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Creating a Roadmap to Capture a Vision for a Sustainable Community in Transition; a Case Study in a Dutch town Best

Laura Elvebakk
Norway
laura.a.elvebakk@gmail.com

Gerrit Muller
University of South-Eastern Norway
Kongsberg, Norway
gerrit.muller@gmail.com

Abstract. Best Duurzaam is a cooperation that aims to facilitate a transition to a sustainable living at a local level. However, it is missing an overall vision. Additionally, Best Duurzaam would like to have a closer collaboration with the local municipality.

Roadmapping is a planning tool used for framing a vision shared by project participants. It aids in communicating the dynamic relations between group's ideas and accessible resources. A roadmap makes a project approach more specific in both contents and time.

The goal of this study was to investigate how roadmapping could help in solving communication issues. Researchers used roadmapping to understand the issues, to explore solutions and to improve communication. The research was done at municipality level to study the tool's effectiveness in the context of local sustainability transition. The research result suggests that the roadmap is a valuable tool for communication and sharing ideas among stakeholders.

Introduction

2018 The Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2018) report is stating that human activities have caused roughly 1.0°C (+/- 0.2°C) of global warming. If temperature continues to rise at the current rate, a 1.5°C increase will be met between year 2030 and 2052. This warming trend must be dealt with urgently to avoid altering the climate system. If 1.5°C of global warming will be exceeded, ecosystems and biodiversity would be harmed irreversibly. Sustainable development supports, and often enables, the fundamental societal and systems transitions and transformations that help limit global warming to 1.5°C (IPCC, 2018).

Global Perspective. In 2015, United Nations defined a collection of 17 Sustainability Development Goals (SDGs) (The United Nations, 2015). It is a plan of action for "People, Planet, Prosperity, Peace, and Partnership". No Poverty, Good Health, Gender Equality, Climate Action, and Sustainable Cities and Communities are only a few of the 17 SDGs. 193 countries have adopted the agenda and are committed to implementing the SDGs.

To succeed in the realization of the 17 SDGs, there should be a change in many interlinked systems, such as social, political, economic, etc. The UN goals must be implemented on many governmental levels - EU, national, provincial, regional, and municipal. The transition must happen in energy, industry, agriculture, urban and infrastructure systems. Over the past decade, a number of available technologies have greatly improved. However, political, economic, and social circumstances still create challenges for transition to sustainability.

Local Initiative. Due to global warming being a pressing issue, new movements and actions are taking place across the world. In the Netherlands, several groups of concerned citizens have started local initiatives working towards more sustainable communities. One of such initiatives is Best Duurzaam (Sustainable Best) - a volunteer organization established in the Dutch town Best.

Figure 1. Town Best in Netherland and Best as System-of-Systems

The town of Best located near Eindhoven in the south of the Netherland (Figure 1), has 30 thousand inhabitants. The municipal government consists of a mayor and 4 aldermen, where 2 of the aldermen have sustainability topics in their portfolios. The rest of the office consists of about 240 employees divided among 6 departments. The municipality is responsible for the administration of the town and most of its infrastructure. The municipality is a part of the province Noord Brabant. Many of the governing processes are directly linked to the provincial strategies.

Case Study. Best Duurzaam was established in 2013. Its aim is to facilitate a transition to a sustainable way of living at the local level. The cooperation currently has around 360 members and about 40 active volunteers. The cooperation's goals are inspired by and in line with The United Nations' 17 SDG (The United Nations, 2015). Best Duurzaam has been working mainly towards an Affordable and Clean Energy for All. This includes educational activities on the same subject. Best Duurzaam wants to increase residents' awareness of energy use and the importance of green energy. Best Duurzaam is committed to an energy-neutral and waste-free municipality in 2050.

The cooperation has practical activities where skilled volunteers provide advice on energy saving, as well as energy generation (solar panels). Best Duurzaam has a mediator role, supporting residents through knowledge sharing initiatives. The cooperation makes residents aware of how they can lower their energy consumption, and what the alternatives are for gas use.

Figure 2 shows the energy consumption in Best, with fossil fuel and gas being the major source. National legislation mandates the municipal government to deliver a "Heat Transition Plan" in 2021. The Heat Plan must outline how the existing and commonly used gas heating system can be replaced by greener alternatives. This makes the local government an important stakeholder in the development of the roadmap.

Another challenge is the diversity in the oldness of the buildings in the Best. The age of houses correlates with the degree of insulation. Since the thermal resistance, the R-value, is reverse proportional to the energy required for heating, better insulation means greater energy saving. Figure 2 also shows the territory of Best, its neighborhoods, and R-value per house construction year. 72% are privately owned houses, 20% are buildings own and rented out by the housing corporation, and the remaining 8% are other forms of rental houses (Muller, et al., 2019). The government controls the minimum requirements for R-value through building regulations. Need for after-insulation and demand for low-energy houses makes both housing cooperatives and building entrepreneurs stakeholders of the roadmapping process.

Other Best Duurzaam activities include rising awareness on waste recycling, as well as stimulating transition to a circular economy. The cooperation also wishes to broaden its project portfolio.

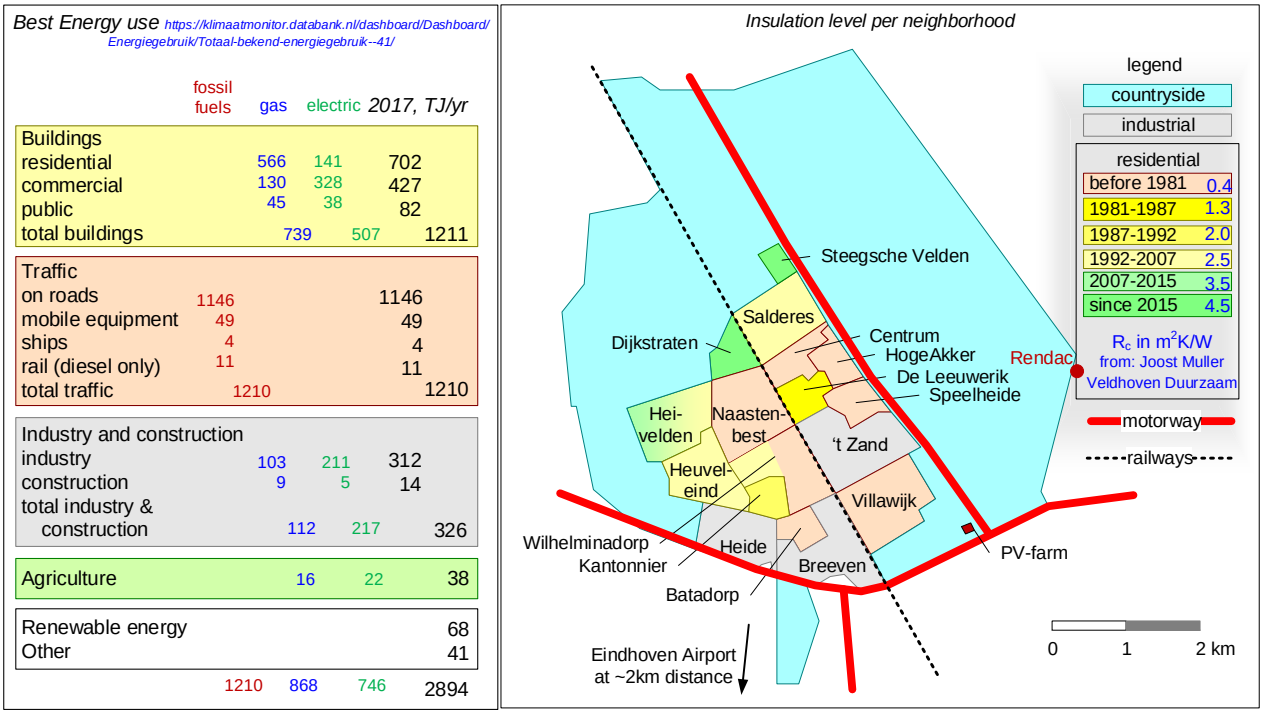

Figure 2. Current Energy Consumption in Best & the Territory of Best and its Neighborhoods

Problem Statement. Best Duurzaam has been organized in groups of expertise and interests, e.g. technical and educational people. This has resulted in a lack of cross-disciplinary proficiency within the cooperation. Several external stakeholders (local politicians, entrepreneurs, housing corporations) are involved in creating a more comprehensive picture of sustainable Best. However, Best Duurzaam and other involved parties are missing a shared understanding for further direction and action.

