CERESiS: ContaminatEd land Remediation through Energy crops for Soil improvement to liquid fuel Strategies

D1.4: Regulatory & policy analysis for contaminated land management and biofuels

H2020-LC-SC3-2018-2019-2020

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1 EXECUTIVE SUMMARY

The scope of deliverable D1.4: "Regulatory & policy analysis for contaminated land management and biofuels" is to review relevant EU policies and to examine how successfully these are pushed down on national level initiatives and further down to the regions and localities. The barriers and constraints encountered along this top-down process, which has its own dynamics distinct from those involved in 'scaling up' policy experiments were also examined and analysed.

Two broad sets of policies were examined: a) policies related to the **contaminated land management** and b) policies related to the market uptake of **biofuels** produced via the processing of suitable feedstock originating from contaminated land.

According to the analysis conducted, the main findings indicate that **soil protection and contaminated land management has not been subject to a specific legislative instrument at EU level.** The lack of a comprehensive and coherent policy and regulatory framework to protect land and soil is a key gap that reduces the effectiveness of the existing incentives and measures and may limit Europe's ability to achieve future objectives. Moreover, the high percentage of non-legally binding tools at EU level indicates that great efforts have been made to protect soils but there is no consistent agreement allowing for the development of a legal framework that guarantees soil protection.

With regards to the regulatory instruments, EU directives have a direct influence on the development of national policies related to soil contamination prevention and management. However, none of them addresses soil contamination as a priority regulation objective, but somehow remediation of contaminated sites or protection of soil against contamination is noted. Due to this lack of specific common framework to prevent soil degradation, several Member States have developed their own legislation to protect their soils, prevent further contamination and regulate the procedure for the assessment and treatment of soil contamination.

With regards to biofuels, the recast Renewable Energy Directive (RED II) is among the strongest policy measures (with Fuel Quality Directive, Alternative Fuels Infrastructure Directive, CO_2 Regulations for light and duty vehicles and Effort Sharing Regulation being other examples) that largely drive the development of the transport sector, as it focuses explicitly on the overall deployment of renewables. More specifically, RED II limits the share of unsustainable crop-based biofuels and promotes certain types of biofuels produced from a list of materials defined in its Annex IX. As per the Delegated Act, this list can be enriched with additional materials but not shortened.

REDII has been a turning point for future fuels, with inclusion of new categories of fuels, such as recycled carbon fuels and promotion of wastes and residues. Nevertheless, those fuels are opted and left to the discretion of each Member State to decide whether or not to count them in the targets. Consequently, a possibly different interpretation of RED II upon its transposition could lead to a fragmented European market as it undermines the ruling of a homogenous policy across the EU. A further drawback of RED II is the fact that

the Directive is rather moderately ambitious considering the changes that need to be done. Therefore, if the ambition level will not raise any time soon, i.e., the RES-T targets of 14% and 3.5% (overall and for advanced biofuels respectively, Article 25) to be in line with the 2030 Climate Target Plan, the necessary developments will be hampered.

Overall, it is concluded that there is not in place a unified overarching legislative framework under which the two sectors (contaminated land and biofuels) can "communicate" on a solid basis.

The new EU Soil Strategy, that is currently in consultation, provides a unique opportunity for EU Member States, that **will ensure a solid policy and regulatory background** for contaminated land management, land decontamination and phytoremediation.

A specified policy and legislative framework should, therefore, be adopted for bridging the gap between phytoremediation strategies and clean biofuel production in a sustainable and optimum manner that will overcome the indirect land use change (iLUC) issue for biofuels and restore lands for agricultural uses.

The framework should include:

- a specific regulation which requires risk management and clearly specifies how to implement risk-based assessment and remediation approaches (including phytoremediation), and ensures that all regulatory instruments are consistent with the aforementioned approach,
- realistic criteria and clear procedures which set screening values, action levels, and site-specific remediation targets, as well as clear guidance regarding site investigation, risk assessment and site remediation, as well as exit mechanisms for site closure,
- a prioritizing system to determine the different levels of risk and urgency in contaminated land management,
- institutional arrangements which assign clear responsibilities and authority to the central, regional, and local governments, to implement site assessment and remediation actions most effectively, and to minimize inconsistency between different government levels and differing local interpretations,
- specific policies and strategies for advanced biofuels production that integrate land-use planning and contaminated sites' incentive schemes,
- a framework that allows advanced biofuels' production to integrate other bioeconomy sectors objectives to avoid any conflicts,
- establishment of a certification-labelling scheme for advanced biofuels' production through remediated contaminated sites, to ensure its sustainability by assessing its whole value chain.

2 BACKGROUND INFORMATION

2.1 Introduction

Soils are essential ecosystems that deliver valuable services such as the provision of food, energy and raw materials, carbon sequestration, water purification and infiltration, nutrient regulation, pest control and recreation. Therefore, soil is crucial for fighting climate change, protecting human health, safeguarding biodiversity and ecosystems, and ensuring food security. Healthy soils are a key enabler to achieve the objectives of the European Green Deal such as climate neutrality, biodiversity restoration, zero pollution, healthy and sustainable food systems, and a resilient environment.

Throughout Europe soil contamination affects almost 250,000 sites and is expected to continue growing. Potentially polluting activities are estimated at nearly 3 million sites across the EU, many of which need further investigation to establish the damage and whether soil remediation is required.

On the other hand, the production of non-food crops for biofuel and energy can contribute to sustainable development policy goals related to renewable energy and carbon management. However, the use of land to produce such biomass has raised a range of concerns about the sacrifice of food growing land, food security, food poverty and habitat land conservation issues.

The project **"Contaminated land Remediation through Energy crops for Soil improvement to liquid biofuel Strategies",** financed by H2020, (CERESiS, the short name of the project that will be used hereinafter in this report) **aims to provide a win-win sustainable solution to both issues** by facilitating land decontamination through phytoremediation, i.e. growing energy crops to produce clean biofuels.

In this context, this report constitutes the Deliverable **D1.4: "Regulatory & policy analysis for contaminated land management and biofuels"**. The aim of D1.4 is to review relevant EU policies and to examine how successfully these are pushed down on national level initiatives and further down to the regions and localities. The barriers and constraints encountered along this top-down process, which has its own dynamics distinct from those involved in 'scaling up' policy experiments will also be examined and analysed.

In particular, two broad sets of policies will be examined:

- Policies related to the contaminated land management under the perspective of utilizing this land in an appropriate way to provide feedstock at the early stages of the CERESiS value chain,
- Policies related to the market uptake of biofuels produced via the processing of suitable feedstock originating from contaminated land (i.e. biofuels as the end-product of the CERESiS value chain).

2.2 Methodology

2.2.1 Rationale and structure of the approach

The methodological approach in this report is inspired by the **"integrated policy framework"**[1], which has been used in S2Biom[2] and Biomass Policies projects[3]. The framework performs a value chain analysis and is structured into two interlinked components:

1. Policy and regulatory analysis and direction setting.

2. Identifications of policy barriers and constraints and assessment.

The **first component** provides an overview of the current state of regulatory and policy framework on contaminated land management and biofuels production. It explores the institutional and overall landscape framework in the two areas, underlying the need for policy interventions and identifies future policy objectives.

The **second component** performs an analysis in the policy framework along the value chain, by addressing the following questions:

- What type of policy mechanisms are in place and how are these introduced/ pushed down to national and local levels?
- What specific gaps, barriers and challenges are prohibiting development?
- Which is the key policy enabler to steer change and ensure sustainability in the long term?
- Which are the potential impacts of current policy and legal measures with regards to projects' implementation?
- What policy measures need to be introduced to facilitate the project's measures and solutions?

Then, it performs a high -level qualitative policy ex ante assessment across the value chain, considering three sets of related policy agendas:

I. Sustainable Development Goals (SDGs)

UN's Sustainable Development Goals (SDGs) are a blueprint for achieving a better and more suitable future for all and addressing the global inter-connected challenges across the three dimensions of sustainable development: economic, social and environment. The

[1] IEE/12/835/SI2.645920. Biomass Policies. project. Deliverable D4.4. Lessons and recommendations for EU and national policy frameworks.

[2] FP7 KBBE.2013. Grant Agreement n°608622. S2BIOM. Delivery of sustainable supply of non-food biomass to support a "re-source-efficient" Bioeconomy in Europe.

[3] IEE/12/835/SI2.645920. Biomass Policies. Strategic Initiative for Resource Efficient Biomass Policies. The project built a consistent knowledge base both for the efficient resource mobilisation and for the assessment of resource efficient biomass value chains n EU28.

SDGs seek worldwide action from governments, organization and even efforts from businesses in private sector to have a role in contributing to these goals.

Contaminated land management and biofuels can play a significant role in achieving the SDGs since they offer solutions to the following goals:

- **SDG (2):** End hunger, achieve food security and improved nutrition and promote sustainable agriculture,
- **SDG (7):** Ensure access to affordable, reliable, sustainable, and modern energy for all,
- **SDG (12):** Ensure sustainable consumption and production patterns,
- **SDG (13):** Take urgent action to combat climate change and its impacts
- **SDG (15):** Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

II. Common Agricultural Policy (CAP)

EU's **Common Agricultural Policy (CAP)** aims to support farmers and improve agricultural productivity, ensuring a stable supply of affordable food, to safeguard European Union farmers to make a reasonable living, help tackle climate change and the sustainable management of natural resources, to maintain rural areas and landscapes across the EU and to keep the rural economy alive by promoting jobs in farming, agri-foods industries, and associated sectors.

III. Clean energy for all Europeans' package

In 2019 the EU completed a comprehensive update of its energy policy framework to facilitate the transition away from fossil fuels towards cleaner energy and to deliver on the EU's Paris Agreement commitments for reducing greenhouse gas emissions. This new framework, called the "Clean energy for all Europeans" package, consists of eight legislative acts, including the **Renewable Energy Directive 2018/2001/EU (RED II).** The new directive establishes a new binding renewable energy target for the EU for 2030 of at least 32%, with a clause for a possible upwards revision by 2023.

2.2.2 Data collection and sources

The main source used in this report is the regulatory and policy landscape in contaminated land management and biofuels at, mainly, European level, while specific examples at national and/or local levels are also indicatively reported. This included collecting publicly available government documents such as regulations, directives, legislative acts, policies, and strategies, as well as reports, assessments, evaluations, and audits. The nature of the methodology applied also required statistical data and trends as supporting evidence.

3 CONTAMINATED LAND MANAGEMENT

3.1 Introduction

Soil is specified as the top layer of the Earth's crust, formed by mineral particles, organic matter, water, air and living organisms. It is the interface between earth, air, and water, and hosts most of the biosphere[4].

Soils are under increasing environmental pressure across the globe, and the associated soil degradation is raising extreme values in Europe due to a high population density and its related activities, such as industrial activity, inappropriate agricultural and forestry practices, tourism, or urban development.

According to the European thematic strategy for soil protection, there are eight threats identified, which confront soils in the EU. These include:

- erosion,
- organic matter decline,
- contamination,
- salinisation,
- compaction,
- soil biodiversity loss,
- sealing,
- landslides and flooding

Contamination is the chemical degradation of soils which affects human health and the environment and reduces the ability of soils to provide the ecosystems services / main soil functions, as follows:

- biomass production, including in agriculture and forestry,
- storing, filtering, and transforming nutrients and water,
- hosting the biodiversity pool, such as habitats, species, and genes,
- acting as a physical and cultural platform for most humans' activities,
- providing raw materials,
- acting as a carbon pool,
- storing the geological and archaeological heritage.

Soil contamination constitutes the trigger for other degradation processes because it affects the ecosystem and causes toxicity to organisms, reducing the biodiversity, which is

[4] European Commission, 2006

associated with the loss of organic soil matter, with nutrient imbalance and consequent soil erosion. Depending on which pollutants are present in the soil, salinisation problems can also be associated with soil contamination, for example the effects of bad agricultural practices such us excessive use of rich sulphates and nitrate pesticides and fertilisers on untreated wastewater for irrigation.

The term "contaminated site" refers to that site where hazardous substances, as defined in Article 3 of Regulation (EC) No 1272/2008, are present in a level that pose a significant risk to the environment and human health. When there is a suspicion of contamination, either because there is/has been an activity considered to be potentially polluting, or because an accident or spill has occurred, an investigation is carried out to confirm such contamination.

Contaminated site management is a broad topic that covers a wide range of regulatory, scientific, technological, financial, and political aspects. The purpose of this section is to provide an overview of policies and regulatory frameworks for existing contaminated site management and clean up in Europe, to review the experiences and lessons learnt, and to make relevant recommendations, for their application within CERESiS project.

3.2 Progress and Trends on contaminated land management practices and methods

3.2.1 Overview of land and soil current situation in Europe

Soil and land lie at the core of most of the Sustainable Development Goals (SDGs) of the UN Agenda 2030, but particularly SDG 15.3 to "combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world by 2030".

Currently, land and soil continue to be subject to severe degradation in the EU, as per the European Environment Agency (2019) report: "The European Environment: State and Outlook 2020". In particular:

- **12.7% of Europe is affected by moderate to high erosion**, causing an estimated loss of agricultural production in the EU of €1.25 billion per year.
- **Organic carbon stocks in cropland topsoils are declining**. The extent of wetland and peatland in the EU has been steadily decreasing with around half of peatlands in the EU now drained and two thirds of European wetlands lost since the beginning of the 20th century. Loss of wetland and peatland has been mostly caused by land conversion for agriculture use. Also, climate change and unsustainable forest management lead to carbon losses from forest biomass and soils.

