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MORALIZED VISIONS
& Technological Design

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Contents

Chapter 1

Introduction

1   Introduction

A recent report establishes European voters as divided in five tribes organized around five crises: climate, health, migration, security, and the economy (Krastev & Leonard, 2024). Together these five crises represent a more general malaise felt in many European countries: the future is perceived as 'closing in on the present', leading to 'temporal claustrophobia' (White, 2019, p. 4). President Macron put it succinctly in his 2018 '*Changeons Ensemble*' speech concerning a pragmatic approach to reducing the share of nuclear energy in France's energy mix:

> What I want to make French people understand – notably those who say 'we hear the president, the government, they talk about the end of the world and we are talking about the end of the month' – is that we are going to treat both, that we must treat both. (McNicoll, 2018)

Furthermore, these are crises of systems. As a way out of these systemic crises, the five crisis tribes entertain different ideas of desirable futures, and different ideas of cumulative decisions and actions to realize these futures (Krastev & Leonard, 2024). In the midst of these crises, governments are called upon to escape their crisis mode and provide long-term commitment to change in the form of visions and missions (Hartley et al., 2024; Janssen et al., 2021; Mazzucato, 2021). These governments should stop tinkering, start leading and give direction: they focus too much on 'fixing things when they go wrong, rather than on improving the everyday lives of citizens in imaginative ways' (Mazzucato, 2021, p.21). Technology, finally, cuts through all these crises and ideas of better futures, sometimes as a proposed solution, sometimes as part of the problem.

Governments should start thinking about, and realizing, desirable futures. Desirable futures are often communicated in the form of visions. Such visions

schematically show a future state of affairs that is considered good, or even ideal. In the case of ideal, or idealized future states of affairs, these visions are called 'utopian'. They present a perfect future world. Visions are perceived as guiding actors out of problematic situations, such as the above crises. For instance, guidance can be offered by showing which institutions (e.g. Rawls, 1999), events (e.g., Skeggs et al., 2021), or buildings (e.g., Hall, 2014; Urban, 2013) are needed to realize a desirable state of affairs. Visions therefore propose societal change, in the form of future states of affairs— such as a sustainable society or a smart city—that are better than current states of affairs and, sometimes, considered perfect.

Technologies have emerged in the 20th century as highly relevant to realize desired societal change. They often feature as instruments to realize good or even ideal states of affairs that were hitherto out of reach. Visions in which certain technologies emerge as dominant means, guide actors in the use, operation and, possibly, design of these technologies, inducive to good future state of affairs. Furthermore, if these technological visions concern the changes in systems through which certain societal goods, such as energy, education, or transportation are delivered, these visions may be called 'sociotechnical' (Kudina & van de Poel, 2024; Sovacool et al., 2020).

This dissertation focuses on sociotechnical visions in which sociotechnical developments are perceived as the main drivers for the realization of desirable futures. I understand a desirable future to indicate a future state of affairs in which a certain idea of good living or the good life is realized through sociotechnical change. However, the manner in which sociotechnical visions influence the design, use, and operation of sociotechnical systems is still unclear. For instance, (1) it is unclear if and how these visions impact the design of technologies, and how values and other moral objectives that are often present in visions relate to the material sphere of technological design; (2) how to understand the role of ideals in both visions and the development of sociotechnical systems; (3) how to assess the feasibility of sociotechnical visions.

Such questions warrant a closer look at processes of formation and moralization of sociotechnical visions. Values and ideals, this dissertation claims, play an important role in this moralization, but a clear understanding of this role is still absent. In the coming sections of this introduction I provide a problem statement and clarify what I mean with values, ideals, and visions in relation to sociotechnical change. I also give an overview of the chapters that follow.

1.1 Problem statement, research objective, and main research question

Many accounts of sociotechnical visions emphasize the long-term, guiding function of visions. For instance, it has been stated that visions, if collectively embraced, shape and support national, technoscientific trajectories (Jasanoff & Kim, 2009, 2013). These accounts also emphasize the moral ends and values visions propose as reasons for the acceptance or refusal of certain sociotechnical changes (Felt, 2015). However, it is still unclear how to understand or analyze the function of values in visions. While visions often motivate, coordinate, and render a complex future less opaque (Borup et al., 2006; Brown & Michael, 2003; van Lente, 2012), research has not addressed how values and moral objectives appear and function in these visions: how exactly these values and moral objectives guide the development of sociotechnical systems, what happens after a certain technology has become embraced through a shared vision.

For instance, it is unclear how values and moral objectives are translated into specific decisions concerning the (further) development of sociotechnical systems. This seems especially the case if these values and moral objectives are part of widely shared, but loosely defined and open visions. In such open visions, what is meant with a certain value or moral objective, such as freedom or health, is often underdetermined. It is therefore unclear how such values and moral objectives would affect the design, operation, and use of sociotechnical systems, as well as the interaction between diverse human

agents. In general, accounts of visions in Science and Technology Studies [STS] seem more concerned with describing and analyzing processes of dissemination and contestation of visions than with processes of moralization and the (normative) assessment of these processes (e.g., Berkhout, 2006; Borup et al., 2006; Brown, 2003; Brown & Michael, 2003; Jasanoff & Kim, 2009; Sovacool, 2019). Whether or not a vision was successful in realizing the values and other moral objectives it proposed, and how to assess this success, are questions hardly addressed in this literature.

Evidently, these are difficult issues, since moral objectives, such as values proposed in visions, are often abstract and therefore difficult to trace in specific decisions concerning the development of sociotechnical systems. While these values seem to justify certain decisions, it is unclear how to understand this justification once we delve a bit deeper. Thus, these initial questions lead to further questions: Sociotechnical visions bring moral objectives and technologies together, but how exactly? And how does this abstract moral sphere of values influence the concrete material sphere of the design, use and operation of certain technologies deemed instrumental for the realization of these values? And what does 'realization' mean in this context?

In the last decades, the philosophy of technology has provided a large body of literature on the ethics of technology and technological design that answers some of these questions. This literature deals extensively with the moral effects of technology and moral aspects of the design of technology. Approaches such as Value Sensitive Design [VSD] and Design for Values [DfV] offer hands-on methods for dealing with ethical issues in the design of new and emerging technologies. They show how salient moral objectives, such as values, can be incorporated by technical artefacts. These methods help to proceed from often abstract values to concrete design decisions that support these values, thereby justifying these decisions. Because the application of VSD and DfV makes the process of design and engineering more transparent and explainable, these approaches allow for more responsibility and accountability (Aizenberg & van den Hoven, 2020; van den

Hoven, 2007). They show both how and why certain design decisions were made that affected the safety, sustainability, privacy, etc. of certain technologies, their users, or society as a whole.

However, this body of literature has not explicitly dealt with the question how shared visions of a good life and ensuing moral values shape moral expectations of technologies. Moreover, it does not offer analytical tools for studying the emergence of salient ethical concerns, or salient values in society through new visions. These values, are either taken as given, in a universal, timeless manner—as human values that have always been pursued in some way or other (Flanagan et al., 2008; Friedman et al., 2002b)—or are taken as the outcome of an empirical process of deliberation, and possibly negotiation, between different stakeholders. Thus, sociotechnical visions do not explicitly figure in the VSD and DfV-literature as a relevant source for the study of values that might impact and instruct the development of sociotechnical systems and technologies used in these systems.

Nevertheless, VSD and DfV have (albeit still sparsely) addressed the possibility of value change (Van de Poel, 2018; Van de Poel & Taebi, 2022; Van der Wey et al., 2023). Such value change especially affects the design, use, and operation of technologies and systems that are meant to have a multi-generational existence, as most sociotechnical systems have. Thus, value change means that certain technologies will be used and operated differently in support of this (future) value change and that, possibly, their design needs to be changed as well, thereby incurring extra costs and loss of efficiency. For instance, the changing design of nuclear reactors in the last decades can be understood as a consequence of new conceptualizations and understandings of the value safety in the context of reactor design (Alleblas, 2024; Delves, 2007; Roeser, 2006; Taebi et al., 2012). This value change, furthermore, can be seen as a consequence of the accidents and incidents that have taught engineers more about the specific risks incurred through previous design choices. This value change, finally, led to new visions of nuclear energy as a sociotechnical system in which safety figured differently or more prominently relative to other moral objectives.

This dissertation aims to contribute to the study of the phenomena mentioned above. Through a set of case studies, this dissertation explores the interplay between visions, values, and technologies and lays the basis for a better theoretical understanding of this interplay. On the one hand, it adds to the STS literature on sociotechnical visions, by providing more insight into the role of values in such visions and a reflection on how these visions relate to value change. On the other hand, it adds to the literature in the philosophy of technology on the interaction between values and technologies, most notably the VSD and DfV-literature, by analyzing the guiding role visions—more specifically the moral objectives these visions contain—might have in such interactions.

This establishes the research objective for this dissertation:

> **To explore the interplay between sociotechnical visions, values, and technological designs in the development of sociotechnical systems.**

This research objective leads to the following main research question (MRQ):

MRQ   **How can we conceptualize the interplay between visions, values, and technological designs in the development of sociotechnical systems?**

The coming sections clarify the main concepts used in this RQ: sociotechnical visions, values and ideals, and technological design (see also table 2 for a definition of these concepts). These sections provide an overview of the dimensions of these concepts, relevant for the coming chapters and provide a preliminary account of their relation. In brief, I see the relation between these concepts as follows: sociotechnical visions attach to moral objectives such as values and ideals. I take ideals to be a specific kind of values, that provide either infeasible, uncompromisable standards, or moral goals for which their apparent infeasibility is not a concern. Technological design is

expected to translate these values and ideals into design decisions, as either functional or non-functional requirements (values), or goals for innovation pathways (ideals).

When introducing the core concepts, I will also introduce four sub research questions. I here already give an overview of these questions that will be further introduced and explained in the next sections:

RQ 1   What types of sociotechnical visions can be distinguished?
RQ 2.   What function(s) do values fulfill in sociotechnical visions?
RQ 3   Is feasibility a criterion for sociotechnical visions and,
          if so, how should it be understood?
RQ 4   What tensions may occur between sociotechnical
          visions and value change?

All four of these questions will be answered in the conclusion to this dissertation (chapter 6). However, while these questions form the basis of the coming chapters, they are not answered one-on-one in those individual chapters. This is a consequence of the characteristics of my research, which is open, explorative, and case study-based. Thus, the explorative research done in the empirical chapters together provides input for the answers to four subsidiary questions (see table 2, in section 1.5). Finally, the question concerning the types of sociotechnical visions (RQ 1) is answered in the form of a general reflection on all four preceding chapters.

Value	Stable, abstract goal transcending specific situations, while at the same time specifying the variety of 'goodness' of certain states of affairs, such as a sustainable home or a safe car.
Ideal	Stable and uncompromisable abstract goal for which its feasibility is not a concern; often appearing in the form of a (universal) principle for

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	action, or a perfect state of affairs, such as an ideal body, or an ideal society.
Vision	*Blueprint for the future realization of a value or ideal, showing which institutions to create, which technologies to embrace.*
Sociotechnical vision	*A discursive representation of an often idealized future state of affairs (as an end) indicating changes in sociotechnical systems (as means) that are deemed critical for the realization of this state of affairs.*
Technological Design	*The design of artefacts on the basis of functional (what a technology will do) and non-functional requirements (how a technology will do what it does). In both forms of requirements values play an important role.*

Table 1: Definition of Main Concepts

1.2   Sociotechnical Visions

A central notion in my thesis is that of 'sociotechnical vision.' But what is meant by his notion? The concepts of 'vision' and 'sociotechnical system' need to be delineated for a discussion of such visions to be possible. Such a delineation, inevitably, leaves out certain manifestations of visions and sociotechnical systems for which the analysis here proposed might not be fruitful. However, clear-cut definitions help to find meaningful examples and to contribute to better theoretical understanding.

Sovacool (2019) uses the term 'vision' as 'a description of what could occur in the near-term, mid-term, or long-term future' (p.12); Berkhout (2006)

tentatively defines visions as: 'collectively-held and communicable schemata that represent future objectives and express the means by which these objectives will be realized' (p. 302); Grin and Grünwald (2000) see guiding visions (Leitbilder) as mental images 'of an attainable future shared by a collection of actors', guiding 'the actions of and interactions between those actors' (p. 11). They are a 'common language […] that guide collective actions' (Grin & Grunwald, 2000, p.11). Though these definitions share a temporal orientation, i.e. the future, and suggest that visions might guide and might be collective, their level of specificity varies.

In the coming chapters, I rely on Berkhout's (2006) definition. I will uphold a distinction between means (technologies) and ends (values and ideals) in sociotechnical visions. I thereby employ a stricter definition than both Sovacool (2019), and Grin & Grunwald (2000). Therefore, propositions such as 'the future is green', though providing an elementary, discursive vision in the account of these authors, do not equate to a sociotechnical vision in my use of the term. Such a future-oriented proposition fails to mention the means, i.e., the technological changes in sociotechnical systems that would be instrumental to the desired outcomes. Additionally, Berkhout (2006) mentions 'social orders' as a third essential element of sociotechnical visions. This element is not explicitly dealt with in this dissertation. On the one hand, it seems that such social orders, as goals—and even as possible means for the realization of certain salient moral objectives—could be understood as a specific kind of values, namely sociopolitical values. On the other hand, it falls outside of the scope of this dissertation to also analyze the (changing) sociopolitical context in which certain technologies and human agents operate and cooperate.

Since a sociotechnical vision concerns changes in sociotechnical systems [ST systems], a better understanding of the concept of ST system is useful here. Conceptualizations of ST systems emphasize that not only technical factors, but also social factors are important when we think about the performance, function, and design of technologies. Such technologies are often part of more complex systems that might themselves be largely technical, social, or

sociotechnical. Thus, the design of a certain nut or bolt might completely depend upon its function in a larger machine that, itself, is part of a pump in a reactor coolant system operated by a computer with, finally, a human supervisor. In these larger systems, humans and technical elements conduct goal-oriented behavior, thus providing a social good, such as electricity, to society (G. H. Walker et al., 2007). In this sense, the design of the nut or bolt ultimately contributes to societal welfare by providing electricity in an efficient and safe manner.

Besides the interaction between human agents and technologies, ST systems need some kind of governance. Thus, institutions are discerned as a third element, besides agents and technologies, of these systems (Kroes et al., 2006). Institutions are often understood as the social rules that determine the interaction between agents in ST systems including the end-users of, for instance, electricity. These institutions consist of laws and regulations or more informal rules, norms, and strategies (Crawford & Ostrom, 1995). Typically, these institutions enable and constrain the interactions between human agents and other human agents, as well as human agents and artefacts in a sociotechnical system (Kudina & van de Poel, 2024). To summarize, an ST system is a system consisting of human agents and technologies that, enabled and constrained by institutions, purposefully cooperate to create, deliver, or consume a certain social good.

Furthermore, what is meant with 'ends' and 'means' in sociotechnical visions needs elaboration. Berkhout (2006) sees the ends of visions as 'the qualitative or quantitative expression of novel future outcomes' (302). He adds that:

> …in the process of being communicated, codified and shared, visions seek in some sense to create a normative space in which they can exist. We have argued that visions are typically moralized—effort is exerted by advocates to attach visions to widely shared values, or contrasted with undesired

outcomes. This is necessary because novelty can only seem plausible if it has a chance of being widely accepted as good. If the innovation eventually does become diffused more widely, an equal and opposite process occurs in which, through a process of 'normalization' it is emptied of moral content. (p. 309)

Berkhout suggests here, as other scholars do (e.g. Beck et al., 2021; Sand & Schneider, 2017), that values in visions are transitory: once they have served their function and made a certain innovation acceptable and/or accepted, these values no longer play a role in the operation and further design of these 'normalized' innovations. At the same time, the moral objectives that sociotechnical visions 'attach' to are often seen as stable and enduring, especially when these values are interpreted as aspirational, i.e., they function as ideals (e.g., Friedman, 1996; Jasanoff & Kim, 2009; Rawls, 1999; Van de Poel, 2024; van den Hoven, 2007).

Thus, in this view, these moral values and ideals become attached to other innovations in other visions that try to motivate and gain acceptance. Therefore, the means articulated in visions might change rapidly—e.g., because technologies go through so-called 'hype cycles' (Borup et al., 2006)—while the moral space in which these technologies seek legitimacy is less likely to change. However, we shouldn't assume that these stable ends, such as values, can't or won't change (Van de Poel, 2018; Van de Poel & Kudina, 2022; Van de Poel & Taebi, 2022). Indeed, much of contemporary literature discusses the negotiation and contestation of sociotechnical visions (Chapin III & Knapp, 2015; Eames et al., 2006). This implies that sociotechnical visions can have a discursive structure. This also implies that different ideas circulate in societies about what values need to be served by technology, and which 'goods' should be prioritized in society, as the crisis tribes made clear.

The above considerations lead to the following definition of sociotechnical visions used throughout this dissertation:

> A sociotechnical vision is a discursive representation of an often idealized future state of affairs (as an end) and indicates changes in ST systems (as means) that are deemed critical for the realization of this state of affairs.

This definition of sociotechnical visions still allows for different types of sociotechnical visions. Visions can, for example, be more or less shared, or more or less elaborate. Such distinctions may be important to answer my main RQ about the interplay between visions, values, and technological designs. This results in my first sub question:

RQ 1   What types of sociotechnical visions can be distinguished?

1.3   Values

Values figure prominently in contemporary literature on the design of sociotechnical systems. Values can inform design choices and trajectories of innovation for certain technologies. Values can also influence, or even determine, the social acceptance of (new) technologies and the moral acceptability of (new) technologies (Taebi, 2017). Another function values (can) fulfill is as moral objectives in sociotechnical visions. While there seem to be two functions of values in sociotechnical change, a social function and a design and engineering function, I believe these functions cannot and should not be separated. This dissertation, therefore, explores the role of values and technologies in visions and the impact these visions have on the design of these technologies. This leads to the following sub-question:

RQ 2   What function(s) do values fulfill in sociotechnical visions?

Below I further explain how I will use the concept of values in this dissertation. This is daunting because is no universally accepted concept or theory of value (Steinert, 2023; Van der Wey et al., 2023). Below, I will first discuss how the notion of value is understood in the literature on VSD and DfV. Next, I will discuss three disciplinary perspectives (sociological, philosophical and anthropological) on values from which I will draw in this thesis.

1.3.1   Values and Design

The VSD and DfV literature on the role of values in the development of sociotechnical systems is not based on a common or specific theory or conceptualization of value. Instead, authors often focus on the (correct) procedures and processes through which technologies come to embody certain salient values. Often it is assumed that values can become part of the design of certain technologies or that, through design, certain values can be supported. This requires the correct specification of a salient value into norms and the correct translation of these norms into design requirements (Van de Poel, 2013, 2015; Vermaas et al., 2015). For much of the history of VSD and DfV, substantive questions about value were not addressed. This meant specific concerns about the philosophical nature of values, or the distinction between social and ethical acceptability, were hardly discussed (see Taebi, 2017; Van de Poel, 2016). As approaches for engineers and designers, handbooks of VSD and DfV left these philosophical questions largely untouched and opted for a more generic and undifferentiated approach to values.

For instance, Friedman (1998), one of the founders of the VSD-approach, initially conceived of values as 'what a person or group of people consider important in life' (p.70). Friedman has at least twice updated this

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conceptualization.[1] She started to focus on 'enduring human values' (to select those 'things' deemed important that have survived the test of time) (Friedman et al., 2013) and has later extended her definition to include 'what people consider important in their lives with a focus on ethics and morality' (Friedman, 2019, p.6). Noticeable is that the focus on morality[2] presumes there is a (clear) methodological demarcation present (or assumed) between moral and other human values. Manders-Huits (2011), however, argues that VSD still provides no methodological account for establishing this demarcation in empirical research.

To further facilitate the process of finding human values of ethical import, Friedman, Kahn and Borning (2002) suggest a list of 12 'frequently implicated values'[3]. Such a list provides a useful shortcut to lively discussions, but lists also bring their own problems. For one, they assume that stakeholders need some help in defining what they truly value in their lives; value lists are therefore condescending. For another, it is often unclear what inclusion criteria are used for the list and how they are operationalized ('enduring'; 'frequently'?). Eventually, a list of important values runs the risk of becoming self-serving and self-fulfilling, advancing research into the values on the list, which thereby become more 'prevalent'. Thirdly, and this is important for this dissertation, a list of values is very static. It is unclear how changing value conceptions or completely new values are accounted for.

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[1] She doesn't give a reason for these changes. It might be that this very open idea of values allows for all kinds of hedonistic impulses—as pleasure is also valuable for most people—to gain the upper hand when we start to include these values explicitly into design practices,

[2] 'Value-Sensitive Design enlarges the scope of human values... to include all values, especially those with moral import.' (Friedman, Kahn, & Borning, 2002)

[3] '... with ethical import that are often implicated in system design' Friedman (2006). These values include: human welfare, privacy, freedom from bias, informed consent, ownership & property rights, universal usability, environmental sustainability, identity, accountability, calmness (Friedman & Kahn, 2002).

Conceptualizations and operationalizations of values (into norms) can differ significantly over time. What we can call the 'generic' or 'nominal' aspect of a value (autonomy, privacy, equality) does not determine in any sense it's contextual, situated, temporal content. What people understood 'equality' to mean 300 years ago (i.e., what they did in the name of 'equality'), people would today consider discriminatory. Thus, the norms associated with the pursuit of a certain stable value can also differ significantly over time. The norms associated with health, the norms associated with gender performativity and equality, the norms associated with love and friendship have undergone drastic changes in recent decades. Indeed, as Baker (2019) asserts, 'Even philosophers who once acted as agents of moral change eschew the concept [of moral change], preferring to view moral change as a process of reinterpreting the fundamental moral principles of our common morality' (p.1). Manders-Huits (2010) attributes this line of thinking to VSD as well, since VSD claims that 'technology developments may enhance, threaten, or transform *existing* values,' (p. 275, italics mine).

1.3.2 Disciplinary perspectives on values

In addition to the VSD and DfV perspective on values, theories of value have been developed in different disciplines, such as psychology, sociology, anthropology, and philosophy (Steinert, 2023). This dissertation adopts an interdisciplinary approach to the study of values. For instance, chapter 1 mostly adopts a sociological perspective on values without explicitly addressing moral/philosophical questions. A more philosophical perspective on values is present in chapters 2 and 4, while chapter 3 considers values from an anthropological perspective.—To take away any doubt, I will indicate these differences in the four 'interludes' between the chapters of this dissertation. Furthermore, I will discuss the costs and benefits of this interdisciplinary approach in the conclusion, which is the final chapter. The three main disciplinary perspectives on values that I apply in this thesis are thus sociological, anthropological and philosophical. I explain these below.

A **sociological** approach to values understands values as shared, or collective, beliefs about what is valuable in society and individual life in that society, in an abstract sense, while translations of these beliefs into concrete norms for (social) behavior maintain the social order (Steinert, 2023). Such shared beliefs about what is valuable in society might be coherent with some relevant moral standard or norm, but not necessarily so. This becomes apparent when we look at examples of historical value change. For instance, in the past, certain societal norms related to racial purity (as 'value'), were widely accepted. From an moral point of view, such norms were contestable. However, the change in norms—and therefore in the underlying value—is not explained by referring to philosophical arguments. Rather, from a sociological point of view, this value change is the result of a variety of factors, such as historical events (wars, protests, etc.), technological advancements, changing immigration patterns, and so forth.

I take the **anthropological** perspective on value to refer to specific cultural processes of value creation and valuation. Because cultures are different, different rankings and classifications of values are present in different cultures. For instance, certain cultures might prefer hierarchy over an egalitarian organization of social life, or are (more) risk-aversive, or are restrained rather than indulgent (Hofstede, 2011). Though this perspective on values does not figure prominently in the coming chapters, except for chapter 4, it is important to note that the anthropological and sociological perspective on value seem to overlap largely. Nevertheless, two important differences can be highlighted. First, anthropologists tend to sees value beliefs as less discursive than the sociologists. Value beliefs can be latent or implicit in the sense that they are hard to articulate and might even be hidden to the members of a certain culture (Steinert, 2023). This makes it more difficult for observers/researchers to research or reconstruct value beliefs, for example on the basis of certain behavioral patterns. Such a latent, or implicit account of values, furthermore, is difficult to integrate with technological design, which seems to assume certain design intentions and

a reflexive approach to design.[4] Second, and related, whereas sociological accounts of value reserve an important role for processes of rationalization of value beliefs and related norms, anthropological accounts are less interested in how members of a culture or community rationalize their value beliefs and norms (Steinert, 2023).

Finally, the **philosophical** perspective on values, shows that moral values such as autonomy, responsibility, or reciprocity have a rich conceptual history in which different meanings over time emerge. They are also shown to have mattered throughout human (known) history (e.g., Alfano et al., 2024; Schwartz, 2012; Steinert, 2023). Thus, moral values are relatively stable over time and prevalent across different cultures and have been widely discussed by philosophers (Steinert, 2023; Van de Poel, 2024). Though I will not often elaborate on these philosophical contributions, they explain one of the reasons why values are such an interesting starting point for thinking about the ethics of technological developments. Values are both accessible and complex.

In the coming chapters, when mentioning 'values', if not indicated otherwise, I refer to 'moral values'. With 'moral values' I mean two things: on the one hand values with a moral content, that can be studied from the perspective of sociology and anthropology; on the other hand it refers to values that are morally right from a salient moral or philosophical perspective. In most chapters, except chapter 1, both meanings will be elaborated on. Furthermore, I take 'values of ethical concern', 'moral values', and 'final values' as interchangeable terms.

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[4] On the other hand, a lot of implicit bias designed into technological artefacts can be understood from this account. See, for instance, Cockburn and Ormrod's account of how technological design implicitly, or explicitly reaffirms gender expectations and stereotypes (Cockburn & Ormrod, 1993).

1.4   Ideals

Ideals form the final concept that needs clarification. Again, the concept has many different meanings in different disciplines. We can, for instance, distinguish between political, epistemic, aesthetic, religious and moral ideals (Appiah, 2017; Rescher, 1987). In each of these domains, ideals and processes of idealization are associated with some kind of perfection and, often, with infeasible standards. These infeasible standards, nonetheless, can have a guiding function as helpful models for science, aspirations for politics and behavior and, as I will argue, as guidelines for design.

Ideals seem to stand in contrast to what we know about the world or what we know about how the world 'works' because they are known to be—in some sense—unrealistic, unfeasible or unrealizable. Despite such (alleged) empirical refutations of the ideal, we need ideals in the form of idealized theories, models, and categorical moral prescriptions that provide or function as useful fictions (Appiah, 2017; Hans Vaihinger, 1924; Rescher, 1987). This can be useful to help guide action (as in the case of moral ideals) but also to help better understand reality (as in the case of models and theories; think for example of ideal gases in physics).

I focus here on moral ideals[5], which are aspirations to a certain standard of goodness that, based on our (shared) experiences, seems desirable but infeasible. Although moral ideals present human beings with unattainable moral and political prescriptions, they at the same time help to discuss and discern reasonable existing exceptions to these prescriptions, and they help in providing and articulating reasons for these exceptions. Finding and eradicating these exceptions is one of the senses in which moral and political ideals guide conduct and can help evaluation. For instance, such prescriptions might help to identify 'instances of partial compliance' with the principles of ideal justice (Valentini, 2012, p. 2).

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[5] As distinct from political, epistemic, aesthetic, and religious ideals

The role of moral ideals in sociotechnical visons needs further treatment. Since such visions describe future states of affairs, that have not (yet) materialized, the distinction between what is feasible and unfeasible seems underdetermined in visions. Furthermore, visions often present future states of affairs—such as completely sustainable cities—as desirable and very well imaginable but seemingly impossible (Berkhout, 2006). Finally, sociotechnical visions that project idealized states of affairs and also describe the sociotechnical developments that are deemed both necessary and sufficient for realizing this perfect future tend to idealize these developments. That is to say: they tend to present such developments as operating flawlessly and resulting effortlessly in the desired future state of affairs. I will refer to this intertwinement of moral ideals and idealized instruments in sociotechnical visions as 'utopian configurations'.

The 'long-termism' of ideals implies a continued commitment, and a commitment of finding solutions how to overcome constraints that inhibit the realization of the ideal. In visions that feature ideals as long-term goals, often solutions are proposed that have eradicated constraints that inhibit actors from perfectly acting upon a certain principle or that inhibit the realization of an ideal state of affairs, such as the completely sustainable city. In the case of sociotechnical visions these solutions are often technical. A perfect state of affairs is presented, e.g., a perfectly safe, or secure transportation system, in which one or a set of technologies plays an instrumental and defining role. In the coming chapters, I give several examples of such utopian configurations. I also discuss how feasible it is to actually realize such utopian configurations. Technologies and innovation may facilitate this realization but at the same time can never take away all constraints.

The role of ideals in visions will be captured through two sub questions. The first one asks about the role of feasibility. It reads:

RQ 3 Is feasibility a criterion for sociotechnical visions and, if so, how should it be understood?

This question is motivated by the fact that, as explained, visions often contain (seemingly) unfeasible ideals, which raises questions about the assessment of visions.

The uncompromising character of ideals and their long-termism also lead to another question about the relation between ideals and value change. As indicated above, it has been recognized in the literature that value can change over time, but it would seem that visions that are composed of long-term ideals—that cannot be compromised—cannot deal with such value change. This leads to the final sub question:

RQ 4   **What tensions may occur between sociotechnical visions and value change?**

1.5   Chapter Overview

The coming chapters use and elaborate on these concepts and their relation. I introduce these chapters in this final section. For an overview, I include table 2 for the subsidiary research questions and their relation to the chapters.

Chapters	RQ
2,3,4,5	RQ 1: What types of sociotechnical visions can be distinguished?
2 (3,4,5)	RQ 2: What function(s) do values fulfill in sociotechnical visions?
3,4	RQ 3: Is feasibility a criterion for sociotechnical visions and, if so, how should it be understood?
4,5	RQ 4: What tensions may occur between sociotechnical visions and value change?

Table 2: Chapters and Research Questions

1.5.1 Chapter 2: Visions of a nuclear France

Chapter 2 analyses the emergence of certain values in newspaper discussions about nuclear technologies in France in the decade after World War 2, when most of these technologies, and their effects, were imagined, but the technologies were not yet developed. The chapter presents a new approach for studying the emergence of value-based visions for emerging technologies in mass media. To do so, it builds on methods for analyzing values in large text archives for other purposes, such as finding shifts in value during the Coronavirus crisis (van de Poel et al., 2022), accounting for values in relation to nuclear energy (Van de Poel et al., 2020), or tracing long-term value change in energy technologies (de Wildt et al., 2022).

Probabilistic topic modelling allows the tracking of values over time, while also taking into account the shifts in meaning a value undergoes. Because this method does not focus on nominal values, such as health or privacy, but on clusters of words that often appear together, so-called 'topics', the method allows for the tracing of (more) latent topics, which values often are (de Wildt et al., 2018, 2022). A latent topic is a topic that has no definite or strict set of words referring to it. For instance, a French newspaper article on the safety of nuclear reactors might contain related words such as 'accident', 'safe', 'incident', 'control', etc. If such words are dominant in discussions of nuclear reactors, the topic of safety is dominant. Furthermore, a certain idea of safety is dominant within this topic. For instance, 'control' might become a dominant term in this topic or, over time, loose dominance relevant to the term 'incident'.

Thus, chapter 2 uses probabilistic topic models to investigate to what extent a shared vision emerged on nuclear technologies in France. Sharing a vision is here understood as sharing an evaluative framework that comes to bear upon an emergent technology, such as nuclear technologies. An archive was made of 1895 articles found in daily newspapers appearing in the period 1945 – 1952. All these articles discussed developments in nuclear

technologies and related news. This period was chosen because of its historical relevance: on the one hand the years immediate following WW2 were marked by internal, ideological strife about the (political) future of France; on the other hand, decisions were made concerning a radically new and largely unknown set of technologies, for which the civilian application, as energy source, was still imaginary. These two aspects meant that a wide range of opposing ideas of the good life/society were circulating at the time in mass media, that could lead to opposing visions of a nuclear France.

Eight values, as topics were selected and traced. These values were selected on the basis of an analysis of the main ideological divisions in France during those years. By tracing the (latent) values mentioned in relation to nuclear technologies in these ideologically diverse newspapers, this chapter establishes whether these values changed and whether, over time, a 'discourse coalition' emerged between these newspapers, meaning that they came to settle on a shared, dominant set of values. I equate this shared, dominant set of values in anticipatory discussions of nuclear technologies with a sociotechnical vision.

Domains	Values
Socioeconomic:	Individual and Collective
Geopolitical:	(World)Peace and Defense
Cultural:	Tradition and Progress
Technological:	Safety and Security

Table 3: Domains and values in newspapers discussions of nuclear technologies in France

1.5.2   Chapter 3: Values and Ideals in Developments of Energy Systems

The previous chapter (2) addresses both a substantive topic (the role of values in new sociotechnical visions) and a methodological topic (how to study the emergence of values and sociotechnical visions in the media).

Subsequently, chapter 3 develops a theoretical model for understanding the relation between values and technologies on the one hand, and ideals and emerging technologies on the other. It sees these pairs as operating in two distinct spheres: a material and imaginary sphere. The material sphere concerns the design of technologies, while the imaginary sphere idealizes these technologies and the societies in which they play a role.

However, several authors have made the suggestion that moral objectives of visions are transitory (Beck et al., 2021; Berkhout, 2006; Sand & Schneider, 2017). Such values and ideals play a role in the dissemination and acceptance of visions but, after acceptance, innovations are 'emptied of moral content' and normalized (Berkhout, 2006). Contrary to this view, chapter 3 argues that such objectives do have a lasting impact on technological design rather than simply being instrumental in the choice of these technologies. Chapter 3 shows this by providing case studies of successful and unsuccessful interactions between the material and imaginary sphere.

With this analysis, this chapter examines an important aspect of energy history and policy: the intertwinement of energy technologies with ideals. It argues that ideals play an important role in energy visions and innovation pathways: aspirations to realize technical, social, and political ideals indicate a long-term commitment in the design of energy systems, distinguishable from commitment to other abstract goals, such as values. Three European cases are discussed that are illustrative of the different roles of ideals in the development of energy technologies and visions: (1) the evolution of safety in nuclear reactor design; (2) visions of atomic power in France; (3) the political idealization of a tidal power scheme in the Severn Estuary.

However, not all these cases are examples of the successful guidance of ideals. Chapter 3 shows how the Severn Barrage became an object of political fixation. It kept on returning on the political agenda, without progressing materially. This case seems to offer a warning: that ideals and technologies, or technological projects, become intertwined. The project

and the ideal that is supportive of can no longer be told apart. In that sense, the realization of the ideal stands or falls with the realization of the project. Although a commitment to both the ideal and a selected technology might be worthwhile in certain cases, the Severn Barrage does not seem to merit such commitment.

By providing both a methodological (chapter 2) and a theoretical (chapter 3) approach to study the interplay of values and technologies, the first theme of this dissertation: **the investigation of the role of values in sociotechnical visions**, is covered. Furthermore, chapter 3 also covers the second theme: **the assessment of the feasibility of visions**, by investigating the role of ideals in the development energy systems. To this end, it makes a distinction between the political feasibility of a certain energy ideal in the UK, and its techno-economic feasibility. Chapter 4 continues exploring this theme.

1.5.3   Chapter 4: Negotiating Visions of Waste

Chapter 4 continues with a deeper analysis of the failure of certain visions to lead to substantial changes in ST-systems, associated with the infeasibility of ideals these visions have become attached to. It shows how the sturdiness and inherent invisibility of waste infrastructures in Europe might impede the performance and materialization of visions of waste in which this waste is both affirmed and problematized in relation to sustainability. It argues that a more dynamic idea of maintenance and repair helps to overcome this sturdiness and invisibility, allowing for a more discursive treatment of waste, and related values such as hygiene, health, and the ideal of sustainability as zero waste.

This chapter develops an anthropological account of the meaning of municipal waste: its disvalue. It argues that a focus on hygiene, health and a 'tidy city' led to the 19th century design of waste infrastructures in Europe in which the invisibility of both waste and waste infrastructure was pivotal. Sustainability was not a value taken into account in this design, nor were

visions of urban sustainability circulating at the moment these waste infrastructures were built. This invisibility, furthermore, led to considerable material resistance for new visions of waste—for instance, as something to be affirmed—to gain a foothold. Current municipal waste infrastructures are kept invisible, thereby upholding beliefs and practices that disvalue waste. This impedes value change from taking place; although sustainability is not a new value, it is relatively new to the ST system of waste. As value, and as ideal (zero waste), it has emerged as a consequence of the toxicity and longevity of many modern forms of waste and their impact on the environment as well as human health.

This chapter argues that the feasibility of proposed, utopian states of affairs (zero waste or the completely sustainable city) is dependent upon the success of efforts to make waste, and waste infrastructures visible, without endangering the moral objectives of both health and hygiene that these infrastructures already support. Though the ideal of zero waste appears as an action-guiding, long-term goal for the continued development of waste infrastructures, in practice this ideal is successfully contested by visions of waste that have materialized and have become normalized in the design of urban waste infrastructures.

As a possible way out of this quagmire, in which new visions of waste seem to disappear, waste infrastructures and their maintenance should be made more visible. This 'visibilization' allows for a more extensive, ethical engagement with waste. This chapter argues that one should approach the (re)design of municipal waste infrastructures through dynamic maintenance and reflexive repair, wherein waste, repair and maintenance are understood as discursive processes. Maintenance of urban infrastructure appears here as a process in which existing ways of dealing with municipal waste can be problematized, actively engaging citizens to reassess their often latent, cultural understanding and valuing of waste. This engagement is seen as first a step in challenging modern notions of dirt and waste as devalued matter to get rid of in the most efficient manner possible.

Visibility is a (new) design criterion for municipal waste infrastructures, allowing for other values and ideals, such as sustainability and zero waste, to emerge as relevant in the context of urban well-being. Visible infrastructure affords the development of new practices around waste, thereby allowing the ideal of zero waste to regain its function as long-term, action-guiding objective in the development of municipal waste infrastructures. Thus, this chapter develops the themes of **feasibility** and **value change**. It shows how certain infeasible ideals fail to guide action, and it shows how certain visions in which new values and ideals are presented fail to change existing practices and meanings of 'goods' around which ST systems are built.

1.5.4   Chapter 5: Maintaining a Vision

Chapter 5 focuses on the issue at the heart of the fourth question of this dissertation: **the** (possibly problematic) **relation between visions and value change**. The chapter provides a detailed analysis of an architectural building in Berlin, conceived of and, eventually, renounced by the Swiss-French architect Le Corbusier. It argues that buildings—such as the one Le Corbusier's design in Berlin—need to be adaptable to new values and norms to survive the test of time, even if they are materializations of a utopian vision of urban dwelling. This analysis challenges the broader idea of visions in which fixed means (technologies) and fixed outcomes (values) provide a definite blueprint for the future. This challenge becomes especially relevant for artifacts meant to be functionally relevant for many decades and generations, such as residential buildings.[6]

This chapter suggests that the more buildings express certain value beliefs of architects that are particular to a given period of time, i.e., the more 'architectural' they are, the less likely they are adaptable to new societal value beliefs. This chapter therefore argues that a failure of an architectural

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[6] Especially those buildings erected before the 1950s in Europe and the advent of the mass-housing crisis after WW2.

vision to completely materialize in certain buildings, such as the Unité Berlin, can also explain—and may hence be pivotal to—the continued success of these buildings. While the Unité Berlin failed to materialize in the way Le Corbusier intended and is, therefore, an incomplete instantiation of his vision, the material building was nevertheless successful if we understand architecture as a dynamic process in which consecutive residents participate. These residents aim to realize their own (changing) ideas of good living.

The analysis of Le Corbusier's architectural vision proceeds by focusing on four central values in his vision: efficiency, community, health, and beauty. These values are further conceptualized by assessing whether Le Corbusier believed these values to be procedural or substantive, instrumental or final, and intrinsic or extrinsic. The properties of these values have important consequences for the perceived success of the building based on Le Corbusier's vision, taking into account Le Corbusier disavowal of the Berlin building. With a further analysis of the translation of these four values into design decisions, this chapter shows that, although Le Corbusier's vision is often called utopian, his vision translated to, what he considered, feasible choices.

The construction process and consequent decades of occupation that the latter half of this chapter focuses on, show a different picture. For a residential building to survive, preservation and conservation are not enough. Autonomy, individuality, and adaptability are important values for residents that an architectural vision needs to take into account. This chapter argues that adaptability to the changing value beliefs of consecutive residents is an important aspect often overlooked in architectural visions. Adaptability is neither a final, substantive, or intrinsic value. However, if we accept that beliefs about what is good in dwelling might change, then adaptivity becomes paramount in visions of urban living, and urban renewal.

Interlude 1   Values and Emerging Nuclear Technologies

This first, empirical chapter investigates the role values play in sociotechnical visions, and investigates how we might determine this role. It thereby provides input for answering **RQ 2**: **What function(s) do values fulfill in sociotechnical visions?** Throughout, this chapter deploys a sociological perspective on values, as shared evaluative devices used in the context of emerging technologies, such as nuclear technologies. Discussions of these technologies in which these values are used determine, to a large extent, whether a certain technological development is socially accepted. This chapter does not ask whether these values are also ethically acceptable from the perspective of a salient ethical norm or theory. Rather, it sees ideologies as shared value systems in a community, a community that considers itself first and foremost catholic, communist, or liberal, etc., and expects the newspapers it reads to endorse and reflect these values and concerns.

This coming chapter focuses on the emergence of nuclear technologies in France. Despite France's extensive transition to nuclear technologies in the decades following WW2, most notably after the First Oil Shock, no quantitative analysis has been made of the development of discussions of these technologies in news media during the first decade after WW2. During these early years, the civilian application of these technologies existed mostly in the imagination. The atomic bombs, thrown on Hiroshima and Nagasaki, had inspired both awe and fear. These years, therefore, were marked by speculation, in which both hope and anxiety came to the foreground. An analysis of newspaper discourse on nuclear technologies in the period 1945 – 1952 helps to establish how newspapers—taken here as a proxy for public discourse—discussed these technologies and developments. An archive of newspaper articles enables the tracking of a set of values that was considered central to the ideologies of three newspaper groups in the aftermath of WW2. As such, it gives a new perspective on how the evaluations of nuclear technologies changed over time in France, and whether these newspapers groups started to 'agree' upon the values most salient in discussions about these technologies.

