
CARBON DIOXIDE EMISSIONS IN RETAIL FOOD

Radojko Lukić¹, Srđan Lalić², Azra Sućeska³, Aida Hanić⁴, Milica Bugarčić⁵

*Corresponding author E-mail: milica.bugarcic@bba.edu.rs

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ABSTRACT

The analysis of the effects of applying the concept of sustainable development in retail has been attracting interest recently. In that context we have considered greenhouse gases emission in retail. This is achieved by using modern ecological technology in business – through the whole food value chain. The goal is to achieve the planned reductions of carbon dioxide in retail food, which positively reflects the overall performance of food retailers. This empirical research is mainly based on the analysis of the original sustainable reports officially disclosed by selected food retailers. These reports are now an integral part of the integrated reporting on performance of global food retailers. Having been universally important, harmonized regulations on sustainable retail food reporting are being increasingly applied as a data source for more efficient environmental management. In the future, this will enable the comparative analysis of the carbon dioxide emission of global and other food retailers.

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- 1 Radojko Lukić, Full Professor, Faculty of Economics, University of Belgrade, Kamenicka 6, 11000 Belgrade, Republic of Serbia, +381638824829, rlukic@ekof.bg.ac.rs, ORCID ID: 0000-0001-6529-0297
- 2 Srđan Lalić, Assistant Professor, Faculty of Economics Brcko, University of East Sarajevo, Studentska 11, 76100 Brcko, Bosnia and Herzegovina, +38765647580, srdjan.lalic.efb@gmail.com, ORCID ID: 0000-0003-1874-8765
- 3 Azra Sućeska, Assistant professor, Belgrade banking academy, University “Union” in Belgrade, Zmaj Jovina 12, 11000 Belgrade, Republic of Serbia, +38166234304, azra.hanic@bba.edu.rs, ORCID ID: 0000-0001-6971-1706,
- 4 Aida Hanić, Research Assistant, Institute of Economic Sciences, Zmaj Jovina 12, 11000 Belgrade, Republic of Serbia, +381603502190, aida.hanic@ien.bg.ac.rs, ORCID ID: 0000-0003-4378-7002
- 5 Milica Bugarčić, Teaching Assistant, Belgrade banking academy, University “Union” in Belgrade, Zmaj Jovina 12, 11000 Belgrade, Republic of Serbia, +381644641881, milica.bugarcic@bba.edu.rs, ORCID ID: 0000-0002-9327-9965

Introduction

Significant attention has been recently paid to the analysis of environmental performance in all sectors, including wholesale and retail trade. Within this, greenhouse gases emission (GHG) in retail food is briefly considered. The overall goal of global food retailers is to reduce carbon dioxide emissions through the entire food value chain. The costs of carbon dioxide emission reduction are significant and affect the performance of food retailers.

The subject of research in this paper is the significance and trend of carbon dioxide emissions in retail food. Based on a comparative analysis of the original officially disclosed sustainable reports of global food retailers, the aim of the research is to comprehensively examine the problem of carbon dioxide emissions in retail through the entire food value chain and to take appropriate measures to achieve the target reduction. The effects of this are the improvement of the overall, especially environmentally-friendly performance of food retailers. The scientific and professional contribution of this work can be reflected in that, because there is scarce literature fully devoted to the issue of carbon dioxide emissions in retail food.

Numerous factors undoubtedly influence carbon dioxide emissions in retail, and these are as follows: type of store, product category, nature of the item itself, sales, location and distance (type of settlement: urban, suburban and rural), carbon policy (Wang et al., 2017), as well as energy sources, type of ventilation and heating of sales and other premises, cooling devices, mode of transport (logistics), waste treatment, and others. Taxation is also a factor in carbon dioxide emissions in all sectors, including retail food (Qin, 2015). Regarding retail formats (types of stores, classical or modern - Internet shops) on-line sales have insignificant carbon dioxide emissions and, viewed through a value chain, it occurs only in warehousing, while in distribution and in the store, equals zero, contrary to the other types of stores (Seebauer et al., 2016). Carbon dioxide emissions vary by product category (food and non-food products) and within one product category, by individual items, depending on their nature (Linda, 2014; Sullian 2016; Eriksson, 2017). All in all, the main sources of carbon dioxide emissions in retail are as follows: electricity, transport, ventilation and heating, refrigeration and waste. Effective control of the factors that influence the emission of carbon dioxide can significantly affect the improvement of economic, social and, in particular, environmental performance in retail. For these reasons, it is necessary to know the size and intensity of carbon dioxide emissions in modern retail food, which is the focus of this work.