- **Local pollution is also present in all countries** and 14% of an estimated total of 2.8 million potentially polluted sites from industrial activities are expected to require remediation, that is 390,000 sites. By 2018, only some 65,500 of these sites were remediated.
- **Diffuse soil contamination** by atmospheric depositions, pesticides, antibiotics, excess fertilisers, microplastics, sewage sludge and other waste disposed of on land is widespread.
- **Land take and soil sealing continue predominantly** at the expense of agricultural land at an annual net land take estimated at 440 km²/year in the period 2012-2018. The target of no net land take by 2050 is unlikely to be met unless annual rates of land take are reduced and land recycling increased.
- **Intensive land management and land use change negatively impacted in recent decades** soil biodiversity such as the species richness of earthworms, springtails, and mites.
- In **Southern, Central and Eastern Europe 25% of soils show high or very high risk of desertification** corresponding to about 411,000 km².Large parts of Southern Europe are likely to become desertified by 2050 as a result of climate change and inappropriate agricultural practices.
- **Salinisation affects 3.8 million ha in the EU,** with severe soil salinity along the coastlines, particularly in the Mediterranean. While naturally saline soils occur, inappropriate irrigation practices, poor drainage conditions or the use of salt for de-icing roads induce anthropogenic salinisation.

The underlying drivers of soil degradation are in general not projected to change favourably compared to current status, so the functionality of soils and land will come even under more pressure. The competition and claims on this declining, finite and degrading natural resource will only increase in the future.

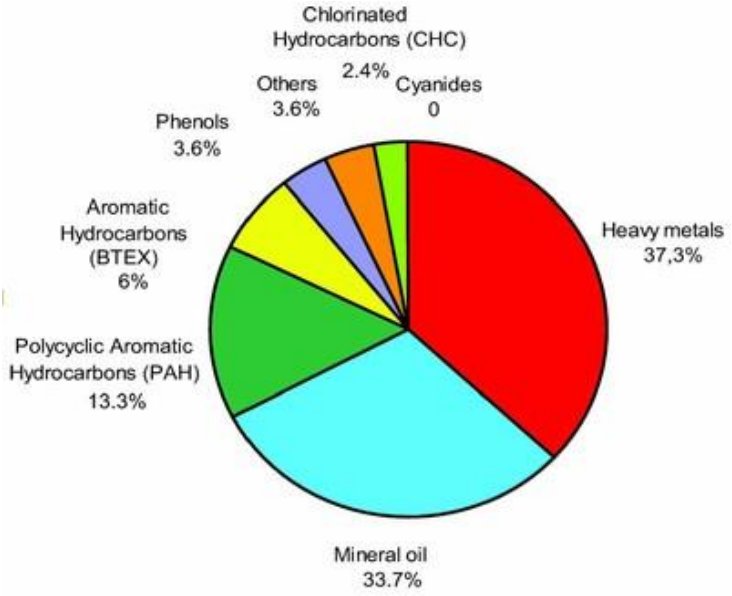
3.2.2 Overview of progress in contaminated land management in Europe

Progress in the management of soil contamination, and the knowledge base, is very different between national legislations and different also even at the regional level. This is mainly caused by the different starting dates of relevant policies since some countries introduced the relevant legislation one or two decades earlier than others. At a regional/provincial level, larger variability is due to non-homogeneous administrative procedures in place that may be highlighted whenever planning/remediation/and licensing relies on local authorities' responsibilities. There are also some examples of there still being no specific national legislation to address soil contamination.

According to European Environmental Agency's Signals data for 2019, the range of polluting activities vary considerably across Europe, with the most important sources being industrial and commercial activities and the treatment and disposal of waste.

Reports from countries across Europe indicate that heavy metals and mineral oil are the most frequent soil contaminants at investigated sites, while mineral oil and chlorinated hydrocarbons are the most frequent contaminants found in groundwater. These estimates are based on the frequency a contaminant is reported at the investigated site.

Figure 1: Overview of contaminants affecting soil and groundwater in Europe.



Source: https://www.eea.europa.eu/themes/soil/soil-threats

Four management steps[5] are defined for the management and control of local soil contamination, namely:

- site identification (or preliminary studies),
- preliminary investigations,
- main site investigations, and
- implementation of risk reduction measures.

Progress with each of these steps provides evidence that countries are identifying potentially contaminated sites, verifying if these sites are actually contaminated and implementing remediation measures where these are required. Some countries have defined targets for the different steps.

[5] • https://www.eea.europa.eu/data-and-maps/indicators/progress-in-management-of-contaminated-sites/progress-in-management-of-contaminated-1

Inventories

Fifteen years after the adoption of the Soil Thematic Strategy in 2006, in which the Member States committed to draw up an inventory of contaminated sites (European Commission 2006, Art. 10), some progress has been achieved, but significant gaps remain to be addressed in the coming years.

The Soil Thematic Strategy sets out the steps to be taken to develop contaminated sites inventories, beginning with the definition of what constitutes a contaminated site and the identification of potentially polluting activities.

Many countries started national strategies in the 1980s and 1990s and have already developed their contaminated sites inventories, based on their own consideration of potentially polluting activities, considering their major industrial activities. There are still considerable differences between countries in the scope, contaminated site definition and the list of potentially polluting activities.

Site assessment

There are several approaches to assess the potential hazardous effects of contamination on soils and groundwater, but the most widely used in Europe is risk assessment. These risk-assessment tools are typically used for contaminated land prioritisation, to quantify harmful effects on human health or the environment, and to address soil contamination on an objective and scientific basis.

Risk-assessment tools used in soil-quality assessment are based on scientific and technical judgement and expertise. Nevertheless, in rare cases, intervention values have been set at higher levels by policymakers for socioeconomic reasons. The intervention values for hazardous substances, set in those risk assessments, are considered as those levels above which there exists risk of damage to the environment or human health. Setting screening levels for each single polluting substance present in the environment is not possible because new contaminants are being released continuously from new industries and materials and because normally more than one pollutant is found in the soil at the same time and interactions occur between them. Furthermore, exposures differ between different land uses, exposure patterns, site characteristics and soil types.

Countries and policymakers tend to adopt integrated risk assessments that consider ecotoxicologic effects and effects to human health of mixtures of pollutants, but scientific evidence in this matter is still scarce.

The existence of diverse legislations that regulate the use of certain chemical substances, or the ones that regulate only certain industrial activities, make the process of establishing harmonised risk assessment tools to evaluate the status of sites suspected of posing a potential risk to the environment and to human health complex.

However, improvements in harmonisation have been achieved due to several FP6-FP7 concerted actions and networks between European countries, namely:

- the Concerted action on risk assessment for contaminated sites in the European Union (**Caracas**) (1996-1998)
- the Contaminated-land rehabilitation network for environmental technologies in Europe (**Clarinet**) (1998-2000)
- the Network for industrially contaminated land in Europe (**NICOLE**) (1996)
- the Human and ecological risk assessment for contaminated land in European Member States (**HERACLES**) (2007).

Moreover, in 2015, the project **Remediate**[6] was launched between five Member States and 15 partner organisations to improve the decision-making in contaminated-land site investigation and risk assessment.

The table below presents the main approaches and legal documents framing site assessment in the various EU countries[7]:

Table 1: Main approaches and legal documents framing site assessment.

Country	Approach for assessing contaminated sites	Guidance and legal instruments framing site assessment
Austria	Environmental quality standards and site-specific risk assessment	ALSAG, water act, waste management act, Austrian Standard ÖNORM S 2088 (part 1: groundwater; part 2: soil; part 3: air)
Belgium (Buxelles Capitale)	For single pollution and mixed pollution: exceeding soil-remediation standards. For orphan pollution: site-specific risk assessment.	Decree on soil remediation and soil management S-Risk model.
Belgium (Flanders)	Historical contamination is evaluated using site-specific risk assessment. New contamination is addressed comparing values with soil-quality standards approach.	S-Risk model
Belgium (Wallonia)	Screening values laid down in soil decree and site-specific risk assessment.	Soil decree and S-Risk model
Bulgaria	Site-specific risk assessment for historical and new pollution.	Liability for preventing and remedying environmental damage act (Lpreda)
Cyprus	Soil-quality standards and site-specific risk assessment are used	No formal procedure

[6] https://cordis.europa.eu/project/id/643087

[7] "Status of local soil contamination in Europe: Revision of the indicator 'Progress in the management contaminated sites in Europe'", JRC Technical Report 2018, https://op.europa.eu/en/publication-detail/-/publication/a7280491-93a3-11e8-8bc1-01aa75ed71a1/language-en

Country	Approach for assessing contaminated sites	Guidance and legal instruments framing site assessment
	indistinctly depending on each situation.	
Czech Republic	Thresholds and site-specific risk assessment.	Methodological guidelines (Svoboda, 1997).
Denmark	Threshold values for contact risk and site-specific risk assessment for groundwater contamination.	JAGG 2.1 tool
Estonia	Site-specific risk assessment to prioritise intervention and screening values to consider remediation completed.	Water Base Management plans Water act
Finland	Site-specific risk assessment, but guideline values can also be applied to determine soil contamination and remediation needs.	Decree on the assessment of soil contamination and remediation needs
France	Site-specific risk assessment.	Interpretation of the state of the environments
Germany	Risk-based soil screening values (trigger values) and site-specific risk assessment.	Federal soil-protection act
Hungary	Site-specific risk assessment to determine remediation limits.	Ministerial decree No 6/2009 (IV. 14.) on the contamination-limit values and measurements necessary for the protection of geological formations and groundwater.
Ireland	Site-specific risk assessment with a prioritisation in three phases	Code of practice for environment risk assessment for unregulated waste disposal sites
Italy	Screening values for assessing the need for investigation and on-site-specific risk assessment for assessing the need for intervention.	Legislative Decree n. 152/2006 approving the Code on the Environment
Latvia	Soil-quality standards	Regulations on soil and subsoil Quality standards (2005)
Lithuania	Soil- and groundwater-quality standards	Requirements on treatment of contaminated sites with chemical substances and requirements on cleaning and pollution limitation for soil and groundwater contamination with oil products.
Luxembourg	Investigations are driven voluntarily by construction projects or legally by cessation of potentially polluting activities.	German trigger values of Rhineland Palatinate

Country	Approach for assessing contaminated sites	Guidance and legal instruments framing site assessment
Malta	Soil screening values and groundwater thresholds are different for industrial and residential sites. Site-specific risk assessment.	N/A
Netherlands	Screening values and site-specific risk assessment depending on the tier.	Dutch soil-protection act/soil ministerial circular Sanscrit risk-assessment decision tool, including the CSOIL exposure model soil protection act
Norway	Soil-quality standards for different land uses and site-specific risk assessment depending on contamination type.	Guidelines for the risk assessment of contaminated sites
Poland	Permissible levels depending on land use. Site-specific risk-assessment approach used to plan remediation.	Environment-protection act
Portugal	Threshold values and site-specific risk assessment.	Under development.
Romania	Alert and intervention thresholds for soil pollutants for sensitive and less sensitive land use.	Procedure for the realisation of the environmental balances Regulation on the environment pollution evaluation
Serbia	Threshold values.	Regulation with the indicators for evaluation of soil degradation and methodology for preparation of remediation programme.
Slovakia	Threshold values and site-specific risk assessment.	Guideline of the Ministry of Environment of the Slovak Republic No 1/2015-7 on Risk assessment of contaminated sites
Slovenia	Soil-quality standards, limit values, alert thresholds, and critical levels of dangerous substances.	New decree under preparation.
Spain	Soil-quality standards and site-specific risk assessment.	Soil decree.
Sweden	Soil-quality standards for screening purposes and site-specific risk assessment to perform remediation.	Guidelines on management of contaminated areas in the environment protection act.
Switzerland	Threshold values and site-specific risk assessment.	N/A

Country	Approach for assessing contaminated sites	Guidance and legal instruments framing site assessment
United Kingdom	Site-specific risk assessment.	Contaminated-land statutory Guidance.

Funding mechanisms and liability for contamination land management

Due to the lack of specific European legislation, that would ensure contaminated site investigation and remediation, other national, regional, and local policy strategies have been designed for management of contaminated land.

In Europe, the costs of investigation-and-remediation projects typically range from EUR 5,000 to EUR 50 million, and some macro site-remediation projects exceed EUR 100 million[8].

An overall estimate of the annual cost for contaminated-soil remediation was made in the proposal for a soil framework directive. The investment needed by each Member State accounted for EUR 290 million per year for the first 25 Member States of the EU (EU-25) in the first 5 years and up to EUR 240 million per year in the following 20 years. The total costs for contaminated land remediation were estimated at EUR 119 billion, considering the average costs of remediation related to the size of the contaminated sites.

Historical contamination and orphan sites

More than 200 years of industrialisation have left their trace on the status of soil. Europe has a problem of historical contamination of soil due to the use and presence of dangerous substances in many production processes while there was no legal framework to control emissions or deal with the problem once it had appeared. An example of historical contamination can be clearly identified in Eastern Europe; countries that belonged to the former Soviet Union have many military and industrial sites that were abandoned after the dissolution.

