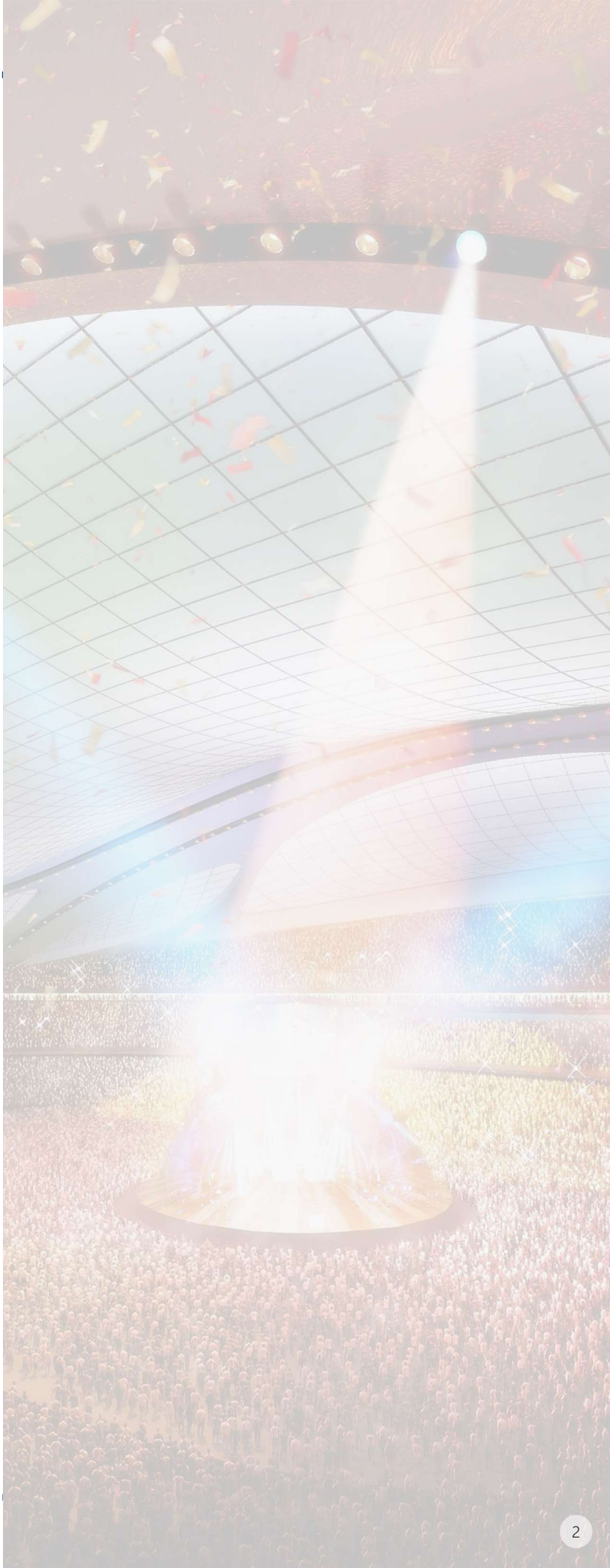
DECEMBER 2016

WHITE PAPER

Potential Circular Economy strategies for the Tokyo 2020 Olympics

Contents



Project Team

This project was conducted as part of a research initiative at the Harvard University Extension School faculty aide research program.

Heads of Project

Professor Mark Esposito, Harvard University's Division of Continuing Education & Judge Business School, University of Cambridge

Professor Terence Tse, ESCP Europe Business School, London, UK, & Judge Business School, University of Cambridge

Jonathan Xu, Harvard University's Division of Continuing Education

Head of Project (World Economic Forum)

James Pennington

Cross-Report Contributors

Alina Gordon (Independent Consultant)

Junko Nagao (Executive Director, C4 Initiative)

Editing and Creative

Jonathan Xu, Harvard University's Division of Continuing Education

Executive Summary

This report provides an overview of the key areas where the Tokyo 2020 Olympics can promote sustainability. The recommendations are primarily based on a Circular Economy framework, which maximizes resource-circulation and minimizes waste.

As Japan plans for the Tokyo 2020 Olympics, it is likely seeking to deliver an environmentally sustainable Olympics experience, while optimizing for costs. By using Circular Economy strategies, which seek to maximize resource reuse and minimize waste, Tokyo 2020 may be able to achieve both goals simultaneously. The resulting benefits are: a more sustainable environment, long-term cost savings, and more content citizenry.

From a sustainability perspective, we suggest that Tokyo 2020 consider the following areas:

- For the overall construction and design of Olympic facilities and related structures:
  - Apply modular design and construction methods
  - Apply lean design principles
  - Promote material reuse
  - Build to Last

- For event transportation during the Olympics:
  - Further improve subway and train systems
  - Further enhance bus system
  - Enable and promote cycling
  - Promote walking

- For energy, food, and waste management during the Olympics:
  - Increase use of clean energy
  - Promote sustainable food supplies
  - Reduce energy use
  - Reduce waste production
  - Increase recycling rates
  - Set sustainability targets and monitor progress

Introduction

Achieving sustainability and cost-savings need not be mutually exclusive

Japan is one of the world's leaders in promoting sustainability and environmental protection. As a modern industrialized G8 nation, Japan frequently leads the world in areas of technology, efficiency, and environmental sustainability.

Sustainability is one of the key pillars of the Olympic Games, alongside sport and culture.[1] In the Olympic Agenda 2020, the International Olympic Committee recommended that Tokyo include sustainability in all aspects of the Olympic Games.[2] Integrating sustainability programs into the Olympics may seem challenging and expensive, especially when Tokyo is already operating on a tight budget and potentially facing cost over-runs.[3] In this environment, cost optimization is as important as promoting sustainability.

