could be possible environmental impacts of the turf filler? What are the environmental consequences when the infill material ends up in the environment? What are the potential environmental impacts over the whole product life cycle (raw material to end-of-life)?
- **Social dimension:** Health and safety for the players

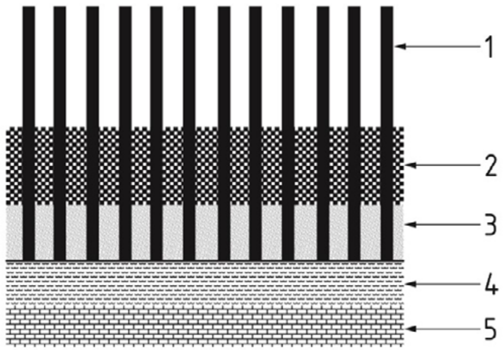
Moreover, at this point it also needs to be emphasized that the wood-chip alternative that is tested and implemented in the Norwegian pilot within the project, seems to be a promising option at the moment. The results of this pilot's implementation, as well as the environmental analysis will be conducted in the next phase of the project and will be released in Intellectual Output 2. After the detailed analysis, it will be possible to make more explicit recommendations in this context.

However, although an alternative to the microplastic turf filler is chosen, nevertheless, it is important to think about containment measures and measures that prevent the dispersal of the respective infill material to the natural environment.

5.2.2 Measures to reduce the spread of infill materials

It is possible to minimize the infill loss when certain measures are implemented. This includes not only design and construction features of the artificial sports pitches, but also appropriate maintenance methods, as well as environmentally friendly end-of-life removal. (CEN 2020)

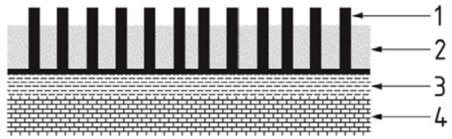
Therefore, first of all the type of synthetic turf surface matters.



Key

1 synthetic turf carpet pile, might be curly
2 performance infill
3 stabilizing infill
4 shockpad (optional)
5 base (or foundation)

Figure 18: Cross section of a long pile synthetic turf sports surface
Source: CEN (2020) Surface for sports areas - Synthetic turf sports facilities - Guidance on how to minimize infill dispersion into the environment.



Key

1 synthetic turf carpet pile, may be curly
2 infill
3 shockpad (optional depending on intended sports use)
4 base (or foundation)

Figure 19: Cross section of a short pile synthetic turf sports surface
Source: CEN (2020) Surface for sports areas - Synthetic turf sports facilities - Guidance on how to minimize infill dispersion into the environment.

A lot of factors influence beforementioned issue such as (CEN 2020, 8 ff):

Types of synthetic turf surface

> **Carpet design:**
First of all, the design of the field surface is an important influential factor. The number of tufts (artificial grass halves) per area determines infill mobility. The more tufts, the less likely the infills are to move, as experience shows. Thus, choosing the carpet with the highest tuft density while still fulfilling the playing requirements seems to be the most sensible choice.

> **Shockpads**
There is anecdotal evidence that shockpads which allow shorter tufts, thus enable less infill migration.

> **Infill**
Rounder infills allow for faster drainage and won't compact as fast, but are more mobile and at risk for dispersion. More angular infill on the other hand is less mobile and provide a more stable playing field.

Field design

> **Field profile**
Fields are often built not in a planar war but with slopes of up to 1 % in order to facilitate drainage. Naturally, a steeper slope facilitates migration of infill to the edges of the field. Therefore, a slope of maximum 0.5 % is recommended.

> **Field perimeter details**
As mentioned before infill might migrate to the boarders of the field. Then factors like playing or maintenance can transfer the infill to the environment. Containment measures should be able to counteract this problem.

> **Containment barriers**
Similarly, physical barriers on the edge have been identified to work best in a general way for containing the infill.

> **Synthetic turf surfacing laid up to the field boundaries & Margins between the synthetic turf playing surface and field boundaries**
If the surfaced infill is collected on the edge of the field measures should be taken so it is not transported out of the field by playing or machinery. Panels of minimum 500 mm height with built-in slits to contain the material should suffice.

> **Field entrance points**
Special mats for scrapping/cleaning off infills of the boots should be installed at all entrance points to the field. They should consist of a smoother decontamination grate and a heavy-duty scraper mat. Those areas should be at least 1.5 m long, so that they cannot be overstepped.

> **Boot cleaning stations**
Those stations should also be placed at prominent spots, especially at entrances to the field and the like. If those stations are placed off-field a drain should accompany them.

5.2.3 Safety for the players

From a chemical point of view, concern was raised that the recycled tires could contain a too high number of toxic substances called PAHs (Polycyclic Aromatic Hydrocarbons). After several studies sponsored by European authorities and the Dutch government it was concluded that the concentrations, albeit low, are still not to be neglected. Therefore, a new limit of 20 mg/kg of 8 PAHs must not be present in infills. The regulation went in force on 10th August 2022. (ECHA n.d.)

5.2.4 Safety/injury risks for players

In order for artificial turf pitches to provide a well-functioning playing surface for football while being safe for the players, there are a large number of parameters that need to be ensured.

Environmental performance is also influenced by the choice of materials, design, operation and maintenance, and waste management, among other things. An illustration of the different variables is presented below.

Figure 20: Selection of variables affecting game characteristics, injury risks, or environmental performance. **Source:** Magnusson, Simon (2020): Systemanalys av konstgräs med och utan infill. Fallstudie Oslo. Luleå tekniska universitet, Institutionen för samhällsbyggnad och naturresurser, Avdelningen för geoteknologi. Luleå

The performance of artificial turf in terms of playing characteristics and injury risks is governed, among other things, by torsional resistance between shoes and artificial turf, friction that may occur between the artificial turf and the players' skin, bounce, rolling resistance, ball trajectory, vertical deformation, and infill splash (FIFA 2015). Excessive rolling resistance or slippery surfaces can cause injuries to players. In northern climates, the issue of water retention becomes important as a frozen pitch is hard and risks injuring players. The colour of the materials also affects how hot the materials can get in summer when it is sunny. Depending on the shape and size of the granules, they will have different tendencies to compact in the mat, with granules of equal size compacting less. Wind, players and drifting machines can disperse granules, and materials with lower specific densities become lighter in the air and can float in water. Fine dust from granules can stick to clothing and skin. Granules that receive a static charge can stick to shoes, clothing and footballs and are more likely to spread and pose an injury risk during nodding as they can get into the eyes (Mitti 2017). The ageing and abrasion properties of materials affect the risk of injury, playing characteristics, environmental performance and longevity. A very important aspect for the longevity of artificial turf is that the grass fibres should not bend and flatten as it is not possible to straighten the fibres again and the performance of the turf will be impaired (Loughborough University 2020). To prevent this, artificial turf pitches are brushed so that the fibres stay upright. Operation and maintenance routines need to be adapted depending on the artificial turf system.

5.2.5 Environmental impact

According to the work Magnusson, a Norwegian study found that, around 4 pitches with no barriers to reduce the emissions, roughly 8 – 20 kg of granules and microplastics were estimated in the surrounding soil. Moreover, if players do not brush off their shoes, 43 kg of granules are transported away from a pitch per annum. Two different studies found that up 15.5 or 38 kg of microplastic can reach surface water per year. (Magnusson 2020)

While those numbers do not seem to be the most important polluters on a global scale, a compelling research work by Borelle et al., suggest to limit global plastic flows entering the oceans to 8,000,000 tons per year, thus every saved kilogram counts. (Borrelle et al. 2020)

5.3 Comparing artificial turf with natural gras fields

Points to consider when choosing an alternative infill material to rubber infill as presented hereafter:

Environmental Dimension

- What is the environmental impact over the whole product life cycle (raw material to end-of-life)?
- Are there any reuse or recycling options of the material?
- What are the possible impacts if the infill ends up in the natural environment?

Technical Dimension

- What is the quality and durability of the material?
- How often is it need to be replaced or refilled?

Social Dimension

- How safe and healthy is the alternative material for the players?
- How does it influence the playing characteristics?

Economic dimension

- Is it economically feasible?
- What is the price of the material?

Moreover, the following table summarizes noticeable differences between the two options:

Natural grass vs. artificial turf

		Natural grass	Artificial turf
Water	**Water usage**	Significant amounts of irrigation are needed for growth.	No irrigation for growth needed, some watering is needed for maintenance of special types of artificial turf.
	Stormwater capture	Natural infiltration of water through the soil profile reducing runoff.	Hinders natural infiltration of water increasing runoff (Drainage systems can be used for that reason).
	Runoff water quality	It not managed carefully, there is the risk of nutrient/chemical leaching from pesticides and fertilizers into waterways.	Possible leaching of heavy metals and other residues form plastics or rubber infill (depending on the used materials).
Carbon	**Carbon footprint**	In general, the carbon emissions come from the installation and maintenance phase. Over the entire life cycle the carbon footprint tend to be lower.	Carbon emissions occur during the processing, production, transportation, installation, maintenance and disposal phase. The material impacts over the whole life cycle increase the carbon footprint.
	Carbon sink	Helps to remove carbon dioxide from the atmosphere through photosynthesis and stores it as organic carbon in soil. This makes it an important carbon sink.	No ability to remove carbon dioxide from the atmosphere.
Material	**Manufacturing**	Grass is a natural product grown from seed. Water and chemical inputs (fertilizer and pesticides) are required for growth and quality.	Petrochemical product where mostly virgin materials are used. Some of the materials can be made from recycled material (e.g., rubber granules infill and shock pad).
	Transport	Natural ready turf has a short shelf life and can only be transported over shorter distances, or it is planted from seeds which have minimal transportation costs.	Generally, artificial turf is transported over long distances (even if it is supplied by a local company the manufacturing of the product often takes place abroad) which results in high transportation costs.
	End-of-Life	There is no definitive end of life of natural grass, but it can be replaced to improve the current surface. Normally, no disposal is required.	Usually ends up in landfill where it takes a long time to decompose. Therefore, the disposal costs are high.
	Soil	The soil is improved because natural grass stimulates the biological life and creates a more favorable soil structure.	Soil structure, soil microbes and soil life is damaged through heavy compaction before installing artificial turf.
	Dust stabilization	Well maintained grass captures dirt and dust from the atmosphere. But in case of drought periods and when water supplies are scare, the condition of natural grass can deteriorate and dust can start to become a problem.	Covered surfaces are effective dust stabilizers. Additionally, artificial turf also stabilizes the dust during dry periods.
	Heat dissipation	Natural grass provides natural heat dissipation. Heat is absorbed by the grass and it cools the surrounding environment.	There is a heat reflection. Absorbs and radiates heat and therefore, heats the surrounding environment. This can be uncomfortable and unsafe in hot weather conditions. The color of the artificial turf may influence the level of reflection.
	Noise	Grassed areas have an irregular, soft surface that effectively reduced noise level.	Artificial turf fibers absorb some noise but not as much as natural grass.
	Glare	Natural grass helps to soften and reduce reflected light, reducing glare.	Sunlight and floodlight can cause severe glare depending on the type of surface.
	Biodiversity and Habitat	Natural grass provides a natural environment for soil organic biodiversity.	There is no organic biodiversity due to compacted base and synthetic surface.