Materials and methods

There is a voluminous literature devoted to analyzing the way company's performance is affected by general problems and effects of carbon dioxide emission reduction through the whole (food) chain (Jones, 2005; Martinuzzi, 2011; Kahn, 2014; Congcong, 2016; Li, 2016; Seebauer et al., 2016; Bazan, 2017, Clune, 2017), as well as consumer

preferences (Ji, 2017). In other words, it is generally known that carbon dioxide reduction increases the economic performance of companies (Cusshiella, 2017), the profitability of producers and retailers, as well as consumer preferences (Eagle, 2017). In view of the significance of the problem of carbon dioxide emissions, generally speaking, the number of papers dedicated to the specificities and impacts of carbon dioxide emission reduction on the performance of retail companies is modest (Patten, 2014; Makarov, 2015; Riboldazzi, 2016; Sullian, 2016). In Serbian literature this issue is only partially considered in some papers (Lukic, 2011a, b, 2012, 2014, 2016a, b, c, 2017). For that reason, this paper attempts to make thorough analysis of specific issues of carbon dioxide emissions in the retail sector, i.e. retail food, firstly on the example of global retailers from different countries, primarily developed market economies, which, due to the general importance of the matter, publish reports on sustainable development along with regular annual financial reports. This practice of global retailers provides them with more reliable information base for efficient management of carbon dioxide emissions through the whole value chain. This is particularly true for retailers in Serbia whose practice of making the reports on environment and sustainable development publicly available has just begun.

The general research hypothesis in this paper is that the reduction of carbon dioxide emissions positively reflects on overall (integrated, especially environmental) performance of retailers (food). The methodology is primarily based on the comparative analysis of the carbon dioxide emission of global selected food retailers from various comparable developed market economies. The problem of comprehensiveness of the research on carbon dioxide emissions in retail food is that, at the time being, there is no unified system of sustainable (environmental) reporting for all retailers. In addition, many retailers still do not publish their reports, thus providing an incomplete “comparability” of data on carbon dioxide emissions by individual food retailers. Nevertheless, understanding of the importance and trend of carbon dioxide emissions from global retailers (food) is very important in order to manage overall, integrated and, in particular, environmental performance in (concrete) retail (food). Globally, other food retailers will increasingly publish reports on sustainable development (with data on carbon dioxide emissions). In this way, they will increase its information base for more efficient management of total business, including environmental protection. This may have a positive impact on the gain of the target profit.

The main data sources for the research of the treated problem in this paper are literature, articles, publications, studies, OECD, Eurostat and, in particular, officially disclosed annual financial and sustainable reports of (global) retailers (food). They were processed in such a way that is easy to comprehend the significance and trend of carbon dioxide emission in retail food.

Results and discussion

The carbon dioxide emission through the entire food value chain is shown in Table 1.

Table 1. Emissions of carbon dioxide through the life cycle of food after farm

Lifecycle stage post-farm gate	Number of GWP (global warming potential) values	Median (kgCO ₂ -eq/kg)	Mean (kgCO ₂ -eq/kg)	Stdev	Min (kgCO ₂ -eq/kg)	Max (kgCO ₂ -eq/kg)
Processing meat	5	0,59	0,66	0,14	0,54	0,87
Processing vegetables	15	0,06	0,07	0,04	0,01	0,013
Packaging	8	0,05	0,06	0,06	0,01	0,21
Transport to RDC (Regional Distribution Centre)	21	0,09	0,13	0,19	0,02	0,95
Retail	20	0,04	0,10	0,25	0,01	1.14

Note: The table is compiled on the basis of various relevant studies.

Source: Clune et al. (2017)

The data in the given table show that, on average, emission of carbon dioxide is higher in the processing of meat than processing of vegetables. It is also higher in transport than in retail, and is the lowest in the packaging phase. This is in line with the nature of the activities concerned.

Different is the carbon dioxide emission of individual retailers (food). This is illustrated by the research results in this paper.

At Wal-Mart (United States of America, Dominant operational format: Hypermarket / Supercenter / Superstore), a great significance is given to reducing carbon dioxide emissions (*Table 2*). This is achieved by the following: investing in renewable energy sources, reducing energy demand, improving energy efficiency, improving refrigeration in stores and maximizing the efficiency of the vehicle fleet.

