

How Schneider Electric's Climate Risks Interact

And how the network view
can help spot opportunities
and avoid the biggest tragedies

Introducing the Schneider Electric™ Sustainability Research Institute

Gwenaëlle Avice-Huet (left)

Chief Strategy and Sustainability Officer,
Schneider Electric

Vincent Petit (right)

SVP Climate and Energy Transition research,
head of the Sustainability Research Institute,
Schneider Electric



Global awareness for a more inclusive and climate-positive world is at an all-time high. This includes carbon emissions as well as preventing environmental damage and biodiversity loss.

Nation states and corporations are increasingly making climate pledges and including sustainability themes in their governance. Yet, progress is nowhere near where it should be. For global society to achieve these goals, more action and speed is needed.

How can we convert momentum into reality? By aligning action with the United Nations Sustainable Development Goals. By leveraging scientific research and technology. By gaining a better understanding of the future of energy and industry, and of the social, environmental, technological and geopolitical shifts happening all around us. By reinforcing the legislative and financial drivers that can galvanize more action. And by being clear on what the private and public sectors can do to make all this happen.

The mission of the Schneider Electric™ Sustainability Research Institute is to examine the facts, issues, and possibilities, to analyze local contexts, and to understand what businesses, societies and governments can and should do more of. We aim to make sense of current and future trends that affect the energy, business, and behavioral landscape to anticipate challenges and opportunities. Through this lens, we contribute differentiated and actionable insights.

We build our work on regular exchanges with institutional, academic and research experts, collaborating with them on research projects where relevant. Our findings are publicly available [online](#), and our experts regularly speak at forums to share their insights.

Set up in 2020, our team is part of Schneider Electric, the leader in the digital transformation of energy management and automation, whose purpose is to bridge progress and sustainability for all.

In this study, we describe how we assessed our climate change risks with an interconnectivity lens. Using expert elicitation and graph theory as our tools, we were able to depict technological, economic, social, governmental, and environmental climate risks in a network, and from it draw concrete actions for managing these risks. We hope our methods, findings, and conclusions may be useful for other organizations trying to assess risk and opportunity in an environment marked by complexity.

Gwenaëlle Avice-Huet

Chief Strategy and Sustainability Officer, Schneider Electric

Vincent Petit

SVP Climate and Energy Transition research, head of the Sustainability Research Institute, Schneider Electric



table of contents

- 1 Introducing the Schneider Electric™ Sustainability Research Institute
- 3 Terminology overview
 - 3 Traditional risk management terminology
 - 3 Network terminology
- 4 Executive summary
- 5 Introduction

Chapter 1: What's so important about interconnectivity?

- 7 Influential risks
- 8 Influenced risks
- 8 Isolated risks and leverage points
- 8 Connected climate risks

Chapter 2: Methods

- 10 Expert elicitation
- 11 Graph theory
- 12 Analysis

Chapter 3: Results

- 14 Individual rankings
- 14 Interconnectivity rankings and overview

Chapter 4: Discussions & conclusions

- 17 Interpretation of pilot results
 - 17 Individual importance
 - 17 Connectivity importance
 - 17 Using the network flow
 - 17 The leverage point
 - 18 Conclusion on climate risk network assessment
- 18 Conclusions on usefulness for others
- 19 References

List of figures and tables

List of figures

- Figure 1. Depiction of a root cause.
Figure 2. Depiction of a vulnerable risk.
Figure 3. Schneider Electric's climate risk network.

List of tables

- Table 1. Top 4 risks ranked by impact, and Top 4 ranked by likelihood.
Table 2. Top 4 risks ranked by influence, and Top 4 ranked by vulnerability.

Terminology overview

Traditional risk management terminology

Used as synonyms

Severity	Likelihood
Impact	Probability

Network terminology

Used to mean the same kind of points in the network

	
Influenced risks	Influential risks
Vulnerable risks	Root causes
Effect events	Causal events
"Can't go wrong" events	"Must get right" events
Nodes with high in-centrality	Nodes with high out-centrality

Executive summary

It has been well-established by now that the myriad of risks arising from climate change interact with one another, crossing not just national boundaries but also classifications such as environmental, social, governmental, economic, or technological. In 2022, Schneider Electric set out to map its different climate risks in a network in order to analyze their interconnectivities, so that it could then optimize its climate risk mitigation and strategy based on this analysis.

Methodology

We used expert elicitation and graph theory (network mathematics). These tools are suited to assess interacting events of different natures and can reveal useful insights in addition to what can be found with more traditional risk assessment tools like the likelihood/severity plot. Using interviews and anonymous surveys with participating Schneider Electric employees in the expert elicitation, we arrived at a climate risk list spanning a wide array, from our supply chain to internal knowledge, from physical impacts on our operations to company values, from changing customer expectations and preferences to geopolitical events. We also asked participants in the expert elicitation which risks they thought were connected to one another. Based on all the responses, we calculated each risk's individual likelihood and severity, as well as connectivity metrics for a risk's influence on other risks (centrality). We also used these outputs to construct a network depiction of how Schneider Electric's climate risks interact.

