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Taking the Lead into Sustainability: Decision Makers' Competencies for a Greener Future

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Abstract: Many research articles describe competencies that people need in order to think, develop, and enact a sustainable future. Based on findings from the political economy, this paper argues that it is the macroscopic decisions in the public sphere that have an impact on society and the environment. Therefore, decision makers in the economy, politics, and civil society are important actors to enable a societal transformation towards sustainability by making macroscopic decisions. Based on these assumptions, this empirical research article analyzes the competencies decision makers such as ministers, CEOs, or union leaders need to contribute to a sustainable future in their professional life. We conducted interviews with 14 high-level decision makers and analyzed their competencies based on Wiek et al.'s framework on sustainability competencies. The findings show how they enact and organize the competencies needed for steering the sustainable transition. Linking all competencies is particularly important, especially at the intersection of different systems, to develop a macroscale, system-oriented decision. The authors suggest to consider systems and interpersonal thinking as extremely interdisciplinary competencies and to put a focus on public-sphere actions when educating future leaders. Moreover, the results indicate that dealing with uncertainty, following one's own values, and building up resilience play a major role for decision makers.

Keywords: key competencies in sustainability; leadership; decision making; sustainable transformation; education for sustainable development (ESD)

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1. Introduction

Complex anthropogenic challenges such as climate change, biodiversity loss, land use change, resource overuse, or novel entities in the environment are already affecting ecosystems and societies around the world [1,2]. The responsible handling of these major environmental and socio-economic challenges needs more than "business-as-usual-solutions" [3]. Instead, a profound social, economic, and political shift toward more sustainable lifestyles is needed to achieve global climate goals such as climate neutrality [2,4,5]. Decision makers in politics, the economy, and civil society play an important role in the collective journey towards sustainability, as they make far-reaching and high-impact decisions leading to major changes [6]. Therefore, decision makers with high-level responsibilities in economics, politics, and civil society require more sustainability competencies than the average citizen. These include perceiving and understanding the world as an interplay of complex systems, committing to values, and far-sighted strategizing as well as communicating in an engaging way [3]. Educational programs regarding sustainability therefore need to incorporate these competencies in order to enable future decision makers to steer societal transformation towards a sustainable future.

This empirical research paper is based on 14 interviews. Interview partners were recruited among high-ranking decision makers in politics, the economy, and civil society. This article describes the competencies decision makers apply when steering the transition toward a more sustainable future. These competencies are viewed through the theoretical

framework of sustainability competencies by Wiek et al. [7] and supported with realistic and meaningful examples of high-impact decisions. This research article contributes to the education for sustainable development (ESD) by expanding on the understanding of what kind of sustainability education is needed for future decision makers.

2. Theoretical Background

2.1. How to Deal with Challenges in Sustainability–Private-Sphere and Public-Sphere Actions

Urgent challenges in sustainability require a deep societal transformation, not only individual changes in consumer behavior. In all industrialized countries, climate policy is confronted with the increasing demand for a post-fossil, carbon-neutral world [2]. In the debate on how to deal with these challenges and to shape sustainable development, profound changes in both private-sphere actions and public-sphere actions are needed [6]. A sustainable transformation cannot be achieved through changes in the private sphere alone. While individual consumer behavior or lifestyle choices (e.g., choosing a bicycle over a car or saving energy at home) are one component of steering civil society towards a sustainable future, macroscale decisions in the public sphere, such as industrial production patterns and political frameworks [8], are more significant. Niebert [9] points out that primarily political, economic, and structural decisions are most effective environmentally. He illustrates this with historical examples of successful solutions for complex environmental problems, such as stopping ozone depletion, phasing out nuclear power, and improving air quality in Europe, which were all solved through political regulation. The results published by Steinebach [10] provide additional evidence that the most effective actions are taken by leaders in politics, the economy, and civil society. Limiting emissions, reducing pollution, and restricting unsustainable consumption of natural resources at a public-sphere level have been shown to be more effective when leaders decide on conservative measurements, which are then compulsory for larger social groups [6].

Further evidence of this is provided by an analysis of emissions during the COVID-19 pandemic-related lockdowns. It became particularly evident that it is not the average consumer making a difference, but rather multinational corporations should be held accountable for their vast environmental impact [11]. Emissions were reduced by only 17% despite strong restrictions in the private sphere, such as the significant decrease in private and business travel and overall decreasing mobility due to compulsory home offices [11]. The fact that 70% of the emissions come from fossil fuel producers makes sustainable transformation predominantly a political task [11] (p. 11).

The 21st century society now demands different skills and values from decision makers in the private, corporate, and non-profit sector than during the past decades [12]. Socially and especially environmentally responsible criteria for decision making continue to grow in importance in public reasoning. In order to steer societal transformation towards a sustainable future, sustainable development initiatives and projects have emerged and aim to provide leadership teams with knowledge on urgent sustainability challenges and the necessary competencies to manage societal change [8] (p. 24).

Education plays a crucial role when it comes to sustainable development. "A large-scale educational transformation is needed to equip a new generation of professionals" [3] (p. 241) towards a more sustainable future. Many approaches in ESD tend to address private-sphere actions by convincing the broader public to change their consumer habits [13]. Choosing a bike, bus, and train over car and aircraft; a plant-based diet over meat; and replacing fossil-based sources of heating with sustainable ones in private housing are among the most popular examples [13]. This way, learners are taught that their everyday decisions contribute to a better future. The overall responsibility to solve complex problems—such as the global climate crisis, loss of biodiversity, and pollution—is focused on individuals instead of on the big players [14]. However, the focus on private-sphere actions is not sufficient in terms of substantially reducing greenhouse gasses [15]. Public-sphere actions and adjustments, such as legal measures or subsidies designed as incentives

to reduce CO_2 emissions at a national level, are needed as effective political strategies to reduce greenhouse emissions [15].

One way to bridge the distance between the private sphere—the domain of individuals—and the public sphere—the domain of decision makers and public actions—is to develop educational programs that enable individuals to actively seek opportunities to participate in decision making at the local and societal level in a meaningful way. Within the academic fields of ESD, several competency models have been developed. Regardless of their target group (pupils, students, professionals), ESD suggests applying a specific set of key sustainability competencies, which will be discussed in the next subchapter. We will refer to selected approaches relevant to the underlying research question and study design.

2.2. Competencies and Key Competencies in Sustainability

Sustainability professionals require specific competencies in order to manage complex societal, economic, and political issues within a rapidly changing natural and technical world [12]. In recent decades, various models for sustainability-related competencies for understanding fundamental sustainable challenges and for developing a sustainable future have been suggested to help decision makers tackle these challenges in a participatory, co-operative, and solution-oriented way [7,16–20]. This section presents terms and definitions relevant to the underlying research question and empirical endeavor of our research.

First, let us give a general definition of competencies. Competencies are "the cognitive abilities and skills available in or learned by individuals to solve specific problems, as well as the associated motivational, volitional, and social dispositions and skills to use the problem solutions successfully and responsibly in variable situations" [21] (p. 27). When it comes to sustainability challenges, there are specific sustainability competencies to deal with these challenges. Wiek et al. define sustainability competencies as "complexes of knowledge, skills, and attitudes that enable successful task performance and problem solving with respect to real-world sustainability problems, challenges, and opportunities" [7] (p. 204).

Education for sustainable development—as an umbrella concept in education—should enable people to shape sustainable development and to critically reflect on individual contributions regarding a greater cause [18,22]. The overarching goal of most ESD approaches is the acquisition of specific sets of key competencies facilitating conscious, sustainable action in the field of education [18,20,23]. When we are talking about key competencies, we use the version defined by Brundiers et al. [24], who summarize a definition from different authors [7,16,25–28]. They describe a key competence as "a distinctive and multifunctional competency, which is composed of several competencies that intersect with each other. [. . .] It is essential for achieving successful performance and a positive outcome related to a particular endeavor in diverse contexts, for instance to achieve societal goals, which are normatively defined by their cultural context" [24] (p. 17).