Table 2. Carbon dioxide emission (Scope 1 and 2) and retail area at Wal-Mart, 2005-2014

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Carbon dioxide emission (million ton CO _{2e})	18,9	19,3	20,1	20,8	20,3	20,6	20,8	21,2	21,0	21,9
Retail area (million square meters)	740	805	867	921	952	985	1,037	1,072	1,102	1,134

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Carbon dioxide intensity (million tons CO _{2e} /million m ²)*	0,025	0,024	0,023	0,022	0,021	0,021	0,020	0,020	0,019	0,019

Note: Calculations performed by the author

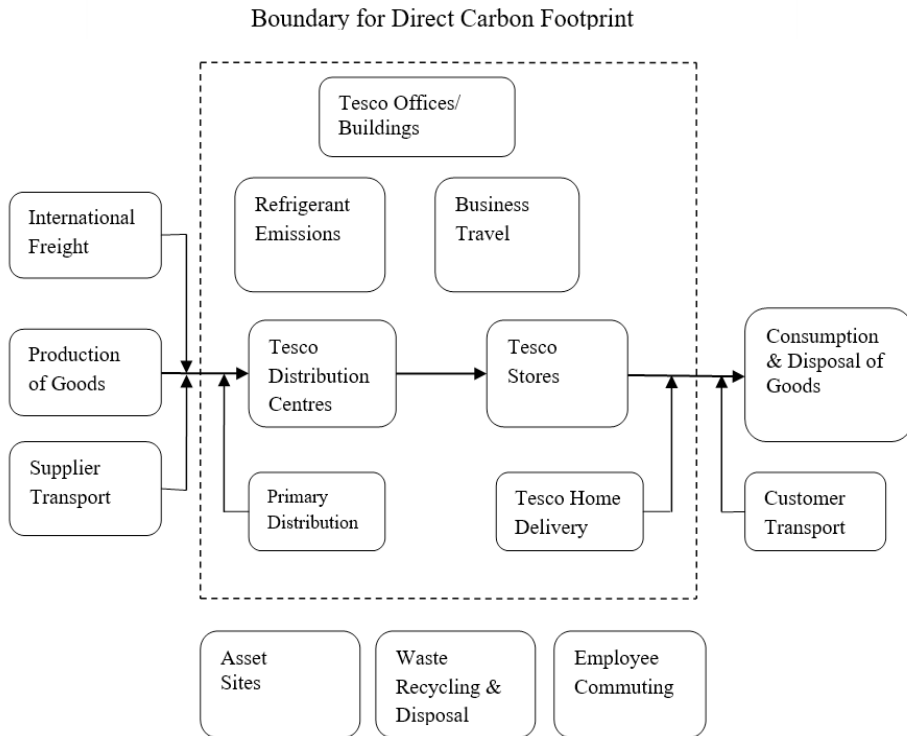
Source: Wal-Mart Stores, Inc. 2016 Global Responsibility Report, available at: <https://cdn.corporate.walmart.com/9c/73/3f9abcef444397f2c771e081e095/2016-global-responsibility-report.pdf#page=58&zoom=auto,-130,628>

In generating greenhouse gas emissions, Wal-Mart participates with the following: electricity supply 69%, refrigeration 18%, fuel transport 5.9%, fuel on the site 7% and mobile refrigerators with 0.1% (Wal-Mart Stores, Inc. 2016 Global Responsibility Report, available at: <https://cdn.corporate.walmart.com/9c/73/3f9abcef444397f2c771e081e095/2016-global-responsibility-report.pdf#page=58&zoom=auto,-130,628>). Therefore, the main source of greenhouse gas emissions in Wal-Mart is electricity supply. With the increased application of the ecological operation principles, Wal-Mart reduced carbon dioxide emissions from year to year, which reflects favourably on its overall performance, especially environmental.

In Kroger (United States, Dominant operational format: Hypermarket / Supercenter / Superstore) carbon dioxide emissions amounted to 32.9 (tonnes of CO_{2e} / 1,000 sq ft) in 2015, and 36.3 in 2006. This means that there was a 9.3% reduction achieved (2016 Sustainability Report / Kroger, available at: <http://sustainability.kroger.com/environment-energy-carbon.html>). The effects of this decrease are the improvement of environmental and overall performance in the company Kroger.

At Tesco (United Kingdom, Dominant operational format: Hypermarket / Supercenter / Superstore), as with Wal-Mart, considerable attention is paid to the research and control of carbon dioxide emissions. This positively reflects on its overall performance, including the surrounding ones. Illustration of the specificity of carbon dioxide emissions measurement at Tesco is shown in *Figure 1*.

Figure 1. Tesco’s emission limit



Source: Carbon Footprint 101: A Guide for Food Retailers, available at: <https://www.fmi.org/docs/sustainability/carbon-footprint-101-a-guide-for-foodretailers.pdf?sfvrsn=4#page=11&zoom=auto,-121.85>

Table 3. and Figure 2. show the greenhouse gas emissions in Tesco.

