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Energy transition on the horizon: Highlights and lowlights within the power energy sector for supply chains decarbonization

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Abstract. *We live demanding times and after two pandemic years the energy prices are rising worldwide. The world is hungry for energy and climate change calls for lower emissions. The major power energy sector challenges are the increased energy demand due to industrial activity, climate change, demographic pressures, and urbanization trends, including pandemic. The companies need efficient and reliable energy and decarbonization technologies to succeed. Industries and power generation companies had to take on many challenges while running their business operations. However, the process of decarbonization takes time and includes the energy transition away from conventional fuels, from coal to gas and then to hybrid systems with renewables and cleaner fuels, such as hydrogen. The aim of this paper is to set a basis to pinpoint the subject of "Supply chains Decarbonization" within the Power energy sector as one of the tough challenges yet to come. The main objective of this article research is to provide a critical review of the commitments for decarbonization of supply-chains with focus on the power energy sector, based on international business experts and research articles. The methodologies used for this research is based on very recent research papers and studies review of major consulting groups, publishers, and energy sustainability councils. Pros and cons hypotheses are being organized as Highlights/ Lowlights over long or short run, in the conjecture of various consulting experts. The findings reveal that consulting groups express concerns and attention for the risks, some of the risks could be significant, results are less to be noted in the short run, but the results and the achievements are to be considered in the longer period. Google trend shows that the syntagms of "decarbonization" and "energy transition" are well known and searched.*

Keywords: Decarbonization, Supply chains, Power Energy, Climate change, Scope 3.

Introduction

The definition of "Climate change" refers to long-term modifications in temperatures and weather patterns. Main drivers of this climate shift are the industrial activities which require burning of fossil fuels (coal, oil and gas) but not limited to. (Shahzad, 2015). Actions which generate greenhouse gas (GHG) emissions contribute to the raising of Earth temperatures as well. Consequences of this climate change situation are intense droughts, large forest and vegetation fires, polar ice melting, rising of oceans level, land areas with catastrophic storms or flooding due to deforestation, affecting biodiversity and Earth ecosystem. (WHO, 2003; Adedeji et al., 2014).

To tackle the negative effects of climate change, the first cornerstone moment came when the world leaders had adopted the "Paris Agreement" in 2015, an historical international treaty

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adopted by 196 parties including the European Union (ECBI, 2020). The 2015 Paris Agreement commits countries to limit the global average temperature rise to well below 2°C above pre-industrial levels, and to aim for 1.5°C (UN, 2015).

In the last few years more attention has been for the topics related to climate change with the following buzzing syntagms: "energy transition", "decarbonization", "supply chain decarbonization", "scope 3".

The main objective of this article research is to provide a critical review of the commitments for decarbonization of supply-chains with focus on the power energy sector, based on international business experts and research articles.

The paper presents an overview of the problem by describing the main concepts from simple to complex. Pros and cons hypotheses are being organized as Highlights/ Lowlights over long or short run, in the conjecture of various consulting experts. It was considered the general opinion for the industrial business, which extends over the power energy sector.

Based on decarbonization targets addressed by climate summits, the triggering questions for this research article are in a logically way as follows:

RQ1 What would be the horizon of this journey of Energy transition?

RQ2What would be the general impacts with High-/Lowlights over the supply chains?

RQ3 What are the general trends and worldwide concerns?

The findings reveal that consulting groups express concerns and attention for the risks, some of the risks could be significant.

Literature review

Energy transition requires a significant structural change of the energy system towards sustainable energy, transition to renewable energy and energy efficiency, with a declared goal to phase-out the fossil fuels to reduce GHG emissions (ECBI, 2020; Hafner & Tagliapietra, 2020). Moreover, different technologies involved in low carbon energy transition should be effective in ensuring resilience, flexibility, adaptability and security for a rapidly changing energy system (Hoggett, 2014), based on measurable indicators, which require a solid international consensus on transparent standards and targets (Noussan et al., 2021).