By applying the concept of key competencies to challenges in sustainability, you need key competencies in sustainability which, according to Wiek et al. [7] and Wals [29], consist "of several sustainability competencies that functionally relate to each other. It facilitates achieving successful performance and a positive outcome that progresses sustainability [. . .], while working on specific sustainability challenges and opportunities in a range of contexts" [24] (p. 17). There are different international frameworks of key competencies in sustainability. In German-speaking countries, the concept of "Gestaltungskompetenz" developed by de Haan and Harenberg [30] is often applied. This refers to the ability to apply knowledge about sustainability and "to enact changes in economic, ecological and social behavior without such changes always being merely a reaction to pre-existing problems" [20] (p. 22). However, the "Gestaltungskompetenz" model has often been criticized for its lack of globalism and international perspective [18]. Around the same time, the international project Definition and Selection of Competencies: Theoretical and Conceptual Foundations *(DeSeCo)* of the Organization for Economic Co-operation and Development (OECD) formulated a framework of "key competencies for a successful life and a well-functioning society" [19]. Primarily, these were developed for OECD countries,

but can also be useful for other countries [18]. More recently—in 2022—the Joint Research Center (JRC) published a Science for Policy Report for the European context and as an input to the EU policymaking process [31]. This European Sustainability Competence Framework *(GreenComp)* should support educators and learners to develop a common understanding of sustainability. It consists of four areas: (1) embodying sustainability values, (2) embracing complexity in sustainability, (3) envisioning sustainable futures, and (4) acting for sustainability. In these four areas, 12 sustainability competencies are organized [31].

The UNESCO publication "Education for Sustainable Development Goals (SDGs): Learning Objectives" [16] presented a set of competencies that attempts to meet the current challenges posed by the SDGs and bundle a very broad debate on ESD competencies. The competencies identified from different competency models by UNESCO are systems thinking, normative thinking, strategic thinking, critical thinking, self-awareness, and integrated problem-solving (p. 10). These competencies are also defined as "cross-cutting competencies" which are transversal and context-independent. They are not specific or "replace specific competencies necessary for successful action in certain situations and contexts" [16] (p. 10).

Similar to UNESCO's work, Wiek et al. [7] have formulated the five key competencies in sustainability, which we will focus on in this publication. This is one of the most influential and most referenced studies (2397 Google Scholar citations, 5 January 2023) in the field and is often seen and applied as the fundamental work of key competencies in sustainability [24,32]. Moreover, the competence model has served as an analytical framework for empirical interview inquiries. It is a critical reference point in sustainability education for developing the sustainability competencies of students expected to be future sustainability leaders. Table 1 shows a brief explanation of the five key competencies to better understand which key terms we use in our analysis.

Table 1. Key competencies in sustainability by Wiek et al. 2011 [7].

Key Competencies in Sustainability	Definition [7] (pp. 207–211)	Selected Aspects and Concepts [3,7]
Systems Thinking Competence	"Ability to collectively analyze complex systems across different domains (society, environment, economy, etc.) and across different scales (local to global)."	Change of perspective Considering inertia, cascading effects, feedback loops
Anticipatory (Futures Thinking) Competence	"Ability to collectively analyze, evaluate, and craft rich pictures of the future related to sustainability problem-solving frameworks."	Concept of uncertainty Possibility, probability of future developments (predictions, scenarios, etc.)
Normative (Values Thinking) Competence	"Ability to collectively map, specify, apply, reconcile, and negotiate sustainability values, principles, goals, and targets."	Concepts of justice, fairness, responsibility Sustainability principles, goals
Strategic (Action-Oriented) Competence	"Ability to collectively design and implement interventions, transitions, and transformative governance strategies toward sustainability."	Concepts of transitions and transformation Understanding theories of change
Interpersonal (Collaboration) Competence	"Ability to motivate, enable, and facilitate collaborative and participatory sustainability research and problem solving."	Concept of leadership, teamwork, stakeholder engagement Limits of cooperation and empathy

The above-mentioned competencies' models address complex problems. However, it is evident that all models have been developed in a theory-driven manner with the idea to influence school or university curricula. Therefore, they have been mainly used to analyze curricula or the competence development of students (mainly those from sustainability studies). However, it is unclear if and how these models can be applied, not only to those who strive for a career in a sustainability science area but also for those who have a successful career outside of science—for example, in politics, the economy, or civil society—with a position where they are required to make sustainability-related decisions with a

high impact. Therefore, we directly asked high-ranking decision makers what they need to make sustainability decisions in order to analyze the importance of the key competencies in sustainability based on Wiek et al.'s [7] framework.

3. Materials and Methods

The aim of this publication was to specify which sustainability competencies decision makers require to steer the transition into a more sustainable future in their professional everyday practices, and how these competencies relate to the established competencies framework of Wiek et al. [3,7]. The following research question guided the project and the analyses: Which competencies do decision makers in politics, the economy, and civil society require to deal with major sustainability challenges in their everyday decisions?

Therefore, one of the authors interviewed 14 actual decision makers from politics, the economy, and civil society with a strong commitment to environmental and social ethics and who are contributing to global sustainable development. Accessing leaders in influential positions—such as federal ministers or CEOs of large corporations who are often persons of public interest—can pose a challenge for academic research teams. The counseling activities in politics of one of the team members provided access to this rather exclusive field. The empirical investigation drew from first-hand narrations gained from the social worlds of CEOs, ministers, management boards of leading national environmental organizations, labor unions, and trade associations. All interviewees—six of which are women—were based in German-speaking European countries (Germany, Switzerland, and Austria), and their contributions to our empirical data have been fully anonymized. Yet, in order to recognize themselves in this publication, they chose a pseudonym.

The interview partners (see Appendix A, Table A1: List of Interview Partners) were selected following three major principles that were deduced from our research question. The person:

1. is occupying an influential, high-ranking position;
2. is not formally trained (e.g., a university degree) in natural sciences or in sustainability science;
3. has already demonstrably contributed to decision making on sustainability issues in the public sphere (e.g., by participating in an environmentally activist manner).

In order to qualify as a decision maker in the scope of this study, interviewees must have been involved in managing large companies, NGOs, unions, public authorities, or national politics. In total, we conducted 14 qualitative, semi-structured interviews following an interview guide (see Appendix B, Table A2). The interview questions were deduced from our research question and developed iteratively. The interview guide was tentatively revised and validated by external collaborators' reviews and three pre-test interviews. Yet, due to contact restrictions during the COVID-19 pandemic that were still in place at the time of the interviews in late 2021 and early 2022, all interviews—except for two—were recorded using the videoconferencing software Zoom. The interviews took 35 to 66 min, with an average interview length of 52 min.

The research design was intended to stimulate a rich narration among our interviewees by asking theory-driven interview questions related to the leader's educational biography, future scenarios they see coming, and competencies required for their current position [33]. The semi-structured interview guide (see Appendix B) was designed to reconstruct narrations and strategies about how the decision makers work, how they deal with sustainability challenges, and what they need to make high-impact decisions. Since many sustainability challenges are science-based problems, the questions focused also on science and science education. Secondary and subsequent interview questions were designed. Examples and links between topics increased the evidence in our category system [34]. The interview recordings were transcribed manually according to the Dresing and Pehl convention [35], and analyzed within the qualitative content analysis framework suggested by Kuckartz [36]. MAXQDA, a software developed to support text analysis digitally, has been applied to assist the inductive and deductive coding, note-taking, summarizing, and categorizing of

research data. We analyzed the interview data with theory-based competency models. In this article, we applied Wiek et al.'s [7] framework of key competencies in sustainability. The entire material has been co-coded by two of the authors of this article, and codes were developed and discussed in face-to-face coding sessions. The processes of analyzing data and theory building took place continuously and were discussed periodically within the whole author group.

The extent to which different persons might apply the same coding to the same section is indicated as interrater reliability in the qualitative content analysis. Research teams apply different simultaneous or successive co-coding techniques for ensuring consistency and validity in their data analysis. In this project, interrater reliability was ensured by the simultaneous co-coding by at least two team members in real-time face-to-face sessions [37]. The quotes we used as examples from the interviews have all been translated and linguistically revised in order to increase comprehensiveness. When mentioning a quote from the interviewees, we also put their pseudonym and the number of the interview section in brackets.