Achieving sustainability while delivering cost savings can be achieved simultaneously and synergistically. They need not be mutually exclusive goals. For example, sustainable buildings typically have lower annual costs for energy, water, maintenance, and repair.[4] A well-designed recycling program eliminates the amount of waste landfills needed, and allows materials to be reused by businesses at a fraction of the cost of new materials. In fact, well-developed sustainability initiatives typically save costs both in the short and long-run. This is not to mention the immense benefits of conserving the environment's resources and producing strong social benefits.[5]

What are Circular Economy Strategies?

Circular Economy strategies are courses of action that maximize resource use, value extraction, as well as material recovery and regeneration. These strategies typically result in long term cost-reductions while contributing to environmental sustainability.

A circular economy is an economic system where resources are kept in use for as long as possible, with maximum value being extracted from them whilst in use, and then recovered or regenerated into new products and materials at the end of their service lives. [6]

For example, in the simple case of a cellphone, instead being discarded after four years of use, it can be returned to the manufacturer and re-made (9 BBC, 2016)into a new model using original materials. A cellphone made this way costs up to 50% less.[7]

A truly Circular Economy enables the decoupling of growth from resource constraints, partly by insulating firms from volatile commodity prices and reducing suppliers' bargaining powers.

Across the private sector, Circular Economy strategies have been highly effective in cutting costs and increasing revenues. Over the past several years, private firms like Boeing, General Electric, Jaguar, Renault, and Phillips have actively applied these strategies in their businesses and their successes have been documented in numerous case studies.[8]

In fact, governments can similarly apply Circular Economy strategies to their projects, especially for large-scale events like the Olympics. Due to the sheer size of the Olympics, the cost savings of applying these strategies will be much greater than those typically experienced in the private sector.

In the case of the Tokyo 2020 Olympics, Circular Economy strategies can be applied to several key aspects of the Games, including: overall construction and design, transportation and accommodation, as well as food, energy and waste management. The next section will explore each of these aspects in detail.

Potential Circular Economy strategies for overall construction and design

As of late 2016, the Tokyo 2020 Olympics is currently estimated to spend as much as $18 billion, of which about one-third may go into the overall construction of facilities and infrastructure (i.e. ~$6 billion).[9] Tokyo's anticipated total spend is four times Rio 2016's final budget, and on par with that of London 2012.[10] Given such a large capital expenditure, there are many opportunities to reduce long-term costs and improve sustainability by applying Circular Economy strategies. In this section, we refer to "overall construction and design" as all of Tokyo 2020's sporting stadiums, buildings and structures, as well as their surrounding infrastructure. Below are the areas where there may be major opportunities for the Tokyo 2020 Olympics.

Apply modular design and construction methods: Buildings should be designed and built by their individual components. Temporary structures should be designed for deconstruction and reuse after the Olympics is over. This will significantly reduce construction waste and post-Olympic ruins.

Apply lean design principles: To the maximum extent possible, the structural design of buildings should be lightweight and hollow. This means avoiding large solid pieces of heavy materials in building structures to reduce material costs.

Promote material reuse: To the maximum extent possible, use recycled materials in new construction. This helps lower costs and avoids wasteful disposal of materials that can still be reused.

Build to last: Strategically decide which buildings and structures to build for permanent use (eg. those with low maintenance costs and frequent future usage). This is also a unique opportunity to renew older city districts. Permanent buildings should aim to be 100% LEED- ("Leadership in Energy and Environmental Design") certified, the leading global certification for sustainable buildings.[11]

Avoiding unnecessary hotel construction by tapping into home-sharing services

Home sharing services (like Airbnb) contribute to an **elastic housing supply**. This can be especially effective in coping with temporary spikes in housing demand.

In the Rio 2016 Olympics, 17,000 listings offered through Airbnb accommodated 85,000 of the city's estimated 500,000 visitors. To have provided accommodation for this surge of visitors, Rio would have had to build an estimated **104 hotels**.[12]

Japan may wish to consider relaxing certain laws (eg. the Hotel Business Act), in light of the contributions that home sharing services can have in bridging temporary gaps in housing supply and demand. [13]

Of course, whether Tokyo 2020 will experience a surge in visitors like Rio 2016 did is difficult to predict, and will depend on a multitude of factors.

Apply modular design and construction methods

To the maximum extent possible, design and build buildings/structures by its individual components – this is a core principle of modular design. Temporary buildings/structures should be designed for deconstruction and reuse after the Olympics is over. Modular design is particularly useful in enabling this.

Where can this be applied?

Stadiums

Buildings

Facilities

Infrastructure

How can this strategy be applied?

Design all temporary venues and buildings for **deconstruction and reuse** to avoid post-Olympic waste

Encourage **compact structural designs** to obtain better performance from energy and materials

Use **offiste and module construction** by building structural components individually offsite. This minimizes onsite waste

Financial, social, environmental benefits

Cuts construction and waste disposal costs

Reduces carbon footprint

Successful examples

Rio 2016: Rio Committee Head Office was pre-built in a modular fashion, with pre-molded steel structures, and was finalized in just 6 months. It is being disassembled after the Games, and 80% of the materials will be reused in new installations [14]

London 2012: Used offsite, modular construction to avoid construction waste [15]

Cautionary examples

Athens 2004: Most buildings were not designed for deconstruction and reuse. Today, venues like the Athens stadium, Olympic Village, and Olympic Softball stadium have largely been abandoned [16]

Beijing 2008: Beijing's main stadium ("the Birdnest") used 9 times the amount of steel as the London 2012 main stadium, and was not designed for post-Game reduction/deconstruction. Today it is occasionally a tourist attraction but largely underutilized. Beijing's beach volleyball competition venue also lies deserted and unmaintained today [17]

Apply lean design principles

To the maximum extent possible, the structural design of buildings/facilities should be lightweight and hollow. It is also wise to avoid using large solid pieces of heavy materials in building structures.

Where can this be applied?

Stadiums

Buildings

Facilities

Infrastructure

Logistics

How can this strategy be applied?

