Evaluation of the use of phosphates in Consumer Automatic Dishwasher Detergents (CADD)

Final Report

European Commission, Directorate-General Enterprise and Industry (DG ENTR)
25 September 2014

Document information

CLIENT	European Commission – DG Enterprise and Industry
CONTRACT NUMBER	30-CE-0602587/00-07- SI2.666481
REPORT TITLE	Final Report
PROJECT NAME	Evaluation of the use of phosphates in Consumer Automatic Dishwasher Detergents (CADD)
PROJECT TEAM	Shailendra Mudgal, BIO by Deloitte Sandeep Pahal, BIO by Deloitte Laura Petersen, BIO by Deloitte Dr. Elke Fries Dr. David Blackwood, University of Abertay Dundee
PROJECT OFFICER	Mr. Federico Musso
DATE	25 September 2014
KEY CONTACTS	Mr. Shailendra Mudgal shmudgal@bio.deloitte.fr or Mr. Sandeep Pahal spahal@bio.deloitte.fr
DISCLAIMER	The project team does not accept any liability for any direct or indirect damage resulting from the use of this report or its content. This report contains the results of research by the project team and is not to be perceived as the opinion of the European Commission.

Please cite this publication as:
BIO by Deloitte (2014), Evaluation of the use of phosphates in Consumer Automatic Dishwasher Detergents (CADD), Report prepared for European Commission – DG Enterprise and Industry

Table of Contents

Abbreviations

7th EAP: The Seventh Environmental Action Plan

ASDA: L-aspartic-N,N-diacetic acid

B-ADA: B-alaninediacetic acid

BNR: Biological nutrient removal

CADD: Consumer Automatic Dishwashing Detergent

EU: European Union

GES: Good Environmental Status

GLDA: L-glutamic acid, N,N-diacetic acid

HEDP: hydroxyethylidene diphosphonic acid

HEIDA: 2-hydroxyethyliminodiacetic acid

IDS(A): Iminodissuccinic acid

kWh: Kilowatt hour

MGDA: methyl glycine di-acetic acid

MSFD: Marine Strategy Framework Directive

MS: Member State

NGO: Non-governmental organisation

P: Phosphorus

P.E.: Population equivalent

SMEs: small and medium enterprises

STPP: Sodium Tri-Poly-Phosphate (the most commonly used phosphate in detergents)

TGAP: Taxe Générale sur les Activités Polluantes

UWWT Directive: Urban wastewater treatment Directive

WFD: Water Framework Directive

WWTP: Wastewater treatment plant

For European Union Member States, the official country code abbreviations were used.

1. Introduction

1.1 Objectives of this study

This study aims to provide the Commission with an evidence base in order to inform future policy actions with a view to address the environmental problems posed by the use of phosphates in CADD. For this purpose, information on the content of phosphates and alternatives in CADD is collected. The availability of the alternatives that could potentially replace phosphorus compounds and reduce the phosphorus pollution of the waterways in the EU are identified with a particular focus on the cleaning efficiency, cost efficiency and impact on wastewater treatment process.

1.2 Overall approach and methodology

The study builds upon previous work conducted on the issue of phosphates use in detergent contributing to eutrophication at EU level. This study focuses on consumer automatic dishwasher detergent (CADD), as previous studies have mostly focused on laundry detergent. It aims to complement and update these previous studies, by analysing the most recent data and by looking at the full EU picture in a comprehensive manner, including possible contrast between Member States, in order to inform the identification and assessment of suitable policy options, especially considering the impending CADD phosphates reduction in 2017.

With regard to CADD, this study focuses on the technical feasibility, market feasibility, and economic, environmental and social impacts of switching from phosphates-based to phosphates-free CADD. It further assesses the relevancy of the EU policy setting a limit of 0.3 grams phosphorus in the standard dosage in CADD from the 1st January 2017.

1.3 Policy background

Environmental Principles

Environmental regulation within the EU is based on several founding principles including the polluter-pays principle, which establishes that the person (legal or real) who causes environmental damage is the one who has to pay to for both the prevention of pollution and the remedying of pollution once caused. Some more principles include the prioritisation of pollution prevention and rectifying damages at the source.

The 7th Environmental Action Programme (7th EAP)[1] calls for better, cost-effective and sustainable management of the phosphorus and nitrogen nutrient cycles by tightening standards where necessary. The 7th EAP also stipulates for creating links among policies that deal with eutrophication and excessive nutrient releases.

In 2013, the European Commission published a Consultative Communication on the Sustainable Use of Phosphorus. The communication was not published with any specific legislation in mind and instead sought to evaluate the sustainability of phosphorus. It found that the current use of phosphorus is inefficient at many stages of the life cycle and that this causes problematic water pollution. Furthermore, when wastewater from human excreta and other household uses of

---

[1] European Commission. 2013. "Decision no 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 'Living well, within the limits of our planet'." http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013D1386&from=EN

phosphorus is uncontrolled or poorly controlled, it contributes significantly to eutrophication. The Communication stated that the recently adopted revision of the Detergents Regulation, which restricts the use of phosphates and other phosphorus compounds in automatic dishwasher detergents, will help to reduce non-essential use and to limit the discharge of phosphorus.[75]

Eutrophication related legislation

Many policies tackling eutrophication exist at the EU level.

One of such measures is the Directive on Urban Waste Water Treatment (Directive 91/271/EEC), which was adopted in 1991 with the goal of installing equipment to remove phosphorus from urban wastewater.

This Directive requires Member States to identify sensitive areas among which are "natural freshwater lakes, other freshwater bodies, estuaries and coastal waters which are found to be eutrophic or which in the near future may become eutrophic if protective action is not taken". In these areas, the Directive prescribes to include removal of phosphorus in the wastewater treatment process "unless it can be demonstrated that the removal will have no effect on the level of eutrophication". Discharges from urban wastewater treatment plants should have a limited concentration of phosphorus (2 milligrams/litre for agglomerations of 10,000 to 100,000 population equivalent[2] (p.e.) and 1 milligram/litre for agglomerations more than 100,000 p.e.) and/or reduce the load of the influent by minimum of 80%. The specified reference method of measurement is molecular absorption spectrophotometry. The Directive also indicates the number of samples that should be taken during the year depending on the number of p.e. and the minimum permitted non-compliance rate for these samples.

Other related pieces of legislation are Directive 91/676/EEC4 (the Nitrates Directive) under which Member States are required to identify vulnerable zones and to establish and implement action programmes in order to reduce water pollution from nitrogen compounds and Directive 96/61/EC5 under which Member States are required to issue permits for certain industrial installations according to the best available techniques. Annex III of the Directive 96/61/EC5 provides an indicative list of the main polluting substances, including substances which contribute to eutrophication, in particular nitrates and phosphates.

Directive 2000/60/EC, the Water Framework Directive (WFD), has led to an increased focus on eutrophication and to a more holistic approach to water management. Member States must enact programmes with measures to ensure that water bodies throughout the EU reach "good status" by 2015. In cases where WFD monitoring and assessment shows that phosphorus inputs are significantly contributing to eutrophication, Member States must implement measures to address this problem. The WFD status objectives mean that if phosphorus discharges to the environment are deteriorating water quality then sewage phosphorus removal should be installed, even for situations not already covered by the Urban Waste Water Treatment Directive.

Directive 2008/56/EC of 17 June 2008, the Marine Strategy Framework Directive (MSFD), aims for all EU marine waters to achieve Good Environmental Status (GES) by 2020 and requires Member States to develop a Marine Strategy. One of the criteria for GES is that "human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters[3]."

---

[2] P.E. is the number expressing the ratio of the sum of the pollution load produced during 24 hours by industrial facilities and services to the individual pollution load in household sewage produced by one person in the same time. For practical calculations, it is assumed that one unit equals to 54 grams of biochemical oxygen demand (BOD) per 24 hours

[3] Directive 2008/56/Ec of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN

There exist several international agreements as well on how to manage shared water bodies that have stipulations about phosphorus and nitrogen in surface waters, such as the Rhine Action programme between Germany and the Netherlands.

Some Member States have regulations related to eutrophication that are stricter than those applied at the European level. Among MS who responded to our questionnaire survey, 12[4] have legal requirements related to discharge of phosphorus from wastewater stricter than as required by EU law.

Detergent related policies (regulatory or voluntary)

Increasing concerns over the contribution of phosphates to eutrophication have led to a move towards phosphate-free detergents in many countries.

Italy used to have major problems with algal blooms and at the time had relatively few phosphorus removal installations. Therefore, in 1985, Italy introduced a restriction of 4% weight/weight STPP content in household laundry detergents after negotiations with the industry. This was followed by regulatory limitation of phosphates use in laundry detergents in Switzerland (1985) and Norway (1990) and subsequently in Austria (1994). In the Netherlands, Denmark and Germany the use of STPP in laundry detergents was not banned, but the governments negotiated with the phosphate industry for a voluntary agreement. By 2001 laundry detergent formulations using STPP were no longer sold in Germany, Italy, Switzerland, Austria and Norway. The use of phosphates in laundry detergents was voluntarily restricted in many US States.[5]

The sole example of a tax on laundry detergent phosphates is the French '*Taxe Générale sur les Activités Polluantes (TGAP)*', which came into force in January 2000 and taxes all detergent sales, with a somewhat higher rate of tax applicable to phosphate-containing detergents[5].

But the restrictions are not limited to laundry detergent alone. As of 2010, seventeen States in the US[6] also restricted phosphate-containing domestic dishwashing detergents[7] and also in 2010, CADD manufacturers that are members of the American Cleaning Council (formerly the Soap and Detergent Association) agreed to a voluntary ban on phosphates in CADD[14].

Other countries have passed laws limiting the phosphorus content allowed in CADD. While neither phosphorus nor phosphorus pentoxide are used in CADD, limiting these substances provides manufacturers with a calculation value that allows them to use phosphorus containing substances up to that point.

Canada imposed a limitation on phosphorus content of 0.5% for phosphorus and 1.1% for phosphorus pentoxide in household dishwashing detergents from 2010. Since May 2005, Switzerland allows a content of phosphorus up to 2.5 grams per washing cycle. Some Nordic countries have restrictions as well, mainly Sweden and Norway. Sweden applies a restriction of 0.5% weight/weight for phosphorus in CADD since July 2011. In Norway dishwasher detergents

---

[4] AT, CZ, DK, EE, FI, FR, HU, IE, LT, SE, UK, and Norway.

[5] Dr. Jonathan Köhler. 2001. P. 3. "Detergent phosphates and detergent ecotaxes: a policy assessment." http://www.ceep-phosphates.org/Files/Document/50/kohler_ecotax.pdf

[6] Illinois, Indiana, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Hampshire, New York, Ohio, Oregon, Pennsylvania, Utah, Vermont, Virginia, Washington, and Wisconsin. Legally banned in Spokane and Whatcom Counties.

[7] Phosphates Facts.org. 2009. "*Global P status.*" http://www.phosphatesfacts.org/pdfs/GlobalAutodishStatus.pdf

manufactured, imported, or placed on the market for use in Norway with phosphorus content higher than 3.8% are prohibited.[8]

The previously mentioned French TGAP *lessives* (laundry) is also applicable to CADD and the amount of the tax is related to the percentage of phosphates expressed in weight.

Current EU Ecolabel (Flower) criteria[9] does not allow any phosphates. The Nordic Ecolabel (Nordic Swan) criteria allows 0.2 grams phosphorus per wash, which for a dosage of 20 grams would allow approximately 4% phosphates (as STPP) in dishwasher detergents.

Many MS have voluntary agreements in place limiting detergent phosphate levels to the minimum necessary for phosphates to play an effective role in the detergent. For example, Austria, Ireland, Denmark and Finland rely on voluntary commitments by detergents formulators to phase-out phosphate-based detergents. Czech Republic had voluntary agreement from 1995-2006) related to only household laundry detergents. Since 2006, a decree issued by the Ministry of Environment banned placing of laundry detergents with P concentration higher than 0,5% weight on the Czech Republic market[10]. The other MS[11] who responded to the questionnaire do not have any legal requirements related to phosphate content in CADD.

With such differing policies among MS, there is a need for a harmonisation of restrictions on phosphates use in CADD. For productivity reasons, manufacturers may also want to produce detergents in a few plants for the whole EU market with the same requirements to adhere to. As a result of this, the Detergents Regulation (EC) No 648/2004 was adopted in 2004 and entered into force on the 8 October 2005. This Regulation includes provisions relating to:

- Ultimate biodegradability requirements (both the level and methodologies used) for all surfactants (Anionic, Non-ionic, Cationic and Amphoteric) used in detergents;

- The information to be provided to the consumer via the labelling of ingredients and websites; and

- The information to be held by manufacturers and to be supplied to medical professionals and competent authorities on request.

Since its adoption, some other Regulations have been published amending the Detergents Regulation:

- Regulation (EC) No 907/2006, which adapts Annexes III and VII;

- Regulation (EC) No 1336/2008, in order to adapt Detergents Regulation to CLP Regulation (EC) No 1272/2008; and

---

[8] European Commission. 14 March 2012. "*Limitations on the content of phosphates and of other phosphorus compounds.*" http://ec.europa.eu/enterprise/sectors/chemicals/files/legislation/art-14-3-overview_en.pdf

[9] European Commission. 2012. "*Commission decision of 28 April 2011 on establishing the ecological criteria for the award of the EU Ecolabel to detergents for dishwashers*."http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02011D0263-20120128&from=EN

[10] This provisions does not apply to:

a) laundry detergents used for washing in industry and institutions that is carried out by trained workers

b) laundry detergents that are intended for export or distribution into other EU member states

[11] AT, CY, CZ, DK, EE, FI, HU, IE, LT, PL, PT and UK.

- Commission Regulation (EC) No 551/2009, which adapts Annexes V and VI (surfactant derogation).

Additionally, as a result of the review on the use of phosphates that was planned under the original Regulation, the Detergents Regulation has been recently amended by Regulation (EU) No 259/2012 as regards to the use of phosphates and other phosphorus compounds in consumer laundry detergents and consumer automatic dishwasher detergents.

Regulation (EU) No 259/2012 of the European Parliament and of the Council of 14 March 2012 states that there is need for limitation of the use of phosphates in consumer laundry detergents and consumer dishwasher detergents in order to reduce the eutrophication risks and costs of phosphates removal by wastewater treatment plants. This regulation sets a limitation of 0.5 grams in the recommended quantity of the detergent for consumer laundry detergents from 30th June 2013 and a limitation of 0.3 grams in the standard dosage in consumer automatic dishwasher detergents from the 1st January 2017. The regulation also states that by 31 December 2014, the Commission should evaluate in light of new information on the CADD markets in Member States and new scientific information whether the restriction for CADD should be modified.

The following Table 1presents a summary of the policies (regulatory or voluntary) related to CADD at both international and national levels.

Table 1: Policies limiting the content of phosphorus in CADD in some countries

Country	Policy type	Policy summary
Norway	Regulatory	CADD with phosphorus content higher than 3.8% are prohibited.
Sweden	Regulatory	CADD with phosphorus content higher than 0.5% are prohibited.
Nordic Swan Ecolabel[12] (Denmark, Finland, Iceland, Norway and Sweden)	Voluntary	It is proposed for the latest revision (version 6) of Nordic Ecolabel for CADDs that starting from July 2015, the total level of phosphorus must not exceed the following: - Dishwasher detergents: 0.20 grams P/wash - Rinsing agents: 0.10 grams P/wash If the product does contain phosphates, must display the following or equivalent text: “Products that contain phosphates should only be used by households that are connected to mains drainage.”
France	Regulatory	The *Grenelle de l’environnement* had for objective to ban all phosphates in dishwashing detergents by 2012, but this has yet to come to pass. ‘*Taxe Générale sur les Activités Polluantes (TGAP)*’, which came into

[12] Nordic Ecolabel. 2014“*Nordic Ecolabelling of Dishwasher detergents and rising agents.*”http://joutsenmerkki.fi/wp-content/uploads/2013/07/Dishwasher-detergents-and-Rinsing-agents-version-6.0.pdf

Country	Policy type	Policy summary
		force in January 2000 and taxes all detergent sales, where the amount of the tax is related to the percentage of phosphates expressed in weight.
Switzerland	Regulatory	Phosphorus content up to 2.5 grams per washing cycle
European Ecolabel[13]	Voluntary	Phosphates are banned.
European Union	Regulatory	Regulation (EU) No 259/2012 stipulates: - a limitation of 0.3 grams in the standard dosage in consumer automatic dishwasher detergents from the 1st January 2017 - the Commission should evaluate in light of new information on the CADD markets in Member States and new scientific information whether the restriction for CADD should be modified by 31 December 2014
Canada	Regulatory	CADD with phosphorus content higher than 0.5% are prohibited.
USA	Regulatory	In some States CADD with phosphorus content higher than 0.5% are prohibited. In some States an industrial standard limiting phosphorus content in commercial and industrial detergents went into effect in the summer of 2013. In 2010, CADD manufacturers that are members of the American Cleaning Council (formerly the Soap and Detergent Association) agreed to a voluntary ban on phosphates in CADD[14].

[13] European Commission. 2012. "*Commission decision of 28 April 2011 on establishing the ecological criteria for the award of the EU Ecolabel to detergents for dishwashers*."http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02011D0263-20120128&from=EN

[14] Clean Water Action. 2010. "*Detergent Industry's Voluntary Phosphate Ban: Good News for Water, But a Long Time Coming.*" http://www.cleanwateraction.org/positionstatement/detergent-industrys-voluntary-phosphate-ban-good-news-water-long-time-coming

2. Data collection

This chapter explains the methodology used for data collection during this study. The data was collected primarily from two sources, first a literature review and secondly through a stakeholder consultation (including a dedicated questionnaire survey).

Information concerning the literature review of the phosphates containing CADD and their alternatives was found through variety of sources such as scientific articles and publically available reports. The main literature sources used for this study are listed in Annex B.

A questionnaire was sent on the 24th of January 2014 to the most relevant stakeholders, including Member State authorities, water management facilities, NGOs, industry associations, detergent manufacturers and suppliers. A complete list of the stakeholders contacted for the survey can be found in Annex A. The feedback of the stakeholders to the questionnaire survey was used to validate and where needed, to improve the findings of the literature review. An example of a questionnaire sent to MS can be seen in Annex C. Suppliers, manufacturers, industry associations, environmental NGOs, Member States and water management companies all replied to the questionnaire survey. Overall, 35 responses were received.

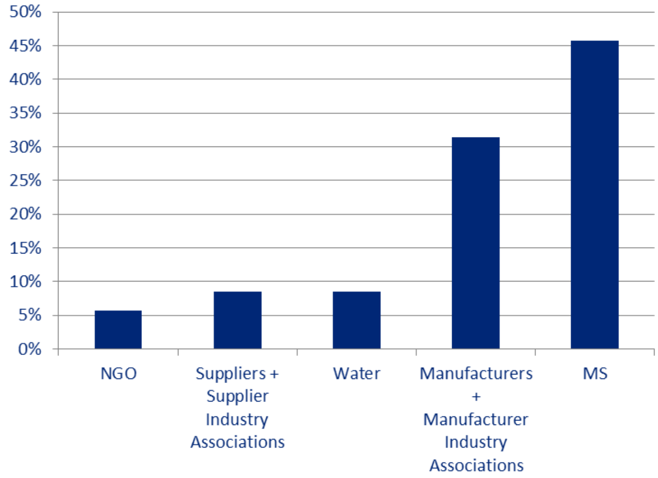

Figure 1: Questionnaire survey responses by stakeholder type

Member State representatives provided the most responses (total 15, including Norway). Manufacturers and their industry associations provided 11 responses, while only three responses from suppliers and their industry associations were received. Water management companies also only had three participants. NGOs participation was the least, with only two responses. Besides responding to the questionnaire, some stakeholders also provided additional information, such as the Euromonitor data reflecting the CADD market evolution in EU and performance test data for a variety of phosphates-containing and phosphates-free CADD. This additional information is incorporated in the analysis performed in this study.

3. Scientific review

This chapter presents a review of available scientific information on the use of phosphates in CADD, phosphate free alternatives, and the treatment options for dealing with phosphates wastewater.

