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Executives' insights about by-products made by recycled CO2: the case of CPGs industry

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ABSTRACT

This paper presents parts of an exploratory, mix-methodology study that concerns the innovative technology of carbon capture and utilization (CCU) in the production of chemical oxo-products. Experts with 13 European CPGs industries were surveyed. It was found that recycling and conservation of energy and water technologies are carried out in all factories, while green applications that concern the composition of products are implemented by half of the industries. All executives hold positive attitudes towards innovative technologies that concern carbon neutrality. Half of them were found willing to include the new, green oxo-products (Glycolic acid, n-Valeraldheyde and Limoxal^{TM}) in their production process of their GPCs, stating prerequisites that concern quality and actual contribution to neutrality. The reservations that were expressed by the other half of the respondents concern the low level of awareness about the recycled CO_2 oxo-products and the early stages of CCU implementation.

KEYWORDS

Green business practices, carbon capture and utilization (CCU), green oxo-products, CPGs industry.

1. Introduction

Frans Timmermans, the executive vice-president (2019-2024) for the European Green Deal, in a recent newspaper interview of his (To VIMA, 2022), declared that neutrality is both necessary and feasible by 2050, as agreed in the UN Glasgow Financial Alliance for Net Zero /GFANZ in 2021 (GFANZ, 2022). The Paris Agreement on climate change stipulates the requirement to pursue efforts to limit the average global temperature increase to 1.5°C (UNFCCC, 2015). Of course, climate crisis is not going to be overcome in a short period of time by just the implementation of one alliance, as for more than two centuries, wealth was built at the expense of climate. Moreover, although climate changes and extreme weather phenomena are ranked high in people's concerns, the working classes are justifiably worried about losing their jobs. This is why European Deal has to place emphasis on the notion of fair transition. "If green transition is not going to be fair, it is just not going to happen at all", Frans Timmermans underlined (To VIMA, 2022). The "It's Possible" podcast held during GFANZ aimed to inspire positive change, unpack the climate emergency, and connect science and action (UNCC, 2021) towards fair economic development, in favour of both humanity and physical environment.

In this regard, the business world faces a series of challenges in order to respond to public increasing environmental concerns, comply to regulations imposed by governments and pressure exerted by non-governmental organizations (Scur and Barbosa, 2017; Schaltegger, 2021). Corporate strategies, as well as marketing practices (Rudawska, 2019) have to adapt towards holistic, sustainable business missions rather than simply apply seemingly green techniques, which sometimes include greenwash (Nguyen et al., 2019). An honest ecological management strategy has to comply to actual sustainability goals, such as reduction of emissions, energy, water and waste (Abutaleb and El-Bassiouny, 2020). In addition, competitive ecological offerings to meet sensitive consumers' needs and wants are required (Delistavrou et al., 2021). Hence, sustainable orientation and practice are becoming an increasingly important part, not just in B2C but in B2B marketing research and practice (Kapitan et al., 2019; Trollman and Colwill, 2021). In fact, ecological values should be penetrated into the centre of the industrial sector philosophy targeting to a range of actions, such as carbon pricing, setting science-based targets, sourcing 100% renewable energy, and climate-related financial disclosures (UN Global Compact, 2019). Among other sectors of manufacturing, chemical industry is often accused of harming the physical environment heavily. Chemical industry has

been found to be the third largest Green House Gas (GHG) emitter in Europe (DECHEMA, 2017).

In the production of consumer-packaged goods (CPGs) the concept of ecologically friendlier ingredients has been gaining importance over time (Duran et al., 2014; AISE, 2022; Cosmetics Europe, 2022). This tendency has increased the challenge to produce CPGs by the utilization of friendlier to the environment raw material. Efforts by the Research and Development (R&D) corporate departments or by academic labs to develop innovative, green technologies able to provide materials towards low or no CO2 emissions appear from sometime now in the relevant literature (Huisingh et al., 2015). On the other hand, it is to be noted that there is not enough knowledge with regards to actual adoption and implementation of green practices by the production and management departments in the European industries (Seuring and Gold, 2013; Scur and Barbosa, 2017; Jones et al., 2017). Therefore, extensive research efforts are required not just to examine the current status quo. Research is necessary to reveal the factors that are able to motivate the willingness to adopt innovative, green practices in the production, in line with the European Green Deal about climate changes and reduction of carbon gas emissions.

Among other innovations, there are recent suggestions that concern a new technology in the field of carbon capture, utilization and storage / CCUS (Linzenich et al., 2019). CCUS aims to remove an amount of CO2 from the atmosphere using Carbon Dioxide Removal/CDR emissions (Cox et al., 2020; Rajabloo et al., 2022). Carbon Capture and Storage (CCS) and Carbon Capture and Utilization (CCU) are two CO2-based technologies aiming at mitigating climate change by capturing and either permanently storing CO2 (CCS) or using it as feedstock (CCU) for commercial products, e.g., chemicals, fuels, or plastic products (Arning et al., 2020; Rajabloo et al., 2022). Although there are similarities, there are also significant differences in both the technology and valorisation between CCU and CCS appearing in public debates and policy processes (Bruhn et al., 2016).

