Summary of the Project to identify Substances and Technologies relevant in the Context of Energy Transition

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The responsibility for the contents of this publication lies with the authors.

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Abstract

In order to carefully weigh the most appropriate risk management measures for a substance under REACH, all available information has to be considered. Especially in the context of substances and technologies also used in energy transition, it is of importance to consider also potentially conflicting goals on a European level. The research project generated a list of substances that are both relevant for energy transitions and are potentially subject for regulatory measures under REACH, in order to identify the necessity of a detailed risk management analysis at an early stage.

Key words:

Energy transition, REACH

Zusammenfassung des Rechercheprojektes zur Identifizierung von Stoffen und Technologien, die für die Energiewende relevant sind

Kurzreferat

Eine ganzheitliche Betrachtung aller verfügbaren Informationen ist für die sorgfältige Abwägung der besten Risikominderungsmaßnahmen zu einem Stoff unter REACH unerlässlich. Insbesondere bei Stoffen und Technologien, die auch bei der Umsetzung der Energiewende eine Rolle spielen, sind mögliche Zielkonflikte auf europäischer Ebene zu berücksichtigen. Im Zuge des vorliegenden Recherche-projekts wurde eine Liste derjenigen Stoffe generiert, die sowohl in der Energiewende von Relevanz sind als auch für Regulierungsmaßnahmen unter REACH in Frage kommen. Sie soll die frühzeitige Notwendigkeit einer ausführlichen Risikomaßnahmenanalyse für die dort aufgeführten Stoffe anzeigen.

Schlagwörter:

Energiewende, REACH

1 Initial situation

More than thirty years ago the term “Energiewende” was coined describing the renunciation of petrol and nuclear energy as basis for German energy supply.
An important step towards implementation was taken in 1991 when German parliament passed the so-called „Electricity Feed-In Act“, warranting stable feed-in tariffs for (small) producers of renewable electricity. With the “Renewable Energy Act” in 2000 and growing public acceptance of human influence on global climate change this concept of „energy transition“, i.e. replacing both fossil and nuclear fuels by renewable energies, gained momentum. In the aftermath of the Fukushima nuclear disaster in 2011 the transformation of the energy supply system in Germany received an even stronger boost when federal government decided to replace both fossil and nuclear fuels by renewable energies until 2050.
Today about 25 % of German electricity are produced from renewables with relevant energy sources including wind- and waterpower, solar energy, geothermal energy as well as biomass from renewable resources. The reduction of energy consumption by economical and efficient uses of energy forms another important aspect. Thus, renewable energies will be the mainstay of future energy supply and promote Germany as a centre of high technology within the wake of innovations and new technologies.
Technological innovations resulting from this transformation can bear additional risks caused by the use of chemicals. Beside possible exposure to new chemicals also new applications for existing chemicals are expected to occur.
Since 2007 the REACH Regulation regulates the manufacturing, placing on the market and handling of industrial chemicals in Europe. It obliges companies to register all substances manufactured in or imported into the EU. It is one of the responsibilities of EU Member States to evaluate these substances (in the formal process called Substance Evaluation defined in the REACH regulation). If a significant risk for workers, consumers and or the environment is identified, it is also the responsibility of a Member State to regulate the substance and thus minimise the risk.
This project targets at identifying materials relevant for technologies and processes in the context of the energy transition. Technologies, products, and processes in the fields of energy production, energy storage as well as energy conservation have been analysed.
The results can form a first knowledge base for qualifying chemical risks posed by these technologies and processes. The data assembled during the study will mainly be used to prioritise substances for Substance Evaluation. Whether or not a risk is associated with the substances has not been evaluated during this study, as it is only a summary of identified substances used.

2 Methodical approach

After identifying relevant technologies and estimating their future market relevance substances used by these technologies have been identified by extensive research of literature, databases, and Internet sources. Interviewing important stakeholders in the energy sector, such as industry, universities, and other research institutions substantiated the results.
For the identified substances public data from the REACH registration database was examined and added to the result sheet. This included tonnage, CLP classification (legal or lead registrant) as an indicator of the hazardous properties of the substance, and use descriptors (process categories) with a high relevance for occupational exposure. Relevant process categories are displayed in Table 2.1.

Tab. 2.1 Definitions of the relevant use descriptors[1]

Process category		Examples and explanations
PROC7	Industrial spraying	Air dispersive techniques Spraying for surface coating, adhesives, polishes/cleaners, air care products, sandblasting Substances can be inhaled as aerosols. The energy of the aerosol particles may require advanced exposure controls; in case of coating, overspray may lead to wastewater and waste.
PROC10	Roller application or brushing	Low energy spreading of e.g. coatings Including cleaning of surfaces. Substance can be inhaled as vapours, skin contact can occur through droplets, splashes, working with wipes and handling of treated surfaces.
PROC11	Non industrial spraying	Air dispersive techniques Spraying for surface coating, adhesives, polishes/cleaners, air care products, sandblasting Substances can be inhaled as aerosols. The energy of the aerosol particles may require advanced exposure controls.
PROC17	Lubrication at high energy conditions and in partly open process	Lubrication at high energy conditions (temperature, friction) between moving parts and substance; significant part of process is open to workers. The metal working fluid may form aerosols or fumes due to rapidly moving metal parts.
PROC19	Hand-mixing with intimate contact (protection equipment)	Addresses occupations where intimate and intentional contact with substances occurs without any specific exposure controls other than PPE

[1] European Chemicals Agency: “Guidance on information requirements and chemical safety assessment Chapter R.12: Use descriptor system”, Version: 2, March 2010, Appendix R.12-3.