Roadmap as Facilitating Tool. A roadmap is a tool that enables discussions and a higher degree of collaboration. By answering the project's "Why?", "What?", and "How?" (Phaal & Muller, 2009), a roadmap can provide an overview of pathways to the possible future scenario. In this study, we applied a roadmap as a tool to study its effectiveness for constructing a non-technical system. Construction of a roadmap can help to create an overall vision and to link various elements of sustainable living to the diverse expertise. A wide variety of stakeholders partook in the project by collectively mapping a vision for sustainable Best. This resulted in a multi-level roadmap that visualizes the strategy for sustainability at a conceptual level.

Case Study Research. This research builds on "Roadmapping for Sustainability" study by G. Muller et al (Muller, et al., 2019). The article identifies the challenges with structuring many mutually dependent systems. The study recognizes an opportunity for use of roadmap as an interaction tool between numerous stakeholders.

Research Questions. To evaluate whether construction of a roadmap achieves anticipated benefits, the researcher will answer these research questions:

- How does creating a roadmap facilitate communication and sharing among stakeholders?
- How does creating a roadmap aid the local community to become more sustainable?
- How does a roadmap help in finding fitting solutions to sustainability goals?
- What factors do help in the creation of a roadmap?
- What factors can prevent the success of the creation of a roadmap?

The Theory of Roadmapping

Roadmapping is a technique that Motorola used already in the late 1970s (Phaal, et al., 2004). Since then it has been widely applied in technology and business planning. A roadmap is a structured framework that addresses three key questions: "Where are we now?", "Where do we want to go?" and "How can we get there?" (Phaal & Muller, 2009). It is a powerful tool for exploring and communicating the dynamic relations between technology resources, organizational objectives, and the changing environment. An important benefit of a roadmap is associated with the ability to balance the markets "pull" and technology "push". Roadmapping is a flexible approach that allows customization to suit various contexts.

Muller states that the key to a good roadmap is the expertise of presenting the relevant development issues connected by the time dimension (Muller, 2011). Typical roadmap models include (Miedzinski, et al., 2018):

- Vision (or target)
- Innovation pathways (milestones, a structured timeline)
- Action Plan
- Baseline analyses (current state of development and participatory approaches)

Recently roadmaps have become relevant instruments for implementation of sustainability goals on both national and regional levels. Science, Technology, and Innovation (STI) policymakers use roadmap as a tool for exploring, formulating, planning and implementation of public policies (Miedzinski, et al., 2018). Roadmaps are used to develop, represent, and communicate strategic plans. The distinct feature of the roadmap is the use of time-based structure, which frames the process progress from the present situation to the vision. A roadmap also helps to align the stakeholders which otherwise represent various institutions and are not connected to each other. Miedzinski (Miedzinski, et al., 2018) suggest using roadmaps as Strategic Framework of Action promoting a shared vision, policy-learning environment, and sustainability transition.

In "Science, Technology and Innovation Policy Roadmaps for the SDGs; A Guide for Design and implementation" M. Miedzinski (Miedzinski, et al., 2019) proposes how to translate the use of roadmaps beyond a focus on technology. It focuses on the practice of roadmapping for sustainable development policy design and implementation. Transformative impact across the society and economy demands that the innovation must happen on system level, rather than on an individual basis. System innovation invites collaboration of various stakeholders at a different level of governance. It also may require a combination of low-risk technological solutions and disruptive innovations. The flexible format of roadmap supports such an ambitious long-term transition. *"The cross-cutting nature of the Sustainable Development Goals (their interdependencies, potential trade-offs, and synergies) and of science, technology, and innovation requires holistic approaches and strategies."* (Miedzinski, et al., 2019).

The key benefit of developing a roadmap is the aspect of communication. A visual time-based, multi-layered chart encourages discussion (Phaal & Muller, 2009). The roadmap provides a holistic structure, "a common language", within which the development can be communicated.

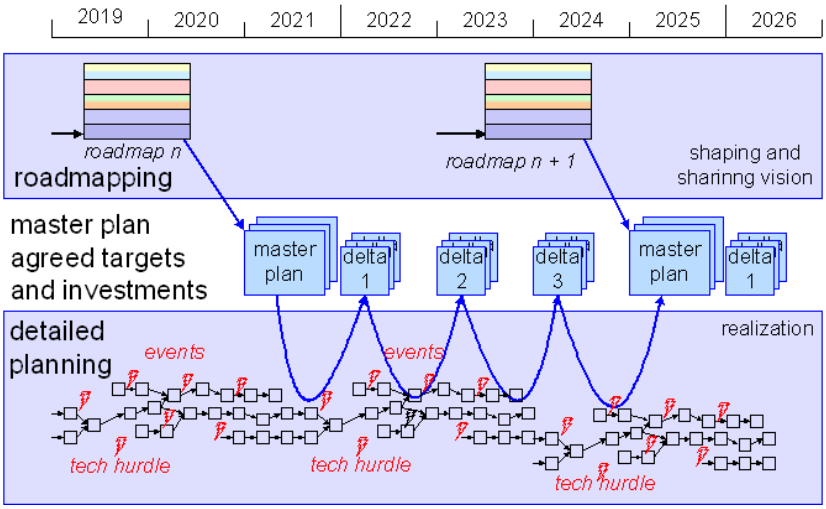

Figure 3. Roadmap as a Starting Point for Creation of Masterplans (Muller, 2011)

Figure 3 illustrates how roadmapping supports strategic and long-range planning. A roadmap is a shared vision that serves as a context for the development of masterplans. A roadmap visualizes the strategy at a conceptual level. It is compact and provides an overview. It also is a way to communicate with stakeholders and to provide the context for short-term projects and activities. A roadmap is a flexible tool – one can and should adjust it as a response to changes.

When it comes to sustainability developments, people make up an important part of the impact. Roadmapping involves a variety of stakeholders. A stakeholder is anyone who is involved in or affected by a course of a project. Stakeholders have the power to determine the success of the project. Therefore, a stakeholder analysis is an essential part of any project. It encourages understanding of different viewpoints and learning about their expertise and influence level.

Workshops are also a vital part of the roadmapping process. Muller (2018) states that the main purpose of workshops is to share, cross-fertilize and to understand vision, drivers, insights, problems, or solutions. Workshops are events where idea sharing and discussions take place. Muller (2011) also suggests having three workshop sessions. Every session should have a short introduced by a seed presentation, followed by discussions, and concluded by a review. In order to have a successful workshop it is important to prepare well (space, format, and goals), keep it (inter)active and focused on the main questions. Constructive attitude and full-time presence of stakeholders are critical for achieving effective workshop sessions.

This research aims to give an insight into the development and application of the roadmapping method. The domain for this research is a sustainability transition on a local, municipal level. Roadmapping is a method that encourages a discussion and helps to organize the generated ideas into a framework. A shared vision encourages a higher degree of cooperation. Simplifying complex projects or strategies facilitates a variety of stakeholders to understand how everything fits together.