This study lies mostly within the topic of CCU, also referred as Carbon Dioxide Utilization (CDU) (Jones et al., 2014; 2015) or CO2 Recycling (Perathoner and Centi, 2014). It concerns a technological innovation for a new, green process that uses recycled CO2, water and sunlight to produce fluid, green oxo-products that are able to replace conventional materials, necessary in the production of CPGs. Currently, the focus is placed on three chemicals that can be produced by the usage of recycled CO2 and are

widely used in the production of cosmetics, fragrances and detergents, among other CPGs. Glycolic acid is used in the production personal care products, n-Valeraldheyde is used in the production of plastic and flavouring and LimoxalTM is used in the production of fragrances, personal care and household cleaning products.

Therefore, this paper presents parts of an exploratory, mix-methodology study, in which experts with European CPGs industries were surveyed in order to reveal their insights about technological innovation concerning green by-products that are going to be made by recycled CO2.

2. Review of the literature

2.1. Chemical Industry in Europe

There is no doubt about the significant role of chemical industry as practically chemicals are utilized in the production of all goods. During the COVID-19 pandemic, chemical industry was found crucial as it offered the necessary health and hygiene equipment and products (Hepburn et al., 2021). In regards to climate changes, the chemical industry has been previously challenged to drastically reduce the carbon gas emissions in order to comply to the relevant European directives (EC 2037, 2000; EC 1005, 2009). The EU27 greenhouse gas (GHG) emissions, in chemical industry, were decoupled in 2019 as they fell by nearly 54% since 1990 (CEFIC, 2022). Still, the European Green Deal goals, for zero carbon gas emissions in 2050, seem quite ambitious. The above-mentioned reduction was actually achieved mainly in the period 1997-2013, while after 2013 there was no significant reductions of GHG emissions (CEFIC, 2022).

Further, it is to be underlined that COVID-19 brought about new research and policy issues imposing modifications of the deal (Barouki et al., 2020; Lara, 2020). In addition, it is not to be overlooked that competitiveness for profitability is always the ultimate business scope. The world chemical sales in 2020 came up to €3,471 billion, with EU27 being the second largest producer of chemicals in the world, with €499 billion (China 1,547 and US 426 billion). However, the predictions, for the decade to come, concern a declining European share in an increasing global market with China, NAFTA and Latin America indicating enlarging tendencies of their own shares (CEFIC, 2022). The Achilles heel of the entire European industry is the energy cost with gas and electricity accounting for two third of the total energy consumption (CEFIC, 2022). The European carbon price has also risen sharply in 2021, albeit much less than the gas price. High gas prices themselves

contribute to an increasing carbon price since they lead to an increased use of coal for power generation and consequently higher demand for emission allowances. It is important to note that the carbon price from the European trading system (ETS) provides a fundamental incentive to switch to cheaper low-carbon energy sources, thus contributing in the longer term to lower wholesale prices (European Commission, 2021). On the other hand, the stronger point of European firms remains the quality of products due to the research and innovation (R&I) superiority. European chemical industry, despite the economic crisis, spends steadily growing resources in R&I, reaching the 9.4 billion in 2020, just 4.6 million less than China (14 billion), which however accounts for triple sales than EU27 (CEFIC, 2022).

Consequently, the European chemical corporates have to encompass creatively three issues: economic sustainability, response to COVID-19 financial shock and transition towards neutrality (CEFIC, 2022). Hence, this challenging era should welcome any innovation strategy towards technology, products and by-products that might be found able to reduce carbon gas emissions, financial and social cost while offering efficient and effective solutions in the production of CPGs, among other product value chains.

2.2. CPGs in Europe

Leaving food out of the box in this study, the main CPGs categories are the household cleaning products (home and fabric care products) and the personal care products (fragrances, cosmetics and other toiletries). The market value for household cleaning products in EU accounted for €32.4 billion in 2020 increasing by 4.7% from €30.2 billion since 2019 (AISE, 2021), with Germany being the largest market with about €4.58 billion sales, followed by UK with €4.23 billion and France €4.22 billion (Statista, 2022a). With regards to specific categories, increase was indicated in all categories and in particular to surface care, dishwashing and bleaches, which is attributed to the increased amount of time spent at home due to COVID-19 restrictions (AISE, 2021). It is expected that the cleaning market will grow further due to the pandemic and its impact on cleaning habits to minimize the risk of COVID-19 contamination (Statista, 2022a).

The market values for personal care products in EU accounts for €76.7 billion and in EU27 accounts for €63.8 billion (Cosmetics Europe, 2020), experiencing a growth of approximately €10 billion between 2015 and 2020 (Statista, 2022b), with Germany's sales value reaching about €14 billion in 2020, France €11.4 billion, UK €9.8 billion and Italy €9.7 billion (Cosmetics Europe, 2020). Spain with sales value of €6.4 billion (Cosmetics

Europe, 2020) had the highest growth rate, with personal care product sales growing by 2.4 percent (Statista, 2022b). As for the specific product categories, 28% of the total sales were for skin care products, 27.7% for toiletries, 18.4% for hair care products, 13.7% for fragrances and 12.2% for decorative cosmetics (Cosmetics Europe, 2020).

