FIFA WORLD CUP
Brasil

Sustainability

Estimate of carbon footprint of the FIFA World Cup TV productions

October 2012

CONTENTS

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1. INTRODUCTION

In this study the carbon footprint of the 2014 FIFA World Cup TV productions, which corresponds to the responsibility of FIFA, is calculated as a forward-looking estimate of potential carbon emissions. There are no international standards for the calculation of carbon footprints of major sports events or the TV productions of such events. This study draws on the framework set up in the study for the estimate of FIFA's share of the carbon footprint of the 2010 FIFA World Cup (FIFA, 2010A).The methodology is based on the Greenhouse Gas Protocol (WRI and WBCSD, 2004).

Assigning a carbon footprint to an event or the TV productions associated with an event bears uncertainties in boundary-setting, i.e. the question of which activities should be included. Further, questions concerning quality should be kept in mind, i.e. concerning the robustness of the methodology and the emission factors chosen. With a boundary-setting process and methodology which aim at a high degree of completeness regarding the carbon footprint, and a selection of emission factors which follow a life cycle analysis view (comprising upstream and downstream emissions), these issues are addressed.

2. METHODOLOGY

2.1 Organizational Boundaries

The organizational boundaries have been set in accordance with the 2010 FIFA World Cup study. They enclose FIFA TV productions, but not the Local Organization Committee (LOC) and not the Media Right Licensees (MRL).

The temporal boundaries are enclosed by the outward and return journeys of TV production staff as well as the inbound and outbound transport of vehicles and equipment for the 2014 FIFA World Cup Brazil. The planning and contracting phases are not included.

2.2 Operational Boundaries

The operational boundaries are described in the following table.

Table 1: System boundaries of FIFA TV production

	Manufacturing	Inbound transport	Staging of FIFA World Cup	Outbound transport
Infrastructure				
BCs	(LOC)	(LOC)	power consumption	(LOC)
IBC	(LOC)	(LOC)	power consumption	(LOC)
Stadia	(LOC)	(LOC)	floodlight	(LOC)
Equipment				
Furniture; uniforms	included	regional transport	-	remains in Brazil
Cables	included	intn'l transport	power consumption	remains in Brazil
Tapes	included	intn'l transport	power consumption	intn'l transport
Further equipment	-	intn'l transport	power consumption, helicopter flights	intn'l transport
Satellites	-	-	transmissions	-
Staff	-	intn'l transport	natn'l transport, accommodation	intn'l transport

BCs – Broadcasting Compounds; IBC – International Broadcast Centre; LOC – Local Organizing Committee

Manufacturing is included for products manufactured specifically for TV production of 2014 FIFA World Cup Brazil or used only at 2014 FIFA World Cup Brazil and recycled or disposed of afterwards.

Not included in the operational boundaries is any merchandising of FIFA TV products, as well as any activities of TV stations and audience.

Emissions from fugitive refrigerants could not be considered, since FIFA TV was not able to provide any details of the air-conditioning system for Brazil at the time of the study completion.

2.3 Emission factors

Greenhouse gas (GHG) emissions are generally expressed as a weight of carbon dioxide equivalent (CO_2e). This is because other GHGs may have a different global warming potential (GWP) from carbon dioxide and it is usual to combine the effect of all greenhouse gases into one number for CO_2e. The GWP for CO_2 is set at 1. Global warming potentials for time horizon of 100 years of the other GHGs were taken from IPCC AR4 (2007).

The deduction of the activity data is illustrated in the respective chapters below. The emission factors are selected to represent life cycle emissions, to best fit the "polluter pays" principle. The main source for the emission factors was the database ecoinvent (2010) from the Swiss Centre for Life Cycle Inventories.

2.4 Methods for extrapolation

The main source for activity data was the 2010 FIFA World Cup. Since the number of stadia and Host Cities increased from South Africa (10) to Brazil (12), some data has to be extrapolated with a factor of 12/10. This applies mainly for venue-related activities and staff-related activities.