Table 3. Emission of greenhouse gases in Tesco

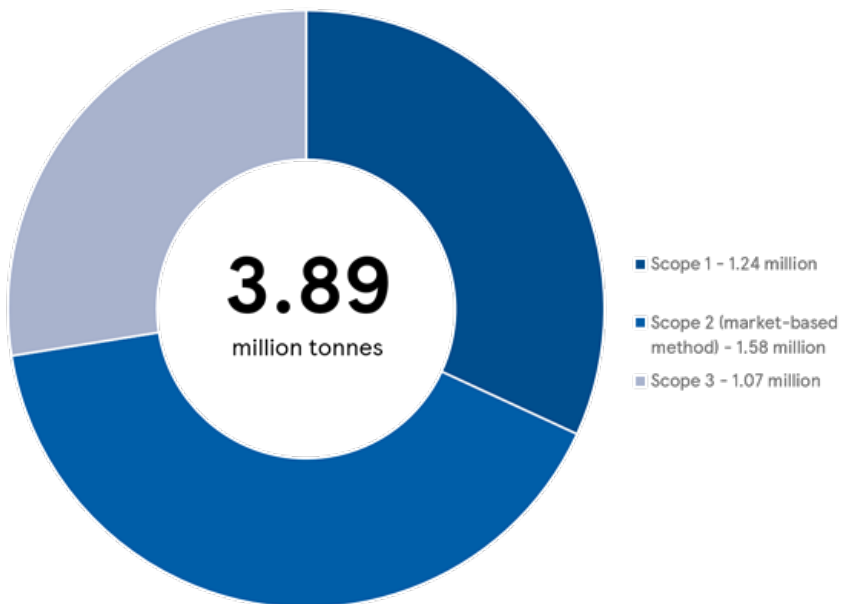
	Total ton CO _{2e}		
	2016/17	2015/16	Base year 2006/07
Scope 1	1,236,980	1,301,746	1,345,507
Scope 2			
Market-based method	1,582,275	2,004,992	Not available
Location-based method	2,357,245	2,528,323	2,259,984
Scope 1 and 2 carbon dioxide intensity (kgCO _{2e} /sq. ft of stores and distributive centres)	22,95	26,33	51,14
Scope 3	1,073,721	1,097,491	1,064,460

	Total ton CO _{2e}		
	2016/17	2015/16	Base year 2006/07
Total gross emission	3,892,977	4,404,230	4,669,951
CO _{2e} from renewable energy exported to the grid	1,154	1,513	-
Total net emissions	3,891,822	4,402,717	4,669,951
Overall net carbon intensity (total net emissions kgCO _{2e} /sq ft of stores and distributive centres)	31,69	35,06	66,23

Source: Tesco PLC Annual Report and Financial Statements 2017, available at: https://www.tescopl.com/media/392373/68336_tesco_ar_digital_interactive_250417.pdf

The data in the given table show that the intensity of carbon dioxide emissions in Tesco is decreasing from year to year.

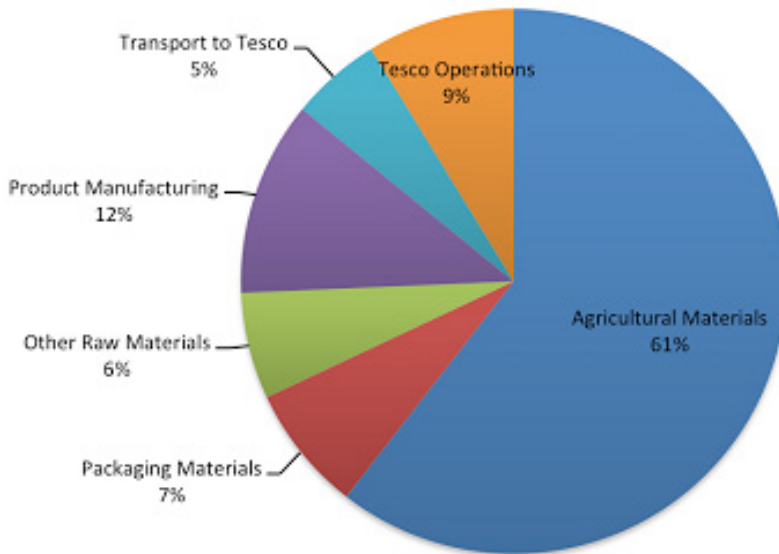
Figure 2. Total carbon dioxide (million tonnes of CO_{2e}) in Tesco 2016/2017



Source: Tesco - Our carbon footprint, available at: <https://www.tescopl.com/tesco-and-society/sourcing-great-products/reducing-our-impact-on-the-environment/our-carbon-footprint/>

Figure 3. shows sources of carbon dioxide emission throughout the value chain, with an emphasis on Tesco's participation in carbon footprint.