Source: (Kent Burton 2021)

5.3.1 The need for artificial turf fields: (Bertling et al. 2021)

> **Hard courts are no longer considered up-to-date** by clubs and players and have therefore been **converted into natural or artificial turf pitches** for some time.

> **Artificial turf surfaces enable a year-round sporting activity** offer for team sports, especially in highly dense cities and/or cities with high land prices.

Recommendations:

- In addition to the benefits of artificial turf pitches, operators and users must also be made **aware of their responsibility for the ecological and social effects** that go hand in hand with them.
- **Sealed areas in urban areas are suitable for conversion to artificial turf pitches.** The realization on such areas should be preferred in order to meet the demand.
- **Evaluate the local demand** in detail and also **consider the potential shift to new trend sports.**

5.3.2 The player's opinion (Bertling et al. 2021)

> Artificial turf plays a **central role in many people's lives** and allows sports to be played **outdoors all year round.**

> **Rubber granules are still the preferred infill type,** but users definitely see **cork and unfilled pitches as an alternative.** In general, the majority of respondents expect artificial turf pitches to become more environmentally friendly.

Recommendations:

- For a lot of people, especially young ones, football and consequently also football pitches are a very important aspect of their lives. For this reason, and because **the players would like to see more environmentally friendly fields,** this offers a **good opportunity for modern participation processes at the municipal level.**
- The interest in sports can serve as a **way to test participatory democracy and the assumption of social responsibility for ecological solutions** and to establish them as a municipal practice.

5.3.3 Structure of artificial turf

Recommendations:

- There are a large number of options and different suppliers of artificial turf pitches. Therefore, **preliminary planning and decision-making** should be largely **independent of the manufacturer.**
- The **manufacturer should be able to provide information on maintenance effort and costs** (including infill refilling). It is important to demand guarantees far above the legal warranty for the durability and service life of granulates and artificial turf carpet, as the pitches are subject to considerable weathering.
- It should be examined whether there is **sufficient demand to achieve a high intensity of use** well above that of natural turf.

5.3.4 How are artificial turf pitches structurally integrated?

> The **selection of the location, the surroundings and the layout of the artificial turf pitch** depend on **local conditions, legal regulations,** and the preferences of the **operator.**

> An artificial turf is **permeable to water and drains precipitation water.** A distinction is made between infiltration (vertical drainage), collection and drainage (horizontal drainage) and (supporting) drainage.

> **Most of the water seeps away on or next to the artificial turf field.** The rest is collected and discharged.

Recommendations:

- When selecting a site, **local water management and ecological conditions,** including extreme weather events and flooding should be considered. In order to avoid infill loss due to heavy rain events, it is important to **create generous infiltration areas in surrounding area.**
- If rainwater is or can be discharged into the storm sewer or directly into the receiving water, the **installation of filter elements to retain infill is recommended.** In the case of combined sewers, retentions options would need to be considered.

5.3.5 Where are artificial turf pitches located?

> Based on a study relying on Germany and Switzerland, the **location of artificial turf pitches varies very much.**

> Within a radius of 1 kilometre, there may be over 50 000 people living or almost none.

Recommendations:

- **Artificial turf pitches should be fully documented in an official database** according to **location, surroundings and construction method.** In addition, also the **population density, as well as environmental and nature protection aspects** in a defined radius should be included.
- Artificial turf pitches should **be implemented in dense, urban areas,** but **not in water protection or flood areas.** Any subsidies should be based on actual demand and should not be granted for construction in natural areas that need protection.

5.3.6 What about the economic dimension of artificial turf pitches?

> There are very **large cost differences,** as different turf systems require different infrastructure and maintenance approaches.

> Annual cost consideration level out **many differences between natural and artificial turf pitches.**

> Regarding **hours of use,** there are **clear cost advantages for artificial turf pitches.** If this would also be the case when more and more environmental regulations become relevant, is still uncertain.

Recommendations:

- The **economic feasibility of artificial turf** should be based **on a detailed survey of demand in hours of use per year.** This should be determined **over a longer period of time** before the decision to build is made. It is also important to consider **external costs due to expected environmental damage.**
- In the economic analysis it is necessary to also take into account the **costs for clean-ups, structural measures such as barriers, walls, additional efforts in wastewater treatment to reduce emissions, as well as the end-of-life phase** (recycling, thermal recover, etc.). Furthermore, also **costs for potential future requirements** in this context need to be included in the analysis.

5.3.7 How much infill is on the pitches and what does it perform?

> A few results on the **change in particle size distribution over time,** suggest that the **performance infill is pulverized over time and also crushed as it becomes more brittle.**

> The **infill is distributed very unevenly on the pitches.** This **effect increases with the age of the pitches.** The relevance of performance infill for the playing characteristics is possibly overestimated.

Recommendations:

- **Innovation efforts for infill-free artificial turf systems and alternative infill materials** should be encouraged. The systems should be tested in **demonstration projects.** When developing new infills, the **technical performance and the risk of injury to players** regarding the different systems should be kept in mind.
- There is a **dissent in scientific publications regarding the thesis that infill accumulates over a wide area on the pitches as a result of compaction.** Therefore, it **should be verified** experimentally and in practice in the case of further use of performance infill in future artificial turf systems.

5.3.8 How much infill is lost?

> **The infill losses vary considerably.** In a study in Germany and Switzerland, the average performance infill. Loss is 2.98 t per year with 2.68 t per year need to be refilled.

> There is **not found a correlation with the age of the pitches,** but a **low density of infill seems to favour discharge.**

Recommendations:

- As refilling and loss rates do not correlate and the **experimentally determined loss rates are significantly higher than many recently published values, experimental evidence** on loss rates depending on design, care and maintenance as well as type and intensity of use **should be carried out and made transparent.**
- The **specifications for the loss rates should be laid down in the corresponding calls for proposals and the relevant standards.**

Depending on how demanding these loss rates are defined, this also favors unfilled or purely sand-filled sites in the call for proposals.

5.3.9 What is known about fiber loss?

> From an environmental perspective it is not only necessary to look at performance infill, but also at **fibre losses.**

> The few available experimental studies suggest **high losses of artificial turf fibres.**

> Discharge may vary **depending on fiber input weight and infill type.** At the same time, it probably **increases with the age of the pitch.** Current estimates range from about 50 kilograms to over 1 ton per year.

> The **extent to which these losses are discharged, captured as waste during maintenance work or remain in the artificial turf has not been investigated.** However, it is obvious that the **dispersion via players plays** a particularly large role.

Recommendations:

- **Information on the durability of the artificial turf** should be provided in the form of **quantitative fiber losses over the lifetime and per year in product data sheets.** At the same time, these requirements should be included in specifications and corresponding guarantees agreed.
- **ECHA or national environmental authorities** should **consider whether abrasion of plastics in applications,** as represented by fiber loss in artificial turf fields, **can also be taken into account in future restriction procedures.**

5.3.10 What are the release pathways of the infill material and where does it stay?

> **Rubber granules are discharged from artificial turf fields** and are found **almost everywhere in the environment of the pitch.**

> **Strong winds and heavy rains** cause the emission **to spread beyond the area surrounding the pitch,** as those rubber granulates are found at inaccessible points sometimes very far from the pitches.

> Infill material often ends up on **natural or artificial barriers,** e.g., green areas or structures, which prevent further mobility of the infill. Large amounts of granules can accumulate in the surrounding area without being visually apparent.

> The **place where the infill ends up** depends on the **layout of the pitch, the surrounding environment, and the geographical conditions.**

Recommendations:

- The pitch environment needs to be designed by means of **barriers in such a way that the spread of infill is prevented, and unavoidable losses are returned to the pitch or disposed.**

  The corresponding **specifications should be included in norms, standards, and quality labels,** whereby it should **not be related to the design,** but the performance in order to give manufacturers the freedom to develop innovative and effective solutions.
- In order to **prevent the dispersal of granules and fibers by players, appropriate technical and organizational measures** need to be considered and the **players' awareness and responsibilities** in that sense needs to be addressed.

5.3.11 What about other environmental effects of artificial turf?

> **Artificial turf pitches largely comply with the limit values for various pollutants.** A few studies show limit values exceeded for individual **heavy metals.** Nevertheless, there are differences between **different material options and discussions and studies on pollutants continue.**

> In addition to the performance infills, the critical consideration should also concern the elastic layers and the artificial turf fibres.

> Additionally, the **potential overheating of artificial turf fields** and their relevance to the urban microclimate, as well as the **water requirements** to counteract these effects, should be considered as part of the advance planning process.

Recommendations:

- Since **artificial turf pitches have a long lifetime** and **are ideally recycled at the end of their life, high standards should be set for the materials to be free of pollutants,** which go beyond current legal requirements. This requires corresponding specifications in the calls for proposals. These should not only apply to **infills,** but also to the **fibers** and the **damping system.**
- It should be checked whether **sufficient quantities of water are available for cooling the pitches** in summer. This should be **included in the ecological and economic assessment.**

5.3.12 What is the standard regarding recycling?

> The artificial turf industry is **striving for the fullest possible mechanical recycling of the artificial turf** and also of the elastic base layer. A **closed-loop approach** for the entire artificial turf or even individual components with the exception of infill sand **is not yet apparent.**

> **Mechanical recycling will result in higher end-of-life costs and recycling of ELT granules form artificial turf fields** could **compete with direct recycling of scrap tire granules.**

Recommendations:

- Include **sufficient provisions for the restoration, recycling or disposal** of the artificial turf at end-of life.
- The **recycling rate and recyclability** of all components should be **part of product description and specifications.**
- **A framework is needed to favor the best recycling routes for ELT granules, both ecologically and environmentally.** In this context it needs to be considered to avoid a disposal bottleneck for scrap tires, and at the same time not to cause a problem shift via cascade uses of pitch components (e.g., infill on riding arenas).

5.3.13 The carbon footprint of artificial turf pitches

> Depending on the type of artificial turf, the **carbon footprint varies between 9.4 to 29.5 kg CO^2-eq per hour played on a 7500 m^2 field.**

> It **strongly depends on the chosen infill.** As a biogenic material, cork has a lower CO^2 footprint compared to fossil-based filling materials. The greenhouse gas emissions associated with disposal are especially relevant for infill types such as SBR, EPDM or TPE.

> **High-quality recycling of components and longer lifetime of filling material and the damping system** can significantly **reduce the carbon footprint.**

Recommendations:

- Permissible **carbon footprints** over the life cycle or at least the manufacturing phase **should be specified in calls for proposals and specifications.** Their calculation should be carried out as part of environmental declarations for artificial turf systems. The permissible values should be reduced to below **10 kilograms of CO^2-eq./m^2.**

5.3.14 Do norms and standards consider environmental aspects?

> The **norms, standards and quality labels hardly go beyond the legal minimum requirements in their environmental requirements.** Microplastic emissions in the form of fibres and granules are addressed only marginally and without targets.

> As environmental **regulations often become more stringent over time** and as more knowledge is gained, the **standards relevant to artificial turf pitches have not yet created sufficient planning certainty** for either manufacturers or operators.

Recommendations:

- **Quality marks for artificial turf pitches must contain demanding environmental targets that go beyond the legal regulations.** This is the only way for manufacturers and operators who rely on these quality marks to ensure that artificial turf pitches meet expectations in terms of environmental compatibility in the long term.
- In order to avoid lock-ins and not to endanger competition between companies, it must be ensured that **norms, standards and quality marks do not define forms of construction, but** rather demanding and measurable **environmental objectives.**

Good success in installing & maintaining your perfect artificial turf pitch!

