Renewable Energy Sector

Roadmap for Responsible Sourcing of Raw Materials

Montanuniversität Leoben

June 2021

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement Nº 869276
Disclaimer:

This publication is part of a project that has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 869276.

This publication reflects only the author’s view. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use which might be made of the information contained in this publication.

Reproduction and translation for non-commercial purposes are authorized, provided the source is acknowledged and the publisher is given prior notice and sent a copy.

Imprint:

Date: June 2021 | Marie-Theres Kügerl, Montanuniversität Leoben

Work package: WP4 | D4.4 RES Roadmap for Responsible Sourcing of Raw Materials | Status/version (Draft v03) | Dissemination level (external)

http://re-sourcing.eu

Acknowledgements:
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Summary</td>
<td>..........................................................</td>
</tr>
<tr>
<td>1</td>
<td>Introduction</td>
</tr>
<tr>
<td>1.1</td>
<td>The RE-SOURCING Project</td>
</tr>
<tr>
<td>1.2</td>
<td>Methodology: The Roadmap Process</td>
</tr>
<tr>
<td>1.3</td>
<td>The Renewable Energy Sector</td>
</tr>
<tr>
<td>2</td>
<td>Vision</td>
</tr>
<tr>
<td>3</td>
<td>Pathway</td>
</tr>
<tr>
<td>3.1</td>
<td>Target 1: Decrease Resource Consumption</td>
</tr>
<tr>
<td>3.1.1</td>
<td>Recommendations for Policy Makers</td>
</tr>
<tr>
<td>3.1.2</td>
<td>Recommendations for Industry</td>
</tr>
<tr>
<td>3.1.3</td>
<td>Recommendations for Civil Society</td>
</tr>
<tr>
<td>3.2</td>
<td>Target 2: Paris Agreement &amp; Environmental Sustainability</td>
</tr>
<tr>
<td>3.2.1</td>
<td>Recommendations for Policy Makers</td>
</tr>
<tr>
<td>3.2.2</td>
<td>Recommendations for Industry</td>
</tr>
<tr>
<td>3.2.3</td>
<td>Recommendations for Civil Society</td>
</tr>
<tr>
<td>3.3</td>
<td>Target 3: Social Sustainability &amp; Responsible Production</td>
</tr>
<tr>
<td>3.3.1</td>
<td>Recommendations for Policy Makers</td>
</tr>
<tr>
<td>3.3.2</td>
<td>Recommendations for Industry</td>
</tr>
<tr>
<td>3.3.3</td>
<td>Recommendations for Civil Society</td>
</tr>
<tr>
<td>3.4</td>
<td>Target 4: Responsible Procurement</td>
</tr>
<tr>
<td>3.4.1</td>
<td>Recommendations for Policy Makers</td>
</tr>
<tr>
<td>3.4.2</td>
<td>Recommendations for Industry</td>
</tr>
<tr>
<td>3.5</td>
<td>Target 5: Level-Playing Field &amp; International Cooperation</td>
</tr>
<tr>
<td>3.5.1</td>
<td>Recommendations for Policy Makers</td>
</tr>
<tr>
<td>3.5.2</td>
<td>Recommendations for Civil Society</td>
</tr>
<tr>
<td>3.5.3</td>
<td>Role of International Organisations (UN/OECD/IFC)</td>
</tr>
<tr>
<td>4</td>
<td>Publication bibliography</td>
</tr>
</tbody>
</table>

---

**Error! Bookmark not defined.**
Figures

Figure 1: Roadmap Process for the RE-SOURCING Project ................................................................. 6
Figure 2: Vision for the renewable energy sector (Kügerl and Tost 2020) ............................................. 10
Figure 3: Depictions of the three sustainability pillars - social, environmental and economic (Purvis et al. 2019) ................................................................................................................…… 12
Figure 4: Doughnut Economics - combining social and planetary boundaries (DEAL 2021) .................. 13
Figure 5: Milestones to decrease resource consumption by 2050 .......................................................... 14
Figure 6: Milestones to reach the Paris Agreement and Environmental Sustainability by 2040 .............. 27
Figure 7: Co-use of land by renewable energy and agriculture at Austria's largest solar PV plant (Wien Energie 2020) ................................................................................................................................. 31
Figure 8: Holistic policy framework for a successful energy transition (IRENA 2020) ......................... 32
Figure 9: Milestones to reach Social Sustainability & Responsible Production by 2030 ....................... 37
Figure 10: Milestones for Responsible Procurement by 2040 .............................................................. 46
Figure 11: Milestones for a Level Playing Field by 2030 ..................................................................... 52

Tables

Es konnten keine Einträge für ein Abbildungsverzeichnis gefunden werden.
Executive Summary

[Every re-sourcing publication must contain an executive summary. The executive summary should place the deliverable within the overall project context, provide an overview of the key objectives, methods of development and results of the deliverable.]

Keywords:

[Please try to include 4-6 keywords/concepts that best reference/describe the content of your deliverable.]
1 Introduction

1.1 The RE-SOURCING Project

Responsible Sourcing (RS) is becoming a reality for more and more businesses, NGOs, and policymakers. Everyone is striving to keep ahead of rapidly evolving ecological and social needs, company practices, business models, government regulations, and initiatives spearheaded by civil society, etc.

In response to the growing challenge of responsible sourcing, the RE-SOURCING Global Stakeholder Platform has been started in 2020.

RE-SOURCING, funded under the European Union’s (EU) Horizon 2020 programme, is a four-year project coordinated by the Institute for Managing Sustainability, at the Vienna University of Economics and Business. The project’s consortium consists of 12 international partners in- and outside the EU working together to create the RE-SOURCING Platform. The project’s vision is to advance and establish Responsible Sourcing as a minimum requirement among EU and international stakeholders. The project will foster the development of a globally accepted definition of Responsible Sourcing, facilitate the implementation of RS practices through direct knowledge exchange within its network and beyond, and advocate for Responsible Sourcing in international political forums.

To guarantee a thorough and comprehensive Responsible Sourcing framework, RE-SOURCING will take a holistic approach by integrating firms and industries (up- and downstream) across the mineral value chains of three sectors: Renewable Energy, Mobility and Electronics – all of which play a decisive role in the EU Green Deal and the clean energy transition. As such, RE-SOURCING equally takes into account traditional minerals, conflict minerals and green tech minerals in its approach. The main target groups of the project will be EU and international industry stakeholders, EU policy makers and civil society.

The RE-SOURCING project actions will:

- facilitate the development of a globally accepted definition of RS;
- develop ideas for incentives facilitating responsible business conduct in the EU, supporting RS initiatives;
- enable the exchange of stakeholders for information and promotion of RS;
- foster the emergence of RS in international political fora; and
- support the European Innovation Partnership on Raw Materials.

RE-SOURCING will deliver:

- For EU and international business stakeholders:
  - increased capacity of decision-makers for implementing responsible business conduct;
  - better understanding and awareness of RS in three sectors of renewable energy, mobility and electric and electronic equipment; and
- facilitated implementation of lasting and stable sectoral framework conditions for RS.

For EU policymakers:
- increased capacity for RS policy design and implementation;
- innovative ideas on policy recommendations for stimulating RS in the private sector; and
- better understanding and awareness on RS in three sectors of renewable energy, mobility and electric and electronic equipment.

For Civil Society:
- integration of sustainable development and environmental agenda into the RS discourse;
- an established global level playing field of RS in international political fora and business agendas; and
- better understanding and awareness on RS in three sectors of renewable energy, mobility and electric and electronic equipment.

1.2 Methodology: The Roadmap Process

The roadmap approach and process are well suited for the RE-SOURCING project to develop a vision for responsible sourcing in the renewable energy sector. It allows for the engagement with all relevant stakeholders i.e. European and international policymakers, businesses along raw material value chains, Civil Society Organisations (CSOs), and academia. The process lends itself well to developing recommendations for actions and collectively defining an agreed vision. In order to achieve the vision, recommendations for actions will be developed involving all relevant stakeholders. For details on this approach please see an earlier publication by the RE-SOURCING project “D1.2 The RE-SOURCING Common Approach” (Degreif et al. 2020).

“The initial development of the technology roadmapping approach in the late 1970s by Motorola (Willyard and McClees 1987) was to support the linkage of strategic product and technology plans. Having since evolved, the tool offers a key benefit, as it organises and clearly communicates the current achievements and challenges, and the future vision, juxtaposed with the means to realising said goal (Phaal et al. 2007). Roadmapping has become one of the most widely used approaches for driving innovation and strategy planning, both at firm and sector levels” (Degreif et al. 2020, p. 28).

The roadmap for the renewable energy sector is developed according to a predefined process (see Figure 1) which aims at involving as many stakeholders of this sector as possible in order to obtain different views on all relevant aspects of the supply chain. The aim is to achieve a result that is widely accepted and adopted by all parties involved. The RE-SOURCING project is characterised by offering a multi-stakeholder platform that is open to all groups involved in order to generate the largest possible pool of knowledge resources.
An important aspect is the open approach to problems in the supply chain. Only through open communication can problems be uncovered and solved in a joint effort. The RE-SOURCING project supports a risk-based approach. This means that the intensity of the measures depends on the severity of the problem. No stakeholder should be excluded because of prevailing issues, but rather be supported in solving them. The ‘actual situation’, including sustainability challenges, actors, and initiatives along the supply chains for wind and solar PV modules were identified in the State of play and roadmap concepts: Renewable Energy Sector (see chapter 1.3 for a short summary of the results).

The State of Play report was developed with input from the Platform Steering Committee during two online consultation meetings and further written feedback, as well as a Roadmap Workshop, involving all stakeholder groups from the renewable energy sector.

The next step was the development of the roadmap containing recommendations for industry, policy makers and civil society in order to reach the RE-SOURCING project’s vision by 2050. For the roadmap development, three consultations in the form of online webinars were held. Firstly, the draft roadmap was presented to the Project Consortium, the Platform Steering Committee and the Advisory Board. [Secondly, a webinar with external experts was hosted, ensuring an even distribution of stakeholder groups and regions was represented. In a third and final webinar, experts from the second consultation as well as the project’s Platform Steering Committee and Advisory Board were consulted.]

Another process that contributed to the roadmap for the renewable energy sector was the elaboration of a Guidance Document for policy makers and industry based on specific case studies of sectoral stakeholders. Four case studies were considered in more detail: (i) a multi-stakeholder consultation process for the Chilean National Mining Policy Development, (ii) Antofagasta Minerals’ development of a cohesive corporate sustainability policy, (iii) auditing for responsible sourcing using the example of Wacker Chemie AG and Together for Sustainability Supplier Assessments, and (iv) First Solar’s circular business model. Further information on the case studies and the Guidance Document can be found at: LINK
Vision and pathway of the roadmap for the renewable energy sector do not merely focus on the procurement process and the interaction between supplier and manufacturer itself, but we also consider the individual supply chain stages and what each stakeholder can improve to achieve a more sustainable supply chain over all.