Figure 3. Emissions of carbon dioxide by source in Tesco



Source: Tesco - Our Carbon Footprint, available at: <https://www.tescopl.com/tesco-and-society/sourcing-great-products/reducing-our-impact-on-the-environment/our-carbon-footprint/>

Therefore, Tesco participated in total emission of carbon dioxide through entire value chain with 9%.

Table 4. shows ecological performances at Tesco.

Table 4. Global ecological performances at Tesco

	2016/17	2015/16	2014/15	2013/14
Carbon dioxide (million ton CO _{2e})	3,9	5,1	5,26	-
Emission of CO ₂ reduction (stores and distributional centres) compared to 2006/07	40,5%	39,5%	38,3%	-
Emission of CO ₂ reduction (distribution) compared to 2011/12	19,7%	17,4%	14,47%	7,8%
Direct water consumption (million m ³)	23,5	25,5	32,6	32,9
Waste percentage (food and non-food) which is recycled, used again or turn into energy	93%	88%	84%	86%

Source: Reducing our impact on the environment, available at: <https://www.tescopl.com/tesco-and-society/sourcing-great-products/reducing-our-impact-on-the-environment/>

Tesco has tendency to improve ecological performances (carbon dioxide emission reduction, direct water consumption reduction and waste treatment improvement). This reflects favourably on its market, economic and financial performances.

Due to the increasing importance, special attention is paid to carbon dioxide emissions in Marks & Spencer (M & S) (United Kingdom, Dominant Operating Format: Department Store), as shown in *Table 5*.

Table 5. Emission of carbon dioxide in Marks & Spencer

	Plan A baseline 2006/7 (000 tCO_{2e})	Legal baseline 2013/14 (000 tCO_{2e})	Last year 2014/15 (000 tCO_{2e})	2015/16 000 tCO_{2e}	Achievement in relation to 2006/7
Total gross/location-based emission CO _{2e}	732	567	592	566	-23%
Total carbon intensity measure (per 1000 sq. ft of sales floor (ton CO _{2e} /1,000 sq. ft))	46	30	30	29	-47%

Source: M & S Plan Report 2016, available at: http://annualreport.marksandspencer.com/M&S_PlanA_Report_2016.pdf.

At Marks & Spencer, a decrease in carbon dioxide emissions was recorded in 2014/15 in relation to 2006/7. Reduction was achieved by improving energy efficiency using the so-called “green energy” through the whole value chain.

In 2015, Carrefour (France, Dominant operational format: Hypermarket/Supercenter/Superstore) emitted 3.61 million tonnes of CO_{2e}. In 2015, carbon dioxide emissions were reduced by 29.7% compared to 2010. The aim is to achieve a reduction in carbon dioxide emissions by 40% until 2025 and 70% until 2050 (Unique and Multiple/2015 Annual Activity and Responsible Commitment Report, available at: http://www.carrefour.com/sites/default/files/carrefour_2015_annual_activity_and_responsible_commitment_report.pdf). This will have a positive impact on Carrefour’s environmental and overall performance.

Aldi (Germany, Dominant operational format: Discount Store) also publishes reports on sustainable development, in which special attention is paid to the emission of carbon dioxide. *Table 6*. shows the greenhouse gas emissions at Aldi.

Table 6. Greenhouse gases emission in Aldi (tons CO_{2e})

	2014	2015
Scope 1	284,831	312,940
Scope 2	369,961	567,424
Total	654,792	680,364

Source: Aldi-Sustainability Report 2015, available at: https://www.cr-aldinord.com/2015/wp-content/uploads/sites/2/2016/04/ALDI_North_Group_NHB_Sustainability_Report_2015.pdf
<http://ea.bg.ac.rs>

At Aldi, greenhouse gases emissions by sectors (in percent) in 2015 were as follows: electricity 53.1%, cooling equipment 20.0%, heating energy 14.3% and logistics 12.6% (Aldi-Sustainability Report 2015, available at: https://www.cr-aldinord.com/2015/wpcontent/uploads/sites/2/2016/04/ALDI_North_Group_NHB_Sustainability_Report_2015.pdf.)

In order to reduce greenhouse gas emissions, special attention is paid to the use of energy from renewable sources (LED lamps).

At Ahold (Germany, Dominant operational format: Supermarket), considerable attention is paid to the reduction of carbon dioxide emissions. This is shown in *Table 7*.