6

SURVEY ON SUSTAINABILITY PRACTICES OF GRASSROOTS FOOTBALL CLUBS

SDG Striker
Scoring Goals for Sustainability

The relevance of sustainability, climate change and renewable energy is undeniable. The priorities of people's lives have changed and with the SDGs the superior goals are defined. Ending poverty, advance gender equality, improve healthcare and counter climate change by the end of 2030 (United Nations n.d.) are only a few of them. Sport has the ability to unite topics regarding health, education, inclusion, poverty and so on. Especially the SDGs 3 (good health and well-being), 4 (quality education), 10 (reducing inequalities) and 17 (partnership for the goals) can be referred to sports.

In order to reflect people's opinions in the three viewed countries (Norway, Portugal, Scotland) a survey was prepared to cover the main aspects.

6.1
Structure of the survey

Main topics in this survey were the general perspectives on sustainability in football, the perception of sustainability in the special clubs and of course some demographic aspects for a better understanding and incorporation. The following graph illustrates the main structure of the survey.

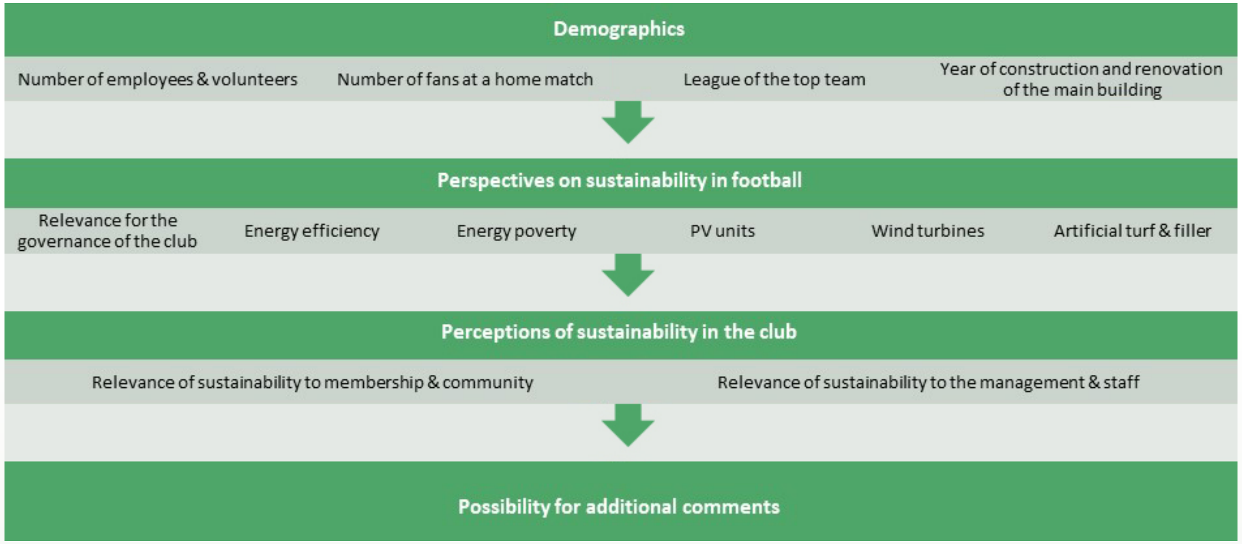


Figure 21: Structure of the SDGStriker survey amoung the football clubs

6.2
Results of the survey

Different countries require different actions. Because of the various response rate of the survey from the three countries, a general consideration is not useful and also not significant. For this reason, in the following, the countries are considered individually per category in order to achieve an approaching comparability. To understand how different the response rates were, it has to be said that there were 79 responses in Norway, 20 responses in Portugal and 17 responses in Scotland. In order to present the results, it was therefore decided to focus on the countries separately in the different categories. There are three main categories (perspectives on sustainability in football, perception of sustainability in the club and demographics) including different factors which are now going to be described.

6.2.1 Perspectives on sustainability in football

Relevance for the governanceof the club

The following factor describes the relevance of sustainability, energy efficiency and renewable energy for the governance of the club. The results reflect the views of the respondents in terms of their perspectives. Summing up the questions sustainability in this context can be described as efforts to reduce the environmental impact of the club, such as reducing waste, reducing energy consumption or lowering the emission from transportation. The questions which were asked focused on the relevance of sustainable governance, energy efficiency, renewable energy, and sustainable alternatives to artificial turf as topics in the governance.

Norway:

With the exception of the topic "renewable energy" all the other aspects were mostly rated as very relevant. In both topics a sustainable governance and the relevance of energy efficiency/ savings the most selected answer was very relevant with a percentage of 47,4 and 48,1. This can especially be seen in Figure 22 which presents the answers to the question of "how relevant is sustainable governance to your club?" Also, the last aspect, the alternatives to artificial turf and its relevance, was mostly answered with very relevant (49,4%). Only the relevance of renewable energy as a topic in the governance was mostly answered with somewhat relevant (49,3%) followed by very relevant with 21,5%.

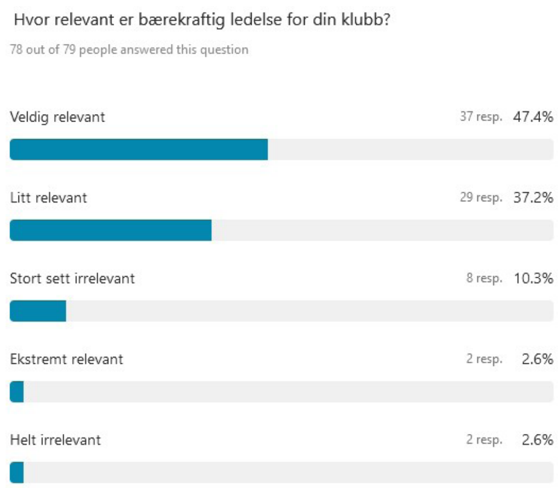


Figure 22

Portugal:

Out of the 20 responses to the survey in Portugal, 80% defined the relevance of sustainability for the governance as either very relevant or somewhat relevant (both 40%). 20% chose extremely relevant. What is interesting to consider is that nobody selected the categories mostly and completely irrelevant. This is illustrated in Figure 23. Similarities are seen in the relevance of energy efficiency and renewable energy as a topic in the governance. Both were answered (60% and 55%) as very relevant followed by somewhat relevant (30%, 35%). In both topics only 5% (in fact one person) chose extremely relevant. Regarding the relevance of sustainable artificial turf 35% assigned it a very high relevance. 25% chose somewhat relevant and 10% extremely. The remainder is distributed among mostly and completely irrelevant and 20% one of those. Summarized the category "relevance for the governance of the club" in Portugal, one can say that the governance is definitely attributed an importance of the topic sustainability. Especially energy efficiency/savings and renewable energy are rated very high.

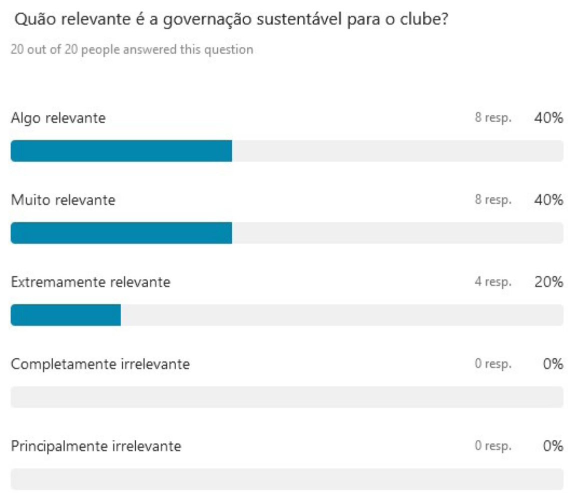


Figure 23

Scotland:

Concerning the cumulated percentages it shows that the most mentioned topic for the Scottish is the relevance of energy efficiency or energy savings (82,3% either chose very relevant, extremely relevant or somewhat relevant). The relevance of renewable energy as a topic to the governance was ranked with somewhat relevant (52,9%), extremely relevant (17,6%) and mostly irrelevant (17,6%). This is followed by the relevance of sustainable governance (82,4% cumulated) but weighted differently because only 11,8% chose extremely relevant (pictured in Figure 24). Interesting to have a look at is the relevance of the sustainable aspect of artificial turf because 29,4% chose extremely relevant followed by 23,5% stating completely irrelevant. The opinions are therefore very far apart. 47% chose either somewhat or very relevant and no one mostly irrelevant or not applicable.

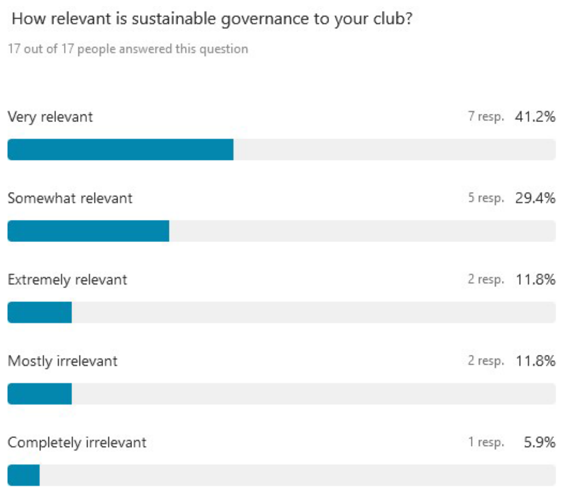


Figure 24

Energy efficiency

The next portraited factor focuses on energy efficiency. Energy efficiency means one important aspect in energy and climate policies. It is one of the main goals to thematize an improvement in energy efficiency to reduce energy use. Furthermore, it is linked to energy security, sustainability and affordability (Goh und Ang 2020). This factor combines the questions about completed energy efficiency renovations to the club building, the implementations of energy efficiency measures in the building and what would be necessary for the club to take energy efficiency measures.

Norway:

Out of all the respondents more than half (50,6%) answered the question about completed energy efficiency renovations to the football club building in the past 5 years with no. Only 31,6% answered this question with yes and 17,7% were unsure or could not find an answer. Those 31,6% who answered the question with yes were followed up with the question about what measures there have been implemented. Out of those 25 people 56% chose switching the lighting to more efficient (e.g. LED) ones, followed by 52% choosing replacing or upgrading the space heater or air conditioner. With a little distance the next measure was upgrading to more energy-efficient large appliances like a fridge, dishwasher or laundry machine (32%). Improving insulation of the building (incl. windows and doors) with 24% and replacing or upgrading the water heater (20%) followed next. Nobody answered this question with installing or upgrading sunshades, 16% chose other [measures] and 4% were unsure or did not know an answer. Those people who answered the first question about the completed renovation with no, were asked why not. The most chosen answer to this question was that it is too expensive (35,9%). 30,8% responded that they are not sure what to do in this context and 28,2% indicated that the financial savings are small. 17,9% chose other reasons and 10,3% that they represent the opinion of being already very energy efficient. 5,1% stated to have no interest in the topic of energy efficiency.

Being asked what would be necessary for the club to take additional energy efficiency measures the clear answer (65,4%) was financial support (Figure 25). This was definitely the strongest answer, followed by only 12,8% choosing energy expert consulting, 9% the interest from fans and the community and 6,4% choosing planning. Also 6,4% were unsure about an answer.

