SUBSTITUTION PLAN

Legal name of applicants:	*REACHLaw Ltd as Only Representative on behalf of Joint Stock Company "Novotroitsk Plant of Chromium Compounds"*
Submitted by:	*REACHLaw Ltd as Only Representative on behalf of Joint Stock Company "Novotroitsk Plant of Chromium Compounds"*
Substance:	*Chromium trioxide,* *EC No: 215-607-8* *CAS No: 1333-82-0*
Use title:	*Functional chrome plating with decorative character*
Use number:	*3*

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Term	Description
Commercialization / Industrialization of qualified alternative	The aim of this phase is to install the alternative process for commercial production, *i.e.* the phase includes planning, site preparation, plant conversion, process evaluation, production line approvals from customers, training and production ramp-up.
CTAC Consortium or CTAC	An industry group consisting of 154 companies founded in 2012 to collaborate for the gathering of data to submit applications for authorization of uses of chromium trioxide. REACHLaw is a member of this group. Five (originally six) out of the seven applicants for authorization of the joint application of Chemservice *et al.* respectively their legal successors are members of CTAC.
CTACSub Consortium or CTACSub	An industry group consisting of seven companies (formulators and importers respectively their Only Representatives) founded in January 2015 that agreed to file an upstream application for authorization for certain uses of chromium trioxide based on the data and draft applications for authorization that had been developed by CTAC. REACHLaw is not a member of the CTACSub Consortium.
Early stage R&D / testing of candidate alternatives	The aim of this phase is to identify the most promising alternative that fulfils all use-specific technical requirements (plating vs. etching) defined for articles and their respective area of application / market sector. Testing is only performed on laboratory scale, i.e. applicability of alternative on industrial / commercial scale is not yet evaluated.
JSC "NPCC"	Joint Stock Company "Novotroitsk Plant of Chromium Compounds" (Promyshlennaya str., 49, Novotroitsk, Orenburg area, 462353, Russia) a non-EU manufacturer of chromium trioxide for supply to the EU market. Through its Only Representative REACHLaw the company has been participating in the CTAC Consortium.
Phase-out of CrVI / ramp-up of production to 100 % alternative	During this phase the last serial production articles requiring the CrVI-based production technology due to contractual obligations are phase out. In parallel, the production of serial production articles manufactured with the alternative process is performed. The time required for this phase allows transition from the CrVI-based technology to the alternative technology under consideration of contractual obligations DUs have.
Plating on Plastics (PoP)	Plating on Plastics (PoP) consists of the deposition of a metal multilayer system on a non-conductive surface.
Qualification of preferred candidate alternative(s)	The aim of this phase is to get all required customer/OEM approvals (*e.g.*, testing of lifetime under serial conditions/condition of use) for the article manufactured with the alternative, i.e. qualification of alternative. The manufacturing of the article is not yet performed on industrialized production lines. This phase does not include customer/OEM approvals for the industrialized/commercialized production line (see Commercialization/Industrialization of qualified alternative).
REACHLaw	REACHLaw Ltd. (Vänrikinkuja 3 JK 21, FI-02600 Espoo, Finland). REACHLaw is acting as Only Representative of JSC "NPCC" under REACH Article 8 and has submitted an application for authorization of certain uses of chromium trioxide using the authorisation dossier prepared by CTAC. REACHLaw and CTACSub have concluded an agreement to collaborate on the preparation of the Substitution Plans as now requested by the Commission for their respective applications for authorization.

ABBREVIATIONS

AfA	Application for Authorisation
CrO_3	Chromium trioxide
DU	Downstream User
OEM	Original Equipment Manufacturer
PoP	Plating on Plastics

IMPORTANT NOTES

REACHLaw Ltd. (as Only Representative of Joint Stock Company "Novotroitsk Plant of Chromium Compounds" – JSC "NPCC" – Russia) (hereafter REACHLaw (as OR for JSC "NPCC")) submitted its upstream application for authorisation on 16.03.2016. It is an upstream application and based on the same data as the Application for Authorization of *Chemservice et al.*[1] (see **GLOSSARY** for further background). The Application for Authorisation of *Chemservice et al.* for the use of chromium trioxide for *functional chrome plating with decorative character (Use 3)* was submitted in 2015.

By letter of March 10, 2020, the European Commission requested REACHLaw to submit a substitution plan for Use 3 by September 10, 2020; an Annex to the letter detailed the requirements for the substitution plan. Pursuant to an extension request filed by the applicant on July 8, 2020, the European Commission prolonged the deadline for submission of the substitution plan to September 24, 2020.

As the joint applicants Chemservice *et al.* received the same request from the Commission to submit a substitution plan for the same use, REACHLaw and Chemservice et al. agreed to collaborate on the Substitution Plan. REACHLaw therefore submits the same report as Chemservice *et al.* in response to the same request from the Commission. The information collected from downstream users for the purpose of fulfilling the Commission requests is from both supply chains. No differentiation between the supply chains was performed for the preparation of this report.

In 2012, more than 150 companies, including chromium trioxide suppliers, formulators and downstream users (DUs) from various industry sectors, formed the **Chromium Trioxide Authorisation Consortium (CTAC).** Between 2013 and 2015, CTAC gathered available information from member companies and the public domain and prepared the documents to support the members' applications for authorization. Some CTAC members, especially larger companies, adapted the draft applications elaborated to their company situation and submitted their own company specific applications for authorization, often with longer requested review times based on specific circumstances. Many of these individual applications have been granted already by the European Commission. CTAC also issued licenses to third parties for the draft authorizations and therefore also non-CTAC members have used the data for their own applications for authorization.

Towards the end of the CTAC work in 2015 and upon request of CTAC members, several CTAC members agreed to submit an upstream application for authorisation under REACH[2]. A new consortium (**CTACSub**) was formed to jointly submit such upstream authorization. The application covered the use of chromium trioxide across six distinct use groups; Use Group 3 specifically addressed functional chrome plating with decorative character. The upstream application approach enabled different members of industry to pool experience, knowledge and resources during preparation of the application, supported consistency in terminology and expectations for substitution based on state of the science across industry. **REACHLaw as OR for JSC "NPCC" is a member of CTAC** but did not become a member of CTACSub. As outlined above, it submitted its own application that was using the CTAC reports. The CTACSub Consortium members or their legal successors are the current joint applicants for the Chemservice et al. application (for more information on the history of both CTAC[3] and CTACSub[4] please see links in footnotes).

This substitution plan arguments and updates information originally compiled between 2013 and 2015 and submitted by *Chemservice et al.* to ECHA in 2015 and later submitted by REACHLaw in its application as OR for NPC "JSCC".

[1] Formerly LANXESS Deutschland GmbH in its legal capacity as Only Representative of LANXESS CISA (Pty) Ltd.

[2] An upstream application is specifically foreseen by article 62(3) of the REACH Regulation.

[3] http://a1r.52d.myftpupload.com/wp-content/uploads/Press-Release-CTAC-Consortium.pdf

[4] http://a1r.52d.myftpupload.com/wp-content/uploads/Press-Release-CTACSub-Consortium-May-2015-Revised.pdf

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SUMMARY

Electroplating of chromium is used in several European industry sectors to impart specific functional performance, including a decorative aspect, to certain parts. These sectors include automotive, sanitary, furniture, medical, and various other sectors. The chromium trioxide-based plating process is complex and involves numerous steps, which depend on the parts to be treated (*e.g.*, substrate, surface area, size, number). In principle, the plating process can be divided into four sub-processes: pre-treatment, intermediate processes, main treatment and post-treatment. Chromium trioxide is used in the main treatment process and also during pre-treatment.

The Chemservice *et al.* application for authorisation was submitted in 2015 and there has been significant progress since 2015 towards the development of alternatives and successful substitution of functional chrome plating with decorative character (Use group 3). In order to gather Downstream User (DU) specific data on the current status of substitution, the CTACSub consortium performed a DU survey via online questionnaire in five languages (English, French, German, Italian, Spanish) from April 06th, 2020 to May 15th, 2020. The questionnaire was distributed as widely as possible via industry associations and in the supply chains of the applicants. The application for authorisation for Use 3 covers both chromium trioxide-based "Pre-treatment (etching)" and chromium trioxide-based main treatment ("Functional chrome plating with decorative character") of both metal and plastic products required by industry sectors in the scope of the application are covered. This is entirely consistent with prevailing guidance for the application process in 2015 (the date of submission of the application) whereas guidance now requests to consider chromium trioxide based pre- and main treatment processes separately. Furthermore, in the 5 years since the application for authorisation was submitted (2015 to 2020), different preferred paths to substitution have emerged for pre-treatment (etching) and main-treatment (plating) processes. Research and development have resulted in a clearer distinction between the substitution profiles for etching and plating as well as the market sector in which the specific product is used. The DU survey was developed accordingly. For a more detailed introduction, please refer to section **1**. The structure of the questionnaire is described in section **1.3**.

In summary, 851 questionnaires of DUs were evaluated for this substitution plan for Use 3. The annual consumption of CrO_3 amongst participating DUs varied. A median annual tonnage of 0.5 tons/a was calculated. The 90th percentile was 7.7 tons/a. The group consuming more than 7.7 tons/a comprised of 85 DUs. Around 60 % of the DUs reported that the sectors "Automotive", "Furniture" or "Sanitary" were their largest market sectors. In approximately a third of all cases, the DUs could not identify their market sectors within the pre-determined options and chose "Other" as the largest market sector. In fewer cases, the sectors "Medical" (5 %) or "Cosmetics" (2 %) were chosen. The largest proportion (84.4 %) of DUs reported to perform only chrome plating of metal substrates. The second largest fraction indicated to perform the combined sub-uses of chrome plating and etching of plastic substrates (8.1 %). The general statistics of the survey are presented in section **2**.

The DUs identified a range of challenges regarding substitution. Concerns relate to the unavailability of a "drop-in" alternative, technical (*e.g.*, surface property limitations) and process-related issues with alternatives, process implementation challenges, economic implications, customer and regulatory compliance requirements. For details on the identified challenges please refer to sections **3.1** and **3.2**.

Chromium(III) sulphate-based and Chromium(III) chloride-based electrolytes are currently the preferred alternative to CrO_3 for the chrome plating of plastic or metal substrates. For the etching of plastic substrates, the DUs preferentially chose permanganates and manganese salts as the most promising alternative (90 % of all answers). Sulfuric acid and phosphoric acid were chosen to a lesser extent (34 %). The preferences shifted for the etching of metal substrates, when (75 %) considered sulfuric acid to be the option of choice. However, also 30 % of the DUs employed with the chrome plating of plastic substrates stated that no alternative was generally available. In the group of DUs performing chrome plating of metal substrates, 50 % were in favor of this view. Regarding the etching, 22 % of the DUs pre-treating plastic substrates were of the opinion that no alternative was generally available. 53 % of the DUs performing etching of metal substrates stated that no alternative was generally available. The main factors leading to the opinion that no alternatives are available were identified as "Surface property limitations" and "Customer acceptance" (see sections **4.2.1** and **4.3.1**).

Hypothetical substitution timelines were integrated into the survey and DUs were asked to agree or disagree with this suggested timeline and justify their response. The timeframes proposed were the 30th of June 2023 for the market sectors "Automotive", "Furniture", "Medical", "Sanitary" and "Other" and 31st of December 2020 for the market sector "Cosmetics". DU agreement to these suggested timelines for chrome plating was generally low (around 25 to 31 %), with the exception of the very small sub-group performing chrome plating in the largest market sector "Cosmetics" (n = 2, 50 % agreement) (see section **4.2.2**). Similar results were found for the etching sub-uses, with agreement rates ranging from 14 to 32 %. No data were available for the etching of metal substrates in the identified largest market sector "Cosmetics" (see section **4.3.2**).

The low agreement rates to the substitution timelines are supported by information relating to the status of substitution, considering four general phases of a substitution program. In general, the vast majority of DUs reported that they had

not started the final substitution phases of "Commercialization / Industrialization of qualified alternative" or "Phase-out of CrVI / ramp-up of production to 100 % alternative". However, DUs reported they have made considerable progress in the earlier stages of R&D. The data illustrate that the DUs' substitution efforts were quite advanced in the steps of "Early Stage R&D" and "Qualification of preferred candidate alternative(s)". This statement can be made irrespective of the sub-use.

Substitution efforts were driven and managed differently by the participating DUs. DUs working with plastic substrates in the sub-uses of plating and etching indicated preference for "Regular meetings specific to R&D project" with the highest frequencies (69 % and 77 %, respectively) and "Allocation of a specific project manager to the R&D project" (60 % and 65 %, respectively). DUs working with metal substrates preferably chose "Other" management systems in the plating sub-use (46 %) and "Regular meetings specific to R&D project" in the etching sub-use (41 %). Generally, for both sub-uses with plastic substrates, higher implementation rates of most of the pre-determined monitoring systems were observed than by the DUs working with metal substrates. In general, the data suggest that the DUs working with plastic substrates have achieved a larger variety in regards of the monitoring options implemented but overall management systems to drive substitution are in place (see section **5**).

No EU-wide date of substitution could be concluded from the provided raw data. The responses from the DUs indicated different approaches to implementing the four phases; the time to complete each phase was reported, however, the data suggested significant variance in the degree of overlap between phases, so expected time to fully substitute could not be determined with confidence in each case. To work around this, an estimate on the total time to complete substitution was derived by assuming overlap of subsequent phases by 50 %. Practically this means that the summed duration of all phases (*i.e.* assuming all phases starting subsequently) was multiplied with a factor of 0.5; the factor was derived based on an analysis of DU responses from several sectors and sub-uses. The methodology for the analysis is presented in section **4.1**.

Only groups including more than 5 DU responses were analyzed in detail. In summary, the data suggest that the majority of the DUs that do not agree with the proposed timelines need at least 6 to 7 years to complete the substitution process. The individual sub-use and market sector specific timelines are presented in sections **4.2.3** and **4.3.3** as well as section **6**.

To assess the reliability of these estimated timelines, an analysis of the requested review period as well as the review period recommended by the RAC and SEAC and/or decided by the EU Commission from separately submitted AfAs for the same use was performed. Only AfAs filed by DUs performing functional chrome plating with decorative character were regarded, *i.e.* no upstream supply chain AfAs were considered. The information was retrieved from the ECHA website. The results are summarized in **Table 26**. Of note, the analysis revealed:

- the timeline of 6-7 years derived from the DU data in this survey probably marks an underestimation. The DUs (see **Table 26)** in most cases requested a review period of 12 years for either sub-use (etching or plating). A reason for this might be the methodology used to calculate the timeline. Another cause might be found in the difference to an individually filed AfA. It can be assumed that an individual AfA contains a higher degree of specificity regarding the applicant's processes and needs. It can also be considered that in an individual AfA, challenges may be depicted in greater depth and are customized to the applicant's situation.
- the RAC and SEAC agreed with the requested review periods and recommended periods of the same length, in all seven cases where opinions were already adopted. The EU Commission already followed this recommendation in two cases and approved the authorisation (one AfA submitted prior to and one AfA submitted after the sunset date). Those authorisations for the use of CrO_3 will expire in 7 to 11 years, making an example of time granted for the substitution to other DUs.
- Critically, only 11 AfAs – covering 28 (mostly large) companies and 20 uses – were submitted by DUs performing functional chrome plating with decorative character. This is in clear contrast to the 851 DUs that contributed data to this SP. It shows that only a very low portion of DUs (around 3%) has the benefit of single or group downstream applications and around 97% of the DUs depend on this upstream application.

In conclusion, our analysis indicates DUs require 6-7 years and likely more to successfully substitute CrO_3. However, given that the substitution process involves numerous uncertainties, prolonged substitution timelines cannot be excluded for some DUs, market sectors or sub-uses. The challenges described and analysed in chapter **3** can only be resolved by DUs and formulators working in close collaboration to further proceed with substitution across market sectors. This is reflected beyond the CTACSub AfA; considering standalone downstream AfAs submitted for similar uses, some critical issues of concern still remain unresolved as the requested, recommended and granted review periods range from 10 to 12 years for plating and etching, independent of the date of submission of the AfA. This is also supported by the small number of DUs employed with decorative chrome plating in the EU that have already substituted CrO_3 completely. Based on industry insights from the formulators forming CTACSub, less than 5 % of those DUs in the EU have completely substituted CrO_3 in decorative plating. For etching, numbers are even lower. These figures are consistent with the results from this survey showing that only a small number of DUs already finalized Phase 4 (Phase-out of CrVI / ramp-up of production to 100 % alternative) (see chapter **4.2.2** and chapter **4.3.2**).

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1. INTRODUCTION

1.1 Functional chrome plating with decorative character

Electroplating of chromium is used in several European industry sectors to impart specific functional performance, including a decorative aspect, to certain parts. These sectors include automotive, sanitary, furniture, medical, and various other sectors such as cosmetic packaging, consumer electronics, household appliances, building and construction, aerospace and military, fashion and jewellery etc.

The industry sector is diverse. There are companies that only plate for certain sectors (customers) or plate their own parts to be marketed, but there are also companies that plate for a variety of customers from different sectors with specifications determined by their customers (so-called job platers). A single chromium plating company may, therefore, serve dozens of customers and different industry sectors and may plate many different parts / components / articles. Many companies of both categories are small and medium-sized companies.

The chromium trioxide-based plating process is complex and involves numerous steps, which depend on the substrate of the part to be plated as well as the part (*e.g.*, surface area, size, number) to be treated. In principle, the plating process can be divided into four sub-processes: *pre-treatment*, *intermediate processes*[5], *main treatment* and *post-treatment*. Chromium trioxide is only used during *pre-treatment* and *main treatment* processes. Depending on the substrate (metal vs. plastic) of the part to be treated, the *pre-treatment* process does not always require chromium trioxide-based etching. However, the *main treatment* process always requires use of chromium trioxide. This combination of *pre-treatment* and *main treatment* results in four potential sub-use combinations, which are illustrated in **Figure 1** below.

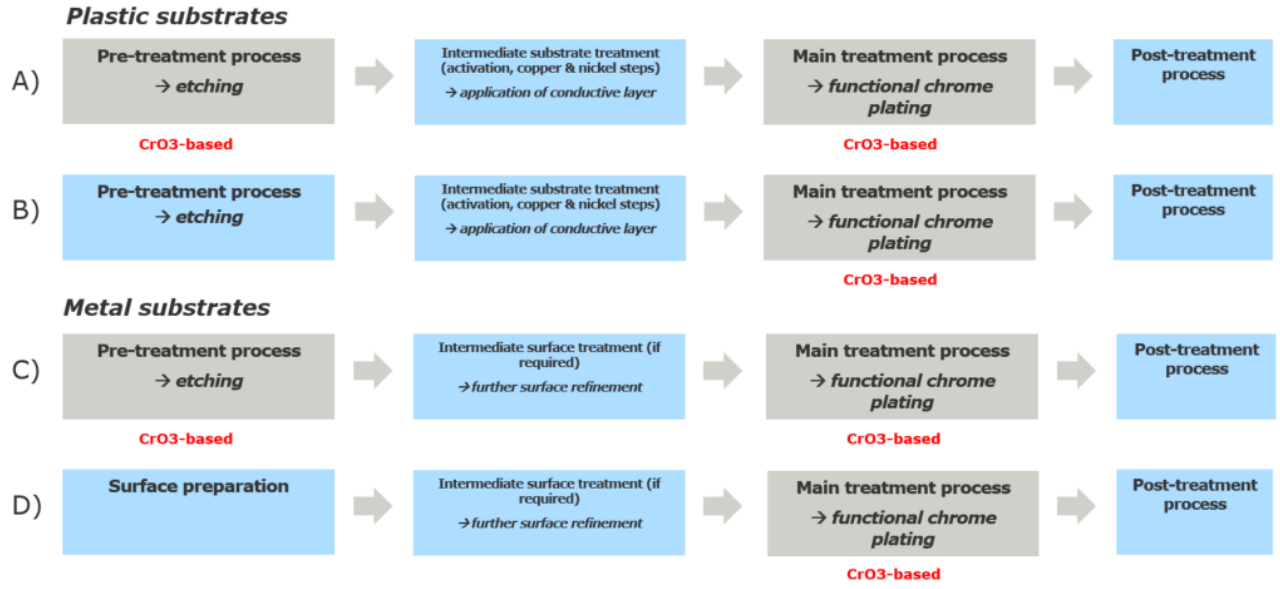


Figure 1: Potential combinations of chromium trioxide-related uses

Regardless of the respective combination, the steps in the plating process/system are highly interdependent; changes in a single step cannot be made without impairing the overall process or performance of the final product. Compatibility and technical performance of the overall system are of fundamental importance during material specification and therefore dictate the search for alternatives.

The initial application for authorisation by *Chemservice et al.* was filed in 2015. As would be expected, there have been significant further efforts invested in research and development of potential alternatives to chromium trioxide in the intervening 5 years. The applicants are aware of available technologies, but do not generally have access to (often commercially sensitive) information within the supply chain regarding progress (and impediments) to successful substitution of electroplating based on chromium trioxide. For this reason and to achieve representativeness of the Substitution Plan, *Chemservice et al.* elected to survey the downstream users (DU) of Use Group 3 to seek to gather

[5] For Plating on Plastics, intermediate substrate treatment involves activation and application of copper and nickel layers as pre-requisite for chrome plating step (→ creation of conductive surface layer)

current information about the status of substitution. The performance of this downstream user survey is described in detail in section **1.3**.

1.2 Current status of alternative development and substitution

Replacing chromium trioxide in etching and electroplating applications has challenged scientists for decades. The finished part has a durable metallic chromium coating which offers reliable safety in a variety of uses. Furthermore, the unique chemical characteristics of chromium trioxide, its relatively low cost and efficacy of waste treatment have proven impossible to replicate in an alternative substance or technology.

The electroplating industry has evolved over many years to reflect the needs of multiple, complex sectors, customers and supply chains. Formulators and platers have distinct and co-dependent capabilities and must work in close partnership. Due to the highly specialised nature of the surface treatment processes, research and development of alternatives to chromium trioxide in electroplating requires highly specialised expertise and is led primarily by the formulators. The formulators have dedicated resources for this activity and benefit from the collective expertise involved in implementing technology across multiple operations. Downstream users on the other hand typically do not have the expertise or funds available to conduct such research. They are also not able to optimise new technology on their own. Formulators thus provide expert support to industry in terms of offering, implementing and operating potential alternatives.

The information regarding alternatives for *plating* and *etching* below is based on the expert knowledge provided by formulators. It shows that significant progress has been made in terms of alternative development since the *Chemservice et al.* application for authorisation was submitted in 2015. The CrIII-based technology for *decorative plating* is now considered technically mature, meaning it is commercially available on the market. However, this is not yet true for etching, especially for etching plastics. Moreover, the technical readiness of (potential) alternatives, the successful substitution of both *etching* and *plating* requires each DU to first resolve various other concerns. These concerns are specific to the respective DU's operation, and therefore must be approached by DU and formulator in close collaboration.

Due to differences in chemistry and functionality, *pre-treatment (etching)* and *plating* must, be considered separately when defining substitution plans.

Main Treatment (plating)

In general, technical options for substitution of chromium trioxide for plating step are well developed, although alternatives have not been widely adopted due to increased complexity and cost. From a process technology perspective, hexavalent chromium (CrVI) may be replaced by trivalent chromium (CrIII) for plating applications. CrIII does not have the same concerns for toxicity to human health as CrVI, and CrIII-based processes are capable of depositing chrome metal coatings that closely match the characteristics of those produced from CrVI-based processes. However, CrIII-based processes have different operating requirements, that have implications for substitution:

- New equipment (tanks, anodes, pumps, filtration) is required for CrIII-based processes. This involves considerable financial outlay. Whilst it may be possible to retro fit existing lines subject to available space and the equipment configuration at any given site, this, involves a period of non-operation. Furthermore, retrofitting a line is not straightforward when it is necessary to phase out the use of CrVI gradually (*e.g.*, to respect existing contractual commitments).
- CrIII-based processes typically require longer processing times due to slower deposition rates, depending on their chemical formulation and desired coating quality. This can vary from 10-300 % longer processing times, which may require additional process tanks or tank volumes to ensure identical production output compared to CrVI-based manufacturing.
- Operating conditions and contamination levels for CrIII-based processes require specialist equipment and need to be maintained within relatively narrow ranges to ensure constant coating quality.
- Waste treatment of rinse waters requires a different approach as CrIII-based plating processes contain different acids, bases and complexing agents. Typically, rinse waters from CrIII-based processes need to be segregated from other waste streams and require four stages of chemical treatment (neutralisation, flocculation, settlement and filtration). Disposal of concentrated waste process solutions are typically treated by external specialist contractors.
- The costs of CrIII-based plating processes are, therefore, higher than CrVI-based processes due to:
    - lower deposition rates → longer processing times for comparable surface quality;
    - use of a more expensive trivalent chromium salt, formulations that contain complexing agents, chemical buffers, wetting agents and other proprietary compounds that increase their production costs;
    - higher wastewater treatment cost.

Pre-treatment (etching)

The substitution of chromium trioxide for etching (especially etching of plastics) is still challenging. Chromium trioxide has been used for etching for over 40 years. The chemistry used is widely known and is made from commodity substances readily available to all applicators. The latest substitution technologies have only been developed during the past 4-5 years and are currently at the industrial scale-up phase, i.e. experience regarding long-term commercial suitability on production lines remains limited. These new chemical etching processes require new specialist processing equipment, techniques and process control equipment. Such alternatives have the following implications / limitations:

- They are not able to treat all forms of existing *acrylonitrile butadiene styrene (ABS)* & *acrylonitrile butadiene styrene-polycarbonate (*ABS-PC) substrate material;
- Etching requires several extra processing steps to complete the process;
- Processing times are 10-25 % longer than conventional CrVI-based etching;
- New equipment is required for the etching process during chemical processing of the component (tanks, pumps, filtration & ancillary equipment). Depending on the local circumstances, it may be possible to retro fit existing lines, depending on the available space and equipment configuration. In any event, a complete line audit is required to establish conversion capability;
- The new etching processes require close chemical management to ensure efficient and effective operation. This may also involve new equipment for analysis and specially trained staff. Both can lead to additional costs.
- Waste treatment of rinse waters and waste solution is simpler compared to CrVI-based etching processes.

Many existing processing lines may be suitable for conversion, but this will not be the case for others that are not sufficiently sized. Furthermore, conversion may not be a straightforward option considering contractual commitments and requirements for business continuity.

Financial Investment

The financial investment and impact of substitution is significant. In order to substitute chromium trioxide in both *etching* and *electroplating*, an existing process line will have to undergo major reconfiguration or rebuild. The equipment cost of converting a single large processing line is estimated between 2-7 million €[6]. This does not consider other costs such as lost revenue during the conversion process and process optimisation. The extra costs for additional plating and etching tanks (required due to lower overall production output) in a new line sum up to around 10-15 % of the total investment.

Substitution support for DUs and timeframe for conversion (exemplarily)

Please note that the following example for a conversion project incl. description of content and time estimates is based on one individual formulator's experiences from actual conversion projects performed; its purpose is hence to serve as a single example to highlight certain experienced challenges but must not be understood as the general view of all formulators as well as of the industry and DUs. Please note further that it only describes the process of "Commercialization / Industrialization of qualified alternative" and is not valid for "Early stage R&D / testing of candidate alternatives" and "Qualification of preferred candidate alternative(s)". All these steps have to be completed before. In addition, it also does not take into account time for "Phase-out of CrVI / ramp-up of production to 100 % alternative". This view from the formulator's standpoint must be regarded as rather optimal. Specific circumstances at the DUs need to be considered when setting realistic timeframes for conversion of individual operations. This is discussed further in sections **4.2** and **4.3**.