4. Results: Empirical Evidence for Sustainability Competencies

We present the results of our empirical inquiry by outlining which sustainability competencies and resources the interviewed decision makers draw from contributing to sustainable transitions in politics, the economy, and civil society and which competencies and resources they require for doing so. The first part (Section 4.1.) aims at briefly reporting on the complex variety of interconnected sustainability challenges the interviewees are dealing with. Section 4.2. gives a comprehensive overview on how the concepts of the five sustainability key competencies—systems thinking, anticipatory, normative, strategic, and interpersonal competence—are relevant for sustainable decision making and steering the sustainable transition.

4.1. Current and Future Sustainability Challenges as Complex Systems

In our interviews, we asked the decision makers which sustainability challenges they are facing today and which challenges they see coming in the next 20 to 30 years (see interview guide in Appendix B, Table A2). In this subchapter, we will briefly look at the responses of the decision makers and accentuate them with two exemplary quotes. More detailed examples for urgent sustainability challenges will be included in the following subchapter. When referring to sustainability challenges, issues related to energy supply and energy security (mentioned 70 times) and the ongoing anthropogenic climate change (mentioned 77 times) are among the most frequently mentioned topics. These major challenges are never presented in isolation as singular events, but always as complex systems intertwined with agricultural aspects, food security, loss of biodiversity, and general over-consumption of limited natural resources.

The following statement supports this finding referring to the problem of climate change. It is not only about soil fertility, rising sea levels, and higher temperatures as results of climate change. It is more importantly about the social consequences of climate change, impacts of economic barriers, resource access, and thus social justice. Natural and social systems of different scales are interconnected and need to be considered in decision-making processes.

> *From an agricultural perspective, the availability of fertile land will be a global issue. How can sustainability and production goals be meaningfully reconciled? [. . .] I also fear climate change. Even if we meet the 1.5 or 1.8 degree targets, we have to deal with dramatic consequences. Other unsolved problems [related to climate change] are soil erosion and rising sea levels. I would also point out the social dimensions–as all sustainability problems are also problems of social justice. Who has access to which resources? Who is allowed to use which resources and how? How do we manage to regulate that? I think the quality with which we have to deal with certain topics will change. But the topics will unfortunately remain the same.* (Agatha, 51)

Another major future challenge, mentioned several times, is the over-consumption of limited resources. In the following quote, Hugo—head of a large environmental NGO—describes climate change as a resource problem. Again, access to resources plays a role, especially regarding the issues of renewable energy, circular economy, and the limited resource of groundwater.

> *I think that the consumption of limited natural resources is a crucial problem. I do not want to play down the emergency of climate change, but I think every environmental problem can be deduced from resources and energy resources. How do we produce energy in a renewable and climate-friendly way? How do we stop producing products that consume resources? How can we save groundwater resources? Water resources are limited as well and we see them becoming increasingly scarce due to climate change. How can we preserve an area so that rainwater can be absorbed, so that groundwater is available? It is all interconnected.* (Hugo, 59)

These examples are intended to provide a brief insight into the level at which the interviewed decision makers deal with sustainability challenges, which are narrated as complex, intertwined systems. The following subchapter discusses how sustainability competencies are applied in the everyday practice of decision makers in addressing sustainability challenges.

4.2. Decision Making in a Complex World: Sustainability Competencies

Borrowing from the framework of sustainability key competencies by Wiek et al. [7], we provide examples of how aspects of these sustainability competencies can be found in the daily tasks of decision makers in politics, the economy, and civil society. The key competencies identified in the interviews are based on Wiek et al.'s [7] model of systems thinking (coded 101 times), as well as anticipatory (coded 69 times), normative (coded 83 times), strategic (coded 65 times), and interpersonal (coded 121 times) competencies.

In the following subsections (Sections 4.2.1–4.2.5), five key competencies are described. For each key competence, an introductory quotation is given, which takes the reader directly into the interview data. Subsequently, various expressions of subcompetencies of Wiek et al.'s [7] framework are substantiated and analyzed using shorter quotes. Quotes were selected to reflect as much heterogeneity as possible in the interview data. They are provided to illustrate how decision makers apply each key competence in their everyday life but are not intended to represent the whole range of our interview data.

4.2.1. Systems Thinking Competence

> *I think we need to abandon our Eurocentric worldview. We need to consider what the rise in sea levels means for inhabitants of the Marshall Islands. Why do a few millimeters cause them problems? What about Bangladesh? Why are they so concerned about their mangroves? In other words, broadening the horizon and becoming aware of problems relevant to communities outside Europe is the key.* (Erna, 114)

The importance of systems thinking for all decision makers when making decisions in the field of sustainability becomes obvious in our interviews. In the interview excerpts, different facets of systems thinking emerge. On the one hand, the decision makers emphasize taking on an international perspective when talking about sustainable ways of decision making, as with Erna—a federal minister—who describes intercultural thinking in the quote above. Decisions in the field of sustainability must be thought of as globally and not just including the consequences for one region. Erna takes this further by emphasizing inter- and trans-disciplinarity. She highlights that it is important bringing different disciplines together to evaluate and reflect the advantages and disadvantages of different points of view (Erna, 82). Wiek et al. describe this as the ability to analyze sustainability challenges "across different scales" [7] (p. 207). Furthermore, systems thinking for complex sustainable decisions means that decision makers always need to consider the social, societal, and economic consequences as well as the understanding among the individual perspectives.

- Developing a Systems Perspective

  If you would approach soil fertility through a purely chemical lens, ignoring the biological aspects, you would just have to fertilize crop fields with nitrogen. Everything would grow. But what would actually happen to the soil? How much energy does it take to produce nitrogen-based fertilizers? (Agatha, 15)

Agatha—a lobbyist for organic agriculture—indicates the importance of knowing about the interconnection of biogeochemical cycles and energy balances when making decisions about organic farming. It is important to consider the material and energy perspectives. It is not only about the subjects (as shown in the quote) but generally about the disciplines, which have to be put in relation to each other. Several interviewees (i.e., Buchholz, 4; Fischer, 116) state the importance of being able to understand the basics and interconnections among subsystems and related systems, such as civil society, economics, international law, natural sciences (earth system issues), legal aspects, and engineering perspectives.

All interviewed persons bring up a broad range of sustainability-related topics, which are usually narrated as complex, intertwined systems that pose wicked problems [38] and require macroscale decision making. Examples refer to stock and flow relationships, such as biogeochemical flows and nitrogen and phosphorus cycles in agriculture (Sonne, 29; Agatha, 15), tipping points, and earth system stability (Buchholz, 54). The multifaceted interplay of the three coordinates (circularity, climate system, and biodiversity) is stated as a "compass" according to which politics, the economy, and civil society must be organized and should act (Buchholz, 44).

- Knowing and Understanding Core Ideas and Being Able to Relate to Them

  I need to filter well. Some things consist of scientifically detailed stuff I do not need to know. I do not have to understand all these complex things in detail. [. . .] I just have to be able to grasp the connections and to know where else I can get more knowledge if I need it. However, a basic understanding of ecosystems, for example, is something you need to have. (Sonne, 9)

This example provides insight into how systems thinking, the inclusion of different systems, and systemic interdisciplinary thinking are important to shape future scenarios. Our interviewed decision makers are able to identify the core of the problem without any formal training in resource, natural, or sustainability sciences through concrete challenges. Seeing the fundamental systemic problems behind the different sustainability challenges is a competence that requires scientific basic knowledge. Evaluating information and sources of knowledge is in higher demand than detailed, field-specific expertise. It is about extracting the essence from the detailed scientific content knowledge, where the relevance, verity, and reliability of sources are as important as the ability to filter knowledge according to its relevance to a broader public. Therefore, many decision makers work closely with a competent team (see Section 4.2.5.) and depend heavily on the input of instructors who can convey technical knowledge to them in a comprehensible way.

