Modeling environmental and economic aspects of a local heat transition

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SUMMARY

The question was raised if it was possible to build a model that would allow for a quick scan of the possibilities for the energy transition of a village in Groningen away from natural gas? This question was added to the idea of allowing local initiatives to work and adapt the model themselves, increasing the integration and participation of locals residents within the transition process. These questions then followed by a check wether existing models would be suitable to fill this role, or if a new model would have to be constructed from bottum up.

As a first step, the question of local participation had to be answered. For this the public knowledge concept of Berman was applied, allowing local initiatives to interact with the decision process through the utilization of local knowledge. The concepts of Berman were distilled into the ideas of taking local knowledge and applying it to a model. With this in mind, several models were investigated and checked. None of the models fitted the desired results of allowing local knowledge to influence the data or operated on the right level of transition. Either the models operated too large, from a province or national level, or too late in the decision-making process. The choice was made to develop a new model from the bottom up, and checking the data sets with the national model of Vesta MAIS to see if the core concepts of the model were within expected values.

Returning to the concepts of Berman, it was chosen to utilize the energy labels of the housing units as well as BAG data (dutch land registry) as base sets for the data the model would utilize. This secures the local knowledge aspects of Berman theories to be applied to the model, as well as future local integration with local participation to improve the models' core data set.

The model was tested against the Vesta Mais model, showing great similarities between the data sets chosen and utilized, giving validation to the model's utility. The development of the model was limited to chosen modules that applied to the case study the model would first be tested upon. These modules were heat districts, biogas, solar energy, wind energy as well as a module for energy label steps through insulation. The results from the model shown that taking into account the limitations set by the local initiative, non of the chosen energy transition pathways would currently the fruitful to further develop within the village. These limitations are all economical in nature.

SAMENVATTING

De vraag rees op of het mogelijk was om een model te bouwen waarmee een quickscan van de mogelijkheden voor de energietransitie weg van aardgas van een dorp in Groningen mogelijk is. Deze vraag werd toegevoegd aan het idee om lokale initiatieven te laten werken en het model zelf aan te passen, waardoor de integratie en participatie van de lokale bevolking in het transitieproces wordt vergroot. Deze vragen werden gevolgd door een check of bestaande modellen geschikt zijn om deze rol te vervullen, of dat er een nieuw model vanaf de grond opgebouwd moet worden.

Als eerste stap moest de kwestie van lokale participatie onder de loep worden genomen. Hiervoor is het publieke kennisconcept van Berman toegepast, waardoor lokale initiatieven kunnen interageren met het besluitvormingsproces door gebruik te maken van lokale kennis. De concepten van Berman werden gedestilleerd tot de ideeën om lokale kennis te nemen en toe te passen op een model. Met het oog hierop zijn verschillende modellen onderzocht en gecontroleerd. Geen van de modellen voldeed aan de gewenste resultaten om lokale kennis de data te laten beïnvloeden of op het juiste transitieniveau te laten opereren. Ofwel de modellen werkten te groot, op provinciaal of nationaal niveau, of te laat in het besluitvormingsproces. Er is gekozen om vanaf de grond af een nieuw model te ontwikkelen. Door de datasets te checken met het landelijke model van Vesta Mais is gekeken of de kernconcepten van het model binnen de verwachte waarden vallen.

Er werd voor gekozen om de energielabels van de wooneenheden en de BAG gegevens van het Kadaster te gebruiken als basissets voor de gegevens die het model zou gebruiken. Dit zorgt ervoor dat de lokale kennisaspecten van Berman-theorieën worden toegepast op het model, evenals toekomstige lokale integratie met lokale participatie om de kerngegevensverzameling van het model te verbeteren.

Het model werd getoetst aan het Vesta Mais-model en vertoonde grote overeenkomsten tussen de gekozen en gebruikte datasets, wat validatie geeft aan het model. De ontwikkeling van het model beperkte zich tot de gekozen modules die van toepassing waren op de case study waarop het model isgetest (Veelerveen). Deze modules waren stadsverwarming, biogas, zonne-energie, windenergie alsook een module voor energielabelstappen door isolatie. De resultaten van de modellen lieten zien dat, rekening houdend met de beperkingen die het lokale initiatief stelt, geen van de gekozen energietransitiepaden momenteel vruchtbaar zouden zijn om zich binnen het dorp verder te ontwikkelen. Deze beperkingen zijn allemaal financieel van aard.

1. INTRODUCTION

How to move away from natural gas? A question raised in Dutch politics in the last couple of years. With climate change and tremors from natural gas exploitation, this rise on the political agenda is no surprise. Potential alternatives looking to break through and adept the Dutch infrastructure are waiting on the sidelines. With projects on the national level in the Netherlands estimated to be even larger then the famous Dutch Deltawerken [NOS, Tennet 2019], the question is raised what are the possibilities for small scale transitions.

In 2015 the Dutch government signed the Paris agreement. This agreement stipulates the reduction of national greenhouse gas emissions by 25% in 2020, 50% in 2030, and 95% in 2050 with a baseline of the emissions of 1990 [UNFCCC, 2020]. In 2019 the Dutch government signed and presented the Dutch National Climate Agreement (National Klimaat Akkoord) [NKA 2019]. This agreement was based on deliberations between the government and several actors from sectors that are influenced by the Climate agreement. The goal was to translate the Paris agreement reductions into effective and manageable measures for the Dutch energy transition. Supported by a lawsuit started by the Urgenda Foundation, the Dutch government is bound to a reduction of 25% by 2020. [rechtspraak 2019]

One measure of the Climate agreement is the division of the Netherlands into 30 regions that would be charged with the investigation of the potential of renewable energy within that region. Besides this main objective, the RES (regional energy strategy) includes a secondary objective. This objective is the removal of the natural gas dependency of the Dutch districts. [Nationaal programma RES, 2020]

An important aspect of these RES strategies is the focus on the importance of local initiatives to help kickstart the transition. Helping local ideas to develop initiatives that can support the transition from bottom up. Organizations, like the Groninger Energie Koepel (GrEK), offer a helping hand to local initiatives to provide knowledge and experiences to guide and help these initiatives succeed.

1.1 Problem statement and goals

Also in the scientific world, the potential of grassroots local energy transition initiatives has become a focal point. In the report by Hargreaves and Hielscher [Hargreaves and Hielcher 2012], it's stated that grassroots initiatives are a potential source of innovation. Yet when they studied these grassroots initiatives, they showed the difficulties these initiatives face in developing and surviving. Bomberg and McEwen state that local initiatives can play a large role in galvanizing communities towards an energy transition and help develop it. Both these reports show the strength that local communities have within the transition, the potential to activate the locals within the transition itself. [Bomberg and McEwen 2012]

As stated by Bomberg and McEwen, the barriers local initiatives face are still large. There are two major sets of tools available to local initiates, structural tools, and symbolic tools. In their research, they conclude that while symbolic tools are the key aspect of success for a local initiative, the presence of structural tools do help. Berman [Bomberg and McEwen 2013] adds to this the influence local knowledge has on the development of local initiatives and the lack of local knowledge within larger energy models. His argument is the incorporation of the local knowledge within the transition will help boost and develop the local initiatives. [Berman 2017]

Berman builds upon this concept and describes two scenarios, unilateral participation and collaborative participation. In unilateral participation, the community is not part of the change in the local situation. The residents are just present while the change happens, with or without their consent. In collaborative participation, the locals are activated and an active part of the process. They take the position of a stakeholder, actively building towards the transition. [Berman 2017]

Part of this local knowledge is the integration of local knowledge into larger nation-wide energy models. A good example of such a model would be the Vesta MAIS model. This model is developed and utilized by the Dutch bureau of environmental planning (PBL) in making energy transition predictions for the Netherlands [Folkert 2012]. However the Vesta model itself lacks local knowledge and interaction, making it less viable for projects on a smaller scale [Wijngaart 2018]. Taking this interaction one step further are commercial projects like Hoom, with their Hoom Dossier [Hoom 2020]. These are commercially developed tools that try to breach the gap between nationwide models and local projects. Similarly, TNO is developing a tool that combines several larger models and databases into the ESDL map editor, although not yet available to use [ESDL 2020].

When trying to find a suitable model as a local initiative in the Netherlands the choice can be rather complex. A great example is the information guidelines by the Dutch energy utility branch organization [Netbeheer Nederland 2020].

1.2 Research Aim

This research aims to develop a model that will simulate the transition of a small village away from natural gas through several potential scenarios. The model should utilize as much open data as possible while being adaptable to local knowledge, perspectives, and influences. This model will then be tested to the Veelerveen case study, a small village in the eastern border region of the province of Groningen in the Netherlands. Finally, the results will be compared to existing models on a national level and evaluated.

1.3 Research question

The main research question is:

What are the possibilities for a quick scan for a small village in the border region of Groningen to undergo an energy transition away from natural gas to a more sustainable source of heat from an economic and environmental perspective and model this accordingly?

Sub questions

- *What existing models could be utilized to base a model upon? (H3/4)*
- *What criteria do local initiatives require of a model and what is local knowledge? (H2)*
- *Build or adapt a model to fit the criteria (H5)*
- *Evaluate the model and compare it to a comparable model with a case study provided by GrEK (Veelerveen) (H6)*

1.4 Structure of the report

In this report, the methods utilized will be described in chapter 2, followed by a description of the model requirements and goals based on the perspectives of GrEK as well as the parameters found in the reports of Berman. The model characteristics are described in chapter 3. Chapter 4 will go into a model analysis, checking to see if an existing model fits into the requirements. Following there will be a description of the model design in chapter 5, followed by the results given by the model in the case study of Veelerveen in chapter 6. The results of the developed model will be tested and compared against an existing model in chapter 7. In chapter 8 the limitations of the developed model will be discussed followed by conclusions in chapter 9.

2. METHODS AND MODEL REQUIERMENTS

what are the possibilities of developing a quick scan model that the predictions for a region by nationwide models while including local knowledge and open data?

The concept is to build a model that simulates the economic and environmental effects of an energy transition in a local area based on local information. The model should indicate the need for storage capacity and differentiate between possible transition scenarios. What will the costs for the locals be, both running and initial costs? What are the environmental effects of the transitions? Overall, the model will evaluate the possible scenario's, with the chosen criteria of local initiatives as sub-goals.

What existing models could be utilized to base a model upon?

Vesta MAIS as a model is utilized in the Netherlands on a national level, it's considered impractical for the local level. Therefore Vesta mais will be considered as a potential national level model for comparison of the model to be build. The Vesta model is described by the PBL (Planbureau voor de Leefomgeving) as a spatial energy model of the built environment in the Netherlands. The goal of Vesta is to explore options to reduce CO_2-emissions in the period up to 2050. Both building and district heat measures can be calculated taking into account local conditions throughout the Netherlands. Simulation and optimization can provide insight into the technical-economic potential of renewable energy. This provides insight into the CO_2-reduction and the costs and benefits for the actors involved, e.g. energy producer, consumer, and investor. Energy companies, consultants, and universities increasingly use the model for regional case studies. This requires thorough knowledge of the local situation and some limitations of the model. [Folkert 2012, 2018] [Leguijt 2012, 2014, 2015] [Wijngaart 2014,2017,2018,2019]

For local level models, several options will be investigated. These are, but not limited to:

- Hoom Dossier [Hoom 2020]
- ESDL (not yet available) [TNO 2020]
- Homer [Homerenergy 2020]

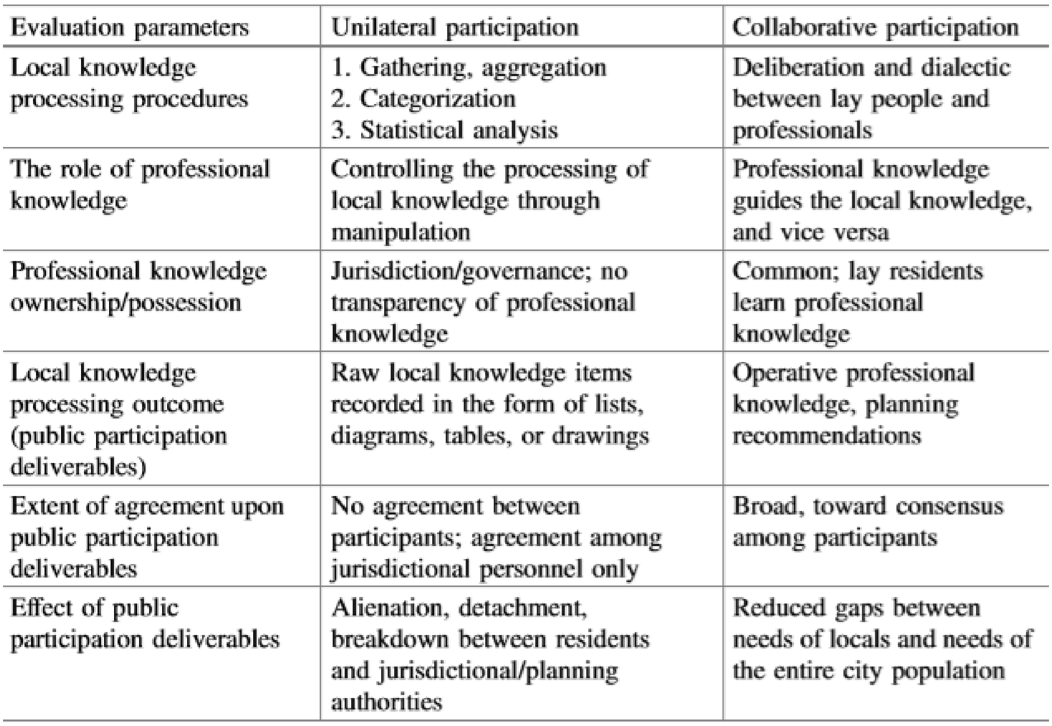
These models will be investigated through literature and documentation provided by the developers to see if they can be used. This use could be baseline data or building blocks to build the model upon.

What criteria do local initiatives require of a model?

First, the model needs to be accessible, due to its uses in developing grassroots initiatives on a local level. Excel could be as complicated but is generally well understood and could potentially help in developing a model that people could utilize as a tool for the first steps of a transition.

The baseline for the criteria will be made based on the studyof Berman in combination with experiences from GrEK as well as input from the case study itself. This combination of academic core criteria adapted with local and case study specific parameters will fit in a model. This concept is based on the idea of Berman to include the local specifics into the model itself allowing it to fit closer to the grassroots initiative. Berman provided a table with baseline criteria to start from. This table is visible in table 1.

TABLE 1: PROCESSING LOCAL KNOWLEDGE AND OBTAINING PUBLIC PARTICIPATION DELIVERABLES (BERMAN 2017)



Evaluation parameters	Unilateral participation	Collaborative participation
Local knowledge processing procedures	1. Gathering, aggregation 2. Categorization 3. Statistical analysis	Deliberation and dialectic between lay people and professionals
The role of professional knowledge	Controlling the processing of local knowledge through manipulation	Professional knowledge guides the local knowledge, and vice versa
Professional knowledge ownership/possession	Jurisdiction/governance; no transparency of professional knowledge	Common; lay residents learn professional knowledge
Local knowledge processing outcome (public participation deliverables)	Raw local knowledge items recorded in the form of lists, diagrams, tables, or drawings	Operative professional knowledge, planning recommendations
Extent of agreement upon public participation deliverables	No agreement between participants; agreement among jurisdictional personnel only	Broad, toward consensus among participants
Effect of public participation deliverables	Alienation, detachment, breakdown between residents and jurisdictional/planning authorities	Reduced gaps between needs of locals and needs of the entire city population

These concepts will be translated into more practical data that can be used in the model . An example of such a transition would be the comparison between the estimated energy consumption of a house within a local area to the actual energy consumption of a house.

This aspect of the research will be done through literature research and talks with senior members of GrEK and their experiences with energy transition projects.

Build or adapt a model to fit the criteria

With the base model chosen the adaptation to local information can then be made. For this, the criteria of Berman will be a guide. The model should take a base set of information that is either providable by the local community or adaptable when based on open-source information. From this, the model then is constructed to evaluate potential scenarios.

These transition options are:

- Heat pumps
    - Solar
    - Wind
- Biogas
- Heat district
    - Low heat

Evaluate the model and compare it a comparable model (VESTA MAIS), with a case study provided by GrEK (Veelerveen)

The model needs to be tested against an existing model, to see if it holds up. For this, the VESTA model has been chosen due to its presence within the Dutch policy-making agencies and recommendations from GrEK. GrEK (Groninger Energie Koepel) is a cooperation that helps residents of the province of Groningen with the realization of their ideas to make their local area for energy projects. This ranges from isolation projects to alternative energy sources. With this expertise, the municipality of Westerwolde approached GrEK with a request to map out the potential and the economic aspects of a transition for the village of Veelerveen from natural gas.

3. MODEL CHARACTERISTICS

Within the Netherlands, there are many potential models available to be utilized when modeling the potential energy transition for a village. Some are more suitable than others for the task at hand. To dig through the forest of options a way of classifying the potential models is required. At first, the input of the models is taken. What input of data does the village have available? What output is expected of the model? In this chapter, the parameters set for the model analysis are described as well as the methodology of the start point of a project within GrEK, the baseline measure.

3.1 Overall characteristics

As a first step, the models will be described using a set of characteristics. These characteristics will be made visual in a radar graph, allowing for a comparison of desired characteristics to the characteristics of each model. The set of ideal characteristics is visible in figure 2. This combination of aspects together should give the best performance for the modeling of a small village in Groningen to act as a quick scan for their potential transition away from natural gas.

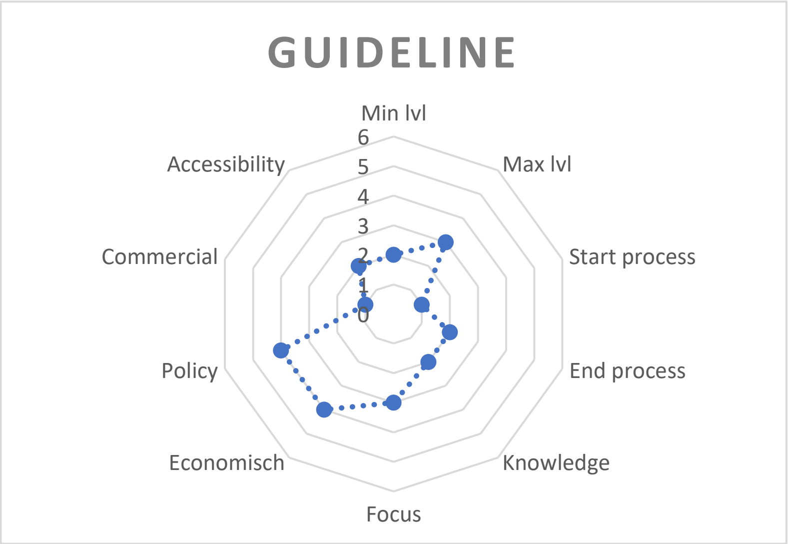


FIGURE 2: RADAR GRAPH OF GUIDELINE FOR MODEL SELECTION

The characteristics chosen are visible in table 2. The first step is to look at the level the model operates on. The utility of a model that describes the transition of a nation will be less suited when looking at the transition of a village. As models have a range of levels they can be utilized on, the level of utilization has been split into a minimum level and maximum level of utilization.

The next step is looking at the starting point of the process the model is utilized for. The transition of a village takes multiple steps, from visualization to the endpoint of exploitation. Each step has different requirements and different accuracy demands. At the start, a broader picture helps eliminate possibilities and allows the focus to shift to the best transition candidate scenarios while the models for the endpoint will need to be very specific about costs and steps to be taken. This characteristic has been split into two, one describing the starting point within the process the model is utilized and the other the endpoint of the model utilization within the transition process.

