Planning for the Energy Transition and How to Overcome the Misfits of the Current Paradigm

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Abstract: The current paradigm for planning an energy transition is often embedded in practices within the existing political and societal regime. Within this paradigm, a genuine transformation to a fully fossil-free future is often not achieved. Thus, the problem is that in order to arrive at such a newly conceived future, the concepts and solutions created need to be fundamentally different from practices in recent past and present. At the same time, the community is not prepared for big changes, and the unknown future is experienced as uncertain and undesirable. These two mechanisms perpetuate current practices and prevent a new future from emerging. In this article, we will demonstrate how these two movements can be connected to disrupt incremental and path-dependent development, allowing people to become visionary and co-design a transformative future with innovative concepts. The Dutch Groningen region is used as an illustrative example for realising fundamental shifts supported by a bottom-up engagement process.

Keywords: transformative change; multi-level perspective; collaborative learning; co-design; energy transition; fossil-free future

1. Introduction

The energy transition towards the use of renewable resources is often seen as a non-linear, wicked problem [1,2]. On one hand, the need for a transition is widely recognised, policies are adopted, and ambitions are clear. To meet the objectives of the Paris Agreement [3], the EU aims to cut greenhouse gas emissions by a minimum of 40% (from 1990 levels), reach at least a 32% share of renewable energy, and improve energy efficiency by at least 32.5%, which are the 2018 upwardly adjusted objectives of the 2014 framework [4]. Besides this, the technology which can make this transition possible is advanced, and ready for implementation. Large scale wind and solar parks [5] have been realised or are under construction, a hydrogen future is envisaged [6], and smart grids have been well-researched [7]. However, this technology is all subject to an existing context in which political negotiations, policymaking, and compromises in governance determine the outcome of what is achievable. Moreover, existing interests of current energy producers prevent a transition towards a novel system, as this places them at risk of losing market value. Therefore, the discussions are often oriented towards the costs of technology for a certain end goal as opposed to discussing a desired sustainable future in which renewable sources are used to supply energy. When the problem is wicked, the basic flaw in thinking is to find a single answer, though for these types of problems, that is usually not possible. The negotiated average as a means to reach the desired transition will undoubtedly provide a solution for a problem that has already changed in an unexpected way once the solution is proposed. It is therefore utterly important a perspective on realizing the energy transition is taken that starts from a novel point of departure, e.g., the need for a fundamental reduction in energy use, reuse of waste energy and the use of renewables. This will need to ban the use of fossil resources
for energy delivery. Moreover, this novel perspective should behold the principle of using less than available and capture more carbon and other GHGs (Green House Gas) than emitted.

This is what occurs in an existing context, where the need for development and institutional governance processes prevails. These contradict with longer term developments and larger spatial scales [8], forming an adaptation gap [9]. In planning terminology, policymaking as well as climate negotiations are “muddling through” [10], while uncertainty and wicked problems require “unsafe planning” [11]. Dealing with wicked problems [12] requires bridging this gap, aligning local and short-term needs with long-term and large-scale uncertainties (Figure 1).

![Figure 1. The adaptation gap and wicked problems [9].](image)

The objective of solving a wicked problem without bridging the adaptation gap, e.g., without thinking beyond current development needs and the attached institutional governance system, is like trying to find a static solution for a dynamic problem or striving for linearity in a nonlinear environment.

Wicked problems are characterised as unstructured. This implies these types of problems are difficult to solve with technical–rational approaches that are commonly used to deal with structured problems [13]. Even “repairing” the existing framework to face fundamentally different problems is not satisfying, because this “repaired existing framework” will still solve problems in the same way it always has. Muddling through [10] interprets planning as looking at incremental changes to the problem in comparison with the former problem. This implies that policymakers “tend to avoid interpreting problems as unstructured, whilst maintaining limited dimensions and targets that do not represent the ‘real world’ using linear trend extrapolations overlooking relevant elements of the problem” [14].

The continuation of planning, policymaking, and negotiating for solutions within the existing set of institutional rules and habits complicates planning for an uncertain future. Problems that are not clear at the start or may be unknown cannot be solved in a singular way. This also makes the end goal of minimising GHG emissions, to keep global warming below 1.5 degrees, almost impossible to achieve.

A fundamentally alternative viewpoint is therefore needed to achieve the desired goal. Here, other ingredients, which are often absent in the discussions about the energy transition, must play a role. Despite being a multi-faceted concept, the energy transition is often looked at from a technological perspective, less so from spatial, engagement, social or time viewpoints. As an example of this orientation the International Renewable Energy Agency (IRENA) states: “The energy transition will be enabled by information technology, smart technology, policy frameworks and market instruments” [15]. Its focus on three pillars, being “(1) Power sector transformation knowledge: knowledge products and methodologies, (2) Energy system models and data: techno-economic and electrical models with associated data and (3) Energy planning support: application of knowledge
and modelling tools to support member countries”, and still resembles a more traditional focus. Stepping away from the technically dominated approaches to energy transition, the imagination and the citizen can play a crucial role in establishing a novel energy system. Imagination can bring an entirely novel future within view, even if this requires a complete overturn of current convictions and necessitates transformative processes. The citizen can play a crucial role in inventing its own future environment and when this happens a larger support for novel ideas emerges. This requires a process in which the citizen is at the heart of the debate and co-designs (and co-authors) the outcomes.