The European Green Deal

In December 2019 the European Commission presented the European Green Deal with the aim of making ‘Europe the first climate-neutral continent by 2050’ (European Commission 12/11/2019). While the RE-SOURCING project’s roadmap for the renewable energy sector supports the goals of the Green Deal, the authors also believe that more ambitious targets are required. This roadmap integrates many aspects of the Green Deal, especially from the strategies on sustainable industry (European Commission 2019b), clean energy (European Commission 2019a) and circular economy (European Commission 2020a). However, these aspects are mostly included with a shorter timeframe – e.g. 100% renewable energy by 2040.

1.3 The Renewable Energy Sector

The work on the renewable energy sector started with the State of Play report which was published in October 2020. The aim of this report was to investigate the current state of the renewable energy sector and the value chains of wind and solar PV energy respectively. The RE-SOURCING project focuses its efforts on the supply chains of copper, rare earth elements and silicon for the production of wind turbines and solar PV modules. The stages of the supply chain that are assessed in more detail are mining of these minerals, manufacturing of wind turbines and solar PV panels, as well as their recycling. Moreover, standards and initiatives addressing sustainability challenges in these supply chain stages are discussed.

The following provides a brief overview of the main findings of the State of Play report. For details see: State of play and roadmap concepts : Renewable Energy Sector

Copper is an essential raw material for numerous applications, including all types of wiring for electric energy supply (European Commission 2020b). The largest supply is produced by large-scale mining (LSM) companies in Chile, providing more than 28% of the world’s supply in 2018. However, also artisanal and small-scale mining (ASM) mainly in the ‘African Copperbelt’ in the DR Congo (6% of global supply in 2018) and Zambia (4% of global supply 2018) play an important role in copper production(Reichl and Schatz 2020). The existence of both LSM and ASM in the same area are often cause for conflict. LSM operations potentially deprive local communities of their livelihoods as they depend on income from ASM. Informal ASM is also more exposed to risks such as child and forced labour. In regions with weak democratic institutions, corruption is also an issue(Maiotti et al. 2019; Sweetman and Ezpeleta 2017). Additionally, mining operations in the Copperbelt also cause significant environmental pollution, including water pollution through effluent discharge leading to health issues, food insecurity, etc.(Kügerl and Tost 2020). The Environmental Justice Atlas also reports other issues related to copper mining projects. A major issue is the disrespect of indigenous lands, for example in Canada and Alaska (Environmental Justice Atlas 2015).

The most important supplying country of Rare Earth Elements (REE) is China, accounting for more than 73% of global supply in 2018 (Reichl and Schatz 2020). REE are crucial for the production of permanent magnets, which are used in certain types of wind turbines among others. For mining and processing of REE, potential environmental pollution is one of the main challenges that need to be
considered. There are numerous risks during this process that can lead to significant pollution with chemicals, heavy metals and radioactive elements. Especially small illegal mines in China pose a threat, as they are not equipped with the necessary treatment facilities, causing serious environmental damage and health hazards (Kügerl and Tost 2020). Furthermore, an important aspect of REE production is resource efficiency, or the lack thereof. Already at the mining stage, the cut-off grade needs to be taken into consideration to ensure a sustainable use of the available resources. This continues at the processing stage, where Chinese floatation plants only achieve recovery rates of approximately 40-60% (Schüler et al. 2011).

Silicon for the use in solar PV modules is mined as quartz. While no major issues in mining operations were found\(^1\), the processing of quartz to high-purity silicon (polysilicon) needs to be considered in more detail. One issue is the vast amount of energy required for the purification process. Moreover, the most important producer of polysilicon for the solar PV industry is the Chinese Xinjiang region, which is subject to allegations of human rights abuses and forced labour (Copley 2020).

For the **renewable energy technologies manufacturing** stage of the supply chain, both wind turbine and solar PV manufacturers show a lack of commitment to human rights principles, including respect for land rights, indigenous people rights and gender equality (Business & Human Rights Resource Centre 2020; Kiezebrink et al. 2018). Moreover, both production processes are very energy intensive, especially the production of materials used. **Wind turbine manufacturing** also needs to consider occupational health and safety. On the one hand, during production employees are potentially exposed to epoxy resins, fibreglass, noise, dust, etc., and on the other hand working in heights and confined spaces pose a risk. **Solar PV modules** use silicon wafers that require large amounts of energy, water, and chemicals in their production. Moreover, the resource efficiency in the production of the wafers is of concern as high material losses occur (Kügerl and Tost 2020).

The **collection and recycling** of wind turbines and solar PV modules already shows high technical recyclability. Both show recycling rates of approximately 90%. For wind turbine blades innovations are required to ensure the efficient reuse of the composite materials, especially considering the increasing waste streams of the coming years. In general, there currently is a gap between collection and recycling possibilities and the expected large waste streams of the future.

## 2 Vision

The horizon considered for the roadmap of the RE-SOURCING project is 2050. The vision for the renewable energy sector was developed based on the underlying concepts of planetary boundaries\(^2\) and strong sustainability\(^3\) and will be incorporated in the definition of responsible sourcing that is developed towards the end of the project.

---

\(^1\)This means that during the preparation of the State of Play report, no reports on sustainability challenges in quartz mining were found. The authors do not wish to rule out the existence of such challenges in quartz mining operations in general.

\(^2\)For further information on planetary boundaries, please refer to Rockström et al. 2009 and Steffen et al. 2015.

\(^3\)An explanation of the strong sustainability concept is provided by Ekins et al. 2003; and Dedeurwaerdere 2014.
Figure 2: Vision for the renewable energy sector (Kügerl and Tost 2020)
3 Pathway

The RE-SOURCING project does not propose a new standard or guideline, rather a roadmap of recommendations for actions. We do not want to ‘reinvent the wheel’. For many areas, appropriate standards have already been developed and the first and most important step is to successfully implement these. Implementation of these standards is part of the roadmap’s recommendations - before we start thinking ‘outside the box’, we have to make sure that we do the basics properly. There is ample evidence of companies that e.g. don’t respect basic human rights, or governments that fail to address the needs of their people. However, to support the implementation of standards, it is crucial to harmonise them, to promote alignment and cohesion and avoid confusion of adopters and customers.

The RE-SOURCING project’s renewable energy sector roadmap takes technological advancements as a given and does not specifically address this issue, apart from the continuation of these advancements and the required support by public and private sectors. Further information on the technological aspects can be found in various reports, such as SolarPower Europe and LUT University (2020) or European Climate Foundation (2010).

The State of play report is considered the baseline and the pathway provides concrete recommendations for policy makers, industry and civil society how to move from the baseline to the RE-SOURCING project’s vision for 2050. The recommended actions for policy makers focus on the EU, whereas recommendations for industry and civil society can be considered on a global level. The RE-SOURCING project recognises the important role of investors, insurance, logistics providers or other business service providers. However, they are out of scope for this roadmap as they are relevant for all three sectors (Renewable Energy, Mobility, and Electric and Electronic Equipment) included in the RE-SOURCING project. Therefore, recommendations for these businesses will be provided in a separate briefing document at a later stage in the project.

The pathway differentiates between targets and milestones. Targets define the desired end points and are kept at a high and aggregated level. They can be medium (2030 & 2040) or long-term (2050). Milestones are points along the desired trajectory from baseline to target and are supposed to help track the progress. They can be short (2025), medium (2030 & 2040) or long-term (2050). Wherever possible, milestones are specified according to desired quantity, quality and/or time (Capacity4dev Team 7/8/2016). While realising that 2025 milestones are short-term considerations, the milestones presented refer to the achievement of commitments that have already been made, or they set the direction for future goals. Targets are defined for the three pillars of sustainability: social, economic and environmental (Figure 3), and developed during a consultation process with the project’s Platform Steering Committee and Advisory Board, as well as the Roadmap Workshop with participants from all stakeholder groups of the renewable energy supply chain. Milestones also include already existing and agreed upon goals, such as the Sustainable Development Goals (SDGs) by the United Nations (UN) and the Paris Agreement. However, the RE-SOURCING renewable energy sector roadmap only includes targets that are relevant for this sector. Targets that are not mentioned here are therefore not considered irrelevant, but go beyond the scope of this roadmap.

---

4 For further information on sustainability challenges in the renewable energy sector supply chains, as well as existing standards and initiatives, please refer to the State of play report for the renewable energy sector.
The classification of the milestones and actions into categories is also based on the authors' preference and should not be regarded as absolute. The timeframe for the achievement of milestones and targets shows the latest deadline, however, earlier completion is strongly encouraged.

![Diagram of sustainability pillars: social, environmental, and economic](image)

**Figure 3:** Depictions of the three sustainability pillars - social, environmental and economic (Purvis et al. 2019)\(^5\)

The roadmap for the renewable energy sector of the RE-SOURCING project follows the idea that the term ‘responsible sourcing’ means more than a simple supplier - manufacturer business transaction. The idea is that responsible sourcing engages all stages of the supply chain and can be understood as a joint effort to make each stage more sustainable. This is why the recommended actions and milestones will not merely focus on procurement, but also touch upon sector specific issues.

\(^5\)Please refer to the report *The International Responsible Sourcing Agenda* for more information on sustainability and responsible sourcing approaches.
3.1 Target 1: Decrease Resource Consumption

Access to energy is a prerequisite for economic and social development and is therefore also included in the Sustainable Development Goals (SDGs) as Goal 7 ‘Ensure access to affordable, reliable, sustainable and modern energy for all’ (Brand-Correa and Steinberger 2017). However, energy systems (including electricity, heat and transportation) are the largest source of manmade greenhouse gas (GHG) emissions (76% in 2018) (Climate Watch 2021; US EPA 2015). While the transition from fossil-fuel based to renewable energy sources potentially has a lot of positive effects, the negative impacts of the ever-increasing energy demand cannot be ignored. A 100% renewable energy system will certainly decrease GHG emissions and have positive environmental effects. However, continuing with business-as-usual consumption patterns can be described as a ‘low-carbon destruction of planetary resources’ (Swilling 2020, p. 101). New systems for both consumption and production are required to satisfy human needs and universal well-being while staying within planetary boundaries (Brand-Correa and Steinberger 2017; Raworth 2017; Swilling 2020).

