

Contribution of the Swiss Chemistry Community to SDGs – Perspective of the SCNAT Platform Chemistry

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Abstract: Sustainability has become indispensable – and so has the role chemistry plays in reaching the Sustainable Development Goals (SDGs). The Swiss Academy of Sciences (SCNAT) and its Platform Chemistry (PFC) can be a partner of the Swiss chemistry community in reaching (some of) these goals through their umbrella network. Next to all existing initiatives, SCNAT PFC recommends the chemistry community to support increasing scientific literacy such that for example students who want to contribute to a better environment in their future career become aware of the impact that chemistry has on sustainability and every day lives. The SDGs are a formalism that can be used to help communicating the impact of chemistry. It is important to keep on advertising also fundamental research, as this is the essential basis for any sustainable development.

Keywords: Chemistry · SCNAT · SDG · Sustainability

1. Introduction: Sustainability

While various definitions for sustainability exist, it generally is a social goal for people to co-exist on Earth over an extended period of time. This can be achieved through a transformation process that aims to achieve an ideal state of human civilization in which ecological sustainability, social justice and economic performance are simultaneously ensured.^[1]

While the term *sustainability* seems to have gained in popularity, especially since the adoption of the 17 Sustainable Development Goals (SDGs) by world leaders at the historic United Nations World Summit in 2015, its importance for chemistry was recognised far earlier, but not always under the umbrella of sustainability. For example, in the 1990s, the European Council issued a directive concerning *integrated pollution prevention and control*, encouraging industrial activities – including chemicals and chemical processes – to adopt more sustainability practices.^[2] Even earlier, in 1981, *Guidelines for the Testing of Chemicals* were implemented by the Organisation for Economic Co-operation and Development (OECD). This is a continuously updated document that is a *de facto* standard (*i.e.* soft law).^[3] The European Commission keeps on highlighting the importance of the topic in various ways. For example, it published a *Chemicals strategy for sustainability* in 2020.^[4] And its research and innovation programme Horizon Europe aims at ‘tackling climate change and achieving the UN’s SDGs’.

1.1. Expected Impact

The chemical industry is fundamental for providing goods for other industries such as construction, pharmaceuticals, agriculture, food processing, and electronics, with a global material production capacity of around 2.3 billion tonnes in 2020 and sales of chemicals projected at almost US\$11.3 trillion annually by 2030.^[5] Within Europe, the European Chemical Industry Council (Cefic), provider of 1.2 million jobs and accounting for approximately 14% of world chemicals production, supports the role of the chemical industry as solution provider for a society in transition.^[6]

For Switzerland in particular, annual exports of the chemical and pharmaceutical industry grew to around CHF 99 billion in 2017, a more than threefold increase since 1995. This renders the chemical and pharmaceutical industry Switzerland’s most important exporter (Fig. 1).^[7,8] In 2022, the chemical-pharmaceutical product’s share of total exports was 48%.^[8] Switzerland is also attractive for innovative startup companies with ChemEurope listing no fewer than 74 chemistry startups from Switzerland in 2024,^[9] of which many are addressing environmental and sustainability challenges. A switch of the chemical industry to more sustainable practices will have a huge impact and likely affect many downstream industries as well.

Swiss trade balance by selected product groups, 2021 and 2022
in CHF billions

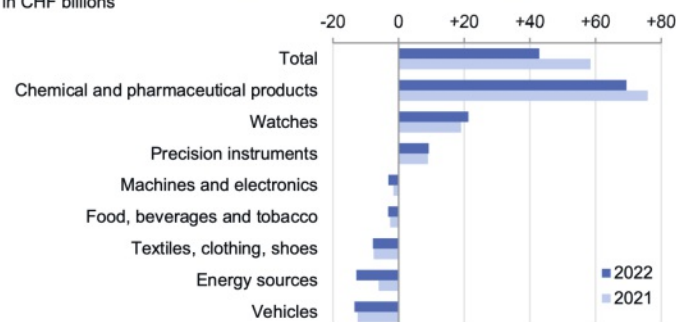


Fig. 1. Importance of chemical and pharmaceutical products for Switzerland. Source Annual report 2022 on Swiss foreign trade.^[8]

2. Chemistry and SDGs

Chemistry seeks to understand natural processes on an atomic and molecular level and has a unique place within the history of Switzerland.^[10] The interpretation of the role of chemistry in the context of sustainability has slightly changed over time. While chemistry has often been perceived as being profit-oriented and a contaminator of the environment, the so-called ‘sustain-

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able chemistry' is an emerging area of chemistry and chemical engineering. It focuses on the design of processes that minimize or eliminate the use and generation of hazardous substances, compensating for what the discipline has created. This shift is also seen in the acknowledgment that chemical science and innovation actually have an impact on achieving **all** of the SDGs and are **essential** for achieving seven^[11] or eight^[12] of the 17 SDGs, depending on the source: zero hunger (**SDG 2**), good health and well-being (**3**), clean water and sanitation (**6**), affordable and green energy (**7**), industry, innovation and infrastructure (**9**), sustainable cities and communities (**11**), responsible consumption and production (**12**) and climate action (**13**), (Fig. 2).