Summarized the situation in Norway shows that more than half of the respondents had no completed energy efficiency renovations in their club building because of financial reasons and a lack of knowledge in that field. Financial support as well as expert support would be a necessity to take further measures in that context.

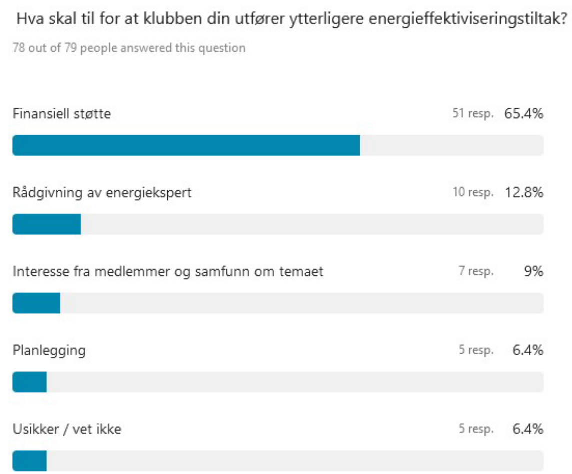


Figure 25

Portugal:

In Portugal nearly half of the respondents (45%) chose the answer yes to the question of completed energy efficiency renovations. 35% were unsure about an answer and 20% answered no. Out of those 45% that answered this question with yes, 77,8% pointed out to upgrade to more energy efficient large applicants such as fridges, dishwashers, laundry machines. 66,7% described switching the lighting to more efficient ones, 44,4% revealed a replacement or upgrade of the water heater and 22,2% an improvement of an insulation of the building. 33,3% chose other measures and no one chose the installation or upgrading of sunshades, the replacement or upgrading of the space heater/ air condition or was unsure.

Further the people answering the first question with no, were asked why there haven't been any renovations to the club. The answers to this question were pretty clear, because all respondents (100%) answered that the financial savings are too small and further another 50% stated that renovations are too expensive. The predominant reason on the view of the respondents is therefore the financial aspect, because no other answers were selected. This is also reflected in the following question relating other measures for implementing additional renovations (Figure 26). 84,2% answered with financial support, 10,5% with the consulting of an expert and 5,3% with more planning. So, there is a clear guarding thread towards financial aspects linked to more energy efficiency.

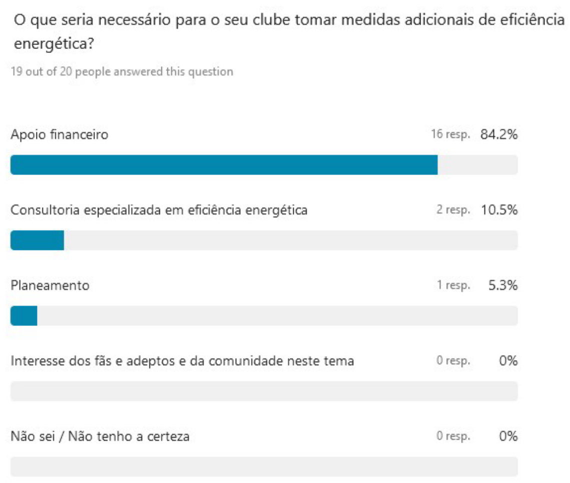


Figure 26

Scotland:

The situation in Scotland is similar to Norway. The most people here (47,1%) also answered the question of completed energy efficiency renovations with no, 29,4% were unsure and 23,5% answered yes. Concerning the measures which were taken by the clubs of where people answered yes, the most chosen aspect was switching the lighting to more efficient ones (75%). This was followed by the answers of improving insulation of the buildings (50%) and replacing or upgrading the space heater/air conditioner (25%) as well es upgrading to more energy efficient large appliances (25%).

The cumulated answer to the follow-up question why there are no energy efficiency renovations show that 75% chose a financial aspect (50% too expensive and 25% small financial savings). Furthermore, 25% represent the opinion of being not sure what to do and 25% chose other reasons.

Answering the question of what would be necessary to take additional measures (Figure 27), most people (58,8%) answered with financial support. 23,5% settled for being unsure and 11,8% for a consult of a energy expert. 5,9% want more planning for an implementation.

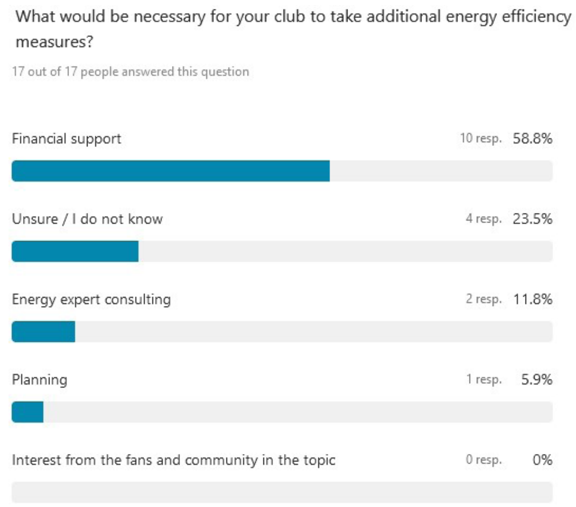


Figure 27

Energy poverty

The next shown factor focuses on energy poverty. Before specifying this topic, the respondents were asked if they are familiar with the concept of energy poverty. Only then the ensuing questions were asked. Energy poverty can be defined as a circumstance were a person, individual, family, household is not able to adequately heat or provide energy services at home at affordable cost. This problem often occurs through high energy prices, low income and low energy efficiency (Pye et al. 2015). After the first question about a general knowledge of the concept, the factor focusses on views of the respondents how many people that frequent the club or are part of it might fit in this definition, what actions could benefit those people, what actions the club could take and how likely it is that the financial savings out of energy efficiency could be used for energy poverty measures.

Norway:

Starting with the fluency of the concept of energy poverty 65,4% out of the Norwegian respondents answered with no. 17,9% were unsure and only 16,7% stated being familiar with the concept. When asked how many people out of their club would fit in this definition nearly half of them (48,1%) responded the view that only very few people would fit in. 30,4% chose the answer some people, 12,7% were unsure and 5,1% decided for many people. Only 3,8% felt that nobody would fit in the concept of energy poverty. So, the tendency in Norway shows that most people intend only few people in their club are affected by energy poverty.

When asked about possible actions that might benefit people living in energy poverty, most people chose the monetary support (25,3%) and more information and awareness about the topic (25,3%). 15,2% hold the opinion that community support will be helpful, 13,9% believe in energy efficiency improvements and 8,9% in energy audits. Focusing on the role of the club 40,5% decided for information and awareness. 30,4% do not see how the club can help and 25,3% would focus on community support. Compared to the question above only 11,4% chose monetary support of the club. So, one can see that the answers do not overlap completely. Only 10,1% believe that energy audits might help those people and merely 5,1% answered with energy efficiency improvements.

In the next question the respondents were asked to express their agreement or disagreement that the financial savings gained through energy efficiency would be used for energy poverty measures. Most people seemed really unsure about this question, because 35,4% chose neither likely nor unlikely and 17,7% were unsure or did not know. 16,5% answered with likely, 13,9% with unlikely. Another 13,9% chose very unlikely and 2,5% very likely.

Portugal:

The first question shows that about 60% of the asked Portuguese are familiar with the concept of energy poverty. 20% stated to have no idea as well as 20% who were unsure. Considering the statements to the question how many people fit in this concept 40% chose some people, 25% nobody, 20% many people, 10% very few and 5% were unsure. So here it can also be seen that the answers are very far apart. Comparing the question about what action do you think could best benefit the people in energy poverty to the question what actions the club could take, the answers are very similar. 42,1% chose financial support as best benefit, followed by information and awareness (26,3%) and energy efficiency improvements (15,8%). The answers concerning actions of the club are very much alike except the most common one. Here 35% chose community support for best help, as well as 35% information and awareness, followed by 25% energy efficiency improvements. Another 25% were unsure, 20% chose financial support and 15% represent the opinion that the club is not able to help. Representing the agreement or disagreement to how likely it is that some of the financial savings through energy efficiency will be used for energy poverty measures, most people (45%) said that it is likely, 15% decided for unlikely, another 15% chose neither likely nor unlikely, 15% were unsure and 10% thought it would be very likely.

Scotland:

The Scottish referred to the familiarity of the concept of energy poverty with more than a half (52,9%) with agreement. 23,5% stated to not be familiar and 23,5% were unsure. When asked how many people could fit in this concept 35,3% thought of many people and 29,4 of some people. 17,6% were unsure and 17,6% chose very few people. The most extreme answers, nearly everybody and nobody, were not chosen by anyone.

As well as in Norway and Portugal the respondents in Scotland (35,3%) chose monetary support as best benefit for people living in energy poverty. 29,4% referred to energy efficiency improvements and 17,6% to more information and awareness. 11,8% trust in community support and 5,9% were unsure. Viewing the actions of the club the most chosen option (41,2%) was the community support, followed by information and awareness (29,4%) and the non-ability of the club to help (29,4%). 11,8% did not know an answer and the other options (energy audits, energy efficiency, monetary support) were not chosen. Showing how likely it is that that the financial savings through energy efficiency will be used to energy poverty measures 41,2% chose neither likely nor unlikely, followed by very likely (17,6%) and likely (11,8%). So, the tendency in Scotland goes to a rather high likelihood. Only 11,8% answered with unlikely, 11,8% with unsure and 5,9% with very unlikely.

PV (solar power) units

This category also refers to the views and actions of the respondents relating on the sustainable governance of the football club. So, this following category, based on the different countries, combines the asked questions of photovoltaic units (solar power).

Norway:

In the first question, the respondents were asked if the club's building has PV units installed and followed by the question what type. 98,7% answered with no and only 1,3% (in fact one person) said yes. According to the fact that only one person answered the question with yes, the followed seven questions were also only answered by one because they were based on each other. So, this one respondent described the function of the PV unit with electricity production and the main reason for installing was a transition from the diesel generator to solar power for the clubhouse and the lighting. Furthermore, the PV unit was financed internally with the club's money as well as externally through sponsors and third parties. The installation made this respondent very satisfied and the question concerning a recommendation installing PV units was answered with yes.

The last question was again answered by the entire sample and discussed the topic of what would be necessary for the club to install any or additional PV units. More than two third (70%) held the view that financial support would be extremely necessary for an installation. Both, energy expert consulting and unsureness were answered by 11,4% and 3,8% chose the answer planning. 2,5% deemed the interest from the fans and community in the topic as a necessity.

Portugal:

90% of the Portuguese respondents provided the information that they do not have PV units installed on one of their club's buildings. 10% answered this question with yes. According to the fact that there were only 20 replies to the survey this means that 10% are in fact two people. So, the following seven question were again only answered by two people. Both answered the question of the type of the PV units with solar thermal water heating. The reason for installing the units was for one person to create revenue and/or reduce costs and for the other one to be more sustainable. With regard to funding, one person was undecided and the other mentioned internal funding with the club's money. On a scale from 1 to 5 how satisfied they were with the PV units 50% answered very unsatisfied and 50% neither unsatisfied nor satisfied, but 100% (both answers) would recommend installing PV units to other clubs.