Figure 4: Doughnut Economics - combining social and planetary boundaries (DEAL 2021)

Absolute decoupling of economic growth, resource consumption and environmental impact is one of the proposed measures to tackle price shocks, resource scarcity and halt environmental degradation (UNEP 2014). Decoupling relies on decreasing resource consumption by improving resource efficiency through technological improvements, substitution of non-renewable by renewable resources, waste prevention through reuse and recycling, etc. The concept of decoupling also faces a lot of criticism and research has not agreed on whether or not absolute decoupling of economic growth, consumption and environmental impact is in fact possible (Parrique et al. 2019; Strand et al. 2021; Wiedmann et al. 2020).
At the same time, 100% circularity of resources within an economy will not be possible, due to physical and economical constraints and in some cases not desirable due to high environmental impacts of recycling processes (Moss 2019; UNEP 2013). However, this roadmap follows a two-pronged approach for the renewable energy sector: on the one hand, increasing resource efficiency, recycling and reuse rates are a prerequisite for achieving the energy transition and cover the growing demand by a growing population. On the other hand, rethinking of the economic system with a focus on changing current consumption patterns is necessary. These considerations are addressed by the Doughnut Economics Principles of Practice: ‘think in systems’ – aim for continuous improvements; ‘be regenerative’ – the 6R of sustainability (reduce, reuse, recycle, repair, rethink and refuse); ‘aim to thrive rather than grow’ (DEAL 2021).

As already mentioned, the recommendations are aimed at EU policy makers and internationally operating companies and civil society organisations. However, the authors recognise the importance of inclusive, green growth for developing countries in order to achieve a suitable standard of living, hence the inclusion of SDG 8 for sustainable growth. Nevertheless, rethinking consumption patterns and considering material and energy ‘needs’ should be included in development programmes.

Figure 5: Milestones to decrease resource consumption by 2050
3.1.1 Recommendations for Policy Makers

Milestones 2025

- Policies for Sustainable Consumption and Production
- Resource efficiency and waste policies
  - incl. legal basis for recycling
  - incl. supporting measures for waste prevention and circularity
  - incl. classification and management guidelines for hazardous waste
  - incl. reporting guidelines for companies
  - Technology specific waste policies for wind turbines (similar to WEEE Directive for Solar PV)
- Adoption of EU energy efficiency directive & ambitious targets for lowering energy consumption

Actions until 2025

General Considerations

- Implement the 10-year framework of programmes on sustainable consumption and production (SDG 12)
  - Ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature (SDG 12)
  - Changing consumption patterns and promoting sustainable consumption also requires a discussion of material and energy ‘needs’ which is a prerequisite for changes in the economic system. (to be elaborated further)
- Ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture’s contribution to sustainable development (SDG 4)
- Include necessary behavioural changes in policies and strategies– energy intensity can only be reduced with the support of citizens (inform & educate & involve!)
  - Examples are provided by the IEA report ‘Net Zero by 2050’: Reduction of water and space heating temperatures (average 19-20°C), increase of space cooling temperatures (av. 24-25°C by 2030), increase of building lifetime (20% by 2050), etc.(IEA 2021)
  - However, while it is important to increase the lifetime of buildings or infrastructure, it is also essential to consider the construction materials used. A building made of wood might not achieve the same lifetime as a concrete building, it can still be more sustainable.
- Implement integrated water resources management at all levels, including through transboundary cooperation as appropriate (SDG 6)
- Include considerations such as employment in expansion & efficiency improvements of energy system(IIEA 2021)
  - Consider policies to support employment and businesses that will be asked to move out of polluting and fossil fuel industries – the no one left behind principle
Mining

- Update mining policies to include resource efficiency considerations & requirements for companies; this is already part of voluntary third-party certification schemes and required by downstream customers of mineral raw materials; policies need to be adapted to market requirements.

The mining industry is already subject of numerous voluntary standards of varying comprehensiveness and some covering all three sustainability pillars. Resource efficiency considerations are also covered by few standards. Kickler and Franken (2017) found in their comparison of mining standards, that IFC Environmental and Social Performance Standards are most comprehensive considering water, energy and material consumption and recycling efficiency. A multi-stakeholder approach is taken by the Initiative for Responsible Mining Assurance (IRMA). IRMA is currently the most comprehensive standard with some of the highest requirements for mining sites. Especially their guidelines for water can be considered as supporting strong sustainability – part of the vision this roadmap wants to achieve (Tost et al. 2018). The requirements provided by these standards should also inform new regulations and policies and provide a common basis among EU member states.

- Bring uniformity in national mining policies & legislation to level the playing field within Europe. Include responsible mining pre-requisites in trade & investment agreements with other countries.

Manufacturing

- Introduce eco-design policies for solar PV and wind turbines (finalise EU Eco-label for solar PV).
- Support of R&D in material efficiency considerations (e.g. material losses of polysilicon in Solar PV production need to be improved significantly).
- Adopt policies to create a market for secondary raw materials on EU level
  - E.g. a tradable recycling credit scheme (Söderholm and Ekvall 2020), i.e. requiring a specified share of secondary raw materials in production, increasing the level over time.
- Increase data disclosure on ESG metrics of manufactured products.

Recycling

- Review waste definition in the context of secondary resources on member state level in line with the EU Waste Framework Directive
  - Substantially reduce waste generation through prevention, reduction, recycling and reuse (SDG 12).
  - Adopt DIN SPEC 4866 for the dismantling & recycling of wind turbines.
  - Support the development of a similar norm for solar PV (possibly project ReSi-Norm will deliver the results needed).
- Create the legal basis for reuse of unrecyclable materials in other sectors, e.g. wind turbine blades in urban construction
  - Reusing materials in other applications needs to be carefully considered. This should only be an option if recycling is not possible. E.g. many metals from complex products end up in infrastructure today and are essentially 'locked in' for a long time.
• Unification of waste stream classification across EU member states and adoption of uniform recycling targets (Bobba et al. 2020)
• Support the recycling activities by introducing recycling subsidies, e.g. by directly supporting the implementation of recycling programmes, or lower costs for collection of end-of-life products, etc. (Söderholm and Ekvall 2020)

For both solar PV and wind turbines the technologies for recycling are mostly already available. The issue is with the economic viability of recycling processes and demand for recycled materials. Policies have to create a market for secondary raw materials (e.g. with financial incentives). This is a prerequisite for the achievement of recycling and circularity goals. An assessment of policy tools and their potential effects is provided in the report ‘Mapping support for primary and secondary metal production by the OECD (McCarthy and Börkey 2018).

• Enable transport of waste to recycling facilities with suitable import/export policies
• Make landfilling economically unattractive by introducing taxes

Milestones 2030

• Circular Economy – Closed loop & zero waste culture\(^6\)
  o Min. rate of circularity for solar PV and wind turbine manufacturers of 90%
  o Achievement of SDG 12 - Ensure sustainable consumption and production patterns
• All new buildings are zero-carbon-ready (IEA 2021)
• Increase of Energy efficiency by 32.5%\(^7\)
• Decrease energy consumption by\(^7\)
  o 37% final energy consumption
  o 41% primary energy consumption
• Achievement of the SDGs
  o 4 - Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
  o 6 - Ensure availability and sustainable management of water and sanitation for all
  o 7 - Ensure access to affordable, reliable, sustainable and modern energy for all
  o 8 - Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
  o 9 – Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

---

\(^6\)Keeping physical (i.e. technological efficiency, loss of properties, etc.) & economic limitations (long lifetime of wind turbines or solar PV installations) in mind.

\(^7\)Current EU Energy Efficiency Targets for 2030, see European Commission 2020c.
Actions until 2030

General Considerations

- Develop innovation friendly environment

The EU is already very active in supporting innovative projects, e.g. in Horizon 2020 or EIT funding schemes. However, it is important to further improve the collaboration between research institutions and industry, to avoid innovations that are irrelevant for mass production and ensure the uptake of innovations. Especially, wind turbines, but also solar PV modules are subject to a lot of research surrounding new technologies, improved efficiency, material substitution, and improved recycling processes. Policy makers have to ensure that this research can contribute to improvements of the industry. E.g. cross-sectoral project ZEBRA (Zero waste Blade ReseArch) bringing together companies and research partners, to ensure technical, economic and environmental relevance of the results (IRT Jules Verne 9/22/2020).

- Achieve the sustainable management and efficient use of natural resources (SDG 12)
  - Incorporate IFC EHS Guidelines in policies

The IFC provides various guidelines relevant for energy and resource efficiency. These guidelines should inform policies and can support the development of a common basis for all EU member states. Examples are: General EHS Guidelines 1.2 Energy Conservation, 1.4 Water Conservation, 1.6 Waste Management.

  - Increase public awareness, foster resource saving attitude and behaviour (Swilling 2020); provide a clear direction & achievable goals for future developments to reduce uncertainty around investments and remove bias against decoupling (UNEP 2014)
  - Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production (SDG 12)
  - Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption (SDG 8)
  - Introduce policy tools to support recycling (e.g. tax breaks for recycling activities and use of secondary raw materials, a resource or virgin material tax system) (UNEP 2014; Söderholm and Ekvall 2020; Swilling 2020). Effects of these policies on resource dependent developing countries need to be kept in mind and negative consequences mitigated by actively supporting long-term sustainable development in raw material supplying countries.

- Enhance policy coherence for sustainable development (SDG 17)

Adding new policies without considering existing regulations or cooperating with other sectors, the risk of implementing contradictory or unimplementable goals is high. For example, when introducing a new mining strategy, it is essential to harmonise this strategy with other policies, such as climate, environment or land-use policies. The cooperation between governmental agencies and institutional coherence is crucial. Considering the complex challenges of today new institutional structures might be needed to address them appropriately. Another example is the
expansion of renewable energy. This has to go hand in hand with energy efficiency considerations to decrease the pressure on raw material supply (UNEP 2014).

- Substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity (SDG 6)
- Continuously increase energy efficiency and decrease energy consumption
  - Improvements of -4.5% energy intensity per year (2020-2030) (IEA 2021)
  - Double the global rate of improvement in energy efficiency (SDG 7)

**Manufacturing**

- Introduce policies & support innovation to improve resource efficiency in production processes

Especially in the production of silicon wafers for solar PV modules material losses (so-called kerf losses) of more than 50% can occur and this material is currently not reused. The development of economically viable recycling processes needs to be supported and appropriate KPIs implemented.

- Implement sector specific energy efficiency targets for wind turbine and solar PV module production

Both the production of wind turbines and solar PV modules is very energy intensive. Energy payback time for the entire life-cycle of the technologies needs to be improved and KPIs implemented.

- Support research for the substitution of critical raw materials and/or the development of sustainable sourcing strategies

Considering the planned increase of offshore wind energy capacity, development of alternatives for rare earth permanent magnets need to be supported and sourcing strategies implemented to support more sustainable rare earth supply chains (see chapter 3.4 Target 4: Responsible Procurement).