Decision makers—in contrast to natural scientists—need to be able to take a broader perspective, including various neighboring disciplines beyond their own expertise, and relate these to democratic processes. They have acquired advanced systems thinking competencies, especially when speaking of the vast corpus of technical and scientific knowledge they have to deal with on a daily basis.

In summary, the central facets of decision makers' systems thinking competence that we were able to identify in our interviews are as follows: considering inter- and trans-disciplinarity; identifying the core behind a sustainable-related problem; and taking a broader perspective between (sub)systems, disciplines, and regions.

4.2.2. Anticipatory Competence

We will still have to deal with rising sea levels. We will still have to deal with the fact that water is becoming scarce in some countries, for example, glaciers are melting in the

> *Himalaya region and if these water reservoirs are gone, water scarcity will become a huge problem in India. If we do not take action very soon, mass extinction will be a major threat.* (Pinni, 79)

The ability to design future scenarios is listed by Wiek et al. [3] as an important learning objective. All interviewees are able to anticipate upcoming sustainability challenges for the next 30 years. This is evident in the responses to the question regarding future scenarios (see Interview Guide: Appendix B, Table A2). They develop many narratives with future pictures to better explain the effects of sustainability challenges.

- Learning from Past Transformations toward Sustainability

> *How did a certain technology develop in the past? Which social or technological restrictions can be identified? How did improvements become possible? At which point did obstacles arise and how were these problems solved?* (Fischer, 14)

Anticipatory competence is a crucial competency for being able to understand the impact of changes in the earth system on civil society and its development, and in dealing with numerous scientific predictions and scenarios related to sustainability challenges. The quote shows an example of how the interviewees use the knowledge about successful problem solving from the past to transfer it to future problems and to better predict future developments. This is important to better assess and classify different dynamics in the time dimension.

Buchholz expresses the importance of considering the time scale in planning. Speaking of the implementation of new technologies, decision makers have to take into account that applications will not enter the market just one month after a specific research paper has been published (Buchholz, 28). Social and economic dynamics are much more complex and need to be taken into account when strategizing a scenario for a sustainable future.

- Acting under Uncertainty

> *Acting under uncertainty will also be extremely important in the future. Today no one can say what the system will look like in 2050. We always try to determine such an accuracy also for 2050, but I think it is impossible.* (Bornholm, 45)

Anticipate thinking is defined as understanding that there are different scenarios with multiple potential effects [7]. In the 21st century, it is well known that dealing with increasing uncertainty is enormously important. Expertise no longer creates one-dimensional, reliable facts in retrospect, but above all is increasingly directed toward the future. Models, estimates, trends, and forecasts require new types of expertise and modeling methods but also a certain mindset that is flexible with regard to planning reliability and can deal with risks. All scenarios have a limited predictability, and decision makers need an open-minded and optimistic attitude to act and decide under uncertainty, and subsequently present an enormous certainty of the results to the outside world. Pinni—a German journalist—also underlines the importance of being able to accept finiteness in a world that is geared towards growth (Pinni, 79). For a good life and social stability, we need enough for everyone, and for this, it is important to reconcile finiteness and growth [39]. The unsustainable use of raw materials, such as fossil fuels to produce energy, will lead to livelihoods being threatened [39].

In summary, the central facets of decision makers' anticipatory competence that we identified in the interviews are as follows: understanding intrinsic times of different systems and different scenarios with their effects, dealing with increasing uncertainty, and accepting finiteness.

4.2.3. Normative Competence

> *A leading position and being in charge requires a political compass. In past times, religion or philosophy might have served this purpose. When identifying with a specific community, you are automatically influenced by its values and attitudes.* (Spreeblick, 9)

Normative competence, defined as expressing underlying norms and values or worldviews driving actions [7], is often expressed implicitly in the interviews. Even though specific sets of values are not explicitly being mentioned here, the metaphors of "compass" and "coordinates" stand for normative factors, which are driving the process of decision making. Spreeblick (35) emphasizes that every kind of scientific decision regarding sustainability also has a value implication. Even though sustainability and environmental questions are normative per se, the underlying and guiding values, ethics, ideologies, assumptions, or reasonings remain implicit within the interviewees' narrations. Our data clearly show that decision makers who contribute to the social transformation towards sustainability are strongly committed to values. These are, for instance, preserving ecosystems (for nature's or human's sake) [40], social justice, responsibility, and accountability. The values of our interviewed decision makers are based on an intensive reflection on scientific evidence regarding the functioning of natural systems and their disruption caused by recent human activity.

- Values as an Orientation Framework for Decision Making

  Before joining a committee, in my working group or in my parliamentary group, I need to adopted an inner attitude for myself. Compared with my values, I encounter completely different opinions and aspects in these groups. [. . .] And then it happens sometimes that I can only semi-assert myself based on my attitude. (Schmidt, 9–13)

Schmidt—a parliamentary group chairman—points out that values offer orientation on the way to a decision but do not lead to a decision that corresponds completely to one's own values in the end. This makes clear, therefore, that normative competence for decision makers also means being able to work with a compromise.

Different values can represent a framework. For many, it is scientific evidence. As an example, we mention Agatha, who is fostering a specific paradigm of organic farming. She does not explicitly mention or further reflect on her ideological background. However, she makes it clear that she uses scientific evidence as the basis for her evidence-based policy and sees this as confirmation that her policy is on the right track (Agatha, 21).

In this context, Pottbäcker—a former United Nations member—points out that politics and science are two different systems. While science is looking for truths, politics is looking for majorities (Pottbäcker, 36). He normatively places democracy above science and underlines that this is a problem of the climate youth, who only preach "follow the science" (36). Decision makers in politics must gain the acceptance of majorities, gain their legitimation, and enable them for participation.

- Acting According to Grown Value Systems, not to Strong Emotions

  Particularly with regard to the shocking forecasts of climate science, it is important to remain calm and not give in to every impulse. Doomsday thoughts are counterproductive and not helpful in moving forward. (Fischer, 72)

As Wiek et al. [7] suggest, normative competence is based on grown values that are constantly challenged by critical self-reflection. An advanced normative competence is also reflected by effective, mindful decision making and a high level of personal affect control. In this sense, individuals with an advanced level of normative competence will not give in to every impulse to take action but will choose a strategic long-term approach instead.

In this context, building resilience also plays a crucial role. In order to remain capable and willing to act, dealing with negative facts in a positive way and working out different options for action are important to go further and change something. In our interviews, the ability of seeing challenges as opportunities for change and for developing new things, not as obstacles, stands out. This optimistic attitude and professional perspective have emerged as being important among our interviewees. Sonne—an activist of the climate movement and member of governmental committees—notes that these are indeed personality traits that decision makers need to develop in order to have difficult conversations and make decisions. She shows this with the following statement:

> *My association has many young members who are shocked [by IPCC reports and] unsettling facts related to the world climate. But they do not feel encouraged to develop guidelines for how civil society might prevent tragic environmental scenarios but become depressed instead. They choose to emigrate or occupy forests. They become tree sitters–no judgment –, but these people do not want to get into powerful positions. Those who want to take responsibility require resilience when subjected to negative facts.* (Sonne, 37)

In summary, the central facets of normative competence that we were able to identify in our interviews are committing to grown values as an orientation framework, seeing challenges as opportunities, and building resilience when dealing with negative facts.

4.2.4. Strategic Competence

> *When someone says that he wants to build new trains so that people can travel by train instead of aircraft, tensions and decreasing acceptance may arise as it will take ten years until the trains are being built. If you do not take this long time span into account, your policy portfolio will lack feasibility.* (Fischer, 20)

Strategic competence is another key competence for leaders assuming responsibility in civil society. People with high strategic competencies are constantly striving to achieve common goals, trying to understand the dynamics of the system, and adapting their decisions and actions accordingly. At the same time, decision makers remain conscious about inertia, obstacles, and path dependencies when strategizing societal transformation towards a sustainable future. With the competence to design future visions (anticipate competence) comes the ability to think about and explain possible obstacles along the way, as the opening quote makes clear.

