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Analysis of the Impact of the FIFA World Cup Brazil 2014 Games on Overall Consumer Behaviors

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Abstract

This paper presents the analysis of the impact of the 2014 soccer FIFA World Cup held in Brazil. This paper focuses on analysis of load curves provide for transmission systems in 4 countries: Brazil, Germany, France and Portugal. The paper shows the behavior of energy consumption before, during and after each game involving these 4 countries, which take part of the ELECON project (Electricity Consumption Analysis to Promote Energy Efficiency Considering Demand Response and Non-technical Losses), comparing at the same time the load profile in each country. This topic was chosen due to the high influence that soccer on many countries, specially in Brazil were the impact in the energy consumption was very strong when compared with the other countries.

Keywords: Energy consumption, Load profile, Soccer.

1. Introduction

Nowadays the energy consumption is increasing with the growing of cities around the world. Recent numbers indicate that the worldwide demand will reach 33,300 TWh by 2030, which is a 60% increase from the 21,000 TWh in 2010 [1]. For this reason, this topic is not only analyzed for the government energy program but also for investors, utilities, service marketers, consumers and academics, specially due to the tendency of demand peaks which put in risk the reliability and cost of the service with shutdowns.

For this and other reasons, it is necessary to know the behavior of the consumption of energy in each season of the year, for individual and collective customers. In some cases some events can change the behavior of the consumed energy, as for example during the FIFA World Cup. This is the most important event in the soccer area. It involves several national teams around the world. Other works about power system analysis during the world cup around the world have been published as described in [2] when the impact of the world cup games in the harmonic distortion is analyzed. In this paper an analysis on the energy consumption behavior during some of the World Cup Brazil 2014 matches is presented. As ELECON project involves universities from Brazil and Europe, the involved countries were taken into account to compare the energy consumption in the transmission network during the games. The matches occurred during the period from 12 June 2014 up to 13 July 2014. The countries involved are Brazil, Germany, France and Portugal. In the next chapter each transmission company involved in the study is

described. The analysis of the load curves is carried out according to the available information from the transmissions companies. The consumption during the days of the world cup is compared on the same weekly day and one or more weeks before and/or after, and sometimes through the operator´s forecast.

2. The Transmission System Operators

In this chapter are presented the main characteristics of the transmission operator companies of the 4 countries used in this paper: ONS (Brazil), 50Hertz (Germany), RTE (France), REN (Portugal).

2.1. ONS - Brazil

Currently, in Brazil, the *Operador Nacional do Sistema Elétrico ONS* (Electric System National Operator) is an entity of private right, non-profitable, created on 26 August 1998, responsible for coordinating and controlling the operation of generation and transmission facilities in the Sistema Interligado Nacional SIN (National interconnected Power System) under supervision and regulation of the Electric Energy National Agency (ANEEL). The Operator is composed of associate members and participating members.

The activities performed by the Electric System National Operator produce benefits for all the sector agents. It also has effects on consumers and, more generally, on society as a whole.

About 80% of energy generation in Brazil is from hydroelectric and there are more than 100,000 km of AC transmission lines from 230 to 750 kV and DC transmission lines in 600 - 800 kV. There are 108 transmission companies in Brazil around its 5 regions: South, South-East, Center-West, North-East and part of the North. All information used in this paper about Brazil is obtained at the ONS web site [3].

2.2. 50 Hz – Germany

In Germany there are 4 transmission companies: EnBW Transportnetze, Tennet TSO, Amprion and 50Hertz Transmission. In this paper 50Hertz was selected for the analysis which is responsible for the operation, maintenance, planning, and expansion of the 380/220 kV transmission grid throughout the northern and eastern part of Germany. The 50Hertz grid covers an area larger than 109,360 km² and runs a length of approximately 10,000 km (the distance from Berlin to Rio de Janeiro). This system supplies power to around 18 million customers and already takes up 40% of the wind power installed in Germany. The total energy production in 2013 was 629 TWh. All information related with the 50Hertz Transmission was obtained from its web site [4].

2.3. RTE – France

The French Transmission System Operator is RTE – Réseau de Transport d'Electricité (Network of Transmission of Electricity). It is a public company responsible for the entire transmission system of France. The system is constituted of 100,000 km of lines from 63 to 400 kV and 45 cross-border lines. In 2008, RTE posted turnover of €4,221m and currently employs around 8,500 staff. The aim of RTE is to ensure the operating and developing of the transmission network and ensure its stability and reliability.

The transmission network remains a monopoly despite of the opening of the electricity market. RTE has a mission of public service whose rules are defined by French law and the French energy regulator (CRE – Commission de Régulation de l'Energie). Every user of the electricity transmission system has to be treated in a non-discriminatory manner with public access charges that do not depend on the distance between the supply and the consumer. The CRE is responsible for fixing the tariff of electricity for using the transmission system – otherwise known as the TURPE charge. RTE also has to ensure compliance to the rules of interconnections between the different European TSO. Those rules are managed by the ETSOE (European Transmission System Operators for Electricity).

Then RTE has to guarantee – at the costs fixed by the authorities – the continuity and quality of supply of electricity. The guarantee of the continuity of supply is obtained by ensuring the balance of electricity flows on the network at all times. This balance is possible thanks to an accurate forecast of the consumption [5].

2.4. REN – Portugal

REN – Redes Energéticas Nacionais – is the transmission system operator of Portugal. It operates the transmission electrical system but also the natural gas system of Portugal (reception, storage and regasification). It also has activities in generation (Enondas – Energia das Ondas, electricity generated from sea waves) and telecommunication via RENTELECOM. Furthermore the company capital has international partners like State Grid and Oman Oil.