Optimize building design to minimize waste before beginning construction

Use **light structures and materials** for all temporary venues and buildings to reduce material usage and cost

Use **virtualized process modeling** to minimize logistical clashes during construction

Partner with innovative firms which can develop unconventional designs to reduce project costs

Financial, social, and environmental benefits

Reduces total project costs and saves time

Reduces carbon footprint

Successful examples

London 2012: Used virtual modeling to reduce logistical clashes and enable the preformation of holes for stadium construction

London 2012: The main stadium used a light, steel structure, using only about 10% the amount of steel used in Beijing 2008's main stadium [18]

Liander head office, Netherlands: Formed an unconventional partnership with a roller coaster company to create the roof of new corporate head office. The steel roof was "hollow" yet structurally sound, and fully reconstructible. Resulted in 30% reduction in quantity of steel used [19]

Cautionary examples

Athens 2004: Actual cost was almost twice its projected budget. Venues used mostly permanent, instead of collapsible designs [20]

Promote material reuse

To the maximum extent possible, use recycled materials in new construction. This helps lower costs and avoids wasteful disposal of materials that can still be reused.

Where can this be applied?

Stadiums

Buildings

Facilities

Infrastructure

How can this strategy be applied?

Use recycled materials (eg. crushed concrete) in **structure construction**

Reuse materials from the installation of temporary structures built for the Olympics

Use recycled material (eg. scrapwood) for **building facades**

Financial, social, and environmental benefits

Minimizes construction and waste processing costs

Reduces carbon footprint

Successful examples

London 2012: 104,000 tonnes of recycled crushed concrete reused, therefore avoiding the need to import the virgin material. Saved £1 million and more than 20,000 truck movements [21]

London 2012: Used a light steel structure, using only 10% of the amount of steel used in Beijing 2008's main stadium [22]

Liander head office, Netherlands: Used upgraded scrapwood (which would have otherwise been burned) to line 50% of interior facade [23]

Build to Last

Strategically decide which buildings and structures to build for permanent use (eg. those with low maintenance costs and frequent future use). Make use of this unique opportunity to renew older districts. Permanent buildings should aim to be 100% LEED certified.

Where can this be applied?

Stadiums

Buildings

Facilities

Infrastructure

Housing

How can this strategy be applied?

Avoid building structures that will be **underutilised** after the Games, yet requiring **high-maintenance**

All permanent buildings should **be LEED-certified**

Buildings should **have a plan for post-Games use**. This should be built into each building's original design

Use the Olympics as an opportunity to **renew older districts**

Build high quality condos for **relocated residents** in new areas

Financial, social, and environmental benefits

Minimizes long-term building and maintenance costs,

Increases public trust

Reduces carbon footprint

Successful examples

Rio 2016: Used the Olympics as an opportunity to pre-emptively improve infrastructure, including new water, sewage, electricity, telecommunications network, sidewalks, street lighting, and landscaping around major districts [24]

Rio 2016: All of the newly-built permanent buildings (related to Rio 2016) are LEED-certified [25]

Rio 2016: Families impacted by construction activities were relocated into new, high quality condos (eg. Parque Carioca). This minimized citizen discontent and was a long-term sustainable solution for the impacted families [26]

Potential Circular Economy strategies for event transportation

Currently, almost 20 million visitors arrive at Japan annually. This number will likely spike during the Tokyo 2020 Olympics, based on historical experiences from Rio 2016 and London 2012. Therefore, transportion will be a major issue as athletes, spectators, and tourists crowd the streets and transit systems. Below are the areas where there may be major opportunities for the Tokyo 2020 Olympics.

Further improve subway and train systems: This is a valuable opportunity to upgrade any older trains and renovate older subway stations which have been in need of attention. In stations and on subways, provide easy-to-understand instructions in several languages so that foreign visitors feel comfortable navigating the subway and train systems without having to ask locals.

Further enhance bus system: It would be prudent to at least double the number of buses in operation during the Games. Use newer vehicles that are more emissions-friendly. In stations and on buses, provide easy-to-understand instructions in several languages so that foreign visitors feel comfortable navigating the bus systems without having to ask locals.

Enable and promote cycling: Consider expanding Tokyo's network of bicycle lanes. Cycling can be encouraged by building bicycle parking spots instead of car parking spots at major venues. There are also numerous innovative bicycle-rental services, which the city can consider partnering with.

Promote walking: Build walkable pathways to promote walking. It would also help reduce excess commuter traffic by building sporting venues as close to each other as possible, so that they are more accessibleby foot.

Further improve subway and train systems

Japan already has highly advanced subway and train systems. However, there will likely be excess strain on the entire system during the Games. Both London 2012 and Rio 2016's experiences showed that these cities handled commuter traffic well as most visitors took public transit. During the London Olympics, both employers and the government urged employees to work from home. This resulted in about 1.5 million workers staying home during the Olympics, thereby significantly alleviating demands on public transit.

Given the existing overcrowding of Tokyo's subway system (especially during peak hours), it may be helpful to increase the number and frequency of subway trains, in anticipation of additional visitor traffic. This is also a valuable opportunity to upgrade older trains and renovate older subway stations which are in need of attention. In stations and on subways, it would be helpful to non-Japanese-speaking visitors if easy-to-understand instructions are provided in several languages. This way, foreign visitors will feel more comfortable navigating the public transit, rather than resorting to taking taxis or driving.

Where can this be applied?

Sporting events

Tourism

Transportation

Logistics

How can this strategy be applied?