Roadmapping Method

In this research, we used a multiple layer roadmap model. This model is flexible in application. Multilayer roadmaps allow exploration and evolution within each layer, as well as interlayer dependencies. The roadmap model considers both ‘the hard infrastructure’ (power grids, heat net) and ‘the soft infrastructure’ (policies, regulatory frameworks, resident mindset). Socioeconomic aspects determine the transition towards a sustainable future heavily. That is why we discuss both technological and nontechnological forms of innovation on a system level in this research.

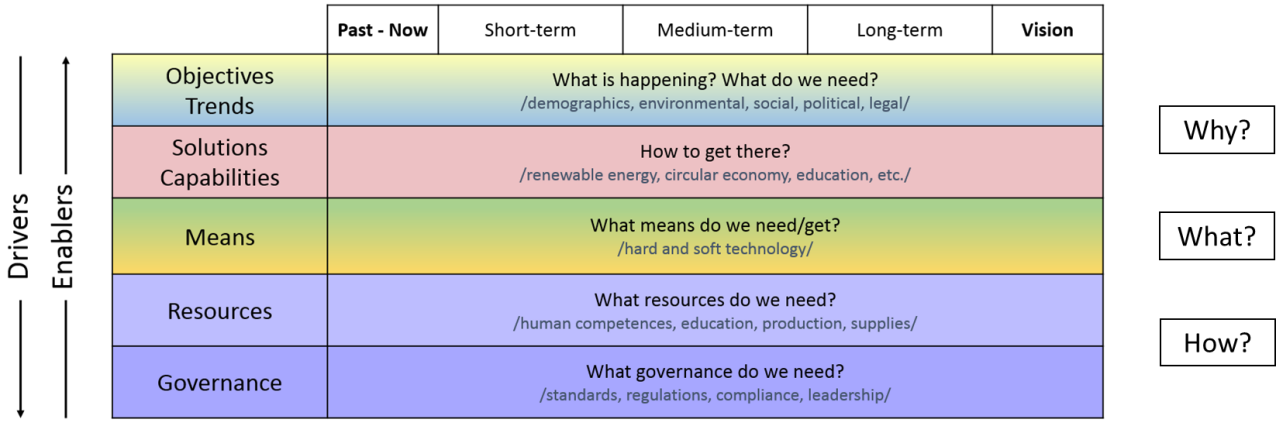

Figure 4. A 5-layer Roadmap Model

A roadmap in this study has 2 dimensions, where the horizontal axis is time, and the vertical axis shows the layers. The time dimension is adapted to fit the milestones for the sustainability transition. It indicates the time from the current situation until the vision for the year 2050. On the vertical axis, 5 layers are presented (Muller, 2011). The top layers give answers on projects "Why?", while the bottom layers explain "How?". The middle layer provides the link between the purpose and the resource, and answers on "What?" (the technology solution layer) (Phaal & Muller, 2009). Once all the information was gathered with the help of interviews, workshops, rapports, and articles, it was structured into these 5 layers. An annotation was placed on the bottom of the roadmap, providing supportive information for the activities mentioned in the roadmap.

The five layers of the roadmap in Figure 4 represent five views:
Objectives & Trends What is happening in the political and social arena? What goals do we want to reach? What change should we be aware of? What milestones do we have, or can we set?
Solutions & Capabilities How to get there? With what solutions can we reach our goals?
Means What technological trends are relevant? What technologies are needed?
Resources What resources do we need? What competencies are required to realize the transition?
Governance What governance do we need? What mandates and regulations are required?

Although each layer and timeline are clearly defined, uncertainties can still occur. A roadmap is only a vision based on current situations, environment, and knowledge. In practice, this means that not all aspects can be predicted. For example, extreme weather, disruptive technology, and political change are ambiguous issues that still should be included in the roadmap.

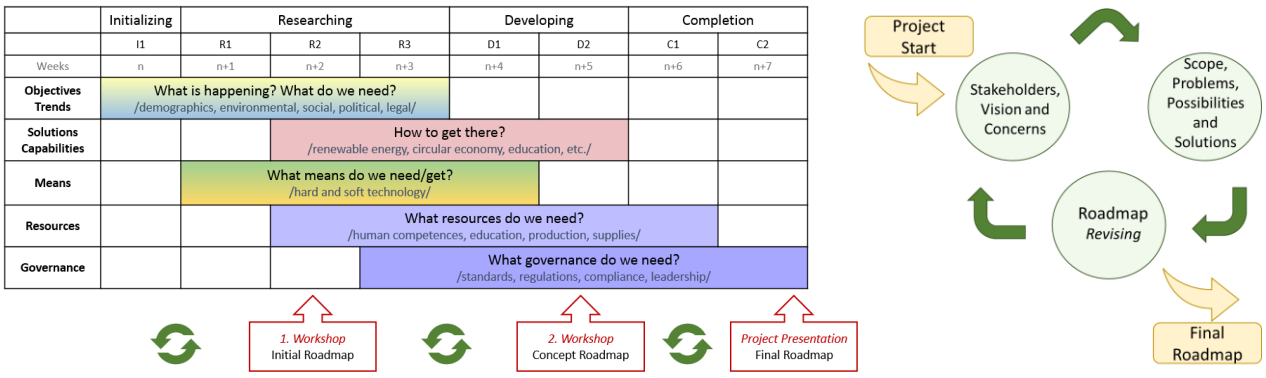

Figure 5. Timeline and Process for Creating a Roadmap

Figure 5 shows the approach to the research project. Since the support of the stakeholders is crucial in roadmapping, the first step of the research was to recognize and comprehend the stakeholders.

Next step was to identify problems and explore the solutions. The third step was to use the information gathered during the first two steps to create a roadmap. There were three iterations with these activities. The final roadmap was the result of the third iteration. The project work was done over a period of 22 weeks (Figure 5).

Stakeholders. Currently, the transition to sustainable Best is mainly about energy transition to reduce CO_2. That is why the groups involved in the roadmapping at this stage share an interest in the energy transition. Other stakeholder groups would have to be included for the development of an extended sustainability roadmap version that also would include waste recycling, water management and "protein transition" (animal-based to plant-based).

Stakeholder analysis. In order to decide whose interests should be considered when developing the roadmap, the core project members performed a stakeholder analysis. Figure 6 shows the prioritizing of the stakeholders. Stakeholder analysis gave a good indication for who should be involved in creating the roadmap and be invited to participate in workshops.

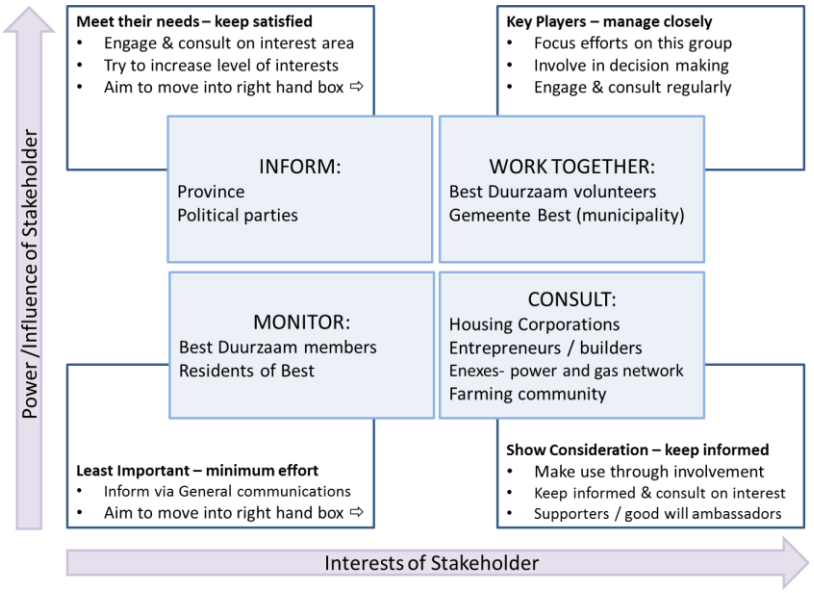

Figure 6. Stakeholder Analysis

The researchers gathered information in two ways: in the form of face-to-face interviews and two workshops (Figure 7). The workshops were taking place during the evenings, while the interviews were held during the daytime.