The last question was again answered what would be necessary for the club to install any or additional PV units and 80% chose the answer financial support. Respectively 5% chose the answer energy expert consulting, planning, interest from the fans and community in the topic and unsureness.

Scotland:

The first question concerning the category PV units and if there are any installed units on one of the club's buildings was answered 100% with no. So, none of the clubs of the respondents have any PV units and this results in the fact that none of the following seven constructive questions were answered. But 58,8% were of the opinion that financial support would be necessary for an installation of any PV units. 17,8% see energy expert consulting as a necessity and 17,6% were also unsure about an answer. 5,9% chose planning as their main aspect and no one the interest from fans and community.

Wind turbines

The following category shows the respondents views on wind turbines and wind power at their club. This category also shows the views and actions relating to a sustainable governance of the clubs. It focuses on the topic wind turbines and combines questions about the presence of wind turbines, what kind, what reason led to an installation and ways to expand this.

Norway:

Since the first question is essential for the further progress of the survey, it is important to point out that 98,7% (78 out of 79 people) have denied the question of the existence of any wind turbines installed at their club. Only one person answered yes, so the following answers only represent actions of this one person and are therefore not significant. But the importance of the last question is undeniable and the most chosen answer (48,1%) to the question what would be necessary for the club to install any wind turbines, was that they were unsure or did not know. 27,8% answered this with financial support, 12,7% with interest from fans and community and 11,4% saw the need of energy expert consulting.

Portugal:

A similar picture is emerging in Portugal. 100% of the respondents answered no to the first question of installed wind turbines. But the answers to the question what would be necessary for the club to install any were more cumulative and clearer. 85% see the need of financial support, 10% were unsure, 5% the need of energy expert consulting and no one chose interest from fans and community or planning.

Scotland:

The first question about the presence of wind turbines is decisive for the further course of the survey. 100% of the Scottish people answered no to this question, so therefore the following seven questions were omitted for them. The last question deals with the matter of what would have to occur to install any wind turbines. The two most frequently mentioned answers (both 37,5%) were financial support and planning. The next two responses were chosen as the second most common (both 12,5%) and illustrate energy expert consulting and unsureness.

Artificial turf

This next factor focuses on the topic of artificial turf, the usage of it in the football clubs and the different infill material.

Norway:

In Norway again 79 out of 79 people started in this topic. The first questions focused on the number of football pitches the club is directly responsible for maintaining and how many of them are in usage of artificial turf (Figure 28). The results show that 64,6% answered that the club is responsible for 2-4 pitches, 19% for one pitch, 15,2% for 5-10 pitches and 1,3% for more than 10 pitches.

54,4% out of these people answered that nearly all of them use artificial turf. 12,7% more than half of them, 10,1% about a half and 7,6% answered with almost none of them. Then 93,7% stated that there is an infill material used for the artificial turf. Those further were asked what infill material is used and 70,3% answered SBR (Styrene-butadiene rubber)/ rubber from tires, 23% did not know, 20,3% answered sand, 8,1% TPE (Thermoplastic Elastomers), 5,4% organic material, 2,7% others and 1,4% EPDM (Ethylene Propylene Diene Monomer). So, the answers were pretty mixed.

The next question focused on possible experiments with different infill material for the artificial pitches and 73% stated that they have not experimented with any. 17,6% answered with yes and 95% were unsure. Those 17,6% answering yes (13 people) were asked further questions and the results are now presented. The question focused on what other infill material the club tested and which of them are considered safest for the players. Both 30,8% equally answered that thy tested sand and SBR. Respectively 7,7% tested organic materials, TPE or others. Nobody chose EPDM. Concerning the factor safety for the players nearly half of the people (46,2%) were unsure about an answer or did not know one. 23,1% chose SBR, 15,4% organic materials and 15,4% as well TPE. Furthermore, SBR is considered to be the easiest to maintain a high-quality pitch (46,2%). Another 46,2% were unsure about an answer an 7,7% chose TPE. Also concerning expenses SBR is the most mentioned one (61,5%), followed by sand 23,1%. The reason for choosing the last artificial turf that has been bought were very partitioned. 61,5% mentioned playing characteristics and 30,8% recommendations from the football association. Respectively 23,1% chose recommendations from the seller, environmental issues and the price. Another 15,4% thought of the idea of choosing the same as the top stadium and 7,7% recommendations from other or other club members.

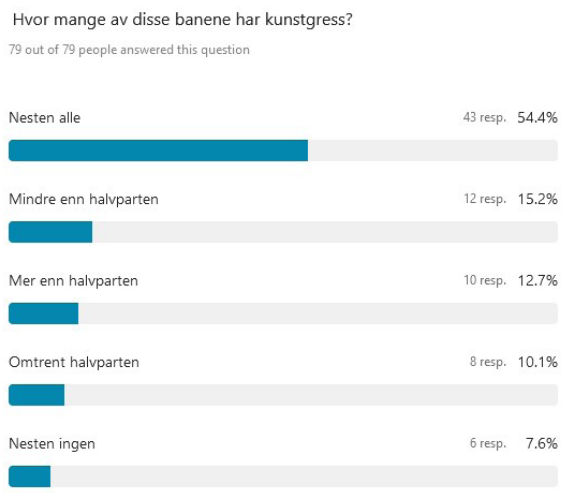


Figure 28

Portugal:

Out of the 19 responses 12 (63,2%) stated that their club is responsible for 2-4 pitches. Shown in Figure 29 one can see those seven respondents (36,8%) answered that about half of those pitches use artificial turf as well as 36,8% chose the answer almost all. 15,8% answered almost none and 5,3% more than half, just as 5,3% less than half (both one respondent). 10 out of 20 people answering the question if there is an infill material used for the turf answered yes (50%). The other 50% are split between the answers no and unsure. Those 10 people answered the following questions and are now described. 40% answered the question what infill material is used with SBR, 20% with sand, 10% with EPDM and 10% with others. 40% additionally were unsure. The last question in this topic was about possible experiments with different infill material and 60% answered no and 40% were unsure. So, the following questions dropped out.

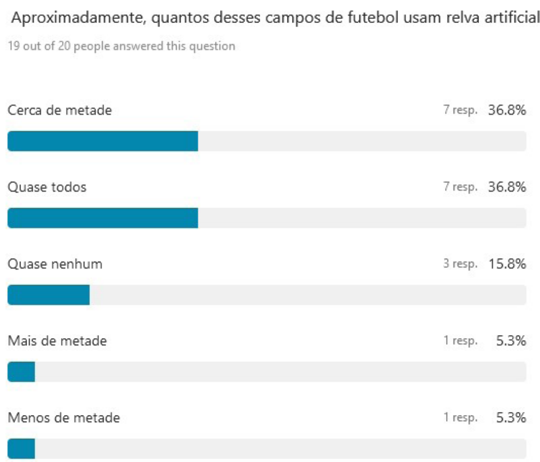


Figure 29

Scotland:

In Scotland, the most chosen answer on how many football pitches the club is responsible for was one pitch (47,1%). 35,3% stated 2-4 pitches and 17,6% 5-10 pitches. 70,6% stated that almost none of those use artificial turf, 17,6% nearly all of them, 5,9% less than half of them and 5,9% more than half of them (Figure 30). Only 3 respondents answered the question of the usage of infill material with yes. Out of those the materials SBR and TPE, with both 33,3%, were the most chosen/ used ones. Another 33,3% were unsure (in fact all three answers were chosen by one person). Concerning experiments with different infill material 66,7% (2 persons) represented that they have not made any and 33,3% (one person) were unsure.

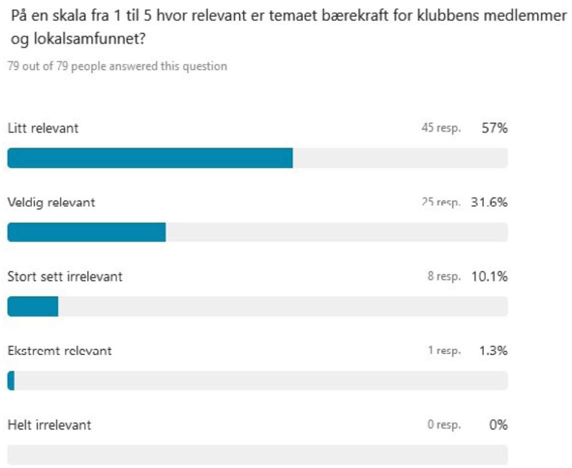


Figure 30

6.2.2 Perceptions of sustainability in the club

The next major section deals with the perception of sustainability as a topic in the membership, team, and community. The previous described factors were focused on the views the respondents had about the governance of their club and general opinions. This section is going to picture the perceptions regarding the membership, team, and community. There were only two questions in form of a Likert-scale asked and the results are presented, country-specific, below.

Relevance of sustainability to membership and community

Norway:

The first question should present the general relevance of the topic sustainability to the membership and community of the club. More than half (57,0%) answered with somewhat relevant, followed by very relevant (31,6%) and mostly irrelevant (10,1%) Cumulative one can see that 88,6% see a high relevance in the topic of sustainability to the community and the membership and 1,3% even chose extremely relevant.

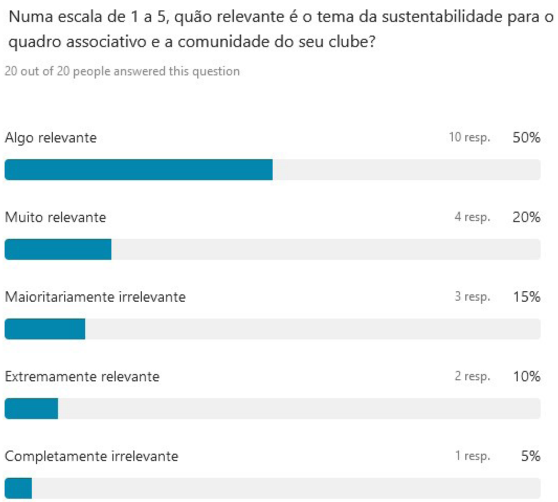


Figure 31

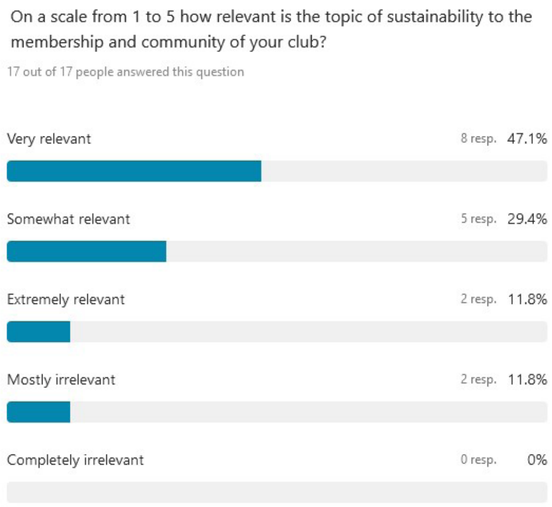


Figure 32

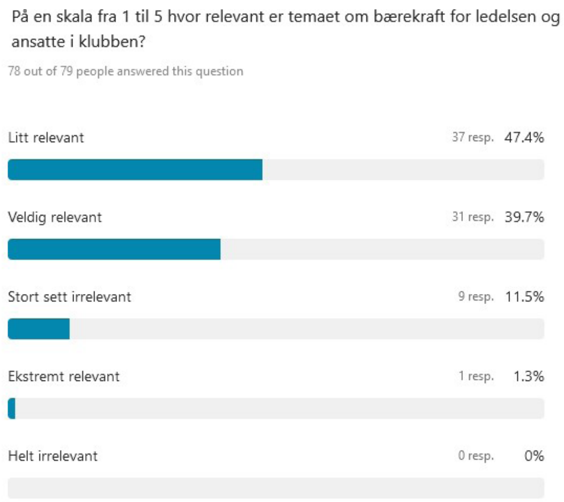


Figure 33

Portugal:

In Portugal, the most chosen answer was also somewhat relevant (50%), followed by 20% answering very relevant. Additionally, another 10% chose extremely relevant, so cumulated 80% see a high relevance. 15% answered with mostly irrelevant and 5% with completely irrelevant.