Upgrade older trains and stations

Link Olympic venues directly to major public transport networks

Actively **promote** public transport usage

Provide easy-to-understand **instructions** for foreign visitors (in several languages)

Deliberately **avoid building large parking lots** around Olympic venues (and communicate to public)

Financial, social, and environmental benefits

Minimizes long-term financial costs

Increases public trust

Reduces carbon footprint

Successful examples

Rio 2016: Targeted 100% use of public transport by spectators and workforce, reinforced by the absence of spectator parking spaces at the venues [27]

Rio 2016: Within the city of Rio, use of public transport increased from 16 to 60% from 2009-2016 due to transportation infrastructure improvements in preparation for the Olympics [28]

London 2012: 86% of Olympic Park visitors traveled by rail. This alleviated any severe road congestions [29]

Further enhance the bus system

It would be prudent to significantly increase the number of buses in operation during the Games. In Rio 2016's case, the city doubled the number of buses in operation during the Games. To meet a surge in demand, Tokyo may wish to establish rental agreements with bus fleet suppliers, so that the excess fleet is returned upon the conclusion of the Games. The Olympics is also a great opportunity to upgrade to newer bus vehicles that have lower emissions. In stations and on buses, it would be helpful to foreign visitors if there are easy-to-understand instructions in several languages. This will allow foreign visitors to feel comfortable navigating the bus system without having to ask locals.

Where can this be applied?

Sporting events

Tourism

Transportation

Logistics

How can this strategy be applied?

Increase the **number of buses** during the games

Use newer vehicles that are more emissions-friendly

Alternatively, **upgrade older vehicles** to reduce their emissions

Financial, social, and environmental benefits

Reduces carbon footprint

Alleviates severe traffic congestions

Successful examples

London 2012: Most of the buses and coaches used were <5 years old, and had to meet the Euro IV standard for PM10 emissions. Older vehicles went through a refurbishment process and were retrofitted with improved filters [30]

Rio 2016: Rio upgraded its buses gradually (20% of city's buses annually) between 2012-2016. Almost all buses in the city met the new Euro V emission standard by the time the Olympics were held [31]

Enable and promote cycling

During the Tokyo Olympics, the spike in visitor traffic may be alleviated by encouraging commuters to use bicycles. Brazil's preparation for Rio 2016 led to the city tripling its bicycle network within 4 years. Tokyo also may also wish to invest in expanding its network of bike lanes in the city, in order to alleviate traffic during rush hours. In addition, the city can encourage biking to venues by building more bike parking spots rather than car parking spots. The bicycle rental docking stations need not necessarily be permanent – they can be temporary stations dismantled after the Olympics are over. Tokyo can also consider partnering with bicycle rental firms to supply bikes during the period. Since cycling is also a physical activity, it is highly compatible with the sporting spirit of the Olympics, and will likely be especially well-received during the period.

Where can this be applied?

Sporting events

Tourism

Transportation

Logistics

How can this strategy be applied?

Increase the city's network of bicycle lanes, linking sporting venues with public transit

Establish and promote **rental programs**

Establish bicycle rental **docking stations** or partner with **remote-unlock** rental services

Build bicycle parking space, rather than car parking spots, at venues

Financial, social, and environmental benefits

Reduces carbon footprint

Reduces costs of operating private/public transit

Alleviates severe traffic congestions

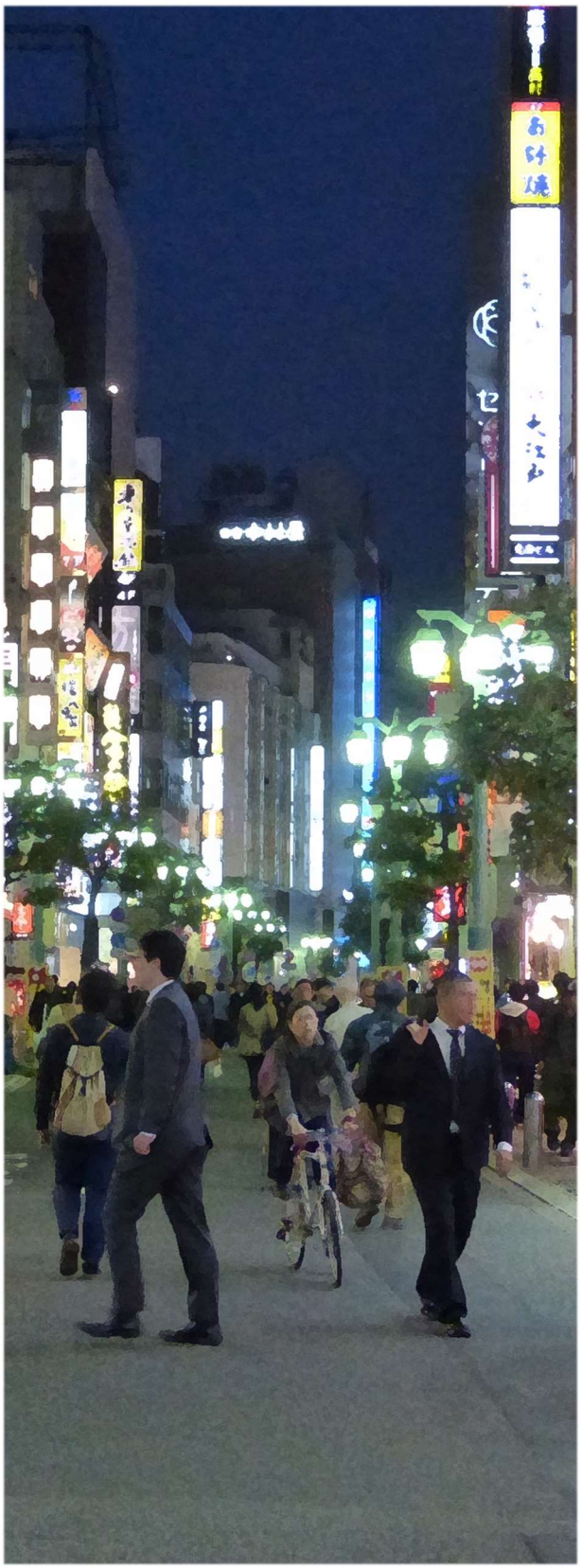
Successful examples

Rio 2016: Rio increased its bike lane network from 150km to 450km from 2012-2016. The bike path network integrated with public transit, linking the games zones and their facilities. Bicycle rental docking stations were established around the city to provide convenience for cyclists [32]

Mobike: a new bike lending service in China where users rent bicycles via an app. The bikes are unlocked remotely, and don't need to be returned to parking stations [33]

Promote walking

Promoting walking is a simple way to reduce vehicle traffic on the roads, thereby reducing greenhouse gas emissions and the strain on public transit. Building a network of walkable pathways will encourage visitors and residents to reach their destinations by foot. Since walking is free, some visitors and residents may be more inclined to walk whenever they can. However, in order for this to be a realistic form of transport, venues have to be constructed within reasonable walking distances from one another (to the maximum extent possible). Since walking is another form of physical exercise, it is blends well into the sporting spirit of the Olympics. Organizers may achieve easy success with such types of public messages.