**Recycling**

- Make reuse/recycling financially more attractive than primary raw materials & disposal
- Support the development of new high-value recycling facilities in Europe
- Support R&D for efficient recycling processes, new technologies, reuse, etc.
- Facilitate communication and collaboration along the supply chain
- Prevent export of recyclable materials outside the EU (=loss of strategic material source!), provided that appropriate collection & recycling infrastructure is available in the EU.
- Prevent export of waste outside of the EU – unless it will be recycled/handled properly
Milestones 2040

- Increase resource efficiency by KPI
- Policies for changes of the economic system

Actions until 2040

General Considerations

- Facilitate the implementation of innovative business models (car sharing, etc.)

Sharing economy (SE) business models often struggle with the lack of policy, regulations, insurance and licensing (Hossain 2020). Policy makers can support SE by implementing respective policy changes and offering local government support (Mi and Coffman 2019). However, also appropriate EHS regulations and taxation schemes are required, to ensure that existing traditional businesses adhering to high European labour, safety, etc. standards are not penalised (e.g. Uber vs Taxi) (Hossain 2020).

- Continue energy efficiency improvements
  - Implement IEA’s 25 energy efficiency recommendations (OECD and IEA 2017)
  - Energy efficiency policies need to be coordinated across policy areas and with existing policies and EU targets; often goals accumulate and don’t provide a clear path (Kern et al. 2017)
  - Energy efficiency considerations have to become part of energy access policies (OECD and IEA 2017)
  - Support off-grid systems in remote areas paired with super-efficient appliances to maximise efficient utilisation and affordability (OECD and IEA 2017)
  - Utilize the energy efficiency potential in buildings (account for 40% share of energy use in Europe) (Kern et al. 2017)
  - Annual energy intensity improvements of approx. -3% (2030-2050) (IEA 2021)

Manufacturing

- Support R&D into new technologies for lower material needs & reuse of secondary materials

Recycling

- Prohibit landfilling of recyclable materials

Milestones 2050

- Decrease energy intensity by 70% (IEA 2021)
- Establish new economic system

Actions 2050
3.1.2 **Recommendations for Industry**

### Milestones 2025

- Implementation of collection and recycling programmes for solar PV modules and wind turbines
- Cooperation with research and academia
- Implement sustainability accounting and reporting
- Support the achievement of sustainable consumption patterns

### Actions until 2025 & Continuous Actions until 2030

**General Considerations**

- Companies need to contribute to the achievement of the SDGs

Considering the necessary reduction of resource and energy intensity, as well as waste prevention, requirements from SDG 12 (Ensure sustainable consumption and production patterns) need to be integrated in management and operation:

  - Substantially reduce waste generation through prevention, reduction, recycling and reuse (SDG 12)
  - Adopt sustainable practices and to integrate sustainability information into reporting cycle (SDG 12)

- Support the development of sustainable consumption patterns

Companies can do their part in changing consumption patterns. Considering energy providers, incentives systems could be investigated. An example is provided by Marks & Spencer’s encouraging their customers to reduce their carbon footprint by offering store vouchers to customers who reduced their energy consumption by 10% (Nagappan 2009).

Another interesting example directly in the energy sector is provided by E.ON partnering with the Global Action Plan International. E.ON has not only introduced energy audits and green travel, but is also encouraging its employees to contribute to the environmental performance of the company. Sites participating in this 3 year project reached out to 1,000 students educating them on energy consumption and efficiency, achieved energy savings of 23,000€ per year and avoided 2,000 tonnes of CO₂ (GAP 2020).

**Mining**

- Mining companies need to implement policies for improving efficiency and resource use in their operations, e.g. based on IFC Environmental and Social Performance Standards, these policies have to include:
  - Implementation of management plan for sustainable use of the entire deposit
  - Optimization of existing mining plan considering energy efficiency (incl. schedule, drilling & blasting, layout, etc.)
  - Energy optimization & increase of renewable energy use in processing
- Cooperation with research & academia
o to develop new mining & processing technologies to increase raw material recovery and sustainable use of deposit
o tailings & waste heap management with focus on decreased environmental impact and possible recovery with future technologies

- Continuous fleet modernization (incl. automation and digitalisation) for electrification & decreased energy intensity

Manufacturing

- Optimize production processes:
  - Decrease material losses during production
  - Improve energy efficiency

Especially silicon wafer production for solar PV needs to be optimised in order to decrease kerf losses; replace slurry-based wafering by other cutting technology (e.g. Diamond Wire Sawing reducing silicon consumption by 15% (Arora et al. 2018)) suitable recycling methods still need to be developed on a commercial scale and implemented. The EU’s SIKELOR project developed a prototype for such a recycling process possible providing a model for industrial application (SIKELOR 2021). Li et al.(2021) provide a further overview of existing methods reviewing benefits and drawbacks.

- Explore new business models with the goal of increasing resource efficiency
- Strengthen cooperation with research & academia, as well as other sectors with the focus on
  - new business models
  - resource efficient production processes
  - new technologies with increased life time, eco-design, etc.

- Implement a global collection & recycling program for all new and already deployed solar PV modules and wind turbines (either company owned or in cooperation with recycling providers)
  - Recommendations from the Guidance Document (WP5) to follow

- Eco-Design considerations for all new products

When developing new products, eco-design considerations need to be included from the very beginning of the process. Cooperate with recycling facilities to improve future recovery of raw materials, also revise existing products according to this aspect.

In solar PV recycling a major challenge is also the large variation of cell and module structure between different types and manufacturers creating problems in the extraction of components. Standardisation of modules would significantly increase recyclability (Tao et al. 2020).
Recycling

- Strengthen cooperation with research & academia, as well as other sectors with the focus on
  - high-value recycling technologies
  - new reuse opportunities
- Improve collection and recycling of copper, rare earth elements and silicon

Given the long lifetime of wind turbines and solar PV modules of approximately 20-30 years, waste volume is still rather low. Infrastructure and technologies for increased waste streams need to be implemented now in order to be prepared for future volumes. Especially considering planned capacity increases of renewable energy technologies, recovering materials from End-of-life (EoL) recycling needs to be seen as a strategic source of raw materials. While copper already shows relatively high EoL collection and recycling rates (65% and 45% respectively in 2011 (Glöser et al. 2013)), rare earth elements and silicon still lag behind significantly (both EoL-RR <1%) (Graedel et al. 2011; EL Latnunussa et al. 2020). Copper can be recycled without any loss of performance or qualities compared to primary copper (Copper Alliance 2014). The only limitations are therefore physical limits of recycling processes (currently overall recycling efficiency rates of 60% are achieved (Glöser et al. 2013)) and economic limits (lifetime of products).

Apart from resource efficiency considerations, recycling of rare earth elements is also crucial considering the EU’s import reliance on China for rare earth elements and permanent magnet supplies. Given the likely increase of permanent magnet demand for offshore wind turbines, ambitious recycling targets need to be implemented. Direct magnet-to-magnet recycling is investigated by various projects, e.g. the H2020 funded project SUSMAGPRO – Sustainable Recovery, Reprocessing and Reuse of Rare Earth Magnets in a European Circular Economy (Susmagpro 2019).

According to Bobba et al. (2020) silicon metal is currently not recovered from post-consumer waste, but recycling of silicon metal from EoL solar PV applications would be possible. Potential for reuse is mainly within the solar PV industry itself.

Milestones 2030

- Support the achievement of the SDGs
  - 7 - Ensure access to affordable, reliable, sustainable and modern energy for all
  - 8 - Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
  - 9 - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
  - 12 - Ensure sustainable consumption and production patterns
- Implementation of Circular Business Models
- Reduction of energy intensity by 30% (IRENA 2021)
- Implement high-value recycling processes for all new and deployed solar PV modules and wind turbines
  - 95% recovery rate for silicon solar PV panels
  - 97% recovery rate for thin-film solar PV panels
  - 95% recovery rate for wind turbines
- Implement optimized resource management
Actions until 2030

**General Considerations**

- Double the rate of improvement in energy efficiency (SDG 7)
- Improve resource efficiency in production processes in accordance with the 10-year framework of programs on sustainable production (SDG 8)
- Upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes (SDG 9)
- Achieve the sustainable management and efficient use of natural resources (SDG 12)

**Manufacturing**

- Collaboration of manufacturers and recyclers, research & academia to substitute unrecyclable or environmentally problematic materials (e.g. Zebra project for wind turbines)
- Implement innovative business models based on usage rather than ownership (e.g. sell light as a service rather than lamps, see Case Study Philips & Turntoo (Ellen MacArthur Foundation 2017) – Selling light as a service and Philips Circular Lighting Modelling (Philips 2017)).

**Milestones 2040**

- Increased resource efficiency KPI

**Milestones 2050**

- Change of economic system
- Reduction of energy intensity by 70% (IRENA 2021)

**Actions until 2040 & 2050**
3.1.3 **Recommendations for Civil Society**

Civil Society organisations already play an important role in the achievement of sustainability in the supply chain of wind and solar PV power. For the target of decreased resource consumption, we especially want to highlight the role of advocacy NGOs (both local and international), industry associations, research institutions.

NGOs can make an important contribution to increasing resource efficiency and reducing energy demand. An important aspect is to increase awareness and inform the population about the effects of consumption patterns and possible alternatives. For example, what does it mean to buy a new mobile phone every year, what raw materials are needed for it, where do they come from and what are the environmental and social impacts. People need to be better informed about the consequences of continuing current consumption patterns. In this area, the necessary and desirable cooperation with policymakers should also be emphasised. On the one hand, this “educational work” is also necessary at the political level, on the other hand, political measures to increase resource efficiency can also be developed and communicated to the population together.

Research and academic institutions are challenged in two ways: (i) they have a very important role to play in developing new technologies and advancing existing ones in order to reduce both the resources and the energy used in their production; but also, in terms of recycling, it is important to pay attention to the subsequent reuse and recovery of materials when designing products. When developing new technologies in the future, attention must be paid from the very beginning to which raw materials are used. Interdisciplinary cooperation must be significantly strengthened and expanded for this purpose. Direct cooperation with industry must also be intensified in order to effectively develop viable new products. (ii) Interdisciplinary cooperation must be strengthened not only in the technical field with regard to the use of raw materials, but also interdisciplinary cooperation between engineering, social sciences, ecology, sustainability research etc. Environmental and social impacts have to be considered, for example in the form of (social and environmental) life-cycle assessments, in product development from the start of a project.

Industry associations have the task of mediating between their members in industry and politics. It is important that laws and regulations are in fact implementable. The aim is not to reduce important climate or environmental targets in order to secure maximum profit for the companies, but to realistically reflect the feasibility in laws. For example, in the area of recycling - regulations on the use of secondary raw materials are not effective if these raw materials are and will not become available due to physical or economic limitations.