- Taking into Account the Complex Dynamics of Democratic Decision Making and the Different Time Scales of Systems

> *Natural scientists totally misunderstand how long it takes until their reports and insights lead to action in civil society. A friend of mine, a scientist, complained that "nothing happened in the last thirty years. We are continually publishing reports on climate change, but nobody takes action in civil society and the economy." I strongly oppose that complaint, because, concerning the way how people perceive problems in technology, so many things actually did change. Natural scientists often have a very poor understanding of what happens in our societies and how such societal dynamics work.* (Buchholz, 28)

Understanding not only the systems of the natural world but also the complex dynamics of democratic decision making, implementation of scientific facts into administrative policies, and societal change toward a sustainable future are an important part of a sustainably competent mindset for decision makers. For analyzing, evaluating, and crafting future pictures [7] (p. 207), it is important to be able to classify different dynamics in different fields and to understand the different dynamics of societal and political change. According to Buchholz, scientists of neighboring disciplines tend to misunderstand the different dynamics of implementation within the area of cooperation with different stakeholders. Fostering interdisciplinary collaboration and understanding the different scales (temporal and spatial) of systems are crucial to developing a sound competence in strategic thinking. Understanding that political and social processes do not directly lead to disruptive change but create the basis for future change is important for assessing the possibility and probability of future developments, and it is an important competency for decision makers.

- Politics Arise From a Value-Driven Idea

> *In my opinion, politics does not manage the possible, it means making the necessary things possible. Because if we only focus on what is already possible, we are stuck in the past. We have to shift the focus to what is necessary.* (Pottbäcker, 174)

In the quote, Pottbäcker opposes making decisions along the lines of what is considered as being possible, mostly on the basis of approval ratings. It thus emphasizes the importance

of orienting one's decisions not along (short-term) obstacles or approvals but along their value-bound and/or factual necessity. This is consistent with WBGU's [8] work that highlights the importance of appropriate attitudes and values for the success of a sustainable transformation.

- Reversibility as a Key Perspective

As a recognized principle of European environmental policy, the precautionary principle calls for preventive action above all when scientific uncertainties exist, and irreversible consequences are to be feared, as is the case in the field of nuclear energy or genetically modified organisms. This principle is broken down in the argumentation of our interviewees based on reversibility as a key perspective in decision making, as the following quotes show:

> *With topics, such as genetic engineering, there is no such thing as being "a little bit pregnant." I cannot go along with letting it out into nature, because you cannot get that back. That is a red line for me. I cannot let that genie get out of the bottle. That would be unfair and socio-politically irresponsible.* (Stefan Schmidt, 15)

> *What are the dynamics that you trigger [. . .], what is reversible? You have to acquire this type of knowledge.* (Buchholz, 22)

The quotes give insights into how values and knowledge are interwoven in decision makers' perspectives: Stefan Schmidt argues based on fairness and responsibility as key values that are infringed upon if new organisms are irreversibly set free in natural environments, while Buchholz argues that specific knowledge is needed to find out if the dynamics of a process are reversible or not. In another interview, Pottbäcker (58) argues that only reversible decisions are capable for democracies. The central role that the aspects of reversibility of one's own decisions play in the argumentation of decision makers shows a high level of metacognition as it goes beyond arguing based on facts or values: it shows an active and intended foresight into the consequences of decisions.

In summary, the central facets of decision makers' strategic competence that we identified in the interviews are as follows: understanding the complex dynamics of democratic decision making, developing transformative strategies towards sustainability, and seeing challenges as opportunities.

4.2.5. Interpersonal Competence

> *We need to be able to deal with environmental problems in more abstract and engaging ways. For example, when we are facing the situation of an actually endangered area of peatland, I will not simply go there and save it all by myself. I would rather assess and involve relevant stakeholders [. . .] and try to build a bridge between them by explaining why the conservation of this peatland is relevant to them personally or their community. I think moderation skills will probably be even more in demand in the future.* (Agatha, 55)

Another important skill related to sustainability competencies refers to interpersonal thinking. In order to steer transformations successfully, decision makers need to reach out to a heterogenous range of stakeholders and moderate among them on an institutional, discursive, and societal level. Their most important capability is enabling communication and collaboration in highly conflicted and controversial settings, namely by engaging as agenda setters in public debates, and participating in political decision making and negotiations among high-ranking industry representatives. In order to achieve large-scale sustainability transitions, decision makers need to focus on institutional, regional, national, and global communication strategies. As a consequence, achieving a certain level of social acceptance for sustainability measures, such as restrictive laws that aim to serve urgent sustainability goals, is crucial.

- Collaboration among Experts

> *The decision makers of the future [. . .] are all part of a system, let it be a ministry, a company, or a labor union. And all these systems have competencies a single person*

> *cannot provide. Leaders need to be able to understand group dynamics and become aware of who is trustworthy.* (Darth Vader, 47)

Decision makers in influential positions are not solitary entities but integrated into powerful institutions. They are surrounded by interdisciplinary teams of consultants and advisors in which cooperation in the context of interpersonal competence and the exchange of knowledge is important. Since many ministers, journalists, or company managers do not hold a university degree in the natural, sustainability, or environmental sciences but rather have a background in social sciences and humanities, such as economics, law, or political science [41], they are dependent on the constant, reliable cooperation with relevant experts when it comes to science-based sustainability challenges. In order to provide their managers and chairs with knowledge, ministries, business associations, and trade unions employ staff units or scientific departments that work with the decision makers. Research advisors serve as filters and gatekeepers who influence the leaders' access to knowledge (Erna, 60), which makes decision making and strategizing sustainable transformations also a collective endeavor.

According to Pinni, most decision makers have a personal, semi-private network of experts who they can consult in case of doubt, and who can also be contrasted with each other in order to avoid reproducing bias in the field and to pass on a differentiated picture. Critical thinking is absolutely essential; never trust proven sources blindly because knowledge quickly becomes outdated. Evaluating the influx of information in terms of relevance, verity, and reliability by its sources is as equally important as the ability to filter knowledge according to its relevance to a broader public (Erna, 60). For interpersonal competence, the emergence of communities with the different disciplines is important for focusing on cooperation and teamwork.

- Translating Complex Issues to Raise Awareness and Engage Broader Audiences

> *We need to be able to translate scientific knowledge into a basic language everybody can relate to. [. . .] We need to argue on one or two pages why we want to reach a goal. A political strategy is successful when individual interests become collective ones.* (Emma, 19)

Translating technical language into everyday language [7] (p. 210) and communicating figures in an understandable way are crucial to achieve effective communication systems with the broader public. Designing a transformative communication strategy is described by the decision makers as a collective process. Emma—CEO of an energy company and involved in public affairs—is active in the strategic management of decision-making processes at the interface between the economy, politics, and civil society. In her policy assessment, she attempts to align individual (i.e., industrial, economic) interests and public interests through the transfer of specialist knowledge. Individual economic interests must be socially compatible and compatible with collective interests in order to reach the political stage.

Interview partners express an advanced level of interpersonal competence for engaging different target groups to steer the transformation process. As opinion leaders, agenda setters, and well-noticed voices in public discourses on sustainability topics and measures, they reach out to large, heterogeneous audiences. Mediating among heterogeneous interests and positions requires a sensitivity for fissures in communication, such as misunderstandings, misconceptions, resentment, and prejudice among disciplines and stakeholders.

In summary, the central facets of decision makers' interpersonal competence that we identified in the interviews are as follows: collaboration with different stakeholders in highly conflicted and controversial settings, working in interdisciplinary teams, and designing transformative communication strategies.

5. Discussion

The main aim of this study was to investigate which competencies decision makers in politics, the economy, and civil society require to deal with major sustainability challenges in their decisions, and to find out how these competencies relate to Wiek et al.'s [7] key competencies model. The unique contribution of this research is the exclusive target group of leaders in influential positions and the valuable insights into their work and decision-making process.

5.1. Concluding Discussion on the Interplay of Sustainability Competencies

As shown in the Section 4, we are able to show that most of the competencies used by our decision makers relate well to Wiek et al.'s [7] model of key competencies in sustainability: We found aspects and concepts for all five sustainable key competencies listed by Wiek et al. [7]. The competencies could be found in the following frequency in our data: systems thinking (101), anticipatory (69), normative (83), strategic (65), and interpersonal competence (121). The results indicate that systems thinking and interpersonal competencies are particularly significant in terms of the number of statements.