CADD consist of several chemical types working together in order to remove soils from dishware. Non-ionic surfactants (surface active agents) are the soap part of the detergent (whether made from soap or synthetically), and are used to lower the surface tension of water in order to loosen and remove soils, keeping them suspended so that they cannot redeposit on dishware. Non-ionic surfactants are very resistant to water hardness and clean well on most soils[15]. These surfactants do not have an electrical charge, which makes them resistant to water hardness deactivation. They are excellent grease removers that are used in laundry products, household cleaners and hand dishwashing liquids[16]. Builders are required in order to sequester calcium and magnesium ions and reduce water hardness – builders are typically strong chelators for these ions. Other chelating agents are also used to bind other metal ions, e.g. to ensure bleach system stability[16]. Next, enzymes may be used to dissolve starches and proteins that are considered very difficult to remove. A bleaching agent is also used to remove bleachable soil, e.g. tea and coffee stains. The bleaching agent tends to be oxygen based, and often a low temperature bleach activator is necessary so that the bleach will perform well. Corrosion inhibitors are also present, to protect both the interior of the dishwashing machine and the cutlery from corrosion. Rinse aids are used in the final stage in order to prevent water droplets and watermarks from developing on glassware[17]. Lastly, often perfumes and colorants are added in order to increase aesthetic appeal, and preservatives may be added to give liquid detergents a longer life[17].

3.1 Phosphate use in CADD

Phosphate in the form of Sodium Tri-Poly-Phosphate (STPP[18]) is the most commonly used compound of modern domestic and industrial detergents due to its cleaning-enhancing properties and the fact that they are cost-effective. STPP was first used in synthetic detergents in 1948 and significantly increased their performance compared to previously used, soap-based products. STPP performs many cleaning services. First of all, it is alkaline, so it raises the pH value, meaning that the charge of ions in the dirt and items washed increases, and it also combats water hardness. A higher pH facilitates repulsion between the dirt and items washed, thus increasing washing performance. Water "hardness" is a measure of its mineral content. Salts found in hard water, such as calcium carbonates or magnesium carbonates, may leave crusty deposits dishes. STPP reacts with these salts forming phosphate-containing compounds which do not precipitate. It also prevents deposition of these salts on elements in the dishwashing machine, extending its useful life. STPP dissolves calcium and magnesium compounds that were present from previous washes and reactivates any remaining soap. Furthermore, condensed phosphates increase the surface activity of the active washing compounds.

---

[15] American Cleaning Institute. "*Soaps & Detergents: Surfactants & Builders*." http://www.cleaninginstitute.org/clean_living/soaps__detergents_products__ingredients_2.aspx

[16] A.I.S.E. Cleanright initiative http://uk.cleanright.eu/index.php?option=com_content&task=pdf&Itemid=168

[17] DEFRA. 2010. "Review of evidence for use of phosphate-free dishwasher detergents in UK."

[18] STPP: Na5P3O10

Complex phosphates such as STPP “deflocculate”, i.e. they break up large particles of dirt such as mud or clay into smaller ones. Additionally, they keep fine particles in suspension in the washing water and prevent them from recombining, thus avoiding redisposition on dishes. This combination of chemical functions allows STPP to contribute effectively to the performance of modern consumer detergents.

Modern dishwashers are designed to operate at lower temperatures and consume reduced water amounts in order to lower environmental impacts and expenditures for households. Even at reduced temperatures or water consumption, STPP keeps high levels of sanitation and bacteria and microorganism removal. In this context, phosphate-based dishwasher detergents could be advantageous as their good performance prevents consumer selection of more intensive wash and rinse programmes.

3.2 Phosphates-free alternatives

To replace phosphates, different solutions exist. Since phosphates provide a variety of functions, the alternatives need to address each one of those functions. Therefore, normally it takes a number of different ingredients to achieve the same results.

3.2.1 Available alternatives

Although there exist many alternatives but there is no one widely accepted solution for phosphates replacement. These alternatives include chelating agents, dispersant polymers, surfactants, and enzymes which are all being suggested as the key to achieving phosphates-like performance in phosphates-free CADD.

Zeolites are now used as a builder in almost all countries where STPP is no longer used in laundry detergent, in particular in the USA and the European Union. However, Zeolites are not suitable for CADD because they are insoluble in water and would lead to pump damage, residues and blocked filters as well as leave unacceptable deposits on all washed tableware[19].

According to some stakeholders[20], key elements in the phosphate replacement package include various builders and less than five percent of phosphonates and polycarboxylates. The builders that are used in phosphates-free domestic dishwashing detergent cited by stakeholders are presented in Table 2.

Table 2: Possible alternatives to be used as builders

Name	Scientific Name
MGDA	Methyl glycine di-acetic acid

[19] On the other hand, zeolites use in laundry detergents is very popular. The reason for this is because in dishwashers the water is continuously pumped around at relatively high speed to ensure performance of the machine, whereas in washing machines the water is normally only pumped away into the sewer at the end of each wash or rinse step. There are some washing machines that pump water around during the wash, but not at the intensity of a dishwasher. Furthermore, dishwashers use rather fine filters that could be blocked, in contrast to washing machines. Deposits will occur on textiles but washing machines rinse more intensely as compared to dishwashers. Also for textiles, most of the fine insoluble deposits, if any, will be dislodged during the drying process (tumble drying or line drying).

[20] Assocasa in merito all’indagine (Italian industrial association), Nederlandse Vereniging van Zeepfabrikanten (NVZ) (Dutch Soap Association), Unilever, leading European manufacturer of CADD, A.I.S.E., RUCODEM, Senzora B.V., Denmark, Estonia, Finland, Lithuania, PAPA (Phosphoric acid and Phosphates), Cefic (European Chemical Council), Ireland, and France. Austria also mentioned MGDA.

Name	Scientific Name
B-ADA	B-alaninediacetic acid
GLDA	L-glutamic acid, N,N-diacetic acid
IDS(A)	Iminodissuccinic acid
HEIDA [21][21]	2-hydroxyethyliminodiacetic acid
ASDA	L-aspartic-N,N-diacetic acid
Sodium Gluconate	Sodium pentahydroxyhexanoate
Sodium salts of citric acid	Sodium citrate

Manufacturers are exploring innovative and eco-friendly alternative builders such as aminocarboxylates methylglycinediacetic acid (MGDA), glutaminic acid diacetic acid (GLDA), and sodium iminodisuccinate (IDS(A)). MGDA can be used as a substitute for phosphates in CADD due to its broad range of properties[22]. However, MGDA has a very high chelating power and thus tends to remove colours and finishes from glassware. According to one stakeholder[23], in order to mitigate this effect, the heavy metal bismuth must be used. GLDA possesses complexing properties similar to EDTA and NTA[24]. IDS(A) is a medium-strong builder, masks alkaline earth and heavy metal ions[25]. It also enhances the effect of the surfactants and is an effective bleaching agent stabiliser, water softener, and deposit remover[25]. Lanxess[26] compared calcium carbonate binding capacity of MGDA, GLDA, IDS(A), and S,S-EDDS to STPP. While IDS(A) performed similarly to STPP at 60°C it was also found to have good peroxide stabilising and corrosion protecting properties. MGDA and GLDA were also found to have good calcium binding properties but were less good at corrosion protection.[27]
Many stakeholders[28] stated that citric acid is used (in a combination of other ingredients) to replace phosphates. Indeed, citric acid is seen as an attractive partial alternative to phosphate in

---

[21] Dow, the manufacturer of HEIDA, informed us that while they had pre-registered HEIDA for REACH with an intended registration timeline of 2013, Dow elected not to register HEIDA. After informing ECHA of their decision, they ceased the manufacture and selling of the substance ahead of the June 2013 deadline. As such, HEIDA will not be examined in further detail in this report.

[22] Comment of BASF (German chemical producer) on ISIS, http://www.icis.com/Articles/2009/01/12/9182061/detergents+shift+to+greener+builders.html

[23] PAPA

[24] Dorota Kołodyńska. 2010. "The effects of the treatment conditions on metal ions removal in the presence of complexing agents of a new generation." http://dx.doi.org/10.1016/j.desal.2010.06.053

[25] Dorota Kołodyńska. 2009. In: Chemical Engineering Journal. "*Polyacrylate anion exchangers in sorption of heavy metal ions with the biodegradable complexing agent*."

[26] Lanxess is the manufacturer of IDS(A)

[27] Lanxess – Ralf Moritz, Malmö. 2013. "P-free household dishwashing detergents - alternative substitutes for STPP." http://www.sepawa.org/dokument/2.%20Nordic%20May%202013_Lanxess.pdf

[28] Assocasa in merito all'indagine (Italian industrial association), Nederlandse Vereniging van Zeepfabrikanten (NVZ) (Dutch Soap Association), Unilever, leading European manufacturer of CADD, A.I.S.E., RUCODEM,

detergents and is now gaining popularity in Europe with 5-7% sales growth[29]. However, these chemicals act only as builders, chelating water hardness ions and cannot fully substitute phosphates. As such, increased amount of enzymes, surfactants, phosphonates and other ingredients are necessary to keep performance up.

Polycarboxylates are not considered strong builders as their effect is not based on complexing properties. Two types of polycarboxylates are used in detergents, homopolymers of acrylic acid (P-AA) and copolymers of acrylic/maleic acid (P-AA/MA). Both polymers are critical in controlling the different kinds of scales[30] formation. Polycarboxylates perform multiple functions in detergents such as they significantly reduce spotting and filming of glassware, they reduce streak formation on silverware, crockery and glassware, and they improve rinsing efficiency even in low water rise programmes[31]. Polycarboxylates are also currently used in phosphates-containing formulations to deliver the above mentioned multifunctional benefits.

Phosphonates combine different functions in one molecule. They prevent mineral deposits in dishwashers and on table and glassware (scaling from water hardness) by modifying calcium salt deposit properties in very low amounts (threshold activity). They are effective at removing tea[32] and starch-based[33] stains. Phosphonates are more efficient than any other component to stabilise peroxide-based bleaches. Phosphonates are normally liquid products as the dried products are hygroscopic. However, for those products that wish to be completely phosphorus-free, the use of phosphonates is not possible.

Many stakeholders[34] also mentioned the use of other ingredients like soda ash (sodium carbonate) and sodium silicate. Sodium silicate and carbonate are alkaline ingredients used in all CADD products and thus are present in phosphates-free as well as phosphates-containing CADD formulations. However they would be used in greater quantities in the phosphates-free CADD to make up for the lack of STPP.

It is important to note that not every manufacturer uses every ingredient, instead detergent formulators choose between the same types of ingredients, for example only one chelating agent is used.

3.2.2 Technical feasibility

Technical feasibility for phosphates-free automatic dishwashing detergent can be confirmed by the fact that a large number of patents are placed on methods for replacing phosphates. Already in 2002, Amway was awarded a patent[35] for a phosphate-free CADD. They patented a formulation containing a polyacrylate, an alkaline stable enzyme, an oxygen-containing bleaching agent, a non-

---

Senzora B.V., Denmark, Estonia, Finland, Lithuania, PAPA (Phosphoric acid and Phosphates), Cefic (European Chemical Council), Ireland, France, EEB, BEUC, Spaintab, Danlind DK, Austria, P&G, EPA, and Norway.

[29] Comment of Reza Selazade, trading manager at Kasel Chemicals (a Vienna-based citric acid trader) on ISIS, http://www.icis.com/Articles/2009/01/12/9182061/detergents+shift+to+greener+builders.html

[30] Carbonate, silicate, phosphonates, and the scale formed from specialty materials

[31] DOW Chemicals. 2014. "*Input into the consultation: Study on the Potential for Reducing Phosphates in Consumer Automatic Dishwasher Detergents-Questionnaire to manufacturers and industrial associations January 2014*."

[32] Cerny et al., SÖFW-Journal, 1999 , 125 (6), p. 58-62

[33] Cerny et al., SÖFW-Journal, 2001 , 127 (10), p. 108-114

[34] BEUC, Danlind DK, EEB, EPA, and Norway.

[35] Patent No. US 6,331,512 Bl

ionic surfactant, and an alkali metal silicate.[36] In 2012, BASF Aktiengesellschaft placed a patent on a phosphates-free CADD[37]. This particular formula allows drip, film, and streak free dishes without the need for a rinse aid[38].

In 2010, several specialised surfactants were also available, such as Cognis' Dehypon GRA rinse aid surfactant[39]. Then in 2011, Access Business Group International LLC was awarded a patent[40] for a phosphate-free CADD, which greatly improved spotting and filming performance[41].

Enzymes also play an important role in boosting performance for phosphates-free detergent formulations. Phosphate free formulations tend to contain more free water and are more hygroscopic. High free water content might affect enzyme stability in phosphates-free CADD formulations. However, in 2009, Novozymes introduced an enzyme mix capable of replacing phosphates while keeping costs the same[42]. In 2011, Genecor developed two enzyme based formulas to aid in phosphates-free CADD performance[43].

Products that are currently on the market use a variety of methods to replace phosphates. Several products have the following composition: Oxygenated bleaching agents, polycarboxylates, non-ionic surfactants, phosphonates, enzymes, perfume, and hexyl cinnamal. For products that wish to be completely phosphorus-free, the use of phosphonates is not possible. These products use even more ingredients in order to achieve the same cleaning quality, and use a variety of sodium salts, enzymes (notably Amylase and Protease), and glycerine, among others.

3.2.3 Performance of alternatives

As previously mentioned, water "hardness" is a measure of its mineral content, and hard waters have a high concentration of salts, such as calcium or magnesium carbonates, which leave crusty deposits on dishes. However, even in soft water, automatic dishwasher detergents need to include a chelating agent because of calcium, magnesium and other ions present in food wastes. Water hardness varies across the EU, from the Scandinavian countries with very soft water to the Mediterranean countries with very hard water. For an overview of water hardness across EU, see Annex E. Due to this variability, limitations placed on phosphates use in CADD may vary in

[36] Focus on Surfactants. May 2002, Volume 2002, Issue 5, P. 5. "*Phosphate-free dishwashing detergent patented*." http://dx.doi.org/10.1016/S1351-4210(02)80158-5

[37] Composed of copolymers of a monoethylenically unsaturated monocarboxylic acid and/or of a salt thereof, and an alkoxylated, monoethylenically unsaturated monomer; complexing agents; low-foaming non-ionic surfactants; bleaches and, optionally, bleach activators; further builders; enzymes; and one or more further additives

[38] FAQS.org.2012. "*Patent application title: Cleaning formulations for machine dishwashing comprising hydrophilically modified polycarboxylates.*" http://www.faqs.org/patents/app/20120010117#ixzz2supih8Rp

[39] Focus on Surfactants. December 2010, Volume 2010, Issue 12, P. 1–2. "*Natural and phosphate-free solutions gaining ground*." http://dx.doi.org/10.1016/S1351-4210(10)70347-4

[40] Patent No. US 7,781,387 B2

[41] To replace phosphate, many different ingredients were used, including one or more of the following: sulphates, a carbonate, a citrate and a silicate; as well as a non-ionic surfactant, a spot reduction system, an enzyme system, and an oxygen bleaching agent. To reduce spotting, a combination of polyacrylate and a carboxymethyl inulin were used. Via: Focus on Surfactants. 2011, Volume 2011, Issue 1, January P. 5. "*Phosphate-free ADD has better spotting performance*". http://dx.doi.org/10.1016/S1351-4210(11)70021-X

[42] Focus on Surfactants. September 2009, Volume 2009, Issue 9, P. 4. "*Consumers want green and clean detergent*". http://dx.doi.org/10.1016/S1351-4210(09)70284-7

[43] Genecor Twin Power, a multi-enzyme system used to eliminate protein soils, and Powerase HS, used for removing complex starch soils via: Focus on Surfactants. September 2011, Volume 2011, Issue 9, P. 4. "*Together we can meet today's sustainability needs and develop high performing automatic dishwashing detergents: new from Genencor*". http://dx.doi.org/10.1016/S1351-4210(11)70263-3

strictness to produce the same desired cleaning effect. Even before phosphate-free CADD was introduced, it was known that the hardness of water is an important factor in the cleaning performance of CADD. However, to mitigate water hardness the use of different qualities of CADD in different regions or adding salt in the dishwasher is possible solutions.

While successful for laundry detergents, an attempt to substitute phosphates with zeolites in automatic dishwashing in the early 1990s failed due to the tendency of zeolites to cause spotting of glassware. Also, as stated earlier, the insolubility of zeolites leads to damaging the dishwashing machine. Leaving white film on glassware sometimes occurs with other phosphates alternatives as well.

Consumer associations from various Member States have performed tests comparing performance of phosphates-free and phosphates-containing CADD. Overall, phosphates-free CADD and phosphates-containing CADD fall into similar performance range based on their cleaning efficiency. While a large number of high performing CADDs are generally phosphates-containing, some phosphates-free CADD are able to achieve similar level of performance. These tests show that the use of phosphates is not the only factor influencing performance (See Annex J for more information).

The majority of stakeholders[44] remarked that the performance of CADD relies on many factors (formulation, product position, raw material prices variations and new technology development) that remain true whether or not phosphates were used. Many stakeholders confirmed that phosphates-free CADD perform as well as the phosphate-containing CADD. A few noted that it is possible to have phosphates-free CADD that performs better than average phosphates-containing CADD, but that it comes at a higher cost[45]. Only three[46] stakeholders maintain that phosphates-free CADD do not perform as well as the phosphates-containing CADD.

3.3 Wastewater treatment options

As explained earlier, the Urban Waste Water Treatment (UWWT) Directive requires Member States to identify sensitive areas among which are "natural freshwater lakes, other freshwater bodies, estuaries and coastal waters which are found to be eutrophic or which in the near future may become eutrophic if protective action is not taken." In these areas the Directive prescribes to include removal of phosphorus in the wastewater treatment, which is known as tertiary treatment, for agglomerations with >10,000 population equivalent in sensitive areas, "unless it can be demonstrated that the removal will have no effect on the level of eutrophication."

The contribution of household detergents to the total phosphorus load of rivers, lakes and reservoirs varies considerably across MS. Phosphates used in domestic detergents may make a significant contribution to the phosphorus content of urban wastewater in some areas, especially if the area is not connected to a wastewater treatment plant equipped with tertiary treatment. EWA estimated in its 2007 report that in Member States where sewage water treatment is poor and most of the laundry detergents contain phosphates, phosphorus from detergents (both CADD and laundry) can account for up to 28% of total phosphorus load.[47] However, since that estimate, the

[44] A.I.S.E., Assocasa in merito all'indagine (Italian industrial association), AT, DECO, DK, EE, FI, FR , LT , Nederlandse Vereniging van Zeepfabrikanten (NVZ) (Dutch Soap Association), P&G, leading European manufacturer of CADD, SE , Unilever and UK.

[45] This claim was however challenged by Swedish Chemicals Agency representing the MS Sweden. Swedish Chemicals Agency remarked this claim of some stakeholders does not correspond to the development of products on the Swedish market. There are several phosphate-free CADD on the Swedish market that perform better than average phosphate-containing CADD and the consumer price is not higher in all cases.

[46] PAPA (Phosphoric acid and Phosphates), Spaintab, and Senzora B.V.

[47] Dr. Thorsten Wind for EWA. 2007. "The Role of Detergents in the Phosphate-Balance of European Surface Waters." http://www.ewa-online.eu/tl_files/_media/content/documents_pdf/Publications/E-WAter/documents/25_2007_03.pdf

law restricting the use of phosphorus in laundry detergents has come into place. In order to calculate the potential reduction of phosphorus in wastewater due to this change, one must first calculate the percent of phosphorus present in STPP. Using the chemical formula of STPP ($Na_5P_3O_{10}$) and stoichiometry, it is possible to do such a calculation[48]. The percentage of phosphorus (by weight) in STPP is around 25%. Assuming that the average dosage of laundry detergent used per wash is 100 grams and that the average quantity of STPP found in phosphates-containing laundry detergents is 25%. Therefore, the average amount of STPP per standard dose of laundry detergent is approximately 25 grams, which leads to an average quantity of phosphorus in laundry detergent in the past to be around 6.25 grams. The limitation of phosphorus content for laundry detergent is currently at 0.5 grams. Assuming that all laundry detergents contained phosphates previously, it can be roughly estimated that the amount of phosphorus going to wastewater from laundry detergents has decreased by about 92%.

In 2006, the total amount of phosphates-based detergents (laundry and CADD) consumed in the EU was the equivalent of 110,000 tonnes phosphorus. Using this figure and assuming that all phosphorus ends up in the phosphorus load that goes to wastewater treatment facilities (there is currently a 94% compliance rate for collecting wastewater[66]), and knowing that laundry and CADD made up 28% of the total phosphorus load going to wastewater treatment facilities in 2007, it is possible to determine the total amount of phosphorus load to wastewater treatment facilities. It was approximately 392,857 tonnes phosphorus. Knowing that 60% of detergents consumed in the EU are laundry detergents[49], the amount of phosphorus coming from laundry detergents can be determined at 66,000 tonnes. Applying the reduction rate of 92% to this phosphorous load, the amount of phosphorus from laundry detergents entering wastewater will be around 5,280 tonnes in 2013. This gives a new total phosphorus load of around 332,137 tonnes in 2013 assuming all other sources of phosphorus (such as food waste, urine, etc.) remain the same. Furthermore, 30% of detergents consumed in the EU are CADD, meaning that approximately 33,000 tonnes of phosphorus to wastewater comes from CADD. This suggests that phosphorus from CADD makes up about 10% of the phosphorus load in EU in 2013. A similar exercise can be carried out for the potential phosphorus load reduction from CADD in 2017 due to the limitation of phosphorus use in CADD to 0.3 grams. Assuming the average standard dosage of CADD used per wash is 20 grams. Assuming that the average quantity of STPP found in phosphates-containing CADD is around 40%[50] (of which 25% is phosphorus), phosphates-containing CADD are made up of around 2.0 grams phosphorus. Assuming that all CADD contained phosphates previously, the amount of phosphorus going to wastewater from CADD would decrease at least by 85% in 2017. As such, phosphorus coming from CADD would go down from 33,000 to 4,950 tonnes, and would thus only account for approximately 1.6 % of the total phosphorus load in EU in 2017.