Scotland:

This first question on relevance of the topic sustainability was answered by the Scottish with nearly a half (47,1%) very relevant. 29,4% chose somewhat relevant and 11,8% extremely relevant. All together 88,3% argued that it is a relevant topic to the membership and community. Only 11,8% answered with mostly irrelevant and no one chose completely irrelevant.

Relevance of sustainability to the management and staff

The next topic focusses on the relevance of sustainability to the management and the staff of the clubs. This question was also in form of a Likert-scale and a possibility to the respondents to show their perception and understandings of this topic.

Norway:

The most chosen answers to this question are somewhat relevant (48,7%) and very relevant (39,7%). 10,3% chose mostly irrelevant and 1,3% extremely relevant. So, the cumulated views on the relevance is at about 88,4% and thereby very high.

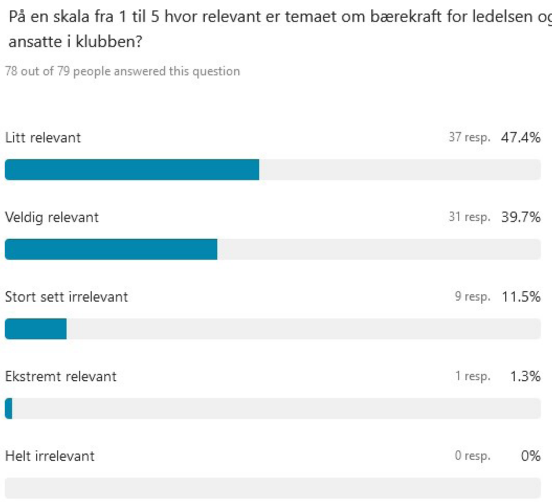


Figure 34

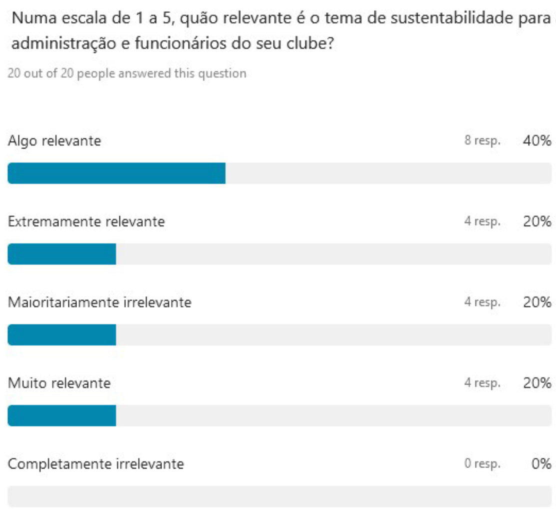


Figure 35

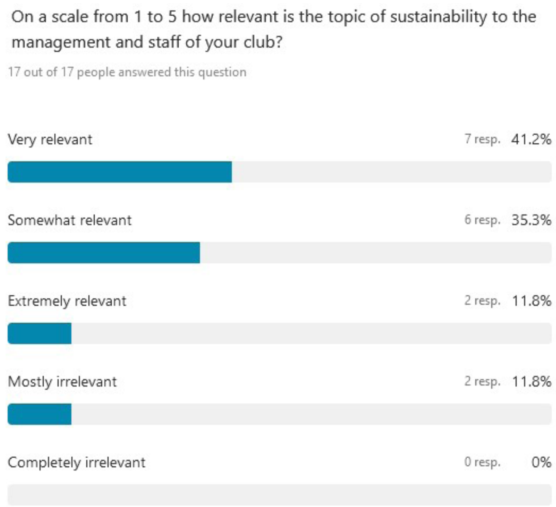


Figure 36

Portugal:

The highest rated answer in Portugal is somewhat relevant (40%), followed by extremely relevant and very relevant (both 20%). Mostly irrelevant was also chosen by 20%. No one chose completely irrelevant so the attributed relevance of the topic sustainability to the management and staff is pretty high.

Scotland:

The Scottish respondents chose, in comparison to the other countries very relevant (41,2%) as the highest answer. This is followed by somewhat relevant (35,3%) and extremely relevant (11,8%). The possible answer mostly irrelevant also got 11,8% reception. So, finally one can say that the cumulated relevance of the topic is with 88,3 very high.

6.2.3 Demographics

To get a better understanding of the respondents of the survey, one should have a closer look on the demographic aspects. It gives the chance to view the dimensions of the different football clubs in the different countries for example on size, memberships, fans, league, and the structure of the buildings.

Norway:

First, one can have a look on how many people work full or part time for a club. The by far most frequently selected answer was 0-9. About 82,3% stated that they have 0-9 people working for their club. 6,3% indicated that they had 10-19 working people. So, one can see that the gap between those answers is very big and therefore the first answer clearly stands out. Another picture forms from the question on how many people work voluntary for the club. The percentages are very wide ranged and most people (17,7%) answered 50-59 people. This is followed by 13,9% stating that 30-39 people volunteer and 11,4% 10-19 people. So, the main number of answers is cumulated up to 100 people. Only 17,9% state that they have more than 100 volunteers.

Portugal:

In Portugal the numbers are a bit different. 40% reveal that they have 0-9 full or part time workers. 20% state 20-29, 10% 30-39 and also 10% 50-59 and 70-79. Concerning volunteers to the clubs 45% respondents chose the answer 0-9 people. This is followed by 20% stating 20-29 people and only 5% chose 120-129 volunteers (the highest number chosen).

Scotland:

The Scottish people also had the most answers in the area 0-9 people working full or part time. The other 23,6% distributed evenly on 20-29, 30-39, 50-59 and 140-150. 23,5% stated that they have 0-9 volunteers, respectively 11,8% on 10-19, 20-29 and 50-59. The main part cumulates between 0-59 people. Only 35% go upon this number up to 189 people.

The next aspect focusses on how many fans and supporters will come to home matches of the top team

Norway:

The most selected answer was 0-99 people with 43,0% followed by 29,1% 100-199 people and 13,9% answering 200-299 people. This question is followed by describing in which league the top team of the football club is. The Norwegian chose the so called 2,3,4 division for the men and the 2 for the women as highest league with 52,6%. 24,4% chose a lower one, 15,4% a local league and 1,3% the so called Eliteserie (the top league).

Changing topics from members and fans to clubhouses and main buildings most of the buildings (26,9%) were built in between 2000 and 2020. 17,9% were built between 1960 and 1979. Summed up, more than two half (75%) were built between 1990 and 2020. Only 24% before that time. Concerning the last major renovation of those central clubhouses or buildings 52,1% stated that those were made between 2000 and 2020. 19,2% selected 1990 to 1999 and only a few respondents named previous data.

Portugal:

Focusing on the topic of how many fans and supporters will come to a home match, the Portuguese answered the most with 25% 100-199 people. Respectively 15% chose 200-299, 300-399 and 400-499. Viewing the leagues in which the top team of the clubs are 55% stated that the top team is in another tier of the national league. 25% selected regional league and 20% the highest tier of the national league.

In Portugal more than half (60%) respondents stated that their clubhouse or main building was built in between 1980 and 2020, but also 15% named 1918 or earlier. The major renovations instead most (50%) took place between 2000 and 2020. The earliest named renovations took place in 1980 to 1989 (16,7%).

Scotland:

The Scottish respondents answered mostly (37,5%) that 0-99 fans and supporters will come to a home match of the top team. 31,3% stated 100-199 people and the rest is distributed evenly on other numbers. In Scotland, the most respondents selected the other tier of the national league (41,2%) as the top team. 35,3% answered the regional league and both local or non-competitive leagues and highest tier of the national league were answered with 11,8%.

In the Scottish football clubs the central clubhouses or main buildings were mostly built between 1980 and 1989 (29,4%), followed by 2000 to 2020 with 23,5%. So again, more than half of the clubs were built between 1980 and 2020 (58,8%). The major renovations took place (52,9%) in between 2000 and 2020. 23,5% even stated renovations after 2020.

7

GOOD PRACTICIES IN FOOTBALL GRASSROOTS

SDG Striker
Scoring Goals for Sustainability

Most of the current sport facilities in Europe were built between the 1960s and the 1980s, and at those times energy efficiency was generally not a design consideration. Currently, energy efficiency renovations and, in particular, RES installations in sport buildings are becoming more common and more required by the building managers and a few excellent and successful examples have been developed. The intention of this section is to present knowledge regarding best practices and important factors supporting measures towards SDGs in football facilities and clubs and successful implementations of the solution proposed are provided as reference wherever available.

7.1

Best practice PV installations for self-powering the facilities

Johan Cruijff ArenA (Amsterdam) [2]

The stadium hosts around 15 league home games a season as well as international ties, European cup encounters and a range of non-sporting events throughout the year.

More than 4,200 solar panels (about 1MWp) have been installed on the roof in 2014 to supply green energy to the ArenA providing about 930 MWh/year (10% of current electricity consumption) with 117,000 tons of CO_2 saving. The ArenA is also equipped with the largest European energy storage system using second life and new electric vehicle batteries installed at a commercial building. Batteries from 148 new and used Nissan LEAF cars provide 3 MW of storage with a capacity of 2.8 MWh.

2 • https://www.johancruijffarena.nl/en/over-ons/duurzaamheid/

Figure 37: Sustainability concept of Johan Cruijff ArenA (Amsterdam)
Source: https://www.johancruijffarena.nl/en/over-ons/duurzaamheid/

The battery, charged to 100%, can be called on to provide full power to the ArenA for one hour during a major event with maximum energy intake or three hours if dispensable consumers (e.g. kitchen facilities) are disconnected.

For the energy storage system, there is an intelligent hard and software solution that manages the battery in multiple use cases. Linked to the PV intervention also up to 200 electric vehicle chargers have been installed.

A sophisticated management system balances the differences in energy supply and demand. The system can provide backup during a power failure and reduces the use of diesel generators. Storage capacity outside the stadium means the battery contributes to a more stable Dutch electricity grid.

A return on investment is expected within 10 years (due to the complex storage system), although this is said to be a conservative estimate.

Bentegodi Stadium is a sports facility in Verona with a total of 39,211 seats (it is the eighth Italian stadium for capacity)

Between July and December 2009, a photovoltaic system was installed on the roof of the Bentegodi with a value of approximately 4 million euro and a nominal power of approximately 1 MW (9591 m^2 of panels for a power of 999 kWp), thus becoming the first solar stadium in Italy and the largest photovoltaic system in Italy on a sports facility, thanks to the installation of 13,328 solar panels; with the proceeds from the energy produced, the maintenance costs of the sports facility are amply covered.