Table 7. Carbon dioxide emission at Ahold

	2008	2009	2010	2011	2012	2013	2014	2015
Carbon dioxide emissions (thousand tons)				2,176	2,106	2,107	2,090	2,019
Carbon dioxide emissions (kg CO ₂ /m ² sales area)	567	574	543	507	480	473	465	420
Sources (%)								
Electricity								49%
Refrigerant appliances								29%
Fuel								12%
Gas								10%

Source: Ahold - Responsible Retailing Report 2015, available at: <https://www.aholddelhaize.com/media/1934/ahold-responsible-retailing-report-2015.pdf>

Carbon dioxide emissions at Ahold has been decreasing. Since 2016, Ahold has been operating under the name of Ahold Delhaize., *Table 8*. shows data on carbon dioxide emissions for Ahold Delhaize (Belgium, Dominant operational format: Supermarket) in 2016.

Table 8. Carbon dioxide emission at Ahold Delhaize

	2016 Actuals	2020 Target
% reduction in CO ₂ equivalent emissions per m ² of sales area (from 2008 baseline)	-22%	-30%
Total CO ₂ equivalent emissions per m ² of sales area – location-based approach	496	n/a
Total CO ₂ equivalent emissions (thousand tonnes) – location-based approach	4,505	n/a
Total Scope 1 CO ₂ equivalent emissions (thousand tonnes) – location-based approach	1,940	n/a
Total Scope 2 CO ₂ equivalent emissions (thousand tonnes) – location-based approach	2,420	n/a
Total Scope 3 CO ₂ equivalent emissions (thousand tonnes) – location-based approach	144	n/a
Offset CO ₂ equivalent emissions (thousand tonnes)	241	n/a
Avoided grid electricity CO ₂ emissions (thousand tonnes)	31	n/a

Source: Ahold Delhaize Supplementary report on Sustainable Retailing performance 2016, available at: <https://www.aholddelhaize.com/media/3984/supplementary-report-on-sustainable-retailing-performance-2016.pdf>.

Significant reduction in carbon dioxide emissions by 2020 (30%) is expected at Ahold Delhaize. This will be achieved by using so-called “green energy” in business operations. Sources of carbon dioxide emissions were the following: electricity 60%, cooling devices 31% and transport 9% (Ahold Delhaize Supplementary Report on Sustainable Retailing performance 2016, available at: <https://www.aholddelhaize.com/media/3984/supplementary-report-on-sustainable-retailing-performance-2016.pdf>). Delhaize Serbia is also part of Ahold Delhaize which employs the same sustainable development strategy and environment reporting.

In the Fast Retailing (Japan, Dominant Operating Format: Apparel/Footwear Specialty), exceptional attention is paid to the issue of carbon dioxide emission reduction. *Figure 4.* shows carbon dioxide emissions through the entire value chain in Fast Retailing.

Figure 4. Sustainable reporting - Carbon dioxide emission through value chain in Fast Retailing

	Planning	Production	Logistics	Sales	Use/Disposal	
In Energy and Raw Materials Usage	Energy, Fuel, etc.	Sewing Factories and Fabric Manufacturers Energy consumed (calories) 17,116,915 GJ Electricity 508,492,602 kWh LPG 1,252,172 kg LNG 7,409,376 kg Natural gas 29,599,589 m ³ Heavy oil 139,789,380 ℓ Light oil 1,440,937 ℓ Gasoline 462,669 ℓ Coal 201,470,102 kg Steam 671,962 t Water usage 24,785,654 t	Logistics Energy consumed (calories) 307,356 GJ	Stores Electricity consumed 217,278,065 kWh City gas consumed 1,455,441 m ³ LPG consumed 1,286,365 m ³		
		Headquarters Electricity consumed 4,779,562 kWh	Headquarters Gas consumed 4,822.2 m ³	Headquarters (Tap) Water usage 13,876 t		
		Headquarters Copy paper consumed 12,098,500 sheets		Stores Packaging 5,573 t		
Materials						
Out CO ₂ Emissions and Waste	CO₂ Emissions	Headquarters CO ₂ emissions (electricity and gas) 2,660 t-CO ₂				
		Sewing factories and fabric manufacturers CO ₂ emissions 1,705,655 t-CO ₂	Logistics CO ₂ emissions 20,991 t-CO ₂	Stores CO ₂ emissions (electricity) 119,502 t-CO ₂ CO ₂ emissions (gas) 11,735 t-CO ₂		
		Headquarters Combustible waste (paper waste, etc.) 218.8 t	Noncombustible waste (plastic waste, etc.) 3.6 t			
Waste and Recycling			Stores General waste 51,440 t	Customers Items collected through All-Product Recycling Initiative 1,457 t		

Notes: The data without annotation is from fiscal 2015. Manufacturing data represent factories that produce UNIQLO products. Logistics figures are for the period from April 2014 to March 2015. Logistics and store data represent UNIQLO stores in Japan. Data from headquarters are figures in Japan (Tokyo head office and Yamaguchi headquarters). Packaging refers to the paper and plastic shopping bags that UNIQLO and GU use in Japan. Items collected through All-Product Recycling Initiative refer to the items received at clothing sorting centers as of August 31, 2015.