3.3.1 Wastewater treatment process for phosphorus removal

The three main processes used by wastewater treatment facilities to remove phosphorus from wastewater are physical, chemical, and biological. While mandatory phosphorus removal requires the use of tertiary treatment, it is important to note that some phosphorus is removed in earlier steps of the wastewater treatment process. Approximately 50% of the phosphorus is taken up via biomass and/or partitioning to solids during secondary treatment. Biological nutrient removal (BNR) or chemical precipitation, which are considered tertiary treatment, increase the removal rate of phosphorus to over 90%.[51]

Enhanced biological removal involves the use of plants or algae, which involves a special group of bacteria which are able to accumulate a higher amount of phosphorus, and may take the form of

---

[48] $P_3/ Na_5P_3O_{10}$, where the molar weight of Na is 23, P is 31, and O is 16; 93/368 = 0.25; 25%.

[49] European Commission. 2010. "*Amending Regulation (EC) No 648/2004 as regards the use of phosphates and other phosphorus compounds in household laundry detergents – Impact assessment.*"

[50] Source : A.I.S.E

[51] UKWIR. 2007.

constructed wetlands. The added biomass must be removed, otherwise the phosphorus will be rereleased into the environment upon decay. Chemical removal generally involves adding chemicals to the wastewater that form bonds with phosphate (which is a soluble phosphorus-containing compound), and convert the phosphorus component into insoluble metallic phosphorus-containing compounds, and then settle, becoming sludge. Calcium, aluminium, and iron are the most commonly used chemicals.[52]

Chemical removal using ferrous or aluminium metal salts is the most traditionally and widely used method due to the fact that the removal efficiency can be controlled quite accurately and after wastewater purification phosphate content can reach almost zero[56]. In the Scandinavian countries, chemical removal has been preferred. However, France, England and Italy mainly use biological removal.[53] The UK prefers chemical treatment, with 200 waste water treatment plants using this method compared to only approximately 12 who use enhanced biological phosphorus removal[17]. Tertiary filtration, or physical removal, is relatively untested in the UK[54]. Germany also prefers chemical treatment, with Bio-P treatment rarely being used alone[55]. The Bio-P method is being used a lot in Denmark making up, 30-40% of total phosphorus removal[57,56,58].

3.3.2 Sensitive areas and good status

The 7th Report on the Implementation of the UWWT Directive stated that approximately 75% of EU territories are either designated or considered as sensitive areas, which is an increase from previous years. They noted that France and Greece had the greatest increase in number of sensitive areas.

15 MS[57] have designated their entire territory or all their water bodies as sensitive areas, and 12 MS[58] have identified only the water bodies where more stringent treatment is required. More specifically, the Baltic Sea, the North-west shelf of the Black Sea, the Danube Delta, and the Northern Adriatic have been identified as sensitive areas.[59] For a more complete overview of sensitive areas at the MS level, see Annex F.

The Water Framework Directive (Directive 2000/06/EC) also lays out standards for the amount of acceptable pollution in water bodies. In 2009, 42% water bodies were in good or high status and the water bodies expected to reach good status in 2015 represent 52%[60]. As per the responses

[52] Peter F. Strom. 2006. "*Technologies to Remove Phosphorus from Wastewater.*" http://www.water.rutgers.edu/Projects/trading/p-trt-lit-rev-2a.pdf

[53] Stark. "*Phosphorus recovery – experiences from European countries.*" http://www2.lwr.kth.se/forskningsprojekt/Polishproject/rep12/StarkSthlm19.pdf

[54] Water UK

[55] Umweltbundesamt. 2007. http://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/3256.pdf

[56] Slothuus et al. 2009. "Assessment of the consequences of a possible ban on phosphates in household detergents."

[57] AT, BE, CZ, DE, DK, EE, FI, LT, LU, LV, NL, PL, SK, SE, and RO.

[58] BG, CY, EL, ES, FR, HU, IE, IT, MT, PT, SI and UK.

[59] European Commission. 2012. "*Technical assessment of the implementation of the Urban Waste Water Treatment Directive (91/271/EC)*." http://ec.europa.eu/environment/water/water-urbanwaste/implementation/pdf/Technical%20assessment%20UWWTD.pdf

[60] It is difficult to establish the percentage of water bodies that will achieve good status in 2021 and 2027 as Member States have rarely provided that information. Via: European Commission. 2012. "Report from the Commission to the European Parliament and the Council on the implementation of the water framework directive (2000/60/ec) River basin management plans."

received to the questionnaire survey, eight MS[61] remarked that water bodies in their country failed to achieve good status as defined in the Water Framework Directive due to excessive levels of phosphorus. Three other MS[62] stated that they had water bodies that did not achieve good status, but that many factors go into achieving good status and information related to phosphorus-only was not available.

In addition, the Marine Strategy Framework Directive requires Member States to achieve good environmental status in their marine water bodies. In 2014, the first implementation report was published and found that while pollution in the marine environment has decreased in some places, levels of nutrients and certain hazardous substances are overall still above acceptable limits. Furthermore oxygen depletion as a result of nutrient pollution is particularly serious in the Baltic and Black seas[63].

According to a 2012 assessment of status and pressures on EU water bodies[64], average phosphate concentrations in European rivers have decreased over the last two decades, falling by more than half between 1992 and 2010, and average lake phosphorus concentrations also decreased over the same period by 31%. The reduction in phosphate and phosphorus content is attributed to increased wastewater treatment and a reduction of phosphorus in detergents. However, the report also states that it is difficult to assess phosphate concentrations as there is limited data available for this substance.

3.3.3 Wastewater treatment infrastructure in EU for tertiary treatment

Following the UWWT Directive, the most recent data (collected in 2009-2010) indicates that the compliance rate for tertiary treatment is at 77%, with 4 MS having reached 100% compliance. However for MS who joined in 2004 or later, the compliance rate is much lower, at only 14%. Most EU-12[65] MS have transitional periods to comply with the UWWT Directive, and in principal these periods do not exceed 2015. Romania is the only MS with a longer period for compliance, ending in 2018. However, unless efforts are increased, compliance for all MS will not be possible until 2028. In contrast, the EU-15 were expected to comply with the directive in 2005.[66] However, most of them are still not at 100% compliance rate. For a more detailed description of the tertiary treatment compliance rates in EU, see Annex G.

Denmark, Germany, the Netherlands, Switzerland and Sweden have all installed a large number of phosphate removal systems. In 2009 in Germany, nearly 100 % of the wastewaters of settlement areas were already treated of which 97% were equipped with a “third step” where phosphorous is eliminated[67]. In 2008, fifteen MS[68] had approximately 48% of their population connected to a tertiary treatment plants. Based on data collected in 2009/2010, in Northern and Central Europe,

---

[61] UK, DK, EE, HU, AT, FR, CY, SE, as well as Norway making nine.

[62] IE, FI, and LT

[63] European Commission. 2014. “The first phase of implementation of the Marine Strategy Framework Directive (2008/56/EC).” http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0097&from=EN

[64] EEA. 2012. “*European waters – assessment of status and pressures*.”

[65] EU-12 refers to Member States who acceded to the EU in 2004 and 2007 enlargements: Bulgaria, Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia and Romania.

[66] European Commission.2013. “*Seventh Report on the Implementation of the Urban Waste Water Treatment Directive (91/271/EEC)*.”

[67] German Federal Ministry of Environment. 2009. “*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, 10/2009*”

[68] AT, BE, CZ, DE, DK, ES, FI, FR, HU, IE, MT, NL, PL, PT, and UK.

70% of the population was connected to a wastewater treatment plant with tertiary treatment, whereas only less than 9% are in Southern and Eastern Europe[69].

Based on data from 2009, in the Netherlands, Germany, Austria, Sweden and Greece, at least four in every five persons are connected to tertiary treatment. In contrast, no more than 1% of the population is connected to tertiary wastewater treatment in Bulgaria.[70]

Eleven of the EU capital cities are currently compliant. This is particularly a problem as large cities have big waste discharges and can cause considerable environmental pollution.[71] However, 66% of the total generated load of big cities discharging into sensitive areas is treated with tertiary treatment[74,72].

Where tertiary treatment is not available, phosphates present in CADD have a much higher risk of entering aquatic environments and contributing to the eutrophication of water bodies. As previously mentioned, phosphorus from CADD can account for up to 10% of the phosphorus load in water bodies where there is no tertiary treatment.

3.3.4 Phosphorus discharge from wastewater treatment plants

Phosphorus removal in sewage plants that use chemical precipitation produces sludge that must be re-used or disposed of. In general, the removal of 1 kilogram of phosphorus produces 15 kilograms of suspended solids (sludge) with a molar ratio between metal and phosphorus of 1.5[56]. There are a few options for dealing with this sludge.

First of all, the sludge may be used as fertiliser in surrounding areas, however the sludge must comply with limits on heavy metal content and other contaminates, which is not always the case. There is also an image problem related to the use of wastewater sludge, and some farmers refuse to use it. Due to the heavy weight of sludge, it is important that the fertiliser be used locally, otherwise costs may be too high. Unfortunately this is not the case in EU, as a majority of tertiary treatment plants are found in highly urbanised areas and therefore additional transportation would be necessary to use the sludge as a fertiliser. This type of sludge recycling is used by approximately 75% of the sludge produced in the UK, making up only 3% of total phosphorus inputs to UK agriculture and being applied to only 0.8% of agricultural land[73]. In Sweden, 25% of sludge is recycled to agriculture and 75% is used for land reclamation[74].

Another option is to dry and then incinerate the sludge. The benefit of this is valorisation in the form of energy production; however it requires careful treatment to control combustion. In the UK, 16% of sludge was incinerated due to unavailability of land for sludge use, and the resulting ash is normally landfilled[73].

In Japan, they use the dried out sludge as a building material or as paving slabs. This option requires heavy investments as well as transportation costs.

---

[69] EEA. 2013. "*Urban waste water treatment (CSI 024)*." http://www.eea.europa.eu/data-and-maps/indicators/urban-waste-water-treatment/urban-waste-water-treatment-assessment-3

[70] Eurostat.2009. http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Water_statistics#Wastewater_treatment

[71] European Commission. 2013. "*Seventh Report on the Implementation of the Urban Waste Water Treatment Directive (91/271/EEC).*"

[72] European Commission. 2012. "*Technical assessment of the implementation of the Urban Waste Water Treatment Directive (91/271/EC)*." http://ec.europa.eu/environment/water/water-urbanwaste/implementation/pdf/Technical%20assessment%20UWWTD.pdf

[73] Water UK questionnaire response.

[74] Swedish Water and Wastewater Association questionnaire response.

It is possible to recycle phosphorus from the sludge to the point where it is potentially reusable by the phosphate industry; however this too requires heavy investments and transportation costs.

Despite the numerous ways to reuse the phosphorus contained in wastewater, only about 25% is being reused, with the most common method being direct application of sludge to fields. Therefore, the potential for recovery is very high at about 300,000 tonnes of phosphorus per year in the EU.[75]

While the UWWT Directive does require phosphorus removal, it does not require phosphorus to be removed in a reusable form. The UWWT Directive allows for the removal of phosphorus through chemical removal with iron, which produces a very strongly bonded compound from which phosphorus is not easily commercially recoverable and may not even be fully available to plants.

However, a European Phosphorus Platform has been set up by stakeholders to create a recycled phosphorus market in Europe and achieve a more sustainable use of phosphorus[75]. While chemical removal of phosphorus may obtain up to 1mg/l phosphorus being discharged from the water treatment plant[75], not every plant is equipped with this type of treatment and so there is still some phosphorus that is discharged in most cases. Table 3 summarises the data provided by some stakeholder about the amount of phosphorus discharged in their country.

Table 3: Quantities of phosphorus discharged by wastewater treatment plants per MS

Member State	Quantities of phosphorus discharged from wastewater treatment plants (tonnes/year)	Year
Denmark	510	2012
Poland	1,900	2012
Czech Republic	1,203	2012
Estonia	91.55	2012
Finland	167	2010
Lithuania	133.8	2012
Austria	806	2010*
Norway	1,250	2012**
Cyprus	7.4	2011***

**Austrian Status Report 2012 on Article 16 UWWTD - Interpretation of "Total amount of phosphorus released to wastewater" in this context is the UWWTP inflow.*

***Quantities of phosphorus discharged from wastewater treatment plants are including leakages and storm water overflows.*

****Quantity of total phosphorus discharged in waters*

3.3.5 Special measures about phosphorus discharge in water bodies

According to JRC report "Long term nutrient loads entering the European Seas", comparing the estimates of nutrient loads for 2005 with those of 1991 at European continental scale, the total phosphorus load had decreased by around 15%, mainly due to a decrease in point source emissions. The total phosphorus concentration in surface water has been decreasing or constant in

[75] European Commission. 2013. "Consultative Communication on the Sustainable Use of Phosphorus." http://ec.europa.eu/environment/consultations/pdf/phosphorus/EN.pdf

river basin outlets around the EU, except for small regions in Sweden and Latvia's Daugava river basin. The report found that in all Member States except for Spain the point source emission of phosphorus has decreased from 1990 to 2005. It was also stated that in the North Sea and in the Baltic Sea the decrease was mainly related to the reduction of point sources due to the implementation of advanced wastewater treatment. The total amount of phosphorus discharged to European seas in 2009-2010 was equal to 223,000 tonnes per year of which 35% (78,000 tonnes/year) were originating from non-compliant urban wastewater discharges.

Overall, the above-mentioned JRC report concludes that "mitigation of point sources of nutrients is the most effective option to reduce nutrients export to European Seas. However, feasibility of this latter is relatively low and further reduction of nutrient emitted as point sources will involve important costs."

The Baltic Sea example

The threat of the eutrophication is well illustrated by the World Wild Fund (WWF) on the example of Baltic Sea which now contains eight times more phosphorus than it did 100 years ago[76]. Contamination with phosphates originating from laundry and dishwasher detergents is one of the major causes of eutrophication of the Baltic Sea and Danube River. It has been estimated that these phosphates (from both CADD and laundry detergents) may contribute up to 24% of the total inputs of phosphorus to the Baltic Sea[77].

WWF claims that the development of agriculture in the MS around the Baltic Sea will significantly contribute to the eutrophication so the limits on phosphorus use in detergents might compensate this effect. Global warming is another concern as rates of algae decomposition increase along with the temperature increase what compounds the effects of the nutrients. With these extraneous circumstances intensifying the effects of eutrophication, it is especially important to reduce the phosphorus load that discharges into these river basins.

One of the main objectives of the HELCOM Baltic Sea Action Plan[78] adopted in 2007 was to have a Baltic Sea unaffected by eutrophication. In order for the ecological objectives to be made operational, indicators with target values, reflecting good ecological and environmental status of the Baltic marine environment, were agreed upon. The 2013 Maximum Allowable Inputs (MAI) of phosphorus to the Baltic Sea, according to the HELCOM agreement, is at 21,716 tonnes[79].

The European Union Strategy for the Baltic Sea Region (EUSBSR[80]) was adopted in 2009. It provides an integrated framework for improving the environmental condition of the Baltic Sea, connecting the region and increasing prosperity. The Priority Areas are implemented by regional stakeholders through detailed actions and Flagship Projects. EUSBSR's objective on saving the sea, particularly the "Priority Area Nutri" (on reducing nutrient inputs to the sea to acceptable levels) closely corresponds to the work of HELCOM for a healthy Baltic Sea environment.

---

[76] WWF. "Threat of eutrophication to the Baltic Ecoregion." http://wwf.panda.org/what_we_do/where_we_work/baltic/threats/eutrophication/

[77] Estonian Fund for Nature. "*WWF's persistent work to ban phosphates in detergents finally paying off*." http://www.elfond.ee/en/news/1385-wwfs-persistent-work-to-ban-phosphates-in-detergents-finally-paying-off

[78] http://helcom.fi/Documents/Baltic%20sea%20action%20plan/BSAP_Final.pdf

[79] HELCOM. "*Targets*." http://helcom.fi/baltic-sea-action-plan/nutrient-reduction-scheme/targets

[80] The EU member states involved in the EUSBSR are Sweden, Denmark, Estonia, Finland, Germany, Latvia, Lithuania and Poland.

3.3.6 Phosphorous control at source

While treating phosphorus during wastewater treatment is possible and technically reliable, stakeholders[81] from water management companies prefer control at the source. Source control is reducing the amount of phosphorus entering into the wastewater facility and water bodies (from such sources as CADD, laundry, phosphates additives in food, etc.). They believe that source control is vital to prevent extra phosphorus from getting into the water cycle and to protect the water environment, especially because the main impact associated with phosphorus, eutrophication, is complex and ecological recovery does not show a direct cause-effect relationship. The 7th EAP also stipulates that in order to reduce phosphorus emissions better source control is needed.

[81] Eureau, Water UK

4. Market review

This chapter provides an overview of the automatic dishwasher detergents market in the EU. Consumer attitudes and expectations are also examined.

4.1 Review of the CADD market

The overall European[82] household detergents and maintenance products industry market for 2013 is estimated to have reached €28.5 billion[84]. Dishwashing products make up 15.1% of the market, and the European[8583] CADD market in 2013 was €2,489 million[84]. CADD products make up about 60% of the dishwashing detergents and maintenance products industry market in the EU and hand washing detergents make up the rest[84]. In the EU[8785], CADD consumption per capita was at 0.864 kilograms per year in 2006[86]. For MS specific data see Annex I.

The consumption of CADD across the MS in EU depends on the share of households that own an automatic dishwasher. For example, in Germany 77% of households own a dishwasher, 80% in Sweden, 52% in France and 42% in Britain[17, 87]. Some stakeholders[88] believe that owning to past trends in automatic dishwasher market, as such their ownership in EU will continue increasing in coming years.

According to Euromonitor, the size of the automatic dishwashing market in retail volume alternative[89] (including liquids, powders and tablets automatic dishwashing consumer detergents) for the EU28 was 295,201 tonnes in 2013. As can be seen in Figure 2, over the course of last six years, their overall market is gradually growing (around 8% increase by 2013 compared to 2008).

---

[82] EU 28 , Norway, and Switzerland.

[83] EU 28, CH, and NO

[84] A.I.S.E. 2014. "*Annual Review and Sustainability Report 2013-2014*." http://www.aise.eu/cust/documentrequest.aspx?DocID=2590

[85] EU 27 except RO, HR, and BG.

[86] RPA. 2006. "*Non-surfactant organic ingredients and Zeloites0based detergents.*" http://ec.europa.eu/enterprise/sectors/chemicals/files/studies/rpa_non_surf_organ_zeolites_en.pdf

Note: Percentage figures based on dishwasher ownership figures (as percentage of households) presented in European Commission (2004) and updated using data from Mintel (2006). Household consumption based on 7 kg/yr for dishwasher owning households. Blanks mean no data available.

[87]Minitel.2011. "*Dishwashing Detergents - UK - April 2011*." http://store.mintel.com/dishwashing-detergents-uk-april-2011

[88] Water UK

[89] According to Euromonitor, Retail volume alternative is a way for many different categories of products to be compared to one another. For instance, different volume measures for liquid detergent, tablet detergent, powder detergent and drier sheets in laundry care mean that total laundry care volume sales are non-calculable. The retail volume alternative option allows for all volume sales to be converted into the same unit measure so that category totals are possible. In this case, volumes across all categories are converted to metric tonnes.