2.3. Green practices in CPGs industry

In EU, big companies (>500 employees) are obliged to report annually their sustainability actions and the requirements are set to become stricter for reports published from 2024 and beyond (EC 95, 2014). Climate investments, energy efficiency and effectiveness, seem to be on top of investment priorities and the majority of business are currently investing or planning to invest in these areas, in the next few years (Euromonitor International, 2021). However, currently just 13% of companies are actually engaged in carbon capture and reuse of CO2 exhausts that go in chemical manufacturing or in soil carbon restoring in agriculture (Euromonitor International, 2022). The stock keeping units (SKUs) carrying such claims are just under 0.1% of a given industry (Euromonitor International, 2022). Although climate change is considered very and extremely important by more than 70% of the business executives, just 14% of the businesses actually have a carbon Net-Zero strategy (Euromonitor International, 2021). Nonetheless, 43.3% of them expect that reduced carbon footprint will be one of the major concerns for the consumers in the future, whereas 34.7% of consumers declare they will try to reduce carbon emissions (Euromonitor International, 2021).

Home care industry in order to respond to the changes in consumers' habits due to environmental concerns, move towards green services and products by adopting innovations in materials and surfaces (AISE, 2022). The European home care industry invests 2-3% of turnover in science, 1-2% in new product development and manufacturing and 4-5% in marketing and sales at an effort to produce new or improved products in the market (AISE, 2022). Green innovation is pursued throughout the life cycle of the home care products, i.e., sourcing and design, production, transportation, use and disposal and include low temperature washing, unit dosing, compaction, controlled dosing, resources efficiency and packaging (AISE, 2022).

The personal care products industry is progressively adopting efficient processes and technologies in production, aiming to reduce energy and water consumption, waste generation and pollution. In order to minimize the environmental footprint of personal care products, companies in the industry employ green strategies such as the use of

biodegradable, recyclable and reusable packaging as well as eco-design of formulas with more sustainable materials (Cosmetics Europe, 2022).

3. Research objectives

The objectives of this research study are:

• to record the innovative, green practices that are already implemented or planned to be implemented in the near future, in the production process of the CPGs industries

• to examine in depth the experts' overall views, thoughts or ideas about innovation and sustainability as well as towards a new technology aiming to produce environmentally friendlier by-products made by recycled CO2, water and sun

• to explore the executives' perceptions about the possibility, the necessary prerequisites and the motivational factors to include into their production the new, green oxo-products and valorise them in their promotional strategy.

4. Methodology

Keeping in mind the visual representation of the process as presented in Figure 1, in the following we describe each step and discuss its relevance.

4.1. The survey

At an effort to gain more and deeper information, a mixed technique to collect empirical data was utilised. In previous studies (e.g. Duran et al., 2014; Kapitan et al., 2019; Abutaleb and El Bassiouny, 2020; Cox et al., 2020) mixed techniques - including both qualitative and quantitative tools - have been found efficient in the examination of similar cases. A semi-structured inventory, suitable for in-depth interviews served as the research instrument. Following Mason (2009) the instrument development procedure included literature search and study, 4 in-depth interviews with chemical engineers (1 researcher and 3 industry experts), who provided valuable consulting services, followed by consecutive pre-testing - pilot techniques that leaded in a series of the questionnaire editing.

Judgement or purposive sampling (Zikmund, 2003; Churchill and Iacobucci, 2005) was implemented in order to gain as much as possible richness of information in favour of this study objectives (Kapitan et al., 2019). A list of 60 CPGs industries was made, based on the criterion of diversity (Duran et al., 2014) with regards to the size. An expert appointed by the management of each company was interviewed and the procedure ended in 13 useable cases. This sample size is considered appropriate as the focus of the survey was

placed on emerging objective, unique perceptions and understanding in depth the respondents' insights (Patton, 2002).

4.2. The inventory contents

The final research instrument included 3 questions about business and experts' characteristics. There were 9 quantitative questions, some of which contained an open part, too. There were also 8 totally open questions prepared for each in-depth interview. In the quantitative part of the instrument the following questions were included, all measured in nominal scales:

Business Characteristics (BC), in which 3 questions were included, namely legal form, number of employees and specialty of the respondent.

Consumer Packaged Goods (CPGs), in which it was recorded which CPGs (fragrances, cosmetics, home care products, fabric care products, personal care products or any other).

Life Cycle Assessment (LCA) and Life Cycle Assessment Impact (LCAI) in which the respondents were asked to state if LCA is performed in their factory. If Yes, they were asked about the aspects that have large impact on their products' LCA; if No, they were asked whether LCA would be of their interest presently or in the future.

Certificates (Cert), in which ISO or other green certification or awards hold by each company were recorded.

Ingredients (In), adopted from Bom et al. (2019), in which the respondents were asked to characterize the majority of ingredients (synthetic, natural, organics), in each one of the above-mentioned categories of products.

