European Commission

ENTEC

Energy Transition Expertise Centre

Terms of Reference

Supply chain risks in the EU’s energy technologies

Terms of Reference – Supply chain risks in the EU's energy technologies

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Table of Acronyms

Abbreviation	Description
CET	Clean energy technologies
EC	European Commission
EU	European Union
GHG	Greenhouse gas
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
JRC	Joint Research Centre
KU Leuven	Katholieke Universiteit Leuven (Catholic University of Leuven)
NZIA	Net Zero Industry Act
RFNBOs	Renewable fuels from non-biological origins

1 Background, Objectives, and Scope

In more recent years, the European Commission has placed much focus on the supply chain risks of clean energy technologies (CET). The subject's first direct assessment came as a result of the Joint Research Centre's (JRC) Critical Raw Materials studies, from 2016 onwards, which has received its latest update in 2023. In between, the EC has also developed the Critical Raw Materials act[1] – an initiative to strengthen the European Union's capabilities with regard to clean energy technologies, at all stages, from raw materials to decommissioning.

The focus on the supply chains of clean energy technologies became especially strong during the REPowerEU plan[2], which followed the Russian invasion of Ukraine and threatened Europe's access to important energy inputs. More recently, on March 16, 2023, the European Commission adopted the Net Zero Industry Act[3] (NZIA), which details a series of measures to boost the manufacturing step of clean energy technologies in the EU. These measures aim at strengthening the manufacturing of components and manufacturing and/or assembly of devices for clean energy technologies. The end-goal is to improve the security of clean energy supply chains, for technologies that are technologically mature, have high contribution towards greenhouse gas (GHG) reduction goals, and may face risks for security of supply and/or competitiveness of EU production.

Many studies build on this analysis (see list in Table 1). The EC regularly publishes progress reports on the competitiveness of clean energy technologies, with the latest edition being published in 2022. Multiple studies from the International Energy Agency focus on clean energy supply chains from a global perspective, and two studies for the EC from Trinomics have focused on the EU context. Some JRC reporting on the subject also includes a foresight study from 2023. This complements some other studies, for example from the JRC, IRENA, and KU Leuven, which review critical materials. Each study has a specific depth and focuses on specific technologies.

1.1 Objectives

In this context, the Commission has requested the following services from the consortium:

- An updated analysis of the current state of energy technology supply chains, in terms of the most relevant changes since the previous study. Contents will include discussions of:
    - Technology components (e.g. anodes and cathodes for batteries, compressors for heat pumps, blades for wind turbines) and potential replacements
    - Transportation aspects, including with regard to ships, road transport, transportation through unstable regions
    - Geopolitical factors, including countries with unfavourable political attributes and politically unstable countries
    - Labour market dynamics, including labour shortages and needs for upskilling
    - Sustainability issues, such as resource shortages, climate and environmental impacts, and social aspects
    - An analysis of market risks, including

[1] https://ec.europa.eu/commission/presscorner/detail/en/IP_23_1661

[2] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en

[3] https://single-market-economy.ec.europa.eu/publications/net-zero-industry-act_en

    - The amount of EU demand, and the capability of EU internal market production to (competitively) meet this demand.
    - The impact of non-price criteria (security of supply, sustainability, system integration, and innovation) on the cost of technologies and key components
    - Market supply power and concentration
    - Market demand changes and future development
    - Efficiency and productivity issues of manufacturers
- (Where available), cost differences between manufacturing within and outside of the EU for the key components and/or devices of clean energy technologies

1.2 Scope

Based on our understanding of the objectives of the study, we believe that in the limited time window for this study, the focus should be placed on the following technologies, in order of priority:

- Solar photovoltaic systems (including balance of system components, such as inverters)
- Wind turbines (both on-shore and off-shore)
- Batteries (in both storage and E-mobility usage)
- Other storage technologies (such as hydrogen storage and thermal storage)
- Hydrogen Electrolysers and Fuel Cells
- Biomass and biomass-based fuels
- Ocean energy technologies
- Carbon capture and storage
- Heat Pumps
- Grid technologies (including both traditional and digital smart grid technologies)
- Geothermal energy
- Solar thermal systems

In addition to this main list, a few other technologies will also be assessed:

- Nuclear fission
- Hydropower (including pumped hydro storage)
- Energy system-related energy efficiency measures
- Solid bioenergy
- Bioliquids, including advanced biofuels
- Renewable fuels from non-biological origins (RFNBOs) excluding hydrogen

Within each supply chain, the study will, as requested, **focus mainly on the manufacturing of precursors and components, and on device manufacture and assembly operations**. Insofar as they are relevant for the manufacture and assembly of CET, optionally these topics in each supply chain will be briefly mentioned:

- Raw/processed materials
- Existing production and assembly lines
- Installation, operation, and maintenance
- Decommissioning/recycling/reuse
- Labour market outlook
- Transportation bottlenecks
- Sustainability issues

The analysis will also consider the potential policy environment of the future, in terms of favouring or discouraging growth in the use of various technologies.

2 Methodology

Given the study's time limitation and technological focus, we will primarily develop these analyses based on desk research, with some potential input from technology experts. We envision this study as proceeding through the following tasks.