3. INFRASTRUCTURE

3.1 Power consumption (IBC and BCs)

The IBC and BCs have an independent power supply for the so-called Broadcasting Power. While Broadcasting Technical Power (utility power and cooling) is fully provided by diesel generator utilities, Broadcasting Domestic Power (lighting) had been provided from grid for a limited number of days. For this GHG inventory, power consumption at IBC and BCs is modelled as 100% diesel generator power, since data on grid consumption is not available.

Since broadcasting power is consumed by FIFA TV as well as by MRLs, the associated emissions have to be allocated to these two consumers as well.

3.1.1 IBC

System boundaries
- manufacturing: not included, under responsibility of LOC
- inbound and outbound transport: not included, under responsibility of LOC
- staging: power consumption included

Activity data
Activity data is based on 2010 FIFA World Cup South Africa data.
- operations (2 June – 12 July; 41 days) 16'000 litre diesel were used per 24h on average
- pre-operations: (24 March – 24 May; 69 days): average consumption per day is estimated to be half the amount of operation phase (=8'000 l diesel per day)
- operational period is 24/7
- pre-operational period is 7 days a week, power generators are switched off from 22.00 – 07.00

Table 2: IBC diesel consumption

	L diesel / 24 h	duration	L diesel
operations	16'000	41 x 24h	656'000
pre-operations	8'000	69 x 15h	345'000
total			**1'001'000**[1]

Based on estimates from FIFA TV, IBC power consumption is allocated as follows[2]:
- FIFA TV share: 10%
- MRLs share: 90%

1 The result is supported by a quote from the power generation provider that diesel consumption at the IBC was "just around 1'000'000 L"

2 Models for allocation of power between FIFA TV, MRLs and other clients are estimated based on the information available from the official booking system at the 2010 FIFA World Cup.

3.1.2 BC

Actual diesel consumption data for BCs was not available from 2010 FIFA World Cup South Africa. Instead, the diesel consumption was estimated, based on two extrapolation models from FIFA TV.

System boundaries
- Manufacturing: not included, under responsibility of LOC
- Inbound and outbound transport: not included, under responsibility of LOC
- Staging: power consumption included

Activity data
Model 1: estimation by venue
- match days: total of 20’000 l diesel is consumed on average per venue over all match-days
- additional (non-match days; set-up): 10’000 l diesel is consumed on average per venue

Table 3: BCs diesel consumption by venues (model 1)

	L diesel / venue	L diesel (10 venues)[3]
match days (48h / match)	20’000	200’000
non-match days	10’000	100’000
total	**30’000**	**300’000**

Model 2: estimation by load
- Match days: 206kW load over 48 hours
- Additional (non-match days; set-up): 50kW load over 50 days
- 0.2 L diesel consumption per kWh

Table 4: BCs diesel consumption by load (model 2)

	hours	kW load	L/kWh diesel	L diesel
match days	3’072h (64 matches x 48h)	206	0.2	126’566
non-match days	14’400h (12 venues x 50d x 24h)	50	0.2	144’000
total				**270’566**

For the GHG inventory, the mean of both models is used, that is 285’000 L diesel consumption[4]. Based on estimates from FIFA TV, BCs power consumption is allocated as follows[5]:
- FIFA TV share: 25%
- MRLs share: 75%

3 Even though in Brazil a total of 12 stadia will be set up, the numbers are extrapolated with the South Africa number of venues (10). With 12 venues, the diesel consumption per venue will be considerably lower, hosting only 5-6 matches on average, compared to 6-7 matches.
4 FIFA TV considers both models valid, since “all estimations are within a +/- 20% range in any case”.
5 Models for allocation of power between FIFA TV, MRLs and other clients are estimated based on the information available from the official booking system at the 2010 FIFA World Cup

3.1.3 GHG emissions

The emission factor for diesel combustion was modelled from ecoinvent modules. It also includes upstream emissions of oil extraction, refinement, and transport.