Innovation Strategy (IS) in which the respondents were asked to characterize the main strategy that is followed by their firm with regards to innovation. This question is followed by Innovative Green Practices Aspects (IGPA) in which the experts were asked to state the most important aspects of innovative, green practices in the production of CPGs. Both questions were adopted from Duran et al. (2014).

Green Deal Actions (GDA) in which the experts were asked to specify which actions, out of a 10-items list (see Table 3), has their company "Already" carried out or plans to adopt "In the future". This question was adopted from "The Community Innovation Survey, 2014".

Green Oxo-products (GOP) examining which new, green oxo-products was most probable to use followed by Green Oxo-products in CPGs (GOPinCPGs) examining for which CPGs they were going to use the above mentioned new, green oxo-products.

In the qualitative part of the inventory, the following open questions were included:
Perceptions about Green Practices (PGP) in which the respondents were kindly asked to share their overall views, thoughts or ideas about innovative, green practices in the CPGs.
Utilization of Oxo-products (UOP) in which the respondents were asked to indicate which of the chemicals, under investigation, are used in the production process in their industry, followed by *Production of Oxo-products (POP)* to examine where and by whom the utilized oxo-products are being produced.
Perceptions about Green Oxo-products (PGOP). In this open question the experts were informed about the production process of the new, green oxo-products and asked to share their inceptive thoughts about the overall idea.
Adoption Willingness (AW) in which the respondents were asked to state how likely it is to adopt any of the above green oxo-products, followed by *Adoption Prerequisites (AP)*, an open question about the prerequisites of adopting the new, green oxo-products in the production process of CPGs in their own company.
Green Oxo-products Attributes (GOPA) examining which attributes would be the 3 more crucial for the adoption of the green oxo-products in the production process of CPGs in their own factory.
Promotional Campaign (PC) of CPGs using Green Oxo-products asking the experts to hypothesize how they were going to valorise in their products' promotional campaign, the potential adoption of one or more of the above mentioned new, oxo-products.

5. Results

The quantitative part of the inventory provided the following results:
All 13 cases were Societe Anonyme. Half of the responding persons are chemistry experts (pharmacist/chemist/chemical engineer) while the other half are management/marketing executives (Table 1). There is 1 firm with more than 100 th. employees, 1 with more than 15 th., 1 with more than 1 th., 4 small and medium enterprises with 80 - 300 employees and 4 very small firms with 4 -10 employees. There are 11 out of 13 factories, in which personal care products are produced, 8 cosmetics, 4 fragrances while there are 4 out of 13, in which home care products and fabric care products are produced (Table 1).
It has to be mentioned that just the 2 largest industries apply a system of Life Cycle Assessment. On certification, there are 9 companies holding one or more version(s) of ISO (9000, 14001, 22716/GMP), while 6 companies hold one more of other, various certificates.

With regards to the synthesis of the main ingredients per product category, there is 1 company (cosmetics and personal care products), in which only natural and organic ingredients are utilized and 1 company (pharmaceutical) that uses solely natural ingredients. There is 1 company (household products) that uses only synthetic ingredients. In all other cases (10) basically chemically produced (synthetic) ingredients are used while some natural and/or organic ingredients are utilized, too (Table 1).

Companies	**Legal form**	**Number of employees**	**Respondent Specialty**	**CPGs**	**Ingredients**		
					Synthetic	Natural	Organic
Company 1	S.A.	100	Chemist	Fabric & Home care	√	√	
Company 2	S.A.	>1,000	Business Dev.	Fabric, Home & Personal care	√		√
Company 3	S.A.		CPGs Director	Fabric, Home & Personal care	√		
Company 4	S.A.	15,000	Procurement Mngt	Cosmetics & Fragrances	√	√	√
Company 5	S.A.	> 100,000	Biotechnology	Fabric, Home & Personal care	√	√	√
Company 6	S.A.	22-40	Chemical Engineer	Fragrances & Personal care	√	√	
Company 7	S.A.	310	Pharmacist	Cosmetics & Personal care		√	√
Company 8	S.A.	20	Chemist	Cosmetics, Fragrances & Personal care	√	√	√
Company 9	S.A.	10	Shareholder	Cosmetics & Personal care		√	
Company 10	S.A.	15	Chemist	Cosmetics & Personal care	√	√	
Company 11	S.A.	80	Dev. & Marketing	Cosmetics & Personal care	√	√	
Company 12	S.A.	140	Chemist	Cosmetics, Fragrances & Personal care	√	√	√
Company 13	S.A.	30	Chemical Engineer	Cosmetics & Personal care	√	√	√

Table 1. Business Characteristics (BC), Consumer Packaged Goods (CPGs), and Ingredients (In).

With regards to the innovation strategy 8 out of 13 experts declared that they develop new and also adopt existing innovations in their production process, 3 reported imitation of leaders and 2 reported progressive development of existing techniques. As for the most important aspects when considering innovative, green practices in the production of CPGs, 8 of the respondents declared that renewable materials is the main issue, 9 carbon neutral production processes while 5 of them stated that biodegradable products is the most important aspect.