Chapter 2

Revitalizing France

Early discussions of nuclear technologies in ideologically diverse newspapers (1945-1952)

2.1   Introduction

Major changes in sociotechnical systems, such as energy systems, are also normative changes. Changes in these systems bring about specific social and political orders (Longhurst and Chilvers, 2019; Genus *et al.*, 2021; Rifkin, 2002) and have effects on how people decide, relate, and perceive their world (Danaher & Sætra, 2023). To gain public acceptance of these impending changes, developments in sociotechnical systems are often moralized: connected to salient values and virtues, or ideas of the good life in general (Jasanoff, 2015). Successful processes of moralization determine, to a large extent, social acceptance or resistance to new and emerging technologies and processes of sociotechnical innovation (Sovacool, 2019). These processes of moralization can be highly controlled (top-down) or emerge spontaneously (bottom up). Scholarship has shown that the successful societal adoption of nuclear technologies depends on the creation and collective adoption of moralized conceptions of futures in which these technologies play a central role (Jasanoff and Kim, 2009; 2013; 2015; Felt, 2015; Valentines-Álvarez and Macaya-Andrés, 2019; Gamson and Modigliani, 1989; Van Lente, 2012). Different societies, and actors within these societies, develop different moralizations of futures enabled by emerging technologies. Therefore, nations have acted diversely on the possibilities of nuclear technologies, in both civilian and military contexts ; Jasanoff and Kim, 2009; 2013). Finally, media play an important role in the construction and dissemination of these moralizations (Felt, 2015; Rothman and Lichter, 1987; Koerner, 2014; Kristiansen, 2017).

This study focuses on the moralization of nuclear technologies in France directly after World War 2. Newspaper discussions of nuclear technologies are analyzed for their evaluative content. Such an analysis of media discussions in large text corpora is often still missing in the context of sociotechnological developments (Tidwell & Tidwell, 2018).[7] This analysis of

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[7] In the case of France, this neglect might be a result of poor data accessibility. For instance, the newspaper archive used in this study, of the Bibliothèque Nationale

values in discussions of nuclear technologies also allows for a more quantitative approach to the study of moralizations of emerging technologies, and their dissemination/construction in newspapers. Selected articles were analyzed through latent and guided probabilistic topic models, a tool for text mining that uses the distribution of words in text corpora, rather than specific keywords. These distributions were related to values that were proposed as the sites of ideological conflict in those early years of the atomic age in France.

The argument of this study and the structure of the remaining sections are as follows: Sections 2 and 3 delves deeper into the proposed relation between processes of moralization, technology and discourse. It argues that values form important discursive elements of the moralization of emerging technologies, a moralization that plays an important role in the mobilization and persuasion of people to accept these technologies. Section 4 assesses the different ideologies that were present in France in the decade after WW 2. Section 5 presents three value pairs fundamental to these ideologies and the appraisal of emergent nuclear technologies in France. Section 6 discusses the method used in the empirical part. Section 7 gives the empirical analysis. This study ends with a discussion and conclusion.

2.2   Values and Technologies

Values figure prominently in contemporary literature on the design and function of sociotechnical systems. Three perspectives can be distinguished: a design and engineering perspective, a social perspective, and an ethical perspective. Regarding the first: values can inform design choices and trajectories of innovation for certain technologies. Regarding the second:

Française [BNF], has only been digitally available since 2016. Digitization started in 2012. The consulted database at **Retronews.fr** is an offshoot of the **Gallica** digital library service of the BNF, and focuses exclusively on articles in the press, from 1631 – 1951/52.

values influence, or even determine, the social acceptance of (new) technologies. The ethical perspective, thirdly, investigates the moral acceptability of (new) technologies (Taebi, 2017). This last perspective doesn't describe the social conditions that determine acceptance of certain technologies, but asks whether the technology is acceptable according to a salient normative standard (Van de Poel, 2016). This study employs the second perspective. It focuses on processes of social acceptance of the possible role of nuclear technologies in France.

Disagreement continues to exist about the origin and status of values. For the purpose of this study the following choices were made: First, this study takes values as distinct from attitudes, preferences, desires and interests (Hechter et al., 1993). Second, it takes values as abstract terms that transcend specific situations, and motivate action as well as reflective judgments (Parsons, 1961). Third, it sees values as having a long-term function in individual lives and in social groups, as 'lasting convictions or matters that people feel should be strived for in general and not just for themselves to be able to lead a good life or realize a good society' (Poel and Royakkers, 2011, p. 72). As reflective judgments, values allow agents to qualify present and future states of affairs. These qualifications can be good or bad, sustainable or not, and so forth (Dewey, 1944).

In addition to these characteristics, this study looks at social values. It follows Tsirogianni, Sammut, and Park (2014) in defining social values as:

> … standards, which individuals and social groups employ to define personal goals and essentially shape the nature and form of social order in a collective i.e., what is acceptable and not acceptable, what ought or not to be, what is desirable or non-desirable. (p. 6187)

Social values are perceived as abstract societal goals that at least some members of a society support—members that as a social group within a society identify with these values (Tsirogianni and Gaskell, 2011; Vermaas et

al., 2015). Social values also involve second-order beliefs: beliefs about what other people believe to be good (Bicchieri, 2016). Social values, as second-order normative beliefs, therefore, are normative expectations (Bicchieri, 2016). These values emerge out of (collective) experience and social interaction and are used to define and justify a social order (Tsirogianni and Gaskell, 2011; Kluckhohn, 2013). Finally, this study posits that these values can be hierarchically ordered relative to another (Schwartz, 2012; Rokeach, 2008), and that values may be in conflict with each other in societies (Van de Poel et al., 2020).

The perspective on social values here adopted does not see values as universal and/or eternal goals. Values are stable, but continuously tested by new experiences and new states of affairs (Dewey, 1944). Sometimes, they might fail this test, leading to value change. Such value change certainly forms a possibility for artefacts that have a multigenerational existence, designed with respect to certain values in these societies (Van de Poel, 2018). In the case of sociotechnical systems, value change means that the ends these systems could help actors, such as social groups, to pursue might no longer be part of these actors' motivational structure, or strongly diminished in importance. It can also mean that the conceptualization of these values has changed, or conflicting values have emerged (van de Poel and Kudina, 2022; van de Poel, 2021; van de Poel and Taebi, 2022). In each case, the design of the system has to be altered to accommodate these changes in salient ends. Finally, value change might also occur in anticipatory discussions of emerging technologies, as this study proposes.

Values can also be new to specific groups in society, in the sense that they have accepted the salience of these values only recently, moved these values to the center of their normative view of (social) reality. In this sense, we can talk about an ideological shift, if we understand ideologies, as systems of

ideas and belief systems to 'specify what general cultural values (freedom, equality, justice, etc.) are relevant for the group' (Van Dijk, 2006, p.116).[8]

In the case of the French adoption of nuclear technologies, even if the transition to nuclear energy turned out so extensive by the early 1980s, the relation to circulating ideas of the good society and good life in the late 1940s and early 1950s is yet to be determined. Three possible scenarios emerge: (1) There was little to no discussion regarding the prospects of the atomic age in French society nor collective agreement what moralization was preferable, i.e., the development of nuclear technologies happened to a disinterested French public (Scheinman, 1965; Nelkin and Pollak, 1980; Callon, 2009); (2) Different moralizations were developed, but consensus did not emerge, and nascent nuclear policy could not build upon such a consensus; (3) French nuclear policy realized dominant values for the 'atomic age' that emerged in anticipatory public discussions of nuclear technologies.

The empirical part of this study examines these scenarios. It analyses the extent to which ideologically diverse newspapers adopted new evaluative frameworks for the discussion of nuclear technologies, moving away from their historical, ideological settings (see also section 4).

2.3   Values and Discourse Coalitions

Discourses are webs of meaning, constituting a particular way of talking and thinking about a certain phenomenon, or reality in general (Hajer, 1995; Ortega Alvarado *et al.*, 2021). They provide narratives and storylines that

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[8] Van Dijk continues: '[…]if ideologies can be gradually developed by (members of) a group, they also gradually disintegrate, e.g. when members no longer believe in a cause and 'leave' the group, when group grievances have been attended to, or under a host of other social and political conditions, as, e.g. was the case for the pacifist and anti-nuclear movements of the 1970s.' (Van Dijk, 2006) (p.117)

allow people to make sense of what is happening. For Hajer (1995), discourse forms

> a specific ensemble of ideas, concepts, and categorizations that are produced, reproduced, and transformed in a particular set of practices and through which meaning is given to physical and social realities. (p.44)

Discourse is a form of communication, but a communication with the higher goal of reaching consensus, a consensus which, in this study, is related to the connection between certain events, such as technological developments, and certain values (Bergmann, 1998). Discourse analysis then 'sets out to trace a particular linguistic regularity that can be found in discussions or debates' (Hajer and Versteeg, 2005, p.175).

The processes of 'onboarding' of actors into specific narratives about events—the emergence of nuclear technologies, the atomic bombing of Hiroshima and Nagasaki—a narrative that, in media, is often a result of encoded ideologies, is complex (S. Hall, 1982). Focusing on persuasion by arguments, plausibility and credibility are mentioned by Hajer (1995), while storylines can convince through the use of metaphor, cliché, and historical analogies. Why exactly certain social groups abandon their initial, ideologically informed, position on a emergent technology, is too much ground to cover in this study. Instead, it will discuss one of the outcomes of such processes of onboarding: the formation of discourse coalitions.

Briefly put, discourse coalitions refer to the sharing of storylines by different social actors (M. A. Hajer, 2002). Such a coalition shares the interpretation of, and the normative orientation of a narrative about, a certain situation or chain of events (Fischer, 2003). Storylines about these situations and events,

> are as much about changing that reality, as they are about simply understanding and affirming it. They are, in short, about 'world making' (Goodman 1978). In this sense, their

objective is to bring about a set of circumstances that does
not yet exist. (Fischer, 2003, p.104/105)

This future-oriented aspect of storylines and their normative orientation allow the analysis of the emergence of discourse coalitions to be linked to technologies that still are largely imagined rather than operational, as is the case for nuclear technologies in the period under discussion. Values, then, are taken as important building blocks of storylines in media discourse that moralize the imagined future use of nuclear technologies. Finally, discourse becomes dominant when an increasing number of relevant actors start using its storylines. Over time, dominant discourses concerning emerging technologies become institutionalized in policies, organizational practices or policy principles (M. A. Hajer, 2002).

Although the extent of institutionalization of discourse lies beyond the scope of this study, a few preliminary remarks about the institutional context can be made. French atomic policy was, until 1952, almost inexistent. Although anti-communist sentiments led to the purging, in 1950, of Joliot-Curie, head of the CEA, parliamentary discussions of nuclear technologies were scarce (Wynne, 2013). Starting in 1952, the first Five Year Plan for the development of nuclear technologies, the plan Gaillard, focused on the industrial application of nuclear technologies for peaceful purposes (Scheinman, 1965). This plan, however, left open the possible construction of a nuclear bomb (Hecht, 2009). On the day the plan was revised to include the building of a third reactor, in 1950, a secret protocol marked the beginning of substantial military contribution to the program (Mendl, 1965).

2.4   Nuclear France

Research into the public acceptance of emerging nuclear technologies is mostly qualitative (Tidwell & Tidwell, 2018). The focus lies on 'thick' descriptions of pivotal moments to highlight either public resistance to nuclear technologies (Felt, 2015; Valentines-Álvarez and Macaya-Andrés,

2019), a break-through in their acceptance as vehicles to a better future (Jasanoff and Kim, 2013; Kim, 2015; Teräväinen, Lehtonen and Martiskainen, 2011), or the role of experts in the articulation of military and peaceful visions of the atomic age (Zeman, 2012; Wynne, 2013).[9] Research involving media representations of nuclear technologies is often qualitative as well, especially when this research considers the early phases of the discussion of these technologies, and emerging visions of their role, in the first decades following WW 2, when the commercial use of these technologies was still overshadowed by their recent military applications.

In the case of France, early discussions and representations of nuclear technologies have not received wide academic attention, and certainly not in the quantitative manner this study proposes. Analyses of the French atomic program pay less attention to the period 1945 – 1952 and instead focus on the design of the first reactors and on the French decision to start producing plutonium and, eventually, create an atomic bomb (Jurgensen and Mongin, 2018; Hecht, 2009; Scheinman, 1965; Jasper, 1992). Politically, in this first half of the Fourth Republic in France (1946 – 1958), both turmoil and immobilism persisted (de Rioux, 1980; Williams, 1964). An official atomic policy was lacking, despite the creation of the Commissariat à l'Énergie Atomique [CEA], in October 1945 (Scheinman, 1965). After 1952 and the start of the first, five year plan for the development of nuclear technologies—scholars seem to argue—nuclear politics finally began, and visions of the future of a nuclear France started to be performed by powerful social actors (Hecht, 2009; Scheinman, 1965). These analyses, furthermore, see little involvement or interest of the French public in this period (Scheinman, 1965; Jasper, 1992; Callon, 2009). This public was either ignored (Jasper, 1992), or passively enjoying the spectacle of the atomic age (Callon, 2009).

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[9] These qualitative descriptions and analyses have focused, amongst others, on expert interviews (Hecht, 2009; Santos Pereira, Fonseca and Carvalho, 2018), policy documents (Teräväinen, Lehtonen and Martiskainen, 2011; Hecht, 2009; Scheinman, 1965), analysis of world fairs and exhibitions (Molella & Knowles, 2019), science museums (Sastre-Juan, 2019), popular science magazines (Van Lente, 2012), and nuclear imagery (Weart and Weart, 2009).

However, the chaotic period immediately following WW 2 merits further exploration, precisely because of its chaos and apparent political immobilism. First of all, influential people such as Joliot-Curie, Dautry[10], and Bidault[11] already were using their ideas of the atomic age to influence the direction of research and future application of nuclear technologies, albeit through informal rather than formal channels (Vaïsse, 1992; Pace, 1991). The stabilization and institutionalization of discourse (M. A. Hajer, 2002) had yet to occur; i.e., discourses concerning nuclear technologies had yet to solidify into widely accepted ways of reasoning and framing (Hecht, 2009). Second, rather than lacking in moralizations of the atomic age, this period was rife with them (Pace, 1991). Third, this period is important in understanding how nuclear technologies were evaluated in mass media and whether 'discourse coalitions' (Hajer, 2002; Ortega Alvarado *et al.*, 2021; Rinscheid, 2015; Szarka, 2004) emerged in newspapers, despite evident ideological differences between these newspapers and their respective readers. Finally, an analysis of this period helps identify the early stages of the formation of a shared vision before a nuclear, sociotechnical regime was formed in France.

Historians of French politics such as Rioux, Kuisel, and Larkin (1997) highlight the political divisiveness of the Fourth Republic (Rioux, 1980; Kuisel, 1983; Larkin, 1997). The acute feeling of crisis that resulted from WW 2, led to

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[10] Raoul Dautry (1880 – 1951), director of the CEA from 1946 to 1951. Technocrat during the Third Republic, Minister of Armament in the first year of WW2. Advocate of decentralized industrialization and regional development in France. Responsible for the shipment of France's heavy water stocks to England, June 18th 1940 (Baudoui, 1992).

[11] Georges Bidault (1988 – 1983), former Resistance leader. Editorial writer for *l'Aube* and editor-in-chief of *Combat*. Founder of the Mouvement Républicain Populair (Christian-Democrat) after the war. Two time government leader: June – December 1946, president of the Provisional Government of the French Republic; October 1949 – July 1950, president of the Council of Ministers. After Joliot-Curie's signing of the Stockholm Appeal (March 19th, 1950), Bidault replaces him at the CEA with Francis Perrin (Vaïsse, 1992).

conflicting ideas of necessary change, which neither of the existing political parties was able to convincingly use for the building of a stable coalition, to realize a sufficient political consensus of interests, testimony to which are the 20 changes of government in the 12 years of the Fourth Republic (1946-1958).

This turmoil played out against a shared sense of backwardness, for which the Third Republic was blamed (Hecht, 2009; Kuisel, 1983; Larkin, 1997). Rebuilding France was an overall imperative. The question was how and to what ends: was it a mere renovation or a genuine revolution? How much social reform was needed? (Larkin, 1997). Authors have shown how nuclear technologies were politically discussed in relation to these questions beginning in the 1950s (e.g., Hecht, 2009; Scheinman, 1965). Their analyses shed light on the politics of atomic power, while neglecting societal deliberations and anticipations in the period 1945–1952.

2.5   Selection of Values

In line with Rioux, Kuisel, and Larkin this study proposes that fundamental questions about post-WW 2 politics, economics, culture, and technology related to the rebuilding of France remained open in the period 1945 – 1952. The political immobility of that period is perceived as a result of conflicting opinions on three important issues: the role of the state in the modernization of the economy (markets vs. plans); the relation to past and future of France; and France's place in the future world order (de Rioux, 1980; Haas, 2019; Kuisel, 1983).

This study proposes to see this immobility through the lens of three value-pairs:

(1) *Socioeconomic*:   Individual vs. Collective
(2) *Geopolitical*:   (World)Peace vs. Defence
(3) *Cultural*:   Tradition vs. Progress

These three value-pairs simplify a very complex situation, but allow us to look at divergent ideas concerning the future of France from an abstract, axiological viewpoint. This viewpoint, furthermore, provides a quick understanding of the possible ideological stalemates regarding, for instance, nuclear technologies. Further simplifying the situation in France, three ideologies were chosen: conservative, centrist/liberal, and communist. These ideologies do not neatly correspond to the political parties in France at the time, nor do they correspond to the views of specific social classes (Duverger, 1958). They do conform, however, to the perspectives of the major newspapers of that time (see section 6). These newspapers had a professed ideology, and strongly relied on editorials and opinion pieces in which their worldview was manifested (Duverger, 1958).

Furthermore, although this selection of values and corresponding ideologies is based upon the political analyses of the woes of the Fourth Republic (de Rioux, 1980; Jasper, 1992; Kuisel, 1983; M. Larkin & Larkin, 1997; Lucas, 1979), it does not follow the political divisions or the short-lived tripartism of its first years.[12] Rather, this study follows the ideological fault lines that Duverger establishes, as 'fundamental political tendencies' in France (Duverger, 1958, p. 84). Figure 1 highlights the choice between three fundamentally different ideas about what future France should (re)turn to, and what role nuclear technologies could play in this future. Furthermore, as figure 1 shows, these three perspectives on the future of France overlap, but none of the values, as abstract goals, is shared by all three ideologies. I will return to these values in the next session.

[12] This tripartism (1945-1947) was the result of De Gaulle's referendum (October, 1945) for a new constitution. In the vote for the assembly, three parties that had played a role in the Resistance (communists: PCF, Christian-democrats: MRP, and socialists: SFIO) took three-quarters of the seats.
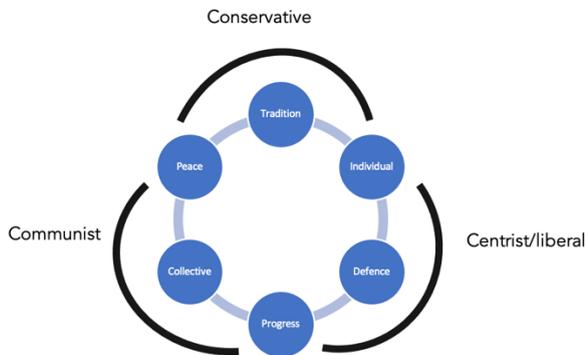
Fig. 1: Immobilism and ideological stalemates in the Fourth Republic (cultural, geopolitical, and socioeconomic).

2.6   Method

General audience media, such as newspapers, reflect public opinion on nuclear technologies, while also contributing to its creation (Gamson and Modigliani, 1989; Geels and Verhees, 2011). Journalists and other contributors may be influenced by expert visions and explanations, politicians and other sources, while also using their own frames for the interpretation of events (Gamson and Modigliani, 1989; Santos Pereira, Fonseca and Carvalho, 2018). The extent to which such a influence took place lies outside of the scope of this study. However, this study is careful not to conflate media discourse with public opinion, especially in the case of highly complex nuclear technologies (Gamson and Modigliani, 1989; Van Lente, 2012; Pollock, Lilie and Vittes, 1993). Rather, this study shows how evaluative frameworks of nuclear technologies developed over time in France, a development to which all these actors contributed, while the technologies in question were still largely anticipated, rather than present.

This study understands values as generalized and shared responses to situations, that are carried over from previous experiences (van de Poel & Kudina, 2022). This account asserts the dynamic nature of values, important

for research into the discussion in French newspapers of emerging nuclear technologies. France was in acute crisis following WW2. Ideological conflicts about the future of France led to political immobilism, despite a shared sense of technological backwardness. Section 5 proposed and argued that different values, established along pre-existing, ideological vault lines, came to bear upon this crisis, as evaluative devices of a future France and its relation to nuclear technologies. These technologies prominently figured as a possible way out of the perceived technological backwardness in France. This values were then related to three ideological frames (conservative, communist, and centrist/liberal), that were empirically analyzed.

To the previously selected values (section 5), two technological values were added: security and safety. This leads to figure 2. These technological values were added because they are expected to be less ideologically divisive, and relevant for the development of knowledge of nuclear fission in those years. Safety is here understood as the prevention of accidents and/or the mitigation of consequences of accidents and the establishment of proper working conditions (Delves, 2007). Security is understood as the prevention of malicious acts involving nuclear material, and technologies (Delves, 2007). Moreover, while research into fission progressed, the early speculations of the future widespread use of nuclear reactors (in houses, cars, etc.) proved to be too optimistic. Safety and security issues were important drivers of this reality-check.
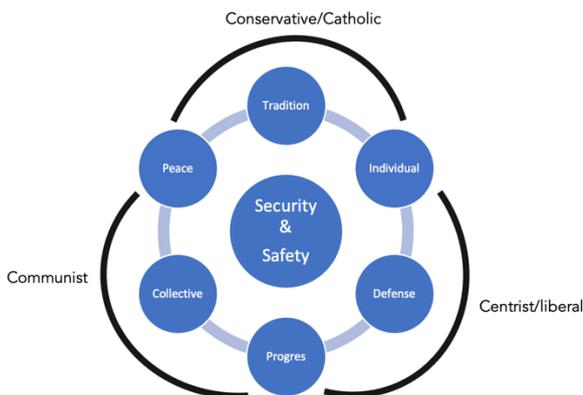
Fig. 2: Expected values in newspaper discussions of nuclear energy

Topic Modelling

Seven newspapers were selected for the period 1945–1952. In conformity with the distinguished ideologies (section 4), a distinction was made between communist/Marxist, centrist/liberal, and Catholic/conservative national newspapers (table 4). The selected communist newspapers were Combat, Ce Soir, and L'Humanité; selected centrist/liberal newspapers were France-Soir and L'Aurore; selected Catholic/conservative newspapers were La Croix and L'Aube. Out of the combined archives of these newspapers mentioning 'énergie atomique' (5094 articles), a random selection was made of 2100 articles. After deletion of unreadable articles, because of faulty microfiches, 1895 articles remained. These articles were analyzed using Topic Models.

Newspaper	Ideology	Professed Political Affiliation	Nr. of Articles
Combat	Socialist/Marxist	MLN – Mouvement de Libération Nationale	327
L'Aurore	Liberal/right	None	300
L'Aube	Catholic	(MRP) Mouvement Républicaine Populaire (Christian-democrat)	300
France-Soir	Centrist/Liberal	None	217
Ce Soir	Communist	(PCF) Parti Communist Français	300
La Croix	Catholic	None	151
L'Humanité	Communist	(PCF) Parti Communist Français	300
		total	1895

Table 4: Selected newspapers

Topic modelling is an approach to capture latent topics, such as values, in large archives (de Wildt et al., 2018, 2022). Topic modelling allows to discern whether these topics/values were therefore relevant in the discussion and description of events, rather than other possible topics/values. The approach enables tracking the change in evaluative frames, the values considered salient for the narrative developed in these newspapers. The assumption is that more salient values are brought up more often. The approach allows the tracking of the topics authors bring up while covering news related to nuclear energy. It doesn't allow the tracking of what they actually say/write on the sentence level. This means that we can't discern whether these topics are treated negatively (e.g. 'no peace', 'not leading to progress', 'not safe', etc.) or positively. However, because this approach addresses multiple terms that together form a topic, it is assumed that these terms are mostly used in an affirming sense, since antonyms exist. Nonetheless, this cannot be ascertained. I return to this issue in the conclusion.

Since certain values related to nuclear energy might be differently expressed over time, a simple key-word search for a specific value, such as safety, might not bring back all articles expressing concerns and developments related to safety. It makes sense, therefore, to look at other words that are related to safety and could be considered as synonyms, or dimensions of the concept. A topic such as safety could encompass words as 'accident', 'incident', 'risk', and 'precaution'. These 'anchor' words are found by reiterating the process of topic modelling and analyzing the topics that emerge.[13] A set of words is thus created which serves as indicative of the presence of a certain value. This set contains both synonyms and hyponyms, and words that have a looser association.

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[13] One aspect of this analysis concerns the evaluation of articles that are brought up in connection to a certain topic, for which the notebook developed by Tristan de Wildt (2021) provides. This allows for a check: is the article selected really connected to a certain topic?

Topic modelling also allows for the tracking of the frequency with which certain latent topics appear in an archive, thereby showing the in- or decreasing dominance of certain values in discussions stretched out over longer periods – one of the characteristics of discussions in democracies, especially discussions that involve visions of the future. Nuclear energy is no exception here, as ongoing debates in many countries show.

Operationalization
Table 5 shows the selected values and the words in the archive associated with them.

	Value	Anchor words
Technological values	Security	sécurité, force, contrôle, assurance, terrorisme, danger, menace, risque
	Safety	risque, accident, précaution, incident, sauvegarde, précaution, maintenir, inspection, prudence
Social Values in archive	Defense	arme, attaque, étranger, sauvegarde, agression, préservation, abri, résistance, étrangère, militaire, conflit, destruction, attaque, protection, défendre, défense, mondiale
	Peace	paix, ratification, négocier, pacifique, désarmement, désarmer, cesser, renoncer, négociation, armistice, entente, pacte
	Technological progress	développement, innovation, pouvoir, capacité, technologie, technique, future, invention, technologique

	Scientific progress	scientifique, recherches, poursuite, vérité, savant, étude, pensée, penser, laboratoire, mesure, découverte, découvrir, connaître
	Tradition (Préservation culturelle)	tradition, traditionnelle, dignité humaine, droit humaine, préservation, conservation, conserver, préserver, esprit, dieu, espoir, foi
	Solidarity	solidarité, cohésion, égalité, collective, collectif, aide, aider, volonté populaire, coopération, commun, sécurité collective
	Individuality	exploitation, commerce, établissement, dirigeants, exploit, propriété, particulier, différente, entreprise

Table 5: Selected values as topics in archive

Two things have to be remarked about this operationalization: First, the topic of progress was split into two. A distinction was made between technological progress and scientific progress. This was a better fit with the topics as they emerged in the reiterative process of topic formation. Secondly, the value pair collective-individual was difficult to operationalize. Reiteration of the process of finding words often appearing together in the archive, led to two semantic changes. Collectiveness moved more towards solidarity (as cooperation and equality), whereas individuality moved towards economic aspects of individualism, such as entrepreneurship, property, and commercial exploitation. Despite these changes, the topic of individuality remained weak. I will return to these changes in the discussion.

Finally, figure 3 provides a timeline with domestic and geopolitical events related to nuclear technologies, to better read the graphs.

1945

6 – 9 May 1945
Bombing of Hiroshima and Nagasaki

8 May 1945
End of WW2 in France

18 October 1945
Creation of CEA

January 1946
Creation Atomic Energy Commission UNEAC

1946

16 March1 1946
Acheson -Lilienthal report on the international control of Atomic Energy.

8 April 1946
Creation EDF

1 July 1946
Nuclear tests U.S. in Bikini Atoll

18 October 1946
Start Fourth Republic

December 1946
USRR & Poland veto Baruch Plan for nuclear disarmament

1947

January 1947
Decision to create a nuclear research centre at Saclay, Île-de-France

12 March 1947
Truman Doctrine announced in Congress.
Signed on May 22nd.

16 April 1946
Baruch is first to mention 'Cold War'

July 1947
Decision taken to start constructing first reactor, Zoé

June 1947
Introduction Doomsday Clock (Bulletin of Atomic Scientists)

October 1947
CEA affirms discovery uranium ore in Limousin region

25 February 1948
Coup d'État Czechoslovakia

1948

November 1947
Start political isolation Communist Party in France.

3 April 1948
Truman signs Marshall plan

GLOBAL

DOMESTIC

24 June 1948
Blockade Berlin (26 June : start Airlift)

15 December 1948
Zoé Reactor activated at Fort de Châtillon

1949

4 April 1949
North Atlantic Treaty signed

Beginning of 1949
Mining operations in Henriette, first uranium mine of France, start in Limousin region

5 May 1949
Creation Council of Europe

24 August 1949
NATO established

29 August 1949
First Soviet nuclear test

November 1949
First extraction of plutonium at factory of Le Bouchet

1950

31 January 1950
Truman orders development of Hydrogen bomb

12 February 1950
Communist riots in Paris

April 1950
Joliot-Curie dismissed as Haute-Commissaire of CEA after signing Stockholm Appeal

7 April 1950
Truman presents NSC 68 (approved September 30th), making the rollback of the Communist expansion a U.S. priority

October 1950
First major French defeat in Indochina, at the Battle of Route Colonial 4.

25 June 1950
Starrt of Korean War

1951

18 April 1951
Treaty of Paris, establishing the European Coal and Steel Community

8 May 1951
Operation Greenhouse: The first thermonuclear weapon is tested in the "George" test on Enewetok Atoll in the Marshall Islands by the United States.

31 December 1951
Marshall Plan expires after distributing 13.3 billion dollars in U.S. aid to Europe (2.3 billion to France)

1952

3 October 1952
First British Test of atomic device at Montebello Islands

18 June 1952
Parliamentary acceptance and start first Five Year Plan for the development of Atomic Power.

23 October 1952
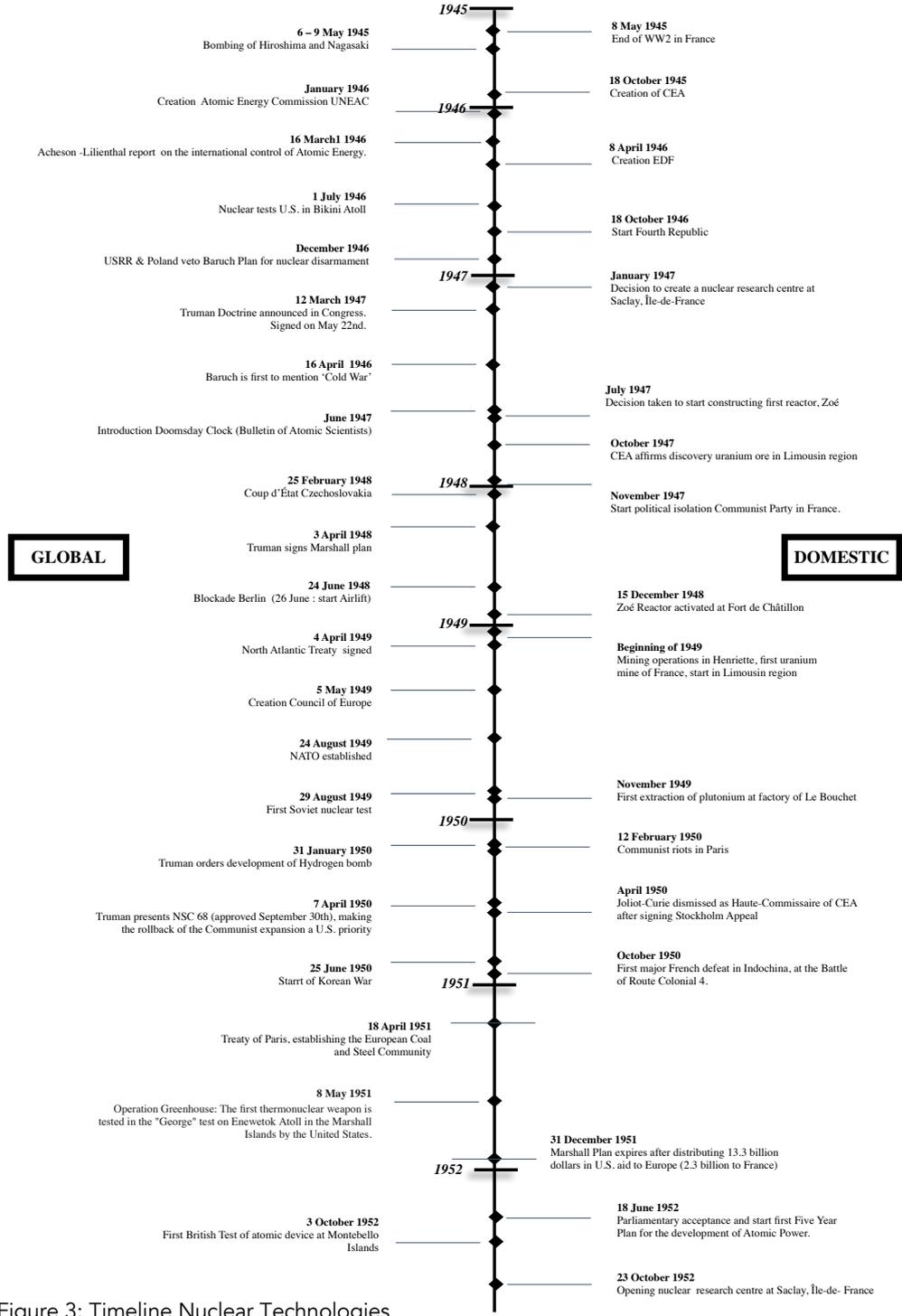Opening nuclear research centre at Saclay, Île-de- France

Figure 3: Timeline Nuclear Technologies

2.7   Results

First of all, a general development of the topics in the archive is given, and per newspaper group. The analysis then moves on to show the results related to the expectations, formulated in section 6, as broad guidelines for the presentation of these results.

Distribution of values over the dataset

The first figure (4) shows the relative importance of the selected values in the entire dataset. The three consecutive figures then show the relative importance of the selected values per newspaper group. This allows us to see differences between the focus of newspapers groups. Four values dominate discussions in the entire dataset, as well as the different newspaper groups: **Defense, Security, Peace, and Scientific progress**. The relative dominance of these values slight differs amongst the newspaper groups.
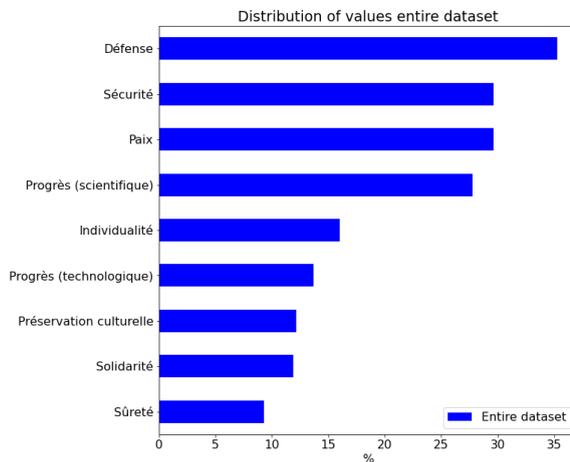

Figure 4: Distribution of values in the entire dataset
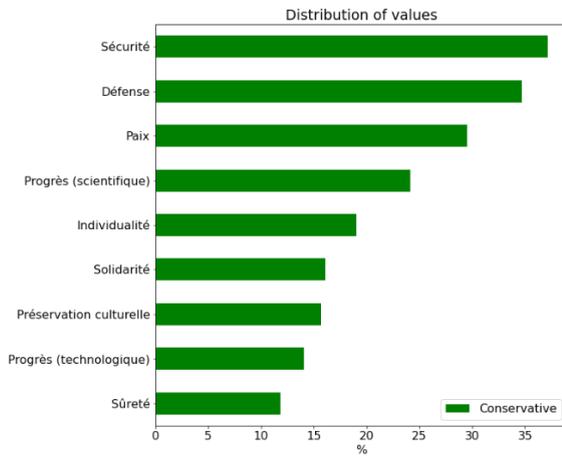
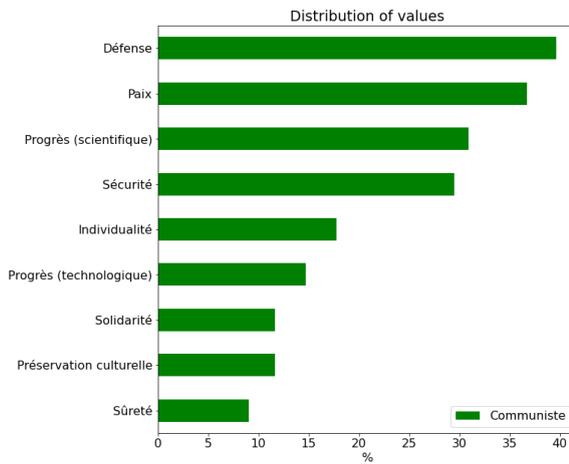Figure 5: Distribution in conservative newspapers

Figure 6: Distribution in communist newspapers
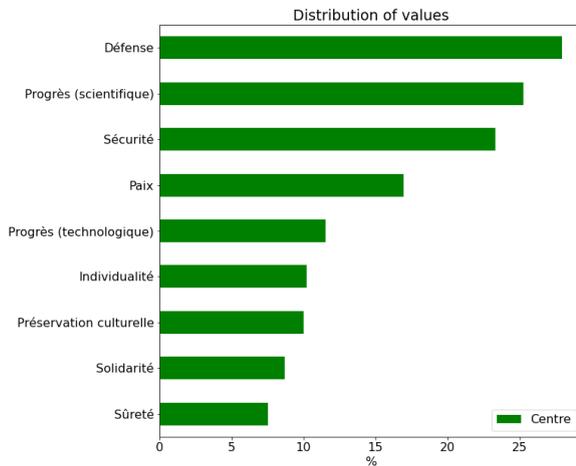
Figure 7: Distribution in centrist/liberal newspapers

Development of frequency in time

This section shows how the relative frequency of values changes over time. Five figures are provided. The first (8) shows the development over time of topics for the entire archive. The second (9) focuses on the dominant values of the previous section. The three others split up the results for the different newspaper groups.
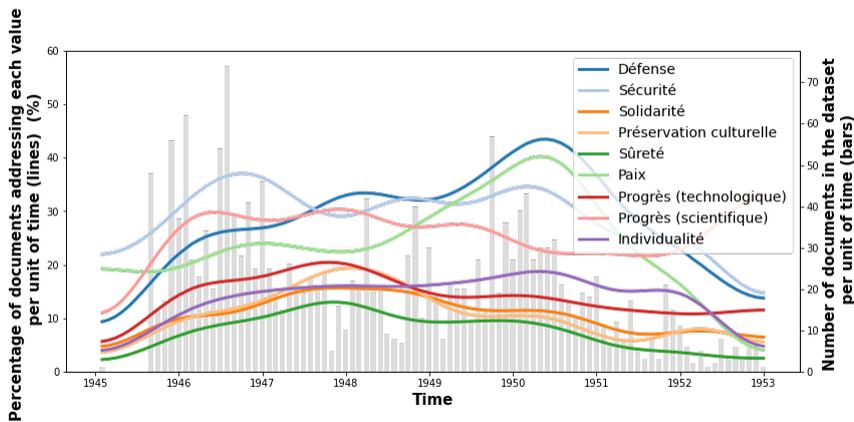
Figure 8: Distribution over time of topics in entire archive
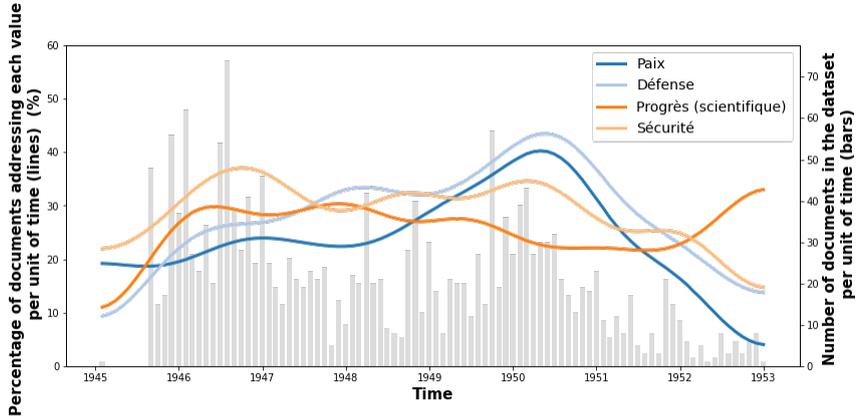
Figure 9: Distribution over time of 4 dominant topics in entire archive
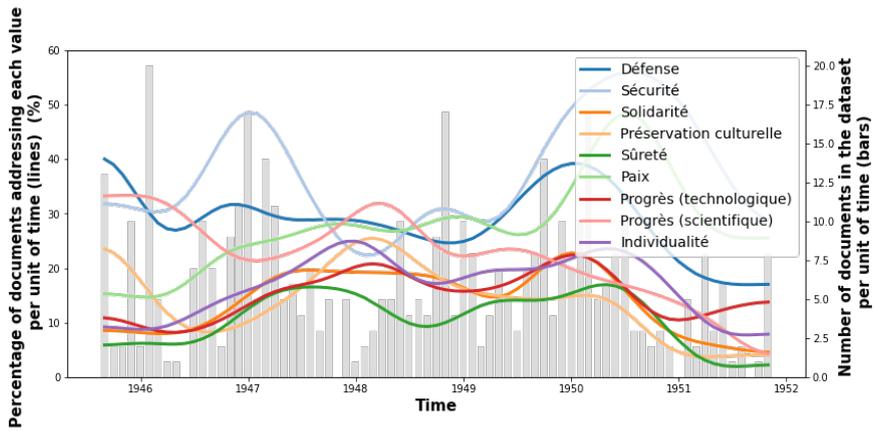
Figure 10: Distribution over time of topics in conservative newspapers
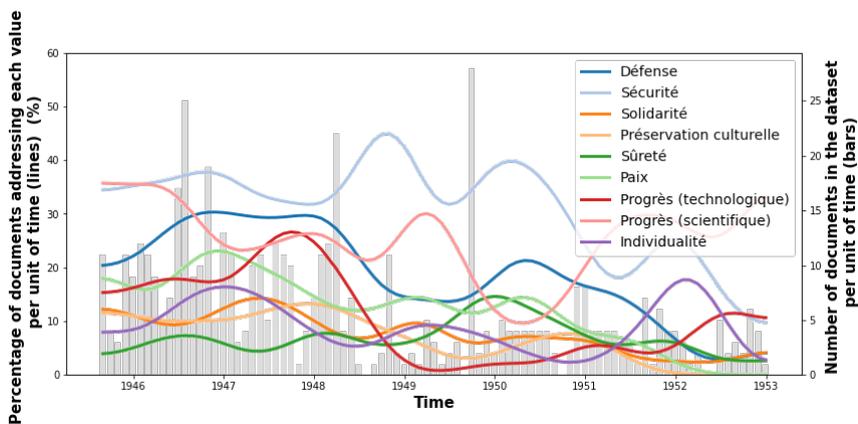
Figure 11: Distribution over time of topics in centrist/liberal newspapers
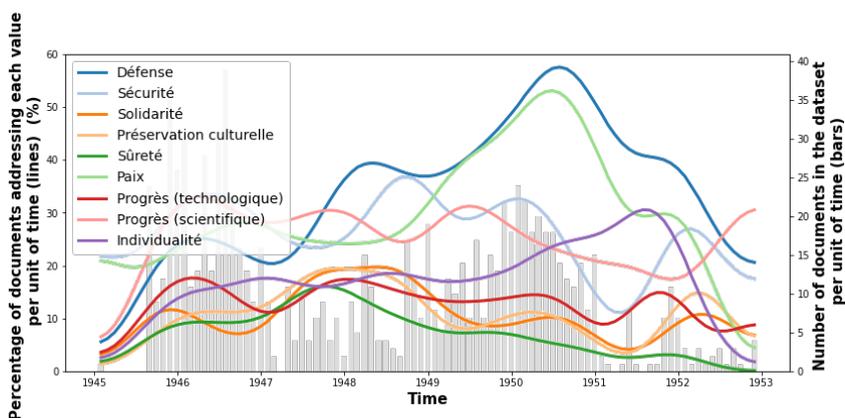
Figure 12: Distribution over time of topics in communist newspapers

Despite the dominance of 4 values for all newspapers groups, figures 10 – 12 show the differences between the newspaper groups. The topic **Peace**, for instance, is on the decline in centrist/liberal newspapers, whereas the topic scientific progress rises in relative importance. Furthermore, regarding the values of **Peace** and **Defense**, two important markers emerge in the

entire archive as well as the conservative and communist newspaper group. Late-1946/beginning-1947 and late-1950. Especially the latter period is addressed in communist newspapers with topics that relate to **Peace** and **Defense**. In centrist/liberal newspapers the topics **Peace** and **Defense** come up in these periods, but are less pronounced in relation to **Security** and **Scientific progress**. Conservative newspapers address the topic of **Scientific progress** less often after the second half of 1948. Overall, in all newspaper groups **Individuality** is becoming more prominent over time until 1952. This is clearly visible for centrist/liberal and communist newspapers (fig. 11 & 12).