Source: Fast Retailing - Sustainability Report, available at: http://www.fastretailing.com/eng/sustainability/environment/co2_popup.html

In 2016, at Fast Retailing, carbon dioxide emissions amounted to 2,917,069 (tCO_{2e}). In logistics it was 17,707 (tCO_{2e}). Table 9. presents carbon dioxide emission (tCO_{2e}) in stores and management offices by sources (generators) at Fast Retailing for 2016.

Table 9. Carbon dioxide emission in stores and management according to sources (generators) at Fast Retailing for 2016 (tCO_{2e})

Store gas	11,436
HQ gas	38
Total Scope 1	11,474
Store electricity	123,932
HQ electricity	2,466
Total Scope 2	126,398

Source: Fast Retailing - Sustainability Report 2017, available at: http://www.fastretailing.com/eng/sustainability/report/pdf/sustainability2017_en.pdf#page=1&pagemode=thumbs&zoom=80

FastRetailingplanstoreducecarbondioxideemissionsinstoresby10%by2020(FastRetailing - Sustainability Report 2017, available at: http://www.fastretailing.com/eng/sustainability/report/pdf/sustainability2017_en.pdf#page=1&pagemode=thumbs&zoom=80.)

Conclusion

A growing number of retailers (food) in the world have been publishing reports on sustainable development. By their reputation, and because of its importance, other retailers will certainly tend to publish these reports in the future. It provides the basis for a comparative analysis of environmental performance in retail food from various aspects. In this report, special significance is given to trend of greenhouse gas emissions, in particular, carbon dioxide.

Carbon dioxide emissions in trade, in total and by sectors, vary by country. They are significantly higher in China than in Europe or the European Union. Likewise, carbon dioxide emissions are significantly higher in trade of France, Germany and Great Britain than in Greece, Croatia, Turkey and Serbia. Carbon dioxide emissions are higher in Croatian trade than in Serbian. These differences are due to the application of various ecological measures in business.

Carbon dioxide emissions differ in individual stages of the product life cycle, retail companies and product categories. Carbon dioxide emission generators in retail companies are as follows: electricity, transport, ventilation, heating and cooking, refrigeration, and waste. The goal of all retailers is to take appropriate measures, primarily ecological, to reach a planned reduction of carbon dioxide emissions in the future. Among other things, this is achieved with the increasing use of electricity from renewable sources (so-called “green energy”), by using modern ventilation, heating and cooking systems, refrigeration units, green logistics (ecological vehicles) and more efficient waste treatment. The effect of this is to improve the overall performance of retail companies (food), especially environmental.

Conflict of interests

The authors declare no conflict of interest.

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CONTENT

1. Branko Mihailović, Zoran Simonović, Miodrag Brzaković
**STRATEGIC PLANNING OF SUSTAINABLE DEVELOPMENT
OF AGRICULTURE OF LAJKOVAC MUNICIPALITY. 475**
2. Snežana Milošević Avdalović
**IMPACT OF FIRM SPECIFIC FACTORS ON PROFITABILITY
OF INDUSTRIAL GRINDING COMPANIES. 493**
3. Siniša Zarić, Igor Ilievski
**THE NONMARKET ENVIRONMENT OF THE WINE INDUSTRY
IN THE REPUBLIC OF MACEDONIA: THE CASE OF WINES OF
MACEDONIA ASSOCIATION (FROM MARKET RIVALS TO
ALLIES IN THE NONMARKET ENVIRONMENT) 503**
4. Viktorija Petrov, Nada Trivić, Đorđe Čelić
**ASSESSING SUSTAINABILITY
OF THE SOUTHEAST EUROPEAN ECONOMIES 519**
5. Mladen Maksimović, Tatjana Janovac, Darjan Karabašević, Miodrag Brzaković
**SOLUTION OF GENERAL AND PREVENTION OF ECOLOGICAL
PROBLEMS OF STARA PLANINA MOUNTAIN AS POTENTIAL
OBSTACLES TO THE DEVELOPMENT OF RURAL TOURISM. 531**
6. Marija Paunović, Olivera Milutinović, Goran Puzić
**PERSONAL SUBJECTIVITY IMPACT REDUCTION IN CHOICE
OF SOUR CHERRY VARIETIES FOR ORCHARD
ESTABLISHMENT USING FUZZY SYSTEM 545**
7. Snežana Urošević, Dragiša Stanujkić, Darjan Karabašević, Pavle Brzaković
**USING SINGLE VALUED NEUTROSOPHIC SET TO SELECT
TOURISM DEVELOPMENT STRATEGIES IN EASTERN SERBIA . . 555**
8. Rade Popović, Dalibor Panić
**TECHNICAL EFFICIENCY OF SERBIAN DAIRY
PROCESSING INDUSTRY. 569**