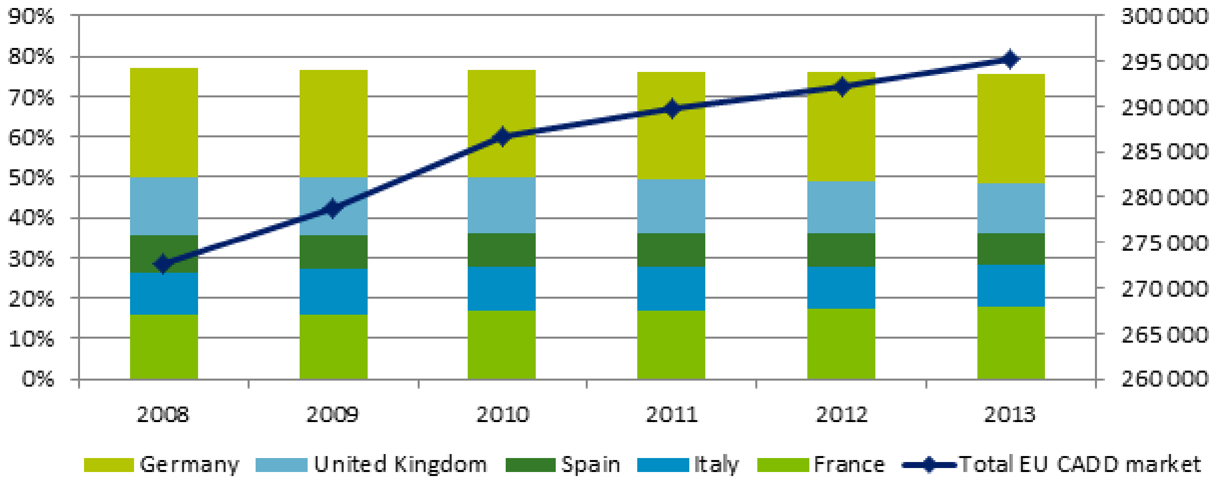

Figure 2: Evolution of overall size (in tonnes retail volume alternative) of automatic dishwashing market (only powders, liquids and tablets) in EU and the percentage share of the five countries with biggest market share[90].

The five countries with the largest market share in 2013 are, in decreasing order of volume, Germany, France, UK, Italy and Spain, as shown in Figure 2,. The majority of remaining MS only have small market shares, on an average around three percent or less.

Two (Germany and France) out of the five MS that had the largest market share in 2013 witnessed continued growth since 2008, as can be seen in Figure 2. At the EU level, only five MS saw decline in the CADD market since 2008 levels (UK, Malta, Spain, Greece and Denmark), but this could be due to compaction of products, to customers switching from “bulk” powders to pre-dosed packaging (tablets) and therefore avoiding overdosing, or increased effectiveness of CADD therefore requiring less product for the same results.

Only two Member State stakeholders provided figures about the CADD market in their country besides the Euromonitor market data. France informed that in 2011, 67,435 tonnes of CADD were sold whereas the Euromonitor data suggests 49,170 tonnes. This difference could be due to the fact that the French data includes other products such as washing additives and rinse aids that have not been taken into account in the Euromonitor figure. France also provided the breakdown in their country for phosphates-free vs. phosphates-containing CADD. Only 38% of CADD on the French market contained phosphates in 2011. Italy commented that in 2013, between 35,000 and 40,000 tonnes of CADD were sold (which is consistent with Euromonitor statistics), of which between 2,000 to 4,000 tonnes were phosphates-free, or between 5 and 10 percent. While not providing any figures, Ireland claims that “many of the dishwasher products on the Irish market contain phosphates.”

One of the leading manufacturers[91] stated that over 90% of their total quantity of CADD sold in Europe is phosphate-free. In contrast, another important European manufacturer[91] estimated that at the European level only “between 5 and 10% the phosphate-free CADD comply with the new proposed phosphorus limit of 0.3 grams per wash.”

4.2 Phosphorus market and its use in CADD

Phosphorus reserves are relatively abundant globally. However, within the EU, there are only small reserves of phosphate bearing rock. Current production of phosphate rock is concentrated in a

---

[90] Data source: Euromonitor 2014 data provided by A.I.S.E.

[91] Based on stakeholder response to the questionnaire survey carried out during this study

limited number of countries. Almost none are in the EU, with the exception of Finland where there is a small amount of production.[92]

Despite having significant global phosphorus rock reserves, the quality of the remaining rock is declining and consequently it will be more expensive to obtain this resource and thus the cost of processing phosphates for detergents can also be expected to rise. Also, the prices of phosphorus are subject to price volatility. In 2008, prices of phosphorus rock rose by 700% in a little over a year, contributing to increases in fertiliser prices. While shortly after prices decreased, they have again been on the rise since 2011.[92]

Phosphates are derived from phosphorus rock and are used in both the fertiliser industry and the chemical industry. Approximately 90% of the global phosphate demand goes to fertilisers and other agricultural uses[93]. Indeed, within the EU, the main use for phosphates is in fertilisers with an estimated consumption of around 3.5 million tonnes P_2O_5/year (equivalent to around 1.5 million tonnes of phosphorus (P)/year) in 2009, whereas phosphates-based detergents (both dishwashing and laundry) had an estimated consumption of around 440,000 tonnes of P_2O_5 in 2006 (equivalent to 110,000 tonnes of phosphorus')[49].

DEFRA also examined UK's annual phosphorus usage for CADD and found it to be a "very small fraction" when compared to the quantity used in fertilisers. They concluded that the price of phosphorus rock is more dependent on fertiliser production and that the relatively small reduction in phosphorus production due to a phosphorus restriction in CADD would not significantly impact the global price of phosphorus.[17]

The worldwide production of STPP is between 1 and 1.7 million tonnes/year[94]. The European STPP manufacturing industry is relatively small and represents less than 10% of worldwide STPP production[75]. In 2009, there were 7 STPP production companies in the EU with an overall production of 270,000 tonnes in 2008 with exports of 100,000 tonnes in the same year. These production and export figures were significantly lower compared to the previous year[49]. However, this could be due to the fact that in 2008 there was a huge price increase for phosphorus, as previously mentioned. In 2007, total EU STPP production was at 515,000 tonnes with 190,000 tonnes going to export[49]. As prices have since come down, the 2007 figures may be a more accurate representation of EU STPP production volumes.

In 2008, phosphates-based dishwashing detergents made up approximately 30% of STPP use in the EU, with consumption for this purpose remaining stable between 2004 and 2007[8]. Another 8% went to Industrial and Institutional (I&I) detergents and approximately 60% went to laundry detergents. STPP is still used worldwide mostly as a detergent chelating agent (88% in 2008), but is also used for food and beverage as a preservative (meat, poultry, seafood, dairy, etc. at 7% in 2008), ceramics (3% in 2008) as well as in paints and some toothpastes[93].

The 2007 figures for European STPP production as well as the global breakdown of phosphate uses and the division among detergents use in the EU can be used to create a clearer picture of the STPP market. Subtracting the exports from total production of 515,000 tonnes leaves 325,000 tonnes of STPP for the domestic EU market, of which it is assumed 88% are used in detergents as is the case globally[93]. Out of the 286,000 tonnes used for detergents, 38% or 108,680 tonnes went to CADD and I&I markets and 60% or 171,600 tonnes in the laundry detergents. Approximately 12% of the total CADD production or 39,000 tonnes was for other non-detergent related uses (food, ceramics, etc.).

---

[92] European Commission. 2013. "*Consultative Communication on the Sustainable Use of Phosphorus*." http://ec.europa.eu/environment/consultations/pdf/phosphorus/EN.pdf

[93] Focus on Surfactants. 2011. "*Industrial phosphates, where now?*"

[94] Global Phosphates Forum. 2014. http://www.phosphate-forum.org/

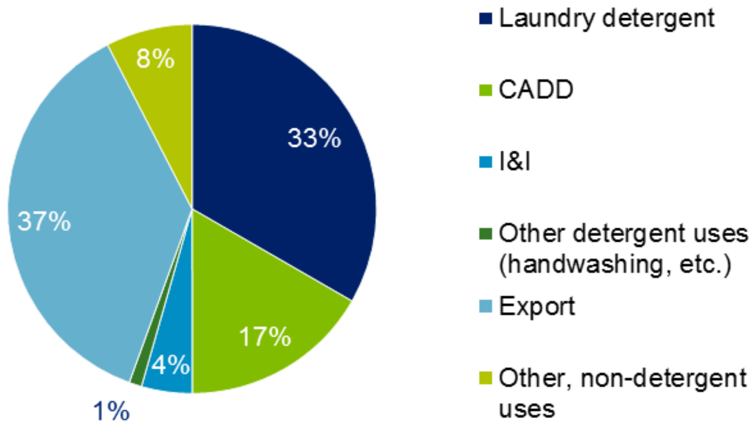

Figure 3: EU STPP production in 2007

As can be seen in Figure 3, the biggest market share of EU STPP domestic production went to exports in 2007, closely followed by domestic use in laundry detergents. Since that time, the laundry market has evolved due to the restriction of 0.5 grams on phosphorus use in laundry detergents. Although the STPP production in EU has been decreasing, however, only one site has actually closed (Thermphos) since the phosphorus restriction in laundry detergents[95]. The other three companies producing STPP earlier have now changed their production to STPP alternatives and remain in business. Therefore, today there are three companies (Prayon, Budenheim, and BKG-ICL) with a total of four production sites remaining. PAPA states that with this limited number of producers of STPP it is not feasible to collect production/market statistics and ensure anti-trust confidentiality.

The three remaining STPP manufacturing companies in EU also produce a wide range of phosphorus products and certain even produce non-phosphorus based goods such as thermoplastic products and other chemicals for pharmaceuticals. For one company, these non-phosphorus based products make up 30% of their business in terms of production[96]. All produce phosphates for a range of uses: cleaning products, fermentation processes, fertilisers, flame protection, food, lithium ion batteries, medical technology, metal, paints and coatings, and more. One already produces phosphonates, which are a possible alternative ingredient to phosphates-use in CADD[97]. While some raised concern for the upcoming limitation of phosphorus in CADD in their annual reports, one stated that demand for their products has actually increased, and another reported some of their other products have compensated for the decline in the detergents sector[96,98].

---

[95] PAPA (Phosphoric acid and Phosphates). 2014.

[96] ICL. 2013. "*ICL Periodic Report*." http://repo.icl-group.com/Lists/ReportsManagement/Financial%20Reports/2013/Annual%20report%202013.pdf

[97] https://www.budenheim.com/en/

[98] Prayon. 2013. "*Rapport 2012*." http://www.prayon.com/media/cms/RA_12_FR.pdf

4.3 Phosphate-free CADD market

Most major companies have recently developed some phosphate-free CADD products. Many manufacturers already offer phosphate-free CADD in some Member States of the EU[99]. The prices of CADD seem to be based mostly on performance (although there are some low performance ranked CADD with high prices) and does not depend on the presence of STPP seeing as both types of CADD are sold within approximately the same price range[100]. Various consumer associations have published articles citing the affordability of phosphates-free CADD. The prices listed in the French consumer magazine "60 millions de consommateurs" showed that phosphates-free detergents can be cost competitive. For tablets, the best ranked product was phosphates-free but was also the most expensive. However, as it is the best performing product, it is only natural that one should have to pay more for its better performance.[101] "Que Choisir" also found phosphates-free products to be the best performing, of which one product was one of the cheapest available[102]. With the complete switch to phosphates-free CADD, majority of the stakeholders expect prices for raw materials to further decline, in turn lowering the phosphate-free CADD prices. A non-exhaustive summary of various phosphate-free CADD currently found on the market is presented in Annex H.

The Swedish Example

Sweden had already restricted the use of phosphates in CADD since 1st July 2011. The restriction was announced in sufficient advance to give manufacturers enough time to adapt to the new law. According to Swedish Chemicals Agency, due to consumer demand, ecolabelling criteria and announced legislation, phosphate free alternatives have been developed and gained significant market shares. From 2005 to 2007 the phosphates-free CADD market grew from 10% to 27%. By 2009, 69% of CADD sold in Sweden were already totally phosphate free. When the restriction plans were announced, concerns were raised that the restriction would pose an obstacle to market entry for smaller domestic producers. In 2007, 74% of the CADD produced in Sweden were phosphate free, and by 2009, the domestic production of phosphorus free CADD had continued to grow to a share of 96%. This suggests that the small Swedish producers adapted to the ban more easily than producers of imported products.

Back in 2006-2007, the manufacturers had raised concerns about raw materials costs increases to replace STPP and a risk of poorer performance, such as filming on glassware for phosphates-free formulations. However, during the consultation with Swedish industry in 2010 no information emerged to suggest that equivalent development and switching to phosphorous-free CADD would not be possible for the proposed phosphates restriction in CADD in Sweden. Furthermore, prices of the CADD have not increased due to the phase out of phosphates and nor have the consumers complained about any decrease in performance. Sweden attributes this to the transitional period it set up for moving to a phosphates-free market.

---

[99] P&G offers it long-standing automatic dishwasher detergent Cascade in phosphates-free formulas. Reckitt Benckiser introduced phosphates-free Finish Quantum. The vast majority of Unilever's SUN brand is phosphate-free as well..

[100] Based on consumer association test information; figures found in France. 60 millions des consommateurs. April 2010. n°448 (pages 27-31) "*Des phosphates à eliminer*." and Que Choisir, October 2010. Version 485 (pages 25-28). "*essais*."

[101] The average price per wash in France for phosphates-free tablets was around €0.19 and that for phosphates-containing tablets was around €0.16. For powders/gels, half of the phosphates-free CADD were less expensive than the least-expensive phosphates-containing CADD. The average price for phosphates-free was €0.18 and for phosphates-containing was €0.23. As mentioned earlier, the phosphates-free powder/gels outperformed their phosphates-containing counterparts.

[102] Best performing products represented the most expensive and one of the cheapest products (€0.33 and €0.12 per wash). The average price listed for phosphates-free products was €0.25 and for phosphates-containing was €0.35. The phosphates-containing had the cheapest product, at €0.08 per wash, however it was also very poorly ranked for cleaning efficiency (14th out of 18 products).

One reason that Sweden was able to have a stricter restriction of phosphates in CADD (up to 0.5% phosphorus by weight) is the fact that majority of the water in Sweden is softer compared to many other MS in the EU. For professional use it is accepted in Sweden that different products are used depending on local variations in water hardness. There are claims in the evaluation of test results that the quality of CADD on the Swedish market today may be unnecessarily good due to the softness of water in Sweden. However, Swedish Chemicals Agency remarked that no particular difficulties were reported from those Swedish regions that have hard water (e.g. Gotland and Uppsala). Phosphates were still allowed in the Swedish case due to the fact that various parties stated the need for the possibility of using low concentrations of various phosphorus-containing substances (such as phosphonates). Consequently, allowing a small level of phosphorus in detergent also leaves a scope for technical development.

4.4 Consumer behaviour

Consumer attitudes toward phosphate-containing detergents (both CADD and laundry) in EU have been influenced by advertised environmental friendliness of phosphates-free brands. Environmentally superior detergents remain the top choice of approximately half of customers in Germany (55%), France (64%), UK (50%) and the USA (40%), according to a 2009 consumer survey by Userneeds[103]. The only hindrance in buying green products is performance, with 47% of French respondents saying they would buy greener products if cleanliness efficiency remained the same[103].

[103] Focus on Surfactants. September 2009, Volume 2009, Issue 9, P. 4. "*Consumers want green and clean detergents*." http://dx.doi.org/10.1016/S1351-4210(09)70284-7

5. Overall analysis

This chapter provides an analysis of the costs and benefits of switching to the alternatives of phosphates-containing CADD in EU.

Majority of the 35 stakeholders who responded to the questionnaire survey agree with current EU legislation limiting phosphorus content in CADD to 0.3 grams starting in 2017, as can be seen in Figure 4. Approximately 78% of these stakeholders say that it is possible to meet this requirement, of which 69% also find it desirable. If the abstentions are counted as consent to the requirements as it stands, then the total percentage of stakeholders who agree goes up to 97%. Only one stakeholder[104] said that further discussion with industry is needed. No stakeholders said that the requirements were not possible.

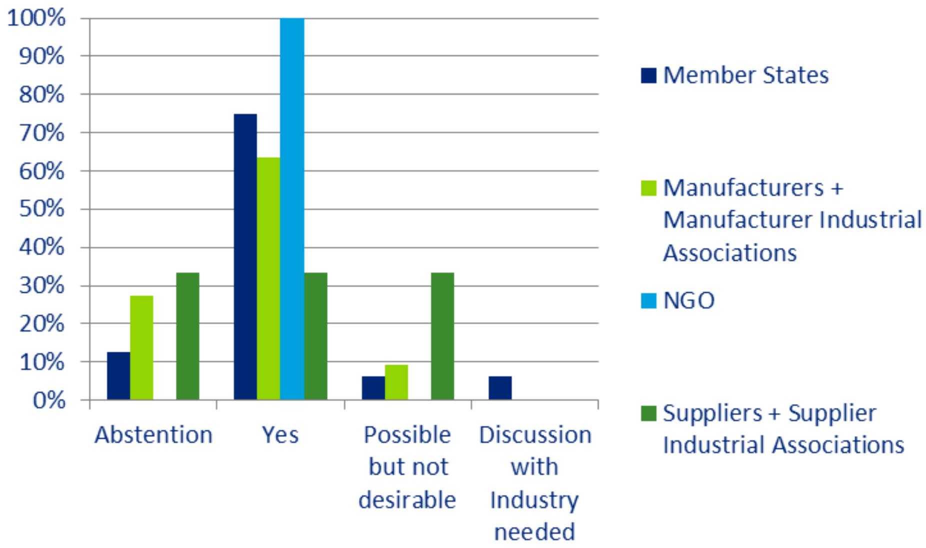

Figure 4: Stakeholder responses to question about the possibility/desirability of the limit of 0.3 grams phosphorus content in CADD from 2017 onwards, as prescribed in current EU law

This high rate of acceptance of the law as it currently stands (0.3 grams phosphorus restriction in CADD starting in 2017) is shared among Member States, Industry, and NGOs. Water management companies also expressed their desire for limiting phosphorus at the source (as discussed in section 3.3.6), which implies their support for this requirement.

Because of the acceptability of this requirement by majority of stakeholders, the impact assessment is limited to any new scientific and market information made available since the publication of the European Commissions' 2010 Impact Assessment of the Amendment to the Detergent Regulation. The new sources of information are mostly the recent literature and stakeholder feedback. In addition, the analysis focuses on the policy option currently required by

[104] UK

EU law as it was no longer considered necessary to further analyse a reduction or an increase in phosphorus quantity limit.

5.1 Economic analysis

The potential economic impacts for the CADD suppliers, manufacturers, retailers, consumers, and wastewater treatment facilities are analysed here and the competitiveness of EU industry and impacts on SMEs (Small and Medium Enterprises) is also reflected upon.

Overall, majority of the 32 stakeholders who provided their feedback on cost do not expect costs to particularly increase in a phosphates-free market (more than 75%) as can be seen in Figure 5. These costs include production, redesign of production facilities, rebranding, and research and development costs.

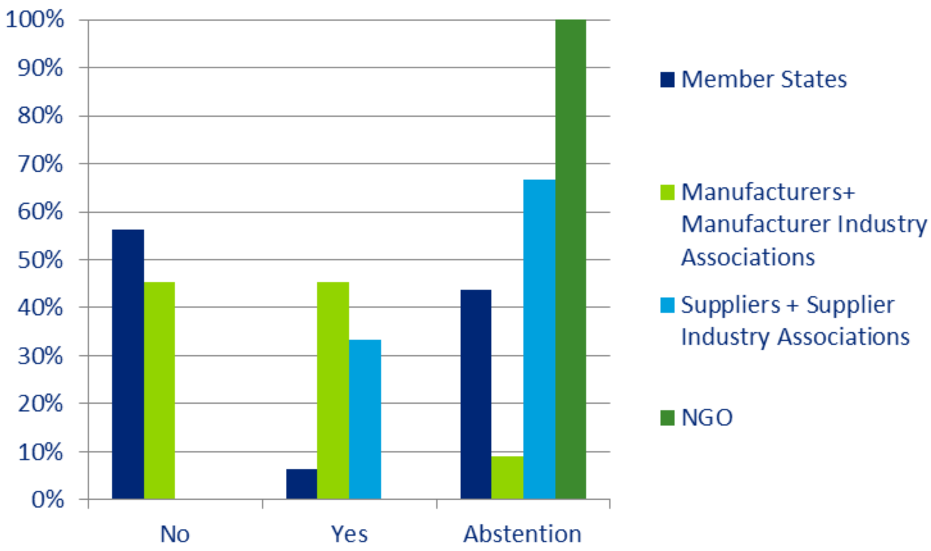

Figure 5: Stakeholder responses to question about any notable differences in costs of phosphate-containing and alternative CADDs

Around 44% of these stakeholders said that there are no noticeable differences in the costs of phosphates-containing and phosphates-free CADD while 34% abstained. All MS stated that costs would not be affected except for one[105], who reiterated that their local industry was concerned about price increase. The differences in opinion among industry are discussed in further detail below in sections 5.1.1 and 5.1.2.