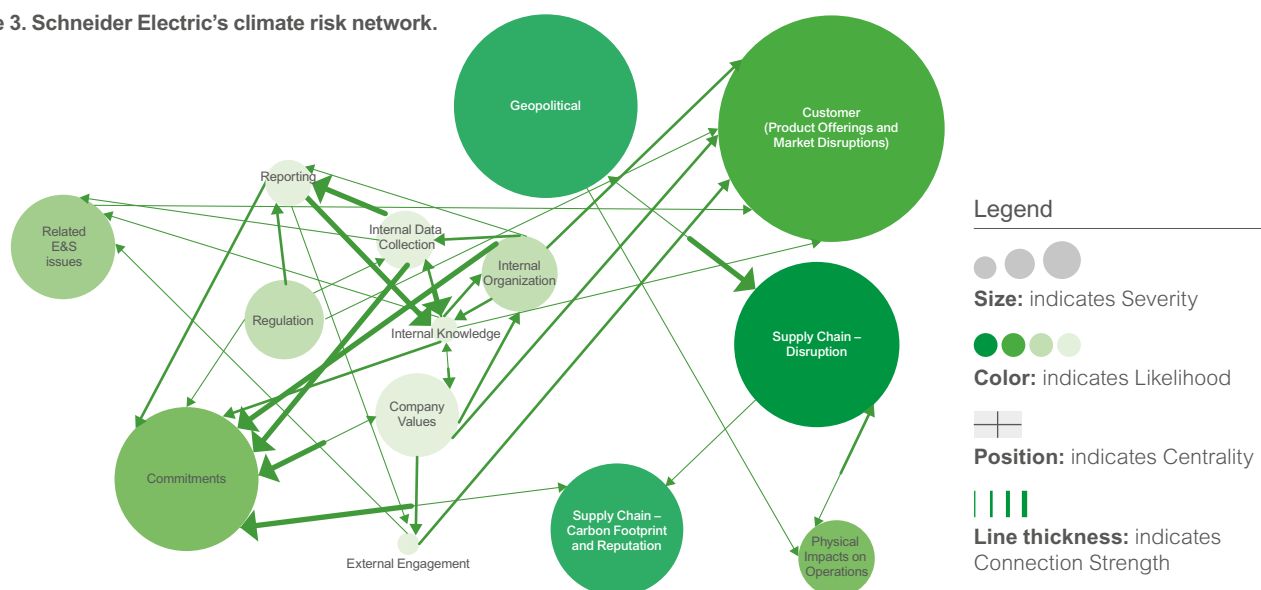
Main findings

We found that the biggest individually significant risks, *Supply Chain – Disruption and Geopolitical*⁽¹⁾, were somewhat hard to manage directly. This means mitigation would be more effective if focused on other risks that trigger the materialization of geopolitical and supply chain disruption risks. In fact, the results revealed that it is most often the case that the risks with the biggest individual impacts, i.e., highest severity, are the ones Schneider Electric has little direct control over; two of the Top 4 most impactful

risks, *Commitments and Customers*, were also in the Top 4 of “vulnerable” risks, meaning they were highly influenced but not influential in the network. The more influential risks, on the other hand, were also revealed. These risks further up the so-called causal chain of events that can trigger materialization of other (more vulnerable) risks were found to be *Internal Knowledge, Internal Data Collection, Company Values, and Internal Organization*. Despite all of them being smaller in individual severity and likelihood, these then would be the climate risks for Schneider Electric to focus on for effective mitigation, and to turn some of them into opportunities. Lastly, *Company Values* was determined to be especially connected, i.e., both likely to trigger and be triggered by other risks. That makes *Company Values* a “leverage point” in the network, revealing that although staying true to company values is hard to quantify, it might be a make-or-break issue.

By sharing this case study, and the methodology behind this climate risk network analysis, we hope to support efforts of other organizations in managing risks, whether from climate change, other sustainability issues, or any risk area marked by complexity. We hope this document enables organizations to find the opportunities in these areas by revealing the potentially large, accumulated impact of hard-to-quantify corporate leadership actions like creating a culture of continuous learning, information sharing, and strong company values. And we invite feedback from those organizations that have used the approach we lay out in this document so we can learn from their experience in turn.

Figure 3. Schneider Electric's climate risk network.



(1) Supply Chain – Disruption ranked third in severity and first in likelihood, Geopolitical second and third respectively.

Introduction

Climate risks include many transition risks, ranging from social, governmental, economic, to technological. To run a comprehensive climate risk analysis thus requires inclusion of many hard-to-quantify factors. Because it is well-established that climate risks are interlinked, meaning they influence one another, it is also critical to include in such an analysis an interconnectivity lens.

This paper is a case study by and for Schneider Electric, mapping such different climate risks in a network. It starts with a chapter on the reasons why we think assessing dynamic behavior – arising from human interactions and interconnectedness of relevant factors in general – is important to assess, even though this behavior poses a challenge to traditional tools because of its qualitative and/or non-linear nature. Next, the methods used to get to some level of quantification and a sense of the interconnectedness of these risks are described. The following chapter consists of what the application of these methods resulted in for Schneider Electric. The last chapter contains some key insights derived from these results, and ends with a brief reflection on the usefulness of both the methods and conclusions to other organizations looking to manage risks and spot emerging opportunities in a dynamic environment.



1

What's so important about interconnectivity?



Chapter 1 – What’s so important about interconnectivity?

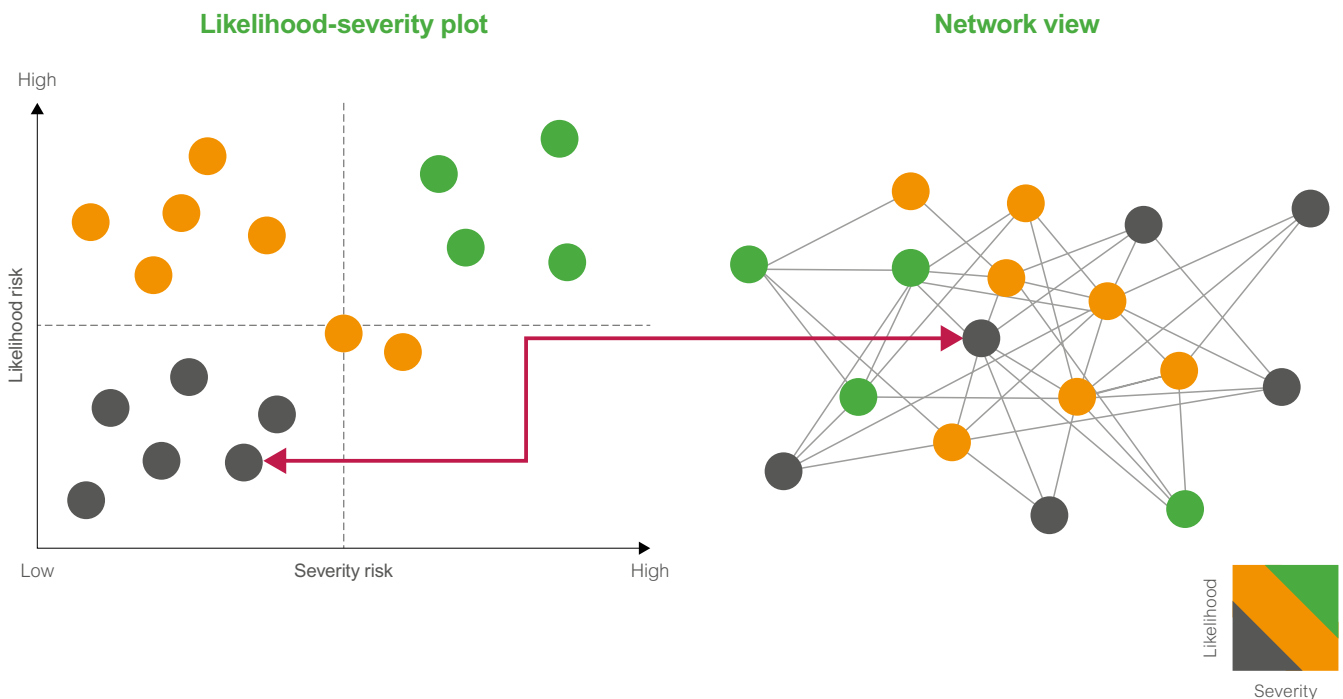
Knowing how risks interact is relevant because we will know better how to manage them⁽²⁾. This importance of risk interconnectedness is also the reason that the World Economic Forum (WEF) includes a network view in its annual Global Risks Report⁽³⁾. Additionally, analyzing how risks are interconnected may enable an organization to identify those risks that can be inverted into opportunities.

