Sustainable Heating:

Comparing Dutch and German Policies

Master's Thesis Environmental and Infrastructural Planning

Egbert Hofstra

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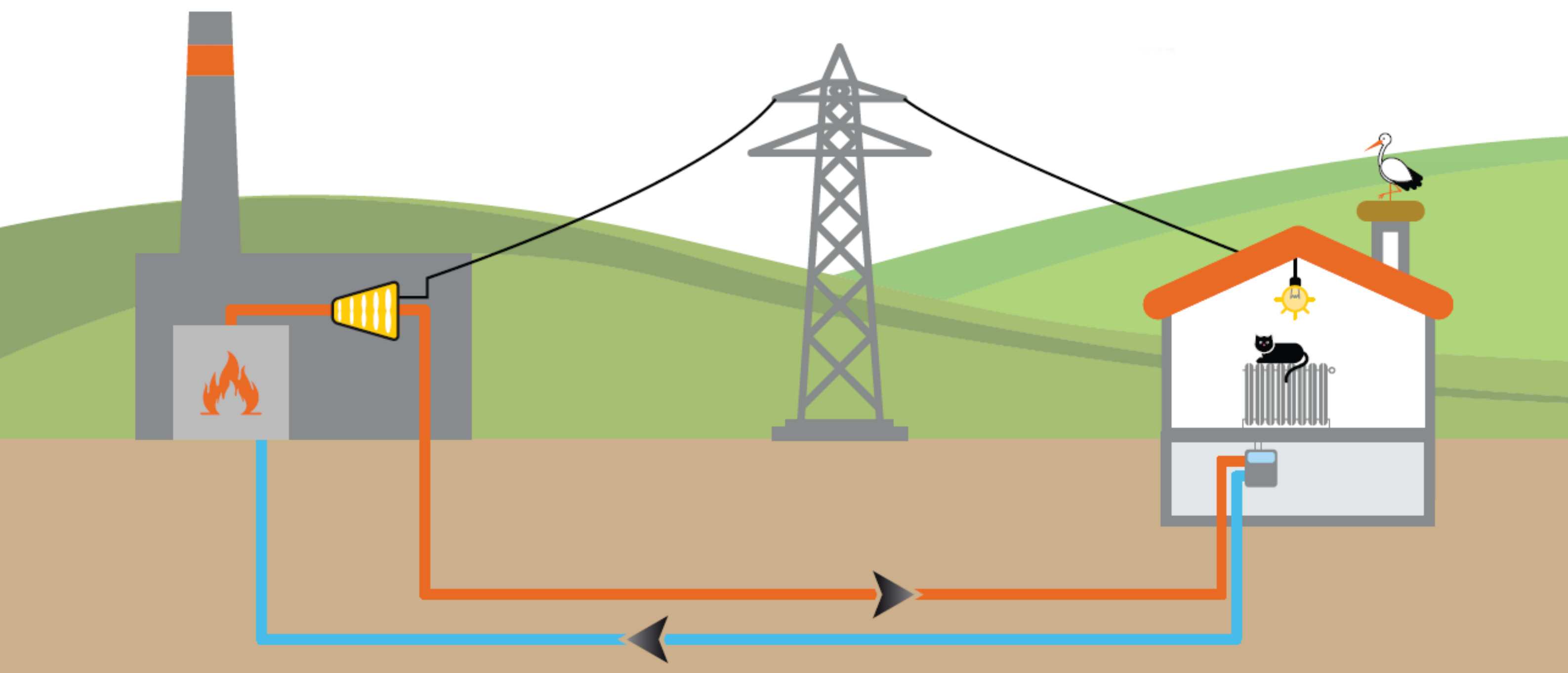

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University of Groningen

Faculty of Spatial Sciences

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Preface

This thesis was written to obtain my degree of Master of Science in the field of Environmental and Infrastructural Planning at the University of Groningen. The master's program was the logical choice after obtaining my Bachelor of Science degree in *Technische Planologie*.

For a long time I have been interested in energy issues. In my view it has become increasingly problematic to continue using fossil fuels. There are a lot of problems concerning the use of these fuels, ranging from climate change to supply security to external security and ever increasing high prices.

A solution can be found in adopting more sustainable heating systems. After all, energy demand for heating spaces in homes, offices and businesses is a large part of the total energy demand. Some countries are more advanced in this regard than others, for various reasons. In this thesis I intend to compare the Dutch and German situations. Perhaps it is possible to learn from each other and if not what are the obstacles to do this? By writing this thesis I hope to help improve the prospects for a transition to a more sustainable heating system.

PhD student Ferry Van Kann and professor Paul Ike have extensively aided me in this endeavour. My thanks go first and foremost to them. I would like to thank them in particular for their professional insights, their swift and useful feedback and last but not least their patience when it took some time to write new texts.

For their unwavering support I would also like to thank my parents. It was not always easy to write this thesis but in the end I managed to pull through. They convinced me more than once to just carry on and eventually the thesis would be completed.

Stadskanaal, August 2012

Egbert Hofstra

Summary

Society is confronted by three major global crises. These are the climate, food and energy crises. These are closely linked. Energy can be defined as the ability of a physical system to perform work. There are many different energy needs in a society. These are among others electricity generation, transportation, industrial processes and heating or cooling needs of households and businesses.

There are some serious problems associated with energy use. These vary from local to global scales. The burning of fossil fuels causes air pollution, especially in the case of coal. Soil and water pollution is also a problem. Besides pollution there is also the question of the increased greenhouse effect which is widely believed to lead to global warming through emission of carbon dioxide. This chemical is produced in all burning of fossil fuel. There are also external security issues, landscape issues in case of open pit mining and supply security issues.

Around 40% of energy is used for heating spaces (Agentschap NL, 2010). Because of this it makes sense to tackle this part of energy use and make it more sustainable. This thesis was about making heating systems more sustainable.

Sustainable development can be defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). For the scope of this thesis the author makes use of a practical approach to this. This approach is called the Trias Energetica. It involves three stages, namely energy saving, using sustainable energy sources and using fossil fuels as efficiently as possible. In the case of heating this can be operationalized as insulation in stage one, using solar collectors, biofuels and geothermal heat in stage two and using waste heat in stage three. For every specific set of circumstances of a locality a custom mix between these stages should be chosen.

In this thesis Dutch and German policies regarding sustainable heating are discussed and compared. Germany has a good reputation in the field of sustainable energy and it was thought that both countries could learn from each other’s policies. In order to compare the countries, the author uses a SWOT analysis. It is used to identify internal Strengths and Weaknesses and external Opportunities and Threats.

Both Germany and the Netherlands have a law about heating, but the laws are very different. The Dutch one, which has not been implemented yet, mainly focuses on consumer rights while the German one puts forward clear obligations for buildings. Buildings have to have a certain number of sustainability measures. German strengths are a high number of jobs and expertise in the sustainable energy sector, a familiarity with district heating, a proficient sector trade association and local utility works. In the Netherlands an important advantage is the dense urban population density and cities are also densely clustered. In contrast an extensive natural gas network, inconsistent government policies and low government investments are holding back the development of sustainable heating in the Netherlands. It is also important to note the role of fossil fuel prices. As these prices are rising so is the profit from selling natural gas. This profit is a large source of Dutch national revenue, with an order of magnitude of billions of euros. This reduces the incentive for the national Dutch government to increase the share of sustainable energy. This would lead to smaller profits. Germany on the other hand has to import most of its energy. Here the fossil fuel prices have the opposite effect. It can be said there is a lock-in situation concerning fossil fuels in the Netherlands caused by a colonial heritage leading to the founding of the Shell company and the presence of large natural gas reserves. In contrast in Germany the focus has historically been more on technological innovations to alleviate energy problems.

German policies could be transferred to the Netherlands. Considering similarities in culture, language and geographical proximity this should be feasible. However there are numerous obstacles to achieve this, these obstacles may proof formidable. The German regional state governments have more power than their Dutch counterparts. This is because Germany is a federation and the Netherlands is a unitary state. Dutch lock-in when it comes to fossil fuel is also an obstacle. Furthermore in the Dutch political constellation it is remarkable that liberal parties play a more important role and green parties a less important role than in Germany. The geographical scope of Dutch energy companies is also different. They operate internationally and have recently been acquired by foreign owners, reducing the influence the Dutch public sector has on them. In Germany local citywide utility companies provide energy services. These companies are owned by the city itself. Operating locally, they are aware of the local situation and can act accordingly. This makes them more suitable to adapting to sustainable heating. Ironically it could be said that the European Union's liberalization of the energy market -or at least the Dutch implementation thereof- which has led to Dutch energy companies moving away from the public sphere, is holding back the EU's policy of increasing the share of sustainable energy. Lastly the fact that energy use is so closely linked with the economy does not help. Energy affects the entire society from mobility to industry and from heating to agriculture. This makes a transition to sustainable energy complex.

Nevertheless the author makes some recommendations to improve the Dutch situation. The first one is to start building a heating network where it is most cost-effective. In practice this comes down to areas where there is supply available in the form of waste heat and demand in the form of households and greenhouse agriculture. This can be done in the Rotterdam-The Hague area, in Limburg, near Arnhem-Nijmegen and around Amsterdam. Of course it can also be done at other places, but the author believes it is most cost-effective to start here. Secondly, re-establish local energy companies. Recent public aversion to neo-liberal politics can help to convince politicians to do this. Finally the European Union should set more ambitious goals accompanied by binding and specific plans. There are goals in place for 2020 but that is not very far away. A comprehensive European strategy could involve for instance increasing the use of solar power in southern Europe. This could also give a boost to these countries' economies which have been hit hard by the financial crisis.

Samenvatting (Dutch summary)

De maatschappij wordt geconfronteerd met drie wereldwijde crises. Deze zijn de klimaat-, voedsel- en energiecrisis. Deze zijn nauw met elkaar verbonden. Energie kan worden gedefinieerd als het vermogen van een fysiek systeem om arbeid te verrichten. Er zijn veel verschillende energiebehoeften in een maatschappij. Deze zijn onder andere elektriciteitsopwekking, transport, industriële processen en verwarmings- of koelingsbehoeften van huishoudens en bedrijven.

Er zijn verscheidene ernstige problemen die samenhangen met het gebruik van energie. Deze variëren van lokale tot globale schaal. Het verbranden van fossiele brandstoffen veroorzaakt luchtvervuiling, vooral in het geval van steen- en bruinkool. Bodem- en watervervuiling is ook een probleem. Behalve vervuiling is er ook de kwestie van het vergrote broeikaseffect dat over het algemeen verantwoordelijk wordt gehouden voor klimaatverandering door de emissie van koolstofdioxide. Deze stof wordt geproduceerd in alle verbrandingen van fossiele brandstof. Er zijn ook zorgen over de externe veiligheid, aantasting van het landschap vooral in het geval van dagbouw en problemen met leveringszekerheid.

Rond 40% van de gebruikte energie wordt besteed aan het verwarmen van ruimtes (Agentschap NL, 2010). Hierom is het verstandig dit gedeelte van het energiegebruik aan te pakken en het duurzamer maken. Deze scriptie gaat over het duurzamer maken van verwarmingssystemen.

Duurzame ontwikkeling kan worden gedefinieerd als “ontwikkeling die in de behoeften van de het heden kan voorzien zonder het vermogen van toekomstige generaties om in hun eigen behoeften te kunnen voorzien te ondermijnen.” (WCED,1987). Voor het bereik van deze scriptie maakt de auteur gebruik van een praktische benadering van duurzaamheid. Deze benadering wordt de Trias Energetica genoemd. Deze behelst drie stappen, namelijk energiebesparing, het gebruik maken van duurzame energiebronnen en het zo efficiënt mogelijk gebruik maken van fossiele brandstoffen. In het geval van verwarming kan dit geoperationaliseerd worden door isolatie in stap één, het gebruik van zonnecollectoren, biobrandstoffen en geothermale warmte in stap twee en het gebruik van restwarmte in stap drie. Voor elke specifieke situatie, omstandigheden en locatie is het van belang een op maat gemaakte mix van deze drie stappen te kiezen.

In deze scriptie wordt het Duitse en Nederlandse beleid met betrekking tot duurzame warmte besproken en vergeleken. Duitsland heeft een goede reputatie op het gebied van duurzame energie en het idee is dat Nederland en Duitsland van elkaars beleid kunnen leren. Om de landen te kunnen vergelijken gebruikt de auteur een SWOT-analyse. Deze wordt gebruikt om de interne Strengths and Weaknesses -Sterktes en Zwaktes- en externe Opportunities and Threats -Kansen en Bedreigen- te inventariseren.

Nederland en Duitsland hebben beide een wet over warmtevoorziening, maar de wetten zijn heel verschillend. De Nederlandse, die nog niet in werking is getreden, richt zich vooral op de rechten van consumenten terwijl de Duitse duidelijke verplichtingen stelt aan nieuwe gebouwen. Deze moeten een bepaald aantal duurzaamheidsmaatregelen hebben.

Duitse sterke punten zijn een groot aantal banen en expertise in de duurzame energiesector, bekendheid met stadsverwarming, een kundige branchevereniging en lokale nutsbedrijven. In Nederland is een sterk punt de hoge bevolkingsdichtheid in steden en de steden liggen ook dicht bij elkaar. In tegenstelling tot Duitsland werken het uitgebreide aardgasnetwerk, inconsequent overheidsbeleid en lage overheidsinvesteringen de ontwikkeling van een ontwikkeling van duurzame warmtesystemen tegen. Het is ook belangrijk om de rol van de prijs van fossiele brandstoffen op te merken. Door het stijgen van deze prijzen, stijgt ook winst voor de Nederlandse schatkist door de verkoop van aardgas. Dit is een belangrijke bron van inkomsten in de orde van grootte van miljarden euro's. Dit vermindert de prikkel voor de Nederlandse overheid om het aandeel van duurzame energie te vergroten. Dit zou immers tot kleinere winsten leiden. Aan de andere kant moet Duitsland het grootste gedeelte van haar energie importeren. Hier heeft de prijs van fossiele brandstoffen het tegenovergestelde effect. Er kan gesteld worden dat er in de Nederlandse situatie sprake is van een lock-in met betrekking tot fossiele brandstoffen veroorzaakt door de koloniale erfenis, die leidde tot de oprichting van Shell, en de aanwezigheid van grote aardgasvoorraden. Duitsland daarentegen heeft zich meer gericht op technologische innovaties om energieproblemen te verlichten.

Duits beleid zou kunnen worden overgezet naar Nederland. Gezien de overeenkomsten in taal en cultuur en de geografische nabijheid zou dit haalbaar moeten zijn. Maar er zijn veel obstakels om dit te bereiken. Deze obstakels zouden wel eens onoverkomelijk kunnen zijn. De Duitse regionale overheid heeft meer macht dan haar Nederlandse tegenhangers. Dit komt omdat Duitsland een bondsstaat is en Nederland een eenheidsstaat. De Nederlandse lock-in situatie is ook een obstakel. Verder is het opmerkelijk dat in het Nederlandse politieke landschap liberale partijen een belangrijkere rol spelen en groene partijen een kleinere rol spelen dan in Duitsland. Het geografische bereik van Nederlandse energiebedrijven is ook anders. Ze opereren internationaal en zijn recentelijk overgenomen door buitenlandse eigenaren. Dit verkleint de invloed die de Nederlandse publieke sector op ze heeft. In Duitsland voorzien lokale stadsnutsbedrijven in energie. Deze bedrijven zijn eigendom van de stad zelf. Omdat ze lokaal opereren, kennen ze de lokale situatie en kunnen overeenkomstig handelen. Dit maakt ze meer geschikt om aan zich aan duurzame warmtevoorziening aan te passen. Ironischer wijze kan gezegd worden dat het Europese liberaliseringsbeleid voor de energiemarkt - of in elk geval de Nederlandse toepassing hiervan- het Europese doel om het aandeel duurzame energie te vergroten, tegenwerkt. Door de liberalisering zijn immers de energiebedrijven uit de publieke sector verdwenen. Tot slot helpt het feit dat energie verweven is met de economie ook niet. Energie heeft invloed op de hele maatschappij, van mobiliteit en industrie tot verwarming en landbouw. Dit maakt een overgang naar duurzame energie complex.