Interviews. Interviews were the fundament for understanding the situation in Best, as well as a start for idea generating. Interviewed people were selected based on 2 aspects – openness (support) and contribution factor (knowledge and/or power to make change). The researchers were interested to hear about the situation in Best and plans for the town, as well as stakeholder involvement in projects. Since many of the stakeholders are also residents of Best, it was valuable to hear their personal opinions about what could or should be done for the transition to sustainable Best.

Workshops. Muller (2011) suggests having tree workshop sessions. However, already during the initializing phase of the research, the researchers saw that only two workshops would be feasible. This was due to the availability of both the researchers and the stakeholders. At that point, the researchers also decided on the content of both workshops. The goal for the first workshop was to describe the present situation in Best and determine a vision for sustainable Best. The next step was to discuss the first two layers of the roadmap- "Objectives & Trends", and "Solutions & Capabilities". The goal for the second workshop was to generate ideas for the remaining layers. The three layers were: "Means", "Resources" and "Governance".

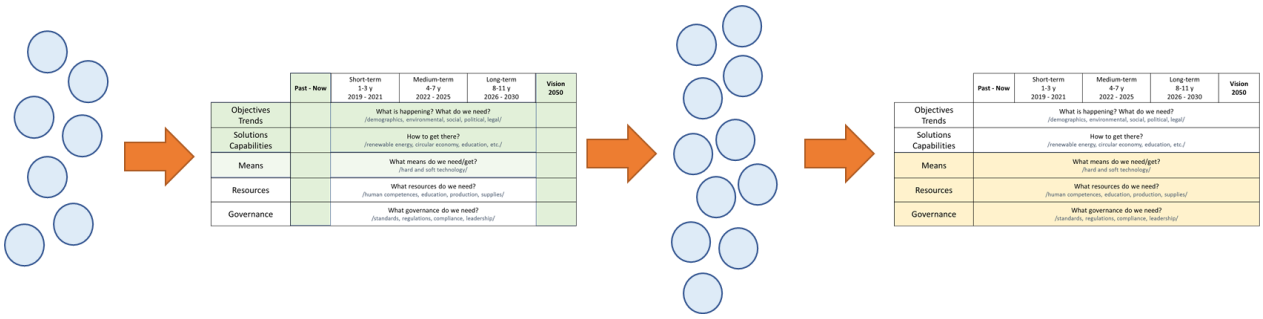

Figure 7. Interview and Workshop Progression

Figure 7 illustrates the progression of the interviews and workshops. Prior to each of the workshops, researchers sent out invitations in presentation format to workshop-relevant stakeholders. The presentation included an explanation of the layers that we were to discuss during the planned workshop.

Evaluation and Impact Factors. The researcher defined five research questions to evaluate if the roadmapping improved communication among stakeholders and aided in finding fitting solutions to sustainability goals. In addition, the researcher wanted to investigate if the roadmapping is a fitting method for solving the problem. For the roadmap to have value, it is important that the stakeholders understand the tool and can relate it to the real world. The researcher borrowed the idea to use impact factors form Engebakken's study (Engebakken, et al., 2010).

- **The interest of the stakeholders** indicates the curiosity stakeholders have for the roadmapping project.
- **Engagement of stakeholders** explains whether the stakeholders were interested in actively participating in the project.
- **Recognizability of the roadmap.** A crucial factor for successful roadmapping is that the stakeholders understand the roadmap model and its layers.
- **Understandability of the time dimension** shows if stakeholders understand how the tasks relate in time.
- **Understanding the project relatability to the real world** was another crucial factor. If this failed, the value of the roadmap would be decreased from a tool for strategical planning to only an illustrative, "never-to-be-used" picture.

We divided project procession into 3 phases: Exploration and Interviews; Workshops; and Synthesizing and Completion. The researcher viewed and evaluated each impact factor through these phases.

Research Approach

The research was a case study, which took place in the municipality of Best. It involved several stakeholders from different areas of interest. Since this was a real-world project, researchers chose to use action research. It is participatory research where also stakeholders become "co-researchers". As O'Brien (O'Brien, 2001) explains, people will be more willing to accept the result of the project if they have been involved in the project. The researcher was holding interviews, arranging workshops, and facilitating the stakeholder's involvement in the roadmapping project. The researcher also presented the findings to the stakeholders at the end of the project.

The researcher divided the research process into 3 phases:

Exploration and Interviews. The researcher started the project by learning about the problem and exploring the situation in the municipality of Best and the Netherlands. This was done by reading

articles in local newspapers and searching for relevant information online. Also talking to some residents of Best helped to assess the circumstances (those were not stakeholder interviews, but rather casual discussions).

Since the roadmap, at this instance, revolved mostly around energy transition, we selected interviewees related to the issue. Representatives from various interest groups were chosen. As preparation for the interviews, the researcher made questionnaires with a set of 12 questions. Questions ranged from stakeholder's involvement in the sustainability project to expectation for the roadmapping project. During the interviews, the researcher kept handwritten notes while interviewing the stakeholders.

Workshops. The project organized 2 workshops. The number of workshops was adjusted from 3 sessions to 2 sessions due to the researcher's possibility to travel to the Netherlands and the stakeholder availability to participate in the workshops. Workshops were in form of brainstorming with the layers of the roadmap used as a frame. For a productive workshop, all participants must be actively involved with the topic. In addition, workshops have to be kept structured, especially if there is a narrow time limit. To ensure productivity and effectiveness, an experienced and skillful workshop facilitator guided the workshops. The researcher was observing the workshop and keeping notes.

Synthesizing and Completion. The synthesis phase included completion of the final delivery - the roadmap, as well as the final presentation. The core project group organized the presentation. It was an open presentation, to which also other interested parties could come, and not only the stakeholders that were involved in the project. While the researcher was presenting the findings, three other people were taking notes. The researcher was interested in stakeholder feedback. The feedback was used for evaluation of the project.

To investigate if the roadmapping is a suitable method for solving the communication problem, researchers created five impact factors. The researcher's involvement and knowledge of the project served as the basis for setting up the factors. Further, the impact factors were assessed based on researcher observations and stakeholder feedback.

The success of this kind of projects is difficult to measure quantitatively. To evaluate if the roadmap meets the needs of Best Duurzaam and other identified stakeholders, the researcher answered the five research questions. Comments from participants, feedback from presentation and subjective observations provided anecdotal evidence.

Research Findings

Interviews. During the stay in Best, the researcher held 15 interviews, with altogether 18 representatives from 6 interest groups. The length of interviews was set to one hour, with only a few going over the time limit. Interview unveiled stakeholder professional interests, as well as their individual hopes for a sustainable future for Best.

Prior to all interviews, the researcher made a questionnaire form. However, already after the first two interviews, the use of the forms was discontinued. The questionnaires were somewhat limiting the interviews, while the purpose of the interviews was to explore.

Many of the interviewed stakeholders had a wide knowledge of the town resident's interest and acceptance for sustainable projects. This was another reason why interviews had to be more illustrative then systemized. The key was to get the interviewee to open-up in a relaxed, unintimidating, and exploratory conversation, rather than an overly structured interview.

Workshops. Over the research period (Dec. 2018 to May 2019), 2 workshops were held. Both workshops were only 2h evening events. The time limits were due to availability of stakeholders, especially since participation was done on voluntary bases. The participants were interviewed just days before the workshops, so they were familiar with the concept of the roadmap.