Influential risks

If we know in what order risks, or events in general, may occur, we can identify things like root causes: those risks that could start a chain of events. Mitigating these risks early on might help prevent other risks with perhaps bigger impacts (i.e., severities) down the causal pipeline. A stylized example of a root cause can be found in Figure 1. In this example, the encircled risk is individually insignificant, as can be concluded from its position in the lower left corner in the likelihood/severity plot. However,

a network view reveals it at the center, which means it has causal significance: it triggers many other risks into existence, the impacts of which are more significant, especially combined. These risks are influential: because they have relatively few risks triggering them while triggering relatively many other risks in turn, they have a large influence in the system. By virtue of this disproportionate influence, it is sometimes also possible to manage these risks in a way that turns them from a risk into a strategic advantage.

Figure 1. Depiction of a root cause.



(2) E.g., Barabási (2003).

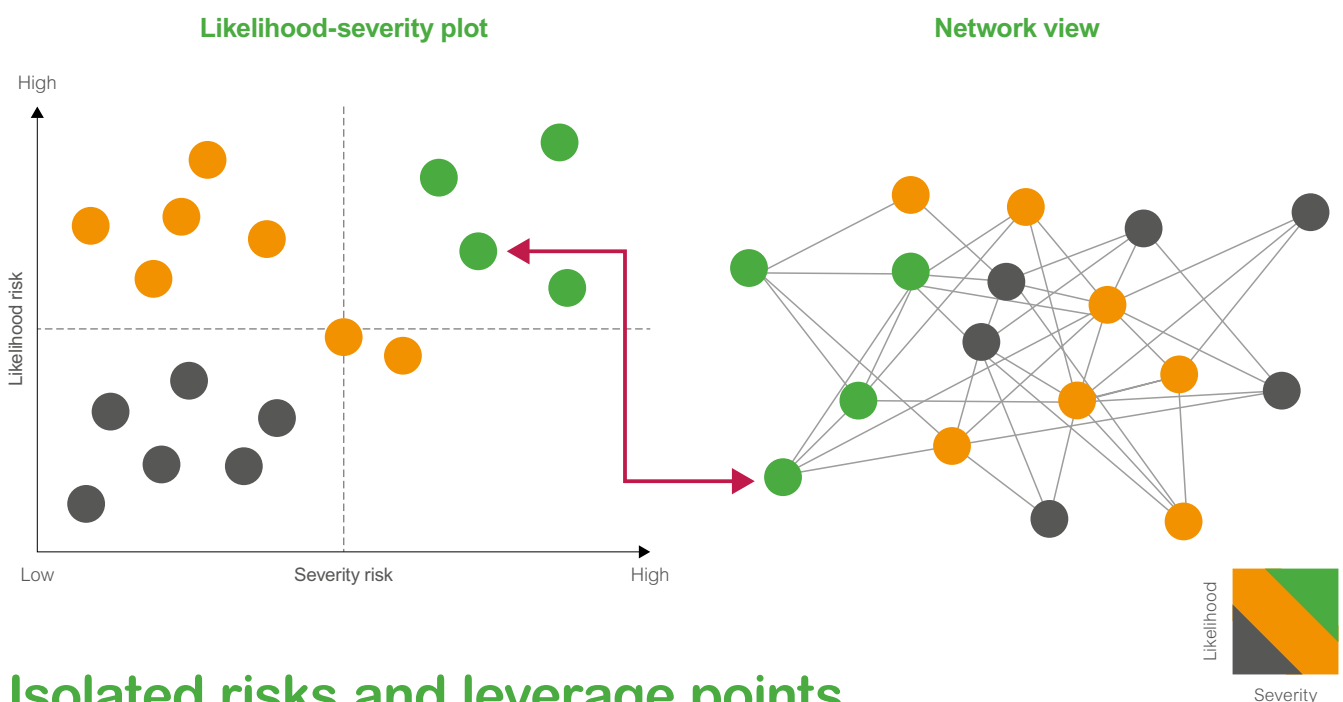
(3) WEF (2023).

Influenced risks

The opposite of such influential risks are the risks down the causal pipeline: these are not influential but rather influenced. Influenced risks are also useful to identify, because if their impacts are large, we might be spending much time and resources on mitigating them directly without knowing how to prevent them early on. Although these influenced, or *vulnerable*, risks are not necessarily large in impact, often enough they are. And in this case, it is also quite possible that by the time such a large-impact vulnerable risk has materialized there are few options left, none of which are very appealing.

In the below figure, the individually significant risk, identified as such in the likelihood/severity plot, is likely to attract management’s attention. But when placed in a network view, it is revealed that it resides on the periphery of the network. This means it is a *vulnerable* risk: there are relatively few risks triggered by it while relatively many other risks can be triggering it, rendering its influence small. This lack of influence in the network indicates that direct mitigation efforts are likely very high in cost or even non-existent. Management’s better bet would be to find this risk’s possible root causes, even if by themselves these seem less important in terms of individual impact.

Figure 2. Depiction of a vulnerable risk.



Isolated risks and leverage points

It is possible for some risks to not be connected much in the network. Risks that neither trigger nor are triggered much by other risks can be managed in isolation. And lastly, it is possible for some risks to both trigger and be triggered by relatively many other risks. This means the risk is very connected, making it a *leverage*

point: managing this risk effectively can yield many benefits, but mismanagement can lead to damaging effects that may spin out of control quickly. The Schneider Electric case in this paper contains examples of both such an isolated risk and a leverage point.