The objectives of REN are to ensure an uninterrupted supply of electricity and natural gas at the lowest cost with quality and safety. Furthermore all consumers have to have an equal access to infrastructures. In order to ensure an uninterrupted supply REN has to maintain the balance between those who require and those who supply energy.

REN has 8,733 km lines all over the country. The 400 kV grid lines mainly run north to south near the coast from the Alto Lindoso power station in the north to the Algarve, and west to east, where they interconnect with the Spanish grid. The 220 kV lines basically run between Lisbon and Oporto, diagonally between Miranda do Douro and Coimbra, along the River Douro and in Beira Interior. The extra high voltage grid is complemented by 150 kV lines, the first ever voltage in the RNT (since 1951). Operation is responsible for keeping all equipment and systems up and running efficiently [6].

3. Impact of the FIFA World Cup 2014 on the consumer behavior

In this section an analysis of the impact of some important matches during the FIFA World Cup 2014 in the consumer behavior of countries such as Brazil, France, Germany and Portugal is presented. The analysis is focused on the main four points of the game: the first half, the half time, the second half and the end of the game. All time intervals presented are in local time. For each country in the ELECON project, 4 or 5 matches are presented. The first and last matches are also studied. Some times 2 or 3 curves are analyzed at the same time depending on the available information from the TSO websites.

3.1. Brazil

- Thursday 12th June:Brazil vs Croatia 17h (3-1)

The opening ceremony of the World Cup occurred at 15h15. In Fig.1 it is possible to see the reduction of load with a decrease slope in the curve (red) of 12,400 MW approximately when compared with a typical day at Thursday 5th of June in the SIN.

The first game also influenced the load curve behaviour in the first time, half-time and second-time of the game in comparison with a typical day. Fig. 1 shows that 30 minutes before the start of the match the reduction was of 5,500 MW and 1,050 MW during the next 13 minutes.

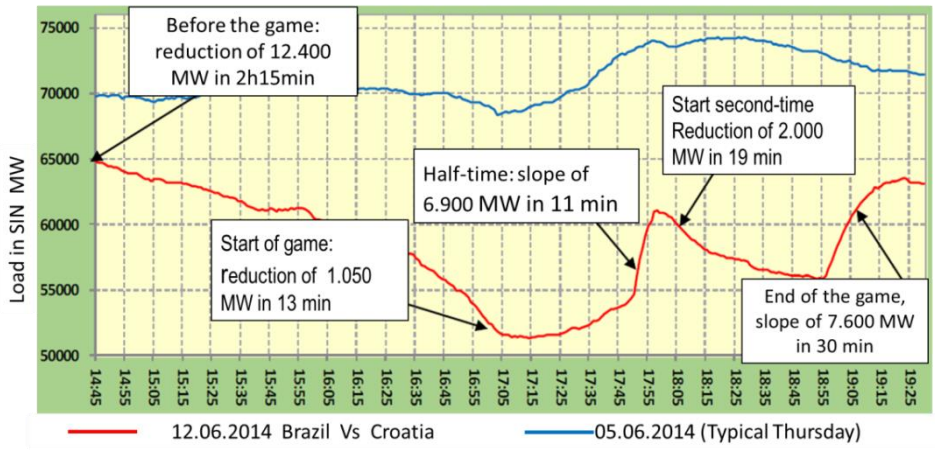

Fig. 1. Behavior of SIN energy consumption during the game Brazil vs Croatia

During the half-time a natural increasing of load of 6,900 MW in 11 minutes is observed. During the second-time the mean difference was 16,600 MW in comparison with a typical Thursday. After the end of the match, an increase slope of load of 7,600 in 30 minutes is observed.

- Monday 16th June Germany vs Portugal 13h (4-0)

During this match there are no relevant events or significant changes in the load profile in the SIN. The curve in Fig. 1 shows the behaviour of consumption during the day compared with equivalent typical day at Monday 2nd of June.

During game and at the end of the game the load behaviour does not present a significant difference with an equivalent typical day. The mean difference was up to 968 MW from the typical day but not related directly with the game.

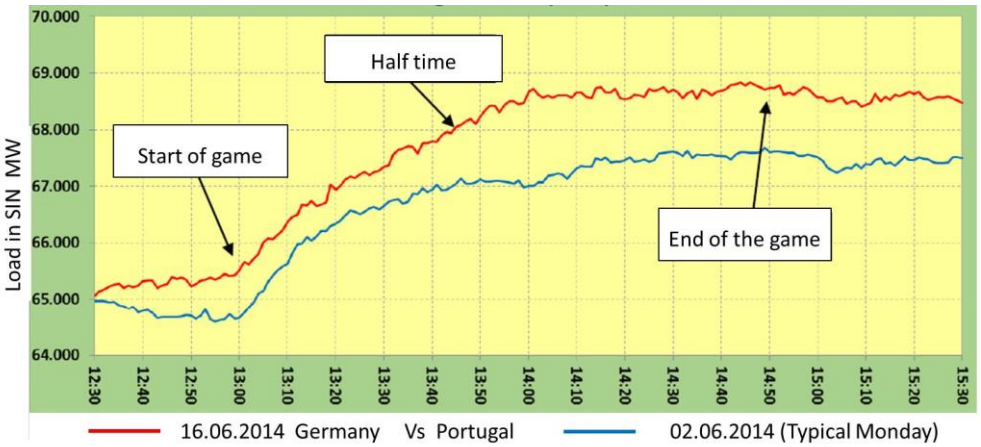

Fig. 2. Behavior of SIN energy consumption during the game Germany Vs Portugal

- Friday 4th June France vs Germany 13h (0-1)

This game does not present significant change in the shape of energy consumption in the SIN. The curve in Fig. 3 shows the behaviour of energy consumption during the day compared with the equivalent typical day of Friday 4nd of June.