It is also important that industry associations promote cooperation among their members. Many of the environmental and social standards will be difficult to implement, especially for small and medium enterprises (SMEs), as they require high investments. This is where these associations can intervene and encourage joint R&D, group certification to a certain standard, the purchase of new equipment that can possibly be shared between companies, etc.
3.2 Target 2: Paris Agreement & Environmental Sustainability

The roadmap for the renewable energy sector of the RE-SOURCING project aims at achieving the Paris Agreement’s +1.5°C target. To achieve this target, the speed required in which necessary transitions are conducted is still under debate. EU policy targets aim at net zero emissions by 2050 including a power sector ‘that is based largely on renewable sources’ (this is stated in the EU green deal, a revision of the targets is currently under way) (European Commission 2019c). This is also reflected in the IEA Net Zero Emissions by 2050 report, which incorporates 88% renewables in electricity generation by 2050. However, this report also acknowledges a probability of 50% that this path will not help achieve the 1.5°C target without overshoot (IEA 2021). In their report the IEA (2021) addresses the increased importance of electricity for the future. While the electricity demand will increase due to electrification advances, it is even more important that this sector also achieves the net zero target as soon as possible. According to the IEA, this should be achieved by 2035 in advanced economies and 2040 globally. Other studies highlight the importance of drastically increasing renewable energy supply to 100% renewable energy by 2050 (Teske et al. 2015; Jacobson et al. 2017; European Climate Foundation 2010) or 2040 respectively (SolarPower Europe and LUT University 2020). This is also reflected by many companies and countries some of which set even more ambitious targets (see RE100 (2021) and REN21 (2021)).

Based on the consultation process, this roadmap recommends the achievement of 100% renewable energy and net zero emissions by 2040. The RE-SOURCING consortium believe the EU must take a clear lead and push for a global shift to renewable energy. However, as already discussed in the previous chapter Target 1: Decrease Resource Consumption this has to be accompanied by energy efficiency improvements and demand reduction.

The recommendations in this chapter focus on the expansion of the renewable energy system. This is equivalent to phasing out thermal coal. The RE-SOURCING project recognises the importance of coal for certain industries (e.g. the production of silicon metal for solar PV, steel manufacturing or the chemical industry). Nevertheless, R&D into the substitution of coal in these industries is also a crucial aspect for decarbonising the economy and reaching the target of net zero emissions (according to the ECF (2021) a 100% renewable energy system is not enough for heavy industries to be compatible with the Paris Agreement). While the authors want to highlight the importance of the phasing out of coal as feedstock, it is out of scope for this report to go into more detail.

Considerations on deep sea mining and legacy issues of abandoned mines will be incorporated in a separate briefing document at a later state of the RE-SOURCING project, as these issues are relevant for all three sectors included in the project.
### 3.2.1 Recommendations for Policy Makers

**Milestones 2025**
- Appropriate waste & land use policies
- Achievement of Aichi Targets

**Actions until 2025**
- Integrate environmental sustainability considerations in policy making across fields
  - Incl. waste & pollution prevention, biodiversity conservation, water use, etc.
  - Regulations need to be harmonised among EU members; again, a common basis could be provided by IFC Performance Standards, incl. Standard 3 on Resource Efficiency and Pollution Prevention and Standard 6 on Biodiversity Conservation and Sustainable Management of Living Natural Resources
  - Waste Classification needs to be harmonised and the disposal of toxic materials carefully regulated (including the export of waste – receiving countries need to have similar standards in place)
  - Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally (SDG 6)
  - Achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment (SDG 12)
  - Prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution (SDG 12)
  - Ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements (SDG 15)
Promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally (SDG 15)

Especially in the mining sector, but also in the construction of wind and solar PV farms, deforestation is an important issue to consider (Bennun et al. 2021; Dai et al. 2015; Turney and Fthenakis 2011). Regulations to prevent deforestation along the supply chain and in the installation of wind and solar PV farms are required as not to offset positive effects of the renewable energy technologies on GHG emissions. The New York Declaration on Forests has been adopted by the EU and its Goals 3 and 4 provide guidance for ‘reducing deforestation from infrastructure and extractive developments’ and ‘support alternatives to deforestation driven by basic needs’. Progress towards achieving these goals both from governments and industry is slow and efforts need to be increased drastically (NYDF Assessment Partners 2020, 2021).

Combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world (SDG 15)

- Biodiversity Conservation needs to be improved across the EU
  - Most 2020 Aichi Targets by the Convention on Biological Diversity have not been met in time throughout the EU, this requires urgent attention and improvement (Convention on Biological Diversity 2021; Earth.Org 2020).
  - The Convention on Biological Diversity is elaborating a Post-2020 Biodiversity Framework, this development needs to be supported and guidance integrated in policies. The Aichi Targets have been criticised because progress is difficult to measure due to their format and countries were not required to report on the measures taken to achieve them. These issues need to be addressed in the following programme with support from policy makers, industry and civil society (Nature 2020; Bennun et al. 2021).
  - Ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development (SDG 15)
  - Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and protect and prevent the extinction of threatened species (SDG 15)
  - Integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts (SDG 15)
  - Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems (SDG 15)
Mining

- Update mining regulations based on existing (voluntary) certification schemes
  - New mines need to include regular auditing processes into their development plan to be approved.
  - Plans for new mines need to include mine closure plans and allocated funds for reclamation to be approved.
  - Implement ESG considerations in mining policies.
  - Harmonise EU mining regulations.

As already mentioned in chapter 3.1, a large number of mining standards has already been developed with their main difference being how they were developed, what type of mines and minerals they focus on and how comprehensive they are. For large-scale mining (LSM) the Initiative for Responsible Mining Assurance (IRMA) is currently the only mining standard that has been developed based on a broad multi-stakeholder process.

According to Kickler and Franken (2017) and Tost et al. (2018) IRMA is not only the most comprehensive standard, but especially considering its guidelines for water and biodiversity management moving towards strong sustainability (see chapter 2 Vision). IRMA can therefore provide a common basis for mining regulations and a starting point for auditing of mining operations to achieve responsible mining.

However, many companies are already certified according to other standards, e.g. ICMM or The Copper Mark. These need to be recognised as well and aspects missing from these standards should be subject of supplementary audits. On the one hand, this has to support the harmonisation of standards and help companies to determine necessary requirements both from a miner’s and a customer’s point of view. On the other hand, this is to prevent mining companies from being constantly forced to obtain new certifications because a new system is published.

- Transparent granting of mining licences & support of responsible EU mining projects

EU mining policies not only need to be harmonised, but the approval of responsible new mining projects has to be made possible. Access to raw material deposits has to be ensured to provide critical raw materials for the energy transition and achievement of the SDGs (Nickless 2018). Various authors emphasise the necessity of developing international guidelines and governance for responsible minerals extraction to ensure access to responsibly sources raw materials. More details in chapter 3.5.

- Stop investment in and approval of new coal mines & coal mine extensions (IEA 2021)

Coal is still an important raw material for production of other products, e.g. silicon metal or steel. Alternatives are not yet ready for commercial production and further R&D is required. However, the pathway provided by the IEA to net zero by 2050 requires no further expansion of coal production, as it has to be phased-out for energy production to achieve the Paris Agreement.
Training & Education of experts for the extractives sector

The extractives industry is struggling with an ageing workforce and very little interest from young people to work in the sector. It is important to set measures to ensure the availability of environmental and OHS inspectors in the future, as well as experts for sustainability considerations in mining operations. Firstly, policy makers need to inform the public better on the necessity and positive aspects of mining to increase interest. Secondly, high-quality study and training programmes need to be ensured, even with low numbers of participants.

Manufacturing & Recycling

Require Life Cycle Assessments (LCAs) for all new technologies/products

Responsible or clean production guidelines should not only cover manufacturing itself (regarding use of renewable energy, chemicals, waste, etc.) but also at the entire life cycle of a product – from mining to recycling. The aim is to move from managing environmental impacts to ‘prevention at the source before environmental effects occur’ (Ceylan and Aydin March). An LCA provides an overview of all environmental impacts of a product, a service or a process and helps to identify stages with optimisation potential. This supports the development of product design with minimised environmental impact (Bongaerts 4/14/2021). A framework for LCAs is provided by ISO 14040:2006 Environmental management – Life cycle assessment – Principles and framework (ISO 2006).

Develop & implement environmental regulations for wind turbine and solar PV manufacturing and recycling

At the time of the State of Play report, environmental standards or guidelines for wind turbine and solar PV manufacturing had not been developed. The American Wind Energy Association, now part of the American Clean Power Association (ACP), was working on a standard on environment, health and safety for wind turbines. However, now updates on this standard could be found. Most existing standards focus on performance, design requirements, testing and monitoring, etc. Only the IFC provides Environmental, Health and Safety Guidelines for on- and offshore wind energy facilities for their entire lifecycle including some recommendations on the decommissioning of wind parks (International Finance Corporation IFC 2015). This should inform requirements and regulations for the sector in the EU.

Standards for solar PV modules mostly focus on technical aspects as well. The EU’s eco-design, energy label and ecolabel standards that are still under development, will hopefully provide further guidance on environmental aspects in solar PV manufacturing.

Considering recycling standards, solar PV modules are covered under the WEEE directive. The German Institute for Standardization (DIN) developed the standard DIN SPEC 4866 in cooperation with various companies, experts and government representatives for dismantling and recycling of wind turbines. This can provide a basis for an EU wide regulation.

Facilitate the transition to renewable energy sources in manufacturing/recycling plants

Many companies are already very active in transitioning to renewable energy sources and are setting themselves ambitious targets. These efforts need to be supported by policy makers, e.g. by subsidies, or higher taxes for companies that still rely on fossil fuel energy systems.
• Recycling Plants need to fulfil similar EHS guidelines as manufacturing plants
• Emissions (gas/water) need to be carefully regulated, especially considering toxic materials such as Cd-compounds in CdTe Solar Modules
• Revise land-use policies with focus on construction of renewable energy plants
  o Land-use policies for solar PV need to be revised and a solar rooftop programme developed (currently 90% or European rooftops are unused)(SolarPower Europe and LUT University 2020)
  o Facilitate co-use of agricultural land and solar PV or wind farms; this needs to be considered from the beginning of project planning and can also support the species conservation, e.g. Austria’s largest solar PV plant is also home to 150 sheep(Wien Energie 2020)

![Figure 7: Co-use of land by renewable energy and agriculture at Austria's largest solar PV plant (Wien Energie 2020)](image)

Milestones 2030
• Reducing GHG emissions by >60% (from 1990 levels)(SolarPower Europe and LUT University 2020)
• Increase renewable energy capacity
  o Wind energy by
  o Solar PV energy by
• Net positive contribution to biodiversity
• Achievement of the SDGs
  o 6 Ensure availability and sustainable management of water and sanitation for all
  o 7 Ensure access to affordable, reliable, sustainable and modern energy for all
  o 12 Ensure sustainable consumption and production practices
  o 14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development
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

- Mandatory EHS Auditing for all stages of the Supply Chain

**Actions until 2030**

**General Considerations**

- Significantly increase the share of renewable energy deployment and reduce GHG emissions, this includes the achievement of SDG 7 Ensure access to affordable, reliable, sustainable and modern energy for all and cooperation with developing countries to support their energy transition
  - Ensure universal access to affordable, reliable and modern energy services (SDG 7)
  - Increase substantially the share of renewable energy in the global energy mix (SDG 7)
  - Expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support (SDG 7)
  - Facilitate the uptake of new business models to improve the affordability of off-grid solutions (OECD and IEA 2017)

IRENA (2020) emphasises the importance of coordinated deployment, integration and enabling policies for the transition to renewable energies.