2.1 Task 1: Defining indicators for the strategic status of a supply chain

This task reviews existing supply chains to identify and define a set of indicators that are indicative of possibly strategic risks with an energy technology. Preliminarily, we understand a strategic supply chain to have the following attributes:

- **High potential impact in the short-term**. This will relate to technologies with developed supply chains (i.e. with a technology readiness level above 8+), which "…are projected to deliver a significant contribution to the 2030 Fit-for-55 target of reducing net greenhouse gas emissions by at least 55% relative to 1990 levels."[4]
  - This impact assessment must also consider future policy development in favour of (or against) the use of specific technologies.
- **High growth requirement for internal EU market production** to meet impact potential for greenhouse gas emissions. This indicator mainly refers to **the difference between current and required future manufacturing capacity in 2030** for components and devices associated with the technology in question. The shortfall of this capacity will inevitably be met with import and its relevant dependencies, considering also the timing required for developing relevant manufacturing capacities.
  - Competitiveness **threats** towards manufacturing/assembly of technology, and also components and precursors, in the EU versus third countries, **market concentration** aspects especially in the case of import dependency, **and other vulnerabilities** such as labour shortages, environmental/regulatory risks, logistics issues, and scale-up concerns.

We present each attribute with an indicator score based on its comparative strategic concern in comparison to other technologies. These values would range from 1 (very low) to 5 (very high), with higher values indicating a higher strategic dimension for the technology and the associated supply chain(s).

2.2 Task 2: Desk research and expert input on energy supply chains

The first step here will be to involve experts who previously worked on the Trinomics (2021) study to review the current state of similar supply chains. This will be an update of the prior study, based on new supply and demand forecasts and supply chain trends since the data collection undertaken in 2020. The update will also involve short-form consultations with relevant stakeholders and experts who provided input as part of the prior Trinomics study.

The second step will involve review of existing (and especially recent) literature on subjects of energy technology supply chains. Resources for this include (but are not necessarily limited to) those listed in Table 1.

[4] EC (2023), COM 161 final: REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on establishing a framework of measures for strengthening Europe's net-zero technology products manufacturing ecosystem (Net Zero Industry Act)

Table 1: Preliminary list of sources for desk research

Author (Year)	Title	Region studied	Techs studied
EC (2022)	Progress on competitiveness of clean energy technologies	EU	Multiple
IEA (2022)	The role of critical materials in clean energy transitions	Global	Multiple
IEA (2022)	Global supply chains of EV batteries	Global	Batteries
IEA (2022)	Special report on solar PV global supply chains	Global	Solar PV
IEA (2023)	Energy technology perspectives	Global	Multiple
JRC (2016)	Assessment of potential bottlenecks along the material supply chain	EU	Multiple
JRC (2022)	Clean Energy Technology Observatory reports (overall strategic analysis, individual technology status reports, modelling report)	EU	Multiple
JRC (2023)	Supply chain analysis and material demand forecast in strategic technologies and sectors in the EU – A foresight study	EU	Multiple
Trinomics (2019)	Study on energy technology dependence	EU	Multiple
Trinomics (2021)	Study on the resilience of critical supply chains for energy security and clean energy transition during and after the COVID-19 crisis	EU	Multiple
KU Leuven (2022)	Metals for clean energy	Europe	Multiple
IRENA (2021)	Critical materials for the energy transition	Global	Multiple

2.3 Task 3: Analyse and rank criticalities

In this task, we use the data and information gathered in Task 2 to understand and compare the criticalities of the different supply chains. The main output here will be a table listing critical aspects of each supply chain, with a qualitative assessment of the supply chain's criticality.

We envision this table consisting of the following columns:

1) A list of technologies as defined in Section 1.2.
2) Envisioned contribution to the EU's 2030 target for greenhouse gas emissions, qualified based on capacity of installed technology (and volume installed for storage technologies).
3) Growth needed compared to current EU manufacturing capabilities.
4) Threats to competitiveness of current EU manufacturing, market concentration concerns, and other vulnerabilities in the manufacturing of the CET.
5) A final composite score for the strategic status of each technology based on assessments of the prior four columns.

2.4 Output

Our initial deliverable for this project will be a PowerPoint presentation on the main findings, including the table described in Section 2.3. Following this deliverable, we will also prepare the main deliverable, a report (of about 20-30 pages) on the current state of clean energy technology supply chains. Upon agreement with the client, our suggestion for this report will review each supply chain technology within 2-3 pages. Additional information may be collected in an annex if relevant. Finally, the report will contain a conclusion section which ranks supply chain risks in a matrix and provides any relevant details and limitations.

3 Work Organisation

The project will run from early April to late May 2023. Based on the Methodology, we imagine the timeline developed in Table 2 for deliverables and meetings. We will rely on regular feedback from the client while progressing in the study, the practicalities of which can be discussed within the first meeting (M1).

We propose a team with diverse experts within Trinomics to cover different supply chains and transversal risk areas.

Table 2: List of deliverables and submission dates

Deliverable/meeting	Contents	Date (original)	Outputs
M1	Kick-off for all tasks	Week of 10 April	PowerPoint slides
D1	Draft slides with preliminary results	2 business days before final meeting (latest 10 May)	PowerPoint slides
M2	Final meeting	Week of 8 May	PowerPoint slides
D2	Draft final report	24 May	Word document
D3	Revised final report	1 week after comments / TBD	Word document

* Note that the **project can officially start only after the final approval of the Terms of Reference (ToR) (i.e. this document).** In the case that these two are delayed, the overall project timeline will have to be adjusted accordingly.

3.1 Resources

Table 3: Planned resources by task

Task/Resource	Resource needs in days	Share of total resources in percent
Project Coordination	4	7%
Task 1 (Defining indicators for strategic status)	6	11%
Task 2 (Desk research and expert input)	30	56%
Task 3 (Analysis)	13	24%
Quality assurance	1	2%
Total	**54**	**100%**

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