Desalniettemin doet de auteur drie aanbevelingen om de Nederlandse situatie te verbeteren. De eerste is om te beginnen met het aanleggen van een warmtenetwerk waar dit het efficiëntst is. In de praktijk komt dit neer op gebieden waar er aanbod is van restwarmte en vraag van huishoudens en glastuinbouw. Dit kan gedaan worden in de regio Den Haag - Rotterdam, in Limburg, Arnhem-Nijmegen en rond Amsterdam. Natuurlijk kan er ook een warmtenetwerk in andere gebieden worden aangelegd, maar de auteur is van mening dat het het efficiëntst is om dat in deze gebieden te doen. Ten tweede raadt de auteur het opnieuw instellen van lokale energiebedrijven aan. De publieke afkeer de afgelopen tijd van neoliberaal beleid kan helpen om politici hiervan te overtuigen. Tenslotte zou de Europese Unie ambitieuzere doelen moeten stellen. Deze zouden samen moeten gaan met concrete en bindende plannen. Er zijn doelen gesteld voor 2020, maar dit is niet zo ver in de toekomst. Een integrale Europese strategie zou bijvoorbeeld het bevorderen van het gebruik van zonne-energie in Zuid-Europa kunnen zijn. Dit zou ook een duwtje in de rug zijn voor deze economieën die hard getroffen zijn door de kredietcrisis.

Contents

1 Introduction

This thesis is about sustainable heating. By heating the author means getting and keeping living and business spaces at a comfortable temperature. In hot climates this can also mean cooling. Heat is a form of energy. Because of this, the introduction will start by explaining what energy actually is. In the next chapter the concept of sustainability will be tackled. After that a short history energy use will be given followed by discussing the problems associated with energy use.

1.1.1 Energy as a physical concept.

Energy can be defined as the ability of a physical system to perform work. Performing work can mean moving an object, heating an object, generating light and sound, charging a battery et cetera. The standard measurement of energy is the Joule (J). A joule is the energy required to lift up an object of approximately one hundred grams one meter high. A single joule is a small amount of energy. The energy contained in a barrel of oil is about six gigajoules or six billion joules. It is important to note that energy cannot be created nor destroyed. This is called the law of conservation of energy.

Nevertheless it is possible to transform a certain type of energy into another one. For example the chemical energy stored in a car’s fuel tank is converted to mechanical energy to move the vehicle. The mechanical energy is also transformed into electrical energy by the car’s generator. This electrical energy can in turn be used to emit light through to the headlights or sounds through the radio.

Each energy transformation also unintentionally generates heat. In the example of the car, about a third of the chemical energy of the fuel is transformed by the combustion engine into useful mechanical energy. The other two thirds is transformed into heat. The ratio between the energy input and the useful energy output is called energy efficiency. In a strict sense wasting energy is not possible since energy cannot be destroyed. Because this thesis is neither a physics nor an engineering or technical thesis, the expression waste energy is not strictly avoided. Instead this is a land use planning thesis. Voogd & Woltjer (2010, p. 16) describe land use planning (Dutch: *planologie*) as influencing the spatial order with the aim of reaching societal goals. For the scope of this thesis this societal goal is increasing the share of sustainable heating. Voogd and Woltjer argue that the spatial order cannot be seen as separate from the societal order. Because of this an integrated approach is needed (ibid. p.18). For this thesis this means that there are many more dimensions besides the spatial one which will have to be addressed in order to reach the stated societal goal. In the next section a short history of human energy use will be given.

1.1.2 A short history of energy use

For the past few years the media have frequently covered the so-called three major global crises. These are the climate, energy and food crises. Recently the financial crisis was added to these three. These are all closely linked (Addison et al., 2010). However the energy and food crises are not a thing of the recent past, there have always been problems with the energy supply and with famines. Only their severity changes periodically (Ó Gráda, 2009).

Humans have always used energy. In prehistoric times man needed no external energy sources. All work was done by hand. The only exception was the use of firewood. This changed when human society transformed from a hunter-gatherer society into an agricultural one. Humans started to use beasts of burden to help them in their farming activities

(Reijnders, 2006, p.16). Firewood and other biomass, like peat or dried manure, continued to play a major until a few hundred years ago.

This was not problematic until population densities started to rise. Forests were cut down to use the wood as fuel. Wood was not only used for cooking and heating but especially the producing of metals out of ore consumed a lot of wood. This was because the simple burning of wood yielded too low a temperature. Wood first had to be made into charcoal and this process required a lot of wood. Water en wind energy also played a large role in covering energy needs. For example, water mills in rivers provided energy for the sawing of timber and grinding of flour. Additionally wind energy was also used for this purpose, but also for

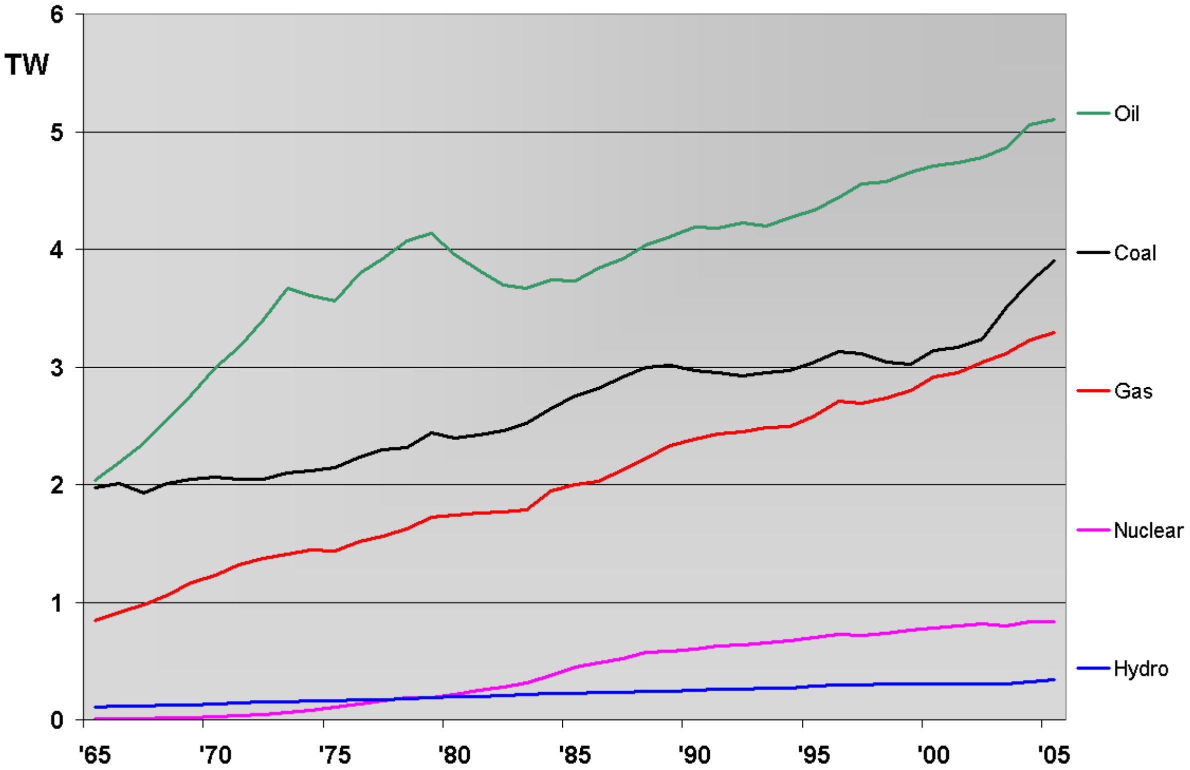


Figure 1.1 World energy use by type, source: BP 2006

drainage and most importantly on sailing ships which remained more economical than steamships until about 1900.

The Industrial Revolution and more specifically the steam engine changed all this. The first coal-fired steam engine was invented and patented by Newcomen in 1718. The engine was used mainly to drain deep mine shafts. Its efficiency was an abysmally low 0.5%. This was later improved to 1% but the real breakthrough was made by James Watt's engine which was invented in 1792. Initially this engine's efficiency was 5% - enough for factories but not for transportation- but around 1830 this rose to 17%. This was enough to use the engine in ships and locomotives, although the ships of the legendary Cunard Line between Liverpool and Boston still used half of their cargo space for storing coal (Reijnders, 2006, p.27).

The second invention which dramatically increased energy use was the electric generator and motor around 1880. Electricity removed the need to transport coal. It also became possible for small businesses to increase mechanization. These developments, together with the use of coal cokes in steel production, caused a huge increase in coal demand. Water power made a comeback with the advent of electricity in the form of hydroelectric dams. These sometimes take the form of huge engineering projects like the Itaipu-dam in Brazil and the Three Gorges-dam in China.

Previously only used in oil lamps, the internal combustion engine caused the position of coal as the main supplier of energy to gradually shift to oil. At one time oil was used to cover virtually every energy need. It was used in ships to fire the boilers, in power plants for electricity generation, for heating and in cars and planes. The military use (tanks, ships, aircraft) of oil made it the most important strategic resource, even more so than coal had been before. (Reijnders 2006, p.92)

The second half of the twentieth century saw the emergence of natural gas and nuclear energy. Natural gas- earlier considered a by-product of oil drilling- came to play an important role. In the 1950's there were very high expectations of nuclear energy. A "nuclear paradise" was predicted (Reijnders 2006, p.143). Up to this day however, nuclear energy remains a relatively small energy source globally, except for some countries like France. See figure 1.1 for the distribution of energy between the different energy supplies. In the next section the problems with the use of fossil and nuclear and other fuels are discussed.

1.1.3 Problems in energy use

As was said in the last section, energy problems are not an exclusively recent phenomenon. In the middle ages the use of firewood for heating and producing iron as well as using timber for shipbuilding led to rapid deforestation in some places. Where forests were not present, like in the Netherlands, peat was used. The excavation of peat in the low-lying west of the country led to soil subsidence and flooding of land. To this day there are lakes in the western Netherlands that were formed by this process.

The use of beasts of burden also became more problematic because the food production for the animals had to compete with food production for humans. There was not enough agricultural land to satisfy both needs. Indeed, in China well into the 20th century, because of high animal food prices, animal labour was more expensive than human labour.

The exhaustion of farmland and forests for energy purposes ended when the use of fossil fuels became widespread. However the use of fossil fuels had quite other but nonetheless serious environmental repercussions. Particularly notorious is the use of coal. The burning of coal causes air, soil and water pollution. There is a whole plethora of harmful chemicals which are released when coal is burnt. These are for instance sulphur dioxide (SO_2), nitrogen oxides (NO_X) and other toxic gases. Coal waste leads to soil and groundwater pollution with heavy metals like arsenic, mercury and lead. Sulphur dioxide in the atmosphere can form sulphuric acid which in turn causes acid rain.

All burning of fossil fuels causes the emission of carbon dioxide (CO_2). This gas is widely believed to lead to global warming due to an increased greenhouse effect (IPCC, 2007). It should be noted however that the amount of CO_2 released depends on the type of fossil fuel burned. Coal is virtually entirely made up of solid carbon. In a full combustion each carbon atom bonds with two oxygen atoms creating CO_2. Oil and gas are carbohydrates which means they also contain hydrogen besides carbon. Burning hydrogen creates water vapour. Natural gas contains lighter carbohydrates like methane. These molecules have relatively more hydrogen than heavier carbohydrates. Oil contains heavier carbohydrates. This means that natural gas is the cleanest fossil fuel in terms of CO_2-emissions followed by oil and coal.

There are also problems concerning the extraction of fossil fuels. Coal extraction is often done through open-pit mining. This involves stripping the top layer of soil with huge excavation machines. Obviously this process destroys entire landscapes. Sometimes entire villages and towns have to be demolished to make room for an open-pit mine. The effects of oil extraction depend on the type of oil extracted, the place and organisation of extraction. Considering the former, lighter oil can be extracted more easily than heavier oil. This means that no further chemical or mechanical process is needed to extract the oil. Unconventional sources of oil like shale oil or tar sand oil are very difficult to extract. In Alberta, Canada, tar sands are extracted in much the same way as coal in open-pit mining. Offshore oil extraction also has environmental risk. This was dramatically demonstrated recently with the leak of the Deepwater Horizon platform in the Gulf of Mexico. Leakage is also a problem on land. Poor quality piping can lead to large oil spills. Good examples of this can be found in Siberia and Nigeria.

Unfortunately fossil fuel alternatives are not without their own environmental problems. In electricity generation the nuclear energy controversy comes to mind. Firstly the nuclear waste problem is still not adequately solved. Secondly external security remains an issue. A nuclear meltdown was considered almost impossible especially in the developed world. Unfortunately the Fukushima disaster has proven this idea wrong. Nuclear power remains a dangerous technology. Extraction of uranium is also environmentally damaging. Hydroelectric dams often have a negative environmental impact because the reservoir floods large areas of land. River flows may also change in unanticipated ways leading to draught problems. There is also an external security risk if a dam breaks.

Besides the environmental hazards described above there are more reasons to abandon the use of fossil fuels and nuclear energy. Supply security and accompanying high prices are the most important of these. The dependency on instable regions and regimes - particularly the Middle East in the case of oil and Russia in the case of natural gas – can lead to supply problems and security problems. Nuclear energy carries a unique risk. This is the danger of proliferation of nuclear weapons. This risk is clearly demonstrated in for instance Iran. It is difficult to ascertain if a nuclear program is exclusively for peaceful purposes.

In short, there are several problems in energy use. These problems are diverse in nature. In the next section the concept of sustainable energy will be introduced as a means to tackle the problems associated with energy use.

1.2. Alternative energy solutions

The problems discussed in the previous section can be solved partially or completely by increasing energy efficiency, decreasing energy demand and making use of renewable energy. These three approaches form a strategy called Trias Energetica (see figure 1.2). Unlike the separation ideals in Montesqieu’s Trias Politica, all three approaches should be used and integrated. The idea is that as the surface area of one and two expands, the surface area of three recedes, in the direction of the arrows, see figure 1.2. There are many different energy needs in a society. These are among others electricity generation, transportation, industrial processes and heating or cooling needs of households and businesses. Heating requirements are responsible for a large part of energy demand. In the Netherlands this is 38% (Agentschap NL, 2010). Because of this it makes a lot of sense to try and apply the Trias Energetica to heating issues.

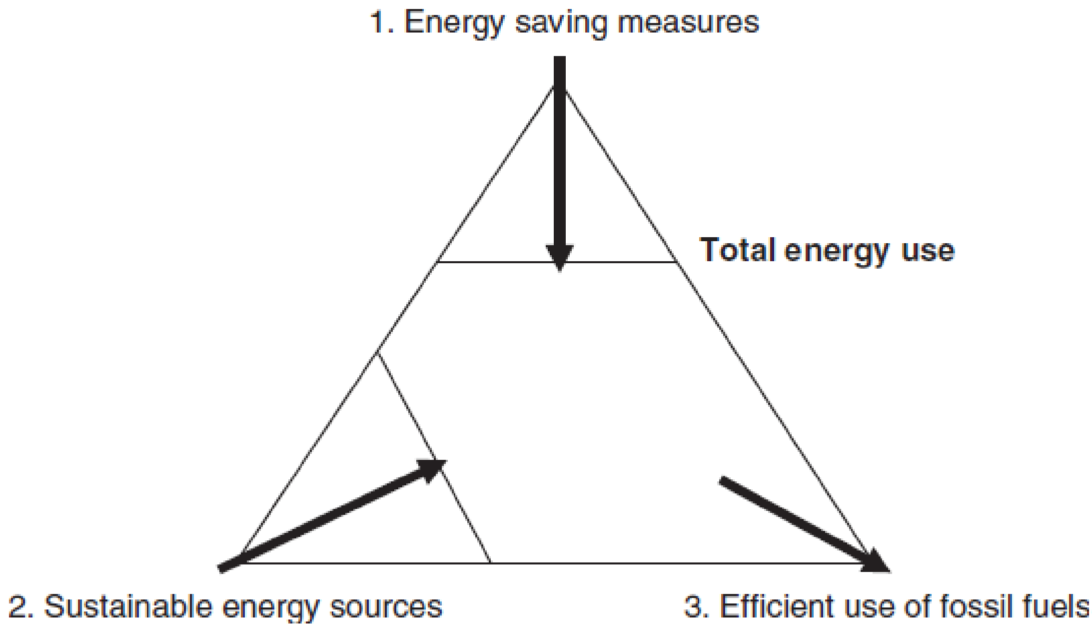


Figure 1.2 The Trias Energetica concept, source: Entrop & Brouwers 2010, p. 302

The first step of the Trias entails reducing the demand for energy by avoiding waste and implementing energy-saving measures. When applying this step to heating the following can be thought of. A lot of heat is wasted in industrial processes, electricity generation, greenhouse agriculture and of course in households. In electricity generation a fossil fuel power plant's efficiency is around 30% to 40%. Most of the heat is wasted through chimneys cooling towers and especially the dumping of cooling water. Heat in waste incinerators is similarly wasted. In homes and businesses heat waste is mainly due to inadequate wall, window and roof insulation.