From the start of the first time to the start of the second time the curves are very similar, about the end of the second time is observed a small decrease in the energy consumption because of next game, Brazil Vs Colombia, would be at 17h in the same day.

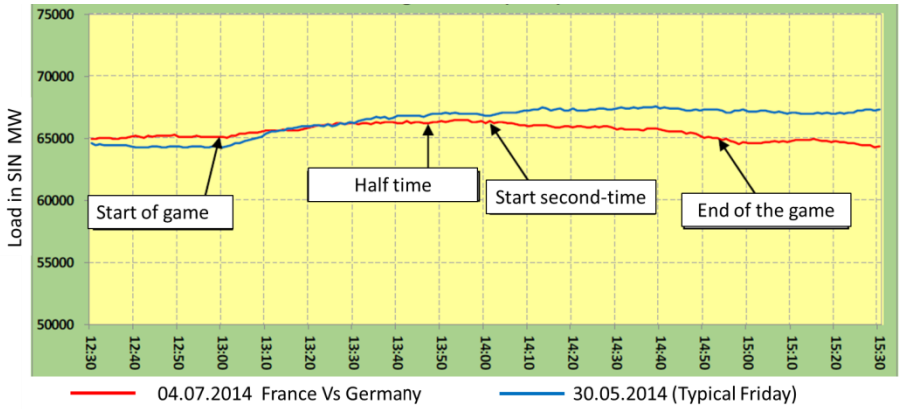

Fig. 3. Behavior of SIN energy consumption during the game France vs Germany

- Tuesday 8th July Brazil vs Germany 13h (1-7)

In this match the energy consumption suffered a change in its curve shape related with the game, as shows Fig. 4. Before the game, from 14h00 up to 15 minutes before the game it was observed a reduction on the load in SIN of 12,400 MW in comparison with a typical Tuesday curve (blue).

The next 30 minutes, that include the start of game, a decrease slope of 6,800 MW is observed. Thus the difference of load between the day of the game and the typical day before the game is nearly 17,000 MW in the first half-time.

In the half-time a 4500 MW load increase in minutes is observed because of the evening peak. At the beginning of the second half-time a reduction of load of 1,000 MW that is out of normal behaviour of a typical day, probably for the score of the game at this time. At the end of the game a slope of 4,200 MW in 15 minutes is noticed.

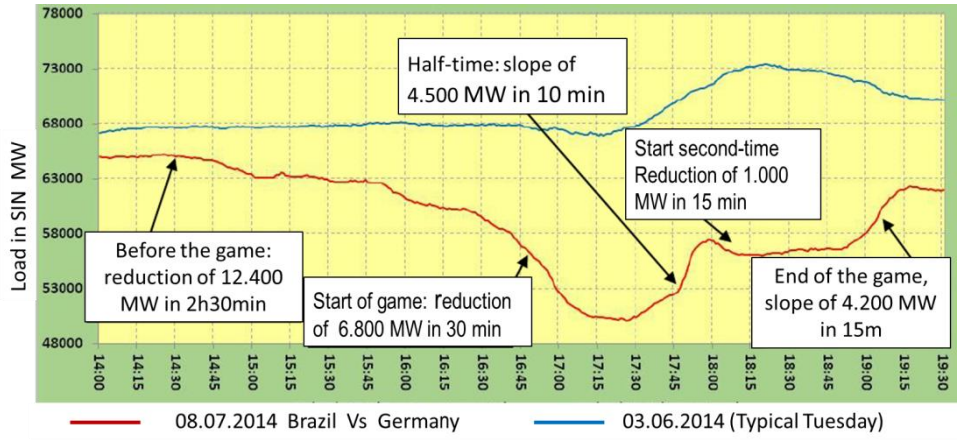

Fig. 4. Behavior of SIN energy consumption during the game Brazil vs Germany

- Sunday 13th July Germany vs Argentina 16h (1-0)

For the final match of the World Cup Brazil 2014 the behavior of the load curve (red) is very similar when compared with a typical day (Sunday - Blue) up to the start of game. At this time, it is noticed a smooth reduction and some changes in the half-time and end of the match when starts an increasing slope of the consumption, as shows Fig. 5. One can state that this game had an impact on the consumption behaviour in the Brazilian territory. However it was not as strong when compared with the first game Brazil vs Croatia or Brazil vs Germany.