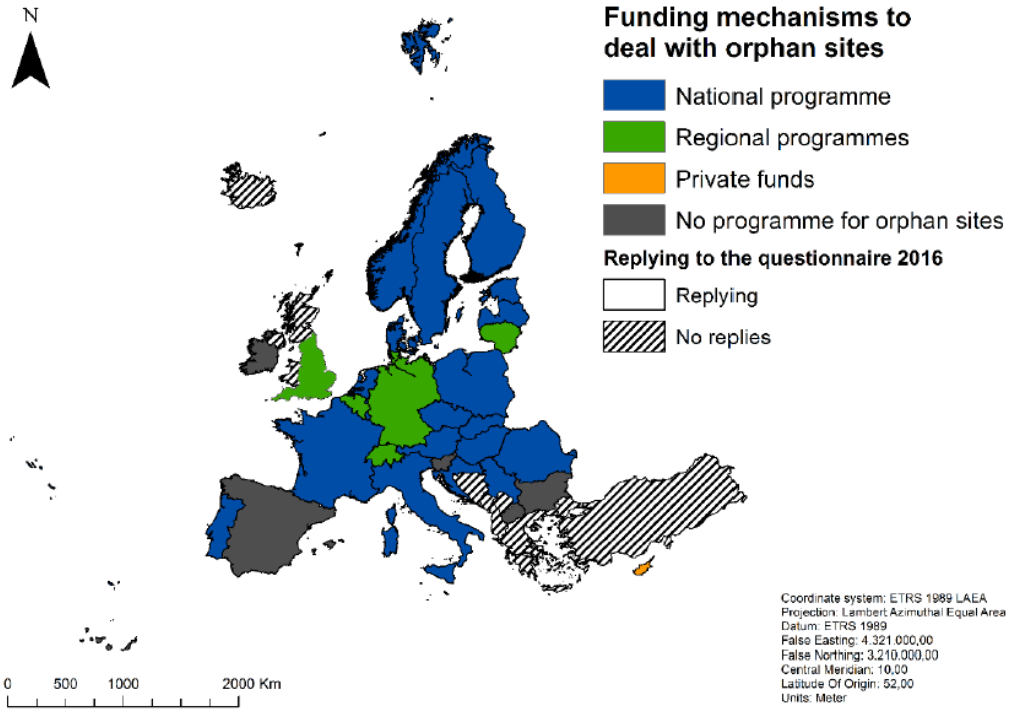
Historic contamination represents a widespread problem attributable, in many cases, to a polluter who is unknown or no longer present in the area. Governments often have difficulties in obtaining funding to address the remediation of such sites. This is one of the most common constrains the countries are confronted with when dealing with contaminated sites. Generally, soil remediation is analysed on the basis of fitness for use, and only when a land-use change is planned, some actions are taken to reduce the risk for the new use. Otherwise, actions are carried out when there is possible damage to the environment and people living close to the contaminated areas.

[8] Status of local soil contamination in Europe: Revision of the indicator 'Progress in the management contaminated sites in Europe'", JRC Technical Report 2018, https://op.europa.eu/en/publication-detail/-/publication/a7280491-93a3-11e8-8bc1-01aa75ed71a1/language-en

In general, it is considered that historical contamination is that which occurred before the introduction of a specific law on soil contamination. The criteria for addressing historical contamination are often laxer and risk-based approaches are applied. In addition, often some provisions are included in legislation to assure that funds are available for the remediation of historically contaminated sites.

In the last three decades, a number of European countries have introduced national policies to deal with historical contamination problems and to assure the availability of funds to remediate orphan sites. The following figure illustrates the funding mechanisms for orphan sites in Europe.

Figure 2: Funding mechanisms for orphan sites in Europe.



3.3 Regulatory Framework in EU

Soil protection has not been subject to a specific legislative instrument at EU level. There is no binding overarching framework that strategically defines policy priorities or parameters for soil protection. Soil protection outcomes in the other laws are mostly derived as a consequence of delivering environmental objectives that are not explicitly soil focused, such as reducing contamination, offsetting GHG emissions, and preventing other environmental threats.

Several EU directives have a direct influence on the development of national policies related to soil contamination prevention and management. A number of aspects directly or indirectly related to soil contamination and remediation issues are addressed by waste, water, chemical, impact assessment, environmental liability, and air quality regulatory instruments. Yet, these directives, regulations, decisions are not primarily oriented towards soil protection and focus mostly on regional rather than local contamination and are limited when dealing with historical contamination and site development issues.

An overview of the European regulatory framework on environmental policies related to contaminated sites is provided in the following two tables.

Table 2: List of EU regulatory instruments addressing soil contamination and the principal goal related to soil.

Regulatory instrument	Objectives
Binding measures — directives, regulations, decisions	
Water framework directive	It aims to prevent and reduce pollution; main pollutants are listed, and thresholds established. Member States to carry out an inventory of surface systems, including terrestrial ecosystems
Nitrates' directive	It aims to protect surface water and groundwater against pollution by nitrates from agricultural sources.
Habitats and birds' directives	It aims to ensure that the species and habitat types they protect are maintained or restored. The main goal is to achieve a favourable conservation status throughout the natural range within the EU, and to reduce the pollution of habitats, which in turn might reduce soil contamination.
Environmental impact assessment directive	It aims to assess the environmental effects of public and private projects that are likely to have significant effects on the environment.
Industrial emissions directive (IED)	It aims to prevent, reduce, and eliminate (when possible) pollution arising from industrial activities. Member States are to establish inventories of sulfur dioxide (SO_2), nitrogen oxides (NO_x) and dust emissions. Operators are also to produce a baseline report to establish the state of soil and groundwater contamination.

Regulatory instrument	Objectives
Sewage sludge directive	It aims to regulate the use of sewage sludge in agriculture in such a way as to prevent harmful effects on soil and it establishes limit values of heavy metals in soils.
Strategic environmental assessment directive	It aims to reduce environmental impacts from plans and programmes in the environment, including soils.
Waste framework directive (WFD)	It provides the basis for remediation of historical contaminated waste disposal sites. Unexcavated contaminated soils are not considered as waste.
Floods' directive	It aims to reduce and manage the risk that floods pose to human health, the environment, cultural heritage and economic activity.
Environmental liability directive	It aims to establish a framework based on the polluter-pays principle (PPP) to prevent and remedy environmental damage to soil, ecosystems, and water resources, if human health is affected.
Pesticides' framework directive	It aims to prevent contamination of the environment by pesticides.
Landfill directive	It aims to prevent or reduce the negative effects of landfilling of waste on the environment during the whole life cycle of the landfill.
Fertiliser regulation	It aims to guarantee that fertiliser does not have negative effects on human health, animals, plants or the environment (including soils) when applied under normal conditions.
Mercury regulation	It aims to identify and evaluate sites contaminated with mercury, including an inventory of sites contaminated by mercury and mercury compounds must be available to the public by 1 January 2021 (Article 15). It includes a list of the main mercury compounds.
Groundwater directive	It aims to prevent the entrance of pollutants (from diffuse sources) into groundwater and to identify contaminated land that can pose a risk in the quality of groundwater. Member States to keep an inventory of pollution sources. It includes threshold values for groundwater pollutants.
National emission ceiling directive	It aims to regulate contaminant emissions in the atmosphere and reduce the eutrophication and acidification on soils. Member States to prepare emission inventories for the pollutants listed and large point-source inventories
Renewable energy directive	It aims to control the impact of production of biofuels on soil quality. Furthermore, it aims to reuse heavily contaminated soil for producing biofuels. Member States to carry out inventories of land carbon stocks.

Few standards have been established related to the types of pollutants or screening values at EU level, being present only in 25 % of the EU directives. When screening values are

included, they are mainly related to bodies of water. An exception is the sewage-sludge directive, which includes threshold values for the input quality and the soil content.

Moreover, six of the European directives discuss the creation of national inventories: the WFD, the IED, the mercury regulation, the groundwater directive, the national emission ceiling directive, and the renewable energy directive. The inventories proposed by the mercury regulation, the groundwater directive, and the national emission ceiling directive are related to soil contamination and can act as the basis for the contaminated sites inventory suggested in the Soil Thematic strategy.

The next table presents a summary of the diffuse soil contamination and local soil contamination aspects included in the European regulatory framework on environmental policies.

Table 3: Aspects on diffuse soil contamination and local soil contamination included in the European regulatory framework.

Theme	Legislation	Diffuse soil contamination aspects		Local soil contamination aspects	
		Directly	Indirectly	Directly	Indirectly
Waste	**Waste Framework Directive 2008/98/EC**				√
	Hazardous Waste- Directive 1991/689/EEC & Commission Decision 2014/955/EU				√
	Disposal of Waste Oils- Directive 1975/439/EEC				√
	Landfill of waste - Directive 1999/31/EC				√
	Sewage Sludge - Directive 1986/278/EEC & Article 5 of Directive 1991/692/EEC	√			
	Management of waste from the extractive industries – Directive 2006/21/EC	√		√	
Water	**Water Framework Directive 2000/60/EC**	√			
	Nitrates - Directive 1991/676/EEC	√			

Theme	Legislation	Diffuse soil contamination aspects		Local soil contamination aspects	
		Directly	Indirectly	Directly	Indirectly
	Urban Wastewater Treatment – Directive 1991/271/EEC		√		
	Bathing Water- Directive 2006/7/EC		√		
Air	**Air Quality Framework Directive 1996/62/EC**		√		
	National Emissions Ceilings- Directive 2001/81/EC		√		
	Integrated Pollution Prevention and Control - Directive 1996/61/EC	√			
	Large Combustion Plants - Directive 2001/80/EC		√		
Chemicals	**Sustainable use of pesticides** - Directive 2009/128/EC	√			
	Biocidal Products - Directive 1998/8/EC	√			
	Plant protection products - Regulation EC 1107/2009 & Directive 1991/414/EEC	√			
Impact assessment	**Environmental Impact Assessment** - Directive 1985/337/EEC amended by Directive 1997/11/EC, Directive 2003/35/EC & Directive 2009/31/EC	√		√	
	Strategic Environmental Assessment- Directive 2001/42/EC	√			
Environmental liability	**Environmental liability with regard to the prevention and remedying of environmental damage** - Directive 2004/35/EC			√	
Renewable energy	**Renewable Energy Directive** 2018/2001/EU (RED II).	√			

3.4 Policy landscape in EU

The European Parliament stated at the beginning of the millennium ***"the urgent need to regulate its (soil) use and assess and mitigate the impact of external actions".*** Some steps have been taken in this regard with the approval of several legal approaches in Europe in the last decade. During the last 20 to 30 years, soil protection policies have been developed and implemented in a stepwise manner both at European and national levels.

EU soil policy action is based on Article 191 of the Treaty on the Functioning of the EU (TFEU), which requires Union policy to aim at preserving, protecting, and improving the quality of the environment, protecting human health, a prudent and rational utilisation of natural resources, promoting measures at international level to deal with regional or worldwide environmental problems, and in particular combating climate change. EU policy action on soil protection is justified due to:

- the transboundary impacts of soil degradation, such as CO_2 emissions from soil organic carbon and loss of biodiversity, hampering EU food security through reduced production of food commodities traded in the internal market, hampering water quality across borders through contaminants and sediments in river basins, food safety concerns from soil contaminants,
- the absence of a level playing field for economic operators subject to very different national soil protection regimes, leading to a distortion of the internal market,
- the risk that the EU and its Member States will fail to fulfil international and European commitments in the field of environment, sustainable development, and climate.

Since 2001, when the 6th Environmental Action Programme (EAP) of the European Union established that soil protection against adverse impacts be a priority for Europe, social and political awareness of soil has risen. After a nearly decade-long attempt to implement a governance framework in Europe to ensure the protection and sustainable use of soils, **the thematic Strategy for Soil Protection was launched in 2006,** which explicitly recognised the necessity of preventing soil degradation. The strategy established a start-point for a common framework on soil protection, encouraged those Member States which did not have a national legislation to increase the efforts to preserve their soil resources, and set out the next steps that must be taken in order to achieve a common insight into the status of soil contamination in Europe. Three sets of measures were set out under the proposal of the soil framework directive addressing soil contamination:

- **Precautionary and preventing measures**, to minimise the adverse effects on soil functions.
- **Identification of risk areas and contaminated sites**. Every Member State had to prepare an inventory of contaminated sites.
- **Operative measures for risk areas and contaminated sites**. Remediation strategies must be prepared, and soil remediation has to be assured.

Currently, **considering that soil protection is not subject to a specific legislative instrument at EU level and there is no binding overarching framework** that strategically defines policy priorities or parameters for soil protection, the European Commission launched an online public consultation[9] on the **development of a new EU Soil Strategy.** This is the last of a set of public consultations on different ecosystems delivering on the specific commitments in the EU Biodiversity Strategy 2030.

The **new Soil Strategy will provide the concrete pathway** towards achieving the following objectives:

- Step up efforts to protect soil fertility and reduce soil erosion,
- Increase soil organic matter and restore carbon-rich ecosystems,
- Protect and enhance soil biodiversity,
- Reduce the rate of land take, urban sprawl and sealing to achieve no net land take by 2050,
- **Progress in identifying and remediating contaminated sites and address diffuse contamination,**
- Address the growing threat of desertification,
- Achieve land degradation neutrality by 2030.

By:

- Promoting the adoption of sustainable soil management practices,
- Setting out actions to restore degraded soils and secure sufficient EU funding to this end,
- Improving the monitoring of soil quality,
- Adapting and improving the relevant EU policy framework in line with the European Green Deal objectives on climate neutrality, zero pollution, sustainable food systems and resilient ecosystems,
- Developing knowledge and research,
- Accelerating the transition towards sustainable soil management and the necessary behavioural change,
- Steering EU global action on soil under the Rio Conventions, EU external action and development cooperation.

9 https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12634-Healthy-soils-new-EU-soil-strategy/public-consultation

The strategy will consolidate, complement, and steer action in the different policy areas that affect and depend on soil and guide the implementation of sustainable soil and land management practices.

The European policy framework on soil includes several EU-level non-regulatory documents related to soil protection. These non-regulatory instruments account for 41 % of legal instruments in the EU related to soil and they include monitoring, funding, and awareness-raising schemes.

The table below presents the main EU policies, strategies and funding instruments addressing soil contamination and the principal goal related to soil.

Table 4: EU policies, strategies and funding instruments addressing soil contamination.