Where can this be applied?

Sporting events

Tourism

Transportation

Logistics

How can this strategy be applied?

Build walkable pathways to promote walking

Build venues as **close to each other** as possible

Use public messaging to **encourage walking** to city destinations whenever possible

Financial, social, and environmental benefits

Reduces carbon footprint

Reduces costs of operating private/public transit

Alleviates severe traffic congestions

Successful examples

London 2012: Although the main Olympic site was far from central London, some events did take place near the River Thames. Approximately 22% more people walked around central London, as indicated by measurements near the Thames River during the Olympic Games. [34]

Potential Circular Economy strategies for energy, food, and waste management

Effective energy, food, and waste management are key to improving the sustainability of the Games. The Olympic games consume a much higher amount of energy than usual, so it is important to ensure that clean sources of renewable energy are used to the maximum possible extent. During the past two Olympic games, food was estimated to have generated about a third of the entire carbon footprint of the Games. The Olympics also produces a huge amount of waste which must be wisely managed by reducing, reusing, and recycling. Below are the areas where there may be major opportunities for the Tokyo 2020 Olympics.

Increase use of clean energy: Solar power is one of the cleanest forms of energy available. Since the Olympics are held during the summer when there is no shortage of sunlight, solar energy may be an ideal form of energy. Installing solar panels may be particularly relevant for permanent buildings and facilities that will remain standing beyond the Olympics. If solar power is going to be a form of energy, the earlier these solar panels are installed, the sooner they can begin to deliver a return on investment. In addition, Tokyo may also wish to substitute fossil fuels for renewable and alternative fuels (eg. low-carbon fuels, such as ethanol, biodiesel and electricity), as was achieved in Rio 2016.[35]

Promote sustainable food supply: Tokyo 2020 can promote food supply sustainability by requiring all meat, vegetable, and fish to be sourced from sustainable agriculture and fishing practices. This requires the development of certification processes with traceability mechanisms that demonstrate the safety and origin of a food product. Promoting these practices will help promote the farming and agriculture industries near Tokyo and around Japan. In terms of food catering, Tokyo 2020 may wish to raise the prices of all beef meals consumed during the event to discourage its consumption. Research has shown that the production of beef meals has a carbon footprint 15 times that of chicken meals, and 5 times that of pork meals.[36]

Reduce energy use: Tokyo 2020 can help lower fuel consumption by giving priority to fuel efficient vehicles. Aother way to reduce energy consumption is to use sustainable low-carbon footprint materials for Olympics-related merchandise. For example, during the Rio 2016 Olympics, Apparel and coins were the top two carbon emissions-generating products. Optimizing on the carbon footprint of these materials will have a significant impact on sustainability.[37]

Reduce waste production: In the spirit of reducing waste, Tokyo 2020 may wish to encourage all event-related products (including utensils) to use minimal packaging. Given the large number of visitors anticipated to arrive in Japan, even a small reduction in packaging quantity will have a major aggregate effect. Tokyo 2020 may also look into optimizing food portion sizes to reduce waste from uneaten/leftover food.

Increase recycling rates: Since a lot of waste will be produced during the Games, Tokyo 2020 should strongly encourage the sorting of garbage by type so that recycling rates can be maximized. This in turn will minimize amount of waste sent directly to landfills. Product packaging can be made with recycled material. Even cooking oil can be recycled into biodiesel (a tactic implemented in Rio 2016).

Set sustainability targets and monitor progress: Both the Rio 2016 and London 2012 Olympics performed comprehensive tracking and reporting of their carbon footprint and sustainability initiatives. London 2012 published a comprehensive London Sustainability Report which analyzed how its Olympics performed vis-à-vis its original goals in a variety of sustainability-related metrics. London 2012 monitored its performance against these metrics before, during, and after the Games, and demonstrated that it had attained most of these goals.[38]

Overview: Circular Economy strategies for managing energy, food, and waste during the Olympics

Set sustainability targets
to promote accountability

Increase recycling rates
to reduce waste and carbon footprint

Reduce waste production
to reduce carbon footprint

Reduce energy use
to minimize operating costs

Promote sustainable food supply
to encourage sustainable farming and fishing industries

Increase use of clean energy
to reduce environmental pollution and costs

Increase use of clean energy

Since the Olympics are held during the summer when there is no shortage of sunlight, solar energy is particularly applicable. Solar power is one of the cleanest forms of energy available. It may make the most sense to install solar panels on facilities and buildings that will remain permanently standing, beyond Tokyo 2020. For temporary venues meant for post-game deconstruction, movable solar installations should be used. The panels can be shifted to permanent buildings (or attached back to the electric grid) after the event is over. The earlier these solar panels are installed, the sooner they can start generating a return on investment. In addition, Tokyo may wish to substitute fossil fuels for renewable and alternative fuels (eg. low-carbon fuels such as ethanol, biodiesel and electricity), as was the case in Rio 2016.

Where can this be applied?

Sporting events

Stadiums

Buildings

Tourism

Food catering

Logistics

How can this strategy be applied?