With regards to the European Green Deal actions (Table 2), 10 out of 13 industries declared that they have already carried out "recycling technologies", 7 "reduction of water and energy technologies", 6 "replacing part of the materials with green substitutes", 5

"moving towards renewable materials" and "waste management technologies", 4 "avoidance of materials tested on animals", "moving towards biodegradable products", "reduction of CO2 emissions" and "sustainable packaging" while just 3 out of 13 declared that they already follow an "environmental management system" and "replace part of fossil fuels with renewable sources". There have been 4 companies, which plan to adopt the latter two actions in the future.

	ALREADY		**IN THE FUTURE**		**No response**		**Total**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Avoidance of materials tested on animal	4	30.8	1	7.7	8	61.5	13	100.0
Environmental management systems	3	23.1	4	30.8	6	46.1	13	100.0
Moving towards biodegradable products	4	30.8			9	69.2	13	100.0
Moving towards renewable materials	5	38.5			8	61.5	13	100.0
Recycling technologies	10	76.9			3	23.1	13	100.0
Reduction of water and energy technologies	7	53.8			6	46.1	13	100.0
Reduction of CO_2 emissions	4	30.8	3	23.1	6	46.1	13	100.0
Replacing part of the materials with green substitutes	6	46.1			7	53.8	13	100.0
Replacing part of fossil fuel with renewable energy	3	23.1	4	30.8	6	46.1	13	100.0
Sustainable packaging	4	30.8	3	23.1	6	46.1	13	100.0
Waste management technologies	5	38.5	2	15.4	6	46.1	13	100.0

Table 2. Green Deal Actions (GDA)

As for the utilization of the oxo-products under examination, the Glycolic acid is used by 5 industries, the n-Valeraldheyde by 2 while LimoxalTM by none of the approached companies. All of the companies declared that they get these oxo-products by their suppliers.

It was found that 4 out of 8 companies are willing to adopt new, green oxo-products in the production of cosmetics, 3 out of 11 in the production of personal care products and 2 out of 4 in the production of home care products.

The elaboration of the *qualitative part* of the inventory indicated the following. It is to be noted that some unforeseen aspects were revealed:

With reference to the experts' perceptions regarding Green Practices, it was found that almost all (10) experts expressed positive to very positive attitudes concerning innovative, green practices in the production of CPGs. 3 of them expressed their belief that sustainability is "*100% our company's philosophy*", "*the key to business strategy*" and

"*plan to move 100 % to biodegradable products that have been produced with renewable carbon origin sub-products*". The most holistic idea that sustainability means "meeting consumer needs and implement practices that will save the planet resources and reduce greenhouse gases" was mentioned by 1 executive while another 1 said that "*sustainability will be feasible only if there is European funding of projects oriented to innovative, green practices along with the appropriate marketing effort*".

There was a semi-structured question, in which the experts were informed by the interviewers that "*a funded by EU project aims to contribute to the non-carbon production technology. A photoelectrocatalytic reactor is to be designed, which is going to use recycled CO2, instead of mineral carbon, for chemicals' production. It is argued that this new, green technology is going to reduce production costs by 10% and the CO2 emissions by 50% for each one of the oxo-products*". The respondents were kindly asked to express their thoughts and perceptions as freely as they would like. There were 7 of them, who just clearly stated their positive reaction towards the above innovative idea. The other 6 experts were rather cautious as they would like to know more about the possibilities of actual implementation of such a perspective. These expressed scepticism regarding the effectiveness of CCUS as long-term solution for mitigating climate change, unawareness of the specifics of the recycled CO2 technology, such as storage inconvenience, duration of stock and quality of the recycled CO2 oxo-products and durability of the final products.

The willingness to adopt any of the 3 new, innovative, green oxo-products was expressed by 9 experts. They provided a list of 7 prerequisites - each of which was mentioned once - that concern secured quality and efficacy - such as, *safety, functionality, equivalence for regulatory registration, more weight efficiency, efficacy, material validation*. The prerequisite of cost reduction was mentioned by 3 respondents, 2 of them expressed the necessity of availability, 1 of them the reliability of supplier while there was also 1 expert, who talked about the incentive of consumer demand.

With regards to the executives' perceptions about the most crucial attributes of the green oxo-products in order to be utilized in production, the contribution to the climate change combat was mentioned by 5 experts and the reduction in fossil fuel consumption by 3 of them; each one of the *carbon neutral ingredients*, product *efficacy and safety* appeared to be mentioned twice while a list of other attributes were mentioned by just 1 respondent (Table 3).

	n	%
Carbon neutral ingredients	2	15.4
Contribution to combat climate change	5	38.5
Preservation of natural resources	1	7.7
Production of regenerative products	1	7.7
Reduction in fossil fuel consumption	3	23.1
Reduction of CO_2 waste	1	7.7
Utilization of advanced green technology	1	7.7
Other		
Safety	2	15.4
Efficacy	2	15.4
No response	3	23.1

Table 3. Green Oxo-products Attributes (GOPA)

In 7 out of 13 companies, the experts declared their intention to leverage in their promotional effort the utilization of new, innovative, green products made by recycled CO_2, while 6 out of 13 did not respond in such a perspective.