Table 5: GHG emissions of IBC and BCs power consumption

	L diesel	kg CO_2e / L	t CO_2e (total)	FIFA share	t CO_2e (FIFA)
IBC	1'000'000	3.16	3'160	10%	316
BCs	285'000	3.16	901	25%	225
total	**1'285'000**		**4'061**		541

3.2 Floodlight

For the 2014 FIFA World Cup Brazil, stadia floodlights need to provide 2'000 Lux minimum in order to guarantee for HD TV quality. Before, 1'600 Lux was the quasi-standard for stadia: Hence, the additional power consumption to provide the extra 400 Lux should be attributed to the FIFA TV carbon footprint.

System boundaries

- manufacturing: not included, under responsibility of stadium authority
- inbound and outbound transport: not included, under responsibility of stadium authority
- staging: power consumption included for extra 400 Lux

Activity data

- duration per match: from 3h before kick-off until 1h after final whistle plus extra 0.5h at reduced level (=6h per match)
- non-match activities (official training, unilateral activities etc.): estimated to be another 6h per match
- Cape Town stadium was taken as reference for the floodlight capacity with its 360 2kW spray lights "ring of fire"[6]
- linear allocation was applied for the extra 400 Lux in the total 2'000 Lux (=20%)

Emissions

The emission factor for grid power in Brazil was taken from ecoinvent.

Table 6: GHG emissions of floodlight

	h	kW floodlight capacity	kg CO_2e / kWh	t CO_2e (total)	FIFA share	t CO_2e (FIFA)
match	64 x 6	720	0.29	80	20%	16
non-match	64 x 6	720	0.29	80	20%	16
total				**160**		**32**

6 see 2010 FIFA World Cup - Host City Cape Town - Green Goal Legacy Report, p.28 for details

4. EQUIPMENT

4.1 Tapes

Tapes are used to store and archive the TV productions.

System boundaries
- manufacturing: included, since the tapes are used only once.
- inbound and outbound transport: included, tapes go back to FIFA HQ in Zurich, Switzerland
- staging: indirect energy consumption through recording devices (included in energy consumption of BCs and IBC)

Activity data
- total of 3'800 tapes was used at 2010 FIFA World Cup South Africa
- number taken for 2014 FIFA World Cup Brazil without further adaption
- transportation is accounted for in the category "transportation of goods"

Emissions
The tapes have been modelled based on general data of LTO tapes (Linear Tape-Open). The following estimates have been applied:
- total weight: 0.3kg
- casing: 0.17 kg plastic
- tape: 0.13 kg magnetite and PET

Table 7: GHG emissions of tapes

units	kg CO_2e / unit	t CO_2e
3'800	2.0	8

4.2 Cables

System boundaries
- manufacturing: included, since the cables are used at the FIFA World Cup primarily. Afterwards they are donated or go into recycling.
- inbound transport: included, cables are sent from Europe to Brazil
- staging: indirect energy consumption through plugged devices (included in energy consumption of BCs and IBC)
- outbound transport: excluded, cables will remain in Brazil for reuse or recycling

3 ISO's guidance on social responsibility

Activity data
BC's:
- total of 1'200 km cables was used in South Africa
- extrapolation with stadia quota 1.2 results in 1'440 km for Brazil

IBC:
- total of 800 km cables was used in South Africa
- number taken for Brazil without further adaption since IBC will have similar size in Brazil

Transportation is accounted for in the category "transportation of goods"

Emissions
The emission factor for cables was taken from ecoinvent. It was modelled as 50% "data cable in infrastructure" and 50% "connector for computer".

Table 8: GHG emissions of cables

	km	kg CO_2e / m	t CO_2e
BCs	1'440	0.26	374
IBC	800	0.26	208
total	**2'240**		**582**

4.3 Furniture

System boundaries
- manufacturing: included, since furniture is used at the FIFA World Cup primarily. Afterwards it is donated or goes into recycling
- inbound transport: included
- staging: no emissions
- outbound transport: excluded, furniture will remain in Brazil for reuse or recycling

Activity data
BC's:
- total of 6'000 units was used in South Africa
- extrapolation with stadia quota 1.2 results in 7'200 km for Brazil

IBC:
- total of 5'000 units was used in South Africa
- number taken for Brazil without further adaption since IBC will have similar size in Brazil

Emissions
The furniture has been modelled based on the myclimate-internal database. It was assumed that all furniture is produced locally in one region in Brazil and transported 2'000 km by road transport to their final destinations in the Host Cities. This distance is based on the mean road distance of 1'660 km between Rio de Janeiro and Host Cities.[7]

The IBC furniture was specified by furniture type. For BCs furniture the same ratio was applied to calculate an emission factor per average unit of furniture.