The second step involves using sustainable sources of energy instead of fossil fuels. In the case of heating this comes down to solar collectors, using biofuels like wood and geothermal heat sources.

The third step is an interesting one. In the case of heating there is a considerable overlap with stage two. When using solutions that cannot completely eliminate the use of fossil fuels, like using solar collectors, it becomes useful to use fossil energy as efficiently as possible. In addition, considering the large amount of waste heat from industry and power plants, the use of this waste heat to heat living and business spaces becomes interesting. It is estimated that the amount of waste heat could supply ten million Dutch homes (Vinken et al, 2011). However in a strict sense this would not be renewable heat, since the waste heat comes from burning fossil fuels. Nonetheless, considering the sheer amount of heat wasted, it would be a shame not to do anything useful with this waste heat.

When considering an approach like the Trias Energetica to advance sustainable energy all three steps should be implemented. This does not mean that in one time and place every step is as appropriate as in another time and place. For example using wood as a biofuel is not very efficient in areas without forests. Because wood does not have a very high energy density, transporting it over greater distances would be inefficient (Magelli et. al 2007). Nussbaumer and Oser advocate a reasonable transport distance of up to about 50 kilometres (Nussbaumer & Oser, 2004, p.8). Geothermal heat should be quite close to the surface. And in an area without industry there is not a lot of waste heat available.

In the next section the research goal of the thesis will be discussed as well as the research methodology and structure.

1.3. Research goal and research questions.

Research goal

In the last section reasons for adopting a more efficient and less dependent on fossil fuels sustainable heating provision were discussed. The goal of the research is provide an answer to how to do this. In order to answer this question a number of research questions will be formulated.

The author's home country is the Netherlands. Bordering this country to the East is Germany. In the Netherlands there is the impression that Germany is ahead of the Dutch when it comes to inventing and implementing sustainable energy solutions (Nieuwsuur 2011) Indeed the German share of sustainable electricity is twice that of the Netherlands (Eurostat 2012).

Because of this it makes sense to investigate the reasons for this German advantage. Perhaps it is possible that the two countries can learn something from each other. In this way the process of transitioning to sustainable heating could be sped up. Other reasons to investigate Germany are that German and Dutch culture is comparable, they share a land border and they have similar languages. The latter point is also practical in nature, since the author can understand written and spoken German. This makes it possible to read German government policy papers, laws, websites and other publications.

Research questions

First and foremost the question of what the sustainability and renewability concepts mean has to be answered. With this question answered the research scope can be narrowed down.

The second question should be: "What can be done to make heating systems more sustainable? In section 1.2 this subject was already briefly touched upon. This question serves to elaborate this.

In this thesis it is assumed that the share of sustainable energy can be increased by pursuing an active policy with this goal in mind. Since the German share is higher than the Dutch share, investigating German policy might prove useful for the Dutch situation. Five research questions are formulated to help compare and if useful transfer policies: What is the Dutch and German historical context with regard to energy? What are the current Dutch and German policies with regard to sustainable energy and sustainable heating in particular? And: What tools can be used to compare two countries' policies and what is the outcome of this comparison? Fourth: Would a transfer of policies be beneficial to promote sustainable heating? And lastly: how can this transfer be achieved?

In total there are seven research questions to be answered. The methods used to answer these questions will be discussed in the next chapter.

1.4. Research methodology

How can answers to the research questions formulated above be found? Research methodology involves this issue. Of course since the subject of sustainable heating is a complex one, it is not possible to give *the* answers. Instead the author will attempt through analysis and synthesis to find *a* solution to the sustainable heating problem. For answering most questions a literature study will be done. Publications studied for the first and second questions include works written by the Brundtland Commission, Pope, Gibson, Lysen and Duijvestijn. The historical contexts of both countries will mostly be given by using the author's knowledge on this subject. Literature study will again be used to gain knowledge of both countries' (sustainable) energy and heating policies. For this subject German and Dutch laws regarding sustainable heating will also be studied. Markovska, Pickton and Wright and others have written extensively on the matter of policy comparison. The comparison between the countries will be done mostly by using a so-called SWOT analysis. This involves identifying and appreciating Strengths and Weaknesses of a policy and Opportunities for and Threats to a policy. In order to produce this analysis secondary data will be statistically and spatially analysed among others. Sources of data will be Dutch, German and European statistics agencies, data of heating industry associations, other government agencies' data and so on. Google's software program Earth will also be used. An example of statistical analysis is using Markowitz' portfolio theory to calculate price volatilities. The author will also develop a means to calculate the spread of major cities in a country. This will be discussed in more detail in chapter five. After the comparison of the countries' policies, possibilities for policy transfer will be discussed. For this section the author will use the model developed by Dolowitz and Marsh.

1.5 Research structure

The structure of the thesis will follow the order in which the research questions were posed in section 1.3.

In chapter two some key theoretical concepts like sustainability and renewability will be discussed. The Trias Energetica concept will be discussed in more detail. In addition policy analysis, comparison and transfer will be discussed.

In chapter three the Dutch situation will be looked into, starting with a short history of energy use in The Netherlands, followed by a discussion about Dutch relevant policies and laws. A similar structure will be followed in chapter four when the German situation is addressed.

In chapter five the comparison between the countries – the SWOT analysis – will be tackled. This is a relatively large chapter in which several aspects will be talked about.

Transferring policies between these countries will be the subject of the second last chapter. The author will discuss what policies are useful to be transferred, on what governmental level and how to do this.

The thesis will end in chapter seven with a conclusion in which the answers to the research questions are concisely addressed. The author will also provide some suggestions on the transfer of policy and implementation of new policies.

2 Theoretical concepts

2.1 Sustainable development in heating: The Trias Energetica

The concept of sustainable development was first put forward by the Brundtland Commission in 1987(WCED 1987). The Commission defined it as: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Although this sounds simple enough, the operationalization of the concept proved difficult. Experts proposed several methods to do this. One such method is called the Triple Bottom Line (Gibson, 2001). This approach strikes a balance between economic, social and ecological concerns. It can be seen as a sort of expanded Environmental Impact Assessment which also incorporates societal and economic issues (Pope et. Al., 2004). The danger of this approach is that ecological concerns are a part of a sum and leads to foreclosure of these issues. This means that if a development scores high economically and socially but poorly environmentally, the development can still be seen as sustainable because there is a two to one score. This approach can be represented by a circle made up of three adjacent sections representing the economy, environment and society (Gibson, 2001).

The other main approach takes a different road. Its proponents argue that sustainability issues are already integral to the environment and as such an EIA has to take sustainability issues into account. This is a so-called "deep green" model and can be represented by three concentric circles. The ring on the outside is considered the most important, this is the environment. Society is the second ring and as such is embedded in the environment. The economy, finally, is embedded in society and thus forms the inner circle (Gibson, 2001). See figure 2.1

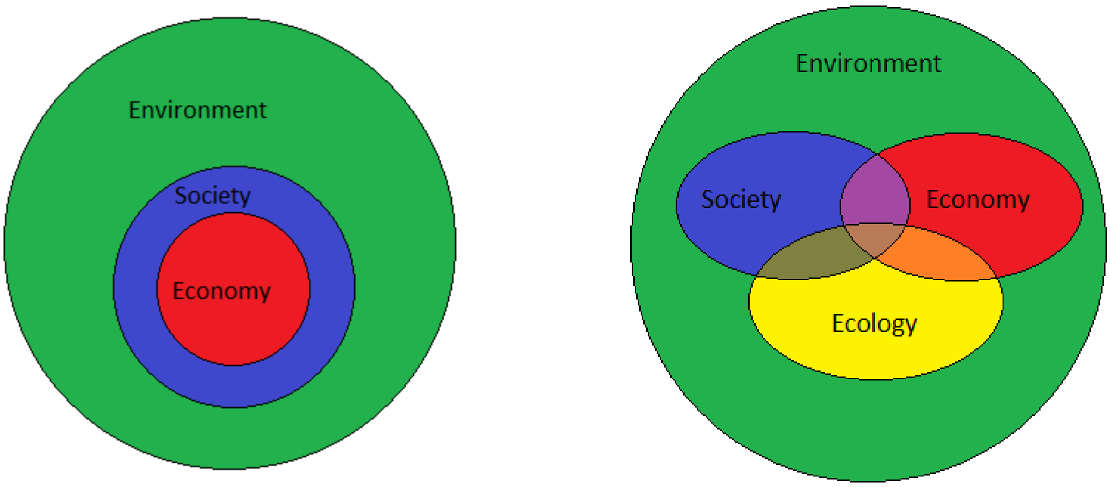


Figure 2.1 Deep green versus TBL perspective, source: Author, based on Gibson 2001

When it comes to sustainable development in a specific sector, like heating, it is easier to avoid choosing either theoretic strategy. A very practical approach can then be followed. For operationalizing of the sustainability concept in heating, Lysen (1996) coined the Trias Energetica concept. This concept was already briefly touched upon in chapter one. His three stage approach was improved by Duijvestijn (1997) who put the stages in order of preferability. The economics ministry of the Netherlands (MinEZ, 2008) has determined a fourth step in its publication *Warmte op stoom*. The four stages are:

1. Use less energy by using energy saving technologies;
2. Use sustainable energy sources as much as possible;

3. When there is still an energy demand left, then use fossil fuels as efficiently as possible.
4. Making as much use as possible of waste heat.

These stages can entail the following when applying them to sustainable heating. In stage one insulation is useful to reduce the energy needs for heating. A building's heat can escape through its windows, walls, doors and roofs. To combat this a building can be equipped with double glazing, cavity wall insulation and roof insulation. A building can also be positioned in such a way as to maximize the amount of sunlight received.

The remaining energy demand after step one should be met by using sustainable sources of energy as much as possible. In case of heating these sources could be geothermal heat, solar collectors, biofuels like wood, etc. Geothermal heat can mean two things. First deep geothermal heat is usually high temperature steam or boiling water. In some parts of the world this "deep" geothermal heat is found at the surface like in Iceland. In the Netherlands and Germany this geothermal heat can be harnessed only by drilling deep bore holes. Second there are geothermal heat pump systems. The systems make use of the moderating effect of the soil on temperatures. In general the deeper the hotter, but for the first meters this is not necessarily the case. In winter the soil is still relatively warm from the summer and so the soil is warmer than the air in winter. In summer the situation is reversed. A heat pump system makes use of this moderating effect and the result is a more efficient system. As such a geothermal heat pump system can be thought of as being part of both step two and step three.

The third step requires the use of more efficient heat generators like high efficiency condensing boilers or even cogeneration in a micro combined heat and power system. Cogeneration in this context means that the system generates both heat for heating and hot tapwater and electricity.

Sustainable or renewable

Another concept strongly related to the concept of sustainability is renewability. Often these words are used as virtual synonyms. There are however important differences which would be useful to clarify. In a strict sense even fossil fuels are renewable. They were formed over millions of years out of organic material, mostly dead plants. So on a geological timescale fossil fuels can be called renewable. In practical terms - that is on a human timescale - fossil fuels are not renewable. Biofuels like wood or some grasses like Miscanthus giganteus are fast-growing and can be considered as renewable. Another way to look at this is the ratio between rate of growth and rate of consumption. Consumption of fossil fuels is still increasing while the "growth" of new fossil fuels is negligible. There can be discussion about the renewability of a resource like peat. This is formed over a period of centuries. Sweden classifies it as a slowly renewable fuel.

Sustainability has a strong temporal component. After all it means meeting the needs of current and future generations. Since human civilization has been around for roughly 10,000 years it makes sense to try not to compromise the needs of generations a few thousand years into the future. The author holds the view that renewability of energy is a prerequisite to sustainability. This in contrast to for example Jaccard who coined the concept of sustainable fossil fuels (Jaccard, 2005). So in short energy sources can be considered sustainable when they can be used continually for at least a few thousand years. For the purpose of this thesis the words renewable and sustainable will be used interchangeably.

In the next paragraph methods for analysing and comparing policies will be discussed.

2.2 Policy analysis, comparison and transfer

Analysis

This section will start with a discussion about the meaning of the word policy. Policy and politics are very similar and in some languages there is not even a different word for the two (Healey, 2006, p.214). According to Healey “[...] the term ‘policy’ is commonly used to refer to an explicit statement of a governance objective, with the implication that the policy articulated will be used in some way as a guide to what the governance entity will do.”(ibid.). Voogd and Woltjer give a similar definition of policy: “Policy is a complex of actions with respect to a problem or focus group.”(2010, p.20). In the case of sustainable heating these objectives are clear: the increase of the share of sustainable energy by 2020.

Comparison

A tool is needed in order to compare the sustainable heating policies of Germany and the Netherlands. A useful tool is the so-called SWOT analysis. This method identifies internal Strenghts and Weaknesses and external Opportunities and Threats of policies. Its roots can be found in the field of business management and it has been widely adopted in public governance affairs (Markovska, 2008). According to Stacey (1993) a SWOT analysis is: “a list of an organization's strengths and weaknesses as indicated by an analysis of its resources and capabilities, plus a list of the threats and opportunities identified by an analysis of its environment. Strategic logic obviously requires that the future pattern of actions to be taken should match strengths with opportunities, ward off threats, and seek to overcome weaknesses.” Pickton and Wright (1998) argue that “SWOT analysis is supremely simple.”

Originally, a SWOT analysis is a tool to aid corporations in their strategic planning. In the analysis a corporation’s relative position to another corporation is investigated. This is done by identifying strengths and weaknesses, which are the beneficial or detrimental factors that influence the company internally, as well as opportunities and threats, which are factors external to a company. The result is a table with four quadrants. The usefulness of a SWOT is not limited to the business sector; it can also be used to compare policies of two countries, this is what will be done in chapter five.

A SWOT analysis is simple but it allows the identification of key factors in the corporation’s development. However, Pickton et al. warn against an oversimplification of the process. A SWOT is not merely intended as a list; “At its most basic, carrying out a ‘SWOT’ is a ‘low-grade’ form of analysis which causes some people to question whether it is truly *analysis* at all.” (Pickton et al.,1998, p. 104). In this form a SWOT does not give any priorities or weights to the factors. The result can be that “weak opportunities may appear to balance strong threats.” (Mercer, 1992, p. 706) Additionally this form of SWOT might give a corporation’s managers a false sense of confidence in its conclusions and in turn bad decisions may be made.

Pickton et al. have concluded that there are three types of limitations when using a SWOT: Inadequate definition of factors, lack of prioritization, and over-subjectivity or compiler bias. Table 2.1 provides a summary of these limitations. Serendipity means stumbling across something useful while looking for something else.

Inadequate definition of factors	Lack of prioritization of factors	Over-subjectivity in the generation of factors
Factors which appear to fit into more than one category	Factors which are given too much emphasis	Factors missed out: lack of comprehensiveness
Factors which do not appear to fit well into any category	Factors which are given too little emphasis	Serendipity in the generation of factors
Factors described broadly: lack of specificity	Factors which are given equal importance	Disagreement over factors and to which category they belong
Lack of information to specify factors accurately		Factors represent opinions not fact

Table 2.1 Limitations in the use of SWOT, source: Pickton et al. 1998, p105

Pickton et al. provide a good example of a factor to clarify this. A factor which is quite susceptible to the limitations in the above table is the exchange rates factor. The exchange rates change constantly, and the factor is difficult to define and prioritize. In this research project the equivalent of the exchange rate is the price for fossil fuels, this will be discussed later in chapter five.