This paradigm shift naturally has implications for the use of existing technologies. A transition towards energy positivity and carbon sinking, though, out of the scope of this article, should be calculated as end of use of these technologies and include a thorough life cycle analysis. Based on these analyses, the opportunities to mix radical and smooth changes should be investigated to come to a balanced transition pathway. In this article, the transformative, more radical elements are highlighted. However, the systems and products that are no longer “of use” in the novel paradigm should not be brought to developing countries where they continue to add to rising GHG levels. Therefore, a carbon-free future requires to be calculated with global consequences of abrupt change in the developed regions in mind, as it is important not to have only clean energy in developed countries whilst pollution continues in developing regions of the globe.

The purpose of this article is to emphasise the organisational and societal constraints of reaching a low carbon future by linking transformational theories and applying these to concrete planning processes. The article is limited to these aspects and does not focus on the mechanisms in the energy industry, presenting concrete industry actions or products, nor does it aim to assess the feasibility of propositions or the economic benefits of planning proposals that are required to enhance the energy transition.

2. Methodology

In this article, three foundations are used to establish an environment in which transformative perspectives can emerge, creating space for the creativity to tackle wicked problems. Emphasis is put on the transformation process itself, the context in which niche innovations emerge, and the way collaborative learning conditions can be created.

These elements together form an integrated framework for a planning process that leapfrogs the current paralysis and self-organises both co-creation and the content. This way, it is able to overcome the established approaches that are ill-suited to delivering satisfying solutions to wicked problems. Moreover, when a linear solution is proposed for a wicked problem, the solution itself can increase the wickedness of the problem, pushing the desired future further away. Therefore, when it comes to wicked problems, unprecedented ideas are needed, which are often too far from current practices to be easily acceptable for people, policy, and politics. The paradox is thus that these ideas are required to deal with the wicked problem but are too extraordinary to be implementable. The question is therefore whether, and if so, how, this paradox can be dealt with.

To investigate this question, the following methodology is applied:

1. A novel framework is constructed for transformative self-organisation (Section 3). This theoretical framework brings together bodies of thought that put emphasis on their emergent capabilities, such as being able to generate self-organizing processes and principles, not only related to physical or technical flexibility, but also to the dynamics of the planning process itself and the prolonged impact of the change of mindset of the participants. Insights from transformation, multilevel perspective and collaborative learning are used to construct the framework;

2. A suitable environment is identified for co-creative innovations (Section 4). Once the theoretical framework is established, the conditions for a successful planning/design process can be defined. The capacity to invent novelties that are able to break through the existing conventions is essential for reaching an alternative future, can be located in the theoretical framework. These conditions are needed to allow for a mindset in which creative jumps, co-creation, and value creation can
emerge. In this section, specific outcomes and initial invented novelties, resulting from this particular environment, are presented;

3. An evaluation and reflection of the outcomes of the planning projects and processes undertaken in the first decade of the 20th century are undertaken (Section 5). The main discussion being whether the spin-off has led to disrupting the mainstream thinking that was apparent in this period. The evaluation has been carried out through 17 conversations and semi-structured interviews with stakeholders who were involved in the design and planning processes. Former project leaders, decision makers, academics and bureaucrats in the region have reflected on the impact and reach of the initial invented novelties primarily with regard to the role spatial planning and design plays within the energy transition.

3. Theoretical Framework

For constructing a theoretical framework to deal with wicked problems, foundations are found in complexity theory and design-led approaches. Bringing together existing thinking on transformations, multilevel perspective and collaborative learning seems eclectic. However, these find a joint basis in dealing with emergent processes and acknowledge self-organisation as a driver for spatial change, process organisation and societal and mental shift. Scenario planning [16–18] is an extremely valuable method, as it broadens viewpoints that are generally limiting the policy field to a single problem–solution relationship. However, scenario planning limits itself, scoping the main axes as the sole defining parameters constructing the scenarios. This implicitly confines the scope and outcomes of the methodology. Especially in a dynamic environment, which has to deal with the wicked problems a scenario-based approach excludes such as the unknown unknowns that are significantly important in dealing with future uncertainties. This gives reason for not making scenario planning part of the framework.

The framework aims to break through existing conventions, hence requires the capabilities to intrinsically enhance processes of self-organisation, emergence, and grounded theory. These encourage transformative processes, developing from the inside, without a clear end, and without embeddedness in the recent past, habits, or unwritten rules and agreements. Instead of “muddling through”, these theories give space for unsafe [11] ways of thinking, designing, and planning.