Table 9: weight and GHG emissions of different furniture types

	IBC ratio	kg CO_2e / piece	weighted kg CO_2e
executive chair	600/5'000	160	19.2
basic chair	2'200/5'000	80	35.2
desk	900/5'000	160	28.8
waste bin	1'300/5'000	10	2.6
average unit			**85.8**

Table 10: GHG emissions of furniture at BCs and IBC

	units	kg CO_2e / unit	t CO_2e
BCs	7'200	85.8	618
IBC	5'000	85.8	429
total	**12'200**		**1'047**

4.4 Uniforms

System boundaries
- manufacturing: included, since uniforms are produced for the FIFA World Cup
- inbound transport: included; uniforms are sent from China to Brazil
- staging: emissions from cleaning energy are insignificant and are under the responsibility of staff
- outbound transport: excluded, uniforms will remain in Brazil for recycling or be reused by staff

Activity data
- total of 2'400 sets was used in South Africa
- extrapolation with stadia quota 1.2 results in 2'880 sets for Brazil
- one set consists of 2 trousers, 3 t-shirts, 1 jacket, 1 sweater, 1 cape, and 1 cap

7 see Annex for all calculations of mean distances

Emissions

The uniform has been modelled based on the myclimate-internal database on shirts with cotton and synthetic fabrics. It was assumed that all uniforms are produced in China and transported 20’000km by sea (Shanghai to Rio de Janeiro) plus 1’660km for mean road distance between Rio de Janeiro and Host Cities.[8]

The following weights have been estimated, resulting in a total of 3kg:

- 2 trousers (2 x 300 gr)
- 3 t-shirts (3 x 200 gr)
- 1 jacket (700 gr)
- 1 sweater (500 gr)
- 1 cape (500 gr)
- 1 cap (100 gr)

Table 11: GHG emissions of uniform manufacture

# sets	kg	kg CO_2e / kg	t CO_2e
2880	8’640	50.5	436

4.5 Helicopter flights

System boundaries

- imanufacturing: not included
- iinbound and outbound transport: included
- istaging: emissions from helicopter operations

Activity data

- ihelicopters are flying for 2h per match
- iit is estimated that helicopters are rented from a regional provider, totalling 1 hour for inbound and outbound transport per match

Emissions

The emission factor for helicopter transport was taken from ecoinvent (excl. the allocated emissions from manufacturing).

Table 12: GHG emissions of helicopter flights

duration	kg CO_2e / h	t CO_2e
64 x 3h	96.5	19

8 see Annex for all calculations of mean distances

4.6 International transportation of equipment

Activity data

- see Annex for all calculations of mean distances air freight (commercial):
  - 70 tons equipment was shipped as commercial air freight bidirectional between Europe and South Africa in 2010.
  - extrapolation with stadia quota 1.2 results in 84 tons for Brazil
  - average one-way distance was modelled as Zurich / Rio de Janeiro. Additionally, 1'238 km for distribution to one of the Host Cities was considered. This is the mean flight distance between Rio de Janeiro and the Host Cities[9]
- sea freight:
  - 590 tons sea freight was shipped bidirectional between Europe and South Africa in 2010
  - extrapolation with stadia quota 1.2 results in 708 tons for Brazil
  - average one-way distance was modelled as Rotterdam / Rio de Janeiro for the sea leg[10] and additional 2'460 km road leg (800 km for Zurich/Rotterdam and 1'660 km for mean road distance between Rio de Janeiro and Host Cities)