The formulator estimated an average conversion time, including planning, site preparation, plant conversion, process evaluation, production line approvals from customers, training and production ramp-up between 18-36 months per production line. An overview of the process to implement the CrVI-free technology is provided in **Figure 2** below (Note: the process described in **Figure 2** is comparable to "Commercialization / Industrialization of qualified alternative").

DUs are supported by the formulator during the substitution and conversion process. This includes not only the supply of chemistry and equipment, but also intensive training and education. These customized services are part of the implementation programs. However, the formulator is also limited in its capacities to provide these substitution services. Thus, the switch to an entirely CrVI-free decorative plating process is not only dependent on the technical & economic capacities of DUs and the acceptance willingness of their customers, but also on the formulator's (production) capacities to provide equipment and service. In the formulator's opinion, this leads to a staggered conversion per market sector and DU and needs to be considered when setting dates for the substitution of chromium trioxide within the EU.

[6] Implementation costs estimated by formulator based on industry experience;

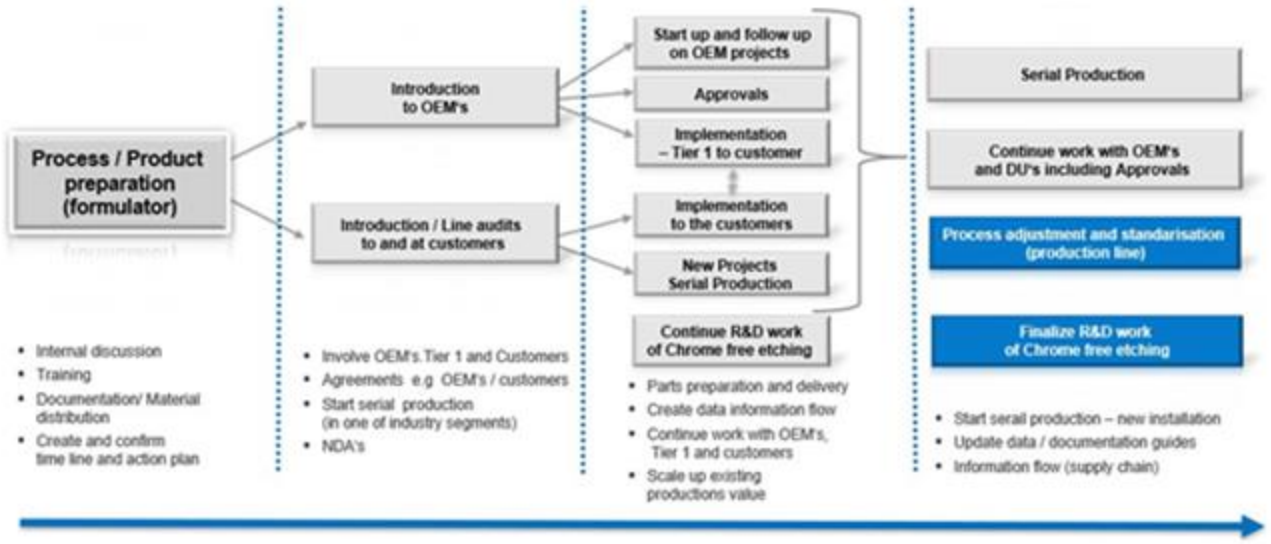


Figure 2: Example of implementation road map of CrVI-free production process

1.3 Survey to gather DU specific data for Use 3

The *Chemservice et al.* application for authorisation was submitted in 2015 and, as anticipated in that application, there has been significant progress since 2015 towards the development of alternatives and successful substitution of chromium trioxide in plating processes with decorative character.

In order to gather DU specific data on the current status of in-field substitution of chromium trioxide in *Chemservice et al.'s* Use group 3, the CTACSub consortium performed a DU survey via online questionnaire in five languages (English, French, German, Italian, Spanish) from April 06th, 2020 to May 15th, 2020. The questionnaire was distributed as widely as possible via industry associations and in the supply chains of the applicants. Following the contractual agreement, the survey was extended to include the supply chain of *REACHLaw (as OR for JSC "NPCC").* **The survey and this report, therefore, address DUs in the supply chains of *Chemservice et al.*, its joint applicants and *JSC "NPCC"*.**

To ensure full engagement in the survey and encourage DUs to supply accurate and comprehensive data in the questionnaire, participation in the survey was deemed mandatory for all DUs that would seek supply following August 24th, 2020[7]; those that did not participate in the survey were considered to have successfully substituted their use of chromium trioxide such that suppliers would not make deliveries of chromium trioxide from August 24th, 2020 onwards.

The CTACSub consortium communicated the necessity for survey participation and above-mentioned consequences for non-participation to the DUs by a letter of March 30th, 2020. The same was done by REACHLaw (see **Annex II**). The letter was distributed via the CTACSub and JSC "NPCC" supply chains (*i.e.* via intermediate formulators/distributors of chromium trioxide) and industry associations.

To participate in the online survey, DUs had to first register with their contact and legal entity information to receive a company-specific survey link to the survey. To increase awareness regarding the need to participate and to explain how to complete the survey (and thus improve data quality/validity), DUs were invited to webinars in which instructions on how to fill the online questionnaire were presented and to give them further background information on the requested substitution plan. The webinars were held in five languages (English, French, German, Italian, Spanish) and DUs were given the opportunity to ask questions. The webinars were also recorded so that DUs could access them at any time throughout the survey. We note that the data gathering exercise was held while the COVID-19 virus lockdown was in force in numerous Member States, while many DUs were non-operational and staff furloughed. Therefore, upon request, several DUs were given additional time to respond. To further ensure a high survey response rate, formulators and distributors provided their sales force and account managers with background information and training regarding the survey to allow them to support their customers directly.

It is noted that the application for authorisation for Use 3 does not separate chromium trioxide-based pre-treatment (etching) and chromium trioxide-based main treatment (chrome plating), or differentiate substrates (metals vs.

[7] DUs that participated in the survey received documentation of participation that could be provided to their suppliers to ensure future supplies.

plastics), products or applications (*i.e.* industry sectors in the scope of the application). This is entirely consistent with prevailing guidance for the application process in 2015 (the date of submission of the application) whereas it is now guidance and best practice to consider chromium trioxide based pre- and main treatment processes separately and consider substitution profiles (*i.e.* most-promising alternatives and substitution timelines) for each separately. Furthermore, in the 5 years since the application for authorisation was submitted (2015 to 2020), different preferred paths to substitution have emerged for pre-treatment (*etching*) and main-treatment (*plating*) processes. Research and development and increased attention to documenting progress since 2015 have resulted in a clearer distinction between the substitution profiles for *etching* and *plating* as well as the market sector in which the specific product is used. The DU survey was developed accordingly.

The survey consisted of five sections. Depending on circumstances some or all of these sections would apply for each DU.

The first section requested general information on the company's supplier, use of CrO_3, major market sectors of Cr(VI)-related products and respective share of CrO_3 for each market sector. The participants could choose from the following six options (more than one choice possible):

1. Sanitary
2. Automotive
3. Medical
4. Cosmetics
5. Furniture
6. Other

According to their selection, the DUs were asked to provide additional information on the CrO_3-surface treated articles/article group (*e.g.,* medical instruments) and the end-application (*e.g.,* surgical instruments for hospitals). At the end of the first part of the survey, the DUs were asked to identify the processes using CrO_3 as well as the annual tonnage used for the respective process. The DUs could choose from the following sub-uses of Use 3 (more than one choice was possible):

1. Functional chrome plating with decorative character of **plastic** substrates (Part 2)
2. Functional chrome plating with decorative character of **metal** substrates (Part 3)
3. Pre-treatment (etching) of **plastic** substrates (Part 4)
4. Pre-treatment (etching) of **metal** substrates (Part 5)

Based on the DU's selection of sub-uses of Use 3, parts 2 to 5 of the survey were automatically presented to the DUs (see also section **4.1**). In these, the DUs were asked to provide information on their company-specific substitution scenario for the corresponding sub-uses selected. For each selected use, the DU was asked to provide information on their preferred alternative(s) and on the limitations/obstacles to implementation based on their largest market sector (measured in % annual chromium trioxide consumption).

Suitable alternatives generally available: SAGA

The DU survey was initiated before ECHA officially announced during the Eurometaux/CETS seminar (May 28, 2020) that the concept 'suitable alternatives generally available (SAGA)' is valid for functional chrome plating with decorative character. Accordingly, the survey still allowed DUs to select 'no alternative generally available' for their use-specific substitution scenarios. However, the survey also required DUs to respond to suggested timelines for substitution (see below) and required them to indicate if and why they could not meet these timelines. By indicating such timelines from the outset in the questionnaire, the default assumption of the survey was, therefore, that suitable alternatives were generally available.

The DUs were asked to contemplate on a substitution timeline for their largest market sector. For doing so, the DUs were presented with and asked to provide the estimated time for completion of four, generally applicable, phases in the research and development of alternatives:

1. Early stage R&D / testing of candidate alternatives
2. Qualification of preferred candidate alternative(s)
3. Commercialization / Industrialization of qualified alternative
4. Phase-out of CrVI / ramp-up of production to 100 % alternative

The proposed substitution timelines in the questionnaire were drawn from the draft decision on *Chemservice et al.'s* and *REACHLaw's (as OR for JSC "NPCC")* Use group 3 adopted by the REACH Committee in February 2019. This draft decision refers to 4 years from the date of decision (which would have meant approx. June 2023). This was adapted in the case of cosmetic applications because the applicants had obtained some information from individual companies that substitution could be possible by December 31st, 2020. However, in the survey, DUs from the cosmetics sector had the opportunity to disagree to that suggested timeline. Thus, for each selected sub-use (part 2 to part 5), DUs were asked whether or not they agree with the indicative timeline for substituting CrO_3 in their largest market sector until the following dates:

Table 1: Suggested substitution dates for largest market sector

Date	**Largest market sector [% annual chromium trioxide]**
December 31st, **2020**[8]	Cosmetics
June 30th, **2023**[9]	Sanitary, Automotive, Medical, Furniture, Others

Please refer to section **3.2** for detailed information on the evaluation and results concerning substitution timelines.

With respect to the company specific substitution scenario, the DUs were further requested to indicate detailed information on technical (*e.g.*, implementation) and economic risks, obstacles, uncertainties or factors that could impact the substitution timeline provided (see section **3**).

Finally, the DUs had to describe the system(s) in place to monitor and document the progress and implementation of their company specific substitution plan (see section **5**).

[8] Indicative timeline based on industry knowledge.

[9] Indicative timeline based on EU COM draft decision for Use group 3 *(Chemservice et al. & REACHLaw (as OR for JSC "NPCC"))*

2. GENERAL STATISTICS

2.1 Sample sizes

In total, >1400 surveys were submitted by DUs until the deadline of May 15, 2020. These included a considerable number of incomplete surveys caused by double registrations from representatives of the same legal entity, distributors, etc. Also, some surveys were received from companies that did not carry out functional plating with decorative character (*e.g.*, covered under Use 2 of CTACSub).

Ramboll checked all correctly submitted questionnaires for completeness (*i.e.*, all questions answered). 832 surveys were deemed suitable for subsequent analysis. From the first responses, several DUs were contacted and asked to provide additional information. Furthermore, as requests for participation were received after the deadline, a second survey was set up which remained open until June 08, 2020. 25 additional questionnaires were collected during that second survey of which 19 were considered complete and integrated into the existing dataset.

In summary, therefore, 851 questionnaires were evaluated for this substitution plan. Please note that DUs were allowed to give more than one answer for several questions. Also, depending on the answers given, not all sections of the survey were necessarily presented to the participants. Furthermore, in several cases individual data were excluded as they were regarded as invalid and not fit for evaluation. The number and justification for doing so is indicated at the respective section of this document. All analyses were performed with Microsoft Excel (2016).

2.2 Tonnage and market sectors covered

The participating DUs comprise a range of different company sizes in regard to the secondary measure of the annual consumption of CrO_3. Four responses were excluded as they stated an invalid annual tonnage (≤ 0)[10]. Approximately one quarter (n= 209, 24.7 %) of the companies uses amounts of ≤ 0.1 tons CrO_3/a. A median annual tonnage of 0.5 tons/a was calculated. The 90th percentile was 7.7 tons/a. The group consuming more than 7.7 tons/a comprised of 85 DUs. A histogram covering all assessed companies is given in **Figure 3**.

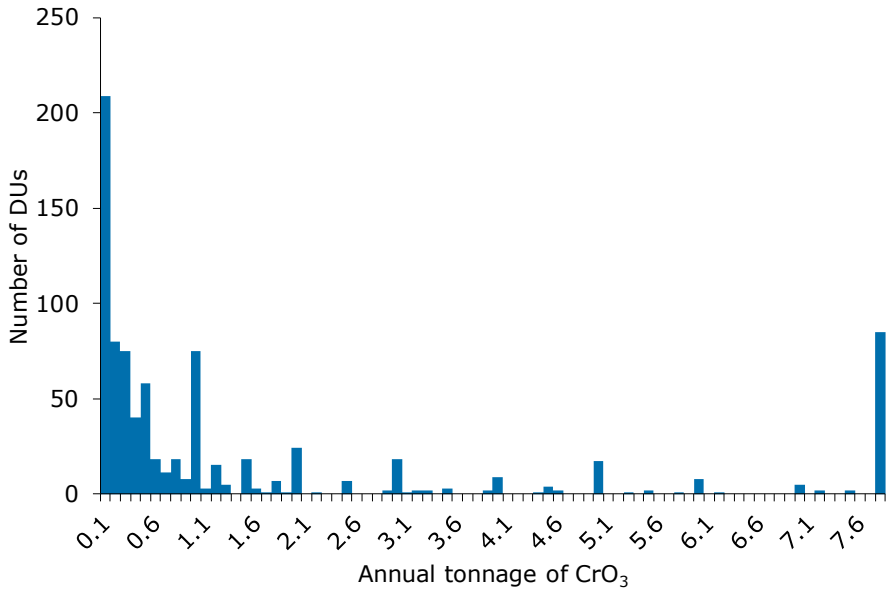


Figure 3: Histogram of the number of participating DUs separated by their annual tonnage of CrO3

Presented is the number of DUs within the 90th percentile (= 7.7 tons/a) of the annual CrO_3 consumption. The DUs are sorted using bins of 0.1 tons/a. All DUs outside the 90th percentile (> 7.7 tons/a) are summarized in an individual bin. Four DUs with invalid statements regarding their annual tonnage (≤ 0 tons/a) were excluded.

[10] 1 DU reported a negative value

As described in section **1.3**, the DUs were asked to provide information about their associated market sectors (% of CrO_3) from a list of six pre-determined sectors (Automotive, Cosmetics, Furniture, Medical, Sanitary and Other). The largest market sector was identified from the information provided on the tonnage/share of tonnage used. The answers of eight DUs were excluded as they did either not provide information on the largest market sector (n = 4) or the largest market sector was not identifiable as the market share was entered as "0" (n = 4). In case of same-sized market sectors, all those with the same and largest sizes were included in the assessment. From the identified largest market sectors (n = 932), the sector "Other" was the largest sector in 34 % of all cases. The sectors "Furniture", "Automotive" and "Sanitary" were chosen with a comparable frequency (19 to 21 %, respectively). The sectors "Medical" (5 %) and "Cosmetics" (2 %) were less abundantly identified as the largest market sectors. Please note that the distribution of market sectors shown here does not necessarily reflect the actual situation in terms of production volume or revenue created. This is because the largest market sectors in this survey were identified from the tonnage/share of tonnage of CrO_3 used by the DUs; the results here are thus only a representation of the primary field of work of the participating DUs. It should also be considered that the analysis is based on the available data provided by the survey participants and certain areas might be underrepresented due to individual applications for authorization (*e.g.,* by automotive platers and sanitary ware manufacturers which are generally larger organisations). The data are graphically presented in **Figure 4**. A non-exhaustive list of product groups and end-applications manufactured by the participating DUs is provided in **ANNEX III.**

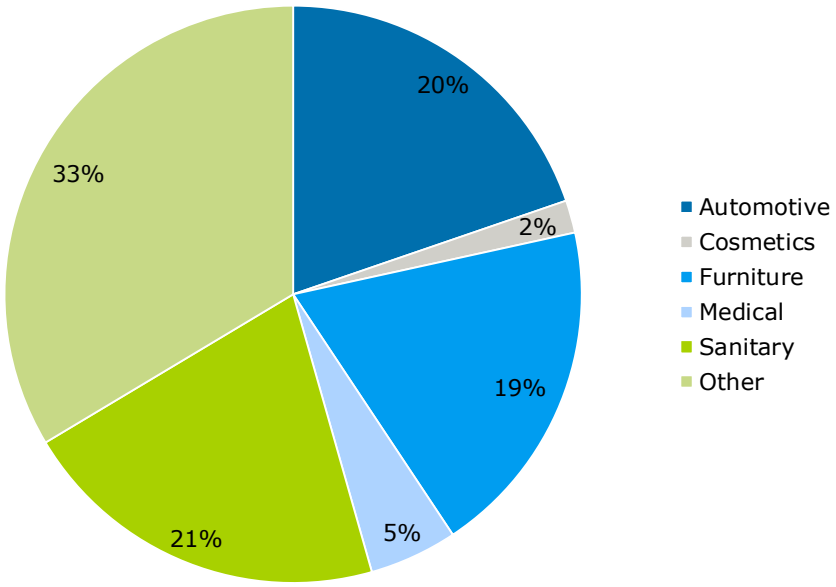


Figure 4: Primary field of work of the participating DUs based on the largest market sectors identified

The figure shows the distribution of the largest market sectors of the participating DUs. For each DU, the largest market sector was identified from the information provided on the tonnage/share of tonnage used. The sectors "Automotive", "Furniture" and "Sanitary" make up 2/3 of the analyzed market. In approximately a third of all cases, the DUs could not identify their market sectors within the pre-determined options and therefore chose "Other". In fewer cases, the sectors "Medical" or "Cosmetics" were chosen. In the case of same-sized market sectors, all same-sized and largest sectors were counted. The total number of identified largest market sectors was 932. Please note that this distribution does not represent the actual size of the different sectors but rather highlights the primary field of work of the participants.

In addition to the largest market sectors, an analysis of the summed tonnage used by each market sector was performed. For this, all reported market sectors were counted, and the analysis was not restricted to the largest market sector identified. The analysis needs to be contemplated with care though because of the statistical restrictions that had to be applied to the dataset. The reasons are described in the following.

DUs were asked to provide information on the percentage share of the tonnage of CrO_3 for each market sector. However, as the format of the values was not inherently restricted by the survey, a range of DUs clearly reported values in the units of kg or tons. This subsequently caused that it could not be universally distinguished between DUs that intentionally reported a sum of shares below 100 % (*e.g.*, companies which might have wanted to suggest that they did not exclusively use all of their total tonnage of CrO_3 in the market sectors asked for "Use 3") and those that reported their shares in the units kg or tons. To avoid misinterpretation of results, the dataset was restricted to DUs which reported a sum of shares per market sectors equal to 100 %. The individually reported shares (%) were then integrated with the reported total annual tonnage to calculate tonnage values for each market sector. In case the same market sector was reported several times by one DU, the tonnage for this market sector was summed.

Moreover, to avoid overestimation of individual sectors, the market sector tonnages were only calculated for all values within the 90th percentile of the total annual tonnage. Under these premises, still 660 DUs were analyzed (**Table 2**). The summed tonnage used was largest for the market sector "Sanitary" with a sum of 206 tons CrO_3. Only slightly smaller is the consumption in the sector "Other" (198 tons), while a similar consumption was found for the sectors "Automotive" and "Furniture" (120 tons each). Considerably smaller values were deduced for the sectors "Medical" (19 tons) and "Cosmetics" (15 tons). While the order of results highlights the smaller extent of the sectors "Medical" and "Cosmetics", the results for the other sectors are surprising. In correspondence with the industry, it was expected that the "Automotive" sector would come out as the largest sector. However, by restriction of the dataset to DUs with an annual tonnage within the 90th percentile, the data may be biased.

To test if this might be the case, the data were also analyzed when restricted to all DUs within the 95th percentile of the annual tonnage (19.7 tons, 701 DUs). When doing so, a shift is observed, and the automotive sector can be identified as the market sector consuming the highest tonnage of CrO_3. Also, the annual consumption within the sectors "Sanitary" and "Other" is increased by ~ 100 tons each.

Please note again that, because of the uncertainty of this specific data, these specific results should be treated with care.

Table 2: Summed tonnage of each market sector

	Annual consumption of CrO_3 per sector (tons)	
	90th percentile [1)]	95th percentile [1)]
Automotive	120	357
Cosmetics	15	50
Furniture	120	128
Medical	19	25
Other	198	282
Sanitary	206	316

[1)] Dataset restricted to DUs with an annual tonnage within the 90th and 95th percentile, respectively

2.3 Sub-uses performed by the DUs

The DUs were asked to provide information on the sub-uses they perform. As described earlier, the DUs could choose from four sub-uses which are referred to as sub-use 1 to 4 in the following:

1. Functional chrome plating with decorative character of plastic substrates (sub-use 1)
2. Functional chrome plating with decorative character of metal substrates (sub-use 2)
3. Pre-treatment (etching) of plastic substrates (sub-use 3)
4. Pre-treatment (etching) of metal substrates (sub-use 4)

The DUs were able to choose up to four of the sub-uses, and 848 DUs provided information regarded as valid. Three DUs were generally excluded from this analysis as no share (= 0) was allocated to either sub-use reported and therefore no conclusion on the validity of the answer could be made.

The largest proportion (84.4 %) of DUs performed "Functional chrome plating with decorative character of metal substrates" as their only field of work (**Table 3**). The second largest reported fraction was a combination of the sub-uses "Functional chrome plating with decorative character of plastic substrates" as well as "Pre-treatment (etching) of plastic substrates (8.1 %). 12 DUs reported to perform only "Pre-treatment (etching)" sub-uses (Use 3, Use 4). Those few cases may reflect both very specific situations at the sites of DUs or a misapprehension of the survey; as the total proportion of cases is only 1.4 % of the total sample they may be considered as less relevant to describe the sample. A

graphical presentation is provided in **Figure 5**. In this, all sub-uses and sub-use combinations < 1 % are summarized as "Other" for visual clarity.

Table 3: Sub-uses and combinations of sub-uses performed by the DUs

Sub-uses performed [1)]	Responses	
	n	%
Sub-use 1	16	1.9
Sub-use 2	716	84.4
Sub-use 3	7	0.8
Sub-use 4	5	0.6
Sub-use 1 & 2	3	0.4
Sub-use 1 & 3	69	8.1
Sub-use 1 & 4	0	0.0
Sub-use 1, 2 & 3	14	1.7
Sub-use 1, 2 & 4	3	0.4
Sub-use 1, 3 & 4	0	0.0
Sub-use 1, 2, 3 & 4	1	0.1
Sub-use 2 & 3	0	0.0
Sub-use 2 & 4	14	1.7
Sub-use 2, 3 & 4	0	0.0
Sub-use 3 & 4	0	0.0
Sum	848	100.0

[1)] **Sub-use 1** refers to "Functional chrome plating with decorative character of plastic substrates", **Sub-use 2** to "Functional chrome plating with decorative character of metal substrates", **Sub-use 3** to "Pre-treatment (etching) of plastic substrates" and **Sub-use 4** to "Pre-treatment (etching) of metal substrates".

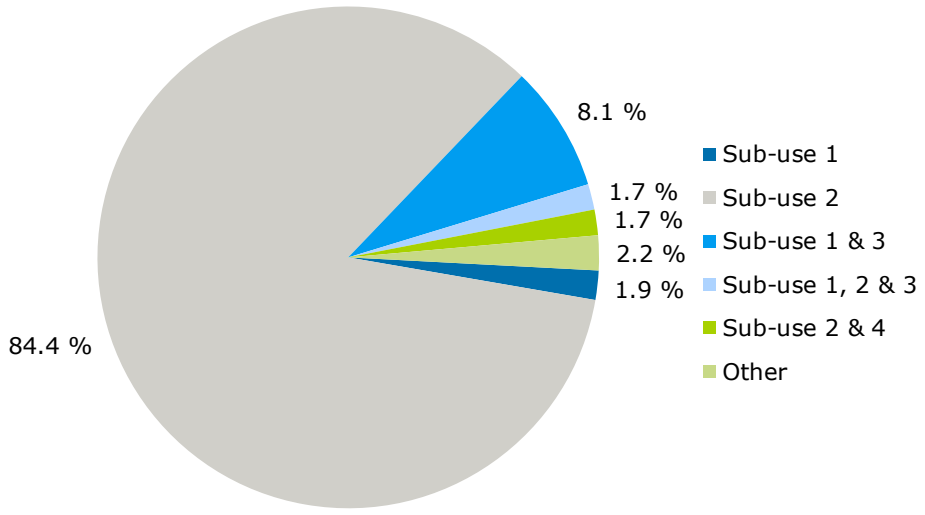


Figure 5: Distribution of processes performed by the participating DUs

The DUs could select more than one answer on the sub-uses performed and therefore a range of combinations of the sub-uses was possible. The combinations are listed in the graph above for 848 DUs. Three DUs did not report a corresponding share to any of the reported sub-uses and were thus excluded from this analysis. The large majority of DUs (84.4%) reported to perform solely "Functional chrome plating with decorative character of metal substrates" (Use 1). The second largest fraction of DUs (8.1 %) reported to perform "Functional chrome plating with decorative character of plastic substrates" (Use 1) in combination with "Pre-treatment (etching) of plastic substrates (Use 3).

3. FACTORS AFFECTING SUBSTITUTION – SURVEY FEEDBACK FROM DUS

In this section, the most important factors affecting the substitution of chromium trioxide and the corresponding substitution timeline are described based on the data set obtained from the survey. The factors/limitations/obstacles are presented for the sub-uses "Functional chrome plating with decorative character" and "Pre-treatment (etching)" separately, but no further breakdown into substrates and/or market sectors was considered due to the high similarity of the DUs' responses. There are of course several substrate- product- and/or market sector-specific issues which currently limit the applicability of alternatives, but the most important factors impacting substitution and its timeline are more high-level and of a general nature (*i.e.* not related to a specific market sector or substrate).

Therefore, we have highlighted the most important factors on a high-level or general basis, but with sufficient detail to cover the entire data set of responses, *i.e.* the differences, difficulties and concerns of 851 DUs. To identify the most important factors, a sample of 164 responses was checked manually, and factors were reviewed, listed and grouped. This sample was created by screening the entire data set of 851 questionnaires for high-quality information regarding substitution efforts and challenges.

The factors/limitations/obstacles described below reflect the DUs' statements regarding applicability of alternatives. However, these accord well with the information independently provided by formulators (see section **1.2**).

Section **3.1** and **3.2** do not show a quantitative linkage between factors/limitations/obstacles to substitution and substitution timelines/delays. Section **4** provides detailed information on use and market sector specific substitution timelines.