Figure 38: Aerial view of Bentegodi Stadium sports facility (Verona)
Source: https://www.stadi.online/stadio-bentegodi-verona/

7.2 Best practice for versatile renewable energy supply

7.2.1 Best practice solar thermal panels installations for renewable thermal energy supply

Allianz Stadium *(Torino)* [3]

The stadium has been inaugurated in September 2011 and has a capacity of just over 41,000 spectators. The new built stadium incorporates advanced environmentally sustainable technologies to ensure a low environmental impact, to reduce energy consumption from non-renewable energy sources reducing waste and optimising the resources available.

The DHW production is supported by two solar thermal systems, dedicated to the athletes' changing rooms and restaurant kitchens, which cover about 60% of DHW demand. The flat type collectors are composed by 8 modules each system and located on the rooftop of the two service blocks roof.

Figure 39: Aerial view of Allianz Stadium (Torino)
Source: https://mole24.it/2020/10/14/lallianz-stadium-di-torino-la-casa-della-juventus/

3 • https://docplayer.it/19248334-Gli-impianti-dello-juventus-stadium.html

7.2.2 Best practice biomass heating systems for renewable thermal energy supply

Pride Park Stadium *(Derby County)*

With a capacity of 33,597, it is the 16th-largest football ground in England and the 20th-largest stadium in the United Kingdom.

The installation of a biomass boiler at the Pride Park Stadium of Derby County Football Club is one of the first example of carbon-neutral heating at a professional football club. The 600 kW STU boiler from Hoval meet the base heating loads of the stadium. It is supported by existing gas-fired boilers (separate Hoval SR-Plus boilers using natural gas) to meet peak loads. Payments under the Renewable Heat Incentive exceed £600 000 through the period of the grant.

Also, at Moor Park training ground (the reference training centre) a 110 kW Hoval BioLyt wood-pellet boiler has been integrated with solar-thermal heating to provide heating loads and DHW.

Figure 40: 3-D model view of Pride Park Stadium (Derby County)
Source: https://www.bdfutbol.com/en/e/e2007.html

7.2.3 Best practice small wind turbines for renewable power supply

Lincoln Financial Field *(Philadelphia)*

Lincoln Financial Field is an American football stadium that represent a good example of implementation of small wind turbines in football buildings as stadiums and training centres.

Fourteen micro wind turbines are located in two sets of seven at opposing ends of the field and connected to the stadium's grid, reducing energy consumption during the day, and putting power back into the grid at night. The fourteen wind turbines are a standard commercial model, each turbine is approximately 15 feet tall and features a vertical-axis design. Together, the turbines and solar panels will annually produce about six times the amount of power used during all Eagles home games. Thanks to their strategic placement, the new energy-producing equipment do not interfere with the fans' experience on game day.

Figure 41: Aerial view of Lincoln Financial Field American football stadium (Philadelphia)
Source: https://inhabitat.com/14-uge-wind-turbines-turn-philadelphia-eagles-home-field-into-nfls-greenest-stadium/

7.3

Best practice for energy efficiency measures

7.3.1 Best practice on LED technology for floodlighting

Griffin Park, UK
(Brentford Football Club)

Brentford Football Club is a professional football club playing in the Football League Championship.

- Four-2kW LED floodlights were installed on the four existing 40m masts
- 92 LED floodlights with a symmetric distribution provide the bulk of the illumination
- 8 LED floodlights provide asymmetric lighting with a low tilting angle to illuminate the corners.
- The floodlights were selected on the basis of providing the best solution from a lighting design aspect as well as the geometry of the stadium. An average lux level of 1,200 has been achieved.

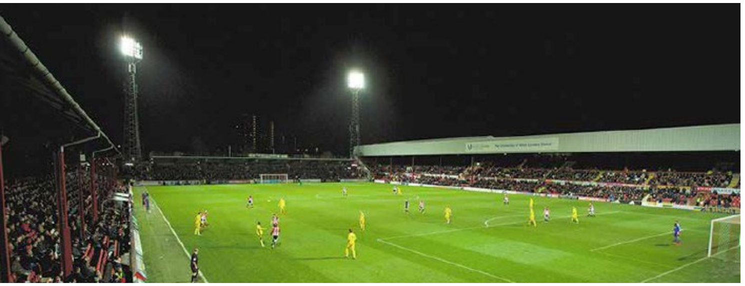


Figure 42: LED technology for floodlighting at Griffin Park, UK (Brentford Football Club).
Source: www.thornlighting.com

7.3.2 Best practice on LED technology for internal lighting

Riverside Stadium, UK
Middlesbrough FC

The Riverside Stadium is a football stadium in Middlesbrough, England has a capacity of 34,742. To comply with requirements of TV broadcasters a significant refurbishment of the lighting system was needed. The design had to be modern, flexible and energy efficient.

A variety of LED luminaires have been installed at Middlesbrough FC to elevate the facility to Premier League standards following the club's promotion to the English Premier League. The new lighting reduces energy consumption and provides much better color rendering.

Figure 43: Refurbished lighting system at Riverside Stadium, UK Middlesbrough FC.
Source: www.thornlighting.com

7.3.3 Best practice on HVAC systems, plants and equipment via cogeneration systems (CHP - Combined Heat and Power systems)

Continassa, *Juventus training centre*

Continassa area is an example of a training centre served from an energy point of view by the integration of different high efficiency systems, district heating, cogeneration, and heat pumps. Here a series of technologies will be available: natural gas cogeneration plant for the combined production of electrical and thermal energy; heat pumps for the production of chilled water; heat exchanger powered by city district heating.

Figure 44: 3-D model view Juventus training centre (Continassa).
Source: https://www.calcioweb.eu/2016/11/juventus-continassa-lavori-jvillage/10055773/

7.3.4 Best practice on Building envelope via green roofs

Barclays Centre, *New York*

Barclays Center is a multi-purpose indoor arena in the New York City borough of Brooklyn with a green roof of about 12,000 m².

The project features custom InstaGreen Sedum Tile vegetation installed over Hydrotech's GardNet technology to accommodate the steep slope of the roof. The slope of the project varies from at grade to 51 degrees at the steepest section. The green plant is especially hardy and does not need an elaborate irrigation system. (There are four hose bibs on the roof just in case of a drought situation)

The Barclays' green roof helps to absorb sounds and lower high energy costs while providing environmental benefits such as stormwater retention.

Figure 45: Aerial view Barclays Centre (New York)
Source: https://www.westonsolutions.com/solutions/infrastructure-improvements/greengrid/greengrid-green-roof-system-on-iconic-sports-arena-ny/

7.3.5 Best practice on electrical equipment and special technologies e.g. undersoil heating system

Anfield Stadium *(Liverpool)*

Anfield is a football stadium in Liverpool, Merseyside, which has a seating capacity of 53,394, making it the seventh largest football stadium in England.

A new undersoil heating system has been put in place to help aid growth and prevent the ground from freezing during the winter months. As part of the undersoil heating system, over 19 miles of pipeline has been put in place to ensure optimum conditions for maintenance and grass growth. Eight heat and moisture sensors have been installed to help monitor the best growing environment for the pitch. Over 40,000 km of artificial grass fibres have been stitched into the layers of sand beneath the pitch, which will be composed of 97% organic grass and 3% artificial grass fibres.

Figure 46: View of Anfield Stadium (Liverpool)
Source: https://www.liverpoolfc.com/news/stadium/266257-photos-and-facts-anfield-pitch-renovation-underway

Royal Sporting Club Anderlecht Stadium *(Anderlecht)*

RSCA Stadium is located within Parc Astrid in Anderlecht and can host up to 21.500 spectators.

The RSC Anderlecht pitch is a semi synthetic field constructed in 2007. It is based on 90% sand and reinforced with 40 million PE fibers.

The electrical system was chosen as:

1) The cables could be installed in a retrofit with a special machine without damaging more than 3% of the PE fibers and the field was playable after 4 weeks.
2) The power supply was already available, thus saving the cost, approval and operation of a 720 kW gas-fired boiler.
3) The control of the heating cables was included in the existing PLC control SMART EYE for irrigation and draining.

Figure 47: Spectators view at Royal Sporting Club Anderlecht Stadium (Anderlecht)
Source: https://footballtripper.com/belgium/anderlecht-stadium/

7.3.6 Best practice on electrical equipment and special technologies e.g. artificial lights for grass growth

***Allianz Arena** (Munich)*

Allianz Arena is a football stadium in Munich with a 70.000 seating capacity for international matches and 75.000 for domestic matches.

The Allianz Arena implemented 4 LED systems with integrated and fully automatic infrared and irrigation to cover the entire width of the pitch along with Infrared Technology. The 4 LED units together cover the entire width of the pitch.

The LED200 IR grow lighting system promotes photosynthesis which enables and reinforces grass growth on sports playing surfaces under all circumstances. The remote-controlled system is designed to quickly and strongly recover grass after games and events and ensures full grass coverage throughout the entire year.

The right amount of Infrared Radiation is added automatically according to climate circumstances.

- Amount of LED fixtures: 104
- Number of Infrared fixtures: 26
- kW consumption: LED only 16kW. Including Infrared 64kW

Figure 48: Led lights for optimal grass growth at Allianz Arena (Munich). **Source:** https://www.stadia-magazine.com/news/field-lighting/allianz-arena-first-to-use-led-lights-to-grow-turf.html#prettyPhoto

7.4 Best practice related to energy povery

A detailed overview of energy poverty activities is available in the Atlas of Energy Poverty Initiatives in Europe available at:

https://www.ecoserveis.net/wp-content/uploads/2019/02/Atlas-of-energy-poverty-initiatives-in-Europe.pdf

Selected more specific activities are e.g:

7.4.1 Energy Cafés

Green Doctors offer residents a range of simple energy efficiency measures. They also signpost residents if eligible to government and energy company grants that can help them to install more significant EE measures. They offer residents debt assistance and also offer energy tariff or company switching advice.

More information is available here:

http://cied.ac.uk/publication/alleviating-fuel-poverty-role-energy-cafe/

7.4.2 Brixton Energy Solar

The Brixton Energy Solar projects are co-operatively Find more information here. 54 owned renewable energy projects on social housing estates. They allow tenants in social housing to make investments on their roof and give access to part of the electricity produced with solar panels for free. Revenues from the projects feed into an energy efficiency fund and provide training opportunities for youth in the community.

More information is available here:

https://brixtonenergy.co.uk/projects/our-first-project/

7.4.3 Edilizia Pubblica Pratese

Self consumption to fight against energy poverty In 2019, the Italian social housing company "Edilizia Pubblica Pratese" inaugurated the NzeB residential complex in San Giusto (Prato) including 29 lodgings, a community centre of 250 square metres, an equipped garden and a new square. This project is a great example of collective self-consumption to fight energy poverty, combining high levels of energy efficiency with social housing to minimise energy costs, thanks to innovative approaches using sun and wind energy.

More information is available here:

https://friendsoftheearth.eu/publication/community-energy-guide/

7.4.4 Home Energy Scotland (HES)

In Scotland, householders (owner occupiers, tenants) and smaller private landlords can access free, independent, personalised, and impartial advice from Home Energy Scotland, provided on behalf of the Scottish Government by EST. There are three types of advice:

Personalised advice over the phone by trained advisors working from regional advice centres across Scotland; focuses on energy efficiency support - both advice and referrals into grant support programmes for energy efficiency and referrals to energy tariffs and income support; Free, in-home expert advice for households identified as needing in-depth advice and support: very vulnerable households, people installing more complex home energy measures and some private landlords; Online advice consisting of both static webpages and online tools, managed and provided centrally by EST.

