LIFE / FIT FOR REACH

Summary
Socio-economic Impact Assessment of Substitution

LIFE fit for REACH

2020

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1. Introduction

The socio-economic impact assessment (SEA) of the effects of substitution of hazardous chemical substances with less hazardous or non-hazardous substances or the introduction of resource efficiency measures was undertaken with a view of comparing the substitution scenario and the business done as usual. The assessment included contextualisation of a wider socio-economic scale for companies in order to better understand the costs and benefits that could be achieved by implementing related measures. The report at hand is a summary of the detailed SEA of the project. Due to sensitive information about partner companies, the detailed long version of the report is for internal use only.

The SEA was carried out for 11 cases of six pilot partner companies and nine cases of other pilot companies that were not direct partners in the project.

The socio-economic impact assessment, or the cost-benefit analysis, done for all substitution and resource efficiency cases in partner and non-partner companies is condensed in Figure 1 below.

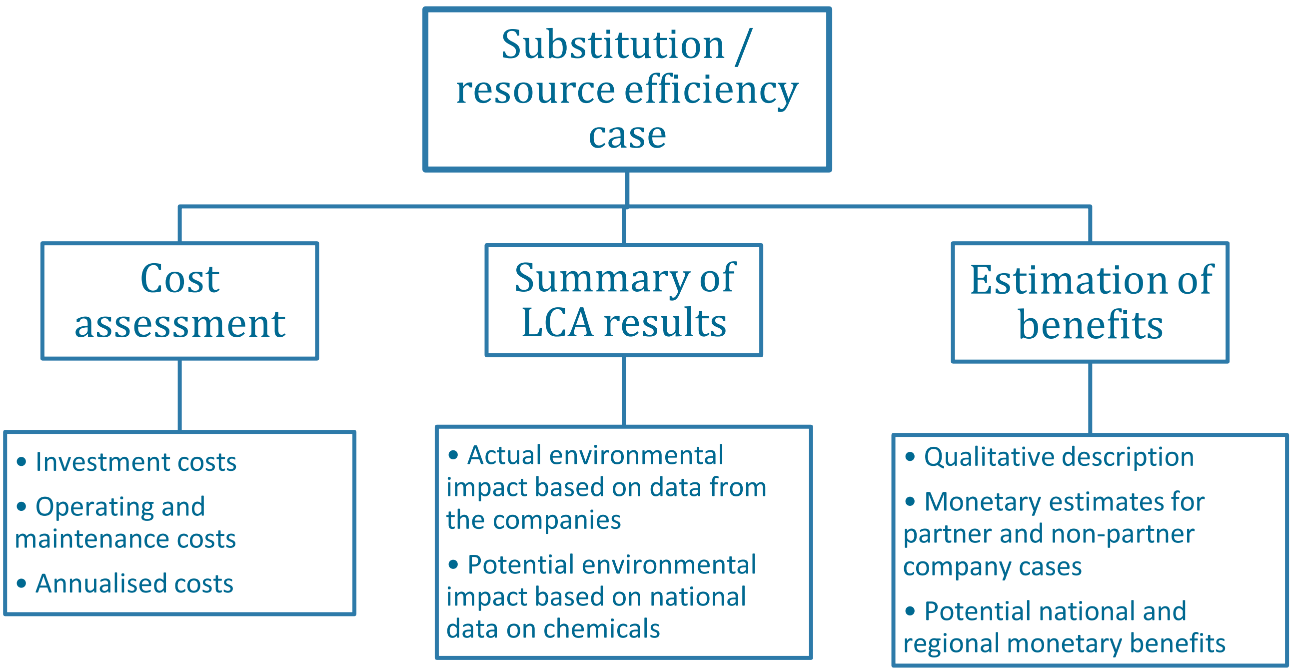

Figure 1. Blocks of socio-economic impact assessment of the FitforReach project

All costs related to the substitution and resources efficiency cases were assessed based on the data provided by the companies, meanwhile all relevant benefits were estimated using various suitable methods. Impacts on different environmental compartments were based on the results of the Lifecycle analysis carried out by the environmental experts of the project and were summarised to show the overall changes in, e.g., global warming, terrestrial acidification or ionising radiation, which the project activities brought. Moreover, the benefits to the companies, employees, health and the environment were described in detail in qualitative terms, as well as monetary estimates were made based on multiple literature sources and valuation studies.

2. Assessment of Costs

2.1. Methodology for Cost Assessment

Cost assessment was based on the changes that took place in each company as a result of the substitution of a hazardous chemical, technology, or through the introduction of resource efficiency measures – the difference between the “baseline” and “substitution” scenario.