Emissions

The emission factors were adapted from ecoinvent:

- air freight: emission factor for international air freight, multiplied by a factor of 2 to take the non-CO_2 effects of aviation emissions into account (myclimate 2010)
- sea freight: emission factor for transoceanic freight ship, adapted to container ship
- road transport: emission factor for lorry, 7.5-16 t, EURO 4

Table 13: GHG emissions of transportation of goods

	tons	route	km	kg CO_2e / tkm	t CO_2e
equipment (air freight)	84	Zurich/Rio + Host Cities	2 x 10'620	2.125	3'791
equipment (sea; sea leg)	708	Rotterdam/Rio	2 x 9'685	0.029	398
equipment (sea; road leg)	708		2 x 2'460	0.222	773
total					**4'962**

9 see Annex for all calculations of mean distances
10 Sea freight distances calculated using http://www.portworld.com/map/

5. SATELLITE TRANSMISSION

System boundaries
Satellite transmission is used as service during the staging of the FIFA World Cup. Two types of transmissions are included in this GHG inventory:
- from BCs to IBC
- from IBC to media stations

Activity data
Per match the following satellite capacity is booked for 3 hours:
- for BC to IBC transmission: 4 transponder (36MHz)
- for IBC to media stations transmission: 2 transponder (36MHz) and 2 transponder (18MHz)

Emissions
Emission factors for satellite transmission are not publicly available to the best of myclimate's knowledge. The emissions have been estimated based on the corporate carbon footprint of SES, a major satellite operator[11]. However, the quality of this estimation is uncertain, especially whether or not the actual launches of satellites are accounted for, since this is outsourced. It is clearly stated that SES included purchased goods and services, yet details on outsourced services are missing.

Table 14: GHG emissions of satellite transmission

	h transmission	# transponders	kg CO_2e / transponder x h	t CO_2e
BCs to IBC	192 (64 matches x 3h)	4	3.4	2.6
IBC to media stations	192 (64 matches x 3h)	4	3.4	2.6
total	**384**			**5.2**

11 Emissions per 365 x 24 h: Quotient of total carbon footprint of SES in 2011(scope 1,2, and 3): 39'200 t CO_2e (see SES, 2012A), over total transponder capacity in 2011: 1'315 of 36MHz transponder (see, SES, 2012B, slide 11)

6. STAFF

6.1 International transport

International transport covers the outward and return journey of FIFA TV staff. Each person travels to and from Brazil only once.

Activity data

- total FIFA TV staff at 2010 FIFA World Cup South Africa was 2’600 persons
- extrapolation with stadia quota 1.2 results in 3’120 persons for Brazil
- FIFA TV estimated that staff will be mainly from Europe with around 10 per cent from South America (= 312 persons)
- further it was estimated by FIFA TV that around 15-20% of the intercontinental flights will be business class (=17.5%) and 80-85% economy class (=82.5%)
- intercontinental flights were modelled as Zurich / Rio de Janeiro
- flights within South-America were modelled as half-distance of Bogota / Rio de Janeiro
- Rio de Janeiro was taken as hub for Brazil with one domestic flight. Mean flight distance between Rio de Janeiro and Host Cities is 1’238 km[12], therefore Rio de Janeiro / Salvador (1’204 km) was taken for the emission calculation of the domestic flights.

Emissions

The flights were calculated using the myclimate flight calculator[13], performing the following steps:

- for each pair of airports, the flight distance is calculated with the great circle distance and corrected with a detour factor
- fuel consumption is extrapolated with generic aircraft types (with a distinction being made between short and long-haul flights), taking into account average seat utilization, number of seats and cabin class
- to derive the global warming potential, the non-CO_2 effects of aviation emissions are also taken into account (myclimate 2010)

For further explanation and details of parameters, see myclimate (2010).