Fig. 2. The 8 SDG targets where chemical science and innovation will be essential to achieve them, according to the European Technology Platform for Sustainable Chemistry (SusChem).

2.1 Sustainable Chemistry

Sustainable chemistry has been defined in various ways, and terms such as green chemistry, circular chemistry or regenerative chemistry are being used interchangeably.^[13] Its concept relies on innovative scientific solutions to tackle environmental problems that arise from chemical reactions in the laboratory. The most broadly adopted definition is probably the one by the OECD that defines sustainable chemistry as *A scientific concept, that seeks to improve the efficiency with which natural resources are used to meet human needs for chemical products and services. Sustainable chemistry encompasses the design, manufacture and use of efficient, effective, safe and more environmentally benign chemical products and processes.*^[14] The broadness in slogans, rather than actual practices, can sometimes lead to misconceptions, and problems in chemistry communication, making it even more difficult for the scientific sectors, and the general public, to move forward with a greater and more positive impact.^[13] A more applied concept are the 12 Principles of Green Chemistry, developed by chemists Paul T. Anastas and John C. Warner in 1998. They are a framework for making a greener chemical, process, or product^[15] and include reducing the number of steps, avoiding stoichiometric reagents, and using environmentally friendly solvents, such as water, supercritical CO₂, cellulose- and lignin-based solvents, *etc.*

3. Existing Initiatives Towards Sustainable Chemistry

There are many good examples of chemical industries and other initiatives that have already embodied R&D in greener and more sustainable materials, processes, and services in several levels and formats – designing, developing, adopting, and even pushing advances in technosciences and regulation, as well as in education.^[13] Providing a full list would be out of scope for this article, but a few are given here as examples.

3.1 Consolidating Initiatives

Various bodies or institutions support outreach and implementation of chemical research results. This varies in size for ex-

ample from global initiatives such as The International Sustainable Chemistry Collaborative Centre (ISC3,^[16]) to the American Chemical Society's *ACS Green Chemistry Institute*,^[17] the *European Technology Platform for Sustainable Chemistry SusChem*^[18] or its Swiss entity, integrated as a thematic community within the Swiss Chemical Society (SCS). They all provide (regional) networking opportunities and overviews of technologies, topics or stakeholders, that are particularly relevant for the chemistry discipline having a favourable environmental impact. For example, SusChem CH lead a brainstorming session with representatives of the Swiss chemical industry and from Swiss research institutions to formulate unmet scientific needs as a guiding inspiration for innovators to design solutions with the potential for a high sustainability impact.^[19]

3.2 Educational Initiatives

In a society so strongly shaped by science and technology, literacy in chemistry is essential and should be a priority. Interest in chemistry could be sparked particularly by educational programmes that can outline where chemistry has an impact. Many students want to contribute to sustainability in their future career, but are not aware how they could, and even less make the link to chemistry. Public perception of chemistry once again plays a role here, where surveys have suggested that green chemistry is the least known environmental tool, but also that this perception could be changed by adequate education.^[20] Since it was shown that task-oriented self-efficacy was the factor which contributed most to a career choice in chemistry,^[21] programmes such as *Beyond Being – Green Chemistry Education* that try to empower educators with educational resources to practice sustainability through chemistry on various levels of education may provide support here.^[22] Chemical education connected to sustainability topics offers many contexts for non-formal learning that are often not yet part of the chemistry formal curriculum.^[23]

3.3 The Swiss National Science Foundation (SNSF)

SNSF, which supports scientific research in all academic disciplines based on a government mandate, has implemented sustainability requirements in some of their funding schemes.^[24] They for example apply evaluation criteria that include a commitment to sustainable development (including economic, societal and environmental consequences) in line with the SDGs and give priority to proposals contributing to sustainability. And their model of excellence expects a sustainable methodological approach, described as, *'considers the costs incurred in relation with the value the project is expected to generate for academia and beyond. The investigators demonstrate awareness of alternative approaches, balancing the choice of method'*. In one of their sub-strategies, they promote, among others, sustainable research and research on sustainable development.