At both workshops, a U-shape seating was arranged. Participants were facing a wall covert with flip-over sheets, with clearly marked layers of roadmap and its timeline. During the workshops, participants wrote their ideas on yellow notes and attached those to the suitable layer on the roadmap. The very important success factor for the workshop was the skillful facilitator who kept the discussion structured. In addition, creating a welcoming atmosphere made the sharing of the ideas easy.

The first workshop was held at the beginning of February 2019. There were 6 participants and a facilitator at the first workshop. Result of the workshop included an assessment of what is happening in Best now, and what is the vision for 2050. In addition, milestones, such as The Heat Plan and The Regional Energy Strategy were marked. Next, the participants produced ideas for the first and second layer of the roadmap - "Objectives & Trends", and "Solutions & Capabilities". Since many people tend to think in solutions, some ideas for the "Means" (third) layer were also produced.

The second workshop was held at the end of March 2019. It had 14 participants, including the facilitator. The workshop began once again with an explanation of the project and the roadmap model, followed by a run-through of the roadmap "so-far" (initial roadmap). Due to the time limit, the focus of the second workshop had to be put on the last three layers of the roadmap, without using too much time on the look-back. The three layers were: "Means", "Resources" and "Governance".

After the second workshop, there were 132 yellow notes on the wall (Figure 8). Those were just regular Post-It notes with 1-5 words written on each. Every note represented one idea from a stakeholder. Yellow note ideas are used not just for a technical solution. Those are thoughts that can be placed in any of the 5 layers of roadmap. At this step, all ideas are welcomed.

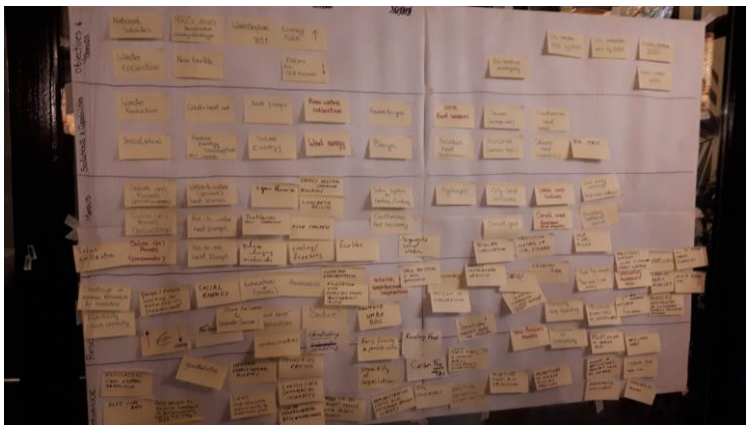

Figure 8. Result of the Second Workshop

The Roadmap. Information gathered during interviews and workshops resulted in the creation of the roadmap. Figure 9 shows the roadmap developed during the research. The research used a real case. The attached roadmap was the final delivery to the project owner Best Duurzaam.

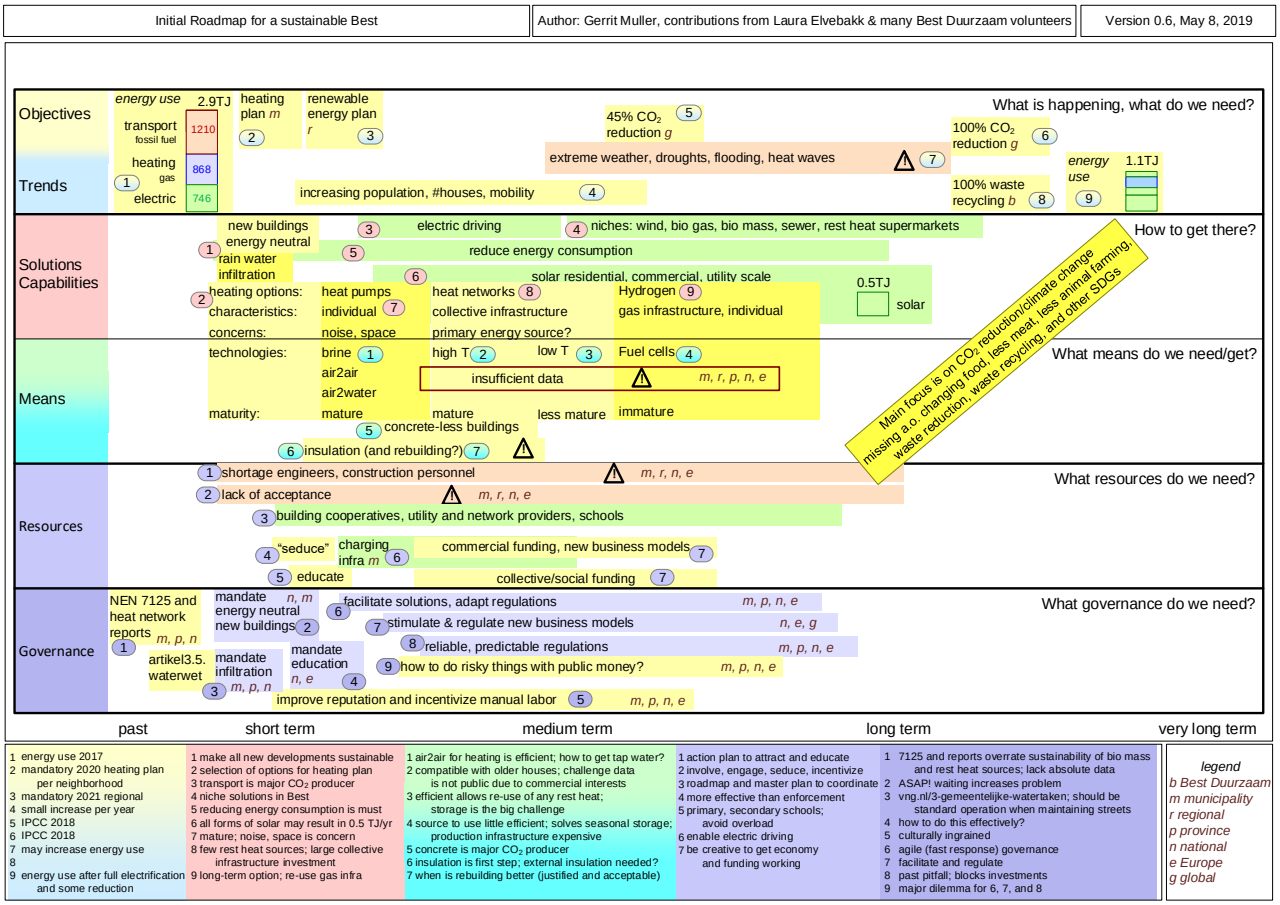

Figure 9. The Roadmap – Delivery to Project Owner

The researcher presented the roadmap for the stakeholders of the roadmapping project in May 2019. Thirty interested people were present. The roadmaps' focus is on CO_2 reduction by means of an energy transition. The supporting background material was present as posters on the walls. The academic supervisor briefly presented some of the supporting information.

The "Objectives & Trends" layer shows the situation from "as it is" until the vision for 2050. It illustrates both current and envisioned energy use in Best. Mandatory municipal and regional plans, together with CO_2 and waste reduction goals are marked. In addition, social and environmental concerns are noted.

The "Solutions & Capabilities" layer proposes alternative heating options, such as heat pumps, heat networks, and hydrogen gas infrastructure. It discusses electricity production possibilities and encourages a reduction in energy use. In addition, it suggests constructing new buildings such that they are energy neutral.

The "Means" layer cover the technical solution options. It suggests types of heat pumps and use of insulation. Maturity of the solutions and lack of date is also pointed out in this layer. The line between the "Solutions & Capabilities" and "Means" layers is lighter than the other lines. This is to illustrate the relatability between the solution options and technological possibilities.