5.1.1 Economic impacts on phosphates suppliers

Any eventual impacts on STPP suppliers are difficult to evaluate due to a lack of data as limited information was made available by the suppliers. Because of only three STPP suppliers in the EU, PAPA expresses its inability to disclose the market data without compromising anti-trust confidentiality.

[105] IE. Although a follow up on this response with Ireland revealed that the industry (mainly one leading European manufacturer) had raised this concern in the past. The project team had received separate feedback to the questionnaire survey from this same leading manufacturer who does not have these cost concerns anymore.

The 2010 Impact Assessment study for the Amendment to the Detergent Regulation noted that a ban of phosphates in detergents would affect the then 7 STPP producing companies in EU. The same report also stated that neither the dishwasher detergent STPP market nor the food and industrial phosphates market offer the demand necessary to absorb the excess STPP production that was originally intended for laundry detergents, and therefore the continuing loss of producers would seem to happen regardless of an additional restriction for dishwashing detergents. Out of the 7 companies in 2010, only three of them still produce STPP, one producer going bankrupt whereas others managed to change their production focus[106]. For example, one STPP producer also manufactures phosphonates, as noted earlier. Also, the site closures could be because of a combination of factors, which makes the potential impact difficult to predict.

The 2010 Impact Assessment study also found that a total ban of STPP in all detergents would most likely mean that "the production of phosphoric acid and its purification would no longer be economically viable in EU, so that the EU would finally become dependent on imports (in particular from North Africa and other phosphates-rock producing areas)."

According to PAPA, the major share of the STPP production in the EU goes to CADD, with a small part to industrial detergents and cleaning solutions, and some to export[107]. Using the 2007 figures for European STPP production, as well as the global breakdown of phosphate uses and the division among detergents in the EU, an estimation of the EU CADD market in 2013 (see Figure 7) can be made. Due to the restriction in phosphorus to 0.5 grams in laundry detergent, 60% of the STPP use in detergents market can be assumed to disappear already. However, this loss should not affect the consumption in other markets, and therefore it is possible to assume that production of STPP for other uses (CADD, etc.) stays the same. In order to estimate the impact on exports, it is assumed that all the 7 companies in 2007 had equal share of total EU STPP production. As in 2013 only 3 of the 7 STPP manufacturing companies remain, therefore the EU STPP exports in 2013 will be around 57% lower compared to 2007. In 2013, the total EU STPP production is therefore estimated to be around 229,110 tonnes. This is about a 56% decrease from total production in 2007.

[106] PAPA

[107] While the 2010 Impact Assessment of the Amendment to the Detergent Regulation said that the loss of the export economy was equivalent to slightly over €100 million, it also noted that the export market had already declined before EU restrictions on laundry detergent were made. It also said that since the European STPP production industry represents less than 10% of worldwide STPP production, the economic loss "would not be considered great in overall EU terms."

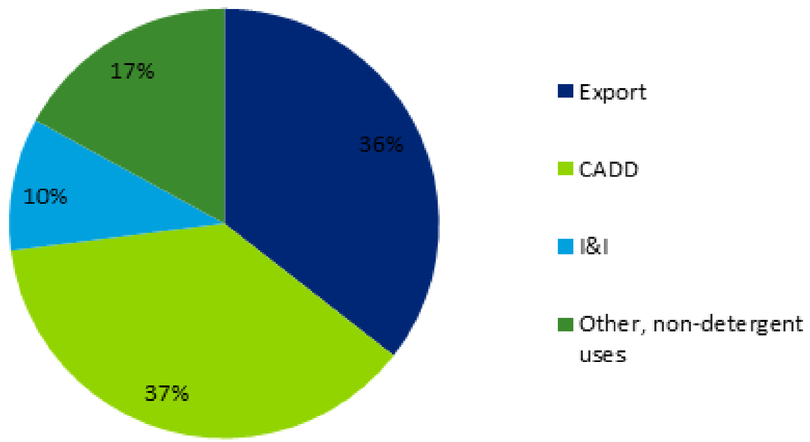

Figure 6: Estimated EU STPP production in 2013

Based on these calculations, it seems that of the total STPP production in EU, the share of STPP use in CADD is similar to that of STPP exports.

Furthermore, if the exercise is carried out for future EU STPP production in 2017 (see Figure 7) taking into account the potential disappearance of the STPP use in CADD market while all other markets remain the same, the total EU STPP production would be reduced to 143,310 tonnes. This is around 37% decrease from before the ban on CADD would come into effect (compared to the production in 2013). It is estimated that exports will have the largest market share, with around 57% of production going to exports. The remaining 43% is estimated to go to I&I as well as non-detergent uses (food additives, pharmaceuticals, etc.).

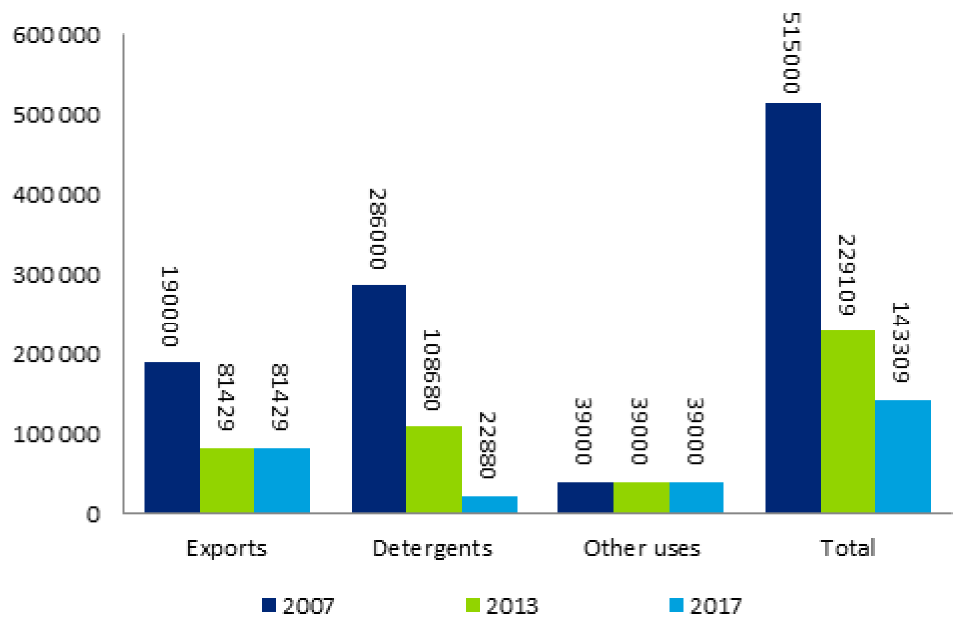

Figure 7: Estimation of evolution of STPP production (in tonnes STPP) for 2013 and 2017 based on 2007 data

Additionally, certain non-detergent uses of STPP have seen increases in the recent years, as is the case for food additives. As stated previously, one STPP supplier company's business has started producing non-phosphorus based goods[96]. One company states in their annual report that demand for other products has compensated for the decline in the detergents sector[98]. These changes would indicate that STPP suppliers are trying to adapt to a changing market where STPP for detergents are less in demand by exploring other applications and other products.

However, PAPA reiterates that it is very unlikely that companies will be able to replace EU STPP sales income by export STPP sales income, and it is furthermore very difficult to maintain ‘export only’ production for a bulk chemical such as STPP in the absence of a home market.

Finally, there still remains time for STPP suppliers to adapt their business before the law comes into effect. However, the supplier companies have voiced concerns about the law affecting their business, including creating further pressures on prices of phosphorus based products in EU[96].

5.1.2 Economic impact on detergents manufacturers

The 2010 Impact Assessment already established that larger detergent formulators operating in several or all MS should find it possible to replace phosphates-containing detergents with phosphates-free ones as many of them already have phosphates-free formulations on the market (as established in section 4.3).

The manufacturers who responded to the questionnaire[108] carried out in this study are divided on the issue of additional costs due to switching to phosphates-free CADD. As can be seen in Figure 8, 45% (5 of these stakeholders[115109]) of them say that costs are mainly based on the formulation, product position and raw material prices variations, regardless of phosphates use or not. It is also important to note that detergent manufacturers reformulate their products regularly (averaging every 3.5 years) in order to maintain competitiveness and as such reformulation to restrict phosphates use would not necessarily engender additional costs[49]. Only one manufacturer (9% of those who participated in the survey), abstained from this question, implying that the issue was not of great importance to them and therefore it is reasonable to assume that for them the costs would not change. Thus, around half of these stakeholders finds no differences in costs.

[108] 11 total responses.

[109] A.I.S.E., Assocasa in merito all’indagine (Italian industrial association), DECO, Nederlandse Vereniging van Zeepfabrikanten (NVZ) (Dutch Soap Association), and Unilever.

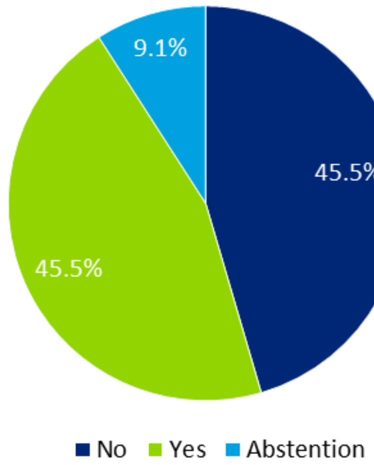

Figure 8: Manufacturers response to question about any notable differences in costs of phosphate-containing and alternative CADDs

Whereas around 45% (5 of these stakeholders) find that costs do increase, two manufacturers[110] said that technologies with the same performance as STPP are more expensive, but poorer performing technologies are cheaper and thus there is no alternative technology with the same cost to performance profile. The other three stakeholders[111] simply said that costs are higher for phosphates-free formulations.

A few of the phosphates-free CADD alternative chelating agents identified in section 3.2.1 are proprietary molecules, under patent, and only sold by one producer. While this could potentially lead to a situation where the owner of a certain molecule may impose whatever price they would like on CADD manufacturers, the fact that CADD manufacturers may choose among a range of alternatives make this unlikely.

Most major players already have phosphates-free CADD on the market, which suggests that costs are not so high as to inhibit manufacturers from making the switch. European manufacturers are also producing and selling phosphates-free CADD in other big markets for CADD (such as the USA) where a restriction of phosphorus is already in place.

5.1.3 Economic impact on consumers

As was already established in section 3.2.3 on the performance of alternatives and section 4.3 on the phosphates-free CADD market, consumers can expect little to no change in the price to performance ratio in switching to phosphates-free CADD. Furthermore, phosphates-free CADD are already preferred by the majority of consumers in the big EU CADD markets (France, Germany, and the UK) as noted in section 4.4[112]. As one of the main hindrance to buying phosphates-free CADD, their cleaning performance, can now be considered the similar as the phosphates containing CADDs, even more consumers should be buying phosphates-free CADD.

---

[110] P&G, and Senzora B.V.

[111] Danlind DK, leading European manufacturer of CADD, and Spaintab.

[112] Focus on Surfactants. September 2009, Volume 2009, Issue 9, P. 4. "*Consumers want green and clean detergents*." http://dx.doi.org/10.1016/S1351-4210(09)70284-7

The price range of both types of CADD available currently on the market is similar (consumer tests discussed in section 4.3 showed costs per wash ranging from €0.08 for phosphates-containing and €0.11 for phosphates-free to €0.33 for both detergent types). However, as phosphates-free CADD is used in greater numbers, there could be economies of scale for replacing the ingredients, thus decreasing their overall price. Also, in the Swedish example described earlier, CADD prices did not increase when they restricted phosphates in CADD.

Both price and cleaning performance are now quite similar for phosphates-free and phosphates-containing CADD. It is therefore reasonable to assume that consumers should not expect any negative economic impacts related to a restriction in the use of phosphorus for CADD.

5.1.4 Economic impact on wastewater treatment operators

The 2010 Impact Assessment study for the Amendment to the Detergent Regulation found that in order to remove the total amount of phosphorus from detergents (approximately 110,000 tonnes) in EU, it would lead to operational costs between €50-96 million (assuming that 100% of the wastewater treatment plants in EU were equipped with tertiary treatment facilities). However, this is not the case, and a more accurate estimation (due to varying tertiary treatment connectivity from 20 to 90%, as seen in section 3.3.3), the cost for P removal lies somewhere between €10-86 million for the entire EU. Removal costs in the UK were estimated at about €30/kg phosphorus for capital and operating costs combined[49]. One stakeholder[113] estimated the costs for P removal range from €0.0469 to €5.31[114] per cubic metre wastewater and that costs depend upon economies of scale for treatment.

Reducing the phosphorus load would mean that less chemicals are needed to perform chemical tertiary treatment, which is estimated to cost €0.47/kg of phosphorus for buying the ferric salts alone (excluding capital costs). Denmark estimated that banning phosphorus in CADD would reduce the phosphorus load by around 17% and together with the ban on phosphorus in laundry detergent would mean that most of the phosphorus removal could be done by biological removal instead of chemical, eliminating the operational costs associated with chemical treatment in wastewater treatment facilities[56]. Several stakeholders[115] commented that the removal of CADD from sewage would reduce the costs of phosphorus removal at wastewater treatment facilities, including energy, chemicals, and sludge aspects.

The study carried out for the EU Ecolabel in 2009 found that a ban on phosphates use in CADD would have a positive effect for WWTP by "lower[ing] operation costs related to reduction in the use of chemicals for phosphate precipitation[116]." The study also found that the current existing alternatives are not expected to affect the biological process of wastewater treatment. Furthermore, the reduced amount of phosphorus from CADD entering WWTP should not affect the treatment process, as there is enough phosphorus from other sources (faeces and urine) for continued treatment of sewage[117]. Furthermore, facilities should not have to invest in new technologies to treat the alternative chemicals. Water soluble, organic acid based alternatives that are readily biodegradable[118] should not require additional treatment technologies above those commonly available in wastewater treatment systems. Considering the fact that the contribution of organic compounds from these alternatives will be really insignificant in comparison to the organic

---

[113] Water UK

[114] Figures converted from Pounds to Euros using xe.com on 21/05/2014.

[115] UK, BEUC, EEB

[116] European Ecolabel. 2009. "*Revision of Ecolabel Criteria for Dishwashing Detergents Background report*."

[117] Calculations performed by DEFRA: P required, g P / 40 g BOD removal = 0.017 x 1 x 40 = 0.68 g P. For a daily flow per person of 250 litres/pe/d = 680 mg P / 250 litres = 2.7 mg P/litre. Where P is phosphorus and pe is person.

[118] Such as: MGDA, HEIDA, ASDA, GLDA, IDS(A), Sodium citrate, etc.

pollutants from human wastes, they should not cause any significant increase in costs for treatment operations. However, for non-biodegradable alternatives, treatment requirements and technologies will usually require additional treatments beyond current practices.

Therefore it can be concluded that eliminating phosphates-containing CADD would reduce the phosphorus load entering wastewater treatment plants, and therefore would reduce costs associated with phosphorus removal.

5.1.5 Impact on competitiveness of EU industry

There is an overall trend of going phosphates-free by major players all over the world, including countries where regulations are less strict. Furthermore, some phosphates-free formulations outperformed phosphates-containing CADD in the consumer reports discussed in section 3.2.3 and therefore the European phosphates-free detergents manufacturers should remain competitive regardless of regulations.

While the restriction on phosphorus content in laundry detergent in the EU reduced the EU STPP manufacturing base, a restriction on phosphorus in CADD should not produce the same effects due to the fact that the CADD market was never big enough to absorb the lack of demand by laundry detergents.

Furthermore, a restriction of phosphates would create a level playing field for EU CADD manufacturers/importers/traders as phosphates containing CADD have already been banned in other parts of EU (e.g. Sweden) the world (e.g. US). The phase-out of phosphates containing CADD placed on EU market would therefore foster innovation and create business opportunities for CADD manufacturers and suppliers in EU to play a leading role in the global context, thus contributing to the competitiveness of EU industry.

5.1.6 Impact on Small and Medium Enterprises

Based on the 2010 Impact assessment, although most Small and Medium Enterprises (SMEs) do not expect adverse economic impacts[119] but they may have a harder time adapting to the phosphorus restriction in CADDs. However, as stated earlier, detergent manufacturers reformulate on average once every three and a half years to remain competitive with new technologies, and as such this cost may be considered a business as usual, in light of around 5 years duration provided for enforcing the phosphorus restricting in CADDs since its adoption in 2012.

As stated earlier, some of the alternatives are proprietary molecules. This could potentially impact, SMEs, who may be unable to obtain access to these alternatives depending on exclusivity or supply priority contracts negotiated with the suppliers by major CADD producers.

The Swedish experience presented earlier in Section 4.3 shows that small Swedish producers adapted to the ban more easily than producers of imported products. The CADD market in Sweden is quite similar to the EU market. The lion's share of the market is held by companies and brands that also market products in the rest of the EU. It therefore suggests that the phosphate restriction in CADD do not benefit large companies over smaller ones, but might well be a business opportunity to smaller enterprises.

[119] Only 25% of SMEs stated they expected adverse economic impacts such as a decrease in sales, a loss of market share, and higher costs of production

5.2 Environmental analysis

In this section, the environmental impacts of alternatives to phosphate-containing CADDs' are reflected upon, focusing on eutrophication, biodegradability, and toxicity.

5.2.1 Environmental impacts related to eutrophication

The excessive presence of phosphorus in surface waters can cause an environmental problem called eutrophication, i.e. the saturation of an aquatic system with nutrients such as nitrates and phosphates leading to the formation of large masses of algal or cyanobacterial blooms. Phosphorous usually plays a lesser role in eutrophication of coastal waters but is often responsible for freshwater eutrophication and vice versa for nitrogen. Therefore, phosphorus found in CADD could potentially lead to eutrophication of fresh waters.

While the 2009 INIA model found that phosphates used in both laundry and dishwasher detergents increase the likelihood of eutrophication in EU waters by between 2.3% and 5.8% and SCHER concluded that detergent phosphate does not play a major role in eutrophication in an overall EU perspective. With the restriction on phosphates use in laundry detergents already effective in EU, the increase in likelihood of eutrophication of 2.3 – 5.8% will thus be significantly be lower for CADD only.

While water management companies are quick to point out the lack of a direct cause-effect relationship between phosphorus in the water and eutrophication (due to the complex nature of ecosystems), they are also adamant for the prevention at the source as the best way to protect the environment. Most phosphates-free CADD alternatives do not contain any phosphorus and as such should not contribute to eutrophication. Phosphonates, however, are phosphorus based and therefore could potentially contribute to eutrophication. Phosphonates greatly reduce the amount of phosphorus when compared to STTP so the risk of eutrophication is also greatly reduced.

The 2010 Impact Assessment study for the Amendment to the Detergent Regulation found that a total ban of phosphate in detergent "would be the most effective policy option for reducing the eutrophication risk throughout the EU and would in particular also address transboundary flows of phosphates in river basins or marine waters shared by several Member States." While completely eliminating phosphorus in CADD would decrease the eutrophication risk even further, due to variances in water hardness throughout EU and the fact that certain organic based alternatives have trace amounts of phosphorus in them, this is not technically feasible. However, the limit of 0.3 grams already greatly reduces the amount of phosphorus in CADD (by more than 75% on average).

5.2.2 Environmental impacts of alternatives

Any eventual impacts on the environment due to alternatives are difficult to evaluate due to some remaining data gaps, especially for certain specific alternatives. Therefore, a global assessment of the alternatives cannot be made. However, the available information has been examined and is further discussed hereafter.

When replacing STPP, these alternatives will be used in greater concentrations than if STPP was not restricted in CADD and therefore the predicted no observed effect concentration (PNEC) needs to be used. DEFRA found that STPP substitution by phosphonates, sodium silicate, or IDS(A) would lead to environmental concentrations of these substances still below PNEC[17].

Since the ecotoxicity of chemicals are evaluated by testing them individually, there is a big question about the mixture toxicity of all the pollutants (and their metabolites which are often still unknown) emitted to the environment. This is known as synergistic effects, and as there are a high amount of different ingredients used to replace phosphates in CADD, there could be some risk. One stakeholder[120] suggested that phosphates-free formulations have a tendency to use increased levels of other chemicals to make up for performance loss, such as polymers, bleaches and phosphonates, which could lead to adverse environmental impacts.