3 Results

3.1 Relevant technologies and substances

In order to quantify expansion paths for relevant technologies, different scenarios of future energy supply in Germany were evaluated. This formed the basis for the decision regarding the inclusion of certain technology fields into this study.

Storage technologies will play a key role in the future. This study has focused on chemical energy storage systems, which include lithium-ion batteries, power-to-gas technology, redox flow batteries, and fuel cells. The variety of systems is mirrored by the complexity of substances used. It is to be expected that in the course of further technical developments the diversity of materials will grow even larger. Another critical aspect is the use of auxiliary materials both in manufacture and in recycling processes.

Today the bulk of **modern energy efficient lighting products** like LEDs/ OLEDs, or energy saving lamps are imported from abroad. Relevant substances in this field of technology are metals (mercury, lead, antimony, barium, strontium) and strong acids and bases, which are required for the production of wafers for semiconductor devices.

Heat insulation materials are used in construction of as well as in existing buildings. New statutory regulations strengthening energy efficiency requirements promote an increasing use of thermal insulation materials. Relevant exposure to hazardous substances is expected in the phase of production, during the installation of insulation materials as well as in the course of maintenance or demolition work. In addition to the risks created by fibrous or powdery products it has to be taken into account that insulation materials are often treated with flame-retardants and other additives like aromatic hydrocarbons or phenol.

Hydropower is of high importance with regard to the energy transition. However, its technological innovation potential is considered rather low, since there is only a small potential for expansion due to ecological and legal restrictions, especially resulting from the European Water Framework Directive. The main focus therefore lies on renovation of existing facilities. Here, occupational risks might originate from the use of anticorrosives as well as from the release of asbestos, PCB, toxic pigments, and other older substances in the course of refurbishments.

Wind energy is a major renewable source of electricity. Epoxy resins are used in rotor blade manufacturing in order to ensure the functionality of the rotor and to form better aerodynamic structures. Other possible hazardous materials are paints, varnishes and corrosion inhibitors included in hydraulic oils.

There are only a few published studies on the substances used in extracting **unconventional gas supplies**, but significant technological developments are expected. In the process of hydraulic fracturing (aka “fracking”) a multitude of substances is used as so-called “frack fluids”, many of them hazardous. During the course of this project, new studies have been published, which show that industry is working on a reduction of hazardous substances.

Near-surface geothermal energy includes drilling up to a depth of about 400 m. Relevant chemicals are hydrocarbons and fluorinated hydrocarbons. Radionuclides or heavy metals can be discharged with deep water used for power generation.

Experts do not expect significant technical innovations with special implications for occupational safety and health.

In 2012, about 36.8 billion kWh of electricity was produced from solid, gaseous and liquid **biomass,** predominantly from biogenic solid fuels. Biomass can be used for energy generation by a variety of different techniques and methods. Additives used in the process are nickel, cobalt, molybdenum, iron, selenium, zinc, copper and manganese compounds. Currently, there are more biofuels in development, e.g. synthetic biofuels, cellulosic ethanol, or biomethanol. Biogas can contain toxic gases like H_2S, NH_3, as well as CO.

Solar power has achieved a major role in the decentralised production of electricity**.** Photovoltaic solar panels are becoming an indispensable energy source, especially covering for peak loads. Raw material analysis for photovoltaic modules showed a high variety. Identified substances are metals like lead, gallium, and arsenic. During disposal and/or recycling acids and hydrogen peroxide are used.

Solar heat uses the thermal qualities of solar radiation to heat water with the help of collectors. Expert interviews revealed the use of substances like flame-retardants, polyurethanes and several metals as possible risks during the stages of production and assembly.

3.2 Identified substances

A total of 446 substances and materials have been identified as being relevant for technologies and processes of the energy transition. In many cases, only general information was available. This information was listed by using substance groups, e.g. “use of organic solvents”. Additionally, many substances are used in multiple fields. Not counting substance groups, a total of 231 unique substances were identified.

The highest diversity of substances has been found for hydraulic fracturing operations while the fewest number of substances have been identified in the field of solar thermal production.

Table 3.1 shows an excerpt of the substance list. 73% of the registered substances are assigned to at least one of the considered process categories as listed in Table 3.1.