Design problems, also seen as wicked, unstructured, problems, can be linked to the “Reflexive Practice Approach” [19]. A so-called collaborative learning strategy is well-suited to tackle these types of unstructured problems [20]. In case there is consensus on values and norms, this is missing, and there is no certainty regarding the required scientific knowledge and an alternative working approach is needed. People involved in design-led approaches are invited to “present information on the issue, become aware of the multiple aspects of the problem, and are enabled to reframe their conception of the problem” [21]. This allows them to develop new visions for the distinguished problems.

3.1. Transformation

The urgency to invent and design innovative and unprecedented future visions is high. Being a wicked problem, the energy transition demands more than technical solutions to linear problems, as these will only exaggerate the problems they aim to tackle. The question is then how and where these novel ideas can be developed. A future vision with these characteristics can only be conceived outside the existing system of policy making and planning. This first creative jump [22] must be made from the existing context to a novel environment, landing on the avenue to an alternative future.

Transformation trajectories [23–25] are described as “the capacity to transform the stability landscape itself in order to become a different kind of system, to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable” [26] or as “disconnected processes of growth” [27]. The disconnection (or the need to part from the original system, A), is represented as a beginning of the next “forming” cycle, a new phase 1 (Figure 2). The start
of a transformative process occurs outside the existing regime while the current system is still in operation [28].

![Figure 2. Transformational process (adapted from [29]).](image)

This transformation requires a (creative) jump to the new cycle at the moment the current cycle of change is getting less and less satisfying. When the tension of the current system with the demands of its environment becomes too strong, a jump is likely to occur. However, smart planning anticipates this tension long before it is actually noticeable, even before the existing system is reaching its highest success, when it is in its highest balance or order, and no urgency to jump is felt.

The forming of the new system (B) can only take place through inventing new things (Figure 3), disconnected from the current system. Once this has happened, system B begins its own trajectory towards the desired or visionary future. It is clear that by establishing such a novel system, B can only happen by moving away from the pathway of system A, as this will only lead to renewed versions of this system, or A-dashes [30], eventually culminating in an unwanted future.

![Figure 3. Transformational jump from existing pathway A towards new system B [30].](image)

When turbulence of the existing context causes disturbances, aiming for a stable equilibrium is difficult and can even be counterproductive. Viewing the urban landscape as perpetually stable is an illusion and could end in a hard confrontation with rapid, unprecedented changes. Aiming for a dynamic change therefore begins with inventing the desired future state B. To reach this future system B, system A is useless, as it only can turn into regressive A-dashes. The transformation can only happen when B-minuses, predecessors of the future system B (or a “hidden novelty” [30]), are found, which can then become the new starting points of development [31]. The future is then “becoming” rather than being planned from the top-down. This post-anarchistic planning emphasises the use
of self-organising groups, planning their own environments without being led by the traditional governmental or political arena, allowing them to create a disordered order of spaces [32]. This “unsafe” way of planning [11] searches for the B-minuses, the peripheral ideas and inventions, to reach the desired end-goal of systemic change to B, which accommodates disruptive and unprecedented changes and ignites growth of a new innovative environment.

3.2. Multilevel Perspective

Once it is understood that the search for B-minuses needs to occur in order to bring about the required transformation, we must acknowledge that the environment within which this happens is important. Conceiving of an unprecedented, intrinsically dynamic future only happens in a niche environment where innovation can emerge. According to the multi-level perspective [28,33,34], change starts in the locus of radical innovations where novel configurations appear. These radical innovations are capable of interfering with and influencing established practices and associated rules that normally stabilise existing socio-technical regimes (Figure 4). Should the regime change under these influences, the exogenous “landscape”, representing the nearly unchangeable values and biophysical features, might transform.

![Figure 4. Regime shift under influence of niche innovations (adapted from [28]).](image)

When a wicked problem is encountered, the desire for a new future system emerges, and the tension with the existing regime is profound, a window of opportunity opens up for new inventions. This only occurs when the right niches are created, within which the ideas are reinforced, becoming the dominant design and growing strong enough to eventually break through the current, forming a new dynamically stable regime. The effectiveness and power of the innovation, e.g., whether a regime transforms, are determined by the strengths of the reinforcements at the regime and/or landscape level [35]. In line with the thinking on how actively enforced change occurs, it seems obvious that a system that is better at reinforcing new ideas is better equipped to tackle unprecedented change or disruptions that cannot be foreseen. However, the tension between the existing regime, reinforced by the unchangeable values and biophysical features of the landscape and the necessity to fundamentally change and disrupt the current regime, is a battlefield between continuation of system A vs. transformation to system B.