![Holistic policy framework for a successful energy transition (IRENA 2020)](image)

- Mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation (SDG 15)
Mining

- Regulations for mining have to advance from responsible mining to sustainable mining
  - Auditing becomes mandatory for both already existing and new operations. Former voluntary third-party certifications are incorporated in regulations as minimum requirements and continuous improvement and review are imperative.
  - Targets have to support the achievement of sustainability in the mining sector.
  - The H2020 SUMEX project is elaborating a guidance for ‘Sustainable Management in the Extractive Industries’. Aiming at offering a toolkit and validated good practices and principles to companies and operations (SUMEX 2021).

Manufacturing & Recycling

Milestones 2040

- Comply with Paris Agreement 1.5°C target
  - 100% renewable energy
  - Net-zero emissions

Actions 2040

3.2.2 Recommendations for Industry

Milestones 2025

- Full integration of Environmental and Climate impacts in company strategy

Actions until 2025

- Implement GRI and IFC Reporting Standards
- Implement GHG accounting & reporting system for entire value chain & product life cycle (e.g. GHG Protocol)
- Shared infrastructure - allow local communities access to (renewable) energy system of operations/expand infrastructure and upgrade technology to sustainable energy systems (in line with SDG 7)
- Achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment (SDG 12)
- Prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution (SDG 14)

---

8 According to SolarPower Europe (2020) 100% Renewable Europe, 100% renewable energy and net-zero emissions need to be achieved by 2040 in order to reach the Paris Agreement 1.5°C target
• Assess companies' impacts on ecosystems, develop mitigation plan accordingly (e.g. utilise WRI The Corporate Ecosystem Services Review or WBCSD Guide to Corporate Ecosystem Valuation)
  o Implement ecosystem & biodiversity accounting & management tool (WBCSD Eco4Biz provides an overview of existing tools, e.g. Ecometrika Biodiversity Metric)
  o Integrate ecosystem services in impact assessment (e.g. using WIR Step-by-Step Guidance)
  o Use data of local data providers or NGOs to assess companies impact on forests, e.g. Global Forest Watch

• Protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes (SDG 6)

• Support and strengthen the participation of local communities in improving water and sanitation management (SDG 6)

• Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally (SDG 6)

• Evaluate companies' impacts related to water use and discharge (e.g. using GEMI Local Water Tool, or Veolia True Cost of Water Toolkit, or Water footprint network)
  o Implement integrated water resources management at all levels, including through transboundary cooperation as appropriate (SDG 6)
  o Implement respective reporting (e.g. GRI 303: Water and Effluent Standard; for mining and metals sector GRI G4 Standard)
  o Advance best practice in water resource management (e.g. in Cooperation with Aqueduct Alliance)

Mining

• Implement a holistic sustainability policy, incorporating environmental and social impacts
  o Recommendations from the Guidance Document (WP5) to follow
Milestones 2030

- Support the achievement of SDGs
  - 6 Ensure availability and sustainable management of water and sanitation for all
  - 7 Ensure access to affordable, reliable, sustainable and modern energy for all
  - 12 Ensure sustainable consumption and production practices
  - 14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development
  - 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

- Reduction of GHG emissions by >60%
- Net positive contribution to biodiversity & environment
- Full integration of Ecosystem Impacts in Companies’ Impact Assessment & Performance Management of Companies
- Increase electrification of operations by

Actions until 2030

- Significantly increase the use of renewable energy sources for all operations (SDG 7)
- Support R&D in the substitution of environmentally harmful substances, substitute wherever possible, responsible use of toxins
- Expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies (SDG 6)
- Substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity (SDG 6)
- Apply regular audits/assessments to evaluate sustainable water management (e.g. Alliance for Water Stewardship Standard)

Mining

- Avoid the use of groundwater and implement desalination plants in arid regions
  - E.g. in copper mining in Chile – BHP implemented a desalination plant for its mines ‘Minera Escondida’ thereby significantly reducing its use of groundwater(Sustainable Copper 2018)
  - Share this infrastructure with local communities
- Use of best available technologies to avoid environmental pollution from tailings – zero hazardous tailings discharge

---

9See Net Positive Project by the Forum of the Future, WWF and the Climate Group: https://www.forumforthefuture.org/net-positive
Manufacturing

Various manufacturers of renewable energy technologies have already announced to change their energy systems to 100% renewables by 2030 or even sooner. E.g. JinkoSolar by 2025 (JinkoSolar Holding Co., Ltd. 8/6/2020), First Solar by 2028 (First Solar, Inc 8/6/2020); Vestas is relying on 100% renewable energy since 2013 (RE100 2021). Industry is already very advanced in this regard and it is important that these goals are pursued vigorously and that more companies take similar initiatives.

Recycling

- Recycling of all recyclable materials – significantly increase recycling rates and optimise processes
- Avoid land filling of unrecyclable materials
  - Cooperation with other sectors to enable reuse, e.g. wind turbine blades can be reused in urban construction
  - No dumping of toxic materials

Milestones 2040

- 100% renewable energy
- Electrification of production
- Zero harmful air emissions
- Zero pollution of land, air & sea
- Net zero GHG emissions

Actions until 2040

3.2.3 Recommendations for Civil Society

Civil Society organisations already play an important role in identifying bad practice cases and making industries and supply chains more responsible. This monitoring and reporting function of CSOs, especially local and international NGOs, will continue to be key in achieving the RE-SOURCING projects’ targets. Advocacy NGOs provide important data for assessing and evaluating environmental and social impacts. It is essential that this work continues.

Key functions relevant for climate related and environmental as well as social issues include:

- Monitoring & reporting of violations to governments, to companies, to public
- Support closure & remediation of the reported incidents
- Capacity building of small businesses
- Empower CSOs to train, monitor and support small businesses
- Solutions providers! – help governments to make Due Diligence laws feasible, suggest accompanying measures to the law that make compliance possible for businesses and make monitoring of compliance for CSOs and governments possible
3.3 Target 3: Social Sustainability & Responsible Production

Figure 9: Milestones to reach Social Sustainability & Responsible Production by 2030

3.3.1 Recommendations for Policy Makers

Milestones 2025

- Gender & Racial Equality
- Procedural & Distributive Justice
- Integration of Social-Life cycle assessment (LCA) & Life cycle planning (LCP)

Actions until 2025

- Review land-use policies to appropriately cover, cultural heritage, land acquisition, etc.
  - Include free-prior informed consent and fair compensation; this might require a review of land owner rights in some countries; the goal of establishing an EU wide system should be pursued;
  - IFC Performance Standards 5 on Land Acquisition and Involuntary Resettlement, 7 on Indigenous Peoples and 8 on Cultural Heritage can provide a basis for harmonised EU policies.
- Incorporate meaningful stakeholder involvement in policy & strategy development processes
  - Recommendations from the Guidance Document (WP5) to follow
- Establish guidelines for companies on grievance mechanisms and stakeholder engagement processes
- Incorporate requirements for companies on support for local development and added value in production regulations as well as community health and safety
• Ratification of new International Labour Organization (ILO) labour standards

The EU has ratified the core ILO conventions and is committed to participating within the ILO and implementing their standards. However, new conventions such as the C190 on Violence and Harassment or the C189 Domestic Workers Convention have not been ratified by all EU members. It is important to continuously update labour and social regulations and also implement these technical guidelines. This will also support the harmonisation of regulations throughout the EU (ILO 2012, 2017).

Mining

As for the environmental considerations, mining policies need to be reviewed considering social impacts of mining operations. IRMA can provide a common framework for all EU member states to ensure responsible mining in the EU.

The UN Economic Commission for Europe (UNECE) provides policy recommendations for ‘Transforming Extractive Industries for Sustainable Development’. This policy brief recognizes the positive impact mining could potentially have on societal development and recommends measures to realise this potential.

Manufacturing

• Review occupational health and safety regulations to incorporate those specific issues
  o For wind turbines the IFC EHS Wind Energy guidance provides a framework

Occupational health and safety is an important issue in wind turbine manufacturing, especially in blade production where workers come in contact with epoxy resins and fibre glass. Similar challenges occur in the manufacturing of thin-film CdTe PV modules.

• Integrate Social and environmental life cycle assessments in product development & operations planning
  o To manage impacts, support sustainability reporting and sustainable investment
  o To detect burden shifting and enable comparison of alternatives (Mancini and Nuss 2020)

Milestones 2030

• Achievement of SDGs
  o 1 End Poverty in all its forms everywhere
  o 2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture
  o 3 Ensure healthy lives and promote well-being for all at all ages
  o 4 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
  o 5 Achieve gender equality and empower all women and girls
  o 8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

• Local & Regional Development
• Corrective Justice
Actions until 2030

- Ensure damages to individuals and communities inflicted by policy makers or companies are addressed in a fair and appropriate way, hold companies accountable for environmental and social damages and ensure repair of losses
- Require social life cycle assessments and life cycle planning for all production and product development processes
- Require companies to apply the same social and environmental standards in all their operations, flight to countries with lower standards must be prevented.
  - Possibly implement a bonus malus system, supporting companies adhering to high standards throughout their production locations and supply chains and increasing taxes for companies that do not.