Furthermore, we found in the statements of our interviewees that the competencies needed to solve a problem often overlap and are intertwined. Obviously, applying sustainability competencies cannot be considered and used separately, but instead always in connection with each other. This result is consistent with Wiek et al.'s statement that "analyzing and solving sustainability problems requires linking and activating all of the individual competencies" [7] (p. 212). The following example of organic farming illustrates how the interviewee combines several competencies in the decision-making process to address sustainability challenges:

> *In order to build our argument for organic farming, we take the meta-topics, i.e., the major crises, the biodiversity crisis, the climate crisis, groundwater, etc. And then we try to figure out where organic farming could make a difference. Therefore, you have to know all these mechanisms in the first place: How does the water shortage come about? How are groundwater or surface water being polluted? What happens to the fish in the river when they are over-fertilized? What happens to the bees when too much pesticides are being applied? In the end, these are all scientific [. . .] correlations, which of course have to be thought of in the system.* (Agatha, 19)

When explaining her strategy for promoting organic agriculture as part of the societal transition towards a sustainable future, Agatha reveals a strong capacity for systems thinking to frame the problem as a socio-scientific issue. A systems approach in communication is required to point out the interconnectedness of sustainability challenges. When dealing with complex systems, Agatha considers multiple interlinked variables, cause-effect chains, as well as temporal and spatial dimensions. She is drawing a complex picture of the initial problem by integrating a strategy with a systems perspective. Agatha is maintaining her expertise on ecological agriculture and food production by constantly studying and evaluating the relevant literature critically and engaging with experts and multiple stakeholders. She also draws from experiences gained directly in the field and uses them to provide reasons for her actions and to corroborate her arguments when talking to lay people. To tackle challenges, such as the climate crisis, biodiversity loss, soil fertility, social justice, or access to resources, this serves as the underlying argumentative hook from which the argument is developed. This strategy also implies an increased relatability, because it might help people focusing on singular environmental issues to see the bigger picture and enable meaningful sustainable citizenship.

5.2. Concluding Discussion of Overall Themes

Decisions with a great scope and high impact are made by decision makers in influential positions [6,11,15]. In this section, we will discuss aspects that are highlighted by the interviewees as particularly important for the decision-making process. The results

presented in Section 4 give valuable insights into the thinking, considerations, decision making, and actions of these persons in positions with responsibility. Each responsible person takes his or her own path to a sustainability decision, but common points could nevertheless be identified, and will be shown in the following sections.

- Sustainable Decision Making Means Translating between Heterogeneous Disciplines, Communities, and Stakeholders

In order to understand and comprehend the work of sustainability decision makers, it is first important to understand that they never work alone but are always embedded in a system: in large institutions or working groups with different focuses and tasks (i.e., Darth Vader, 47). This could explain the dominating appearance of systems thinking and interpersonal competencies (described in Section 4.2.1. and Section 4.2.5.). The challenges of the decision makers consist of multifaceted interdisciplinary networking, i.e., they reach out to various actors, exchange ideas, maintain contacts, and "get people on board" in order to convince them of their strategy (i.e., Erna, 82; Tschaikowski, 103).

There are several gatekeeper positions that select and popularize pieces of knowledge, thus functioning as an interface (Erna, 60). Research advisors conduct research on specific topics, evaluate the research status, redact the results, check legal conditions, translate technical terms into a simplified language, and communicate the conclusion to those in leading positions by writing handouts and reports. For the people in charge, it is important to ask the right questions that help them acquire the knowledge they need for their decisions (Emma, 33; Erna, 90; Hugo, 95).

The collective is organized hierarchically and oriented towards collaboration. This implies systems thinking applied to collaboration and social transformation, which is sensitive to social inequalities and the dynamics of civil society itself. There are always multiple perspectives, demands, and conflicting interests in civil society requiring excellent moderators. Decision makers have to bridge the gaps between scientific disciplines, communities sharing opposing values, and cultures. That implies the ability to apply participatory methods, enable networks, and deliberate in a meaningful way.

Addressee-related communication is a core element in decision-making processes and is indispensable for decision makers. As Johansson, Miller, and Hamrin state, "leading others without communicating seems virtually impossible" [42] (p. 148). Additionally, when it comes to achieving social acceptance for measures, interpersonal competence becomes important for the role of a negotiator and policy maker. Therefore, crafting a consistent, evidence-based story that includes all arguments, raises awareness of sustainability challenges, takes different needs into account, and offers far-sighted strategies for intervention requires all five sustainability competencies suggested by Wiek et al. [7].

- Extrapolating Knowledge among Systems, Time Scales, and Ontological Levels

Leaders need broad knowledge in many areas of expertise to recognize and evaluate relevant information as well as anticipate impacts and consequences of their evidence-based decisions (i.e., Sonne, 9; Spreeblick, 19). They use their knowledge of natural and social systems to develop a strategy to address the fundamental environmental challenges. According to our analyses, successful decision makers always put singular events and problems into a broader social context, which expresses their advanced ability of systems thinking. It is important to focus not only on the microscopic perspective but also on a macroscopic perspective and on relating both perspectives with each other.

According to the interview partners, this is crucial in order to become a leader and to make effective decisions in the public sphere. Taking into account entire systems instead of details is what makes the difference between leaders taking responsibility for a sustainable transition on a societal level and individual activism with a lesser impact (i.e., Sonne, 37). Detailed knowledge takes a back seat for decision makers as they need to understand and be able to classify the interrelationships between the systems more than they need to know the scientific method or the detailed process themselves. In this context, trust in one's own system and network is essential (Section 4.2.5.).

It is important to understand the temporal dynamics of the different systems. In particular, it is important to understand the different time scales when making predictions (anticipate thinking). It is also important to understand the dynamics of a democratic system and to see politics and science as independent systems with their own goals and time scales. These presented results are consistent with Booss-Bavnbek et al.'s work that deals with "the scientification of politics and the politicization of sciences" [43] (p. 1). They also point to the multiple time scales in sustainable development and climate change that can lead to overestimation and underestimation, and further on to misleading solutions in communication.

- Dealing with Uncertainty

The analysis of the interviews showed the following clearly: Decision makers act every day on the basis of incomplete information: they are constantly uncertain in their decision-making processes because the consequences of any decision always occur after the decision has been made, and they can therefore never be certain in an absolute sense. Research on the competencies needed when making decisions while uncertain is ongoing [44–47].

With increasing global change (i.e., climate change, social change, geopolitical change), fundamental uncertainties grow; systems elude linear controllability as complexity increases [48]. This reflects that the decision makers we interviewed usually cannot align themselves with only one goal, but often have to meet conflicting expectations and rationalities. At various points, it becomes clear that reversibility and connectivity are in themselves important conditions for their decisions reached while being uncertain (Buchholz, 22; Stefan Schmidt, 15). Before making sustainability decisions, the evidence-based clarification of all opportunities and risks is needed to make a decision for or against a non-reversible measure.

Another important factor for decision making while being uncertain is trust. This refers in particular to a trust in the system and is reflected both in the professional competencies and personal integrity of the people making the decisions [49]. However, system trust is also identified as being particularly significant, i.e., trust in the functioning of institutions and rule- and procedure-based decision making, in an integrity of input independent of personal interests and judgments. In acceptance research [48], the management of decisions is also mentioned as an important aspect of making decisions while being uncertain. Von Ameln [48] takes the example of the COVID-19 pandemic to explain the challenges of decision-making processes in uncertain times. He highlights the state of not knowing, the multiplicity of variables, politely, and paradox in complex systems as reasons that make macroscopic political decisions particularly difficult under uncertainty.

Decision makers need a strong, secure standing to make a decision and communicate it in the form of a political strategy (strategic, anticipate, interpersonal thinking). A political strategy is effective when it is not only about individual interests (individual opinions, individual companies) but becomes about the collective interest (Emma, 19). In the case of our interview partners, this is reflected in the involvement of different actors in decision-making processes and is thus again a partial competence of interpersonal competence. It has become clear that it must be possible to make decisions even in the face of resistance, especially in crisis situations and while being highly uncertain.