Use **solar panels** since the Olympics are held during the summer. Install earlier to yield return on investment earlier

Substitute fossil fuels for **renewable and alternative fuels** (eg. low-carbon fuels, such as ethanol, biodiesel and electricity)

Financial, social, and environmental benefits

Reduces long-term energy costs

Reduces carbon footprint

Successful examples

Liander head office, Netherlands: This was a large office complex (housing 1500 employees) which installed solar panels and underground water for thermal storage [39]

Rio 2016: Rio encouraged the substitution of fossil fuels for renewable and alternative fuels. Used cooking oil from the food catering process were recycled into biodisel

Promote sustainable food supplies

Tokyo 2020 may wish to prioritize local and national markets when sourcing for healthy and sustainable foods. This will help develop local industries and drive business growth. Food suppliers can be certified for sourcing their foods from sustainable agriculture and fishing industries. The certification can have traceability mechanisms that demonstrate the safety and origin of the product. This will promote sustainable practices in farming and agriculture across Tokyo and Japan. In terms of food catering, analysis has shown that producing beef meals involves the release of 15 times the carbon dioxide of chicken meals, and 5 times that of pork meals. Tokyo 2020 may wish to raise the prices of all beef meals during the event to discourage it consumption.

Where can this be applied?

Sporting events

Tourism

Food catering

How can this strategy be applied?

Prioritise **local and national markets** in supplier selection

Develop **certification programs** and traceability mechanisms

Set goals for **sustainable sourcing** (eg. serve only certified fish and seafood aross all Olympic events)

Financial, social, and environmental benefits

Promotes local businesses

Increases public trust

Ensures sustainable agriculture and fishing industries in Japan

Successful examples

Rio 2016: A policy of prioritising local suppliers helped transform small fishermen into suppliers for the 2016 Games. This boosted the development of a sustainable fishing supply, with benefits lasting beyond 2016. Brazil also established traceability mechanisms to verify the safety and origin of food products

London 2012: Served 15.5 million sustainably sourced meals. The Game attracted 0.5 million visitors over the same period [40]

Reduce energy use

One of the ways Tokyo 2020 can help reduce energy use is to lower fuel consumption. This can be done by giving priority to fuel efficient vehicles in the bus and coach transit systems used for the Games. Another way to reduce energy consumption is to use sustainable low-carbon footprint materials for Olympics-related merchandise. For example, during the Rio 2016 Olympics, Apparel and coins were the top 2 carbon emissions-generating products. For Tokyo 2020, discouraging the sale of these products will help significantly reduce the carbon footprint of the Games.

Where can this be applied?	How can this strategy be applied?
Transportation	Give priority to **fuel efficient vehicles** (private vehicles, public transit)
Logistics	Use sustainable **low-carbon footprint materials** for Olympics-related merchandise (eg. apparel and coins)
Merchandise	Promote production and sales of **long-life products** vs disposal merchandise
	Encourage sales of **mono-material** products, which are easier to recycle
	Discourage polyester t-shirts: producing polyester apparel requires a 260% higher carbon footprint than cotton
	Build **rooftop gardens** for large buildings. This helps remove heat from the air through plant transpiration, thereby reducing electricity costs

Financial and environmental benefits

Reduces carbon footprint

Reduces long term energy costs

Successful examples

Rio 2016: Active monitoring allowed Rio to identify apparel and coins as the top two carbon emissions-generating products [41]

Bloomsbury Street Hotel, London: the green roof of this hotel features "edible roof gardens" where organic vegetables are grown and then used in the Hotel's restaurant [42]

Another way to reduce energy use is to have rooftop gardens (i.e. green roofs) for large buildings. Not only are rooftop gardens aesthetically pleasing, they offer shade and remove heat from the air through plant transpiration. This reduces roof surface temperatures and that of the surrounding air, thereby reducing the need for air-conditioning.

Reduce waste production

In the spirit of reducing waste, Tokyo 2020 may wish to discourage excessive packaging for all event-related products (including utensils). Given the large number of visitors anticipated to arrive in Japan, even a small reduction in packaging quantity will have a major aggregate effect. Recent innovations have produced edible utensils (made of sorghum, rice, and wheat flours) which are both functional and edible. Tokyo 2020 may also look into optimizing food portion sizes to reduce waste from uneaten/leftover food. The city can establish partnerships with various charitable organizations to collect daily leftover foods that have remained fresh. Daily leftover food can also be processed and utilized as animal feed.

Where can this be applied?	How can this strategy be applied?
Food catering	Encourage all products (including utensils) to use **minimal packaging**
Logistics	For utensils, consider phasing out disposable cutlery and adopting **edible vegan utensils** (eg. Bakeys)
Merchandise	Optimizing food **portion sizes** to reduce possibility of uneaten/leftover food

Financial, social, and environmental benefits

Reduces carbon footprint

Reduces waste processing costs

Successful examples

Rio 2016: Ensured packaging for utensils met a set criteria for reduced packaging

Bakeys: This is an innovative firm that developed edible utensils as an alternative to disposable plastic and wood cutlery [43]

Increase recycling rates

Consumers often fail to put their garbage in the correct bin because they are not sure which bin it should actually go in. Figuring this out can sometimes be troublesome, time-consuming, especially when people are on the go. Tokto 2020 organizers can make this easier for visitors by requiring all event-related merchanise and items to be tagged with a color code that corresponds to the bin that it should be discarded in. This may be particularly helpful to foreign visitors since Japan's recycling classification system is seen by some as being more detailed than many other countries'. Color-coding disposable merchandise was something that London 2012 did painstakingly, and with great success, resulting in the diversion of 99.7% of all waste away from landfills. [44] To the maximum extent possible, product packaging should be made with recycled materials. The use of bottled water can be minimized by establishing water fountains at all events. Even cooking oil can be recycled into biodiesel (an approach that Rio 2016 took).

Where can this be applied?

Sporting events

Food catering

Logistics

Merchandise

How can this strategy be applied?