An important step for energy transition, besides Renewable, Efficiency and Fuel switch to non-fossils fuels, is also the Circular Carbon Economy to reduce waste, to enable restorative processes (WBCSD, 2020), and to efficient reuse of emitted carbon dioxide (Ramirez-Corredores et al., 2021)

Decarbonization is a general goal of the global economic world and represents the reduction of carbon dioxide emissions through the use of low carbon power sources, to limit climate change and global warming (Misztal et al., 2021). These actions include a complex interaction of multiple technologies and major challenges for all the sectors with higher impact on the energy sector (Markard, 2018; Galea-Pace, 2020; ECBI, 2020; Burchardt et al., 2021).

Power Energy sector is the industry related to the production and supply of energy and it consists of power generation, power transmission and distribution, being one of the major contributors to climate change and global warming (Dalir et al., 2018; Ramirez-Corredores et al., 2021). Power generation generates electricity from primary energy sources like fossils, nuclear, renewables. Hydrogen, which is or could be co-fired with natural gas, is produced by electrolysis that provide flexibility by absorbing electricity at times of high availability of intermittent sources (Sgobbi et al., 2016), being an energy carrier, not an energy source, and can deliver or store the

energy in order to generate electricity, power or heat (Kumar, 2015; Parra et al., 2019; Stöckl et al., 2021). Energy sector decarbonization is a very complex issue where many political, environmental, economic, social, and ethical aspects should be considered all together (Papadis & Tsatsaronis, 2020; Watari et al., 2021). However, the ratio cost – efficiency in emission reduction could influence energy industry in production technologies associated with the full supply chains involved (Speirs et al., 2018; Parkinson et al., 2019), so it is importance to develop an integrated energy system framework with multiple energy drivers in providing cost-effective energy system decarbonization (He et al., 2021).

Supply Chain is the sequence of processes involved in the production and distribution of a commodity. For example, for the power energy industry, the supply chains consist of all upstream vendors and suppliers meant to provide key components for the focused sector (core components of turbines, generators, switchgears, automation, etc.) (Saavedra M. et al., 2018; WEF, 2021; Burchardt et al., 2021). The impact of supply chain emissions is a significant factor in total emissions estimates and varies considerably across different routes to produce energy, the range of potential supply chain emissions being a significant proportion of total emissions (Balcombe et al., 2018). Globalization of supply chains has led to increasingly emission transfers from the developing to the developed world, thus, developed countries being able to decarbonize internally, at the expense of enhanced emissions in developing countries (Wood et al., 2020).

GHG Protocol corporate standard (WBCSD & WRI, 2012) classified a company's GHG emissions into three scopes (Figure 1).



Figure 1. Scope 3 upstream to the focus of supply chain decarbonization

Source: (WBCSD, 2021).

Scope 1 Direct GHG Emissions refers to emissions that occur from operational activities and sources that are controlled or owned by the organization and Scope 2 Electricity indirect GHG emissions refers to emissions associated with the purchase of electricity, steam, water, heating or cooling. Scope 3 includes all other indirect GHG emissions that occur upstream or downstream of the organization, in the supply value chain. Scope 1 and 2 are mandatory to report, whereas scope 3 is voluntary and the hardest to monitor. However, companies succeeding in reporting all three scopes will gain a sustainable competitive advantage (WBCSD, 2021; Spiller, 2021).

The sectors are unevenly exposed in the net-zero transition. According to Hertwich & Wood (2018), out of all the sectors which account for gas emissions, the power energy and the transport account for the larger scope 1 and the industry, building and agriculture, forest and land-use related are account for the larger scope 3. In this context the power energy sector has the strategy to focus and build the energy transition on non-fossils fuels to reduce its scope 1 and 2. However, scope 3 is equally important and major international energy players express firm statements to commit for decarbonization of their supply chains and reduce emissions by 2030.

Methodology

The methodologies used for this research is based on very recent research papers and studies review of major consulting groups, publishers, and energy sustainability councils, as well energy companies decarbonization commitments.