Different transformation pathways are possible, depending on the readiness of niche developments, the magnitude of the landscape change and the susceptibility of the regime actors [36]. Geels and Schot distinguish transformation (Transformation path: If there is moderate landscape pressure
("disruptive change") at a moment when niche innovations have not yet been sufficiently developed, then regime actors will respond by modifying the direction of development paths and innovation activities. In this pathway, moderate landscape changes create pressure on the regime, leading to reorientations by regime actors. Moderate landscape pressure occurs early in disruptive landscape change. Niche innovations cannot take advantage of landscape pressure on the regime, because they are not sufficiently developed [36]), reconfiguration (Reconfiguration pathway: Symbiotic innovations, which, developed in niches, are initially adopted in the regime to solve local problems. They subsequently trigger further adjustments in the basic architecture of the regime. Radical innovations are initially developed in niches. If they have symbiotic relations with the regime, they can be easily adopted as add-on or component replacement), technological substitution (Technological substitution: If there is much landscape pressure ("specific shock", "avalanche change", "disruptive change") at a moment when niche innovations have developed sufficiently, the latter will break through and replace the existing regime. This pathway assumes that radical innovations have developed in niches but remain stuck because the regime is stable and entrenched. This differs from the de-alignment and re-alignment path, where the regime destabilised early in the process), and de- and re-alignment (De-alignment and re-alignment path: If landscape change is divergent, large and sudden ("avalanche change") then increasing regime problems may cause regime actors to lose faith. This leads to de-alignment and erosion of the regime. If niche innovations are not sufficiently developed, then there is no clear substitute. This creates space for the emergence of multiple niche innovations that co-exist and compete for attention and resources. Eventually, one niche innovation becomes dominant, forming the core for re-alignment of a new regime) pathways. In summary, the timing of landscape pressure and niche development determines the type of pathway (Figure 5). Wicked problems, as described in this article, implicitly lead to pathways that suit serious pressure at landscape level. The readiness of niche developments then distinguishes the pathway between the de- and re-alignment and (technical) substitution. The transformative development, as described in Section 3.1, puts emphasis on the hidden novelties [30], or B-minuses [31], suggesting that if these hidden novelties can be brought to fruition, they will be ready to break through existing conventions and substitute the current regime.

![Figure 5. Different transition pathways (based on [36]).](image)

3.3. Collaborative Learning

The fact that these contradictory processes, continuation and path-dependency and a transformative, disruptive pathway, meet at a battlefield urges the highest level of learning in an emergent self-organising process. In this context, it is simply not satisfying to transfer information as an instructor, to be an expert, or to build skills and competencies focusing on the learner (Figure 6). Shifting mental models and knowledge creation are needed, which are oriented towards teams, partnerships, and community collaboratives [37].
The framework for co-creative innovation is constructed by connecting the three bodies of knowledge: process, in which all the participants establish multiple connections and interactions. This allows for novel inventions to appear in the most natural way. In literature this is dubbed third level learning [22], also transformational learning. This environment of collaboration is best suited to generate solutions to wicked problems. By creating a transformation arena where multi-actor collaboration is stimulated, breakthrough visions can be developed [38]. The emergence of novel, shared visions and unprecedented mental models will happen in an effective way, acting as novel “theories-of-action” [39–41].

3.4. Co-Creative Innovation

In the context of rapid change and disruptive futures, many problems are dubbed wicked. Three theoretical concepts have been distinguished as suitable for a creative approach envisioning responses to unprecedented events and the unknown unknowns, making use of the insights that collective participants (alias “the citizen”) and design-led approaches (alias “the imagination”) can provide. This way, a transformation to an unforeseen future can be conceived. As mentioned above, the transformation starts at “B-minus”, in a niche environment, and must use collaborative learning to be ready for the “battle” (the battlefield, Figure 7) with the existing regime or the societal establishment. The framework for co-creative innovation is constructed by connecting the three bodies of knowledge to one whole (Figure 7). The multilevel perspective, depicting the landscape, regime and niche levels, is taken as the basis for the framework. When this is combined with the three learning levels, instruction, individual learning and collaborative learning the linkages between them become visible. At the landscape level, all three learning types appear, from well-established instructions, interactive learning of tutor–student relationships and team learning. At regime level the advanced forms of learning are applicable, while the niche level can only be supported by collaborative forms of learning, because novelties are only invented when unprecedented interaction can occur between multiple actors. The third addition is the principle of transformative change. All systems evolve and undergo transformation. At first, they are starting off when a niche novelty is mature and able to replace existing elements at the regime level, becoming the regime itself. As the system evolves further and turns into an established “landscape”, tensions and cracks in the once innovative system will occur, placing the system at risk of malfunctioning and decline. Before this is about to happen, the alternative
system is getting ready to replace the former. The novelties, or B-minuses, become attractors for components of the existing system, which make the jump to the new reality. In order to allow this to happen, the conditions at niche level must be created to develop novelties and allow these to become mature. Therefore, the cyclic and iterative process of creation is established.