Clear differences emerge even within newspaper groups. If we look at the development of topics over time within newspapers groups, we see major differences. Figure 13, 14, and 15 show this development for communist newspapers.
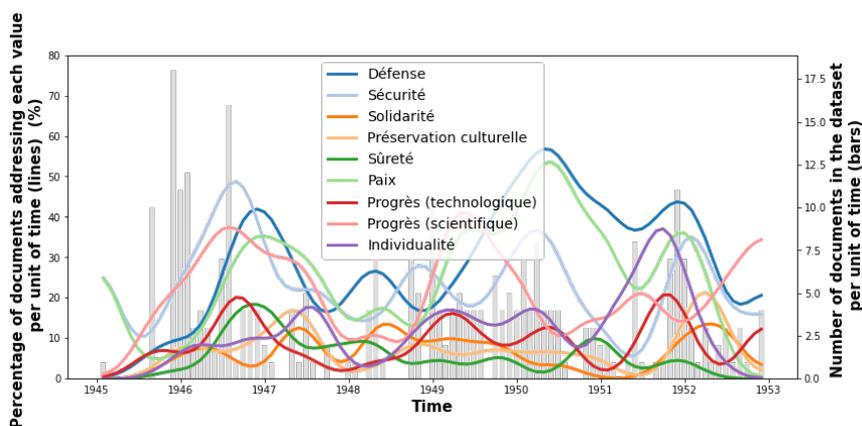
Figure 13: Topics in Ce Soir
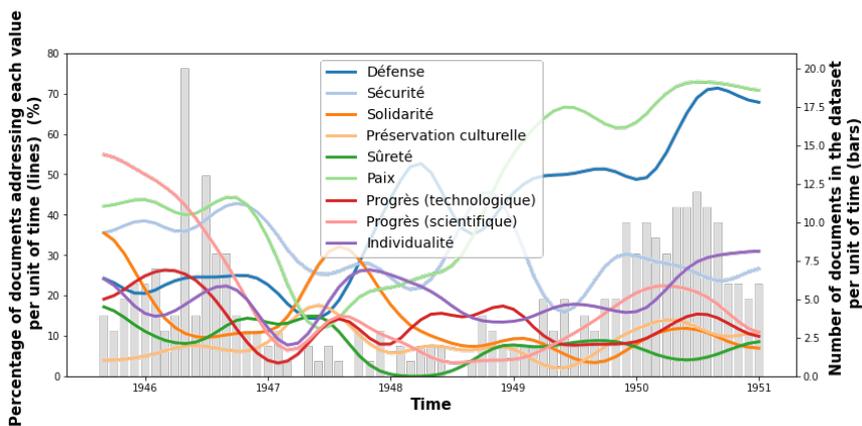
Figure 14: Topics in l'Humanité
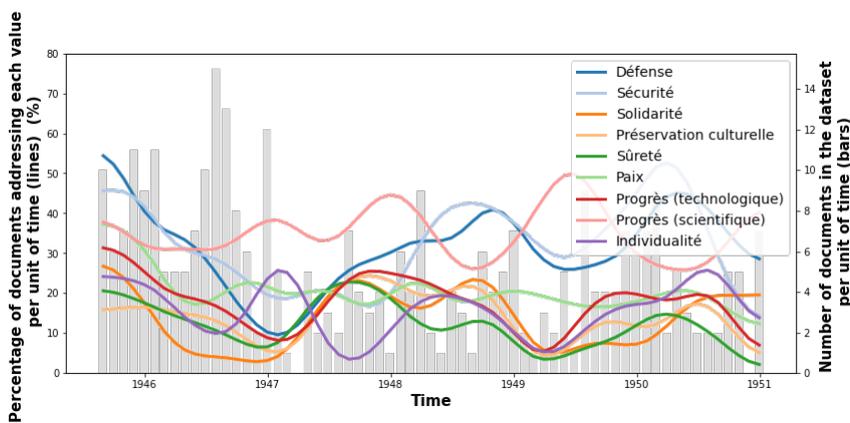
Figure 15: Topics in Combat

Combat focuses more on the topic of **scientific progress** rather than **peace** or **defence**. **Security** also is quite dominant compared to the other two. L'Humanité more often uses topics related to **peac**e and **defense**, and **individuality**. Ce Soir, finally, has a focus on the dominant values (**peace, defense, security** and **scientific progress**), although that focus becomes meddled in the final 1,5 years of the archive.

Development of topics Safety and Security
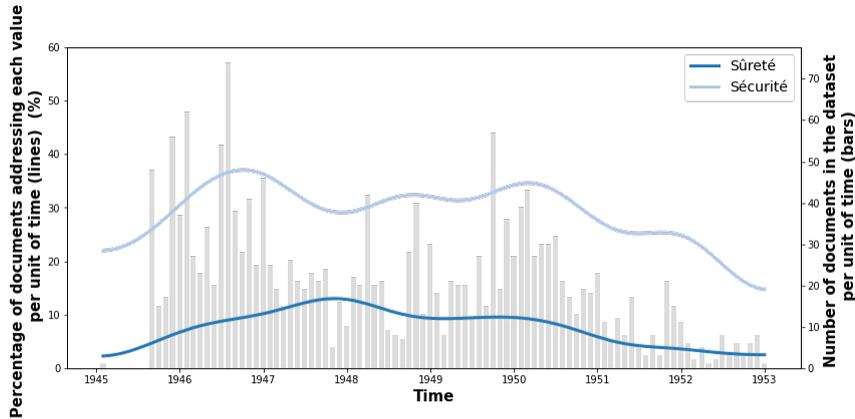
Figure 16: Security and safety over time in entire archive

There are no indications that **Safety** became more dominant, or a dominant topic over time. **Safety** hardly seemed to have been addressed, despite progress in scientific discoveries and technological know-how. Concerning the latter, **Technological progress** is not a dominant topic in newspaper discussions. **Security** remains an important topic over time. It is very dominant in conservative and centrist/liberal newspapers. Relative to other dominant values (**Defence** and **Peace**), **Security** over time seems to lose some of its importance (fig. 9). This seems mostly due to its decline in communist and centrist/liberal newspapers (fig. 11 & 12). In the entire period, **Security** is never a dominant topic in communist newspapers. These newspapers focus more on topics related to **Defense** and **Peace**.

Converging values sets

There are indications that certain values move to the forefront in newspaper discussions of nuclear technologies and events. I provide fig. 9 – 12 again underneath.
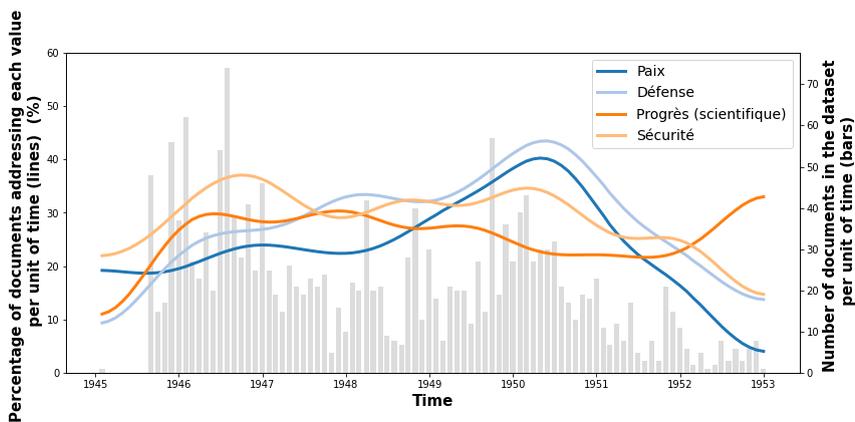
Figure 9: Distribution over time of 4 dominant topics in entire archive
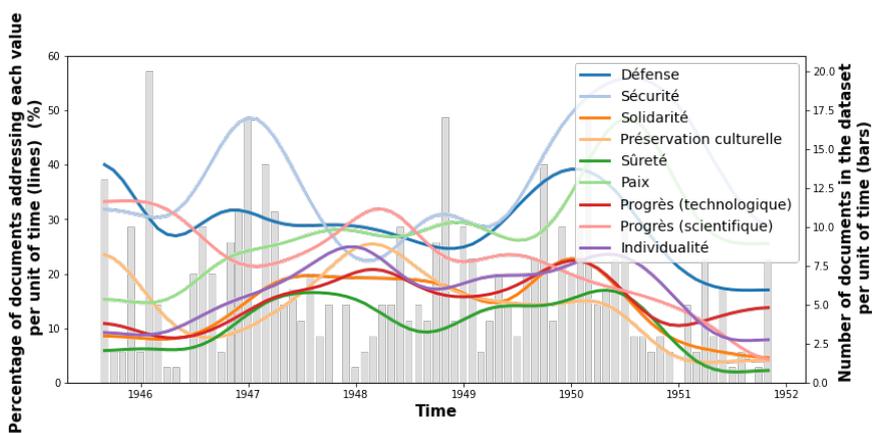
Figure 10: Distribution over time of topics in conservative newspapers
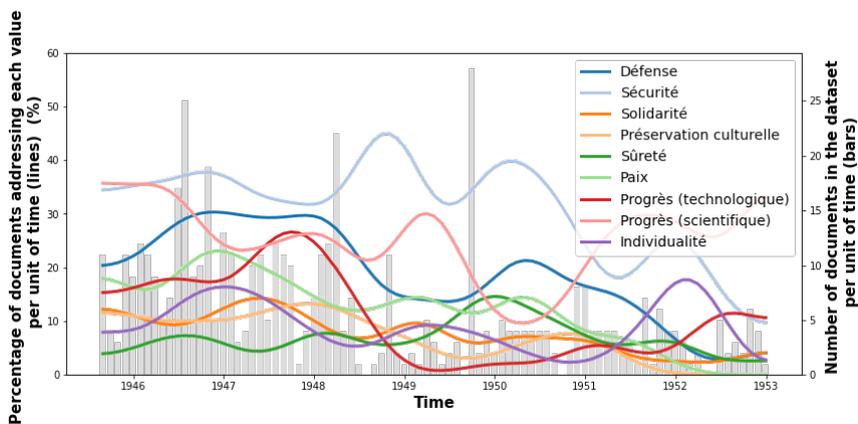
Figure 11: Distribution over time of topics in centrist/liberal newspapers
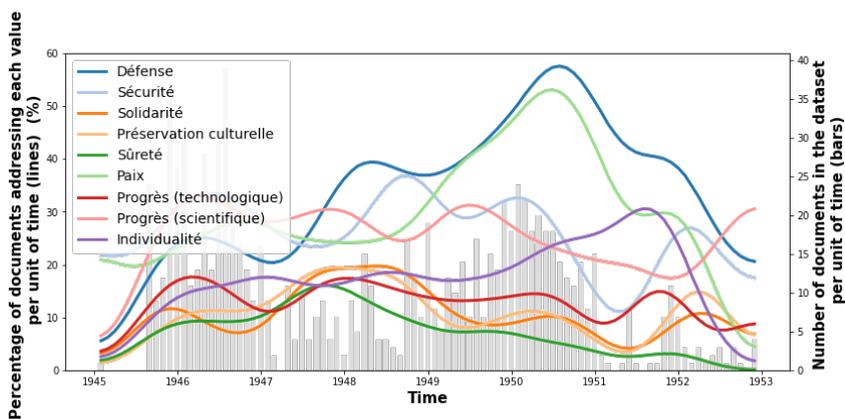
Figure 12: Distribution over time of topics in communist newspapers

Overall, **Peace** and **Defense** gradually gain in relative importance up to 1951 (fig. 9), as do **Individualism** and **Scientific Progress** (fig. 9). However, a more diverse picture emerges towards 1952, looking at the newspaper groups (table 6).

Newspaper Groups/Values	Value Prioritization close to 1952		
	Conservative	Centre/Liberal	Communist
1	Security	Scientific progress	Defesce
2	Peace	Security	Individuality
3	Defense	Individuality	Peace
4	Technological progress	Technological progress	Security

Table 6: Value prioritization in newspaper groups

If we look at the different newspaper groups, a more complex picture emerges of the prioritization of these salient values. For communist newspapers, the dominant topics are **Peace/Defense**, **Scientific Progress**, and to a lesser extent, **Individualism** and **Security**. **Collectiveness (Solidarity)** is not that present as topic as it is in conservative newspapers. On the other hand, centrist/liberal and conservative newspapers show a more dispersed discussion of atomic power and events. For instance, the topic related to **Tradition** (Préservation culturelle) moves in and out of focus in conservative newspapers (fig.10). If we look in more detail which words of the topic were used in this period in conservative newspapers, we come to fig. 17. **Hope**, **trust**, and **spirit** are the dominant words.
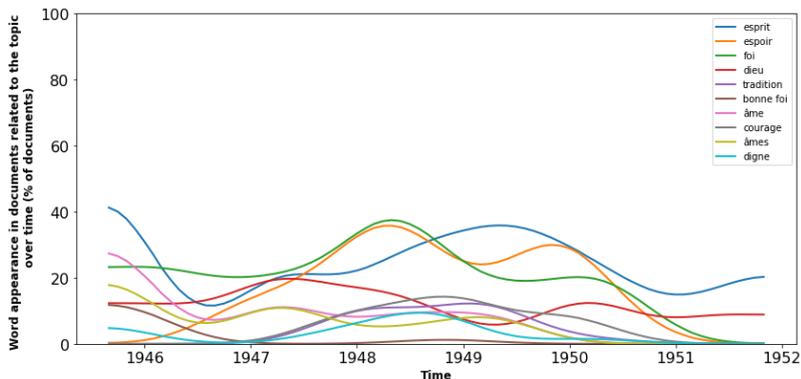
Figure 17: The topic of Tradition over time in conservative newspapers

We can compare this, for instance, with the topic 'tradition' in communist newspapers, see fig. 18.
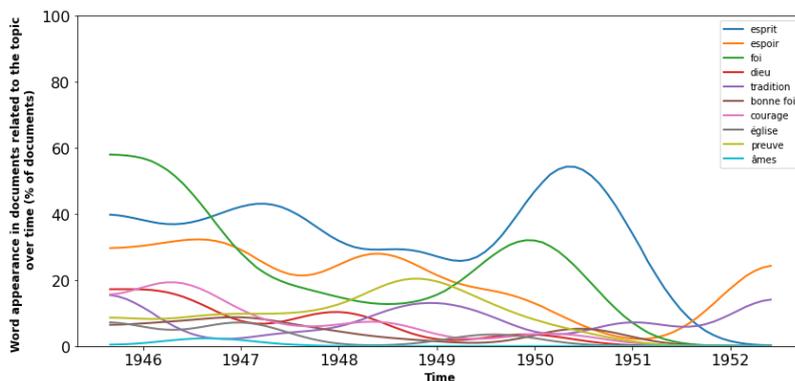
Figure 18: The topic of Tradition over time in communist newspapers

We can see here a more pronounced dominance of **spirit**, with less prominence of words relating to religion. **Hope** (Espoir) appears to gradually decline after 1949, whereas **Hope** is still a dominant word in conservative newspapers in the same period in this topic.

If we look at the convergence of values over time (fig. 10, 11, and 12), **peace**, **defense**, and **security** are the dominant values for conservative and communist newspapers towards the end of the period. In communist newspapers, the values **scientific progress** and **individuality** also become important around 1951 (fig. 12). These values are on the decline in conservative newspapers, starting in late 1949. Centrist/liberal newspapers show a different picture (fig. 11). Here, **scientific progress** and **individuality** emerge as dominant values, with the values **defense**, **peace**, and **security** losing relevance (as topics) over time.

2.8   Discussion

Section 7 shows a very diverse treatment of nuclear technologies and related events from which it is difficult to draw easy observations. A complex picture emerges in the empirical section. Although we see a clear difference in the value-topics that newspaper groups bring forward to discuss nuclear technologies and related events, it is difficult to relate these differences to changing perspectives on a nuclear France over time. This section will nonetheless try to do so. Of course, we are dealing with indications, and not conclusive evidence. I focus on figure 9 and refine the implications I draw here with more detailed figures of section 7.

Figure 9 is relevant. It shows the development over time of 4 dominant values. It could indicate that, over time, beginning in the early 50s, another view on nuclear technologies emerges: one that is less focused on military purposes and the possibility of global destruction, and more on progress and civilian purposes. It is questionable whether we see emerging here a shared narrative that we can relate to an emerging shared moralization. However, we can eliminate scenario 1 (disinterested public), developed in section 1. Especially conservative newspapers continue to focus on peace and defense in the 1950s (fig. 10). Overall, however, we see a tendency in which values related to progress and peaceful application become more dominant (see table 6). This could be the start of the sharing of a moralization of atomic power (scenario 3) in which the centrist perspective on desirable change becomes dominant.

As we have seen, dominant values are **peace** and **defense**, **security** and **scientific** progress both for the entire archive, and for the newspaper groups with their corresponding archives. These values do not correspond neatly to three ideological visions established in section 3, and 4. However, in time some indications can be found that these values become less dominant or change dominance between them. Changes are especially evident for centrist/liberal newspapers. Here, **peace** and **defense** lose their dominance to **scientific and technological progress** and **individuality** and **security**. This

could indicate that this centrist moralization establishes itself over time. **Peace** and **defense** remain dominant values in conservative and communist newspaper groups, but also here we can see a sharp decline. After mid-1950, both peace and defense lose their relative dominance, and give way to other values, such as **individuality** and **scientific progress**. This is a possible indication of the adoption of the centrist/liberal moralization, while the conservative and communist values lose their hold on the narratives of these newspapers.

Furthermore, we can see different reactions to two important moments: late–1946/beginning–1947, and late–1949, beginning 1950. These two periods coincide with important international developments, and further crises. The first period marks the failure of the plan Baruch for nuclear control and disarmament, often taken as the beginning of the Cold War. The second period marks the first tests of a Soviet nuclear bomb, leading up to the Stockholm Appeal in March 1950. This was an appeal for nuclear disarmament in the face of an imminent atomic war, signed, amongst others, by Joliot-Curie. In both communist and conservative newspapers, the focus in these periods seem to be on **peace** and **defense**, as well as **security** for conservative newspapers. However, centrist/liberal newspapers seem to focus on **defense** and **scientific progress**, and less on **peace**. These are indications that centrist/liberal newspapers discussed these events differently, in line with their ideology.

In section 4, it was postulated that communist newspapers would focus on the values **solidarity**, **peace**, and **technological** and **scientific progress**. It seems this imaginary took the hardest hits after the start of the Cold War in late–1949. Although **solidarity** was never a dominant value, **peace** as a topic declines rapidly, while **individuality** and **scientific progress** advance in importance and bring the communist framing of nuclear technologies more in line with the centrist vision.

Finally, safety is hardly brought up in these early discussions. This is in line with what we know about technological development: values such as safety

come up in later stages (de Wildt et al., 2021). There was only one operating reactor (Zoé) in most of this period, that didn't deliver any electricity. Safety, therefore, is expected to rise in importance later in the 1950s and 1960s, especially after the first incidents and accidents with operating reactors. It falls outside of the scope of this study to check on this.[14]

2.9   Conclusion

This study analyzed how values changed in the discourse concerning nuclear technologies in selected newspaper articles. It proposed an ideologically charged set of values as the site of contestation between newspaper groups. Guided and probabilistic topic modelling was used to understand how narratives evolved in this speculative period of nuclear technologies, against a perceived crisis in France. In the 1940s (1945 – 1950) we see a large fluctuation of values as ways to understand the atomic age. This period could be considered the origin of different moralizations of atomic power.

This study has found indications that a certain set of values, related to a nuclear France, became more shared through a discursive framing of events and developments in both France and the world. It locates a turning point in discussions of nuclear technologies around 1950. Despite the beginning of the Cold War, values related to peaceful applications of nuclear technologies become more dominant. This could be indicative of the sharing of an idea of 'peaceful progress', focusing on industrial use of nuclear energy for the generation of electricity. However, both geopolitical developments, and atomic policy in France, seem misaligned with these values.

Furthermore, this study shows that nuclear technologies were extensively discussed in French newspapers, and that different evaluative frameworks were used in these discussions per newspaper (group). Changes in these

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[14] Furthermore, at the time of writing there is still a large archival gap of French newspapers after 1952 until the 1980s.

evaluative frameworks show that, despite a globally tense situation, centrist and communist newspapers tended towards topics of progress and civilian application of nuclear technologies in the early 1950s. This indicates a convergence of values and evaluative frameworks that this study relates to discourse coalitions. Regarding the scenarios discussed in section 2, we might therefore cautiously propose that such a coalition started emerging in printed media.

The used method in this study is just one way to look at the moralization of emerging technologies in text corpora. It used, for the first time, an archive of newspaper articles of this period to analyze values related to nuclear technologies in France. It showed how discussions of nuclear technologies can be related to values, and shared discursive processes of moralization. Further research could look into these processes in more detail. It could further investigate how stabilization of evaluative frameworks happens over time in other contexts of technological change. Especially moments of crisis need further scrutiny. We can think here of discussions of GMO related to food crises and discussions of geo-engineering technologies in relation to perceived failures to stop climate change. Furthermore, the observed lacuna in topic modelling, the inability to assess whether values are treated negatively or positively, needs further development. For instance, a methodological fusion between topic modelling and sentiment analysis could establish whether the tone of a sentence, relevant for a certain topic, is positive or negative.

Interlude 2   Values and Ideals in the Context of Energy Systems

The previous chapter has delved into the question what role values might play in sociotechnical visions. It showed how these values can be tracked in text archives to analyze the changing evaluations of an emerging technology (nuclear technology in France) over time, as this technology gained a foothold and became widely—or least more widely—adopted. The current chapter delivers a more theoretical reflection on the role of values in visions and, furthermore, investigates the differences between values and ideals in visions. This chapter examines an important aspect of energy history and policy: the intertwinement of energy technologies with ideals. It argues that ideals play an important role in energy visions and innovation pathways. In this way **it contributes to further answering RQ2 about the function of values in sociotechnical visions.**

Aspirations to realize technical, social, and political ideals indicate a long-term commitment in the design of energy systems, distinguishable from commitment to other abstract goals, such as values. This chapter offers an analytical scheme that could help to conceptualize these differences and their impact on sociotechnical developments. In the proposed model, two spheres of interaction are highlighted: a material sphere in which values and technologies co-evolve, and an imaginary sphere in which ideals interact with idealized technologies. The relation between these two spheres can be understood in different ways. This chapter examines three cases that are illustrative of the different roles of ideals in the development of energy technologies and visions: (1) the evolution of safety in nuclear reactor design; (2) visions of atomic power in France; (3) the political idealization of a tidal power scheme in the Severn Estuary.

Again, the focus on values and ideals is here (mostly) sociological. However, empirical analyses play a less important role in this chapter. Furthermore, in the treatment of values and ideals, I argue for a substantive difference in how these moral objectives function.   While this argument stays close to colloquial uses of the terms 'value' and 'ideal'—i.e., what is important vs.

what is perfect—I make a more rigorous claim about the long-term guidance of ideals that steers away from a purely sociological view on ideals. Rather, my emphasis is that ideals should inform innovation processes without becoming too attached to/intertwined with specific projects. By distinguishing between the political feasibility and techno-economic feasibility, **this chapter also makes a contribution to answering RQ 3 about the feasibility of visions.**

Chapter 3

Analyzing the Role of Values and Ideals in the Development of Energy Systems

How Values, their Idealizations, and Technologies Shape Political Decision-Making

3.1   Introduction[15]

The cultural history of energy (systems) is rife with ideals and utopian visions that have become connected to emerging technologies for the generation, distribution, and storage of energy. Historians have shown how the electrification of America at the turn of the 20th century was more than a technological transformation (e.g., Hughes, 1993; Granovetter & McGuire, 1998). This electrification was informed by diverse normative visions of new, idealized ways of living made possible by electricity (Nye, 1997).

Alternatively, changes in energy systems can also inspire nostalgic, idealized versions of the past. Limmer and Zumbrägel (2020) discuss how innovations in hydropower in Germany led to a romantic idealization of the 'dying waterwheel' as emblematic of pre-industrial means of energy use. Hanel and Hård (2015) argue that nostalgic sentiments regarding heavy-water reactors in both Sweden and former West Germany in the 1960s and 70s delayed the adoption of the more efficient light-water reactor through an appeal to an idealized 'nuclear tradition'.

The idealization of past and future states of affairs, made possible by energy technologies, can take many forms. This study focuses on the idealization of *future* states of affairs related to the development of energy systems through the adoption and persistence of a certain type of moral goals: ideals. It shows that the pursuit of these ideals through technological innovation can have both a positive and negative impact on the development of energy systems.

In brief, the emergence of these ideals can be sketched as follows: First, the history of energy systems shows how emerging and existing elements of these systems create new, morally problematic situations. This means that actors, through their engagement with energy systems, encounter situations in which previous moral responses no longer work. Second, these actors

might then start to create new norms, practices and values to cope with these situations. For instance, Mitchell (2011) shows how, over time, social justice and equality concerns emerged in the coal mines of northern France. More recently, the transition to renewable energy resources has been related to concerns for ecological sustainability and intergenerational justice raised by fossil fuel use (van de Poel & Taebi, 2022). Third, problematic situations might also lead to the adoption of new ideals. This happens when values come to be seen as absolute, universal, and uncompromisable, turning these values into often infeasible principles of moral conduct and engineering design.

Thus, morally problematic situations, encountered in the operation and development of energy systems, may lead to the adoption of new energy practices, new values and ideals. The latter two are here both understood as abstract moral goals, but ideals are distinguished from values in the sense that they are uncompromisable goals for which their feasibility is not a concern. Ideals may thus be seen as idealized values (see section 2). Often, around ideals what I call **utopian visions** are formed. These visions offer a blueprint for the 'realization' of a certain ideal, showing the sociotechnical configuration that allegedly realizes the ideal. In the case of energy, I argue, these visions often rely on (promising) technologies that seem to enable energy systems to become perfectly safe, perfectly just, perfectly secure. These technologies, then, become idealized themselves.

Sometimes, these utopian visions include the type of monumental projects that seemingly realize a perennial ideal in one stroke. The history of energy offers many examples of such utopian plans addressing morally problematic situations, but failing to materialize. Hermann Sörgel's Atlantropa project (1932), for instance, envisaged a hydro-electric dam across the Strait of Gibraltar, solving Europe's electricity needs while, at the same time, unifying Europe's belligerent states (Gall, 1998; 2006). The Qattara depression hydropower project (approx. 1930) in the desert of Egypt proposed the inlet of seawater in a natural depression via a tunnel connecting to the Mediterranean Sea (or, alternatively, to the Nile). The project was again

discussed as important for realizing Egypt's 2030 plan for clean energy while also cultivating the area (Elsayed & Ismaeel, 2019). However, researchers have pointed out its negative environmental effects, as well as its costs compared to other clean electricity solutions—such doubts in fact go back to 1982 (Ibrahim, 1982).

Another such hydropower project is analysed in this study. I discuss a large tidal power project proposed in the Severn Estuary between Wales and South-West England. A tidal barrage for energy generation in this estuary has been discussed since the 1880s, but has never materialized. In this tidal power project, a persistent political ideal allegedly comes within reach through a single project. However, once the feasibility of the project is considered from other perspectives, such as environmental effects, costs, and social consequences (e.g., displacements, job losses, loss of cultural heritage) doubts ensue. Consequently, the project loses much of its appeal though not necessarily its political support (Gall, 2006).

Such cases show that ideals have played an important role in the history of energy, helping to understand why, for instance, technological projects do not lose their political attraction, regardless of their techno-economic feasibility. However, despite a wealth in historical examples, the relation between ideals, values, and technologies needs more analysis. This study provides such an analysis. It proposes a new model to understand how ideals, values, and technologies interrelate in the development of energy systems. This model helps in understanding the complex interaction between political discourse, visions, and constraints as they develop over time. As illustrations of specific aspects of this model, this study presents three cases: 1. The evolution of safety in engineering design, with a focus on design for safety in nuclear reactors. 2. The role of ideals in the development of nuclear technologies in France; showing how utopian visions of a future France impacted design decisions. 3. The aforementioned analysis of the Severn Barrage tidal power scheme.

Through these examples, this study provides more general insights into the role of ideals in the development of sociotechnical systems. Amongst others, it shows how (once) promising technological projects could become entangled with certain ideals in political discourse, making it difficult to relinquish these projects. In this entanglement, it can become difficult to distinguish socio-political ends from technological means. The Severn Barrage tidal power scheme is presented as an example of this entanglement.

Section 2, 3 and 4 elaborate on the role of values and ideals, and the distinction between them, in engineering design and the development of energy systems. Sections 5 and 6 focus on ideals in the development of nuclear technologies and further develop the proposed model. Section 7 discusses the Severn Barrage tidal power scheme. Section 8 and 9 provide the discussion and conclusion.

3.2   Ideals and Values in Energy Systems

Over the last decades, a wide range of approaches has been proposed to capture the way moral considerations influence the design of technologies, the choice of certain technological and scientific projects, and the selection of innovation pathways. The Value Sensitive Design [VSD] literature, for instance, investigates how salient ethical values can be embedded in technological artefacts (Friedman, 1996; van de Poel, 2009). Research into technological mediation traces how technology mediates the relation between humans and their lifeworld, leading to new moral considerations, and eliminating others (Verbeek, 2006). Furthermore, literature in Science and Technology Studies has used the notion of the 'sociotechnical imaginary' to explore the role of collective conceptions of the good life in the development of sociotechnical systems (Jasanoff & Kim 2009; 2013), systems in which humans and technical elements conduct goal-oriented behaviour, thus providing a social good (Walker et al., 2008). Research into these sociotechnical imaginaries offers an analysis of how anticipatory

discussions of possible and desirable futures determine specific policy decisions in the present (Stilgoe et al., 2020).

Despite the interest in idealized technologies and technological utopias, or 'technotopias', ideals can be difficult to conceptualize and distinguish from other abstract goals, such as values (Coady, 2008). Following Van de Poel's (2009) account of values in engineering design, this study takes ideals to refer to stable goals that transcend specific situations as well (see table 7). Indeed, stability and abstractness are shared characteristics of values and ideals. Furthermore, values might start to function as ideals over time, and vice versa. Likewise, what is considered 'utopian' might differ over time and place. However, ideals are uncompromisable and often unfeasible, whereas values are not (Rescher, 1987). This has implications for how values and ideals function in engineering design and innovation.

Value	Stable, abstract goal transcending specific situations, while at the same time specifying the variety of 'goodness' of certain states-of-affairs, such as a sustainable home or a safe car.
Ideal	Stable and uncompromisable abstract goal for which its feasibility is not a concern; often appearing in the form of a (universal) principle for action, or a perfect state-of-affairs, such as an ideal body, or an ideal society.
Vision	Blueprint for the future realization of a value or ideal, showing which institutions to create, which technologies to embrace.
Utopia	Blueprint of a future society in which an ideal or set of ideals is realized: a perfectly just/free/autonomous/healthy society; often based on the embrace of a specific set of technologies.
Energy Utopia	Blueprint of a future state of the energy system in which (a set of) energy ideals are fully met in the design of material (technological) and immaterial (institutional) aspects of the energy system.

Table 7: Definition of terms

Notwithstanding the vagueness of the boundary between ideals and values, in the case of engineering design, we are able to make a distinction between them: because of their uncompromisable character, ideals do not 'materialize' in technological artefacts in the manner that values can. Ideals are by definition not completely feasible and therefore can never be fully realized in a certain design. This means that ideals are instructive for innovation trajectories, but cannot become embedded in specific technological artefacts and systems. Because of their unfeasibility, engineers do not have the possibility of translating ideals into (realistic) design requirements for specific technologies, like they do for values—as the VSD-literature proposes (van de Poel, 2013). Ideals will never be fully realized because of the concessions engineers and designers need to make while designing for certain salient values. Instead, because ideals motivate and orient actors in their decisions, we can find them in visions of the future, especially as these visions are often 'encoded and decoded as utopias and dystopias' (Berkhout, 2006). Striving to realize these ideals would then have an impact on the kind of decisions made concerning the design of energy systems, as the coming sections makes clear.

3.3   Ideals and Energy Visions

Ideals have been extensively discussed in political philosophy. In these discussions, certain social ideals, such as ideal justice, motivate institutional change (e.g., Rawls, 1971; Gaus, 2016; Estlund, 2019). Questions of feasibility do play an important role in these debates. For instance, Rawls (1971) calls his vision of a just society, achieved through institutional reform, a 'realistic utopia', emphasizing the tension between political hope and realistic ambition.

In discussions of visions for the development of sociotechnical systems, existing literature seems to refrain from *explicitly* addressing the impact and function of ideals, as well as the question of feasibility. It is unclear, for

instance, to what extent Jasanoff and Kim's (2009; 2013) sociotechnical imaginary has ideal or utopian aspects. The good life that a society collectively aspires to—as a desirable future that shapes and supports national technoscientific trajectories—might very well be imaginable but hardly feasible. Jasanoff and Kim seem to give no answer to the question what happens when the pursuit of collective ideals is in fact hampered by the technoscientific projects that are collectively chosen on the basis of these ideals. Furthermore, these imaginaries might differ in degree of their feasibility, and might differ in the degree to which the abstract goals around which these imaginaries are formed, are compromisable. A certain vision of social order might, over time, prove unfeasible. One could then either abandon it, and adopt alternative imaginaries, or continue pursuing it.

One might also intentionally develop an unrealistic collective vision of a desirable future (an abstract 'moonshot'), as a long-term navigational tool to inform decision-making regarding social and technological issues.[16] Such, some authors claim, is the role of ideal justice (Rawls, 1971; Estlund, 2019).[17] Figure 19 shows this navigational function. The Ideal State of Affairs [ISoA] is needed to decide upon the right course of action in Intermittent States of Affairs [Intermittent SoA]. A thought experiment is used to arrive at a set of shared principles of justice that form the basis for an ideal institutional configuration in the ISoA. This ISoA, as utopian vision, then informs decision-making at critical junctions on the road to a fully just society (see figure 19). At each junction, therefore, a teleological evaluation is made in which the absolute end-goal determines the rightness of the decision—and the actions proceeding from it.

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[16] See, for instance, Mazzucato's *Mission Economy* (2021).

[17] Rawls and Estlund focus on social issues only. In my opinion, this navigational function of ideals can be extended to innovation trajectories of technologies and the energy system at large. I develop my arguments for this position in the coming sections.

We might similarly perceive the role of ideals in other processes of decision-making, e.g., political decisions concerning the future of an energy system or design decisions made by engineers. In these cases, the formulated abstract ambition functions as a long-term beacon, deciding the choice of technologies, materials, etc. The ideal can be a moral principle, one that actors know they cannot always comply with in their actions (such as principles of ideal justice, ideal safety, etc.), or a utopian vision of a future state of affairs in which these limitations have disappeared. In these cases, the role of ideals in engineering design is teleological, rather than evolutionary and adaptive—as I see the role of values. These different roles are further developed in the next sections.
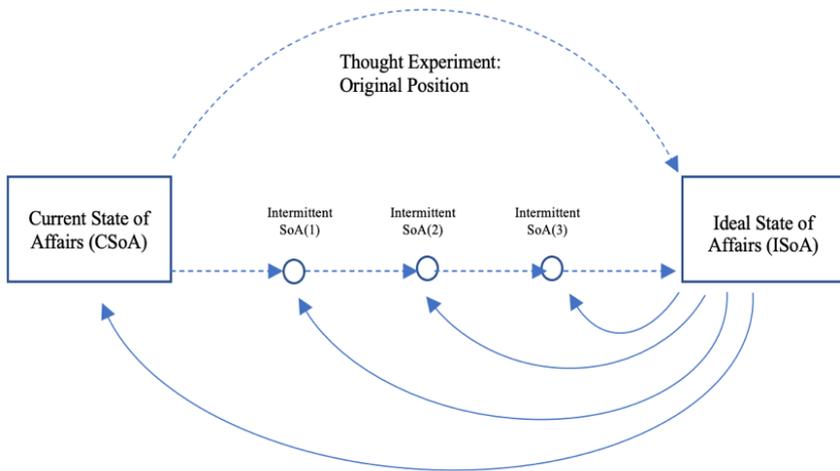

Figure 19: The creation and function of ideal justice

3.4   Ideals and Engineering Design

Moral ideals often come in the form of universal principles for action. They are, in a normative sense, 'conceptions of genuine perfection' (Brownlee, 2009, p. 434) that concern the performance of ourselves as agents, of our

institutions, or of our technologies.[18] Holding on to such guiding principles (e.g., to never lie, never hurt an animal, to build a completely sustainable economy or a completely just society) might come with considerable effort and costs, while on a personal level, attaining perfection might not always be desirable (Wolf, 1982). Still, on a societal level, benefits could result from adopting these principles, even if they are often impossible, impractical, and unachievable (Rescher, 1987). First, benefits result from the presumed navigational function of ideals. For some authors, ideals facilitate the comparison of possibilities in the present with regards to their proximity to a formulated ideal.[19] Second, according to most definitions ideals aim for the absolute (Rescher, 1987; Rawls, 1971; Nozick, 1993). This means an ideal, as end goal, surpasses the merely feasible, understood as what actors can achieve given historical, local, physical, biological and social or psychological constraints. An ideal, therefore, challenges actors to perform to the limit of their abilities (e.g., Rescher, 1987).

Despite their unfeasibility, societies strive to 'realize', or at least to approach, moral ideals. This means the ideal is collectively recognized as desirable, while its full realization requires a level of (human) perfection that is highly unlikely to be achieved. There seem to be two reasons why actors may not be able to comply with an ideal as moral principle in their actions. On the one hand, there could be external obstacles that inhibit them from following the moral principle. This means they perceive themselves as unable to act in accordance with the principle. On the other hand, we can think of internal obstacles that cause social agents to make an exception in certain situations. In this case they perceive themselves as unable to will the act in accordance with the principle.[20] Both forms of inhibition are no longer present in a

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[18] Whereas aesthetic ideals concern the perfect form.

[19] This is an important issue in the contemporary debate about the use, if any, for Rawls' ideal justice. See, for instance, Sen (2009), Valentini (2012), Cohen (2009), Gaus (2016), Estlund (2019), amongst others.

[20] This can be seen as a second form of inability, namely, something that seems to be against the 'nature' of a social agent, or against the 'deepest features of human psychology' (Valentini, 2012, p. 660). Estlund (2011) calls this 'limits to what humans

utopian vision, all agents are assumed to be able and willing. At that moment the principle truly becomes a universal moral law, and exceptions no longer exist.

In the meantime, before this realization, visions help in navigating real-world situations of imperfection. As Gaus (2016) argues, holding on to ideals would mean striving for an absolute optimum, instead of a local one.[21] A local optimum occurs when goals are realized in conjunction with other, and often incompatible, goals. An absolute optimum occurs when such a goal is an ideal, and no longer in competition with other goals. This ideal helps societies distinguish between local and absolute optima while they navigate political, technological, and technopolitical landscapes and futures.[22] At the same time, as a navigational tool, it makes sense to require from an ideal an accompanying, and detailed, itinerary how to achieve it (see figure 20).

Taking the presumed comparative function of ideals into account for innovation trajectories, another important difference emerges between values and ideals in engineering design. Approaches such as design for values offer an evolutionary, adaptive perspective on design, in which value conflicts (e.g., between security and privacy, sustainability and safety) are seen as issues that can be resolved, amongst other strategies, through innovation (van de Poel, 2009; 2015; van den Hoven et al., 2012). An absolute end-goal is missing. Innovation processes might stop when an acceptable solution to a value conflict is achieved.

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will be able to muster the will to do' (p. 207) despite their recognition of the desirability of the action.

[21] Gaus, however, follows Sen (2009) in developing a strong criticism of the possibility of comparative judgment based on the ideal.