For the baseline analysis it was considered sixteen international major publishers and consulting groups and six major power energy international companies listed randomly, whose statements on decarbonization and energy transition have been corroborated with conclusions of several research studies. The analysis is an extensive qualitative comparison to balance the opinions pros-and-cons and to draw pertinent conclusions.

Using Google Trends, the worldwide interest in decarbonization and energy transition topics over the last five years were analyzed.

Results and discussions

The analysis of several relevant statement over the energy transition and decarbonization of energy sector companies reveals that the power energy companies are setting ambitions decarbonization targets to reduce emissions by 2030 and by partnering with their supply chains for scope 3 (Mitsubishi Electric Group, 2022; Maiden, 2022; Schneider Electric, 2022; Siemens Energy, 2022; ABB, 2020; Norton, 2020). There is a strategic opportunity for the power energy companies to accept the challenge of the energy transition towards renewable clean energy and new sources and reliable technologies. The supply chain value mapping and the close monitor is another challenge to mitigate risks and achieve scope 3 targets.

To have an accurate and stand-alone analysis, sixteen major international consulting groups have been analyzed in their reports and studies over the past two years (Table 1).

Table 1. Statements of major international consulting groups: Significant Risks and Highlights - Lowlights over Long - Short terms on the topic of Decarbonization Global Supply Chains

No.	RISKS 1 =>4 High/Long High/Short Low/Long Low/Short	Source of research: Consulting Group/ Publisher/ Online Magazine/ International Agency/ World organization\	Authors opinion as Highlights Highlights on long-time 1=>4 Highlights on short-time 1=>4	Authors opinion as Lowlights Lowlights on long-time 1=>4 Lowlights on short-time 1=>4
1	4	Power (Larson, 2022)	- Solar energy sector increase in 2021 - New opportunity by innovative academic mindsets for new technologies	- Supply chains are a "potential stumbling block" due to constraints leading to price increase - Artificial demand by placing multiple online orders, a "rising tide of demand" with limited capacity - Water treatment raw materials shortage, road truck transportation issues - Effect of ripples "by rock throwing into a pond": after 1st wave, come the 2nd and 3rd effects -
	3			
	2			
	4			
	3			

No.	RISKS 1 =>4 High/Long High/Short Low/Long Low/Short	Source of research: Consulting Group/ Publisher/ Online Magazine/ International Agency/ World organization\	Authors opinion as Highlights Highlights on long-time 1=>4 Highlights on short-time 1=>4	Authors opinion as Lowlights Lowlights on long-time 1=>4 Lowlights on short-time 1=>4
2	4 2 2 3 3	**Ernst & Young Global** (Roost & Nelson, 2021)	- SC professionals shall see the opportunities for changes - Operations teams shall focus on four key energy areas: fuel source, energy distribution, energy storage, demand response;	- SC professionals will face struggles to deal with both trends of -decarbonization strategies and policies firm - Understanding energy is the key to delivering in all the sectors SC - Capital is flowing into the challenges of -decarbonization
3.	3 3 1 4 5	**Boston Consulting Group** (Burchardt et al., 2021)	- Related to power energy sector the article lists the construction and electronic sectors as two out of 8 focused industry which generate more than 50% gas emissions - Decarbonization is less expensive at the end of any given value chain	- Less progress due to complex calculation of scope 3 compared with scope 1/ scope2 - Supply chain multitier emissions the more complex the more difficult to estimate - Strong procurement to enable supply chain transparency - Upstream decarbonization a hard and overtime consuming process
4.	5 2 1 4 4	**McKinsey&Comp.** (Spiller, 2021)	- Study case Scope 3: Product and logistic optimization + SC energy = average 30% of the total GHG - Target definition, program set-up, implementation, and tracking - Becoming a role model	- Lack of carbon-accounting foundations - Reliance on secondary data -High uncertainty, higher costs? - Building alliances -Sustaining engagement
5.	3 3 2 4 5	**Deloitte** (McClowry & O'Brien, n.d.)	- Moving towards sustainability - Supply Chain Value Map, Supply Chain Maturity Models, Supply Chain Optimization Modeling, Supply Chain Assessment Tool	- Moving towards profitability - Bottlenecks and breakpoints can introduce excess costs, waste, and customer dissatisfaction - Scarce resources to service the booming offshore markets of China and India in particular
6.	4 4 3 4 3	**KPMG** (KPMG, 2020)	- Renewable energy; Low carbon emissions, Environmental technology, Wind Power, Innovation, Paris Agreement	- Air pollution, biodiversity affecting, stronger environmental policy
7.	3 3 3 2	**PriceWaterhouseCoopers (PWC)** (Galea-Pace, 2020)	- PWC is making a commitment to decarbonize its operations and supply chain while trying to achieve net zero GHG emissions by 2030	- A net zero world is within reach. Getting there will take innovation, hard work, collaboration, and bold thinking