The "Resources" layer proposes the creation of new business models and collective funding. It also suggests using roadmap and masterplan as a resource, especially as a mean of communication among stakeholders. Main concerns – shortage of personnel and lack of acceptance – are also noted in this layer.

The “Governance” layer pushes for change in policies and regulations. While some areas (education, energy neutral new buildings, rainwater infiltration) need mandating, others need facilitation and stimulation. A delicate question for the use of public money on risky pilot projects is also mentioned.

Although the roadmap model has previously been used mostly in technology or business domain, it proved to be well suited for this particular project for the transition to a sustainable community.

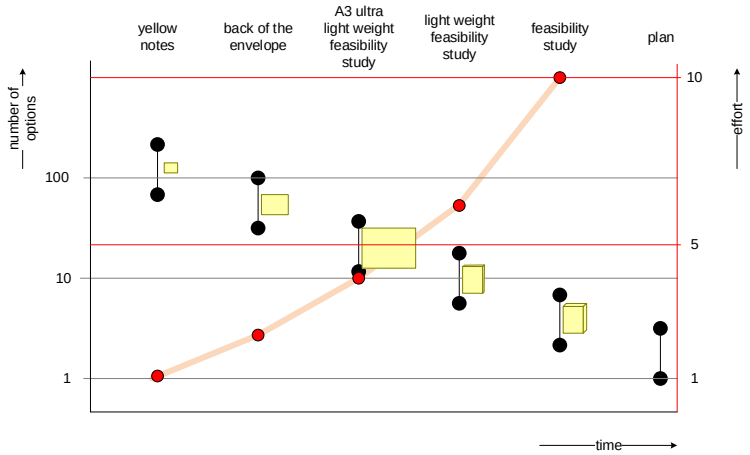

Figure 10. Solution Funnel

From yellow notes to a plan. Roadmapping can also be looked upon as the first step for an all-inclusive solution selection process. In order to come to a decision in a complex project, an extended amount of research is necessary. To avoid wasting resources this study suggests the use of “Solution Funnel” approach (Figure 10). This approach proposes to move from many options with little to no research, to very few feasibility studies, to one strategic plan. As time goes, the project would be left with fewer options. At the same time, more research effort will be required for each step.

Next proposed step in the solution-selection process is Back-of-the-Envelope studies (Figure 11). It is a quick exploration of some solution options. Such studies would give an indication for the size of the problem of interest. Back-of-the-Envelope also provides an estimate of the economic impact of potential solutions. This step of the research would look on about 50 ideas.

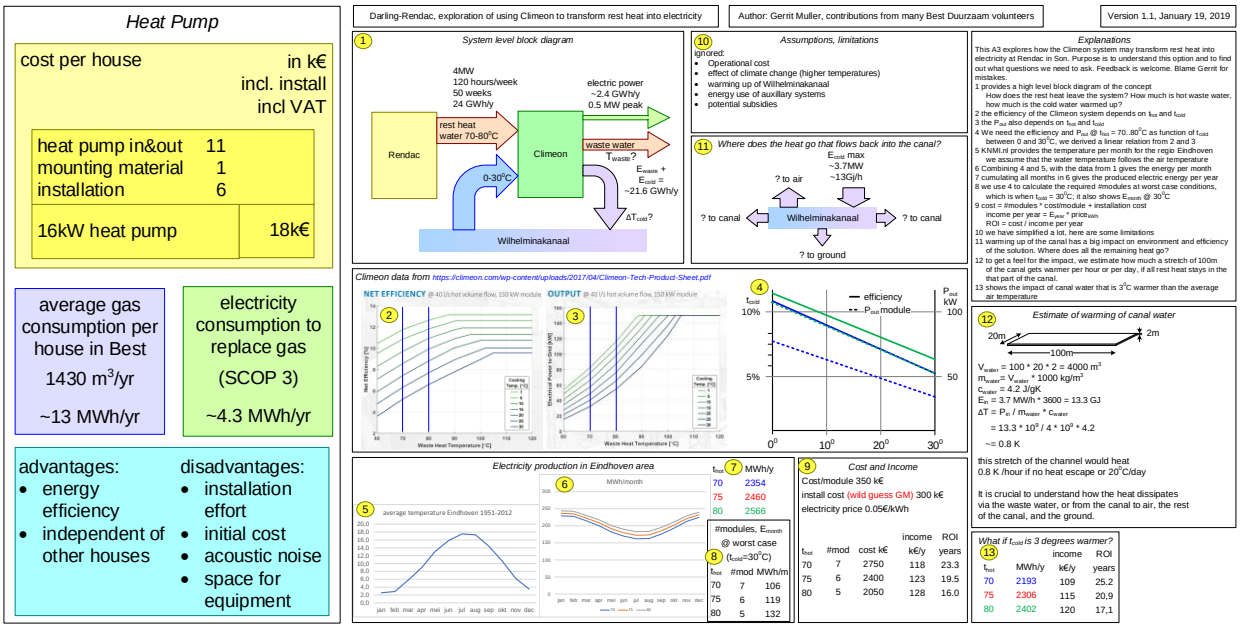

Figure 11. Examples of Back-of-the-Envelope & A3 as Ultra-Light Feasibility Study

Further, an ultra-light feasibility study presented in A3 format is suggested (Figure 11). A3 is a tool for knowledge sharing and effective communication; Borches (Borches, 2010). It provides a highly graphic process overview. Around 20 A3s could be produced. As it contains more details, more research effort will be required.

Following steps would include a Lightweight feasibility study exploring 5-10 options. In addition, a Feasibility study for only 3-5 options. Finally, 1 or 2 plans based on wide research could be produced. This format is an untested idea, based on the assumption that each step should reduce the number of options with about a factor of 3, while the amount of elaborated data is increasing with one order of magnitude, as shown in Figure 10. An open question is whether these step sizes (reduction by a factor of 3, increasing data by a factor 10) are effective.

Another helpful tactic for the selection process can be the construction of scenarios. Scenarios are simplified studies using assumptions and approximations. The main purpose of making the transition scenario is to discover what question should be asked and what problems need further exploration.