According to Kotler (1991) the limitations of SWOT can be countered by introducing an assessment of the probability and the impact a factor could have on a business. This can improve the appropriate prioritization of factors as well as their definitions. Ideally a business should give weights to factors' importance and probability by using Delphi techniques, (Hurd, 1977) but that is beyond the scope of this thesis. So the author has decided to use the SWOT tool while keeping in mind its weaknesses. In chapter five the SWOT analysis will be applied to compare the German and Dutch situations.

Transfer

While opportunities and threats are largely determined by the geographical location and scope of a policy, strengths and weaknesses are not. The last two are internal to an organisation. It is possible to transfer good parts of a policy to another organisation who wants to improve its strengths or mitigate its weaknesses. This is what Dolowitz and Marsh (1996) call voluntary transfer. Voluntary indicates a willingness to adopt another policy than one's own. In this case it means the political will to do this. There can be many reasons why this political will is formed. Among other things there can be a sense of lagging behind another country, increased globalization which demands increased standardization, improvements in communications technology which makes it easier to learn about another countries' policies and a government change through elections. It is not only national governments who transfer policy, it may also involve regional or local governments or international organisations.

They also identify coercive transfer. In this case another country is forced to adopt a certain policy. Often an international organization demands this. For example in South America and more recently in Greece, the international monetary fund has only been willing to supply credit in exchange for austerity measures. In chapter six the author will go into specifics regarding the transfer of German and Dutch policies.

In the next section a brief history of energy use in the Netherlands will be given, followed by a discussion about the Dutch heating act (Warmtewet) and a summary of the Dutch sustainable heating policy: *Warmte op Stoom.*

3. Energy use in the Netherlands

3.1 Introduction

Well into the nineteenth century Dutch energy needs were covered by peat sources. This later shifted to coal, which was mined in the extreme south of the country and to a lesser extent oil. In the 1960's a real revolution in energy started. This was caused by the discovery of the Groningen gas field. This is a large gas field containing over 3000 billion cubic meters of natural gas, see figure 3.1. By around 1980 virtually all Dutch electricity and heating needs were covered by natural gas. The coal mines in the south were closed, a nation-wide natural gas piping network was built and the Netherlands became the third energy exporter in the world, after the United States and the Soviet Union. The decision was later made to use less of the Groningen gas and import more oil. There were also some experiments with nuclear power. An experimental reactor was built at Dodewaard and later a commercial power plant was built at Borssele. However due to continued discussion about safety and nuclear waste concerns, and especially the Chernobyl nuclear disaster, the Borssele plant remained the only one in the Netherlands after Dodewaard was closed in 1997. At this time natural gas remains virtually the only source of heat in the Netherlands, see figure 3.2

During the oil crisis of the 1970's and recently there has been more attention in the Netherlands for sustainable energy. This follows the trend seen around the world. However, compared to for instance Denmark and Germany the Netherlands lag behind in developing wind and solar power and other sustainable energy sources. The authors Van der Slot & Van den Berg (2011, p.6) made a comparative ranking which they call a clean tech ranking, it illustrates the lagging behind of the Netherlands. Denmark and Germany hold first and third place respectively, while the Dutch position is 21. Nevertheless the Dutch goal is to use 20% sustainable energy sources by 2020. In the next section some laws and programs relating to sustainable heating will be discussed.

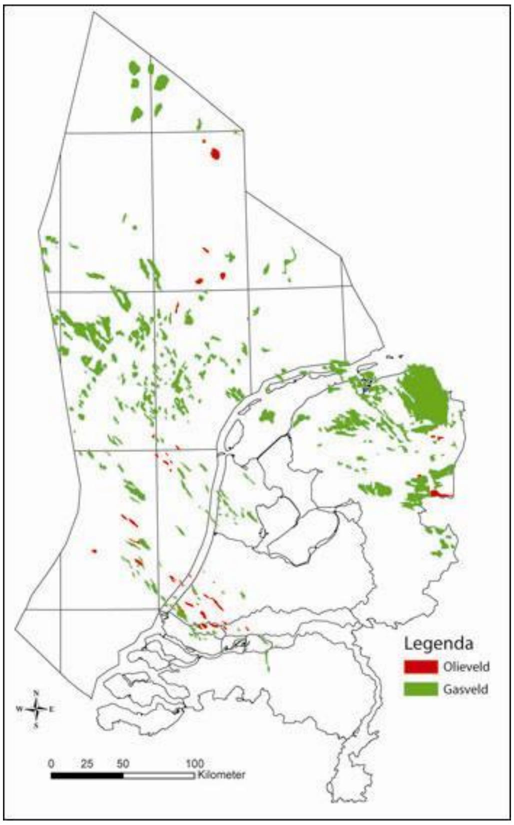


Figure 3.1 The Groningen natural gas field in the northeast source: Kennislink 2008

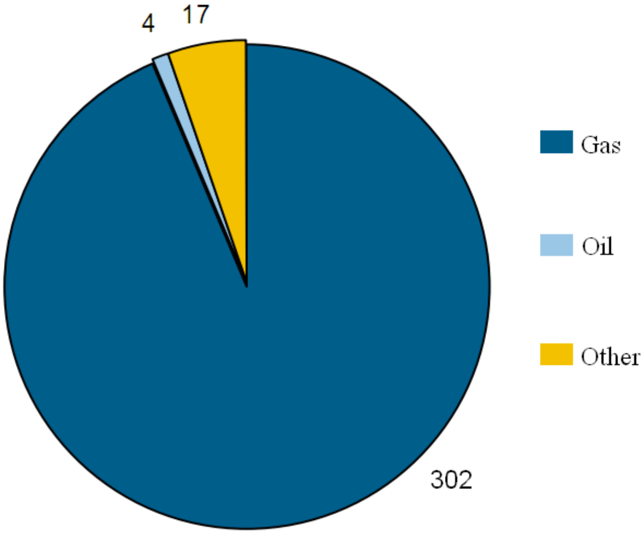


Figure 3.2 Dutch household heating sources in PJ, source: Agentschap NL 2010

3.2 The *Warmtewet*

In 2003 two members of the Dutch parliament submitted a piece of legislation on district heating called the *Warmtewet* (literally: heat act). Interestingly, the name of this act is very similar to the name of the German heating act, the *Wärmegesetz*. In fact it is a literal translation. The German heating act will be discussed in the next chapter. Despite this however, unlike in the German heating act, there is no focus on increasing the market share of renewable heating in this proposal. Instead, the draft proposal was motivated by the increasing level of liberalization of the energy market. The members argued that the potential loss of customers of energy companies which had previously held a monopoly position might potentially lead to bankruptcy of some of these companies (Tweede Kamer, 2003, p.1).

Households with access to district heating systems usually do not have access to the natural gas network. These households would lose their supply of heat if their supplier went out of business. A supplier might also be tempted to raise his prices, since customers are obliged to use district heating because of a lack of alternatives.

Because of the new commercial orientation of the energy companies, the main focus shifted towards pleasing the stockholders by increasing profits. The members of parliament wanted to avoid a situation where the households with no alternative had to pay too much for their heating demands.

A secondary problem was the loss of a single clear reference price for heating in district heating systems . The price had up to now been established by the price of the local natural gas. Because of liberalization there is no longer a single natural gas price. Consequently it has become unclear which price to use as a reference for calculating heating prices (Tweede Kamer, 2003, p. 2).

According to the proposers of this law there is insufficient legal protection for these so-called tied-up households. Terminating the heating agreement is impossible because of the lack of alternatives, and taking legal steps through the competition law (*Mededingingswet*) is not possible for the average household because such a procedure would be lengthy, complex and would require a high level of technical and legal expertise (Tweede Kamer, 2003, p. 3).

Their solution was the introduction of a legal obligation of energy companies to securely supply their customers with heat at a reasonable price. This obligation could only be revoked if another company had taken over the district heating system or if an alternative heating system was installed, like access to the natural gas network (Tweede Kamer, 2003, p. 5, 9).

It was mentioned earlier at the beginning of this section that promoting or increasing the use of sustainable heating is not a goal of this piece of legislation. Because of this the *Warmtewet* will not be discussed in further detail. In the next section a program of the Dutch economy ministry - *Warmte op Stoom*- will be discussed more thoroughly.

3.3 *Warmte op Stoom*

At the end of 2008 the Dutch economic Ministry published a new policy initiative called "*Warmte op stoom*" which literally translated means Heat on steam. In it the Dutch vision and ambitions for sustainable heating and cooling are put forward.
More than a third of fossil fuel use is used for heating, cooling and industrial processes. Of this third a third is used for heating buildings, a third for industrial processes and a tenth for heating of greenhouses (MinEZ, 2008).

Industrial processes produce a lot of waste heat. Unfortunately, the temperature of this heat is often too low to be used to warm buildings, also most built-up areas are not close to industry. Besides heating spaces, heat is also used for showering and washing. Virtually all heat is generated by natural gas. Renewable sources and waste heat are rarely used. Starting in the 1980's there have been several programs to save energy used for heating, especially by promoting insulation of houses. In planning and building new houses more and more attention is paid to waste heat use, heat generation and insulation (ibid.).

Because of the relatively large part in the total operating costs, greenhouses have been trying to save energy for a long time. The use of small cogeneration facilities, in which heat and electricity production are combined, is very popular in the greenhouse industry.
As was mentioned in the last chapter, the ministry's recommendations neatly fall into the Trias Energetica stages with the addition of a fourth step. These four steps are:

1. Use less heat by using energy saving technologies;
2. Use sustainable heat sources as much as possible;
3. When there is still a heat demand left, use fossil fuels as efficiently as possible.
4. Making use of waste heat as much as possible.

To attain these goals the ministry emphasises promoting favourable market conditions for the use of sustainable sources. The *Warmte op stoom* program is supposed to save fossil energy equivalent to the electricity use of 1.4 million households (ibid.).
The goals of each step in the Trias Energetica will now be described in more detail. To save on the demand for heat a number of solutions are suggested. Firstly existing and new buildings should be properly isolated. Secondly appliances –like dishwashers, clothes washers and dryers - should be made more economical. Thirdly individual behaviour should be adapted to be more energy economical. Additionally, existing industrial processes can be made more efficient, with an emphasis on internal heat recycling, or new industrial processes invented.

Generating heat in a sustainable way can be done in a number of ways. For the Netherlands the most important are, in random order, biomass, solar heat and geothermal heat. It is expected that due to rising energy prices the conditions for sustainable energy in 2020 will be favourable. However higher initial costs, immature sustainable technologies and insufficient supporting policies are holding its development back. In the initial four years of the program, the most viable and profitable sustainable sources should be identified.

Fossil fuels can be used more efficiently by making use of cogeneration. Businesses and households can use it to generate a part of their own electricity needs.

The fourth step, which only plays a role in heating, is using waste heat. This does not play a role in other energy uses, after all there is no such thing as waste electricity or waste petrol. Waste heat is especially abundant in industries and power plants. Sometimes the waste heat can be used in the same industry or supplied to nearby consumers. Often however this is not possible because either the temperature is too low or the distance between the producer and the user is too large. The ministry wants to identify places where waste heat can be used more intensively.

As was previously mentioned, creating favourable market conditions for sustainable generation and use of heat is the main goal of W*armte op Stoom*: “The government sees it as its role to develop a stable and dynamic market for energy saving and sustainable heat products and services. At the moment such a market does not yet exist.” (MinEZ, 2008 p. 9) The government identifies seven reasons why such a market does not yet exist. As was touched upon earlier, high initial investment costs for making heating sustainable in housing leads to property owners and developers often choosing a conventional heating option, even though the sustainable option could well be less expensive in the long run. Secondly businesses and government agencies hardly have any knowledge of the costs and benefits of sustainability measures. Thirdly investments to make power plants and industries suitable for supplying waste heat are very costly. It also takes a long time before the investment is earned back.

Connected to the issue of waste heat is the problem that there is not yet a clear overview of waste heat supply and demand locations and where these two are in close proximity, it is also difficult to set up contact between them. Another problem is the lack of expertise in industries in supplying heat, after all it is not a main goal of industry. Setting up waste heat projects is also quite complex and difficult to manage, a leading party is clearly needed.

To mitigate these issues *Warmte op Stoom* puts forward three types of solutions. The first is to develop and share knowledge about sustainable heating. The second is to improve cooperation between producers and users, between government and citizens and businesses and between different levels and agencies of government. And finally to create suitable conditions for a market of sustainable heat and saving products and services. In the next three sections these types of solutions will be discussed. Each section will start with a brief introduction and will then roughly follow the order of industry, newly planned buildings, existing buildings and the agrarian sector.

3.3.1 Developing and sharing knowledge

To develop and share knowledge, the *Nationaal Expertisecentrum Warmte* - National Centre for Expertise on Heat (NEW) was founded and started in the beginning of 2009. Its goal is to provide parties concerned with making investments in the heating sector with information regarding the effectiveness of heat saving and generation methods.

The effectiveness of different energy sources is often unclear, especially with respect to their level of sustainability. In other words, the NEW wants to know which is most sustainable in what situation. The centre wants to develop a universal tool for measuring this. In order to do this, field tests will be held and a monitoring system will be put in place to give access to relevant parties of experiences obtained in pilot projects and government grants programs. Initially the centre will focus on housing and later on this will be expanded to industry.

To gain insight in the locations of suppliers and users of waste heat *Warmtekaarten* – Heat maps – will be made by the NEW. The maps will also show suitable locations for geothermal heat generation. Local governments, businesses and other relevant parties can use these maps as a tool to easily consider heating solutions in their plans. As of 2012 these maps are already available to the public, they can be accessed online (www.warmteatlas.nl).

The Innovation Program on Heat and Cold has started pilot projects in which sustainable heating solutions can be achieved faster and heating products put on the market easier and faster.

Several Dutch municipalities have expressed the ambition to reduce their CO_2-output drastically. The cities participating in the *Klimaatneutrale Steden*, climate neutral cities even have the ambition to become CO_2-neutral. The municipalities explore waste heat and geothermal heating solutions and some municipalities are starting sustainable energy companies. By doing this locally, knowledge and energy awareness are spread to local citizens.

For new buildings the government has reached an agreement with the building industry to reduce the energy by 25% in 2011 and 50% in 2015. Local government and market parties are also expected to share and spread knowledge. An important point for new buildings is the idea to make their worth more dependent on their energy efficiency. New buildings for the government will be held to stricter standards, to serve as an example for the building industry.

Owners of existing buildings usually have very little knowledge of energy saving possibilities. When making an investment in their homes they usually choose options that will make their property more valuable or increase their living comfort. In 2008 it was decided that independent housing consumer organisations would be used to increase knowledge about energy saving measures and subsidies. This was done in support of the *Meer voor Minder* project (More for Less). Also in 2008 to MvM pilot projects were started. However, as of January 2010 these measures appear to have had little effect. In a study done by TNS NIPO with a sample size of 1800 households, it was shown that owners of houses built before 1975, hardly knew and made use of subsidies for improving the insulation of their houses. (Milieu Centraal, 2010)

In the agrarian sector the emphasis is on biomass. Goals are increasing the supply of biomass, the improvement of biomass logistics, creating sustainable ways of storing biomass and developing new means of processing biomass such as making bio fuels and chemicals.

3.3.2. Promoting Cooperation

As was mentioned in this chapter's first section, making waste heat useful is difficult. Problems with different supply and demand in the temperature, time and distance dimensions are exacerbated by a large number of relevant parties and long and complex relations between them. Nevertheless, waste heat can be used successfully in some areas. To bring potential users and suppliers of waste heat together, the cooperation between these parties must be improved.

In industrial enterprises increasing heat efficiency and harnessing waste heat is a question of custom solutions. To promote these, several pilot projects are to be started in which industries are completely scanned for increased efficiency and waste heat use opportunities. Subsidies will also be given to waste heat projects which are not expected to be profitable at first but will be once waste heat technology matures. The previously mentioned heat maps are also expected to boost waste heat use. Experiences gained with the pilot projects will be spread by the NEW.