Costs had been provided by the companies via questionnaires which covered, but were not limited to, the following cost elements:

Investments

- Technology/equipment
- Research and development
- Property rights
- Performance testing
- Decommissioning

Operation and maintenance

- Energy
- Materials
- Services
- Labour (number, salary, insurance of employees, etc.)
- Maintenance (testing, monitoring, emergency provision, material transportation, etc.)
- Payments for natural resources
- Pollution charges
- Payments for packaging

In addition to the questionnaires, visits to some companies were needed to acquire more information, e.g., on technologies, cost elements and other related issues.

Annualised costs were calculated according to the following formula:

$$AC = \frac{I * r}{1 - (1 + r)^{-n}} + O\&M$$

AC – annualised costs, EUR/year

I – total investment costs, EUR

r – social discount rate

n – lifetime of investments, number of years

O&M – operation and maintenance costs, EUR/year

Social discount rate of 5 per cent was applied to calculate annualised costs.

2.2. Costs of Substitution

Costs of substitution or resource efficiency cases at the partner companies are summarised in Table 1. The total investments of 11 pilot cases at the partner companies amounted to EUR 6.4 million. The largest share of these costs relates to the technology change as a result of the BPA substitution. If these investments are not considered, the total investment/one-off costs make up EUR 303 000. Additional operating and maintenance costs related to the substitution/resource efficiency case are required only in three cases. In other cases, however, no additional O&M costs were needed, or there were financial savings.

The total investments of nine non-partner company cases amounted to approximately EUR 90 000. O&M costs were saved in all cases, except for one. There were also quite considerable annualised savings in six out of nine companies. Thus financially, the substitution cases at the non-partner companies under consideration were highly effective.

The figures below illustrate a number of cases per main groups of costs where additional costs were required or where cost decreases (savings) at the partner and non-partner companies were reported.

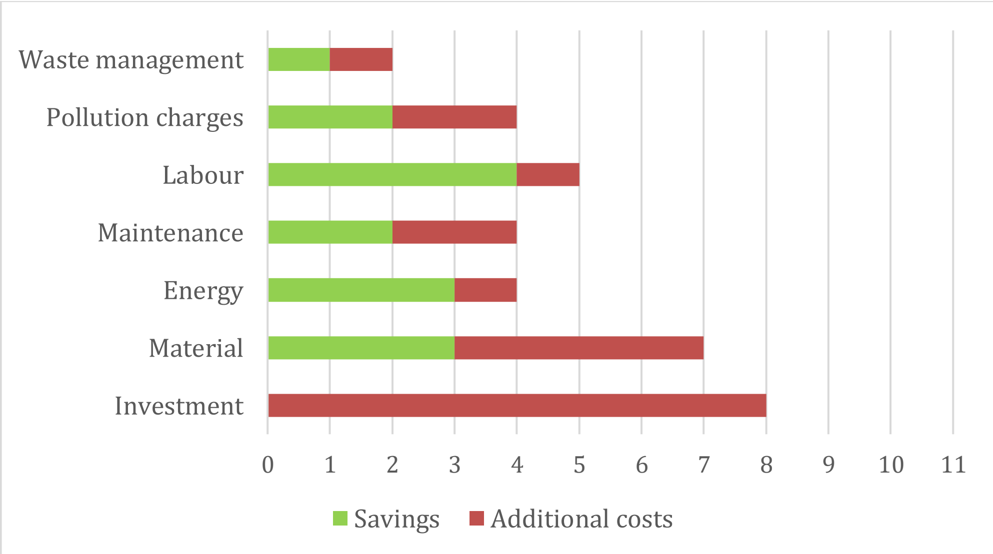

Figure 2. Number of cases with increased and decreased costs at the partner companies

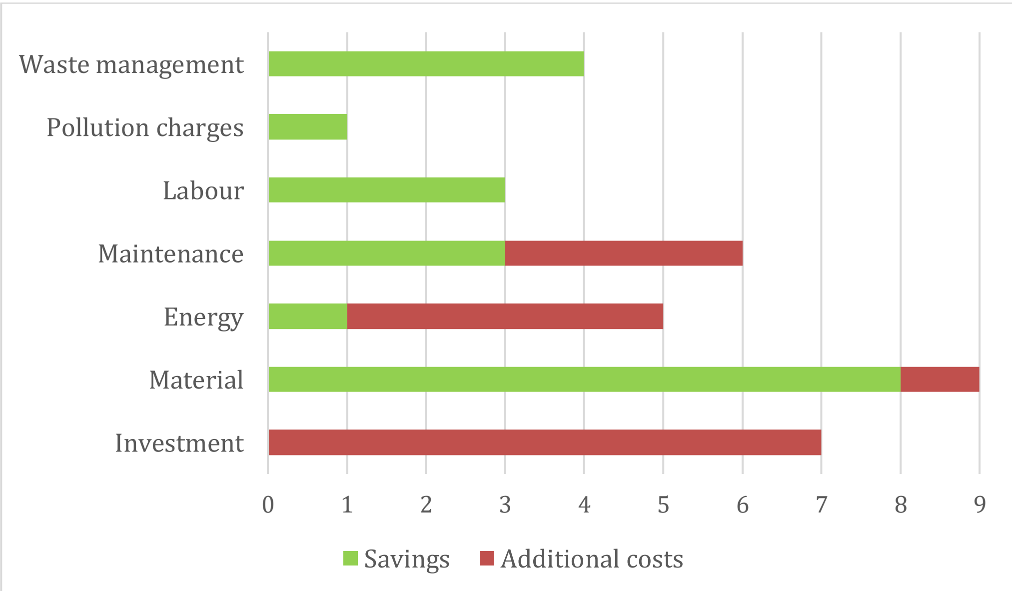

Figure 3. Number of cases with increased and decreased costs at the non-partner companies