Of particular importance for the chemistry discipline is the National Centre of Competence 'Sustainable chemical processes through catalyst design' (NCCR Catalysis), as it brings together various subdisciplines of chemistry.^[25,26] It aims to develop technologies to base the chemical industry on renewable resources and allow chemical production without waste, contributing to the transition towards a carbon-neutral society.

3.4 Promotion of Start-ups

Higher education institutions can also have an important role in promoting sustainability efforts across all disciplines by providing an ecosystem with accessible technology transfer and innovation offices that can give advice by providing licence agreements and formulating 'green' selling points.^[27]

4. Fundamental Research vs Broad Impact

4.1 Society

In 2015, the Royal Society of Chemistry conducted a study on the public attitude to chemistry in the UK.^[28] One of their main findings was (contrary to what researchers thought) that the biggest public challenge was not to overturn the negative images people have of chemistry, but to convince them of the fields' relevance (Fig. 3): "(...) *People struggle to imagine how chemistry affects their everyday lives and regard chemists as lacking in agency: they do not recognize how chemists are involved in the end product of their own work. Chemistry is a 'science for scientists', rather than for the public*". This once again highlights the importance of improving literacy in chemistry and science.

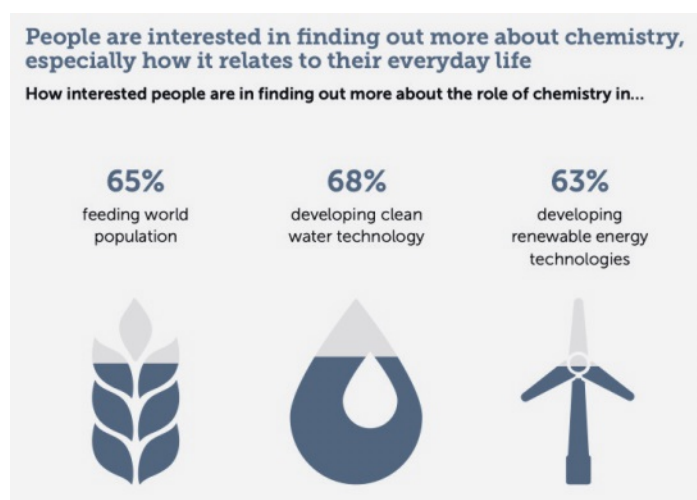


Fig. 3. People are interested to learn how chemistry affects their everyday life. Adapted from RSC study.^[29]

4.2 The Researchers

What the definitions of sustainable chemistry neglect, is that they often do not resonate with the researchers' own perception. When scrolling through academic project descriptions, it is obvious that many of them address fundamental sustainability questions without claiming to do so. Especially in an academic environment, where researchers of particularly the natural sciences are used to a decent amount of failures before experiments succeed, it seems that the claim that their results (will) have an impact on the environment, social justice or the economy seems to be far-fetched.

4.3 Publishers

On the other hand, publishers of topical scientific journals on sustainable chemistry, such as the Royal Society of Chemistry's *Green Chemistry*^[29] or the American Chemical Society's *ACS Sustainable Chemistry and Engineering*^[30] cover topics as fundamental and general as 'organic/inorganic synthesis' or 'process design and intensification' and they claim, that "to be suitable, the novel advance should have the potential for reduced environmental impact relative to the state of the art" or they have even written a series of editorials describing the scope of the journals call for creativity in its interpretation to encourage researchers to submit their manuscripts.^[31]

5. The Swiss Academies of Arts and Sciences (a+)

The academies are the largest scientific network in Switzerland and offer dialogue to policy-makers and society on socially relevant issues. In their performance agreement with the State

Secretariat for Education, Research and Innovation (SERI), sustainable development is formulated as being a priority in the basic tasks. Strategic period objectives are to pool scientific knowledge on important sustainability topics and to support the implementation of the SDG goals by means of early detection of important developments, research agenda, dialogue with politics and society (sensitization), promotion of junior researchers and transdisciplinary research. These objectives go far beyond the chemistry discipline and encompass for example climate and energy, mountain regions and protected areas. Between 2013 and 2016, the Network for Transdisciplinary Research (td-net) has led the 'Sustainable Development at Universities Programme' (SDU), launched by the Swiss University Conference. Its successor project U Change,^[32] a funding program to promote the implementation of sustainable development project ideas by students at Swiss research institutions, might also be interesting to chemistry students.