Table 15: GHG emissions of international transport

	route	km	passengers	t CO_2e / round trip	t CO_2e
intercontinental Business	Zurich/Rio/Zurich Rio/Salvador/Rio	18’763 + 2’408	491	8.18	4’016
intercontinental Economy	Zurich/Rio/Zurich Rio/Salvador/Rio	18’763 + 2’408	2’317	4.51	10’450
South America Economy	Bogota/Rio Rio/Salvador/Rio	4’547 + 2’408	312	1.45	452
total			**3’120**		**14‘918**

12 All flight distances calculated using the myclimate flight calculator (https://www.myclimate.org/nc/offsetting/co2-offsetting/offset-your-flight.html). See Annex for calculation of mean distance between Host Cities.
13 https://www.myclimate.org/nc/offsetting/co2-offsetting/offset-your-flight.html

6.2 Accommodation

Activity data

- at 2010 FIFA World Cup South Africa, FIFA TV staff had a total of 65’000 room nights
- extrapolation with stadia quota 1.2 results in 78’000 room nights for Brazil since there will be on average more staff in Brazil than in South Africa
- FIFA TV estimated that staff will mainly stay at hotels of 3-star category, with around 100 persons to stay at hotels of 4-5 class category

Emissions

The emission factor for hotel stay was taken from the Carbon Footprint study of FIFA (2010B). The myclimate database has carbon footprint data for several hotel classes. Electricity consumption is a major source of GHG emissions associated with hotel stays. Therefore the emission factors were adapted to Brazil, using the country mix of electricity from ecoinvent. Further, emissions from other resource consumption, such as heating demand and food, are included with a star-category specific term. The emission factor for category 4/5-stars is the mean of the respective 4-star and 5-star emission factor.

Table 16: GHG emissions of accommodation

	room nights	kg CO_2e / room night	t CO_2e
3-star hotel	75’500	12.9	974
4/5-star hotel	2’500	40.4	101
total	**78’000**		**1’075**

6.3 National transport

National transport covers the transport of FIFA TV staff in Brazil during the staging of the 2014 FIFA World Cup. The geographical characteristics of Brazil and its Host Cities had an impact on national transport. While road transport was predominant in South Africa for inter-city transport, charter flights will play an important role in Brazil, due to the large distances between the Host Cities. On the other hand, public transport might play a more important role in the intra-city transport in Brazil, compared to South Africa.

Activity data

- there will be 48 charter flights, each for around 120 passengers and an average duration of 80 minutes
- daily staff transportation between accommodation and IBC / BCs was modelled as 50 km bus transport on average. Based on the room nights to staff quotient, an average stay of 25 days was assumed (78’000 / 3120 = 25)
- at 2010 FIFA World Cup South Africa, a total of 3’000 Taxi Service trips took place for FIFA TV staff between accommodation and IBC. Extrapolation with stadia quota 1.2 results in 3’600 trips for Brazil, estimated to transport 10 persons over 50 km on average.

Emissions

- the emission factor for charter flights were calculated with the above described myclimate flight calculator. Rio de Janeiro to Belo Horizonte was taken as reference flight. Since this flight takes 75 minutes only, the respective emissions have been adapted by a factor of 80/75.
- the emission factor for coach and shuttle transport was taken from ecoinvent.

Table 17: GHG emissions of national transport

	passengers or trips	kg CO_2e / unit	t CO_2e
charter flights	48x120 passengers	129.9	748
50 km road (venue)	3'120 passengers daily, over 25 days	2.6	203
50 km road (social)	3'600 trips	26.1	94
total			**1'045**

7. SUMMARY OF RESULTS

As shown below, the carbon footprint of 2014 FIFA World Cup TV productions, which corresponds to the responsibility of FIFA, is estimated at around 24’670 t CO_2e. Major contributor is international travel, being responsible for more than half of the emissions. Another significant share with almost a quarter of the total footprint is caused by air freight.