The third step is looking at the knowledge the model requires to operate. Does the model take local knowledge as input and how does it utilize this knowledge. The fourth step is looking at the core direction the model takes for the transition. Electric, heat, or a combination? The fifth, sixth, and seventh steps are simplified as yes or no answers. Does the model have financial data as an output, does the model have policy integration, and is the model a commercial product? Finally, the accessibility of the model's output is looked at. Is it simple to understand or does the model require an additional step of translation to make it viable to use within a local energy transition as a point of data? This final aspect flows further into the next step of the process, together with the characteristics of knowledge.

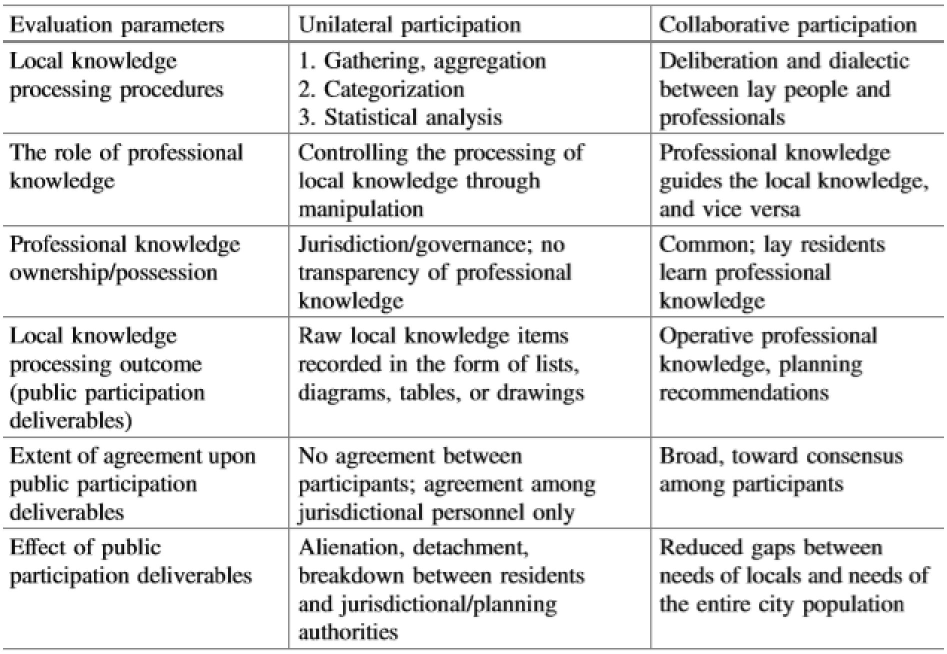
TABLE 2: MODEL PARAMETERS

Characteristic	description
Min lvl (minimum level)	Minimum level the model operates on: 1- house 2- district 3- city 4- region 5- national 6- international
Max lvl (maximum level)	The highest level the model operates on: 1- house 2- district 3- city 4- region 5- national 6- international
Start process	The point within the process the model starts: 1- Vision 2- Masterplan 3- Urban planning 4- Project planning 5- implementation 6- Exploitation
End process	The point of the process the model ends: 1- Vision 2- Masterplan 3- Urban planning 4- Project planning 5- Implementation 6- Exploitation
Knowledge	The balance between professional and local knowledge 1- Local knowledge 2- local knowledge/prof knowledge 3- prof knowledge
Focus	The focus of the model: 1- electric 2- electric/heat 3- heat
Economic	the economic output of the model 1- yes 4- no
Policy	Policy application? 1- yes 4- no
Commercial	Is the model-free? 1- Yes 4- No
Accessibility	How accessible is the model? 1- Very accessible 5- Not very accessible

3.2 Local knowledge and parameters

Berman is an urban planning expert who did a PhD on the utilization of local knowledge within urban planning projects. As part of his research, he looked at the core concepts and implications local knowledge had and how they describe their interaction within a project. Berman stated that local knowledge is important for the success of any large-scale infrastructure project [Berman 2017]. This importance is visible in the planning process of these projects, where local knowledge can dictate and build trust for new projects within a community. This process is visible in Table 3. It allows the residents to become part of the planning process as well as finetune the project to their needs and wishes. This combined, as stated by Berman, could result in an optimistic outlook on participatory processes and searches for means, conditions, and guidelines that may enable participation through the incorporation of local knowledge into planning decisions and processes [Berman 2017].

TABLE 3: OVERVIEW OF PARTICIPATION PARAMETERS FOR AN INFRASTRUCTURAL PROJECT (BERMAN 2017)



Evaluation parameters	Unilateral participation	Collaborative participation
Local knowledge processing procedures	1. Gathering, aggregation 2. Categorization 3. Statistical analysis	Deliberation and dialectic between lay people and professionals
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When distilling the concepts of Berman into practical parameters for a model to be analyzed table 3 is used. This table shows the evaluation parameters utilized by Berman. These parameters are then distilled down into the parameters seen in table 4. These parameters will be utilized to analyze the potential energy models, as well as the resulting homebrew model based on the chosen models.

TABLE 4: DISTILATION OF PARTICIPATION PARAMETERS INTO MODEL SELECTION

Parameter	
Local knowledge	Yes/No
Professional knowledge	Yes/No (How)
Professional knowledge	-
Local knowledge input	How
Public participation	Method, actor position
Effect participation	Results of public participation

4. MODEL ANALYSIS

The model analysis has been done according to the characteristics as described in chapter 3. The process is in two steps. , first, an analysis on characteristics followed on closer inspection with the help of the parameters of the participation model as well as a SWOT analysis.

4.1 Model characteristics

The first step of the model analysis is to visualize the different aspects of each model with the help of a radar graph.

4.1.1 Vesta MAIS

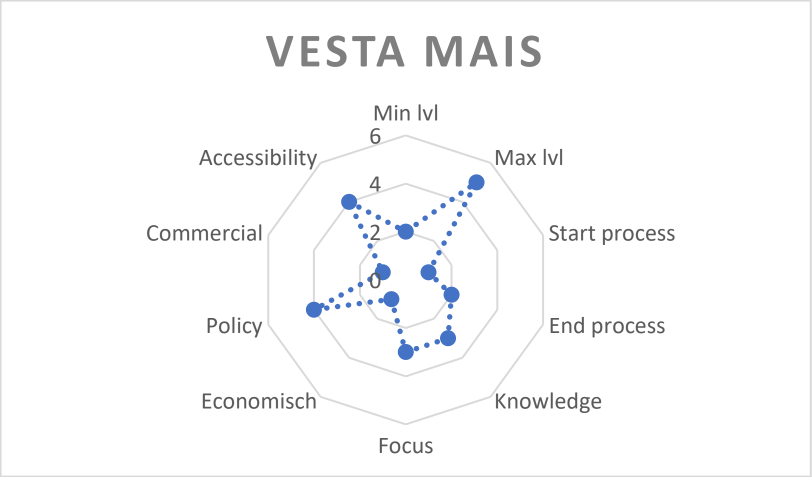

FIGURE 3: RADAR GRAPH OF VESTA MAIS

The Vesta MAIS (Multi Actor Impact Simulation) model is a model designed by the Dutch bureau of envorinmental planning [Leguut and Schepers 2011]. The goal of the model is to act as an investigation tool to find the best suitable options for emission reductions within an area over a timeframe till 2050. It utilizes open data sources on the Netherlands as a base on which predictions are built. The strength of the model is that it is a generalization of the Dutch transition, allowing for broad and clear indications to be presented for large areas within the nation. As indicated in the radar graph, the start and end of the process in which Vesta MAIS has the most impact are during the initial planning and development of a project, showing its strength as a discovery tool. It includes mostly professional knowledge and expects local knowledge to adapt its findings during the next steps of the process of developing an energy plan for an area. The model includes policy options, allowing for up to date processes. The end product of the model is tables, graphs, and maps. The maps are generated with the help of QGis. The radar graph of Vesta MAIS is depicted in figure 3.

4.1.2 Hoom dossier

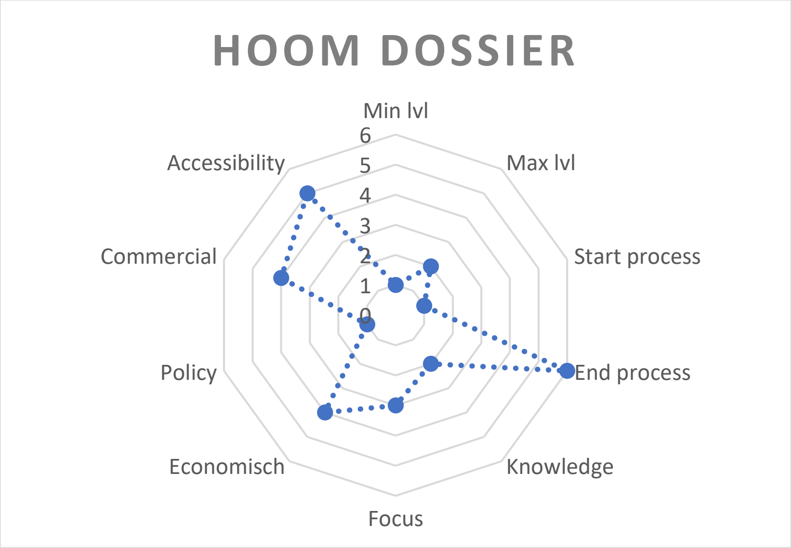

FIGURE 4: RADAR GRAPH OF HOOM DOSSIER

The Hoom Dossier is an online tool developed by energy cooperation called Hoom [Hoom 2020]. It's used to help local energy initiatives to give insight into the potential of a district in becoming more energy efficient and possibly even energy neutral. It works on the individual house level, taking as much local knowledge and data as possible. Any missing data is then substituted with open data sources to build a complete picture of the district. This picture then helps the local initiative develop a multi-year strategy, from the house level towards the district level. To utilize the model local energy initiatives are required to purchase a license. On the input side, the Hoom dossier works through developing a, or several, base theoretical houses for the district from a set of theoretical houses Hoom designed for the Netherlands. These houses then function as base sets of information, on which the residents then substitute information with their own, more accurate, information. This then slowly develops the model from house to house, building a strategy for the district. The main advantage of this method is the social impact of generating awareness of the transition potential of each house. The disadvantage is the amount of work the model requires before utilization. The radar graph of the Hoom Dossier is depicted in figure 4.

4.1.3 ESDL

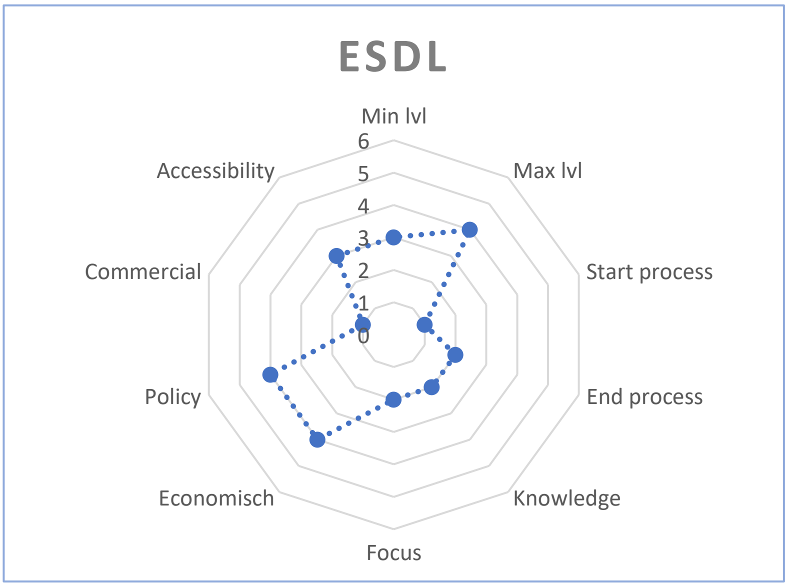

FIGURE 5: RADAR GRAPH OF ESDL

ESDL (Energy System Description Language) is a model that is still in development within TNO, a Dutch research institute [ESDL 2020]. Its goal is to combine several Dutch models into one accessible and practical model that can act as the main transitional model in the Netherlands. The model operates on the lower levels, ranging from district to region. Its main utilization will be in the early phases of a new project, ranging from vision to the masterplan phase. It will utilize some local knowledge in the application with the choice of boundaries. The focus of the model is on heat transition and will include economic data as well as policy integration. The commercial aspects of the model as still unclear. The accessibility is good. The biggest drawback of the model is the fact that the model is still in development and not ready for utilization. Once this model is available it could potentially be a good fit, if the promises of development are kept.

4.1.4 PICO/GEODAN

PICO is an adaptation of the Vesta MAIS model by a consortium of energy consultancies in cooperation with TNO and the PBL. It utilizes the data provided by Vesta MAIS and makes it more accessible by streamlining the graphic integration into map-based interphase. This allows for the main drawback of the Vesta MAIS model of accessibility to be less of a burden. As this model is based on the Vesta MAIS model for its data, the characteristics are the same. The differences are accessibility and commercial characteristics. PICO had a free version to be used, although currently this model is no longer updated and strongly recommends a paid version provided by GEODAN.

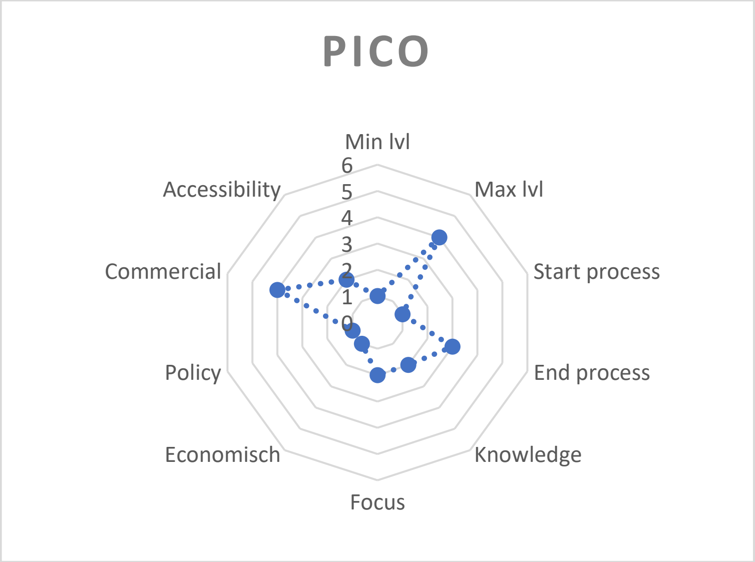

FIGURE 6: PICO/GEODAN

4.1.5 Heat models

There is a subset of models that have been looked at, that only focus on the heat aspects of the transition. This limits the utilization of these models when attempting to apply them to a broader transition within a small village in Groningen. The electricity aspect will play a role in its transition, therefore these models are unsuited for this utilization during this step of the process. These models include CHESS, COMSOF HEAT, ETA, and HEAT. Their radar graphs are visible in appendix A.

4.1.6 Electrictricity models

There is a subset of models that only look at the electrictricity aspect of a potential transition. This limits the utilization of these models in a broader picture during the transition of a small village in Groningen during this step of the process. While these models could potentially be useful in later steps if a choice towards electrification has been made. At that point, a transition of model choice from a broader all-round transition model to a more specific electrictricity focused model would be helpful. These models include HOMER, MERLiN. Their radar graphs are visible in appendix A.

4.1.7 Advanced planning models

There is a subset of models that focus on advanced planning steps within the transition process. Attempting to model aspects relevant to the urban planning or exploitation phase. These models are less suited for utilization during the vision and masterplan phase of the process. For future steps, during the transition project, these models could be taken into account as potential stepping stones. But, at the time of this project, these models are unsuited for utilization. These models include ES-IT, Gebiedmodel, Moter, Omons. Their radar graphs are visible in appendix A.

4.1.8 No economic or policy aspects

There is a subset of models that lack an economic or policy part within their process. This makes these models less suited for the transitional process of the energy transition for a small village in Groningen. The economic aspects are important to make an insightful choice during the masterplan phase of focusing the potential options to a few strong candidates. This also included potential policy impacts upon the process. Therefore these models are not suited for the process of a practical plan. These models include Artis, Cegoia, Energeyes, energiepotentiekaart, het duurzaam dataplatform, Leap, Opera, Transform, Warmtevraagprofielen, Win3d, Woonconnect, DSSM. Their radar graphs are visible in appendix A.

4.2 Participation parameters

The next step is to take the four models and analyze them with the use of the participation parameters from chapter 3.2 . In the following subsections, the models will be made visible with tables to describe the different aspects utilizing a SWOT methodology. Then in the analysis section, the overall choice will be described.

4.2.1 Vesta MAIS

Table 4: SWOT of Vesta MAIS based on participation parameters

SWOT	**Helpful**	**Harmful**
Internal	**Strengths:** • **Available** • **Field-tested** • **Used in policymaking** • **Heat focus**	**Weaknesses:** • **Nationwide picture** • **No local knowledge**
External	**Opportunities:** • **Baseline** • **National view/perspective**	**Threats**: • **No public participation**

Table 5: Tech aspects of Vesta MAIS

Tech		
Input	Local data	Energy consumption (house)
		Behavior
	Open data	Theoretical base house
Output		Different scenarios
		Multi-year plan

Tabe 6: Participation parameters applied to Vesta MAIS

Parameter	
Local knowledge	No
Professional knowledge	Yes
Professional knowledge	Black box
Local knowledge input	No
Public participation	Results
Effect participation	Alienation

4.2.2 Hoom Dossier

Table 7: SWOT of Hoom Dossier based on participation parameters

SWOT	**Helpful**	**Harmful**
Internal	**Strengths:** • **Available** • **Field-tested** • **Homeowner agency** •	**Weaknesses:** • **Commercial** • **Closed system** • **Focused on individual home improvements**
External	**Opportunities:** • **Awareness generation** • **Starting point**	**Threats**: • **The big picture**

Table 8: Tech aspects of Hoom Dossier

Tech		
Input	Local data	Energy consumption (house)
		Behavior
	Open data	Theoretical base house
Output		Different scenarios
		Multi-year plan

Table 9: Participation parameters applied to Hoom Dossier

Parameter	
Local knowledge	Yes, individual household
Professional knowledge	Yes, the model itself
Professional knowledge	Black box
Local knowledge input	House data, house improvements
Public participation	Yes, own house dossier

Effect participation	Awareness, agency

4.2.3 ESDL

TABLE 10: SWOT OF ESDL BASED ON PARTICIPATION PARAMETERS

Tech		
Input	Local data	Energy consumption (house)
		Behavior
	Open data	Theoretical base house
Output		Different scenarios
		Multi-year plan

SWOT	**Helpful**	**Harmful**
Internal	**Strengths:** • **Combination of several models** • **Accessible**	**Weaknesses:** 5. **Not done yet** 6. **Focus unknown**
External	**Opportunities:** • **Interactive**	**Threats**: • **Black box potential** • **Complex**

TABLE 11: TECH ASPECTS OF ESDL

TABLE 12: PARTICIPATION PARAMETERS APPLIED TO ESDL

Parameter	

Local knowledge	No
Professional knowledge	Yes, several models
Professional knowledge	Black box
Local knowledge input	Model application
Public participation	Yes
Effect participation	Awareness, agency

4.2.4 PICO/GEODAN

Table 13: SWOT of PICO/GEODAN based on participation parameters

SWOT	**Helpful**	**Harmful**
Internal	**Strengths:** • **Available** • **Field-tested** • **Distinct optimization levels**	**Weaknesses:** • **New district focus**
External	**Opportunities:** • **-**	**Threats**: • **The big picture**

Table 14: Tech aspects of PICO/GEODAN

Tech		
Input	Local data	Energy consumption (house)
		Behavior
	Open data	Theoretical base house
Output		Different scenarios
		Multi-year plan

Table 15: Participation parameters applied to PICO/GEODAN

Parameter	
Local knowledge	No
Professional knowledge	Yes, several models
Professional knowledge	Black box
Local knowledge input	Model application
Public participation	Yes
Effect participation	Awareness, agency

4.2.5 Analysis

When taking into account the partiicipation parameters, it shows that local knowledge is lacking in a lot of these models. The local knowledge is applied as an additional step after the model runs its national information, on which the local operator of the model makes the adjustments to make the model fit the local level knowledge. While the application of this translation with local knowledge is not bad, it's also not the goal of this research where the attempt to find a model that specifically takes into account local knowledge as a source of information. This aspect of lacking a direct influence of local knowledge plays a major role in the Vesta MAIS model, and therefor as well in the PICO/GEODAN adaptation of the Vesta MAIS model. These aspects are visible in the tables of 4.3.1 and 4.3.4.