Policy instrument	Objectives
Strategic initiatives	
Thematic strategy for soil protection	It aims to protect soils by preventing soil degradation and restoring degraded soils, included those contaminated.
7th Environmental Action Programme (EAP)	One of the priority objectives includes the sustainable management of land, adequate soil protection and remediation of contaminated sites.
Resource efficiency road map	Provides an overarching framework for policy transformation towards a European Union where resources, including soil, are sustainably managed.
Soil sealing guidelines	It aims to limit soil sealing or mitigate its effects. Some definitions are given such as brownfield and soil quality.
Biodiversity strategy	It aims to halt the loss of biodiversity and ecosystem services in the EU as well as to contribute to stop global biodiversity decline by 2020. Promotes healthy soils.
EU Forest strategy	It aims to support and enhance sustainable forest management and the multifunctional role of forests.
Adaptation strategy	It aims to increase adaptation through different mechanisms, which enhance the readiness and capacity to respond at different levels to climate change effects, develop a consistent approach and improve coordination.
LULUCF Regulation	It aims to protect the soil carbon-sequestration function.
Funding instruments	
European Regional Development Fund (ERDF)	It is for the sustainable development and structural adjustment of regional economies.
Cohesion Fund (CF)	It aims to decrease the differences between the EU's regional economic development, focusing on improving the urban

Policy instrument	Objectives
	environment, decontaminating brownfield sites and reducing air pollution.
LIFE+ programme	It is the EU's funding instrument for environment and climate actions.
Horizon 2020 (H2020) actions	It is a comprehensive funding mechanism of pan-European projects.
Common agricultural policy (CAP)	It is the set of legislation and practices adopted to provide a common, unified policy on agriculture.

The **2006 Soil Thematic Strategy** is the most relevant and wide strategic instrument at EU level related to soil. Soil contamination is set out here as one of the main threats to soils in Europe and presents an extensive analysis of contamination consequences, risk identification and measures to reduce the risk, and possible costs of investigation and remediation.

The **7th EAP to 2020** 'Living well, within the limits of our planet' alludes to remediation of contaminated sites. By 2020 land is managed sustainably in the Union, soil is adequately protected, and the remediation of contaminated sites is well underway. This requires, in particular to increase efforts that will reduce soil erosion and increase soil organic matter, to remediate contaminated sites and to enhance the integration of land-use aspects into coordinated decision-making involving all relevant levels of government, supported by the adoption of targets on soil and on land as a resource, and land planning objectives.

The **biodiversity strategy** marks the importance of having a framework directive to protect soil to ensure biodiversity conservation. By addressing the use and release of chemicals in the environment, the road map for resource efficiency acts on the protection of soils, mainly focuses on the negative effects of SO_2 and NOx emissions. It also includes the mandate for Member States to set up a contaminated site inventory and have remedial works.

The importance of land coverage to avoid soil degradation is one of the lead points in the **EU forest strategy**.

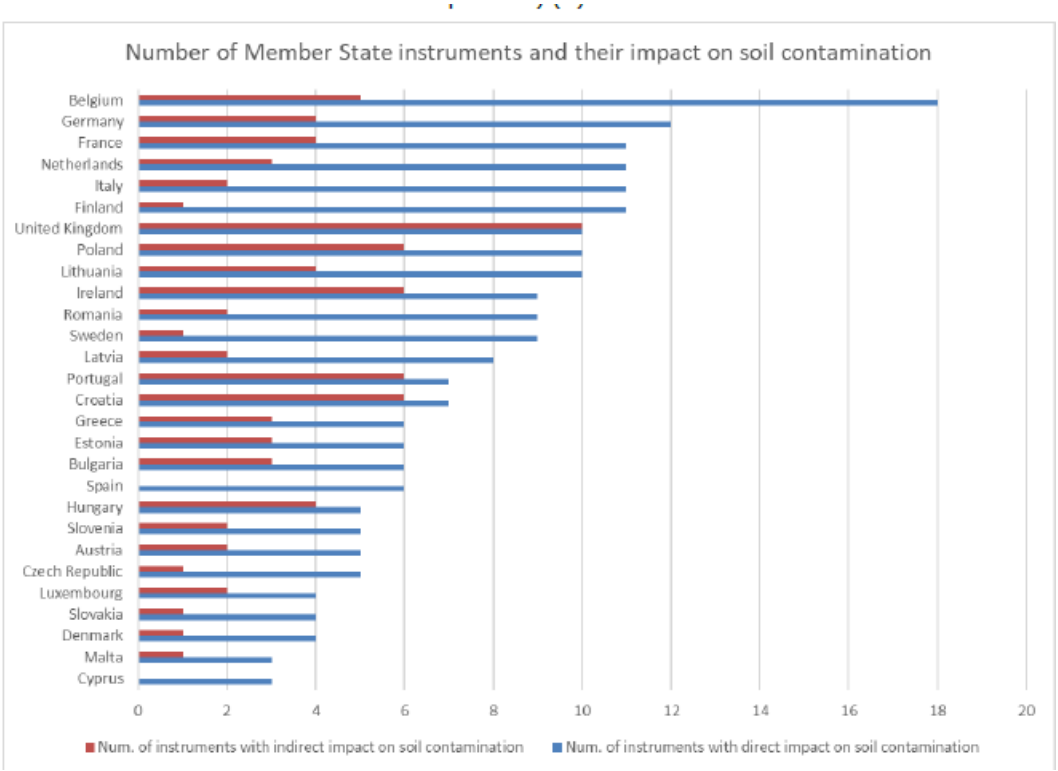
Soil protection is also a main issue for the strategy on adaptation to climate change and the LULUCF regulation, as the role of soil in the uptake of carbon dioxide (CO_2) from the atmosphere has been widely recognised. Brownfield and industrial contaminated sites are frequently located in urban and peri-urban areas; hence these sites are considered under the soil-sealing strategy to be eligible to reuse them for redevelopment instead of sealing green areas.

3.5 National legal and policy tools addressing soil contamination.

According to the 2018 JRC Technical Report on the status of local soil contamination in Europe (Revision of the indicator 'Progress in the management contaminated sites in Europe"), there are 671 instruments identified across the EU-28 (sometimes at regional level), of which nearly half are directly linked to EU policies (45 %), where implementation is mandated by EU law (the acquis). Another 21 % are linked partly to EU binding instruments, which means that they implement the EU binding legislation but also go beyond the acquis in either the degree of ambition that they set for EU requirements or they regulate additional areas that do not derive from the EU acquis. This means that a total of 225 identified instruments (35.5 %) are 'nationally initiated' policies, namely policies partly linked to EU non-binding policies or not linked to any EU requirements.

A significant proportion of national instruments (44 %) explicitly address either directly (215 instruments) or indirectly (85 instruments) industrial and point-source soil contamination, as depicted in the below figure.

Figure 3: Number of national policies that explicitly (directly) or indirectly address contamination of industrial and point sources.



Of the 215 instruments explicitly addressing soil contamination, 143 are linked to EU policy and **72 are national legislation not related to EU policies, which demonstrate the importance of this issue at national level** for most Member States and indicates to some extent the legal vacuum of EU policy.

However, **the distribution of nationally initiated instruments is uneven** with a large concentration in some which have a very strong national legislation on soil contamination and on the other side, a lack of specific national legislation in others.

The general approach for discussion of soil contamination makes a distinction between source-oriented soil protection and contaminated-land management. Source-oriented soil protection aims to prevent further contamination of the soil, whilst contaminated-land management deals with the clean-up, remediation, and reuse of soil, which is already contaminated, often as a result of past activities.

Every EU Member State has a national policy that includes the "polluter pays principle" in compliance with EU treaties (either a specific policy or regulations included in a more generalist environmental code). They also include contamination-related definitions, screening values, risk reduction measures and guidelines for site identification.

In the European Union, 24 national policies explicitly address soil contamination and its remediation in specific legislation. Generally, all these regulations aim to prevent harmful changes in the soil and the rehabilitation of contaminated soils and groundwater. In some cases, preventing air contamination by emissions is also included under specific legislation on soil contamination.

In addition, several Member States have developed overarching instruments such as national plans or codes that implement at the same time multiple EU directives in order to facilitate the applications of these laws. The most relevant examples are:

- the environmental code of France, which implements 17 EU instruments,
- the Swedish environmental code that implements 12 EU directives,
- the proposal of a Dutch environmental and planning act, that, when approved, adopts 20 EU legal instruments.

The adoption by the European Parliament of the water framework and landfill directives represents a crucial point in the development of many of the national legal instruments addressing soil contamination specifically. These two directives are implemented by 24 % of the 215 national policies explicitly addressing soil contamination.

Despite the non-binding character of the thematic strategy for soil protection, up to 40 national legal tools are adopting its goals and directives.

The figure below provides an overview of national policies and EU directives addressing specifically soil contamination and the dates of entrance into force, up to 2017[10].

[10] Status of local soil contamination in Europe: Revision of the indicator 'Progress in the management contaminated sites in Europe'", JRC Technical Report 2018, https://op.europa.eu/en/publication-detail/-/publication/a7280491-93a3-11e8-8bc1-01aa75ed71a1/language-en

Figure 4: Overview of national policies and EU directives addressing specifically soil contamination and the dates of entrance into force.

EU directives	Year	National Laws addressing soil contamination
Sewage-sludge directive	1986	
	1987	Netherlands — Soil-protection Act
	1988	
	1989	Austria — Law on the remediation of contaminated sites
	1990	
Nitrates directive	1991	
Habitats directive	1992	
	1993	
	1994	Finland — Waste Act
	1995	Estonia — Contaminated-site management Belgium (Flanders) — Decree on soil remediation and soil protection Switzerland — Environmental Protection Act (EPA)
	1996	Hungary — Decision No 2205/1996 (VII.24) adopted the national environmental remediation programme (before being part of EU) Slovenia — Decree on limit values, alert thresholds and critical levels of dangerous substances into the soil
	1997	
	1998	Germany — Federal soil-protection Act
The landfill directive	1999	Denmark — Act on soil contamination Italy — Regulation laying down criteria, procedures and methods for the safety, reclamation and restoration of polluted sites Luxembourg — Law on classified establishment
Water framework directive	2000	France — Environmental Code United Kingdom — Contaminated-land Regime (Part 2A of environmental-protection act, 1990) Finland — Environmental Protection Act

EU directives	Year	National Laws addressing soil contamination
Strategic environmental assessment directive	2001	Latvia — Law on pollution
	2002	Cyprus — Water- and soil-pollution control Law
	2003	
Environmental liability directive (ELD)	2004	Belgium (Brussels-Capital) — Ordinance on the management and clean-up of soils Belgium (Wallonia) — Decree on the management of soils Slovakia — Soil-protection Act Sweden — Regulation on compensation for contamination damage and state aid for remedial (implementing Swedish environmental code of 1999)
	2005	Hungary — Decree on rules concerning the screening surveys of remedial site investigation Spain — Decree on defining soil polluting Activities and criteria
Thematic strategy for soil protection Waste-management extractive industries directive	2006	Ireland — Energy Act. Historic mine sites — inventory and risk classification Italy — Environmental Code Lithuania — Regulations on contaminated-sites treatment procedures
	2007	Bulgaria — Soil Act Finland — Government Decree on the assessment of soil contamination and remediation needs Romania — Decree on remediation Slovakia — Act on the prevention and remedying of environmental damage
Waste framework directive	2008	Czech Republic — Act concerning the prevention of environmental harm and its rectification
Pesticides directive	2009	Belgium (Brussels-Capital) — Decree on soil remediation and soil management of 5 March 2009 amended 23 June 2017
Industrial emissions directive	2010	Serbia — Regulation on the programme for systematic monitoring of the soil quality, indicators for evaluation of soil degradation and methodology for preparation of remediation program

EU directives	Year	National Laws addressing soil contamination
Environmental-impact-assessment directive Biodiversity strategy	2011	Spain – Law on waste and contaminated soils
	2012	Malta — National Environment Policy
	2013	
	2014	Croatia — Ordinance on the protection of agricultural land against pollution
	2015	Serbia — Law on soil protection
	2016	
Mercury regulation	2017	Greece — Law for the protection and sustainable use of soil (under preparation) Poland — Assessment of the land surface contamination (under preparation) Portugal — Contamination prevention and soil-remediation legal regime (under preparation) Slovenia — Decree on status of soil and rules on soil status (under preparation)

Norway was one of the first countries to enact a pollution control act, in force since 1981. It was the first reference in Europe aiming to protect the environment against contamination.

The **Dutch** soil protection act was adopted in 1987 with the main objective of setting out the accountability of individuals: for each case of soil contamination, which parties are fully liable. This national instrument was the first one adopting the liability for environmental damage in Europe.

The **Austrian** CS-remediation law, that entered into force in 1989 aims to ensure the availability of funds for remediation of historical contaminated sites.

In **Finland**, the efforts for contaminated sites' identification and management began in 1989 with the Samase project. Soil pollution has been prohibited by the waste legislation since 1994 and the obligation to inform, investigate and remediate polluted areas is provided for in that legislation. Nowadays, soil contamination falls under the EPA, which came into force in 2000.

Switzerland has two different ordinances to regulate soil contamination: the soil ordinance for diffuse soil contamination and the contaminated-sites ordinance for point-source soil contamination.

In **France, Italy, Malta** and the **United Kingdom** provision on contaminated sites' identification, definition, management, and remediation are comprised in national environmental codes.

Italy approved its first regulation on soil contamination in 1999 (Ministerial Decree 471/99). This regulation was revised and included under the environmental code in 2006 (Legislation 152/06), currently in force. This specific regulation includes five technical annexes on risk assessment, characterisation, remediation techniques, soil, and groundwater screening values.

Belgium (Flanders) adopted its first decree on soil remediation and soil protection in 1995. Its main goal was to deal with past soil contamination, over a period of 40 years, starting in 1996. It includes the provision of contaminated sites registering and establishes the figure of soil certificates as an information tool to establish the quality and the status of the soil. This decree was revised in 2006, entering into force in 2008, and its main improvements are the simplification of the administrative procedures and the regulation on excavated soils.