Table 18: GHG emissions of 2014 FIFA World Cup TV productions

	t CO_2e	%
power consumption (IBC&BCs), floodlights	573	2%
equipment, satellite transmission	2‘097	9%
air freight	3‘791	15%
sea freight	1‘171	5%
international travel	14‘918	61%
national travel	1‘045	4%
hotel stays	1‘075	4%
total	**24‘670**	**100%**

8. CONCLUSIONS AND RECOMMENDATIONS

Ex-ante calculations of carbon footprints are subject to known and unknown uncertainties. First of all, it is challenging to correctly define the scope of an event that will happen in the future. Since the FIFA World Cup and its TV production are staged every four years, FIFA knows very well the associated activities. Therefore, the uncertainties from the scope of the carbon footprint analysis are considered to be irrelevant.

Secondly, the actual consumption data regarding the defined activities is difficult to correctly estimate in advance. The effective consumption data can only be assessed retrospectively. Again, the routine in performing the FIFA World Cup TV productions as well as the experience of the people involved in this project reduced the uncertainties in this area. Below, the major remaining uncertainties are specified.

Besides activity data, emission factors play an important role for the quality of the final results. Adequate emission factors were available or could be modelled for all activities but satellite transmission.

Power consumption at IBC and BCs
The quality of the actual consumption data is good. It is either based on 2010 FIFA World Cup South Africa data (IBC) or has been validated with two different extrapolation models (BCs) that differ by 10% only.

However, the allocation of power consumption to FIFA and the MRLs had to be approximated from the official booking system at the 2010 FIFA World Cup. However, even a margin of error of 100% in the allocation of FIFA's share would increase the total carbon footprint of FIFA World Cup TV productions by a mere 2% and is therefore not considered a critical source of uncertainties.

Refrigerants
Air-conditioning systems can be a source of GHG emissions, if fugitive emissions of certain types of refrigerants occur (see table 19). In this inventory, GHG emissions from refrigerants could not be considered, since FIFA TV was not able to provide any details of the air-conditioning system for Brazil at the time of the study completion. Since certain refrigerants have a very high global warming potential (e.g. R-22 has a GWP about 1'800 times higher than CO_2), this aspect of the carbon footprint of the FIFA World Cup TV productions has critical uncertainties and should be updated, once the specification for the air-conditioning systems are available.

Table 19: GWP critical refrigerants

chemical group	regulations
HCFCs, CFCs (e.g. R12,R22)	banned or phase-out by 2020 in most industrial countries (Montreal Protocol)
PFCs (Fluorocarbons)	covered in Kyoto Protocol
HFCs (Hydrofluorocarbons)	covered in Kyoto Protocol

Cables
The cable data has high accuracy with regard to the total length of the cables. However, the specific weight of the cables is uncertain. For this study, the average cable was modelled with ecoinvent modules, as 50% "data cable in infrastructure" and 50% "connector for computer". That results in a specific weight of 60 gr/m.

According to feedback of FIFA TV to the first draft of this study, the specific weight of cables is more likely to be in the area of 400 to 600 gr/m. An average specific weight of 500 gr/m would result in a total weight of 1'120 t for the cables. Since this amount is inconsistent with the sea freight, which totals 708 t and includes further goods besides cables, the specific weight was not adapted in the study.

Running the analysis with the higher specific weight would add 2'892 t CO_2e emissions (12%). Therefore, the weight of the cables is a critical uncertainty as well.

- Manufacturing: thicker cables have higher emission per m of cable, yet the relative emission factor per kg of cable decreases.
  - Besides "three-conductor cable" with a specific weight of 1.04 kg / m, all other cables in ecoinvent are thin cables with a specific weight of less than 0.075 kg / m. Therefore the emission factor of "three-conductor cable" was taken and adapted to the specific weight of 0.5 kg / m
  - cable emissions: 2'240 km x 1.186 kg CO_2e/m = 2'657 t CO_2e (an extra 2'075 t CO_2e)
- Transport: thicker cables have higher weight and therefore higher transport emissions
  - relative sea freight emissions (one-way: sea leg + road leg): 0.83 t CO_2e / t
  - cables extra weight: 2'240 km x (500 gr/m – 60 gr/m) = 986 t
  - additional transport emissions: 986 t x 0.83 t CO_2e / t = 818 t CO_2e

Staff
Accounting for more than 60% of the emissions, international travel of staff is the main driver for the carbon footprint of FIFA World Cup TV production. On average, the international travel emissions are 4.78 t CO_2e per person. Therefore, a 10% change of the total amount of staff would change the emissions from international travel by almost 1'500 t CO_2e, which corresponds to 6% of the total carbon footprint. Accordingly, the emissions from national travel (extra 105 t CO_2e) and accommodation (108 t CO_2e) would change as well. In total, a 10% change in staff number would change the carbon footprint by 7%.