9. Marijana Joksimović, Biljana Grujić, Dušan Joksimović
CORRELATION AND REGRESSION ANALYSIS OF THE IMPACT OF LEASING ON AGRICULTURAL PRODUCTION IN REPUBLIC OF SERBIA. 583
10. Boris Kuzman, Dajana Ercegovac, Mirela Momčilović
DEVELOPMENT OF DERIVATIVE TRADING ON FINANCIAL MARKET AND AGRIBUSINESS SECTOR IN SERBIA. 601
11. Goran Perić, Marko Gašić, Marija Stojilković, Ivana Nešić
THE IMPACT OF EMPLOYEE SATISFACTION ON THE TOURIST SATISFACTION WITH THE SERVICES OF SPA TOURISM 617
12. Nebojša Gvozdenović, Dejan Brčanov
VEHICLE SCHEDULING IN A HARVEST SEASON 633
13. Srđan Šapić, Srđan Furtula, Danijela Durkalić
PRESTIGE AND NATIONAL IDENTITY AS PREDICTORS OF FOOD PRODUCTS PURCHASE 643
14. Sonja D. Radenković, Jelena Šaranović, Boban Stojanović, Zorana Kostić, Bojan Jokić
APPLYING INTELLECTUAL CAPITAL IN IMPROVING AGRI-INDUSTRY AT REPUBLIC OF SERBIA 659
15. Mersida Jandrić, Vladimir Zakić
APPRAISAL OF THE DAIRY CAPITAL VALUE ON THE TERRITORY OF THE PESTER PLATEAU 673
16. Goran Milošević, Marija Vuković, Duško Jovanović
TAXATION OF FARMERS BY THE INCOME TAX IN SERBIA 683
17. Milan Počuča, Ivan Joksić, Bojana Drašković
ENVIRONMENTAL PROTECTION IN THE LIGHT OF DISCREPANCY BETWEEN THE NORMATIVE AND THE REALITY . . 697
18. Sonja Lučić
EU TRADEMARKS FOR WINE WHICH CONTAINS INDICATIONS OF GEOGRAPHICAL ORIGIN 715
19. Dejan Đurić, Vladimir Mitrović, Dragana Đurić, Jelena Ristić
EU TRADEMARKS FOR WINE WHICH CONTAINS INDICATIONS OF GEOGRAPHICAL ORIGIN 731
20. Miljan Leković, Drago Cvijanović, Milena Jakšić
FARMLAND REAL ESTATE INVESTMENT TRUSTS 745

-
21. Aleksandra Vujko, Nataša Papić-Blagojević, Tamara Gajić
**APPLYING THE EXPONENTIAL SMOOTHING MODEL FOR
FORECASTING TOURISTS' ARRIVALS –
EXAMPLE OF NOVI SAD, BELGRADE AND NIŠ 757**

 22. Svetlana Vukosav, Vuk Garača, Milan Bradić
**ANALYSES OF REGULATIONS REGARDING
ACCOMMODATION FACILITIES CATEGORISATION
IN RURAL TOURISM IN SERBIA 769**

 23. Mihajlo Munćan
**ECONOMIC EFFECTS OF IRRIGATION OF BASIC FIELD
CROPS ON FAMILY FARMS 787**

 24. Srećko Novaković, Dragan Vukasović, Bogdan Laban, Mladen Ivić,
Vera Popović, Slobodan Popović
**MANAGING AGRICULTURAL COMPANY BY USING INTERNAL
CONTROL AND SIGNIFICANCE OF RISK PRESENTATION 801**

 25. Slobodan Nešković, Verica Savić
**NATURAL RESOURCES PROTECTION STRATEGIES IMPORTANT
FOR AGRICULTURE IN THE INTERNATIONAL COMMUNITY
AND REPUBLIC OF SERBIA 813**

 26. Goran Maričić, Sanja Škorić, Danijela Radenković
**APPLICATION OF THE PRINCIPLES OF CORPORATE
GOVERNANCE IN AGRICULTURE COOPERATIVES 827**

 27. Marija Kostić, Marija Lakićević, Snežana Milićević
**SUSTAINABLE TOURISM DEVELOPMENT OF MOUNTAIN
TOURISM DESTINATIONS IN SERBIA 843**

 28. Radojko Lukić, Srđan Lalić, Azra Sućeska, Aida Hanić, Milica Bugarčić
CARBON DIOXIDE EMISSIONS IN RETAIL FOOD. 859