Stakeholders mention that there will be differences in impacts of alternatives compared to phosphates as phosphates are inorganic and majority of the alternatives are organic. They advise that each alternative be evaluated on a case-by-case basis. For certain alternatives, such as polycarboxylates, this is already the case. Several stakeholders also note that there is no or limited available information related to environmental impacts of certain alternatives. One stakeholder[121] comments that the alternatives consume less energy during production and therefore they would have a reduced carbon footprint compared to STPP. Some other stakeholders remark that the only benefit of switching from phosphates-containing to phosphates-free CADD is reduced eutrophication. Some stakeholders[122] raised a concern that if cleaning efficiency is compromised when switching to phosphates-free formulations, consumers may respond by increasing either the number of wash cycles or the temperature of the wash cycle until the same level of cleaning efficiency is achieved. It is important to note that the use phase has the greatest amount of environmental impacts over the any life cycle of a detergent. According to one stakeholder[123], "an estimation suggests that if lower performance of P-free CADD results in just 10% of households selecting a more intensive dishwasher wash programme, this would result in an increased consumption of electricity of more than 500 kWh/year, equivalent to around 35,000 tonnes/year of CO_2 emissions and a cost to consumers of around €50 million/year"[124]. However, the results of the consumer association tests show that cleaning efficiency is not reduced and the risk of increased intensity in dishwashing cycles seems limited.

Some phosphates substitutes do not have publically available data about their environmental impacts currently published on ECHA, which is a matter of concern. One stakeholder[125] said the lack of publically available data is especially disconcerting due to the fact that two chelating agents (MGDA and GLDA) may contain NTA as impurities, and NTA may cause cancer. However, when substitutes like GLDA and MGDA are used in the optimum quantities (like in ecolabelled products) the products fulfil all the required criteria (i.e. NTA impurities in GLDA and MGDA concentration should be lower than 1.0 % in the raw material as long as the total concentration in the final product is lower than 0.10 %).

The environmental impacts of the commonly cited replacements for STPP listed in section 3.2.1 are presented in Table 4[126].

---

[120] PAPA

[121] Unilever

[122] PAPA, UK and Ireland.

[123] PAPA

[124] Calculation based on France figures, multiplied x5 for EU: Electricity consumption per domestic dishwasher cycle at 55°C = 1.07 kWh, at 65°C = 1.44 kWh. (b) Level of dishwasher ownership in French households = 48%. (c) Number of French households = 26.4 million. (d) Number of dishwasher use cycles per year = 220. (e) Electricity carbon emissions equivalent for France = 70g/kwh CO2

[125] PAPA

[126] This table is not exhaustive as 100% of information desired is not available for certain alternatives

Table 4: The environmental impacts of the commonly cited replacements for STPP

Alternative chemical	Function	Fate in Environment	Registered with ECHA	Producer information	Fate in wastewater treatment
Sodium Citrate	Builder	May result in heavy metal mobility[127, 128]. Low acute toxicity based on daphnia test[129]	NA	NA	Readily biodegradable (OECD 301 B test)
Polycarboxylates	Used as co-builder; Used to avoid incrustation and soil redeposition	No overall environmental risk[130] identified in HERA report	Registered[131]	NA	Not readily biodegradable but are partly accessible to ultimate biodegradation particularly under long incubation conditions[130].
Phosphonates[132]	Used as co-builder; Used to enhance stain removal and prevent spotting & filming on	More research is needed to determine fate factor; Not mutagenic or carcinogenic;	Registered[134]	NA	Phosphonates are not readily biodegradable however a number of studies have shown that they do

[127] Jean-Soro et al., (2013) Environmental Pollution. Volume 164, May 2012, Pages 175–181.

[128] EPA has concerns about the study, stating that "this is the only paper claiming a remobilization of Chromium 3+ from sediments. Until now [there has been] no answer about the reliability of this study and the actual relevance for the environment." However as it is the most up to date scientific information available, it remains relevant to the study.

[129] Dr Georg Karlaganis. "*Citric acid CAS N°:77–92–9. SIDS Initial Assessment Report*."

[130] HERA reports. 2014 "Polycarboxylates used in detergents (Part I) Polyacrylic acid homopolymers and their sodium salts (CAS 9003-04-7)" and "Polycarboxylates used in detergents (Part II) Polyacrylic/maleic acid copolymers and their sodium salts (CAS 52255-49-9)".

[131] The publically available REACH dossier end-point information on polycarboxylates is not available on the ECHA website simply because these materials are polymers and polymers are exempt from REACH. However, the individual monomers are REACH registered as well as the ancillary substances used to manufacture them.

[132] Unless otherwise noted, the information in this category comes from: HERA (2004). Human & Environmental Risk Assessment on ingredients of European household cleaning products. Draft report. 06.09.2004.

Alternative chemical	Function	Fate in Environment	Registered with ECHA	Producer information	Fate in wastewater treatment
	glass Antiscaling additive Corrosion inhibitor Complexing agent	No overall environmental risk was identified in HERA report; Despite being phosphorus based does not pose a significant risk to eutrophication[133]			biodegrade in both river water, river sediment, soil[135] and in wastewater/activated sludges under P-limiting conditions[136].

[134] EPA –detergents phosphonates dossier July 2013 – page 10. HEDP, DTPMP, ATMP and PBTC are registered under REACH Regulation

[133] EPA –detergents phosphonates dossier July 2013 – page 6&7

[135] EPA – detergents phosphonates dossier July 2013 – page 9;

[136] Schowanek, D., Verstraete, W., 1990. "Phosphonate utilization by bacterial cultures and enrichments from environmental samples." Appl. Environ. Microbiol., 56(4):895

Alternative chemical	Function	Fate in Environment	Registered with ECHA	Producer information	Fate in wastewater treatment
Sodium Gluconate	Chelating agent	NA	Pre-registered. Envisaged substance registration deadline was 30/11/2010.	NA	NA
MGDA (Methylglycin diacetic acid, sodium salts)[137, 138]	Chelating agent	Does not bioaccumulate Daphnia test no observed effect concentration is > 100mg/l	The trisodium salt of MGDA is pre-registered. The envisaged substance registration deadline is 31/05/2018	Patent protected and produced and sold by only one supplier (BASF)	Readily biodegradable
ASDA (L-aspartic-N,N-diacetic acid, sodium salts)	An aspartate	NA	NA	NA	Readily biodegradable[139], [140]

[137] BASF. 2007. "Technical information Trilon M types."

[138] BASF. 2008. "Safety data sheet Trilon M Powder." http://worldaccount.basf.com/wa/NAFTA/Catalog/ChemicalsNAFTA/doc4/BASF/PRD/30215074/.pdf?title=&asset_type=msds/pdf&language=EN&validArea=US&urn=urn:documentum:ProductBase_EU:09007af88008f61f.pdf

[139] Baraka-Lokmane, S.,Sorbie, K.S., Poisson, N, Lecocq, P. 2008. "Application of environmentally friendly scale inhibitors n carbonate coreflooding experiments. SCA2008-05."

[140] This result is for marine environments, which are not directly comparable to fresh water tests

Alternative chemical	Function	Fate in Environment	Registered with ECHA	Producer information	Fate in wastewater treatment
GLDA (L-glutamic acid, N,N-diacetic acid, sodium salts);	Chelating agent	Not mobile in the environment The carbon source of GLDA is primarily bio based. Therefore, GLDA is the only chelating agent with ‘green’ carbon atoms[141] Daphnia test no observed effect concentration is > 100mg/l Not mutagenic for cells or bacteria	Registered	Patent owned by Akzo Nobel	Readily biodegradable (OECD 301D, 302B, 303A)

[141] Dorota Kołodyńska. 2010. “The effects of the treatment conditions on metal ions removal in the presence of complexing agents of a new generation.” http://dx.doi.org/10.1016/j.desal.2010.06.053

Alternative chemical	Function	Fate in Environment	Registered with ECHA	Producer information	Fate in wastewater treatment
IDS(A) (Iminodissuccinic acid, sodium salts)	Chelating agent Excellent calcium binding properties, stability in a wide pH Good complexation of heavy metal ions	Low remobilization of heavy metals from sediments[142] Toxicologically and ecotoxicologically safe	Pre-registered. Envisaged substance registration deadline is 31/05/2018.	Patent owned by Bayer/LANxess	Readily biodegradable
B-ADA (B-alaninediacetic acid)	Chelating agent	NA	Pre-registered. Envisaged substance registration deadline was 20/11/2010.	NA	Readily biodegradable[143]

NA: in the above table signifies information Not Available

For further details about environmental impacts of alternatives, consult Annex D.

142 Lanxess. “General product information Baypure.” http://www.aniq.org.mx/pqta/pdf/BAYPURE%20DS%2010040%20(HT).pdf

143 Maragrete Bucheli-Witschel, Thomas Egli. 2001. “Environmental fate and microbial degradation of aminopolycarboxylic acids.”

Only three alternatives (B-ADA, ASDA, Sodium gluconate) appear to have data gaps and the other alternatives do not seem to pose a significant environmental risk based on current scientific knowledge.

Recently a comparative Life Cycle Analysis was conducted in 2013 on a phosphates-based CADD, a phosphates-free CADD, and an ecolabelled CADD, which were allowed to contain limited phosphates at the time of the study. While the outcomes of the study are not representative of overall CADD market in EU, it underlined that the phosphates-based CADD had higher impacts than the other two, and that phosphates removal is a proven environmental benefit based on the ecotoxicity result.[144] This study should not be taken as the definitive answer to the question of which type of CADD is the most environmentally friendly as more research needs to be done to confirm these findings[145].

5.3 Social analysis

In this section, the potential social impacts (such as impact on health and job creation in EU) of switching from phosphates based CADD to alternatives are discussed.

5.3.1 Health

There exist a few data gaps relating to the health of certain alternatives. There is data missing for sodium gluconate, ASDA, and B-ADA and further research should be done for these chemicals. This is a matter of concern as an overall conclusion about the health of alternatives cannot be made.

However, the remaining alternatives to STPP appear to have low risk to human health based on current scientific knowledge. The 2013 HERA report found that polycarboxylates are of low toxicity by all exposure routes. The 2004 HERA report on phosphonates found that the use of HEDP in detergents is safe and "does not cause concern with regard to consumer use." The 2005 HERA report for citric acid found that the use of citric acid in household laundry and cleaning products raises no safety concerns for consumers[150, 146]. The product safety information for MGDA, GLDA and ISD(A) note that they do not pose a risk to consumers. As phosphates do not pose a risk to human health either, the impact of these alternatives remains neutral.

5.3.2 Employment

Any eventual impacts on employment are difficult to evaluate due to a lack of data. Limited information was made available by STPP suppliers.

The three remaining EU STPP producers provide in total approximately 2000 jobs directly in the EU, either in the whole company (where company is phosphates centred) or in phosphates business (for companies with other different activities). They also generate around three times this number of jobs indirectly in related suppliers and services. [151, 147]

Following the reduction in phosphorus content in laundry detergent in the EU, one of the 7 STPP producers at the time went bankrupt, causing a direct job loss of 450 jobs at their site in the Netherlands. Although, a majority of the STPP suppliers (three out of four) were able to adapt to

---

[144] IGOS, Elorri et al. 2013. "*Development of USEtox characterisation factors for dishwasher detergents using data made available under REACH.*" http://dx.doi.org/10.1016/j.chemosphere.2013.11.041

[145] PAPA voiced strong concerns about the scientific validity of this study based on the use of USEtox data for STPP as USEtox was designed for organic chemicals and not inorganic (like STPP).

[146] HERA. 2005. "*Substance: Citric Acid and Salt*." http://www.heraproject.com/files/37-F-05-HERA_citricacid_version1_April05.pdf

[147] PAPA. Personal communication. 2014.

new materials since the coming into force of phosphates requirement on detergents regulation, however the corresponding impact on jobs owing to this adaptation for these companies cannot be evaluated due to lack of data.

6. Annex A: Stakeholder List

Table 5: Stakeholders list

Type of questionnaire	Type of organisation	Organisation	Contact Name	Geographical scope
Manufacturers and Industry associations	Industry Association	A.I.S.E. (International association for soaps, detergents and maintenance products)	Ms Laura Portugal	EU
Manufacturers and Industry associations	Industry Association	CEEP / PAPA (Centre Européen d'Etudes des Polyphosphates, part of Phosphoric Acid and Phosphates Producers Association (PAPA, Sector Group of CEFIC))	Mr Marc Vermeulen	EU
Manufacturers and Industry associations	Industry Association	EPA (European Phosphonates Association)	Caroline Andersson	EU
Manufacturers and Industry associations	Industry Association	CESIO (Comité Européen des Agents de Surface et leur Intermédiaires Organiques European Committee of Organic Surfactants and their Intermediates) (Sector Group of CEFIC) ECOSOL (European Centre of Studies on LAB/LAS) (Sector Group of CEFIC) European Committee of Organic Surfactants	Ms Chantal De Cooman	EU

Type of questionnaire	Type of organisation	Organisation	Contact Name	Geographical scope
		and their Intermediates (CESIO)		
Manufacturers and Industry associations	Industry Association	EUZEPA (The European Zeolites Producers Association (Sector Group of CEFIC))	Mr Joël Wilmot	EU
Manufacturers and Industry associations	Industry Association	Chemicals Industries Association (CIA)	Dawn McCaughey	UK
Manufacturers and Industry associations	Industry association (Research institute)	European Sustainable Phosphorus Platform	Chris Thornton	EU
Manufacturers and Industry associations	Industry association (Research institute)	German Phosphorus Platform (Deutsche Phosphor-Platform DPP) Fraunhofer	Jasmin Raslan	DE
Manufacturers and Industry associations	Manufacturer	Colgate Palmolive	Mr Jean-Bernard Vidaillet	Worldwide
Manufacturers and Industry associations	Manufacturer	Reckitt Benckiser	Mr Luciano Pizzato	Worldwide
Manufacturers and Industry associations	Manufacturer	Unilever	Mr Gerard Luijkx	Worldwide
Manufacturers and Industry associations	Supplier	DOW Chemicals	Ms Kate Geraghty	EU
MS	MS agency	Federal Public Service for Health, Food Chain Safety and Environment	Mr Fabrice Thielen	BE

Type of questionnaire	Type of organisation	Organisation	Contact Name	Geographical scope
MS	MS agency	Ministry of Health	Ms Spomenka Uremović	HR
MS	MS agency	Ministry of Health	Ms Petra Cigić	HR
MS	MS agency	Ministry of Environment	Ms Jindra Sisrova	CZ
MS	MS agency	Environmental Protection Agency	Ms Sidsel Dyekjær	DK
MS	MS agency	Ministry of Social Affairs		EE
MS	MS agency	Finnish Safety and Chemicals Agency (Tukes)	Ms Ulla-Riitta Soveri	FI
MS	MS agency	Ministry of ecology, sustainable development & energy	Ms Bénédicte Tardivo	FR
MS	MS agency	Ministère de l'Économie et des Finances	Ms Marion Aubert	FR
MS	MS agency	Federal Environment Agency	Ms Sabine Sur	DE
MS	MS agency	General Chemical State Laboratory	Ms Chrysanthi Nakopoulou	EL
MS	MS agency	Ministry of Rural Development	Ms Beatrix Kiss	HU
MS	MS agency	Department of Jobs, Enterprise and Innovation	Ms Cliona Ryan	IE
MS	MS agency	Ministry of Health	Mr Pietro Pistolese	IT
MS	MS agency	Ministry of Health	Ms Anita Seglina	LV

Type of questionnaire	Type of organisation	Organisation	Contact Name	Geographical scope
MS	MS agency	Ministry of Economy	Ms Ilona Golovaciova	LT
MS	MS agency	Ministry for Infrastructure and the Environment	Mr Mari van Dreumel	NL
MS	MS agency	Division of International Cooperation and Promotion of the Inspection Chief Inspectorate for Environmental Protection	Mr Andrzej Podscianski	PL
MS	MS agency	Bureau for Chemical Substances	Mr Włodzimierz Szymański	PL
MS	MS agency	Ministry of Economy (DGAE)	Ms Ana Paula Félix	PT
MS	MS agency	National Environmental Protection Agency	Ms Mariana Mihalcea Udrea	RO
MS	MS agency	Ministry of Economy	Ms Božena Brinzová	SK
MS	MS agency	Centre for Chemical Substances and preparations	Mr Jan Cepcek	SK
MS	MS agency	Ministry of Health	Mr Alojz Grabner	SI
MS	MS agency	Instituto Nacional del Consumo	Mr Basilio Vicente Bejar	ES
MS	MS agency	Health and Safety Executive (HSE)	Mr Nigel Chadwick	UK
MS	MS agency	DEFRA	Mr Tom Bradbury	UK
MS	MS agency	Norwegian Environment Agency	Ms Pia Sørensen	NO

Type of questionnaire	Type of organisation	Organisation	Contact Name	Geographical scope
MS	MS agency	Norwegian Environment Agency	Ms Bodil Nygård Faarlund	NO
MS	MS agency	Federal Ministry for Environment	Ms Renate Paumann	AT
MS	MS agency	Ministry of Environment and Water	Ms Teodora Venislavova Bandakova	BG
MS	MS agency	Ministry of Health	Ms Chrystalla Kaiafa Nicolaidou	CY
MS	MS agency	Administration de la Gestion de l'Eau	Ms Sabine Röhler	LU
MS	MS agency	Malta Standards Authority (MSA)	Ingrid Borg	MT
MS	MS agency	Swedish Chemicals Agency	Mr Erik Gravenfors	SE
MS	MS agency	ADEME	Olivier THEOBALD	FR
MS	MS agency	Ministry of the Environment	Pirkko Kivelä	FI
MS	MS agency	MATTM	Maddalena Mattei	IT
MS	MS agency	DEFRA	Paul Fawcett	UK
NGOs	Others	EFTA (European Free Trade Association)	Mr Haakon Riegels	IS, Switzerland, Norway, Liechtenstein, and EU
NGOs	Others	FEAD - European Federation of Waste Management and Environmental Services	Giorgio Cerniglia	EU

Type of questionnaire	Type of organisation	Organisation	Contact Name	Geographical scope
NGOs	Others	FEAD - European Federation of Waste Management and Environmental Services	Laetitia Reynaud	EU
NGOs	Others	FEAD - European Federation of Waste Management and Environmental Services	Patrizia Di Mauro	EU
NGOs	Others	BEUC (The European Consumers' Organisation)	Ms Sylvia Maurer	EU
NGOs	Others	EEB (European Environmental Bureau)	Ms Tatiana Santos	EU
Water Management companies	Company (water treatment)	Stockholm Vatten AB	Anders Finnson	SE
Water Management companies	Company (water treatment)	Tekniska Verken i Linköping AB	Mattias Filipsson	SE
Water Management companies	Company (water treatment)	SITA		FR
Water Management companies	Company (water treatment)	Scottish Water		UK
Water Management companies	Company (water treatment)	ENVA		UK, IE
Water Management companies	Company (water treatment)	VKU	Thomas Abel	DE
Water Management companies	Industry Association (water	Asociacia vodarenskych spolocnosti		SK

Type of questionnaire	Type of organisation	Organisation	Contact Name	Geographical scope
	treatment)			
Water Management companies	Industry Association (water treatment)	Asociacion Espanola de Abastecimientos de Agua y Saneamiento		ES
Water Management companies	Industry Association (water treatment)	Associacao Portuguesa de Distribuicao e Drenagem de Aguas		PT
Water Management companies	Industry Association (water treatment)	Association Luxembourgeoise des Services d'Eau asbl		LU
Water Management companies	Industry Association (water treatment)	Association of Dutch Water Companies		NL
Water Management companies	Industry Association (water treatment)	Bulgarian Water Association		BG
Water Management companies	Industry Association (water treatment)	Danish Water and Wastewater Association		DK
Water Management companies	Industry Association (water treatment)	EUREAU- European Federation of national Associations of Water and Wastewater Services		EU
Water Management companies	Industry Association (water treatment)	European Water Association (EWA)	Johannes Lohaus	EU

Type of questionnaire	Type of organisation	Organisation	Contact Name	Geographical scope
Water Management companies	Industry Association (water treatment)	EWTA- European Water Trade Association		BE
Water Management companies	Industry Association (water treatment)	Romanian Water Association		RO
Water Management companies	Industry Association (water treatment)	Swedish Water and Waste Water Association - Svenskt Vatten AB		SE
Water Management companies	Industry Association (water treatment)	EUREAU - European Federation of National Associations of Water Services	Almut Bonhage	EU
Water Management companies	Industry Association (water treatment)	British Association for Chemical specialities (BACS)		UK
Water Management companies	Industry Association (water treatment)	SOCIETY OF BRITISH WATER AND WASTEWATER INDUSTRIES (SBWWI)		UK

7. Annex B: References

60 millions des consommateurs. April 2010. n°448 (pages 27-31) "*Des phosphates à eliminer*."