The Hoom dossier, with its tables in 4.3.2, does include local knowledge, yet this model operates on the smallest level of the housing unit. This makes its application less suitable for a village level transition, as the step from house level to village level would be an overwhelming amount of data to process. During the transition process, this model could see utilization when generating awareness of small scale insulation initiatives is required. This is the strength of the model, and it should be utilized in that specific way.

ESDL, with its tables in 4.3.3, would be a perfect fit with its options for boundary choice as well as accessible output, yet this model is still in development, therefor at this moment unable to be utilized. When this model does reach completion, then it would be a strong contender to the utilized in this particular application.

Taking these aspects into account the Vesta MAIS model would be a good fit, although lacks detail for the small local level as its goal is to be a nationwide model. This aspect can be utilized in developing a new model, a model that fits all the criteria decided upon in chapter 2. The Veste Maiz model can then be utilized as a check to see if the data provided by the newly developed model is within acceptable ranges.

5. MODEL DATA

Taking the analysis of available models from 4.2.5 as a basis, it has become clear a new model needs to be developed to fit the parameters set for the required model. A new model would allow us to fine-tune the aspects required to the parameters. A visual overview of the flow of the model is visible in figure 7.

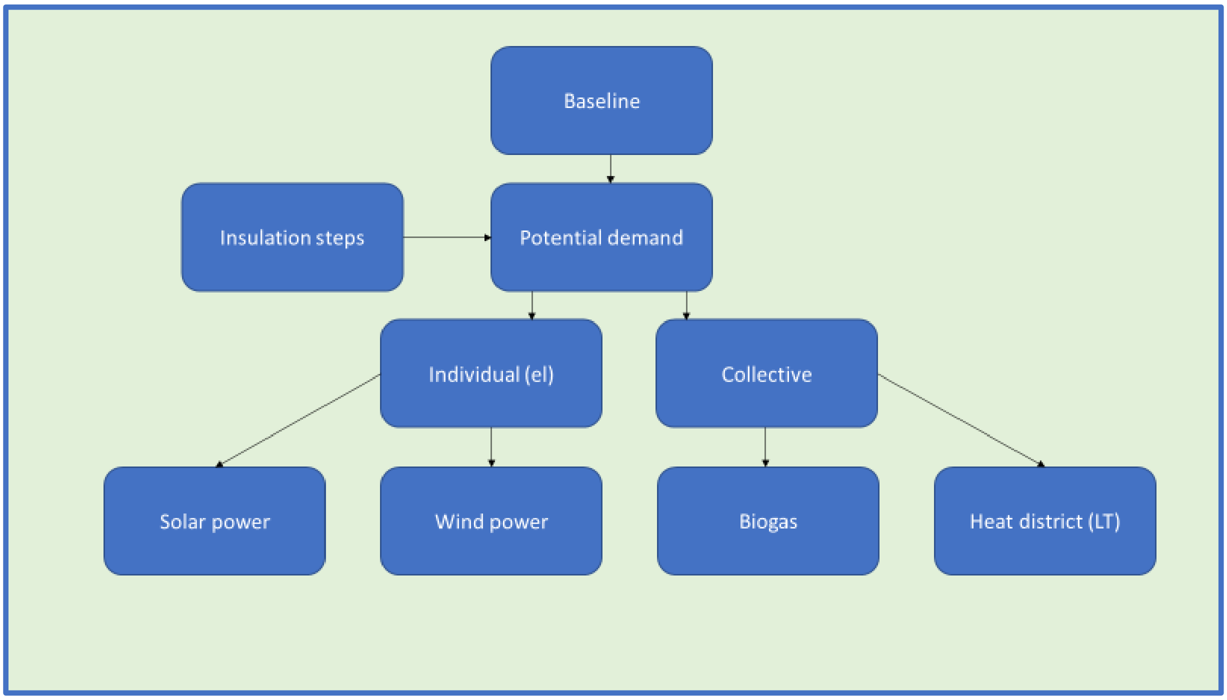

FIGURE 7: SCHEMATIC OVERVIEUW OF THE PROPOSED MODEL

The goal of the model is to act as a quick scan for a new local energy transition initiative to see what options would be fitting for the specific location to utilize. The model takes the local knowledge of the initiative as a baseline to build the model upon. For this, the energy-labels of the houses of the chosen area as well as the surface area of the houses have been taken. These data are openly available as open data and can be adapted with more specific local energy consumption information when available.

Next, the potential heat demand of the village is calculated and adapted with potential housing insulation options for the area. The assumption is made that the entire village will be insulated to reach a specific minimum energy label, this goal label will be a modifier within the model. With the potential demand identified the model splits between individual and collective solutions. The individual solutions focus on total electrification of the village with the use of heat pumps to deliver the required heat. The electricity needed to power the heat pumps will be through either solar power or wind power with a storage solution attached to the network.

For the collective approach, the concepts of biogas through a digester and a low-temperature heat district were implemented. The digester focuses on how much biomaterial would be needed from the area and is available. The district heating system is tested with economic values from Denmark indicating the economic potential of a district heating network in an area.

5.1 Baseline-measure

The basis of the model is local knowledge. In discussion with GrEK, the basis of their baseline-measure was taken as a starting point for the development of the model itself. This baseline-measure is based on the concept of "what information and data do the locals know or have access to". This was then refined into an overview called the baseline-measure. The basis of information of the baseline-measure was utilizing the public data of energy labels of the houses of a chosen village. CBS has provided data on the energy consumption for heat and electricity based on the energy label of a house [CBS 2016]. These data are provided in several steps, which for this model have been translated into a Low, Mid and High consumption pattern. The Low consumption is the amount that would cover the lowest 25% of the houses within an energy label with their consumption. For Mid it’s the lowest 50% of the houses and High it’s the lowest 75% of the houses.

TABLE 16: CBS GAS CONSUMPTION DATA FOR EACH ENERGY LABEL [CBS 2019]

Energylabels	Low (m3/m2)	Mid (m3/m2)	High (m3/m2)
A+	7.5	9.5	11.5
A	7.5	9.65	11.8
B	7.7	10.05	12.4
C	8.2	10.6	13
D	8.6	10.95	13.3
E	9	11.15	13.3
F	9.1	11.45	13.8
G	9.2	11.65	14.1

The energy labels in combination with the surface area of the houses give an estimation of the heat demand in gas usage yearly. The surface area of the houses was obtained by the use of BAG data [BAG Kadaster 2020]. The equation for this is visible in equation 1.

$$1)\quad Energielabel * suface\ area = estimated\ gas\ demand$$

The data required to transition from energy label through the surface area into the gas usage of a yearly basis was obtained from CBS. To normalize the values obtained and bring them closer to the expected values, a theoretical maximum of surface area has been implemented. This maximum surface area limits the range of surface areas available within the region, by adding a hard cut off point for surface area of the houses. This reduces all houses with a surface area above the theoretical limit to the theoretical limit. The idea behind this limit is that even though some houses have a very large surface area they are not all heated or utilized fully.

A similar approach to the gas use calculation has been done for electricity consumption, with the number of residents instead of the surface area of the houses. The steps taken can be seen in equation 2.

$$2)\quad Energielabel * nr\ of\ residents = estimated\ electricity\ demand$$

The gas usage and electricity usage both utilize a separation between the low, mid, and high demand. The CBS data gives numbers for Low, where at least 25% of the houses within this energy label fit these demand profiles. Medium, where at least 50% of the houses within this energy label fit these demand profiles. High, where at least 75% of the houses within this energy label fit these demand profiles. The numbers found for average gas consumption and electricity consumption can then be compared with the data provided by the CBS in their report ''wijk en gemeente'' (yearly report) [CBS 2018]. This comparison gives insight whether the data is within reasonable boundaries for the area chosen. A large difference might indicate aspects like large consumers within the area or a mismatch with energy labels. As a second step of comparison the consumption data from the different energy providers in the Netherlands can be used to compare the consumption within an area. Similar to the CBS data report, there might be some differences due to the chosen area the model will be deployed in, which could possibly not have a perfect overlap with the areas used in the CBS report or the energy providers data sets.

5.2 Energy label steps

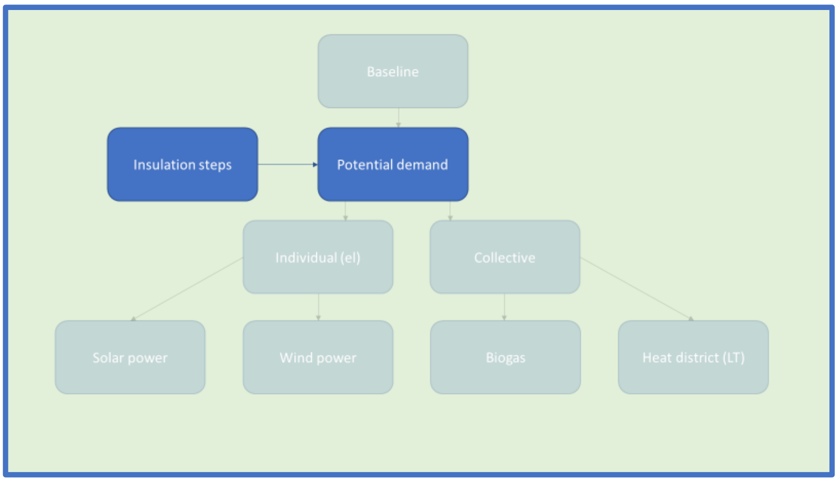

FIGURE 8: SCHEMETIC OVERVIEW OF MODEL FOCUSED ON INSULATION

Insulating the houses within a region is the first step that would be investigated, as indicated in the schematic overview of the model visible in figure 8. In this approach the assumption is madethat by insulating the houses an energy label transitional step is taking place, allowing for an upgrade of the energy label at the cost of a certain economic investment. For modeling the potential of energy label steps, through for example better insulation, the report of CE Delft about the transition for the province of Limburg is used [CE Delft 2018]. This report gives amounts of money connected to label steps based on the surface area of a house. This allows for the model to calculate estimations of the total budget requirements needed for the chosen area to increase the energy labels up to the chosen label. The numbers utilized are visible in table 17.

TABLE 17: ENERGY LABEL STEPS AND THE CORRESPONDING COSTS

/m2	A+	A	B	C	D	E	F
G	€ 303	€ 170	€ 140	€ 123	€ 69	€ 66	€ 33
F	€ 277	€ 166	€ 128	€ 106	€ 72	€ 35	€ -
E	€ 232	€ 147	€ 107	€ 85	€ 49	€ -	€ -
D	€ 198	€ 122	€ 76	€ 49	€ -	€ -	€ -
C	€ 218	€ 185	€ 69	€ -	€ -	€ -	€ -
B	€ 82	€ 70	€ -	€ -	€ -	€ -	€ -
A	€ 31	€ -	€ -	€ -	€ -	€ -	€ -

The numbers given indicate how much money there needs to be invested per square meter to reach a certain energy label on average. These numbers are an indication and not specific for each house.

Calculating the reduction between steps is based on a combination of the data from the CE Delft report as well as the CBS data utilized in the baseline-measure step [CE Delft 2018, CBS 2020]. Both reports indicate a difference between the amount of potential savings between energy label steps. After calculating the difference between both methods there is a difference of reduction of around 40%. This calculation is based on a theoretical house moving from energy label G to energy label B. The CE report indicates a 40% higher potential reduction in energy consumption compared to the CBS data. As an assumption the middle road between these values have been taken of an additional consumption reduction of 20% added to the CBS consumption predictions. The resulting values have been tested by checking the payback period of the isolation steps against the payback times stated in a report from the PBL [PBL 2020].

5.3 Collective

For the collective approach two methods of delivering heat that is based on a collective method of providing the required heat to the village. These methods are a low-temperature heat district and a digester into biogas.

5.3.1 Heat district

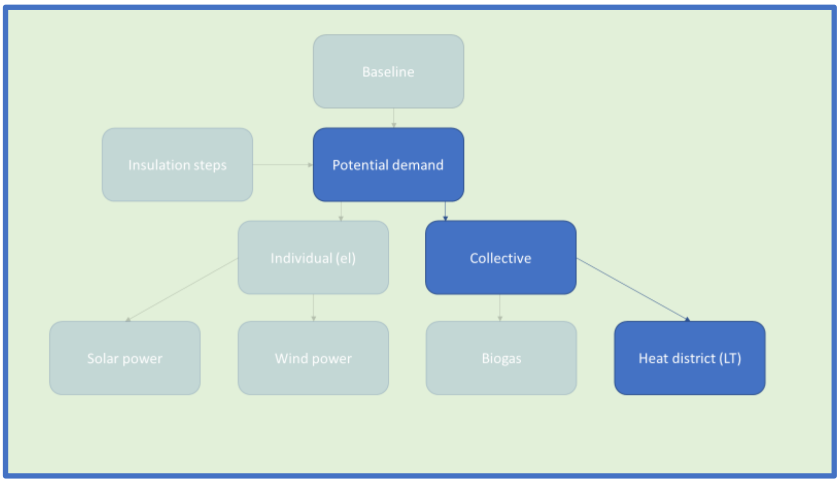

FIGURE 9: SCHEMETIC OVERVIEUW OF MODEL FOCUSED ON HEAT DISTRICT

For a heated district, there are many potential sources available to deliver the heat demand. Especially a low-temperature heat districtallows the most potential heat sources to be utilized. The first step is looking at the heat district itself and see if it would be viable to develop a district within the chosen village.

For Europe the Stratego project mapped the potential of district heating for the member states. As a guideline it took 100 TJ/km^2 to check if an area is economically suited for district heating or not [Stratego 2016]. This check is based on a value for the total heat demand per square kilometer in a chosen area. If the heat demand in the area is below this value then it indicates that a heated district is economically not viable to be utilized within the area. At the moment of this writing, this critical value is at 100TJ/km^2. The model does a check based on the available information of the chosen area if the heat demand per square kilometer is high enough or not. It does this by taking the total gas consumption of the chosen area and devide this to total area in square kilometers. This number calculated gives the total heat demand in natural gas per square kilometer of the chosen area. The total gas consumption per square kilometer is then multiplied by 35.17, giving the total heat demand per square kilometers in MJ. This can then be compared to the critical value of 100TJ/km^2. This number is not a hard limitation; however if the heat demand is far below this value then it makes it clear other alternatives will be more suitable.

5.3.2 Biogas

For the biogas, the assumption of a anaerobic co-digester with a manure quota of at least 50% mass has been chosen. This 50% is due to Dutch policies and potential subsidies on the development of the co-digester [Hermann & Hermann 2019]. The first step is taking the total heat demand of the local village, in cubic meters of natural gas and try to adapt this to the amount of manure and biomass needed to supply this amount of gas. For this the data from the report from Ecofys has been utilized, giving potential biogas production levels for several biomass base types [Ecofys 2005]. The most common biomass type within the chosen area is then selected, allowing to focus only on the local potential. Then the local biomass potential is investigated and compared to the requirements of the co-digester. The comparison will give insight into the potential of a biogas based method for the local village energy transition.

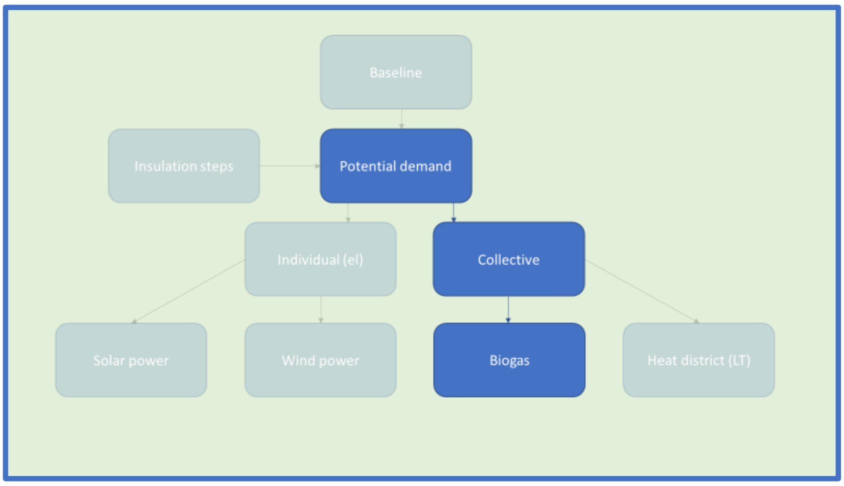

Figure 10: Schemetic overvieuw of model focused on Biogas

5.4 Individual

For the individual options, the assumption has been made that the village makes a full transition into electric power to supply in their heat demand. To utilize this the model takes into assumption three possible heat pumps with each house making the same move to the same heat pump. The chosen parameters of these heat pumps are visible in table 18. The costs and SPF data have been estimated based on several suppliers of heat pumps in the Netherlands as well as information provided by TNO [Valiant 2020, TNO 2020, Energiewacht 2020, CVtotaal 2020, energieloket 2020].

Table 18: Average costs and SPF of heat pumps in the Nehterlands

Heat pump	Cost low	Cost high	SPF
Air-Water (L/W)	€ 10.000	€ 15.000	2,8
Ground-Water (G/W)	€ 15.000	€ 25.000	4,5
Water-Water (W/W)	€ 15.000	€ 20.000	3,9

The parameters are the type of heat pump, the costs (low and high), and the SPF. The SPF is the seasonal performance factor and it's a method of describing the output of a heat pump. The formula used for the SPF is presented in equation 3.

$$3)\quad SPF = \frac{Total\ heat\ energy\ output}{total\ electrical\ energy\ input}$$

Air-Water (L/W) pumps extracts heat from the outside air to deliver heat inside the house. They are easy to install and utilize. The ground-water pumps utilize the ground to extract heat, and depending on the method of pipe placement the costs can vary largely. The two main method are horizontal piping, taking more space, or vertical piping deeper into the ground, at higher costs. The third pump type is the water-water pump (W/W) and it utilizes ground water, and therefor requires a well to the ground water level to be drilled. A fourth type are air to air pumps, but these demand a minimum energy label of B to be utilized well and have therefor been ignored for the current iteration of the model.

By utilizing the total heat demand of the houses it's possible to calculate the expected power demand after the transition towards heat pumps. This eliminates the aspect of determining specific heat pumps for specific buildings and generalizes the heat demand. It gives an overview of the total demand of electricity of the electrification of the village. For the power supply, three pathways would be possible. Utilizing the national electricity grid, solar power or wind power. As an addition, the inclusion of a storage capacity has been added to the placement of heat pumps. This storage capacity runs at an efficiency of 88% and costs 10.000 euro for each house in the area. This is based on a Tesla powerwall [Tesla 2020] with a capacity of around 13 kWh of storage in each house.