[22] In line with previous and classic discussions of ideals as navigational tools, I stick here to the motif of the voyage towards utopia (Gaus, 2016).
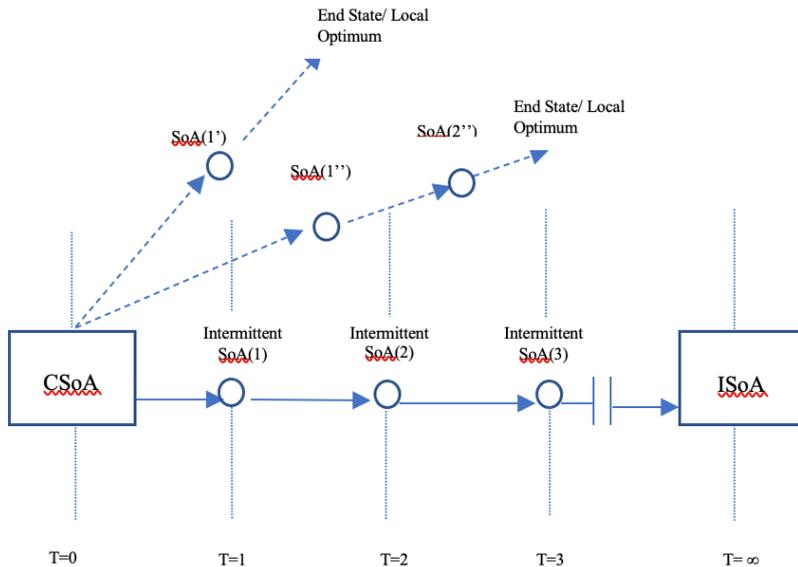
Figure 4: The navigational function of ideals, showing us the way from a current state of affairs (CSoA) towards absolute (ISoA), instead of local optima (dashed lines, indicating innovation trajectories without ISoA's)

Holding on to ideals has consequences for the way we innovate in engineering design. Again, I use Gaus' (2016) distinction between local and absolute optima to make this clear. In technological innovation, I argue that a local optimum occurs through incremental change to realize a certain salient value, such as safety or privacy, taking into account material and other constraints (see figure 21, left-hand side).

Designing to incorporate a certain value, means to maximize it given the circumstances. We can also imagine achieving in design a minimal, required 'threshold' level for a certain value, as outlined in the VSD-literature.[23] This

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[23] When addressing safety as an engineering value, we ask the question: *How can we maximize a value given material, social, and epistemic constraints, and given possible conflicts with other values we seek to maximize?* This means that we expect value

idea of design we could understand as an evolutionary process of adaptation to new circumstances, such as new societal demands or higher threshold levels. As ideal, however, we envision an absolute realization of a certain goal, an absolute optimum, without having to compromise the goal given the demands of other values and goals with which it might be in conflict (see figure 21). This process is teleological, meaning that the often unfeasible end-point is clear from the start.
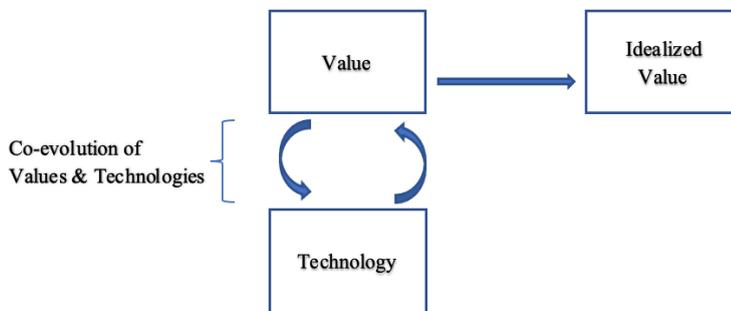
Figure 21: Distinguishing values from ideals in technology design

A technology that is imagined to fully realize an ideal, we could call 'an idealized' technology. Such a technology is therefore envisioned, but never realized. The result of the interaction between an ideal and an idealized technology, I refer to as an (technical) utopia[24], showing in what (sociotechnical) configuration a certain ideal, or set of ideals, will be achieved. This rudimentary distinction is shown in figure 22. Furthermore, the dashed line in figure 22 indicates a possible influence of the idealized

trade-offs and set value thresholds (van de Poel, 2009), such as minimum safety levels.

[24] Evidently, utopia can be defined in many ways. Although often meaning 'ideal society', or 'ideal community', I here take it to refer to certain kind of visions, in which a blueprint is available for achieving a certain ideal in a certain society (Rawls, 1971; Gaus, 2016). In cases that this blueprint relies on a specific energy technology or project, we could call such a utopian vision a technical utopia, or energy utopia.

technology on the idealized value. I will return to this possibility in sections 8 and 9.
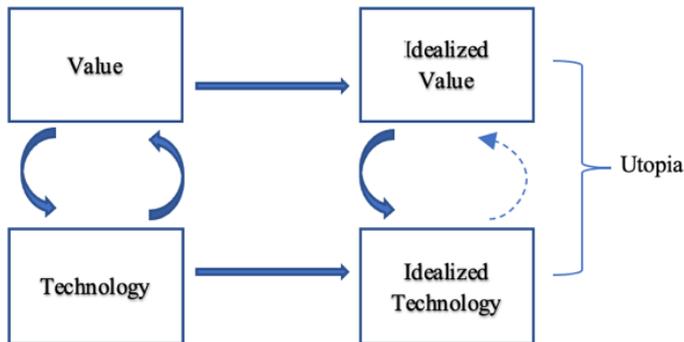
Figure 22: Utopian configuration in technology design

3.5   Inherent safety in reactor design

As an illustration of figure 21 and 22, I provide an analysis of the evolution of safety in the design of nuclear reactors. Although the idealization of safety in reactor design is contested, this section argues that, at least from a political and public perspective, safety started to function as an ideal in discussions of nuclear technologies in the 1990s. This analysis, furthermore, highlights that thinking in an idealistic vein had (radical) implications for reactor design. As an ideal, inherent safety had a clear political and public function, attesting to an absolute, political commitment to this ideal. However, it is less evident that the ideal continues to be pursued through reactor design.

At first safety functioned as a value amongst other values in reactor design, such as sustainability, security, and economic viability (see figure 21, left-hand side). The first safety approaches entailed what was later called 'active safety', the value of safety was supported by active involvement of an

operator monitoring processes to impede a reactor core meltdown (Taebi & Kloosterman, 2015). Hazards needed to be controlled through this active involvement. Increasing active safety meant adding more monitoring systems, further complicating the role of the operator of nuclear power plants. Furthermore, reactor safety was an incremental objective: an aspiration to achieve a local optimum (see figure 20), given the then existent particulars of the Light Water Reactor-design, and given the restraints the realization of conflicting values put on reactor safety (Taebi & Kloosterman, 2015).

This situation, however, changed drastically with the occurrence of the first nuclear accidents, most notably the one in Three Mile Island (1979) and Chernobyl (1986). These accidents made safety a public priority in Generation II reactors (1965 – 1996). The rationale was that existing Generation II reactors needed to be made much safer. Furthermore, with the anticipated growth of nuclear energy—referred to as the 'nuclear renaissance'—the occurrence of nuclear accidents and incidents was likely to rise too. In the 1980s, estimations of the number of reactors in the 1990s exceeded 5000, which was a tenfold of the operational reactors at that moment (Taebi & Kloosterman, 2015).[25] This meant acceptable levels of safety as stipulated in public policy back then (1 serious nuclear accident per 10.000 reactor years, or years of reactor operation), prior to the 1980s, were no longer deemed sufficient: with ca. 500 reactors globally, that meant about 1 accident every 20 years. With the possibility of 5000 reactors in full operation, the likelihood of an accident would become about ten times higher; this meant the possibility of a serious accident every two years. Higher levels of safety were, however, difficult to achieve through the existing safety regime: active safety. Adding even more complex systems,

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[25] This projection proved highly exaggerated. At the beginning of the 1990s, approx. 420 reactors were in operation (Statista Research Department, 2022) compared to approx. 250 in 1980 (Char & Csik, 1987). The latest IAEA-report of May 2022, counts 439 operational reactors. This means the original, acceptable safety level of $1/10^4$ reactor years would entail, grosso modo, 1 serious reactor accident every 20 years.

more back-up generators, redundant pumps etc. would on the one hand increase safety but the complexity could also contribute to decreasing safety. A (local) optimum had been achieved that proved to be unacceptable. Existing safety regimes needed to be reconsidered.

Passive safety emerged in the 1990s as a new and complementary understanding of safety in reactor design, because of the aforementioned concerns with active safety. This new understanding meant designed safety features of reactors often became based on natural forces, such as gravity (INSAG-3; INSAG-5, 1992; Juhn, Kupitz, Cleveland, Cho, & Lyon, 2000). The use of these natural forces meant that safety was less dependent on active intervention by system operators or by pumps that required external power (Juhn et al., 2000). Passive safety features also reduced complexity, resulting in considerably safer reactors, reducing the probability of an accident. This probability was now estimated as lying in between 100,000 and a million reactor years, depending on the type and magnitude of the accident (IAEA, 1992). Both active and passive safety, however, continued to be considered in relation to other values, such as output reliability, security, economic viability, and ease of maintenance (Juhn, et al., 2000; INSAG-5). Furthermore, improvements in safety were seen as 'evolutionary' (INSAG-5), or adaptive, rather than teleological, as would be the case with the pursuit of safety as an uncompromisable ideal. INSAG-5 attests to the limits of this evolutionary approach, stating:

> There seems to be a limit to the benefits to be gained from evolutionary improvement of current designs. Three main factors set the basis for this limitation. These are: human factors in operation, the complexity of plants and limits on the benefit from confinement systems. (INSAG-5, p.50)

Inherent safety emerged from a new safety philosophy, a new way of thinking about safety. It is often conceptualized as an ideal (figure 21, right-hand side). In these articulations, inherent safety concerns the elimination of **all inherent hazards** instead of controlling them (IAEA, 1991; Kletz, 1978; Kletz

& Amyotte, 2019).[26] Instead of accepting that hazards are inevitable, and seeking solutions to reduce their probability or to mitigate their negative effects, the hazard should be completely removed. This elimination could only be 'achieved' through substantial changes in the reactor design; it often meant that a design from scratch needed to be proposed with inherent safety as the leading principle (Taebi & Kloosterman, 2015).

However, different interpretations of inherent safety were developed over time. In some of these accounts inherent safety functioned as a value, in others as an ideal.[27] For instance, Weinberg (1985) does not equate inherent safety with absolute safety or a fail-safe design, but with passive safety. Even inherently safe reactors may suffer from accidents, in the range of once every 10^9 reactor years (Core Melt Probability) (Weinberg 1985; Spiewak & Weinberg, 1985; van de Poel, 1988). Despite functioning as a guiding principle for reactor design (van de Poel, 2003), the principle of inherent safety thus conceived is not an ideal. The IAEA, on the contrary, defined inherent safety as 'equivalent to absolute safety; i.e., an inherent safety characteristic is not subject to failure of any kind. Stated another way, an inherent safety feature represents conclusive, or deterministic safety, not

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[26] 'Inherent Safety refers to the achievement of safety through the elimination or exclusion of inherent hazards through the fundamental conceptual design choices made for the nuclear plant. Potential inherent hazards in a nuclear power plant include radioactive fission products and their associated decay heat, excess reactivity and its associated potential for power excursions, and energy releases due to high temperatures, high pressures and energetic chemical reactions. Elimination of all these hazards is required to make a nuclear power plant inherently safe. For practical power reactor sizes this appears to be impossible. Therefore the unqualified use of 'inherently safe' should be avoided for an entire nuclear power plant or its reactor.' (IAEA, 1991)

[27] Mårtensson (1992) discusses four interpretations of inherent safety: '[1] One inherent risk factor would be eliminated; [2] At least one very important inherent risk factor would be eliminated; [3] All of the very important inherent risk factors would be eliminated; [4] All inherent safety hazards would be eliminated.' (p.668) Only the last of these interpretations is an absolute, unfeasible principle that we could consider an ideal for reactor design.

probabilistic safety' (1991, p.10). But, for the IAEA, only components of reactors can be inherently safe, not reactors themselves, thereby undermining the aim of a new design approach for the reactor as a whole (van de Poel, 1998). To the public, furthermore, proponents of nuclear energy presented inherent safety as an ideal pursued in reactor design, especially in the 1990s (Barkenbus, 1988; Mårtensson, 1992; van de Poel, 1998). The inherently safe reactor was proposed as a technological solution to a political problem (Barkenbus, 1988). Researchers have focused on the public acceptability of nuclear risks (Barkenbus, 1988; Mårtensson, 1992; Adamov et al., 2015). In these accounts, inherent safety concerns the elimination of **all socially unacceptable** and therefore 'important' hazards.

Design for inherent safety was effective in redirecting technological development and changing the technological regime in reactor design. However, while an inherently safe reactor can be designed that cannot melt down, it is not inherently safe against other hazards and risks such as the risk of large scale radiation leakage. As public ideal, inherent safety cannot be achieved, since it is impossible to remove all hazards through nuclear reactor design. For that reason, Kletz and Amyotte (2019) instead discuss 'inherently safer designs', in which the 4 principles of inherent safety for chemical plants—intensification, substitution, moderation, and simplification—have been applied to *minimize* known hazards.[28] Furthermore, not all accidents can always be anticipated, leading to the occurrence of 'normal accidents' as Charles Perrow (1999) calls them.

The extent to which inherent safety continues to function as a guiding ideal in the design of nuclear reactors, while having fundamentally altered the conceptualization of safety in this field, is therefore contested. While certainly presented as an ideal in public discussions of nuclear energy—as uncompromisable, absolute, and guiding long-term innovation

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[28] 'Note that we use the term inherently safer, not inherently safe, as we cannot avoid every hazard.' (Kletz & Amyotte, 2019, p. 368)

trajectories—especially in the 1990s, it is unclear how and to what extent engineers continue to embrace inherent safety as an engineering ideal.

3.6   The role of ideals in visions of energy system development

The previous section has shown how the adoption of an ideal can lead to a radical rethinking of (reactor) design. On a larger scale, ideals can also impact the design and development strategies of energy systems. These strategies often rely on visions to make them socially and politically viable (Trutnevyte, 2014; Ziegler, 1991; Van der Helm, 2009). As they define some future state of the energy system, these energy visions can become utopian. Berkhout (2006) argues that visions are characterized by expressed objectives, suggested technologies, and are representative of a social order. Once the expressed objectives and required technological performance move further away from what is currently deemed possible, the vision starts to become utopian. In the case of far-reaching visions for energy systems, we can speak of energy utopias.

A clear example of such a utopian vision, we find in France, in the aftermath of WW2. This vision concerned the development of a nuclear energy system. The state agency that led the nuclear research program, the Commissariat à l'Énergie Atomique [CEA], created in 1945, envisioned a nation that would be completely sovereign, dominant in the geopolitical order, and self-sufficient in terms of energy generation, thus aligning energy policy with foreign policy (Hecht, 2009). Nuclear technologies (for both civilian and military purposes) were deemed quintessential for the realization of this utopian vision (see fig. 6). This is what we could call an 'energy utopia', since it idealizes a future state of affairs to be brought about by radical changes in the energy system, through idealized new technologies, and the goals that are achieved through it. As Hecht (2009) sees it, 'They [the technologists] agreed on the ideal of a technologically radiant France, but they did not necessarily agree on the best route toward that ideal' (p. 53).

The CEA's vision of a radiant, nuclear France, however, did form a blueprint of a future society based on a radical redesign of its energy system. The blueprint was meant to convince French citizens of the necessity of nuclear energy and motivate short-term sacrifices in exchange for long-term gains (Hecht, 2009). Furthermore, in a political sense, the utopian vision led to specific technological choices in which three political and uncompromisable ideals (sovereignty, Frenchness[29], and technological prowess) consistently trumped values such as efficiency, and economic viability (Hecht, 1996; Hecht, 2009; Scheinman, 2015). At least, in the design decisions of the CEA, the state agency that dominated decision-making concerning the development of nuclear technologies until the late 1950s (Hecht, 2009).[30]

The decisions through which this utopian vision of nuclear proliferation was pursued include: the choice to build homemade reactors (gas cooled, using natural uranium) instead of importing North-American technologies, that ran on enriched uranium, which would have to be imported as well; the choice to have a closed fuel cycle that would allow for hosting facilities to produce weapons-grade plutonium; the construction of a costly loading system that wouldn't require a shutdown of the reactor during loading and unloading enabling a fast extraction of plutonium; the decision not to optimize reactor design for goals such as electricity production or cost-effectiveness (Hecht, 2009).

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[29] Although I suggest Frenchness here as an ideal pursued in the design of nuclear technologies, what actually constituted this ideal, French identity, was something discovered and created through this design, rather than being a fixed goal from the beginning (Hecht, 1988). 'Technology and Frenchness would shape each other' (ibid, p. 52).

[30] I cannot here further analyze the competing technopolitical regimes regarding atomic power that emerged in post-WW 2 France in the late 1950s. The Électricité de France, erected in 1946, focused on economic calculations, costs per Kwh, in their competitive reactor design. The 'war of the systems' (Hecht, 2009) ended in the late 1960s/beginning 70s.

These decisions made in the early stages of the French nuclear program show the pursuit of a utopian vision through design decisions of nuclear technologies. It is beyond the scope of this paper to analyse to what extent these ideals have been followed in the design of nuclear technologies, policies, and strategies in France while it was confronted with geopolitical events, nuclear disasters, and political conflict (see, for instance, Scheinman, 2015; Pelopidas, 2012; 2019, Jurgensen & Mongin, 2018). That is, this paper cannot give a detailed account of the abandonment of the utopian vision of the CEA.

However, some observations can be made. First, the return of De Gaulle as head of state, in 1958, meant that the CEA lost some of its independence. This meant that 'conducting nuclear technopolitics now involved more than embedding pre-existing political goals into technological artifacts' (Hecht, 2009, p.91). Second, the competing vision and corresponding reactor design of the Électricité de France [EDF] won 'the war of the systems' (Hecht, 2009). This design was focused on a wider range of goals, related to the industrial and commercial application of nuclear technologies. In other words, the utopian vision of the CEA was replaced with the more pragmatic vision of the EDF (Scheinman, 2015). Third, national sovereignty over time became a problematic ideal in the case of nuclear energy production, that required international agreements and international control (Taebi & Mayer, 2017). Fourth, recent struggles in Mali and Niger have shown that uranium isn't a conflict-free resource (Keenan, 2008; Filippov; 2015), and the ideal of energy sovereignty is liable to geopolitical changes and post-colonial struggles.

Therefore, despite the continued possibility of an unconditional pursuit of the aforementioned ideals from the perspective of engineering design, a design which would continue the vision of the CEA, politically this pursuit was no longer desirable. As absolute goals, these ideals became politically compromised, and started to function as values instead. Concessions therefore became necessary, value trade-offs occurred.

3.7   The Severn Barrage

The previous two sections have focused on the productive force of ideals in engineering design and the development of energy systems. In contrast to the last section, that focused on the political abandonment of certain ideals despite their successful guidance in engineering design, this section shows an opposite process: the political pursuit of ideals through a politically idealized technological project, in which these ideals have no productive impact on engineering design.

Wave and tidal power have gained considerable interest in the UK as a stable renewable energy source. However, hardly any projects make it beyond the pilot stage. One project in particular stands out in terms of political commitment, research funds, and academic discussion: the Severn Barrage, a proposed tidal power barrier in the Severn Estuary, between Wales and the South-West of England. Interest in this barrage started in the 1880s already, but really took off in the middle of the 1970s, after the first Oil Shock. Since the 1980s, at least six feasibility studies have investigated electricity output, costs and a wide range of possible effects of this barrage, as well as its most favourable location in the Severn. Despite this continued political interest, the barrage was never realized.

Political procrastination in the UK regarding large infrastructure projects has gathered considerable academic attention. We can, therefore, give several possible explanations for this persistent political focus on the large tidal power scheme in the Severn, despite its apparent techno-economic infeasibility. First, some authors (e.g., Lijphart, 2012; Watson, 1992) have stressed the adversarial character of the Westminster, majoritarian model of government as a possible source. This model leads to competition and conflict. It is a 'free-for-all pluralism' (Lijphart, 2012), that doesn't motivate coordination and cooperation. Second, Keay (2016) has suggested the UK is stuck in ideological limbo, as far as its energy policies are concerned. Third, an escalation of commitment might explain the persistence of this paper project. The political fixation on a project could occur because politicians are

unable to accept the failure of a project, because they are too invested in it (Maxwell et al., 1997). It is possible that politicians have connected their reputation to this project, and perceive abandonment of the project as 'ego-threat' (Zhang & Baumeister, 2006).

Without denying the relevance of the aforementioned factors, I propose another perspective for the persistence of the Severn Barrage, as part of a far-reaching vison, an energy utopia. While no final decision on the barrage was made in the period of 1981-2014, 'tidal power' and the 'Severn Barrage' were mentioned approximately 2000 times (table 8), in 378 separate debates in the House of Commons and House of Lords (hansard.parliament.uk).[31] This continued political attention led to six consecutive feasibility studies that were unable to form final conclusions. Nor did consecutive UK governments draw them. The project was not abandoned, despite consistent findings that tidal power in the Severn, in its 'current' form, would not be able to compete with nuclear or wind energy in terms of costs per kWh (DECC, 2009; DBER, 2008; SDC, 2007). Despite an apparent technological infeasibility, political support continued. This support was partly grounded in the conclusions of each feasibility study, which repeatedly stated that changing external circumstances and innovation efforts might, one day, tilt the balance in favour of the Barrage.

Term	Wordcount
Severn	1078
Barrage	430
Severn Barrage	1445
Tidal	1731
Tidal Power	606

Table 8: Word count Hansard archive

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[31] The archive at hansard.parliament.uk allows for a keyword search.

Concluding, the interpretation this section proposes of the failure to make a final political decision concerning the Severn Barrage is the persistence of tidal power as part of an utopian energy vision connected to a range of ideals which were upheld in some corners of British parliament. While these ideals were unrealistic and unfeasible, they could persist as ideals because a lack of realization is often not an argument against holding certain ideals, as section 2 and 3 have made clear.

In a nutshell, these ideals led to aspirations and commitments regarding the Severn Barrage that the project was unable to fulfil and politicians were unable to discard. In this perspective, furthermore, the Severn Barrage itself seemed to serve as the blueprint for the realization of these ideals, as a *necessary* milestone. In this reading, abandonment of the Barrage, would also mean an abandonment of cherished political ideals, as means (technologies) and ends (ideals) became confused.

3.8   Discussion

The three case studies indicate that the role of ideals in energy policy is multifarious. Ideals can have both a positive and negative impact on the development of energy systems. As a result of the three cases discussed, figure 23 presents 2 spheres of interaction: an imaginary sphere of energy policy, and the material sphere of engineering design. This figure represents what a (energy) vision does, in which certain salient values - in the current, engineering context still compromised by other goals and restraints - become idealized. Unfeasible standards and principles infuse future visions and become part of a utopia once they get linked to specific technological arrangements. These technologies can be already existent, or only imagined (such as certain geo-engineering technologies). In either case, these technologies are idealized as well; that is, functioning in full service of utopia,

'realizing' the ideals.[32] Finally, this utopian blueprint of a future society can lead to the creation of a specific innovation trajectory (a pathway) that specifies how a technology can become what it should be.[33]
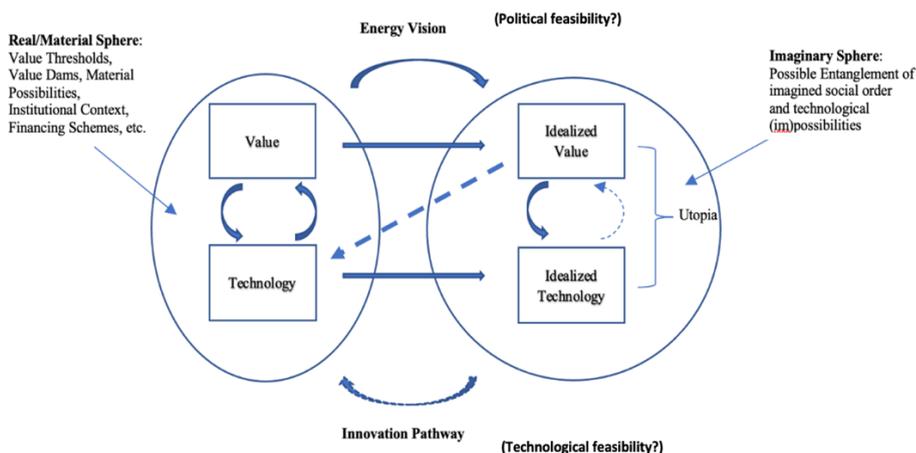
Figure 23: Innovation cycle in energy system development and/or transition

This updated model allows us to visualize a mechanism: A value could become more prominent over time (e.g., safety in reactor design, sustainability in energy systems, national energy sovereignty) and starts to be conceptualized as an ideal which affects idealizations of certain technologies (nuclear technologies, hydropower projects), or lead to a

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[32] We can think, for instance, of standards and principles formulated in the Energy Justice literature, most notably by Sovacool et al. (2016) in their *Energy Justice Decision-making Framework*: 'All people have a right to fairly access energy services', or 'All people should have access to high-quality information about energy and the environment, and fair, transparent and accountable forms of energy decision-making.' (p.5)

[33] Or, if thinking about not yet existing technologies, the kind of artefacts and systems we should be developing, the kind of R&D we should fund.

radical rethinking of technological regimes, such as in reactor design (dotted straight arrow). Secondly, while a vision formed around ideals and idealized technologies might affect the actual design of these technologies via an innovation pathway, the full realization of this vision remains technologically unfeasible. How actors react to this unfeasibility, determines whether or not the vision is abandoned. This reaction is possibly informed by the extent to which means and ends have become intertwined in utopian visions. If certain technologies and projects (means) are deemed necessary for the realization of one or more societal ideals (ends), the technology might replace the ideal as navigational beacon for innovation.

Two questions, furthermore, emerge. We can ask if the prioritization of a value, its idealization and henceforth uncompromisable character, is **politically feasible**. In this case, the question is whether we can 'onboard' all relevant stakeholders to accept the absolute, uncompromisable character of a certain abstract goal—an ideal. The other question concerns the possible formulation of an innovation pathway that leads to a sufficient approximation of an ideal. Are engineers able to use the vision **as determinative in their design decisions**?

3.9   Conclusion

This study adds to the growing body of literature regarding the role of visions, imaginaries and shared conceptions of 'the good life' in the development of sociotechnical systems. Ideals and utopian visions enable developments because they unite and mobilize actors around collective, and (potentially) unachievable, ends. Such ideals can guide thought and action on the levels of policy-making, engineering and public support.

However, this study also presents indications that, sometimes, idealized technological projects start to behave more and more like beacons themselves. They take over the navigational function of ideals. In some cases, this might not be problematic. In other cases, in which alternatives

exist, and changes in society fail to inform new visions, idealized technologies and projects can become a hazard. They keep on demanding more research and more money. Technological unfeasibility and political ideals are here in conflict. This study argues that such projects may be hard to abandon, for that would mean abandonment of the ideal. The resulting stalemate, a back-and-forth between politicians, experts, and other stakeholders, can be obfuscating the potential of other projects.

Alternatively, idealistic aspirations to realize an unfeasible vision or set of ideals are not in vain. This study shows that ideals might lead to radically new perspectives on the design of energy systems. In these cases, ideals are productive, they impact the material sphere (fig. 23) via innovation pathways in which ideals guide innovations for the long-term. Future research into the function and presence of ideals should therefore incorporate more sources to provide support for the arguments given in this study. This is especially true for the Severn Barrage case, in which the suggested interaction between (political) ideals and idealized projects needs to be more thoroughly addressed. Furthermore, this study recommends researching other energy projects and technologies in the current energy transition to renewables, and the way idealistic (political) discourse concerning these technologies/projects has developed.

The new perspective, developed in this chapter, is not only relevant for the analysis of inactivity regarding tidal power projects or developments in the design of nuclear technologies. It also provides more general insights into the guiding role of ideals for the development of energy systems. Once intertwined with specific projects, ideals may lead to conflicts, denialism, and empty promises. They fail to coordinate and motivate action, or lead to radical decisions that have no ground in (social) reality. In these cases, the tenacity of ideals becomes a liability.

Interlude 3   Maintenance and Value (Change)

Chapter 4 does not focus on energy systems, but on another sociotechnical system: waste infrastructures in urban areas. The starting point of my argument is that new visions of waste have failed to gain a foothold in High Income Countries. I further argue that this is caused by the almost seamless, invisible operation of waste infrastructures. This leads to my claim that waste infrastructures and their maintenance should be made more visible to allow for a more extensive, ethical engagement with waste, thus facilitating the possibility of value change.

This chapter claims that the (re)design of municipal waste infrastructures should proceed through dynamic maintenance and reflexive repair. In these approaches to the upkeep of waste infrastructures, waste, repair, and maintenance are understood as discursive processes, in which politics, values, and norms play an important role. Maintenance doesn't only concern the restauration of a certain function and modus operandi of a system. It might also entail a reflection on the validity and desirability of this function and modus operandi. However, waste infrastructures and their maintenance are mostly invisible in daily interactions in cities in High Income Countries, despite a diversity in waste practices, such as collection and processing.

Invisibility is an intended outcome of the design and operation of these infrastructures, stemming from a 19th century waste-imaginary called 'the tidy city'. Current municipal waste infrastructures are kept invisible, upholding beliefs and practices that disvalue waste. While visions have been proposed that challenge this disvalue, few of them have materialized in stratified municipal waste management systems. The engagement this chapter proposes through dynamic maintenance is seen as first a step in challenging modern notions of dirt and waste. Visibility is posited as a (new) design criterion for municipal waste infrastructures, a criterion that this chapter relates to waste-affirming beliefs and practices, elaborating on anthropological perspectives on dirt and waste.

This chapter employs an anthropological perspective on value, in which specific cultural processes of value creation and valuation are central to the argument. Because cultures are different, different perceptions of dirt and waste exist, that might be unconsciously affirmed. Therefore, such anthropological accounts are less interested in how members of a culture or community rationalize their value beliefs and norms (Steinert, 2023). Furthermore, value beliefs related to dirt and waste might be less discursive and more rooted in feelings of disgust and repulsion, which are often hard to articulate. Finally, as this chapter argues, dirt and waste play a role in all cultures, whether as something that must be avoided or something to be embraced. This chapter offers proposals to change deeply rooted perceptions of waste, thereby bringing design, vision, and maintenance together, while critically engaging with the feasibility of existing proposals to change our treatment of waste. **Although this chapter does not directly deal with one of my sub questions, it adds relevant insight to several of them. It offers insights in different kinds of visions (RQ 2), issues of feasibility (RQ3) as well as value change (RQ4).**

Chapter 4

Negotiating Visions of Waste

On the Ethics of Maintaining Waste Infrastructures

4.1 Introduction: Waste, Ethics, and Maintenance[34]

The ethics of waste has become an important academic and societal topic (Hawkins, 2006; Hawkins & Muecke, 2002; Hird, 2022; Strasser, 2000; Thompson, 1979). The growing literature on this subject shows the many ways in which waste has evolved as a normative category to control and form peoples, bodies, and identities. Literature also shows how waste has become a global problem in which responsibility and accountability are difficult to assign. However, the relation between the ethics of waste and the maintenance of waste infrastructures in urban contexts is still underdeveloped, despite the ongoing urbanization of the global population, and ever increasing amounts of improperly managed municipal waste. Accordingly, this chapter seeks to highlight how cultural understandings of waste have become embedded in waste infrastructures, becoming instructive for their design, and explore what role maintenance plays in the continued embedding of these understandings. Furthermore, a collective reimagination of waste is crucial, especially in High Income Countries [HIC] (UN-Habitat, 2010). Support for the behavioral and lifestyle changes deemed necessary to deal with the current environmental crises, are only possible through a collective confrontation with waste in these urban contexts. An analysis of the sociotechnical systems of waste and the ways in which these systems are maintained, allows us to better grasp how emergent, new interpretations of what constitutes waste and how to best deal with it, are hampered by the design of these systems, and by a static conception of their maintenance & repair.

Previous chapters in this volume have discussed how the imagination, design, and construction of systems and artefacts is intricately related to their maintenance & repair, and how maintenance can actually be conceptualized as an extension of the design process (see also Edwards, 2003; Young, 2021a, 2021b). However, regarding the combination of maintenance and

[34] Co-author: Ben Hofbauer. Originally published in: *Maintenance and Philosophy of Technology: Keeping Things Going* (2024). Chapter 12. DOI: https://doi.org/10.4324/9781003316213-14

waste, this idea seems counterintuitive. Maintenance and waste are temporally related, but do not necessarily overlap: On the one hand, maintenance seeks to uphold the functioning of a system or artefact, potentially reimagining it in the process.[35] Waste, on the other hand, represents the end of a system or an artefact's life cycle. What is wasted, is no longer of use, or its usefulness has been neglected (Hawkins, 2006). Waste, therefore, often marks an end of what has been maintained, the end of value. Furthermore, though dirt and waste are distinct concepts, improperly managed waste can lead to the creation of dirt. Dirt has been amply discussed in the maintenance & repair literature (e.g., (Dant & Bowes, 2003; Harmer et al., 2019; Lejeune, 2019). Here, dirt stands in an antagonistic relation to the maintenance & repair of artefacts, such as cars, vacuum cleaners and cameras, bridges and server parks, but also urban infrastructures.

Thus, three perspectives on waste and maintenance emerge: 1) waste as the discarded, disvalued object or material (solid, liquid or gaseous, hazardous or not); 2) waste as that which, if improperly managed, endangers the functioning of machines and instruments, processes and systems, leading to more maintenance & repair, and more hazards; 3) maintenance & repair of artefacts as a counterforce in consumer societies, keeping things from turning into waste. The effective management of waste then is a critical service in a society. Waste management infrastructures appear as critical for the maintenance of urban areas and urban living conditions (Nagle, 2013; Steele & Legacy, 2017). Indeed, urban areas are the sites of the most dense expressions of infrastructure, and urban dwellers almost completely depend on these networks (Graham, 2010).

However, urban infrastructures are not always perceived as critical. The invisibility of infrastructure, together with urban habits and routines regarding waste, obfuscate the flow of waste through a city, and conceal the relevance for urban dwellers of unhindered waste streams. This waste flow

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[35] See (Steinert, 2024)

takes place in sewers and pipes, grinders and incinerators, opaque bags thrown in underground collectors and garbage trucks, processes modern urban dwellers tend not to notice — except when driving behind a truck in a small street, or when waste stops flowing (Nagle, 2013). Here, maintenance creates one of the moments through which municipal waste infrastructure becomes (temporally) visible. Breakdown and crisis, as instances of failed maintenance, also create moments in which infrastructure reappears. However, this appearance doesn't necessarily lead to insights concerning previously hidden features and embedded meanings (Young, 2021b).

In this chapter we investigate the maintenance of sociotechnical systems that handle waste, especially but not exclusively in advanced urban settings. These systems include sewage systems, drains and canals, all the way to recyclable and biodegradable waste, landfills replete with miscellaneous and electronic waste, waste-to-energy incinerators, the shipping and transportation of waste, nuclear waste and less obvious instances of waste, such as greenhouse gases. The focus during our investigation is on the ethical implications of maintaining sociotechnical systems that handle municipal solid waste, to discuss how these systems have become problematic from a moral perspective, and to explain why updating these systems to comply with new societal goals and visions is difficult, especially in HIC. We do this on the basis of the subsequent two-step process of analysis and normative argument.

The first step of the analysis consists of laying out the methodological framework for assessing existing infrastructure, based on Henke and Sim's reflexive repair of infrastructure (Henke & Sims, 2020) as well as Mark Thomas Young's dynamic conception of maintenance (2021a; 2021b). From this basis, we explore how waste itself is being viewed, and how that view is representative of current socio-political structures, assumptions, values, and norms. This gives a descriptive outlook of what waste is and can be, and how it manifests itself in today's industrialized societies. Here we draw on anthropological, sociological, and philosophical scholarship that has sought to understand the phenomenon of waste through different theoretical lenses

(Douglas, 2002; Hawkins, 2006; Hawkins & Muecke, 2002; Nagle, 2013; Scanlan, 2005; Thompson, 1979). We then introduce the normative claim of how waste-maintenance should be viewed. Here we seek to evaluate our interaction with waste, arguing how the engagement with and view of waste should, and could change. Specifically, we claim that the maintenance of municipal waste infrastructures should be reimagined as an active and dynamic process, rather than the caring for a stable, rigid artefact.

Since we believe the issues discussed here are particularly relevant for urban areas in HIC countries, because of high levels of stratified socio-material organization, in which infrastructure appears as stable and permanent (Graham & Thrift, 2007), we give examples mostly from these countries. We argue that first and foremost, sociotechnical systems of municipal waste management in the Western Hemisphere are made to be invisible, and hidden from the public, and their operation is taken for granted, while the continuous effort to keep this system in operation is often neglected. This feature of invisibility has co-evolved with modern understandings of civilian culture and urban progress. Our claim is that the invisibility of waste infrastructure fixes the socio-ethical perception of waste as something to be avoided, something contaminated, thereby fixing its disvalue for society. This modern perception of waste, we claim, is problematic in terms of achieving a more sustainable relationship with waste in light of ecological concerns, health concerns, and climate change. This modern perception, facilitated by the current design of municipal waste infrastructures in HIC, hampers the realization of new visions of waste. A circular economy, for example, should be able to reconceptualize waste for its potential as a resource, and something that has not lost its value. Despite steps taken in this direction, a shift in the collective understanding of waste in advanced urban areas has yet to occur. With 56% of the world's population already living in cities (Worldbank, 2021), the need to change this understanding is urgent. One step towards achieving this reconceptualization is through the dynamic maintenance and reflexive repair of waste infrastructures (Henke & Sims, 2020; Young, 2021a, 2021b). In this study we combine these insights with a focus on the values and meanings embedded in waste infrastructures.

Our conclusions amount to a first step that we deem essential for new visions of waste to gain a foothold in advanced urban contexts.

The structure of the chapter outlining this argument is as follows. First, we introduce our methodological background considerations, outlining key concepts of maintenance and infrastructure. Then, we discuss waste as a dynamic and normative concept. In sections 4 and 5 we explore how current waste management infrastructures tend to reproduce a specific waste imaginary, linked to a modern, urban ideal of tidiness. In these sections, we look at municipal waste mostly from a HIC perspective. Section 6 provides a further theoretical reflection by looking at waste infrastructure through the lens of socio-technical systems. This section highlights how values are embedded, afforded and resisted through the use of such systems. The subsequent sections 7 to 8 introduce how value change affects these systems, subsequently presenting budding alternative visions of waste realized through dynamic maintenance and reflexive repair. The concluding section gives recommendations for further research.

4.2   Maintenance and Infrastructure

In recent years, maintenance has emerged as an important topic in the ethics and philosophy of technology, challenging the dominant focus on design and innovation. Maintenance, scholars stress, should be understood as more than simply preserving the function of artifacts (Graham & Thrift, 2007; Jackson, 2014; Young, 2021a, 2021b). Instead, maintenance often involves (re)design and innovation, creativity and adaptivity. Therefore, rather than as static objects in which designers' ideas are realized and carefully guarded, artefacts should be seen as processes of change, in which maintenance interferes with, reinforces, guides, or blocks these processes (Graham & Thrift, 2007; Young, 2021a).

Conversely, maintenance can also be understood as a challenge to the ideology of consumer societies, in which innovation, creative destruction,

planned obsolescence, and excessive growth (and thus lots of waste) are ultimate goals. Instead of a narrative of technological progress, maintenance offers an ideology of care for artefacts and, thus, for the people that depend on these artefacts (Denis & Pontille, 2015). The maintenance of urban infrastructure is no exception. Rather than building new infrastructures that deliver new public goods, most of the time cities are places where existing infrastructure is updated, altered, repaired, and maintained, often within tight budgets. This maintenance is an aspect of daily, urban life. However, it's relevance is often neglected, even though maintenance carries the burden of keeping intact material and social orders in urban contexts (Graham & Thrift, 2007).

Urban infrastructure, i.e. the pipes, drains, cables, road networks, etc. plus the agents and institutions running and maintaining them, are often invisible to the everyday user. Despite this common association, the (in)visibility of infrastructure remains a contentious topic (B. Larkin, 2013). Star's (Star, 1999) influential study on the ethnographic background of infrastructure has reinforced the idea that infrastructure goes unnoticed, as a seamless web (T. P. Hughes, 1986), in order to serve its function. Likewise, Edwards (Edwards, 2003) sees infrastructure as invisible background, and the substrate of modernity. At the same time, however, infrastructures do often become noticeable and apparent when we interact with them. This might come in moments of breakdown, which open new perspectives on the technologies we use, and are often instructive of innovation trajectories (Jackson, 2014). Furthermore, as Jackson (2014) implies, it is in maintenance & repair that we might encounter relations of value and social order that are often obscured under the 'smooth functioning of complex sociotechnical systems' (p. 231), although this encounter is contested (Young, 2021b). But breakdown and maintenance are not the only ways in which infrastructures reappear. As repair scholars Henke and Sims write:

> Infrastructures are never truly invisible, but their salience to us, including their role in shaping power and privilege, shifts in and out of our consciousness based on their

> operation and to what extent we depend on or are
> oppressed by them. (Henke and Sims 2020, 143)

A second aspect of infrastructure that is relevant for our discussion, besides the issue of (in)visibility, is fragility. Nagle's (2013) analysis of urban sanitation workers in New York shows that garbage collection is a fragile assemblage of people, punching clocks, bureaucratic measures, weather forecasts, noses, luck, intuitions, truck maintenance schedules, and grunting citizens. In her account, the 'smooth functioning' of this system is far from obvious. Rather, it seems to be in a constant mode of crisis, always about to come to a halt and disintegrate. It can only appear smooth from the outside. Indeed, maintaining a technological artefact or a sociotechnical system can be understood as the continuous abatement of letting that object or system go to waste, despite seemingly solid and robust infrastructures. In the case of urban sanitation and many other urban structures, what needs to be maintained, furthermore, are not only machines, but also work relations and routines, a company culture, and a precarious relation to other urban dwellers. What is maintained, then, is a socio-material world (Sormani et al., 2019). Furthermore, this maintenance is not always successful. Rather, the system breaks down repeatedly, making waste suddenly a public concern (Nagle, 2013). As a consequence, the politicization of waste in urban contexts, is often made possible by unsuccessful and neglected maintenance & repair of waste management systems. The fragility of the system is precisely what enables its politicization.

Maintaining sociotechnical systems means ensuring their continuity, alongside the inherent values and agents that underpin that system[36]. Evidently, infrastructure manifests human values and norms (Edwards et al., 2009). Furthermore, infrastructures, given both their centrality and invisibility, continuously reproduce certain values and norms, certain ways of social being, cooperation, and existence. Their repair in the form of maintenance often leads to those values and norms being reified through

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[36] See Steinert (2024).

adaptation and slight, which in turn makes the infrastructure ever more resilient to change. In a similar vein, Henke and Sims problematize the fact that repair as maintenance reproduces and embeds current '... material and discursive investments and assumptions embedded in those infrastructures …' (2020, 121) Repair as maintenance could, in this sense, lead to the further entrenchment of the status quo.