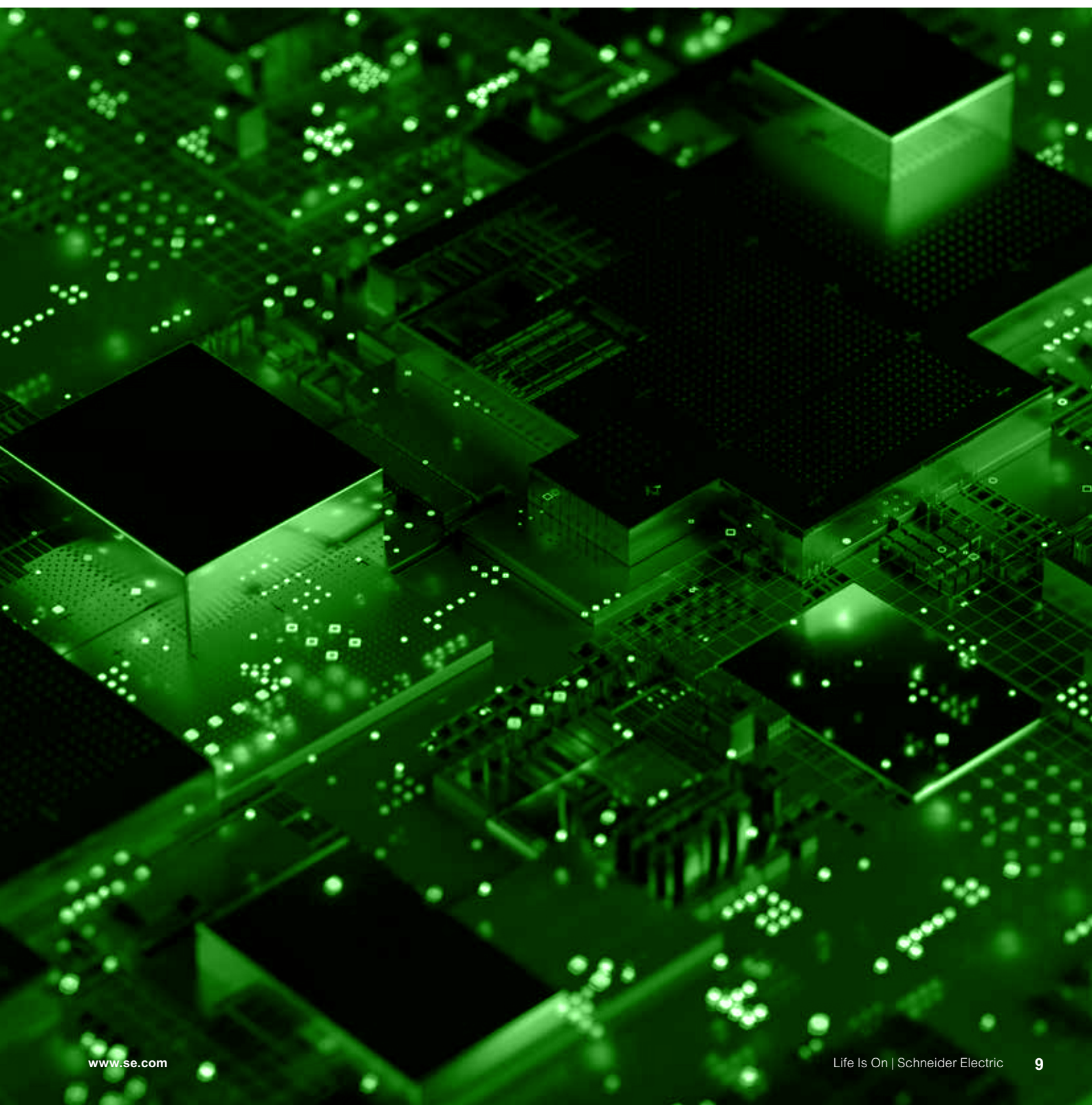
Connected climate risks

Risks stemming from climate change, of course, are no different in the sense that they vary greatly in the extent to which a person, organization, or even a society has control over a specific one. Take the WEF’s Global Risks Report 2023: the top three risks on a 10-year horizon are *Failure to mitigate climate change*, *Failure of climate change adaptation* and *Natural disasters and extreme weather events*. These three risks vary in the extent to which we can manage them directly. On one hand, once an extreme weather event has materialized, humans have little to no control over it. Managing this risk would have to be done by going up the chain

of events and mitigating the causal factors of extreme events, including climate change. The top risk in the WEF report of failure to do so, on the other hand, is something humans have much more control over. That is not to say that such behavior change is easy. But for now, while climate tipping points may not yet have been reached⁽⁴⁾, mitigating climate change is nonetheless under humanity’s control.

(4) Armstrong McKay et al. (2022).

2 Methods



The climate risk mapping consisted of a qualitative part and a quantitative part; we started with a qualitative expert elicitation and subsequently quantified the results using graph theory (network mathematics). Both methods are discussed in general first, followed by a description of how we applied them.

Expert elicitation

Expert elicitation is a structured way of synthesizing opinions from a group of expert authorities on an issue that is characterized by considerable uncertainty. Reliable data collection could be practically infeasible, for example, or the circumstance that is studied may involve a rare or unprecedented event. Or, perhaps the subject is part of a complex system and therefore exhibits dynamic changes in behavior that render past events near useless for predicting future events. Expert elicitation does not rely on high data availability, but rather leverages the by now well-established *wisdom of crowds*⁽⁵⁾ in a, as the RAND corporation puts it, “select crowd” of experts⁽⁶⁾. The experts will have informed themselves by means of data, among other sources, but for a decision-relevant overview or a conclusion about where to start and focus efforts, human insight is crucial. Such forward-looking insights are stored to at least some extent in the mental models of people⁽⁷⁾, i.e., in a person’s notions about how things in their environment work. Although these notions shape our behavior, they are hard, if not impossible, to express in numbers and often they’re not routinely expressed at all. Expert elicitation facilitates the explication of this tacit knowledge of the select crowd⁽⁸⁾.

Expert elicitation uses some structure to elicit the experts’ answers to a central question, and then aggregates these. There exist several different structures, typically involving several rounds of feedback-gathering in alternating individual and/or group settings with intermediate aggregate answers shared after each such round. To minimize the effects of humans’ inherent biases, the expert group should be sufficiently diverse in terms of backgrounds, field of expertise, years of experience, racial and gender identity, and other socioeconomic and cultural traits⁽⁹⁾. This way, the effects of these biases are optimally canceled out in the final aggregate answer⁽¹⁰⁾.

Because expert elicitation deals well with uncertainty and non-quantitative input, it is a useful scientific tool for forward-looking planning in a complex environment. Expert elicitation by now has seen numerous business and research applications for assessing emerging trends, ranging from future costs of nuclear fission technologies⁽¹¹⁾, to guideline or indicator development for management of large organizations⁽¹²⁾, and identifying future warfare technology⁽¹³⁾. Given the complex and unprecedented nature of climate change, and the fact that many of the risks it brings to business are behavioral, we concurred with the many academic researchers before us⁽¹⁴⁾ ⁽¹⁵⁾, that expert elicitation would be a useful tool for our climate risk assessment.



(5) This is the phenomenon that a diverse group of individuals is likely to make certain types of decisions and predictions better than any single expert. See Surowiecki (2005).

(6) RAND (2023).
(7) Stermann (1994).
(8) Ford and Stermann (1999).
(9) Kahneman (2011).
(10) Surowiecki (2005).
(11) Rai (2013).

(12) RAND (2023).
(13) Mayer et al. (2021).
(14) Usher and Strachan (2013).
(15) Stermann (2000).

Graph theory

Because we wanted to know how our climate risks interacted, and ideally even make use of these interconnections, we needed a method to assess interconnectivity. We decided that graph theory would fit our needs best. Graph theory, or network mathematics, can help with creating a network depiction: essentially a snapshot of a system in time. Many excellent books have been written about network theory and its promise for real-life applications, including business⁽¹⁶⁾ ⁽¹⁷⁾. We will not go into the theory here more than necessary, but we should discuss centrality, because it is a key indicator we used in our analysis. Centrality is a measure of how important a certain point in a network is. There are four kinds of centrality in graph theory, each kind indicates a different way that a point (or to use the official term: node) in a network can be of importance. We used *eigenvector centrality*, which indicates how connected one node is. Another way to put this is that eigenvector centrality determines how influential or influenced a node is. Google uses eigenvector centrality to determine its page rankings⁽¹⁸⁾, for example. A social media influencer will have a high eigenvector centrality. In the context of risk mapping, eigenvector centrality identifies the risk events that are more likely to affect a larger part of the overall risk network and/or with a more significant impact⁽¹⁹⁾.