![Figure 7. Framework for co-creative innovation.](image)

In the framework, there exists a **creative jump** from system A, on its way to belonging to the regime and/or landscape (in black), to B-minus (in red), located in the niche environment, where a **carousel** of consecutive learning environments is providing the context for establishing the new ideas that allow the new system to mature, break through the existing regime, and influence the overarching landscape. Here, team learning is imperative to achieving a successful outcome. This transformative carousel consists of three interactive components:

1. **Creative jump**: B-minus and breakthrough ideas—the creative jumps must bring together the most creative minds who are experts in thinking “beyond the ordinary”. This is a necessary step, in order to find methods that are not hindered by the regular and well-known solutions for day-to-day problems. This initial step combines expert knowledge, creative thinking, and the generation of novel concepts and ideas. Ideally, this process is undertaken by a mix of professional and local expertise, e.g., academics and citizens alike;

2. **Co-creation**: the visionary citizen—the extraordinary concepts and ideas form the inspiration for a co-creative process. The uniqueness of concepts stimulates people to think beyond the normal and collaboratively find solutions that respond to the wicked problems of the region. Out of everyone’s insights and understanding, in a transparent and inviting atmosphere, fluidity of thinking occurs, and the participants come up with unexpected and unique outputs;

3. **Creating value**: acceptance of breakthrough ideas and implementation—the process of co-creation leads to people being profoundly attached to the ideas and solutions. This causes a strong
ownership of the conceptual ideas, which will be defended by the group as their individual brainchildren. Through this, the implementation of ground-breaking ideas has created value and will be supported by a growing network of people.

This “carousel” moves between the niche environment, where novelties are invented, and the regime level, aiming to break through existing conventions. The idea behind the carousel is that it circulates as long as necessary to gain power and become strong enough to stand firm on the battlefield of change. This must be seen as an iterative process in which the mutual cross-fertilisation of creative jumps and the co-creative process eventually leads to added value, which accelerates the uptake of invented novelties at the regime level.

4. Northern Netherlands’ Energy Transition

The co-creative innovation framework is used to identify the recent status of the energy environment, to analyse ambitions for an energy transition, and to understand the potential for a transformation towards a clean and local energy supply, fully based on renewable resources. The northern region of the Netherlands is used as a case study.

4.1. Multi-Level Perspective: Landscape and Regime

The northern part of the Netherlands is prosaically called Energy Valley [42]. Through the ages, it has been an energy-generating region; first, as a peat harvesting landscape, and since the late 1950s, as the location of natural gas exploitation.

At the landscape level (Figure 8), gas industries, represented by the Gasunie and NAM, have established an indispensable position in the northern economic, cultural, and political elite. The fact that natural gas was discovered in 1959 gave the region a crucial role, as one of the major economic drivers, hence providing growth of wealth to everyone in the country. For 60 years, the Netherlands became dependent on the abundance of affordable energy. Not only in direct supply, but also as a source of economic growth. The Dutch national government uses the profits for investments in its economy, such as through financing large infrastructure works. This also implied a strong interconnection between public and private interests. The Ministry of Economic Affairs and the gas industry partners, Gasunie and NAM (Dutch Petroleum Company) became dependent on each other for the continuation of prosperity.

![Figure 8. The co-creative innovation framework for energy transition in northern Netherlands.](image-url)

At the regime level, the entire nation is supplied with a well-operating system of natural gas delivery, reliant and cheap, using a dense and widespread grid. People are accustomed to using gas...
for cooking and heating in their households, and the majority of the houses are deliberately designed for this type of energy supply.

Looking at the existing system (A), the discovery of the Slochteren gas field led to a rise in innovative technologies, necessary for the exploitation, distribution, and export of the fossil resource. The new technologies were used to build the distribution network across the Netherlands, which was also used to transport natural gas to foreign countries. This made the gas industry very powerful, not in the least because the revenues flooded back into the national treasury.

4.2. Transformation and Creative Jump

Somewhere along the curve of system A (Figure 8), tensions start to increase and the first cautious attempts to make a creative jump could be witnessed in the early 2000s, when the fossil-based industry was confronted with worrying research outcomes on climate change and the contribution of greenhouse gas emissions to global warming. This was the moment discussions started about whether the distribution network could be sustained in its current form, and if a transition to an alternative system would be necessary in the near or far future. Global discussions on a transition to a renewable energy future led to research projects such as the Bridging to the Future project, in which sustainable urban system designs [43] were explored. In this case, a combination of dissatisfaction with the existing regime aligned with the awareness of the limits of fossil resources. The global impact of ongoing fossil resource depletion increased attention to alternatives, and in terms of transformation, urged a possible jump from the current system (A) to an alternative system (B), to be made. At first, the general objective to create an independent clean and local energy supply was formulated. However, by itself, this did not lead to a straightforward process of inventing and implementing the new paradigm. Therefore, the counterforces were too strong and the vested interests too important to just switch. However, a cautious shift to a new emerging curve (system B) by experimentation and academic investigation, proved a safe enough platform, far enough from the existing practice, to start exploring what inventions the new system could bring forward. Establishing co-creative environments reinforced an innovative context, required to develop ideas that are far enough from existing practice, hence could function as B-minuses for a desired system.