This resistance to change is a third aspect important for our analysis, besides invisibility and despite fragility. Resistance is closely related to Henke and Sims' (2020) idea of resilience in infrastructure design: the protection against destabilizing feedback loops in infrastructure use. According to Henke and Sims, growing resilience is a consequence of the two ways in which infrastructure is reflexive (2020, 124f.) One, infrastructure is causally reflexive, i.e. infrastructures are shaping the very environments within which they operate. Sewer pipes have become a necessity for most cities, and they serve their function well. At the same time, their installation and maintenance requires new forms of infrastructure (maintenance crews, urban planning, interaction with other infrastructures such as the electricity grid or fresh water pipes, etc.) Two, infrastructures are 'self-aware', and agents operating them make the system adapt and integrate changes into the decision-making process and the actions surrounding it. Waste infrastructure is planned to be resilient against disruptions to fulfil its role, be these disruptions natural (e.g. flooding of the sewers) or social (e.g. poor recycling habits). Again, the degree to which disruptions succeed in discontinuing urban flows, seems to determine, to a large extent, the degree to which citizens are able to engage with the politics, ideology, and embedded values of waste, and waste infrastructures (Graham, 2010).

Concluding, urban infrastructures are essential to (modern) society and resistant to change. However, the age of the Anthropocene and environmental reckoning of societies built on ever-increasing consumption, has shown the limitations and dangers of these infrastructures. Despite their continued function and delivery of energy, urban sanitation, and stability, these systems are also 'broken'. Fossil-fuel based energy systems, for

example, show all of the above characteristics of an incredibly resilient piece of infrastructure, that at the same time has become an existential threat to humanity. Similarly, albeit to a much lesser existential degree, current waste infrastructures are struggling to break free from now problematic and unsustainable perceptions of resource-depletion—what we refer to as a 'modern' waste imaginary (see section 4.6). The question then arises whether we can change these current infrastructures, whether we can reimagine waste and waste-management to account for meaningful sustainability and social justice—all this without proposing a design from scratch, or letting waste management systems break down and disintegrate completely. Maintenance seems to fit this role well. It allows the questioning of sociotechnical regimes and socio-material routines and practices in urban environments without necessarily falling for the intrusive dogmas of innovation and design. Maintenance, breakdown, and repair of infrastructure, furthermore, are able to engage citizens. They might successfully bring to the fore the inconspicuous culture and politics of waste.

4.3   Reflexive Repair and Dynamic Maintenance

Scholarship on maintenance and repair provides us with at least two possible answers to the question how to change critical infrastructure, such as municipal waste management systems. In both these answers, the focus is on challenging the existing material and social order through the maintenance of infrastructures that always already reinforce these orders. One, through 'reflexive repair' (Henke & Sims, 2020), and two, through a more dynamic and procedural conception of maintenance (Young, 2021a, 2021b).

The guiding principle behind 'reflexive repair' is mainly discursive, i.e. making the agents maintaining infrastructure projects aware of the underlying power dynamics, as well as the values purported through these projects. Reflexive repair means ' … asking questions that bring the sometimes obscure but always present properties of infrastructures to the

surface, critically appraising the embedded dynamics of power, discourse, and materiality that are built into these sociotechnical structures.' (Henke & Sims 2020, 143) Reflexive repair opens up a space for debate, for interaction among those stakeholders who otherwise would not communicate with one another. Such interaction might lead to the realization that maintaining a given kind of infrastructure in a specific way through repair, is not a value-neutral undertaking. Rather, it is the re-assertion of specific worldviews and specific ideas of urban living and cooperation. A re-assertion of ways of disclosing the city and disclosing urban life. Preceding that re-assertion by a reflexive and discursive engagement could highlight problematic power dynamics and injustices.

Henke and Sims (2020) summarize their views by proposing that reflexive repair will be able to 'repair infrastructural repair itself', providing a critical, political form of repair. Thus, reflexive repair proactively considers the limitations and (unintended) consequences of repair and maintenance, effectively negotiating maintenance amongst stakeholders with different aims and needs. The authors are aware of the difficulties of putting their approach in practice. For instance, we can question the manner in which a representative group of stakeholders is brought together in a globalized economy with complex supply chains. As an example, vast amounts of discarded 'fast fashion' from the Global North end up in Africa and increase economic inequality (Brooks, 2019). Second, the unprotected disassembling of container ships in Bangladesh (Jackson, 2014), and informal recycling of e-waste in developing countries (Ádám et al., 2021), show that discarded artefacts have become a global issue with a global supply chain, in which questions of justice are still disregarded. Can reflexive repair consider all these global consequences? And how would a hierarchy of repair preferences be justified? We do not attempt to answer these questions concerning 'waste justice' here, but realizing its complexity is important.

The second approach to changing infrastructures is based on Young's reconceptualization of maintenance as a dynamic procedure, rather than a static continuation of a given sociotechnical system. The main thrust of this

reconceptualization of maintenance stems from a fundamental shift in how technology is viewed. Many current approaches in the philosophy of technology still frame technological artefacts as expressions of human (usually engineers' and designers') intentions. For instance, the value-sensitive design approach (Friedman et al., 2002a) prioritizes intended values in the design process of HCI-technologies. Proponents of Constructive Technology Assessment have stressed the importance of broadening design, development, and implementation processes (Schot & Rip, 1997) and Verbeek's (2011) mediation approach also focuses on the design of human-world relations through technology. In all these approaches, the focus is on the design stage of artefacts: how an object is brought into the physical world through construction, following an ideal, preconceived form. The artefact is complete and ready to use at its creation, and any deviation from the designed ideal form is remedied through repairs or adjustments. Maintenance here plays an auxiliary role, meant to aid a finished design to cope with reality. This is what Young (2021a) dubs 'technology as form'.

Thus, maintenance, under this framing, is conservative of an initial design and function. In this understanding, artefacts are discarded when this initial design and function can no longer be restored. These artefacts are beyond repair—the change that time and use have created, have pushed them over the brink of 'preservation' (Young 2021a, 360). With the intent to move the focus from the designers to the maintainers, Young proposes maintenance as the primary drive and functioning of technology. Rather than highlighting the design and innovation phase of an artefact, more emphasis should be placed on the continuous process of maintenance through repair, readjustment, and upkeep. Technology should be seen as 'a process sustained by constant human activities of maintenance and repair', i.e. 'technology as a process' (Young 2021a, 102).

Hence we should think of the process of making, using, and maintaining a technology as a process of growth, guided throughout different, fluctuating

phases of interaction with the artefact. The following quote exemplifies this idea:

> Technologies are understood as fluid entities which constantly respond to the changing environments in which they exist, and which therefore require guidance through time in order to appear for us as stable entities. (Young 2021b; 364)

This fluidity and room for growth, coupled with reflexive repair is in focus when we argue that waste-management systems can be reimagined to represent different visions of waste. In other words, we claim that a dynamic and reflexive conception of technology as process gives theoretical room to re-conceptualize waste infrastructure/management systems and open up these systems for the negotiation of new, sustainable visions of waste. In the coming sections, we also show that this reconceptualization encounters considerable sociomaterial resistance. However, we first need to establish what we mean by 'waste'.

4.4   A Dynamic Concept of Waste

Having established the concepts that we need to address and problematize municipal waste management, we now turn to waste itself. For the focus of this chapter we chose municipal solid waste as a distinct category of waste, aside from fluid and gaseous municipal waste. Municipal solid waste has several characteristics that we will explore in relation to municipal waste management and waste infrastructures. Additionally, we show different perspectives on waste, and then highlight how different valuations of waste have emerged over time. Finally, we show how the modern imaginary of waste hampers the materialization of new visions of waste, as, for instance, proposed in the European Union.

Based on philosophical, anthropological, and sociological scholarship, we identify four main characteristics of waste. Waste is 1) a socially determined product, 2) a normative category, consisting of ethical and aesthetic components, 3) an environmental agent, and 4) inevitable. These four aspects give respective explanations of waste's ontological standing and ethical significance (1 & 2), its practical implications (3), and why waste merits debate in the first place (4).

First, waste is a socially determined product. Importantly, waste is not a predetermined, ontological category, something that can be objectively distinguished. Rather, waste is a relational process of categorization (Douglas, 2002; Hawkins & Muecke, 2002). Structurally, we can argue that waste, like dirt, always is 'matter out of place' (Douglas, 2002). However, that doesn't determine what counts as matter out of place in a certain (cultural) context. Thus, what is considered waste is culturally dependent (e.g., Edgerton, 2007). The category of waste is itself a social product, something that has to be agreed upon and negotiated to be 'waste'. This means that waste itself is a dynamic concept that changes based on historical context, societal norms and values, and the possibilities present in societies to reinterpret what constitutes waste. However, this dynamism of waste is curtailed by fixed processes, institutions, and infrastructures for waste. Thus while waste is nominally dynamic, real processes and structures fix its meaning through reproduction and static engagement.

This nominally dynamic character of waste becomes especially poignant when considering the ethical and aesthetic relevance of waste. Waste is an ethical and aesthetic category. From an aesthetic perspective, waste is something that is unpleasant, even disgusting and unclean. We want to avoid contact with waste. The idea of waste evokes sentiments of disgust, uncleanliness, potential danger through contamination, etc. These aesthetic judgments also have moral implications. Especially if these judgments are mobilized to produce emotional reactions and relationships with waste, they fall clearly into the category of the ethical (Roeser & Todd, 2014). In those

cases, these reactions have real-world effects that bear upon other people, close-by or far-off, affecting their lives and livelihoods.

Waste surrounds us, while always being something undesirable. Designating something as waste entails that it no longer has use, has lost its initial purpose, or is spent. On the ethical significance of waste, we follow Hawkins when she writes that '[w]aste is now a field of activity structured by legislated and normative moralities, by disciplinary codes that order conduct in the interest of wider objectives: from reduction of landfill to global ecological survival.' (2006, 22) The way we engage with, categorize, and maintain waste has important moral implications, since waste is a normative category: it tells us how to interact with a given artefact or phenomenon. We focus more in depth on this criterion of waste in the following sections.

Thus, the ethical and normative character of waste highlight the third and fourth practical and moral criteria of waste tied to its maintenance. From this third perspective, waste is relevant as an environmental phenomenon. The production and effective management of waste is seen as crucial in dealing with environmental degradation. Spilled and improperly processed waste can emerge as pollution and environmental hazard. This aspect of waste is further compounded by environmentalists' and climatologists' realizations that one of the biggest threats to humanity yet—the continuous emissions of CO_2 through combustion—is the ultimate kind of waste through its double invisibility. Not only is it invisible in the physical sense, as it cannot be perceived by the human eye and is odorless, i.e. our senses cannot make sense of it. It is also invisible in its direct impact.

Finally, waste seems inevitable. There will always be matter out of place, as waste and dirt establish material and social orders and borders. The very human condition seems trapped in the necessity to produce waste, to create excess. The inevitability of waste-production is particularly glaring in industrialized consumption-based societies, where waste rears its head undeniably through packaging, sewage, broken gadgets—societies in which, as Nagle (2013) puts it, 'San[itation] workers are key players in

maintaining the most basic rhythms of capitalism.' (46). This connects to Schumpeter's (1976) more general idea of 'creative destruction', the destruction of old forms of wealth to create new ones, i.e., the constant upheaval of economic structures in capitalist societies. The production of waste becomes necessary for economic progress.

4.5   Modern Waste Management: an institutional perspective

So far, we have argued that the dynamic nature of waste is most properly complemented by a dynamic concept of maintenance, that allows infrastructure to be aligned with new visions of waste. However, as we have indicated, infrastructures provide resistance to change as well. The coming sections pay attention to some of the forms of resistance that urban infrastructures exhibit.

Given the sheer production and amount of waste, modern municipal waste management systems *need* to be invisible. In this aspect, they differ from other systems operating in our urban backgrounds. Insensibility is deliberately designed into municipal waste management systems (Hawkins, 2007). Rather than retreat into the background of modern urban life, municipal waste management infrastructure always already has retreated. Recent garbage crises that affluent societies have faced mostly concerned the re-emergence of the sensibility of waste, and the re-emergence of the question how to best deal with this sensibility. More philosophical, and ethical questions about waste often escape the political agenda. That is, infrastructural innovation is directed towards technological efficiency and efficacy regarding a set of predetermined goals taken as exogenous 'givens': health, tidiness and, therefore, insensibility. The existing rationale for waste management was, and to a large extent still is: 'expand and upgrade', based upon design principles committed to universal, reliable, and affordable service (Guy et al., 2001, p.5/6). Figure 24 shows a schematic overview of the four phases of solid waste management in urban areas in HIC, phases that are (in)formed by infrastructures, technologies, habits, and institutions.
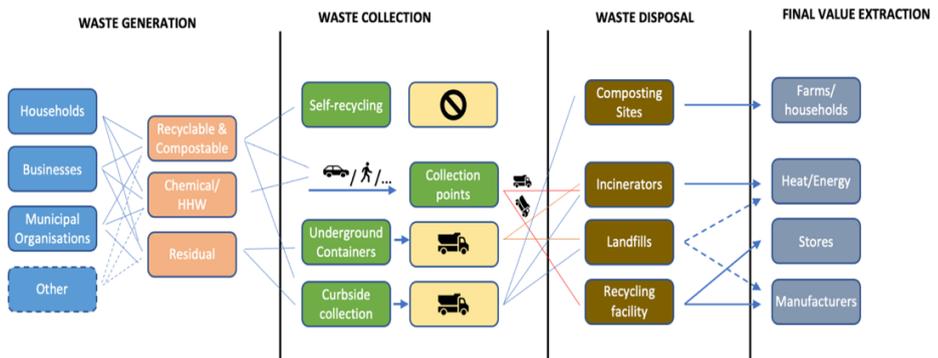
Figure 24: Schematized Municipal Waste Infrastructure.

One way to understand the neglect of philosophical and ethical questions concerning waste is provided by the literature on socio-technical regimes. In this institutional perspective, the focus on efficiency, expansion, and upgrading is seen as part of the socio-technical regime of urban solid waste management in HIC, constituting its paradigmatic center. This regime is the result of the co-evolution of infrastructure and institutions. It has its own 'logic' and 'grammar' (Fuenfschilling & Truffer, 2014). Problems and their solutions come about as salient through this logic, which forms 'coherent arrangements of beliefs, norms, values and practices' (Ibid. p. 773).

We have seen, furthermore, that waste management systems (fig. 24) come into the public eye when they break down, or when their continued use and operation leads to morally problematic situations, such as disease, pollution, the involvement of organized crime, and increased global inequality. In a sociotechnical regime, these problems are often interpreted and dealt with in preconfigured ways, along already established innovation pathways. The robustness of this institutional logic, its endurance, is determined by both internal and external events, such as the arrival of new actors and niche technologies, changes in the distribution of power, and the social impact of crises and disasters (Geels, 2010).

The institutional perspective adopted in the socio-technical regimes literature explains how institutions and technologies co-evolve in socio-technical systems, such as municipal waste management systems. From this perspective, the extent to which a complete reimagination and system transition is deemed necessary depends at least in part on the success of other (and earlier) attempts of the regime to cope with problematic situations caused or endured by the system. These attempts might have left the material design of the municipal waste management system largely intact. We can think here of failed attempts at the improvement of the institutional context (new rules, guidelines, laws, etc.) or failed efforts at educating city dwellers about good and bad waste habits (stickers on garbage bins, codes on packaging materials, waste separation folders, school trips to landfills, etc.). In these cases, new objectives and goals in waste management are pursued at the supply side of waste, changing the waste behavior of citizens through education and regulation. In the case these new goals amount to substantial revisions of the ultimate objectives of waste management, we refer to these new objectives as 'values'. The pursuit of new values is often associated with socio-technical transitions, in which new practices, rules, and technologies emerge (Geels, 2004).

We depict changes in these practices, rules, and technologies in figure 25. In this visualized trinity of (re-)education, institutional (re)design, and material (re)design, the latter option, the material (re)design of parts of the sociotechnical system of waste management, is often the most time-consuming and costly. We are dealing in these infrastructural systems with a materialization of norms and values associated with waste, that have 'locked in' certain waste practices. The underground sewage pipes, the closed off garbage trucks, or covered trash cans, all represent physical manifestations of a certain understanding of waste that leaves its mark on waste practices. At the same time, physical infrastructures embedding entrenched norms are very difficult to change, which is why acting on them is often the last option to be considered.

This leads to a paradoxical situation: *citizens are instructed to change their behavior and practices while existing infrastructure keeps reinforcing that behavior and those practices.* Institutionally, therefore, citizens, are motivated to change, while materially they are motivated to keep on doing what they did. A purely institutional perspective on change is therefore not enough. If cities want to successfully implement new waste visions, all three aspects of figure 25 need to be put into operation. Institutional change, citizen education and motivation, and material change need to go hand-in-hand. This means the inclusion of diverse stakeholder groups, such as citizens and maintainers, and the development of new ideas concerning the interaction of these groups. In our view, maintenance offers an underestimated opportunity for effectively bringing to the fore the material aspects of sociotechnical transitions, that are inspired by new visions of urban waste.
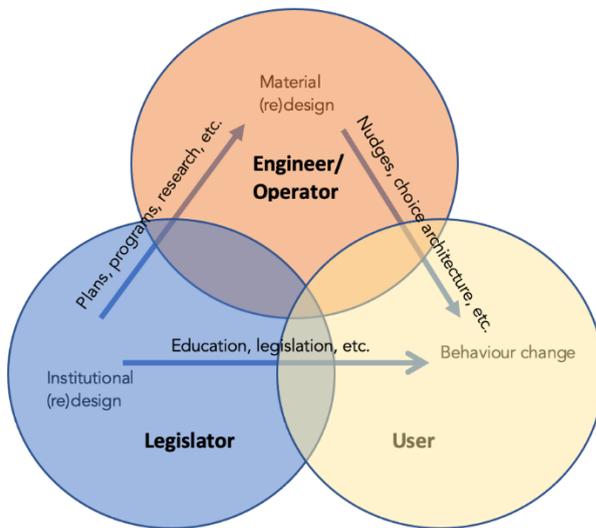
Figure 25: Visions of changing (waste) practices in sociotechnical systems.

Finally, upholding a modern vision of municipal waste ('Burning, Burying, Be rid of it') through the static maintenance of waste infrastructures is costly. Most of these costs might be borne by future generations, the environment, or subaltern social groups. Some of these costs might be invisible (air pollution, CO_2 emissions of waste transport), or might not be experienced collectively (the shipping of waste into other regions/countries). Hence, local invisibility is often associated with affluent parts of the city, or affluent parts of the world, while waste becomes more visible in marginalized localities. Affluence, in this sense, determines the period during which municipal waste is visible and still affirmed, and a confrontation and negotiation can take place.

This is a development long in the making. As a number of scholars have pointed out, the modern imaginary of urban living and waste focused around conceptions of tidiness that emerged throughout the 19th century in cities in Northern America and Europe (Chakrabarty, 1992; Hawkins, 2006, 2007; Melosi, 2004). These conceptions have solidified in infrastructural design choices for modern urban waste management systems and continue to inform contemporary choices.

4.5 Modern Imaginary of Waste

The modern imaginary of urban living and waste emerging in the 19th century is the 'tidy city' (Chakrabarty 1992; Hawkins 2006; 2007). In this tidy city, the management of waste (and health) has become a public concern. This means that urban sanitation is no longer an individual responsibility, as it was prior to the 19th century, but a communal responsibility and a service that the city provides (Melosi, 2004). Furthermore, responsible waste practices become an important aspect of civic life and citizen-culture. The administrative treatment of waste and public health becomes a sign of urban progress. As the Dutch environmental ministry's homepage puts it: 'It is the role of governments to prevent the waste of raw materials and energy and to ensure that human health and the environment are not harmed by waste'

(Ministerie van Infrastructuur en Waterstaat, 2022). Modern waste management is a public concern.

A wide range of scholars of waste have shown how this 19th–century imaginary of waste is both persistent and resistant in the Western Hemisphere. It has set societies on sociotechnical pathways of waste management systems that have led to both technological and institutional lock-in. The force of this imaginary of tidiness is dependent upon several of its features. First, its geopolitical power. As Newell (2015) and Chakrabarty (1992) argue, the assumed connection between cleanliness and civilization has justified colonization and subjugation of the 'dirty native' in the 19th and early 20th century. Filth today is still associated with lower social classes (Berg, 2015; Forty, 1986), and with 'othering'.[37]

Secondly, overconsumption, and therefore waste, started to be taken as a fact of civilian life. 19th century affluent citizens began showing their wealth by buying things they wanted, but didn't need, and could discard at will (Benjamin, 1999). Thirdly, the medical sciences of virology and bacteriology emerged at the end of the century, as modern public health science established relations between (human) dirt, disease, and death, that are still prevalent today (Melosi, 2004). Finally, the emergence of municipal sanitation had both ethical and aesthetic consequences. The 'tidy city' still is an attractive epithet. It attracts tourists, yuppies, and supports increasing levels of gentrification (Hawkins, 2007). Clean, tidy, and orderly urban districts preserve the otherness of waste—as something that is both aesthetically and morally disavowed.

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[37] Indeed, modernity is often associated with these strict categorizations and dualisms, such as the distinctions between mind and body, nature and culture, public and private, agency and structure (Bauman, 2013; Douglas, 2002; Giddens, 2023; Jackson, 2014; Latour, 2012).

On this basis we introduce the modern waste imaginary. In this imaginary, waste is something to be discarded; something that is both aesthetically unpleasant and morally bad, and unwanted. It is out-of-place and should be put away, either geographically or excised and obliterated as a whole. Even apparently more reflective approaches, such as the Zero Waste plans of cities like San Francisco and Singapore uphold this image: 'Zero Waste' here does not refer to a completely circular (urban) economy or 100% biodegradable consumer goods. Rather, these Zero Waste plans rely heavily on waste-to-energy incinerators. These incinerators reduce waste mass up to 90% (Setoodeh Jahromy et al., 2019). Since the leftover material can be used for roads construction and leftover metals can be separated and recycled, these Zero Waste plans almost realize Zero Waste.

However, as we detail in later sections of this chapter, these plans fall short of realizing a new vision of waste on the supply side of waste, e.g. with urban dwellers. In the next section we introduce how sociotechnical systems can entrench or hinder the expression and materialization of new values. This provides theoretical tools to explore how current waste infrastructures either reproduce the modern waste imaginary, or do not go far enough where they seek to go beyond it, given the inherently static underlying assumptions of current waste management systems.

4.7   Value change

A growing amount of recent scholarship recognizes that sociotechnical systems, since they're bound to exist for multiple generations, will see some level of value change. In short, although these systems might have been designed while keeping certain social, ethical, and public values in mind, the relative importance of these values, their conceptualization, or the (design) norms associated with their realization, might change (Van de Poel, 2021; Van de Poel & Kudina, 2022; Van de Poel & Taebi, 2022). We can even imagine completely new values emerging in society that start to weigh down

on the operation of certain systems, such as energy or waste systems (Taebi et al., 2020).

The literature on value change argues that morally problematic situations, whether caused by these sociotechnical systems or not, create an urgent call to reassess the design of those systems, with this value change in mind. These might be values new to the context (e.g., new to the context of waste management systems, such as ecological sustainability) or completely new values as abstract goals (e.g., intergenerational justice). That is, the redesign of parts of the system of waste management, deemed necessary because of the problematic situations the current design has caused, is often guided by new requirements that stem from new values. As is evident from our discussion so far, the realization of these new values, cannot be achieved through institutional change only. Despite a recognition that municipal solid waste management needs to transition to more sustainable, just, and ecological practices, urban waste management infrastructures continue to express an imaginary of tidiness that trumps the expression of these new values. Both education and institutional (re)design (fig 25) have been unable to realize major shifts in collective beliefs and practices concerning waste in European urban areas. To date the focus has been primarily on how to deal with waste, and visions are built around answers to this question. Yet another question often goes unmentioned: to what extent should we change what we consider waste in the first place?

For instance, in Europe the Smart City concept developed in the early 2000s, hardly pays attention to the reimagination of municipal solid waste, despite a focus on issues such as urban pollution, sustainability, and sanitation. Smart waste collection does receive attention in urban contexts (e.g. Ali et al., 2020), but seems to focus more on Internet-of-Things-solutions in which garbage cans communicate with garbage trucks (e.g. Bhor et al., 2015) and sensors determine the level of air pollution. The focus here is on efficiency and reliability, rather than new values emerging in relation to waste management.

Furthermore, the EU directive of 2015 established a hierarchy of goals in relation to waste management: prevention, reuse, recycling, recovery of energy, and disposal. However, many member states have difficulties achieving these goals and often focus on waste-to-energy processes instead of higher order goals (European Commission, 2015). The failure to achieve more radical transformation of municipal waste practices can be understood to stem in part from limitations in the political directives themselves. For example, one of the research foci of the Horizon 2020 program was the circular economy [CE] and urban metabolism, which developed valuable insights into the challenges of CE in urban contexts, mostly from a governance perspective (e.g. Obersteg et al., 2019; Remøy et al., 2019). At the same time however, the program failed to address the affordance and resistance of waste management systems, or the potential for a collective reimagining of waste and related practices.

Hence waste is often assumed as a given fact of urban life. Contemporary debates concerning the ethics of waste highlight problematic attitudes to waste, delivering a moral appeal to change these attitudes (Hawkins, 2006). Yet the extent to which the current treatment of and attitudes towards waste are seen as problematic are as much the result of the history of waste (see section 4.6), as of the persuasive power that circulating new perspectives on waste are able to exercise. This persuasive power itself, we argue, depends both on the possibilities to render visible the problematics of the current operation of municipal waste management systems, and on the historical meanings of waste still designed into these systems, in the form of embedded values. We call these two aspects *infrastructural affordance* and *infrastructural resistance*.

A collective reimagination of waste, deemed necessary for collective support of changes in sociotechnical systems of waste management and the burdens these changes might impose on citizens, requires a collective confrontation with municipal waste in which new values can be brought forward as essential for the accumulation, collection and disposal of solid waste in urban contexts. For such a confrontation to take place, it will be essential to explore

new ways of experiencing waste. However, despite a range of art projects involving waste, the conditions for such positive 'waste experiences' are still largely absent in affluent societies. One of the reasons for this may be found in the physical aspects of waste infrastructures, where the resistance presented in the infrastructurally embedded historical meanings of waste weakens the persuasive power of new visions.

Reconceptualizing the maintenance of municipal solid waste management systems as reflexive repair and a dynamic process can play two roles here. Firstly, it can undermine the resistance to value change designed into these systems by rendering them visible during the act of maintenance and allowing for new forms of political engagement with them, thus bringing to the surface the problems associated with their operation. Second, maintenance can be seen as a process of redesign of urban infrastructure instead of replacement/repair and short-term fixes, making maintenance an important strategy for bringing political and ethical questions to the fore and thus creating *infrastructural affordance*. However, the redesign of critical urban infrastructures is often avoided because of costs and risks to urban flows of utilities. While we do not claim to have a solution to this problem, we argue that the creation of public acceptance for new visions of waste can only be achieved through the 'visibilization' of waste infrastructures, a process of creating *infrastructural affordance* in which maintenance can play a crucial role.

4.7   Some Politics of Waste infrastructures in the EU

As noted above, affordance and resistance of contemporary municipal solid waste management systems determine the extent to which new meanings of waste can establish themselves in urban contexts. In a very basic sense, this would encompass the transition from a waste and dirt-rejecting, to a waste and dirt-affirming system of beliefs and practices (Douglas, 2002) in the city, and supported by a waste-affirming vision. Anthropologically, dirt-affirmation refers to societies in which some forms of pollution and

corruption are 'enshrined in sacred places and times' (Douglas, 2002), whereas in dirt-rejecting societies dirt loses all identity and cannot acquire new functions before it is completely disintegrated and undifferentiated, when it has stopped being dirt.[38] Importantly, waste serves as a proxy for dirt in the modern waste imaginary. Most advanced urban areas are dirt-rejecting in a non-religious sense, as places where 'order, efficiency, and perfection' (Scanlan, 2013) leave no room for the reintroduction of garbage as an object or even commodity before it has completely disintegrated in landfills or incinerators. Before it has stopped being garbage, that is. Nonetheless, we argue, some level of dirt-affirmation must occur to effectively negotiate waste and open up a critical space for a collective reimagination of what constitutes waste.

However, existing waste infrastructures are both robust and durable, and infrastructure tends to become more resilient over time (Henke & Sims 2020, 121). Late 20th-century problems with landfills and levels of toxicity and contamination of water tables have led many European countries to focus on waste-to-energy incinerators (McCauley, 2013). The current ubiquity of incinerators is a consequence of the mixed nature of most solid municipal waste, stalled efforts at sorting out different types of waste, protests against shipping waste abroad, and failed attempts at large-scale recyclable plastics. Nevertheless, many of these countries have also seen (local) forms of resistance against these incinerators that, in some cases, have led to further innovations (e.g., reduction of fly-ash, better filters). EU directive 2018/851 recognizes that many member states have not yet developed the necessary waste management infrastructures to achieve a circular economy. It does

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[38] We are aware that dirt and waste are not synonymous. In Douglas' work, the two concepts are not always easy to keep apart. On the one hand, dirt seems an interpretation and evaluation of superfluous things, materials, words, and bodily aspects, as excessive 'things' that confuse and endanger accepted social classifications. On the other hand, as we have noted in the introduction, waste is always in immediate danger of becoming dirt. Douglas herself gives examples of human matter in food such as hairs in soups. For the sake of our argument, we do not think a strict conceptual boundary is necessary.

not, however, provide reasons for this failure to adapt. Overall, directive 2018/851 pays little attention to raising public awareness (and visibility) of waste. Action point (30) states:

> The promotion of sustainability in production and consumption can contribute significantly to waste prevention. Member States should take steps to make consumers aware of that contribution and encourage them to participate more actively in order to improve resource efficiency. As part of measures to reduce waste generation, Member States should include continuous communication and education initiatives to raise awareness on the issues surrounding waste prevention and littering and may include the use of deposit-refund schemes and the setting of quantitative targets, and provide, as appropriate, adequate economic incentives to producers. (EU, 2018)

EU directive 2018/851 focuses on education and institutional design to raise awareness (see fig. 2) about negative effects of waste. Awareness, we have argued, is something that is hampered by the design of modern waste management systems, characterized by the processes of 'invisibilization' of municipal waste. Efforts at prevention, reusage, and recycling (EU directive 2015) are all hindered by these processes.

Problems of citizen education and the collective reimagination of waste come together in the design of waste infrastructures in affluent countries. To gain collective support for the proposed and much needed changes in the way these countries deal with waste, waste perceptions in advanced urban contexts must first be laid bare as both historically contingent and antiquated. This means that anthropological, sociological, psychological, and urban geographical insights concerning waste and its management must be combined to address local, economic, environmental, and social issues. Here we believe that both the dynamic reconceptualization of maintenance as well as the reflexive repair approach can be of use.

What both of these approaches to maintenance highlight is the fact that infrastructure is more than a simple network of technologies, and that its upkeep is a value-laden process. This realization, we believe, is paramount to making room for the re-imagination of waste infrastructure, and the way we experience waste itself. As Henke and Sims put it,

> [I]nfrastructural repair is not just about fixing things but also relationships and negotiation. An approach to reflexive repair that focuses only on technical fixes and eschews conversation misses opportunities to build common discourses and identities around a complex and urgent problem; talk also allows us to listen and learn when we disagree and misunderstand. (2020, 134)

Thus the remaining two sections of this chapter explore potential avenues of re-conceptualizing our modern vision of waste through waste-affirmation.

4.8   Waste-affirmation and municipal solid waste management

It is difficult to imagine what a waste-affirming modern society would look like. Indeed, such a society might be considered 'postmodern' in the sense that it would make previously established boundaries and strict dichotomies between concepts and categories permeable and porous. In this light, Douglas (2002) asks how it is possible that something as destructive as dirt can also have a creative force. Douglas (2002), citing William James (1902), claims that the most complete systems of thought need to find some way of affirming what has been rejected, whether it is matter out of place (Douglas, 2002), objects that have lost their aura (Benjamin, 2021), or the abject excrements of the body (Kristeva, 1982). A more complete philosophy of the city would account for the presence of secular rituals in which the 'mixing up and composting of polluting things' (Douglas, 2002) takes place without recourse to technological perspectives on waste. The practical question is

how such rituals or, more generally, practices of waste-affirmation can be firmly established in urban environments. Do we need to design crises of waste, or are other venues possible?

As we've shown in the previous sections, cities are not designed for zero waste visions, but rather for zero visibility waste visions. This zero visibility paradigm problematizes efforts to challenge the modern imaginary of tidiness, with its hygienic and aesthetic connotations, and problematizes efforts to remind citizens that waste is an integral aspect of urban living that, at the same time, has negative consequences. Waste infrastructures resist new interpretations and visions of waste. Before becoming waste-affirming, we need to become waste-admitting. Besides education and institutional (re)design (see fig. 2), waste infrastructures should also play a part in this admission. Several authors have explored what dirt-affirmation would look like from a material, architectural perspective (e.g., Campkin, 2013; Shonfield, 2014). In these elaborations, dirt-affirmation is related to Foucault's (1986) thoughts on heterotopias, places of otherness that function as mirrors to the city, as counter-sites. In these 'othering' spaces, we could find the celebration of dirt and waste, the denial of purity and tidiness, an inverted city, turned inside out, the 'garbage cities' presented in documentaries such as Waste Land (L. Walker, 2011) or Plastic China (Wang, 2016). However, despite the existence of heterotopias (Foucault names places of 'deviation' such as psychiatric hospitals, rest homes, cemeteries, zoological gardens), it is unclear how these sites, except as places of contestation and experimentation, could contribute to changing urban waste practices and beliefs.

The 'broken world' thinking of Jackson (2014) may offer a new paradigm here for thinking about urban problems and solutions. We refer to his oft-quoted idea that we should aim at:

> an appreciation of the real limits and fragility of the worlds we inhabit – natural, social, and technological – and a recognition that many of the stories and orders of

> modernity (or whatever else we choose to call the past two-hundred-odd years of Euro-centred human history) are in the process of coming apart, perhaps to be replaced by new and better stories and orders, but perhaps not. (221)

One such story that needs to be dismantled is the myth of urban infrastructures as stable, and permanent. This myth of fixed and stable infrastructure (Graham & Thrift, 2007), while cities expand, and urban flows change, obscures the extraordinary everyday effort of keeping the city 'running'. The ongoing process of infrastructure, exempt from a narrative of progress and innovation, needs to be brought into focus. Post-modern cities, in this sense, are 'cities of repair' (Graham & Thrift 2007, 10.) Visibilization of waste, we have argued, comes in two forms. On the one hand, maintenance can serve to lay bare waste infrastructures by enhancing the visibility of maintenance activities. However, this first form of visibilization only temporally allows for critical engagement with waste. The second form is more permanent. It focuses on dynamic maintenance as an act of redesigning waste infrastructures to allow for the engagement with waste. The re-sensibilization to waste does not mean that we return to filthy streets filled with manure and all kinds of litter. It would mean that through this re-sensibilization, waste becomes something relatable, positive and affirmative. What is repaired & maintained are positive meanings of waste that have become obfuscated by modern imaginaries of tidiness and unlimited progress. We can think here of maintenance and repair as a continuous laying bare of waste streams in urban contexts comparable to the way the Centre Pompidou in Paris lays bare its inner tubing, its flows of air, energy, and waste.

4.9   Conclusion

Waste and maintenance are inadvertently connected. We hope to have shown that this connection can serve as a point of exploration to problematize current Western urban societies' relationship and imaginary of

waste. Perceiving waste as something aesthetically and ethically problematic inhibits the transition to a more environmentally aware vision of consumption patterns. Our current vision of waste-rejection is further entrenched into the very infrastructure we rely on to rid ourselves from our waste, which makes the re-imagination of waste all the more difficult. A dynamic conception of maintenance alongside a reflexive approach to infrastructure repair could aid us in reconfiguring our understanding of what waste is and how we ought to treat it, it would create infrastructural affordance for new practices related to new values. However, these approaches alone will not be sufficient. Instead it will take radical new visions of waste that go beyond the modern understanding on an institutional, societal, and technological level in order to re-imagine waste as a necessary reminder and remainder of our consumption, as something that we can gladly claim.

Interlude 4   Feasibility and Architectural Visions

The final empirical chapter of this dissertation considers the failure of visions from another perspective than chapter 4. Chapter 4 focused on material resistance of sociotechnical systems regarding new visions. This chapter focuses on a case that I consider emblematic for a certain type of very strict visions. Those visions offer a blueprint of the future of, in this case, urban living. While the vision itself is concerned with seemingly timeless values, such as beauty, community, and health, the buildings proposed to embed, support, and realize these values do not seem that timeless, but rather particular to a certain day and age. Furthermore, such strict visions leave little room for agency for the prospective inhabitants (or users, operators, etc.).

This chapter helps to answer **RQ 4: What tensions may occur between sociotechnical visions and value change?** In this chapter, I show how specific cherished social values, such as community and health, are translated into specific architectural choices, such as the use of certain materials, and the shape and measurements of certain living quarters. Though these choices were not infeasible, the architectural vision this chapter examines, the vision of architect Le Corbusier, is often called utopian and idealistic—or even dystopian, by some critics.

The ideals that Le Corbusier held for (new) architecture can be readily found in his writings. This chapter shows how these social ideals were translated into the design of mass housing complexes called Unités d'Habition. I also show how these ideals, for Le Corbusier, represented objectives for architecture that he considered timeless and inherent to the enterprise of architecture. Tracing the justification of his architectural choices in support of these ideals also allows for a more systematic grasp of Le Corbusier's vision for urban renewal. The specificness of these choices emphasizes the 'blueprint'-aspect of his vision: everything was taken into account and designed for the urban future his buildings would herald.

This chapter, therefore, offers a case study into how well strict, idealistic visions survive the test of time. I consider this 'test of time' from the perspective of value change. I, therefore, provide the history of the Unité in Berlin and its counterpart in Marseille to show that the strict translation of social ideals into architectural norms for mass housing complexes does not leave much room for the reimagination of such buildings, by city councils, new generations of residents, or maintenance crews.

With this final empirical chapter, a third ST-system is added to that of energy (chapter 2 and 3) and waste management (chapter 4). Decent housing is another essential 'good' in society that needs governance. It was a housing crisis after WW2 that Le Corbusier proposed to eliminate with this vision for urban renewal. That this vision was not that strictly implemented in the mass housing complex in Berlin has, in my opinion, increased its chances of survival.

Chapter 5

Maintaining a Vision

Le Corbusier's Unité d'Habitation 'Typ Berlin'

5.1 Introduction[39]

Changing societal value beliefs are important but difficult to deal with for architects. Buildings, such as public housing complexes, are often designed to last for multiple generations. Therefore, such complexes, during their existence, are likely confronted with changing societal beliefs about what is valuable in human dwelling. Changing value beliefs might affect the design, use, and operation of these buildings. For instance, changing beliefs about what is beautiful, just, or healthy might impact the way people think about a 'good' building, that is, a building that is good for living or working in. The extent to which buildings can be adapted to such changing value beliefs is relevant for their continued use and occupation, and hence continued existence. For instance, the way a public housing complex has built-in features to promote community might no longer be in line with beliefs about community that inhabitants have and the behaviour they think is appropriate to pursue this value. Whether people will keep on wanting to live in such a building depends on the extent to which these features can be deleted, repurposed or updated to align with these changing (societal) beliefs of tenants concerning community.

This chapter suggests that the more buildings express certain value beliefs of architects that are particular to a given period of time, i.e., the more clearly 'architectural' they are, the less likely they are adaptable to new societal value beliefs. In this chapter, I take buildings to be 'architectural' if their conception and construction is dependent upon an architectural vision. I take architectural visions as future-oriented schemata for human dwelling in which the architect's value beliefs play a central role. This means that some buildings are less architectural than others. Less architectural buildings I consider derivative of earlier visions of good dwelling. In these derivative

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buildings normalized architectural features are present. These normalized features, furthermore, might stem from different architectural visions of the past. Such buildings are not the topic of this chapter. I argue that there is an inherent tension between architectural visions and changing societal value beliefs: adaptability to new societal value beliefs requires that architects are willing to give up some of their own value beliefs. It requires that their architectural visions are less strictly implemented or can be deviated from.

However, adaptability doesn't need to pose an obstacle for building. Opposite the idea of the strict and fixed translation of architectural visions of human dwelling into the design of buildings, or what we might call the 'static perspective' on architecture, stands a perspective on buildings as processes, and living in them as an activity which changes their appearance. In this second perspective, the interior and exterior of buildings are constantly adapted to changing value beliefs. They are maintained, renovated, updated, retrofitted, and so forth, by a variety of stakeholders that might have differing ideas about what 'good buildings' are. In this perspective, a building is a continuous process that only ends with the building's destruction or negligence.

Evidently, the maintenance of a building that is allowed to constantly evolve and is understood as a process rather than a fixed entity is bound to clash, over time, with the idea of a building as an instantiation of an architectural vision, and the architect's value beliefs. First, the 'process view' of building challenges the notion that architecture is finalized once the vision of the architect(s) is realized; i.e., it challenges the idea that architecture can ever be complete. Second, it introduces the possibility that other stakeholders are involved in the creation of buildings as well, based on their own ideas of the good life, long after the 'original' architects have done their job.

Elaborating on the tension between the static and dynamic perspective on the built environment, this chapter discusses the history of a mass housing complex designed by the Modernist architect Le Corbusier. The Unité d'Habitation 'Typ Berlin' [Unité Berlin], also known as the 'Corbusier-haus',

or 'Strahlende Stadt', is one of Le Corbusier's buildings that, at first glance, instantiates his architectural vision of urban living—a vertical city inside a concrete housing block. Completed in 1958, the building provides one of the few examples of Le Corbusier's residential, mass housing design outside of France. It received the status of monument (Denkmalschutz) in 1994.[40] However, during its construction in Berlin, existing building codes and other obstacles collided with Le Corbusier's principle-based, utopian vision of urban living. The many forced changes the original plans of the Unité Berlin underwent, resulted in it being disavowed by its architect, notwithstanding the building's immediate—and lasting—positive reception in Germany.

Depending on the perspective taken on architecture, Le Corbusier's project in Berlin can be conceived of as either a failure or a success. This chapter elaborates on both these interpretations. First, to explain the *failure* of the Unité Berlin, this chapter gives an account of the role of value beliefs in architectural visions. Section 2 of this chapter argues that value beliefs are essential elements of architectural visions: as beliefs about valuable states of affairs in human dwelling to which architecture contributes the necessary means. For some value beliefs at least, we can say that they 'moralize' these visions and justify choices concerning architectural features, materials, and design principles. Furthermore, section 2 introduces four values as leading in Le Corbusier's modernist vision of urban living achieved through architectural choices. In line with this vision-based perspective on architecture, section 3 shows how these four values were translated and specified in Le Corbusier's ideas for the five Unités d'Habitation de Grandeur Conforme, of which the Unité Berlin is one.