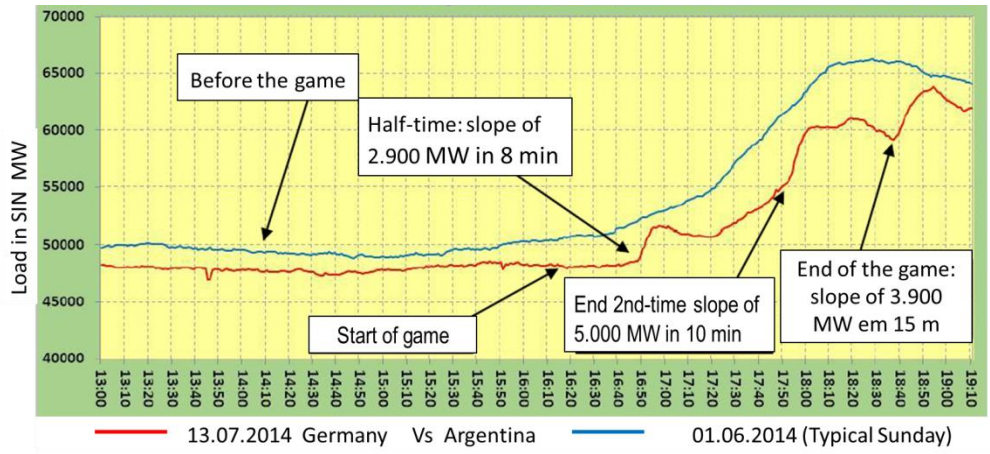

Fig. 5. Behavior of SIN energy consumption during the game Germany vsArgentina

3.2. Germany

- Thursday 12th June Brazil vs Croatia 22h (3-1)

From Fig.6 it is possible to see a similar shape of load curve in 50Hertz system in comparison with a typical day. The reduction of load occurs after the opening ceremony and continues almost constantly during the start of the game (354 MW) and the end of the game (529 MW). The reduction could be associated with the world cup but the impact is very low in the consumption profile. The curve does not show representative changes, probably because the time of the match.

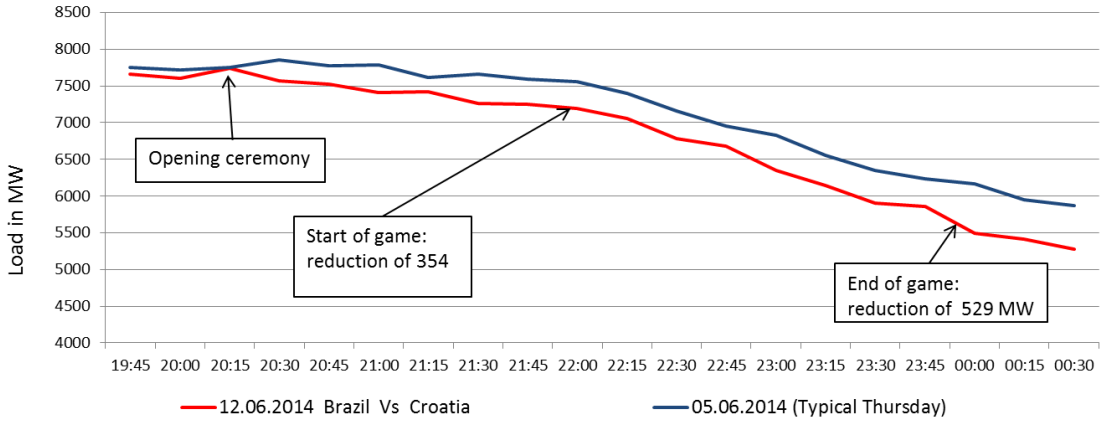

Fig. 6. Behavior of 50Hertz energy consumption during the Brazil vs Croatia

- Monday 16th June Germany vs Portugal 18h (4-0)

The behavior showed in Fig. 7 is quite similar to the match analysed before. This match had a low impact on the energy consumption.

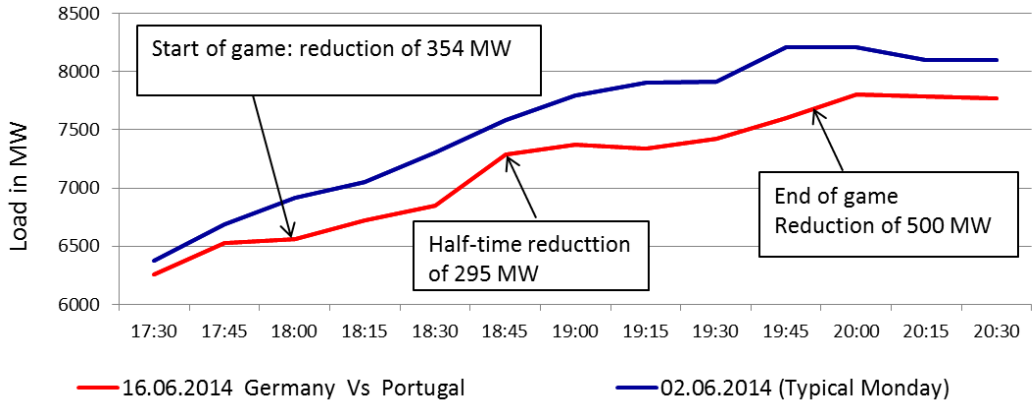

Fig. 7. Behavior of 50Hertz energy consumption during the game Germany - Portugal

- Friday 4th July France vs Germany 18h (0-1)

This match seems to not affect the behavior of energy consumption in Germany, because the reduction of load is very low in the start of the match and during half-time. The only remarkable variation is in the middle of second time with 807 MW of difference when compared with a typical day (06 June 2014).