In addition to the deal between the national government and the building industry mentioned in the previous section, a lot of new cooperation is already going on at the regional and local levels, for example an action plan has been made by the provinces of Groningen, Friesland and Drenthe. Specifically for existing buildings the national government, housing corporations, building and plumbing businesses have set up the previously mentioned MvM plan. Its goal is to reduce the energy demand of residential buildings with 20% to 30% by the year 2020. An organisation will be formed to start twenty pilot projects. Concerns of homeowners will be explored in these projects. It is hoped that in this way the best method of involving homeowners will be found.

In 2008 the national government and the agricultural sector reached an agreement on how to achieve a reduction of carbon dioxide emissions and on how to let the sector contribute a significant part to producing sustainable energy. Small energy waste heat networks between greenhouses and heat users are especially useful here. At places where there is a lot of biomass available, small power stations can be built and their electricity can be supplied to nearby users. The national government will facilitate bringing producers and users together.

3.3.3 Improving market conditions

Sustainable energy technologies are still in full development. The technologies have not yet matured and this means a lot can still be done to decrease the cost of implementing sustainable technologies. To speed up the development and maturing of these technologies it is important to improve their current market conditions. This will result in a greater use of these technologies and - it is hoped- in turn reduce their costs

A particularly young technology is the use of geothermal energy. While in countries like Iceland geothermal energy is used in areas where the earth's crust is very thin, here small scale geothermal heat pumps are meant. The geothermal heat can be found close to the surface. Unlike in Iceland, this is not about very high temperatures or steam vents, but about relatively low temperatures to heat homes. The temperature is often not even high enough to use directly for heating, but it costs less natural gas to heat water from ten degrees to twenty degrees than from zero to twenty. A few pilot projects have already been completed in the Netherlands. For example in the extreme south of the country, hot water from disused coal mining shafts is pumped up to heat homes. An important point of attention in geothermal energy is that a hole needs to be drilled. This is an expensive process and there is a substantial risk of a failed drilling. This happens when a wrong soil layer is drilled into, making the borehole useless.

Because drilling for geothermal heat is such a recent phenomenon it is very difficult to insure against a failed drilling. Because of this, the national government has established its own insurance policy against failed drillings. In order to qualify for this policy geological research has to be done on the site. Success will be measured by the profitability of the drilling, marking every attempt at or above breakeven point as successful. The probability of success needs to be at least 90% because it is essential for the further development of the technology that there are as many successful drills as possible. Premiums will cost about 7% of the investment amount and after the policy has been given, a policy holder will have six months to start the drilling process. The policy will last until one month after the drilling has taken place. Policy holders will also be required to publicize the geological research and drilling results. Should a drilling fail, the insurance will pay out 85% of the investment costs.

The European Union Emission Trading System (ETS) stimulates businesses to cut down their carbon dioxide emissions. In order to do this as cost effectively as possible, the Dutch government wants to give a financial advantage to sustainable energy generation.

Cogeneration facilities supply a large portion of heat in the Netherlands. As was mentioned earlier, cogeneration facilities produce both heat and electricity. This increases the efficiency of energy production because it makes use of waste heat. The cost effectiveness of a cogeneration facility largely depends on the price for natural gas, which is coupled to the price of oil. It is expected that cogeneration technology will further mature in the near future, increasing cost effectiveness.

Waste heat produced in biomass electricity production is largely wasted at the moment. Because of this, subsidies on biomass electricity production will be based on electricity and useful heat generation together. The national government will also work on reducing permit requirements for small scale facilities burning waste materials to generate electricity and useful heat.

The new spatial planning act offers the possibility to provinces to make waste heat use a *Provinciaal Belang*, Provincial Interest. In doing so a province can direct a municipality to make supply and demand match. Provinces will be encouraged to do so. Additionally, the national government can declare waste heat use a *Groot Openbaar Belang*, Great Public Interest. This will make it easier for heat networks to acquire the necessary permits.

A new tax deduction scheme will make it possible to deduct part of research costs into energy saving solutions. This scheme also applies to heat networks and other waste heat investments. Businesses can give new suggestions of what energy and heating investments are eligible for tax deduction.

Current laws regarding permits for geothermal exploration and exploitation projects are based on old laws about mining. These laws are not suited to the needs of geothermal heat generation. This is why procedures for obtaining geothermal permits will be simplified and accelerated. The mining act also gives the national government the right to demand payment for using a natural resource from a concession holder. Because of the importance of promoting geothermal heating, the government has waived this right.

The national government wants to kick start the development of supply and demand for sustainable heating technologies. Aside from more traditional means like insulation, there has to be attention for solar collectors, heat pumps and passive energy demand reduction. For existing buildings the energy performance has to be improved by 50% in 2015.

The method of measuring energy performance has been overhauled in 2011. This has been done to make it simpler to determine a house's performance as well as taking into account real energy use versus modelled energy use, a dwelling's comfort and the interior environment of a dwelling. A performance grading system for regions will also be made. This shows for instance the availability of collective heating systems.

Heating a building with a gas flame is inherently wasteful. A gas flame's temperature is very high, while demand is for a room temperature of about twenty degrees. It would be more efficient to heat a building with a lower temperature. This also has additional advantages. It increases the potential sustainable energy sources, because a lot of these sources cannot produce a high temperature like a gas flame. It also raises the comfort level of a building by distributing the heat more evenly in a room; low temperature heating often uses floor heating instead of radiator heating. To promote its use, the national government wants to see a standardization of these systems as well as include it in the previously mentioned energy performance index.

In the next chapter the heating situation in Germany will be discussed. The discussion will start with a brief history of energy use in Germany and will continue to discuss the new German Heating Act, the "*Wärmegesetz*"

4. Energy use in Germany

4.1 Introduction

Germany has the third largest economy in the world, after the United States and Japan. Germany consisted of several smaller kingdoms and duchies until unification in 1871. This is why Germany became a federal country. Because of this unification Germany suddenly became a major industrial power. Around this time Germany's energy needs were met by large domestic coal and lignite supplies.

Around the turn of the century oil became more important, especially for war needs. Ships switched from coal fired boilers to oil fired boilers and the invention of the internal combustion engine only added to the importance of oil. Unfortunately, Germany has only very little oil reserves. And because of its late unification it became a major power too late to claim any important overseas colony.

In the first and especially the second world war the quest for oil became a major war goal. In the interbellum Germany imported oil from the Soviet Union, the United States, Romania and the Netherlands (Dutch East Indies). The oil rich Caucasus was an important reason for the German invasion of the Soviet Union in 1941.

Not only violence was used as a means to acquire more oil. The lack of domestic resources lead to a number of innovations to replace a certain foreign resource by a domestic one. An important example is the invention of synthetic rubber, Germany lacked the colonies were natural rubber was produced. In the field of oil the invention of the Fischer–Tropsch process was most important. This invention allows coal -of which Germany possesses huge reserves- to be transformed into oil. In spite of this being an expensive and inefficient process it was extensively used to reduce Germany's dependence on oil imports. The Leuna-Werke near Leipzig was a huge industrial complex which became famous for its production of synthetic fuels, see figure 4.1.

Figure 4.1 Leuna Werke, source: Flickr 2007

After the war Germany lost a lot of territory to Poland, including the industrially important and coal rich region of Silesia. The remaining part of Germany was split in two. The Western part of the country was rebuilt quickly and became a major industrial power. The East of the country lagged behind economically. Energy needs were met by coal and lignite production, some oil and natural gas imports and later on by nuclear power. Coal and lignite mining takes place in open pits. This strips away the upper soil layer and damages huge areas of land , sometimes even entire villages were demolished to mine coal. See figure 4.2 for an example. Because of this and other problems associated with fossil fuels Germany has stimulated energy conservation and renewable energy generation for a long time. As early as 1991 a law was adopted regulating electricity supply to the power grid by decentral systems like solar panels, wind turbines or cogeneration devices. In addition to this there is also a guaranteed minimum price for electricity delivered to the grid generated by renewables. This has given Germany an important edge in sustainable energy technologies. In the area of heating, Germany adopted a new law which obliges owners of new buildings to use renewable energy for heating. This is called the *Wärmegesetz* (Heating Act). In the next section this new law will be discussed.

Figure 4.2 Destructive effects of open pit mining near Hambach, Germany, source: Fasolt 2006

4.2 Sustainable energy laws and the *Wärmegesetz*

As was mentioned in the previous section Germany has adopted laws stimulating the generation and use of sustainable energy. This chapter will start with a brief overview of these laws.

In 1991 the "*Stromeinspeisungsgesetz*" (Feeding-in Act) came into effect. This act obliged the electrical companies to buy electricity from small producers, such as a windmill owner. The act also set minimum prices for renewable electricity. Before this time large electrical companies made feeding-in very difficult or sometimes even refused to allow it altogether. For wind power the law made it possible to let the costs and profits break even. For solar energy this was still far away, as solar technology was quite expensive at the time.

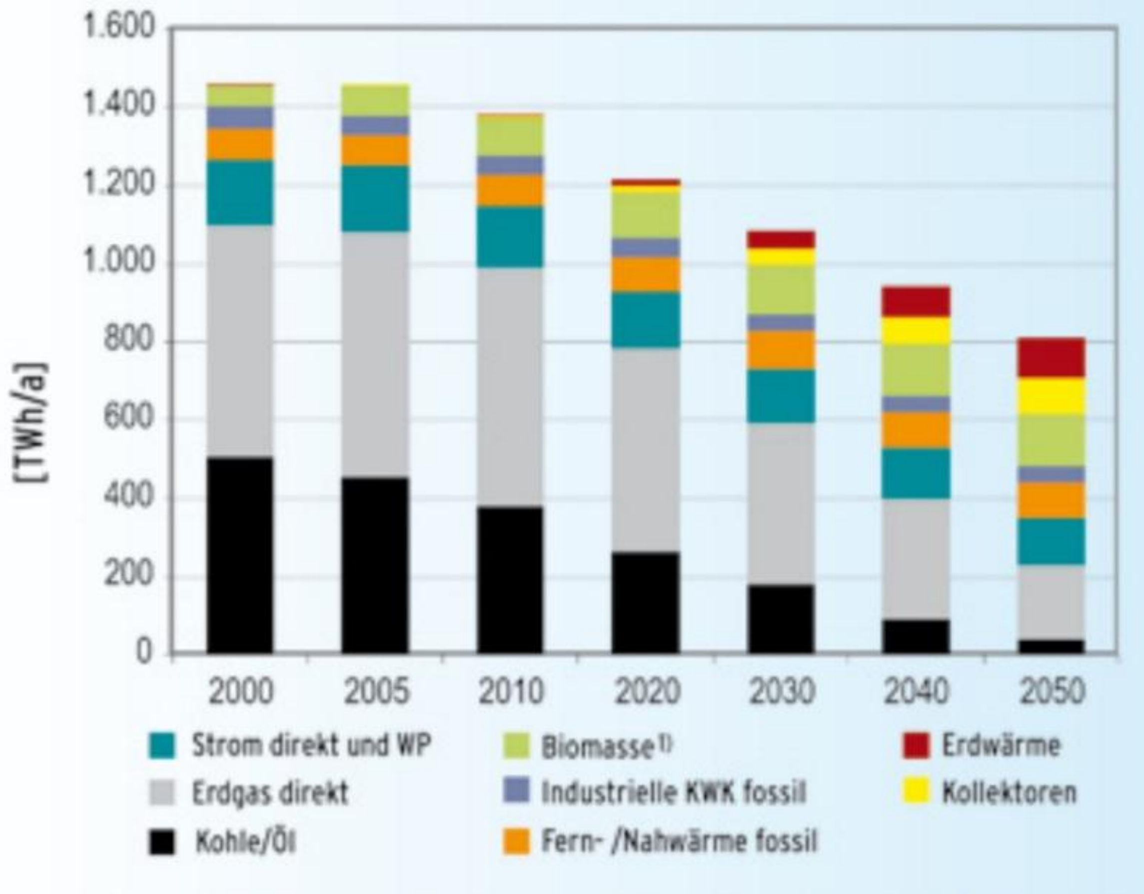


Figure 4.3 Historical and projected energy sources for heating, source: BMU 2008

The second important law was the "*Erneuerbare-Energien-Gesetz,"* the Renewable Energy Act. This piece of legislation, which came into effect in 2000, replaced the earlier Feeding-in Act. It included the new field of geothermal energy as well as an emphasis on subsidizing household scale energy generation. The law was updated on the 1st of January 2004 to include the subsidizing of solar energy which was until then covered by another federal program. Also in 2004 some adaptations were made regarding the legal status of small scale energy suppliers. The obligation to deliver electricity was abolished for this group. As a result of these laws, renewable energy generation has risen sharply since 1990.

In 2009 a new goal was set for the future. By 2020 up to 30% of all energy used should be covered by renewables. Strangely, the renewable energy act only regulates renewable electricity generation. A lot can be gained by tackling heating, as half of energy use is meant for heating. This is why the Heating Act was introduced next to the Renewable Energy Act.

The Heating Act came into effect on the 1st of January 2009. In short, it obliges property owners to use some form of renewable energy to heat their buildings (BMU, 2009, p.10). Its goal is to increase the share of renewables in heating from 6% in 2007 to 14% in

2014, see figure 4.3. The 6% was mainly comprised of wood, which has - although it is a renewable source- the disadvantage of causing fine particles air pollution (Brunekreef, 2002).

The law only applies to new buildings with a useful surface area of 50 m^2 or more, as such it is estimated that at least 150,000 new buildings a year fall under the new law. There are some exceptions like stables, open halls, movable structures and churches. Owners of older buildings are eligible for subsidies to replace their old heating units, this is expected to represent about 650,000 buildings. Initially the law also prescribed a use obligation for older buildings, but this was later amended and removed. However it is expected that with new European Union regulations this obligation will return. The Heating Act is not entirely new, it is partly based on legislation adopted by the federal state of Baden-Württemberg in 2008.

The obligation to use renewable sources can be fulfilled in many ways. The first way is to directly use renewables. Renewables in the sense of this law are geothermal, solar and biomass sources. Each of these three types of renewable sources has its own fulfilment requirements. If one chooses geothermal heat 50% of total heat demand must be covered by geothermal sources. In the case of solar sources this is 15%. In practice the 15% requirement is simplified to a solar collector area of $4m^2$ for every $100m^2$ of a detached or semidetached house's useful area. In the case of biomass it comes down to 50% when using fluid or solid sources like bio-oil or wood and 30% if biogas is used (BMU 209, p. 12). It is interesting to note that Germany does not consider waste heat to be a renewable resource like in the Dutch *Warmte op Stoom* program.

In practice however, waste heat is equal to solid biomass use. The use of waste heat is one of several so-called *Ersatzmassnahmen,* replacement measures. These can be used to fulfil one's legal obligation instead of directly using purely renewable sources. When using waste heat this comes down to a 50% share in the total heat demand, the same as for solid biomass. Another replacement measure is the use of a cogeneration installation. Half of a dwelling's heating demand should be supplied by a cogeneration unit if this measure is chosen. The cogeneration unit has to be at least 10% more efficient than a normal heat-only unit. A third measure is increasing a building's insulation. The level of insulation in this case needs to be 15% more than the level which is already legally required. Finally a property owner can opt for a connection to a heat network of which half of the heat is generated by large scale cogeneration facilities (BMU 2009, p.17,19).

The individual requirements for direct use of renewables and of replacement measures can be combined. For instance one can choose to increase insulation by 7.5% above required levels and cover 25% of heat demand by geothermal energy. Also people can agree to work together and combine their renewables or replacement measures use. The average score of the buildings is then used to fulfil the legal obligation. This is quite useful if for example one house gets more sunlight and the next house is better positioned to use geothermal heat. The authorities check compliance with the new law on a sample basis.

Another goal of the law is to promote the laying out of a heat network which will use renewables, subsidies will be used for this. Local authorities will also be allowed to make a connection to such a heat network obligatory. As was mentioned earlier regional authorities in Baden-Württemberg already adopted a Heating Act in 2008. This act is stricter were older buildings are concerned. As soon as a central heating boiler has to be replaced homeowners are obliged to use renewables to cover at least 10% of their heating needs. Alternatively they can increase their house's insulation levels.