3.1 Functional chrome plating with decorative character – DU perspectives on challenges to overcome on the way to substitution

The factors/limitations/obstacles mentioned below relate only to CrIII-based alternatives. This is in good accordance with **Figure 6**, which shows that most DUs consider CrIII-based technologies the most promising alternative for substitution of chromium trioxide.

No "drop-in" alternative

DUs stated that still the biggest and far-reaching limitation for substitution is that there is no drop-in alternative to chromium trioxide available which can be applied using identical process equipment, identical wastewater treatment systems and which allows manageable process control (*e.g.*, bath analytics) on a commercial scale.

Indeed, while the commercially available CrIII-based alternatives basically follow the same process principle (*i.e.* electroplating based on the principle of electrolysis), they need completely different process equipment and wastewater treatment systems. Furthermore, process control and process stability are more complex[11] than chromium trioxide technology and require additional equipment (*e.g.,* atom adsorption spectrometry) and/or support from external experts (*e.g.*, formulators). In addition, for DUs, the CrVI-based technology still has the advantage of being capable to treat a larger scope of substrates (*e.g.*, different metal or plastic compositions), components, component geometries, etc. while keeping process control low. This consideration is relevant as most DUs do manufacture many different products made from different substrates and geometries. For these DUs, the alternative process selected and implemented must be suitable to cover their product portfolio to allow to continue profitable business.

Technical challenges

Surface property uncertainties

The technical surface performance requirements (*e.g.*, wear, corrosion and chemical resistance, etc.) of products need to be tested under serial conditions to prove technical maturity. DUs stated that challenges to meet these serial approval requirements are the main driver for extended substitution timelines. This is further complicated as different OEMs from the same market sector (*e.g.*, automotive) have different approval processes and requirements. This affects alternative development timelines, as the complete switch to an alternative technology by a DU is only possible once all (indispensable) customers have accepted the change (*i.e.* products are in compliance with their individual technical test requirements) and maintain their business relationship. In other words, for most DUs, one alternative process must be suitable to fit all customers (also from other market sectors) in order to be considered an economically feasible change.

In the current highly competitive EU market, there is no trend or requirement for standardization among OEMs concerning decorative criteria (surface appearance/color, haptics, etc.). Indeed, CrIII-based technology (in combination

[11] CrIII-based electrolytes have narrow operating window regarding chemical composition, concentration of chemicals, additives, pH level, etc. In addition, CrIII-based electrolyte are very sensitive to impurities carried over from previous processes.

with a specific CrIII-based electrolyte) is capable to deliver a broad range of different surface appearances and colors (white to dark). While this represents a business opportunity for DUs (*e.g.*, entering new market and customers) on the one hand, on the other hand it also presents challenges for existing contracts as the switch to a specific CrIII-based formulation results in a specific optical appearance that differs from the previously agreed specification. DUs need to decide very carefully and in close collaboration with their different customers if, and when they can perform the switch together.

Process-related challenges

DUs stated that the process control for CrIII-based plating baths is complex as many variables (CrIII concentration, pH level, concentration of additives, etc.) need to be monitored exactly on commercial scale production to enable constant product quality. As CrIII-based bath chemistries are very sensitive to contaminants and, therefore, have a very narrow process window, flawless process monitoring is crucial to deliver constant product quality. Slight variations in the chemical bath composition (*e.g.*, cross contamination from previous nickel treatment) already cause color differences between production batches. This causes an increased scrap rate and thus higher costs per part. Increased process monitoring is required, which can be solved with support from technical experts (*e.g.*, formulators), but requires additional time, cost and expertise to master.

Process implementation challenges

DUs stated that the transfer of technology from CrVI → CrIII involves substantial and costly reconstruction of their plants as the CrIII technology has significant higher space requirements (CrIII plating lines are 10 to 15 m longer). Therefore, additional space needs to be created at the sites (if possible), entailing plant modification (*e.g.*, additional buildings) and additional regulatory approvals, often including an environmental impact assessment. These challenges are aggravated by the fact that the CrVI-based process needs to run in parallel during the transition period, *i.e.* phase out of CrVI-based serial production parts and ramp-up of serial production parts manufactured with the alternative.

Additionally, the DUs stated that the wastewater treatment systems need to be completely updated as the chemicals involved in the CrIII formulation require significantly more complex technologies (*e.g.*, wastewater evaporation, UV / peroxide treatment systems, etc.) to be reduced to levels which comply with respective national waste water discharge limits.

Economic challenges

DUs stated that their biggest concern regarding technology transfer from CrVI to CrIII is competitiveness against EU-based companies with granted authorisations for continued use of chromium trioxide, often for 12 years, and non-EU companies which are able use chromium trioxide today and in the future. The reason behind is that market prices for CrIII-based products are between 15-30 % higher due to higher production & running costs (wear parts (*e.g.*, anodes), process chemicals, process control, process time (approx. 3x higher resulting in lower production output and higher energy consumption)[12]. However, the increased overall production costs cannot be passed on to the customers. Customers are not willing to accept additional costs caused by regulatory requirements affecting certain suppliers, as long as cheaper alternatives, *i.e.* parts from other EU suppliers with an authorisation or non-EU suppliers[13] exist.

The technology transfer from CrVI to CrIII requires significant investments to be made by the DUs. Per plating line (without etching) approximately 1-2 mio € need to be calculated for the equipment change only. This does not include DU-specific costs for plant modifications (*e.g.*, new buildings, wastewater system, etc.) and costs related to compliance requirements according to national regulations.

Customer-related challenges

As indicated above, the usage of a specific CrIII-based formulation results in specific surface properties, especially regarding optical appearance (*e.g.*, color). Thus, it is very challenging for DUs to switch to a specific CrIII formulation when supplying different customers having different color specifications for their parts. Vice versa, customers purchasing parts from multiple suppliers potentially demand identical surface properties from their chrome-related supply chain.

Concluding, for DUs supplying multiple customers, the switch to a specific CrIII-formulation carries a significant risk to lose customers due to non-compliance with their part specifications. Customers can easily switch to non-EU suppliers in case EU suppliers are struggling to meet their requirements due to the substitution process.

[12] Note: Investments for plant reconstruction, equipment, regulatory compliance, etc. are not included;

[13] Note: No hazard arises from metallic chrome coating deposited from Cr(VI)-based electrolytes and therefore chrome plated articles from non-EU are allowed to be imported into the EU

The situation is further complicated as customers do not allow their supplier to change the plating system in active serial productions if this presents a risk to product approval (*e.g.,* absence of tests proving lifetime requirement of product/surface). If DUs would perform a change for the serial production, *i.e.* change of the plating system, they would need to perform the product approval at their own cost, which is not economically feasible for any active serial production. In other words, DUs must phase out the CrVI-based serial productions for which contracts have been signed (before the plating system can be changed). For the phase out, sufficient time is required.

Compliance and regulatory challenges

As indicated above, the switch to the CrIII-based technology requires massive plant reconstruction for which additional space is needed. According to national environmental legislation, additional space requirements could require a time-consuming environmental impact assessment before the actual plant modification is possible.

An additional regulatory aspect is that there is currently a high uncertainty concerning the effectiveness of the treatment of the wastewater resulting from the CrIII-based technologies. DUs stated that the issue of potential chemical cross reactions is not resolved. This is especially aggravated by the complexity of CrIII-based formulations, the availability of different formulations from different formulators and the resulting lack of experience from serial production.

3.2 Pre-treatment (etching) – challenges to overcome on the way forward to substitution

Please note that the factors/limitations/obstacles mentioned below are not related to a specific alternative but cover the general limitations for the alternatives shown in **Figure 22** and **Figure 23**. Furthermore, the limitations/factors/obstacles stated by DUs are very specific for the "Pre-treatment (etching) of plastic substrates". However, this is in good accordance as only a very small number of the 851 DUs performs etching of metal substrates.

No "drop in" alternative

DUs stated that for the "Pre-treatment (etching)", no drop-in alternative is available on the market that can be applied using the CrVI technology, *i.e.* process equipment, wastewater treatment system, etc. This is aggravated by the fact that a CrVI-free formulation is specific to the formulator producing the mixture, highly complex in its composition and therefore requires the alternative etch process to be specifically adjusted. For DUs this is highly restrictive regarding the choice of formulators (→ high dependency) and especially critical regarding the actual switch of technology as investments for equipment, wastewater treatment system, new buildings, etc.) are made for **one** specific formulation (→ not "simply" possible to switch to another formulator on a commercial scale as series production equipment is specifically built and adjusted for **one** formulation). In other words, the "chosen" alternative technology must not fail on a commercial scale as investments for repeated technology changes are simply not possible.

Concluding, the change to an alternative technology to CrVI-based etching is a challenging and long-lasting process for the DUs affected. DUs need to be absolutely sure about the success of the **one** technology they are going for as additional investments are in most cases not possible, especially for small and medium sized companies. In addition to that, DUs are not formulators themselves and therefore are highly dependent on the technologies appearing on the market.

Technical challenges

DUs stated that the commercially available alternatives still show deficiencies compared to the CrVI-based etching technology *e.g.*:

- adhesion of PoP[14] layer to base material is only sufficient for minority of parts (certain chemical compositions of plastic substrates, certain component geometries, etc.) manufactured by DUs → alternative etching process currently not yet applicable in series production where one process must fit all parts to be manufactured; it is ot possible for DUs to implement multiple variants of alternative etching process to cover the entire product portfolio due to technical (*e.g.,* complexity of process alignment between CrVI-free "etching" and "plating", space requirements, etc.) and economic reasons (*e.g.*, plant reconstruction, running costs, etc.);
- application of selective chrome coating on two or more component plastics only partly possible on parts etched with alternative process → product portfolio of companies performing PoP includes various plastics substrates and thus etching alternative need to be developed further to be suitable for all parts to be manufactured;
- lifetime requirements for product/surface are currently lower compared to parts etched with CrVI-based process (*e.g.,* chrome coatings applied on parts etched with CrVI-free process are not resistant to temperature/climate changes);

[14] Plating on Plastics (PoP) consists of the deposition of a metal multilayer system on a non-conductive surface.

Additionally, DUs stated that the additional space required for the implementation of an alternative "Pre-treatment (etching)" in parallel to an alternative plating processes is challenging as the "old" CrVI-based process variant needs to be run in parallel as long as the "last" series production of CrVI-based parts is finished (note: DUs have contractual supply obligations with their customers). DUs simply do not have enough free space at their production plants to perform parallel implementation of two alternative processes (*i.e.* etching and plating) and therefore envisage a staggered approach (→ first implementation of alternative plating process → transition to 100 % alternative plating → deconstruction of "old" CrVI-based plating process → start implementation of alternative etching process → time required for 100 % transition to alternative etching process (*i.e.* 100 % CrVI free overall plating process).

Economic challenges

As indicated in the paragraph above, the switch of technology (*i.e.* transition from "old" CrVI-based etching to "new" alternative etching) and the corresponding phase out of the CrVI-based technology would require both processes to be run in parallel for a certain amount of time (→ transition period). For DUs it is economically challenging to have two commercial etching processes (*i.e.* CrVI-based and CrVI-free) implemented in parallel. Therefore, the implementation must be performed with extraordinary care to reduce risk of technical failure on a commercial scale.

Besides these risks, there are additional economic risks which are caused by higher prices for the alternative formulations (estimation based on current prices for commercial alternatives) which lead to higher process costs (→ 50-100 % higher compared to CrVI-based etching process) for "Pre-treatment (etching)" only which in turn impacts the price of the end product. This has negative impacts on the DUs' competitiveness (as already indicated under section **3.1**). Higher production costs and thus higher prices for end products carry a risk for DUs to lose business if their customers are not willing to accept these. This is aggravated by the constant availability of CrVI-plated products from non-EU countries (or for a limited period of time from EU-based companies with granted authorisations to use chromium trioxide). In this respect, customers have an additional advantage when they continue to purchase CrVI-plated products, as absolutely no quality changes (*e.g.*, color, haptics, etc.) need to be accepted nor do any expensive approval processes need to be carried out.

Finally, bigger DUs stated that relocation to non-EU countries is definitely a valid option for them, as overall this would result in lower re-qualification cost (*i.e.* re-qualification of alternative process, re-qualification of wastewater treatment system, re-qualification of final product, etc.) compared to the change to the CrVI-free process. However, it can be assumed that many smaller DUs will not survive the change, as relocation is economically not possible and the availability of low priced CrVI-plated products (either from EU suppliers with granted authorisations or non-EU suppliers) endangers their competitiveness.

Customer-related challenges

As indicated in section **3.1**, DUs have multiple contractual delivery obligations based on the agreed technology. Customers do not allow their supplier to change the overall plating system in active serial productions since this could have substantial implications for product quality and approval, with substantial repercussions. If DUs were to perform such a change in an active serial production, they would need to perform the required product approval (*e.g.*, tests for lifetime requirements: wear, corrosion and chemical resistance under serial conditions) by themselves, which is economically not possible. Customers are not incentivized to risk a "pre-mature" change to an alternative etching process. They will only change if there is proof for identical serial product quality and track record of reliable performance over time (→ customers will choose less risky and less expensive solution as long as the option remains (*i.e.* source parts form authorized EU suppliers or non-EU suppliers).

Concluding, sufficient time is required to allow industry to continue to build a set of performance data that demonstrates reliability of alternative etching processes and enables reduction of costs to meet customer requirements. Under these premises DUs are able to phase out their "last" CrVI-based serial production (*i.e.* staggered approach for implementation of CrVI-free plating and CrVI-free etching process) while complying with contractual arrangements by being able to continue CrVI-based etching.

Compliance and regulatory challenges

As already indicated in "technical challenges", the switch to an alternative etching technology requires massive plant reconstruction for which additional space is needed. According to national environmental legislation, additional space requirements could require a time-consuming environmental impact assessment before the actual plant modification is possible.

4. SUBSTITUTION OF CHROMIUM TRIOXIDE – ALTERNATIVES AND TIMELINES

4.1 Introduction and data analysis

The following section is separated into a section for the sub-uses "Functional chrome-plating with decorative character" (section **4.2**) and "Pre-treatment (etching)" (section **4.2**). Each sub-section is divided into three main parts.

In the first part (section **4.2.1** and **4.3.1**, respectively), information on sub-use specific alternatives to CrO_3 as disclosed during the survey are described. As stated in section **1.3**, the survey was initiated prior to the introduction of the SAGA concept, and DUs were able to state that no alternative was generally available. In this case, the DUs were asked to define the reasons/limitations to justify their answer. The data are presented separately for the sub-uses "Functional chrome plating with decorative character of plastic/metal substrates" and "Pre-treatment (etching) of plastic/metal substrates". As DUs were able to select more than one sub-use, selected sub-uses were only considered if an annual tonnage > 0 was entered. Moreover, based on their choices of alternatives available for the sub-uses "Functional chrome plating with decorative character of plastic/metal substrates", the DUs were asked if the sub-use "Pre-treatment (etching) of plastic/metal substrates" was still relevant (if one of it was selected in combination with the "plating"-sub-uses). Dependent on the answer, the section on "Pre-treatment (etching) of plastic/metal substrates" was either presented or excluded from the survey and not considered in the evaluation.

In the second part, information on the substitution process are presented (section **4.2.2** and **4.3.2**, respectively). In these sections, the DUs were asked to provide information on their general agreement to the proposed timelines until substitution (30th of June 2023 / 31st of December 2020) as well as evaluate the status ("Not started", "In progress", "Completed") of their substitution efforts. These data were analysed on the level of sub-use, applying the same restrictions on data as described above, and also feature information of the DUs' largest market sector.

In the third part (sections **4.2.3** and **4.3.3**, respectively), we discuss the estimated time to completion for each of the four prescribed phases ("Early stage R&D / testing of candidate alternatives"; "Qualification of preferred candidate alternative(s)"; "Commercialization / Industrialization of qualified alternative"; "Phase-out of CrVI / ramp-up of production to 100 % alternative"). In contrast to the analysis of alternatives, the data were not only evaluated per sub-use but also per market sector. DUs not providing information on a largest market sector were excluded. The relevance of the sub-uses "Pre-treatment (etching) of plastic/metal substrates" was identified as mentioned above. Importantly, the data were also evaluated separately for DUs that were or were not in agreement with the provided dates of substitution (30th of June 2023 / 31st of December 2020) to clearly distinguish the complexity of the different views on the time necessary. In cases where an insufficient number ($n \leq 5$) of responses was identified for a sub-set, the data were not evaluated in further detail to avoid an artificial and incorrect indication of accuracy. The overall agreement rates are presented at the beginning of each market sector sub-section.

The DUs' responses on the estimated time to completion of the four phases were evaluated as the average of all values incorporated within the 90th percentile of the dataset. Values were disregarded when they were considered not fit for evaluation. This was the case when data were entered with a value of "0", or the value's format clearly deviated from the requested format in months (*e.g.*, "2030"). For reasons of visualization, the values are presented graphically for each market sector and separated for DUs in agreement/not in agreement with the proposed timelines (30th of June 2023 / 31st of December 2020).

With a view to keeping the survey as simple and clearly structured as possible, the survey only asked DUs to indicate the timeline to complete each (remaining) phase to successful substitution; it did not request an overall timeline. The dataset shows that DUs have different schedules and/or approaches to the request, with some describing the duration of the phases following a staggered approach in which the estimated lengths until completion were entered sequentially and others starting the phases of substitution[15] in parallel.

For example, any DU might have entered for the first phase ("Early stage R&D / testing of candidate alternatives") a time of 6 months, for the second phase ("Qualification of preferred candidate alternative(s)") a time of 12 months, for the third phase ("Commercialization / Industrialization of qualified alternative") a time of 24 months and for the fourth phase (""Phase-out of CrVI / ramp-up of production to 100 % alternative" a time of 48 months until completion. Assuming the DU followed a parallel approach (*i.e.*, that all phases started in parallel) the total time until completion would be 48 months. On the other hand, assuming that the DU described a staggered approach (*i.e.* a phase would only start after completion of the preceding phase), the time until substitution would be calculated as the sum of all phases (90 months).

[15] Please note that the substitution process needs to be performed separately for plating and etching sub-uses.

This means that a process of substitution, in which all phases were exclusively initiated in parallel, would take exactly as long as the estimated time needed to complete the "Phase-out of CrVI / ramp-up of production to 100 % alternative" (average of the data within the 90th percentile). The resulting value is the lower threshold of the estimated time needed until completion, and most probably marks an underestimation of the actual time needed as it would neglect the possibility that the DUs were entering the data following a staggered approach and hence result in implausibly short time frames until completion of the substitution process. When assuming a completely staggered approach on the other hand, the sum of the time needed to complete each phase (average of the data within the 90th percentile) would likely overestimate the actual time needed based on the data submitted as it would fall short of the DUs that followed a parallel substitution process in the survey.

Hence, differences in the approach to substitution or in the approach to responding to the question confounded this analysis. To nonetheless determine a more general and realistic estimate on the time needed until substitution, it was recognized that some degree of overlap between the different phases of sequential substitution might also be possible. To consider this, the data of the DUs that agreed with the timeline of 30th of June 2023 were analyzed, following the assumption that these DUs would completely substitute in ~3.5 years from the time of data collection (May 2020). When considering results of DUs that appeared to have entered the estimated time to completion based on a sequential or staggered approach (*i.e.* the sum of all phases), it was found that the sum of the periods entered exceeded the duration of 3.5 years by a factor of ~2. This might be suggestive of overlap between the phases by as much as ~ 50 % in at least some of these cases; however, further information from each DU would be required to confirm this.

The results of all approaches – parallel, sequential/staggered and, indeed, overlapping – are presented in unison in each sub-section, where possible according to the sample sizes.

4.2 Functional chrome plating with decorative character of plastic/metal substrates

4.2.1 Alternatives and limitations

The DUs were asked to define their preferred alternatives for the sub-uses "Functional chrome plating with decorative character of plastic substrates" and "Functional chrome plating with decorative character of metal substrates". For each sub-use, they could choose from five pre-determined options. Multiple choices were possible, unless DUs responded that there was no alternative generally available:

1. Chromium(III) sulphate-based electrolytes
2. Chromium(III) chloride-based electrolytes
3. Physical Vapor Deposition (PVD)
4. Other
5. No alternative generally available

Because of the structure of the survey, the opinion on the general availability of an alternative is presented at first. The DUs were asked for the availability or non-availability of an alternative The rate for the option "availability of alternatives" has been calculated as the percental difference to a total of 100 %.

Based on the answers, there is a difference between the "Plating" sub-uses. While only 30 % of the DUs employed with "Functional chrome plating with decorative character of plastic substrates" were of the opinion that no alternative was generally available, a proportion of 50 % was in favour of this view in the group of DUs performing "Functional chrome plating with decorative character of metal substrates". The results are summarized in **Table 4.**

Table 4: View of the DUs on the general availability of alternatives

		Functional chrome plating with decorative character of	
		Plastic substrates	Metal substrates
Alternative available	n	74	375
	%	70	50
No alternative generally available	n	32	376
	%	30	50

When examining the alternatives chosen by those DUs stating that an alternative was generally available (70 % and 50 % of the groups, respectively), it was revealed that the DUs preferentially chose Chromium(III) sulphate-based and Chromium(III) chloride-based electrolytes as an alternative for CrO_3 in the sub-use of "Functional chrome plating with decorative character" (**Figure 6**). Those options were chosen with a frequency of 86 % for the "Plating" of plastic substrates and 75 % for the "Plating" of metal substrates. "Other" alternatives and Physical Vapor Deposition (PVD) were chosen less frequently for either sub-use (13 to 15 % and 5 to 6 %, respectively). The graphical presentation of the preferred alternatives was restricted to those DUs that supported the view an alternative was generally available.

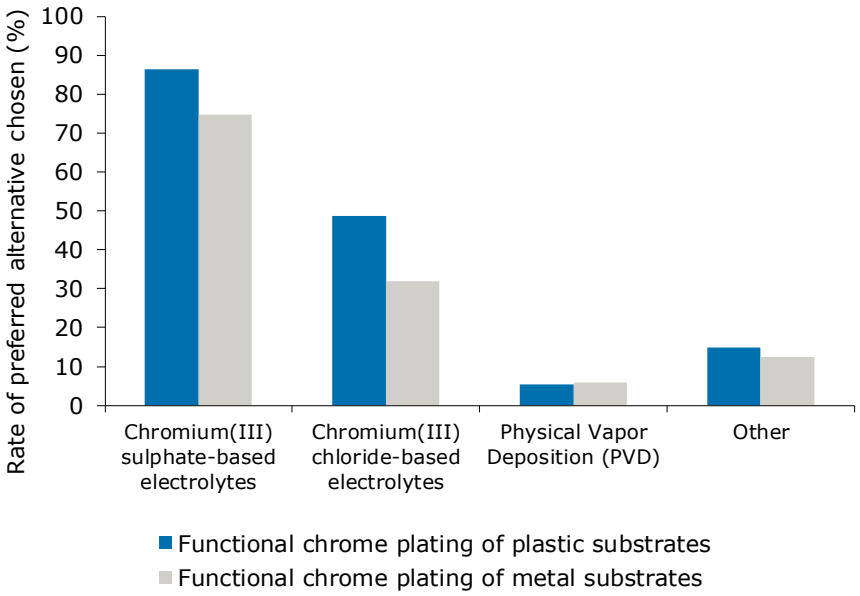


Figure 6: Preferred alternatives of the DUs for the substitution of CrO3 in the sub-uses "Functional chrome plating with decorative character of plastic substrates" and "Functional chrome plating with decorative character of metal substrates"

When asked for the limitations regarding the chosen option "No alternative generally available" in the sub-use "Functional chrome-plating with decorative character of plastic substrates", 84 % of the DUs found that surface property limitations and customer acceptance were restrictions applicable to their processes (**Figure 7**). 72 % of the DUs invoked that no suitable alternatives were generally available due to technical reasons ("process application limitations"). Consistently, 82 % of the DUs reported for the sub-use "Functional chrome-plating with decorative character of metal substrates" that surface property limitations and customer acceptance were restrictions applicable (**Figure 8**). However, the process application limitations were regarded as less applicable (53 %).

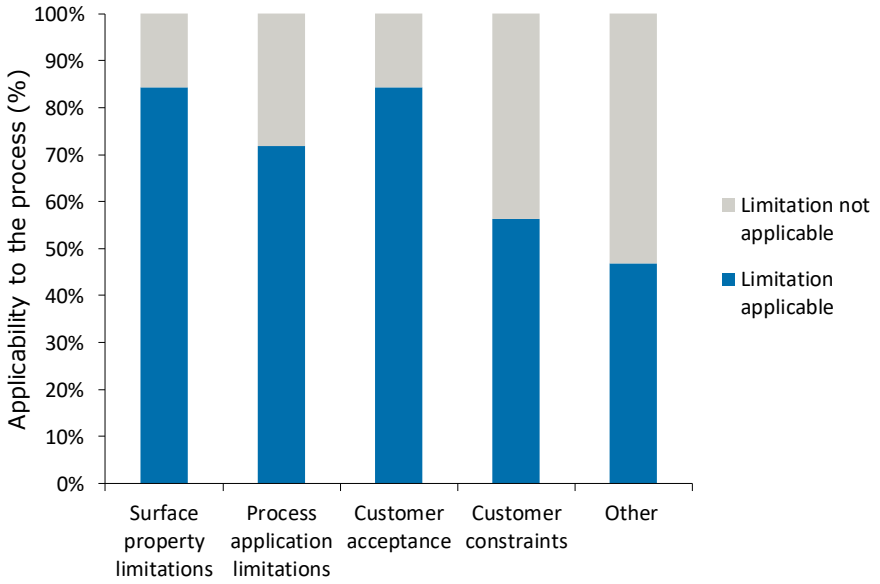


Figure 7: Limitations regarding "No alternative generally available" and their applicability to the DUs processes in the sub-use "Functional chrome plating with decorative character of plastic substrates"

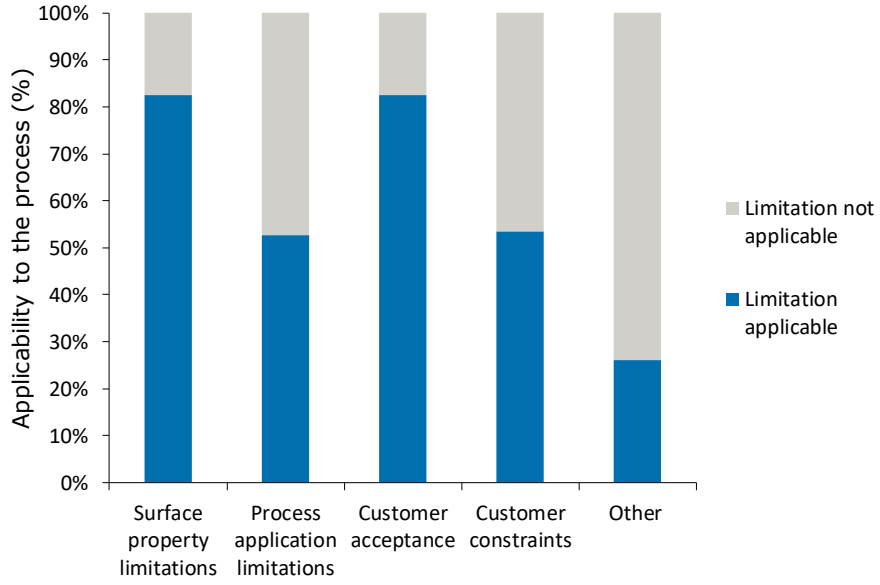


Figure 8: Limitations regarding "No alternative generally available" and their applicability to the DUs processes in the sub-use "Functional chrome plating with decorative character of metal substrates"

4.2.2 Level of agreement with suggested timelines and status of the substitution processes

The level of agreement with the proposed substitution timelines (30th of June 2023 for the market sectors "Automotive", "Furniture", "Medical", "Sanitary" and "Other" / 31st of December 2020 for the market sector "Cosmetics") was generally low.