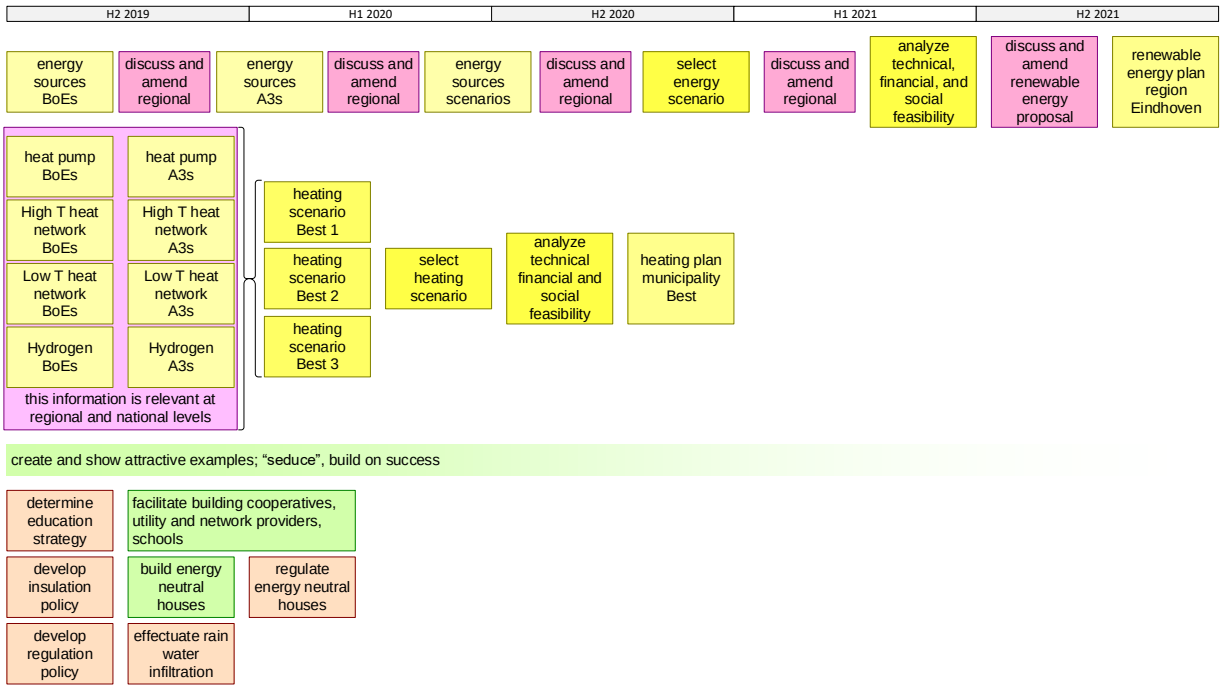

Figure 12. Masterplan

Master plan. The developed roadmap was further structured into a masterplan (Figure 12). This gave a more simplified view of the tasks in chronological step-by-step order. The masterplan is made for two most pressing issues: Regional Energy Strategy for Eindhoven region and Heat Transition Plan for the municipality of Best. Below these tasks, other issues need to be dealt with immediately. These issues are more of a governing type – regulations, policies, and strategies. Work can and should start on those immediately, especially since they are not dependent on any pre-occurring events.

The Heat Transition Plan requires more research before any decisions on fitting solutions can be made. Figure 12 shows a suggestion for how such research might have to be done. In addition, the Regional Energy Strategy Plan needs more research. However, since it is a regional plan, it involves more communication among the municipal and regional administrations.

Steering Group. To continue the work on the transition to sustainability in a collective matter a steering group will be formed. They will also hold the ownership of roadmap and will be responsible for its maintenance. The idea is to have around 10-member group. However, initially, the group may be formed from around 4-5 members. The members will be stakeholders from different areas of interest. The main prerequisites for each of the steering group members will be the ability to contribute

with expertise, the power to influence, as well as an enthusiastic and positive look at the transition process. The steering group will be “small and concentrated”. However, the key is to have a good mix of interest groups, as well as age and gender diversity. In addition, a “roadmap expert” is required for applying the updates to the roadmap. A good understanding of the roadmap model is vital for its upkeep. In addition, since only two out of the suggested three workshops sessions were executed during the project, the steering group should organize the third Roadmapping workshop. The third workshop should include the planning for a shared integration of the roadmap.

Stakeholder Analysis (Figure 6) gave a suggestion for which stakeholders should be a part of a group responsible for future ownership of the roadmap. The analyses showed that the stakeholders with the highest interest in the roadmapping are the ones that should be involved in the upkeep of the roadmap. These stakeholders hold the most enthusiasm about the transition to sustainability. They are essential for moving the project along. The stakeholders with the most power, such as local and provincial politicians, could be beneficial to have in the project group, but only if they hold or gain interest in sustainable developments.

Evaluation

The Impact Factors confirms the choice of the method that was chosen for this project. It explains if the roadmapping method was easy to understand for the stakeholders, and therefore – a good choice for solving the communication issue. The success of the first two Impact Factors was assumed based on the researcher’s observations, while the success of the last three factors was based on stakeholder questions, or rather the lack of them.

The interest of the stakeholders. During the exploration phase, nearly all the people invited to the interview responded with both interest and excitement. When it came to the workshops, approximately 2/3 of the invited people had the possibility to participate. Scheduling issues was the main reason for declining the invitation. The final presentation was well attended, indicating the interest in the project. Generally, involved stakeholders have been responsive and have had a positive attitude towards the project.

Engagement of stakeholders. Except for a few approached stakeholders, people were willing to come to both interviews and workshops. People saw the value of roadmap and wanted to be part of it. Creation of opinion-welcoming atmosphere during both interviews and workshop was crucial. Interview host’s people skills and ability to listen was important. In addition, the facilitator's skillful workshop guidance was a crucial factor for stakeholder participation. There were around 30 people at the presentation. Questions raised after the presentation, as well as comments made on face-to-face bases, gave a clear indication of stakeholder interest in further participation in both roadmapping and transition process.

Recognizability of the roadmap. To ensure this, the roadmap model was explained both individually, at the beginning of each interview, and at the start of each workshop. At the presentation, the layout of the roadmap was explained once more, before presenting the final roadmap. After each explanation, no questions concerning its format were received, indicating good recognizability of the roadmap.

Understandability of the time dimension varied depending on the background of each stakeholder. Individuals who were ready for transition work to start immediately were more interested in near-future tasks. Stakeholders whose daily work includes or is dependent on long-term planning were more accepting of the idea of a vision and setting tasks in a time-dependent matter. This “future attitude” was especially distinct for larger business owners and politicians. The time dimension was less of the focus during the workshops. The main reason for this was the time limitations of the workshops, where the focus had to be put on idea-generation. Timeline for the transition to sustainability was decided during the syntheses phase of the roadmap. Maturity of the technology was the

deciding factor for the placement of tasks on the roadmap's time axis. During the presentation, this was explained to and accepted by the stakeholders.

Understanding the project relatability to the real world. During the interviews, various pro-sustainability tasks were discussed. During the workshops, the same tasks were aired, explained to other workshop participants, and marked on the roadmap. Since stakeholders were the contributors to the development of the roadmap, the tasks on the roadmap were well understood. During the presentation, a generous amount of time was used for explaining how both the roadmaps and the planned tasks translate to the real world.

Feedback from the stakeholders confirmed that created roadmap provides a much needed "helicopter view". They also recognized that roadmapping project has established new communication lines among stakeholders or improved the existing ones. The roadmap was the trigger for interviews and workshops. Especially workshops served as social events for establishing communication among stakeholders. The stakeholder feedback served as bases for answering on the research questions.

How does creating a roadmap facilitate communication and sharing among stakeholders? Roadmapping served as a great facilitator for communication and knowledge sharing among stakeholders. Combination of joint interests and common goals gave stakeholders a realization that they are in the same team. Roadmapping project united stakeholders also by showing how their individual ideas and strategies fit in the roadmap that is intended for a bigger system. Roadmap illustrates that it is beneficial for stakeholders to work together towards a common vision. Now, when the communication is established, it is vital to maintain it. The visual aspect and compactness of the roadmap appear simple and non-threatening. That will expectantly encourage further discussions and help to keep the communication among stakeholders alive.

How does creating a roadmap aid the local community to become more sustainable? Although the stakeholders participating in the project were just a small and selected group, their contribution signified interests of larger groups. The roadmap developed during the project includes actions that concern the local community as a whole. The roadmap is a steppingstone towards more specific plans. When ready, the plans should be conversed to the local community (residents) for them to partake in transition. The best media for communication with residents is yet to be found.

How does a roadmap help in finding fitting solutions to sustainability goals? The roadmap helps in not only communication and formation of vision but also finding fitting solutions. Since this project's focus was on energy transition, also the discussed solutions were mostly on energy. Reduction of energy use and green energy were central topics. In addition, heat transition is a pressing matter. Therefore, several alternatives for heating were sat up as possible solutions. The knowledge sharing initiated by the roadmap is the contributor to efficient solution finding.

What factors do help in the creation of a roadmap? The non-intimidating workshop ambiance was an important contributing factor for encouraging communication and sharing during the project. "Positive atmosphere" was the most common comment after both workshops. The positive setting may have helped to avoid communication-blocking (blaming others or finger pointing).

What factors can prevent the success of the creation of a roadmap? Failing to see the benefit of the roadmap would influence stakeholders' interest and motivation to participate. Uninterested stakeholders and the unsupportive government could prevent the success of roadmapping project. This was not the case during this project.