No.	RISKS 1 =>4 High/Long High/Short Low/Long Low/Short 5	Source of research: Consulting Group/ Publisher/ Online Magazine/ International Agency/ World organization\	Authors opinion as Highlights Highlights on long-time 1=>4 Highlights on short-time 1=>4	Authors opinion as Lowlights Lowlights on long-time 1=>4 Lowlights on short-time 1=>4
8.	4 2 3 4 3	**IEA-International Energy Agency** (Cozzi & Gould, 2021)	- The social and economic benefits of accelerating clean energy transitions are huge and the costs of inaction are immense.	- The economic recovery in 2021 has tightened commodity markets and put pressure on fossil materials (natural gas, coal, crude oil, etc.), and consequently, on the prices. - No single blueprint to phase-out the coal-fired generation due to local circumstances and priorities. - Energy security and the risk of disorderly change
9.	4 2 1 4 3	**World Economic Forum** (WEF, 2021)	- Create transparency, build value chain emissions baseline, and exchange data with suppliers. - Optimize for CO2, redesign products for sustainability, design value chain/ sourcing strategy for sustainability - Engage suppliers by working with suppliers to address their emissions, integrate emissions metrics in procurement standards and track performance - Push ecosystems, engage in sector initiatives for best practices, certification, advocacy. - Introduce a low-carbon governance to align internal incentives and empower your organization	- Companies often struggle with a clear mandate for the sustainability function to engage with procurement on supply chain emissions – they are most often still focused on their direct operations.
10.	4 2 3 3 4	**GreenBiz** (Scheepmaker, 2021)	- Interpret: Understand your supply chain context and climate impacts - Intent: Articulate your intentions - Involve: Engage with stakeholders - Inform: Guiding and supporting suppliers - Impact: Create results with a thorough approach	- For most multinational organizations, climate impacts from doing business do not originate from their own operations, but from their suppliers - Reducing supply chain emissions is not only a matter of financing and technological solutions — it is a matter of building and maintaining relationships

No.	RISKS 1 =>4 High/Long High/Short Low/Long Low/Short	Source of research: Consulting Group/ Publisher/ Online Magazine/ International Agency/ World organization\	Authors opinion as Highlights Highlights on long-time 1=>4 Highlights on short-time 1=>4	Authors opinion as Lowlights Lowlights on long-time 1=>4 Lowlights on short-time 1=>4
11.	3 1 2 3 3	**Carbon Footprint** (Carbon Footprint, 2021)	- Services to calculate the environmental impact of your supply chain. - Supply chain footprint appraisal and supply chain footprint verification	- Services to calculate the environmental impact of your supply chain. - Supply chain footprint appraisal - Supply chain footprint verification
12.	4 1 2 4 3	**Roland Berger** (Henzelmann, 2021)	- Climate change is one of the greatest challenges of the twenty-first century. - Roll-out plan and close working cooperation with suppliers	- The energy value chain is one of the biggest culprits when it comes to GHG. The main activities in the industry generating emissions are power generation from fossil fuels
13.	2 3 1 2 1	**Future Energy Week** (Future Energy Week, 2021)	- Move forward with the zero-emission pledges to embed them into practical plans and actions - Incentivize suppliers to ensure a resilient climate-smart supply chain - Embed the latest decarbonization trends in your company, build alliances and partnerships - Carbon neutral-value manager speakers invited	- There is lagged and insufficient action across many large corporations - Many companies have as Scope 3 up to 80% emissions account of their overall climate impact.
14.	3 2 2 3 4	**World Business Council for Sustainable Development** (WBCSD, 2021)	- Multinationals are in a unique position to influence supplier behaviors, operations, and investments through incentives - Solutions to incentivize supply chain decarbonization; reward-based outcomes, to those that take a more penalty-based approach. The second axis shows whether the incentives are monetary in nature, ranging from financial to non-financial. - Share learnings and resources.	- Higher product prices due to longer term investments, pay for performance, beneficial payment terms and other benefits to incentivize. - Upskilling and peer benchmarking versus contract termination versus