Make it easier for people to identify the right garbage bin: use **corresponding color codes** that match items to their waste bins

Establish more water fountains to reduce bottled water consumption

Manufacture packaging with **recycled material**

Financial, social, and environmental benefits

Reduces carbon footprint

Reduces waste processing costs

Successful examples

London 2012: Organisers used "strikingly visible and prominent coloured waste bins: green for recyclables, orange for compostables and black for non-recyclables". 77% agreed that it was easy to of recycle at the Games [45]

Rio 2016: Rio actively recycled cooking oil into biodiesel. The recycling of cooking oil avoids the possibility of water pollution (one litre of cooking oil can pollute more than 10,000 litres of water)

Set sustainability targets and monitor progress

Both the Rio 2016 and London 2012 Olympics performed comprehensive tracking and reporting of their carbon footprint and sustainability initiatives. London 2012 published a comprehensive London Sustainability Report which analyzed how its Olympics performed vis-à-vis its original goals in a variety of sustainability-related metrics. London 2012 monitored its performance against these metrics before, during, and after the Games, and demonstrated that it had achieved most of its goals.

Where can this be applied?

Stadiums

Buildings

Transportation

Logistics

Food catering

Sporting events

Merchandise

How can this strategy be applied?

Establish key **performance indicators (KPIs)**, which will be used to judge progress

KPIs can be measured in terms of **targets** for waste recycling, landfill diversion, waste disposal by type and method, carbon emissions, etc.

Measurement and assessment should be conducted **before, during, and after the Games**

Financial, social, and environmental benefits

Reduces carbon footprint

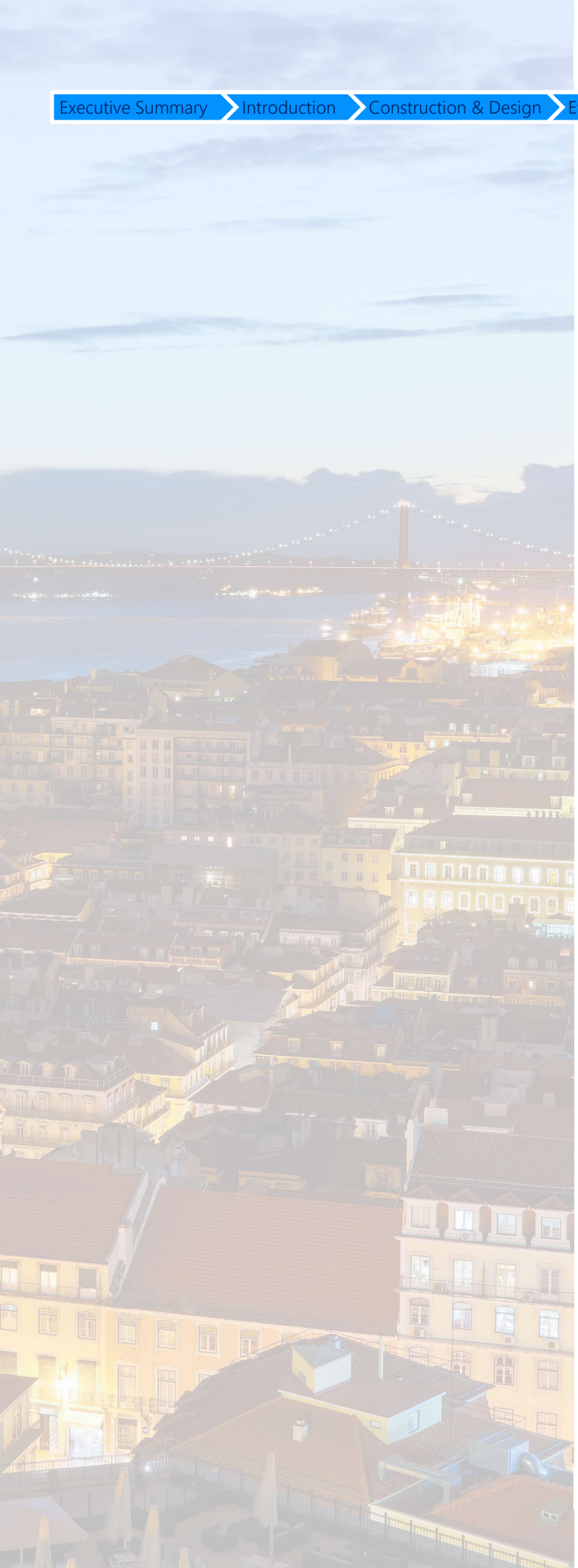
Reduces waste processing costs

Increases public trust

Successful examples

London 2012: Organisers did surveys before, during, and after the Games. They set specific targets on carbon emissions, recycling and reuse rates. The results were also published online. Publishing and tracking the results enabled the organisers to be fully accountable for their commitment to "Zero-waste Games": London 2012 diverted 99.7% of waste from landfills [46]

Rio 2016: Rio actively recycled cooking oil into biodiesel. The recycling of cooking oil avoids the possibility of water pollution (one litre of cooking oil can pollute more than 10,000 litres of water) [47]



Conclusions

In summary, large scale public events like the Tokyo 2020 Olympics can likely be optimized for sustainability and cost-savings simultaneously. Circular Economy strategies aim to achieve these two objectives together.

For Tokyo 2020, Circular Economy strategies can likely help make the Games more sustainable and affordable in the following key areas:

- Overall construction and design:
  - Apply modular design and construction methods
  - Apply lean design principles
  - Promote material reuse
  - Build to Last

- Event transportation:
  - Further improve subway and train systems
  - Further enhance bus system
  - Enable and promote cycling
  - Promote walking

- Energy, food, and waste management:
  - Increase use of clean energy
  - Promote sustainable food supplies
  - Reduce energy use
  - Reduce waste production
  - Increase recycling rates
  - Set sustainability targets and monitor progress

Next Steps

This report intends to provide an overview of the range of sustainable Circular Economy strategies that may benefit the large scale public events, such as the Tokyo 2020 Olympics. Many of the suggestions raised in this report are based on tried-and-true strategies undertaken by other Olympics host cities (notably Rio 2016 and London 2012).