The subsidies will be financed out of the profits of the selling of emission permits. The subsidy package already existed since 2000 but with the adoption of the Heating Act it is the first time it has legal basis. Every year until and including the year 2012 500 million euros are made available in this way.

In the next chapter a SWOT analyses will be presented to compare the Dutch and German sustainable heating policies.

5. Comparing Dutch and German sustainable heating policies

5.1 Introduction

In chapter two the author discussed policy analysis and comparison in general terms. In the following section the specifics will be tackled. As was pointed out in chapter two, a SWOT analysis will be done. The scope of the SWOT-analysis will be narrowed to economic and ecological factors. This is done because these are two elements of sustainability (Gibson, 2001). First the strengths of the German approach will be discussed, followed by the Dutch situation.

5.2 The German situation

In Germany there are a lot of jobs in the sustainable energy sector. This means that there is an important spin-off effect of investing in sustainable energy. In figure 5.1 the number of jobs in this sector is shown for other European Union countries. Note that the Netherlands only has 4400 jobs in this sector. Even though these are absolute numbers the relative numbers are still striking, about 3.25 jobs per 1000 inhabitants vs. 0.26 jobs.

Additionally, because of the high number of jobs in this sector, Germany has more experience in implementing sustainable heating projects and is consequently better able to

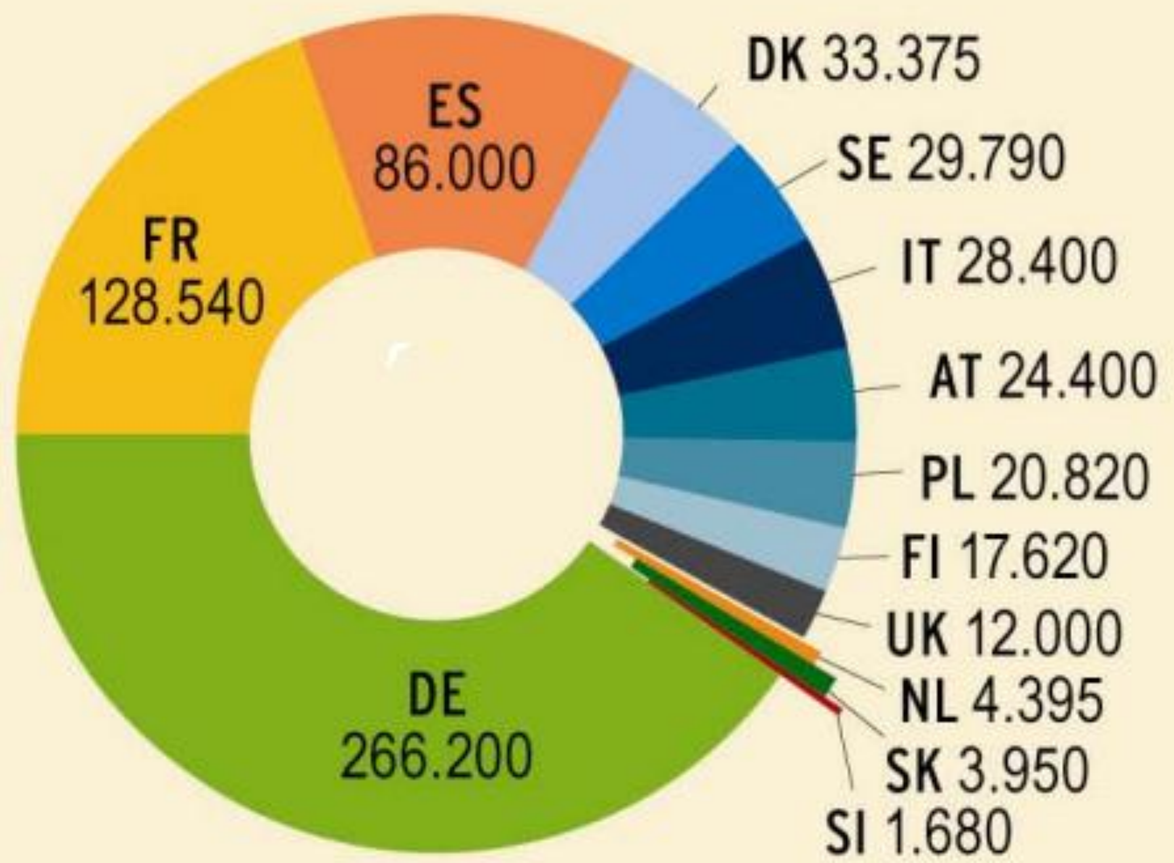


Figure 5.1 Number of jobs in sustainable energy, source: BMU 2010 p. 51

fulfil the potential for sustainable heating. Another important strength is the already high number of households which use district heating, especially in the former GDR. In Germany as a whole this is 13% and in the former GDR 30% (AGFW, 2009 p.8). With the basic infrastructure already in place it is easier to make the district heating systems more sustainable. It also means the concept of district heating is more familiar.

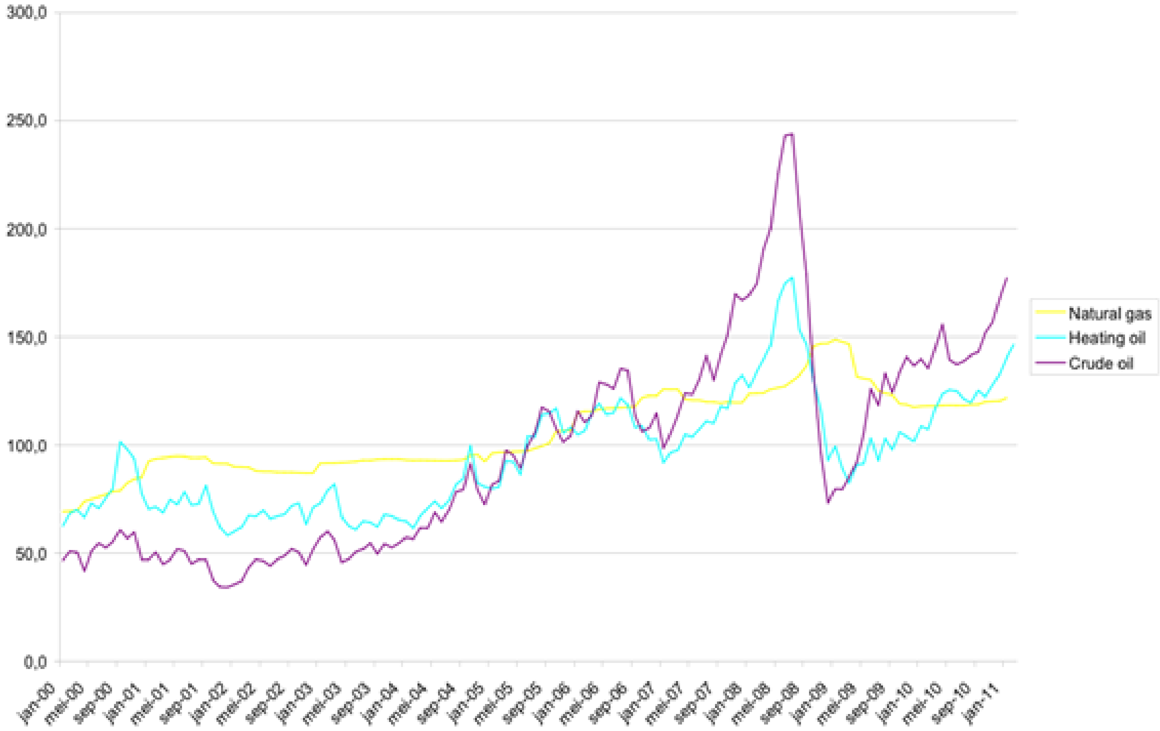


Figure 5.2 Index of crude oil price and German consumer price indices of natural gas and heating oil., source: Author, based on data from EIA, 2011;Destatis, 2011)

The prices of sustainable heating also fluctuate less than the prices of heating by fossil fuels. This makes it easier for consumers considering a sustainable heating solution, to predict if their investment will be economical. (ibid. p. 15) This fluctuation is especially visible in oil prices. Since the 1973 oil crisis, prices have risen and fallen in rapid succession and the trend has been upwards, see figure 5.2 . This is especially important in Germany where heating oil is used in 30% of households. (ibid. p.12) To demonstrate the volatile nature of fossil fuel prices the author looked into academic literature about this theme. Volatility in prices can be measured by calculating the standard deviation of prices. Using the standard deviation as a measure of volatility in stock portfolios was first proposed by Markowitz in his modern portfolio theory (Markowitz, 1959). Using monthly crude oil prices from 1987 to present, the author calculated the standard deviation, which is \$25.0 and the mean, which is \$34.2 per barrel, consequently the coefficient of variation is 0.73. The coefficient of variation is a dimensionless statistical unit used as a measure to describe the dispersion of a variable around its mean value. It is calculated by dividing the standard deviation by the mean (Norušis, 2000, p.66) Because this unit does not have a dimension it becomes possible to compare the fluctuation of prices of different variables. These variables are in this case the heating prices when using different energy sources. A barrel is about 159 litres. However, for German consumers the price of heating oil in their own country is what matters. From 1987 to present the standard deviation of the price of heating oil is €14.29 and the mean price of heating oil is €30.68 per 100 litres, with a coefficient of variation of 0.47 (author, based on data from Destatis, 2011). A conclusion that can be drawn from this is, that although the volatility of heating oil prices for consumers are less than that of crude oil, it is still high.

The index of the natural gas price from 2000 to present for households was used to calculate volatility figures for natural gas. This is considerably less than heating oil at a coefficient of variation of 0.17. This implies that price fluctuation is less of a problem for Dutch consumers, since Dutch heating needs are almost entirely met by natural gas. So in Germany there is a larger consumer incentive to switch to sustainable heating.

The largest share of sustainable heating is the biomass sector. This biomass is mainly comprised of wood. Wood can be burned in traditional stoves and fireplaces but more efficient is a fully automated system which stores wood pellets and burns them when there's a demand for heat in the household. Germany has an advantage in this respect. The country's surface area is 31% covered with forests. This means there's 0.14 hectares of per capita. (BWI, 2012) By comparison there are few forest in the Netherlands. Its surface is only covered by 10.6%. This comes down to 0.022 hectares of forest per capita (Probos, 2011, p.2)

The German government invests large sums of money in sustainable energy, particularly in solar electricity generation and heat generation, see figure 5.3. Besides having

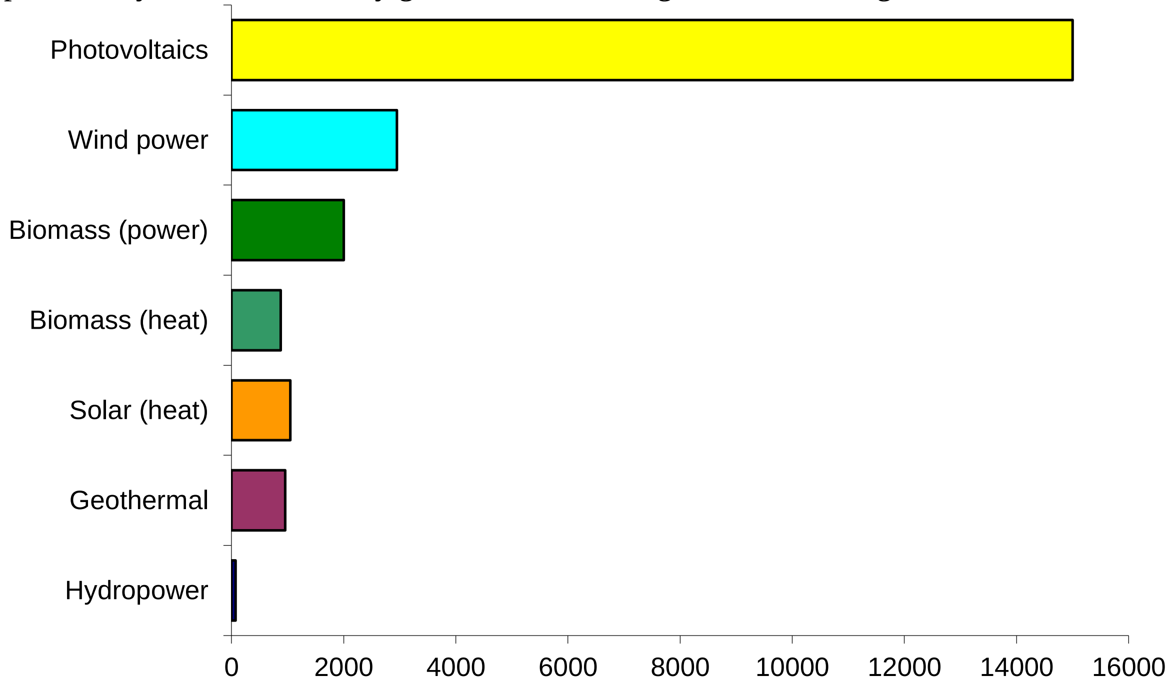


Figure 5.3 Investments in sustainable energy in millions of Euros, source: BMU 2012 p.40

a direct impact on the speed of German adaption of more sustainable energy systems, it also serves to demonstrate an apparent political willingness in Germany to transition to sustainable energy.

Another German strength is the presence of well-informed associations in Germany regarding sustainable energy. For heating the most important one is the AGFW, *Arbeitsgemeinschaft für Wärme und Heizkraftwirtschaft.* This association is a cooperative effort of over 200 heat supplying companies. The association's actions are providing legal and technical assistance, lobbying in politics and giving tips for an efficient organization. It should be noted however that a business association's loyalty is first and foremost to its members. At this juncture the interests of making the heat supply more sustainable and the interests of the company members coincide. Were this to change then a strong business association might put a brake on new innovations and new competitors that it sees as potential threats to its position.

An institutional factor is the organization of the utility companies in Germany. In Germany these are organized along geographical lines and not sector lines. That is to say every city has its own utility works called *Stadtwerke*, city works. These works provide services from power supply to waste disposal, water supply, heating, telecommunications, sometimes even public transport etc. This is in contrast to the Netherlands where there is an energy company, a waste company, public transport company and so on. With some exceptions these companies are active in the entire country and sometimes even abroad. The German local companies are public property and run either directly by the city municipality or semi-autonomous but still owned by the municipality.

A local approach means these companies are more suited to adapting to local needs and opportunities. It can be assumed that they know a great deal about the local situation and they can use this knowledge to organize a more efficient energy system than a larger scale company. Because of the public nature of these companies they do not have to provide a profit for their shareholders like in the Netherlands. This promotes a long term investment in sustainable systems since an incentive for short term profits is not there. Additionally any profits that may still be generated at least flow back to the community and is possibly even invested in turn to promote a transition to a more sustainable energy system.

There are also a number of external opportunities helping the German expansion of sustainable heating. Oil prices reached $145 per barrel in July 2008, right before the start of the financial crisis an then plummeted to $30 at the end of that year. Since then the economy has been recovering and oil prices are already back up to about $90 in January 2011 (oil-price.net, 2012). The U.S. Energy Information Administration predicts oil prices for 2012 to be about $98 (EIA, 2011). Long term predictions are of course more difficult but in this thesis the assumption is that the prices will rise further, this assumption is based on research done for the German government (Schlesinger et al., 2010, p.30). The rising oil prices mean that conventional heating using oil and natural gas- the price of which is based on the oil price- will become ever more expensive. This in turn means that sustainable heating will become more competitive. This is potentially a major opportunity for expanding sustainable heating since 30% and 49% of Germans households use heating oil and natural gas respectively as a heating source (AGFW, 2009; Destatis, 2011)

Another point, which is connected to the higher oil prices and to climate concerns is the price of CO_2-emission certificates. These will also rise. (Schlesinger et al., 2010, p.30) It is to be expected that suppliers of conventional heat will offset these higher prices by increasing the prices they charge their customers. Having lower CO_2-emissions, this will also enhance sustainable heating's competitiveness.