Tab. 3.1 Substance directory (excerpt)

Category	Component	CAS-Nr.	Substance	Tonnage (kt p.a.)	PROC 7	PROC 10	PROC 11	PROC 17	PROC 19
Energy saving lamp	Lamp base	7439-92-1	Lead	1,000 - 10,000	X				
Light emitting diode	Processing raw silicon	7647-01-0	Hydrochloric acid	1,000 - 10,000		X	X	X	X
Hydro-power	2-component epoxy coating	25068-38-6	Bisphenol-A-Epichlorhydrin Epoxy resin	100 - 1,000	X	X	X		X
Frackfluid	Inhibitor aids	64-18-6	85% Formic acid	100 - 1,000	X	X	X		X
Frackfluid		112-34-5	Butyldiglycol	10 – 100	X	X	X	X	X
Photo-voltaics		7440-50-8	Copper	1,000 - 10,000	X	X	X	X	X
Wind energy	Corrosion inhibitors	68512-30-1	Methylstyrenated phenol	1 - 10	X	X	X		X
Geo-thermal		106-97-8	n-butane	1,000 - 10,000	X	X	X	X	
Solar-thermal		13674-84-5	Tris (2-chlori-sopropyl) phosphate (TCPP)	10 - 100	X	X	X		X
Biomass	Biogas production	7664-41-7	Ammonia	10,000 - 100,000	X	X	X	X	X

The distribution of substances on the diverse fields of technology is displayed in Figure 3.1.

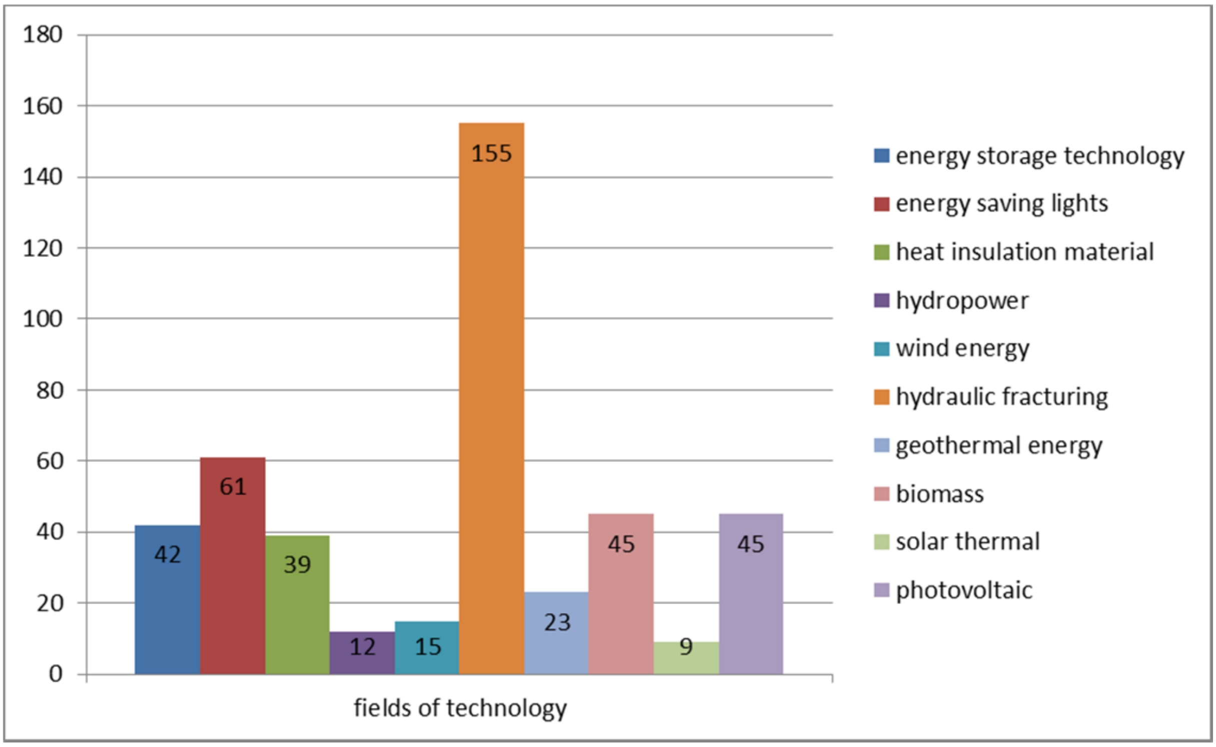

Fig. 3.1 Distribution of substances on fields of technology

In all areas of the energy transition work steps have been identified where hazardous substances are used. The highest number of materials was identified in the field of energy production, since it contains the most of the investigated technologies.
About 60% of all identified substances are classified according to the CLP regulation. For the remaining substances it is unclear whether no hazardous properties exist or whether the substance has not been classified yet. According to experience with registered chemicals in general, a proportion of 60% hazardous substance fits well.
By itself the data yields no information on the occupational risks associated with the working steps for the production, maintenance, use, or disposal of products in the different areas. But based on the data generated, a prioritisation for Substance Evaluation can now be conducted.