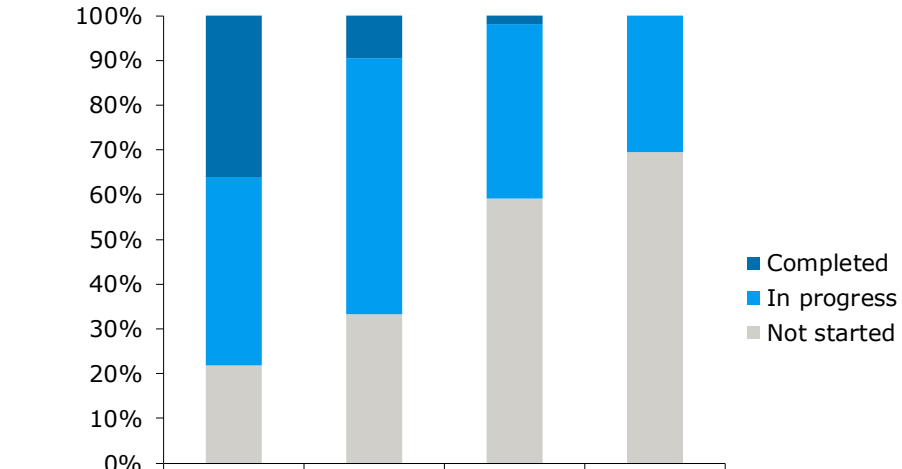
Please note that the number of DUs performing a certain sub-use may differ from the number of the identified largest market sectors as multiple answers on the market sector were allowed and similar sized largest market sectors (*e.g.*, two market sectors making up 50 % each of one DUs line of work) were included in the assessment. In the market sectors "Automotive", "Furniture", "Medical", "Sanitary" and "Other" of the sub-use "Functional chrome plating with decorative character of plastic substrates", an agreement of 25 % (n = 26 of n = 105 identified largest market sectors) to the 2023-timeline was reached. Similarly, in the market sector "Cosmetics" 29 % (n = 2 of n = 7 identified largest market sectors) agreed with the 2020-timeline.

DUs that were employed with "Functional chrome plating with decorative character of metal substrates" showed a slightly higher agreement within the market sectors "Automotive", "Furniture", "Medical", "Sanitary" and "Other" to the 2023-timeline (31 %; n = 255 of n = 813 identified largest market sectors) and an even agreement with the 2020-timeline (50 %; n =1 of n =2 identified largest market sectors). Please note the low sample size of the latter group though.

The DUs were also asked to assess the status of four predetermined substitution phases ("Early Stage R&D", "Qualification of preferred candidate alternative(s)", "Commercialization / Industrialization of qualified alternative", "Phase-out of CrVI / ramp-up of production to 100 % alternative") as "Not started", "In progress" or "Completed". The state of substitution is displayed separately for both timelines and sub-uses. The state of substitution for the sub-use "Functional chrome plating with decorative character of plastic substrates" is shown in **Figure 9** (market sectors with a proposed substitution until 30th of June 2023) and **Figure 10** (market sector with a proposed substitution until 31st of December 2020).The results for the other sub-use "Functional chrome plating with decorative character of metal substrates" are presented in **Figure 11** and **Figure 12**.

Similar trends can be observed for either sub-use or timeline: While more than 50 % of all DUs are in progress or have completed the "Early stage R&D", the proportion shifts when considering more elaborate stages of the substitution process. Consistently, only a small number of DUs reported to have completed the final phase 4 "Phase-out of CrVI / ramp-up of production to 100 % alternative" and this was restricted to the sub-use of "Functional chrome plating with decorative character of metal substrates". It has to be noted though that in this sub-use the sample size is considerably higher than in the other sub-uses.

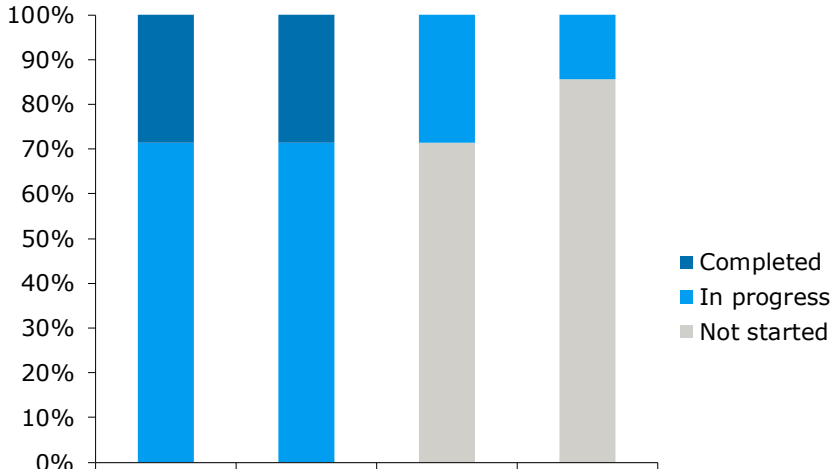
In general, the data show that substitution efforts are incurred by the DUs and the substitution process is progressing. Especially regarding the "Early stage R&D", the majority of the DUs appears to have selected preferred processes and technologies for substitution.



	Phase 1	Phase 2	Phase 3	Phase 4
Completed	38	10	2	0
In progress	44	60	41	32
Not started	23	35	62	73

Figure 9: Status of the substitution phases (until 30th of June 2023) of DUs with the largest market sectors "Automotive", "Furniture", "Medical", "Sanitary" and "Other" performing "Functional chrome plating with decorative character of plastic substrates"

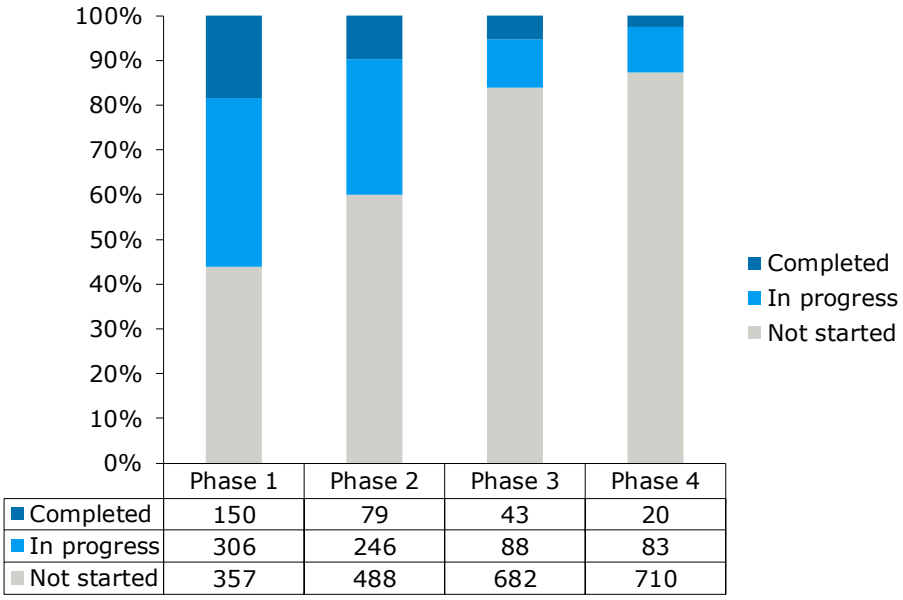
Phases 1 – 4 refer to the "Early Stage R&D", "Qualification of preferred candidate alternative(s)", "Commercialization / Industrialization of qualified alternative" & "Phase-out of CrVI / ramp-up of production to 100 % alternative"



	Phase 1	Phase 2	Phase 3	Phase 4
Completed	2	2	0	0
In progress	5	5	2	1
Not started	0	0	5	6

Figure 10: Status of the substitution phases (until 31st of December 2020) of DUs with the largest market sector "Cosmetics" performing "Functional chrome plating with decorative character of plastic substrates"

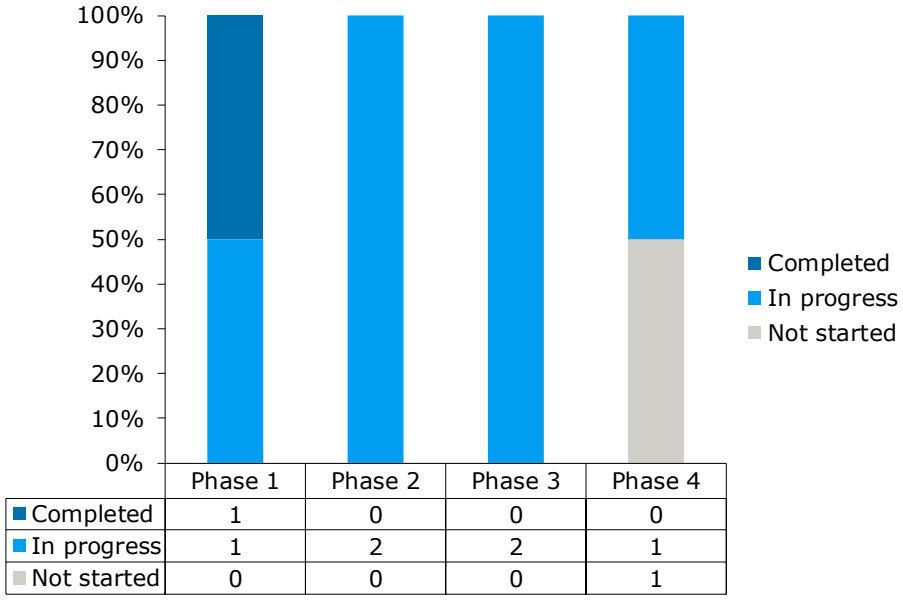
Phases 1 – 4 refer to the "Early Stage R&D", "Qualification of preferred candidate alternative(s)", "Commercialization / Industrialization of qualified alternative" & "Phase-out of CrVI / ramp-up of production to 100 % alternative".



	Phase 1	Phase 2	Phase 3	Phase 4
Completed	150	79	43	20
In progress	306	246	88	83
Not started	357	488	682	710

Figure 11: Status of the substitution phases (until 30th of June 2023) of DUs with the largest market sectors "Automotive", "Furniture", "Medical", "Sanitary" and "Other" performing "Functional chrome plating with decorative character of metal substrates"

Phases 1 – 4 refer to the "Early Stage R&D", "Qualification of preferred candidate alternative(s)", "Commercialization / Industrialization of qualified alternative" & "Phase-out of CrVI / ramp-up of production to 100 % alternative"



	Phase 1	Phase 2	Phase 3	Phase 4
Completed	1	0	0	0
In progress	1	2	2	1
Not started	0	0	0	1

Figure 12: Status of the substitution phases (until 31st of December 2020) of DUs with the largest market sector "Cosmetics" performing "Functional chrome plating with decorative character of metal substrates"

Phases 1 – 4 refer to the "Early Stage R&D", "Qualification of preferred candidate alternative(s)", "Commercialization / Industrialization of qualified alternative" & "Phase-out of CrVI / ramp-up of production to 100 % alternative"

4.2.3 Estimated Time Until Completion of Substitution

4.2.3.1 Sanitary

Within the group of DUs, for which the sector "Sanitary" was identified as the largest market sector, the agreement rate to the timeline of substitution (30th of June 2023) was low and below 30 % for both sub-uses covered (**Table 5**).

Table 5: Agreement with the timeline for substitution of CrO_3 in the sub-uses "Functional chrome plating with decorative character of plastic substrates" and "Functional chrome plating with decorative character of metal substrates" by DUs with the largest market sector "Sanitary"

	Functional chrome plating with decorative character of	
	Plastic substrates	Metal substrates
Agree (n)	*4*	48
Disagree (n)	19	129
Agreement (%)	17	27

The estimated average time (of the 90th percentile) to completion of the phases is presented in **Figure 13** for the "Functional chrome plating with decorative character of plastic substrates". The estimates are only shown for DUs, which are not in agreement with the timeline due to the small sample size of the other group (*cf.* section **4.1**). **Figure 14** displays the results for the "Functional chrome plating with decorative character of metal substrates".

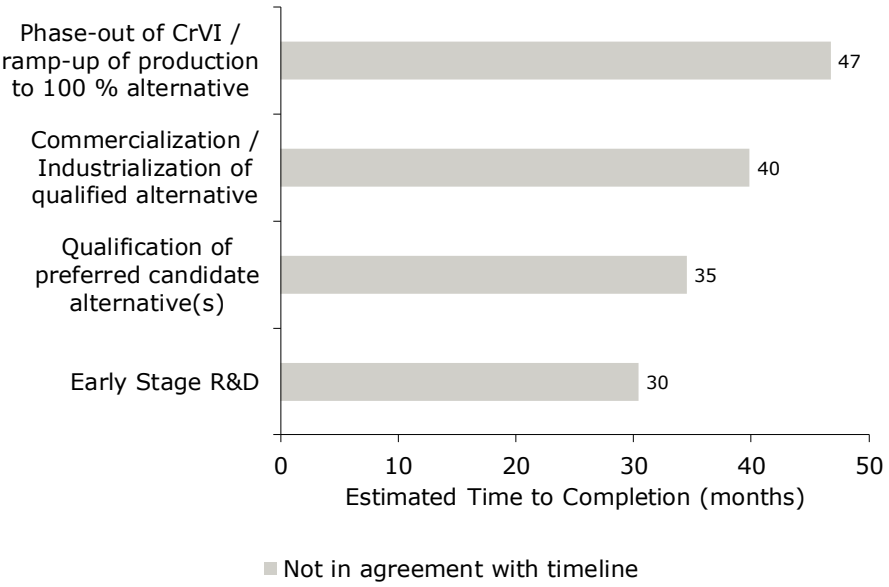


Figure 13: Estimated average (90th percentile) time to completion of the different substitution phases for the sub-use "Functional chrome plating with decorative character of plastic substrates" by DUs with the largest market sector "Sanitary"

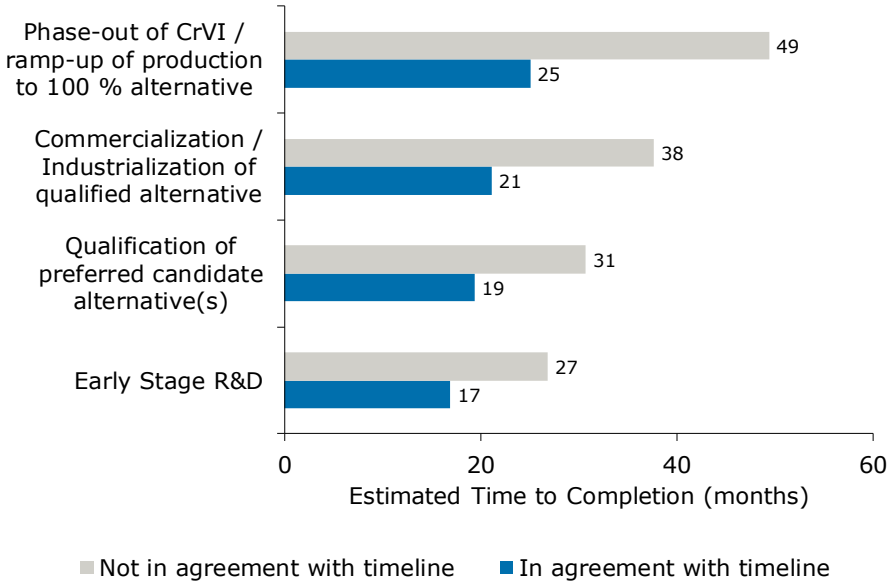


Figure 14: Estimated average (90th percentile) time to completion of the different substitution phases for the sub-use "Functional chrome plating with decorative character of metal substrates" by DUs with the largest market sector "Sanitary"

As mentioned before, it could, however, not be determined from the data if the DUs were executing the phases in parallel or sequentially staggered (see section **4.1**). The results for the three discussed approaches in the largest market sector "Sanitary" are presented in **Table 6** for the average value of data within the 90th percentile.

Table 6: Upper and lower bounds (years) as well as an intermediate, adapted timeline (years) for substitution in "Functional chrome plating with decorative character of plastic/metal substrates" in the largest market sector "Sanitary"

Substrate	Agreement to the timeline (30th of June 2023)	Phases parallel [years]	Phases overlapping [1)] [years]	Phases staggered [years]
Plastic	Yes	n/a	n/a	n/a
	No	3.9	6.3	12.6
Metal	Yes	2.1	3.4	6.9
	No	4.1	6.0	12.1

[1)] Following the procedure described in section **4.1**, a hypothetical overlap factor of 50 % was determined to provide a refined estimate on the time needed for substitution

4.2.3.2 Automotive

In the automotive sector the agreement rates to the timeline of substitution (30th of June 2023) are slightly higher than for the sanitary sector. 22 % and 37 % of DUs are in agreement with the timeline for their respective uses of "Functional chrome plating with decorative character of plastic substrates" or "Functional chrome plating with decorative character of metal substrates" (**Table 7**).

Table 7: Agreement with the timeline for substitution of CrO3 in the sub-uses "Functional chrome plating with decorative character of plastic substrates" and "Functional chrome plating with decorative character of metal substrates" by DUs with the largest market sector "Automotive"

	Functional chrome plating with decorative character of	
	Plastic substrates	Metal substrates
Agree (n)	12	50
Disagree (n)	42	84
Agreement (%)	22	37

The low agreement rate to the timelines is also displayed by the estimated time to complete the different phases, especially in the sub-use "Functional chrome plating with Decorative Character of plastic substrates" (**Figure 15**). The DUs estimated on average (of the 90th percentile) a duration of 107 months for completion of the "Phase-out of CrVI / ramp-up of production to 100 % alternative". In the sub-use "Functional chrome plating with Decorative Character of metal substrates", DUs reported an average duration (of the 90th percentile) of 51 months for the same phase (**Figure 16**).

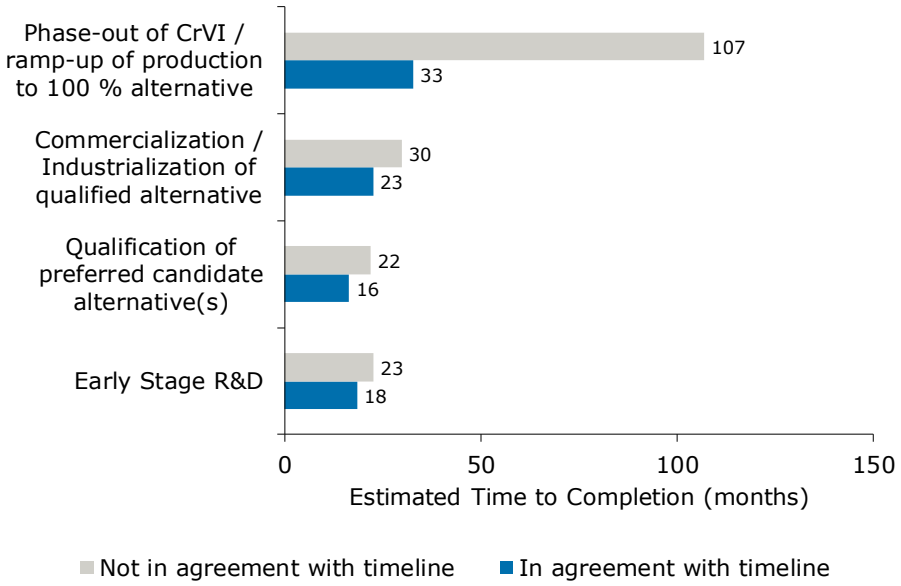


Figure 15: Estimated average (90th percentile) time to completion of the different substitution phases for the sub-use "Functional chrome plating with decorative character of plastic substrates" by DUs with the largest market sector "Automotive"

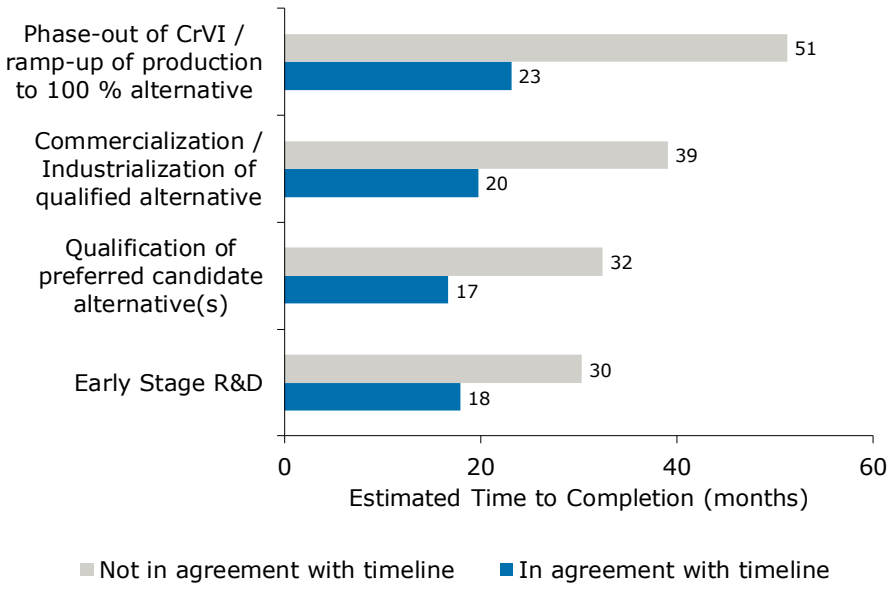


Figure 16: Estimated average (90th percentile) time to completion of the different substitution phases for the sub-use "Functional chrome plating with decorative character of metal substrates" by DUs with the largest market sector "Automotive"

When analyzing the phases of the largest market sector automotive according to the procedure described in section **4.1**, estimated adapted timelines until substitution of 7.6 years and 6.4 years were derived for the substrates plastic and metal in the "Plating"-sub-use for those DUs that did not agree to the timeline (**Table 8**). It is noteworthy that in the sub-use of "Plating" plastic substrates, the parallel estimate (8.9 years) is longer than that allowing for an overlap of 50 % of the phases. In this specific case, the average of the data within the 90th percentile for the last phase "Phase-out of CrVI / ramp-up of production to 100 % alternative" was determined as 107 months, corresponding to 8.9 years (*cf.* **Figure 15**). However, the overlap factor was estimated on the basis of all data and was not defined further. In addition, the factor was applied to the results of the staggered approach (*i.e.* the sum of the averages of values within the 90th percentile of each respective phase), which was 15.1 years.

Nonetheless, while the very high DU estimates for completion of the last phase of substitution in the sub-use "Functional chrome plating with decorative character of plastic substrates" leads to a parallel value by a factor of 2.1 higher than estimated for the sub-use of "Plating" metal substrates (8.9 to 4.3 years), the factorial diminishes when regarding the estimates for the overlapping (7.6 to 6.4 years; factor 1.2) and staggered (15.1 to 12.8 years, factor 1.2) approaches. It may, hence, be concluded that the actual difference in time needed until completion between the two sub-uses of "Plating" plastic or metal substrates is more similar than initially indicated by the estimates based on parallel progress of all phases.

Table 8: Upper and lower bounds (years) as well as an intermediate, adapted timeline (years) for substitution in "Functional chrome plating with decorative character of plastic/metal substrates" in the largest market sector "Automotive"

Substrate	Agreement to the timeline (30th of June 2023)	Phases parallel	Phases overlapping [1)]	Phases staggered
Plastic	Yes	2.7	3.8	7.5
	No	8.9 [2)]	7.6	15.1
Metal	Yes	1.9	3.2	6.5
	No	4.3	6.4	12.8

[1)] Following the procedure described in section **4.1**, a hypothetical overlap factor of 50 % was determined to provide a refined estimate on the time needed for substitution

[2)] Estimate higher than for the corresponding "overlapping phases" due to the high values entered for the final phase of substitution by the DUs (see text for details).

4.2.3.3 Furniture

While "Functional chrome plating with decorative character of plastic substrates" was reported by a lesser number of DUs in general (*cf.* **Figure 5**) there is a distinct difference in sample sizes between the sub-uses in the largest market sector "Furniture". The agreement rates are nonetheless comparable. Less or equal to one third of the DUs agreed with the substitution timeline (30th of June 2023) (see **Table 9**).

Table 9: Agreement with the timeline for substitution of CrO3 in the sub-uses "Functional chrome plating with decorative character of plastic substrates" and "Functional chrome plating with decorative character of metal substrates" by DUs with the largest market sector "Furniture"

	Functional chrome plating with decorative character of	
	Plastic substrates	Metal substrates
Agree (n)	*1*	57
Disagree (n)	*4*	116
Agreement (%)	*20*	33

Due to the small sample size for the sub-use "Functional chrome plating with decorative character of plastic substrates", the data for the DUs performing this sub-use were not evaluated in further detail (*cf.* section **4.1**). Hence, the data are presented graphically only for the sub-use "Functional chrome plating with decorative character of metal substrates" (**Figure 17**). The difference in time needed between those in agreement and those not in agreement was similar for the first two phases "Early Stage R&D" and "Qualification of preferred candidate alternative(s)" (18 months and 17 months, respectively). However, when regarding the later phases, the difference increases to 26 and 27 months, respectively. While the DUs estimated for the phases "Early Stage R&D" and "Qualification of preferred candidate alternative(s)" a similar duration until completion (13 months and 15 months when in agreement with the timeline, 31 months and 32 months when not in agreement with timeline). This is in line with the general observation of the status of the different phases described in section **4.2.2**, where it could be demonstrated that the initial phases were further progressed in comparison to the third and fourth phase. At maximum, the DUs estimate to need 23 months to "Phase-out of CrVI / ramp-up of production to 100 % alternative" when in agreement with the timeline and 50 months when not.

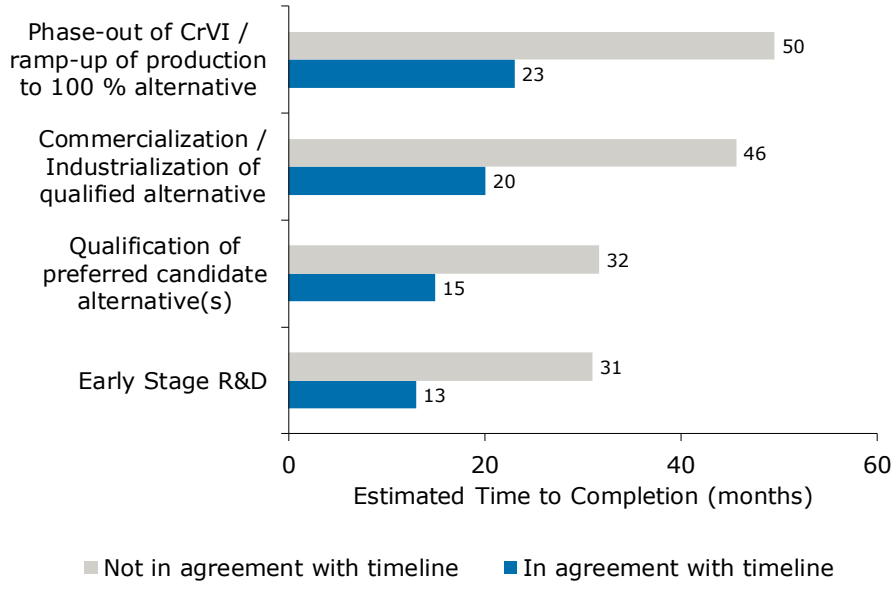


Figure 17: Estimated average (90th percentile) time to completion of the different substitution phases for the sub-use "Functional chrome plating with decorative character of metal substrates" by DUs with the largest market sector "Furniture"

Following the approach described in section **4.1**, a refined timeline of 3.0 years and 6.6 years was derived for DUs in agreement or not in agreement with the timeline and performing "Functional chrome plating with decorative character of metal substrates" (**Table 10**). As mentioned earlier, no analysis could be performed for DUs performing "Functional chrome plating with decorative character of plastic substrates".