No.	RISKS 1 =>4 High/Long High/Short Low/Long Low/Short	Source of research: Consulting Group/ Publisher/ Online Magazine/ International Agency/ World organization\	Authors opinion as Highlights Highlights on long-time 1=>4 Highlights on short-time 1=>4	Authors opinion as Lowlights Lowlights on long-time 1=>4 Lowlights on short-time 1=>4
15.	3 3 2 3 4	Forbes (Panditi, 2022)	- The bigger the company the bigger the responsibility; Lead by example - Many companies are making progress in addressing Scope 2 emissions through renewable energy purchasing - Automotive = Power Purchasing Agreements (long-term agreements between buyers and sellers of energy to finance the development of renewable sources) to help finance the decarbonization of their suppliers' operations.	- Tackling Scope 3 emissions, which for many companies account for the majority of their GHG emissions, is much more complex - While we can't control the actions of every partner, there's a domino effect across the value chain - Automotive could create Scope 3 emissions account for 98% of its total emissions,
16.	3 4 2 4 4	World Economic Forum (WEF, 2009)	- Mapping Sustainability, the way of representing knowledge content in the domain of "sustainable development," with the full expectation that such knowledge changes over time	- Different stakeholders may have different views and priorities about what is "real," what is "important," and what can or should be done as a result. - The complexity of sustainability as a notion coupled with ambiguities in its meanings and understandings

Note: Summary overview and impact scores 1=Low; 2=Low-to-Medium; 3=Medium-to-High; 4=High
Source: Author's own research consisting of cross analysis for a total of 16 major international consulting groups and councils for areas of risks mitigation and Highlights - Lowlights over Long - Short terms on the topic of decarbonization global supply chains.

The analyzed criteria have been considered within a cartesian coordinate system where on X-axis is the Expected Effects (Positive if Highlights, Negative if Lowlights) and Y-axis is the Expected Time (Positive if on Long-run, Negative if on Short-run). The used Weighted Criteria Matrix is considered to evaluate the potential options against a scale of weighted factors from 1=Low, 2=Low-to-Medium, 3=Medium-to-High and 4 =High. The more optimist statement for the best-case scenario the X-Axis will be higher, the longer effects to show on timeline the Y-Axis will be higher. The 5th element is the significant risk and consists of the intersection of all the statements from each consulting reviewer's point of view. The process of scoring is an original author's approach to showcase debatable pros-and-cons on the selected topics (Figure 2).

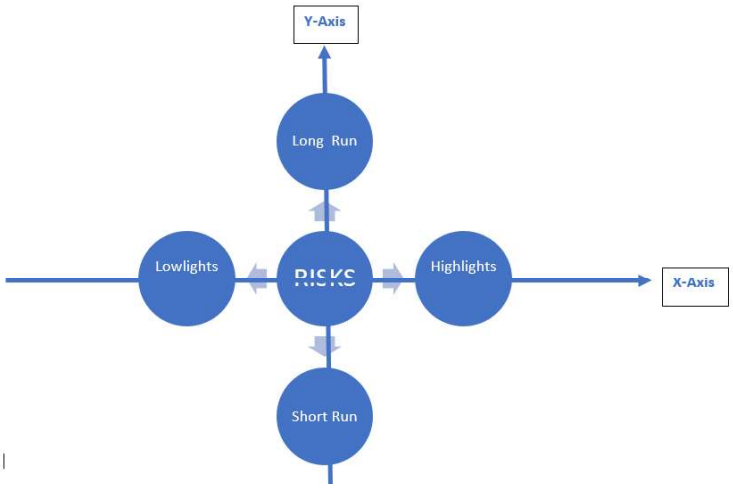


Figure 2. Analysis criteria with Effects High- Lowlights versus Timeline Long - Short run
Source: Author's own risk assessment methodology.