Additionally, if one is working in a directed network, like we did in our assessment, there is both out-centrality and in-centrality. A directed network means that a connection between nodes A and B can be both $A \rightarrow B$ and $B \rightarrow A$. Because of this, one can distinguish nodes that are central in that they connect to many other nodes

(i.e., have a high *out-degree*), and those nodes that are highly connected in that many other nodes flow towards them (i.e., have a high *in-degree*).

Nodes with a high out-eigenvector centrality are the influential events. These are the causal nodes, or root causes; the events that trigger other events. As briefly mentioned in the section on interconnectivity, focusing mitigation efforts on these risks will have the most impact, because these efforts will indirectly reach a good number of other risk events in the network too. In fact, because of this outsized influence, some of these risks may be able to be inverted into opportunities. These events are the ones that an organization “must get right”, because their pay-off in risk mitigation and possible opportunity is relatively high.

Nodes with a high in-eigenvector centrality are the influenced events. These are the effect events, the nodes most vulnerable to other nodes in the network. These events are hard and high-resource to mitigate at best, because such mitigation efforts will be working against the flow of the network. In other words, these vulnerable risks are the ones that “can’t go wrong”; once they have materialized there are few options and perhaps even less time left. These then, are areas where an organization might want to work with another party – private business, government, or NGO – that may have more influence on that specific event. The organization will also want to prepare contingency plans, doing things like a pre-mortem, for their most impactful vulnerable risks in advance.



(16) E.g., Amini et al. (2018).

(17) E.g., Barabási (2003).

(18) E.g., Hansen et al. (2020).

(19) Barabási et al. (2005).

Analysis

The above two methods were combined in Schneider Electric's climate risks analysis. As mentioned, we started with expert elicitation for the qualitative part, the results of which were then quantified in the second part using graph theory.

In the expert elicitation, we conducted an anonymous survey among a group of several dozens of diverse participants across Schneider Electric. The selected participants showed a balanced

gender ratio and a wide variation in terms of educational background, geographical location, age, and department.

First, we asked the participants in interviews what they thought were Schneider Electric's most important, missed, or underestimated climate change risks over the next five years. From that, we distilled the following risk list.

Risk name	Risk description
Physical Impacts on Operations	The physical risks from climate change on the company's own operations, e.g., floods and other weather disasters that can disrupt deliveries and/or expose our employees to unsafe working conditions.
Supply Chain – Carbon Footprint & Reputational	The risk that the company is unable to bring its suppliers along on its climate reduction journey because they do not want to, do not know how, and/or the company has insufficient overview of its supplier network.
Supply Chain – Disruption	The risks from climate change on the company's supply chains, ranging from a lack of supplier readiness to deliver parts for future fit products, to physical climate impacts that may disrupt deliveries and manufacturing capabilities.
Related Environmental & Social Issues	The risk that the company does not prepare for or misses the opportunity to create valuable services related to social and environmental issues that are linked to climate change. Includes the risk of not thinking through issues of water scarcity, reduced ability to grow food, displacement of people, social unrest (especially among younger generations), and international conflicts.
Customers (Product Offerings & Market Disruptions)	The risk that the company fails to adequately translate its climate vision into competitive business offerings by tailoring its products and services to fit clients' changing needs along with the changing climate. Risk includes not being forward-looking enough in terms of adaptation needs, but also failing to accurately gauge how customers will weigh cost against carbon performance, reliability, and safety.
Internal Data Collection	The risk that the company fails to collect sufficient relevant data on its full lifecycle impacts on the climate and other issues like pollution and resource use. This risk includes potential damage to credibility due to reporting inaccurate data, and also potentially suboptimal internal decision-making, which might come in the form of missed opportunities or inadequate operations continuing longer than necessary.
External Engagement	The risk that the company does not engage with society in order to tackle the broadest sustainability issues, including climate change. Includes missed opportunities to form and scale best practices with other companies in our industries.
Company Values	The risk that the company does not maintain the proper company values, that too many employees are not clear enough on how to act on these values, and/or that the company consciously compromises on its professed values when faced with what seems a trade-off between profit and the social and environmental goals that were set based on these values.
Internal Knowledge	The risk that internal information on climate performance and other sustainability goals is not defined, tracked, or shared adequately for employees to understand and communicate all the company does in this area, and to enable each person to consciously contribute to these goals in their everyday practice.
Regulation	The risk that the company does not anticipate upcoming stricter climate regulations, especially with regards to carbon, including in mobility.
Reporting	The risk that the company does not report any or too low-quality data on its sustainability performance to maintain a frontrunner position, or even for compliance.
Commitments	The risk that the company does not meet its climate and other sustainability goals, because it is not optimally organized, becomes complacent, and/or lacks the data to be able to monitor and/or demonstrate its achievements.
Geopolitical	The risk that international conflict resulting from various impacts of climate change will disrupt the company's ability to produce or deliver its products and services, and/or does not anticipate these accurately in its global strategy setting.
Internal Organization	The risk that the company fails to organize itself optimally to achieve its climate goals, i.e., with adequate agility, efficiency, and alignment around common ways of working. This risk encompasses the company's internal flows of information, decision-making processes, and international structures.

Second, we asked participants to assess each risk on likelihood and severity, by placing the risk in a likelihood/severity plot. In addition, the participants were asked to draw directional lines between risks that they thought were connected.

Lastly, the aggregate results were analyzed with network mathematics. This resulted, among other outputs, in individual rankings in likelihood and severity, interconnectivity rankings, and a risk network map.

3

Results



Individual rankings

Just as in more traditional risk assessments, risks were ranked according to severity and likelihood.

Schneider Electric participants' responses indicated that *Customers (Product Offerings & Market Disruptions)*, *Geopolitical*, *Supply Chain – Disruption*, and *Commitments* were deemed the highest in impact among the individual risks.

Participants saw *Supply Chain – Disruption*, *Supply Chain – Climate Footprint and Reputational*, *Geopolitical*, and *Physical Impacts on Operations* as most likely to happen. In particular, supply chain disruptions resulting from climate change were seen as relatively likely.

Table 1. Top 4 risks ranked by severity, and Top 4 ranked by likelihood.

Severity Top 4	Likelihood Top 4
Customers (Product Offerings & Market Disruptions)	Supply Chain – Disruption
Geopolitical	Supply Chain – Carbon Footprint & Reputational
Supply Chain – Disruption	Geopolitical
Commitments	Physical Impacts on Operations

Supply Chain – Disruption and *Geopolitical* were both in the severity and likelihood Top 4, arguably making these the two most important individual risks resulting from climate change to the company.

Interconnectivity rankings and overview

We also ranked the risks for centrality. Table 2 below shows both the Top 4 influential risks (causal events) and the Top 4 influenced risks (vulnerabilities).