These different pathways are then utilized to see the emission reduction each pathway would result in by comparing the required energy to the amount of CO_2 emissions per energy unit. This can then be compared to the alternative pathways. For the Individual pathways the average green energy emissions for the Netherlands are used as a substitute for the solar and wind pathway.

5.4.1 Solar

When utilizing solar energy for the power demand of the village the total amount of solar cells needs to be calculated. This is taken with the assumption of establishing a single solar field for the power supply. Alternatives, like roof, could be possible but would rquier additional data for the model to utilize. How many square meters of solar cells would be required to deliver the energy demand of the village throughout the year? This also includes storage capacity. To eliminate part of the complexity, the storage capacity has been chosen to be the size of 100 MWh with a 50% starting load. The storage unit supplies energy in case of a shortage or takes energy in case of a surplus. When taking energy the storage unit has an efficiency of 88% [Tesla 2020]. This large size storage unit is to find the minimum amount of solar cells needed to supply the town. The formula used to calculate the energy generation for the solar cells is visible in equation 4.

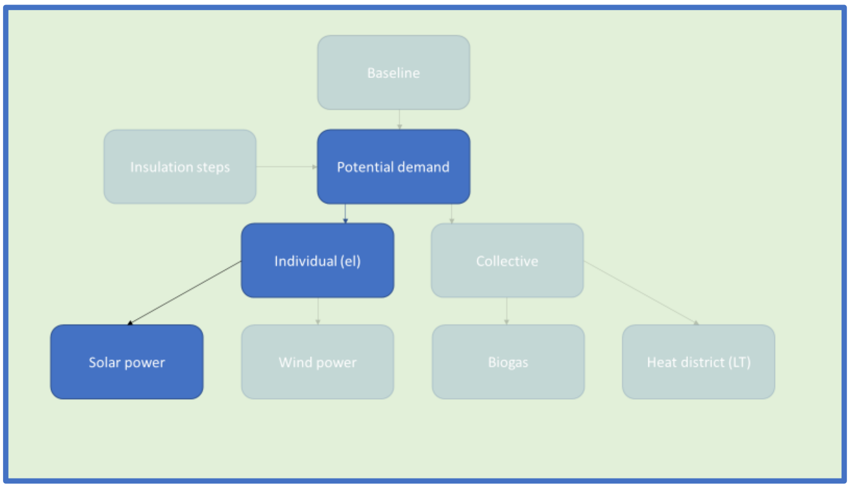

FIGURE 11: SCHEMETIC OVERVIEUW OF MODEL FOCUSED ON SOLAR POWER

4) $$\begin{aligned} &Total\ power\ generated = \\ &beam\ angle\ coefficient * solar\ cell\ efficiency * solar\ radiation\ \left(\frac{j}{m^2}\right) \\ &* total\ solar\ cell\ surface\ (m^2) \end{aligned}$$

The hourly solar radiation data has been taken from the KNMI, by finding the suitable weather station and taking its hourly data for the solar radiation [KNMI 2008]. This then gives the amount of solar energy 1 m^2 of solar cels could potentially generate at a specific hour of a day. The year taken from the KNMI matches the year that has been taken for the gas demand profile, in this models case 2008.

With the total gas consumption known of a chosen area, it is possible to generate a estimation of a energy demand profile based on Dutch heat demand profiles. These profiles split the year up in hourly pieces, giving the amount of the yearly demand that is demanded at each specific hour [Nedu 2008].

When comparing the solar output with the demand there are three options. The demand matches the supply, the supply is higher or the demand is higher. The model checks if the demand is higher or lower then the supply and then subtracts or adds energy to the storage capacity with the efficiency of 88% [Tesla 2020]. The model then attempts to match the energy demand to the energy consumption as best as possible.

5.4.2 Wind

For the wind turbine approach, a similar method to the solar steps has been taken in the model. The same storage unit has been taken as a baseline with 100 MWh storage capacity, 50% load at the start, and an energy storage efficiency of 88%.

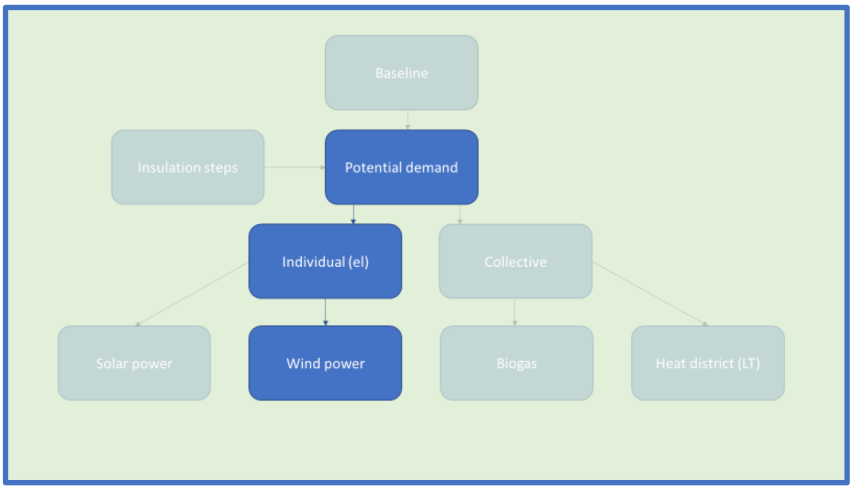

FIGURE 12: SCHEMETIC OVERVIEUW OF MODEL FOCUSED ON WIND POWER

The wind turbine chosen is a medium-size wind turbine at around 3MW capacity and a height of around 90m. The wind data from the KNMI have been taken from a close-by weather station and gives an indication of power generation by the wind turbine at specific times of the day and year [KNMI 2008]. This hourly wind data is then compared to the energy demand of the heat demand profile of the area [Nedu 2008]. The surplus energy is stored and if there is more demand then supply the energy is taken from the storage capacity stored in the individual storage space available at each house. The KNMI data has been matched with the heat profile data, both from 2008.

Alternativly, the utilization of smaller EAZ windturbines will be done using the same method. The data points for these windmills are a windmill of around 15m, with a capacity of 0.03MW and a cost price of around 50.000 euro [EAZ 2020].

5.5 Emissions

As a method of comparison the emission of each pathway is calculated. For this the emission database of Stimular has been utilized [Milieubarometer 2016]. This database gives CO_2 emissions for each of the sources based on the energy consumed, allowing to compare potential emission savings to each other. Therefor if emissions are calculated, the total energy consumption is taken for that pathway, which is then multiplied by the emissions stated in the Stimular database.

6. MODEL RESULTS / CASE STUDY

To test the developed model a case study was done on the small village of Veelerveen in the province of Groningen and the municipality of Westerwolde. This case study was provided by GrEK as a current project that had a local energy initiative starting up their operations within the village. These operations included setting up a quick-scan and baseline-measure to develop insight into the village itself and the potential of the village.

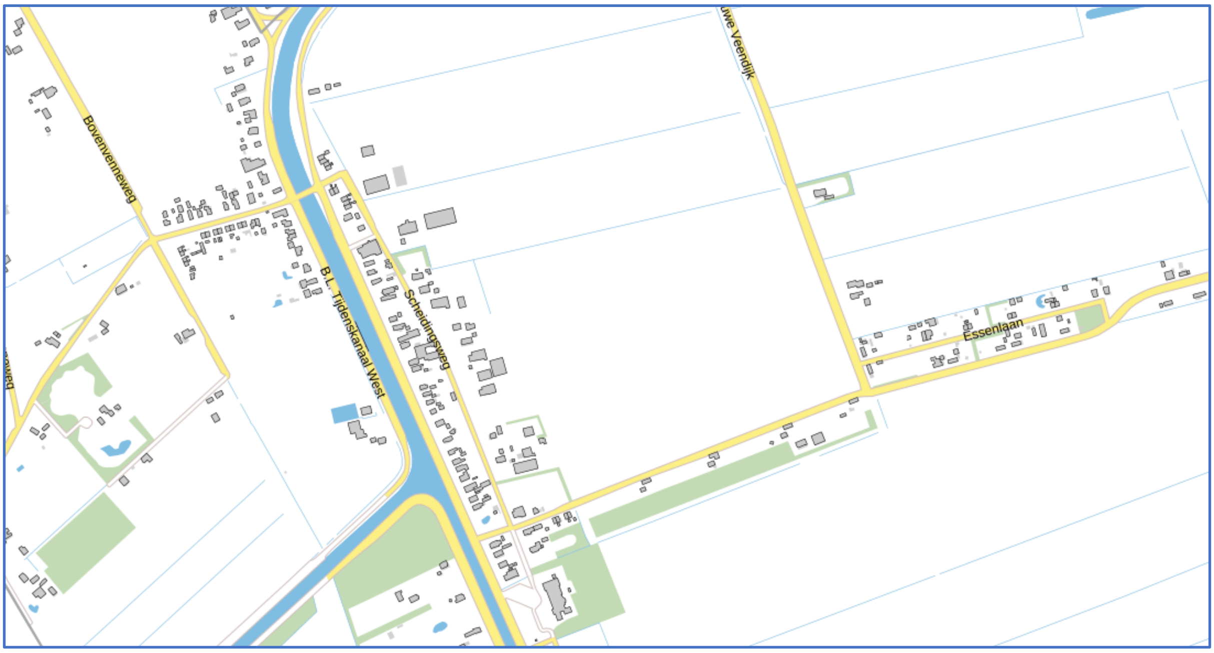

FIGURE 13: MAP OF VEELERVEEN

The Village of Veelerveen is a typical linear canal village in the Province of Groningen. The village hugs the Ruiten-Aa-channel and the B.L.-Tijdens-channel and was founded as a centre point between three bridges that cross these channels. The village is strentched in a single line with some houses dotted around in the Groninger landscape. For this case study a boundary of 336 houses was chosen within the village area. The village itself has around 725 residents, with an even mix over the age groups. The average number of residents per household is just over 2 at 2.2 residents. The goal of the case study, as given by the local energy initiative, was to find the best energy transition pathway with the lowest cost for the village that would allow an emission free village possibility at 2035.

6.1 Baseline-measure

For the baseline-measure the first step was to acquire the energy labels of the houses in the village. This has been done by acquisition of open data sources providing both actual given energy labels as well as energy label assumptions for houses without an official label. The spread of labels is visible in table 19 and figure 14. The data shows that the houses in Veelerveeen in general fall in the lowest energy label category of G. This is not unexpected as the village is an older village build slowly in the last century.

TABLE 19: ENERGY LABELS IN VEELERVEEN

Energy Label	Nr. Of houses
A+	1
A	14
B	37
C	35
D	15
E	17
F	45
G	120

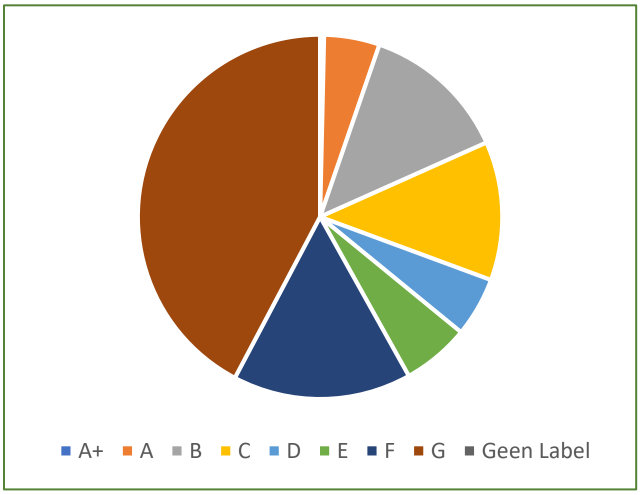

FIGURE 14: GRAPH OF ENERGY LABELS IN VEELERVEEN

The houses are for the majority detached with a couple of semidetached houses. The time of construction ranged from the '20s to the last decade, with the majority pushing '50s and '60s. This uniformity allows for a generalization of the housing types in Veelerveen and allowed for the assumption that all houses are detached and older (average age between 60-70 years). With only 33% of the energy labels being actual given labels and around 66% estimations, makes the energy label aspect less trustworthy. Yet this also opens up an opportunity for the local initiative to adapts and improve the open data by providing better data themselves.

TABLE 20: GASCONSUMPTION IN VEELERVEEN

Gas consumption	average	Total
Low	1.384 m^3	393.129 m^3
Mid	1.762 m^3	500.428 m^3
High	2.140 m^3	607.727 m^3

Taking all this into account Veelerveen the average energy consumption per household is calculated to be between 1760 m^3 and 2140 m^3 natural gas, as is visible in table 20. Comparing this to the data from CBS who has taken it from the energy companies in the area it's very much spot on. The CBS gives an average gas consumption of 2045 m^3 per household, right between the expected mid and high value of the model. The differences between low, mid and high are explained in 5.1.

When looking at the data provided by Enexis [Enexis 2020], they have the village of Veelerveen at a higher demand of around 2400 m^3 of natural gas each year per building. The difference between this and the estimations from the baseline-measure can be explained as that the chosen area of Veelerveen has been cherry picked for the baseline and is avoiding any major consumers (fo example factories, farms) within the area. With the low number of houses within the area chosen in Veelerveen, even a single large consumer could influence the measured demand of the area largely. With this in mind, the assumption is that the estimated values are correct to function for the rest of the model.

6.1.1 Emission base

For the emissions a base line was taken for the Dutch CO_2 emissions of 0.556 kg CO_2/kwh of natural gas [CBS 2018]. This amount was found to be a estimate of the amount of CO_2 emissions for standard Dutch non green electricity. Based on these numbers, the estimate total emissions for the village of Veelerveen was found to be just below 960t of CO_2 on a yearly basis.

6.2 Energy label steps

For the case of Veelerveen the choice was made to look at trying to achieve energy label B for the entire village. With most of the village hovering around the G label, this is a huge challenge for the village itself.

6.2.1 Energy demands

Looking at the energy demand after the step to a minimum energy label B within the village of Veelerveen, it shows a clear reduction in gas usage. As is visible in figure 15, the consumption of natural gas has dropped by around 25-30%. The baseline gas consumption was around 500.000 m^3 of natural gas, the new gas consumption would be estimated around 350.000 m^3 of natural gas.

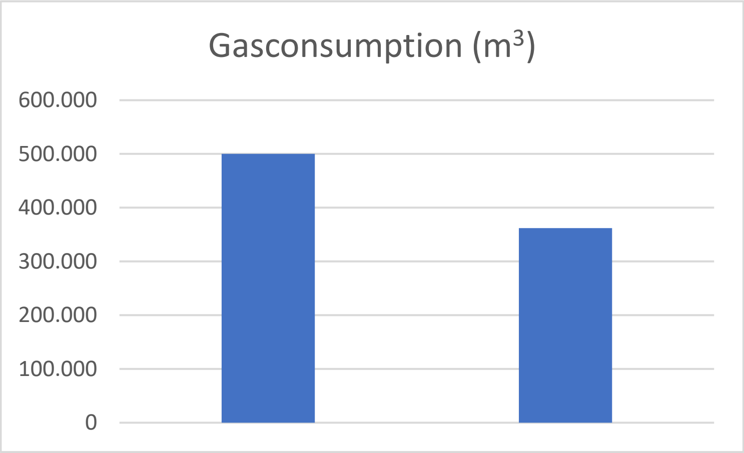

FIGURE 15 : CURRENT GAS CONSUMPTION AND POTENTIAL GAS CONSUMPTION AFTER ENERGY LABEL STEP

6.2.2 Emissions

When comparing the emissions of the village of Veelerveen before and after the potential step of insulation, it shows a similar drop compared to the drop of gas consumption. Currently the estimated emissions of the village of Veelerveen would be around 950t of CO_2 for heating the houses. When applying the new improved labels the new emissions drop by around 25-30% to 670t of CO_2. This is under the assumption nothing else changes.

6.2.3 Economic

For the energy label steps the cost increase for every step the village takes to come closer to the A+ label. As is visible in figure 16, the estimated cost of the village to reach label A+ are over 12 million euro. This would be an estimated cost for each house of around 50 thousand euro. A cost that would be outside the range of a small local energy initiative. The goal of label B, as chosen for the continuation of the model, is more achievable at just over 5 million euro. In combination with the reduction in gas comsumption, the insulation alone would have an estimated payback time of 38 years at current gas prices. This value is similar to estimations by the PBL, as in their latest report on insulation in the Netherlands [PBL 2020].

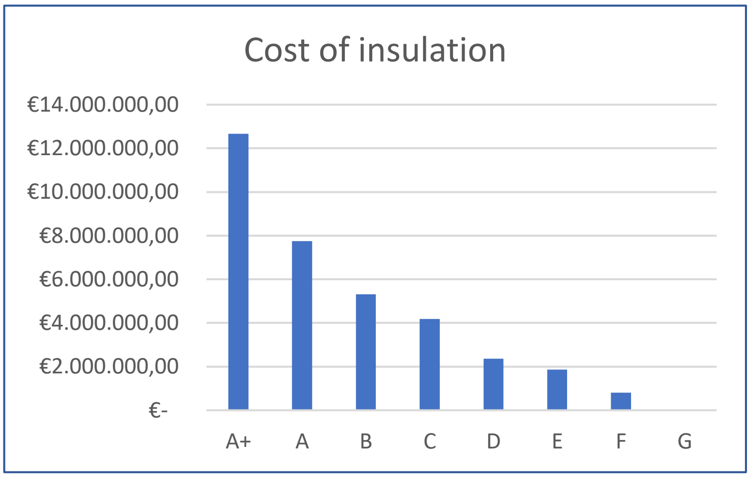

FIGURE 16: COST OF ENERGY LABEL STEPS

6.3 Heat districts

For heat districts in the area of the village of Veelerveen there are two main candidates. Waste heat or geothermal as sources of heat for the development and exploitation of a low temperature heat district.

6.3.1 Energy demands

The demand of energy for the village of Veelerveen has been determined to be around 500.000 m^3 of natural gas on a yearly basis. Taking this amount of gas and transitioning it into a source of heat would indicate a source of around 0.5 MW would be required to provide a suitable amount of energy for the village of Veelerveen. This would indicate a small geothermal source of energy or a waste heat source with a similar output of waste heat.

6.3.2 Emissions

Taking a look at the emissions of a potential heat district in the village of Veelerveen, there are two main theoretical alternatives, geothermal and waste heat. The emissions on geothermal are on 378t of CO_2 on a yearly basis, while the emissions on waste heat are around 442t of CO_2 on a yearly basis. The estimated reduction for Waste heat would be around 54% compared to the base line consumption. The comparison for geothermal comes down to a reduction of 60%.

6.3.3 Economic

When adapting the heat demand of Veelerveen to see how high the heat demand per square kilometer is, it comes to 29145 m^3 of natural gas demand per square kilometer. When comparing this to the Danish standard of 150 TJ per square kilometer, it is clear that this is far below the set standard. Therefore the economic viability of a low heat district is very low, close to zero. This does not indicate that a low heat district can’t be funded in other methods. The possibility of an economic self-sustaining heat district is not viable for Veelerveen.

6.4 Biogas

For biogas a suitable source of biomass would be required. For Veelerveen the amount of manure is very low in the region, although the potential for straw as a base source material for biogas generation would have potential.

6.4.1 Energy demands

The demand of energy for the village of Veelerveen has been determined to be around 500.000 m^3 of natural gas on a yearly basis. A biodigester would have to generate a similar amount of biogas to provide the village of Veelerveen with enough energy to supply the heat demand. An estimated 500t of straw would be required to feed into a digester to generate enough biogas for the village of Veelerveen. When pursuing a mix of 50% manure and 50% straw, there would be a need for 250t of straw and 1000t of manure. With the potential maps for biomass of the region [Energieatlas 2020], the manure would most likely not be available.