5.1 The Swiss Academy of Sciences (SCNAT)

SCNAT is a non-profit organization within a+ that forms an independent network and specialist organisation in the domain of education, research and innovation. It raises public awareness of the natural sciences as a central pillar of Switzerland's cultural and economic development. It offers dialogue to political institutions and scientific information to the public, supports early recognition of socially relevant problems, develops ethical guidelines for scientific work and its use and fosters the dialogue between the natural sciences and society. One of its visions is to – together with scientific institutions and researchers – develop holistic solutions for social problems, particularly with regard to sustainable development. This for example in the form of synthesizing a scientific fundament for a close dialogue between science, politics and society with the specialist societies and professional bodies. A variety of initiatives have a sustainability and/or chemistry aspect, which are further detailed below.

5.1.1 SCNAT Sustainability Research Initiative (SRI)

The SRI supports science in participating in a sustainable development of society.^[33] It provides researchers, research funding agencies and political decision-makers with important synthesis reports, projects, event information and news from a+ and other institutions on how sustainable development can be achieved in Switzerland. One point was the identification of cross-cutting societal priority topics that need to be set on the Swiss scientific agenda, for which the *Whitepaper on Sustainability Research* was published in 2020. It outlines Switzerland's most urgent research needs in order to meet the SDGs.^[34] A follow-up report in 2023 argues that one of the most effective ways to support sustainable development is to establish large, integrated funding programmes to which they refer to as *Lighthouse Programmes in Sustainability Research and Innovation*.^[34]

5.1.2 Commission for the Promotion of Young Talents

The Commission promotes young people's interest in the STEM subjects (Science, Technology, Engineering and Mathematics), including chemistry.^[35] It helps to address the lack of well-trained professionals in certain professions at various educational levels and helps improving scientific literacy.

5.1.3 Commission for Research Partnerships with Developing Countries (KFPE)

The KFPE is the information hub for global research partnerships in Switzerland. It promotes efficient, effective, and equitable research cooperation with low- and middle-income countries.^[36] By doing so, the KFPE contributes to sustainable development and to solving local and global problems. While its focus is not specific to the chemistry discipline, it may provide support for partnerships with developing countries.

5.2 SCNAT Platform Chemistry (PFC)

Through a broad-based debate and the provision of expert knowledge, the PFC aims to inform the interested public about chemical topics and the importance of chemistry in everyday life.^[37] PFC commits itself to foster an integrated development and the health of the chemistry discipline in Switzerland. Our role is the early identification of topics and the assessment whether action is needed. This is achieved through projects that support the network maintenance, education and promotion of young talents, dialogue with society on the role of chemistry, science policy and culture on the various fields of chemistry. We closely collaborate with our independent scientific expert associations, the Swiss Chemical Society (SCS),^[38] the Swiss Society for Food Chemistry (SFC)^[39] and the Swiss Society of Science Teachers (VSN).^[40]

Being the umbrella association of chemistry researchers in Switzerland, the PFC can contribute to **SDG 17**: partnerships for the goal. We can contribute to strengthening the means of implementation and revitalize the global partnership for sustainable development through our network of researchers and with our member societies, for example through recommending suitable partners for particular needs.^[41] It needs to be noted that our contribution can be most valuable on a national level, which is our core task, but less on an international level or for reaching out to developing countries – for such requests we would refer to KFPE.

From our point of view, there are mainly two recommendations we would like to give to chemistry researchers in view of achieving the SDGs, as discussed below.

5.2.1 Recommendation 1: Help Increasing Scientific Literacy

Chemistry is everywhere in daily life – pharmaceuticals, cleaning products in the home, cooking, and charging batteries for a smartphone, home tools or car. These are just a few of our dependencies upon chemistry. Knowledge forms the basis of understanding what we are doing, what is happening, and how the world we live in is made up. Knowledge will support making sustainable choices, which is particularly important in a democracy. Education forms a central pillar herein, needs to get the recognition it deserves, and scientific literacy forms an essential skill that

needs highest attention from early on. The PFC is already in close connection with the VSN and the Commission for the Promotion of Young Talents.

Along those lines, we propose that chemistry should extend its role to even more SDGs, namely to **SDG 4** and **SDG 5**: to ‘Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all’, and ‘Achieve gender equality and empower all women and girls’, respectively. SCNAT has its share here with the Commission for the promotion of young talents.

5.2.2 Recommendation 2: Improve Outreach and Public Communication

We believe it is not enough to inform only future voters through educating them. Chemistry scientists should generally embrace a more strategic and contextual approach of public communication where as much planning goes into understanding our audience and crafting an effective narrative as it does in building the content. It may be useful to explain the sustainable component of research projects, for example on institutional websites, where they could also use layman’s terms rather than exclusively using complex scientific language. This may not only help in recruiting suitable young talents, but generally increase visibility of what chemistry can do and show accessibility to discussions. Even researchers working on very fundamental projects, where the application is still years away, should not shy away to label their work with the term sustainable, of course without overselling.