Table 1. Summary costs for pilot companies (- additional spending, + savings)

Case / substance	Investments, EUR	Annualised investments, EUR/year	Operating and maintenance costs, including increase in sales, EUR/year	Annualised total, EUR/year
Xylene	0	0	300	**300**
BPA	-6 059 440	-583 780	1 640 000	**1 056 100**
CO_2, NO_x	0	0	16 000	**16 000**
Sodium perborate	-47 400	-6 140	-10 810	**-16 900**
Sodium percarbonate	-1 000	-230	-68 640	**-68 900**
4-nonylphenol	-45 000	-10 400	0	**-10 400**
Benzyl alcohol	-119 350	-11 500	0	**-11 500**
Methylene chloride	0	0	-5 440	**-5 440**
Diphenyl-methane diisocyanate	-45 000	-2 900	6 320	**3 420**
Dibutyltin dilaurate	-22 500	-2 900	0	**-2 900**
DINP	-22 500	-2 900	0	**-2 900**
Sodium hypochlorite solution and lauryl dimethylamine oxide	-11 620	-1 120	176	**-940**
Styrene	-17 500	-4 040	39 740	**35 700**
Acetone	-2 980	-390	-510	**-900**
BPA	-10 320	-830	28 930	**28 100**
Boric acid	-12 500	-2 460	7 600	**5 140**
Xylene, isophorene and m-tolylidene diisocyanate	0	0	29 070	**29 070**
Toluene, butanone	-16 100	-2 080	1 110	**-970**
d-limonene	0	0	83 160	**83 160**
Phenol formaldehyde resin and polymer, methanol	-19 140	-2 480	105 000	**102 500**
Total	**-6 452 000**	**-634 000**	**1 860 000**	**1 240 000**
Total without BPA case	**-393 000**	**-50 600**	**221 300**	**182 000**
Median	**-16 100**	**-2 500**	**700**	**-300**

Financially, substitution and resource efficiency measures in the non-partner companies were more effective than in the partner companies. However, one should bear in mind differences in the nature of the partner and non-partner company cases, i.e., non-partner cases were mainly of a technological character, whereas substitutions in the partner companies were much more complex, involving a selection of alternative chemicals, technological, administrative and other changes.

3. Results of Environmental Impact Assessment (Lifecycle Analysis)

3.1. Methodology for Extrapolation of LCA Results

Any socio-economic impact assessment (or cost-benefit analysis) depends on the results of the Environmental Impact Assessment (Lifecycle Analysis, LCA), which, in general, is a procedure for the assessment of environmental burden of an activity. The FitforREACH environmental experts, who carried out the risk assessment and the LCA, provided results on risk reduction ratios, changes in LCA indicators and also changes in emissions of chemical substances under consideration. As these changes were obtained in specific units, such as kg NO_x, kg SO_2, kg N, etc., this allowed, where possible, recalculating changes in one company to the national and regional levels. Changes in the emissions of chemicals under consideration were used to monetise the benefits both for the companies and for the society in general.

Extrapolation of the environmental impact of chemical substance substitution/reduction was carried out in two broad ways: the *actual* environmental impact of reduced substances and the *potential* environmental impact of reduced substances. Both types of the results are presented at the national as well as regional (Baltic States) level.

The sum of the environmental impact of substance reduction from all national partner companies reflects the total *actual* environmental impact of substituted/reduced substances. For Lithuania, the total actual environmental impact of substance substitution/reduction was calculated by aggregating the data of two participating companies. For Estonia, the total actual environmental impact of substance substitution/reduction was calculated by aggregating the data of three partner companies. For Latvia, the total actual environmental impact of substituted/reduced substances could not be presented due to the lack of the LCA results. The sum of the total actual environmental impact of substituted/reduced substances in individual countries reflects the total regional actual environmental impact of substituted/reduced substances during the project.

The *potential* environmental impact reflects a situation when all the substances under consideration would be eliminated in all similar companies in the Baltic States.

3.2. Summary of LCA Results

The analysis of the total actual environmental impact of the substitution/reduction of substances of concern shows a positive effect for a majority of LCA categories on the national and regional level. In Lithuania, a negative overall impact was noticed on stratospheric ozone depletion and human carcinogenic toxicity in all implemented cases. In Estonia, substitutions in three companies have negative results only for freshwater ecotoxicity.