The share of international staff is a further driver of international travel emissions. Due to language challenges, the share of local employees will decrease from 15% (FIFA World Cup 2010) to 10% (FIFA World Cup 2014). With a 15% share of local employees, flight emissions would change as follows:

- intercontinental flights: decrease by 804 t CO_2e
- South American flights; increase by 227 t CO_2e

In total, the emissions would be lower by 577 t CO_2e (2%). Therefore, this issue is not considered a critical source of uncertainties.

Satellite transmission
As mentioned in chapter 5, an emission factor for satellite transmission has been estimated based on the corporate carbon footprint of a major satellite operator. Since it is uncertain, whether or not the actual launches of satellites are accounted for, this is also a critical uncertainty for which the margin of error cannot be calculated.

9. GLOSSARY & ABBREVIATIONS

Parts of this glossary were adopted from the Greenhouse Gas Protocol Corporate Standard (WRI and WBCSD, 2004).

BCs	Broadcasting Compound
Carbon dioxide	A greenhouse gas
CO_2-equivalent	CO_2-equivalents (CO_2e) are the universal unit of measurement to indicate the global warming potential (GWP) of each of the six greenhouse gases; expressed in terms of the GWP of one unit of carbon dioxide. The term is used to evaluate the release (or the prevention of the release) of different greenhouse gases against a common basis.
Emission factor	A factor allowing GHG emissions to be estimated from a unit of available activity data (e.g. tons of fuel consumed, tons of product produced) and absolute greenhouse gas emissions.
Greenhouse gas	For the purposes of this study, greenhouse gases are the six gases listed in the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs); perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6).
Greenhouse Gas Protocol	A corporate accounting and reporting standard for greenhouse gas emissions.
Global warming potential	A factor describing the radiative forcing impact (degree of harm to the atmosphere) of one unit of a given GHG relative to one unit of CO_2.
Hydrofluorocarbon	Hydrofluorocarbons (HFCs) are compounds derived from hydrocarbons by partial replacement of hydrogen atoms by fluorine atoms. Hydrofluorocarbons are greenhouse gases.
IBC	International Broadcast Centre
LOC	Local Organization Committee
Methane	A greenhouse gas
MRL	Media Right Licensees
Nitrous oxide	Nitrous oxide (N_2O), commonly known as “laughing gas”. A greenhouse gas.
Perfluorocarbon	Perfluorocarbons (PFCs) are compounds derived from hydrocarbons by replacement of hydrogen atoms by fluorine atoms. Perfluorocarbons are greenhouse gases.
pkm	Person kilometer
Radiative forcing	The role of different greenhouse gases in global warming varies due to their different properties. In scientific publications the contribution of a greenhouse gas is referred to as radiative forcing.

10. LITERATURE

ecoinvent (2010)	Ecoinvent database v2.2
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ANNEX

Table 20: distances of host cities from Rio de Janeiro

	air distance (km)	road distance (km)
Rio – Rio	0	0
Rio – Sao Paulo	353	450
Rio – Manaus	2'839	4'250
Rio – Fortaleza	2'181	2'650
Rio – Natal	2'079	2'600
Rio – Recife	1'862	2'300
Rio – Salvador	1'204	1'630
Rio – Cuiaba	1'569	2'000
Rio – Brasilia	918	1'200
Rio – Belo Horizonte	345	450
Rio – Curitiba	374	850
Rio – Porto Alegre	1'129	1'550
Mean distance	**1'238**	**1'660**

Air distances were calculated with myclimate online flight calculator, road distances with www.maps.google

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