5.3 The Dutch Situation

After having discussed German strengths and opportunities about sustainable heating, the Dutch strengths and opportunities will now be discussed.
Unfortunately, the Dutch strengths are not so numerous as the German ones. One strength is the density of the Dutch population, especially in the west of the country. See figure 5.3. In densely populated areas it is cheaper to connect a large number of households to a heat distribution network. Of course, it can be argued that population density is also a German strength, since Germany is also densely populated. But the object of a SWOT is to compare two entities. Dutch population density is 491/Km^2 and German density is 231/Km^2.

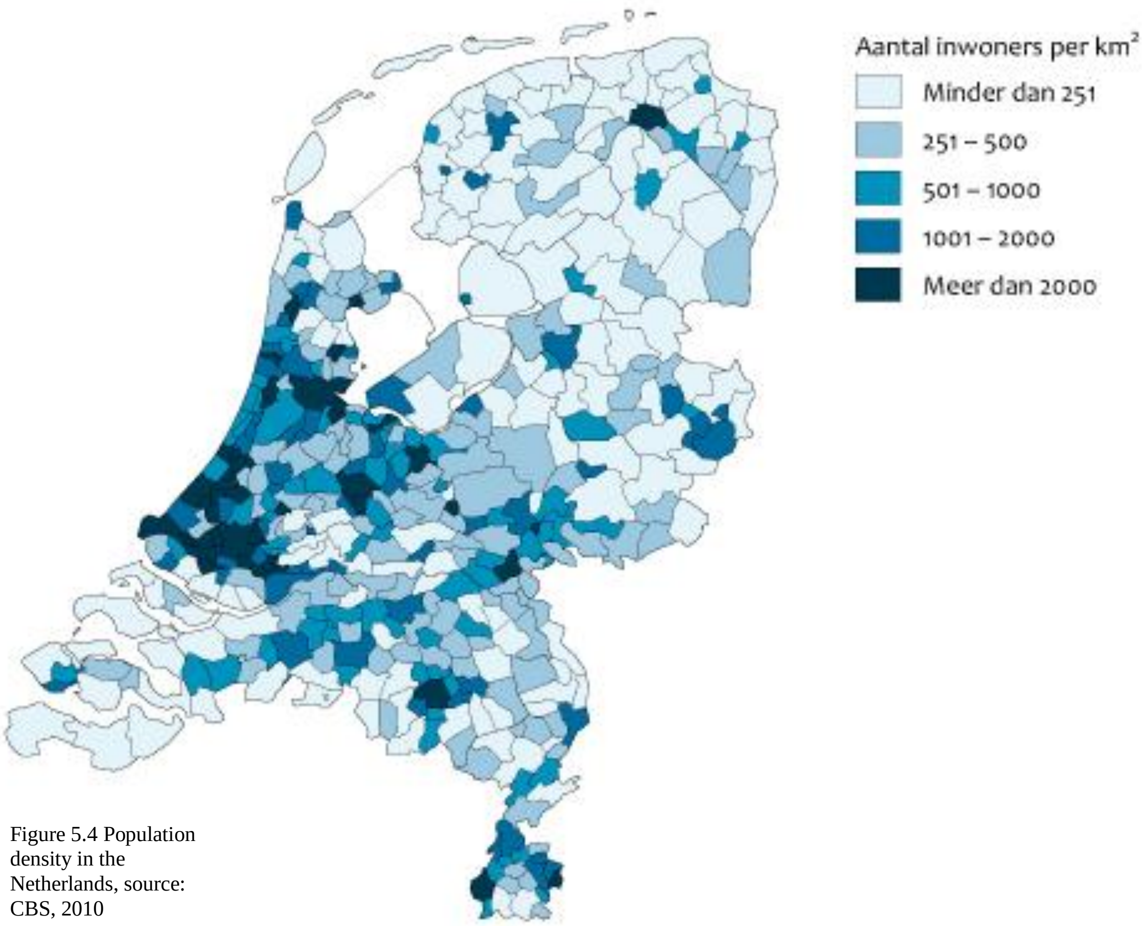


Figure 5.4 Population density in the Netherlands, source: CBS, 2010

However, population density is somewhat misleading. National density does not say anything about concentrations of the population in the country. What would be more useful is a measure of the intra- and interurban density i.e. the population density in the cities and the distribution of cities in the country. An effort to measure this was made by the author by comparing the population densities in both countries' one hundred most populous cities as well as calculating the average number of cities a particular city has within a 50 km radius. For example: The city of Essen in Germany has 25 other cities of the largest 100 cites in a 50 km radius. This figure is calculated for every city and subsequently averaged. It was found that the average density of Dutch cities is 3985/Km^2 and the average German density is 1554/Km^2. The average number of cities within a 50 km radius in the Netherlands is 19.3 and in Germany 7.6 (author, based on data from CBS, 2011; Destatis, 2011) This means that Dutch cities are both denser and more tightly clustered. The process by which the author has reached this conclusion is described in appendix one.

There are however several serious weaknesses of the Dutch situation. Some of these weaknesses are due to the relative Dutch abundance of domestic natural gas.
About 99% of Dutch households have access to natural gas (Environmental Change Institute, 2011) and use it to heat their homes and to cook. This is in sharp contrast with the German situation where heating sources are more diverse, see figure 5.4. The use of natural gas for heating has a smaller carbon footprint than for example heating oil, which is still widely used in Germany. However, the extensive natural gas infrastructure holds back development of a competing heat distribution network.

Some towns in the Netherlands do have district heating systems, however many people have no experience with other means of heating than natural gas. This unfamiliarity of other heating systems is holding back innovations in sustainable heating.

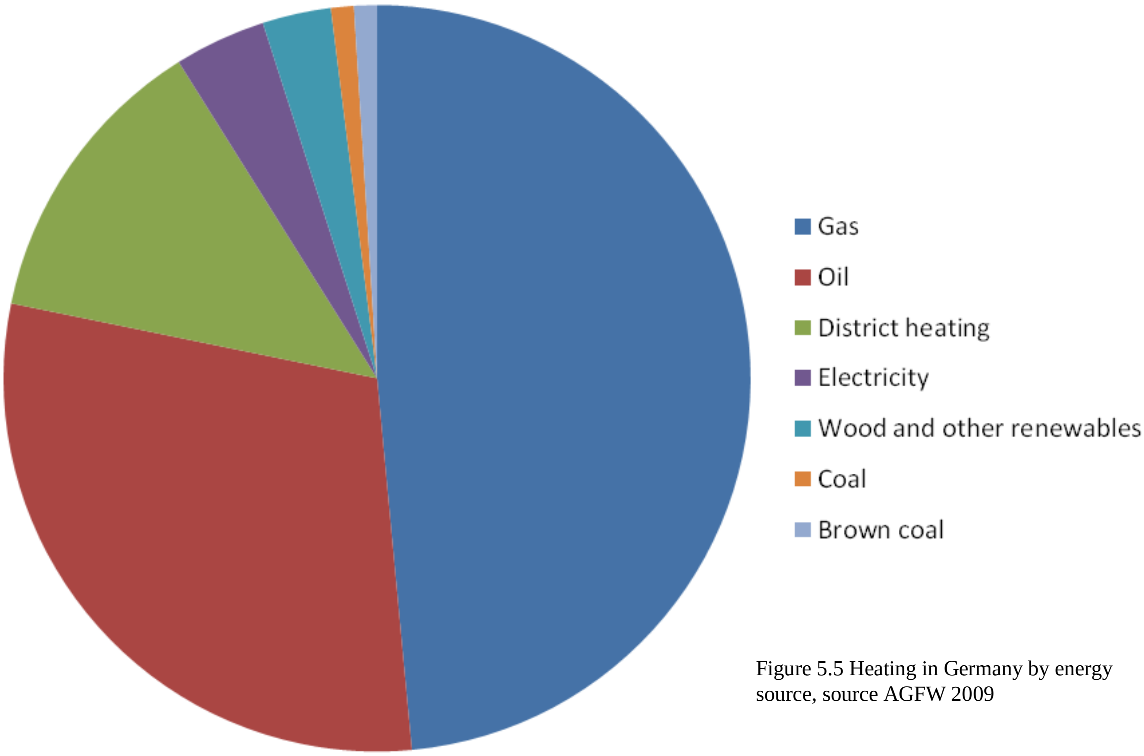


Figure 5.5 Heating in Germany by energy source, source AGFW 2009

Even though the Dutch government has set a goal of 20% sustainable energy of total energy consumption by 2020, the Dutch government's investments in sustainable energy are lower than the German investments, even relative to population size.

Possibly even worse, subsidy policies in the Netherlands have long been inconsistent. Whereas some subsidies in Germany date from 1991 and are still in effect today, consecutive Dutch governments have abolished and subsequently re-instated various sustainable energy subsidies. In general, conservative governments have emphasized short term cost savings over long term environmental gains. Considering the fact that the use of sustainable energy is more costly in the short term than conventional energy, subsidies are needed to make an investment by a homeowner worthwhile. This inconsistency has made it difficult for consumers and businesses to make investments, since long term investments in sustainable energy systems are worthwhile for them if sustainable energy's higher price was compensated by a subsidy.

Not surprisingly, the number of jobs in the sustainable energy sector in the Netherlands is lagging behind with a mere 4,400 jobs compared to Germany's 262,000 (BMU, 2010). Consequently there is little expertise in the workforce to expand sustainable energy systems.

An external threat with a large impact is the oil price. As was pointed out in the discussion about Germany's opportunities to sustainable heating, the oil price is expected to rise. For a medium timeframe to 2020 this will probably be a threat to the development and expansion of Dutch sustainable heating systems and consequently detrimental to achieving the 20% sustainable energy share goal by 2020 the Dutch government has set for itself. Because of the large domestic gas deposits and the link between the price of natural gas and that of oil, the government's revenue from sale of this gas will also rise. In 2008 this was a record €14.8 billion; a share of 9.8% of total government revenues (CBS, 2009). This raises the question whether the government is willing to subsidize sustainable heating systems, a competitor to natural gas consumption. It should be noted however that natural gas prices for consumers are not related to oil prices at a 1 to 1 ratio. Gas prices are based on average oil prices during the last half year, thus gas prices lag behind oil prices (Infonu, 2011). In the long run however, the gas deposits will run out. As of 2007 two thirds of the original natural gas supplies have already been depleted. This means that in the long run the oil prices will change from a threat into an opportunity.

Compared to Germany, sustainable energy in the Netherlands still seems to be in its infancy. This view is supported by the fact that the share of sustainable sources in final energy consumption for heat in 2007 was 2.3% compared to Germany's 8.5% (Eurostat, 2010)

The findings of the performed SWOT analysis are summarized in the SWOT table below. In the next chapter ways to mitigate the Dutch weaknesses will be discussed. Possibilities for policy transfers from Germany to the Netherlands will be emphasized in that chapter.

Strengths		Weaknesses	
Germany High number of jobs in sector More expertise in sustainable solutions District heating familiar Large government investments Sector trade association More forest per capita Local cross-sector utility works (*Stadtwerke*)	Netherlands Cities densely populated Cities closely clustered	Germany Interests of business association may diverge from sustainability	Netherlands Extensive natural gas network Inconsistent subsidy policy Low government investments Sparse forests
Opportunities		**Threats**	
Germany Rising prices of non-renewables High fluctuation in price of non-renewables Rising price of CO2 emission certificates		Germany (Law of the handicap of a head start)	Netherlands Rising prices of natural gas (short medium term)

Table 5.1 Results of the SWOT-analysis, a SWOT-table

6. Transferring policy

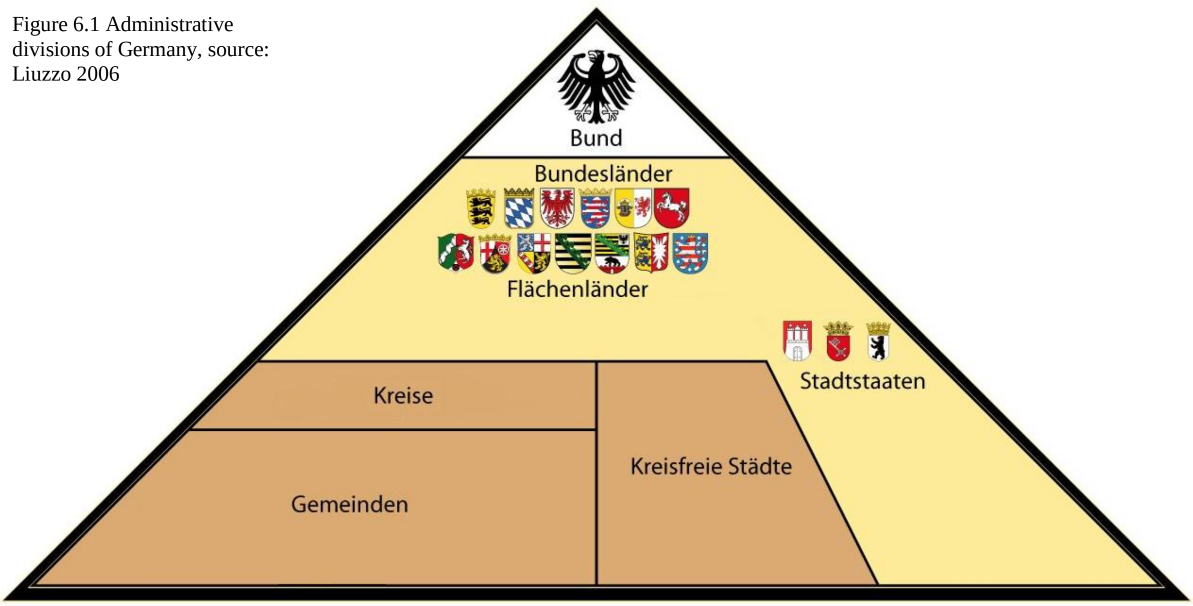
6.1 Introduction

The SWOT analysis in the previous chapter was made to identify areas of improvements regarding a move to sustainable heating. While a lot of the factors discussed in the last chapter are out of a government's control, some factors are related to government policy. One government's policy might be better in one respect and another government's policy might be better in other respects. When this is the case it can be mutually beneficial to engage in policy transfer from one country to another. Policy transfer has been extensively written about. An important article in this respect is the article by Dolowitz and Marsh (Dolowitz et al., 1996).

Dolowitz and Marsh describe policy transfer as follows: "Policy transfer, emulation and lesson drawing all refer to a process in which knowledge about policies, administrative arrangements, institutions etc. in one time and/or place is used in the development of policies, administrative arrangements and institutions in another time and/or place." (Dolowitz et al., 1996, p. 344)

It should be noted that governments in this sense are not only national governments. In Germany there are four different levels of government. These are the federal, state/city-state,

Figure 6.1 Administrative divisions of Germany, source: Liuzzo 2006



regional and local levels. In German these are *Bund, Länder, Kreise, Gemeinde, Städte* respectively. There are some peculiarities in Germany's territorial divisions. For instance the city states of Berlin, Hamburg and Bremen have all three lower levels combined in to one administrative unit. Also some larger cities are not part of a *Kreis*, they form their own administrative unit, these are so-called *Kreisfreie Städte*. At the lowest level smaller cities form a *Stadt*. Municipalities (*Gemeinde*) are predominantly rural areas. Figure 6.1 provides some clarification. In the Netherlands the situation is simpler. There is the national level, provincial level and municipal level. In Dutch these are *Rijk*, *Provincies* and *Gemeenten*, see figure 6.2

Dolowitz and Marsh argue that policy transfer is not simply lesson drawing. Although appropriate in some cases like learning form another's mistakes, the word learning would imply a free choice in drawing lessons or choosing not to do so. They argue that "an important category of policy transfer involves one government or supra-national institution pushing, or even forcing, another government to adopt a particular policy."(ibid.). As such a distinction can be made between voluntary and coercive transfer of policy.