Table 10: Upper and lower bounds (years) as well as an intermediate, adapted timeline (years) for substitution in "Functional chrome plating with decorative character of plastic/metal substrates" in the largest market sector "Furniture"

Substrate	Agreement to the timeline (30th of June 2023)	Phases parallel	Phases overlapping [1)]	Phases staggered
Plastic	Yes	n/a	n/a	n/a
	No	n/a	n/a	n/a
Metal	Yes	1.9	3.0	5.9
	No	4.1	6.6	13.2

[1)] Following the procedure described in section **4.1**, a hypothetical overlap factor of 50 % was determined to provide a refined estimate on the time needed for substitution.

4.2.3.4 Medical

None of the DUs performing "Functional chrome plating with decorative character of plastic substrates" stated "Medical" as their largest market sector. The agreement rate to the timeline of substitution (30th of June 2023) for the other sub-use ("Functional chrome plating with decorative character of metal substrates") is, however, comparable to that of the other assessed market sectors (30 %, **Table 11**).

Table 11: Agreement with the timeline for substitution of CrO3 in the sub-uses "Functional chrome plating with decorative character of plastic substrates" and "Functional chrome plating with decorative character of metal substrates" by DUs with the largest market sector "Medical"

	Functional chrome plating with decorative character of	
	Plastic substrates	Metal substrates
Agree (n)	*0*	13
Disagree (n)	*0*	31
Agreement (%)	—	30

The difference of time until completion between the DUs agreeing or not agreeing ranges from 7 to 14 months for the first three phases (**Figure 18**). Again, a larger difference is found when regarding the last phase of substitution ("Phase-out of CrVI / ramp-up of production to 100 % alternative"). Here, a difference of 32 months was observed. No analysis could be performed for the sub-use "Functional chrome plating with decorative character of plastic substrates" due to the absence of data.

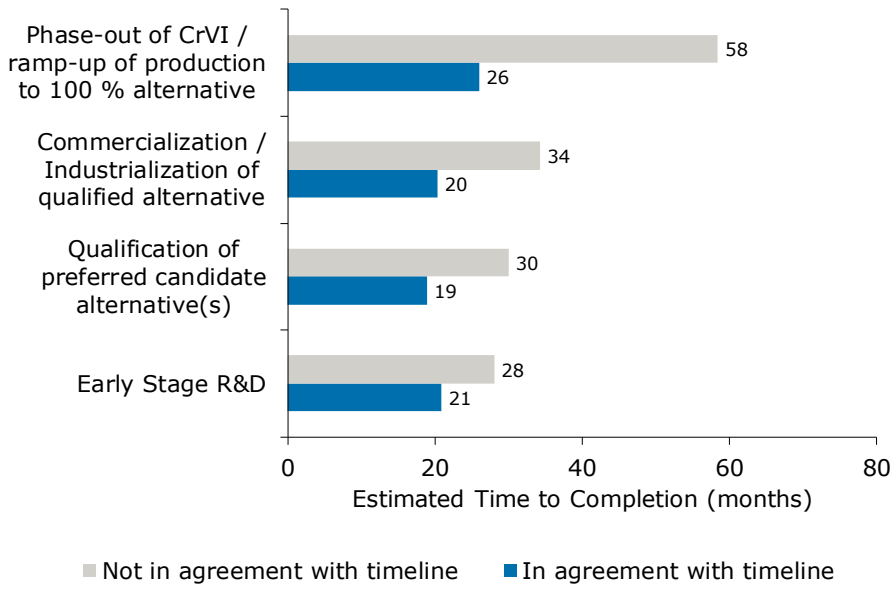


Figure 18: Estimated average (90th percentile) time to completion of the different substitution phases for the sub-use "Functional chrome plating with decorative character of metal substrates" by DUs with the largest market sector "Medical"

According to the results shown above, the duration of the parallel, overlapping and staggered approaches was only evaluated for "Functional chrome plating with decorative character of metal substrates" in the largest market sector "Medical" (**Table 12**). An intermediate time until completion of 3.6 years and 6.3 years for the DUs in agreement or not in agreement were identified following the procedure described in section **4.1**.

Table 12: Upper and lower bounds (years) as well as an intermediate, adapted timeline (years) for substitution in "Functional chrome plating with decorative character of plastic/metal substrates" in the largest market sector "Medical"

Substrate	Agreement to the timeline (30th of June 2023)	Phases parallel	Phases overlapping [1)]	Phases staggered
Plastic	Yes	n/a	n/a	n/a
	No	n/a	n/a	n/a
Metal	Yes	2.2	3.6	7.2
	No	4.9	6.3	12.6

[1)] Following the procedure described in section **4.1**, a hypothetical overlap factor of 50 % was determined to provide a refined estimate on the time needed for substitution.

4.2.3.5 Cosmetics

The timeline for substitution of CrO_3 in the market sector "Cosmetics" differed from that for the other market sectors, and the DUs were asked if they agreed with the substitution date 31st of December 2020. The sample size of DUs stating "Cosmetics" as the largest market sector was small. In total, the "Cosmetics" sector was identified as the largest market sector for 8 DUs in the sub-use "Functional chrome plating with decorative character of plastic substrates" and for 7 DUs in the sub-use "Functional chrome plating with decorative character of metal substrates". However, during the survey, only DUs stating a percentual tonnage > 49 % in the sector "Cosmetics" were asked to express their agreement to the shorter timeline, leading to a reduced number of responses. Of those respondents, 29 % and 50 %, respectively, agreed with the timeline (**Table 13**). No further evaluation was conducted as the sample size was too small to draw any robust conclusions (see section **4.1**).

Table 13: Agreement with the timeline for substitution of CrO3 in the sub-uses "Functional chrome plating with decorative character of plastic substrates" and "Functional chrome plating of metal substrates" by DUs with the largest market sector "Cosmetics"

	Functional chrome plating with decorative character of	
	Plastic substrates [1)]	Metal substrates [1)]
Agree (n)	*2*	*1*
Disagree (n)	*5*	*1*
Agreement (%)	*29*	*50*

[1)] One (electroplating of plastic substrates) and five (electroplating of metal substrates) questionnaires were not included as the question was not presented to the DUs; DUs stating that their tonnage in the market sector "Cosmetics" was < 49 % of the total tonnage were not asked to provide information on their agreement with the timeline.

4.2.3.6 Others

The last option that could be selected as a relevant market sector was termed "Other". A list of products/article groups as well as end applications covered can be found in **ANNEX III**. A higher number of DUs agreed with the timeline until substitution (30th of June 2023) in the sub-use "Functional chrome plating with decorative character of plastic substrates" (39 %) than in the sub-use "Functional chrome plating with decorative character of metal substrates" (31 %) (**Table 14**).

Table 14: Agreement with the timeline for substitution of CrO3 in the sub-uses "Functional chrome plating of plastic substrates" and "Functional chrome plating of metal substrates" by DUs with the largest market sector "Other"

	Functional chrome plating with decorative character of	
	Plastic substrates [1)]	Metal substrates [1)]
Agree (n)	9	87
Disagree (n)	14	198
Agreement (%)	39	31

Regarding the time to complete the phases, the DUs estimated similar periods until completion for the "Early stage R&D" and the "Qualification of preferred candidate alternative(s)" for either sub-use and when in agreement with the timeline (14 to 16 months) (**Figure 19** and **Figure 20**). An interesting observation is the large difference between the estimated time to completion of any phase by the DUs agreeing or not agreeing with the timeline performing "Functional chrome plating with Decorative Character of metal substrates", which appears to be more consistent for the sub-use "Functional chrome plating with decorative character of plastic substrates". This difference becomes smaller when considering the later phases of substitution.

The duration until completion of "Phase-out of Cr(VI) / ramp-up of production to 100 % alternative", for the DUs not agreeing with the timeline was estimated to an average period (90th percentile) of 41 to 51 months ("Functional chrome plating with Decorative Character of plastics substrates" and "Functional chrome plating with Decorative Character of metal substrates", respectively). This is also reflected by the state of the substitution process presented in **4.2.2**, where the data indicated that DUs performing "Functional chrome plating with decorative character of plastic substrates" were more advanced in the process of substituting CrO_3.

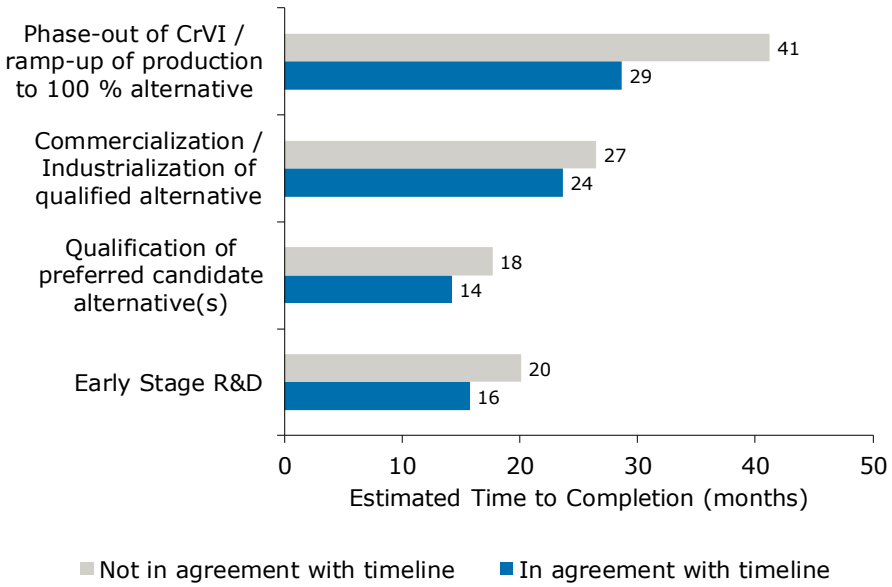


Figure 19: Estimated average (90th percentile) time to completion of the different substitution phases for the sub-use "Functional chrome plating with Decorative Character of plastic substrates" by DUs with the largest market sector "Other"

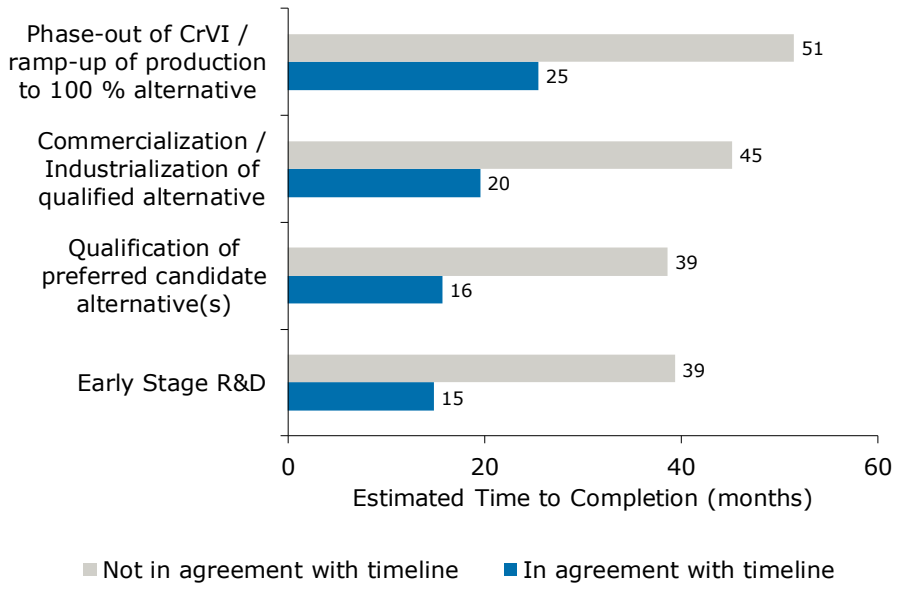


Figure 20: Estimated average (90th percentile) time to completion of the different substitution phases for the sub-use "Functional chrome plating with Decorative Character of metal substrates" by DUs with the largest market sector "Other"

In the largest market sector "Others", estimates for the lower, upper and intermediate bound for substitution in "Functional chrome plating with decorative character" were computable for either substrate as well as both DUs in agreement or not in agreement with the predetermined timeline. The procedure is described in section **4.1** and the results are shown in **Table 15**.

The timelines allowing for overlapping phases were short for DUs performing "plating" with plastic substrates and not in agreement with the timeline in comparison to the other sub-uses and market sectors. A value of 4.4 years was derived, being close to the lower bound and possibly underestimating the actual time necessary. For the "plating" of metal substrates larger sample size was available, and the refined estimate of time needed until completion of the substation process was calculated as 7.3 years.

Table 15: Upper and lower bounds (years) as well as an intermediate, adapted timeline (years) for substitution in "Functional chrome plating with decorative character of plastic/metal substrates" in the largest market sector "Others"

Substrate	Agreement to the timeline (30th of June 2023)	Phases parallel	Phases overlapping [1)]	Phases staggered
Plastic	Yes	2.4	3.4	6.9
	No	3.4	4.4	8.8
Metal	Yes	2.1	3.1	6.3
	No	4.3	7.3	14.6

[1)] Following the procedure described in section **4.1**, a hypothetical overlap factor of 50 % was determined to provide a refined estimate on the time needed for substitution.

4.3 Pre-treatment (etching) of plastic/metal substrates

4.3.1 Alternatives and limitations

The sub-uses "Pre-treatment (etching) of plastic substrates" and "Pre-treatment (etching) of metal substrates" were in general selected with lesser frequency than the electroplating uses. The distribution into largest market sectors accordingly lead to small sample sizes. As described in section **4.1**, after providing data on the most promising alternatives for substitution for the "Electroplating"-sub-uses, the DUs were asked if the "Etching"-sub-uses were still relevant for them. In case they were not, the subsequent questions on "etching" were not presented to them. This may lead to a difference in the number of DUs indicating that they perform the "Pre-treatment (etching)" sub-uses (*cf.* section **2.3**) and the number of DUs presented in the following sub-sections. Anyway, the DUs who were presented with the question could select from five choices:

1. Permanganates and manganese salts
2. Sulfuric acid (H_2SO_4) and/or phosphoric acid (H_3PO_4)
3. Other mineral acids
4. Other
5. No alternative generally available

As described in section **4.2.1**, the opinion on the general availability of an alternative is presented at first before specifying the preference of the listed alternatives and the reasons for the DUs to choose the option that no alternative was generally available. In total, the data of 91 DUs performing "Pre-treatment (etching) of plastic substrates" were evaluated. A lesser number of answers could be considered for the "Pre-treatment (etching) of metal substrates" (n =17). Interestingly, there was a distinct difference within these sub-samples regarding the general availability of an alternative. While only 22 % of the DUs performing "Pre-treatment (etching) of plastic substrates" were of the opinion that no alternative was generally available, 53 % of the DUs performing "Pre-treatment (etching) of metal substrates" stated that no alternative was generally available (see **Table 16**). Interestingly, despite the small sample size of the latter group, the results are in good accordance with the views on the availability of an alternative for the "Plating" sub-use (cf. section **4.2.1**).

Table 16: View of the DUs on the general availability of alternatives

		Pre-treatment (etching) of	
		Plastic substrates	Metal substrates
Alternative available	n	71	8
	%	78	47
No alternative generally available	n	20	9
	%	22	53

In the sub-use "Pre-treatment (etching) of plastic substrates", permanganates and manganese salts were considered as the most promising alternative (90 % of all answers) for substitution CrO_3 (**Figure 21**). Sulfuric acid and phosphoric acid were chosen to a lesser extent (34 %). The preferences shifted in the sub-use "Pre-treatment (etching) of metal substrates", where (75 %) considered sulfuric acid to be the option of choice. The options "Other mineral acids" and "Other" were chosen rarely for the first sub-use (1 % and 6 %, respectively), but more often for the second sub-use (25 % and 38 %, respectively). In general, the data suggest that one preferred alternative was identified in either sub-use. However, the DUs performing "Pre-treatment (etching) of metal substrates" appear to be more flexible on the choice of the other options. However, it needs to be stressed again that the sample size of the latter group is small, and the conclusions need to be tended with care.

Overall, the data for the "Pre-treatment (etching) of plastic/metal substrates" strongly resembled the limitations reported for the respective "Plating" sub-uses. When examining the limitations causing the DUs to respond that no alternative was generally available, it became clear that more than one limitation was considered of importance (**Figure 22**). 75 to 85 % of the DUs performing the "Pre-treatment (etching) of plastic substrates" stated that not only technical limitations – "Surface property limitations" and "Process application limitations" – were an issue, but also "Customer acceptance". For "Pre-treatment (etching) of metal substrates", the "Process application limitations" were regarded of lesser importance, while "Surface property limitations" were still the factor chosen with the highest preference (**Figure 23**).

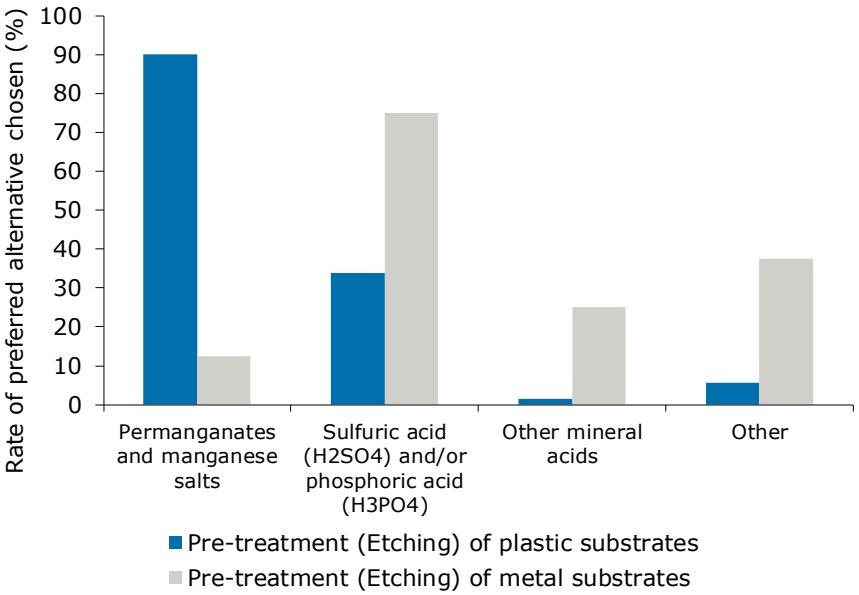


Figure 21: Preferred alternatives of the DUs for the substitution of CrO3 in the sub-uses "Pre-treatment (etching) of plastic substrates" and "Pre-treatment (etching) of metal substrates"

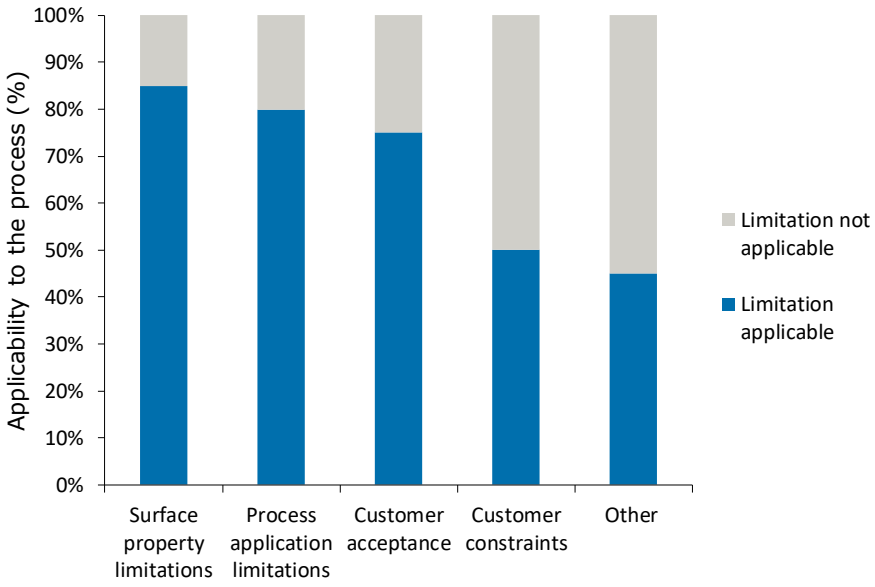


Figure 22: Limitations regarding "No alternative generally available" and their applicability to the DUs processes in the sub-use "Pre-treatment (etching) of plastic substrates"

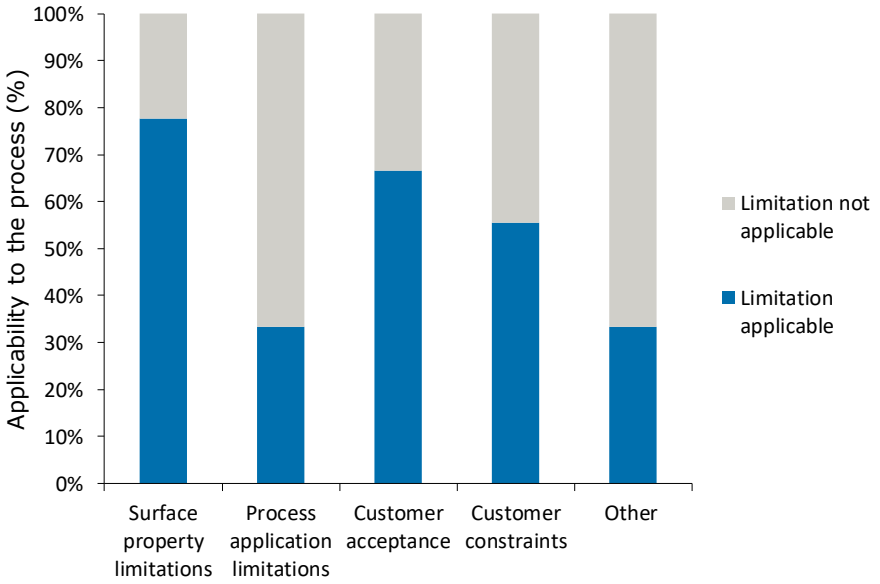


Figure 23: Limitations regarding "No alternative generally available" and their applicability to the DUs processes in the sub-use "Pre-treatment (etching) of metal substrates"

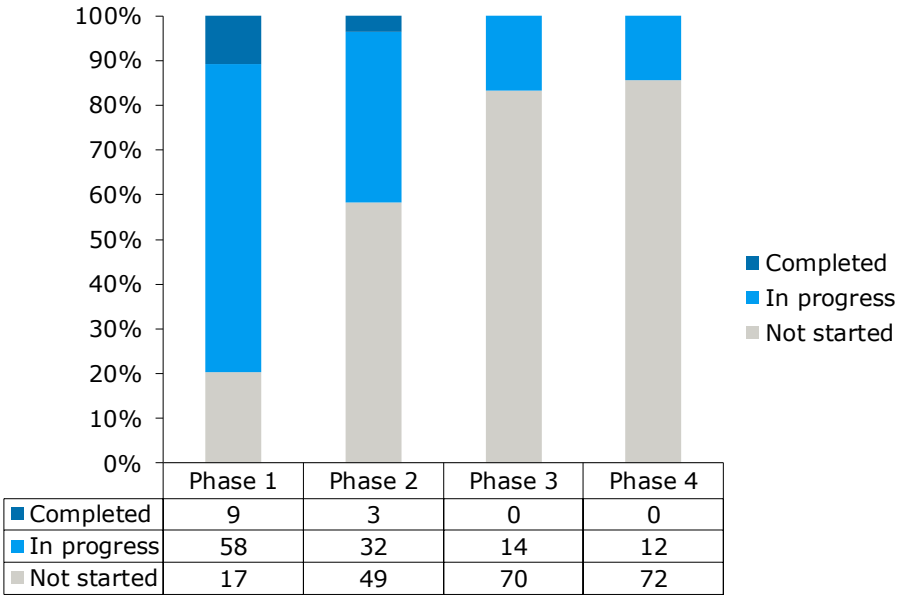
4.3.2 Level of agreement with suggested timelines and status of the substitution process

The overall agreement to the proposed substitution timelines for the sectors "Automotive", "Furniture", "Medical", "Sanitary" and "Other" (30th of June 2023) as well as "Cosmetics"(31st of December 2020) for the "Pre-treatment (etching) of plastic substrates" was even lower than for the "Plating"-sub-use. Please note that, complementary to the statement made in section **4.3.1** and congruent to the remark in section **4.2.2**, for several DUs that were presented with the sections on "Etching" in the survey, more one than largest market sector with the same size was identified. This might lead to a discrepancy between the number of responding DUs and the number of largest market sectors identified.

The results for the sub-use "Pre-treatment (etching) of plastic substrates" are described firstly. When considering the identified largest market sectors "Automotive", "Furniture", "Medical", "Sanitary" and "Other" (substitution until 30th of June 2023), an agreement rate of 17 % (n = 14 of n = 84 identified largest market sectors) was found. In the largest market sector "Cosmetics", 14 % (n = 1 of n = 7 identified largest market sectors) agreed with a date of substitution until the 31st of December 2020. When considering "Pre-treatment (etching) of metal substrates", the agreement to the 2023-timeline was comparable to the associated "Plating"-sub-use, and 32 % (n = 5 of n = 22 identified largest market sectors) agreed with the timeline. No data were available for the "Pre-treatment (etching) of metal substrates" in the market sector "Cosmetics".

The results of the status of the different substitution phases ("Early Stage R&D", "Qualification of preferred candidate alternative(s)", "Commercialization / Industrialization of qualified alternative", "Phase-out of CrVI / ramp-up of production to 100 % alternative") are presented in **Figure 24** to **Figure 26**. When examining the status of the four phases of substitution, the partly small sample sizes must be considered. In general, the trend is similar to the results observed for the "Plating" sub-uses. However, a higher proportion of DUs stated not having started the phases "Commercialization / Industrialization of qualified alternative" and "Phase-out of CrVI / ramp-up of production to 100 % alternative" in the sub-use "Etching" of plastic substrates compared to the sub-use "Plating" of plastic sub-use (**Figure 24** and **Figure 25**, *cf.* section **4.2.2**). This observation is reversed for the DUs working with metal substrates (**Figure 26**), where a higher proportion indicated that the advanced substitution phases 3 and 4 were in progress or completed in comparison to the "Plating" sub-use (*cf.* section **4.2.2**). It has again to be stressed that some of the analysed groups are small.