Mining, Manufacturing, Recycling

3.3.2 Recommendations for Industry

Milestones 2025

- Gender & Racial equality
- Procedural & Distributive Justice
- Integration of Social & Environmental Life Cycle Assessment and Life Cycle Planning

Actions until 2025

General Considerations

- Strengthen efforts to protect and safeguard the world’s cultural and natural heritage (SDG 11)
  - IFC Performance Standard 8 provides guidance on Cultural Heritage
- Integrate children’s rights into impact assessment and develop mitigation plan accordingly (see UNICEF guidance)
- Ensure procedural, distributive and corrective justice in all operations
  - Involving affected communities in decision making processes
  - Provide all relevant information in an understandable manner
  - Allow for free prior informed consent
  - Introduce effective grievance mechanisms (both for employees and local communities) suitable for local conditions
- Assess companies’ impact on sustainable development (e.g. Oxfam & UN Global Compact Poverty Footprint to understand business’ impacts, Business and Human Rights Resource Centre Human Rights Compliance Assessment, UN Global Compact Guide to Human Rights Impact Assessment and Management. WBCSD Measuring socio-economic impact) and develop mitigation plans accordingly
- Implement slavery grievance mechanisms (see e.g. WBCSD & UN Global Compact Implementing effective modern slavery grievance mechanisms - A guidance note for business)
- Integrate UN Guiding Principles on Business and Human Rights in company policies
- Continuous education & training of local communities and support local recruitment
o substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship (SDG 4)
• Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment (SDG 8) & including access to safe water, sanitation and hygiene (see WBCSD WASH Pledge)
• Assess gender equality in your company, e.g. using GEP Assessment tool based on Gender Equality Principles, to identify areas that need improvement
• Support local development
  o By sharing infrastructure with local communities (electricity & water supply, roads, internet, etc.)
  o In remote areas with a lack of health care and educational availability, support the development of this infrastructure
  o Support local businesses & organisations
• Ensure fair wages and provide insurance for employees
• Adhere to ILO Labour Conventions

**Mining**

As mentioned in previous chapters, guidance on social responsibilities of mining companies is provided by various standards, the most comprehensive being IRMA. An important aspect is to avoid the so-called resource curse, by ensuring long-lasting and sustainable development of the region. To mention just a few necessary measures:

• Include planning for mine closure from the very beginning of project development and set aside funds accordingly, all operational activities must consider continuous & future reclamation
• Mine reclamation has to include environmental and social considerations to allow optimal use after the operation, decrease risks and create opportunities for local communities
• Facilitate multi-stakeholder governance mechanisms
• Meaningful stakeholder involvement
• Transparent reporting on all environmental and social aspects has to be included in management practices
  o Guidance on what is expected by mining operations to be made publicly available is provided by the biannual report of the Responsible Mining Foundation (RMF)

**Manufacturing & Recycling**

• Include social life-cycle assessment and life cycle planning in operations and product development
Milestones 2030

- Application of same standards in every country of operation
- Support the achievement of the SDGs
  - 1 End Poverty in all its forms everywhere
  - 2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture
  - 3 Ensure healthy lives and promote well-being for all at all ages
  - 4 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
  - 5 Achieve gender equality and empower all women and girls
  - 8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
- Moderate profit driven production
- Optimisation of production processes & use of best available technologies
- Local & Regional Development
- Corrective justice

Actions until 2030

- Apply the same standards in every country of operation
  - Occupational & community health and safety
  - Environmental & social impacts

The common practice of moving production in countries with lower environmental and social standards to save production costs has no place in responsible production. International companies need to accept their responsibility and perform according to the highest possible standards whether or not required by a country’s regulations.

- Local value creation, knowledge sharing and training of local communities
  - Fair compensation for land use & resources
  - Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all (SDG 9)
- Continuous improvements and use of best available technology (incl. considerations for water & energy efficiency, environmental impacts, automation, etc.)
- Main goal social and environmental sustainability in operations

Currently operations are set up to generate maximum profits for companies and shareholders. However, companies need to accept their responsibility in social and environmental impacts and ensure increased sustainability of their operations to create value not only for their shareholders, but also for communities and regions. This means moving from maximum profit to moderate profit by internalising all external costs (Drebenstedt 2021).
**Mining**

- Improve collaboration between large-scale mining (LSM) and artisanal and small-scale mining (ASM), support the development of sustainable livelihoods of AS miners
  - see collaboration between IRMA and the Alliance for Responsible Mining (ARM) to promote coexistence between LSM and ASM and improve social and environmental practices of all miners (ARM and IRMA 2021)
- Avoidance of tailings and waste rock by efficient reuse
- Zero hazardous tailings discharge

### 3.3.3 Recommendations for Civil Society

Local operational NGOs must increasingly take on a mediating role and support a multi-stakeholder approach. This should ensure that, on the one hand, concerns of the local communities are heard, but also that sustainable developments by companies and policy-makers are supported and promoted. This role is particularly important in the field of ASM. NGOs that are already active in areas with a large ASM sector know the conditions and specifics on the ground. Both companies and policy-makers need to be supported on what capacity building should look like and how it should be implemented. Capacity building, infrastructure development, etc. must always be done in consultation with the local population and their wishes must be considered. Standard solutions do not lead to the desired results.

Labour Unions play an important role not only considering occupational health and safety aspects, but also social sustainability in general. A good practice example is the framework agreement between IndustriALL Global Union and Siemens Gamesa, one of the largest wind turbine manufacturers worldwide. This agreement aims at improving social and environmental sustainability both in Siemens Gamesa’s facilities and along the supply chain of the company. Commitments included are the respect for the new ILO Convention 190 on violence and harassment at work, life-long learning and training programmes for employees and supply chain due diligence based on the OECD guidance (IndustriALL 2019). This shows collaboration between labour unions and companies can have very positive effects on occupational health and safety of the employees, community health and safety along the supply chain and other major due diligence issues in a company’s operations.
### 3.4 Target 4: Responsible Procurement

#### 3.4.1 Recommendations for Policy Makers

**Milestones 2025**
- Implement a Standard for tracing mineral raw materials
- Include considerations on responsible supply chains in all Trade Agreements

**Actions until 2025**
- Appoint a responsible government agency for supply chain due diligence (Initiative Lieferkettengesetz 2020)
- IFC Performance Standards included in Chapter 3.1.2 have to be included in supply chain due diligence as well (Cultural Heritage, Indigenous Peoples, Land Acquisition, etc.)
- Support developing countries and incorporate international companies to support development along their supply chains to
  - End hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round (SDG 2)
  - Increase investment in rural infrastructure and technology development (SDG 2)
  - Increase Aid for Trade support for developing countries, in particular least developed countries, including through the Enhanced Integrated Framework for Trade-Related Technical Assistance to Least Developed Countries (SDG 8)
  - Promote and enforce non-discriminatory laws and policies for sustainable development (SDG 16)
  - Strengthen domestic resource mobilization, including through international support to developing countries, to improve domestic capacity for tax and other revenue collection (SDG 17)
  - Significantly increase the exports of developing countries, in particular with a view to doubling the least developed countries’ share of global exports (SDG 17)
Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed (SDG 17)

Respect each country’s policy space and leadership to establish and implement policies for poverty eradication and sustainable development Multi-stakeholder partnerships (SDG 17)

- Enforce high labour standards for international companies along their entire supply chains
  - Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment (SDG 8)
  - Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and end child labour in all its forms (SDG 8)

For example, in the supply chain for polysilicon required for the solar PV industry, forced labour in the Chinese Xinjiang region is a significant issue (Murphy and Elimä 2021). Regulations for transparent reporting on labour practices along the supply chain have to be put in place and companies have to be able to prove that those practices are not used in their supply chain in order to be able to sell their products in the EU.

- Governments have to adopt the same supply chain due diligence standards required by companies
  - Promote public procurement practices that are sustainable, in accordance with national policies and priorities (SDG 12)
- Promote the rule of law at the national and international levels and ensure equal access to justice for all (SDG 16)
- Substantially reduce corruption and bribery in all their forms (SDG 16)
- Broaden and strengthen the participation of developing countries in the institutions of global governance (SDG 16)
- Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements (SDG 16)
- Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism (SDG 17)

**Mining**

- Implement a tracing standard for raw materials (examples are IRMA’s and CERA’s Chain of Custody Standards)
- Enable responsible mining in Europe, no more 'burden-shifting'
- Raw materials imported from outside the EU have to fulfil the same responsible mining requirements as operations inside the EU
Milestones 2030

- Supply Chain Due Diligence Law
  - Mandatory for large international players
  - Preparation/Voluntary for SMEs
  - Mandatory non-financial reporting
- Local/Regional Development
  - Incl. Procedural and distributive justice
- Support of the achievement of all SDGs mentioned in previous chapters along the supply chain

Actions until 2030

- Integrate UN Guiding Principles on Business and Human Rights into supply chain law and requirements for companies (Initiative Lieferkettengesetz 2020)
- Integrate OECD Guidelines for Multinational Enterprises & OECD Guidance for Responsible Supply Chains of Minerals into supply chain law and requirements for companies (Initiative Lieferkettengesetz 2020)
  - Both UN & OECD Guidelines include risk analysis with obligation to investigate, prevention and mitigation measures, grievance mechanism and remediation
  - Transparency & documentation of supply chains and operations
- Implement control mechanism for supply chain due diligence measures
- The disregard of due diligence obligations, as well as the non- or incomplete submission of a due diligence plan, should be linked to clear penal consequences under public law (Initiative Lieferkettengesetz 2020)
- Companies are liable for human rights violations caused by their failure to comply with due diligence obligations
- Former voluntary certification schemes for responsible sourcing (e.g. Together for Sustainability (TfS), EcoVadis) are accepted, missing aspects need to be re-audited, regular re-auditing and improvements are required
- Supply chain due diligence also needs to consider local & regional development, by supporting the development of infrastructure, fair payment, etc.
- Support the achievement of the SDGs along the supply chain
  - Ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance (SDG 1)
  - Build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters (SDG 1)
  - Ensure equal access to land (SDG 2)
  - Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws (SDG 5)
  - Adopt and strengthen sound policies and enforceable legislation for the promotion of gender equality and the empowerment of all women and girls at all levels (SDG 5)
- Support and strengthen the participation of local communities in improving water and sanitation management (SDG 6)
- Implement the principle of special and differential treatment for developing countries, in particular least developed countries, in accordance with World Trade Organization agreements (SDG 10)
- Encourage official development assistance and financial flows, including foreign direct investment, to States where the need is greatest, in particular least developed countries, African countries, small island developing States and landlocked developing countries, in accordance with their national plans and programmes (SDG 10)
- Develop effective, accountable and transparent institutions at all levels (SDG 16)
- Ensure responsive, inclusive, participatory and representative decision-making at all levels (SDG 16)
- Adopt and implement investment promotion regimes for least developed countries (SDG 17)
- Fully operationalize the technology bank and science, technology and innovation capacity-building mechanism for least developed countries and enhance the use of enabling technology, in particular information and communications technology (SDG 17)
- Enhance international support for implementing effective and targeted capacity-building in developing countries to support national plans to implement all the sustainable development goals, including through North-South, South-South and triangular cooperation (SDG 17)

**Transparency**

- Transparent and traceable supply chains are key aspects for due diligence reporting
  - Transparent ESG reporting has to be provided by all companies producing and trading in the EU, transparency is a prerequisite for supply chain due diligence.
    - The Responsible Mining Foundation (RMF) assesses mining companies and mine sites based on their publicly available documents and reports (or ‘evidence-based assessment [...] on environmental, social and governance issues’ (RMF 2020)). The requirements provided by this assessment serve as an important guidance for policy makers on what to expect from companies.