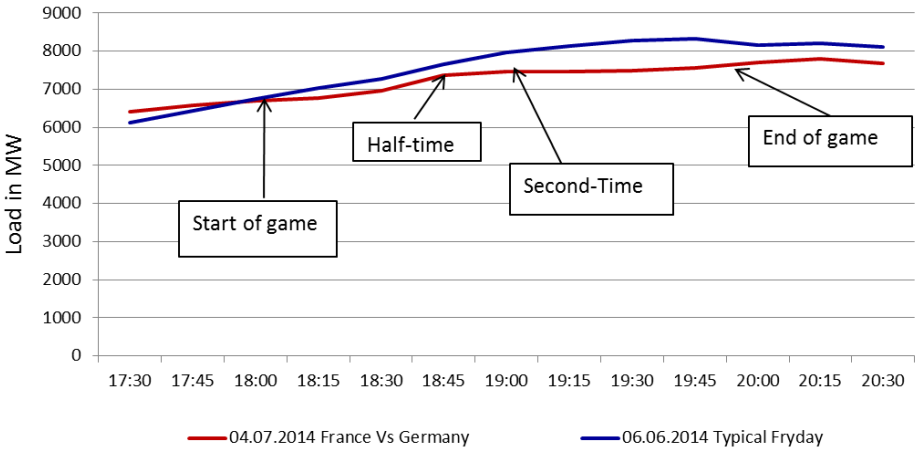

Fig. 8. Behavior of 50Hertz energy consumption during the game France vs Germany

- Tuesday 8th July Brazil vs Germany 18h (1-7)

In this day the game does not affect the behaviour of energy consumption, because the difference of load with a typical Tuesday is quite constant. In the end and the end of second half-time the difference is minimal as shown in Fig. 9. The main reason of that is probably that the game started at 22h when many people were resting.

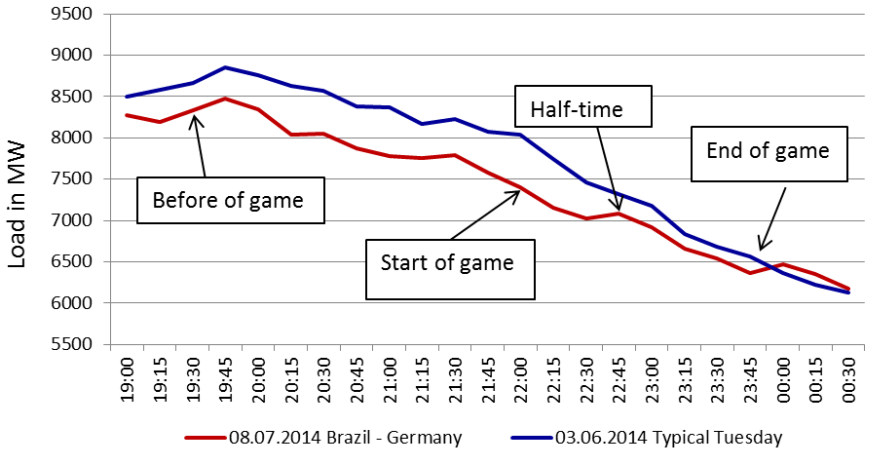

Fig. 9. Behavior of 50Hertz energy consumption during the game Brazil vs Germany

- Sunday 13th July Germany vs Argentina 21h (1-0)

For the final of World Cup Brazil 2014 the behaviour of the load curve (red) presents a reduction without fast changes if compared with a typical Sunday 1 (more than 1 month before, in blue) and an increase consumption when compared with the typical Sunday 2 (1 week after, in green) . This match does not present a high impact on the energy consumption in East Germany, perhaps due to the time of the match.

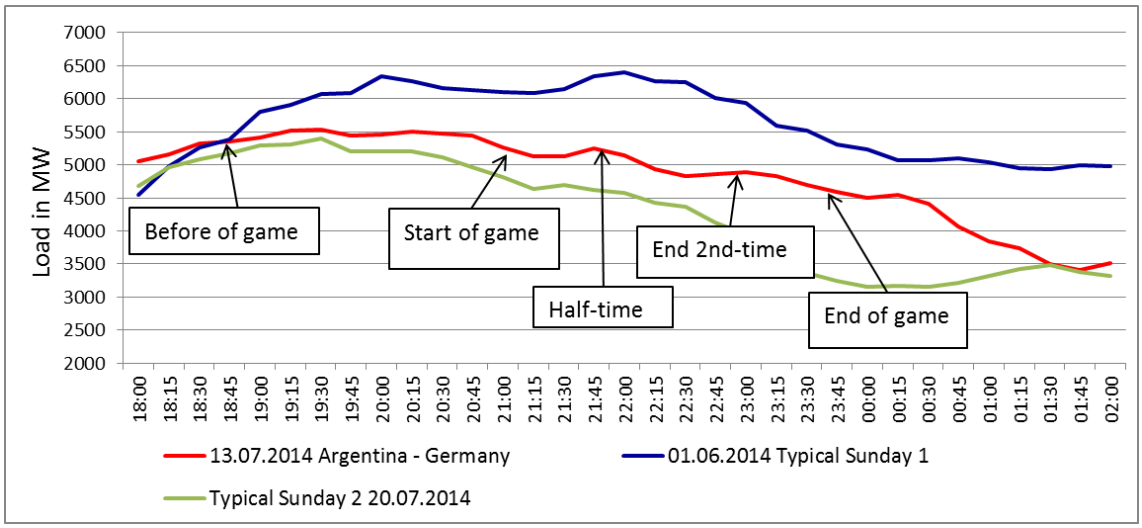

Fig. 10. Behavior of 50Hertz energy consumption during the game Argentina - Germany

3.3. France

- Sunday 15th June: France vs Honduras (3-0)

At the beginning of the game the consumption is higher that the forecast: 702 MW for the forecast a day before and 502 MW for the daily forecast. The consumption remains higher than the forecasts during the first half of the game. The trend is inverted after the half-time and the consumption begins to be lower than the forecast during the second half. At the end of the game the load curve fits again to the forecasts. By looking at the consumption of the Sundays a week before and a week after, it appears that the load curve is not similar to a normal consumption of a Sunday of June during the first half. From the moment of half-time the load curve fit with the curve of the day a week before. Nevertheless the average gaps observed between the real consumption and the forecasts during the game (340 MW for the forecast D-1 and 292 MW for the forecast D) are not big enough to represent a significant event.