Le Corbusier's Unité Berlin was challenged from the start by German building codes, social housing norms in the late 1950s, as well as financial

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[40] The monumental status concerns the entrance hall, the inner streets and the facades. Several other dates are offered by different sources. The Le Corbusier Foundation suggests 1994, Clemens (2006) 1993, Högner (2020) 1995. I stick to 1994, mentioned in the Corbusierhaus Monument Conservation Plan of 2005.

worries. I elaborate on these challenges and their consequences in section 4 and 5. Questions about the viability and feasibility of his vision, furthermore, reappeared in recent decades. A changing ownership structure, material innovations, and changed value beliefs of residents played an important role here, as did the Unité Berlins status as monument. For instance, private ownership allowed individual homeowners to decide what to do with the interior arrangement of their apartments, based on their personal ideas of good living. Section 6 elaborates on these aspects and their relevance for the continued *success* of the Unité Berlin. It does so by comparing the Unité Berlin with the most famous of the five realized Unités, the one built in Marseille.

In the concluding section of this chapter, I argue that the success of the Unité Berlin as mass housing unit is more relevant than its failure to live up to Le Corbusier's standards. Rather, this failure, and Le Corbusier's rejection of the Unité Berlin, are part of its success as 'lived-in' architecture. However, this proposition needs elaboration in Le Corbusier's case. His belief that buildings were *machines for living in* proposes to see the Unité Berlin as a process, but a strictly controlled process. This process had a fixed input and output. Value beliefs and social relations were to be created in residents, rather than accepting that residents already had salient value beliefs and social relations. Architectural visions, therefore, do not need to conceive of the buildings that are based on these visions as fixed entities. But, even if architects perceive of buildings as processes, their architectural visions tend to present a fixed set of value beliefs and social relations as outcomes of these processes. This means (societal) value change remains an issue for such visions, such as the Modernist visions of mass housing that emerged after WW2.

5.2   Architectural visions and values

Architectural visions delineate how in the future, actions and states of affairs are supposed to be enabled and promoted through architectural design, corresponding to a set of salient value beliefs of an architect or school of

architecture. Architectural visions might, for instance, propose a future in which buildings promote actions and states of affairs that are believed to be healthy, sustainable, just, or beautiful. Such proposals function as 'bids for the future' (Berkhout, 2006). They can organize, motivate, and guide different societal actors involved with building and dwelling (Borup et al., 2006; Brown & Michael, 2003; van Lente, 2012). Architectural visions also provide a theoretical and often ideological frame that supports the need for change in the built environment (Lefèbvre, 1972).

Despite his image as an authoritarian architect who strictly implemented his radical vision of urban dwelling, Le Corbusier was not categorically opposed to changes made to his designs. For instance, Boudon's (1972) analysis of Le Corbusier's design of the Cité Frugès (1924–1927), in Pessac, shows an architect willing to concede, when confronted with alterations made by the inhabitants of the 51 houses in Pessac, that 'life is always right, it is the architect who is wrong' (quoted in Boudon (1972), p. 65). However, his authoritarian idea of architecture is reaffirmed in claims such as that the Pessac houses required that 'the tenant must change his outlook' (ibid, p. 65). These quotes suggest that the tension between architecture as static, and 'lived-in architecture' as a continuous process, existed within Le Corbusier's own conception of architecture as well. Among other things, this meant he was pioneering attempts to resolve the tension between standardization and individuation in the design of mass housing complexes (Boudon, 1972; Sbriglio, 2015).[41] I elaborate on these attempts in section 3.

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[41] Le Corbusier was one of the first architects to suggest a fusion between accommodation/housing and architecture. The housing of the urban working class had already been a concern from the second half of the 19th century onwards, but only became an architectural concern for the modernist movement and it's forerunners, such as Garnier (1869 – 1948), Taut (1880 – 1938). To make mass housing an architectural concern meant that aesthetic questions and utopian ideals of dwelling merged in visions of future cities in which the built environment would allow *all* social classes to live decent lives (Urban, 2013). It also meant that mass-housing buildings could become monuments.

Furthermore, his disavowal of the Unité Berlin indicates that Le Corbusier made a distinction between acceptable and unacceptable changes to his designs. It is unclear, however, how to conceptualize this distinction, without a clear view of how, and which, value beliefs informed his architectural choices. The analysis of the role of value beliefs in architectural visions I will provide below will help to conceptualize this distinction. The analysis below builds on three philosophical distinctions concerning value beliefs in architectural visions: between substantive and procedural value beliefs; between instrumental and final value beliefs; and between extrinsic and intrinsic value beliefs. Together, these distinctions help to pinpoint the moment when Le Corbusier felt compelled to disavow the Unité Berlin as well as providing reasons for this disavowal.

First, substantive value beliefs can be distinguished from procedural value beliefs in architectural visions.[42] Simply put, it concerns the distinction between the process of architecture or building and the results of that process, i.e., between building and dwelling. Procedural value beliefs express how architecture and/or building should be conducted, whereas substantive value beliefs express what is believed essential in human dwelling. For instance, value beliefs can appear as procedural principles for architectural design (principles such as: *the new architecture is economic* (Van Doesburg, 1970 [1924]) or *form should follow function* (Le Corbusier, 2007 [1923])). Such principles specify how architecture should be conducted, rather than specifying the ends of such processes. However, architects—or schools of architecture—are often told apart by the different substantive value beliefs they have. Substantive value beliefs moralize objectives for architecture: they qualify future states of affairs that architecture should bring about. These states of affairs are believed to be good in a specific way; they are healthy, sustainable, just, serene, and so forth. Finally, both procedural

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[42] To avoid confusion, I do not propose that value beliefs are substantial or procedural. Rather, these beliefs are about what are considered substantive or procedural values.

and substantive value beliefs inform and justify decisions made concerning materials, measurements, location, interior space, and so forth.

Le Corbusier's vision of urban living was centred around beliefs concerning four dominant values that informed and moralized his architectural choices for mass housing design: efficiency, beauty, health, and community.[43] His beliefs concerning efficiency take this value as procedural, his beliefs concerning the other three values take these values as substantive. Beliefs concerning efficiency mostly sprung from the need Le Corbusier, and many others, saw for mass housing, scalability and mass production after both World War 1 and 2, as well as a need for efficiency in living realized through the interior design of dwellings, such as built-in storage space and kitchens optimized for cooking (Le Corbusier, 1938, 1987, 2007, 2016). Thus, Le Corbusier's beliefs about efficiency qualify what is good for the process of building and good for the process of living in buildings, without qualifying what good buildings are or good living is. Efficiency concerns the economy, effort, and waste with which certain objectives are met. It doesn't concern the content of these objectives.

Le Corbusier's beliefs about beauty, health, and community specify the substantive moral and aesthetic ends that architecture should pursue: He stressed the intertwinement of functionality and beauty in industrial artefacts such as grain silos, and automobiles; He studied how community was 'designed' into monasteries and ocean liners; He related moral and physical degeneration to the medieval design of many cities. Their narrow, winding streets, resulted in small, damp living quarters of the workers (Fishman, 1982;

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[43] I mainly focus here on (moral) final values. Values such as simplicity, objectivity, and rationality—often associated with the Modernist movement—are left out here. I consider these values instrumental and will return to them in section 3. Evidently, efficiency is not a moral value, but emerges as a dominant concern for public housing after WW2 and therefore warrants inclusion here. The coming sections show that this was the dominant value for authorities involved with public housing, and its shortage.

Le Corbusier, 1987, 2007).[44] The dire state of their dwellings brought those workers on the streets at night and to the cafés (Le Corbusier, 2007). The moral degeneration that resulted led to alcoholism and stoked fears of a revolution (Eribon, 2019).

These three substantive values form the centre of Le Corbusier's modernist vision of architecture. As values, they were not controversial. These values are equally important today for architecture and urban planning, though other values, such as sustainability and equity, would need to be added to this list. The innovative aspect of Le Corbusier's architectural vision lay in its social, technical and aesthetic intentions (Henket, 1998). What was controversial about his vision is the specific beliefs he had in relation to these three values and the architectural choices he proposed to support these beliefs (see, for instance, Hall (2014); Jacobs (1992); Sennett (2006); Urban (2013)). Section 3 elaborates on these beliefs and choices.

A second distinction that needs to be made is that between beliefs about the finality of certain values and beliefs about the instrumental status of certain values. Objects and states of affairs are believed to have instrumental value if they are valued for the sake of something else, which might be another object or state of affairs with instrumental value, or something that is believed to have final value (Korsgaard, 1983). Thus, value beliefs in architectural visions, such as Le Corbusier's, might specify the moral ends, or the means of architecture. In Le Corbusier's case, these moral ends were appeased and healthy workers, communal living and beauty (often identified

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[44] 'In our walks through this maze of streets we are enraptured by their picturesqueness, so redolent of the past. But tuberculosis, demoralization, misery and shame are doing the devil's work among them.' (Le Corbusier, 1987, p.284); 'We are unhappy living in unworthy houses, because they ruin our health and our morale. We have become sedentary creatures, it is our lot; The house eats away at us in our immobility, like consumption. We will soon need far too many sanatoria. We are unhappy. Our houses disgust us; we flee from them and frequent cafés and dance halls; or we gather together glum and skulking in houses like sad animals; we become demoralized.' (Le Corbusier, 2007, p.96)

as harmony, proportionality, or serenity). He also qualified the means to foster these ends: he envisioned the apartments in his Unités d'Habitation as being open, accessible, and modular. In this latter case, architectural features were believed to be valuable because of certain properties Le Corbusier considered inducive to valuable states of affairs. These are beliefs about the instrumental value of these features. Modular, open apartments might be inducive to efficient and harmonious living and efficient building, while efficient building itself was believed instrumental in dealing with housing shortages in France after WW1 and WW2. Efficiency, thus, is not and end in itself.[45]

The relation between means and ends in architecture is not always strictly causal, since inhabitants might not always exhibit the behaviour that the architectural features provide the means to.[46] Such features are perhaps necessary but not sufficient for certain inhabitant behaviour. A proposed building or city design affords a certain way of behaving and living. In most cases, it doesn't enforce this behaviour or living. Le Corbusier's choice for large windows, for instance, might foster health and mental well-being. It is still a question whether inhabitants will actually behave in accordance with these value beliefs. For instance, they might keep their curtains closed all day out of concerns for privacy that trump their concerns about health.[47] It might also be questioned whether these inhabitants share the belief that large windows are valuable, or that they value them for reasons of health. They might keep their curtains open because they want to spy on their

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[45] Le Corbusier's veneration of efficiency in city-planning sometimes brings efficiency close to being an end-in-itself for the survival of the city. However, it's finality is not of a moral kind, since it concerns the fate of cities, rather than its inhabitants. See sections 3 and 6.

[46] See, for instance, the analysis of the housing-units and their inhabitants of the 'Cité Frugès', in Pessac, designed by Le Corbusier in the 1920s (Boudon, 1972). Boudon's analysis is similar to the argument developed here, although my conclusions differ.

[47] However, some features such as the fixed, concrete brise-soleils (sun-breakers) in the Unités, to 'control the sun', designed for climate control/health, seem less about affordance than about coercion (Siret, 2004).

neighbours, etc. What an architectural vision, such as Le Corbusier's, often implicitly proposes is that people will live in accordance with what a building or city affords, because they value, or come to value, this way of living, e.g., they value beauty, health, community, and efficiency. More precisely, they (come to) agree with the beliefs concerning beauty, health, community, and efficiency that architects, such as Le Corbusier, put forward in their architectural visions, and specify in their designs, such as the Unités d'Habitation.

To fully understand the possible reasons why Le Corbusier disavowed the Unité Berlin, a final distinction needs to be made: between beliefs about what has intrinsic or extrinsic value in architectural visions. Although often conflated with the distinction between instrumental and final values, these two distinctions need to be kept apart (Korsgaard, 1983; Van de Poel, 2015). If an object or state of affairs is believed to have intrinsic value, this value is believed to supervene only on intrinsic or non-relational properties (Korsgaard, 1983; O'Neill, 1992; Van de Poel, 2015) and, in its strongest sense, its value is believed to be independent of human acts of valuing (O'Neill, 1992). If an object or state of affairs is believed to have extrinsic value, its value is believed to be derivative, i.e., its value does not depend on intrinsic properties alone, but also on relational properties. Such extrinsic values might be instrumental, but not necessarily so. Think, for example, of historical objects that are valuable because they belonged to someone or were used for a certain purpose (both relational features), for example Lincoln's pen with which he signed the Emancipation Proclamation in 1863 (Kagan, 1998).

Based on these three distinctions, Table 1 shows how Le Corbusier's beliefs about the four central values can be characterized. For instance, we can assume Le Corbusier believed beauty to be an intrinsic, final, substantive value. He argues at length that beauty is the ultimate goal and concern of architecture (Le Corbusier, 1987, 2007). In *Toward an Architecture* (2007[1927]), furthermore, Le Corbusier emphasizes the need for a return to a classical idea of beauty in building and urban planning, with a distinct

modern twist, as the next sections will show. He considered his buildings as intrinsically beautiful, regardless of the actions of (future) inhabitants and their valuings, or the context in which these buildings were placed.

We can therefore make a distinction between the states of affairs Le Corbusier's Unités d'Habitation, as means, would enable their inhabitants to realize, their relational value in his architectural vision, and the values that he believed to be intrinsic to building. These relational final values are community and health. Beauty, however, supervenes on the intrinsic properties of his buildings, or so Le Corbusier believed. In the latter sense, we might argue, Le Corbusier perceived his buildings not only as means, but also as intrinsically good.

Value	Instrumental/ Final	Intrinsic/ Extrinsic	Procedural/ Substantive
Efficiency	I	E	P
Community	F	E	S
Health	F	E	S
Beauty	F	I	S

Table 9: Properties of Le Corbusier's beliefs concerning efficiency, community, health, and beauty.

The different properties of Le Corbusier's value beliefs lead to two hypotheses about Le Corbusier's reaction to enforced architectural changes of his design for the Unité Berlin. First, I propose that when architectural features that Le Corbusier considered inducive to substantive values were challenged or changed by others, he was more likely to abandon or disavow a project, than when features believed inducive to procedural values were changed or challenged. Although efficiency was a necessity for dealing with housing shortages and mass-production, beliefs about efficiency concern the process rather than the design of a building. Therefore, it wouldn't seem likely that Le Corbusier would disavow a building because the building

process is believed to be inefficient. Second, amongst substantive value beliefs, I propose that beliefs concerning beauty, which Le Corbusier understood as both a final and intrinsic value, once challenged through proposed architectural changes, are most likely to lead to his disavowal of a project. Enforced changes in the design of a building means that its intrinsic properties might change. Since beauty, according to Le Corbusier, supervenes on the intrinsic properties of buildings, any changes in these properties will affect beauty, even to the extent that it ceases to exist. I return to these two hypotheses in section 5.

5.3 Four Values in Detail

Architecture equals a force of destiny for Le Corbusier. It is a 'technocratic engineering of souls' as Gasiorek puts it (2005, p.141). For Le Corbusier, the house is an efficient tool, but not one with which an inhabitant is free to interact. The building determines what takes place in it. A new form of human agency was (intended to be) a result of Le Corbusier's buildings rather than leaving room for the agent to express and realize their own value beliefs.[48] As Thompson (2005) puts it, 'The idea is not that its occupant should modify it, but that it should modify its occupant' (p. 33). These aspects emphasize the paternalistic nature of Le Corbusier's vision: residents would only come to understand what was good for them through living in the buildings that Le Corbusier proposed.

This section elaborates on the four values central to the design of the Unités d'Habitation within Le Corbusier vision of urban renewal. I discuss these values and the impact they had on Le Corbusier's architectural choices with

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[48] This runs counter to Winston Churchill's often quoted line at a meeting in the House of Lords, in 1943: 'We shape our buildings; thereafter, they shape us.' In Le Corbusier's vision, the collective 'we' Churchill presupposes in the design and rebuilding of the (destroyed) House of Commons, emerges only afterwards, as a result of building.

4 schematic renderings that are based on the writings in: *Toward an Architecture* [TA] (2007 [1923]); *The City of Tomorrow and its Planning* [CTP] (1987[1924]); *Precisions* [P](1991 [1930]); and *A Radiant City* [RC] (1967[1934]). Each scheme shows two processes: of moralization, in which instrumental architectural norms and design choices are justified through higher-order value beliefs; and of specification, in which salient value beliefs are specified into norms, plans, and buildings. These schemes help to analyse how the different levels (principles, values, norms, material choices) hang together discursively, and how a failure to meet a certain norm has potential consequences for higher-order moral principles and values. I give examples of both realized and unrealized projects that manifested these choices and value beliefs. Furthermore, in the Unités d'Habitation, Le Corbusier's ideas for urban renewal, mass housing, and individual living come together. I therefore include these three levels in the schemes where possible.

The schemes here presented are based on a careful reading of the selected works. Appendix A shows a sample of selected text fragments and the coding that took place to identify the values, principles, and norms.[49] It is important to show that Le Corbusier's visionary ideas could be analysed systematically to understand how substantive final values and lower level architectural choices (materials, measurements, etc.) hang together. The often pamphlet-like character of the cited works does not preclude such an analysis. In other words, there is coherence in his architectural beliefs, beliefs that are often repeated.

On Beauty

Figure 26 provides a systemized account of Le Corbusier's ideas of beauty. As we have seen, we assume that according to Le Corbusier, beauty supervenes on the intrinsic properties of buildings, their geometric form,

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[49] The complete set of fragments and interpretations can be found in the 4TU repository. Chapter title or author name suffice as search terms.

their regulating lines, the way they let light enter. This beauty exists independently from human observers. Furthermore, Le Corbusier believed that the experience of beauty would create appeased, and productive citizens (CTP). The home would become a place in which one could think, rest, and even meditate (Dunnett, 2000). The eradication of any historical referents in the building would allow inhabitants to retreat within themselves and arrive at self-knowledge (Richards, 2003). Residents would no longer feel compelled to leave their house/apartment in search of outdoors entertainment. Furthermore, Le Corbusier's insisted that beauty was already pursued, albeit 'unconsciously', in the design of modern machines: in the Farman Goliath biplane, the Cunard ocean liner *Aquitania,* the Voisin C7 automobile (TA; P). In these designs, form followed function, and the result was an experience of modern beauty (serenity, harmony), that was to 'crystallize the spirit of the modern age' (Gasiorek, 2005, p.140).
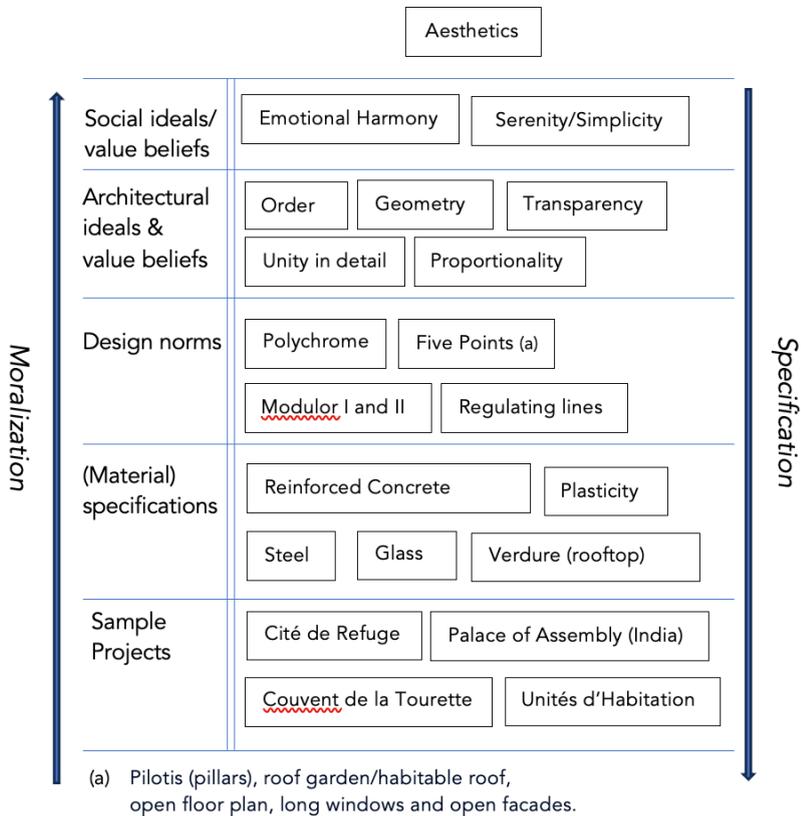
Figure 26: Specification and moralization of beauty.

Levels move from the concrete up to the abstract: Specific projects are mentioned at the bottom. In this projects, the choices made regarding material and design correspond to architectural ideals and values. These ideals and values, in their turn, are believed supportive of or inducive to social ideals and values.

On Efficiency

Efficiency is, in the view of Le Corbusier, an extrinsic instrumental value, which nevertheless in both TA and CTA often appears as almost a final value, especially for urban planning. 'Efficiency' concerns the economy with which

certain goals are met. This economy of goal-realization we find in the design of machines but needs to be transposed to the design of cities and buildings, since these are conceived by Le Corbusier as being machines as well. The architect creates the efficient conditions for the collective to emerge. Furthermore, efficiency plays out on two other levels: besides an efficiency in movement in the city by means of modern transport (trains, planes, and automobiles), there is efficiency in interior design and efficiency in building processes. Figure 27 provides a rudimentary scheme of these three levels of efficiency.

Architects should be envisioning a *house-machine*, urban planners should be creating a *town-tool* in which efficient social engineering takes place. For instance, the city depends on mobility and speed for its 'success' (CTA, p.179). Efficiency of movement in the town-tool is achieved by a grid-like structure and straight, wide avenues as well as 'vast and sheltered public parking places where cars can be left during working hours' (CTA, p.122).

The design of the house was pivotal in maintaining a work-oriented society. A house should be 'as practical as a typewriter' (TA, p 267), maximizing 'domestic economy' (TA, p. 275). It contained equipment rather than furniture (Le Corbusier, 1937). Efficiency applied to interior design meant that there was a minimum of interior walls to avoid claustrophobia (Flint, 2014). Bedrooms had sliding doors. Since interior load-bearing walls were mostly absent, the interior organization was open (TA). The use of reinforced concrete allowed for seamlessly connected spaces inside houses and apartments, allowed for open kitchens, designed according to the needs and movements of the person cooking (Flint, 2014). Storage space was often built-in as were bookcases, disappearing into the few walls. Furniture was kept to a minimum.

> We must arrive at the 'house-machine' which must be both practical and emotionally satisfying and designed for a succession of tenants. The idea of the 'old home' disappears, and with it local

architecture, etc., for labour will shift about as needed, and must be ready to move, bag and baggage. The words 'bag and baggage' will do very well to express the kind—the 'type'—of furniture needed. Standardized houses with standardized furniture. (CTP, p. 231)
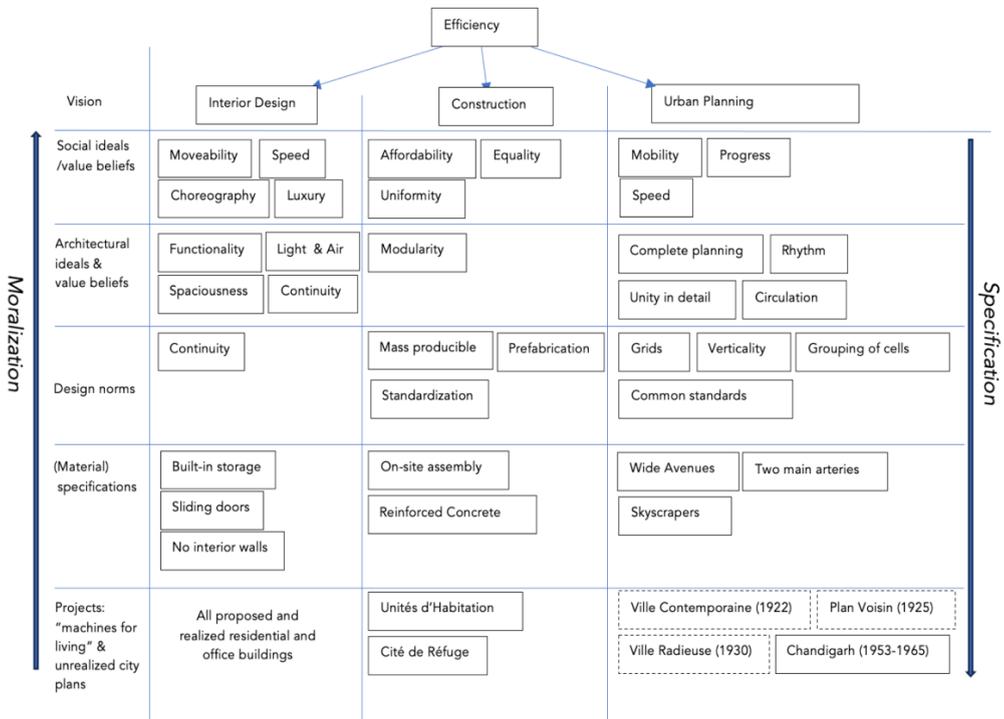

Figure 27: Specification and Moralization of Efficiency

On health

Health played a prominent role in both city planning and the design of the Unités d'Habitation. Le Corbusier distinguishes between moral and physical

health—although often entwined in his propositions for architecture. I will leave moral health aside here, since it is mostly mentioned as a consequence of sensations of beauty and serenity. Physical health is both passively and actively pursued, in the design of buildings and their surroundings.

Passively, it is a question of natural light, space, and greenery. A return to nature played a pivotal role in restoring health to the urban worker (Dummett, 2008; Dunnett, 2000). In this passive sense, health almost appears as an intrinsic feature of the build environment, regardless of the attributions and behaviour of inhabitants. Healthy dwellings were created by the circulation of clean air, access to sun light, and access to nature around the buildings (González-Avilés et al., 2022). Furthermore, in his unrealized urban proposals *Ville Contemporaine* (1922), *Plan Voisin* (1925), and *Ville Radieuse* (1930), the high-rises in the city centre stood isolated from each other in open, park-like, spaces that included urban gyms and other sports facilities. Buildings were put in a park, rather than parks being created between buildings 20/01/2026 09:46:00

Actively, in the unrealized urban proposals, sports play an important role, to such extent that Le Corbusier has been accused of an 'sportivisation' of urban life (Perelman, 2015).[50] Sports were to be everywhere; as soon as one left the home one would stumble upon a sports field (P, p.142). Free time would be passed by playing sports (P). But also within the proposed residential buildings and mass housing complexes, sport was integrated into daily life. The mass housing complexes, the Unités d'Habitation, would have an interior gymnasium as well as a running track and small pool on the roof.

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[50] This, combined with Le Corbusier's collaboration with the Vichy regime, has led to an intense debate in France, whether or not Le Corbusier was a fascist. See, for instance, Brott (2017).
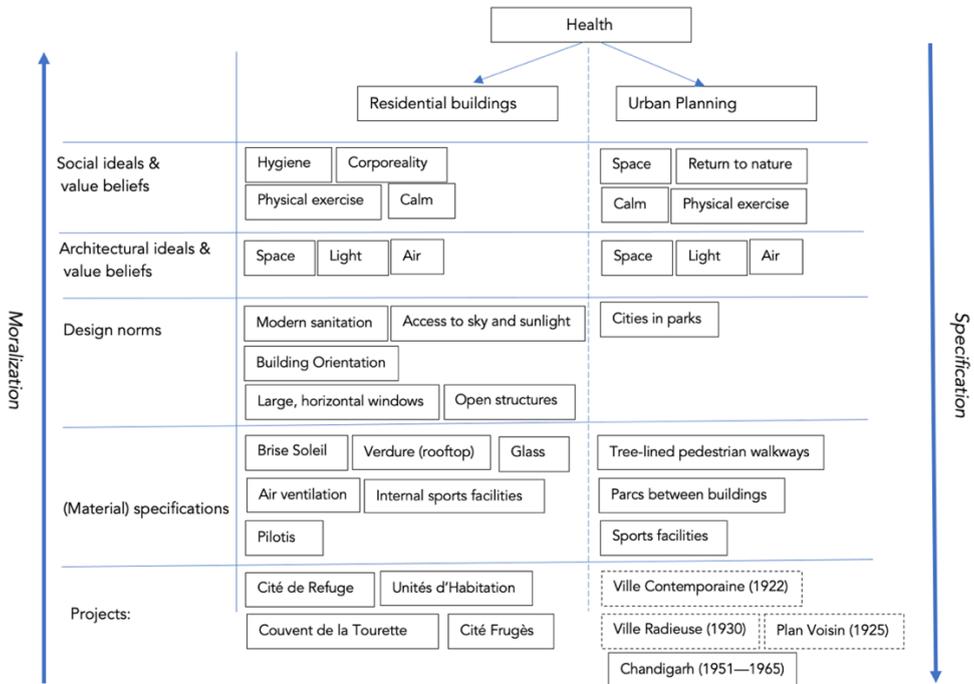
Figure 28: Specification and Moralization of Health

On Community

Community is an extrinsic, final value in Le Corbusier's view and it is a value that is often overlooked in analyses of his legacy. Community was to be created inside the mass housing complexes and outside, in the shared sports facilities and parks. The mass housing complexes were conceived of as vertical cities (CTP). For these complexes, the ocean-liner was taken as the ideal machine that brought individual freedom and collective pleasures together (Gans, 2006), while Le Corbusier was also using the insights concerning the communal life he had studied in monasteries in the 1920s (Taylor, 1987). His mass housing complexes set out to create a residential community, in which shared facilities, such as a day-care centre, nursery school, and primary school, as well as a restaurant and cooperative food

store and laundry would link the residents with each other (Fishman, 1977; Flint, 2014). The mass housing complex would be a 'happy hive' (Flint, 2014), the 'manifestation in daily life of a wise social order' (P, p. 71).

However, within Le Corbusier's proposals for urban renewal, social congregation would be completely controlled. No provisions were made for active political participation (Richards, 2003). Chance encounters were hardly possible in the planned cities. There was little need to get outside the 'vertical city' after returning from work. Entertainment was to be sought inside the house, or the housing complex. Le Corbusier celebrated the gramophone over 'the germ-ridden concert hall' (Richards, 2003, p. 3). The community that Le Corbusier envisioned therefore also entailed a clear cut between the private and the public, as he had witnessed in the monasteries. Here, the reflective and subdued private lives of the monks was kept strictly apart from the collective life. Their individual cells were isolated from each other, while each cell had a garden space and a view of the hills (Toland, 2001)

People lived apolitical, segregated lives in the city, governed by technocrats, while apolitically living together in their mass housing complexes. The emergence of this intramural community was also planned. Le Corbusier designed his buildings for encounters in the nursery schools, the sports facilities, the laundry rooms, in which a lack of ornament and a focus on functionality would eliminate the expression of social rank and, therefore, social strive (Richards, 2003). The urban community as political entity would disappear (Sennett, 2006). It would make place for a community that maintained, through their engineered interactions, an already perfected machine for living (Richards, 2003). In a letter to the Minister of Reconstruction and Urbanism, Claudius-Petit, on the occasion of the inauguration of the Unité Marseille, in 1952, Le Corbusier already claimed success:

> These tenants from Marseille, left to their own
> devices in the building, inaugurated on October 14,

1952, were quick to form an association, a true vertical community without any political affiliation, to defend its interests and develop its human value, etc… (Le Corbusier, 1953, p.190)[51]
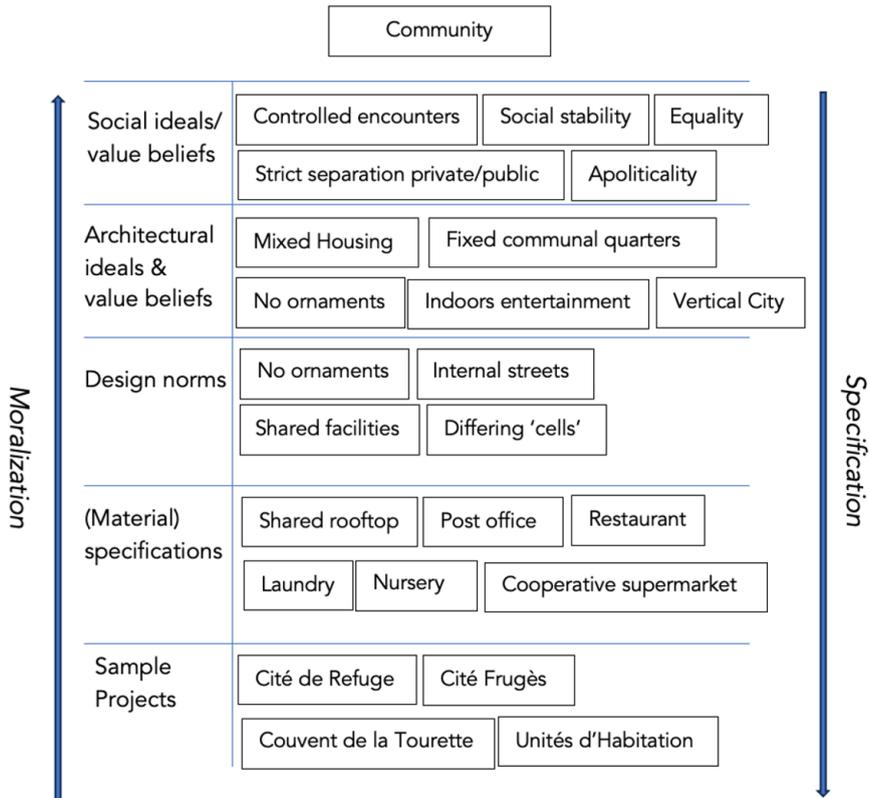

Figure 29: Specification and Moralization of Community

[51] Translated by the author. Original text: 'Ces locataires de Marseille, laissés à eux-mêmes dans l'immeuble inauguré le 14 octobre 52, n'ont pas tardé à se constituer en association, véritable communauté verticale sans politique, destinée à la défense de ses intérêts et au développement de sa valeur humaine, etc … '

5.4   Unités d'Habitation: Values and Vision Materialize

This section shows how Le Corbusier's ideas for mass housing came to fruition, especially in the first built Unité in Marseille. The Unité Marseille, furthermore, will be compared with the Unité Berlin in section 7, leading to my main insights concerning the success and failure of Le Corbusier's ideas.

In 1944, Raoul Dautry, minister of Reconstruction and Urbanism in newly liberated France, asked Le Corbusier to create proposals for mass housing in new industrializing zones such as La Rochelle (Millais, 2015). Only in Marseille, in 1945, the first opportunity presented itself to Le Corbusier to realize a vertical garden-city (Sbriglio et al., 2004; Jenkins, 1993). Although he had experimented with mass-produced housing for the working classes before the war, this was the first time that Le Corbusier could really put his ideas, developed in *The City of Tomorrow and its Planning* (1924) and *Toward an Architecture* (1923), along with the precise norms of *Modulor I and II*, into practice for a seventeen-storey building (Millais, 2015). Conceived of as a steel framework, in which the prefabricated housing units could be slid, the entire design of the first Unité was meant to resemble a city in itself. There were interior streets, communal facilities in/on the rooftop, shops, a restaurant, and a hotel on levels 7 and 8 (Sbriglio et al., 2004; Millais, 2015). As a further novelty, the building also had fixed, concrete sunshades (Blake, 1966).

For Le Corbusier, to guarantee equal access to sensations of serenity and harmony in the built environment, standardization of both housing units and even furniture was required. Such standardization fitted the reconstruction programs for French cities bombed by the Germans and, beginning in 1943, the Allied forces (Cohen, 2014). It would allow for the mass-production of affordable housing units on an industrial scale. The building site should become an assembly line (Sbriglio et al., 2004). 'If everything could be mass-produced, prefabricated, and assembled onsite, the beauty and convenience of his scheme for modern living could be delivered to the masses, a confluence of popularity and good taste.' (Flint, 2014, p.104).

Understanding that his ideas for the complete redesign of cities through rigorous urban planning might be too idealistic, Le Corbusier's started to redesign inner cities one building at a time. The Unités d'Habitation de Grandeur Conforme could be seen as instances of his broader vision for the cities of the future. Five Unités d'Habitation were built: four in France[52], and one in Germany.

The Unité in Marseille is the most studied of the five Unités. Although this building is often hailed as an uncompromised realization of Le Corbusier's vision, initiating the hegemony of the Modern Movement, and the building in Berlin as a great deception of compromise and ignorant German authorities, the situation was more complex (Millais, 2015; Sbriglio et al., 2004; Jenkins, 1993; Blake, 1972). Le Corbusier accepted the Marseille commission on the condition that he wouldn't have to comply with 'outdated' building codes (Sbriglio, 2004), but he soon encountered complaints from the *Conseil Supérieur d'Hygiene Publique de France.* According to this Council, public health regulations were being violated. Children's rooms and other facilities, such as the kitchen and bathroom, were dependent on mechanical ventilation and were too far removed from outside windows or, as was the case in some of the children's rooms, had no windows at all (Millais, 2015; Blake, 1977). Furthermore, the height of the ceilings (2,26 m.) was below the legal minimum (Millais, 2015). In the end, Le Corbusier was spared from all these restrictions and structural changes through a waiver, signed by the minister of construction, which exempted him from all restrictions and laws, even from obtaining a building permit (Millais, 2015). The building was thereafter labelled an 'experiment' or prototype (Gans, 2006). Furthermore, instead of eight months, the building process took five years; concurrently, the building costs rose to eight times the originally estimated costs (Millais, 2015).

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[52] Marseille (1945–1952), Rezé (1948–1955), Briey (1954–1960), and Firminy (1959–1967)

This 'success' of the first Unité could therefore hardly be expected to be replicable. That the prototype in Marseille resembled the originally planned building was a lucky combination of circumstances and the goodwill of national authorities in France that protected Le Corbusier's artistic license, rather than a convincing sign that Le Corbusier's architectural ideas had adequately addressed the urgent issues of his time. Such goodwill was not to be expected in Germany, where the *Interbau* exhibition in Berlin (1957) focused on the rebuilding of German cities in West Germany, especially isolated West Berlin, emphasizing 'a clear commitment to the western world. It should show what we understand to be modern urban development and decent housing in contrast to the false ostentation of Stalinallee' (Mahler, 1953, p. 682). All projects of Interbau needed to comply with the standards of the Baupolizei (Permit Service), the Bauverwaltung (Construction Administration) and the Bauamt (Building Office). The Abgeordnetenhaus (Room of deputies) of West Berlin, chaired by Willy Brand, would oversee the correct application of all these standards despite Le Corbusier's appeals for exemptions (Clemens, 2006).

5.5   l'Unité d'Habitation 'Type Berlin'

The Unité Berlin stands opposite the 1936 Olympic stadium, on Olympic Hill, in Charlottenburg-Wilmersdorf, on a slightly elevated piece of land called the 'Heilsberger Dreieck' (Image 1). The building measures 141m in length, 23m in width, and 53m in height (Clemens, 2006). It has 530 apartments on 17 floors, which are accessible via ten internal 'streets' (Image 2, more images in Appendix B).

Image 1: Unité Berlin, West façade (© Alleblas)

Image 2: Internal street in the Unité Berlin (© Alleblas)

Built in a relative short period (18 months, January 1957–August 1958) compared to the other Unités, the building process was time- and cost-efficient (Högner, 2020; Müller-Reppen, 2014; Scholz, 2008). However, this building process was anything but smooth. Le Corbusier and his assistant/project manager Wogenscky acted as supervisors on the project without being able to interfere with, and direct, the building process itself (Clemens, 2006; Högner, 2020). They could object to the many changes that the original plans underwent, but were often confronted with these changes

after the fact, on the construction site. Many of these changes during this construction process were, therefore, not communicated and not formally accepted by Le Corbusier. As a result, only one reference to the building is found in Le Corbusier's *Complete Works (book 6: 1952–1957)*:

> Despite his strenuous objections, Le Corbusier's working plans for the Unité in Berlin were not respected. For all intensive purposes, the building corresponds, in its functional aspects to a Unité d'habitation of Congruent Size. However the manner of execution and the aesthetical interpretation are quite incompatible with Le Corbusier's desires. (Le Corbusier, 1995, p.192)[53]

And, in a foreword to builder-owner Müller-Reppen's account of the process that accompanied the inauguration of the building, Le Corbusier states:

> I worked out the plans for the residential unit at the 'Heilsberg Dreieck' extremely carefully and harmoniously, with passion and seriousness, and I can claim that an architectural work of art would stand on Berlin's Olympic Hill today if my plans could have been realized in their entirety. […] I must be allowed to state these deviations from my design. Because I cannot approve of them. (Müller-Reppen, 2014, p.9)[54]

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[53] Apart from Müller-Reppen's account (1958) of the building process (that Le Corbusier found vindicative) no serious study of the building was published for the next 50 years (Högner, 2020). To Müller-Reppen's account of the building process, Le Corbusier's added a foreword, listing his misgivings.

[54] Translated from the German by the author.

The proposed and enforced changes negatively affected, for Le Corbusier, the possibility of realizing the four central values in his architectural vision. They result in the (perceived) *failure* of the building as Unité d'Habitation. Here, a distinction has to be made between negotiated changes to the original plans, and changes made during the building process of the Unité Berlin that were often unnegotiated. It is these latter changes that exasperated Le Corbusier (Clemens, 2006). Table 2 organizes negotiated and unnegotiated changes and the values they affected, based on the schemes in section 3. This list is probably far from exhaustive, but covers the changes mentioned in the available literature (Clemens, 2006; Högner, 2020; Müller-Reppen, 2014; Scholz, 2008; Weber, 2010). I have indicated the most important deviations from the original plans, according to Le Corbusier himself, in blue (see: Müller-Reppen, 2014 and Clemens, 2006).

Date	Change	Changed during Planning	Changed during Building	Agreed upon by LC	Affected Design Principle	Affected Architectural Principle	Affected Value
Oct '55/ Jan '58	**Removal of rooftop structures**	Yes	No	Yes	Five Points of Architecture	Controlled encounters/ greenery	Community & Health
July '56	**Suppression of exterior fire escape**	Yes	No	Yes	None	None	None
July /Sep '56	**Room size/height; Rejection of the two-storey living room**	Yes	No	Yes	Modulor Principles	Proportionality	Beauty
Sep '56	**Underground parking lot cancelled**	Yes	No	Yes	Green surroundings	Building in a park	Health & Beauty

Sept '56	Installation of partition walls for bedroom and kitchen	Yes	No	Yes	Five Points of Architecture	Transparency/openness	Beauty & Interior Efficiency
Sept '56	Moving building 20 m. to the north	Yes	No	Yes	None	None	None
Oct '56/ Jul '57	Placing the machine room[55]/heating plant[56] at ground level, between pilotis, instead of underground	Yes	Yes	Yes & No. Le Corbusier proposes separate building, disconnect-ed from Unité (Clemens, 2006)	Five Points of Architecture	Transparency/permeability	Beauty
Dec '56	Change in prospective tenants: singles and couples without children[57]	Yes	No	Yes	Distribution of apartments	Mixed housing	Community
Apr '57	Change in size and position of the pilotis	No	Yes	No	Five Points of Architecture	Transparency/permeability	Beauty
Jun '57	Change in window size on first six levels (ribbon windows)	No	Yes	No	Five Points of Architecture	Transparency/access to natural light	Beauty & Health

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[55] With central air-conditioning plant, elevator machines, and generators.