Table 2. Total actual environmental impact of substituted/reduced substances in the Baltic States

Impact category	Total actual change in the Baltic States	Total actual change		
		in Lithuania	in Latvia	in Estonia
Global warming, kg CO2 eq	-503 838	-483 797	no data	-20 041
Stratospheric ozone depletion, kg CFC-11 eq	0.021	0.126	no data	-0.105

Impact category	Total actual change in the Baltic States	Total actual change		
		in Lithuania	in Latvia	in Estonia
Ionising radiation, kBq Co-60 eq	-1 182	-1 092	no data	-89.5
Ozone formation, human health, kg NOx eq	-749	-714	no data	-35
Fine particulate matter formation, kg PM2.5 eq	-285	-270	no data	-15.1
Ozone formation, terrestrial ecosystems, kg NOx eq	-670	-632	no data	-37.9
Terrestrial acidification, kg SO2 eq	-894	-832	no data	-62
Freshwater eutrophication, kg P eq	-12.6	-9.3	no data	-3.4
Marine eutrophication, kg N eq	-11.1	-9.1	no data	-2.1
Terrestrial ecotoxicity, kg 1,4-DCB	-286 242	-222 563	no data	-63 679
Freshwater ecotoxicity, kg 1,4-DCB	3 006	-344	no data	3 350
Marine ecotoxicity, kg 1,4-DCB	-609	-604	no data	-4.6
Human carcinogenic toxicity, kg 1,4-DCB	-310	74	no data	-384
Human non-carcinogenic toxicity, kg 1,4-DCB	-38 823	-31893	no data	-6 930
Land use, m2a crop eq	-17 606	-16123	no data	-1 483
Mineral resource scarcity, kg Cu eq	-10 726	-10607	no data	-119
Fossil resource scarcity, kg oil eq	-91 240	-88443	no data	-2 796
Water consumption, m3	-1 072	-249	no data	-823

The results show a positive *potential* environmental impact for a majority of LCA categories in each and all the Baltic countries, except for five LCA categories which would experience a negative impact, namely, ozone formation, human health; ozone formation, terrestrial ecosystems; freshwater ecotoxicity; marine ecotoxicity and fossil resource scarcity (Table 3).

Table 3. Total potential environmental impact of eliminated substances in the Baltic States

Impact category	Total potential change in all Baltic States	Total potential change		
		in Lithuania	in Latvia	in Estonia
Global warming, kg CO_2 eq	-38 244 437	-18 610 968	-3 492 177	-16 141 291
Stratospheric ozone depletion, kg CFC-11 eq	-67	-31	-6.9	-28.6
Ionising radiation, kBq Co-60 eq	-1 104 101	-576 670	-42 308	-485 124
Ozone formation, human health, kg NO_x eq	481 227	156 531	131 142	193 554
Fine particulate matter formation, kg $PM_{2.5}$ eq	-33 200	-14 767	-3 450	-14 983
Ozone formation, terrestrial ecosystems, kg NO_x eq	791 057	258 577	213 973	318 507
Terrestrial acidification, kg SO_2 eq	-139 012	-71 837	-5 072	-62 103
Freshwater eutrophication, kg P eq	-34 321	-18 889	-372	-15 060
Marine eutrophication, kg N eq	-29 361	-16 235	-257	-12 869
Terrestrial ecotoxicity, kg 1,4-DCB	-435 280 419	-232 944 847	-8 883 538	-193 452 033
Freshwater ecotoxicity, kg 1,4-DCB	3 207 265	17 742 007	331 625	14 005 633
Marine ecotoxicity, kg 1,4-DCB	219 810	123 504	4 972	91 333

Impact category	Total potential change in all Baltic States	Total potential change		
		in Lithuania	in Latvia	in Estonia
Human carcinogenic toxicity, kg 1,4-DCB	-3 312 484	-1 658 892	-207543	-1 446 049
Human non-carcinogenic toxicity, kg 1,4-DCB	-27 331 995	-13 801 471	-1 481 786	-12 048 738
Land use, m^2a crop eq	-8 954 826	-447 580	-517 500	-3 961 947
Mineral resource scarcity, kg Cu eq	-738 422	-359 532	-84 461	-294 429
Fossil resource scarcity, kg oil eq	33 672 659	18 279 932	876 051	14 516 675
Water consumption, m^3	-6 801 959	-3 733 401	-68 496	-3 000 062

4. Asessment of Benefits

4.1. Methodology for Estimating Substitution Benefits

The benefits gained from the substitution of chemicals or implementation of resource efficiency cases were defined as direct financial benefits/losses to companies and their employees (i.e., results of cost assessment) and environmental and health (social) benefits to the whole population. Taken together, these elements constitute socio-economic benefits, which were captured as much as possible in the analysis.