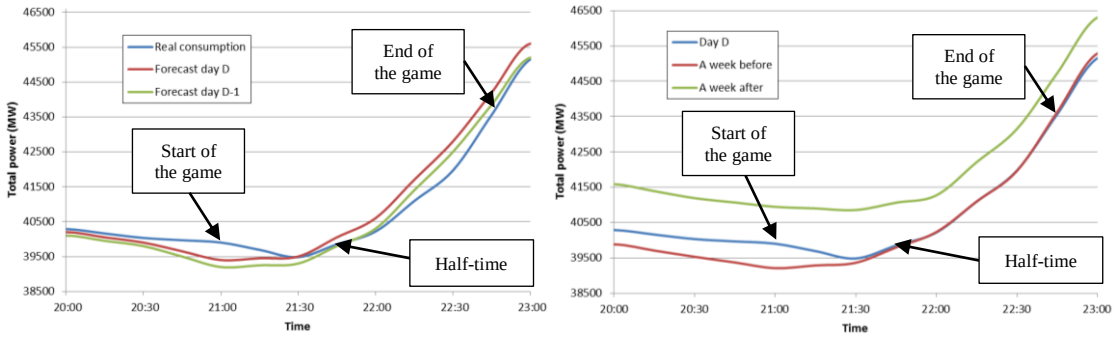

Fig. 11. Behaviour of RTE energy consumption during the game France Vs Honduras

- Friday 4th July: France vs Germany (0 – 1)

One hour before the match the forecasts are pretty good and the gap between the daily forecast and the real consumption is only 79 MW. The load curve seems also to fit well with the curve of the Friday a week after. But whereas the forecasts remain stable during the game, the consumption decreases by 507 MW during the first half-hour of the match. Then the gap between the forecasts is equal to 789 MW for the day D and 889 MW for the day D-1. During the end of the first half and the half-time the consumption increases by 528 MW. After that the load curve follows the trend of the forecast and the consumption a week before and after but stay low compared to them. Nevertheless the average gaps observed between the real consumption and the forecasts during the game (573 MW for the forecast D-1 and 440 MW for the forecast D) are not big enough to represent a significant event.

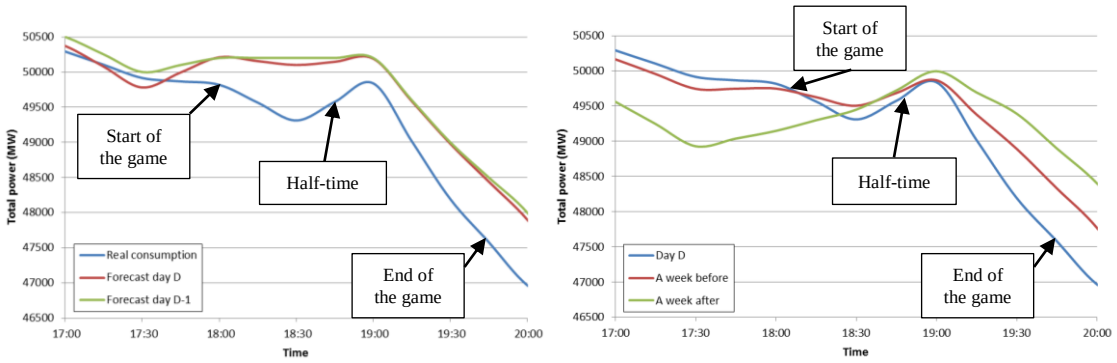

Fig. 12. Behavior of RTE energy consumption during the game France Vs Honduras

- Tuesday 8th July: Brazil vs Germany (1 – 7)

At the beginning of the match there is a gap of 993 MW with the forecast D-1 and 693 with the forecast D. During the second part of the first half the load curve fits with the forecast. After the half time the consumption is once again higher than the forecast and is 1242 MW higher than the forecast D and 1342 higher than the forecast D-1 at the end of the match. Nevertheless the average gaps observed between the real consumption and the forecasts during the match (727 MW for the forecast D-1 and 525 MW for the forecast D) are not big enough to represent a significant event. Furthermore the load curve is pretty similar to the profiles of the day a week before and after.

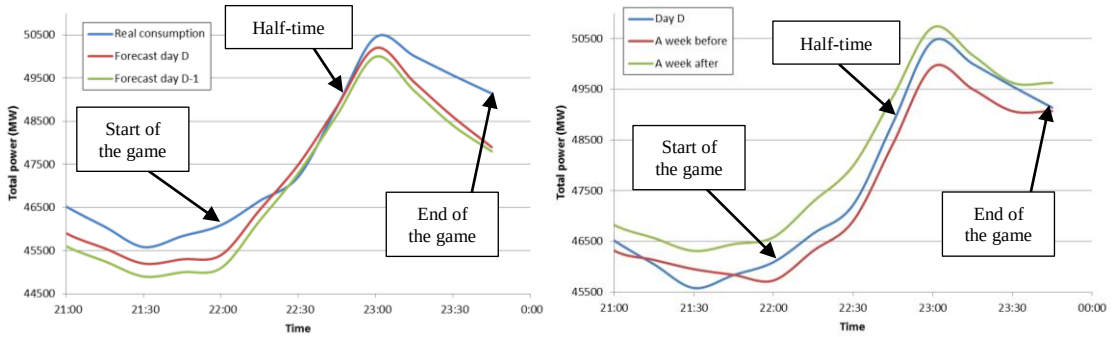

Fig. 13. Behavior of RTE energy consumption during the game France Vs Honduras

- Sunday 13th July: Germany vs Argentina (1 – 0)

During the entire match the consumption stays higher than the forecasts: up to 1068 MW for the forecast D and 859 MW for the forecast D-1. Nevertheless the average gaps observed between the real consumption and the forecasts during the match (800 MW for the forecast D-1 and 567 MW for the forecast D) are not big enough to represent a significant event. Furthermore the load curve is pretty similar to the profiles of the day a week before and after.