Possible next steps may include more detailed study of the process of implementing each strategy. There can also be further research to quantify the costs and benefits of these strategies over the short and long term, so as to prioritize certain initiatives over others. Today, Circular Economy strategies are also increasingly being utilized in the private sector to bost reduce waste and improve sustainability. Additional research can help ascertain whether these strategies are can be applied to the Tokyo 2020 Olympics.

Endnotes

1. The Tokyo Organising Committee of the Olympic and Paralympic Games. (2016). *Tokyo 2020 Olympic and Paralympic Games High-level Sustainability Plan.* Tokyo: The Tokyo Organising Committee of the Olympic and Paralympic Games.

2. Ibid

3. Gibson, O. (2015, July 17). *Japan scraps Zaha Hadid plan for Olympic stadium*. Retrieved from The Guardian: https://www.theguardian.com/world/2015/jul/17/japan-scraps-zaha-hadids-tokyo-olympic-stadium-design

4. US Department of Energy. (2004). *The Economic Benefits of Sustainable Design.* US Department of Energy. Retrieved from https://www1.eere.energy.gov/femp/pdfs/buscase_section2.pdf

5. EY, Boston College. (2016). *Value of sustainability reporting.* Boston: Ernst & Young LLP.

6. Waste and Resources Action Programme. (2016, November 6). *WRAP and the circular economy*. Retrieved from WRAP: http://www.wrap.org.uk/about-us/about/wrap-and-circular-economy

7. World Economic Forum. (2014). *Towards the Circular Economy: Accelerating the scale-up across global supply chains*. Geneva: World Economic Forum.

8. Ibid

9. BBC. (2016, August 22). *Tokyo 2020: Lessons in management from Rio?* Retrieved from BBC: http://www.bbc.com/news/business-37151881

10. Leahy, J. (2016, July 7). *Brazil's Olympic costs running 51% over budget, report warns*. Retrieved from Financial Times: https://www.ft.com/content/ef122cb6-43d6-11e6-864d-01c0167ff470

11. LEED. (2016, December 1). *LEED*. Retrieved from LEED: http://www.usgbc.org/leed

12. Pennington, J. (2016, November 24). Airbnb's impact on the 2016 Olympics in Rio de Janeiro. (J. Xu, Interviewer)

13. Solomon, Richard . (2016, June 24). *Airbnb takes off in Japan, but the party is over for many seeking to ride the boom*. Retrieved from Japan Today: https://www.japantoday.com/category/opinions/view/airbnbtakesoffinjapanbutthepartyisoverformanyseekingtoridetheboom

14. Ellen MacArthur Foundation. (2016). *Circularity in the built environment: case studies*. CE100.

15. Ibid

16. Beers, Lucy. (2016, August 8). *What happens when the carnival moves on*. Retrieved from Daily Mail: http://www.dailymail.co.uk/news/article-3730579/AsRioOlympicskickseeriephotographsrevealderelictsitespastgames.html

17. Ibid

18. Ellen MacArthur Foundation. (2016). *Circularity in the built environment: case studies*. Ellen MacArthur Foundation.

19. Ibid

20. (2014, August 7). *Ghostly Ruins: Athens Olympic Venues Ten Years Later*. Retrieved from NBC News: http://www.nbcnews.com/news/europe/ghostly-ruins-athens-olympic-venues-ten-years-later-n175096

21. Ellen MacArthur Foundation. (2016). *Circularity in the built environment: case studies.* Ellen MacArthur Foundation.

22. Ibid

23. Ibid.

24. Rio 2016 Organising Committee for the Olympic and Paralympic Games. (2014). *Carbon Footprint Management Report.* Rio 2016 Olympic and Paralympic Games.

25. Rio 2016 Organising Committee for the Olympic and Paralympic Games. (2013). *Sustainability Management Plan: Rio 2016 Olympic and Paralympic Games.* Rio 2016.

26. Ibid

27. Ibid

28. Ibid

29. London 2012. (2012). *London 2012 Post-Games Sustainability Report.* London: London 2012.

30. Ibid

31. Rio 2016. (2013). *Sustainability Management Plan.* Rio 2016.

32. Ibid

33. (2016, October 20). *Two-wheel drive: China tech giants bet on 'Uber for bikes' in hunt for next unicorn*. Retrieved from Reuters: http://www.reuters.com/article/us-china-mobike-idUSKCN12K2ST

34. London 2012. (2012). *London 2012 Post-Games Sustainability Report.* London: London 2012.

35. Rio 2016. (2016). *Carbon Footprint Management Report Rio 2016 Olympic and Paralympic Games.* Rio 2016.

36. Ibid

37. Ibid

38. London 2012. (2012). *London 2012 Post-Games Sustainability Report.* London: London 2012.

39. Ellen MacArthur Foundation. (2016). *Circularity in the built environment: case studies.* Ellen MacArthur Foundation.

40. London 2012. (2012). *London 2012 Post-Games Sustainability Report.* London: London 2012.

41. Rio 2016. (2014). *Carbon Footprint Management Report.* Rio 2016.

42. Mavrogordato, Tass. (2013, August 13). *Offices are turning their roofs into edible gardens and bee sanctuaries*. Retrieved from The Guardian: https://www.theguardian.com/sustainablebusiness/officesroofsediblegardensustainablecities

43. Bakeys. (2016, November). *About us*. Retrieved from Bakeys: http://www.bakeys.com/aboutus/

44. London 2012. (2012). *London 2012 Post-Games Sustainability Report.* London: London 2012.

45. Ibid

46. Ibid

47. Rio 2016. (2014). *Carbon Footprint Management Report.* Rio 2016.