6.4.2 Emissions

Biogass based on a straw input would have a total emission of around 454 ton of CO_2 on a yearly basis. This number is based on a biogas digester based on straw input {Stimular 2016]. This results in a reduction of around 52%.

6.4.3 Economic

To adapting locally available biomass into a co-digester into biogasthe possibilities are limited to straw and cow manure as a biogas source. Cow manure is rare in the area and will therefore be a limitation on the possibilities of generating local biogas ina co-digester. The cow manure amounts are estimated between 1000 and 2000 tons of manure a year. The straw component is estimated to be between 2500 tons and 5000 tons a year for biogas generation. While the straw has potential in the area, the cow manure limitation blocks the potential of a co-digester for the generation of biogas [Energiekaart 2020, biomassapotentieel].

6.5 Heat pumps

With heat pumps the options for Veelerveen are air to water (L/W), ground to water (G/W) and water to water (W/W). The option to utilize an air based heat pump (L/L) was not deemed viable for the village of Veelerveen due to the low energy label requierment . Those pumps demand a minimum threshold of energy label B to be utilized, which is not available or suitable for the village of Veelerveen at this time.

6.5.1 Energy demands

TABLE 21: ENERGY CONSUMPTION FOR EACH HEAT PUMP

L/W	0,18 MW
G/W	0,11 MW
W/W	0,13 MW

Taking the energy demand of Veelerveen at 500.000 M^3 of natural gas each year, this can be utilized to determineto the total amount of electrical power the different pumps would require to operate if they would be utilized at the current situation. These values are visible in table 21. Therefor any renewable source of energy that would be utilized within the village of Veelerveen would have to be able to provide those amounts of power to sustain the heat demand of the village.

6.5.2 Emissions

For the heat pump pathway there have been two different emissions calculations. The first assumption is installthe heat pumps in the village of Veelerveen,utilizing the Dutch electricy net as their source of power. For this the average emissions for non green electricity in the Netherlands is utilized. This resulted in the data visible in Table 22.

TABLE 22: EMISSIONS FOR EACH HEAT PUMP POWERED BY CURRENT DUTCH ELECTRICITY MIX

Non green	reduction	CO_2 emissions (t)
L/W	19%	774
G/W	49%	482
W/W	42%	556

With L/W pumps reducing the emissions by around 19% and having a total estimated emissions of 774t of CO_2 on a yearly basis. The G/W pumps reducing the emissions by around 49% and having a total estimated emissions of 482t of CO_2 on a yearly basis. The W/W pumps reducing the emissions by around 42% and having a total estimated emissions of 556t of CO_2.

When adapting this to green energy sources, the data changes accordingly

TABLE 22: EMISSIONS FOR EACH HEAT PUMP POWERED BY CURRENT DUTCH GREEN ELECTRICITY MIX

green	reduction	CO_2 emissions (t)
L/W	92%	77
G/W	95%	48
W/W	94%	56

With L/W pumps reducing the emissions by around 92% and having a total estimated emissions of 77tof CO_2 on a yearly basis. The G/W pumps reducing the emissions by around 95% and having a total estimated emissions of 48tof CO_2 on a yearly basis. The W/W pumps reducing the emissions by around 94% and having a total estimated emissions of 56tof CO_2 on a yearly basis.

6.5.3 Economic (Solar)

The solar adaptation takes into account a full transition of the electrification of the village of Veelerveen. The first step is calculating the costs of the pumps as well as adapting the energy demand of the village from m^3 of natural gas into kWh of electric power. Once those steps have been taken the demand of the entire village of Veelerveen can then be adapted from the yearly demand to an hourly demand with the help of a heat demand profile. This allows us to see a rough estimation of heat demand at all times, allowing us to see if it matches the solar energy output and the need for a storage system.

First, a non-insulation route has been checked and is visible in table 23, showing the size of the solar field needed as well as the costs of the pomps and solar cells.

TABLE 23: COSTS SOLAR PATHWAY NO INSULATION

Without insulation	Solar cells (m^2)	Costs solar cells	Costs pomps	insulation	Storage	total
L/W	2721	€ 272.000	€ 2.840.000	-	€ 2.840.000	€ 5.952.000
G/W	1453	€ 145.000	€ 4.260.000	-	€ 2.840.000	€ 7.245.000
W/W	1775	€ 177.000	€ 4.260.000	-	€ 2.840.000	€ 7.277.000

Secondly, an insulating route has been chosen in which the village has been insulated up to the energy label B, followed by the same steps as the non-insulating route. These results are visible in table24.

TABLE 24: COSTS SOLAR PATHWAY WITH INSULATION

With insulation	Solar cells (m^2)	Costs solar cells	Costs pomps	insulation	Storage	total
L/W	2401	€ 240.000	€ 2.840.000	€ 4.333.000	€ 2.840.000	€ 10.253.000
G/W	1255	€ 125.000	€ 4.260.000	€ 4.333.000	€ 2.840.000	€ 11.558.000
W/W	1545	€ 154.000	€ 4.260.000	€ 4.333.000	€ 2.840.000	€ 11.587.000

Looking at the numbers obtained, the notion of mandatory storage comes forward. The demand for power does not match the supply of the solar cells well, therefor storage in one shape or another is required. The current storage system in the model is, on the other hand, rather large and above the potential costs of the village energy transition. This might be a weak point within the model. Even the non-insulating route with more expensive heat pumps seems to be more economically viable then the insulating route with the cheapest pump. The potential costs are most likely higher, due to the special conditions of each house.

Separating the costs by energy unit, as are visible in table 25, the picture becomes bleaker. The costs based on a runtime of 20 years for the solar cells and the storage system would result in an energy price of 33 cents per kWh for the air-water (L/W) pump with insulation. When comparing this to the average Dutch electricity price of 7 cents per kWh the difference is large. This does take into consideration that both electricity prices are stripped of any taxation and other added costs. The average price for the ground-water (G/W) and water-water (W/W) pumps are even higher.

TABLE 25: COSTS OF ENERGY IN THE SOLAR CEL PATHWAY

	With insulation /kWh	Without insulation /kWh
L/W	€ 0,33	€ 0,17
G/W	€ 0,60	€ 0,34
W/W	€ 0,52	€ 0,29

When taking away the insulation aspect the prices become closer to the current Dutch electricity price, although it would still be higher then the current prices.

6.5.4 Economic (Wind)

The wind adaptation follows a similar path to the solar adaptation, with the full electrification of the village of Veelerveen. The difference lies in the installation of a wind turbine. The assumption for Veelerveen has been made that the wind turbine will be around 90m high, have an electric power output of 3MW, and costs around 2 million. This is then tested against a route without insulation and one with insulation. The results are visible in table 26 for the without insulation route and table 27 for the insulation route.

TABLE 26: COSTS WIND PATHWAY WITHOUT INSULATION

Without insulation	windturbine	Cost windturbine	Costs pomps	insulation	Storage	total
L/W	1	€ 2.000.000,00	€ 2.840.000	€ -	€ 2.840.000	€ 7.680.000
G/W	1	€ 2.000.000,00	€ 4.260.000	€ -	€ 2.840.000	€ 6.260.000
W/W	1	€ 2.000.000,00	€ 4.260.000	€ -	€ 2.840.000	€ 6.260.000

TABLE 27: COSTS WIND PATHWAY WITH INSULATION

Without insulation	windturbine	Cost windturbine	Costs pomps	insulation	Storage	total
L/W	1	€ 2.000.000,00	€ 2.840.000	€ 4.333.000	€ 2.840.000	€ 12.013.000
G/W	1	€ 2.000.000,00	€ 4.260.000	€ 4.333.000	€ 2.840.000	€ 10.593.000
W/W	1	€ 2.000.000,00	€ 4.260.000	€ 4.333.000	€ 2.840.000	€ 10.593.000

Comparing both sets a similar pattern to the solar adaptation is visible. The insulation is the most costly aspect of the transition. The economic viability of the wind turbine is also fairly low, coming at a higher cost overall in comparison to the solar adaptation. A specific issue with the large windturbine is the overproduction compared to the total demand of the village. Selling the excess power to the national grid could be an option, although at a price of around 7 cents per kWh, it would only be a minor reduction of the total costs in comparison to the price of energy of the windmill itself.

TABLE 28: COSTS OF ENERGY IN THE WIND PATHWAY

	With insulation /kWh	Without insulation /kWh
L/W	€ 0,38	€ 0,22
G/W	€ 0,55	€ 0,29
W/W	€ 0,47	€ 0,25

Taking the alternative smaller windturbine, the issue of massive overproduction is avoided. The data for the model runs with the small EAZ windmills is visible in table 29 and 30, with and without insulation. The data shows that the windmills are cheaper, and closer to the demand of the village.

TABLE 29: COSTS OF SMALL WIND PATHWAY WITH NO INSULATION

Without insulation	windturbine	Cost windturbine	Costs pomps	insulation	Storage	total
L/W	34	€ 1.718.000	€ 2.840.000	€ -	€ 2.840.000	€ 7.398.000
G/W	20	€ 990.000	€ 4.260.000	€ -	€ 2.840.000	€ 5.250.000
W/W	23	€ 1.168.000	€ 4.260.000	€ -	€ 2.840.000	€ 5.428.000

TABLE 30: COSTS OF SMALL WIND PATHWAY WITH INSULATION

Without insulation	windturbine	Cost windturbine	Costs pomps	insulation	Storage	total
L/W	31	€ 1.532.000	€ 2.840.000	€ 4.333.000	€ 2.840.000	€ 11.546.000
G/W	18	€ 885.000	€ 4.260.000	€ 4.333.000	€ 2.840.000	€ 9.478.000
W/W	21	€ 1.038.000	€ 4.260.000	€ 4.333.000	€ 2.840.000	€ 9.631.000

TABLE 31: COSTS OF ENERGY IN THE SMALL WIND PATHWAY

	With insulation /kWh	Without insulation /kWh
L/W	€ 0,37	€ 0,21
G/W	€ 0,49	€ 0,24
W/W	€ 0,43	€ 0,22

The energy costs per kWh are also slightly lower then the costs of running the larger windmill, although the differences are minor.

6.6 Veelerveen Advice

The goal of the model was to identify a potential pathway from Veelerveel to adopt an emission free and gas free perspective on 2035 at no cost. With the economic data it is clear that non of the plans show much potential when it comes to being low cost. Each pathway has a certain cost associated with it, all higher then the envisioned perspective of the local initiative. The emissions data, as visible in figure 17 and 18, all show that even the most impactfull transitions will still have a component of emissions. With the total emissions at the current day at around 960 tons of CO_2 for the village of Veelerveen. Only the pathway of heatpumps in combination with renewable energy lowers the emissions closest to zero within the current model.

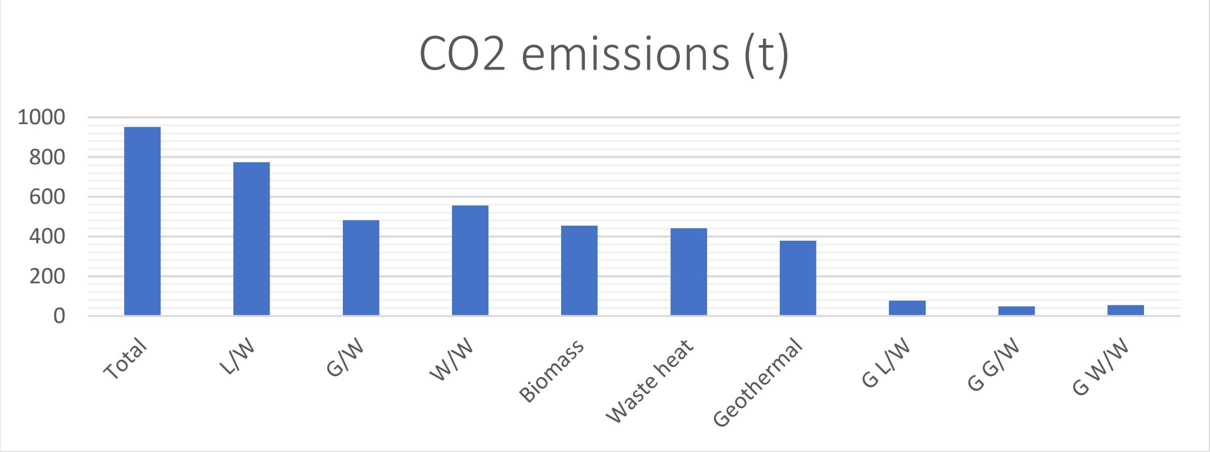

FIGURE 17: TOTAL EMISSIONS IN TONS OF CO_2

The emissions data show great potential for full electrification for the village, and combined with the economic data this pathway might be the most fruitfull endevour for the village to pursue.

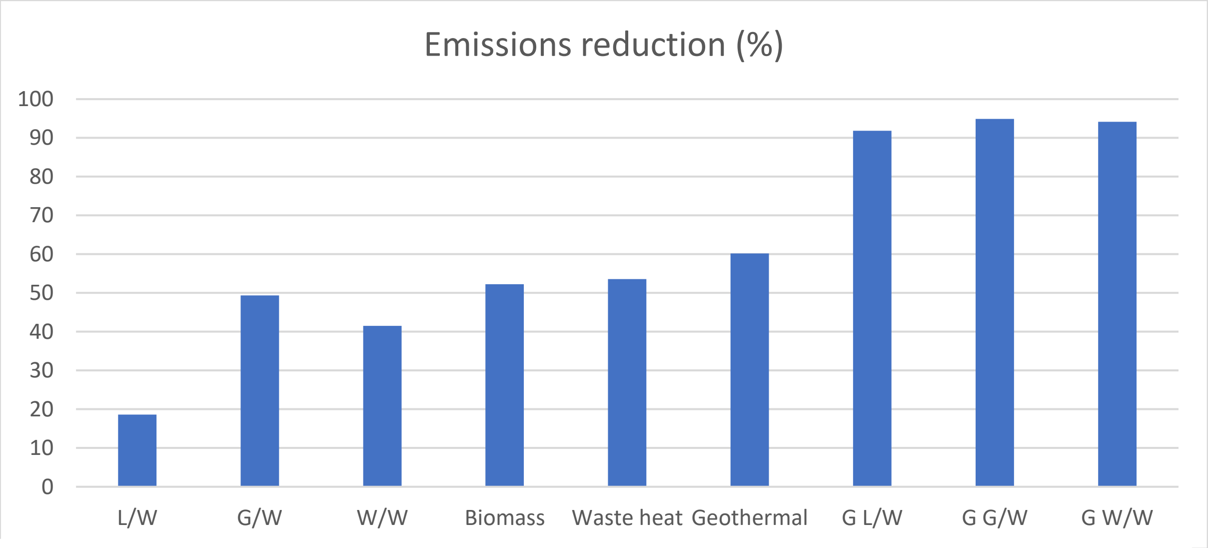

FIGURE 18: TOTAL EMISSIONS REDUCTIONS IN PERCENTAGE OF CURRENT DAY EMISSIONS

When looking at the requests of the local energy initiative, the demands were threefold. Low impact on the residents, low costs and no emissions by 2035. Combining these demands you can build a triangle graph, like figure 19, and map the regions in wich each of the pathways fall.

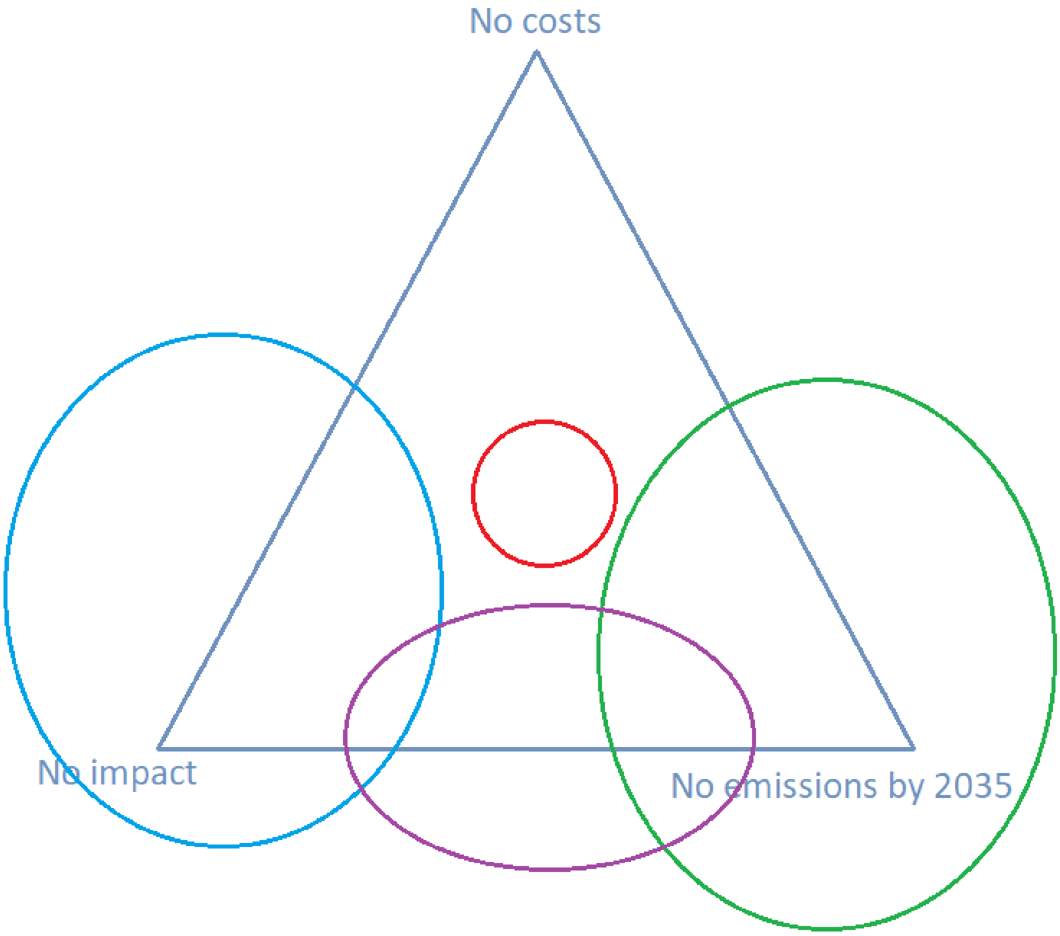

FIGURE 19: TRIANGLE GRAPH BASED ON VEELERVEEN ENERY INITIATIVE DEMANDS, MAPPING THE DIFFERENT TRANSITION PATHWAYS

Most of the pathways fall within the green and purple area. The heat pumps approach, in combination with renewable energy, comes closest to the no emissions by 2035 goal. Yet this pathway has high costs and has major impact on each of the residents when their houses need to switch towards a heat pump. Others alternatives have a higher impact, and less emissions reduction, like the biogas pathway with the potential role of manure to fullfill the demand. Overall there are no pathways that reach the goal of the red circle, although one pathway that has not been investigated within the model at this time might look fruitful. Although clear data is missing on this pathway, it might be worth investigating to see the potential of full electrification and the potential for a hybrid solution to be cheaper. One alternative not yet investigated would be the hybrid solution of combining a smaller cheaper heat pump with the current central heating system based on natural gas. This would also result in a reduction, although not as high as envisioned.