This translation of our work is also important when it comes to funding, as funding bodies often ask for sustainability aspects of the work or its impact. The discussion needs to be held that applied research – while it is important - builds on insights from basic research. Fundamental research is essential and needs to keep access to appropriate ways of funding, even if the direct result may not be a product (yet), and too much categorisation may be too constricting.

Institutions may support their researchers in various ways, for example by translating their research to layman’s terms like for example “*from Karrer’s colorful carrots...to Nevado’s marine organisms*” by the University of Zurich^[42] or by providing

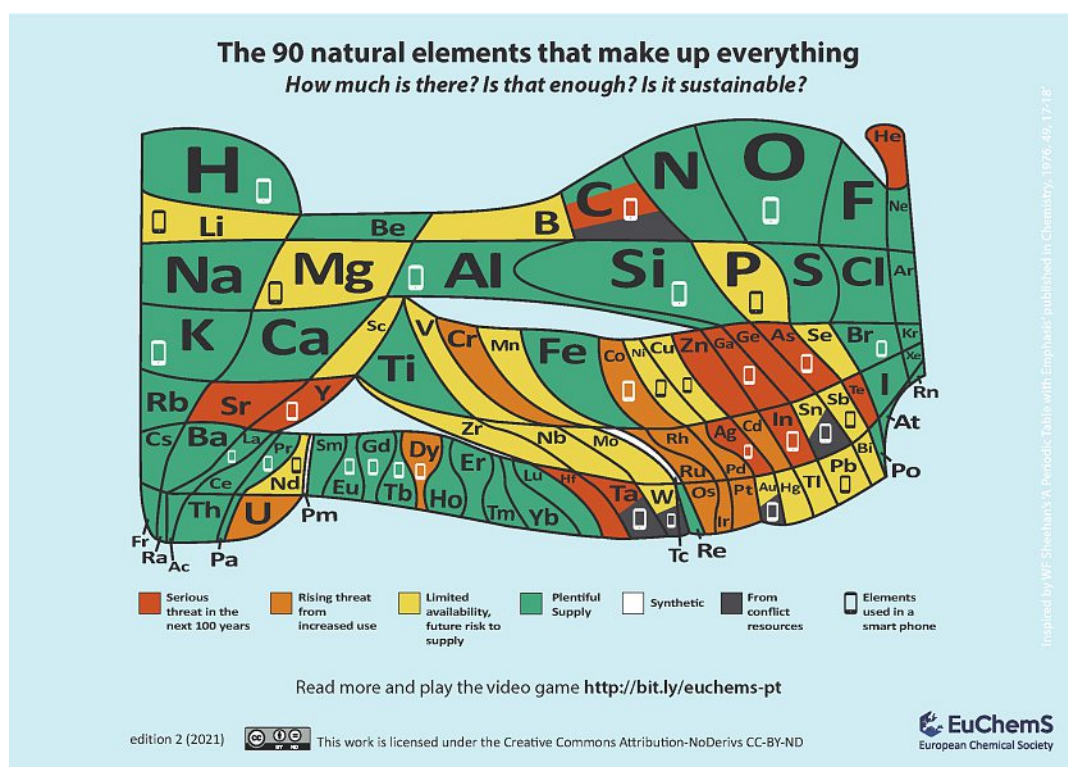


Fig. 4. The EuChemS periodic table highlights rare elements in consumer electronics (Smartphones).

SDG indexing on the websites of their employees (example: <https://research.tue.nl/en/persons/dc-kitty-nijmeijer>).

As a chemistry community, we all can improve advertising and spreading the word about how chemistry affects everyone's lives. We can actively share plausible examples like the top 10 emerging technologies in chemistry of the International Union of Pure and Applied Chemistry (IUPAC).^[43] Or we can stimulate the discussion on which elements of the periodic table compose our mobile phones and which of them raise concerns because of scarcity or sustainability issues with the European Chemical Society (EuChemS) Element scarcity table (Fig. 4).^[44]

6. Summary

Chemistry is at the forefront of sustainability research - its role in achieving sustainability and reaching SDGs is essential, albeit not as prominently visible to the public. What needs to come next is moving from theory to action, and that starts with spreading knowledge and skills to those interested. And, after all, we can all make our own small contributions with our attitude and behaviour towards the world, oneself and others.

Acknowledgements

We thank Prof. Catherine Housecroft for supporting the initiation of the SCNAT sustainability project when she was President of SCNAT Platform Chemistry and Dr. Marie-Francine Lagadec for supporting conceptualisation.

Received: March 31, 2024

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