[56] Currently called the 'Waschhaus', and used for events by the residents.

[57] In 2010 there were: 169 1RA (1 room apart.), 263 2RA, 90 3RA, 7 4RA and 1 FRA (Weber, 2010)

Aug '57	Cancellation of internal shopping street on floors 7/8 (middle of building)	Yes	Yes	Unclear: discussed but no decision (Clemens, 2006)	Self-sufficiency	Vertical City	Community
Jan '58	Removal of Brise-Soleils (sun breakers)	No	Yes	Yes	Shading	Climate control	Health
'58	Change of Kitchen Design	No	Yes	No	Open floor plan	Transparency	(Interior) Efficiency
'58	Enclosed staircases in apartments	No	Yes	No	Open floor plan	Transparency	(Interior) Efficiency

Table 10: List of changes made to the original plans before and during construction

Two values seem particularly impacted by the changes made to the design: first, the beauty of the building, as an intrinsic value supervening on the building's properties; second, features that would be inducive to community-formation, according to Le Corbusier's beliefs. I highlight the changes that seemed to have had the greatest impact on Le Corbusier (see also Clemens, 2006; Högner, 2020; Müller-Reppen, 2014; Scholz, 2008). Equally, I show how these changes were defended from the perspective of the builder-owner and German authorities.

First, concerning Le Corbusier's aesthetic beliefs: The Modulor principles were not respected, affecting the proportionality of the housing units. The original ceiling height of 2,26 m. was not accepted by the Baupolizei. Furthermore, for the apartments to appeal to tenants (considering the Berlin climate and average body length), the ceiling should be at least 2,50 m. high, conform social housing regulations (Clemens, 2006; Högner, 2020; Müller-Reppen, 2014). Also, the gallery design of the apartments was cancelled.

The double ceiling height in the living room disappeared. The second floor of the apartment was supposed to open to this living room but this idea was discarded. This further added to the claustrophobic aspect of the original 2,26 m. rooms (Müller-Reppen, 2014). All these changes were accepted in the planning phase by Le Corbusier—through Wogenscky (Clemens, 2006).

Second, the 'shopping street' on level 7/8 was moved to the ground floor between the pilotis during the construction process—the vertical sun-shades on these levels still refer to the planned location of the shops. The machine/heating room, originally planned below ground, and then proposed to be located in a separate building outside of the main structure, eventually ended up between the pilotis during the construction process. This meant the building no longer seemed to float on these pilotis, and the see-through property of the ground floor was largely cancelled. The building no longer resembled an ocean-liner. The amount of shops on the ground floor was reduced to a post-office, a small supermarket, and a flower shop, south of the entrance (Högner, 2020). Builder-owner Müller-Reppen cited the costs and logistics as main reasons for these unnegotiated changes (Müller-Reppen, 2014). Le Corbusier wanted the service area and entrance in the middle of the building, as they were in Marseille (Müller-Reppen, 2014). Furthermore, the loss of these amenities meant the building was not 'self-sufficient', damaging the idea of a vertical city and a building that could feed up to 1200 people.

Third, the open floor plan was rejected, which threatened the transparency of the apartments, their simplicity and serenity, as well as the efficiency of movement. The Berlin Senate deemed these features impractical (Högner, 2020). Furthermore, three-room apartments in the 1950s in Germany were required to not exceed 70 sqm to be eligible for subsidy (Högner, 2020). The relative large size of the Unité Berlin's apartments (three-room at 106 sqm) meant that smaller units, divided up in more rooms, were more likely to attract tenants (Högner, 2020). Finally, the rental price was set at 1,43 DM

per m² for the *Interbau* housing developments[58], including those made in the Hansa Viertel (Weber, 2010). The relative high and 'risky' (Müller-Reppen, 2014) rental prize and large size of the apartments for couples with or without children meant that only the higher echelons of the middle-class would be able to rent an apartment (Weber, 2010).

Regarding community, almost all of the originally proposed features had disappeared in the realized Unité. Le Corbusier's initial plans foresaw a rooftop space with a nursey school, a crèche, an open-air crèche garden, a refreshment bar, a buffet bar, and an open air theatre for 265 spectators (Clemens, 2006). All these rooftop structures were cancelled by the Baupolizei in October 1955, because of budgetary reasons and, again, the Berlin climate.[59] However, negotiations about these structures continued until January 1958 (Clemens, 2006). In December 1956, the Baupolizei declared the Unité apartments incompatible with family life, and repurposed the building for singles, and couples without children, for whom the housing shortage was most acute (Clemens, 2006; Högner, 2020; Weber, 2010). The mixed housing principle of Le Corbusier, inducive to community, was almost completely discarded. 80% of the apartments were one-room, or two-room apartments (Weber, 2010). Only the shared entrance, internal streets, and some small communal spaces remained.

Literature on the rejection of the finalized project mostly points towards the aesthetic beliefs of Le Corbusier (Clemens, 2006; Högner, 2020; Scholz, 2008). This is in line with the hypotheses formed in section 2. The beauty of the building was encroached upon by successive, unnegotiated changes made during the construction process. The change of the window size at the lower six floors (June, 1957), not respecting the horizontal ribbon window

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[58] Compared to 1,10 DM per m² for other public housing projects in Berlin (Weber, 2010)

[59] To be complete: none of the four Unités built after the one in Marseille had the set of rooftop structures seen in Marseille.

concept (Five Points of Architecture) of Le Corbusier, seems to have been a breaking point. Le Corbusier wrote to Senator Schwedler in July 1957:

> Dear Mr. Schwedler, I'm sorry to bother you, but it was you who brought me to Berlin and ordered me to build a Unité d'Habitation on Olympic Hill. You mentioned this in your advertising. I committed myself morally, not only with regard to myself (which is the most important), but vis-à-vis public opinion. The unit will not be completed for July 6, there is no doubt. Therefore, we can wait a few days more or less, a few months if necessary. What we will find in Dreieck is a functioning housing unit or a housing unit that does not work and that is where my responsibility lies and I do not accept that it is flouted. (quoted in: Clemens, 2006, p. 145)

The building process, however, didn't stop. And, despite promises to the contrary, the windows remained (Clemens, 2006).

5.6   The Unité Berlin as Open Process

The survival of the Unités d'Habitation runs counter to the criticism that has been levelled at the Modernist movement and the public housing projects that followed in its wake. Critics such as Sennett (2006), Jacobs (1992), and Scruton (2021) blame Modernism, and especially Le Corbusier, for everything that has gone wrong in urban planning and mass housing in the 1960s and 70s: Instead of creating urban utopias, rigid idealistic visions created new polarities between urban dwellers and led to social conflict. The high-rise projects, although a sign of hope and progress in the 1950s and early 60s, soon created a new generation of disenfranchised and isolated city

dwellers, in places defined by boredom and crime, especially in the USA and Europe (P. Hall, 2014b; Toland, 2001; Urban, 2013).[60]

Two possible perspectives on these problems exist. On the one hand, they seem to prove that the ideas of Modernist architects were not in accord with the 'natural' evolution of cities and the desires, values and behaviours of city dwellers. Indeed, Modernists such as Le Corbusier argue that these desires, values and behaviours are a result of the design of cities and buildings and can be changed accordingly. Critics would argue that this idea of malleability disregards individuality, autonomy, and the force of habit. On the other hand, however, these problems might be a result of a lack of will in authorities to really invest in the ideas of community, health, and beauty that Modernists, such as Le Corbusier put forward. In this line of argument, authorities in the 1950s and 60s were mainly interested in quickly built, cheap apartments for the working class and not much more. The Modernist Movement provided the utopian narrative around these buildings, but many of their ideas concerning health, community, and beauty were left on the drawing table, since they cost too much, or took too long, or didn't comply with existing regulations. Only the Unité in Marseille manifested all the ideas Le Corbusier had in mind for his machine. 'The State was the client, and there were no restrictions', he wrote proudly to the French Minister of Reconstruction and Town Planning (Le Corbusier, 1953, p.191).

Indeed, though the criticism of the Modern Movement might be levelled at Le Corbusier's grand vision of urban renewal, his isolated 'skyscrapers in a park' of the *Plan Voisin* (1925), it doesn't apply equally well to his Unités d'Habitation, as materialized instances of this vision. For one, the concept of the vertical city has endured, especially in luxurious skyscrapers and high-end hotels. These are buildings, conform Le Corbusier's ideas, which one

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[60] Telling examples of such projects are Pruitt–Igoe in St. Louis, USA, and the Robin Hood Gardens in London, England. The demolition—with dynamite—of the Pruitt-Igoe estate, in 1972, is sometimes taken as the beginning of the end of the post-WW2, utopian dream of high-density, mass social housing (e.g., Luckhurst, 2016).

doesn't need to leave in search of entertainment, nourishment, or exercise. However, while the concept of a city within a city has endured, the manner in which these amenities become part of a building and which amenities are included might have changed. Furthermore, the different Unités d'Habitation de Grandeur Conforme, despite their name[61], were not copies of the building in Marseille or meant to be copies. Rather, the Unité d'Habitation was a concept executed in plural (Toland, 2001) and not in series. This execution took into account local contexts (Millais, 2015). However, as we have seen, it is a question how much local context (wants, needs, laws, building codes, etc.) could be incorporated into a particular Unité d'Habitation before it stopped being one, according to its creator.

Although the Marseille building is the most famous, and most in line with Le Corbusier's original plans and vision, it is not necessarily the most successful when we consider its 'lived-in' history. A case can be made that the Unité Berlin has stood the test of time best. To defend this argument, Weber's (2012) extensive study of the experiences of residents of the Unité Berlin is pivotal. I use her insights here to argue that the adaptability of the Unité Berlin is key to its continued occupation: despite Le Corbusier's disapproval of the building, its *failure* as an Unité, it has been a *success* as mass housing complex (Högner, 2020; Weber, 2010). This adaptability and survival have to be analysed in light of the monumental status of the building. Though this status guarantees the continued upkeep of the building, it doesn't necessarily explain its success as mass housing complex.

Marseille

Evidently, the survival of the Unité Berlin is a consequence of the building's status as monument, but other factors are at play to explain the building's enduring success. First, turning buildings into monuments doesn't necessarily improve their liveability. There is often little space for 'adaptive re-use', a concept of renovation associated with the continued, functional

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[61] Housing Units of Standard Size

use of Modernist buildings (see, for instance, Melenhorst, 2019; Moors, 2019; Mumford, 1981; Russo, 2021). Residents of the Unité Marseille, in which Le Corbusier's beliefs concerning beauty, community, and health were most faithfully 'realized', also saw the effect of this success: an inclusion as a World Heritage Site (2016). As a result, the residents' committee overseeing the endless maintenance and repair works, focused mostly on restoration of original features and preservation without updating the building to address relevant value beliefs of residents, such as concerns raised about safety related to the roof terrace (Toland, 2001), concerns about fire safety (Delemontey, 2016) as well as more general concerns about certain outdated features and a perceived lack of privacy (R. Hughes, 1991; Millais, 2015). The roof terrace, therefore, became a tourist attraction rather than a communal space for the residents and their children (Toland, 2001). Furthermore, a fire in 2012 raised concerns about the initial exemptions the Unité Marseille had received from regulatory bodies in France, exemptions that had marked the building as a prototype or experiment (Delemontey, 2016; Gans, 2006). However, these concerns could not readily be addressed because of the monumental status (Delemontey, 2016).[62]

Second, the inclusion as World Heritage Site meant more features[63] of the building in Marseille were recognized as worthy of protection, such as the waste collection facilities and the ground level garden, as well as unobstructed views of the building and the need for a buffer zone (La Fondation Le Corbusier, 2015). This further emphasized preservation of the vision and its materialization (based on the original blueprint), rather than adaptation to changing values in society, such as sustainability and protection against heat domes (Toland, 2001; Weber, 2010). Indeed, Henket (1998) argues that internationally important buildings, such as the Unité

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[62] The Unité Marseille had already received a status as National Historical Monument in 1986. This status extended to the façades, the roof terrace, the area of the pilotis, the entrance hall and porch, the internal 'streets' and apartments No. 643 & 50, which were open to visitors (Delemontey, 2016; La Fondation Le Corbusier, 2015)

[63] More than those recognized when it was still a National Historical Monument.

Marseille, have to be restored as 'close as possible to the original' (p.13). Such a perspective on preservation explains why new functional requirements such as those based on changing beliefs about safety, privacy, or community were often not honoured in the case of the Unité Marseille (Delemontey, 2016; Toland, 2001).

These are some of the paradoxes and problems regarding the preservation of a monumental, residential building in relation to new or changing functions, uses, and value beliefs. This is particularly relevant in the thinking about the preservation/conservation of Modernist buildings. These buildings are often fragile and not built to endure (Henket, 1998, 2015). The exposed reinforced concrete structure, one of the defining architectural elements of the Modernist Movement, is often also its weakest point (Jocelyn et al., 2024; Urban, 2013). Therefore, to preserve the façade of the Unité Marseille and the inherent fragility of its béton-brut structure, the building risks becoming a permanent construction site (Delemontey, 2016). This potentially further decreases the quality of living.

Whether current residents want to live in the Unité Marseille because of its cult status as an icon of Modernism, or because of the quality of living it affords through its unaltered, original architectural choices, is not fully known. A majority of the residents considered—and probably still—the building an important part of their identity (Janson & Krohn, 2007). In any case, residents cannot expect the building to fully adapt to their value beliefs (R. Hughes, 1991). Rather, residents have to adapt to the building. The repurposing of features such as communal spaces is kept to a minimum (Delemontey, 2016). The residents' committee, furthermore, oversees activities meant to highlight the historical and architectural relevance of the Unité Marseille, as well as activities focused on community-building (*Activités - Cité Radieuse Marseille*, n.d.). In these activities, the original design and purpose of the building appear to take a central place.

Finally, the increased costs of building the Unité Marseille severely impacted its use. The government needed to sell off apartments as soon as

construction ended to curb costs. Already in the 1950s, the building had a mainly bourgeois occupation, instead of the intended working class (Toland, 2001). In contrast to its initial success as building experiment, therefore, the Unité Marseille never fulfilled its intended function: to elevate the working class to a healthy life of sports, serenity and contemplation, as well as contributing to a sense of community.

Berlin

The Unité Berlin was built quickly, at relatively low cost and in recognition of the German/Berlin building regulations. The builder-owner as well as authorities in Berlin were more interested in cost-efficiency of the housing units and of the building process than features that would support community and health. Because of the many changes during the building phase, the building was not included in the list of Unesco World Heritage Sites in 2016. The Denkmalschutz it received in 1994 focused on the entrance hall, the inner streets and the facades. These protected features are associated with the intrinsic beauty of the building and not with community or health, despite Le Corbusier's disavowal of the realized aesthetics of the building. The relative few and non-intrusive features under protection from the Denkmalschutz amount to what Henket (2015) calls a 'pragmatic approach' to conservation and preservation: 'Provided the alterations or additions are designed with great respect for the original and are worthwhile in themselves, these are acceptable in order to make the building suitable again for new functional requirements' (p.13). In 1993 the complete outer façade of exposed concrete received a layer of plastic coating that challenged the intended weathering of béton-brut, but decreased the fragility of the material (Högner, 2020). Currently, in 2025, the West façade is undergoing extensive renovations. During these rounds of renovation and maintenance none of the originally intended features have been restored.

The formed community of homeowners is meeting once a year to discuss maintenance, preservation issues, and purchases, and developed a monument conservation plan for the building in 2004–2007 (Högner, 2020).

All other community events seem to have a more free-flowing character. There is an annual summer festival, the laundromat serves as occasional late night hot spot with beamer and disco ball, an association organizes in-house yoga-classes (Högner, 2020). The Unité Berlin functions as a 'Kiez', a neighborhood typical for Berlin (Högner, 2020, p.92). Residents of the Unité Berlin, however, are free to follow the original plans and ideas of the architect. The change in ownership structure as well as the lack of monumental status of the apartments has created more autonomy for the residents regarding interior design. Apartment 205, for instance, has been restored to its original plan by the architect Philipp Mohr in 2016–2018 (Griffiths, 2018). He has lowered the ceiling and moved the walls to create the originally intended proportions. The interior design now matches that of the Unité in Marseille. This apartment however, has no special protected status, whereas the 'model'-apartments in the Unité Marseille are covered by the World Heritage Site status (Delemontey, 2016).

Furthermore, Weber's (2010) research into the experiences and feelings of inhabitants vis-à-vis the Unité Berlin shows largely positive results. A majority is aware of the architectural relevance and status of the building and mentions it as a reason for having moved into the Unité. They are satisfied with their living quarters, except for the experienced lack of storage space. Furthermore, residents believe the design of the Unité Berlin supports social interactions, community-building, and daily living activities. Weber's research also reports on the modifications made by residents to their living spaces and their motivations for doing so, reflecting how the building accommodates evolving lifestyles and expectations. This highlights the building's flexibility in meeting practical and emotional needs over decades of occupancy (Weber, 2010). For instance, the fact that the open gallery[64]

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[64] The original idea, realized in Marseille, was to have a living room, open on two levels (thus 2*2,26m high), as the center of the home, while upstairs the parents' room would occupy the mezzanine. This often meant, however, that people working nightshifts had no possibility to find a quiet, dark place to sleep after returning home.

was never realized in Berlin, means that the two separated floors of the apartments afford more privacy and more functional flexibility in line with contemporaneous needs and changed daily rhythms. Most residents (i.c., homeowners), furthermore, wanted a larger kitchen and bathroom. The functional efficiency of Le Corbusier's small kitchen needed to make room for an 'eat-in kitchen', that offers more coziness.

Furthermore, Le Corbusier's strict distinction between living and working (outdoors), meant a room for a home-office was missing. Some residents created such a room but most constructed a make-shift separation with room dividers. However, this was only possible in the larger apartments. Together, these changes show the importance for residents of individuality and autonomy in dwelling. Le Corbusier did not design for these values. He saw people changing apartments 'bag and baggage' as the shifting demands of labor turned workers into nomads (Le Corbusier, 1987). However, the fact that the Denkmalschutz covers mainly the external features of the building, means the residents have ample possibility to change the internal features according to their ideas of beauty, community, and peaceful living.

The entrance hall has seen extensive changes over time. Meant to replace the cancelled shopping streets on levels 7 and 8, the foyer initially offered amenities such as a greengrocer, butcher, milk seller, a post office, and even a fashion boutique. These amenities were also meant to bring together the residents and create one of the orchestrated instances of collective living/community. Initially, these 'vertical city' amenities were not only used by the residents, but also the soldiers of the British Infantry Brigade, stationed nearby (Weber, 2010). Most of these shops were replaced by a supermarket that, in 1994, because of the departure of the British troops, was no longer profitable and closed (Weber, 2010). The renovation of the foyer in 1999–2000 removed almost all of the facilities, installed over the years. In the entrance hall in Berlin, one currently can find a small kiosk, housed in the former post office, that sells basic groceries in the mornings and evenings.

Finally, not all changes in the original plans have worked out. Residents complain about the noisiness of the apartments, which originates in the simplified construction of the Unité Berlin (Weber, 2010). The serenity that Le Corbusier envisioned in the apartment as a place to withdraw from the world and collective life, not unlike the monk in its individual cell, is negatively impacted. Furthermore, the lack of big apartments that span the complete width of the building, from east to west, means that a large part of the realized apartments suffer from poor ventilation. When I visited last summer, many of the doors of the smaller apartments facing west were opened to the empty and cooler 'inner streets', presumably to air the apartments. Equally, the intended isolation of the building is considered problematic. Residents experience a lack of shopping, sporting and entertainment facilities in the immediate neighborhood of Charlottenburg-Wilmersdorf. The intended 'shopping street' and intended roof-top facilities might have provided for some of these wants and needs. However, Weber (2010) shows that what residents lack most is a place to meet one another, such as a café, that would reinforce the feeling of a Berlin *Kiez*.

5.7   Conclusion

Architecture provides one of the clearest and most visible examples of the materialization of visions. If preserved in their original state, buildings show how architects/inhabitants of the past thought about good living and the choices they made in relation to the values they believed essential to dwelling. Such monumental buildings then start to function as visual metaphors for human life in a certain epoch. Whether one would still want to live in such a building is a personal choice, and seems to depend on either the willingness to adapt to the building or the realization that one shares the same beliefs about dwelling as its creator.

This chapter has shown that visions are important in architecture to articulate and show the value change that an architect or school of architecture beliefs in. In Le Corbusier's case, new beliefs about beauty, health, and community

emerged out of wider changes in societies, and the poor living conditions of workers. At the same time, the analysis in this chapter has indicated that the value change an architect beliefs central to a certain epoch is not always in line with what inhabitants value or come to value over generations of occupancy. This leads to a tension between the visionary architect and those that come to live in his/her vision. Too much focus on the original vision and intentions of this architect might cause a building to be neglected, abandoned or changed beyond recognition. The five Unités were not intended to become visual icons or monuments; they were supposed to be built all over the world. The remaining Unités do no longer fulfil their intended, original function: to elevate the working class to a life of community, health, and serenity. In fact, both the Unité Marseille and the Unité Berlin have never housed large numbers of the intended members of the working class. In this sense, both buildings could be considered failures.

This chapter has juxtaposed ideas of architectural visions as being static versus dynamic. The tension between visionary architecture and 'lived-in architecture' was shown through the analysis of the Unité Berlin and the Unité Marseille. I argued that the success of the Unité Berlin, amongst other things, depended on the local building/housing criteria in Berlin during the construction of the Unité that exempted it from becoming a static, preserved relic from the past. These deviations from the original plans ensured the adaptability of the building to what mattered most to its residents: freedom and autonomy in deciding how to live in the Unité Berlin. The realized building did not have all the properties that Le Corbusier believed beauty would supervene on, nor did it have the features that would be inducive to community. However, over time the building has evolved into a site where his ideas about community and beauty have evolved. For a residential building to survive, preservation and conservation are not enough. Autonomy, individuality, and adaptability are important values for residents that an architectural vision needs to take into account.

With a tentative, systematic analysis of Le Corbusier's urban mass housing vision, I have shown how value beliefs justify certain architectural choices. I

have also argued that adaptability to the changing value beliefs of consecutive residents is an important aspect often overlooked in such visions. Adaptability is neither a final, substantive, or intrinsic value. However, if we accept that beliefs about what is good in dwelling might change, then adaptivity becomes paramount in visions of urban living, and urban renewal.

Appendix A

Method

Sample of selected fragments in *The City of Tomorrow and its Planning* (1987[1924])

page number	fragment	value	instrumental/final	comment
Foreword p. 2	The DWELLING again puts before us the architectural problem in the demand for totally new methods of building, the problem of new plans adapted to modern life, the problem of an aesthetic in harmony with the new spirit.	Harmony with new spirit	Instrumental/(final?)	On modern life: Foreword p. 3 : "The simple and ingenuous pleasure of being in the centre of so much power, so much speed. We are a part of it. We are part of that race whose dawn is just awakening. We have confidence in this new society, which will in the end arrive at a magnificent expression of its power. We believe in it."
Foreword p. 2	To-day, our enthusiasm is for exactitude. An exactitude carried to its furthest limits and raised to an ideal: the search for perfection.	Exactitude/Perfection	Instrumental	
Foreword p. 2/3	But a time has now come when modern town planning can be conceived of as a possibility, for a widespread enthusiasm has been made dynamic by the most brutal necessities of our daily life. It is directed by a lofty desire for truth. The awakening spirit of man is already rearranging our social forms.	Desire for truth/re-ordering of social life	instrumental	These are not really values, but shows the dynamic between social forces, truth in architecture/urban planning, and their alignment.
Foreword p. 4	On the other hand, when an architecture was genuinely appropriate to its environment it gave a pleasing sensation of harmony and was profoundly moving. Only when this was so, and without recourse to the text-books, did I feel the presence of one essential factor ; TOWN PLANNING, a word I only learnt later.	Appropriateness/harmony	instrumental	Again the poetry is mentioned, harmony as moving (as emotions).
p.16	But a modern city lives by the straight line, inevitably ; for the construction of buildings, sewers and tunnels, highways, pavements. The circulation of traffic demands the straight line ; it is the proper thing for the heart of a city. The curve is ruinous, difficult and dangerous ; it is a paralyzing thing.	Geometry/straightness	instrumental	Straight lines against congestion and towards cleanliness, openness, and mobility. P.17: "The straight road is a reaction, an action, a positive deed, the result of self-mastery. It is sane and noble." "In the history of forms, the moment which sees the straight line is a climax; behind it and within it lie all the arduous effort which has made possible this manifestation of liberty." (p.43) "The forms we are discussing are the eternal forms of pure geometry and these will enshrine in a rhythm which will in the end be our own, going far beyond the confines of formulae and charged with poetry, the implacable mechanism which will pulsate within it." (p.69)

Table 11: Sample of fragments with value allocation in CTP

Sample of selected fragments in *Toward an Architecture* (2007 [1923])

Page	Quote	Value	Final/Instrumental	Comment
86	The great problems of modern construction must have a geometrical solution.	geometry	Architectural/Instrumental	
86	The necessity for order. The regulating line is a guarantee against wilfulness. It brings satisfaction to the understanding.	(visual) order	Architectural/Instrumental	p.122: "Though we may reserve our judgment as to the relationship of the various zones of this industrial city, one experiences here the beneficent results of order. Where order reigns, well-being begins."
87	Machinery contains in itself the factor of economy, which makes for selection.	Economy	Architectural/Instrumental	
87	Architecture operates in accordance with standards.	Standardization	Architectural/Instrumental	
87	The business of Architecture is to establish emotional relationships by means of raw materials.	Emotional relationships	Final	
88	Architecture has for its first duty, in this period of renewal, that of bringing about a revision of values, a revision of the constituent elements of the house.	value change		"If we wrest from our hearts and minds static conceptions of the house and consider the question from a critical and objective point of view, we will come to the House-Tool, the mass-production house, healthy (and morally so too) and beautiful from the aesthetic of the work tools that accompany our existence." p.254
88	We must create the mass-production spirit. The spirit of constructing mass-production houses.	serie productivity/standardization/modularity	Architectural/Instrumental	
89	….. we shall arrive at the "House-Machine," the mass-production house, healthy (and morally so too) and beautiful in the same way that the working tools and instruments which accompany our existence are beautiful.	(moral) health	final	
95	Our engineers produce architecture, for they employ a mathematical calculation which derives from natural law, and their works give us the feeling of HARMONY.	Harmony	final	"Harmony is a state of accord with the norms of our universe." p.189 "From this we get a possible definition of harmony, that is to say a moment of accord with the axis which lies in man, and so with the laws of the universe,—a return to universal law."
97	The purpose of construction is TO MAKE THINGS HOLD TOGETHER; of architecture TO MOVE US.	Architectural Emotion/Passion	final	"Architectural emotion exists when the work rings within us in tune with a universe whose laws we obey, recognize and respect." "With inert materials, based on a more or less utilitarian program that you go beyond, you have established relationships which have moved me. This is Architecture." p. 215

Table 12: Sample of fragments with value allocation in TA

Appendix B

Pictures of the renovation/restoration of Unité d'Habitation 'Typ Berlin' (courtesy of the author)
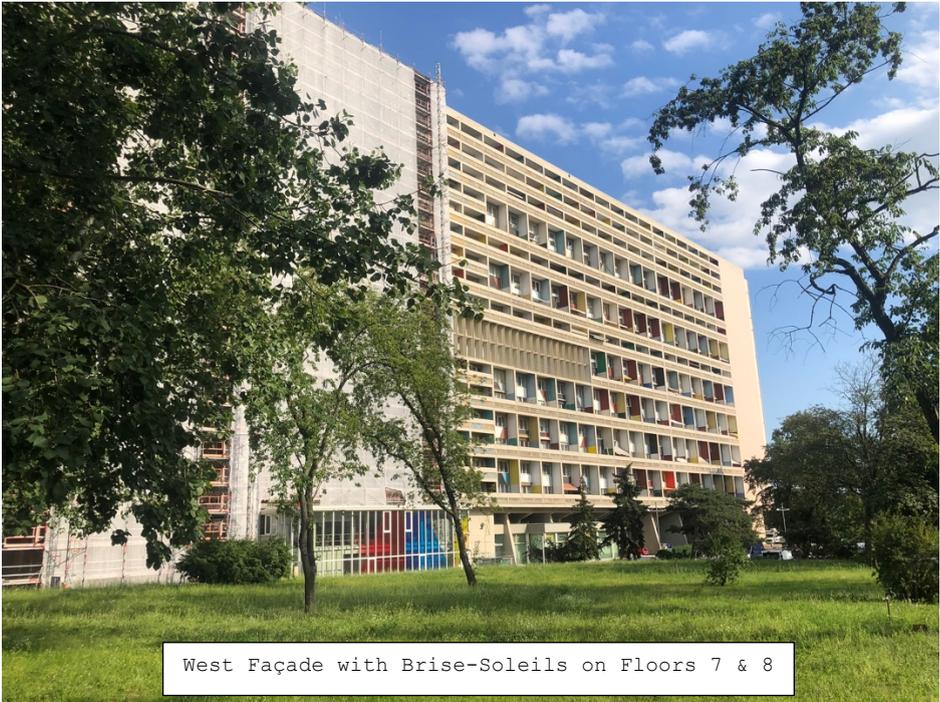

West façade Ongoing Renovations

Main Entry Hall West Façade

Modulor Man Engravings West Façade

West Façade with Brise-Soleils on Floors 7 & 8

Restored interior of apartment 205 by Philipp Mohr, including new ceiling height at 2.26m (© Didier Gaillard-Hohlweg)

Chapter 6

Conclusion

The objective of this dissertation was to investigate the interplay between values, technologies, and sociotechnical visions. Four chapters have investigated this interplay. These chapters investigated topics like the public evaluations of emerging technologies, political discourse on the future of sociotechnical systems and technologies, the material resistance to new visions (of waste), and the survival of a utopian architectural vision. Although visions of the future are ubiquitous and many contemporary visions are formed around new and emerging technologies, an important question is how exactly they inform existing practices and design. Four questions were developed in the introduction of this dissertation to answer this question. I will repeat these questions in section 6.1, and provide short answers to them.

This concluding chapter focuses on the answers to the four sub-questions and shows how the results of the four chapters hang together. It offers, albeit often tentatively, a descriptive and normative analysis of sociotechnical visions. The first section states the main conclusions of this dissertation, in relation to the four sub-questions. These conclusions are further elaborated on in the sections that follow. Therefore, the second section develops a tentative typology of visions that is used throughout this chapter. Section 6.3 further examines the role of values and ideals in sociotechnical visions. Section 6.4 critically discusses the requirement of feasibility for sociotechnical visions. Section 6.5 elaborates on the challenge of value change for visions of the development of sociotechnical systems. The final section shows the limitations of the research done in this dissertation and provides suggestions for future research.

6.1   Main Conclusions

This section presents the main conclusions, divided in answers to the four sub-questions.

RQ 1 What types of sociotechnical visions can be distinguished?

As the preceding chapters illustrated, sociotechnical visions come in many forms. In section 6.2, I will categorize various types of sociotechnical visions. In brief, this section plots visions on three dimensions: complexity, idealization, and sharedness. To better understand sharedness, I argue that sharedness is closely related to acceptance and, furthermore, that acceptance of a vision depends on the extent to which the values and ideals that a vision proposes are new to a certain society or collective.

The three dimensions (complexity, idealization, and sharedness) help to make the relation between visions and technological design more palpable. Section 6.2 will argue in more detail that not all visions equally impact technological design. This impact depends on the complexity and sharedness of sociotechnical visions. Furthermore, complexity in visions seems contradictive, since visions are often (said to) simplify futures and render them less opaque. However, I argue, simplicity comes with a prize: that of the possible 'tyranny' of a certain value that obfuscates other concerns. With a nod to Walzer's (1983) idea of the monopolization of a certain dominant social good, I argue that simple visions equally monopolize a certain dominant future good, such as sustainability or energy security.

RQ 2 What functions do values fulfill in sociotechnical visions?

Building on this first conclusion, the second conclusion highlights that values in visions serve two functions. I have called these two functions the 'sociological' (or 'social'), and 'design' perspective. The sociological perspective *selects* technologies on the basis of salient values and ideals, the design perspective *develops* these technologies on the basis of salient values and ideals. I argue that these two functions cannot and should not be separated.

At the same time, these two functions of values and ideals do not necessarily overlap: what is deemed important for the selection of certain technologies might not be deemed important for their design. Furthermore, authors who take the first, sociological perspective often see the role of values as

transitory. Once these values and ideals have convinced and motivated different stakeholders in a sociotechnical system that a certain technology/technological development serves a certain cherished collective goal, these moral objectives 'disappear'.

Nonetheless, I argue that these two spheres are related and that they should be related. To understand this relation, I argue that the second distinction I make in 6.2—that relates to the idealization of visions—is important. Ideals do not impact design in the same manner as values. Instead of being embedded in technologies, ideals are instructive for innovation processes. Thus, widely shared, complex visions in which emerging technologies are joined to salient values are most instructive for technological design, whereas widely shared, complex visions in which technologies are joined to ideals are best understood as instructive for long-term processes of innovation.

RQ 3 Is feasibility a criterion for sociotechnical visions and, if so, how should it be understood?

The third conclusion further develops the distinction between values and ideals in sociotechnical visions, by focusing on feasibility as a criterium for the acceptance or rejection of sociotechnical visions. I argue that feasibility, as such a criterium, needs further scrutiny. Section 6.4 establishes feasibility as a complex phenomenon. First, I make a distinction between social, political, moral, and technological feasibility of sociotechnical visions. These forms of feasibility are not necessarily related: technological feasibility does not imply social, political, or moral feasibility, and vice versa. Second, I argue that feasibility also depends on the perceived necessity and urgency of change. Such perceptions typically require problems, caused by the current design of sociotechnical systems, to be visible. However, infrastructure tends to retreat over time and become invisible. The social, political, or moral feasibility of a certain vision of sociotechnical change therefore depends on efforts to undo this retreat. Finally, 6.4 also gives a normative assessment of the role of feasibility. One important danger I see, based on my analysis in

chapter 3, is that ideals, when guiding long-term processes of innovation, might become inseparable from the technologies that are being developed. Means and ends become intertwined and certain technologies cannot be abandoned. Infeasibility, in such circumstances, becomes a liability, since ideals and blueprints for their realization cannot be told apart.

RQ 4 What tensions may occur between sociotechnical visions and value change?

The fourth and final conclusion concerns the tension between visions and value change. Section 6.5 is dedicated to showing how this tension can be understood and to explore what possible remedies exist. In brief, idealistic, complex visions may acquire a strong hold on the development of sociotechnical systems because their prescriptive force has become institutionally entrenched. Depending on the strictness with which ideals and technologies are connected in a vision, such idealistic visions might not be adaptive to societal value change. Furthermore, ideals, because of their long-term guiding function, pose another obstacle for value change. On the one hand, such value change might imply that the ideals that guide the long-term development of sociotechnical systems are no longer (or less) relevant for innovation trajectories. On the other hand, commitment to the realization of a moral ideal means that actors might be unwilling or unable to discard this guiding role.

6.2   Typology of Sociotechnical Visions

In the introductory chapter, I defined sociotechnical visions as discursive representations of an often idealized future state of affairs (as an end) that indicates changes in sociotechnical systems (as means) that are deemed critical for the realization of these states of affairs. However, that is still a broad definition in which many different types of visions can be distinguished. We might, for instance, based on the case studies developed in this dissertation, distinguish different sociotechnical visions with respect to the

question how complex or elaborate they are: to what extent is the desirable future state of affairs clearly delineated? In this section I adopt the sociological/social perspective on visions and develop three dimensions: complexity, idealization, and sharedness, as illustrated in Figure 30.
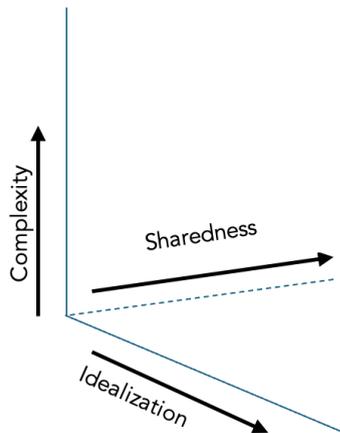
Figure 30: three dimensions of sociotechnical visions

6.2.1   Complexity: simple versus elaborate visions

Propositions such as 'renewable energies will herald a green future', or 'nuclear energy is necessary for the future decommissioning of polluting fossil fuel technologies' fulfil the minimal requirements of a discursive sociotechnical vision that I developed in the introduction. However, such propositions hardly express values or future states of affairs that could guide the design of new technologies and their place in a sociotechnical system. I call visions 'simple' when they are vague or when they connect technologies to a simplified future state of affairs. Axiologically, a simplified future state of affairs might consist of a single value embedded in a future state of a sociotechnical system, such as a future *sovereign energy system*, or a future *sustainable transportation system*. While these simple visions may onboard

many different stakeholders, and successfully gain public acceptance as shared narratives about the future, their performative power vis-à-vis design is unclear.

All visions simplify, but to different degrees. On the one hand, simplicity has been highlighted as an important, positive aspect of visions (e.g. Berkhout, 2006; Longhurst & Chilvers, 2019; Lösch, 2006). By rendering the future less opaque and less complex, simple visions open up the present for action by pointing to an (accepted) idea of a certain proposed future state of affairs. The complexity of this future enters piecemeal and seems secondary to an idea of visions as primarily concerned with instigating change in the present. On the other hand, simple visions often assume linear and predictable progress without taking into account complex social realities and uncertainty regarding the effects of certain technologies (Burri, 2015; Grin et al., 2000; Jasanoff, 2015). Simple visions also are difficult to contest. There is often little to disagree with. However, this contestation emerges as soon as such visions are made more specific and come to bear on specific projects and communities (van Lente, 2012).

Furthermore, such simple visions run the risk of becoming 'tyrannical'. Tyrannical visions are visions that are dominated by one value. Such a single value is considered supreme: it trumps all other values. Although visions in general do not portray value conflicts, such value conflicts are resolved ex ante in tyrannical visions: the dominant value reigns. The vision determines this value as the single 'currency' (Andre, 1992) of a sociotechnical system. Such a vision proposes that all efforts in the development of sociotechnical systems are directed towards this one value, such as sustainability or energy sovereignty. Criticism of such tyrannical goods has been developed, in other areas of inquiry, by Sandel (2021), Frank (2001), and, most notably, Walzer (1983). However, these criticisms have not focused on the development of sociotechnical systems and technologies (Popa et al., 2023).

Finally, in simple visions the dominant good does not clash or conflict with other goods. However, in practice it often does. Simple visions offer

frictionless versions of the future. This absence of friction further simplifies future states of affairs and might lead to future problems, once these frictions become manifest. —The 'crisis tribes' I referred to in my introduction might be one result of the friction caused by (pursued) tyrannical visions. These tribes might not agree with the dominance of a certain value or might feel that emerging value conflicts are not taken seriously. However, this needs to be investigated further. For instance, Berkhout (2006) argues that all visions have winners and losers. For him, the idea that sociotechnical visions 'are consensual in the sense implied by transition management theorists therefore appear[s] to be atypical' (Berkhout, 2006, p. 300). Furthermore, what it means to 'share' or 'consent to' a vision needs further elaboration, especially in cases where a discursive sociotechnical vision doesn't reach beyond the level of a (political) slogan or rallying cry.

6.2.2   Idealization: Value-based and Ideal-based visions

The distinction between values and ideals has been an important topic in this dissertation. I have elaborated on this distinction mostly in chapter 3, but also in chapters 4 and 5. In chapter 3, I considered the distinction quite absolute: in sociotechnical visions, values are adaptive, whereas ideals are not: ideals I considered absolute and teleological. In the operationalization and realization of a vision, values can be adapted, whereas ideals cannot. Thus, I argued, values interact with other values in the realization of visions through design and engineering, whereas ideals are instructive for innovation processes as long-term goals. In chapter 3, furthermore, I defined an ideal as a '*stable and uncompromisable abstract goal, for which its feasibility is not a concern; often appearing in the form of a (universal) principle for action or a perfect state-of-affairs, such as an ideal body, or an ideal society*' (Table 7, p. 56). There, I gave the example of the evolution of safety in reactor design. Safety, conceptualized as inherent safety, I argued, started to function as an ideal, rather than as a value that could be traded off against other values.

Visions often do not feature value conflicts and value tradeoffs in the future they depict. Thus, we might argue, the moral goals that sociotechnical visions put forward as ends for sociotechnical change often function *as if* they are ideals: it seems *as if* these goals will not (have to) be compromised. It is in the operationalization of visions—into plans, programs, frameworks, roadmaps, deals, strategies, etc. for sociotechnical change[65]—that the distinction between values and ideals becomes prominent. Berkhout's (2010) claim that visions are often encoded as utopias—and, I claim, as a result of this encoding, feature ideals—is therefore partly true. Indeed, visions do not completely determine whether or not certain abstract moral goals are to be understood as ideals or not. Different actors, however, might interpret them as uncompromisable, or not. Here, again, the elaborateness and complexity of a vision are important. Elaborate and complex visions might show different moral goals and might distinguish between ideals and values more clearly. As an illustration, the recent European Commission's Vision for Agriculture and Food (2025) states:

> The Union of 2040 must be a place where farming and food production thrive across our continent in all their diversity. A place where farming is attractive for future generations, and the agri-food sector is competitive, resilient, future-proof and fair. (EUR-Lex, 2025)

And

> Finally, essential to the delivery of this Vision, Europe's agri-food system is investing and leveraging the transformative power that research, knowledge, skills and innovation offer. (EUR-Lex, 2025)

Several ends are mentioned here: attractiveness, competitiveness, resilience, future-proofness and fairness. It seems assumed that all these goals can be

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[65] The distinction between these different forms of elaboration of visions is not clearly delineated and I will not attempt it here.

simultaneously pursued and realized through research, knowledge, skills, and innovation. These different goals are further defined, or rather elaborated on, in the EC's communication. However, even in this quite elaborate vision, it is unclear which of these more elaborate goals are uncompromisable. Future-proofness, for instance, as a goal for the agri-food sector, entails a…

> … sector that is functioning within planetary boundaries, where farming and the food sector contribute together to the EU's climate objectives, while preserving healthy soils, clean water and air, and protecting and restoring Europe's biodiversity. Stakeholders along the food chain contribute jointly to delivering these results and share transition risks. All segments of the agri-food system are much better prepared to withstand the effects of climate change, biodiversity loss and pollution, use natural resources sustainably and efficiently and operate in line with a One Health approach. (EUR-Lex, 2025)

Future-proofness is thus developed into a set of norms that refer to values associated with future-proofness, such as environmental protection and preservation, climate resilience, and sustainable resource use. Climate resilience is referred to as 'better preparedness' and therefore clearly seems neither absolute nor uncompromisable. The status of the other goals cannot be ascertained.