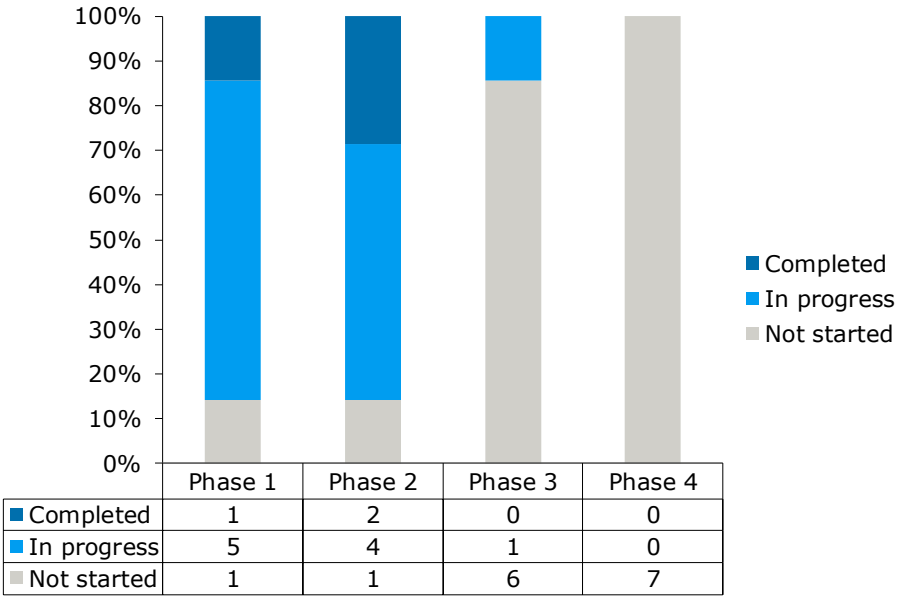
No data were available for the 2020-timeline ("Cosmetics" in the sub-use "Pre-treatment (etching) of metal substrates". Accordingly, no graphs are presented.



	Phase 1	Phase 2	Phase 3	Phase 4
Completed	9	3	0	0
In progress	58	32	14	12
Not started	17	49	70	72

Figure 24: Status of the substitution phases (until 30th of June 2023) of DUs with the largest market sectors "Automotive", "Furniture", "Medical", "Sanitary" and "Other" performing "Pre-treatment (etching) of plastic substrates"

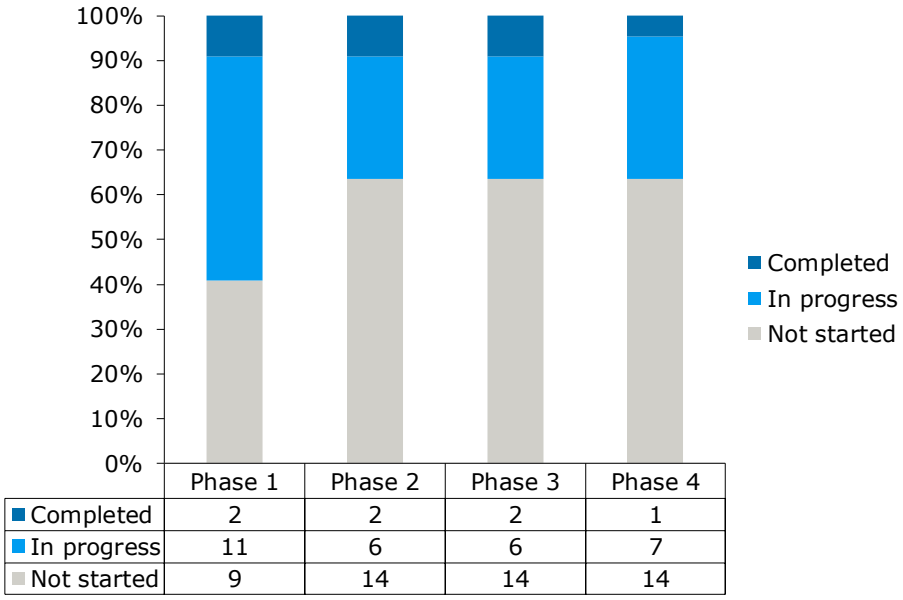
Phases 1 – 4 refer to the "Early Stage R&D", "Qualification of preferred candidate alternative(s)", "Commercialization / Industrialization of qualified alternative" & "Phase-out of CrVI / ramp-up of production to 100 % alternative".



	Phase 1	Phase 2	Phase 3	Phase 4
Completed	1	2	0	0
In progress	5	4	1	0
Not started	1	1	6	7

Figure 25: Status of the substitution phases (until 31st of December 2020) of DUs with the largest market sectors "Cosmetics" performing "Pre-treatment (etching) of plastic substrates"

Phases 1 – 4 refer to the "Early Stage R&D", "Qualification of preferred candidate alternative(s)", "Commercialization / Industrialization of qualified alternative" & "Phase-out of CrVI / ramp-up of production to 100 % alternative".



	Phase 1	Phase 2	Phase 3	Phase 4
Completed	2	2	2	1
In progress	11	6	6	7
Not started	9	14	14	14

Figure 26: Status of the substitution phases (until 30th of June 2023) of DUs with the largest market sectors "Automotive", "Furniture", "Medical", "Sanitary" and "Other" performing "Pre-treatment (etching) of metal substrates"

Phases 1 – 4 refer to the "Early Stage R&D", "Qualification of preferred candidate alternative(s)", "Commercialization / Industrialization of qualified alternative" & "Phase-out of CrVI / ramp-up of production to 100 % alternative"

4.3.3 Estimated Time Until Completion of the Substitution

4.3.3.1 Sanitary

Only two answers were received from DUs performing "Pre-treatment (etching) of metal substrates" in the largest market sector "Sanitary". For the sub-use "Pre-treatment (etching) of plastic substrates", "Sanitary" was chosen as the largest market sector by 17 DUs. DUs, which considered the sub-use "Pre-treatment (etching) of plastic substrates" still relevant after their previous answers on the alternatives of the plating process, did generally not agree with the presented timeline of substitution until 30th of June 2023 (18 %) (**Table 17**).

Table 17: Agreement with the timeline for substitution of CrO3 in the sub-uses "Pre-treatment (etching) of plastic substrates" and "Pre-treatment (etching) of metal substrates" by DUs with the largest market sector "Sanitary"

	Pre-treatment (etching) of	
	Plastic substrates	Metal substrates
Agree (n)	*3*	*1*
Disagree (n)	14	*1*
Agreement (%)	18	*50*

When analyzing the estimated time to completion, the picture was consistent with the previously described data for the "plating" sub-uses. DUs which were not in agreement with the timeline generally estimated to need 44 months to complete the "Phase-out of CrVI / ramp-up of production to 100 % alternative". As described in section **4.1**, the results for the three DUs in agreement with the timeline have not been analyzed in further detail. (**Figure 27**). Also, no analysis was performed for the two DUs identified in the sub-use "Pre-treatment (etching) of metal substrates".

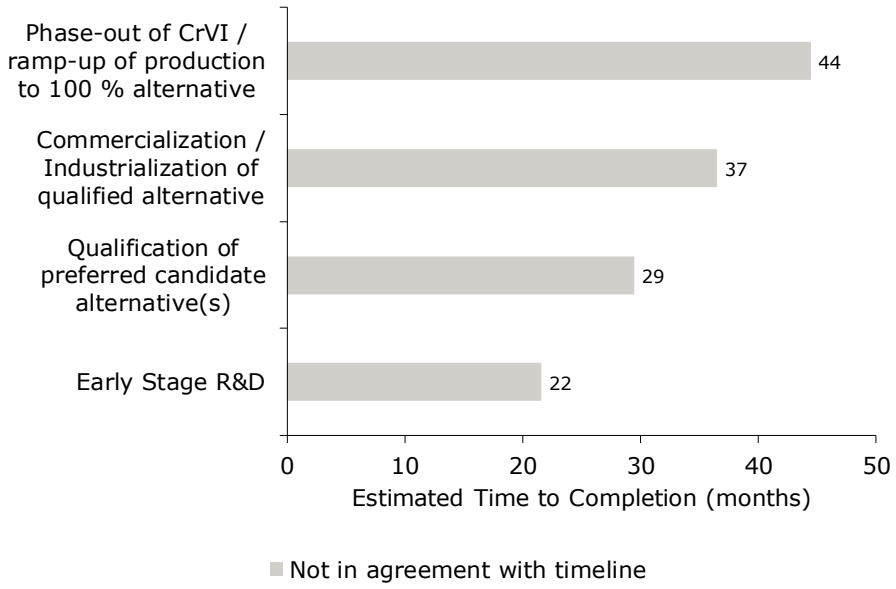


Figure 27: Estimated average (90th percentile) time to completion of the different substitution phases for the sub-use "Pre-treatment (etching) of plastic substrates" by DUs with the largest market sector "Sanitary"

In accordance with the results shown above, detailed timelines were deduced only for DUs who did not agree to the pre-determined timeline and performing "Pre-treatment (etching) of plastic substrates" (**Table 18**). From an upper bound of 11 years, an intermediate period allowing for a 50 % overlap of the substitution phases of 5.5 years until substitution was calculated (see also section **4.1**).

Table 18: Upper and lower bounds (years) as well as an intermediate, adapted timeline (years) for substitution in "Pre-treatment (etching) of plastic/metal substrates" in the largest market sector "Sanitary"

Substrate	Agreement to the timeline (30th of June 2023)	Phases parallel	Phases overlapping [1)]	Phases staggered
Plastic	Yes	n/a	n/a	n/a
	No	3.7	5.5	11.0
Metal	Yes	n/a	n/a	n/a
	No	n/a	n/a	n/a

[1)] Following the procedure described in section **4.1**, a hypothetical overlap factor of 50 % was determined to provide a refined estimate on the time needed for substitution.

4.3.3.2 Automotive

An acceptable amount of data was also available for "Pre-treatment (etching) of plastics" in the largest market sector "Automotive", but not for "Pre-treatment (etching) of metals". Compared to the market sector "Sanitary", less DUs accepted the timeline of substitution until the 30th of June 2023 (12 % and 33 %, respectively) (**Table 19**).

Table 19: Agreement with the timeline for substitution of CrO3 in the sub-uses "Pre-treatment (etching) of plastic substrates" and "Pre-treatment (etching) of metal substrates" by DUs with the largest market sector "Automotive"

	Pre-treatment (etching) of	
	Plastic substrates	Metal substrates
Agree (n)	6	*1*
Disagree (n)	43	*2*
Agreement (%)	12	*33*

The high disagreement is reflected by the average period estimated (of the 90th percentile) to complete the "Phase-out of CrVI / ramp-up of production to 100 % alternative" (113 months) by DUs that do not agree with the timeline (**Figure** 28). Interestingly, the estimated duration to complete "Phase-out of CrVI / ramp-up of production to 100 % alternative" is also long for DUs who are in agreement with the timeline in comparison to other sub-uses and market sectors (36 months).

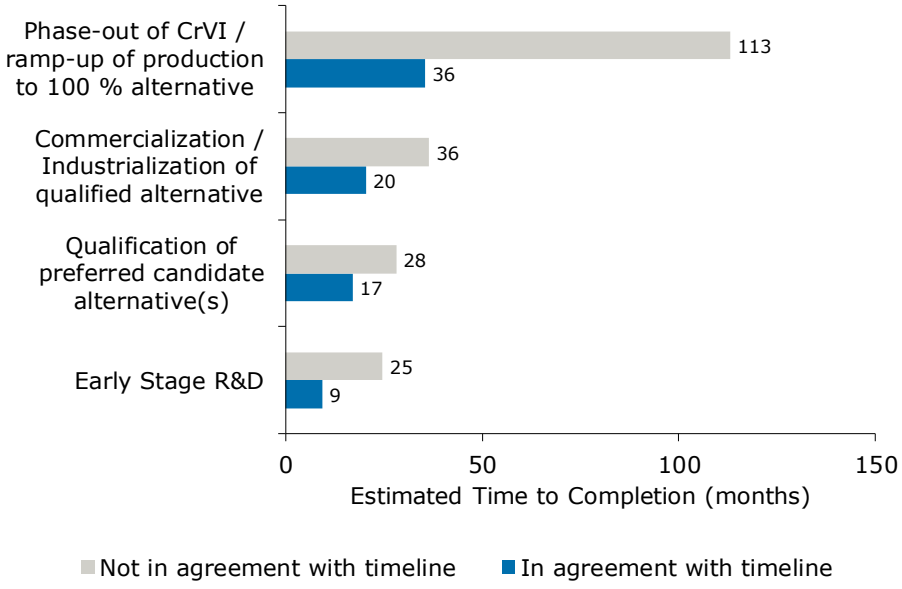


Figure 28: Estimated average (90th percentile) time to completion of the different substitution phases for the sub-use "Pre-treatment (etching) of plastic substrates" by DUs with the largest market sector "Automotive"

When analyzing the data for the DUs performing "Pre-treatment (etching) of plastic substrates" in the automotive sector, it became obvious that especially distinct differences exist between DUs who reported to be in agreement with the timeline until substitution and those who are not (**Table 20**). The difference amounted to 5 years when allowing the phases to overlap and 10 years when assuming all phases are initiated sequentially. This disparity is also driven by the stretched, estimated duration until completion of the "Phase-out of CrVI / ramp-up of production to 100 % alternative" by the DUs who are not in agreement with the timeline. As already described in more detail in section **4.2.3.2**, the potential overestimate of the time needed causes that the refined estimate including a potential overlap of substitution phases (8.4 years) is shorter than the total period of substitution when assuming parallelism of the phases (9.4 years) (*cf.* section **4.1**).

Table 20: Upper and lower bounds (years) as well as an intermediate, adapted timeline (years) for substitution in "Pre-treatment (etching) of plastic/metal substrates" in the largest market sector "Automotive"

Substrate	Agreement to the timeline (30th of June 2023)	Phases parallel	Phases overlapping [1)]	Phases staggered
Plastic	Yes	3.0	3.4	6.9
	No	9.4 [2)]	8.4	16.9
Metal	Yes	n/a	n/a	n/a
	No	n/a	n/a	n/a

[1)] Following the procedure described in section **4.1**, a hypothetical overlap factor of 50 % was determined to provide a refined estimate on the time needed for substitution.
[2)] Estimate higher than for the corresponding "overlapping phases" due to the high values entered for the final phase of substitution by the DUs (see also section **4.2.3.2** for details).

4.3.3.3 Furniture, Medical, Cosmetics

Due to the small number of relevant responses for "Pre-treatment (etching) of plastic/metal substrates", the three market sectors "Furniture", "Medical and "Cosmetics" were summarized. Neglecting the low sample sizes, the agreement to the timelines of substitution ("Furniture" and "Medical": 30th of June 2023; "Cosmetics": 31st of December 2020) was generally low (0 to 25 %)

Table 21: Agreement with the timeline for substitution of CrO3 in the sub-uses "Pre-treatment (etching) of plastic substrates" and "Pre-treatment (etching) of metal substrates" by DUs with the largest market sectors "Furniture", "Medical" and "Cosmetics"

		Pre-treatment (etching) of	
		Plastic substrates	Metal substrates
Furniture	Agree (n)	*0*	*0*
	Disagree (n)	*2*	*2*
	Agreement (%)	*0*	*0*
Medical	Agree (n)	*0*	*1*
	Disagree (n)	*0*	*3*
	Agreement (%)	—	*25*
Cosmetics	Agree (n)	1	*0*
	Disagree (n)	6	*0*
	Agreement (%)	14	—

In the market sector "Cosmetics" and the "Pre-treatment (etching) of plastic substrates", the highest number of answers was identified (n = 6) for DUs not agreeing with the timeline (31st of December 2020). Accordingly, only those were evaluated in further detail (*cf.* section **4.1**). Even though the information were retrieved from a small sample size, the distribution of the estimated average (of the 90th percentile) time to completion of the substitution phases was comparable to the previously presented timelines for other sectors and sub-uses (**Figure 29**). In total, the estimated time to complete "Phase-out of CrVI / ramp-up of production to 100 % alternative" was however high (70 months).

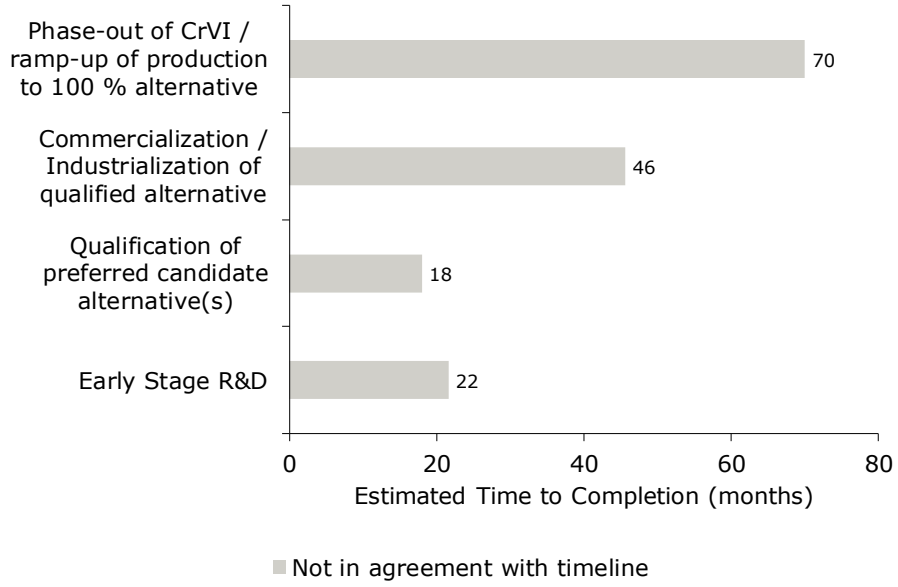


Figure 29: Estimated average (90th percentile) time to completion of the different substitution phases for the sub-use "Pre-treatment (etching) of plastic substrates" by DUs with the largest market sector "Cosmetics"

Table 22 summarizes the results of the refinement approach to provide a more realistic estimate on the time to substitution necessary for the market sector "Cosmetics" and the sub-use "Pre-treatment (etching) of plastic substrates. Data were only evaluable for the group of DUs not in agreement with the timeline (31st of December 2020). Irrespective of the approach taken (see section **4.1**), the proposed timeline is exceeded to a large extent, illustrating that DUs would need more time to substitute the use of CrO3 in the "etching"-sub-use.

Table 22: Upper and lower bounds (years) as well as an intermediate, adapted timeline (years) for substitution in "Pre-treatment (etching) of plastic/metal substrates" in the largest market sector "Cosmetics"

Substrate	Agreement to the timeline (31st of December 2020)	Phases parallel	Phases overlapping [1)]	Phases staggered
Plastic	Yes	n/a	n/a	n/a
	No	5.8	6.5	12.9
Metal	Yes	n/a	n/a	n/a
	No	n/a	n/a	n/a

[1)] Following the procedure described in section **4.1**, a hypothetical overlap factor of 50 % was determined to provide a refined estimate on the time needed for substitution.

4.3.3.4 Other

In total, 16 DUs reported the market sector "Other" as the largest market sector for the "Pre-treatment (etching) of plastic substrates" (**Table 23**). An additional 11 DUs stated "Other" as the largest market sector for the sub-use "Pre-treatment (etching) of metal substrates" taking into account their opinion on the relevance of the "etching" process based on their answers on the substitution in the "plating" sub-uses (*cf.* section **4.1** and statements in sections **4.3.1** and **4.3.2**). Around 1/3 (31 % and 36 %, respectively) of the DUs agreed with the timeline of substitution (30th of June 2023).

Table 23: Agreement with the timeline for substitution of CrO3 in the sub-uses "Pre-treatment (etching) of plastic substrates" and "Pre-treatment (etching) of metal substrates" by DUs with the largest market sector "Other"

	Pre-treatment (etching) of	
	Plastic substrates	Metal substrates
Agree (n)	*5*	*4*
Disagree (n)	11	7
Agreement (%)	31	36

The estimated time to completion of the phases for the different sub-uses are presented in **Figure 30** and **Figure 31**. In the sub-use "Pre-treatment (etching) of plastic substrates", DUs that were not in agreement with the timelines estimated to need 56 months until "Phase-out of CrVI / ramp-up of production to 100 % alternative", which is approximately twice as long as for any other phase reported. The differences were smaller in the sub-use "Pre-treatment (etching) of metal substrates", although the time needed until completion of "Phase-out of CrVI / ramp-up of production to 100 % alternative" was comparable (49 months).

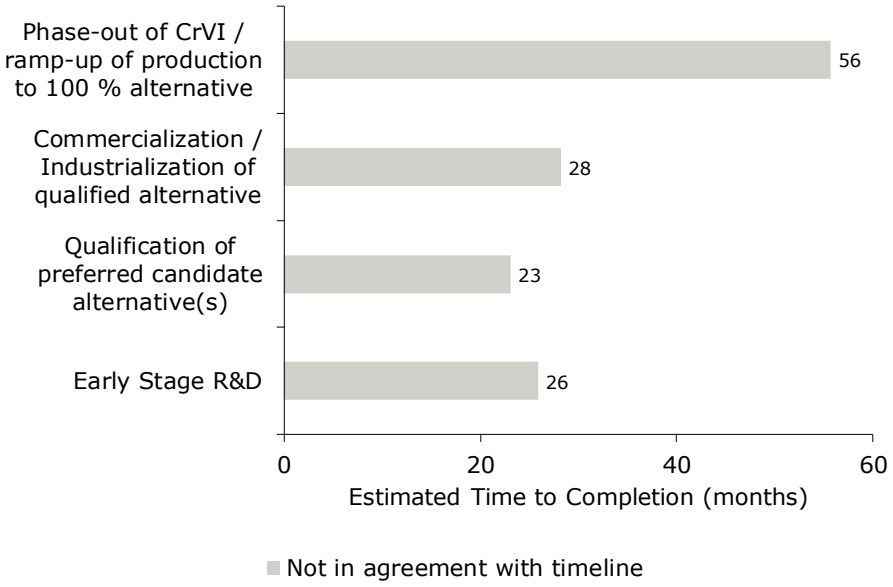


Figure 30: Estimated average (90th percentile) time to completion of the different substitution phases for the sub-use "Pre-treatment (etching) of plastic substrates" by DUs with the largest market sector "Other"

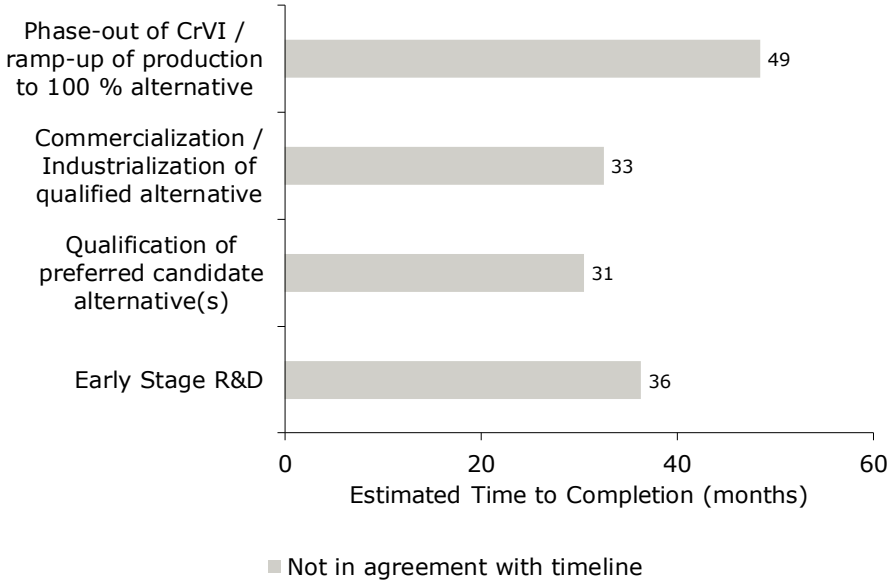


Figure 31: Estimated average (90th percentile) time to completion of the different substitution phases for the sub-use "Pre-treatment (etching) of metal substrates" by DUs with the largest market sector "Other"

A detailed analysis of the time to substitution was only conducted for the DUs that are not in agreement with the timeline (30th of June 2023) for both substrates (plastic and metal) pre-treated (section **4.1**). All estimates are highly comparable. Allowing for an overlap of the substitution phases, a substitution period of 5.5 to 6.2 years was calculated (**Table 24**).

Table 24: Upper and lower bounds (years) as well as an intermediate, adapted timeline (years) for substitution in "Pre-treatment (etching) of plastic/metal substrates" in the largest market sector "Others"

Substrate	Agreement to the timeline (31st of December 2020)	Phases parallel	Phases overlapping [1)]	Phases staggered
Plastic	Yes	n/a	n/a	n/a
	No	4.6	5.5	11.1
Metal	Yes	n/a	n/a	n/a
	No	4.0	6.2	12.3

[1)] Following the procedure described in section **4.1**, a hypothetical overlap factor of 50 % was determined to provide a refined estimate on the time needed for substitution.

5. MONITORING OF THE IMPLEMENTATION OF THE SUBSTITUTION PLAN

At the end of each sub-use section, the DUs were asked about the system in place to monitor the progress and implementation of the company-specific substitution plan. The DUs could choose from up to four pre-determined options. Also, more than one option could be selected:

1. Allocation of specific project manager to R&D project
2. Regular meetings (quarterly, half-yearly) specific to R&D project
3. Regular reporting of substitution plan progress to R&D steering committee resulting in necessary action plan for further steps
4. Other

As described before, the section on "etching" was only presented to the DUs if they regarded the "etching" process still relevant based on their answers regarding substitution of the "plating" sub-uses. Hence, 106 DUs provided answers for the sub-use "Functional chrome plating with decorative character of plastic substrates", 751 for the sub-use "Functional chrome plating with decorative character of metal substrates", 91 for the sub-use "Pre-treatment (etching) of plastic substrates" and 17 for the sub-use "Pre-treatment (etching) of metal substrates".

DUs working with plastic substrates during "plating" and "etching" chose "Regular meetings specific to R&D project" with the highest frequencies (69 % and 77 %, respectively). Moreover, it was also quite favored to allocate a specific project manager to the R&D project (60 % and 65 %, respectively). For both sub-uses featuring plastic substrates, generally higher implementation rates of any of the pre-determined monitoring systems were observed than by the DUs working with metal substrates. An exception is the choice of "Other", which gained a higher agreement rate in the "plating" sub-use of metal substrates (46 %). In general, the data suggest that the DUs working with plastic substrates have achieved a larger variety in regards of the monitoring options implemented. The reasons for this remain, however, unresolved. The total number of responses is presented below in **Table 25**. A graphical presentation of the results is given in **Figure 32** to **Figure 35**.

Table 25: System in place to monitor and document the progress and implementation of the company-specific substitution plan

Sub-use	Response	Allocation of specific project manager to R&D project	Regular meetings (quarterly, half-yearly) specific to R&D project	Regular reporting of substitution plan progress to R&D steering committee resulting in necessary action plan for further steps	Other
1	Yes	64	73	50	32
	No	42	33	56	74
2	Yes	235	277	171	342
	No	516	474	580	409
3	Yes	59	70	44	26
	No	32	21	47	65
4	Yes	4	7	5	5
	No	13	10	12	12

Remark: Sub-use 1 refers to "Functional chrome plating with decorative character of plastic substrates", sub-use 2 to "Functional chrome plating with decorative character of metal substrates", sub-use 3 to "Pre-treatment (etching) of plastic substrates" and sub-use 4 to "Pre-treatment (etching) of metal substrates".