As a final note, for the electrification route, the grid capacity needs to be taken into account. The village of Veelerveen is on the border of the Netherlands, far away from major grid connections by Dutch perspectives. The local grid could potentially already be close to maximum capacity, therefor electrification of the village can potentially only be achieved in conjunction with the grid operators doing upgrades to the local grid. Although this is not certain at this moment, it is an aspect to take into consideration as it could jeopardize the entire potential of electrification.

7. MODEL COMPARISON

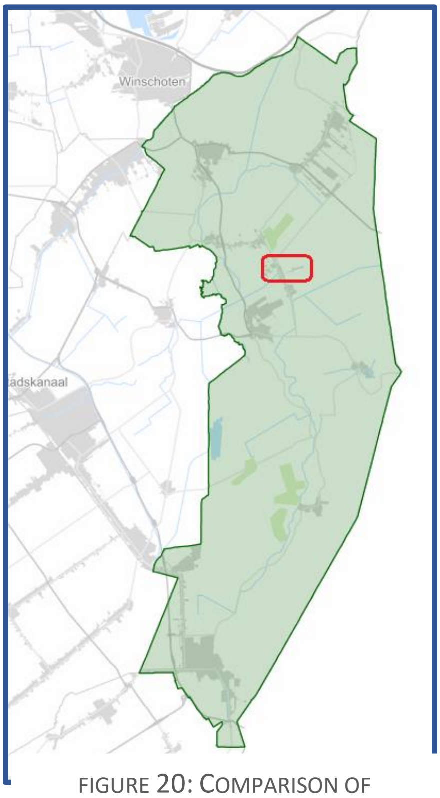

FIGURE 20: COMPARISON OF VEELERVEEN WITH WESTWRWOLDE IN VESTA MAIS

For comparison the Vesta MAIS model has been chosen, utilizing the Pico/Geodan interface of NP RES viewer. This interface allows for easier access to the Vesta MAIS model. Therefore whenever it is stated that the Vesta MAIS model has been utilized, it is through the lens of this interface.

For comparison the lowest level of interaction in Vesta MAIS has been chosen, the municipality level. Therefore the comparison between the case study of Veelerveen will have some difficulties, as the closest comparison is the municipality of Westerwolde. The difference between the two areas is visible in figure 20. To be able to make a comparison between the two models, a correction factor on the Vesta MAIS model will need to be applied. This correction factor was chosen to be based on the number of housing units within the municipality of Westerwolde [statline 2018] and the number of housing units in the chosen area of Veelerveen. This correction factor was 0.024.

First the heat demand of Veelerveen, as visible in table 32, in the model this was calculated at 17.2 TJ. In comparison, the Vesta MAIS model, with the correction, gives an estimated heat demand of 16.2 TJ. These values are in similar ranges, with an expected lower value for the corrected Vesta MAIS value. This is due to the presence of multi-storey buildings in some of the towns of the municipality, reducing the heat demand on a house to house level. The electricity demand is also very similar, with the value for the model at 3.1TJ and the corrected Vesta MAIS model at 3.07 TJ. These values are much closer, as the house types play a lesser part in calculating the electricity demand in comparison to the number of residents. As these values are comparable, the base dataset for the model was deemed suitable for future calculations. The concept of building a model based on local knowledge was therefore possible, allowing for the data to be utilized in the capacity of a quick-scan.

TABLE 32: COMPARISON OF DEVELOPED MODEL WITH VESTA MAIS

	Vesta MAIS	VM Corrected	Model
Heat demand (TJ)	675	16.2	17.2
Electricity demand (TJ)	128	3.07	3.1

8. DISCUSSION

Looking at the model a couple of limitations are visible. The model is developed for a very specific type of area. The Groninger village is generally very homogeneous with older single houses. When trying to apply the model to a more diverse area it will run into issues. Although with time this can be adapted by incorporating more information on more types of houses and implementing a separation between house types and groups.

The second issue is the energy labels. In the case study, more than 65% of the labels are an estimation. This builds an assumption on an assumption, that even with the CBS wijk en gemeente check, could become an issue of trust. Even during the development of the model, the local initiative of Veelerveen was disturbed by the data provided, causing more potential harm than good. The step for a local initiative to acquire more specific energy label data or the possibility of integrating more specific house to house energy consumption data might be very valuable to improve the model itself.

The third aspect is the collective adaptations. Those models of the model are underdeveloped and could use more in-depth analysis for future projects. The specific economic costs of building a low heat district in the Netherlands could be estimated and implemented allowing to step away from the Danish limitation number. The biogas module could allow for more specific local data to be entered and see if the supply and demand of biogas could match up.

The fourth aspect is the storage aspect of the solar and wind module. The currently used storage is too large to be useful in a real situation or be economically viable. A dashboard could be a nice integration, allowing for more interactivity with the user and increasing the ease of use for new users. Overall the model itself is a nice basis, yet could use years of improvements to become a potential tool for quick scans everywhere.

The model comparison was based on an interface that had limitations with regards to the output data of the model. These limitations did not allow for an in-depth comparison of the economic aspects of the models, raising the question of the legitimacy of the second part of the model. Therefore additional studies into the suitability of the model and it’s long term utility should be recommended. As well as improving the different modules to allow for more specific and useful data output. The development of more modules, with regards to hybrid solutions, should also be investigated as possible additions.

9. CONCLUSION

The possibility to utilize local knowledge in the shape of energy labels as well as bag data, with the possibility of small improvements with specific household energy data, was proven to be successful. The model build resulted in comparable data to the nationwide model on the data entry point of the model. Thes aspects have shown that it is possible to build a quick scan style model around the available data, allowing local initiatives to develop and make insightful decisions based on their local situations. Open data has provided a basis for the first steps, allowing for improved data and specifics to be entwined into the model once gathered and available on the local level.

Vesta MAIS has been successfully utilized, with the help of the pico/geodan interface, to show the validity of the dataset. While future steps to improve the validity of the model should be taken, the core idea of allowing open data and local knowledge to influence the baseline datasets have been proven fruitful and useful. The deviations with the data provided with Vesta MAIS was within reason and was explained by local deviations of the chosen areas, with regards to differences in housing types and styles.

The criteria of Berman, which have shown that local knowledge can improve both the decision-making process as well as the local participation within a project, have shown that local knowledge can be distilled into core concepts. These distillation into core concepts were the open data and available local knowledge of energy labels as well as bag data. This combination was fruitful in building a data set that allowed for modeling and potential construction of a quick scan of a chosen area, a Groningen village.

The model build was field-tested on the case study of Veelerveen and has shown that all possible solutions for the village are outside the parameters set by the local initiative. Either through economic limitations or availability limitations within the project. Future studies would need to be done to arrive ad a more acceptable conclusion for the local initiative, especially on the hybrid solutions. Alternatively, the concept of a hybrid gas and heat pump set-up could fit the criteria set by the local initiative, although this pathway has not yet been investigated.

Overall, the conclusion is that local knowledge is a very fruitful path of inquiry to build a quick scan type model upon. This takes both the local interest as well as the local parameters into consideration when developing a potential pathway of transition for the local energy initiative. With additional work and effort, the model could be utilized by local initiatives themselves as a guideline to help them find their pathway within the transition of the village. Limitations of the model are focused on the chosen parameters of this project. For example the limitation of deployment of the model in an alternative area that shows little similarities to a Groninger village. As well as further development of some modules of the model into giving more specific information inquiries suited for local initiatives. Furthermore, the interface as well as the presentation of information could be improved.

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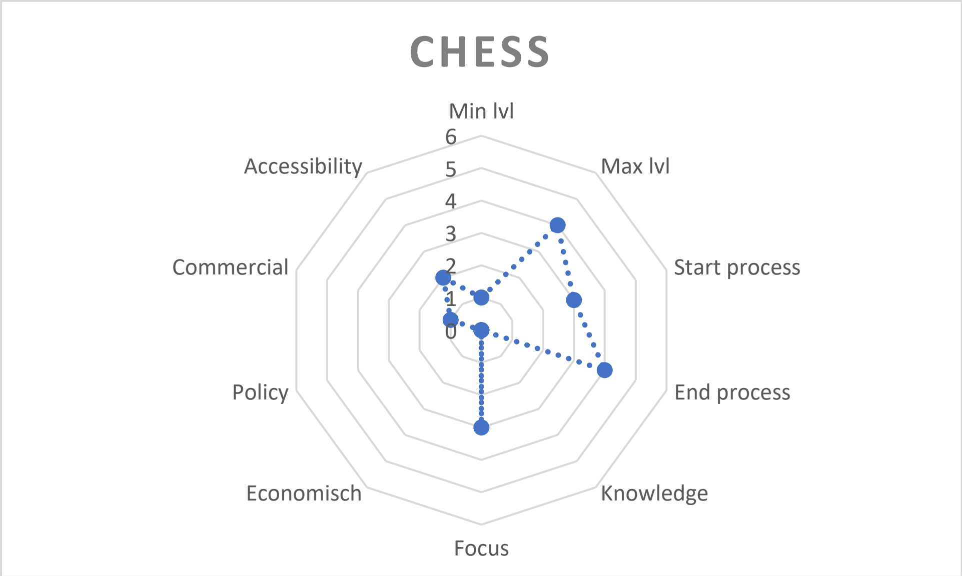
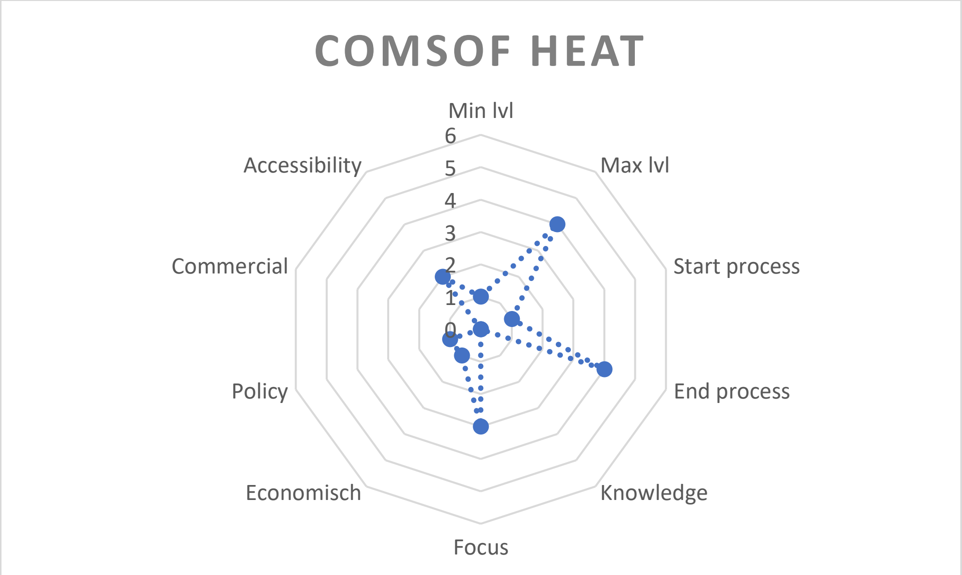
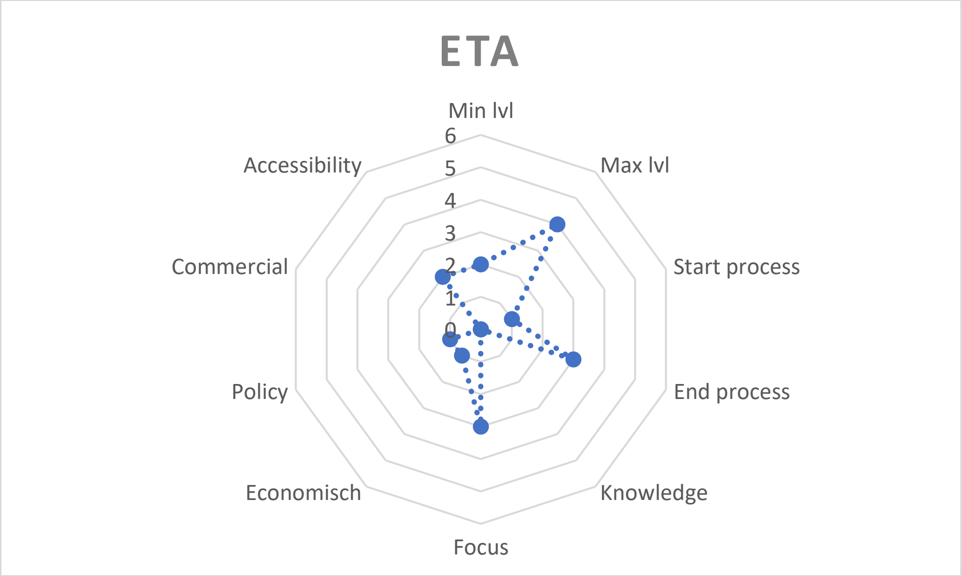
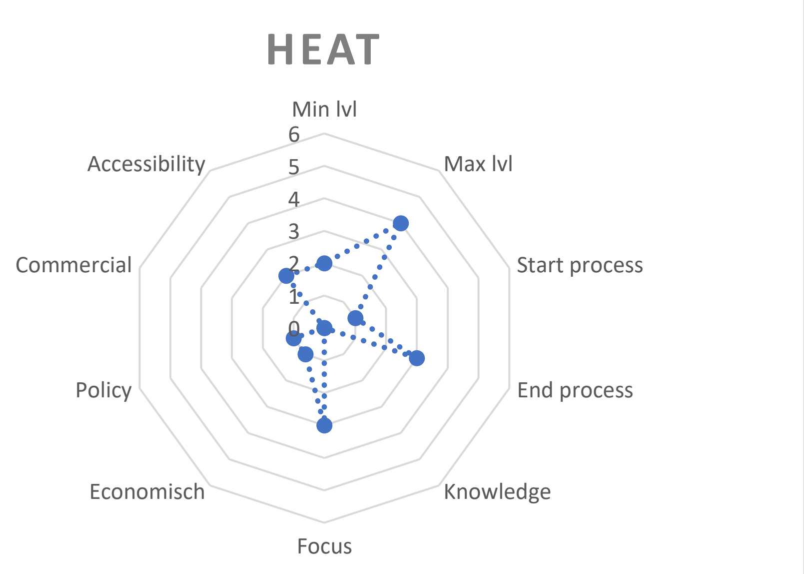
APPENDIX A: RADAR GRAPHS





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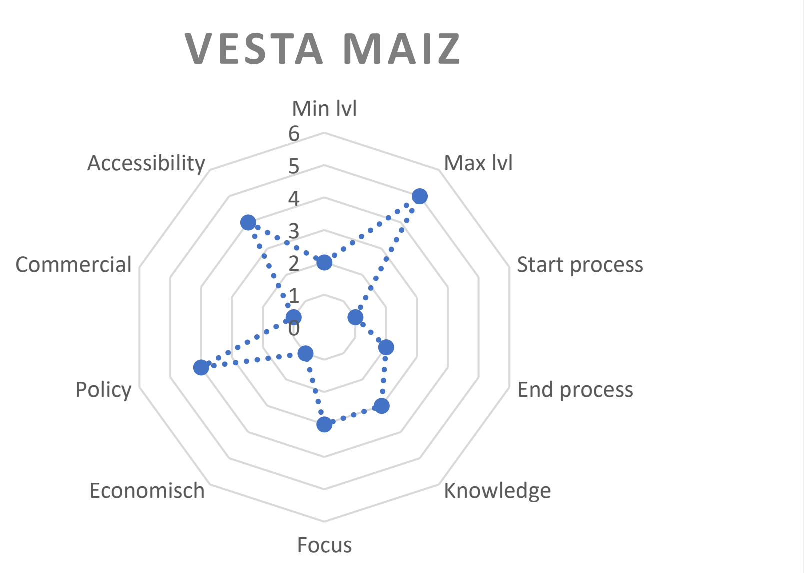
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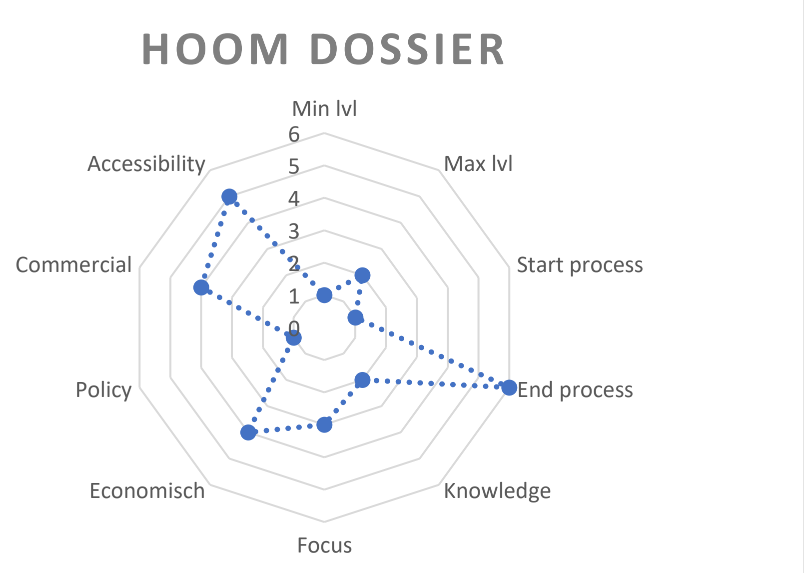
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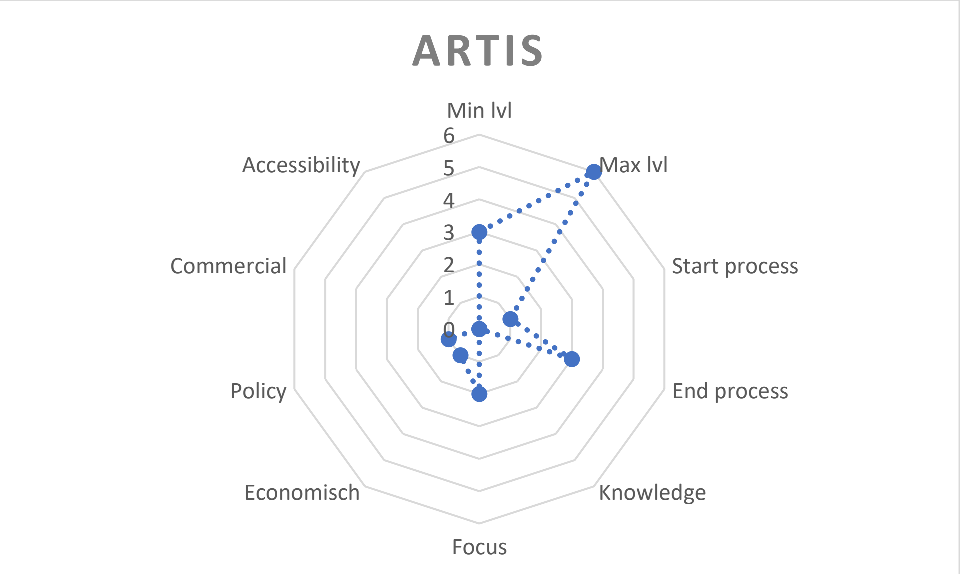
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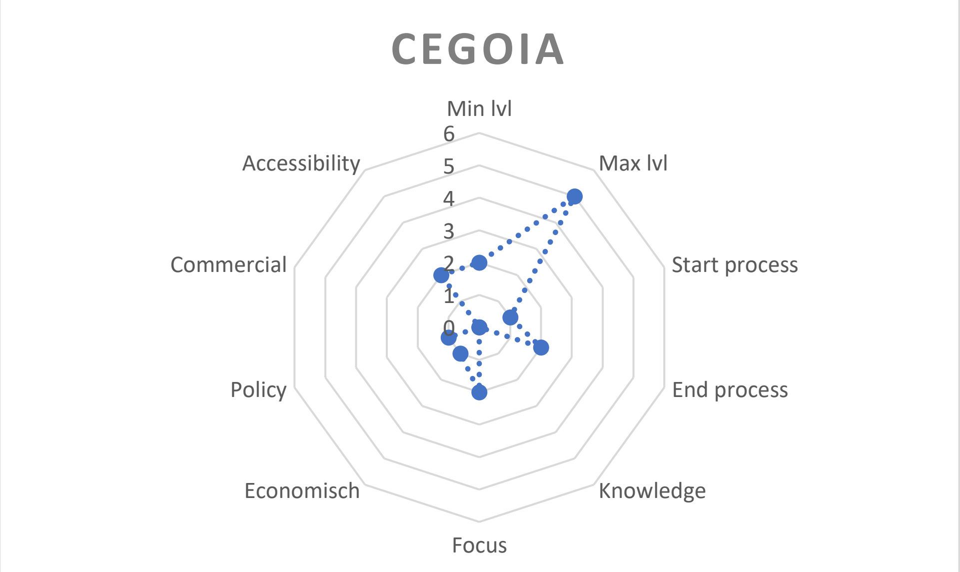
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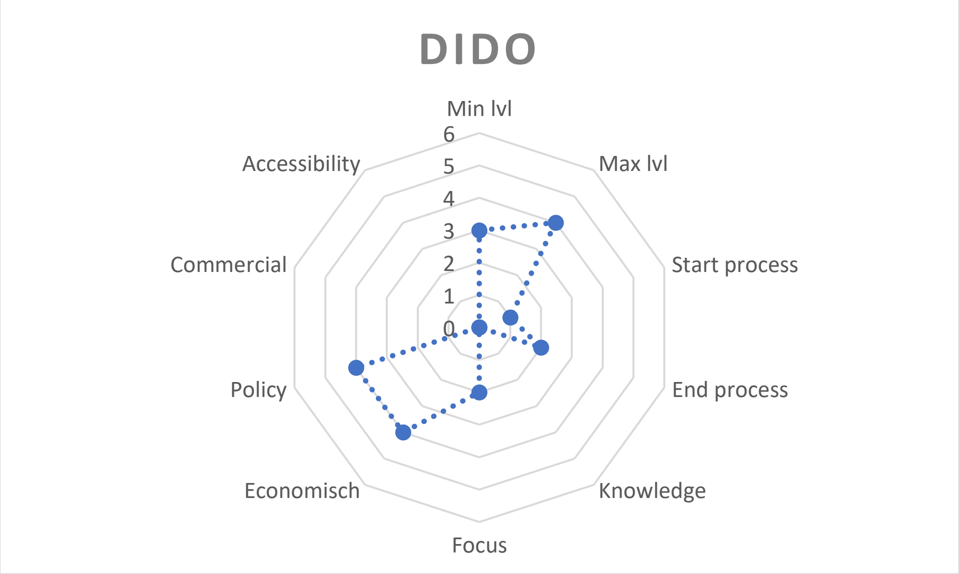
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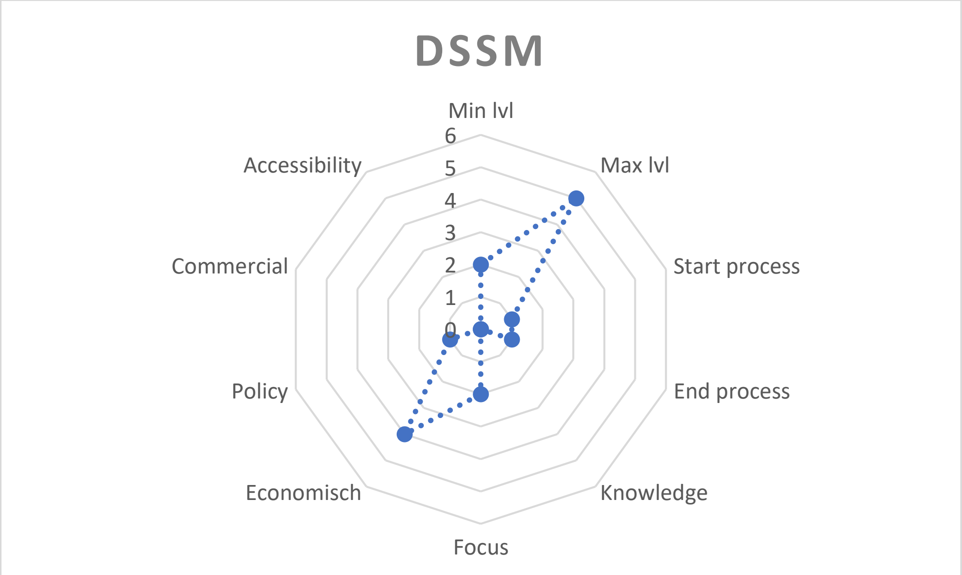