The clearest manifestation of enabling a creative jump is the creation of a subsequent meeting series under the acronym INCREASE (INternational Conference on Renewable Energy Approaches for the Spatial Environment) [44,45]. In this context, international experts were brought together in a design-led process to create innovative and break-through concepts for a long-term feasible and sustainable energy system. The multidisciplinary group consisted of regional policy makers, energy engineers, data scientists, architectural and landscape designers, academics, energy strategists, energy market economists, entrepreneurs, lifehackers, and sustainability experts. The task for the group was to design a region without using fossil resources for its energy provision, nor importing any energy from outside the area [45]. In order to create an atmosphere of free-thinking, being out of the daily routines and context, and for the participants to be really committed, these meetings were organised in Jordan and China, respectively. An additional advantage was being able to support the local participants with innovative concepts for zero-carbon regional development.

The meetings were designed to stimulate discussion and allow for reflection and feedback, while eluding to unusual solutions and remaining iterative. A constant flickering between spatial scales, technical analyses, and design provided an inspirational and lively context for extraordinary outcomes. While designing, preliminary results were computed, and provided the input for new design iterations. Whole-system thinking iterated with detailed analysis of thematic and component aspects related to the energy and food systems. The expectations were set high and needed to result in a concluding presentation for decision-makers and key persons.

The INCREASE meeting series led to the design of a so-called Groningen Fast Forward (Figure 9), a spatial design in which the entire provincial area of Groningen could generate its own energy and food.
In the conceptual design, the provincial area is transformed into an energy- and food-generating area, providing all basic needs for its population. It includes specific objectives for different parts:

- The peat colonies transform into energy factories. In PV (photovoltaic)-coated glasshouses, most of the food and organics are grown and energy is generated. The wind-turbines are spread in between the greenhouses. Waste heat is stored and reused locally in a closed loop system;

- Biofuels are produced using algae technology in the northeast;

- The processing of food, biomass, bio-fuels, organic waste, and waste water is implemented in the “Green Industrial Heart”, fully bio-based;

- The potential for wind energy and geothermal heat in the northern part of the area is high. Additionally, tidal and osmosis power-plants find a natural habitat in this part of the design. Shrimp farms and other uses requiring heat benefit from the abundance of geothermal sources;

- The salinity in the coastal zone provides the conditions to introduce saline agriculture for local food production;

- The areas marked with a “?” represent redundant space which can be used when needed for different purposes according to new future circumstances, for instance for nature reserves, to capture surpluses of rainwater, or to store flood water temporarily.

The potential benefits of the proposed design are calculated for 2050. An estimated 76 PJ/year of energy can be provided by creating a cascade of heat, electricity and fuel [47]. It can be concluded that approximately 42% of the energy demand can be locally generated using the available renewable energy sources. On top of a predicted 50% reduction in future energy demand (e.g., 90PJ), a further reduction to 70PJ in 2050 is possible. The Groningen Fast Forward plan, implementing the additional innovations as described above, can supply 90-113PJ [46], hence generating a surplus. Basing the
energy system on the readily available renewable sources, the reduction in CO₂ emissions for the Groningen region is calculated at 72%, avoiding 7190 kton CO₂/year. Realising a fossil-free future increases this percentage by definition to 100%.

The Groningen Fast Forward design illustrates the possibility to realise an energy system innovation that can supply the region with energy without making use of any fossil resource. Additionally, it is capable of producing substantially more food than is demanded. This surplus can be shared with people in other areas that have to live with food shortages.

This INCREASE collaborative can be seen as one of the outstanding initiatives of the broader innovation climate in the northern part of the Netherlands. Amongst others, several creative jumps can be distinguished:

- Blue energy, generating electricity using osmosis technology [48,49], research conducted at the Wetsus institute (https://www.wetsus.nl/research-themes/blue-energy/);
- Design and local production of small-scale wooden wind turbines fitting in the spacious northern landscapes (https://www.eazwind.com/nl).

4.3. Co-Creative Learning Environments

As part of the Bridging to the Future project, instigated by the International Gas Union (IGU), a design process called Grounds for Change [50] was organised with collaborating teams from Japan, Canada, India, China, and the Netherlands. The Dutch Gasunie, as the next chair of the IGU conference in 2006, asked the design teams to develop future visions for a climate neutral energy supply for their regions. In the Dutch context, the team investigated the potential to supply the entire northern region with renewable resources and transform the land use accordingly. Part of the design process was a series of design charrettes with participants from the international teams, energy and design students from Groningen and Wageningen Universities, regional NGOs, policy makers, academics, and professional experts. Within the design charrettes, the conditions for collaborative learning were established: participants worked towards an innovative and shared vision, everyone was heard and valued, a mix of people participated, large, small, and individual work methods were applied, there was ample time for reflection, the ideas and output were systematically collected, and the process was smoothly organised. This led to creative, inspiring interactions, participants who were proud of the final results and defended the outcomes to others, and a final presentation to the responsible decision makers from Gasunie as well as regional governments. The atmosphere created illustrates that the attention given to designing the process is equally as important as the design outcomes themselves. Even the smallest details are relevant to involving citizens and non-professionals in a genuine way [51].