The federal soil-protection act adopted by the **German** government in 1998 aims to protect and restore the functions of the soil. This legislation has a strong preventive basis but also specifies the risk-assessment procedures and steps to be followed for investigation and remediation.

In **Poland**, since 2001, soil protection and in particular, soil contamination has been included within the EPA.

Slovenia has, since 1996, a decree on limit values, alert thresholds, and critical levels of dangerous substances in soil, which established the threshold values above which further investigation or risk reduction measures must be applied. The decree on the status of soil together with the rules on soil-status monitoring aim to establish harmonised rules to soil sampling and site-status characterisation.

The law adopted by the **Luxembourg** government in 1999 on classified establishment determines the need for investigation after cessation of certain activities and regulates the permits for remediation works. However, this legislation does not leave legal room for risk-based land management.

3.6 Regulatory and institutional challenges inhibiting development.

Soil is one of the most complex of all ecosystems. It is a habitat in its own right, and home to an incredible diversity of organisms that regulate and control key ecosystem services such as soil fertility, nutrient cycling, and climate regulation. Soil is a hugely important non-renewable resource, vital for human and economic health, as well as the production of food and new medications.

Land and soil continue to be subject to severe degradation across the EU. Land and soil degradation have transboundary effects such as CO_2 emissions from soil organic carbon and loss of biodiversity, hampering EU food security through reduced production of food commodities traded in the internal market, hampering water quality across borders through contaminants and sediments in river basins, food safety concerns from soil contaminants.

As already discussed in previous sections of this report, soil protection and contaminated land management has not been subject to a specific legislative instrument at EU level. Soil is still subject to many pressures that lead to its degradation. The EU has recognised the importance of soil protection as fundamental to achieving other environmental objectives in the coming decades, but there is as yet no agreement to regulate land use, including soil protection against contamination.

Due to this **lack of specific common framework to prevent soil degradation**, several **EU countries have developed their own legislation to protect their soils**, prevent further contamination and **regulate the procedure for the assessment and treatment of soil contamination**.

Also, most European countries have a national policy that includes the Polluter Pays Principle (PPP), whether it is a specific policy on soil contamination or regulations included in a more general environmental code. They also include definitions related to contamination, screening values, and guidelines for site identification.

This **lack of a comprehensive and coherent policy and regulatory framework at European level to protect land and soil is a key gap** that reduces the effectiveness of the existing incentives and measures and may limit Europe's ability to achieve future objectives.

Moreover, the **high percentage of non-legally binding tools at EU level** indicates that great efforts have been made to protect soils but there is no consistent agreement allowing for the development of a legal framework that guarantees soil protection.

Despite the lack of a specific EU instrument that ensures soil protection, including the prevention of soil contamination, **other EU policies have contributed significantly to soil protection.**

With regards to the **regulatory instruments**, EU directives have a direct influence on the development of national policies related to soil contamination prevention and management. However, **none of them addresses soil contamination as a priority regulation objective**, but somehow remediation of contaminated sites or protection of soil against contamination is noted.

In a nutshell, the main regulatory and institutional challenges inhibiting development can be summarised as follows:

- There is not in place a common framework to protect soil on the basis of the principles of preservation of soil functions, prevention of soil degradation, mitigation of its effects, restoration of degraded soil and integration with other sectorial policies,
- There is not in place a common framework to identify, describe and assess the impact of various sectorial policies on soil-degradation processes aiming to protect soil functions,
- There is not in place a common approach to soil sealing to ensure a more rational use of land and to maintain as many soil functions as possible (in essence a policy drive prioritizing contaminated land redevelopment).

Hence, a new policy framework is needed because the 2006 EU Soil Thematic Strategy is no longer adapted to the policy context of today and the improved scientific knowledge base, while there is a high risk that the EU will fail its Green Deal and international objectives.

In this context, the new EU Soil Strategy, that is currently in consultation, provides a unique opportunity for EU Member States, that will ensure a solid regulatory background for contaminated land management, land decontamination and phytoremediation.

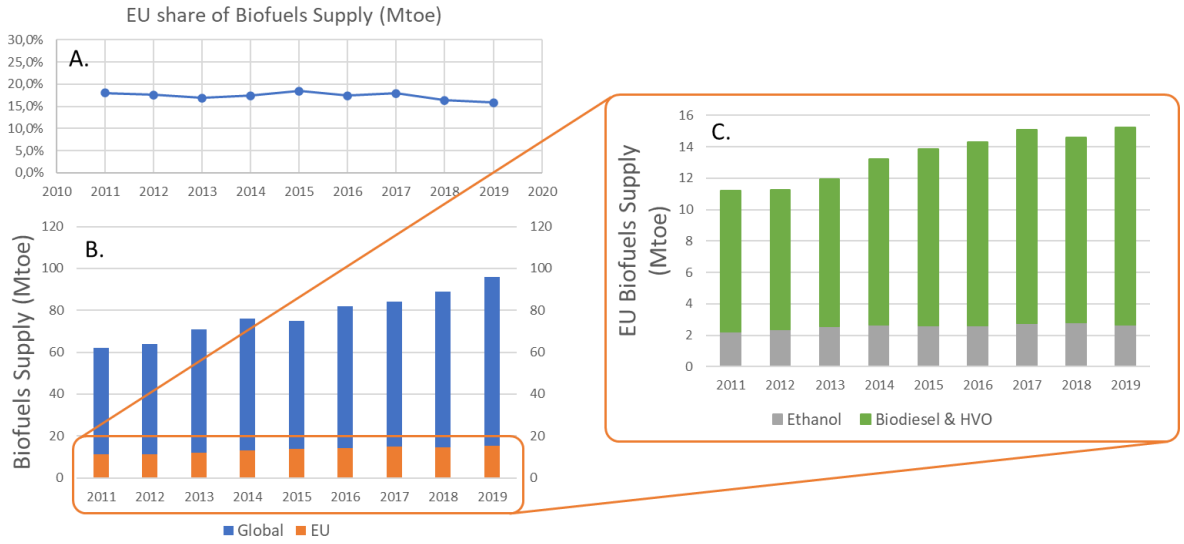
The new EU Soil Strategy will provide the overarching framework and the concrete pathway towards achieving several objectives, including the identification and remediation of contaminated sites and address diffuse contamination. **The strategy will consolidate, complement, and steer action in the different policy areas that affect and depend on soil** (such as pollution prevention, agriculture, research) and guide the implementation of sustainable soil and land management practices. It will also include the legally binding EU nature restoration targets that the Commission will propose in 2021 and which should contribute to the achievement of the objectives of the new Soil Strategy and the restoration of degraded soils.

4 BIOFUELS

4.1 Progress and Trends in biofuel supply and demand

The growth in biofuels supply observed so far has been underpinned by favorable feedstock crops, biofuels mandates across the globe and the commissioning of new commercial-scale plants. Since 2011 and up to 2019, the global supply of biofuels gradually increased to reach 96 Mtoe in with the share of EU biofuels (i.e. biodiesel & HVO and Ethanol) supply varying from 15,8% to 18% during the aforementioned period of time (Figure 5)[11].

Figure 5: Historical data of global and EU biofuels supply



Catalysing mandates have also been the driving force of the observed biofuels consumption. Global biofuels consumption in transport in 2015 was reported to be 82 Mtoe[12] slightly lower than the 85,1 Mtoe reported in 2018[13]. The same year, biofuels consumption in the transport sector in the EU was 15,7 Mtoe. One year later, i.e. in 2019[14],

[11] https://www.iea.org/reports/medium-term-renewable-energy-market-report-2015

[12] IEA, Biofuel consumption breakdown in the Sustainable Development Scenario, 2015-2030, IEA, Paris https://www.iea.org/data-and-statistics/charts/biofuel-consumption-breakdown-in-the-sustainable-development-scenario-2015-2030

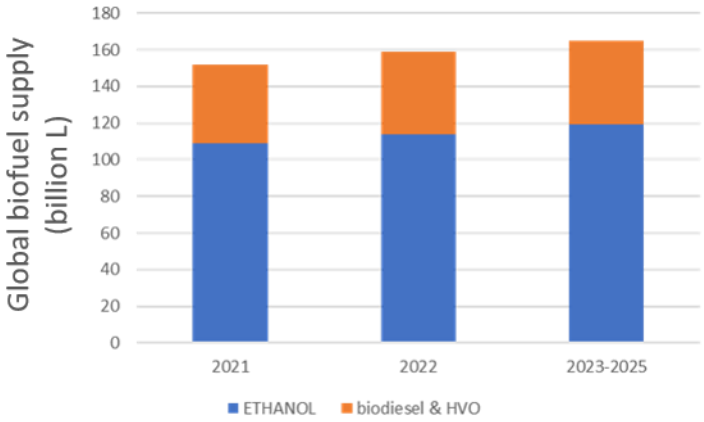
[13] https://www.ifpenergiesnouvelles.com/article/biofuels-dashboard-2020

[14] https://www.iea.org/reports/medium-term-renewable-energy-market-report-2015

consumption of both bioethanol and biodiesel (including hydrogenation derived renewable diesel or HDRD) increased in the EU[15].

As reported by the IEA[16], the COVID-19 pandemic resulted in lower transport fuel demand and, subsequently, in reduced biofuel consumption in countries where mandate policies require a set percentage of biofuels to be blended with fossil transport fuels. It is also noted that the lowering of crude oil prices since the start of the pandemic has made biofuels less competitive with fossil transport fuels. Nevertheless, the global biofuel production forecast shows a gradual recovery(Figure 6).

Figure 6: Global biofuel production forecast



D. Chiaramonti *et al*[17] report the projections on the total final energy consumption in the transport sector in EU, as well as the actual biofuels and advanced biofuels volumes consumption projections for the years 2030, 2040 and 2050 (Figure 77). Their work relied on a thorough screening of available literature and selection of publications that complied with the RED II 2030 targets and included the contribution of a least one of the following: conventional biofuels, advanced biofuels, renewable fuels of non-biological origin (RNFBIO) and recycled carbon fuels (RCF).

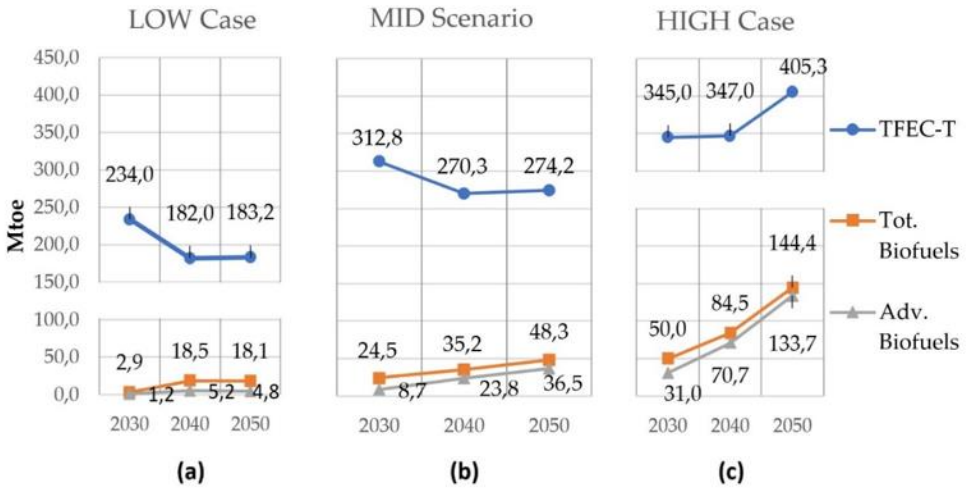
Three scenarios are investigated: the main, a more optimistic ("HIGH" case) and a more pessimistic ("LOW" case). The "MAIN" scenario is obtained as the mean value of all the collected scenarios projections, for a specific parameter, whereas the "LOW" and "HIGH" cases are also presented. The forecast average biofuels share in the fuel mix is 8%, 13% and 19% in 2030, 2040 and 2050, respectively.

[15] https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Biofuels%20Annual_The%20Hague_European%20Union_06-29-2020

[16] https://www.iea.org/reports/renewables-2020/transport-biofuels

[17] D. Chiaramonti, G. Talluri, N. Scarlat, and M. Prussi, "The challenge of forecasting the role of biofuel in EU transport decarbonisation at 2050: A meta-analysis review of published scenarios," Renew. Sustain. Energy Rev., vol. 139, no. December 2020, p. 110715, 2021, doi: 10.1016/j.rser.2021.110715.

Figure 7 Projections on the total final energy consumption in the transport sector (TFEC-T), as well as on the actual biofuels and advanced biofuels consumption for the (a) LOW case; (b) MAIN case and (c) HIGH case.



4.2 Policy landscape in EU

The first biofuel related targets were implemented by the EU Commission in 2003 with Directive 2003/30/EC, setting an indicative biofuel penetration target of 2% by the end of 2005 and 5,75% by the end of 2010.

Two major directives were passed in 2009, further promoting the use of biofuels. The Renewable Energy Directive (RED)[18] mandated that at least 10% renewable fuels must be used in road transport by 2020. The aviation and shipping sectors are eligible for this target, without however being mandatorily counted in the calculation. In parallel, the Fuel Quality Directive (FQD)[19] was amended, requiring that the road transport fuel mix in the EU should be 6% less carbon intensive compared to the (fossil diesel and gasoline) baseline by 2020. An additional 4% carbon intensity reduction indicative target was set, out of which 2% aim at electrification and carbon capture/storage savings and 2% is linked to the purchase of Clean Development Mechanism credits.