Table 2. Top 4 risks ranked by influence, and Top 4 ranked by vulnerability.

Influence Top 4	Vulnerability Top 4
Internal Knowledge	Commitments
Company Values	Customers (Product Offerings & Market Disruptions)
Internal Data Collection	Related Social & Environmental Issues
Internal Organization	Company Values

Schneider Electric participants' responses indicate that *Internal Knowledge*, *Company Values*, *Internal Data Collection*, and *Internal Organization* are things we must get right to mitigate climate risks

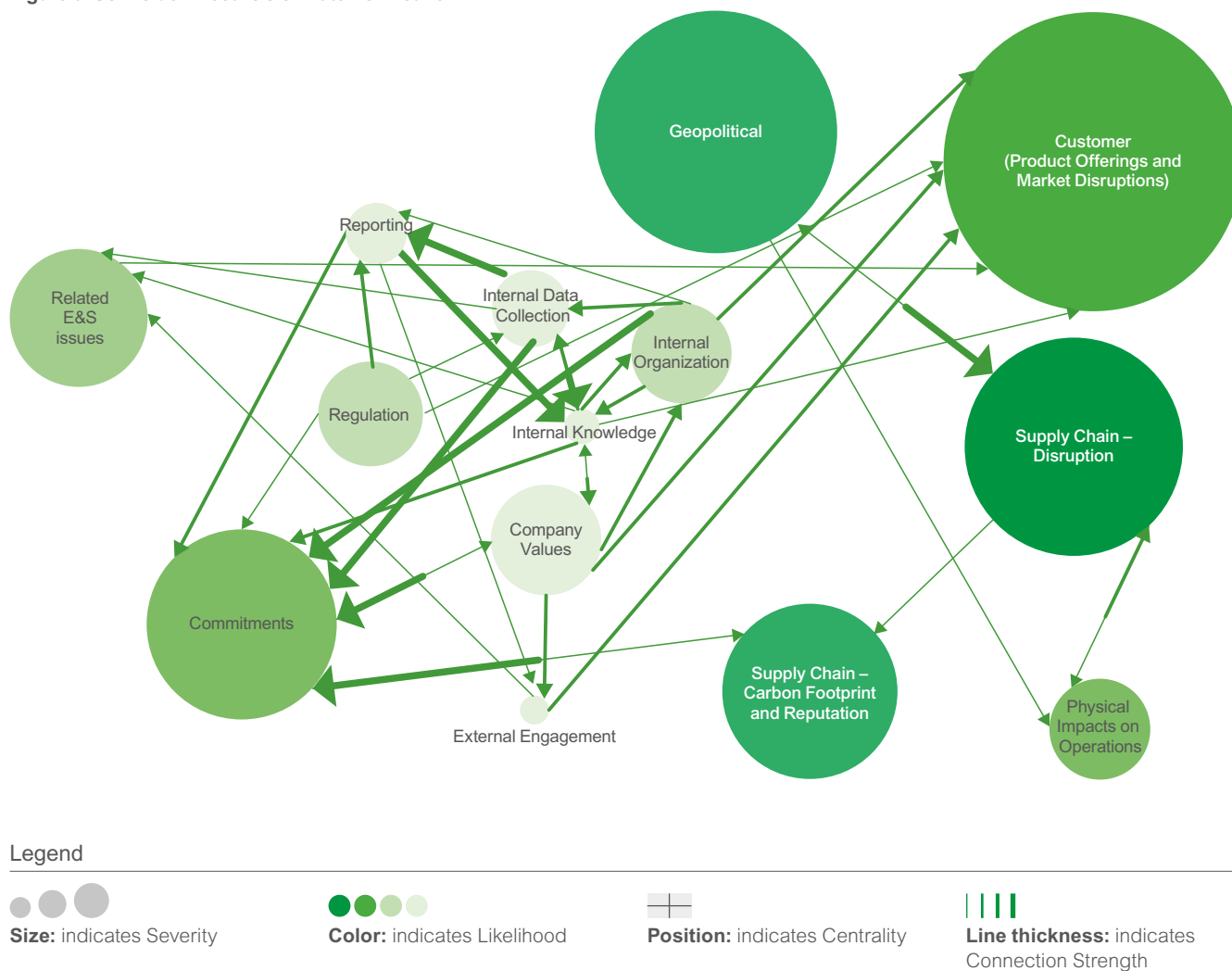
effectively. Acting on such risks directly can generate major ripple effects throughout the company, and possibly, the direct influence it has in these risks can be used to turn them into opportunities.

Responses also indicate that *Commitments*, *Customers (Product Offerings & Market Disruptions)*, *Related Social & Environmental Issues*, and *Company Values* are the issues that can't go wrong. They are the most vulnerable risks, with the exception of *Company Values*, which also appears in the Influence Top 4, thus making it a leverage point rather than a vulnerable risk. This means that Schneider has little direct influence in the first three mentioned risks and is unlikely to invert them into opportunities. Yet, if they were to materialize, there would be major consequences.