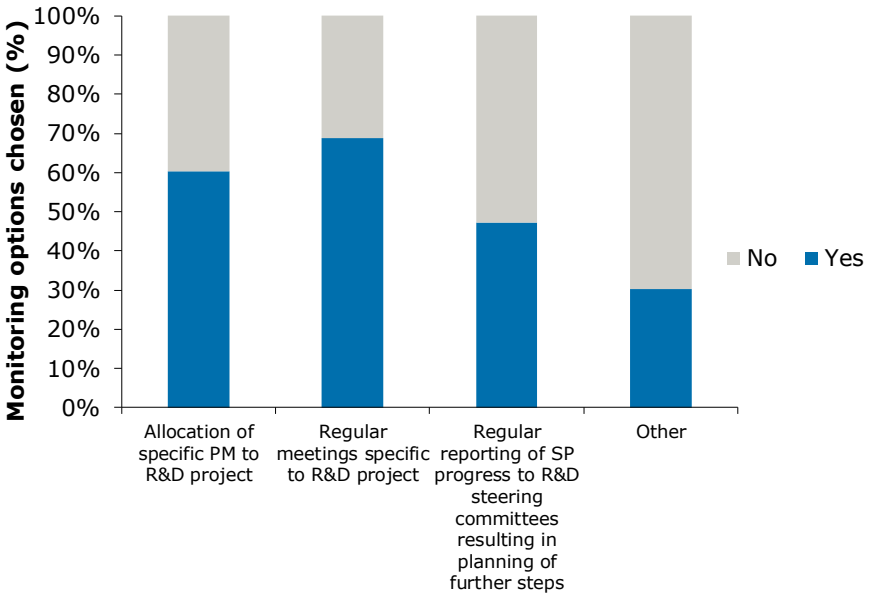


Figure 32: System in place to monitor and document the progress and implementation of the company-specific substitution plan of DUs performing "Functional chrome plating with decorative character of plastic substrates"

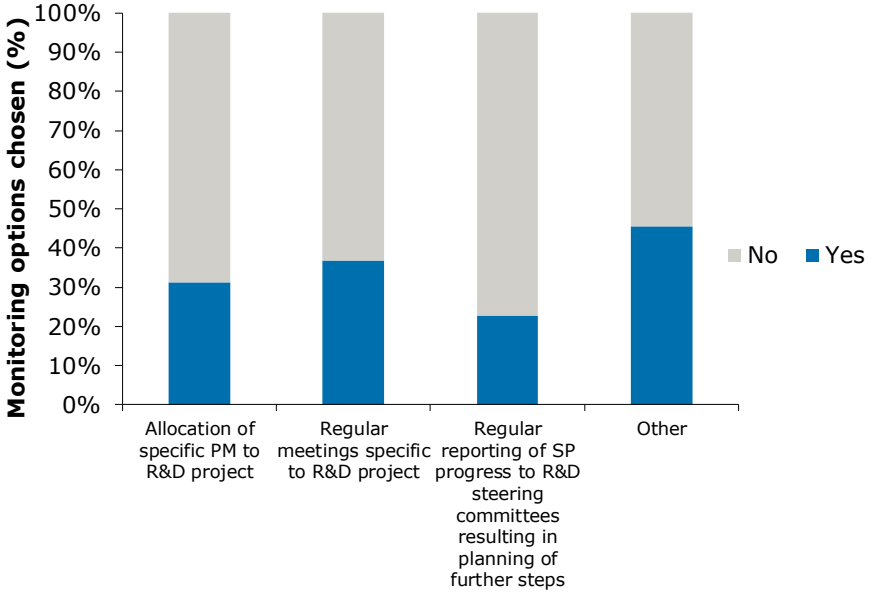


Figure 33: System in place to monitor and document the progress and implementation of the company-specific substitution plan of DUs performing "Functional chrome plating with decorative character of metal substrates"

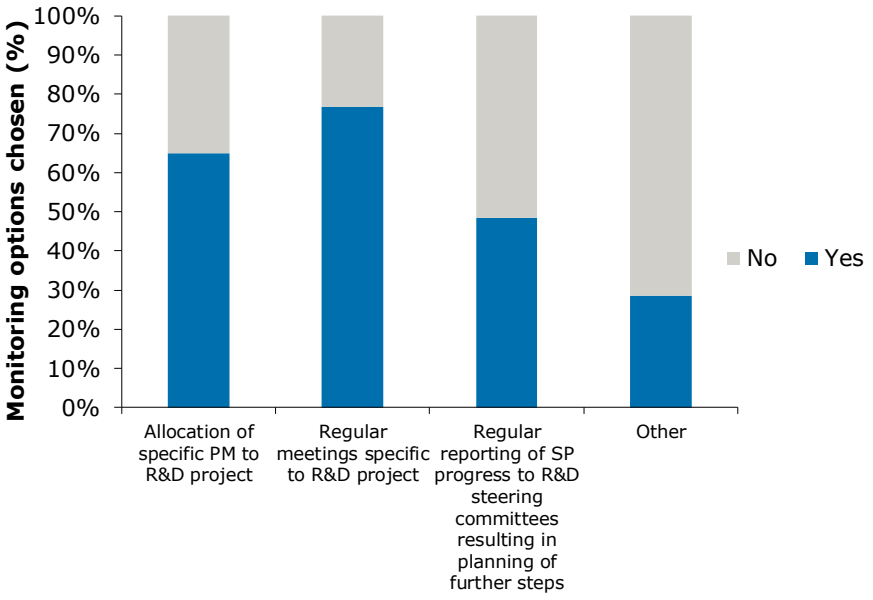


Figure 34: System in place to monitor and document the progress and implementation of the company-specific substitution plan of DUs performing "Pre-treatment (etching) of plastic substrates"

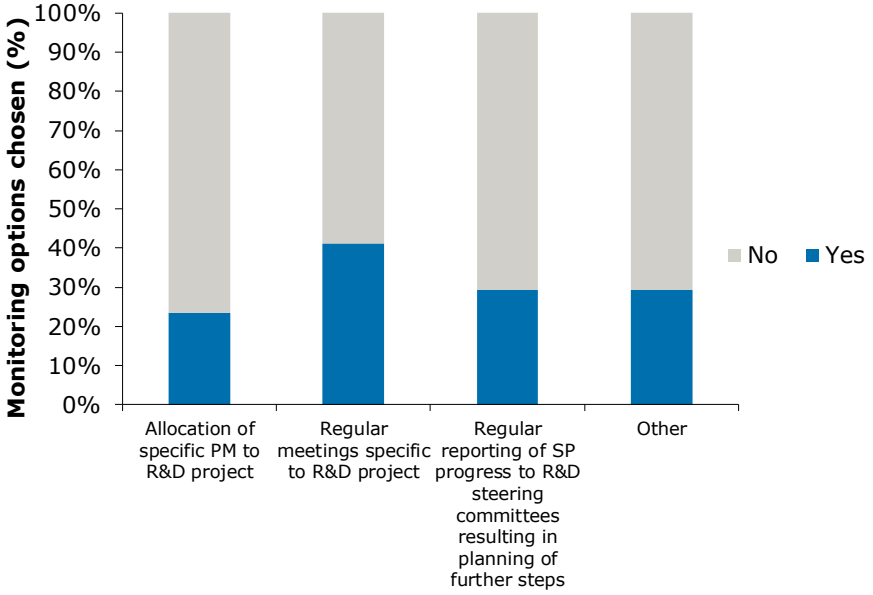


Figure 35: System in place to monitor and document the progress and implementation of the company-specific substitution plan of DUs performing "Pre-treatment (etching) of metal substrates"

6. CONCLUSION

The survey was initiated to gather up to the minute information from DUs to support the substitution plan on the use of chromium trioxide (CrO_3) for "Functional chrome plating with decorative character", also referred to as CTACSub's Use Group 3 and REACHLaw's DUs for Use 3 of their application. The aim of the survey was to characterize the affected DUs, to explain the individual concerns and challenges posed by substitution, and to describe efforts made towards the substitution process. Moreover, it aimed to better understand the differences between four sub-uses and all relevant market sectors to allow for a specific consideration of the diverse lines of action.

The DUs were also asked to provide information on the state of their substitution and the estimated time needed to complete the four pre-determined phases of substitution (*i.e.* "Early Stage R&D", "Qualification of preferred candidate alternative(s)", "Commercialization / Industrialization of qualified alternative" and "Phase-out of CrVI / ramp-up of production to 100 % alternative").

In general, the survey was a success as a very high response rate was achieved (see section **2.1**). However, there were certain challenges to a) the consistency in approach to substitution between the DUs and/or b) the quality/consistency of the responses received. This shows – even when considered carefully – the difficulty to collect data from a multi-regional and complex supply chain, including organisations who, despite operating similar processes, have multiple facilities, customers, insights, data and cultures. These challenges reflect differences observed during data collection for original CTAC work.

The analyses of the annual tonnage revealed that the survey covered a wide range of company sizes. As described in section **2.2**, a large proportion of the DUs may be referred to as small- or medium-sized companies based on their annual consumption of CrO3. Also, the responses on the market sectors indicated that the survey covered a broad range of different market interests. The largest proportion of DUs was classified in the largest market sector "Other" (33 %), compared to one of the pre-determined sectors "Automotive", "Furniture", "Medical", "Sanitary" and "Cosmetics". This indicates that the fields of work covered by "Use 3" are highly diverse and cannot simply be separated into pre-determined sectors. This issue is also confirmed by the list of products and end-uses, comprising a wide variety of goods (see **ANNEX III**). Approximately 20 % of the DUs were allocated to the largest market sectors "Automotive", "Furniture" and "Sanitary", respectively. Fewer DUs are engaged with the sector "Medical" (5 %), but the product list suggests that the availability and quality of those products is of high value for society. Only a small fraction of DUs (2 %) indicated "Cosmetics" as their largest market sector, hinting at its secondary role regarding the proportion of CrO_3 used within Use 3.

When split by sub-use (section **2.3**), the largest proportion of DUs could be associated with "Functional chrome plating with decorative character of metal substrates" (84 %). According to the percentage of answers, this sub-use appears to be of highest importance within Use group 3. As metals substrates can, in most cases, be readily plated without pre-treatment, the combination of etching and plating for metal substrates was only reported with a frequency of 2 %. Regarding plastic substrates, general accordance by DUs with galvanic sequences and the necessity to treat plastic substrates prior to the actual plating process to make the substrates' surfaces conductive was found. 10% of DUs were associated with the combined sub-uses plating and etching. Smaller fractions of DUs reported to perform solely plating (2 %) or etching of plastic substrates (1 %). This may either reflect differences in site-specific sequences or could be the result of a misapprehension of the survey.

From sections **3.1** and **3.2** it can be concluded that the switch to an entirely CrVI-free production process is a challenging and complex task for most DUs. They need to consider many different levels (technical, economic, etc.) when assessing alternatives for implementation at their production sites. At the end, the overall result of the respective DU' assessment must ensure that the implementation of alternatives (either for plating or etching) entails the lowest risk possible for failure on commercial stage and/or losing business.

In general, the points regarding the challenges of substituting CrO_3 raised by DUs are in good accordance with the view of the formulators of CrVI-free technologies (see section **1.2**). Sections **1.2**, **3.1** and **3.2** can be considered as a good estimation for the status of alternative development and implementation in respect to the market reality. Further, it can be concluded that industry is well informed about alternatives and eager to pursue a reasonable way towards substitution (see sections **4.2.2** and **4.3.2**).

When considering a substance or substance group to substitute CrO_3, many DUs were confident that a technical alternative existed (sections **4.2.1** and **4.3.1**). 22 % of all DUs stated that no technical alternative was generally available for etching of plastic substrates and 30% provided the same statement for plating. The DUs performing etching and plating of metal substrates were even more pessimistic. 50 % (etching) and 53 % (plating), respectively reported that there was no alternative generally available.

When asked for possible alternatives, the DUs referred to few "main" alternatives. For the chrome plating sub-uses of metal and plastic substrates these were Chrome(III)-sulphate- and Chrome(III)-chloride-based electrolytes. The results indicate that these electrolytes are suitable for either substrate (metal or plastic). This is in line with the information

received from formulators (see section **1.2**) and the extent of the challenges of the substitution process, as described herein (see section **3**). PVD and *Other* alternatives comprised only a small fraction of the responses given.

For the etching sub-uses, the DU indicated that different alternatives (Permanganates and Manganese-salts for plastic substrates; Sulfuric acid and or Phosphoric acid for metal substrates) were the preferred alternatives, which might complicate the substitution process if a combination of both etching sub-uses is performed by a DU. In case the DUs stated that no alternative was generally available, similar applicable limitations were identified. For all sub-uses, these mainly encompassed not only concerns about the "customer acceptance" of the alternatively etched or plated product, but also limitations of the "surface property" of the final product.

All of the identified obstacles are reflected in the DU responses on the target substitution timelines (30th of June 2023 / 31st of December 2020) suggested for the purpose of achieving clear statements in the survey as well as the estimated time to complete either of the four predetermined phases of substitution (sections **4.2.2** and **4.2.3** as well as sections **4.3.2** and **4.3.3**).

The agreement with the timelines was low. When only considering those sub-uses and market sector combinations with more than five responses, the lowest agreement rate was observed for etching of plastic substrates in the largest market sector "Automotive" (12 %). The highest agreement rate was 38 % for plating of plastic substrates in the market sector "Others" and plating of metal substrates in the largest market sector "Automotive". This suggests that many DUs will not be able to substitute before the end of the authorisation period set out in the current draft authorisation decision. However, substitution in the cosmetic sector appears to be more advanced and could be achieved within this timeframe.

Regarding the market sector specific time necessary for substitution, it has to be noted that the fragmented analyses of sub-uses and market sectors resulted in high granularity. Inferentially, the granularity was also accompanied with the creation of partly small sample sizes, rendering it difficult to draw robust conclusions for several sub-use and market sector combinations.

The low agreement rates to the substitution timelines are also partly displayed by the state of the substitution phases. In general, the vast majority of DUs reported that they had not started the final substitution phases of "Commercialization / Industrialization of qualified alternative" or "Phase-out of CrVI / ramp-up of production to 100 % alternative". However, it was also found in the data that the DUs have made considerable progress in the earlier stages of R&D. The data illustrate that the DUs' substitution efforts were quite advanced in the steps of "Early Stage R&D" and "Qualification of preferred candidate alternative(s)". This statement can be made irrespective of the sub-use. Interestingly, the substitution processes for plating of metal substrates appears to be generally less developed. The rate of DUs stating that they had not started especially phases 2 to 4 is higher. As expected, DUs in agreement with the suggested timeline generally reported shorter periods until completion of either phase while those not agreeing with the timeline reported to need longer.

In any case, no final date could be concluded from the provided raw data as it could not be clarified in many cases if the data were entered as parallel or consecutive periods. To overcome this, a more realistic estimate on the total time until completion was derived, allowing an overlap of the phases by 50 %. Due to the partly small sample sizes, only groups including more than 5 DUs were analyzed in detail. In summary, the data suggest that the majority of the DUs – those not agreeing with the proposed timelines – need at least 6 to 7 years for the substitution process. As mentioned before, this timeline assumes overlapping phases.

The estimated periods needed until completion based on the data reported by the DUs for the different sub-uses are presented on the following two pages.

Estimated time until completion of substitution of **"Functional chrome plating with decorative character"** based on DU data, including an estimated overlap of 50 % of the individual substitution phases (see section **4.1**):

- Substrate: **Plastic**
  - Proposed timeline (see section **1.3**): **30th of June 2023**
    - Agreeing with the timeline [n = 26]
      - Sanitary: n/a [n = 4 / 17 %]
      - Automotive: 3.8 years [n = 12 / 22 %]
      - Furniture: n/a [n = 1 / 20 %]
      - Medical: n/a [n = 0 / n/a]
      - Other: 3.4 years [n = 9 / 39 %]
      - On average: **3.6 years**
    - Not agreeing with the timeline [n = 79]
      - Sanitary: 6.3 years [n = 19 / 83 %]
      - Automotive: 7.6 years [n = 42 / 78 %]
      - Furniture: n/a [n = 4 / 80 %]
      - Medical: n/a [n = 0 / n/a]
      - Other: 4.4 years [n = 14 / 61 %]
      - On average: **6.1 years**
  - Proposed timeline (see section **1.3**): **31st of December 2020**
    - Agreeing with the timeline
      - Cosmetics: **n/a** [n = 2 / 29 %]
    - Not agreeing with the timeline:
      - Cosmetics: **n/a** [n = 5 / 71 %]
- Substrate: **Metal**
  - Proposed timeline (see section **1.3**): **30th of June 2023**
    - Agreeing with the timeline [n = 255]
      - Sanitary: 3.4 years [n = 48 / 27 %]
      - Automotive: 3.2 years [n = 50 / 37 %]
      - Furniture: 3.0 years [n = 57 / 33 %]
      - Medical: 3.6 years [n = 13 / 30 %]
      - Other: 3.1 years [n = 87 / 31 %]
      - On average: **3.3 years**
    - Not agreeing with the timeline [n = 558]
      - Sanitary: 6.0 years [n = 129 / 73 %]
      - Automotive: 6.4 years [n = 84 / 63 %]
      - Furniture: 6.6 years [n = 116 / 67 %]
      - Medical: 6.3 years [n = 31 / 70 %]
      - Other: 7.3 years [n = 198 / 69 %]
      - On average: **6.5 years**
  - Proposed timeline (see section **1.3**): **31st of December 2020**
    - Agreeing with the timeline
      - Cosmetics: **n/a** [n = 1 / 50 %]
    - Not agreeing with the timeline:
      - Cosmetics: **n/a** [n = 1 / 50 %]

Estimated time until completion of substitution of **"Pre-treatment (etching)"** based on DU data, including an estimated overlap of 50 % of the individual substitution phases (see section **4.1**):

- Substrate: **Plastic**
  - Proposed timeline (see section **1.3**): **30th of June 2023**
    - Agreeing with the timeline [n = 14]
      - Sanitary: n/a [n = 3 / 18 %]
      - Automotive: 3.4 years [n = 6 / 12 %]
      - Furniture: n/a [n = 0 / 0 %]
      - Medical: n/a [n = 0 / n/a]
      - Other: n/a [n = 5 / 31 %]
      - On average: **3.4 years**
    - Not agreeing with the timeline [n = 70]
      - Sanitary: 5.5 years [n = 14 / 82 %]
      - Automotive: 8.4 years [n = 43 / 88 %]
      - Furniture: n/a [n = 2 / 100 %]
      - Medical: n/a [n = 0 / n/a]
      - Other: 5.5 years [n = 11 / 69 %]
      - On average: **6.5 years**
  - Proposed timeline (see section **1.3**): **31st of December 2020**
    - Agreeing with the timeline
      - Cosmetics: **n/a** [n = 1 / 14 %]
    - Not agreeing with the timeline
      - Cosmetics: **6.5 years** [n = 6 / 86 %]
- Substrate: **Metal**
  - Proposed timeline (see section **1.3**): **30th of June 2023**
    - Agreeing with the timeline [n = 7]
      - Sanitary: n/a [n = 1 / 50 %]
      - Automotive: n/a [n = 1 / 33 %]
      - Furniture: n/a [n = 0 / 0 %]
      - Medical: n/a [n = 1 / 25 %]
      - Other: n/a [n = 4 / 36 %]
      - On average: **n/a**
    - Not agreeing with the timeline [n = 15]
      - Sanitary: n/a [n = 1 / 50 %]
      - Automotive: n/a [n = 2 / 67 %]
      - Furniture: n/a [n = 2 / 100 %]
      - Medical: n/a [n = 3 / 75 %]
      - Other: 6.2 years [n = 7 / 64 %]
      - On average: **6.2 years**
  - Proposed timeline (see section **1.3**): **31st of December 2020**
    - Agreeing with the timeline
      - Cosmetics: **n/a** [n = 0 / n/a]
    - Not agreeing with the timeline
      - Cosmetics: **n/a** [n = 0 / n/a]

To assess the reliability of these estimated timelines, an analysis of the requested review period as well as the review period recommended by the RAC and SEAC and/or decided by the EU Commission from separately submitted AfAs for the same use was performed. Only AfAs filed by DUs performing functional chrome plating with decorative character were regarded, *i.e.* no upstream supply chain AfAs were considered. The information was retrieved from the ECHA website. The results are summarized in **Table 26**. Of note, the analysis revealed:

- the timeline of 6-7 years derived from the DU data in this survey probably marks an underestimation. The DUs (see **Table 26)** in most cases requested a review period of 12 years for either sub-use (etching or plating). A reason for this might be the methodology used to calculate the timeline. Another cause might be found in the difference to an individually filed AfA. It can be assumed that an individual AfA contains a higher degree of specificity regarding the applicant's processes and needs. It can also be considered that in an individual AfA, challenges may be depicted in greater depth and are customized to the applicant's situation.
- the RAC and SEAC agreed with the requested review periods and recommended periods of the same length, in all seven cases where opinions were already adopted. The EU Commission already followed this recommendation in two cases and approved the authorisation (one AfA submitted prior to and one AfA submitted after the sunset date). Those authorisations for the use of CrO_3 will expire in 7 to 11 years, making an example of time granted for the substitution to other DUs.
- Critically, only 11 AfAs – covering 28 (mostly large) companies and 20 uses – were submitted by DUs performing functional chrome plating with decorative character. This is in clear contrast to the 851 DUs that contributed data to this SP. It shows that only a very low portion of DUs (around 3%) has the benefit of single or group downstream applications and around 97% of the DUs depend on this upstream application.

In conclusion, our analysis indicates DUs require 6-7 years and likely more to successfully substitute CrO_3. However, given that the substitution process involves numerous uncertainties, prolonged substitution timelines cannot be excluded for some DUs, market sectors or sub-uses. The challenges described and analysed in chapter **3** can only be resolved by DUs and formulators working in close collaboration to further proceed with substitution across market sectors. This is reflected beyond the CTACSub AfA; considering standalone downstream AfAs submitted for similar uses, some critical issues of concern still remain unresolved as the requested, recommended and granted review periods range from 10 to 12 years for plating and etching, independent of the date of submission of the AfA. This is also supported by the small number of DUs employed with decorative chrome plating in the EU that have already substituted CrO_3 completely. Based on industry insights from the formulators forming CTACSub, less than 5 % of those DUs in the EU have completely substituted CrO_3 in decorative plating. For etching, numbers are even lower. These figures are consistent with the results from this survey showing that only a small number of DUs already finalized Phase 4 (Phase-out of CrVI / ramp-up of production to 100 % alternative) (see chapter **4.2.2** and chapter **4.3.2**).

Table 26: List of submitted Applications for Authorization by Downstream Users performing functional chrome plating with decorative character

Application listing, type and submission date	Applicant(s)	Sector(s)	Use	Requested review period	Review period recommended or decided by ECHA	Status	Remaining period (from May 2020)
1 – Single (07.10.2015)	Grohe AG	Sanitary	Plating	12	*12 – 21.09.2029*	Commission decided (08.02.2017)	9.4
			Etching	10	*10 – 21.09.2027*		7.4
2 – Consortium (22.02.2016)	Gerhardi Kunststofftechnik GmbH C. Hübner GmbH SAXONIA Galvanik GmbH Simon Systems GmbH & Co. KG [1)] Galvanoplast Fischer Bohemia, s.r.o. [2)] Fischer Oberflächentechnologie GmbH [3)] WAFA Germany GmbH Boryszew Oberflächentechnik Deutschland GmbH Bolta Werke GmbH Heinze Gruppe GmbH C+C Krug GmbH BIA Kunststoff- und Galvanotechnik GmbH & Co KG Aludec Galvanic s.a.	Automotive	Plating	12	12	Opinion adopted	n/a
3 – Single (15.11.2016)	Hansgrohe SE	Sanitary	Plating	12	*12 – 14.02.2031*	Commission decided (14.02.2019)	10.8
			Etching	12	*12 – 14.02.2031*		10.8
4 – Single (19.11.2018)	Aloys F. Dornbracht GmbH & Co.KG	Sanitary	Plating	12	12	Opinion adopted	n/a
5 – Single (20.11.2018)	Schell GmbH & Co. KG Armaturentechnologie	Sanitary	Plating	12	12	Opinion adopted	n/a
6 – Single (20.11.2018)	KEUCO GmbH & Co KG	Sanitary	Plating	12	12	Opinion adopted	n/a
			Etching	12	12		n/a
7 – Single (20.11.2018)	Ideal Standard - Vidima AD Ideal Standard Produktions-GmbH Jado Iberia-Produtos Metalurgicos Sociedade Unipessoal LDA (withdrawn)	Sanitary	Plating	12	12	Opinion adopted	n/a
	Ideal Standard - Vidima AD		Etching	12	12		n/a
8 – Single (n/a)	C. Hübner GmbH	Automotive/ Sanitary/ Consumer	Etching	31.12.2028	[/]	Opinion development	n/a
			Etching	31.12.2028	[/]		n/a
			Plating	31.12.2028	[/]		n/a

Table 26 (continued): List of submitted Applications for Authorization by Downstream Users performing functional chrome plating with decorative character

Application listing, type and submission date	Applicant(s)	Sector(s)	Use	Requested review period	Review period recommended or decided by ECHA	Status	Remaining period (from May 2020)
9 – Consortium (n/a)	LARS Chemie, spol. s r.o. CASTELCROM SRL MATRIDOS S.L.U PLATING BRAP S.A.U.	Automotive/ Sanitary	Etching	12	[/]	Public consultation	n/a
	LARS Chemie, spol. s r.o. CASTELCROM SRL MATRIDOS S.L.U PLATING BRAP S.A.U.	Automotive/ Sanitary	Plating	12	[/]		n/a
10 – Single (n/a)	Oras Oy Oras Olesno Sp.z.o.o.	Sanitary	Plating	12	[/]	Public consultation	n/a
	Oras Oy		Etching	12	[/]	Public consultation	n/a
11 – Single (n/a)	Viega Supply Chain GmbH & Co KG	Sanitary	Plating Etching	12 12	[/] [/]	Public consultation	n/a

[1)] Name of co-applicant in the original application: Karl Simon GmbH & Co. KG updated due to a notified legal entity name change
[2)] Correction of the name of the original applicant: Fischer GmbH & Co. surface technologies KG and of the successor applicant: Fischer Surface Technologies GmbH
[3)] Correction of the name of the original applicant: Fischer GmbH & Co. surface technologies KG and of the successor applicant: Fischer Surface Technologies GmbH

ANNEX I – EU COMMISSION LETTER SENT TO REACHLAW (MARCH 10TH , 2020)

Ref. Ares(2020)1472546 - 10/03/2020

EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR INTERNAL MARKET, INDUSTRY, ENTREPRENEURSHIP AND SMES
Chemicals and Consumer Industries
DIRECTORATE-GENERAL FOR ENVIRONMENT
Circular Economy and Green Growth
The Directors

Brussels, 10/03/2020
GROW/D1/RZ
grow.ddg1.d.1(2020)1484462

Mr Jouni Honkavaara
REACHLaw Ltd.
Vänrikinkuja 3 JK 21
02600 Espoo Novotroitsk
Finland
oper_sief@reachlaw.fi

Subject: **Your application for authorisation under Regulation (EC) No 1907/2006 (REACH) for the use of chromium trioxide in 'functional chrome plating with decorative character'**[1]

Dear Sir,

We are contacting you in relation to the application for authorisation by REACHLaw Ltd. for the use of chromium trioxide in 'functional chrome plating with decorative character', in particular as regards the analysis of alternatives and the possible requirement regarding a substitution plan.