6. Limitations and FRS

Although time and effort were spent at the preliminary stages of this study (literature review and in-depth interviewing consultants) the innovative, pioneering character of the subject under investigation brought certain limitations that are expected in an exploratory study. Limited previous research on this topic impacted on the inventory design of this study, which should be amended in a future duplication. Low level of awareness concerning the production of green oxo-products by the utilization of recycled CO_2 impacted on the firms' observed level to participate and thus to a rather low response rate (13/60). It is to be mentioned that Limoxal™ was not reported to be used by any executive. This was surprising as this is a widely used liquid that adds perfume in both personal fragrances and home care products. According to one of our science consultants this might be attributed to unawareness. Most of the companies that participated in the survey customarily buy their oxo-products by a supplier and do not produce them in their own premises. A future study should focus on those industries that are likely to actually install a reactor to produce oxo-products by recycled CO_2.

7. Discussion and conclusions

The results of this study indicated that although a tendency towards natural or organics (Statista, 2022b) is evident in the literature (Duran *et al*., 2014), it is with no doubt that chemicals are still the main ingredient not just in the production process of detergents but of personal care products, too (Table 1).

With regards to those European Green Deal actions (Table 2), which concern the composition of a product (and thus are more related to this study), focus was placed on the following: "replacing part of the materials with green substitutes", "moving towards renewable materials", "moving towards biodegradable products", "reduction of CO_2 emissions" and "replace part of fossil fuels with renewable sources". It was found that these practices are carried out by less than half of the examined industries, which is, to an extent, in line to the findings of Euromonitor International (2021). It is to be noted that 3 of these firms are among the largest in the sector. As for the total sample, the most applied practices concern recycling and conservation of energy and water. This is in line with the relevant findings in Cosmetics Europe (2022).

With regards to the experts' overall views, thoughts or ideas, the qualitative techniques revealed that the executives primarily expect carbon neutrality (renewable materials, carbon neutral production process and biodegradable products) when considering adoption of innovative technologies. Almost all experts were found to hold positive attitudes towards innovative technology in the production of CPGs while further, half of them expressed positive inceptive thoughts towards the specific innovative, green oxo-products under examination. The other half, who were found somehow sceptic, expressed need for more information and reservations, similar to those argued by Arning *et al.* (2019). These reservations may be attributed to the low level of awareness and the very early stages of CCU implementation.

With regards to the executives' perceptions about adopting the new, green oxo-products, the tendencies reported by Cosmetics Europe (2022) and AISE (2022) were verified, to an extent, by the results of this study, as half of the companies that produce cosmetics as well as half of those that produce home care products were found willing to include them in their production process. The majority of the respondents expressed prerequisites that concern secured quality and efficacy of the 3 oxo-products while cost reduction was mentioned by one out of four of the executives. With relevance to the new oxo-product attributes, most responses (contribution to the climate change combat and reduction of

fossil fuel consumption) concern the actual contribution to the Green Deal goal of carbon neutrality (Table 3). Finally, more than half of the firms declared their intention to valorise the future utilization of these new, green oxo-products in the promotional campaign of their own CPGs. This final finding of the study calls for further research as it was found that a 4-5% on turnover is annually spent in marketing and sales (AISE, 2022) while this aspect was also outlined by several respondents.

REFERENCES

Abutaleb, S., and El-Bassiouny, N., (2020). Assessing sustainability marketing from macromarketing perspective: a multistakeholder approach. World Journal of Entrepreneurship, Management and Sustainable Development 16(4): 287-305, DOI: 10.1108/WJEMSD-02-2019-0017

AISE / International Association for Soaps, Detergents and Maintenance Products (2022). One of Europe's hidden "motors of innovation". AISE, 2022. Available at: https://www.aise.eu/our-industry/driving-innovation.aspx. Accessed on February 2022.

AISE / International Association for Soaps, Detergents and Maintenance Products (2021). A.I.S.E. activity & sustainability report 2020-21. AISE. Available at: https://www.aise.eu/our-industry/market-and-economic-data-2292.aspx. Accessed on February 2022.

Arning, K., Offermann-van Heek, J., Sternberg, A., Bardow, A., and Ziefle, M. (2020). Risk-benefit perceptions and public acceptance of Carbon Capture and Utilization. Environmental Innovation and Societal Transitions 35: 292-308, DOI: 10.1016/j.eist.2019.05.003.

Barouki, R., Kogevinas, M. Audouze, K., Belesova, K., Bergman, A., Birnbaum, L., Boekhold, S., Denys, S., Desseille, C., Drakvik, E., Frumkin, H., Garric, J., Destoumieux-Garzon, D., Haines, A., Huss, A., Jensen, G., Karakitsios, S., Klanova, J., Koskela, I-M., Laden, F., Marano, F., Franziska Matthies-Wiesler, E., Morris, G., Nowacki, J., Paloniemi, R., Pearce, N., Peters, A., Rekola, A., Sarigiannis, D., Šebková, K., Slama, R., Staatsen, B., Tonne, C., Vermeulen, R., and Vineis, P. (2021). The COVID-19 pandemic and global environmental change: Emerging research needs, Environment International 146: 106272, DOI: 10.1016/ j.envint.2020.106272.