Chapter 3 – Results

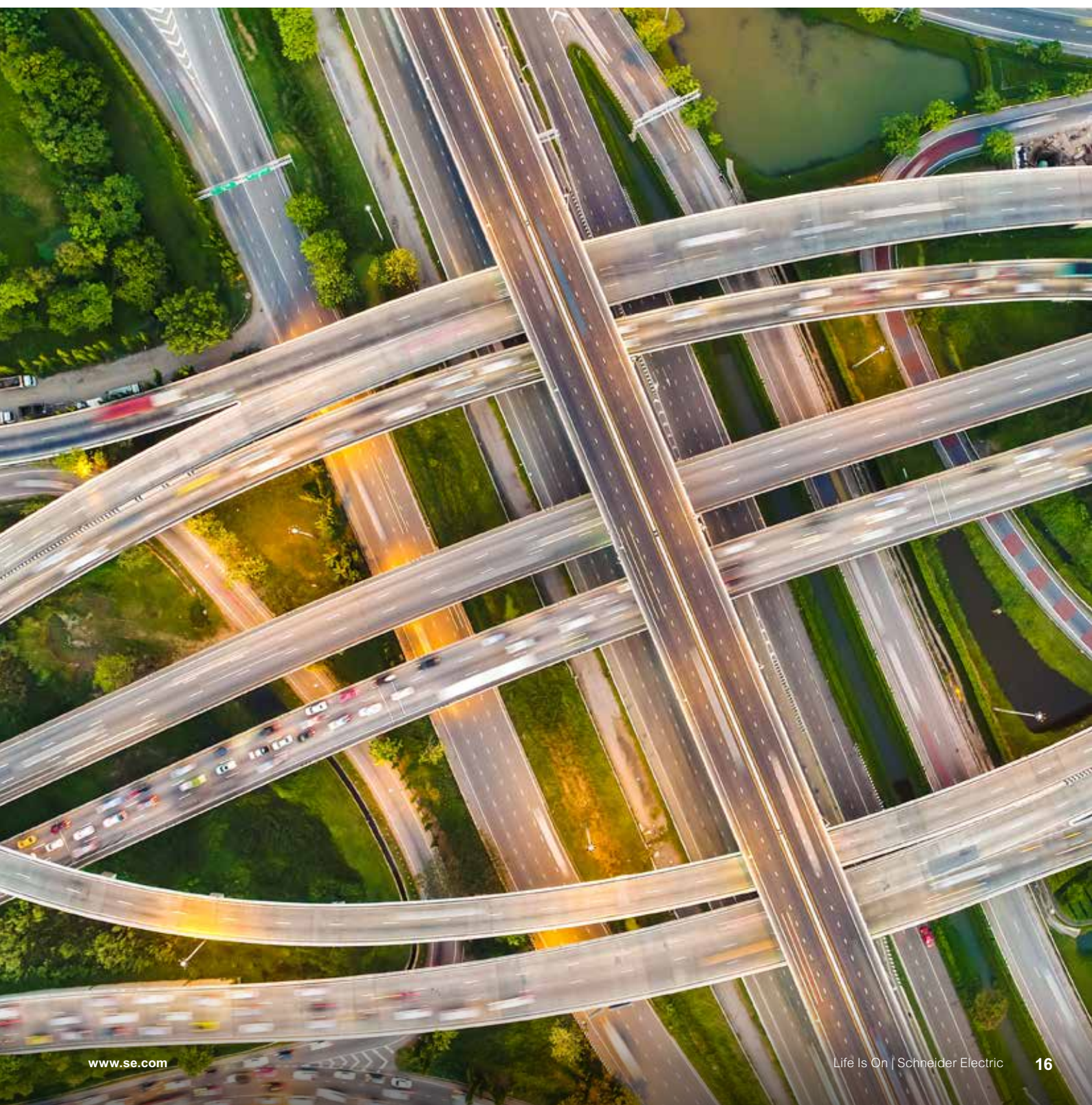
An overview of how the risks interact, i.e., a risk network map, is shown in Figure 3. The most central risks (measured by in-centrality, i.e., influence) are placed in the center of the map, the least central risks lie on the outside of the network.

Figure 3. Schneider Electric's climate risk network.



4

Discussions & conclusions



In this last chapter, we draw conclusions from our climate risk network in the form of concrete consequences for corporate governance. We then close with a reflection on how the methods and findings of our risk network assessment could be of merit to other organizations.

Interpretation of pilot results

Individual importance

Participants' responses suggest that the most impactful individual risks loom in failure to keep up with changing customer preferences and market disruptions spurred by climate change, failure to meet carbon commitments, climate-induced geopolitical instability and supply chain disruptions. The first two risks were deemed to be unlikely for Schneider Electric, however, the latter two were deemed among the most likely risks to materialize. Two other risks high in likelihood were a failure to bring suppliers along on the company's climate reduction journey and physical impacts from climate change on operations. Geopolitical and supply chain disruption risks were in the Top 4 of both severity and likelihood, making them the most important individual climate risks (not withstanding that these two are obviously interrelated too).

These findings are useful. However, they are complemented by the interconnectivity part of this analysis, which highlights several other risks to include in a comprehensive and effective management strategy.

Connectivity importance

The Top 4 influential risks revealed that leveraging and upgrading internal knowledge, data collection, and organization around climate change and other related social and environmental issues can be expected to generate major benefits for the organization. By themselves, these root causes may not seem to merit priority because their individual severity and likelihood scores are relatively low. But the other side of that is that acting on them is relatively low in effort and cost too. When viewed with a systems lens, i.e., taking into account their accumulated effects over the entire risk network, their cost/benefit ratio is unparalleled.

Conversely, the vulnerable (or: influenced) risks would be less likely to be underprioritized; two of the Top 4 vulnerable risks are also in the Top 4 of most impactful risks, with customer preferences and market circumstances as the single most impactful one. Failure to keep up with changing customer preferences and market disruptions that climate change spurs, will likely yield major negative consequences.

The same would be true in the case of not living up to commitments or broadening our scope to other social and environmental issues than climate change. Participants viewed these two events as much less likely, nonetheless, if we were to find ourselves in this hypothetical situation there would not be much left to do about it at that point in time. Because these risks are influenced, we should resist the temptation to mitigate them directly, and instead, find more effective mitigation strategies by working on the risks further up the chain of events. That is to say: those influential risks our network reveals as likely to trigger the more vulnerable risks.

Using the network flow

Moving up the chain of events is possible in this network for more than just the Top 4 vulnerable risks; except for the physical impacts on operations from climate change, individually high-ranked risks are also highly connected and more often than not reside further down the causal pipeline. This is also true for geopolitical risk and supply chain disruption risk, the two most important individual climate risks. Although not in the Top 4 of vulnerable risks, the full ranking lists revealed that these risks too are still relatively connected and more vulnerable than influential.

The leverage point⁽²⁰⁾

Company Values is the only risk that appears in both the Top 4 of influential and vulnerable events (second and fourth, respectively). This means it is a leverage point, i.e., it works strongly in both ways: if values are right, then one can expect to generate major benefits, but straying from them might come with detrimental impacts. Although respondents did not express concerns about the current company culture being weak⁽²¹⁾, they seemed to be acutely aware that there is always a risk of getting complacent about such "soft" aspects, and the potentially detrimental effects of doing so. This accords with what management consultants and researchers have been pointing out for years about the importance of company values and the culture they spur⁽²²⁾. Their conclusions are mostly based on their professional expertise or empirical studies. Although not that surprising an outcome to us, we did think it interesting that with different methods, Schneider Electric too found that maintaining the right company values is a make-or-break issue.



(20) It is possible to have more than one leverage point; it is simply not the case here.

(21) In fact, the Company Values risk was ranked at the very bottom of individual likelihood.

(22) There are many papers and books on this; one recent and easily digestible example is the Harvard Business Review article by Ingram and Choi (2022).

Conclusion on climate risk network assessment

In short, the single most important conclusion from this network analysis is that to mitigate the high-likelihood and high-severity climate risks around geopolitics and supply chain disruption, as well as the most vulnerable risks of failure to live up to sustainability commitments or to keep up with changing customer preferences and market disruptions that climate change and other sustainability issues spur, strong attention must be placed on internal knowledge, data collection, and organization around climate change and other related social and environmental issues. These actions would likely not only reduce risk levels significantly, but also open some additional opportunities. Such action requires proper prioritization and a long-term view, something that can be expected to occur in a company that stays true to its values.