This design charrette process resulted in a vision on the future energy supply of the northern region. The spatial vision on future land-use found its base in the regional landscape, climatic, topographic, and geographic characteristics depicting the local renewable energy potentials. Energy Potential Mapping (EPM) charted the regional energy potentials for harvesting wind, solar, hydropower, geothermal energy, and biomass [52–54]. By overlaying these “energy potential maps”, the energy-mix map could be derived (Figure 10). The most suitable land-use for different areas can be depicted by area-specific renewable energy potentials. Potential-driven implies that the available amounts of renewable energy of different types determine the applicable land-uses, instead of the other way around, namely, the urban uses demand the amount of energy to be delivered no matter which natural resources are available.
Finally, the design of a spatial vision for the region (Figure 11), depicting spatial interventions that were deemed most urgent and effective, established an independent clean and local energy supply for the northern region in the Netherlands.

4.4. Value Creation

The existence of natural gas in the northern region has led to not only material wealth but also to the establishment of an innovation cluster, investigating and inventing technological solutions for the energy system and its logistics. It also bolstered academic research in the field. The foundation of Energy Valley in 2003 as a conceptual umbrella for regional economic, technological, and social development in the north of the Netherlands can be seen as smart marketing, but it also proved its relevance and raised awareness and pride in the region. Soon after, the Energy Delta Institute was founded, aiming to transfer knowledge to other comparable regions around the world. These formed the fertile context in which the Grounds for Change design process and INCREASE could flourish. These creative processes brought a reciprocal value to the region, enhancing the appetite for innovative spatial thinking about the energy transition in the northern provinces.

Figure 11. Regional vision based on EPM [56].
As a result of these examples, the mindset in the north changed considerably. This can still be witnessed today. It co-caused an acceleration in the implementation of initiatives which contribute to renewable energy system innovations. The New Energy Coalition emerged as a merger of Energy Valley and the Energy Delta Institute, and new innovative projects were ignited such as NorthH2, a collaborative initiative of Gasunie, Groningen Seaports, and Shell, establishing Europe’s largest green hydrogen project using renewable electricity generated by a mega offshore wind farm. Besides large-scale projects such as this one, there were a range of local initiatives, such as Grunneger Power and several others [57,58].

Moreover, the region has attracted considerable funding for a range of research projects, such as taking a leading role in the H2020 project, Making City, which aims to investigate and implement net positive energy districts in urban precincts (www.makingcity.eu). Additionally, the universities in Groningen have established a series of Bachelor, Masters and Doctoral programs in the field of sustainable energy. A specific Master study, Energy4Society (https://www.hanze.nl/eng/education/engineering/school-of-engineering/programmes/master/energy-for-society) at the Hanze University of Applied Sciences, explores the impact of energy transformation for societal, economic, and technological systems.

These examples illustrate only a few highlights of the impact that two decades of thinking about the integration of energy, technology, society, and spatial planning has had. The focus in the region is continual and will not easily disappear. This means a long-term value creation has been established from the early 2000s onwards. However, transformation towards an entirely new system (B) is still not secured.

5. Reflective Contemplation

Upon taking the lead in establishing novel planning approaches, these kindled a movement in Energy Valley, the north of the Netherlands. The conversations with stakeholders that were involved in the initial stages of project development, planning and policymaking, nationally and internationally, in hindsight the abovementioned projects and processes have led to breakthroughs. They have disrupted mainstream thinking, which, in the early 2000s, emphasised a continuation of the existing fossil-based energy supply. The conversations and interviews have highlighted a range of impactful outcomes, which can be divided into four categories, each of which gained momentum and created value for the inhabitants of the region, the academic knowledge base, the attractiveness of the region for Dutch and foreign companies, residents and students alike. The following added-value categories have been identified:

1. A novel mind-set. The fact that spatial planning was approached by analysing and mapping the renewable energy potentials instead of the other way around created a novel mindset for decision-makers, the research community and the residents of the northern provinces. Where a certain type of renewable energy source is available determined the land-use and urban development principles. Additionally, an ongoing effort is carried out in research and education to put energy transition at the heart of academia, such as is illustrated by the recent development of the new Master Energy4Society, but also the fact a range of international research funding is attracted to the region. The Horizon 2020 project Making City is a recent example of the attractiveness and thorough opposition of the region in the international scientific community. Finally, the emergence of local initiatives to collaborate and organise themselves with the objective to collectively generate non-fossil energy is illustrative for the novel mind-set in the region. Initiatives such as Grunneger Power and several others underpin this.