Thus, moral goals in visions are underdetermined in the sense that we often cannot assess whether these goals function as values or ideals. Regarding this underdetermination of abstract goals in visions, my example of the evolution of the French nuclear program in chapter 3 showed that certain ideals that initially formed part of the vision of a nuclear France (namely: sovereignty, technological prowess, and Frenchness) over time became compromised and started to function as values, traded off against other values. These initially

uncompromisable goals were no longer pursued with the same strictness. At the same time, in the design and operation of the French nuclear system other values became more prominent, such as affordability, scalability, and safety. The latter, as we have seen, over time, started to function as an ideal for innovation efforts.

Despite the underdetermination of moral goals in sociotechnical visions, I have argued in chapter 3, ideals exist in sociotechnical visions. Such ideals imply a certain tenacity in the actors that pursue it. Thus, a moral ideal in sociotechnical visions seems to imply a form of long-term commitment to a certain specification and definition of a moral goal. In cases, this might also imply a commitment to the technology that is supposed to bring about a state-of-affairs in which the ideal, such as ideal sustainability or ideal justice, is achieved. Chapter 3 shows how such political commitment to both an ideal and a selected technology played out in the case of the Severn Barrage in the UK. I will return to the implications of this case in the coming sections.

Finally, whether a moral goal functions as a value or an ideal, for a large part, depends on its conceptualization. Energy justice, for instance, might be conceptualized as an ideal or as a value in energy visions. As an ideal, it might be conceptualized as 'affordable renewable energy for all'. As a value it might be conceptualized as 'a more equal distribution of renewable energy'. However, such conceptualizations are not necessarily part of visions, especially simple visions. Whether energy justice functions as an ideal in a sociotechnical vision, then, depends on the perseverance with which we pursue its formulation as an abstract, uncompromisable goal.

6.2.3   Sharedness: Distinguishing shared and fringe visions: new versus old means and values

We might, finally, analyze to what extent a sociotechnical vision is shared and endorsed by a wide range of stakeholders. This endorsement and sharedness might have a temporal aspect: sociotechnical visions typically originate in

small groups, or even individuals, and become shared over time (Berkhout, 2006; Hilgartner, 2015; Sovacool, 2019). I consider three of the four visions discussed in the preceding chapters as 'fringe'. My analyses show that these visions were not widely shared at the time and encountered considerable resistance. This resistance might entail that the vision was only partially implemented, as was the case with Le Corbusier's modernist vision in Berlin, or not implemented at all, such as the Severn Barrage or the Zero Waste vision. Though part of this resistance might be 'material' in nature, as I will explain in 6.4, this resistance can also be explained by the values that were put forward in the vision. Therefore, to understand why certain visions are not widely shared, I propose two further, relevant distinctions: between new and old means, and new and old ends, see Figure 32 and Table 13. These distinctions further help determine the level of acceptance and 'sharedness' of visions. The arrow in Figure 32, furthermore, represents the possibility that, over time, fringe visions gain public acceptance, once the ends proposed have become recognized as both valid and salient.
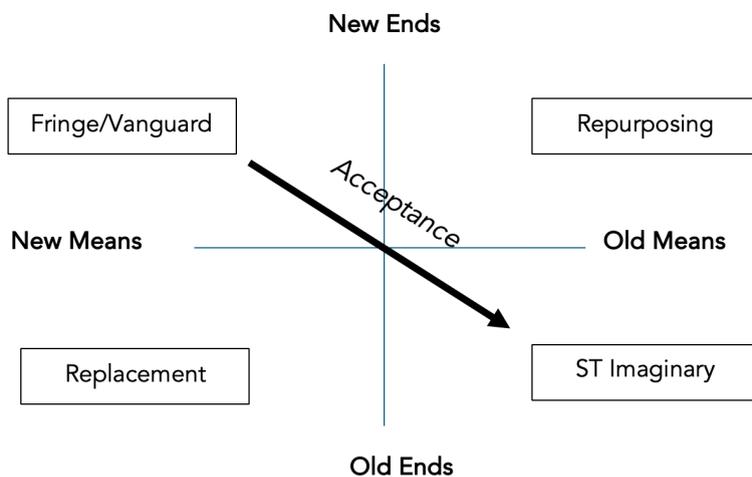
Figure 31: Organization of visions according to new and old technologies/values

Fringe visions are visions in which both new values and new technologies figure. Following Hilgartner (2015) such fringe visions can be called

'vanguard'. Completely opposite to such vanguard visions stand visions that figure old means and old technologies. Such configurations of means and ends might, strictly speaking, no longer appear as visions: they have to a large sense materialized and been normalized. Nonetheless, I have included them here. In between we find visions that introduce new means, and visions

1. Visions of which both means and ends are stabilized and performed/entrenched in society— *(sociotechnical imaginaries)*
2. Visions in which new means are proposed for (better) achieving established ends—*(replacement visions)*
3. Visions in which old means are reinterpreted/repurposed to achieve new ends— *(repurposing visions)*
4. Visions in which both ends and means are new— *(vanguard visions)*

that introduce new ends. I call these 'replacement' and 'repurposing' visions respectively (see Table 13):

The four cases I have studied in this thesis can also be organized along the two axis of Figure 31, see Figure 32 underneath. While I consider the Severn Barrage vision a fringe vision, over time the technology it proposed was no longer new, although the size and scope of its application remained controversial. As chapter 3 argued, furthermore, the Severn Barrage has a long history of possible purposes in the UK, in which new ends came into view for this tidal barrage. Thus, the Severn Barrage moved from being a vanguard, to a repurposing vision, while still remaining idealistic and techno-economically infeasible.

Table 13: Typology of Visions

New Ends

Modernist Vision in
the 1950s for Urban
Development

Severn Barrage
UK

Zero Waste
Vision Europe

New Means   **Old Means**

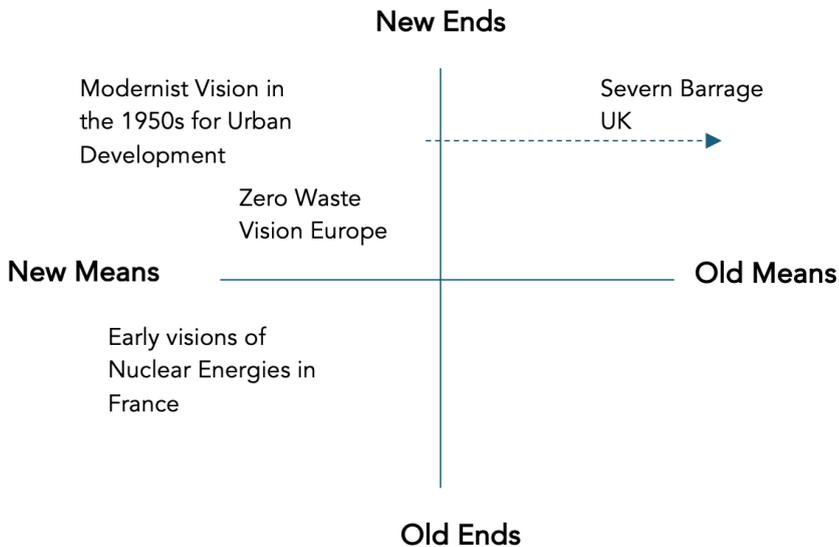Early visions of
Nuclear Energies in
France

Old Ends

Figure 32: Organization of case studies along two axis

As indicated, the first type in Table 13 is, strictly speaking, no longer a vision. Rather, it is what is left over from a successful vision. Both means and ends have become normalized. This type of vision resembles what Jasanoff and Kim (2009; 2015) call a **'sociotechnical imaginary'**. Such imaginaries are 'collectively imagined forms of social life and social order reflected in the design and fulfilment of nation-specific scientific and/or technological projects' (Jasanoff & Kim, 2009; p.120). Furthermore, these imaginaries are institutionally stabilized. This dissertation has addressed such imaginaries in chapter 3 and 4, but not extensively.

While the first type of visions did not figure in the chapters of this thesis, the others did. In chapter 2 and 3, the emergence and reception of nuclear technologies in France provided an example of a **replacement vision**. It shows how nuclear technologies came to be perceived as restoring French 'grandeur' and sovereignty. Although the technology proposed was radically

new, the values were not. Rather, nuclear technologies were meant to bring back a certain conception of the bright history of France, it's 'radiance' (Hecht, 2009). **Replacement visions**, furthermore, seem rather common. Many of the technological changes that a typical sociotechnical system goes through over the decades seem to qualify as **replacement visions**, in which new technologies are claimed to perform better vis-à-vis already established moral goals. This is the idea of 'linear' and incremental innovation, in which improvement is steady and easily measurable, since the goals remain the same over time (e.g., Norman & Stappers, 2015). Some of these goals, finally, might be understood as ideals (see 6.4). They guide this incremental innovation long-term, as long as the ideal is recognized as valid and productive. Ideals do not (necessarily) impact the acceptance level of a vision. Some authors, however, have suggested that future state of affairs in visions are often idealized, or encoded or decodes as utopian and/or dystopian (see, for instance: Ballo, 2015; Berkhout, 2006; Borup et al., 2006).

In **repurposing visions** we see yet another dynamic: previously endorsed technologies might be repurposed to serve new ends. Chapter 3 gives an example of such a repurposed technology. In this case, it concerns a 'paper project', the Severn Barrage, a tidal power structure in England/Wales, that is constantly repurposed in British Parliament to meet new political, and idealized ends while, at the same time, failing to materialize. The tidal barrage appears in visions of British marine power, the UK as a leader in green innovations, and in visions of a stable and sovereign energy system. Though this **repurposing vision** concerns the reimagining of a fictional technological project, other cases come to mind that rely on existing infrastructure. For instance, the proposed use of fossil fuel infrastructure for the offshore production and transportation of green hydrogen (Cardinale, 2023; Patel et al., 2025); the use of abandoned oil and gas wells for carbon storage (Orr, 2004) and/or the production of geothermal energy (Santos et al., 2022).

The fourth type of visions—so-called **vanguard visions**—is more radical and revolutionary. Previously existing values no longer seem desirable while

existing technologies cannot be repurposed, or further developed to help achieve proposed new values. Cultural legitimacy, furthermore, is not guaranteed, since both ends and means are new—not just new to the sociotechnical system in question, but often new to the social collectives involved and impacted. A **vanguard vision**, therefore, has to create support on two fronts. It has to convince actors that new values, as abstract goals, are necessary, and it has to convince actors that certain emerging technologies will help realize these new values.

Both chapter 4 and 5 gave examples of such **vanguard visions**. Chapter 4 argued that new ideas and meanings of waste have become necessary in Europe, but are hampered by a seemingly efficient and sufficient infrastructure—the old means seem to do their job quite well. A new vision has been proposed, focused on prevention, re-use, re-cycle, and recovery. Besides requiring the institution of new waste practices, the vision, also requires an overhaul of existing infrastructure and waste technologies. Chapter 4 showed that the EC's waste vision has not been very effective, despite a recognized economic and political need. Chapter 5 showed how new ideas of beauty and efficiency emerged in the Modern Movement in architecture. Technological innovations, such as reinforced concrete, allowed for a radically new vision of urban living to take root. In this vision, values that had previously been disregarded by urban planning and mass public-housing design, such as health and community, became salient objectives for architects such as Le Corbusier. The public, and (local) authorities, however, were not always convinced.

6.3   Values in Sociotechnical Visions

The introduction to this dissertation highlighted two functions of values in the development of sociotechnical systems. I called these the 'social' and 'engineering' function. Sociotechnical visions contain values because these values form part of a shared moral space that legitimizes such visions and the sociotechnical changes they propose. Conversely, these values are

considered instructive for technological design: as functional and non-functional requirements for technologies. Simply put, functional requirements concern the *what* of the performance of a certain technology, and non-functional requirements the *how*. Visions often focus on the *what* of a technology, its place in the sociotechnical system as an instrument for desired sociotechnical change, its contribution to this change; moral values in design often seem to concern the *how*, the non-functional requirements. A technology might produce, deliver, or store renewable energy (functional requirement) *but* it does so in a safe, sustainable, just, etc. manner (non-functional requirements). Furthermore, an energy storage technology that contributes to the overall sustainability of the energy system as a functional requirement (increasing the system's independence from fossil fuels for instance) is different from a sustainable storage technology (that uses recyclable materials, sustainably mined metals, etc.) as non-functional requirement.

In this line of thinking, the social and the engineering functions of values seem apart. In the social perspective, values are either used to convince stakeholders to embrace a certain future to which certain technologies provide the necessary means, whereas on the engineering perspective values figure as concrete objectives that need to be translated and specified for certain technologies to embody these values. In the first case, values seem transitory: they are used to give certain technological developments legitimacy, i.e., to show that certain ideas of the good life/good society are (finally) within reach once stakeholders accept and endorse these developments. For instance, visions propose the emerging technology of Small Modular Reactors to create energy autarky and local autonomy, or to end energy poverty and water scarcity (Sovacool, 2019). Likewise, visions of tidal power in the Severn Estuary present tidal barrages as means to guarantee a green future and to establish the UK as leading in renewable energy development, as explained in chapter 3. The effectiveness of these visions lies in their singling out very few goals. Thus, visions of tidal power attach to moral values that are salient at a specific time. They do so in a simple, communicable manner, that does not affect the design of

technologies, but rather their place in a sociotechnical system, ownership structures, governance structures, etc.

One might argue that the two functions of values relate to two stages of sociotechnical development: social acceptance and technological design. One could then also argue that these two stages do not interact; what is important in one stage, doesn't need to be relevant in the other. Though this seems a neat solution that connects both functions of values, I think this connection is insufficient from a normative point of view. It might lead to even greater problems: if visions disregard the values that will come into play during the design phase of an (emerging) technology, they raise false expectations of the performance of this technology. Such visions seem to pretend that these other values do not matter and will not matter. This might lead to future value conflicts that affect the performance of the technology vis-à-vis the desired sociotechnical change.[66] This is particularly a problem for simple visions, because—as I have argued in section 6.2.1—such visions tend to focus on one value, for instance visions in which proposed technologies solely contribute to the reliability or sovereignty of an energy system. Consequently, such visions will ignore the engineering role of values and may well lead to technologies whose design is unacceptable from a social or moral point of view.

Finally, the case studies in this dissertation have shown that the two perspectives on values developed throughout this dissertation, the social

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[66] For instance, some of the now available visions of AI in sociotechnical systems concern the optimization of processes in terms of both precision, speed, efficiency, etc. Different countries, furthermore, have 'distinct visions of how AI will contribute to desirable technological futures, and how government policy can push that vision forward' (Chen & Metcalf, 2024). These visions concern the implementation and scope of implementation of AI, rather than fundamental concerns raised by the AI community such as those of the transparency and explainability, accountability and contestability of different forms of AI used in sociotechnical systems. These non-functional requirements affect the design of AI once the vision has created social acceptance of the technology.

and engineering/design perspective, should be related. Chapters 4 and 5 have discussed elaborate visions in architecture and urban waste management that translated into concrete design decisions: what was relevant for the performance of the system (social function of values) was relevant for the design of the technologies within this system (engineering function of values), *and vice versa.* Chapter 5 in particular has shown how certain value beliefs translated to the design of a building as instantiation of the vision in which these beliefs played an central role.

6.4   Feasibility of Visions

Though the preceding chapters have not very explicitly discussed the issue of feasibility, it lingered constantly in the background. STS literature on visions is mostly descriptive without specifying possible requirements for visions. Visions can be utopian or dystopian, feasible or infeasible. What is important is that these visions are convincing and motivating. They are 'futures for the present' (Longhurst & Chilvers, 2019) and function as devices for communicating about the future. By simplifying a complex and often opaque future, they create the possibility of agency towards this future and the possibility of deliberation among different actors. Such visions might guide actors with respect to the actions required to realize this future. Visions might also unify, motivate and give a sense of purpose (Borup et al., 2006; Brown & Michael, 2003; van Lente, 2012).

However, whether or not it is possible to realize a sociotechnical vision through the adoption of certain technologies or innovations, seems an important question to ask. We could formulate such feasibility questions as: Are the proposed future, desirable states of affairs realistic? Can these states of affairs be effectively translated into the technology in question? To what extent does the institutional framework in which these new technologies will be embedded have to change? Nonetheless, feasibility remains a contentious aspect. For instance, in their book on technological visions, Dierkes et al. (1996) state:

Visions and ideals do not differ in terms of their plausibility, popularity, distribution, or power, but rather primarily in terms of their relation to what is feasible and the concomitant mooring in the everyday world. (p. 45)

Dierkes' et al. (1996) main problem with infeasible visions is that they turn into a 'chimera' (p. 45) and are 'disastrous' (ibid.). This is a common concern with ideals, in political theory as well as literature on sociotechnical visions[67], if we consider infeasibility a necessary characteristic of ideals, which I don't. As I proposed in chapter 3, I conceive of ideals as (moral) goals for which their feasibility is not a concern. Such a characterization of ideals avoids defining moral feasibility. Definitions of moral feasibility often employ the, in my opinion, problematic concept of human nature. My characterization also emphasizes that actors might pursue a moral ideal even if they believe it—or come to consider it as—infeasible.

In each case, the more elaborate visions are, the more likely they will function as a blueprint for the future. The more they are accepted as blueprint, the more their apparent infeasibility might lead to friction between actors, especially those actors that question the pursuit of what they consider moral ideals. Simple visions, which might function more as slogans than as guiding ideas about the future, seem to suffer less from their perceived infeasibility. It might be that actors are used to these visions accompanying new and emerging technologies, or are used to so-called 'hype cycles' (Brown, 2003).

Chapters 3 and 4 in this dissertation were, inter alia, concerned with feasibility. Both chapters focused on how resistance to change, claiming

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[67] See, for instance, the intense discussions of the feasibility constraints for Rawls' 'realistic' utopian vision of a just society in: Gheaus, 2013; Gilabert & Lawford-Smith, 2012; Majone, 1975. For a discussion of the relevance of (perceived) feasibility for the social and moral acceptance of sociotechnical visions, see Beck et al., 2021; Lucivero, 2016; Roßmann, 2021.

infeasibility of the proposed moral goals, can be understood from the perspective of existing sociotechnical systems and actors within these systems. Chapter 3 showed that idealized technologies, such as tidal power technologies in the British case, run the risk of becoming perceived as necessary milestones, while failing to materialize. Rather than instruments to realize a certain desired future—e.g., a green, self-sufficient England—these technologies come to be seen as 'ends-in-themselves': the moral ideal and the technology became merged in the mind of certain actors. Some politicians in parliament could not let go of the Severn Barrage. To understand the stalemate in England, I made a distinction between political and technoeconomic feasibility: what seems realistic from a political perspective, is unrealistic from the perspective of engineers, planners, and other actors.

Chapter 4 suggested that feasibility might also depend on the manner in which infrastructure retreats over time and becomes invisible, only to reemerge when there is a problem, a malfunction, a blockade, and so forth. Here, I argue that efficient and effective waste infrastructures hamper the performance of new visions of waste. Furthermore, chapter 4 highlighted a fundamental distinction that characterizes modern societies: that between clean and unclean matter, hygienic and unhygienic behavior, and related distinctions such as healthy and sick bodies. These distinctions run deeper than mere rational convictions; they have fundamentally influenced the design of modern waste infrastructures since at least the 1880s. Every effort to change the perspective on waste in societies that have optimized their waste infrastructures in light of these fundamental attitudes towards dirt, must take into account that the level on which these attitudes operate may not be open to rational or discursive arguments. Thus, the retreat of such infrastructures hampers the feasibility of visions in which infrastructure comes to serve new values (repurposing vision) or in which new infrastructure projects serve new values (vanguard visions).

However, chapter 3 also argued that infeasibility might not be unproductive. It showed that ideals might guide the development of sociotechnical

systems in the long-term, in the form of universal prescriptions that actors aim to follow. These actors also strive to eliminate obstacles that hinder the universal application of the ideal. Inherent safety, it was argued, functions as such an ideal. It guides innovation processes of nuclear reactors by striving to eliminate all possible risks at a reactor meltdown. Even though such a conceptualization of safety might be create an infeasible standard for engineers, it guides their research and development in the long term. Furthermore, in times of (energy) transitions, it is often unclear which abstract goals are feasible or infeasible. Especially technologies with a low Technology Readiness Level might be overpromising in terms of their contribution to a certain cherished moral goal. They might be branded as inducive to a state of complete justice, sustainability, or sovereignty. Here, circulating ideals become attached to emerging technologies in so-called 'hype cycles' (Borup et al., 2006; Brown, 2003)

Therefore, this dissertation suggests that feasibility is an important but contested concern for visions. Moreover, it suggest that feasibility it multi-facetted. While the Severn Barrage seemed a feasible political option, its techno-economic feasibility was repeatedly challenged through a series of reports. To these two forms of feasibility we may add social feasibility, i.e., whether human agents are able to comply with the norms for behavior that the sociotechnical development requires. This might be moral norms, but not necessarily so. This third form of feasibility is closely related to a fourth form: moral feasibility. Here the question is whether the moral requirements that a vision puts forward can (always) be complied with. Though social and moral standards for behavior often overlap, this is not necessarily the case. For instance, socially accepted behavior might deviate from a certain categorical moral norm (e.g. to never lie) that is considered pivotal for a certain vision. In this case, technological design is inducive to certain moral values, but depends on the behavior of human agents (such as operators, supervisors, users, etc.), who might not always be able or willing to comply with the behavioral requirements.

Though these four forms of feasibility are related, we can also approach them in distinct ways, as questions concerning: (1) The political will-power and possibility of coalition-building; (2) The limits of engineering design; (3) The strength of institutions/institutional design; (4) The moral capacities of the actors involved (see figure 34). Evidently, not all these forms of feasibility are immediately apparent once we analyze simple, or even elaborate, sociotechnical visions. Rather, these concerns emerge in discussions and assessments of visions with different stakeholders, in feasibility reports, or moments when visions are contested. Furthermore, it seems, feasibility becomes a more central concern once one starts thinking about the steps necessary to realize the vision.
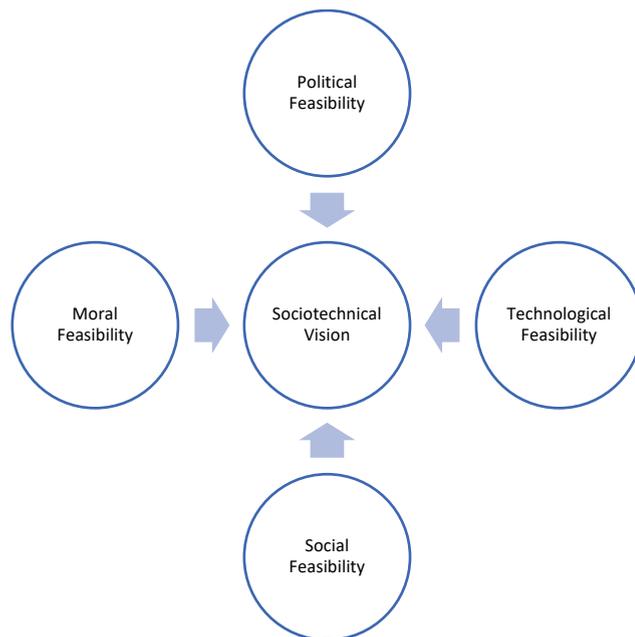
Figure 34: Four forms of feasibility impacting sociotechnical visions

6.5   Visions and Value Change

Chapter 5 has shown how an instantiation of a utopian architectural vision and changing value beliefs in society might conflict. That chapter offered a systematic analysis of value beliefs that justify certain architectural choices. However, despite that justification, if we accept that beliefs about what is good (in dwelling) might change, then adaptivity becomes a paramount concerns, but one that might conflict with certain visions.

There seems to be an inherent tension between visions, especially those that involve ideals that act as long-term guides for the further development of sociotechnical systems, such as energy justice, and changing values in society. Aspirations to realize a certain ideal, i.e., to take away certain obstacles that stand in the way of full compliance with a certain universal principle, often imply a long-term commitment to a certain idea of 'goodness'. As the previous section has made clear, feasibility can appear as a question for the political, social/institutional, technological, and moral aspects of sociotechnical change. Thus, we can think of political, social, technological and moral ideals. I will focus here on technological and moral feasibility and connect them to both visions and value change.

First, the previous chapters and this concluding chapter have argued that especially elaborate sociotechnical visions have an impact on design. The values that appear as moral objectives in such visions are translated into norms and design requirements. As examples of such elaborate visions, I have analyzed visions of waste and visions of public housing/urban renewal (chapter 4 and 5). These elaborate visions can materialize and have a lasting impact on sociotechnical systems and the embedding of certain values in these systems. This seems to hamper the possibility of value change, i.e., the possibility that new moral goals for sociotechnical systems successfully alter the composition (technologies, institutions, actors) of these systems. This seems especially the case when the discursive force of a vision, as a rhetorical narrative about the essence of a system's relevance and function, is still present in plans, educational programs, practices, negotiations, public

communications, etc. Though this vision might be 'outdated' from a certain salient societal/moral perspectives, it continues to hold prescriptive power over the imagination of important stakeholders. This prescriptive power is, to an extent, institutionally 'entrenched': the dominance of certain technologies supporting certain values, first laid out in a sociotechnical vision, is upheld.

Second, as we have seen in section 6.2.2, visions can roughly be organized on the axis of new/old technologies, and new/old values. In the case of new values, visions also appear as devices for communicating value change and advocating technologies that support this change. In the case of new and emerging technologies this support is still untested and, often, the possibility of conflict with values—once this vision starts affecting technological design—is minimized. As the previous chapters have shown, ideals, as uncompromisable goals, can come into conflict with other values important to the design of new and emerging technologies that figure in visions of the future of sociotechnical systems. These ideals then might start to guide the innovation trajectory of these technologies, in which the goal is to overcome these conflicts. Ideals thus function as long-term goals for the development of sociotechnical systems.

Finally, ideals might pose another hurdle for the implementation and recognition of value change.
Changing value beliefs might imply that the ideals that guide the long-term development of sociotechnical systems are no longer (or less) relevant for innovation trajectories. However, the commitment to the realization of a moral ideal means that certain actors might be unwilling or unable to discard this guiding role. Again, guidance and commitment are not only aspects of the intentions of stakeholders, but also have been institutionalized, for example through textbooks and funding programs, celebrated heroes and maligned foes. Furthermore, these ideals might still function in other sociotechnical systems as cherished goals and limit the possibility of value change. We might reflect here on the ideal of inherent safety in reactor

design and what happens if other (potentially conflicting) values become more important in visions of nuclear energy.

6.6   Limitations and Suggestions for Further Research

Case studies typically provide indications for relations between phenomena that need further research. Especially in previously unexplored areas of research, an in-depth investigation of certain phenomena is important, to cast a wide net for relevant insights that form the basis of a more quantitative research approach to these phenomena. If case studies are used for this explorative purpose, furthermore, a diversity in cases makes sense: it provides for a rich set of tentative propositions about sociotechnical visions, as this chapter has made clear. I will discuss these ends here in relation to my suggestions for future research while indicating the limitations of the research undertaken in the previous four chapters.

First of all, the focus on discursive visions means that other manifestations of visions were not taking into account. We could think here of images, movies, and other cultural, non-discursive artefacts. My empirical research has, for the same reason, consisted of document analyses to find values mentioned in relation to developments of sociotechnical systems. Both my analysis of values related to nuclear technologies in France (Chapter 2), and of values related to waste management systems in Europe and energy in the UK (Chapter 3) focused on a limited amount of sources, such as newspapers, directories, and parliamentary discussions. These findings need to be further triangulated and corroborated. For instance, larger periods of digitized newspaper archives could be used to analyze how visions of a nuclear France further evolved. Such analysis of public discourse on new and emerging technologies could also help to understand the dynamics of anticipatory discussions of such technologies in terms of value change.

Second, this research has tried to establish links between engineering design and vision-making. These links need to be further researched. The

suggestions this chapter has made, that elaborate, collective visions are more likely to impact the design of sociotechnical systems, need further research. For instance, the simple dichotomy between simple and elaborate sociotechnical visions could be further developed: how do visions become more elaborate over time, and which relation does this elaboration have to the collective performance of such visions?

Third, this conclusion has argued that ideals in vision (as moral objectives) can be productive and counterproductive. I have shown how feasibility can take different forms, leading to different assessments. Furthermore, I have argued that feasibility is, at best, a problematic requirement for sociotechnical visions. However, more work needs to be done on why certain ideals are productive, while others aren't. Future research could investigate the role of ideals in utopian visions. While this role might be evident in discursive utopian visions, I am not sure they are equally important in the forms of communication through which we often encounter elaborate utopian visions: literature, movies, and images.

Finally, more research needs to be done on sociotechnical visions in relation to value change, The chapter on Modernist architecture has argued that visions should be less strictly implemented and more adaptive to changing value beliefs. However, how this would apply to other sociotechnical systems is not clear. For instance, simple visions often leave ample room for conceptual change. While the technological means might be clear, the moral objectives they foster are often not. Furthermore, less defined visions might also motivate and guide less. Thus, a vision that emphasizes that the moralized goals it presents can change over time, might appear less convincing.

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Summary

Summary

This dissertation investigated how **sociotechnical visions**—defined as discursively articulated images of desirable futures—shape the development, design, and evaluation of sociotechnical systems through the moral objectives they contain. It focuses in particular on the roles of **values** and **ideals** in these visions, and on how such moralized visions interact with technological design, feasibility constraints, and processes of value change over time.

This dissertation sets out with the claim that contemporary societies face systemic crises—such as climate change, energy insecurity, and urban sustainability issues—that call for long-term direction rather than incremental problem-solving. Governments, engineers, and designers can use visions of desirable futures to guide sociotechnical change. These visions typically combine normative claims about what constitutes a good society with assumptions about which technologies and systems are necessary to realize that future. Despite their prominence, however, it remains insufficiently understood how the moral content of visions—especially abstract values and seemingly infeasible ideals—actually influences technological design and system development.

The dissertation therefore pursues the overarching research question:

How can we conceptualize the interplay between visions, values, and technological designs in the development of sociotechnical systems?

To address this question, the author adopts an interdisciplinary approach drawing on Science and Technology Studies (STS) and the philosophy of technology, and develops a series of empirical and conceptual case studies.

At the conceptual core of the dissertation is a clear distinction between **values**, **ideals**, and **visions**. Values are understood as relatively stable but revisable moral objectives—such as safety, sustainability, health, or equality—that guide evaluation and action. Ideals are treated as a specific subset of values that function as uncompromisable or aspirational standards, often without regard for immediate feasibility (for example, "zero waste" or "perfect safety"). Sociotechnical visions are defined as discursive representations of future states of affairs that connect such values or ideals

to proposed changes in sociotechnical systems, specifying both desired ends and technological means.

Chapter 1 introduces these concepts, situates the research within existing literatures, and formulates four subsidiary research questions concerning (1) types of sociotechnical visions, (2) the functions of values within visions, (3) the role of feasibility, and (4) tensions between visions and value change.

Chapter 2 provides an empirical study of the emergence of sociotechnical visions in early post-war France through an analysis of newspaper discourse on nuclear technologies between 1945 and 1952. Using probabilistic topic modelling, the chapter traces how different ideological newspapers articulated values such as safety, progress, peace, security, and national strength in relation to nuclear energy. The analysis shows that, despite ideological differences, a shared evaluative framework gradually emerged— a discourse coalition—constituting an early sociotechnical vision of a "nuclear France." This chapter demonstrates how values function as discursive resources that moralize emerging technologies and facilitate their social acceptance, even before concrete technological designs are in place.

Chapter 3 moves from discourse analysis to conceptual theorization, examining the relationship between values, ideals, and technological development in energy systems. The chapter introduces a distinction between a **material sphere** (where technologies are designed and operated) and an **imaginary sphere** (where ideals and visions are articulated). Contrary to claims that moral objectives in visions are merely transitory tools for legitimization, the chapter argues that values and ideals can have a lasting influence on technological design trajectories. This argument is supported through case studies on nuclear reactor safety, French atomic energy visions, and the UK's Severn Barrage tidal power project. The Severn Barrage case, in particular, illustrates how strong political ideals can become fixated on a specific technological project, even when techno-economic feasibility remains low, thereby raising critical questions about how feasibility should be assessed in vision-driven innovation.

Chapter 4 examines sociotechnical visions of waste management in Europe, focusing on the tension between long-standing infrastructures and emerging sustainability ideals. The chapter shows how modern waste systems were historically designed around values of hygiene, health, and invisibility, which

continue to shape contemporary practices and constrain value change. The ideal of "zero waste," while prominent in sustainability discourse, struggles to materialize because existing infrastructures disvalue waste and render it invisible. To address this tension, the chapter proposes a reconceptualization of waste management through **dynamic maintenance** and **reflexive repair**, arguing that making waste infrastructures more visible can enable ethical engagement and facilitate the integration of new values such as sustainability. This chapter deepens the analysis of feasibility by showing how material resistance and institutional inertia can undermine even widely shared ideals.

Chapter 5 turns to architectural design and examines the relationship between sociotechnical visions and long-term value change through a detailed case study of Le Corbusier's Unité d'Habitation in Berlin. The chapter analyzes how values such as efficiency, community, health, and beauty were translated into architectural design decisions, and how these values reflected a specific historical vision of urban living. Importantly, the chapter argues that the building's partial failure to realize Le Corbusier's original vision contributed to its long-term success, because it allowed residents to adapt the structure to changing values and practices. This case challenges static notions of visions as fixed blueprints and emphasizes **adaptability** as a crucial—though often overlooked—design consideration for sociotechnical systems intended to endure across generations.

Chapter 6 synthesizes the findings and answers the four subsidiary research questions. It proposes a typology of sociotechnical visions along three dimensions: complexity (simple versus elaborate visions), idealization (value-based versus ideal-based visions), and sharedness (widely shared versus fringe visions). The chapter concludes that values in sociotechnical visions function not only as justificatory tools but also as enduring guides for design and system development. Feasibility, rather than being a binary criterion, is shown to be multidimensional, encompassing technical, economic, political, and cultural aspects. Finally, the dissertation demonstrates that tensions between visions and value change are inevitable, particularly in long-lived systems, and that designing for adaptability is essential to managing these tensions responsibly.

Overall, the dissertation makes a substantive contribution to debates on sociotechnical change by showing how moralized visions shape

technological development beyond initial legitimation, and by offering conceptual tools to assess feasibility and value change in vision-driven design. It bridges STS and philosophy of technology, providing both empirical insights and normative reflections on how societies imagine, design, and sustain their technological futures.

Samenvatting

Samenvatting

Dit proefschrift onderzoekt hoe **socio-technische visies**—gedefinieerd als discursief gearticuleerde beelden van wenselijke toekomsten—de ontwikkeling, het ontwerp en de evaluatie van socio-technische systemen sturen via de morele doelen die zij bevatten. Daarbij ligt de nadruk op de rol van **waarden** en **idealen** in deze visies, en op de manier waarop dergelijke gemoraliseerde toekomstbeelden zich verhouden tot technologisch ontwerp, haalbaarheid en processen van waardeverandering in de tijd.

Het onderliggende onderzoek begint met de claim dat hedendaagse samenlevingen geconfronteerd worden met systeemcrises—zoals klimaatverandering, energietransities en vraagstukken rond stedelijke duurzaamheid—die vragen om lange termijn richting in plaats van louter incrementele probleemoplossingen. Overheden, ontwerpers en ingenieurs kunnen visies van wenselijke toekomsten gebruiken om socio-technische verandering te sturen. Deze visies combineren doorgaans normatieve opvattingen over wat een goede samenleving is met aannames over welke technologieën en systemen nodig zijn om die toekomst te realiseren. Ondanks hun prominente rol is echter onvoldoende duidelijk hoe de morele inhoud van visies—met name abstracte waarden en ogenschijnlijk onhaalbare idealen—daadwerkelijk doorwerkt in technologisch ontwerp en systeemontwikkeling.

Dit proefschrift adresseert daarom de centrale onderzoeksvraag:

Hoe kunnen we de wisselwerking tussen visies, waarden en technologisch ontwerp in de ontwikkeling van socio-technische systemen conceptualiseren?

Om deze vraag te beantwoorden hanteert de auteur een interdisciplinaire benadering, waarin inzichten uit Science and Technology Studies (STS) en uit de filosofie van de techniek worden gecombineerd met een reeks empirische en conceptuele casestudies.

Centraal in het proefschrift staat een analytisch onderscheid tussen **waarden**, **idealen** en **visies**. Waarden worden opgevat als relatief stabiele maar herinterpreteerbare morele doelstellingen—zoals veiligheid, duurzaamheid,

gezondheid of gelijkheid—die richting geven aan evaluatie en handelen. Idealen vormen een bijzondere categorie waarden: zij functioneren als niet-onderhandelbare of geaspireerde standaarden, vaak los van directe haalbaarheid (bijvoorbeeld "nul afval" of "volmaakte veiligheid"). Socio-technische visies worden gedefinieerd als discursieve representaties van toekomstige toestanden die dergelijke waarden of idealen verbinden aan voorgestelde veranderingen in socio-technische systemen, waarbij zowel gewenste doelen als technologische middelen worden gespecificeerd.

Hoofdstuk 1 introduceert deze kernbegrippen, positioneert het onderzoek binnen bestaande literatuur en formuleert vier deelvragen, gericht op (1) typen socio-technische visies, (2) de functies van waarden binnen visies, (3) de rol van haalbaarheid en (4) spanningen tussen visies en waardeverandering.

Hoofdstuk 2 presenteert een empirische analyse van de opkomst van socio-technische visies in het naoorlogse Frankrijk aan de hand van krantenartikelen over nucleaire technologieën in de periode 1945–1952. Met behulp van probabilistische topic modelling wordt onderzocht hoe ideologisch uiteenlopende kranten waarden als veiligheid, vooruitgang, vrede, zekerheid en nationale kracht articuleerden in relatie tot kernenergie. De analyse laat zien dat zich, ondanks ideologische verschillen, geleidelijk een gedeeld evaluatief kader ontwikkelde—een discourscoalitie—die kan worden opgevat als een vroege socio-technische visie op een "nucleair Frankrijk". Dit hoofdstuk toont aan hoe waarden functioneren als discursieve middelen om opkomende technologieën te moraliseren en maatschappelijk acceptabel te maken, zelfs voordat concrete ontwerpen of toepassingen bestaan.

Hoofdstuk 3 verschuift de focus van empirische analyse naar theoretische verdieping en onderzoekt de relatie tussen waarden, idealen en technologische ontwikkeling in energiesystemen. Het hoofdstuk introduceert een onderscheid tussen een **materiële sfeer** (waarin technologieën worden ontworpen en geëxploiteerd) en een **imaginaire sfeer** (waarin idealen en visies worden geformuleerd). In tegenstelling tot opvattingen dat morele doelstellingen in visies slechts tijdelijk legitimerend zijn, betoogt dit hoofdstuk dat waarden en idealen een blijvende invloed kunnen hebben op ontwerpkeuzes en innovatiepaden. Dit wordt onderbouwd met casestudies over nucleaire veiligheid, Franse atoomvisies

en het getijdenenergieproject in de Severn Barrage (estuarium). Met name dit laatste voorbeeld laat zien hoe politieke idealen kunnen verstrengelen met specifieke technologische projecten, zelfs wanneer de technisch-economische haalbaarheid beperkt is, wat fundamentele vragen oproept over hoe haalbaarheid moet worden begrepen en beoordeeld.

Hoofdstuk 4 richt zich op socio-technische visies rond afval en afvalbeheer in Europa. Het hoofdstuk laat zien hoe bestaande afvalinfrastructuren historisch zijn ontworpen rond waarden als hygiëne, gezondheid en onzichtbaarheid, en hoe deze waarden hedendaagse pogingen tot waardeverandering—met name richting duurzaamheid—belemmeren. Het ideaal van "nul afval" blijkt moeilijk te materialiseren omdat afval en afvalinfrastructuur systematisch worden gedevalueerd en aan het zicht onttrokken. Als alternatief ontwikkelt het hoofdstuk het concept van **dynamisch onderhoud** en **reflexieve reparatie**, waarbij zichtbaarheid van infrastructuur wordt opgevat als een ontwerpcriterium dat ethische betrokkenheid en nieuwe praktijken mogelijk maakt. Hiermee verdiept het hoofdstuk het begrip haalbaarheid door te laten zien hoe materiële en institutionele inertie morele idealen kan ondermijnen.

Hoofdstuk 5 behandelt de relatie tussen socio-technische visies en waardeverandering in de context van architectuur, aan de hand van een casestudy van Le Corbusiers Unité d'Habitation in Berlijn. Het hoofdstuk analyseert hoe waarden als efficiëntie, gemeenschap, gezondheid en schoonheid zijn vertaald in architectonisch ontwerp, en hoe deze waarden verbonden waren met een historisch specifieke visie op wonen. Tegelijkertijd wordt betoogd dat het gedeeltelijk falen van het gebouw, in termen van Le Corbusiers visie, juist bijdroeg aan zijn langdurige functioneren, doordat bewoners het gebouw konden aanpassen aan veranderende waarden en praktijken. Deze analyse ondermijnt het idee van visies als statische blauwdrukken en benadrukt **aanpasbaarheid** als een cruciale ontwerpkwaliteit voor socio-technische artefacten.

Hoofdstuk 6 integreert de bevindingen en beantwoordt de deelvragen. Het introduceert een typologie van socio-technische visies langs drie dimensies: complexiteit (eenvoudige versus uitgewerkte visies), idealisering (waarde-gebaseerde versus ideaal-gebaseerde visies) en gedeeldheid (breed gedeelde versus marginale visies). Het hoofdstuk concludeert dat waarden in socio-technische visies niet louter legitimerend zijn, maar ook blijvende

richting geven aan ontwerp en systeemontwikkeling. Haalbaarheid blijkt een meerdimensionaal begrip te zijn, waarin technische, economische, politieke en culturele aspecten samenkomen. Ten slotte laat het proefschrift zien dat spanningen tussen visies en waardeverandering onvermijdelijk zijn, vooral bij systemen met een lange levensduur, en dat ontwerp voor aanpasbaarheid essentieel is om deze spanningen verantwoord te hanteren.

Samengevat levert dit proefschrift een inhoudelijke bijdrage aan het begrip van socio-technische verandering door te laten zien hoe gemoraliseerde visies technologische ontwikkeling beïnvloeden, ook voorbij de fase van initiële legitimering. Het bouwt een brug tussen STS en de filosofie van de techniek en biedt zowel empirische inzichten als normatieve handvatten voor het kritisch beoordelen van toekomstvisies, haalbaarheid en waardeverandering in technologisch ontwerp.