A.I.S.E. 2014. "*Annual Review and Sustainability Report 2013-2014*." http://www.aise.eu/cust/documentrequest.aspx?DocID=2590

A.I.S.E. Cleanright initiative http://uk.cleanright.eu/index.php?option=com_content&task=pdf&Itemid=168

Annex VI of Technical assessment of the implementation of Council Directive concerning Urban Waste Water Treatment (91/271/EEC). http://ec.europa.eu/environment/water/water-urbanwaste/implementation/pdf/Annex%20VI_20121009.pdf

Baraka-Lokmane, S.,Sorbie, K.S., Poisson, N, Lecocq, P. 2008. "Application of environmentally friendly scale inhibitors n carbonate coreflooding experiments. SCA2008-05."

BASF. 2007. "Technical information Trilion M types."

BASF. 2008. "Safety data sheet Trilion M Powder." http://worldaccount.basf.com/wa/NAFTA/Catalog/ChemicalsNAFTA/doc4/BASF/PRD/30215074/.pdf?title=&asset_type=msds/pdf&language=EN&validArea=US&urn=urn:documentum:ProductBase_EU:09007af88008f61f.pdf

Borén, Tobias et al. AkzoNobel. 2009. "Eco-Efficiency Analysis -applied on different chelating agents."

Budenheim. https://www.budenheim.com/en/

Cerny et al., SÖFW-Journal, 1999 , 125 (6), p. 58-62

Cerny et al., SÖFW-Journal, 2001 , 127 (10), p. 108-114

Clean Water Action. 2010. "*Detergent Industry's Voluntary Phosphate Ban: Good News for Water, But a Long Time Coming.*" http://www.cleanwateraction.org/positionstatement/detergent-industrys-voluntary-phosphate-ban-good-news-water-long-time-coming

DEFRA. 2010. "*Defra Clarification on Aspects of DLCP Impact Assessment 20th January 2010*."

DEFRA. 2009. "*Impact Assessment of Ban on Phosphorus In Domestic Laundry Cleaning Products*."

DEFRA. 2010. "Review of evidence for use of phosphate-free dishwasher detergents in UK."

Directive 2008/56/Ec of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN

Dorota Kołodyńska. 2010. "The effects of the treatment conditions on metal ions removal in the presence of complexing agents of a new generation." http://dx.doi.org/10.1016/j.desal.2010.06.053

Dorota Kołodyńska. 2009. In: Chemical Engineering Journal. "*Polyacrylate anion exchangers in sorption of heavy metal ions with the biodegradable complexing agent*."

Dr Georg Karlaganis. "*Citric acid CAS N°:77–92–9. SIDS Initial Assessment Report*."

Dr. Jonathan Köhler. 2001. P. 3. "Detergent phosphates and detergent ecotaxes: a policy assessment." http://www.ceep-phosphates.org/Files/Document/50/kohler_ecotax.pdf

Dr. Thorsten Wind for EWA. 2007. "*The Role of Detergents in the Phosphate-Balance of European Surface* Waters." http://www.ewa-online.eu/tl_files/_media/content/documents_pdf/Publications/E-WAter/documents/25_2007_03.pdf

DOW Chemicals. 2014. "*Input into the consultation: Study on the Potential for Reducing Phosphates in Consumer Automatic Dishwasher Detergents-Questionnaire to manufacturers and industrial associations January 2014*."

EEA. 2012. "*European waters – assessment of status and pressures*."

EEA. 2013. "*Urban waste water treatment (CSI 024)*." http://www.eea.europa.eu/data-and-maps/indicators/urban-waste-water-treatment/urban-waste-water-treatment-assessment-3

Estonian Fund for Nature. "*WWF's persistent work to ban phosphates in detergents finally paying off*." http://www.elfond.ee/en/news/1385-wwfs-persistent-work-to-ban-phosphates-in-detergents-finally-paying-off

Euromonitor 2014 automatic dishwashing detergents and maintenance products industry market data (only powders, liquids and tablets) provided by A.I.S.E.

European Commission. 2010. "*Amending Regulation (EC) No 648/2004 as regards the use of phosphates and other phosphorus compounds in household laundry detergents – Impact assessment."*

European Commission. 14 March 2012. "*Limitations on the content of phosphates and of other phosphorus compounds.*" http://ec.europa.eu/enterprise/sectors/chemicals/files/legislation/art-14-3-overview_en.pdf

European Comission. 2012. "*Commission decision of 28 April 2011 on establishing the ecological criteria for the award of the EU Ecolabel to detergents for dishwashers*."http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02011D0263-20120128&from=EN

European Commission. 2012. "*Technical assessment of the implementation of the Urban Waste Water Treatment Directive (91/271/EC)*." http://ec.europa.eu/environment/water/water-urbanwaste/implementation/pdf/Technical%20assessment%20UWWTD.pdf

European Commission. 2012. "*Report from the Commission to the European Parliament and the Council on the implementation of the water framework directive (2000/60/ec) River basin management plans*."

European Commission. 2013. "*Decision no 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 'Living well, within the limits of our planet'*." http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013D1386&from=EN

European Commission.2013. "*Seventh Report on the Implementation of the Urban Waste Water Treatment Directive (91/271/EEC)*."

European Commission. 2013. "Consultative Communication on the Sustainable Use of Phosphorus." http://ec.europa.eu/environment/consultations/pdf/phosphorus/EN.pdf

European Commission. 2014. "*The first phase of implementation of the Marine Strategy Framework Directive (2008/56/EC).*" http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0097&from=EN

European Ecolabel. 2009. "*Revision of Ecolabel Criteria for Dishwashing Detergents Background report*."

Eurostat.2009. http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Water_statistics#Wastewater_treatment

FAQS.org.2012. "*Patent application title: Cleaning formulations for machine dishwashing comprising hydrophilically modified polycarboxylates.*" http://www.faqs.org/patents/app/20120010117#ixzz2supih8Rp

Focus on Surfactants. May 2002, Volume 2002, Issue 5, P. 5. "*Phosphate-free dishwashing detergent patented*." http://dx.doi.org/10.1016/S1351-4210(02)80158-5

Focus on Surfactants. September 2009, Volume 2009, Issue 9, P. 4. "*Consumers want green and clean detergent*". http://dx.doi.org/10.1016/S1351-4210(09)70284-7

Focus on Surfactants. September 2011, Volume 2011, Issue 9, P. 4. "*Together we can meet today's sustainability needs and develop high performing automatic dishwashing detergents: new from Genencor*". http://dx.doi.org/10.1016/S1351-4210(11)70263-3

Focus on Surfactants. December 2010, Volume 2010, Issue 12, P. 1–2. "*Natural and phosphate-free solutions gaining ground*." http://dx.doi.org/10.1016/S1351-4210(10)70347-4

Focus on Surfactants. 2011. "*Industrial phosphates, where now?*"

Focus on Surfactants. 2011, Volume 2011, Issue 1, January P. 5. "*Phosphate-free ADD has better spotting performance*". http://dx.doi.org/10.1016/S1351-4210(11)70021-X

German Federal Ministry of Environment. 2009. "*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, 10/2009*"

Global Phosphates Forum. 2014. http://www.phosphate-forum.org/

Global Phosphate Forum. 2011. "*Global Phosphate Forum GPF Info Number 34*."

HELCOM. "*Targets*." http://helcom.fi/baltic-sea-action-plan/nutrient-reduction-scheme/targets

HERA. 2004. "*Human & Environmental Risk Assessment on ingredients of European household cleaning products. Draft report. 06.09.2004*."

HERA. 2005. "*Substance: Citric Acid and Salt*." http://www.heraproject.com/files/37-F-05-HERA_citricacid_version1_April05.pdf

HERA reports. 2014 "Polycarboxylates used in detergents (Part I) Polyacrylic acid homopolymers and their sodium salts (CAS 9003-04-7)" and "Polycarboxylates used in detergents (Part II) Polyacrylic/maleic acid copolymers and their sodium salts (CAS 52255-49-9)".

Icakuriren. http://www.icakuriren.se/Test-Rad/Tester/maskindiskmedel/

ICL. 2013. "*ICL Periodic Report*." http://repo.icl-group.com/Lists/ReportsManagement/Financial%20Reports/2013/Annual%20report%202013.pdf

IGOS, Elorri et al. 2013. "*Development of USEtox characterisation factors for dishwasher detergents using data made available under REACH.*" http://dx.doi.org/10.1016/j.chemosphere.2013.11.041

ISIS. Comment of BASF (German chemical producer) on ISIS, http://www.icis.com/Articles/2009/01/12/9182061/ detergents+shift+to+greener+builders.html

ISIS. Comment of Reza Selazade, trading manager at Kasel Chemicals (a Vienna-based citric acid trader) on ISIS, http://www.icis.com/Articles/2009/01/12/9182061/detergents+shift+to+greener+builders.html

Jean-Soro et al., (2013) Environmental Pollution. Volume 164, May 2012, Pages 175–181.

Lanxness. "General product information Baypure." http://www.aniq.org.mx/pqta/pdf/BAYPURE%20DS%2010040%20(HT).pdf

Lanxess – Ralf Moritz, Malmö. 2013. "P-free household dishwashing detergents - alternative substitutes for STPP." http://www.sepawa.org/dokument/2.%20Nordic%20May%202013_Lanxess.pdf

Maragrete Bucheli-Witschel, Thomas Egli. 2001. "Environmental fate and microbial degradation of aminopolycarboxylic acids."

Minitel.2011. "*Dishwashing Detergents - UK - April 2011*." http://store.mintel.com/dishwashing-detergents-uk-april-2011

Nordic Ecolabl. 2014"*Nordic Ecolabelling of Dishwasher detergents and rising agents.*"http://joutsenmerkki.fi/wp-content/uploads/2013/07/Dishwasher-detergents-and-Rinsing-agents-version-6.0.pdf

Nowack, Water Research 36, p 4636-4642, 2002

Peter F. Strom. 2006. "*Technologies to Remove Phosphorus from Wastewater.*" http://www.water.rutgers.edu/Projects/trading/p-trt-lit-rev-2a.pdf

Phosphates Facts.org. 2009. "*Global P status.*" http://www.phosphatesfacts.org/pdfs/GlobalAutodishStatus.pdf

Prayon. 2013. "*Rapport 2012*." http://www.prayon.com/media/cms/RA_12_FR.pd

Que Choisir, October 2010. Version 485 (pages 25-28). "*essais.*"

RPA. 2006. "*Non-surfactant organic ingredients and Zeloites0based detergents.*"
http://ec.europa.eu/enterprise/sectors/chemicals/files/studies/rpa_non_surf_organ_zeolites_en.pdf

Slothuus et al. 2009. "Assessment of the consequences of a possible ban on phosphates in household detergents."

Stark. "*Phosphorus recovery – experiences from European countries.*"
http://www2.lwr.kth.se/forskningsprojekt/Polishproject/rep12/StarkSthlm19.pdf

Stiftung Warentest corresponds to years 2010 and 2011. Further info can be found in the publication "test 8/2010" by "Haushalt und Garten" (pages 62-67) and "5/2011 test" by "Haushalt und Garten" (pages 64-69)

The Swiss Federal Council. 18 May 2005. "*Ordinance on the Reduction of Risks relating to the Use of Certain Particularly Dangerous Substances, Preparations and Articles (Chemical Risk Reduction Ordinance, ORRChem).*" http://www.admin.ch/ch/e/rs/8/814.81.en.pdf

Umweltbundesamt. 2007.
http://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/3256.pdf

UNEP. 2008. "*Water Quality for Ecosystem and Human Health."*
http://www.unep.org/gemswater/Portals/24154/publications/pdfs/water_quality_human_health.pdf

Which?. March 2010. P.48 - 49. "*Test Lab Dishwasher Tablets*."

Which? September 2010. "*Testing dishwasher detergents*."

WWF. "Threat of eutrophication to the Baltic Ecoregion."
http://wwf.panda.org/what_we_do/where_we_work/baltic/threats/eutrophication/

8. Annex C: Questionnaire

A copy of the questionnaire sent to MS is present here as an example indicative of the questionnaires sent to all stakeholders.

8.1 Questionnaire for Member States

This questionnaire aims to collect information to feed into the study on 'potential for reducing phosphates in Consumer Automatic Dishwasher Detergents (CADD)' conducted by BIO Intelligence Service (BIO) for the European Commission (DG ENTR).

The objective of this study is to provide the Commission with a solid evidence base in order to inform future policy actions with a view to addressing the environmental, economic and social problems posed by the use of most common phosphate, sodium tripolyphosphate (hereafter STPP), in CADD. In particular this study will assist the Commission in evaluating whether restriction set out in point 2 of Annex VIa of the Detergents Regulation (Regulation (EC) No 648/2004) should be modified. Point 2 of Annex VIa stipulates that CADD shall not be placed on the market if the total content of phosphorus is equal to or greater than 0.3 grams in the standard dosage from 1 January 2017.

This study will include:

- Information on the current content of phosphates and alternatives in CADD
- Forecast on the availability of alternatives to phosphates containing CADD in the future in EU
- Evidence on national level restrictions on phosphorus content in CADD
- Assessment of the current 0.3 grams limit introduced by the Detergents Regulation
- An in-depth analysis of the EU legislation on the environment, industry and consumers
- Recommendations on maximum phosphorus content to be allowed for use in CADD in EU

This study will build on previous reports on this topic but aims to update and describe the full EU picture in a comprehensive manner, with a breakdown of data per Member State (MS), allowing us to identify any significant contrasts between MS and all relevant market and scientific/technical information available.

An active participation of MS in providing relevant data is thus essential to help us build a robust evidence base and take into account the variety of situations across the EU when identifying possible policy options.

Supplementary information

If you have any supporting documents and datasets (concerning your national or even at regional levels) that may be useful for this study, we would be very grateful if you could submit this information together with your reply to this questionnaire. You may also want to indicate specific links to website or reports containing useful information.

We thank you in advance for your time and participation.

Please do not hesitate to contact us for clarification or any information regarding the questionnaire.

Kindly send your replies to: spahal@bio.deloitte.com

at the latest by 21 February 2014

Hard copies of documents can be mailed to the following address:

Sustainability Services | Deloitte Conseil

185 avenue Charles de Gaulle, 92200 Neuilly-sur-Seine, France

Contact persons: Shailendra Mudgal / Sandeep Pahal ☏ + 33 (0) 1 5561 6755

8.1.1 Questions

Contact Information

Name:_____

Position:_____

Country:_____

Telephone:_____

E-mail:_____

Address:_____

Existing National Regulations going beyond the EU legislation[152][148]

Q1: Are there any legal requirements related to the phosphate content in CADD in your country?

☐ No

☐ Yes

If yes, please specify the requirements:

Q2: Are the legal requirements related to discharge of phosphorus from wastewater in your country stricter than as required by EU law?

☐ No

☐ Yes

If yes, please specify the requirements:

[148] Relevant EU regulations include:

- Detergents Regulation (EC) No 648/2004
- Regulation (EC) No 907/2006, which adapts Annexes III and VII;
- Regulation (EC) No 1336/2008, in order to adapt Detergents Regulation to CLP Regulation (EC) No 1272/2008;
- Directive 2000/60/EC, the Water Framework Directive (WFD)
- Directive 91/271/EEC, Directive on Urban Waste Water Treatment
- Regulation (EC) No 551/2009, which adapts Annexes V and VI (surfactant derogation)

Phosphate-containing CADDs and their alternatives

Q3: What are the other materials available and in use that can serve as alternatives for phosphates in CADD?

Q4: Are there any notable differences in performance and costs of phosphate-containing and phosphate-free CADD in your country?

Phosphate released to water

Q5: Do you have an estimate of the **phosphorus waste quantities** produced and treated in your country?

☐ No

☐ Yes

If yes, please indicate available data in the table below.

	Units	Year of data	Value
Share of population connected to wastewater treatment plants	%		
Total amount of phosphorus released to wastewater	Tonnes/year		
Of which: Share of fertilisers	%		
Share of metabolic waste from humans and livestock (urine + faeces)	%		
Share of detergents	%		
Share of CADD	%		
Share of Other sources	%		
Share of CADD in the overall phosphorus release to wastewater			

	Units	Year of data	Value
	%		
Quantities of phosphorus discharged from wastewater treatment plants	Tonnes/year		

Additional information/comments concerning the above table:

Economic Aspects

Q6: Do you have any economic estimates concerning CADD used in your country?

☐ No

☐ Yes

If yes, please indicate available data in the table below.

	Units	Year of data	Value
Totally quantity of CADD sold	Tonnes/year		
Of which: Share of phosphate containing CADD	%		
Share of alternative (phosphate-free) CADD	%		
Expenses on phosphorus removal by wastewater treatment plants	€/year		
Economic losses incurred because of eutrophication (e.g. fisheries, water quality reduction)	€/year		
Expenses on the restoration of water bodies from eutrophication	€/year		

Additional information/comments concerning the above table:

Environmental aspects

Q7: Are there any sensitive areas in your country as specified by the Annex II of the Directive on Urban Waste Water Treatment (Directive 91/271/EEC)?

☐ No

☐ Yes

If yes, please specify:

Year	Number of sensitive areas	Millions people in sensitive areas

Q8: Are there any water bodies in your country that fail achieve good status specified by the Water Framework Directive (Directive 2000/60/EC) **because of excessive levels of phosphate in it**?

☐ No

☐ Yes

If yes, please specify (the year of data):

Type of water body	Total number of water bodies in the MS	Number of non-compliant water bodies in the MS	Number of km or km^2 covered by such non-compliant water bodies in your MS
Rivers			
Lakes			
Transitional waters			
Coastal waters			
Ground water			

Additional information/comments concerning the above table:

Q9: Are there any additional (despite reduction of phosphorus load) environmental benefits associated with the alternatives to phosphates used in CADD?

Q10: Are there any possible environmental damages associated with the use of alternatives in CADD?

Policy options

Q11: Is the limit of 0.3 gm phosphate content in CADD from 2017 onwards, as prescribed in current EU law possible/desirable?

☐ Yes

☐ No

If no, please specify the levels of phosphate concentration in CADD that should be prescribed in the EU legislation?

Q12: Any other suggestions on policy options that should be considered at EU level in this context?

9. Annex D: Environmental Impacts of Alternative Chemicals Summary

9.1 Polycarboxylates

The 2013 HERA assessment of polycarboxylates found no environmental risk for all relevant compartments including water, sediment, soil, and sewage treatment plant with risk characterization ratios below 1. The test also found that polycarboxylates are not readily biodegradable but are partly accessible to ultimate biodegradation particularly under long incubation conditions. The outcome of this present environmental risk assessment provides a sound basis for the conclusion that the use of P-AA and P-AA/MA in detergent products does not pose a risk to the environment.[149]

9.2 Phosphonates

Phosphonates are phosphorus based and therefore may contribute to eutrophication. Hydroxyethylidene diphosphonic acid (HEDP) is the main phosphonate used in dishwasher detergents. In phosphonates the phosphorus (P) content does not pose a great eutrophication risk because in sewage works[150], 80 – 97% of phosphonates are removed from water to the sewage sludge[151, 152]. Tertiary treatment is not necessary for phosphonates to be removed[153], as they are mainly removed in the biological process of treating organic matter in the sewage. Any phosphonates reaching surface waters will tend to adsorb to sediments. Phosphonates degrade slowly, so that the P they contain will not contribute to rapid algal growth and algal bloom problems. Where sewage sludge is used for agricultural purposes after treatment, the P will be slowly released from the degradation of phosphonates and will generally be absorbed by soil or plants, and not reach surface waters.

9.3 GLDA (L-glutamic acid N,N-diacetic acid, tetra sodium salt)

According to the Swedish Society for Nature Conservation GLDA is 86% based on natural, raw materials. It is the only chelating agent with “green” carbon atoms, and it has a good safety profile

---

[149] HERA reports. 2014 “Polycarboxylates used in detergents (Part I) Polyacrylic acid homopolymers and their sodium salts (CAS 9003-04-7)” and “Polycarboxylates used in detergents (Part II) Polyacrylic/maleic acid copolymers and their sodium salts (CAS 52255-49-9)”.

[150] This figure is for secondary biological sewage treatment. Even in sewage works operating only “primary treatment” (settling without treatment) over 50% of phosphonates are removed

[151] HERA. 2004. “*Human & Environmental Risk Assessment on ingredients of European household cleaning products. Draft report. 06.09.2004*.”

[152] Nowack, Water Research 36, p 4636-4642, 2002, in tests in real sewage works, found 95% removal after secondary (standard biological) treatment, and 97% after iron-dosing (nutrient removal)

[153] Either biological or chemical nutrient removal will result in even higher phosphonates removal rates

with regard to human health and ecological effects. The production of GLDA (Dissolvine GL-38) process is based on the flavour enhancer monosodium glutamate (MSG) from the fermentation of readily available corn sugars and as such the carbon source of GLDA is primarily biobased.[154]

GLDA is a registered substance with ECHA. While the criterion for readily biodegradability was not reached, it did degrade at a higher level than the reference substance of acetate, which indicates that it is probably readily biodegradable. The tests for mobility in the environment found that GLDA will not be absorbed by sludge in sewage treatment plants.