2. Novel concepts. During the first energy and spatial planning processes, new concepts have been developed to respond to the pressing problems of that time. The question of how to find an answer to supply energy without using fossil resources has led to a pressure cooker context for finding these novel ways of thinking. The Energy Potential Mapping was developed as a methodology in the context of the Grounds for Change project and has since been used and improved within
the northern region as well as in other projects and plans across the Netherlands. The creative approaches of convening design charrettes and organizing international think-tank workshops, which not only brought the best international expertise together with local knowledge but also provided the context for creativity and out-of-the-box thinking that brought about the ideas and novel concepts. The design-led approach has since been applied to other topics, such as climate adaptation, landscape ecology, urban development, sustainable building and recreation and tourism, in many different places across the globe. Finally, innovative thinking in new conceptual directions has seen the emergence of the Green Hydrogen economy in the NortH2-consortium, aiming to transform the northern energy system towards a clean and high-tech future.

3. Novel initiatives. In the early stages of the process organisational entities have been established, such as the regional branding as “Energy Valley” and the supportive research and Development institute called EDI (Energy Delta Institute). These institutional initiatives have led to broadening of the knowledge base and coherence in the research pathways. Recently this has been strengthened by the launch of the New Energy Coalition, in which research institutions, such as the University Groningen and the Hanze University of Applied Sciences, collaborate with the northern municipalities and governmental bodies and a range of industries across the region.

4. Novel products. A range of new products have been developed in the north, made possible by the climate of experimentation, innovation and investigation. This innovation cluster is supported by investments in research, prototyping and developing proofs of concept, so individual enterprises and companies are able to experiment without being afraid of immediate bankruptcy. Several initiatives, inventions and discoveries have been made possible in this context: the reversed osmosis program to generate electricity from bringing fresh and saltwater together (e.g., Blue energy, Wetsus), the design and construction of wooden wind turbines build with local materials and fitting in the spatial context of the north, or the novel ways of implementing solar parks in the landscape and on lakes and ponds.

The energy transformation movement, which ignited in the early 2000s, is still moving forward and cannot be stopped. It is expanding its influence on daily life, ground-breaking research innovations, attracting students, researchers and research funding, residents and companies, and providing Energy Valley with a brand that will not be wiped out. The process of transformation in the north of the Netherlands has brought about serious novel value, and this process is ongoing.

6. Conclusions

In this article, the ways to increase the chance at implementing a highly necessary energy transition is presented as a transformative way of jumping off the current system to ignite the emergence of a new cycle, by establishing creative collaborative learning environments. Several conclusions can be drawn.

The innovative regional spatial visions, the method of Energy Potential Mapping, linkages between energy technologies, social innovation, and spatial design show that transformative ideas have been conceived in the innovation environment in the north of the Netherlands. This is exemplified by the Groningen Fast Forward project and the fact that many of the initial ideas and concepts have turned into products, such as blue energy and the wooden wind turbines. Currently, this line of innovative thinking continues with the creation of environments that generate more energy using renewable resources than they use, as investigated in the Making City project.

These innovations can only happen when people themselves are given the opportunity to become visionaries. The role of creating collaborative learning environments, such as in design charrettes, allows people to self-organise the collaboration such that novel concepts will emerge. Most recently within the Making City projects, local residents are involved in becoming visionaries by establishing so-called enabling ecosystems [59] in which the social construct enables them to self-organise and form a strong and lasting network for innovations.
The transformation towards a new cycle starts by searching for the B-minuses in those niche environments where creation of novelties can take place and collaborative learning is possible. In combination, these form the optimal cocktail for reaching a desired future.

Still, the battle is ongoing. Established networks of the politically responsible decision-makers in industry, the grid administrators, the energy providers, and companies send out a coherent message that society is still dependent on fossil resources to supply energy in a secure way. On the other hand, individuals, local initiatives, and renewable energy coalitions and alliances prove that a reliant supply of renewable energy for household, street, precinct, and city-region is possible, making the point that striving for a net zero-carbon future is achievable and should be pursued.

To achieve the best results, the principle of self-organising should be applied both at the process and organising level, as well as to the invention of new content. Therefore, the goal of finding solutions that are self-organising, increase the adaptive capacity, and are capable of adjusting to the future is best achieved in a self-organising process, which allows for the emergence of joint ideas and the invention of novel concepts. This adventurous pathway in itself requires backing by the decision-makers, who must acknowledge the sense of urgency. During the process, gaining support is a continuous concern, aligning the innovations that might lead to breakthroughs with the decision-making reality.

The carousel of the creative jump, co-creation, and creating value can (or should) happen in any particular order, its components occurring simultaneously. It does not start at one point followed by the logical next, but can start at any place, any time, and can occur simultaneously in multiple environments.

The urgency for a fast forward energy transition is clear, however, a transformation to achieve this is still very much needed.

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