Qualitative benefits of substitutions to the health and environment were examined and described in detail for each of 20 cases. The following substances and their emissions were explored in terms of their impact on health and the environment.

At the partner companies:

- Xylene
- 2-methoxypropanol
- 4,4'-isopropylidenediphenol's (Bisphenol A)
- CO2
- NOx
- Sodium perborate
- Sodium percarbonate
- 4-nonylphenol
- Benzyl alcohol
- Methylene chloride
- Diphenyl-methane diisocyanate (MDI)
- Polyol blend
- Di-isononyl phthalate (DINP)
- Dibutyltin dilaurate

At the non-partner companies:

- Sodium hypochlorite solution
- Styrene
- Acetone
- 4,4'-isopropylidenediphenol's (Bisphenol A)
- Boric acid
- Isophorene diisocyanate

- M-tolylidene diisocyanate (TDI)
- Methylene diphenyl diisocyanate (MDI)
- Toluene
- (R)-p-mentha-1,8-diene; d-limonene
- Phenol formaldehyde resin
- Phenol formaldehyde polymer
- Methanol

In addition, the assessment sought to identify monetised values. Since it was not possible to carry out valuation studies on the monetisation of the benefits to the environment, the valuations publicly available online in Europe and the world were reviewed. Where suitable, estimates of these studies were used in the assessment through the benefit transfer method. In the process of work it turned out that estimates of environmental benefits from chemical reduction are very scarce, so health impacts and their monetisation were also examined and dominated the benefit monetisation.

Benefit transfer methodologies for benefit monetisation are unique to each pilot company substitution or resource efficiency case. Table 4 below specifies the main elements used for developing methods for monetisation of benefits from the reduction of substances of concern.

Table 4. Basis for monetisation of benefits from substitution / reduction of substances

Substance	Monetisation based on
Xylene	values from European assessment of VOCs in terms of improving air quality by reducing the amount of tropospheric ozone, impact on human health and buildings
2-methoxypropanol	analysis of reprotoxic chemicals with a view to analyse the health, socio-economic and environmental impacts and assumptions on potentially exposed workforce
Bisphenol A	assessments of environmental chemicals that are thought to cause disruption of endocrine functions leading to a variety of diseases and dysfunctions; values of exposure to BPA causing childhood obesity
CO_2 and NO_x	the CO_2 European Emission Allowances system; values of NO_x effects on human health, indirect effect on agricultural crops, acidification and eutrophication of waters and soils, formation of particulate matter and ground-level ozone
Sodium perborate	analysis of reprotoxic chemicals with a view to analyse the health, socio-economic and environmental impacts, and assumptions on potentially exposed workforce
Sodium percarbonate	no monetary estimation
Nonylphenol (NP)	two options: NP as EDC substance, using values of burden of disease and costs of exposure to endocrine disrupting chemicals in the European Union, and using values of the damage to the aquatic environment caused by NP, based on willingness to pay for improved marine environment
Benzyl alcohol	environmental risk-based ranking of solvents using the combination of a multimedia model and multi-criteria decision analysis, and value of xylene as basic value
Methylene chloride	cost-benefit analysis prior to the approval of the Regulation of Paint and Coating Removal for Consumer Use in the US, value of potential avoidance of fatalities to workers
Diphenyl-methane diisocyanate	the Report on Proposal for a Restriction of Diisocyanates by ECHA, costs per case of occupational allergic asthma
DINP	no monetary estimation

Dibutyltin dilaurate	the potential burden of health effects associated with occupational exposures to Reprotoxic 1A/1B substances, but without carcinogens or mutagens and some assumptions on potentially exposed workforce
Sodium hypochlorite solution and lauryl dimethylamine oxide	values of the damage to the aquatic environment, based on willingness to pay for improved marine environment
Styrene	environmental risk-based ranking of solvents using the combination of a multimedia model and multi-criteria decision analysis, and value of xylene as basic value
Acetone	values from European assessment of VOCs in terms of improving air quality by reducing the amount of tropospheric ozone, impact on human health and buildings
Boric acid	analysis of reprotoxic chemicals with the view to analyse the health, socio-economic and environmental impacts, and assumptions on potentially exposed workforce
Isophorene diisocyanate	monetary values in the reduction of VOCs, which causes improvements of European air quality by reducing the amount of tropospheric ozone, lowers negative impact on human health and buildings
M-Tolylidene diisocyanate	the Proposal for a Restriction of Diisocyanates, values of avoidance the occupational asthma and assumptions on exposed workforce
Toluene, butanone	environmental risk-based ranking of solvents using the combination of a multimedia model and multi-criteria decision analysis, and value of xylene as basic value
d-Limonene	environmental risk-based ranking of solvents using the combination of a multimedia model and multi-criteria decision analysis, and value of xylene as basic value
Phenol formaldehyde resin, polymer	two options: the study Economic Valuation in Formaldehyde Regulation, carried out for the OECD, predicted number of cases avoided for two health effects (nasopharyngeal cancer and eye irritation) and potentially impacted businesses; values of improvements in protecting human health and the environment by reducing air toxic emissions
Methanol	environmental risk-based ranking of solvents using the combination of a multimedia model and multi-criteria decision analysis, and value of xylene as basic value

Actual – company level – *monetised* benefit of substituted or reduced substances was also extrapolated to the national and regional level, i.e., a bottom-up approach was used. In some cases, on the contrary, a top-bottom approach was used when the known monetised benefits of avoidance of some substances, e.g., avoidance of some illnesses, at the national level were calculated for the company level.