According to the RED and the FQD, biofuels must meet specific sustainability criteria, related to the greenhouse gas (GHG) emissions savings and the types of land that may be used to produce biofuels. Specifically, for a biofuel to be eligible for support under EU member state policies, a minimum 35% GHG emissions savings must be achieved compared to fossil fuel. This threshold was increased to 50% beginning January 2017 and 60% for installations starting production after January 2017 from January 2018 onward. Both directives prohibit biofuel production on high biodiversity[20] or high carbon content land[21].

In addition, the FQD allows for the blending of ethanol into petrol up to 10 % (v/v) and for a FAME content of 7 % (v/v) in diesel.

In December 2018, the revised renewable energy directive RED II (2018/2001/EU)[22] raised the overall EU target for renewable energy sources to 32%, also requiring a minimum of 14% of the energy consumed in road and rail transport to be supplied as renewable energy by 2030. The RED II introduced sustainability for forestry feedstocks as well as GHG criteria for solid and gaseous biomass fuels. It also sets limits on high ILUC-risk biofuels, bioliquids and biomass fuels with a significant expansion in land with high carbon stock.

Green deal and biofuels in transport

EU's Green Deal sets ambitious goals for Europe to become the world's first climate-neutral continent by 2050. To achieve this, every sector will have to contribute. The transport sector is responsible for almost a quarter of EU's GHG emissions, road transport

[18] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32009L0028

[19] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0030

[20] High biodiversity land: wooded land where there is no evidence of human activity and ecological processes have not been disturbed, nationally designated nature protection areas, internationally designated conservation areas, highly biodiverse grassland, whether or not that biodiversity is maintained by human intervention.

[21] High carbon land: wetlands, continuous forests, discontinuous forests with greater carbon content than the replacement system, peatland where exploitation would involve drainage.

[22] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0082.01.ENG

representing more than 70% of this share and significantly contributing to air pollution in urban areas[23].

The transport sector has therefore a central part for the efficient implementation of the Green Deal. In her mission letter to the Commissioner for Transport (01/12/2019)[24], EU's Commission President underlines the need to 'focus on increasing the uptake of sustainable and alternative transport fuels for road, maritime and air transport and the alignment of the Energy Taxation Directive with EU's latest climate ambitions in order to bring an end to fossil-fuel subsidies'.

Furthermore, according to a Communication by the European Commission on the European Green Deal (11/12/2019)[25] a 90% reduction in transport emissions is needed by 2050, priority areas including road, rail, aviation, and waterborne transport and focusing on clean hydrogen, fuel cells and other alternative fuels, energy storage, and carbon capture, storage and utilization. Among others, the Communication states that the EU should ramp-up the production of deployment of sustainable alternative transport fuels and that it will consider legislative options to boost the production and uptake of sustainable alternative fuels for the different transport modes.

The European Parliament adopted a resolution on the Green Deal (15/01/2020)[26], welcoming the upcoming strategy for sustainable and smart mobility and agreed with the Commission that all modes of transport will have to contribute to the decarbonization of the transport sector in line with the objective of reaching a climate-neutral economy. The EP also called for 'a clear regulatory roadmap for the decarbonization of aviation, based on technological solutions, infrastructure, requirements for sustainable alternative fuels and efficient operations, in combination with incentives for a modal shift'.

ReFuelEU Aviation – Sustainable Aviation Fuels

As part of the EU's efforts to achieve its climate change related goals, the Commission is preparing a new legislative initiative titled 'ReFuelEU Aviation – Sustainable Aviation Fuels'. The aim of this initiative is to boost the supply and demand for sustainable aviation fuels in the EU, which will in turn result in the reduction of the aviation's sector environmental footprint. The Commission is considering several policy measures, including a mandatory minimum share of sustainable aviation fuels to be supplied to airlines and/or to be used by airlines and a financial and technical support mechanism to promote the production and use of these fuels. It is worth noting that sustainable aviation fuels represent only 0.05% of total jet fuel consumption[27], this fact demonstrating the significant potential of such fuels in reducing aircraft emissions.

[23] https://ec.europa.eu/clima/policies/transport_en

[24] https://ec.europa.eu/commission/commissioners/sites/comm-cwt2019/files/commissioner_mission_letters/mission-letter-valean-2019-2024_en.pdf

[25] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1576150542719&uri=COM%3A2019%3A640%3AFIN

[26] https://www.europarl.europa.eu/doceo/document/TA-9-2020-0005_EN.html

[27] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12303-ReFuelEU-Aviation-Sustainable-Aviation-Fuels

FuelEU Maritime initiative

In parallel to the aforementioned actions, the EU aims to address the issue of maritime transport sector's emissions, accounting for approximately 11% of all EU CO_2 emissions from transport and 3-4% of total EU CO_2 emissions[28].

The European Parliament adopted a resolution on the deployment of infrastructure for alternative fuels (25/10/2018)[29], calling for the decarbonization of the maritime and shipping sector with a clear focus on innovation, digitization and adaptation of ports and ships. It also supported the deployment of shore-side energy supply at both inland and maritime ports and underlined that the gradual adoption of alternative fuels by shipping would have a significant positive effect on the environment.

On its resolution on the European Green Deal (15/01/2020)[30], the Parliament called for measures to move away from the use of heavy fuel oil and for urgent investments in research into new technologies to decarbonize the shipping sector, and in the development of zero-emission and green ships.

Lastly, the European Commission announced its intention to launch a legislative proposal on maritime fuels on January 2020[31]. This initiative – FuelEU Maritime – aims to increase the use of sustainable alternative fuels in European shipping and ports by addressing market barriers that hamper their use and the uncertainty about which technical options are market-ready.

[28] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12312-FuelEU-Maritime
[29] https://www.europarl.europa.eu/doceo/document/TA-8-2018-0438_EN.html?redirect
[30] https://www.europarl.europa.eu/doceo/document/TA-9-2020-0005_EN.html
[31] https://ec.europa.eu/info/publications/2020-commission-work-programme-key-documents_en

4.3 Regulatory Framework in EU

Renewable Energy Directive II: The RED II forms the continuation of the RED I and sets EU renewable energy policy for the period 2021-2030. Overall, RED II is considered as the strongest policy driving the deployment of RES in the EU, including all transport sectors as well. RED II establishes an overall renewable energy target of 32% by 2030. For each Member State, it sets a target for renewable energy in transport of at least 14%. This target may be lowered based on a Member State's cap on crop-based biofuels. The cap may be at most 7% of energy consumed in the road and rail sectors and may not exceed a Member State's contribution of crop-based biofuels in 2020 plus 1%. Member States may implement a cap of 2% regardless of their crop-based contribution. It sets a cap of 1,7% on feedstocks from Annex IX-B, such as used cooking oil and animal fats, that may be lifted with the consent of the European Commission. In addition, it includes a sub target of 3,5% by 2030 for biofuels produced from feedstocks listed in Annex IX-A. The Directive also foresees a 1,2x multiplier for biofuels supplied to the marine and aviation sector that may be applied in conjunction with the above mentioned 2x multiplier.

RED II is about to be updated to become in line with the aspirations of the Green Deal and the 2030 Climate Target Plan. Although the details of RED II revision are not known yet, the contributions to the consultations on the Inception Impact Assessment for the revision of RED II suggest that the overall RES ambitions will be raised[32].

Fuel Quality Directive FQD applies to petrol, diesel and biofuels used in road transport as well as gasoil used in nonroad mobile machinery. It sets common fuel specification standards for the EU primarily for the control of air pollutant emissions, such as sulphur. The FQD also calls for a 6% reduction as compared to the 2010 levels by 2020 of the GHG intensity of fuel supplied to the EU market for use in road transport and inland waterway. Fuels supplied to the marine sector for uses other than inland waterway navigation, are not considered by the FQD.

The CO_2 Standards Regulation

Passenger cars and vans account for approximately 12% and 2.5%, respectively of total EU emissions of carbon dioxide[33]. Mandatory emission targets have been set by the EU legislation since 2009 for new cars and since 2011 for vans. These regulations were replaced by the CO_2 Standards Regulation (Regulation (EU) 2019/631[34]), setting CO_2 emission performance standards for new passenger cars and for new vans in the EU, including targets for 2020, as well as targets that apply from 2025 and 2030. The targets are defined as a percentage reduction compared to 2021, as follows: 15% reduction from 2025 on and 37.5% reduction from 2030 on concerning cars and 15% reduction from 2025 on and 31%

[32] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12553-Revision-of-the-Renewable-Energy-Directive-EU-2018-2001

[33] https://ec.europa.eu/clima/policies/transport/vehicles/regulation_en

[34] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019R0631

reduction from 2030 on concerning vans. The Regulation also contains an incentive mechanism for the uptake of zero and low emission vehicles (ZLEV).

Further revision of CO2 Standards legislation is envisaged by the Commission in an effort to achieve the broader climate-neutral EU target by 2050. Several aspects will be reviewed including real world representativeness of the CO2 emission and energy consumption values, deployment of ZLEV, roll-out of recharging and refuelling infrastructure, role of synthetic and advanced alternative fuels produced with renewable energy, emission reductions observed for the existing fleet, ZLEV incentive mechanism, impacts for consumers, aspects related to the just transition, 2030 targets and identification of a pathway for emission reductions beyond 2030.

Lastly, the Car Labelling Directive[35] will also be reviewed, covering both CO2 and air pollutant emissions of cars and evaluating the options for the introduction of a fuel economy and a CO2 emissions label for vans.

The Alternative Fuels Infrastructure Directive

The Alternative Fuels Infrastructure Directive was adopted by the European Parliament on 29 September 2014[36]; it contains the following points:

- Requires Member States to develop national policy frameworks for the market development of alternative fuels and their infrastructure,
- Foresees the use of common technical specifications for recharging and refuelling stations,
- Paves the way for setting up appropriate consumer information on alternative fuels, including a clear and sound price comparison methodology.

Alternative fuels are defined as 'fuels or power sources which serve, at least partly, as a substitute for fossil oil sources in the energy supply to transport and which have the potential to contribute to its decarbonization and enhance the environmental performance of the transport sector'. They include, inter alia: electricity, hydrogen, biofuels as defined in point (i) of Article 2 of Directive 2009/28/EC, synthetic and paraffinic fuels, natural gas, including biomethane, in gaseous form (compressed natural gas - CNG) and liquefied form (liquefied natural gas - LNG), and liquefied petroleum gas (LPG).

In addition, the Directive highlighted that biofuels were the most important type of alternative fuels, accounting for 4,7 % of the total fuels consumed in Union transport in 2011. It also stated that biofuels can contribute to a substantial reduction in overall CO2 emissions if they are produced sustainably and could provide clean power to all forms of transport.

[35] https://eur-lex.europa.eu/eli/dir/1999/94/2008-12-11
[36] https://eur-lex.europa.eu/eli/dir/2014/94/oj

In a recent resolution (25/10/2018)[37], the European Parliament underlined the need to accelerate the development of alternative fuel infrastructure. It also stressed the link between the availability of alternatively fueled vehicles, the deployment of alternative fuels infrastructure and consumer demand for these technologies. Furthermore, the resolution called on the Commission to revise the 2014 Directive to fill the gaps in the build-up of infrastructure and to replace the system of national plans with more efficient instruments, such as binding and enforceable targets.

EU Sulphur Directive

The EU Sulphur Directive[38] was last updated in 2016 and follows developments at the international level under MARPOL Annex VI. It regulates the sulphur content of gas oils and heavy fuel oils used for marine applications while establishing the Sulphur Emission Control Area (SECA) in line with MARPOL Annex VI. The directive applies to all shipping sectors, but it is of note that the inland shipping sector is already subject to much stricter limit under the FQD of 0,001%.

Among other, the Directive notes that access to emission abatement methods, such as the use of onboard exhaust gas cleaning systems, the mixture of fuel and liquefied natural gas or the use of biofuels should be recognized and facilitated in the Union. The Directive also stated that the mixtures of biofuels and marine fuels shall comply with the sulphur standards, as set out in Article 5, Article 6(1), (2) and (5) and Article 7.

EU Emissions Trading System - ETS

The EU Emissions Trading System (ETS)[39], set up in 2005 as the world's first international emissions trading system, is Europe's cornerstone climate policy instrument that covers close to 40% of the EU's GHG emissions. The EU ETS guides nearly 11,000 stationary installations (power stations and industrial plants) and around 600 aircraft operators to reduce their combined emissions by 43% compared to 2005 levels. To achieve these targets, participants can reduce their own emissions and trade emission allowances in the carbon market. The total cap on emissions is reflected by the total amount of allowances made available; a number that declines each year. The system has developed over time and with each development has gained more and more trust to be the long-term fundament for delivering the EU's climate ambitions.

A revision of the ETS is foreseen in the near future, possibly expanding its scope to buildings, road transport and intra-EU maritime navigation. The revision of the ETS, along with other EU's instruments on climate change related targets, will present opportunities for the uptake of alternative fuels, for instance the increase of Sustainable Aviation Fuels uses in the aviation transport sector. Applying stricter carbon pricing (eventually to all fossil fuel use) will further incentivise innovation and research in sustainable technology, products, and processes, including the energy, maritime transport and aviation sectors,

[37] https://www.europarl.europa.eu/doceo/document/TA-8-2018-0438_EN.html
[38] https://eur-lex.europa.eu/eli/dir/2016/802/oj
[39] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM%3Al28012

which is expected to produce a positive effect on the development and use of biofuels in these sectors.

Effort Sharing Regulation

Reductions for non-ETS sectors such as transport, buildings, agriculture, non-ETS industry and waste find their legal basis in the Effort Sharing Regulation (ESR). The ESR sets binding annual reduction targets at Member States level, aiming at a 30% reduction in GHG emissions compared to 2005 by 2030. The ESR targets are set according to national wealth and cost-effectiveness, allowing for flexibilities such as transfers between Member States. Combined these two pieces of legislation (ETS and ESR) would ensure a 40% emissions decrease compared to 1990[40], excluding Land Use, Land Use Change and Forestry Regulation (LULUCF) and including aviation.