The five selected criteria have been visually showcased by radar-graphic type and where the average score is represented by the red color (Figure 3).

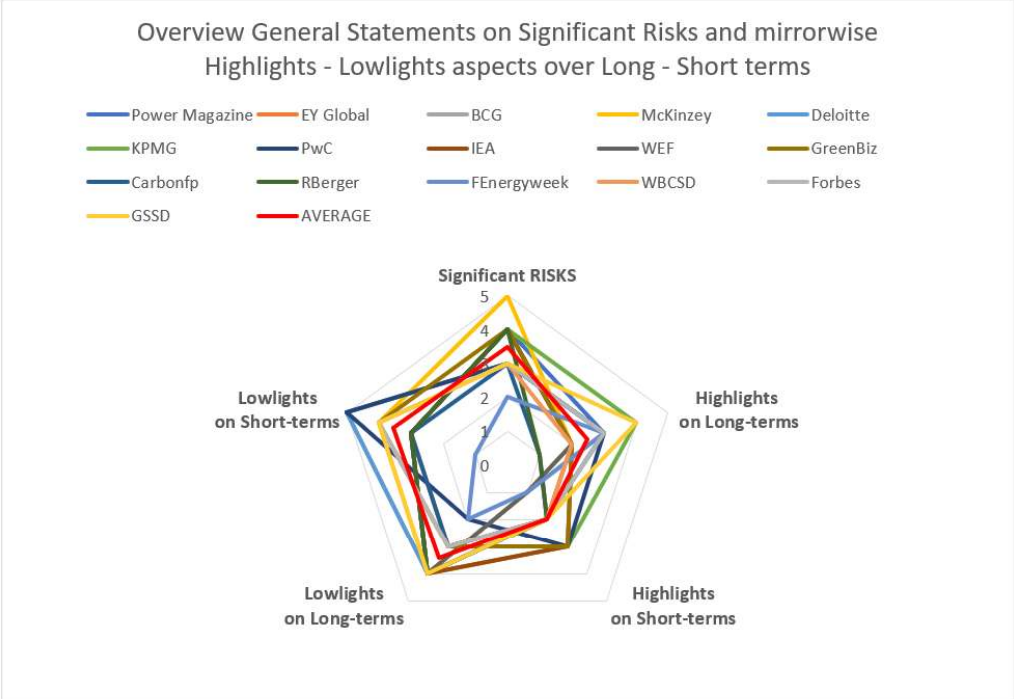


Figure 3. Visual comparison of potential scenarios based on experts' analysis
Source: Author's visual radar graphic to showcase concerns due to risks, highlights, and lowlights on short to long-time with impact scores on the scale 1=Low/ 2=Low-to-Medium/ 3=Medium-to-High/ 4=High.

Average Total Risks = Σ Risks scores/ Σ no. = 3.50
Average Total Highlights on Long-time = Σ (Highlights on Long-time)/ Σ no. = 2.50
Average Total Highlights on Short-time = Σ (Highlights on Short-time)/ Σ no. = 2.00
Average Total Lowlights on Long-time = Σ (Lowlights on Long-time)/ Σ no. = 3.44
Average Total Lowlights on Short-time = Σ (Lowlights on Short-time)/ Σ no. = 3.56

The analysis is an extensive qualitative comparison to balance the opinions pros-and-cons and to draw pertinent conclusions. As a general conclusion, the consulting groups express concerns and attention for the risks, some of the risks could be significant, results are less to be noted in the short run, but the results and the achievements are to be considered in the longer period.