Another important point comprises underlying norms, values, and worldviews. Decision makers are therefore conscious of their values in their decisions (normative thinking), try not to be guided by strong emotions, and try to pursue a policy of making the necessary possible (Pottbäcker, 174).

- Building Resilience

When dealing with negative facts, it stands out how leaders are handling this aspect in terms of personal resilience and professional perspective (Section 4.2.3.). An optimistic attitude and resilience are important in order to remain cool in the face of negative facts and not fall into climate gloom, to engage one's mind, and move forward with the optimism of being able to change something (Sonne, 37; Pinni, 75; Darth Vader, 43). This finding is

consistent with the previous literature by Brundiers and Wiek [50] and Skovholt and Trotter-Mathison [51]. They have shown that "compassion, empathy, gratitude, mindfulness, and other positive behaviors" improve cooperation and leadership [50] (p. 1) and emphasize preventative self-care and personal wellbeing as enablers, despite negative facts [51]. This also applies to education. Ojala [52], for instance, has shown that the role of addressing emotions in climate change education is important. A key point mentioned for education is that it is not only about focusing on actions at the individual level to deal with negative emotions and bring this to a constructive level with individual actions, such as the so-called private-sphere actions by Stern [6]. It is also about helping students to learn and reflect upon examples of public-sphere actions, which have a high impact on solving sustainability challenges [52,53]. When addressing the urgent sustainability challenges, they make a clear distinction between a microscopic and a macroscopic approach to strategizing and steering sustainable transformations.

5.3. Limitations

The following section discusses the limitations concerning the results of the study. One limitation is that the sustainability challenges mentioned are of course determined by the choice of interviewees and their respective views of the world and the timing of the surveys. In addition, it is crucial to consider the respective view of global events or extreme weather events, which are supposed to cause unintended discourse effects. The interviews were conducted in late 2021 and early 2022. If the interviews had been conducted during the summer of 2022, issues such as energy security would have been given even greater consideration.

Due to the explorative approach and study setting, the sample size is rather small with 14 participants. In our analysis, we focused on narratives of individual cases, which is why the number of interviewees was sufficient for our research question. Even though access to leaders in positions of influence is rather exclusive, future research could use a larger sample size.

We decided to ask only people without any formally trained science or sustainability science background (e.g., a university degree). We have chosen to do this in order to explicitly understand how these decision makers acquire or draw on scientific knowledge. However, for future research, it might be interesting to ask decision makers with a science background.

We could only determine the competencies by self-statement but not check which ones they really use. Further studies should investigate research on the actions and identify competencies in the field.

5.4. Future Research

As a next step, the findings of this study should be extended to the field of sustainable leadership, science education, political science, and, from a sociological perspective in the context of the Great Transformation, sustainability.

- Sustainable Leadership

Social sciences and humanities are increasingly involved in sustainability discourses and also increasingly envisioned as active agents and drivers of change toward sustainability. Not only technology but also the cultural and social dimension are considered in visions and strategies regarding sustainable change. Political scientists, sociologists, historians, and cultural studies scholars within the transdisciplinary field of transformation research aim to investigate past and present societal transformation processes. Drawing from these insights and deeper understandings, they also aim to strategize and steer future change on an institutional, idealistic, and innovation level [54]. The analytical perspective of transformation research might benefit from investigating the dimensions of sustainable leadership and education.

- Science Education

Sustainability leaders have to be able to analyze and solve problems at the intersection of different systems, which require linking the different individual sustainability competencies. Our results support recommendations by Kranz et al. [15] to include both social and scientific issues in education because sustainability is always discussed at the interface of science and civil society. Moreover, a one-sided focus on private-sphere actions in education should be avoided, and public-sphere actions must be incorporated when educating future leaders. As a next step and bridging the gap between sustainability competencies of leaders and education, we suggest analyzing learning opportunities with regard to the various dimensions of sustainability competencies. Information on how sustainability competencies are incorporated and a comparison with the results of decision makers might give valuable insights into the current state of the development of competencies of learners in educational settings. Further, since many sustainability challenges have a scientific core, it would be important to investigate what scientific knowledge and skills decision makers need.

- The Great Transformation as a Heuristic for Sustainable Leadership

The presented results indicate that leaders committed to sustainable change are following a holistic political vision of sustainability in their decision making. Not individual consumer behavior but rather binding macroscale measures in politics, civil society, and especially shifts in industrial modes of production constitute effective contributions to a more sustainable future [6]. The self-concept of sustainable leadership is closely tied to assuming responsibility for larger collectives and protecting civil society from the threats of social disruption and environmental disasters caused by the unsustainable status quo. The concept of the Great Transformation [8,55] addressing the complex path dependencies in political, industrial, cultural, technological, and legal systems around the globe implicitly and explicitly serves as a heuristic for decision making among the interviewed agents of change. Future empirical research might investigate how deeply the heuristic of a Great Transformation is already implemented among decision makers, which nuances in notions they share, and how the heuristic enables them to drive socio-technical change toward a sustainable future.

6. Conclusions

The main contribution of the current research is that it gives valuable insights in the work and macroscopic sustainability-related decision-making process of high-ranking leaders such as federal ministers and NGOs of large companies. Until now, ESD models have been developed on the basis of theoretical considerations and tested—if at all—on school students or university students in sustainability studies. So far, no empirical testing of ESD competencies on people in positions where these are required to make sustainability-related decisions with a high impact has taken place. Our research was able to fill this gap by directly asking high-ranking decision makers how they make macroscopic sustainability-related decisions. From this, we were able to deduce which competencies they need in decision-making processes, and how these relate to influential ESD models. The project has innovative character, as it addresses a clear research desideratum. Working with decision makers to draw conclusions about ESD is a new approach that can bring significant insights in this field. The study draws from first-hand narrations gained from the hardly accessible worlds of CEOs of large companies; federal ministers; and the management boards of leading national environmental organizations, labor unions, and trade associations. By analyzing the competencies needed by those who make decisions on sustainability, and not only by those who study sustainability issues, this research article provides the ESD world unprecedented answers.

Drawing from these unique presented results, we highlight the following concluding aspects of sustainability competencies which are particularly important for decision makers.

1. Systemic Interdisciplinary Thinking

   The evidence shows that systems thinking, interconnected with the other sustainability competencies, is particularly important in decision making. The authors suggest reconsidering the notion of systems thinking in decision making by observing the following dimensions:

   (a) Private- vs. Public-Sphere Decisions The decisions of our interviewees have a large-scale impact on the public sphere and are binding for vast audiences [6]. They have to take strategic measures and can thus develop a great leverage effect. This is why it is important that decision makers have leading sustainability competencies, which should already be addressed in school with special regard to the public sphere.

   (b) Taking a Macroscopic Standpoint According to the interviewed decision makers, their positions require a broad, basic scientific knowledge. Detailed knowledge plays less of a role for people with leadership functions. The evaluation of information and sources of knowledge has a higher priority than detailed specialized knowledge. It is about extracting the essence from detailed knowledge and grasping concepts. In this regard, many decision makers mention that they see themselves in an interface function, where they have to take knowledge from many different disciplines into account, use critical thinking, and make decisions on the basis of this knowledge.

   (c) Understanding the System Effect behind Many Individual Systems Our interview examples provide insights into how the interviewees are able to identify the core of the problem behind individual challenges. If we generalize this, we can say that decision makers are able to include different systems and explain the consequences in terms of the interrelated challenges.

2. Building Resilience Not giving up on an optimistic attitude and trust in civil society and science are key personal traits that have emerged as being important among our interviewees. Dealing with negative facts in a positive way, not becoming depressed, and using strategic thinking to work out different options for action constitute one important aspect. The strategic thinking of our interviewees enables them to craft positive counter-scenarios based on ecologically effective interventions.
3. Following Own Values Decision makers need grown and reflected values as an orientation framework in the decision-making process. In the spirit of strong sustainability and nature-based thinking, their actions are guided by the motivation to shape politics, the economy, and civil society within planetary boundaries as well as on the basis of the circularity of resources and biodiversity conservation. By the fact that their driving values serve more as guidelines, they can be handled flexibly in a given situation if this serves a strategic long-term goal.
4. Teamwork and Diverse Stakeholder Management Many decision makers emphasize that they work closely with a competent team. People with decision-making functions are heavily dependent on the input of experts who can convey technical knowledge to them in a comprehensible way. Trust in the network and the collaborators is a central aspect.