Bom, S., Jorge, J., Ribeiro, H.M., and Marto, J. (2019). A step forward on sustainability in the cosmetics industry: A review. Journal of Cleaner Production 225: 270-290. DOI: 10.1016/j.jclepro.2019.03.255.

Bruhn, T., Naims, H., and Olfe-Kräutlein, B. (2016). Separating the debate on CO2 utilisation from carbon capture and storage. Environmental Science & Policy 60: 38-43, DOI: 10.1016/j.envsci.2016.03.001.

CEFIC / European Chemical Industry Council (2022). European chemical industries facts & figures 2022. Available at: https://cefic.org/a-pillar-of-the-european-economy/facts-and-figures-of-the-european-chemical-industry/. Accessed on January 2022.

Churchill, G. A., Jr. (1995). Marketing Research, 6thed, Orlando, Fl: The Dryden Press.

Community Innovation Survey (2014). The community innovation survey, CIS 2014 - Harmonised survey Questionnaire. Eurostat. Available at: https://ec.europa.eu/eurostat/cache/metadata/en/ inn_cis9_esms.htm. Accessed on February 2021.

Cosmetics Europe (2020). Market performance 2020: European cosmetic, toiletry & perfumery data, Cosmetics Europe.

Cosmetics Europe (2022). Driving sustainable development. Cosmetics Europe. Available at: https://cosmeticseurope.eu/how-we-take-action/driving-sustainable-development/. Accessed on January 2022.

Cox, E., Spence, E., and Pidgeon, N. (2020). Public perceptions of carbon dioxide removal in the United States and the United Kingdom. Nature Climate Change 10: 744–749. DOI: 10.1038/s41558-020-0823-z

DECHEMA (2017). Low carbon energy and feedstock for the European chemical industry, Frankfurt, DE: DECHEMA. Available at: https://dechema.de/dechema_media/Downloads/ Positionspapiere/Technology_study_Low_carbon_energy_and_feedstock_for_the_European_chemical_industry.pdf. Accessed on January 2021.

Delistavrou, A., Tilikidou, I., and Krystallis, A. (2021). Nested relationships in pro-environmental purchasing: A moderated mediation model. Journal of Consumer Behaviour 20:1648-1663, DOI: 10.1002/cb.1958

Duran, I., Bikfalvi, A., and Llach, J. (2014). New facets of quality. A multiple case study of green cosmetic manufacturers. European Accounting and Management Review 1(1): available at: https://ssrn.com/abstract= 2532481, accessed on November 2021.

EC 1005 (2009). Regulation (Ec) No 1005/2009 of the European Parliament and of the Council of 16 September 2009 on substances that deplete the ozone layer. Official Journal of the European Union, L 286, 31.10.2009: 1-29. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/ PDF/?uri=CELEX: 32009R1005&from=EN. Accessed on November 2021.

EC 2037 (2000). Regulation (EC) No. 2037/2000 of the European Parliament and of the Council on substances that deplete the ozone layer. Official Journal of the European Communities, L 244, 29.9.2000: 1-24. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri= CELEX:32000R2037&from=EN, accessed on November 2021.

EC 95 (2014). Directive 2014/95/EU of the European Parliament and of the Council regarding disclosure of non-financial and diversity information by certain large undertakings and groups. Official Journal of the European Communities, L 330, 15.11.2014: 1-9.

Euromonitor International (2021). How to win in climate neutral investing. Euromonitor International. Available at: https://go.euromonitor.com/webinar-sustainability-210826-climate-neutral-investing.html. Accessed on February 2022.

Euromonitor International (2022). Net zero and carbon neutral claims under scrutiny, 21/1/2022, Euromonitor International. Available at: https://www.euromonitor.com/article/net-zero-and-carbon-neutral-claims-under-scrutiny. Accessed on January 2022.

European Commission (2019). Communication from the commission: The European Green Deal, Brussels: European Commission. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/? uri=CELEX%3A52019DC0640. Accessed on November 2021.

European Commission (2021). Communication from the commission: Tackling rising energy prices: a toolbox for action and support. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0660&from=EN. Accessed on February 2022.

GFANZ (2022). Glasgow Financial Alliance for Net Zero. GFANZ. Available at: https://www.gfanzero.com/. Accessed on January 2022.

Hepburn, C., Qi, Y., Stern, N., Ward, B., Xie C., and Zenghelis, D. (2021). Towards carbon neutrality and China's 14th Five-Year Plan: Green COVID-19 recovery, sustainable urban development and clean energy transition. London: Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science.

Huisingh, D., Zhang, Z., Moore, J.C., Qiao, Q., and Li, Q. (2015). Recent advances in carbon emissions reduction: policies, technologies, monitoring, assessment and modeling. Journal of Cleaner Production 103: 1–12, DOI:10.1016/j.jclepro.2015.04.098.