What are the general trends and worldwide concerns? By the means of Google Trends, the graphic analysis presents the worldwide interest of decarbonization (blue color) and energy transition (red color) topics over the last five years. However, the "supply chain footprint" syntagm is much less used and quite recently began to increase its frequency of occurrences (Figure 4).

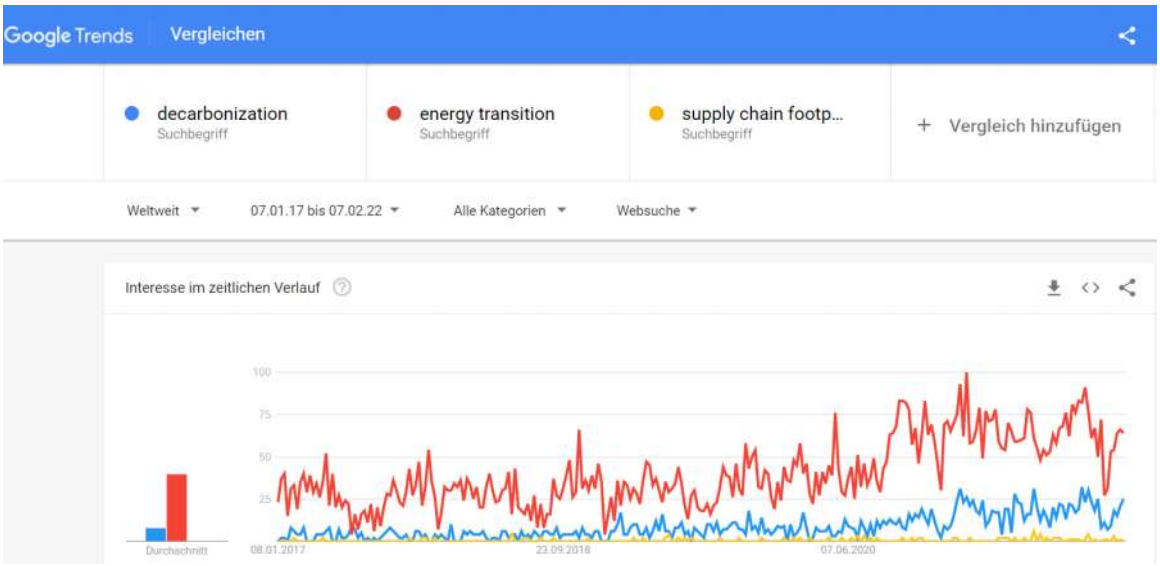


Figure 4. Google Trends Graphic Web search all categories for the selected words over past 5years
Source: Author´s design based on data from Google Trends, 2022.

Visual graphic showcases the fact that if the syntagms of "decarbonization" and "energy transition" are well known and searched, the occurrences of "supply chain footprint carbon" are less to show up. Just to note that other syntagms, synonyms for the closed areas of terminologies, such as "decarbonization supply chains" or "decarbonization scope 3" are quasi linear to null which means that are not sufficiently popular or generally meant for frequent usage.

Conclusion

Achieving net zero for Scope 1 and Scope 2 emissions is an important technical and economic challenge for many companies, especially those in energy- and resource-intensive sectors. Scope 3 upstream related to supply chain decarbonization is a complex process according to the cross analysis considered. Gaps have been identified, however the proposed strategies in major lines shall be aligned.

The analysis of major international consulting groups' reports and studies over the past two years reveals that consulting groups express concerns and attention for the risks, some of the risks could be significant, results are less to be noted in the short run, but the results and the achievements are to be considered in the longer period of time.

Google trend analysis showcases the fact that if the syntagms of "decarbonization" and "energy transition" are well known and searched, the occurrences of "supply chain footprint carbon" are less to show up.

For further research, identifying the areas of risk mitigation is relevant to conduct a supply chain baseline and mapping exercise. Also it is necessary to establish a roll-out development plan for supplier decarbonization incentives. This plan includes setting emissions baseline and periodical reviews of supplier's actions and commitments. Appropriate data collection (carbon metrics) is to be tracked to show the emissions reduction progress.

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