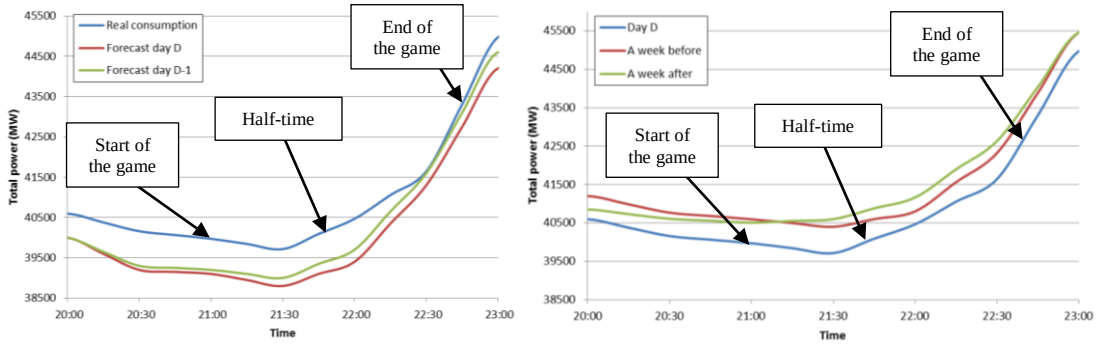

Fig. 14. Behavior of RTE energy consumption during the game Germany – Argentina

3.4. Portugal

- Thursday 12th June Brazil vs Croatia 22h (3-1)

During the opening of the world cup the behaviour of REN energy consumption in Portugal is very closed to a normal day, compared to the consumption a week before and a week after. The noticed differences are that the consumption remains higher than the for other normal days (up to 200 MW higher) and that the peak of consumption is emphasised.

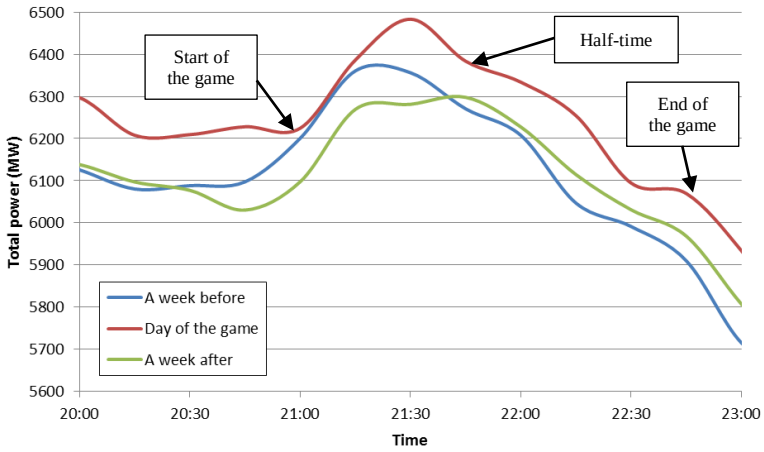

Fig. 15. Behavior of REN energy consumption during the game Brazil vs Croatia

- Monday 16th June Germany vs Portugal 18h (4-0)

For this particular day where the Portugal is playing it can be noticed firstly that the consumption remains higher that the other normal days, up to 800 MW higher. This is the biggest difference that is recorded among the days of matches in the world cup. Nethertheless the behavior of the energy consumed is quite the same as for normal days.

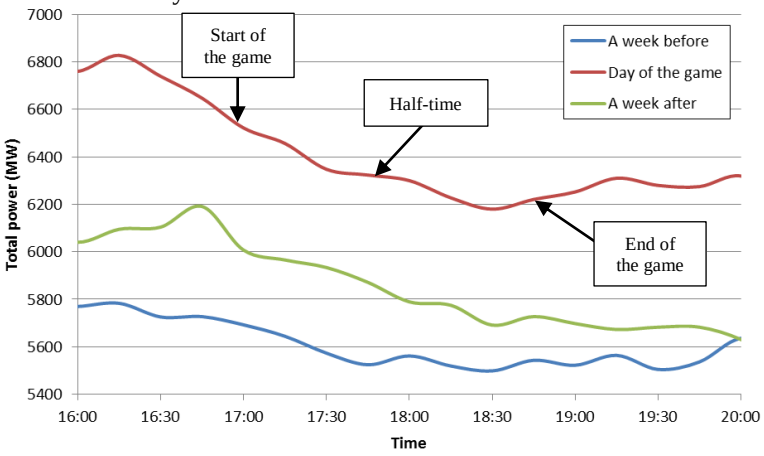

Fig. 16. Behavior of REN energy consumption during the game Germany – Portugal

- Friday 4th July France vs Germany 18h (0-1)

There is no impact of the world cup on the consumption on this day: the consumption level is comparable to other normal days, i.e.the behavior is similar. There is a progressive decreasing of the consumption during the match.