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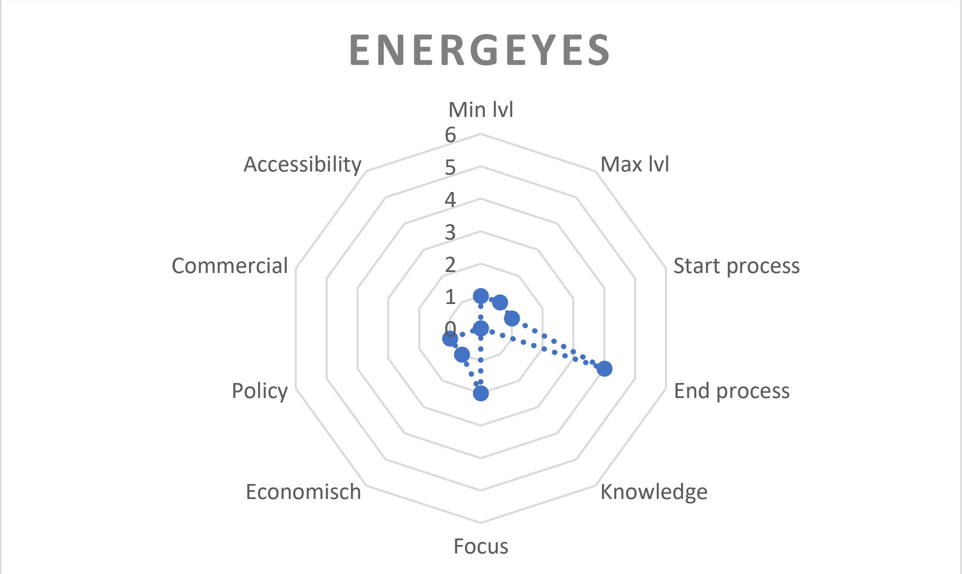

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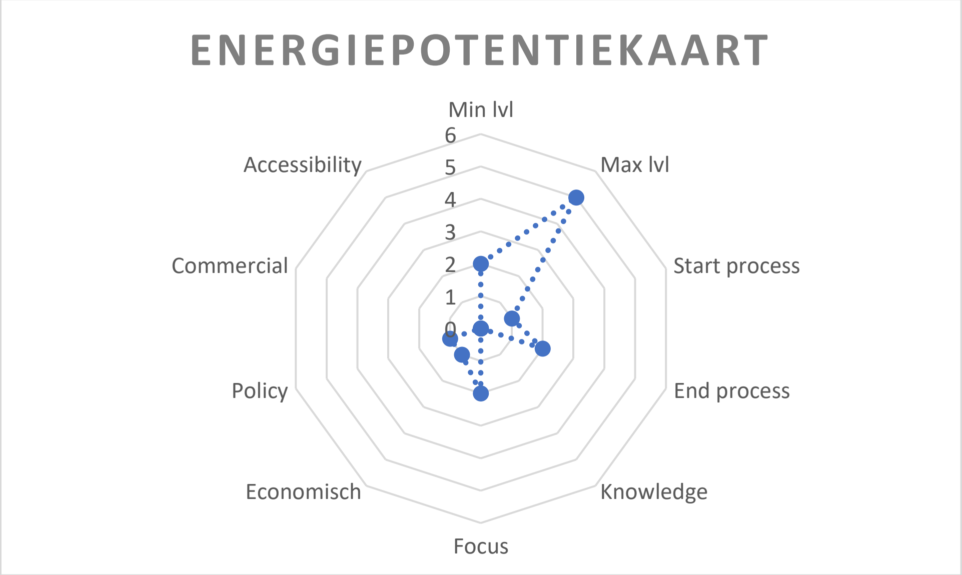