More information is available here:

https://www.energysavingtrust.org.uk/sites/default/files/EST%20Programmes%20In%20Scotland%20FINAL.pdf

8

EXCEL TOOL

FOR PRE-FEASIBILITY ASSESSMENT OF PV INSTALLATIONS

SDG Striker
Scoring Goals for Sustainability

EXCEL TOOL for pre-feasibility assessment of PV installations

Saving energy costs helps in two ways: the environment and the wallet of clubs and stakeholders. Energy-efficient refurbishment of buildings and the installation of photovoltaic system or solar heating on the roof to reduce energy consumption and pay for themselves through the reduced costs. For the purpose of pre-feasibility assessment of PV installations, we have adopted a calculation model in an easy to operate excel tool that can help you to calculate the profitability. In an Excel table, you can enter various parameters of the planned installations and find out in what time and with what return they pay off. The following pages represent screenshots from the tool.

Figure 49:
PV installations assessment tool

Status 11/04/2022

prepared by
Johannes Lindorfer
within the framework of the project SDGStriker

Energieinstitut an der Johannes Kepler Universität Linz
lindorfer@energieinstitut-linz.at

Function and result of the calculation table:
The spreadsheet **allows the calculation of the profitability of solar power systems for sports clubs** (photovoltaic systems) taking into account tax aspects. The value added tax on the acquisition costs is refunded and is therefore treated as a transitory item in the invoice. The average return (internal rate of return) is given as a measure of profitability.
Annual returns are calculated as the difference between revenues and expenses. The revenues are generated from the sale of electricity and the savings from direct consumption, while the expenses are calculated from the running costs and the debt service. For the latter, it is assumed for simplicity that the loan (e.g. from local providers) was paid out either at the beginning or in the middle of the year, depending on whether the PV system goes into operation in the first or second half of the year.

The **electricity yield** is subject to regional differences. In the central europe area, one can assume 1000 kWh/a per kWp of installed capacity. In the more northern partner regions like scotland or norway, the yield is significantly lower (up to 20%), in the south like portugal and spain

The **inflation rate** is included in the calculation because it is assumed that the running costs (insurance, maintenance) increase with the inflation rate.

Systems with storage system: Storage systems are then treated as part of the system for tax purposes if they are installed together with the PV system.

Note: The result for the internal rate of return (IRR) depends on the equity capital employed. As a rule, it is higher the larger the share of debt financing. In some cases (e.g. if the plant is largely debt financed) the calculation of the IRR leads to an error message (#Div/0!). The decisive factor is then the net present value, i.e. the sum of the annual returns discounted at the discount rate. A positive net present value means profit, a negative net present value means loss.

Questions will be answered by Johannes Lindorfer, Energy Institute at the Johannes Kepler University Linz, Austria, lindorfer@energieinstitut-linz.at

The Excel spreadsheet has been carefully tested. Nevertheless, no guarantee can be given for the correctness and the correct function.

estimating economic efficiency of photovoltaic plants
status 11/04/2022

notes:
The framed fields can be changed as desired; the contents are only guide values.
The other fields are locked against accidental overwriting.
The sheet protection can be removed if necessary.

results:				
internal rate of return (IRR)	**6,4%**	**p.a.**		
payback period	**15**	**years**		
electricity generation costs (LCOE)	**0,118**	**€/kWh**		
net present value (profit or loss)	**4.522**	**€**		
initial equity (incl. VAT)	**9.660**	**€**		
PV plant				
Plant capacity (data representative < 100 kWp)	10,0	kWp		
installation cost of the PV system (without batteries, net, withou	**14.000**	**€**	**corresp**	1.400 €/kWp
subsidy for PV system	0	€		
power storage / battery (yes=1, no=0)	0			
cost of power storage / battery system (net, without VAT)	5.000	€		
subsidy for power storage / battery		€		
preliminary costs, interim financing	280	€		
running cost for PV system	**210**	**€ p.a.**		
other running cost e.g. roof rental costs	0	€ p.a.		
specific electricity yield	**950**	**kWh/kWpa**	**see:**	PVGIS
yield decrease per year	0,40%			
direct use in % of PV electricity yield	**20%**			
PV power feed into the power storage / battery	40%			
power stroage / battery charge-discharge losses	10%			
annual decrease in direct use via power storage / battery	2,0%	p.a.		
year of start up PV system	2022			
month of start up PV system (1-12)	5	correspond	69%	proportionale solar yield in the year of start-up
total installation cost PV system (incl. Batteries etc.)	14.000	€		
feed-in tarif for PV electricity	0,0649	€/kWh		
financing				
1st credit / loan	7.000	€	50%	self-financing share
payment	100%			
provision per month	0,15%			
interest rate (nominal)	2,84%	p.a.		
period / runtime	10	years		
period of fixed interest rate (5 / 10 / 20 years)	10	years		
Redemption/ repayment free period	2	years		
Interest rate after period / runtime of fixed interest rate	5,00%	p.a.		
2nd credit / loan (constant annuities)	0	€		
interest rate (nominal)	3,0%	p.a.		
period / runtime	15	Jahre		
miscellaneous				
income tax exemption (yes/no)	no			
direct selling via power purchase agreements (yes/no)	no			
inflation rate	1,5%	p.a.		
interest rate for present value calculation (discount rate)	2,0%	p.a.		
Interest rate on reinvestment	0,0%	p.a.		
Annual electricity consumption	3.000	kWh/a		
Annual basic charge for electricity (net, without VAT)	90	€/a		
Electricity price in the first year (net, without VAT)	0,2400	€/kWh	corresponds 0,2856	€/kWh gross
estimated Electricity price increase	1,5%	p.a.		
feed-in tarif for PV electricity	0,0372	€/kWh	0% 0,0000	€/kWh on self-consumption
individual tax rate (in the first 10 years)	30%			
Tax rate (after 10 years)	30%			
Investment deduction in %	0%			
20% special depreciation?	no			

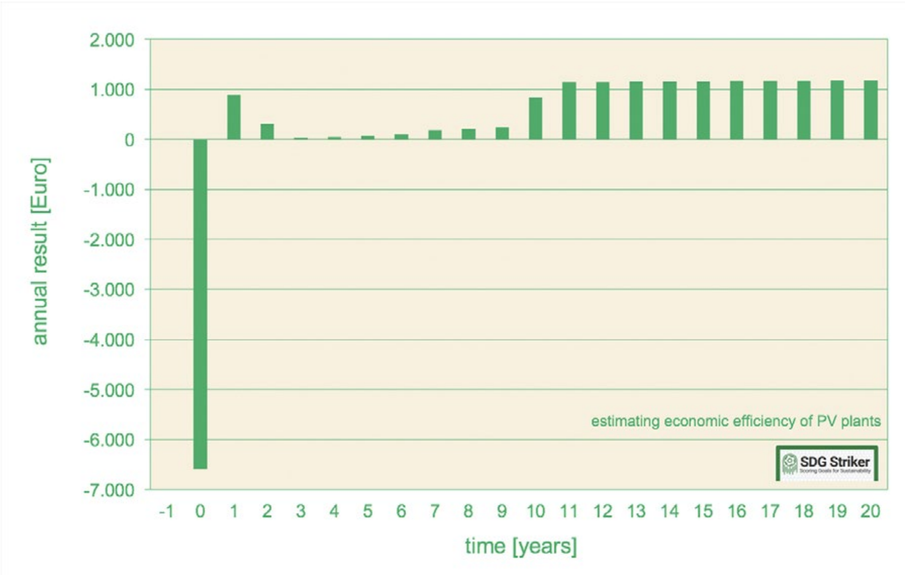


Figure 50: annual result calculation

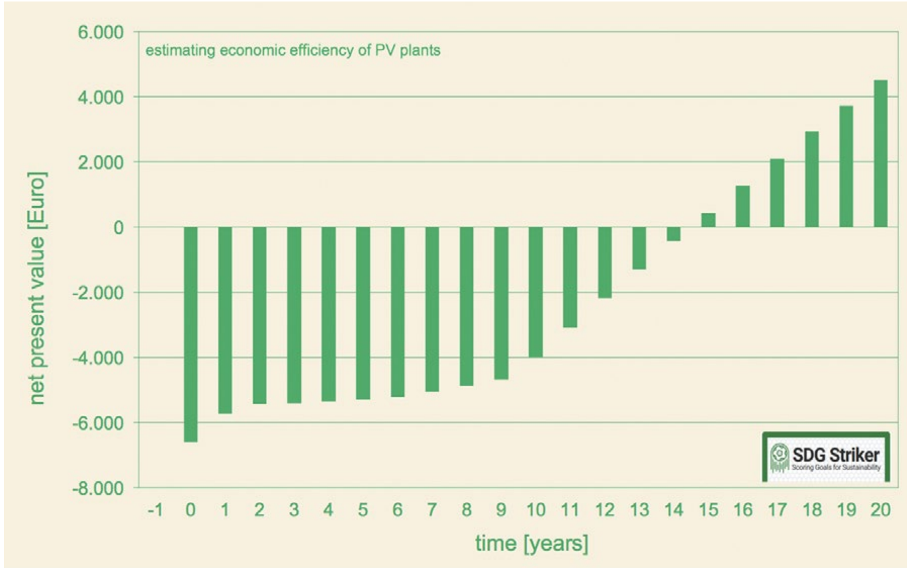


Figure 51: net present value calculation

The simplified mathematical relationship is shown the following equation.

Equation: The formula used to calculate net present value.

$$NPV = -C_0 + \sum_{t=0}^{n} \frac{(\text{Earnings} - \text{payments})}{(1+i)^t}$$

—C_0 denotes all of the taken investments, n the number of years observed and I is the calculated interest rate.

All earnings and payments are discounted over a certain period of time, in this case 20 years which is below the actual reported lifetime of PV installations. If the final value is positive, so is the investment's rating. The number is directly proportional to profitability of the installation.

8.1
Additional tools

Please find below a set of additional tools that could help you with the implementation of more sustainable actions

> **Energy systems planning**

Polysun (free trial version only) is comparable to PV*SOL available at:

https://www.velasolaris.com/#:~:text=Polysun%20ist%20die%20leistungsstarke%20Softwarepalette,Energiesystemen%20f%C3%BCr%20Geb%C3%A4ude%20und%20Quartiere

> **PV & Wind yield simulation**

Renewable ninja, available at:

https://www.renewables.ninja/

> **PV GIS simulation**

EU Photovoltaic geographical information system, available at:

https://re.jrc.ec.europa.eu/pvg_tools/en/#PVP

> **PV project simulator**

SUNNY DESIGN, available at:

https://www.sunnydesignweb.com/sdweb/#/Home

> **Carbon Footprint Calculators**

Available at:

https://footprint.wwf.org.uk/#

https://www.carbonfootprint.com/calculator.aspx

https://offset.climateneutralnow.org/footprintcalc

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SDG Striker

Scoring Goals for Sustainability

PRACTICAL GUIDELINE TO INCORPORATE AND COMMUNICATE SDGs IN THE SPORTS ORGANISATIONS

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