For the ESR the legally defined target for 2030 is at the collective EU level and - with binding targets at national level defined in regulation 2018/842 [41] – also at Member State level, but not at the level of individual actors. While the targets clearly specify the collective end goal, the diversity of sectors and policy measures to achieve the targets adds a layer of complexity to collective target achievement. To this end, a governance framework was adopted with the National Energy and Climate Plans (NECPs) at its centre.[42] These NECPs, supported by a solid review and country specific recommendations have proven to be a powerful tool to support overall compliance within the framework of the ESR.

The effective decarbonization of the EU should ensure the continuation of a coherent regulatory and incentive structuring for the current effort sharing sectors.

Innovation Fund and taxonomy regulations

The EU Innovation Fund[43] is one of the world's largest funding programmes for the demonstration of innovative low-carbon technologies. The aim is to help investments in clean energy for the commercial demonstration of innovative low-carbon technologies. This is done through calls for large and small-scale projects focusing on innovative low-carbon technologies and processes in energy-intensive industries, carbon capture and utilization (CCU), construction and operation of carbon capture and storage (CCS) innovative renewable energy generation energy storage.

The revenues for the Innovation funds are provided by the ETS, with an estimated amount of approximately EUR 10 billion to be collected for the period 2020-2030.

[40] Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework and amending Regulation (EU) No 525/2013 and Decision No 529/2013/EU. The Land Use, Land Use Change and Forestry (LULUCF) Regulation ensures land use, land use change and forestry is included in the EU regulatory framework and requires the that the net sink from land use does not deteriorate compared to how it would have evolved continuing existing land use management practices.

[41] https://ec.europa.eu/clima/policies/effort/regulation_en

[42] Regulation (EU) 2018/1999 of 11 December 2018 on the Governance of the Energy Union and Climate Action.

[43] https://ec.europa.eu/clima/policies/innovation-fund_en

Taxonomy regulations

The EU taxonomy regulation[44] defines a list of environmentally sustainable economic activities by introducing six environmental objectives: climate change mitigation, adaptation, protection of water, ecosystems, circular economy and tackling pollution.

The regulation is expected to create security for investors, protect private investors from greenwashing, help companies to plan the transition, mitigate market fragmentation and eventually help shift investments where they are most needed. As such, the EU taxonomy is an important enabler to scale up sustainable investment and to implement the European Green Deal.

It is noted that since the feedstock requirements set by the taxonomy for forestry and agriculture appear to go beyond what is foreseen in RED II, this causes a new additional barrier for investments in advanced biofuels. Furthermore, the exclusion of other forms of sustainable biofuels, e.g., that meets the low-iLUC criteria for green investments is not well-motivated. At the same time, the proposed criteria for different types of vehicles and vessels, are unnecessarily restrictive and misaligned with mobility policies currently in force (Renewable Energy Directive, the Alternative Fuels Infrastructure Directive or the Clean Vehicles Directive). This inconsistency threatens currently available low emissions mobility solutions, while businesses, governments and financial market participants should not be faced with different targets and criteria in the same area.

[44] https://ec.europa.eu/info/law/sustainable-finance-taxonomy-regulation-eu-2020-852_en

4.4 Regulatory and policy challenges inhibiting development.

RED II is among the strongest policy measures (with Fuel Quality Directive, Alternative Fuels Infrastructure Directive, CO2 Regulations for light and duty vehicles and Effort Sharing Regulation being other examples, as mentioned in the previous part of the report) that largely drive the developments in the decarbonization of the transport sector, as it focuses explicitly on the deployment of renewables. More specifically, RED II limits the share of unsustainable food and feed crop-based biofuels and promotes certain types of biofuels produced from a list of materials defined in its Annex IX: Annex IX Part A considers the so-called advanced biofuels, while Annex IX Part B considers biofuels made from used cooking oil and animal fats.

REDII has been a turning point for future fuels, with inclusion of new categories of fuels, such as recycled carbon fuels and also through the promotion of wastes and residues and renewable fuels of non-biological origin (RFNBO). Nevertheless, those fuels are opted and left to the discretion of each Member State to decide whether or not to count them in the targets. Consequently, a possibly different interpretation of RED II upon its transposition could lead to a fragmented European market as it undermines the ruling of a homogenous policy across the EU.

The European Commission has already started the process for the revision of RED II[45]: such a revision has become necessary following the adoption of the European Green Deal (EGD), where the Commission has committed to stronger action on climate change and aims at a reduction of EU's greenhouse gas emissions by at least 55% by 2030.

Considering the ambition of the EGD, RED II is rather moderately ambitious. The amended RED II is expected to translate into legal measures the actions proposed in other energy components of the European Green Deal, which for the transport sector would imply changes to raise the ambition level of the RED II targets of 14% and 3.5% (overall and for advanced biofuels respectively) in line with the 2030 Climate Target Plan[46]. It is noted that a series of other provisions have to be amended in a way to support the deployment of the fuels that will eventually deliver the target. Indicatively, the following are mentioned[47]:

- Establishment of sub-mandates for the aviation and maritime sectors
- Calculation rules with regard to the minimum shares of renewable energy in the transport sector
- Sustainability and greenhouse gas emissions saving criteria for biofuels, bioliquids and biomass fuels,

[45] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12553-EU-renewable-energy-rules-review

[46] According to the scenarios presented in the 2030 Climate Target Plan, a RES share in transport of up to approximately 28% by 2030 is needed to achieve the 55% reduction of the total GHG emissions.

[47] Consultation on the Revision of RED II - Statement of the ART Fuels Forum (https://artfuelsforum.eu/)

- Verification of compliance with the sustainability and greenhouse gas emissions saving criteria,
- Calculation of the greenhouse gas impact of various fuels categories.

Even though RED II needs to be transposed into national law by Member States by 30 June 2021, not many EU countries have progressed in this task. A potential delay in the transportation of RED II by the MS, also considering the aforementioned process of RED II amendment as well, will not support the development of a uniform regulatory and market framework that would allow the uptake of low carbon solutions for transport decarbonization.

In addition, it should be noted that any amendment of RED II towards the alignment of its targets with the overall climate targets of the EGD, should be combined with revisions in the other related directives to eventually develop a set of policy measures that will directly support the transport sector decarbonization. Indicative interventions in other key regulations consist of, among others:

- Update of the GHG reduction of the FQD for the post 2020 period as per the needs stemming from the 2030 Climate Target Plan
- Revision of the Tank-to-Wheel (TtW) approach followed in the CO2 standards regulations to a Well-to-Wheel (WtW) approach

Finally, a supportive financial landscape is critical in order to deploy new technologies in the EU: the policy framework must thus support this by creating a Market based on stable legislation which investors will support.

5 CASE STUDIES AT NATIONAL LEVEL

The review on policy and regulatory frameworks for contaminated site management and biofuels' production, as presented in previous sections, has indicated that they are largely disconnected to each other. In particular, the key issues regarding the exploitation of biomass produced in a contaminated land for the production of a transport biofuel are the following:

- The regulatory framework for contaminated site management should allow for the utilization of contaminated land for the production of feedstock for further uses, including conversion to biofuels.
- The regulatory framework for biofuels stipulates that the feedstock to be utilized for the production of biofuels should be sustainable, and in fact also provides an incentive to the fuel suppliers to use biofuels stemming from such feedstocks.

It is therefore evident form the above, that the eligibility of biomass from contaminated land for use as a biofuel feedstock, is the critical factor that enables the link between the policy and regulatory frameworks of the two areas.

This section presents examples from various jurisdictions, both from EU and non-EU countries, focusing on the implications stemming from the relative policy and regulatory frame on establishing an effective site contamination management scheme that can be further exploited for biofuels' production.

5.1 EU Level

5.1.1 Germany

In Germany, soil protection is carried out at the federal and local levels. The UBA as Germany's main environmental protection agency and the Federal Ministry of Environment, are the main legal authorities which compile, assess, and provide information on soil status, soil conservation, and optimization of measures. The federal government lays down the legal frameworks, which are implemented by the regional states. One of the main regulations is the Federal Soil Protection Act (1998). In Germany, contaminated-site remediation is based on a graduated concept, where suspected site contamination is verified by the existence and concentration of hazardous substances, and their impact on receptors and other natural resources. The official identification of site contamination results from a definitive hazard assessment and forms the basis for protective and remediation measures.

5.1.2 Austria

In Austria there is not in place an integrated regulatory regime for soil contamination, but applicable provisions are spread over a considerable number of laws and regulations. The

Clean-up of Contaminated Sites Act and the Directive on Funding Clean-Up of Contaminated Sites 2008, stipulate provisions for the remediation of contaminated sites. The latter also sets out rules with regards to the public funding of remediation measures. In addition, the assessment of soil quality is based on provincial soil protection regulations, where Soil Protection Acts have been enacted in 5 provinces (Burgenland, Lower Austria, Upper Austria, Styria, and Salzburg), but with different measurements of soil qualities and soil sensitivity classes. Soil protection on both the federal and local level, is aided by the traditional cadastre updated into a modern monitoring system by GIS.

5.1.3 France

In France, land contamination, environmental protection and waste regulations are in effect. ICPE regulation involves a proactive regulatory watch on soil problems, and there are also administrative and criminal sanctions provided by ICPE, while waste regulations can apply to non-compliance with clean-up provisions. Where known soil contamination justifies investigation and contamination management measures, in particular when the use of the land changes, the state classifies the land within a "land information sector" and publishes relevant information about the land. In cases of soil contamination, the enforcing authority can perform of its own accord the necessary works, at the expense of the responsible party.

5.2 Non-EU Level

5.2.1 United Kingdom

Regulatory Framework

In the United Kingdom, the first institutional mechanism to address contaminated land issues was the Inter-departmental Committee on the Redevelopment of Contaminated Land (ICRCL), which was set up in 1976 with the role of providing guidance on human health hazards arising from the re-use of contaminated land and coordinating advice on remedial measures. The ICRCL published the Guidance Note 59/83 (the 2nd edition, dated July 1987), to guide practitioners dealing with the various hazards and types of contamination. This note defined 'trigger values' (threshold and action values) for three main groups of contaminants and for different planned land uses. ICRCL 59/8 was formally withdrawn in 2002 for human health risk assessment, yet another ICRL publication from 1990 (ICRCL 70/90 Notes on the restoration and aftercare of metalliferous mining sites for pasture and grazing) is still in place.

Currently, contaminated land in the United Kingdom is identified on the basis of risk assessment. In England, Scotland and Wales, the contaminated land regime is implemented through the Contaminated Land Regulations which enforce Part IIa of the Environment Protection Act (1990). Section 57 of Part IIa was introduced into the Environment Protection Act (1990) by the Environment Act (1995) and was implemented in April 2000 in England, in July 2000 in Scotland and in July 2001 in Wales. Part IIa

introduced a new statutory regime for the identification, assessment, and remediation of contaminated land in the UK. In response, DEFRA and the UK Environment Agency have developed risk-based procedures for assessing harm from contaminated sites to ecosystems (including surface waters) and human receptors.

Comprehensive packages of technical guidance relevant to the assessment of health risks arising from long-term exposure to soil contaminants have been published by DEFRA and the UK Environment Agency. Following a revised approach towards contaminated land management, the United Kingdom has chosen to develop guideline values rather than standards, for the assessment of risks within the overall policy context of ensuring that land is suitable for its actual or intended use.

A risk-based approach has been adopted for the management of contaminated land in accordance with UK policy as set out in "The Contaminated Land Regime". which includes the related legislation, statutory and non-statutory guidance and the "risk assessment framework", which includes the models and procedure described in CLR11.This requires remedial action to be taken where:

- the **contamination poses unacceptable actual or potential risks** to health or the environment, controlled waters, or property,
- there are **appropriate and cost-effective means** available to do so, considering actual or intended use of the site,
- remediation may also take place **on a "voluntary" basis,** for instance as part of a redevelopment program, where it is regulated under the planning regime rather than Part IIA, which is now the case for the majority of remediation in the UK.

The assessment and management of land contamination risks involves identifying the co-existence of three main components:

- the source (namely the contamination)
- the receptor (namely the entity that could be affected)
- the pathway (namely the route by which a receptor can come into contact with the contamination).

In September 2004, the Environment Agency published the **Model Procedures for the Management of Land Contamination** (CLR 11, 2004). The Model Procedures were developed to provide the technical framework for a risk management process when dealing with land contamination. The process involves identifying and taking appropriate action to deal with land contamination in a way that is consistent with government policies and legislation within the UK. The 2004 report version of CLR11 has recently been withdrawn (8-10-2020) and replaced with a series of webpages. Both versions were based on a tiered approach to progressively investigating the risks of contaminated sites:

1. **Preliminary risk assessment** – first tier of risk assessment that develops the initial conceptual site model to establish whether there are any potentially unacceptable risks.
2. **Generic quantitative risk assessment** – uses generic assessment criteria and assumptions to estimate risk.
3. **Detailed quantitative risk assessment** – uses detailed site-specific information to estimate risk.

A number of organisations (e.g. the Chartered Institute for Environmental Health) and companies (e.g. Atkins, Land Quality Management) have used the official risk modelling software (Contaminated Land Exposure Assessment, CLEA) and technical guidance to develop bespoke Generic Assessment Criteria (i.e. reference values) for a wide range of contaminants and several generic land use scenarios, including concentration thresholds below which there is no significant possibility of significant harm (SPOSH), as in the Category 4 Screening Levels (C4SLs) or at which slightly contaminated land may still be considered Suitable for Use (S4ULs).