The sum of the total *potential* environmental and health benefits of the substituted or reduced substances in each country reflects the total potential environmental and health benefits of substituted or reduced substances at the Baltic States level. Potential duplication of monetised benefit results when they reflect, e.g., a group of substances rather than an individual one, was noted in the overall benefit presentation.

4.2. Summary Benefit Estimates

Health and environmental (social) and total socio-economic benefits (including financial costs/savings a company incurred) gained from substitutions at pilot (partner and non-partner) companies, are presented in Table 5.

Table 5. Monetised benefits from substitution at pilot companies, EUR/year

Case (substance reduced/eliminated)	Social (health and environmental) benefits		Total benefits from substitution in a company	
	from	to	from	to
Xylene	1 030	2 270	**1 330**	**2 570**
Bisphenol A	1 760 000	1760000	**2 816 100**	**2 816 100**
CO_2, NO_x	330	330	**16 330**	**16 330**
Sodium perborate	120 000	500 000	**103 100**	**483 100**
Sodium percarbonate	-	-	**-68 900**	**-68 900**
4-nonylphenol	3 400	15 300	**-7 000**	**4 900**
Benzyl alcohol	3 860	3 860	**-7 640**	**-7 640**
Methylene chloride	400	400	**-5 000**	**-5 000**
Diphenyl-methane diisocyanate	30	30	**3 450**	**3 450**
DINP	-	-	**-2 900**	**-2 900**
Dibutyltin dilaurate	430	1 150	**-2 470**	**-1 750**
Sodium hypochlorite solution and lauryl dimethylamine oxide	20	40	**-920**	**-900**
Styrene	2 160	2 160	**37 860**	**37 860**
Acetone	1 700	1 700	**800**	**800**
Bisphenol A	211 000	5 000 000	**239 100**	**5 028 100**
Boric acid	20 000	80 000	**25 100**	**85 100**
Xylene, isophorene diisocyanate, m-tolylidene diisocyanate	6 600	6 600	**35 700**	**35 700**
Toluene, butanone	50	50	**-930**	**-930**
d-limonene	5 520	5 520	**88 720**	**88 720**
Phenol formaldehyde resin and polymer, methanol	100	19 300	**102 600**	**121 800**
Total	**2 140 000**	**7 400 000**	**3 376 000**	**8 640 000**
Total without one BPA case	**376 000**	**5 640 000**	**560 000**	**5 824 000**

Depending on the benefit monetisation method, the annual health and environmental benefits brought by the substitution and resource efficiency cases in pilot companies ranged between approximately EUR 0.4 million and EUR 7.4 million. Although the total benefits for separate companies were different, the participation in the project was beneficial for most pilot companies not only financially but also from the socio-economic point of view.

The calculation of a potential environmental impact and potential benefits from substitutions at the national level covered only the main substances of concern as well as those for which the national data was available or any other kind of extrapolation was possible.

Table 6. ***Potential*** **monetised social benefits from substitution of pilot company chemicals at the national level, EUR/year**

Case	Lithuania	Latvia	Estonia	Remarks
Xylene, 2-methoxypropanol	2 500 000	2 240 000	3 100 000	
4,4'-isopropylidenediphenol's (Bisphenol A)	688 000 000	417 000 000	422 000 000	
CO_2, NO_x	-	-	-	Not possible to extrapolate to national lavel
Sodium perborate	160 000 000	96 000 000	83 000 000	
Sodium percarbonate	-	-	-	Only qualitative description of benefits
Nonylphenol	5 700 000	3 300 000	3 200 000	
Benzyl alcohol	48 200	48 200	48 200	
Methylene chloride	37 550	19 550	35 780	
Diphenyl-methane diisocyanate (MDI)	69 000	45 000	33 000	
Diisononyl phthalate (DINP)	-	-	-	Only qualitative description of benefits
Dibutyltin dilaurate	18 110	39 100	20 820	
Sodium hypochlorite, lauryl dimethylamine oxide	591 500	340 000	318 000	Benefits to aquatic environment
Styrene	10 000 000	1 200 000	5 000 000	
Acetone	5 730 000	6 430 000	1 240 000	
Bisphenol A	688 000 000	417 000 000	422 000 000	Duplication, not considered in the total
Boric acid	2 000 000	2 750 000	1 700 000	Cover reprotoxic 1A/1B substances in general
Xylene, izophorene diisocyanate, m-tolylidene diisocyanate	2 570 000	2 300 000	3 133 000	
Toluene, butanone	3 380 000	21 300 000	3 700 000	
(R)-p-mentha-1,8-diene; d-limonene	76 600	40 500	40 300	
Phenol formaldehyde resin and polymer, methanol	59 339 000	58 911 110	59 275 700	
Total, rounded	**940 000 000**	**612 000 000**	**590 000 000**	