While we recognise the importance of audits and certifications for ensuring sustainable practices, it also needs to be recognised that an audit can only be a snapshot of a specific moment in time. Companies need to be held accountable for what they claim in their sustainability reports or similar. This can be ensured by transparent reporting on their actions to achieve their claims.

- Introduction and implementation of the EU Non-financial Reporting Directive
- Companies wanting to enter the European market have to provide information on their supply chains (incl. environmental and social practices)
Without fulfilling EU standards for responsible production in all stages of the supply chain trading in the EU is not possible. However, it is important to emphasize that trade is not a ‘one-way street’ and the EU has a responsibility to support their partners.

Companies or countries that are currently not meeting EU standards have to be supported in their capacity building and it has to be recognised that this development takes time and cannot be achieved over night. This means, the EU has to support trade partners who are willing to improve their practices in advance in order to meet the standards in time.

**Milestone 2040**

- Mandatory Supply Chain Due Diligence for all international actors (independent of company size)
  - Incl. control by government agencies
  - Environmental and Social Sustainability
  - Civil liability/accountability

**Actions until 2040**

**3.4.2 Recommendations for Industry**

**Milestones 2025**

- Resilient & risk-proof supply chains (e.g. considering Covid-19 and other black swan events)

**Actions until 2025**

- Assess and understand strategic vulnerabilities of companies’ supply chains (Shih 2020)
  - Local sourcing when possible (incl. increased use of secondary raw materials)
  - Develop alternative suppliers (also by accepting higher prices) & build safety stock
  - Long-term purchasing commitments to diversify sourcing
  - Re-think production processes, one factory should be able to conduct various work steps or produce various models to enable regionalised production and flexibility in case of disruptions elsewhere
- Include risk-management in infrastructure planning & development, incl. energy & water supply
- Report on all activities of operations and supply chains related to human rights, energy and water use, biodiversity impact, etc. see GRI reporting standards
- Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and end child labour in all its forms (SDG 8)
- Cooperation with suppliers and development shared cost models for certifications
- Commit to anti-corruption programme and assess risks along the supply chain, develop mitigation plan accordingly (e.g. Transparency International Anti-Corruption Toolkit)
- Respect regional differences and adapt accordingly (utilise regional expertise to help find the best solution, e.g. The Danish Institute for Human Rights - The human rights and business country guide)
- Implement UN Business & Human Rights Principles and the UN Guiding Principles Reporting Framework

Manufacturing
- Set decisive action against modern slavery and forced labour in the supply chains of solar PV and wind turbines

As elaborated in the State of play report for the renewable energy sector, the main supplier of polysilicon for the global solar PV market is China, more specifically the Uyghur region accounting for 45% of the global supply. It is known that polysilicon production in this region is carried out using forced labour by the indigenous population (see e.g. Murphy and Elimä (2021)). Manufacturers have to commit to full transparency and ensure that their supply chains are free of forced labour.

Milestones 2030
- Support the achievement of all afore mentioned SDGs along the supply chain
- Supply Chain Due Diligence (mandatory for large companies, voluntary for SMEs)
- Zero financial crime
- Local & regional development

Actions until 2030
- Make supply chains transparent and traceable, e.g. by applying (voluntary) certification schemes such as IRMA, CERA Chain of Custody Standard, or Together for Sustainability (TfS) and implement tracing programs
  - Recommendations from the Guidance Document (WPS) to follow
- Facilitate conflict free mineral supply chains and implement OECD Due Diligence Guidance for Multinational Enterprises and Responsible Mineral Supply Chains
- Ensure zero human rights violations, gender and racial equality along entire supply chain
- Accept responsibility for environmental degradation & social impact along entire supply chain, conduct risk assessment and develop mitigation plan accordingly
- Support responsible production practices by upstream companies and facilitate capacity building
- Substantially reduce corruption and bribery in all their forms (SDG 16)
- Integrate ESG considerations in investment decisions (e.g. apply UN Global Compact Principles for Responsible Investment)
- Ensure transparent financial flows (tax payments, investments, etc.) aligned with EU accounting and transparency directive
- Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed (SDG 17)
- Enhance support for implementing effective and targeted capacity-building in developing countries to support national plans to implement all the sustainable development goals (SDG 17)
Milestones 2040

- Adhere to Mandatory Supply Chain Due Diligence

Actions until 2040

3.5 Target 5: Level-Playing Field & International Cooperation

![Figure 11: Milestones for a Level Playing Field by 2030](image)

3.5.1 Recommendations for Policy Makers

Milestones 2030

- “Polluter Pays” Principle and Introduction of a Carbon Tax
- Clear global criteria for responsible and sustainable practices
- Harmonised reporting systems
- Achievement of the SDGs 1, 5, 6, 7, 8, 9, 10, 11, 17
- Harmonised EU mining policies
- Responsible production policies
- Extended producer responsibility
- Formalisation Artisanal and Small-Scale Mining (ASM)
Actions until 2030

General Considerations

- Introduction of a carbon tax as a first step towards a level playing field
- Internalisation of external costs (“unsustainability is unprofitable”)
- Create sound policy frameworks at the national, regional and international levels, based on pro-poor and gender-sensitive development strategies, to support accelerated investment in poverty eradication actions (SDG 1)
- Ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation, in order to provide adequate and predictable means for developing countries, in particular least developed countries, to implement programmes and policies to end poverty in all its dimensions (SDG 1)
- Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women (SDG 5)
- End all forms of discrimination against all women and girls everywhere (SDG 5)
- Ensure women’s full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life (SDG 5)
- Expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies (SDG 6)
- Enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology (SDG 7)
- Achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value (SDG 8)
- Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets (SDG 9)
- Promote inclusive and sustainable industrialization and significantly raise industry’s share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries (SDG 9)
- Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities (SDG 9)
- Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending (SDG 9)
- Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States (SDG 9)
• Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all (SDG 9)
• Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries (SDG 9)
• Empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status (SDG 10)
• Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and action in this regard (SDG 10)
• Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality (SDG 10)
• Improve the regulation and monitoring of global financial markets and institutions and strengthen the implementation of such regulations (SDG 10)
• Ensure enhanced representation and voice for developing countries in decision-making in global international economic and financial institutions in order to deliver more effective, credible, accountable and legitimate institutions (SDG 10)
• Strengthen efforts to protect and safeguard the world’s cultural and natural heritage (SDG 11)

Mining

• International cooperation to develop harmonised mining standards for responsible extraction; crucial to ensure access to resources (Nickless 2018; Mancini and Nuss 2020; Ali et al. 2017)
• Support development of new sustainable mining projects in the EU
• Imported raw materials need to fulfil the same standards in their extraction & processing as EU mined raw materials

Artisanal and Small-Scale Mining (ASM)

• Formalise ASM operations & ensure easy access to markets
  o Cooperate with organisations such as ARM or Impact to support sustainable development of ASM operations
• ASM needs to be supported to build capacity and include environmental and social considerations in their operations, certifications & audits usually require large investments that are not possible for the ASM sector, therefore cooperation between ASM and customers needs to be supported by policy-makers, e.g. by reducing taxes for companies engaged in local development of the ASM operations and communities
  o To enable capacity building an enabling operating environment is required, i.e. good governance

EU policy makers have to support developing countries in establishing a framework supporting the formalisation of ASM. Considerations include – participatory and inclusive law & policy design, enforcement of laws (incl. fight against corruption and money laundering)

Manufacturing
• Apply the same standards for imported goods as for products produced within the EU
• Goods manufactured with higher social & environmental standards must be preferred over others (e.g. lower taxes)

3.5.2 Recommendations for Civil Society

The level playing field will be a difficult goal to achieve, but one that is all the more important for achieving sustainable and responsible global supply chains.

NGOs can support this development by playing a mediating role between different countries and stakeholders. Especially for countries with conflicting political interests, an independent advisory body is of great importance.

Another important step is the harmonisation of reporting requirements and the mutual recognition of legal regulations as well as audits and certifications.

3.5.3 Role of International Organisations (UN/OECD/IFC)

Due to the complex and global structure of the renewable energy sector's supply chains, it is important that international organisations such as the UN and the OECD are strengthened. These organisations have an important contribution to make in shaping the level playing field and harmonising the requirements for companies. The role of the UN's international judiciary should also be extended to companies, so that internationally operating companies can be held more easily accountable for financial offences, as well as crimes against the environment and humanity.

The three organisations, the UN, OECD and IFC, already provide important templates for responsible behaviour by international companies in general. In addition, there are specific guidelines for mining, manufacturing and responsible sourcing of raw materials, all either specific to or applicable to the commodities under consideration. These guidelines must be implemented by member states on a mandatory basis and without delay, thereby also supporting an international level playing field.
4 Publication bibliography


Degreif, Stefanie; Farooki, Masuma; Endl, Andreas; Barriere, Noé; Berger, Gerald; Schluep, Mathias et al. (2020): D1.2 The RE-SOURCING Common Approach. Horizon 2020 Project Deliverable. Edited by RE-SOURCING (869276).


Ekins, Paul; Simon, Sandrine; Deutsch, Lisa; Folke, Carl; Groot, Rudolf de (2003): A framework for the practical application of the concepts of critical natural capital and strong sustainability. In Ecological Economics 44 (2-3), pp. 165–185. DOI: 10.1016/S0921-8009(02)00272-0.


Li, Jingwei; Lin, Yinhe; Wang, Fanmao; Shi, Jian; Sun, Jifei; Ban, Boyuan et al. (2021): Progress in recovery and recycling of kerf loss silicon waste in photovoltaic industry. In *Separation and Purification Technology* 254, p. 117581. DOI: 10.1016/j.seppur.2020.117581.


Parrique, Timothée; Barth, Jonathan; Briens, François; Kerschner, Christian; Kraus-Polk, Alejo; Kuokkanen, Anna; Spangenberg, Joachim H. (2019): Decoupling debunked: Evidence and arguments against green growth as a sole strategy for sustainability. Edited by European Environmental Bureau, checked on 6/7/2021.


RE100 (2021): RE100 Members. Edited by RE100. Climate Group; CDP. Available online at https://www.there100.org/re100-members, updated on 6/9/2021, checked on 6/10/2021.