Case study

In the UK, phytoremediation seems to fall between the cracks of current regulations for UK contaminated land remediation and agriculture. One problem is that phytoremediation is not considered to be active remediation, so trials cannot easily be permitted in the same way as for active remediation methods, including bioremediation, which makes approvals difficult. It is not possible to get a treatment permit (plant license) for vegetation as is done for a mechanical or chemical process.

5.2.2 Ukraine

Regulatory Framework

In Ukraine, there are some statutes specifically relating to land contamination. General provisions concerning environmental contamination (including contamination of land) are contained in the Law of Ukraine "On Environmental Protection," dated 25 June 1991. Specific requirements for land protection are stipulated in the Land Code of Ukraine[48], dated 25 October 2001, the Law of Ukraine "On Land Preservation," dated 19 June 2003, and the Law of Ukraine "On State Control over Land Operation and Land Preservation," dated 19 June 2003 (the "State Control Law").

Relevant norms are also included in the Code of Administrative Offences of Ukraine, dated 12 December 1984 and the Criminal Code of Ukraine, dated 5 April 2001. The Law of Ukraine "On the Legal Status of the Territory radioactively contaminated in the Result of Chornobyl Disaster," dated 27 February 1991 may apply to radioactive contamination of land.

Among other legal acts regulating land contamination are the following:

- The Law of Ukraine "On Waste Products," dated 5 March 1998.

[48] Land Code of Ukraine. https://zakon.rada.gov.ua/laws/show/2768-14#Text

- The Law of Ukraine "On Pesticides and Agro-Chemicals," dated 2 March 1995.
- The Tax Code of Ukraine dated 23 December 2010.
- Resolution of the Cabinet of Ministers of Ukraine No. 284 "On Procedure for Determining and Compensating Damage to Landowners and Land Holders," dated 19 April 1993.
- Resolution of the Cabinet of Ministers of Ukraine No. 661 "On Approval of Regulation on Land Monitoring," dated 20 August 1993.
- Order of the Ministry of Agricultural Policy of Ukraine No. 51 "On Approval of Regulation on Agricultural Land Monitoring," dated 26 February 2004.
- Order of the Ministry of Agricultural Policy of Ukraine No. 283 "On Approval of Procedure of Land Conservation," dated 26 April 2013.
- Methods for Determining Damage Caused by Contamination and Clogging of Land Resulting from Environmental Legislation Violations as approved by Order of the Ministry of Environmental Protection and Nuclear Safety No. 171, dated 27 October 1997 (as amended).
- Estimated indicators of the sanitary condition of the soil in populated areas.
- Maximum Permissible Concentrations of Chemical Elements in Soil.
- Sanitary Norms Regarding Permissible Concentrations of Chemical Elements in Soil.

According to Ukrainian legislation, **land is considered contaminated** if there is a negative quantity and quality change in the composition thereof resulting from commercial activity or other factors. Article 1[49] also provides for the term "**land contamination**" and defines it as the accumulation of pesticides, agrochemicals, heavy metals, radionuclide, and other elements in the soil and subsoil waters that is caused by an anthropogenic influence in the amount exceeding their natural levels, leading to the change of their quality and quantity therein.

In addition, in accordance with Article 171[50],, **degraded lands** include:

- land plots, the surface of which is disturbed due to earthquakes, landslides, karstification, floods, mining, etc. That is, lands whose surface has undergone harmful changes and physically does not allow for effective economic activity;
- land plots with eroded, waterlogged, high acidity or salinity, contaminated with chemicals and others soil. That is, land plots, the soils of which, according to their substantive characteristics, cannot be used effectively.

[49] Law of Ukraine "On State Control over Land Operation and Land Preservation". https://zakon.rada.gov.ua/laws/show/963-15#Text

[50] Land Code of Ukraine. https://zakon.rada.gov.ua/laws/show/2768-14#Text

The cause of degraded lands can be both natural emergencies (storms, earthquakes, floods, etc.) and anthropogenic activities (farming, mining, etc.).

Article 172[51], stipulates that **marginal lands** include agricultural lands, the soils of which are characterized by negative natural properties, low fertility, and their economic use for its intended purpose is economically inefficient. To restore such lands, land conservation is used, namely the termination of their economic use for a specified period and alkalization of soil or afforestation. Land conservation is carried out by decisions of executive authorities and local governments on the basis of agreements with landowners in accordance with the Procedure approved by the Order of the Ministry of Agrarian Policy and Food of Ukraine dated 26.04.2013 № 283.

In order to reduce the area of degraded and marginal lands, noncontinuous land monitoring is carried out.

According to Article 169[52], **technologically contaminated lands** include lands contaminated as a result of human economic activity, which has led to land degradation and its negative impact on the environment and human health. Land contamination due to human economic activity and its negative impact on the environment and human health can occur both in the case of anthropogenic factors (accidents, technological disasters, etc.) and in the event of situations beyond human control (floods, earthquakes, etc. in the locations of harmful technological factors). Such lands include:

- **radiation hazardous lands**, where it is impossible for the population to continue living, obtaining agricultural and other products, food products that meet national and international permissible levels of radioactive substances, or which should not be used under environmental conditions (Article 3[53]).
- **radioactively contaminated lands**, which require radiation protection measures and other special actions aimed at limiting additional exposure caused by the Chornobyl catastrophe and ensuring normal economic activity (Article 4[54]).
- **lands contaminated with heavy metals and other chemical elements**.

The legal regime of lands contaminated with heavy metals and other chemical elements is determined depending on the degree of such contamination. In the event of danger to human life and health or the state of the environment, these lands are subject to conservation in accordance with Article 172[55].

[51] Land Code of Ukraine. https://zakon.rada.gov.ua/laws/show/2768-14#Text

[52] Land Code of Ukraine. https://zakon.rada.gov.ua/laws/show/2768-14#Text

[53] Law of Ukraine "On the Legal Status of the Territory radioactively contaminated in the Result of Chornobyl Disaster". https://zakon.rada.gov.ua/laws/show/791%D0%B0-12#Text

[54] Law of Ukraine "On the Legal Status of the Territory radioactively contaminated in the Result of Chornobyl Disaster". https://zakon.rada.gov.ua/laws/show/791%D0%B0-12#Text

[55] Land Code of Ukraine. https://zakon.rada.gov.ua/laws/show/2768-14#Text

Case study

A small plantation of Robinia pseudoacacia (0.5 ha) was developed at the site of the Kremenchuk Metallurgical Company (Kremencuk city, Poltava region, Ukraine), contaminated with the spent molding mixture with slag. Experimental planting of Robinia pseudoacacia was developed in order to see the growing potential of this species in this type of soil. The owners of the plantation faced the ban on cutting down trees. The reason is that the trunk diameter of trees is more than 5 cm.

In Ukraine, according to the Decree of the Cabinet of Ministers of Ukraine N 1045 "About the statement of the Order of removal of trees, bushes, lawns and flower beds in settlements"[56] of August 1, 2006, it is forbidden to cut down trees with a trunk diameter of more than 5 cm without a special order.

It is noted that in the case where contaminated sites are located within the settlement, growing energy crops for phytoremediation of contaminated sites with woody species, the harvest of biomass is forbidden and requires special permission according to the acting legislation. Development of new legislation that will allow harvesting of the biomass of energy crops grown on contaminated sites is therefore needed.

[56] https://zakon.rada.gov.ua/laws/show/1045-2006-%D0%BF#Text

5.3 Comments on the considered case studies with respect to applicability of policies at regional and local levels

Sections 5.1 and 5.2 present applicable legislations and regulations regarding contaminated land management and remediation in different EU and non-EU countries. The most relevant elements, and their implications for establishing an effective site contamination management framework, combined with biofuels' production, are presented below:

- There is not in place a clear identification and allocation of responsibilities, which as a result, poses lengthy and costly litigation procedures which do not contribute to effective contaminated site management. Also, regulating interventions in contaminated sites is often complicated by the division between various governmental authorities' responsibilities.
- There is not in place a clear framework that defines risk management and specifies how to implement risk-based assessment and remediation approaches.
- It is vague whether a permission should be issued to allow the harvest of biomass, that has been grown in a contaminated site. Worse still, in some cases such as the UK, current legislation does not consider innovative remediation solutions such as phytoremediation, making it difficult to obtain approval for such techniques.
- The Ukrainian case-study revealed that specific environmental regulation, i.e. prohibition of tree cutting, can impede the progress of phytoremediation. This point to the need for the development of new legislation or the update of existing ones, that will facilitate the harvesting of biomass.
- There is lack of provisions which tackle historical and existing contaminated sites, and also lack of provisions for monitoring and preventing future site contamination.
- There is not in place a prioritizing system to determine the different levels of risk and urgency in contaminated land management.
- New technologies, i.e. GIS based monitoring system, can render soil protection easier and more pertinent, as is already the case in Austria.

6 MAIN FINDINGS & RECOMMENDATIONS

A number of networks worldwide (the Sustainable Remediation Framework (SuRF) in different countries - SuRF-UK, SuRF-Canada, SuRF-United States, the Contaminated land rehabilitation network for environmental technologies (Clarinet), the Network for Industrially Co-ordinated Sustainable Land Management in Europe (NICOLE), the Road Map for Sustainable Remediation, Common Forum, have been discussing over the past 10 years how to find consensus on the best available techniques to remediate soil contamination.

Currently, there is not in place a unified overarching legislative framework under which the two sectors (contaminated land and biofuels) can "communicate" on a solid basis. Despite the lack of a specific EU instrument that ensures soil protection, including the prevention of soil contamination, other EU policies have contributed significantly to soil protection.

Current policy mechanisms have not yet been adequate to facilitate the market uptake of advanced biofuels, a necessary step for the achievement of 2030 targets. Tailored policy interventions covering all aspects of advanced biofuels value chain are necessary at all governance levels, addressing obstacles to the sustainable development of the value chain stages and ensuring the alignment with the Green Deal and the Sustainable Development Goals.

The efficient and prompt mobilization of sustainable biomass feedstock necessitates synergies with agriculture, forestry, and rural land-use planning. Demonstration examples, ideally across different regional climatic and ecological zones within Europe, are needed to provide clarity and evidence of such optimal mobilization, including actors' involvement and specific contractual and business structures.

Furthermore, tailored financing mechanisms can mitigate high capital costs and financial risk, offering incentives for public and private funding bodies to increase their investment portfolios. Measures such as taxation and carbon credits can help to reduce the price gap between biofuels and fossil fuels, especially in aviation, maritime and heavy-duty road sectors that present fewer alternatives and more challenges in CO_2 emissions reduction. In this respect, a carbon pricing introduction for the external costs of fossil fuels will also contribute to the competitiveness of biofuels.

These actions are expected to increase investors' confidence, allow the industry to ameliorate their technical and financial performance, leading to the improvement of upstream and downstream performance of the biofuel value chain, as well as their market-roll out towards the 2030 targets.

An improved common EU policy framework and strategy with clear objectives and plan of action will increase legal certainty for European companies and citizens and provide clarity on the joint principles and vision for soil protection and remediation, combined with clean biofuels' solution in the EU. Investments in the remediation of polluted sites

will contribute to the post-pandemic recovery and EU's resilience, and provide a substantial return on investment.

A specified policy and legislative framework should, therefore, be adopted for bridging the gap between phytoremediation strategies and clean biofuel production in a sustainable and optimum manner that will overcome the indirect land use change (iLUC) issue for biofuels and restore lands for agricultural uses.

The framework should include:

- a specific regulation which requires risk management and clearly specifies how to implement risk-based assessment and remediation approaches (including phytoremediation), and ensures that all regulatory instruments are consistent with the aforementioned approach,
- realistic criteria and clear procedures which set screening values, action levels, and site-specific remediation targets, as well as clear guidance regarding site investigation, risk assessment and site remediation, as well as exit mechanisms for site closure,
- a prioritizing system to determine the different levels of risk and urgency in contaminated land management,
- institutional arrangements which assign clear responsibilities and authority to the central, regional, and local governments, to implement site assessment and remediation actions most effectively, and to minimize inconsistency between different government levels and differing local interpretations,
- specific policies and strategies for advanced biofuels production that integrate land-use planning and contaminated sites' incentive schemes,
- a framework that allows advanced biofuels' production to integrate other bioeconomy sectors objectives to avoid any conflicts,
- establishment of a certification-labelling scheme for advanced biofuels' production through remediated contaminated sites, to ensure its sustainability by assessing its whole value chain.

ANNEX I: INSTITUTIONAL FRAMEWORK

The European Commission constitutes the main institutional stakeholder in the field of policy making and implementation in the field of biofuels and their market uptake in the transport sector.

DG ENER: Among the activities they undertake, DG ENER also facilitates energy technology innovation, develops the European legal framework for the market uptake of the advanced sustainable biofuels, develops strategic analyses and short, medium- and long-term policies for the energy sector and ART Fuels in particular as well.

DG RTD: The Overall strategy of DG RTD with respect to advanced biofuels is, among others, to target the sector challenges of (a) Technology and cost competitiveness, (b) Technology improvement and diversification, (c) Feedstock availability and (d) Feedstock diversification.

DG AGRI: DG AGRI considers the impact of advanced biofuels on agricultural markets and on land use both in the EU and third countries, focusing also on trade aspects and the impact on food prices and food security.

DG CLIMA leads the European Commission's efforts to fight climate change at EU and international level. Within its scope of work, DG CLIMA promotes the development of low-carbon technologies and adaptation measures, including standards for vehicle-efficiency and fuel quality.

DG ENV is the European Commission department responsible for EU policy on the environment, developing and facilitating the implementation of policies and legislation that contribute to this end. Within its activities, DG ENV also studies the Environmental Aspects stemming from the use of various fuels under the perspective of the inherent link between energy and environment.

DG MOVE: Among the targets of DG MOVE is to promote a sustainable, efficient and environmentally friendly mobility.