In the EU General Court judgment of 7 March 2019 in Case T-837/16, *Sweden v. Commission*[2], the Court has given its interpretation of the condition set out in Article 60(4) and (5) and Article 62(4)(f) REACH as regards suitability of alternatives and the requirement of a substitution plan. The Court has in particular established that *'where (...) there remain uncertainties as regards the condition relating to the lack of availability of alternatives, it must be concluded that the applicant for authorisation has not discharged the burden of proof and, therefore, that he cannot be granted authorisation'* (par. 79). However the Court also ruled that where the information gathered and analysis made *'(...) suggest that suitable alternatives are available in general, but that those alternatives are not technically or economically feasible for the applicant for authorisation, this does not necessarily mean that authorisation under Article 60(4) of the regulation must be refused'* (par. 75). If that is the case, *'(...) and if it is shown that socio-economic benefits outweigh the risk to human health or the environment arising from the use of the substance, (...) authorisation may be granted if the applicant for authorisation submits, in accordance with Article 62(4)(f) of that*

[1] 'Use 3' of the application, reference number 11-2120131732-65-0002. This letter does not concern the other uses of your application.

[2] http://curia.europa.eu/juris/document/document.jsf?text=&docid=211428&pageIndex=0&doclang=EN&mode=lst&dir=&occ=first&part=1&cid=1351718

Commission européenne/Europese Commissie, 1049 Bruxelles/Brussel, BELGIQUE/BELGIË - Tel. +32 22991111
Office: BREY 12/205 - Tel. direct line +32 229-85668

regulation, a substitution plan within the meaning of Article 60(4)(c) of that regulation' (par. 76).

This interpretation provided by the Court judgment differs from the interpretation resulting from the currently applicable guidance of the European Chemicals Agency ("**ECHA**") on the preparation of an application for authorisation (the "**ECHA Guidance**")[3]. In particular, the Court links the requirement to provide a substitution plan not to the availability of a suitable alternative specifically *for the applicant* (as this was reflected in ECHA's guidance) but to the availability of a suitable alternative *in general* (i.e. not only for the applicant but for any economic operator in the EU, as explained under Section 1 of the Annex to this letter).

As you are aware, the Committee on Socio-economic Analysis (SEAC) of ECHA, in its Opinion of 19 May 2017 on this application for authorisation, concluded that concerning the use at stake, '*overall, technically feasible alternatives for chromium trioxide-based functional chrome plating with decorative character do not seem to exist before the sunset date*'. However, SEAC also noted that, '*due to the extremely broad scope of this application for authorisation and especially of the precise applications covered by this use applied for,* ***SEAC cannot exclude that there are indeed applications where substitution is already feasible or will become so in the short term***'[4] (emphasis added). In fact, the relevant information available to the Commission (including information from other applications and public consultations) indicates that there may be suitable alternatives available in general, for specific utilisations falling within the scope of the use at stake.

In the light of the above and as it is not necessarily demonstrated that there are no suitable alternatives in general for the entire scope of the use at stake, an authorisation may only be granted if you submit a substitution plan for the utilisations or groups of utilisations for which it is concluded that there are suitable alternatives in general[5]. As this interpretation had been provided by the Court only after the submission of your application, you are hereby given the opportunity to provide the relevant additional information, including an explanation on the availability of suitable alternatives in general for the utilisations or groups of utilisations covered by the use at stake and a substitution plan for those utilisations or group of utilisations for which suitable alternatives in general are available, before the Commission takes a decision on your application.

To that end, ECHA's guidance (Section 4) provides advice on how to prepare a substitution plan. More details on the criteria identified by the Court regarding the concept of 'suitable alternatives in general' and further information as regards the content of the substitution plans are given in the Annex to this letter.

You will need to send the above-mentioned additional information to ECHA so that it undergoes the scrutiny of the ECHA's scientific committees. We foresee that a draft of this assessment[6] will be made available to you for possible comments before being transmitted to the Commission for a final decision on this use. A public consultation would not be necessary in this case.

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[3] https://echa.europa.eu/documents/10162/23036412/authorisation_application_en.pdf. This guidance will be updated to reflect the mentioned change of interpretation

[4] Opinion concerning the use at stake, Section 7.2, p. 39.

[5] It has to be recalled that even if a substitution plan is submitted, an authorisation may only be granted if all conditions of Article 60(4) are fulfilled, including that there are no suitable alternative substances or technologies available for the applicant and/or his downstream users

[6] ECHA will be requested to prepare a draft addendum to the original opinion addressing the additional information and the substitution plan.

Please note that if you do not submit the additional information and, where applicable, a substitution plan for the utilisations or groups of utilisations for which it is concluded that there are suitable alternatives in general, the authorisation will have to be refused. Please also note that no other parts of your application should be updated or modified at this stage.

We invite you to submit the above information to ECHA (Unit Risk Management II), by 10 September 2020. The contact address at the Commission is GROW-D1@ec.europa.eu.

Yours sincerely,

(e-sign)
Carlo Pettinelli

DG Internal Market, Industry Entrepreneurship and SMEs

(e-sign)
Kestutis Sadauskas

DG Environment

Annex

1) Criteria to identify 'suitable alternatives in general'

In paragraphs 72 and 73 of the above-mentioned judgment the General Court has provided key criteria to identify what is a 'suitable alternative in general'. According to the Court, a suitable alternative should be **safer** (entailing a lower risk for human health and/or the environment) and **suitable in the EU** (this 'suitability' is not limited to the existence of an alternative in abstracto or in laboratory or exceptional conditions, but relates to the availability of alternatives technically and economically feasible in the EU). The analysis concerning the suitable alternative in general should be carried out from the perspective of the production capacities (for someone in the market) for those alternative substances and feasibility of those alternative technologies in the light of the legal and factual requirements for placing them on the market.

2) Further information on a substitution plan in your specific case

The availability of a suitable alternative in general, as defined above, is the trigger for the requirement to submit a substitution plan as a part of the application for authorisation, i.e. a substitution plan is not required where there are no suitable alternatives in general.

In line with the objective of progressive substitution included in the REACH Regulation, the substitution plan allows companies to set out a specified timetable for a possible replacement of a substance of very high concern with a safer substitute, available and feasible in general in the EU that, nevertheless, for technical or economic reasons, they cannot implement by the time of applying for authorisation.

As mentioned above in the letter, you should submit a substitution plan as regards the utilisations or groups of utilisations covered by the use at stake for which there are suitable alternatives available in general. For the utilisations or groups of utilisations for which there are no suitable alternatives available in general, a substitution plan is not required. However, in your particular case and in view of the broad use applied for, as well as the broad scope of the analysis of alternatives submitted for that use, you should also provide an explanation for reaching the conclusion that there are no suitable alternatives in general for those utilisations or groups of utilisations. This additional information should be provided in a separate document, as an addendum to the analysis of alternatives.

In addition, we would like to clarify the following points:

- Part of the elements for a substitution plan may already be contained in the analysis of alternatives submitted as part of your application. In so far as relevant, those elements may be taken up in the substitution plan, complemented and updated to provide the appropriate timeline for actions in the substitution plan.
- Where it is clear that a suitable alternative in general will become feasible for you or your downstream users within a certain timeline, the substitution plan should contain a clear and credible timeline to substitute the use of the substance. If appropriate, the substitution plan may be updated later in time as part of a review report, and justification provided regarding the reason for which it is updated.
- Where substitution towards a suitable alternative in general depends on the results of ongoing research, development or testing, the substitution plan should contain a clear and credible commitment to undertake the necessary actions to undertake research on,

develop or test alternatives to make them technically and economically feasible for the you or your downstream users, with a clear timetable following the indications provided in the Guidance on Authorisation. In particular for the initial actions, that timetable should be the subject of a clear and credible commitment. For actions later in that timetable, it is accepted that those may depend on the outcome of earlier actions.

- Where it is clear that a suitable alternative in general cannot become economically and technically feasible for you or your downstream users in a short or medium term, you should still submit a substitution plan, explaining that substitution can only take place in a long term (e.g. when building a new plant or after the end of lifetime of the product). Obviously, such a long-term substitution plan also needs to have clear timelines.
- The addendum to the analysis of alternatives should also cover your downstream users' situations. It should allow to clearly identify for which utilisations or groups of utilisations alternatives in general exist and the substitution plan should link the actions for substitution to those utilisations or groups of utilisations. The more concrete and specific the actions included therein are for certain subsectors, companies and sites, the more specific this information must be. Conversely, too general and imprecise information provided may undermine the justification for the need of a certain time, or even the appropriateness itself of an authorisation.

ANNEX II – REACHLAW LETTER SENT TO DUS

REACHLAW
COMPLIANCE. SUSTAINED.

14.04.2020

April 2020

Important information to all downstream users of Chromium trioxide for use 3 "Functional chrome plating with decorative character" in the Novotroitsk supply chain

If you are using **Chromium trioxide** as a substance or in a mixture for **functional plating with decorative character** including pretreatments (such as etching) ('**Use 3**') supplied directly or indirectly (via distributors or formulators) from **Joint Stock Company "Novotroitsk Plant of Chromium Compounds**" (Novotroitsk), you will need to read this Information Notice carefully. You will need to contribute to the information gathering efforts described to ensure that you may continue your use after 2021.

Why are we contacting you? We are contacting you as REACHLaw Ltd. acts as REACH Only Representative (OR) for Novotroitsk for its chromium trioxide (CrO3) authorization application. If you are a user of CrO3 in the Novotroitsk supply chain, your use since 21st September 2017 is solely possible due to this authorisation application under transitional arrangements, as the Commission has not yet taken a decision on the application.[1]

Commission request to submit a substitution plan for Use 3 of the authorisation application: REACHLaw has now received a request from the Commission for use 3 of the application "functional chrome plating with decorative character". In a letter dated 10th March 2020, the Commission has requested REACHLaw to draw up a "substitution plan" specifically for this use and submit it to ECHA by the 10th September 2020. The request is based on legal reasons relating to a judgment of the General Court at the Court of Justice of the European Union of 7 March 2019.[2]

This Substitution Plan must be submitted by REACHLaw as the applicant and must be based on Downstream User information, i.e. information from all users who are using CrO3 as a substance or supplied in a mixture for decorative chrome plating in the Novotroitsk supply chain.

What is a substitution plan? A Substitution Plan is a report that documents the Chromium trioxide replacement efforts taken by the actual users (timetable, drop-in replacements and R&D and investments into alternatives, reasons why substitution is not feasible for a specific use etc.) for the specific end use applications (e.g. sanitary, automotive, white goods, etc.).

[1] Details of the authorisation application for the use of CrO3 for functional chrome plating with decorative character is available on the ECHA website at https://echa.europa.eu/fi/applications-for-authorisation-previous-consultations/-/substance-rev/15306/term

[2] EU General Court T-837/16

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If you are using CrO3 as a substance or in a mixture for decorative chrome plating, you need to contribute to information gathering to ensure your use may continue!

How does this affect me? If you want to continue your use of Chromium trioxide as per use 3 of the authorisation application after 2021, you will need to contribute to the substitution information gathering.

REACHLaw is working with the Chromium Trioxide Authorisation Consortium Submission Consortium (CTACSub) as they received the same request from the Commission for their application for the same use. Novotroitsk relied on the CTACSub dossier to prepare its application. CTACSub is a consortium of applicants who submitted an upstream application covering various uses by downstream users in their supply chain.[3] The information letter prepared by CTACSub to inform its downstream users is available on the JonesDay website.[4] CTACSub's technical consultant Ramboll will act as trustee and collect information from all users of CrO3 in the CTACSub and Novotroitsk supply chains. Ramboll will use this information to prepare the substitution plan. Ramboll will not be able to prepare a substitution plan without comprehensive and up to date information from the users.

If you do not contribute to the effort, it is likely that the Novotroitsk application will be rejected and you will have to stop your use sometime in 2021 when the negative decision is issued by the Commission

How do I contribute to the information gathering?

Ramboll have prepared an online questionnaire to collect the information needed from CTACSub and Novotroitsk downstream users. You will need to submit the completed questionnaire as soon as possible but **no later than 15th May 2020**. Ramboll will treat the information you provide as 'confidential business information' acting as a third party trustee. It will aggregate all information it receives to compile the report.

The online questionnaire will be available in English, French, German, Italian and Spanish.

- You must register at https://surveys.ramboll.com/LinkCollector?key=6RAA1MNNSN1P in order to receive your own invitation to the survey. Once you have registered, Ramboll will send you a link to the survey in the language of your choice.
- Ramboll hosted a series of webinars in early April to explain how to fill in the online questionnaire. Once you have registered, please contact Ramboll for a link to the webinar in the language of your choice.
- You will need to follow the webinar before completing the online questionnaire.

[3] Information on the CTACSub consortium and their application for authorisation for certain uses of CrO3 is available at https://jonesdayreach.com/substances/

[4] CTACSub Consortium Information Notice March 30, 2020 To the Downstream Users of the Members of the CTACSub Consortium who use Chromium trioxide for Use 3 'Functional Plating with Decorative Character' is available at https://jonesdayreach.com/wp-content/uploads/Information-Notice-CTACSub-Consortium-EN-DE-FR-IT-ES-March-2020.pdf

- You must fill in the online questionnaires by **May 15, 2020**. If you do not send back the fully completed questionnaire by this date, it will be assumed that you are no longer using CrO3 for this use.

For further information on the information gathering (online questionnaire, webinar, how your information will be handled), please contact Valentin Probst (vprobst@ramboll.com; +49 89 978 970 169).

How can I know if my supply of CrO3 is via the Novotroitsk supply chain? The SDS supplied to you for the CrO3 itself or the formulation that contains CrO3 should have the REACH registration number. This number is specific for the registrant. Where the SDS supplied to you has the following registration number **01-2119458868-17-0011**, you are then a user in the Novotroitsk supply chain and your use as per the use 3 description should be covered by the Novotroitsk authorisation application. If you are not sure, please contact your distributor who can provide this information to you. The information may also be on the label of the drum supplied to you.

For questions relating to the authorisation status of CrO3 in general, please contact the REACHLaw Authorisation Team at authorisation@reachlaw.fi.

ANNEX III – PRODUCTS MANUFACTURED BY DOWNSTREAM USERS AFFECTED BY USE GROUP 3

In the subsequent sections a summary of the products affected by use group 3 is provided. The products were sorted according to substrate (*i.e.* plastic / metal) and the market sector for which they are produced.

The section does not differentiate between *plating* and *etching* as all products treated by *etching* are finally chrome plated (no products result from *etching* only).

Please note that the summary tables provided for each market sector described solely the feedback from the DU survey. Therefore, the product lists only provide an exemplary overview of the market and are not comprehensive.

Table 27: Products affected in market sector "Sanitary"

Substrate	Application	Product
Plastic	Bathroom appliances	Shower components/accessories, heating valves, handrails, handles, buttons for toilet cistern, bathroom fittings, faucet mounts, water taps, hooks, towel holders, covers for toilet systems, toilet fittings, water meters, temperature controllers, soap dispensers, hand dryers, sink outlets, bathroom mixer covers, foot covers, toilet brushes, water basins
	Consumer goods	Toothbrushes, shaving machines
	Plumbing	Tubes, fittings, pipes
Metal	Bathroom and kitchen appliances (private households, private buildings, hotels, public installations, industry, semi-public installations)	Faucet fittings, shower heads, shower bodies, rosettes, levers, bath plates, knobs, soap dishes, bathroom furniture components, washing basins, toilets, flushing systems, handles, pipes, fittings, towel holders, toilet paper holders, hooks, covers, bidets, valve covers, rotatory valves, soap dispenser, water pipes, spa fittings, hand dryers, outlets, sink connections, valve plugs for drains, overflow valves, mirrors, mirror furniture, decorative components, brush holder, bathroom brushes, sponge baskets, shower bars for disabled people, sanitary bag dispensers, tap extensions, angle valves, urinals, washbasin hole covers, radiators, temperature sensors, floor outlets
	Kitchen appliances	Faucet fittings, handles, extractor hoods, knobs, decorative components, dishwashing equipment, counter fittings
	Consumer products/others	Coffee machine parts, wire laundry baskets, fruit juicers, hose reel systems, beer and soft drink dispensers
	Plumbing	Parts for pneumatic mechanisms, tubes, pipes, frames, high pressure fittings, water meters, thermostat valves, hydraulic valves, pneumatic mechanisms, spouts, disposal bins, water-saving equipment, tube fittings, heating equipment, water connections, flow controllers, hoses, crane bodies
	Cleaning parts	Parts for cleaning cart and polishing machines

Table 28: Products affected in market sector "Automotive"

Substrate	Application	Product
Plastic	Light weight and heavy-duty vehicles (interior parts)	Door handles, door knobs, buttons, decorative pieces, emblems, steering wheel components, gearshift levers, gearshift paddles, buttons, buttons with backlighting, caps, logos, lettering, dashboard covers, consoles, ventils, breaking pedals, cockpit frames, covers for loudspeakers, seatbelt decoupling disks, seat adjusters, headrests, sensor aids, radio frames, switches, cupholders, mirrors, cap for ignition switch, hand break levers, ash trays, hinges on armrests, door levers, clocks, locking cylinders in heater box, interior mirror rods mirror brackets, motif bars, speaker grille meshes, door sills, restored pieces for old models, rear-view mirrors
	Light weight and heavy-duty vehicles (interior parts)	Front grilles, emblems, mirror caps, ledges, decorative strips, bumpers, decorative mouldings, wheel covers, ventilation inlet frames, valve displays, door handles, side strips, fog lamp covers, radiator guard frame, bottom covers, tailpipe covers, plaques, odometer, bezels, skid plates, fender vents, lift gate handles, exterior badges, tyre valve fittings, fuel tank covers, hub caps, mounts, restored pieces for old models
	Motorcycles	Fuel tanks, fenders, footrest, mudguards, trim parts, symbols, emblems, windshield frames, mufflers, headrest frames, fork shrouds, bezels, sump guards, tank badges
	Others	Car keys, key buttons, tyre air pressure attachment, airbag components
Metal	Light weight and heavy-duty vehicles (interior parts)	Door handles, door knobs, buttons, decorative pieces, emblems, steering wheels, gearshift levers, gearshift paddles, buttons, caps, logos, lettering, dashboard covers, consoles, ventils, breaking pedals, cockpit frames, covers for loudspeakers, seatbelt guides, seatbelt decoupling disks, seat adjusters, headrests, sensor aids, radio frames, switches, cupholders, mirrors, cap for ignition switch, hand break levers, ash trays, hinges on armrests, door levers, clocks, locking cylinders in heater box, interior mirror rods, mirror brackets, motif bars, speaker grille meshes, door sills, restored pieces for old models
	Light weight and heavy-duty vehicles (interior parts)	Front grilles, emblems, mirror caps, ledges, decorative strips, bumpers, decorative strips, decorative mouldings, wheel covers, ventilation inlet frames, valve displays, door handles, side strips, fog lamp covers, radiator guard frame, bottom covers, tailpipe covers, plaques, odometer, bezels, skid plates, fender vents, lift gate handles, exterior badges, tyre valve fittings, fuel tank covers, plate holder, hub caps, wheel bolts, roof rack mounts, restored pieces for old models
	Motorcycles	Exhaust pipes, fuel tanks, wheel rims, fenders, front forks, rear shock absorber, footrests, mirrors, handlebars, silencer, downpipes, mudguards, chainguards, headlight rims, luggage carriers, trim parts, symbols, emblems, windshield frames, mufflers, exhaust pipes, headrest frames, fork shrouds, gear box levers, grab rails, handlebar eye bolts, headlamp brackets, heat shields, long curve tail pieces, lower cover tubes, meshes, mudguard stays, oil seal holders, pedals-gear change, pushrod cover tubes, rocker spindle dome nuts, seat knobs threaded, side stands, springs, steel rims, sump guards, tank badge screws, tank badges, wheels enclosed coils, ferrules, hinges, mounting studs, posts, socket cap screws, engine bars restored pieces for old models
	Others	Car keys, key buttons, tyre tread gauges, tyre air pressure attachment, elbow mandrels, airbag components, radio antenna components, break discs, battery compartments for electric cars, power supply rails

Table 29: Products affected in market sector "Furniture"

Substrate	Application	Product
Plastic	Furniture and related parts	Wall plates for lighting, soap dishes, lamps, shelves, chairs, armchairs, handles, knobs, lightning covers, armrests, chair and table legs, logos, plugs, stands, furniture profiles, frames, fittings, cabinet handles, drawer handles, inserts for furniture handles, hinge covers for furniture doors, hinge covers for doors, hinge covers for windows, furniture body screws, furniture hole covers, ferrules for furniture handles, furniture inserts, furniture friezes, lighting lamp components, ferrules for lamps and chandeliers, parts of lamps and chandeliers, embellishing inserts for lamps and chandeliers, plates for bathroom fittings, buttons for bathroom fittings, small components for bathroom fittings, ferrules for bathroom fittings, knobs for bathroom fittings, taps for bathroom fittings, soap dishes, soap dispensers
	Household appliances, electronic devices and related parts	Stove and oven knobs, portholes for washing machines, intercom keys, teapots, cheese makers, juicers, beverage dispensers, coffee machine covers, grills, timer rings, telephone keys, refrigerator frames, washing machine components, paper and towel dispensers, ironing machine handles, detergent trays
Metal	Furniture articles and parts	Chairs, chair frames, tables, benches, desks, nightstands, shelves, cabinets, sofas, stools, furniture handles and hinges, locks, clothing racks for sales areas, shower cabin profiles, towel rails, dispenser, holders, hinges, handles, hangers, legs, armrests, panels, doorbells, license plates, lamps, lamp components, lamp fixtures, frames, trims, coat holders, napkin holders, office mobiliary, stalls, kitchen baskets, decorative metal articles, worktops, safe boxes, table frames, base crosses, drawers, laundry baskets, bookcases, ceiling roses, window fittings, letterboxes, grids, consoles, displays, dish racks, pantry units, shoe racks, name plates, side rails, bed heads, clocks, stove components, fireplace doors, wall trays, sockets, switch plates, door knobs
	House appliances and electronics	Television frames, touchpads, ovens, refrigerators, coffee machines, stoves, shaving machines, potato peelers, corkscrews, staplers, vacuum machine parts, cooking pots, pans, roasters and pressure cookers, pens, ink cartridges, hangers,
		Printing machines, parts for safety buttons, components for vending machines, components for slot machines, component for machines in the textile industry, baking machinery, plumbing machinery, weightlifting equipment, pole dancing equipment, components for sewing machines, components for packaging machines, refrigerator pieces
	Hospital mobiliary	Chairs, stools, trolleys, I.V holders, hospital beds, bed parts, stretchers, frames for neonatal incubators, monitor doors, visitor slides, window frames, tables, benches

Table 30: Products affected in market sector "Medical"

Substrate	Application	Product
Plastic	Medical equipment	Ventilator components, laser devices, cases, buttons, housings, electrodes, cannulas, protheses, pacemakers, stethoscopes, covers for electronic shielding, measuring devices, oxygen tanks
Metal	Medical, dental and veterinary equipment	Hospital equipment, supports, scrolling guides, connectors for dentist benches, walking equipment, wheelchairs, rehabilitation devices, supports for operating room chairs, aseptic components for operating rooms, oxygen valves, orthopaedic equipment, medical instruments, orthopaedic equipment, gas distribution valves, headrests for gynaecological chairs, detachable connections, respirators, ventilator systems, defibrillators, radiation shields, dentist equipment, veterinary equipment, needles, anaesthetising equipment, stair lift components, ball end stems, knee block parts, lateral brackets, eye and ear inspection equipment, rehabilitation instruments, oxygen and liquid carrying lines, plugs, hose clamps, flowmeter bodies and pressure reducers, X-ray machines, vacuum machines, life support machines, endoscopy apparatus, hearing equipment, ophthalmology instruments
	Laboratory supplies	Tripods, pliers, sequencing system components, microscope components, measuring devices, sensors, beakers, angle bars, handles, buttons,

Table 31: Products affected in market sector "Cosmetics"

Substrate	Application	Product
Plastic	Packaging	Perfume bottles and caps, casings, lipstick and mascara tubes, cream containers, hair care applicators, decorative elements for packaging, spray caps, vodka and cognac bottle corks,
	Consumer goods	Razor heads, belt and bag buckles, hairbrushes, hair combs
Metal	Packaging	Perfume caps and bottles, lipstick tubes and caps, packaging for cosmetic products
	Consumer products and parts	Pocket mirrors, fashion accessories, nail clippers, tweezers, badges, buttons, nippers, nail files, mirror frames, decorative elements for luxury items, handles for shaving machines, zippers

Table 32: Products affected in market sector "Others"

Substrate	Application	Product
Plastic	Diverse appliances	Heels for shoes, studs for shoes, covers for leather, buttons for clothing, chains for clothing, chains for shoes and boots, costume jewellery for necklaces, bracelets, earrings, bracelets, puller for clothing, puller for boots, snap-on buckles for backpacks and handbags, snap-on buckles for underwear, snap-on buckles for swimsuits, clothing embellishment plates, rings for clocks, watch hands, trolley components, rings, bezels, heads and handles for umbrellas, logos, lettering, clothing labels
	Electronics and machinery	Electromagnetic shielding of electronic plugs, sewing machines, nozzles and controllers for varnishing devices, light switches, covers for mobile phones, frames for electronic equipment and displays, wire guide wheels for weaving machinery, light guide cylinders, levers and switches for electrical equipment, aesthetic parts for coffee machines, components for beverage dispensers
	Weapons and military	Covers for missile flares, sights for laser equipment, firefighter helmet components
Metal	Diverse appliances	Cow bells, dog collars, scaffolds, crossbows, shoulder straps, heat exchangers, decorative swords, fire sprinkler heads, diving equipment, turntables, device banderols with radioactive logos, safety signals on cruise ships, cabin numbers, fire door designations, descriptions of monuments, cycle path signals, descriptions of works of art, picture frames, keys, cutlery, trophies, roulettes, transport tubes for airport luggage transportation, garden sprinklers, diving equipment, wall clocks, record players, steering and control equipment for kickboards and sleds, ice skate blades, fishing rods, rope fasteners, components for floor lamps, ceiling lights, suspensions, wall lamps and spotlights, record players, film industry equipment, USB modules, microphones, writing machines, sprinklers, signal horns for fire brigades, emergency doctors, ambulances and special vehicles including accessories such as snow protection caps, frames
	Electronics and machinery	Electrical components in relays, airplane cockpit components, mining tools, saws and knives for meat industry, road construction components, fire extinguisher supports, screwdrivers, spanners, ratchets, locks, steel rulers, measuring tubes, screws, pins, plates, caps, latches, hooks, hinges, buttons, joints, nuts, bezels, swivels, studs, rings, plates, cuffs, lock cases, shafts, gears, stands, levers, couplings, valves, brackets, pliers, sliders, cylinders, tractor components, drills, sharpeners, light switches, metal grid for metal printing, cameras, computer systems,
	Weapons and military	Rocket components, parts for guns, command joysticks, communication systems