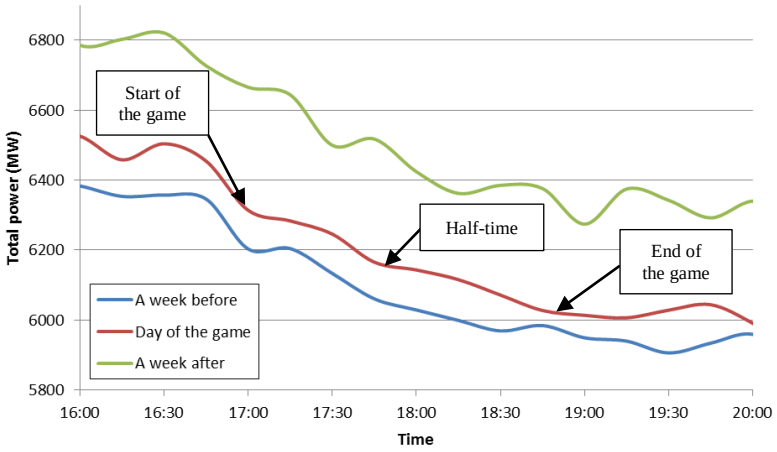

Fig. 17. Behavior of REN energy consumption during the game France vs Germany

- Tuesday 8th July Brazil vs Germany 18h (1-7)

There is no impact of the world cup on the consumption on this day: the consumption level is comparable to other normal days, i.e. the behavior is similar. There is a slight peak of consumption at 21h30 and then a slow decreasing of the consumption during the end of the match.

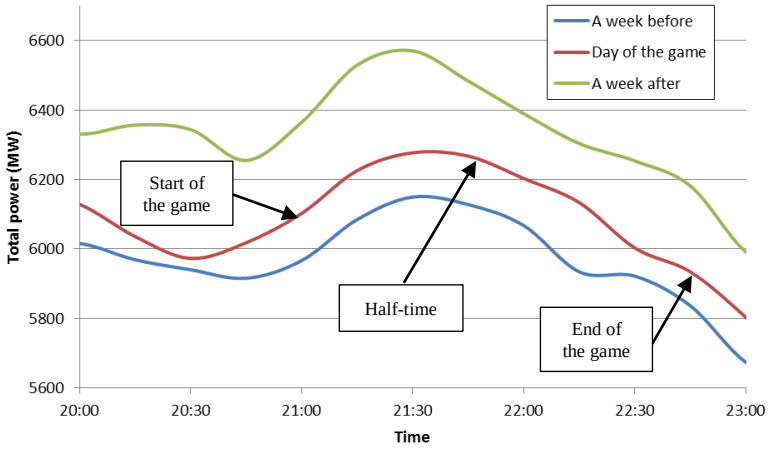

Fig. 18. Behavior of REN energy consumption during the game Brazil vs Germany

- Sunday 13th July Germany vs Argentina 21h (1-0)

During the final day of the world cup the consumption level in Portugal is higher than in other normal days. Comparing to a week before and a week after, up to 400 MW higher. Nevertheless the behavior is quite similar to the normal days. There is slow increasing of the consumption during all the match.

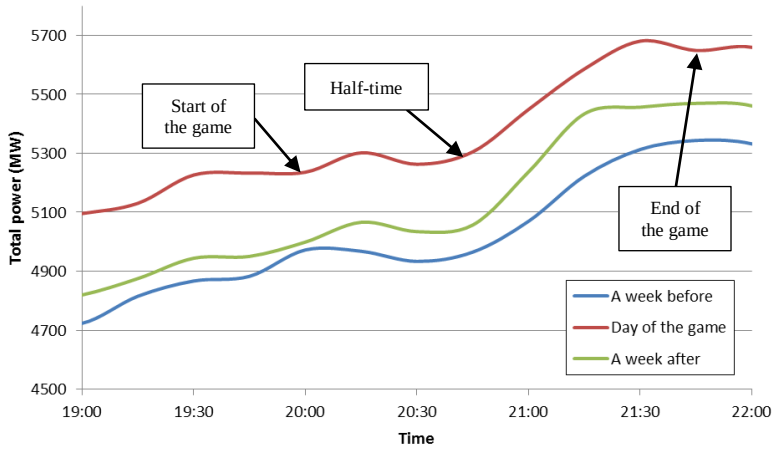

Fig. 19. Behavior of REN energy consumption during the game Argentina vs Germany

4. Conclusion

After analyzing 4 or 5 matches of the FIFA World Cup Brazil 2014 for the countries involved with the ELECON project, it is possible to conclude that:

- A high impact on the behavior of energy consumption in Brazil, especially first day (12 June 2014) due to the opening ceremony and the game Brazil vs Croatia, as shown in Fig.1. On other countries (Germany, France and Portugal) the impact was very small, due to local times in Portugal (4h ahead) and in France and Germany (5h ahead). Most of the matches occurred in the afternoon in Brazil, which means night time in Europe.
- Other matches involving Brazil showed high impact too in Brazilian territory especially when compared with the impacts in European countries. Another reason for that is that in the city where the game occurred, it was declared holyday and in the other cities in Brazil there was flexibility in industrial, commercial and education areas. Some days the banks were closed and the holiday period in the schools were moved because of the world cup.
- Matches involving European teams did not show an impact in the energy consumption in Brazil, except for the world cup final that shows some changes in the load profile. For the other countries the final match (Argentina vs Germany) did not show impact, probably because it started at 21h (Germany and France local time) ending at 23h40 approximately. It means that most of the match occurred in resting time in European territory.

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