These conclusions align with other risk assessments conducted internally and externally, which include Schneider Electric's broader annual Enterprise Risk Management (ERM) assessment and the more in-depth climate risk analysis with third-party Resilience. The ERM exercise encompasses all sorts of risks, but environmental risks are high-priority, especially from climate change. This climate risk network analysis offered deeper insights into that risk. The engagement with Resilience, on the other hand, offered a quantification of potential physical climate impacts beyond what this analysis could deliver⁽²³⁾. While the most important climate risks were determined to be of behavioral and political nature, physical impacts on operations were deemed significant too, especially in terms of likelihood. This risk was ranked last and second to last in the connectivity rankings, however. Relatively disconnected from the other risks, physical risk thus can be fairly well managed on its own using more conventional but highly sophisticated risk mitigation tools, such as are used by Resilience. For these reasons, Schneider Electric feels that this interconnectivity assessment on its climate risks is a valuable complement to other exercises.

Conclusions on usefulness for others

We started this paper by describing why interconnectivity matters; in other words, why proper risk management, and good leadership in general, includes a systems lens. We described two practical tools that we believe in combination can help gain a better understanding of how risk events in a specific area might interact for an entity: expert elicitation and graph theory. We then provided an example of such an application of our own internal climate risk network assessment and shared our interpretations of the outputs. We believe that both the conclusions of our climate risk network assessment and the general approach we outlined in this paper can be useful to others.

Although every risk network will be unique to a particular organization, it's easy to see how the findings for Schneider Electric about where to focus efforts in order to effectively mitigate its climate risks could be applicable for other organizations. Continuously improving on internal knowledge sharing and upgrading, data collection systems, and agile organizational structures might prove wise for other companies too. The same goes for aligning strategy and daily management fully with the right company values.

Additionally, we believe that the combination of expert elicitation and network analysis may be beneficial for other entities to apply, on climate change risk or another area. Most tools today focus on physical risks from climate change, not necessarily because physical risks are deemed the most severe and likely ones, but because many transition risks from climate change are marked by even higher uncertainty than the physical ones. Any organization may wish to supplement such a physical risk-focused assessment with one that can shed some light on the more elusive spectrum of climate change transition risks, and how to effectively mitigate or prepare for those eventualities. By the same reasoning, the combination of these two tools forms a useful risk management or strategy setting tool for many more areas than just climate change, given that each organization is operating in an interconnected and thus dynamic business environment today. You may have noticed that the root causes depicted in the center of our network are also smaller in size.

Similarly, the largest risks are located on the network's edge, suggesting that risks with bigger impacts are further down the causal pipeline. Although this is certainly not always the case, we find it to be quite common. It could be dramatically termed "the tragedy of life"; the tragedy lies in the fact that many large damages are avoidable with comparatively little effort. However, because individual severity from such causal events is also relatively small, it takes equally little effort to ignore them. Additionally, these root causes are often more qualitative, as they are in Schneider Electric's network, making them easy to overlook or dismiss by someone accustomed to an environment that uses numerical information in many of its processes (like a company). While such a risk cascades through a network, unfolding as a (probably less than ideal) scenario, its impact keeps accumulating. Once the scenario culminates in the materialization of a risk on the periphery of a network, the impact of that event more often than not is large. By now it likely also has become hard to miss, because it is easy to quantify as, say, ocean surface polluted, number of people hurt, sales reduced, market cap lost, or legal costs incurred.

Our hope for this paper is that it will encourage corporate leaders to invest in their continuous learning and information sharing when it comes to climate change, embolden them to stay the course on their company values, and help them get a firmer grasp of how risks of any kind may interact for their organizations, thereby increasing their ability to avoid the most undesirable events from ever materializing. Any company that has found this to be the case by using the approach we have laid out here, Schneider Electric – on the same path of continuous learning – would be happy to hear from.

(23) Results of the Resilience analysis will be published in upcoming publications and disclosures such as those for the Task Force on Climate-related Financial Disclosures (TCFD).

References

2. Barabási (2003). *Linked: How everything is connected to everything else and what it means for business, science, and everyday life*. NY: Basic Books.
3. World Economic Forum (2023). *Global Risks Report 2023*. Accessed: January 2023. <https://www.weforum.org/reports/global-risks-report-2023/>
4. Armstrong McKay, et al. (2022). Exceeding 1.5°C global warming could trigger multiple climate tipping points. *Science* (377), 6611. DOI: 10.1126/science.abn7950
6. RAND (2023). *ExpertLens™*. Accessed January 2023. <https://www.rand.org/pubs/tools/expertlens.html>
7. Sterman (1994) Learning in and about complex systems. *System Dynamics Review* 10: 291–330. <https://doi.org/10.1002/sdr.4260100214>
8. Ford and Sterman (1999). Expert knowledge elicitation to improve formal and mental models. *System Dynamics Review* 14: 309–40.
9. Kahneman (2011). *Thinking, Fast and Slow*. New York: Farrar, Straus and Giroux.
10. Surowiecki (2005). *The Wisdom of Crowds*. New York: Doubleday; Anchor.
11. Rai, V. (2013). Expert elicitation methods for studying technological change under uncertainty. *Environmental Research Letters* (8), 4. DOI 10.1088/1748-9326/8/4/041003
12. RAND (2023). *ExpertLens™*. Accessed January 2023. <https://www.rand.org/pubs/tools/expertlens.html>
13. Mayer et al. (2021). *A Structured Elicitation Approach to Identify Technology-Based Challenges: With Application to Inform Force Planning for Technological Surprise*. Santa Monica, CA: RAND Corporation, 2021. Accessed December 2022. https://www.rand.org/pubs/research_reports/RRA701-1.html
14. Usher and Strachan (2013). An expert elicitation of climate, energy and economic uncertainties. *Energy Policy* (61), 811-821, <https://doi.org/10.1016/j.enpol.2013.06.110>
15. Sterman (2000). *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Boston: Irwin/McGraw-Hill.
16. Amini et al. (2018). *Sustainable interdependent networks: From theory to application*. NY: Springer.
17. Barabási (2003). *Linked: How everything is connected to everything else and what it means for business, science, and everyday life*. NY: Basic Books.
18. Hansen et al. (2020). *Analyzing Social Media Networks with NodeXL: Insights from a Connected World*. DOI: <https://doi.org/10.1016/C2018-0-01348-1>
19. Barabási et al. (2005). *The structure and dynamics of networks*. Princeton, NJ: Princeton University Press.
22. Ingram and Choi. *What Does Your Company Really Stand For? Align what matters to you as an organization with what matters to your employees*. Harvard Business Review. Accessed November 2022. <https://hbr.org/2022/11/what-does-your-company-really-stand-for>

Legal disclaimer

The contents of this publication are presented for information purposes only, and while efforts have been made to ensure their accuracy, they are not to be construed as warranties or guarantees of any kind, express or implied. This publication should not be relied upon to make investment advice or other strategic decisions.

The assumptions, models and conclusions presented in the publication represent one possible scenario and are inherently dependent on many factors outside the control of any one company, including but not limited to governmental actions, evolution of climate conditions, geopolitical consideration, and shifts in technology.

The scenarios and models are not intended to be projections of forecasts of the future and do not represent Schneider Electric's strategy of business plan.

The Schneider Electric logo is a trade mark and service mark of Schneider Electric SE.

Any other marks remain the property of their respective owners.