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Informed Consent Statement: This study was conducted with decision makers from economics, politics, and civic society and their participation was voluntary. Their contributions to the empirical data have been fully anonymized. In order to recognize themselves in this publication, they chose a pseudonym.

Data Availability Statement: The interview guide and a list of our interview partners are available in (Appendices A and B). The coding system is available upon request from the corresponding author.

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Appendix A. Interview Partners

Table A1. List of Interview Partners.

Interview Partners (Pseudonyms *)	Domain	Position	Education	Area of Expertise
Tschaikowski	Civil society	Policy coordinator	Political science	Political transformation and technical progress
Fischer	Economy	Leader, energy agency	Physics, economics	Energy transition and climate protection
Buchholz	Politics	Leader, federal agency	Political science, economics	Development cooperation, environmental issues
Erna	Politics	Federal minister	German studies, political science	Steering transformations
Emma	Economy	Leader, energy company	Political science, economics	Energy transition and energy supply
Pinni	Civil society	Editor, major newspaper	Political science	Climate and environmental policy, post-growth (in economics)
Stefan Schmidt	Politics	Parliamentary group chairman	Law (agricultural law)	Climate change, distribution issues
Darth Vader	Economic policies	Union president	Chemical lab technician	Energy supply/security, resources; coal phase-out
Bornholm	Economy	Leader, energy company	Administrative sciences	Energy transition and supply
Spreeblick	Economic policies	Leader, federal agency	Economics	Climate change, digitalization
Sonne	Civil society	Activist, climate movement; member of governmental committees	Business administration	Resource utilization, migration barriers, biodiversity
Hugo	Civil society	Leader, environmental NGO	Political science, communication sciences	Environmental protection, climate, and energy
Agatha	Economy	Leader, agricultural organization	Agricultural sciences	Organic farming, transformation to sustainable agriculture
Pottbäcker	Politics	Former UN official	Economics	Environmental policy, climate change, circular economy

* In order to ensure anonymity, all interview partners are mentioned by their self-given pseudonyms only.

Appendix B. Interview Guide

Table A2. Interview Guide.

Greeting and Introduction:		**Aim/Goal**
Dear . . . Thank you very much for agreeing to participate in our study. Our experience shows that the interview lasts about 45 min. We are currently conducting a survey with leaders/decision makers in politics, economics, and civil society. We aim to find out how school education affects sustainability awareness. In this study, we are specifically interested in the contribution that science education, as taught in school, can make. Basically, we are aiming at a list of content, practical skills, concepts, and meta-competencies typically taught in science curricula that shape decision makers in their everyday decisions. Do you have any questions beforehand? We have already talked about the fact that our conversation here will be recorded on tape. Please do not worry, the material will be completely anonymized and, after transcription, deleted with the help of the CC-Cleaner program for devices. Absolutely no inference to your person is possible as we also anonymize, for example, institutions or real persons who are named by mistake, such as [Uni X] or "external person Y." You can stop the interview at any time and if you want to exclude positions from the analysis that is also no problem. Do you have any questions left? As soon as you give me your consent, I will turn on the recorder.		Create trusting atmosphere; open, narrative-generating setting. Make it clear in advance that it is about the connection between school education, natural sciences, and decisions in responsible positions in order to avoid rambling digressions during the interview.
Questionnaire Block 1: The Role of Scientific Knowledge and Skills against the Background of the Current Position of the Interviewee		
Stimulus	**Specific Inquiries**	**Scientific Objectives**
1.1 [Individual introduction, address current position or project.] In this function, you do have to make decisions about [a specific area of sustainability] on a daily basis. On what basis do you decide on the scientific aspects? What do you need to make good decisions in regards to sustainability [individualized examples]?	For example, how do you enquire about [named or specific sustainability area]? How do you deal with challenges and what do you need to make a decision?	Relevance for the present/present day relevance. Capturing the main themes of the person and the role of natural science education in the current position.
1.2 Regarding your decisions, what is the relationship between scientific knowledge and, for example, economic or legal knowledge? [If applicable, thematic reference to current area of responsibility.]	Could you give us an example?	Emphasis of natural science education. Education compared to other knowledge systems.
1.3 If you were to hire a deputy: What (natural) science skills would they need to complement you?	Could you give us an example?	Establishing epistemic authority in the field.
1.4 I assume that in your position you receive a lot of expert assistance/support. When do references, especially between scientific, economic, and legal aspects, seem strange/odd to you?	(Adapt individually.) Climate change: relations between budget approach and reduction dates. Genetic engineering: precautionary principle/provision principle.	Knowledge network, critical thinking.
Questionnaire Block 2: Implementation in School Lessons		
Stimulus	**Specific Inquiries**	**Scientific Objectives**
2.1 How and where did you acquire the scientific knowledge and skills you need in your current situation? When you took up your current position: Were there any aspects that you had to delve into in greater depth? How did you do this? What sources of information did you consult? Maintenance question: You deal with issues of [adapt] on a daily basis. After all, these issues have a strong (natural) science background. When you think back to your own science lessons, what content or competencies you acquired there help you to make your decisions today?	What knowledge and skills that you acquired in school do you still benefit from today and what knowledge did you have to acquire later? Dependent follow-up questions: You said that you have to think ahead–in what natural science topics in biology, chemistry, physics, or geography classes did you learn this? You mentioned that you gained this knowledge primarily in chemistry classes. Can you elaborate more specifically which thematic blocks you have in mind?	[Reference to the past.] The role of (natural) science education in the context of experts and their dimensions. Relate learning experiences to current position.

Table A2. *Cont.*

2.2 What were some key experiences in your life that led you to become involved in issues such as [advocate XYZ issue]?	And with regard to school education? And with regard to natural sciences?	Biographical experiences; attitudes and interests of the interviewee.
2.3 In natural sciences, attempts are now being made to divide knowledge and skills into the areas of - expertise, i.e., knowledge [e.g., adapted individually, e.g., about climate change]. - knowledge acquisition, i.e., knowledge about [how climate models are created]. - assessment [i.e., linking physical knowledge of the greenhouse effect to one's everyday life]. - communication [i.e., being able to understand and create emission diagrams]. To classify: What role do these different aspects play in your decisions? [Cards are taken away.]	Prepare areas of competencies as cards. If necessary, forced-choice: If you were to set priorities in teaching, where would you set them in regards to competencies?	
2.4 It is often requested that we should think in a more interconnected way. What role does this play in your everyday working life? Could you give us an example?		Are technical aspects mentioned above/over interdisciplinary competencies aspects? How linear/interconnected are the statements/levels?
Questionnaire Block 3: Future Social Scenarios		
Stimulus	**Specific Inquiries**	**Scientific Objectives**
3.1 What societal challenges related to sustainability issues do you see coming up, especially [in your field]? What contribution can knowledge and skills from natural sciences make to overcoming them?	What topics will your successor probably deal with? What are the hot topics in your field right now?	[Reference to the future and recommendations for action.] Attitudes and interests of the interviewee.
3.2 Think about your position in 20 years: If you were to name three aspects that young people today should learn in natural sciences in order to be able to do your job at least as well later on, what would they be?	What role do natural sciences play in this?	[Concrete recommendations for action.]
Conclusion/End of the Interview		
Are there any other aspects of the topic that are particularly important to you that we have not discussed yet? Well, there are no more questions from our side now, thank you very much for the provided information and the exciting insights into your area of responsibility/authority and the corresponding scientific principles! I am impressed! Do you still have any questions? Would you like to share your feelings about conducting the interview study? Thank you very much again! We will keep you informed about the results of the study and emphasize again the anonymity of the survey.		

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