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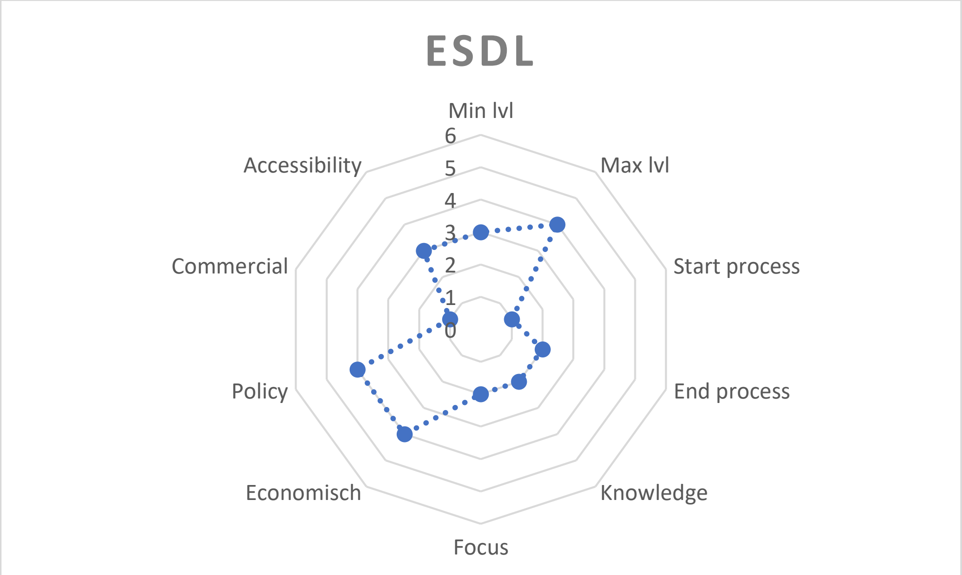
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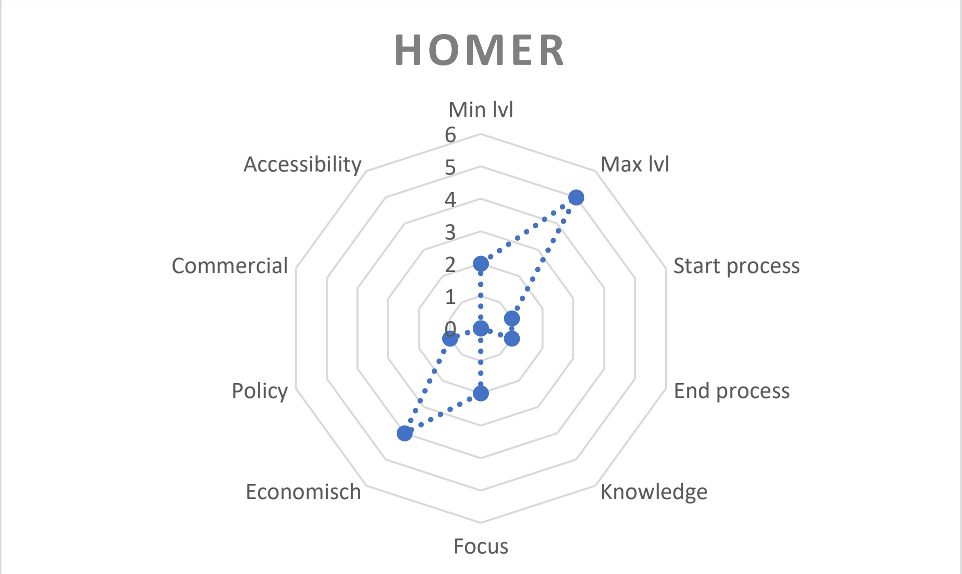
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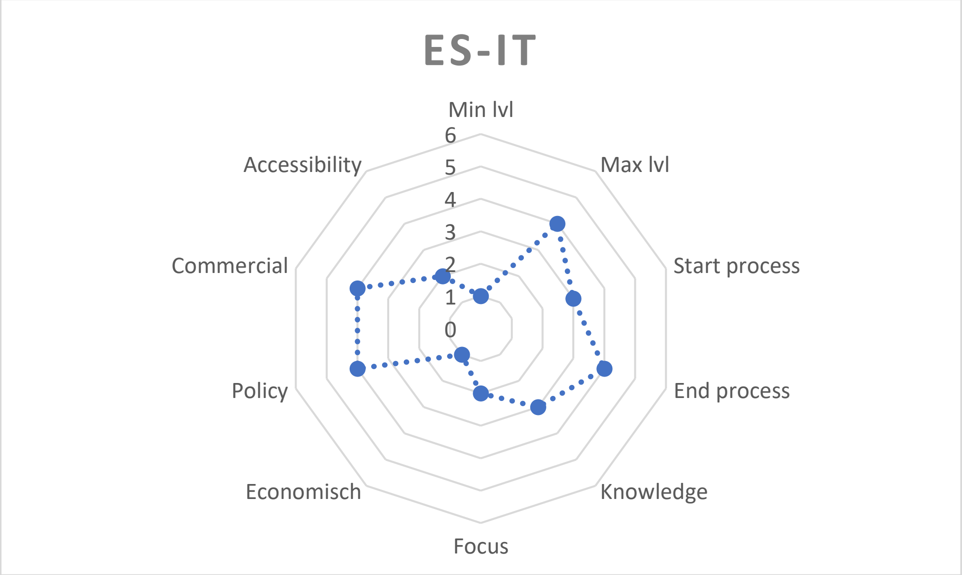
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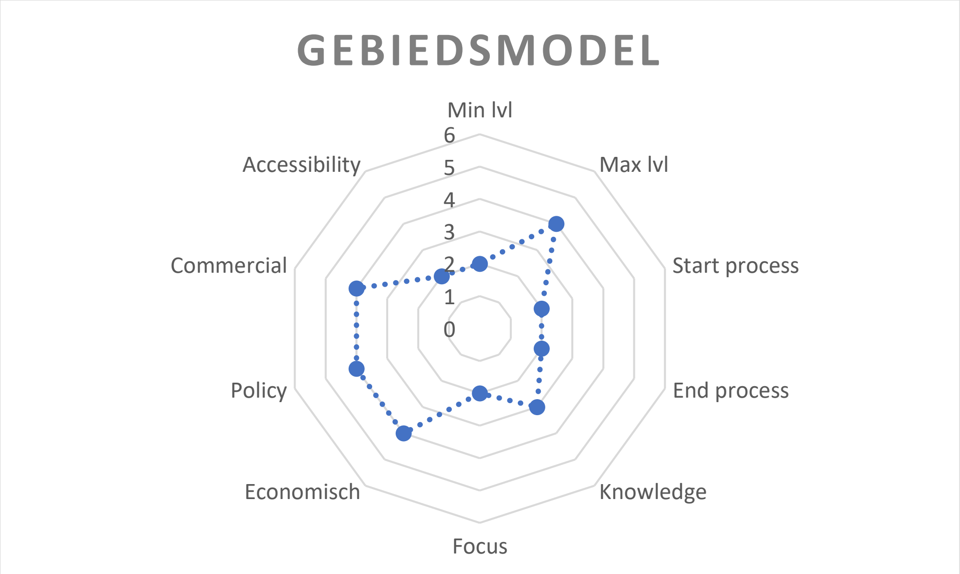
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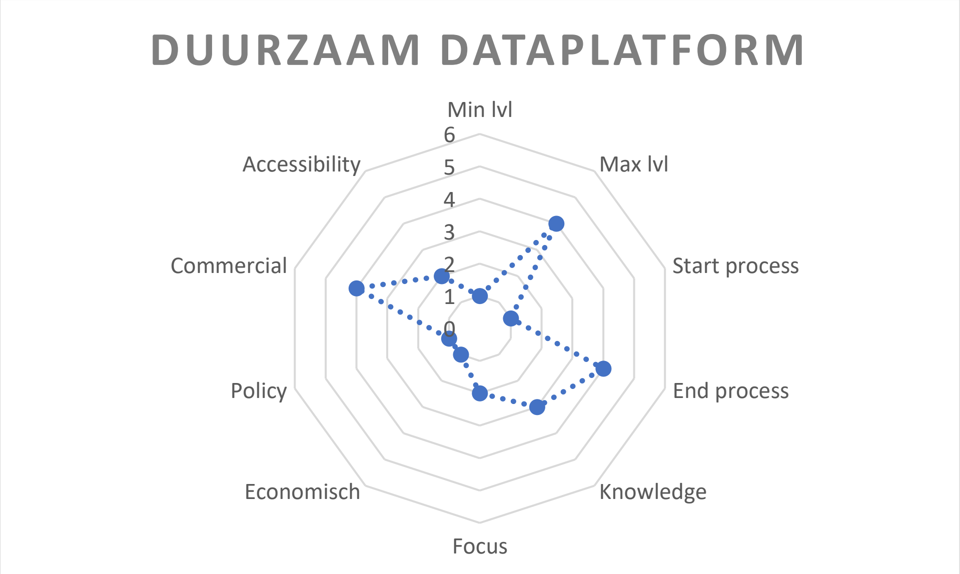
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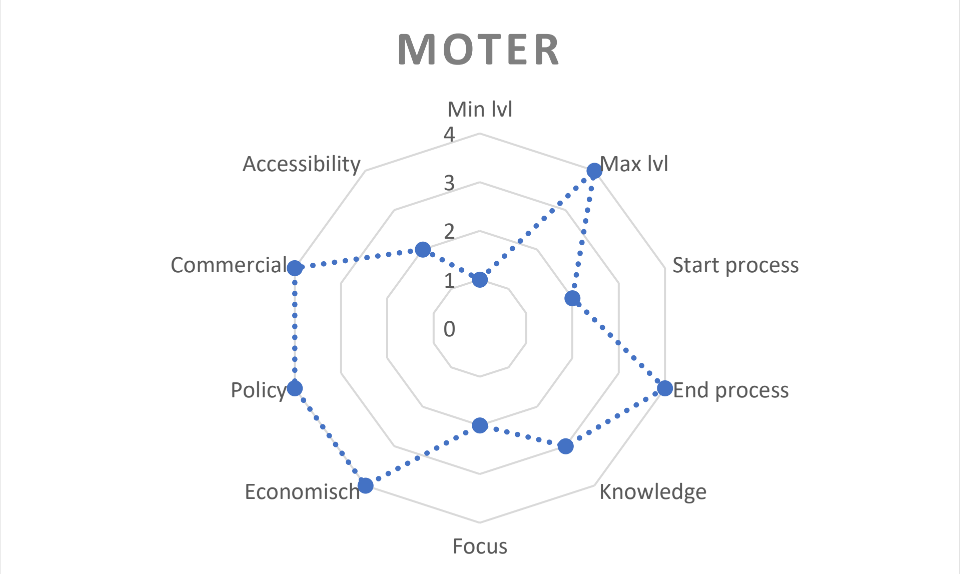
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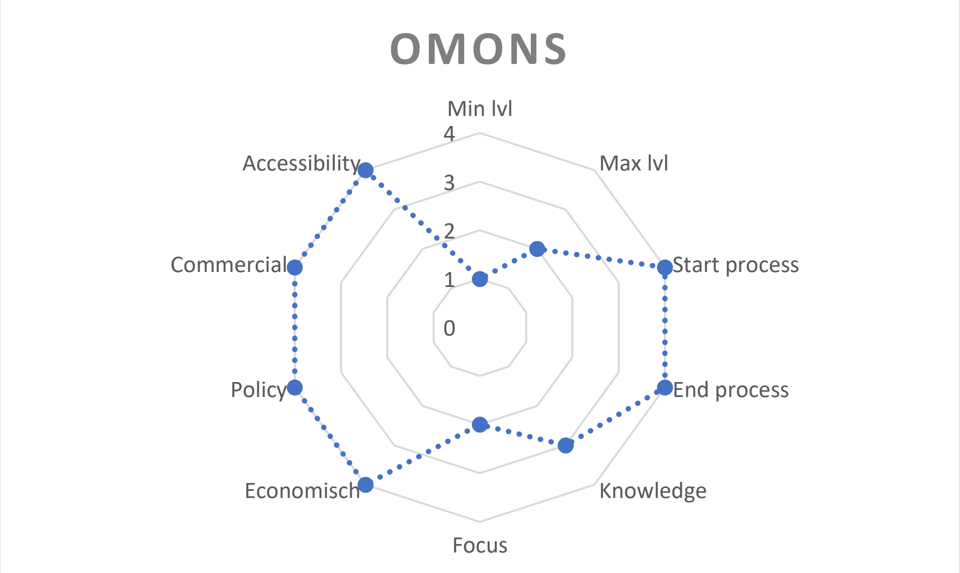
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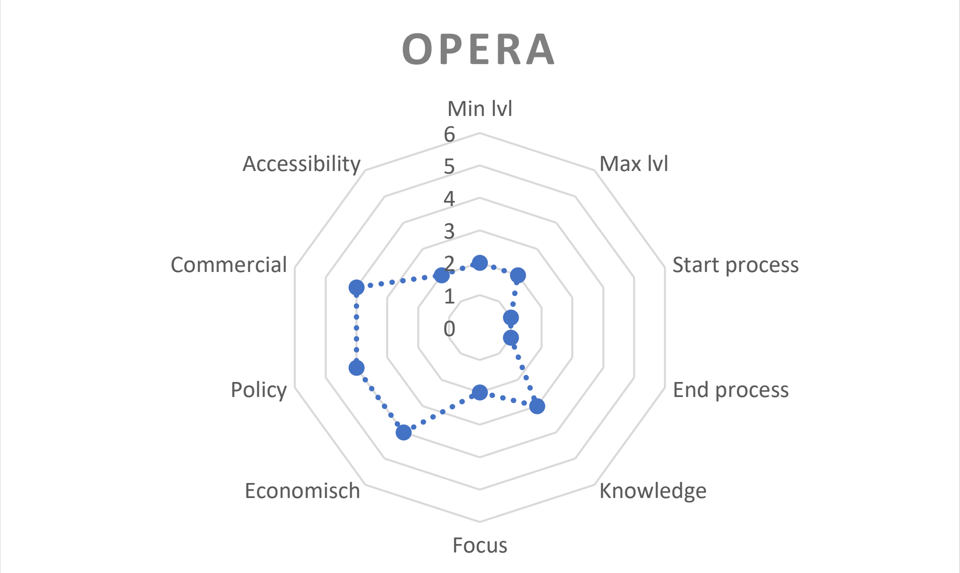
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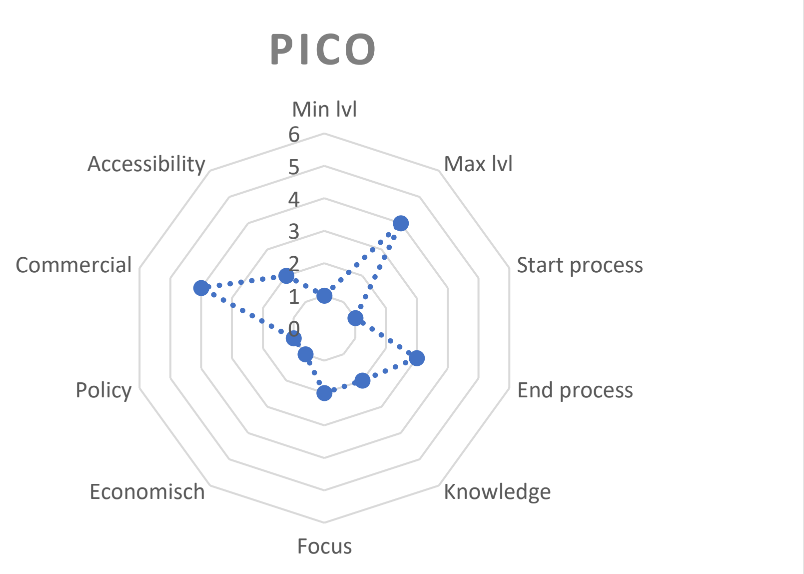
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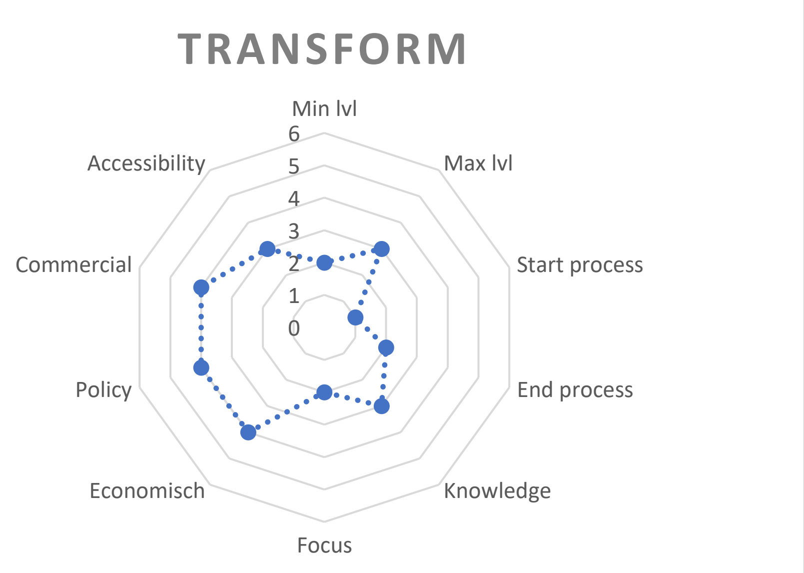
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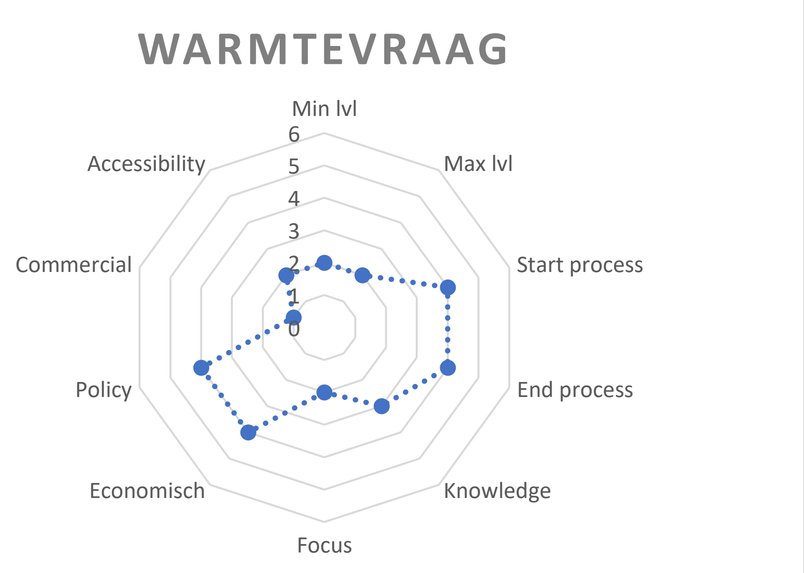
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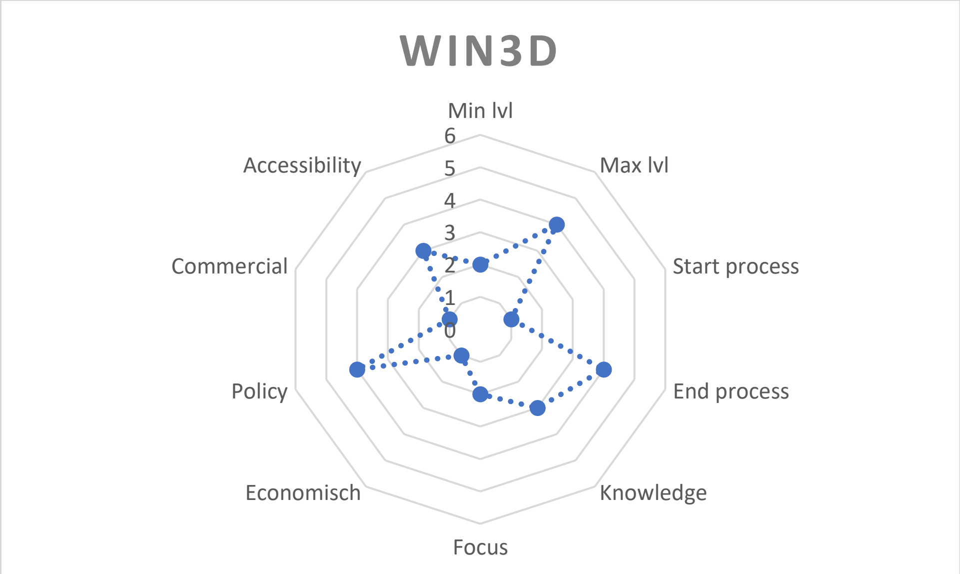
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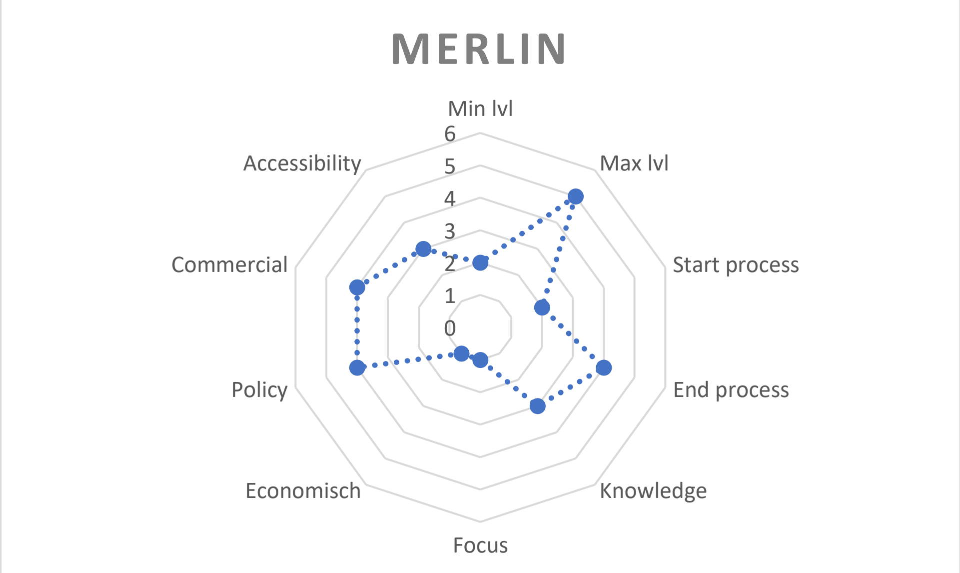
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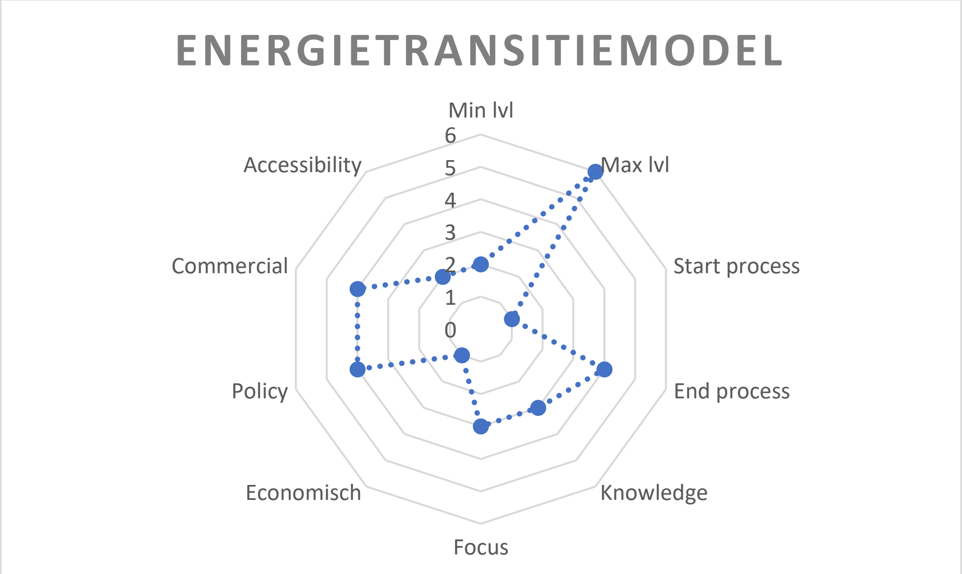
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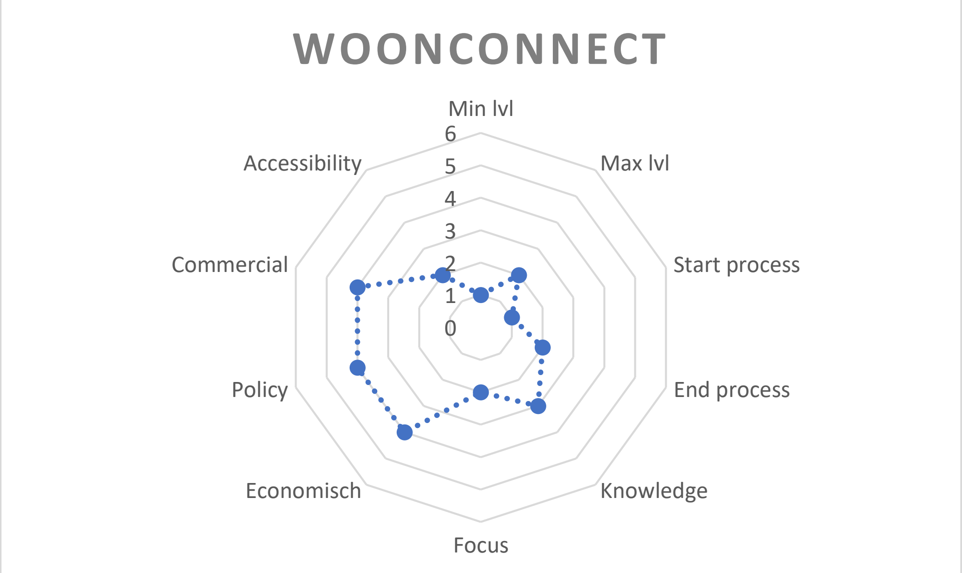
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APPENDIX B: DUTCH MANUAL OF MODEL

Handleiding Quick scan model GrEK V1.20201018

Introductie

Geachte gebruiker van het GrEK quickscan model. Als eerste stap moet er gekeken worden of het versienummer van het model overeenkomt met de versie nummer van deze handleiding. Als dit het geval is kunt u aan de slag.

Deze handleiding maakt gebruik van een stappenplan om U door het model heen te leiden. Deze stappen zijn:

Stap 1 Opzetten model, basisinformatie

Stap 2 checken en feedback

Stap 3 modules

Stap 1 Opzetten model, basisinformatie

Voor deze stap heft U maar 3 tabbladen nodig. Deze tabbladen zijn Overzicht, Individueel en Data. Overzicht is het tabblad waar alle verwerkte informatie samengevoegd wordt in een overzichtelijke bundel data met grafieken. Dit tabblad zal later ook gebruikt worden voor de terugkoppeling en checks. Individueel is het tabblad waar u op dit moment de heeste werk zult verzetten. Dit tabblad verzameld alle data van de individuele huizen in uw gebied. Deze data moet u handmatig invoeren. Het tabblad data is een verzameling van nationale data die verwerkt wordt als checks en terugkoppeling.

Nu u bekend bent met de verschillende tabbladen dient u de gegevens van de duur u gekozen gebied in te voeren in de individuele tab. De gegevens die u moet aanpassen zijn de gegevens onder de kopjes:

- Postcode
- Straatnaam
- Huisnummer
- Toevoeging
- Oppervlakte
- Functie
- Bouwjaar
- Type (indien beschikbaar)
- Energielabel
- V (voorlopig label)

De meeste van deze data zijn te verzamelen uit het BAG kadaster (https://bagviewer.kadaster.nl/), maar dit kost veel tijd. U vult de adresgegevens in en u krijgt de gewenste data voor elk adres, individueel. Deze stap levert u alle gegevens op met uitzondering van de energielabel. Deze kunt u opvragen voor elk adres op de website van de energie labels (https://www.energielabel.nl/woningen/zoek-je-energielabel/)

Met deze gegevens heft u de basisinformatie voor uw gebied in handen. Deze dienen nu alleen nog vergeleken te worden met de nationale gegevens.

Stap 2 checken en feedback

De volgende stap volgt met het invullen van de gegevens in de tab data. Hier kunt u de gegevens van de energie labels aanpassen aan de laatste data van het CBS (https://www.cbs.nl/nl-nl/achtergrond/2018/14/energieverbruik-van-particuliere-huishoudens). Daarnaast dient u de CBS data voor wijk en buurten in te voeren voor de door u gekozen gebieden. Het kan zijn dat de door u gekozen gebieden niet goed overeenkomen met de CBS gekozen gebieden, maar probeer zo veel mogelijk deze op elkaar aan te laten sluiten. (https://www.cbs.nl/nl-nl/dossier/nederland-regionaal/wijk-en-buurtstatistieken) Neem niet altijd de nieuwste data, soms lopen deze nog achter en zijn niet complete.

Met deze gegevens ingevuld kunt u naar de tab Overzicht gaan en kijken naar de basisinformatie van het door u gekozen gebied. Vergelijk de gegevens van uw gebied met die van het CBS en besluit of deze overeenkomen. Als u vragen heft hierover neem dan contact op met uw contactpersoon bij GrEK.

Stap 3 Modules

In de modules de verschillende mogelijkheden worden bekeken waarbij de eerder ingevoerde data als basis wordt genomen. De modules volgen een simpele constructie. Het groene gebied geeft resultaten. Het rode gebied geeft invoer opties. Het gele gebied is waar de data verzameld wordt en verwerkt. Incidenteel kan het zijn dat ook in de gele gebieden data ingevoerd dient te worden.

Module: Isolatie

In deze module de isolatie mogelijkheden en kosten worden berekend. De gegevens voor de verschillende energielabel stappen zijn al ingevoerd. In het kopje energielabel is de mogelijkheid om een minimum label te kiezen waar alle huizen binnen het gebied naar opwaarderen. De gasverminderingscorrectie is een correctie om de gegevens van de verbruiksvermindering en CBS-data beter op elkaar aan te laten sluiten. De optie alleen woningen geeft de optie om alle niet woningen uit te sluiten van de isolatie stap.

Module: Power individueel

In deze module wordt de basis gelegd voor een gehele elektrificatie van de door u gekozen gebied. Hierin wordt de aanname genomen dat binnen het gebied alle woningen naar één (van drie) specifieke warmtepomp overstappen. De keuzen zijn Lucht-water, water-water en grond-water. De verschillende kosten, zowel laag als hoog kunnen hier ingevoerd worden. Ook de SPF-data kan hier ingevoerd worden. Verder kan de levensduur van de pompen ingevoerd worden als mede de efficiency van de huidige cv-ketels binnen het gebied. Dit geeft dan een overzicht van de totale koste voor het gebied.