An eco-efficiency analysis performed by AkzoNobel comparing GLDA, EDTA, NTA, and STPP found that GLDA "is the most environmentally benign chelating agent, and that the main reasons for this are that it is biodegradable, phosphorus free, and based on a renewable raw material.[155]" Finally, GLDA does not give rise to phosphorus emissions to water.

9.4 MGDA (Methyl glycine di-acetic acid)

MGDA is also highly stable throughout the entire pH range and is even found at high temperatures. According to BASF, the patent owners of MGDA, MGDA has "an excellent ecological and toxicological profile" and there are no restrictions on its use. It was tested against OECD criteria and found to be readily biodegradable. It does not bioaccumulate. For environmental toxicity the daphnia test was used, and the no observed effect concentration is > 100mg/l. For toxicity to microorganism, the test showed that the inhibition of degradation activity in activated sludge is not to be anticipated during correct introduction of low concentrations.[156] [157]

The trisodium salt of MGDA is a pre-registered compound with ECHA with the envisaged substance registration deadline of 31/05/2018. MGDA was not found in the ECHA database.

9.5 ISD(A) (iminodissuccinic acid) [163]

ISD(A) is readily biodegradable and its toxicological and ecotoxicological safety was confirmed in both EU and the USA in 1998. It leads to low remobilisation of heavy metals from sediments.[158]

ISD(A) is pre-registered in the ECHA chemical registration system as Aspartic acid, N-(1,2-dicarboxyethyl)-, sodium salt (1:4) and the envisaged substation registration deadline is the 31/05/2018.

9.6 ASDA (L-aspartic-N,N-diacetic acid)

Little information is available about ASDA. ASDA is a polyaspartate, is biodegradable and has achieved the stringent standards required for use in the North Sea[159].

---

[154] Dorota Kołodyńska. 2010. "*The effects of the treatment conditions on metal ions removal in the presence of complexing agents of a new generation*." http://dx.doi.org/10.1016/j.desal.2010.06.053

[155] Borén, Tobias et al. AkzoNobel. 2009. "Eco-Efficiency Analysis -applied on different chelating agents."

[156] BASF. 2007. "*Technical information Trilion M types*."

[157] BASF. 2008. "*Safety data sheet Trilion M Powder.*" http://worldaccount.basf.com/wa/NAFTA/Catalog/ChemicalsNAFTA/doc4/BASF/PRD/30215074/.pdf?title=&asset_type=msds/pdf&language=EN&validArea=US&urn=urn:documentum:ProductBase_EU:09007af88008f61f.pdf

[158] Lanxess. "*General product information Baypure.*" http://www.aniq.org.mx/pqta/pdf/BAYPURE%20DS%2010040%20(HT).pdf

[159] Baraka-Lokmane, S.,Sorbie, K.S., Poisson, N, Lecocq, P. 2008. "*Application of environmentally friendly scale inhibitors n carbonate coreflooding experiments. SCA2008-05.*"

9.7 B-ADA(B-alaninediacetic acid)

Little information is available about B-ADA. It was found to be biodegradable in activated sludge for inoculum and aerobic conditions[160].

It is pre-registered with ECHA and the envisaged substance registration deadline was 20/11/2010.

9.8 Sodium gluconate

Little information is available about sodium gluconate. It is pre-registered with ECHA and the envisage substance registration deadline was 30/11/2010.

9.9 Sodium Citrate

Sodium citrate is readily biodegradable, with citric acid reaching 97% degraded for the OECD 301 B test. However, it may result in heavy metal mobility[161].

[160] Maragrete Bucheli-Witschel, Thomas Egli. 2001. "*Environmental fate and microbial degradation of aminopolycarboxylic acids*."

[161] Jean-Soro et al. 2013. "*Environmental Pollution. Volume 164, May 2012, Pages 175–181*"

10. Annex E: Map of Water Hardness in EU

Data was taken from the Global Environmental Monitoring System to measure water hardness in milligrams Litre^{-1}, where anything under 60milligrams Litre^{-1} can be considered soft water, and anything above 120 milligrams Litre^{-1} as hard water. As can been seen in Figure 9[162], water hardness varies throughout EU, even throughout individual MS.

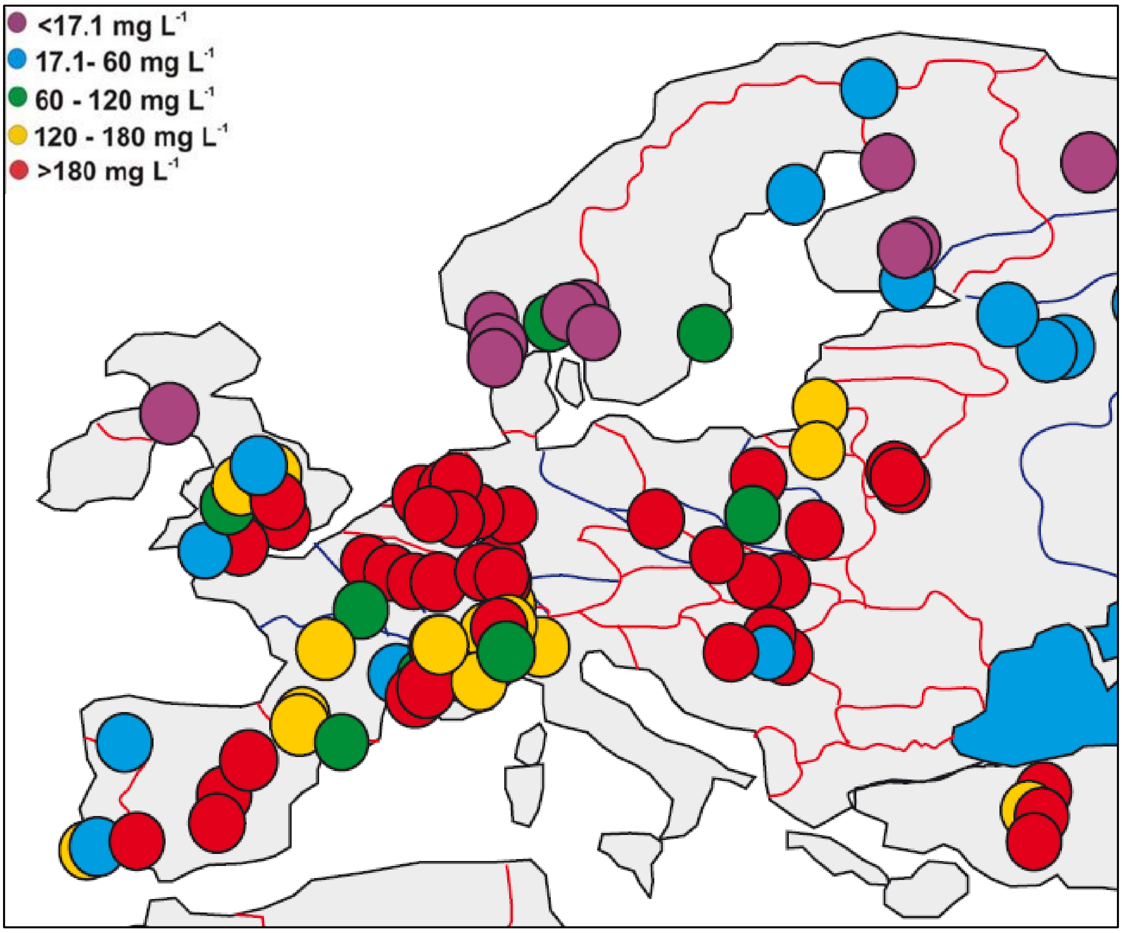

Figure 9 : Map of water hardness throughout EU[162]

[162] UNEP. 2008. "*Water Quality for Ecosystem and Human Health.*" http://www.unep.org/gemswater/Portals/24154/publications/pdfs/water_quality_human_health.pdf

11. Annex F: Sensitive Areas

Table 6: Sensitive Areas per Members State[163]

MS	Number of sensitive areas	Population
AT	applies more stringent treatment within the	whole
BE	3	
BG	14	
CY	1*	0.145
CZ	all surface waters*	10*
DE	applies article 5(8)	
DK	applies article 5(8)	
EE	All of Estonia*	1.286*
EL	46	
ES	426	
FI	applies article 5(8)	
FR	111*	
HR	-	
HU	3 areas (20 agglomerations involved) 2010	0.556*
IE	59	
IT	204	
LV	applies article 5(8)	
LT	All of Lithuania*	3*
LU	applies article 5(8)	
MT	8	
NL	applies article 5(8)	
PL	8	
PT	25	
RO	applies article 5(8)	
SE	3	9*
SI	58	
SK	applies article 5(8)	
UK	279 (2013)*	22*
Norway	2*	1.75*
EU 28		

[163] * Stakeholder provided data. Otherwise: Annex VI of Technical assessment of the implementation of Council Directive concerning Urban Waste Water Treatment (91/271/EEC). http://ec.europa.eu/environment/water/water-urbanwaste/implementation/pdf/Annex%20VI_20121009.pdf

12. Annex G: Tertiary Treatment Compliance

Information about Urban Waste Water Treatment Directive implementation is based on the Seventh Report on the Implementation of the Urban Waste Water Treatment Directive (91/271/EEC) and can be seen in Table 7.

Table 7: Tertiary Treatment compliance per MS, and total for EU

MS	Tertiary treatment compliance rate	MS	Tertiary treatment compliance rate
Austria	100	Lithuania	85
Belgium	52	Luxembourg	38
Bulgaria	2	Malta	0
Cyprus	0	Netherlands	100
Czech Republic	20	Poland	100
Denmark	94	Portugal	20
Estonia	21	Romania	transitional period
Finland	97	Slovakia	transitional period
France	87	Slovenia	23
Germany	100	Spain	54
Greece	100	Sweden	87
Hungary	48	United Kingdom	63
Ireland	2	EU 15	90

MS	Tertiary treatment compliance rate	MS	Tertiary treatment compliance rate
Italy	86	EU 12	14
Latvia	0	EU 27	77

13. Annex H: Phosphates-free CADD available on the market

Many manufacturers already offer phosphates-free CADD. A first look at major players' websites showed the following non exhaustive list of phosphates-containing and phosphates-free CADD available on the market today that can be seen in Table 8.

Table 8: List of Phosphates-free and P-containing CADD currently on Market in gel or tablet form

Detergent name	P-containing/P-Free CADD	Type	Company	Geographical Area	Price (€/tablet)
Cascade Complete All-in-1 ActionPacs Dishwasher Detergent, Fresh Scent	P-Free	Tablet	P&G	North America	0.23
Quantum Dishwasher Tabs, With Baking Soda	P-Free	Tablet	RB	North America	0.18[164]
Method Smarty Dish	P-Free	Tablet	Method	North America	
Sun all in 1 Turbo Gel	P-Free	Gel	Unilever	FR, NL	
Sun classic Tablets	P-Free	Tablet	Unilever	FR, NL	0.16
Sun all in 1 Tablets	P-Free	Tablet	Unilever	FR, NL	0.12
Tablettes lave-vaisselle Classic protection verre	P-Free	Tablet	Carrefour	EU	0.08
Tablettes lave-vaisselle Tout en 1 écologique	P-Free	Tablet	l'Arbre Vert	FR	0.22
Ecover Powered by Nature Dishwasher Tablets	P-Free	Tablet	Ecover	North America, EU	0.21

[164] Original price in US $ of 0.24$/tablet. Converted to € by using an exchange rate of $1.29 for €1 (exchange rate based on an 18/09/2014 from the website: http://www.xe.com/)

Detergent name	P-containing/P-Free CADD	Type	Company	Geographical Area	Price (€/tablet)
Claro ECO All in 1 Tablets	P-Free	Tablet	Claro Products GmbH	EU	
Claro classic tablets	P-Free	Tablet	Claro Products GmbH	EU	
Claro high energy 2020 Tablets	P-Free	Tablet	Claro Products GmbH	EU	
Amway Home Dish Drops automatic dishwasher tablets	P-Free	Tablet	Amway	EU	
Sonnet	P-Free	Tablet	Sonnet	EU	0.21
Alma Win Organic Dishwasher Tablets	P-Free	Tablet	Alma Win	EU	0.22
Ecological Dishwasher Detergent	P-Free		SODASAN	EU	
Pastilles pour lave vaisselle écologiques	P-Free	Tablet	AUCHAN	FR	0.14
Tablettes vaisselle	P-containing	Tablet	AUCHAN	FR	0.09
Pastilles tout en 1 pour lave vaiselle aux agrumes	P-containing	Tablet	AUCHAN	FR	0.12
Tablettes vaisselle Powerball	P-containing	Tablet	FINISH	FR	0.17
Tablettes vaisselle sans pré-rinçage	P-containing	Tablet	SUN	FR	0.25
Tablettes vaisselle sans pré-rinçage Clean boost	P-containing	Tablet	SUN	FR	0.24
Tablettes vaisselle Classic	P-containing	Tablet	SUN	FR	0.20

14. Annex I: Per capita CADD consumption by MS

MS	CADD consumption per capita in kilograms/year
AT	1.5
BE	1.3
BG	-
CY	0.7
CZ	0.2
DE	1.7
DK	1.6
EE	-
EL	0.9
ES	0.8
FI	1.6
FR	1.4
HR	-
HU	0.1
IE	0.9
IT	1
LV	-
LT	0.1
LU	1.5
MT	0.2
NL	1.3

MS	CADD consumption per capita in kilograms/year
PL	0.1
PT	0.9
RO	-
SE	1.8
SI	0.8
SK	0.1
UK	1.1
EU 28	0.864

Table 9: CADD consumption in kilograms per year per capita per MS[165]

Notes: *Population data taken from Eurostat (2004). Percentage figures based on dishwasher ownership figures (as percentage of households) presented in European Commission (2004) and updated using data from Mintel (2006). Household consumption based on 7 kg/yr for dishwasher owning households. Blanks mean no data available.*
**While not at real zero, consumption is so low as to be irrelevant in these countries.*

[165] RPA. 2006. "*Non-surfactant organic ingredients and Zeloites0based detergents.*" http://ec.europa.eu/enterprise/sectors/chemicals/files/studies/rpa_non_surf_organ_zeolites_en.pdf

15. Annex J: Comparison of alternatives' performance:

A German product testing company Stiftung Warentest[166] performed a test on 10 different phosphates-free CADD tablets for environmental impact and cleaning efficiency. The temperature of the dishwasher program was 40 and 50°C, respectively. At 50 °C the dishes were also washed after letting them dirty for 4 weeks at 30° C air temperature and 65% air humidity. For environmental impact, the rating is on a scale from 1 to 6, where 6 reflects the highest impact. Cleaning efficiency is also rated on a scale from 1 to 6, where 6 reflects the worst cleaning efficiency. Sodium carbonate and sodium silicate were marked low for environmental impact and not very effective for cleaning efficiency (1.3 and 4.8; 1.6 and 4.6, respectively).
The test also found sodium carbonate, sodium citrate, phosphonates, and polycarboxylates leave a white film on glassware when water is very hard (21°dH) when used in multi-tab tablets. However, when used in solo-tablets no white film appeared, but this result may be due to a diminished water hardness (9°dH).

PAPA remarked that Stiftung Warentest also tested 14 all in one tabs of CADD in 2013. All of these were P-based. The overall conclusions of the 2013 test indicate: *"phosphates are important against lime stone, but concern inshore waters. They bind calcium and magnesium. Besides that they keep dispersed particles/dirt from dishes in suspension preventing precipitation of such on the dish. Less effective are citrates and polycarboxylates"*.

A study performed by Belgian consumer association magazine "TestAchat" on thirteen consumer automatic dishwashing detergents (seven phosphates-based and six phosphates-free) showed that the only phosphates alternative that was able to perform with the same cleaning efficiency as phosphates-containing formulations were the two tablets using MGDA as the complexing agent[167]. The other phosphates-free formulations were underperforming, however not all phosphates-containing CADD were highly rated. Ecover all in 1 tabs, which use citrate as the chelating agent, scored equally well as the two worse performing phosphates-containing CADD, and were in the lower half of worse performing products. The replacing chelating agent for the other phosphates-free formulations was not specified.

In the UK, the consumer association "Which?" tested 12 CADD in 2010. Whereby two phosphates-free CADD made it into the top six (Green Force 5 in 1 and Sainsbury's Clean Home tablets), and both were rated highly for protein and starch removal. Green Force 5 in 1 was found to have outstanding rinsing capabilities, but not as good at cleaning away burnt milk. However, Sainsbury's Clean Home was found to be great for cleaning away burnt milk, and less good with rinsing, meaning that there might be watermarks on cutlery[179, 168]. 50°C wash programme was used for the dishwasher detergent test with water hardness of 35°F, and tea, milk, starch mix and egg yolk are

---

[166] Stiftung Warentest corresponds to years 2010 and 2011. Further info can be found in the publication "Test 8/2010" by "Haushalt und Garten" (pages 62-67) and "5/2011 Test" by "Haushalt und Garten" (pages 64-69)

[167] Global Phosphate Forum. 2011. "*Global Phosphate Forum GPF Info Number 34*."

[168] Which?. March 2010. P.48 - 49. "*Test Lab Dishwasher Tablets*."

used of as the food soils[169]. However, more recently published data by “Which” that tested 17 CADD, indicates that the 3 “Best Buys” are all P-based, and there is only one P-free, which is in lower performance range.

The consumer magazine “60 millions des consommateurs” in France found that the best products for both product categories (all-in-one tablets and powders/gels with rinse-aid and dishwasher salts added) were phosphates-free (Sun Green Power for tablets and Auchun Mieux Vivre for powders/gels)[170]. It must however be noted that this test includes Phosphate content as one of the factors for the “Ecotoxicity potential”, thus prone to positive bias towards the overall scoring of Phosphate-free CADD. They tested 12 powders/gels, eight of which were phosphates-free, and 13 tablets, five of which were phosphates-free. For powders/gels, four out of the five top performers were phosphates-free. Phosphates-free tablets, with the exception of Sun Green Powder which is MGDA based, however, are in the bottom half of the rating. Despite this, they were still able to outperform two phosphates-containing CADDs. The test concludes that for all-in-one tablets, it is difficult to obtain products with good wash performance which do not contain phosphates.

Again in France, “Que Chosir?” ran a test of 18 tablets, 12 phosphates-free and six phosphates-containing[171]. The test measured for calcium build up, glass shine, and washing ability against burned milk, dried tea stains, egg yolk, and spaghetti. The dishes were washed at 50°C with hard water. Removing the negative mark for containing phosphates, the two top performing CADD are ranked equally for cleaning performance, and one contains phosphates while the other is phosphates-free. This means that if the mark for washing performance only is considered (not taking into account the mark for phosphate), then 4 out of 6 in the good performance (2 or 3 stars for washing) are Phosphate-based CADD, and only two are Phosphate-free CADD. “Que Chosir?” concludes that the results of their test prove that phosphates are no longer necessary for cleaning efficiency.

There are several tests carried out in Sweden over the years on the performance of CADD publically available from Testfakta, Råd&Rön and ICAkuriren[172]. According to these tests there are few dishwasher detergents that can handle all kinds of food stains most detergents have for instance problems with porridge stains. Most of the detergents that have been tested clean the dishes effectively. But the result and the efficiency depends on the kind of food or stain left on the glass or china. Leftovers of dried rice or cereal can be difficult to remove as well as tea spots. In many of the test the German standard from SGS Institut Fresenius was applied testing 8 kinds of stain types that the detergents should be able to remove. The temperature was 50°C. The test shows that the use of one tablet or the prescribed dosage for powders or fluids is enough to get the dishes clean. According to new tests carried out by ICAkuriren[173] comparing the results from a test conducted for 7 years ago the CADD has been largely improved. Seven years ago 1/3 of the cutlery got rust marks and now seven years later no rust was to be found after dishes. The tablets also dissolved and no remaining CADD was found after dishes.

---

[169] Which? September 2010. “*Testing dishwasher detergents*.”

[170] 60 millions des consommateurs. April 2010. n°448 (pages 27-31) “*Des phosphates à eliminer*.”

[171] Que Choisir, October 2010. Version 485 (pages 25-28). “*essais.*”

[172] http://www.icakuriren.se/Test-Rad/Tester/maskindiskmedel/

http://www.test.se/maskindiskmedel/

http://www.testfakta.se/hem_hushall/article18822.ece

http://www.testfakta.se/hem_hushall/article59587.ece

http://www.testfakta.se/hem_hushall/article95944.ece

http://www.testfakta.se/hem_hushall/article14842.ece

[173] http://www.icakuriren.se/Test-Rad/Tester/maskindiskmedel/