As the substitution of BPA demonstrated an impact not only on the population of the country where it was carried out but also on other countries where the production is exported and because BPA was eliminated in two cases, the total potential social benefits were estimated without one BPA case. The results show that if the substances of concern were eliminated from use in the Baltic States, the monetised social benefits would amount to more than EUR 500 million per year. It is important to note that these results do not include the benefits that could not be monetised. Also, the costs have not been considered here, since it is impossible to calculate the substitution costs in all companies of a country.

5. Employees Affected

The substitution and resource efficiency cases were implemented at, and environmental and socio-economic analysis carried out for 15 pilot companies. If not all, at least a certain number of the employees in those companies heard of and participated in the FitforReach project. Some of them were specifically affected by the significant changes. There are approximately 680 persons working at the partner companies and 22.5 per cent of those were exposed to the substances, which were substituted during the project. At non-partner companies, 319 employees (18 per cent) out of almost 2 000 had been exposed to the chemical substances before the project.

In total, approximately 470 persons out of almost 2 500 employees in all companies under consideration were provided with safer and healthier working conditions.

In some cases, the substitutions resulted in the introduction of new technologies, which, in turn, stipulated reduction in the number of employees. On the other hand, the substitution and/or resource efficiency cases required more people, so employment increased. However, the difference in the overall number of employees before and after the implementation of the project was negligible.

6. Challenges Faced, Assumptions and Conclusions

The socio-economic assessment of the impacts of the FitforReach project and the extrapolation of the impacts to the national and regional levels was quite challenging.

The socio-economic impact assessment of the FitforReach project examined the costs and benefits of the chemical substitution and resources efficiency cases in the project partner and non-partner companies. In total, 20 cases were studied in detail: 11 cases in the project partner companies and nine ones in the non-partner companies. Literature and other types of sources on at least 22 chemicals were sought and studied thoroughly.

Most risk assessments usually are not specifically designed in the context of socio-economic analysis. They are mostly meant for "screening" or "safety" assessments and ***do not provide the results and conclusions needed to support typical approaches to socio-economic analyses***[1]**.** To balance this, the qualitative interpretation of the risk assessment and LCA results were evaluated against examples of monetised assessments of the effects of relevant substance reduction.

Investments required for a substitution case varied from EUR 0 to more than EUR 6 million per company, making the median of EUR 16 000. Part of these investment costs were covered by the FitforReach project but the resulting socio-economic impact calculations included all investments to reflect a more probable situation that any similar company may have in the future without subsidisation.

Operating and maintenance costs ranged from additional more than EUR 70 000 to the savings of more than EUR 1.6 million per year. ***Annualised costs***, illustrating spendings if they were to occur

[1] Chiu, W. (2017). Chemical risk assessment and translation to socio-economic assessments. *OECD Environment Working Papers*, No. 117. https://doi.org/10.1787/a930054b-en.

equally in every year of the project lifetime, varied from almost EUR 70 000 to the annual savings of more than EUR 1 million. Median annualised costs equal to almost EUR 3 000 at the partner companies and median annualised savings at approximately EUR 28 000 at the non-partner companies.

Substitution cost estimates, although much more reliable than estimates of benefits, have deficiencies as well. In many cases ***it was difficult for the partner companies to separate costs specifically associated with the substitution or resource efficiency case*** from the overall company costs, for example, to link the number of employees, investment proportion or payments for pollution to a specific case, if this case represented only a fragment of the company's overall technological system.

Benefits derived from the substitution of chemicals or implementation of resource efficiency cases ***were defined as direct financial benefits/losses to companies and their workers as well as environmental and health (social) benefits to the whole society.*** Taken together, these elements provide socio-economic benefits, which were captured as much as possible in the analysis.

Instead of using one method to calculate monetised benefits, different methods of benefit estimation for different companies had to be applied to account for the uniqueness of each case and different level of existence of benefit values. This resulted in a more complex workload.

Qualitative benefits to health and the environment were examined and described in detail for each of 20 cases and 22 substances. ***Certain benefits were monetised for most cases***. This assessment employed the benefit transfer method and used the monetised values available in the literature from the Baltic States, Europe or the world. It should be emphasised that the calculation of benefits for each company case was different, as each company's situation was individual, and so were benefit estimates provided in relevant literature. Thus, ***methodologies for benefit monetisation were unique to each partner and non-partner company*** substitution or resource efficiency case.