Discussion and Reflection

The developed roadmap does not provide, nor does it suggest one specific solution for the transition process. However, it does support the exploration of different scenarios. It exposes key findings and

ideas that could lead to feasible solutions. The roadmap also reveals the bottlenecks of the transition. The two major ones discovered during this project are the shortage of human competencies and the mindset of people. Those are both local and national problems. The lack of acceptance could be solved, or at least eased, by "seducing" people by "leading by example". Transition to sustainability may provoke development of new business models. The success of such models can further lead to an increase of interest for sustainable developments and greener future. Cooperation such as Best Duurzaam no-doubtingly plays an important role in raising awareness. However, for their activities to become even more valuable, they should be synchronized with the local government and other influential stakeholders.

The researcher was an "outsider" to Best Duurzaam, and not native to Netherland. That had its positive and negative sides. During the research, the language barrier was somewhat of an obstacle. Most of the project-relevant information was in Dutch, so it presented some challenges. However, when interviewing the stakeholders, the language was not a barrier, since all interviewees spoke English. Researcher's newness to the country and its governance was possibly a time-related challenge. Familiarization with the project and learning about local and national challenges took some time, whereas this would not have been an issue for a local researcher. The positive aspect of not being local was the ability to approach the project from a more neutral viewpoint.

The work on the roadmap was done iteratively. Part of a reason for this was researcher's availability to travel to and stay in Best for extended periods. Another reason for iterative work was the roadmap model itself. It almost dictates a natural progression for how it should be filled out. When these two factors were combined with the project plan, the work was split into iterations without difficulties. The iterations were logical and fit well with project work.

The biggest challenge when constructing the roadmap was the data allocation with respect to the time axis. It was not done during the workshops due to the time limit of the events. That is why it was done later, without stakeholder involvement. When this was explained at the project presentation, stakeholders did agree with data placement in the roadmap. Since the steering group will use the roadmap, it is highly likely the data will get further adjustments. Challenges with using the roadmap may arise when maintenance and updating are necessary. This process requires some expertise. Persons updating the roadmap must have a good understanding of its format.

Although the project was considerably focused on technological possibilities, it was a very social study. Research pushed to broaden the knowledge of many types of renewable technologies and green technology trends. However, the most valuable lesson learned during roadmapping was the use of soft skills. Research required a high level of people skills since it involved a significant amount of communication. First, the interview skills were important. Second, the facilitation of workshops required experience. In both cases, the ability to listen to and communicate with stakeholder was crucial. In addition, it is possible that the biggest value of the project lays in roadmapping as a process, and not necessarily the roadmap as a final product. Although the roadmap has a great value on its own, the biggest value was in bringing stakeholders together for them to "start talking".

The validity of the research of the roadmapping method is limited. Although the project was a success, the research work was done somewhat adaptively, adjusting to the development of the project. The flexibility of both the roadmap and the case gave a positive result. However, the evaluation of the case was based on stakeholder feedback and observations, and assumptions of the researcher.

Conclusion

This paper was set out to research how roadmapping could help in creating a shared vision, and how it could aid in cross-disciplinary stakeholder communication. The project was initiated by a volunteer organization Best Duurzaam. With the information gathered by interviews, workshops and written material, a 5-layer roadmap was created. The roadmap explores the current situation in Best and, to

some degree the world. The vision for 2050 is sketched as well. It looks at possible technical needs and solutions while encouraging further exploration. The roadmap discusses what resources are available and what are still needed. In addition, it gives a suggestion for the governance of the transition to sustainable Best.

The benefits of creating a roadmap were evaluated by identifying five impact factors and by answering the research questions. Research suggests that roadmapping is a well-suited method for sustainability projects and transition process on a municipal level. Feedback from the stakeholders was highly positive. They saw the value of having a "helicopter view". The visualization and compactness of the roadmap attracted broad attention. Some of the presentations' audience members expressed interest in using a roadmap model in other innovation and sustainability projects.

Future research

For future research, it would be interesting to see roadmap being applied to other sustainable developments. The same research could be repeated in other municipalities. Innovative projects for different interest groups could also profit from roadmapping method. In addition, it would be valuable to explore the upkeep of the roadmap in cross-disciplinary projects. The research of this project should be continued for observing how the roadmap will be maintained and updated. A specific improvement of this roadmap is increasing the quantitative support. The funnel and the step sizes in the funnel need further research.

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Appendix

The roadmap for Best Duurzaam needs supporting A3s to explain and elaborate on various options for the transition to sustainability, such as energy harvesting, generation, storage, and distribution. This presentation by G. Muller is the collection of supporting A3s.

The link to the presentation: https://gaudisite.nl/BestDuurzaamRoadmapA3sSlides.pdf

References

Engebakken, E., Muller, G. & Pennoti, M., 2010. Supporting the System Architect: Model-Assisted Communication. *Systems Research Forum,* 4(2), pp. 173-188.

IPCC, 2018. *Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of,* Geneva, Switzerland: World Meteorological Organization.

Miedzinski, M., McDowall, W. & Fahnestock, J., 2018. Paving the pathways towards sustainable future? A critical review of STI policy roadmaps as policy instruments enabling sustainability transitions.

Miedzinski, M. et al., 2019. *Science, Technology and Innovation Policy Roadmaps for the SDGs', Innovation for Sustainable Development Network.* Brussels (Belgium): FJD.

Muller, G., 2011. Roadmapping. I: *Systems Architecting: A Business Perspective.* s.l.:CRC Press.

Muller, G., 2018. *Workshop How To.* s.l.:status: preliminary draft.

Muller, G., Elvebakk, L., van der Velde, J. & Mac Lean, F., 2019. Roadmapping for Sustainability; How to Navigate a Social, Political, and Many Systems-of-Systems Playing Field? A Local Initiative. *SoSE*.

O'Brien, R., 2001. *Um exame da abordagem metodológica da pesquisa ação [An Overview of the Methodological Approach of Action Research]*. *In Roberto Richardson (Ed.), Teoria e Prática da Pesquisa Ação [Theory and Practice of Action Research]*. João Pessoa, Brazil: Universidade Federal da Paraíba: s.n.

Phaal, R., Farrukh, C. & Probert, D., 2004. Technology roadmapping—A planning framework for evolution and revolution. *Science Direct*, 71(Technological Forecasting & Social Change), pp. 5-26.

Phaal, R. & Muller, G., 2009. An architectural framework for roadmapping: Towards visual strategy,' Technological Forecasting and Social Change. *Elsevier Inc.,* Volum 76, p. 39–49.

The United Nations, 2015. *17 Sustainability Development Goals (SDGs).* [Internett] Available at: https://www.un.org/sustainabledevelopment/sustainable-development-goals/ [Funnet 17 12 2018].

Biography

Laura Elvebakk received her master's degree in systems engineering from the University of South-Eastern Norway in Kongsberg in 2019. In 2013, she received her bachelor's degree in mechanical (product development) engineering from University College of South-Eastern Norway in Kongsberg.

Gerrit Muller, Gerrit Muller, originally from the Netherlands, received his master's degree in physics from the University of Amsterdam in 1979. He worked from 1980 until 1997 at Philips Medical Systems as a system architect, followed by two years at ASML as manager systems engineering, returning to Philips (Research) in 1999. Since 2003, he has worked as a senior research fellow at the Embedded Systems Institute in Eindhoven, focusing on developing system architecture methods and the education of new system architects, receiving his doctorate in 2004. In January 2008, he became a full professor of systems engineering at University of South-Eastern Norway in Kongsberg, Norway. He continues to work as a senior research fellow at the Embedded Systems Innovations by TNO in Eindhoven in a part-time position. Since 2020, he is INCOSE fellow.