Jones, C. R., Kaklamanou, D., Stuttard, W. M., Radford, R. L., and Burley, J. (2015). Investigating public perceptions of carbon dioxide utilisation (CDU) technology: a mixed methods study. Faraday Discussions 183: 327-347, DOI: 10.1039/C5FD00063G

Jones, C. R., Radford, R. L., Armstrong, K., and Styring, P. (2014). What a waste! Assessing public perceptions of carbon dioxide utilisation technology. Journal of CO2 Utilization 7: 51-54, DOI: 10.1016/j.jcou.2014.05.001.

Jones, C.R., Olfe-Kräutlein, B., Naims, H., and Armstrong, K. (2017). The social acceptance of carbon dioxide utilisation: a review and research agenda. Frontiers in Energy Resources 5:11, DOI: 10.3389/fenrg.2017.00011

Kapitan, S., Kennedy, A-M., and Berth, N. (2019). Sustainably superior versus greenwasher: a scale measure of B2B sustainability positioning. Industrial Marketing Management 76: 84-97. DOI: 10.1016/j.indmarman.2018. 08.003.

Lara, G. (2020). Open Innovation in Times of Covid-19: The case of Project OxyGEN. European Accounting and Management Review, 7(1), 47-65.

Linzenich, A., Arning, K., Offermann-van Heek, J., and Ziefle, M (2019). Uncovering attitudes towards carbon capture storage and utilization technologies in Germany: Insights into affective-cognitive evaluations of benefits and risks. Energy Research & Social Science 48: 205-218, DOI: 10.1016/j.erss.2018.09.017.

Nguyen, T.T.H., Yang, Z., Nguyen, N., Johnson, L.W., and Cao, T.K. (2019). Greenwash and green purchase intention: the mediating role of green skepticism. Sustainability; 11(9):2653. DOI: 10.3390/su11092653

Perathoner, S., and Centi, G. (2014). CO2 recycling: a key strategy to introduce green energy in the chemical production chain. ChemSusChem 7(5):1274-1282, DOI: 10.1002/cssc.201300926.

Rajabloo, T., De Ceuninck, W., Van Wortswinkel, L., Rezakazemi, M., and Aminabhavi, T. (2022). Environmental management of industrial decarbonization with focus on chemical sectors: A review. Journal of Environmental Management 302(B): 114055. DOI: 10.1016/j.jenvman. 2021.114055.

Rudawska, E. (2019). Sustainable marketing strategy in food and drink industry: a comparative analysis of B2B and B2C SMEs operating in Europe. Journal of Business and Industrial Marketing 34(4): 875-890, DOI: 10.1108/JBIM-05-2018-0171

Schaltegger, S. (2021) Sustainability learnings from the COVID-19 crisis: Opportunities for resilient industry and business development. Sustainability Accounting, Management and Policy Journal 12(5): 889-897, DOI: 10.1108/SAMPJ-08-2020-0296

Scur, G., and Barbosa, M. E. (2017). Green supply chain management practices: Multiple case studies in the Brazilian home appliance industry. Journal of Cleaner Production 141: 1293-1302, DOI: 10.1016/j.jclepro. 2016.09.158.

Seuring, S., and Gold, S. (2013). Sustainability management beyond corporate boundaries: from stakeholders to performance. Journal of Cleaner Production 56: 1-6, DOI: 10.1016/j.jclepro. 2012.11.033.

Statista (2022a). Cleaning products industry in Europe – statistics and facts. Statista. Available at: https://www.statista.com/topics/4114/cleaning-products-industry-in-europe/#dossierKeyfigures. Accessed on January 2022.

Statista (2022b). Personal care market in Europe – statistics and facts. Statista. Available at: https://www.statista.com/topics/4132/personal-care-market-in-europe/#dossierKeyfigures. Accessed on January 2022

To VIMA (2022). Politics. Frans Timerman at VIMA- "If green development is not fair, it will not be conducted". To VIMA, 8 January 2022. Available at: https://www.tovima.gr/2022/01/08/ politics/frans-timermans-an-i-prasini-metavasi-den-einai-dikaii-den-tha-ylopoiithei/. Accessed on January 2022. (in Greek).

Trollman, H., and Colwill, J. (2021). The imperative of embedding sustainability in business: A model for transformational sustainable development. Sustainable Development 29: 974– 986, DOI:10.1002/sd.2188

Tull, D. S., and Hawkins, D. I. (1993). Marketing Research, 6th ed, New York, NY: McMillan.

UN Global Compact (2019). Business leadership for 1.50 C. New York: UN Global Compact.

UNCC (2021). Welcome to UN climate change's it's possible podcast. Available at: https://unfccc.int/its-possible-podcast . Accessed on January 2022

UNFCCC (2015). Adoption of the Paris Agreement FCCC/CP/2015/L.9/Rev.1. UN/Framework Convention on Climate Change, 12 December 2015. Available at: https://unfccc.int/resource/ docs/2015/cop21/eng/l09r01.pdf. Accessed on January 2022.

Zikmund, W. G. (1999). Essentials of Marketing Research, Orlando, FL: The Dryden Press.