Social (health and environmental) annual monetised benefits from substitutions at the partner companies vary depending on the method of calculation and range from EUR 430 to EUR 1.7 million; the median figure amounts to EUR 1 000 – 2 300 per year. Taking into consideration both costs and benefits, the ***results of substitution at the partner companies span from additional costs of almost EUR 70 000 per year to additional benefits of EUR 2.8 million per year.*** The median result of the partner companies equals EUR -2 500 - EUR +2 600 per year.

The social benefits gained by the non-partner companies after the substitutions total from EUR 20 to EUR 5 million per company. It should be noted that, depending on the data available, some social benefits include more considerable impacts, such as impacts of the whole group of EDC substances rather than a particular one. The median social benefit figure for the non-partner companies equals EUR 2 200 – 5 500 per year per company. Taking into consideration both costs and benefits, ***the substitutions were beneficial to most non-partner companies*** (from EUR -930 to EUR +5 million per year; median equals EUR 36 000 – EUR 38 000). The monetised benefits were exceeded by costs only in two companies.

In addition to the monetised benefits of the elimination of hazardous chemicals at the companies, potential social benefits of complete elimination of the chemicals under concern in Lithuania, Latvia and Estonia were estimated both at the national and the Baltic States level. ***The elimination of the substances of concern potentially implies social benefits worth of hundreds of euros in each Baltic***

State. Moreover, it should be remembered that ***qualitative descriptions of the benefits are equally important***, since there are no sufficient instruments created yet to monetise all kind of benefits.

It should be noted, however, that ***extrapolation of the data of one company is a very vague idea***, as every company, even the one belonging to the same NACE activity, is unique, i.e. all companies differ in size, use different technologies and unidentical products. Figures based on the emissions data of one company which are then ***extrapolated to the national level contain quite big margins of error***.

There are many angles and a number of challenges in estimating the social benefits of the elimination or reduction of the use of chemicals. Not all could be captured in the socio-economic assessment at hand. For example, when chemicals are released to the environment, in many cases there may be ecosystem lags of up to a few decades for results to be felt and/or seen. The same process, only reverse, occurs when some hazardous chemicals are eliminated as emissions. This should be borne in mind when interpreting chemical reduction benefit valuation results.

Evidence on environmental risks from chemicals is scarcer than that on health risks. Due to data limitations, many studies analysed could only value the benefits from few health effects and thus focus on financial and health impacts. Environmental, social, wider economic and distributional impacts have either been evaluated qualitatively or not evaluated at all. This was an important reason for challenges in the SEA in the study at hand. Moreover, there is a lack of approaches for environmental and health impact assessment, so there is ***a great need to develop methods that would transform information about chemical effects and risks into impacts*** and, ultimately, into damages or benefits. Corroboration with new information is vastly required concerning many statements on the impacts of chemicals on the environment and health.

Another important issue is ***reliability or absence of data***. Many inconsistencies in the statistics of chemicals were noticed, which did not allow providing reliable results. For example, in some cases the usage of a chemical in one company exceeded the overall amount of the chemical use in a country. There are no comparable national registers of the amounts of chemicals used. ***Many assumptions had to be taken*** during the socio-economic impact assessment at hand, from the amounts of chemicals to willingness to pay for certain environmental and/or health improvements. All this hinders the socio-economic impact assessment of chemical use or substitution. Due to a large number of uncertainties involved, particularly benefit estimates, the ***range of figures in this report should be seen as illustrative of the general order of magnitude of potential benefits rather than definite estimates.***

Other studies have estimated that the *global burden* of disease attributable to environmental exposure and management of some chemicals amounts to 4.9 million deaths or 86 million DALYs per year[2]. This accounts for approximately 8.3 per cent of total deaths or 5.7 per cent of the total burden of disease in DALYs in the world. These figures are underestimates, because only a fraction of impacts is monetised. ***Similar information for the Baltic States is not available***. The Baltic States appear in some studies of the EU level, but no original research has been carried out. Cultural and other socio-economic differences suggest that health and environmental benefit estimates may differ in the Baltic

[2] European Commission (2016). Study on the Calculation of the Benefits of Chemicals Legislation on Human Health and the Environment. Development of a System of Indicators. Final Report.

https://ec.europa.eu/environment/chemicals/reach/pdf/study_final_report.pdf

States from the estimates of other countries or regions, therefore ***primary research studies in the Baltic countries would be very valuable*.**

At present, knowledge on exposures to chemicals and coverage of it by the literature represents only a small part of the chemical universe and their full spectrum of effects on human health and the environment. ***The challenges faced during the project and the conclusions drawn will, hopefully, be useful for conducting future socio-economic as well as environmental impact assessments of chemical substances in the Baltic States and can be inspirations for further work. Also, calculation of costs and benefits of chemicals reduction or elimination is useful in developing resource allocation and prioritisation strategies in public and environmental health.***

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