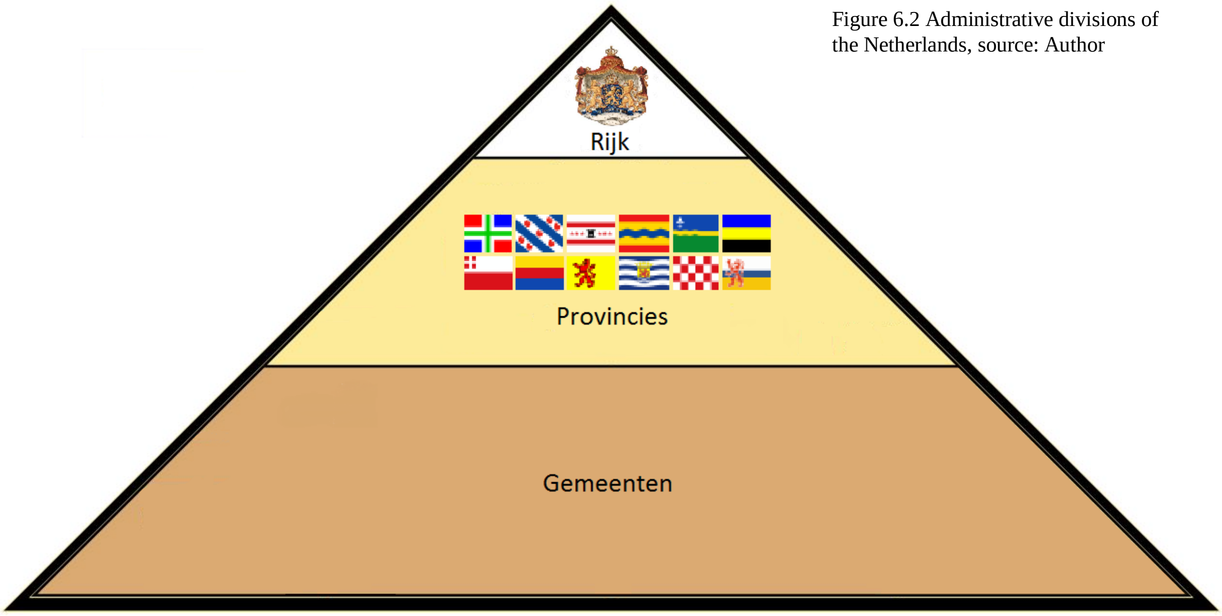


Figure 6.2 Administrative divisions of the Netherlands, source: Author

6.2 Voluntary transfer

Voluntary transfer happens when governmental agencies – dissatisfied with a policy- become aware of the policies of other agencies and that by adopting those policies their own situation can be improved. A policy can be adopted entirely and unchanged, although this is rare. More often parts of a policy are transferred and modified to suit the adopting government's needs. There are many obstacles before transfer can take place. First of all there has to be the idea that another government's policies are actually better than one's own. It is not enough for external parties, like for example NGOs, scientists or the general public to believe that another agency's policy is preferable, the agency itself will have to think so as well. External parties can however start a discussion about which policy is preferable. The result of this discussion may impact election results. Polsby (1985) argues that elections are often policy changing events, especially in presidential systems.

Additionally, the question whether to adopt another agency's policy is first and foremost a political one. Especially in a democratic context, the decision making process can be very complicated. This process also varies from one country to another. In the comparison between Germany and the Netherlands it should be noted that both countries have a parliamentary system. This means that the governments of both countries always need to have the support of a parliamentary majority. The parliamentary system in both countries is based on the principle of proportional representation, with an election threshold in Germany of 5%. This in contrast to for example the UK's and the US' plurality, winner takes all, system where a parliament seat is given to the person with the most votes in a district.

Germany and the Netherlands differ greatly however in their organization of the tiers of government. Germany is a federation whereas the Netherlands is a unitary state. This means that in the Netherlands the power of the central government is relatively larger than the power of the federal German government. In contrast, the power of the second tier of government is larger in Germany than in the Netherlands. In short: German *Länder* are more powerful than Dutch provinces. This in turn means that German states have a far greater autonomy where sustainable energy is concerned. This is especially striking when comparing Berlin, Hamburg and Bremen which are city states, to Dutch cities, which are third tier government. To sum up the political systems: The Netherlands and Germany are unitary respectively federal parliamentary states with proportional representation.

Given this basic organizational context, the deeper institutional context also varies greatly. Probably the most important factor in this deeper context is the relationship between fossil fuels and the political system in the Netherlands and Germany. Starting with the former it is interesting to note that fossil fuels and more broadly speaking other raw materials as well were more abundant in the Dutch context than in the German one. This is largely due to the long colonial history of the Netherlands. By far the most important part of this history concerns the Dutch Indies, present-day Indonesia. In 1890 the Royal Dutch Petroleum Company was granted a charter to prospect for oil in the Dutch Indies. Oil was indeed found on Sumatra and the Netherlands became an oil producer. The Royal Dutch Petroleum Company merged with the British Shell company in 1907 and became the largest oil producing corporation in the world.

After independence the Dutch lost control over this resource but by that time the Shell company had already become very important for the Dutch economy. The government's interests and Shell's interests ran parallel and were intertwined. Even today this relationship remains very strong. Later in the 20th century the bond of the Dutch government with fossil fuels was increased further when large natural gas reserves were found in the north of the country. The income for the Dutch treasury through the sale of natural gas, the proceeds of fuel duties and the tax income paid by Shell is very large. As a result a path dependence on fossil fuels has emerged in the Dutch context.

This path dependency has reinforced the country's link to fossil fuels and as a result switching to other energy supplies has become increasingly difficult. This is a phenomenon called lock-in. See figure 6.3 for an illustration. In this figure the Dutch situation is in phase three. A clear example of this lock-in is the almost total dependence on natural gas for residential heating.

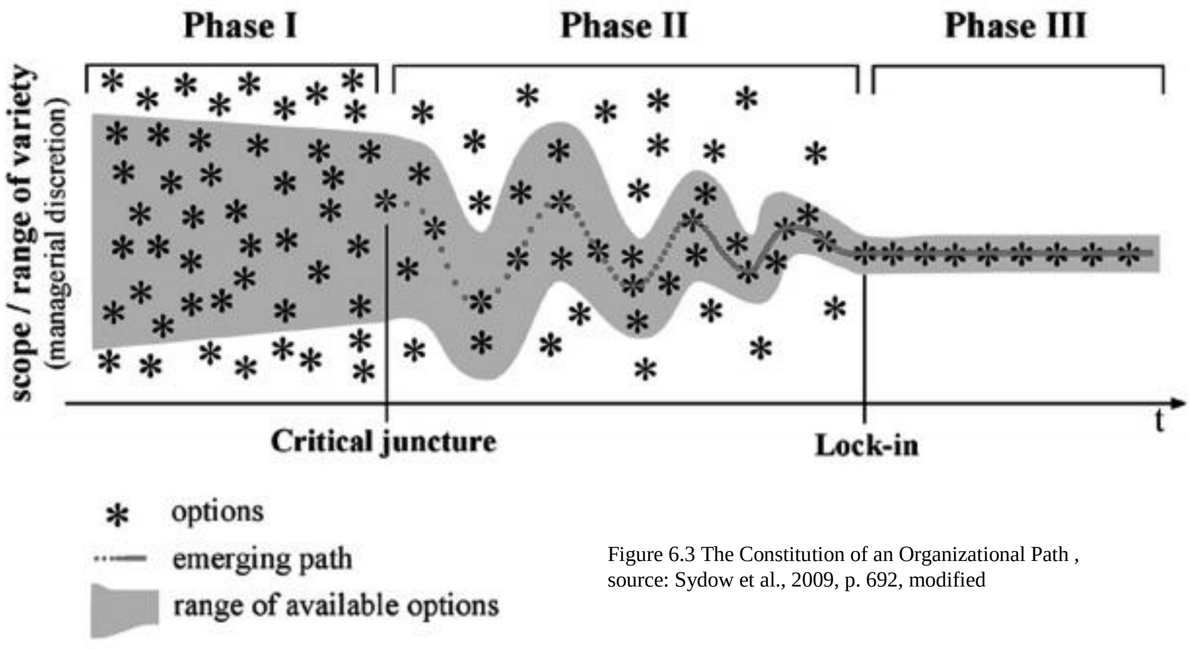


Figure 6.3 The Constitution of an Organizational Path , source: Sydow et al., 2009, p. 692, modified

The German situation is different. The German state was only unified in 1871. As a result of this Germany never was a major colonial power and oil always had to be imported.

In both world wars the absence of indigenous oil reserves and other natural resources were a major handicap for the German war effort. Indeed, a goal of German strategy was to gain control over these resources, especially in Romania and Russia. The absence of oil and rubber also led to some technical innovations. Due to the boycott of Germany in the first world war, Germany was unable to purchase oil and rubber. Chemical processes were invented to alleviate these problems. As was mentioned earlier the Fischer-Tropsch process allowed for the production of petrol out of coal, of which Germany had plenty and similar processes were invented to produce synthetic rubber.

Because there are no large oil and natural gas reserves in Germany it is not surprising that there is no large German oil company. Germany also has to import its natural gas, which is subject to volatile costs and at times the security of supply is unreliable. The large power company RWE relies on coal for 56% in its fuel mix (RWE, 2011). However, the share of this company in the German economy is much lower than Shell's. Because of this its influence on the German government is lower than that of Shell on the Dutch government. In short, a path dependence on fossil fuels has never emerged in the German context. Instead a history of technical innovations exists. In figure 6.3 the German context should be placed somewhere around the end of phase one. Given these circumstances it is not surprising for the German government to advocate a move to sustainable energy.

6.3 Coercive transfer

According to Dolowitz and Marsh coercive transfer can either be direct or indirect. A direct transfer of policy from one country to another is rare. Much more common are policies that supranational organizations impose on countries. A good example of direct coercive transfer is the policies the International Monetary Fund imposes on countries which are in need of capital. In the past this has happened in a lot of third world countries. A current example would be the strict austerity measures the IMF is imposing on Greece as a result of that country's debt crisis.

What can be seen as indirect coercive transfer are the regulations the European Union is imposing on member states. This is however not coercive in a strict sense, as individual member states can block the adoption of new policy. This happened in the case of the European Constitution where referendums in France and the Netherlands blocked its adoption. Once ratified however the voluntary part of the transfer ends and member states are obliged to carry out the new policy. For example, current EU policy obliges The Netherlands to attain a 14% share in renewables in 2020.

Dolowitz and Marsh identify five factors that can play a role in indirect coercive transfer. First there is functional interdependence. An example of this are Canadian environmental regulations which were drawn up mainly to deal with the effect of cross-border US pollution. A situation like this does not exist between Germany and The Netherlands, at least not where energy issues are concerned.

Second, there is the rapid pace of technological developments. Especially in the case of IT-technologies countries look to experiences of early adopters to draw lessons on how to deal with new problems caused by new technologies.

Another factor is the world economy. Under the influence of globalization and freedom of the movement of capital rules and regulations in for example the banking sector have become similar in most countries.

A fourth factor, though less coercive is the perception of influential political forces that a country is lagging behind in an important matter. Dolowitz et. al give the example of Canada's car emission standards which were based on the American standards because Canada was felt to be lagging behind in the matter of environmental regulations. In the Dutch case however, these influential political forces are obviously not influential enough.

Finally international consensus can play an important role. If an international problem has been recognized and defined in a certain way by most nations and there is agreement on how to deal with the problem, countries not adopting this course of action will come under increasing pressure to do so. In this case European consensus is a more relevant issue. Obviously there is consensus on what to achieve i.e. the reduction of CO_2-emissions. However, there is no consensus on how to achieve this reduction.

Why Transfer? Continuum Want To............. Have To			Who Is Involved in Transfer?	What Is Transferred?	From Where			Degrees of Transfer	Constraints on Transfer	How To Demonstrate Policy Transfer	How Transfer leads to Policy Failure
Voluntary	Mixtures	Coercive			Past	Within-a Nation	Cross-National				
Lesson Drawing (Perfect Rationality)	Lesson Drawing (Bounded Rationality)	Direct Imposition	Elected Officials	Policies (Goals) (content) (instruments)	Internal	State Governments	International Organizations	Copying	Policy Complexity (Newspaper) (Magazine) (TV) (Radio)	Media	Uniformed Transfer
	International Pressures		Bureaucrats Civil Servants	Programs	Global	City Governments	Regional State Local Governments	Emulation	Past Policies	Reports	Incomplete Transfer
	(Image) (Consensus) (Perceptions)									(Commissioned) (uncommissioned)	
	Externalities	Pressure Groups	Institutions			Local Authorities		Mixtures	Structural Institutional	Conferences	Inappropriate Transfer
	Conditionality	Political Parties	Ideologies					Inspiration	Feasibility	Meetings/ Visits	
	(Loans) (Conditions Attached to Business Activity)								(Ideology) (cultural proximity) (technology) (economic) (bureaucratic)		
	Obligations	Policy Entrepreneurs/ Experts	Attitudes/ Cultural Values						Language	Statements (written) (verbal)	
			Consultants Think Tanks Transnational Corporations Supranational Institutions	Negative Lessons			Past Relations				

Table 6.1 A policy transfer framework source: Dolowitz et al. 2000

A conceptual framework

In a later publication, Dolowitz and Marsh made a conceptual framework. In this framework they also explicitly mention other typologies (Dolowitz et al. 2000). They identify voluntary and coercive transfer as the why-question. Others include who is involved? What is transferred and from where? See table 6.1.

It is worthwhile noting that Dolowitz and Marsh do not consider voluntary and coercive transfer to be completely separate. There are often grey areas. Policy makers seldom feel complete freedom in their transfers. There is usually some kind of pressure, mostly international. In the next section Dolowitz and Marsh's framework will be applied to Dutch and German district heating systems.

Applying the framework to Dutch and German heating systems

As was discussed in section 5.2, German district heating systems are more extensive and widespread than Dutch district heating systems, especially in the former GDR. Expanding the district heating system in the Netherlands can be helpful in attaining the renewable energy goals for 2020. Which German policies concerning district heating can be transferred? In order to help answering that question an attempt will be made to fill in the conceptual framework.

It is difficult to maintain that any transfer of policy will be just drawing lessons i.e. be entirely voluntary. After all an agreement was reached in the European Union to achieve a certain share of renewable energy by 2020, this is an obligation. While it is true that most political parties in the Netherlands are in favour of expanding renewable energy, it is difficult to determine the true extent of their commitment to this cause. In any case their reasons differ. Some parties stress the importance of reducing carbon emissions while others refuse to believe these emissions are having any effect on the climate and are stressing supply security and energy independence. In short, it is safe to say that there are currently no political parties which can or want to force a transfer of German policies to the Netherlands.

In Germany the political situation is different. The national political systems are quite similar; both have a system of proportional representation although Germany has a 5% election threshold, see also paragraph 6.2. Similar is also the influence of the christian democrats and social democrats. An important difference on the one hand is the larger share of the green party. As early as 1983 the German green party *Die Grünen* had 5,6% of the votes for parliament. The Dutch green party *Groen Links* was not even founded until 1990. This electoral success culminated in the coalition government of the greens and the social democrats from 1998 to 2005. In the Netherlands the greens have never been part of a coalition government. It is difficult to ascertain if the rise of the greens were the cause or the effect of environmental issues becoming mainstream in politics. What can be said however is that environmental issues have played a more important and earlier role in German politics than in Dutch politics. On the other hand is another important difference. Whereas in the Dutch political system the green party plays a smaller role, the liberal party plays a larger role. The Dutch liberal party *VVD* is a successor to pre-war Dutch liberal parties and was founded in 1948. Since the size of parliament was increased from 100 to 150 seats in 1959, the party has held on average about 25 seats or 17%. In contrast the German liberal party FDP has had around 9% of the vote on average since 1949. Liberal parties tend to emphasise the free market and are generally averse to government regulation, intervention and subsidies.

At this moment there are thirteen Dutch district heating systems with more than 5,000 customers. These are owned by large private power companies like Essent and Nuon. There is one exception, this is the district heating of Purmerend which is owned by the municipality of

Purmerend (Schepers et. al., 2009). In Germany most district heating systems are owned by companies who only operate in their own home cities. These so-called *Stadtwerke* or city works often provide not only heat, gas and power but also water, waste disposal and public transport services. Although these companies are nominally privatised, the shares of these city works are usually controlled by the municipality itself. They were briefly discussed in section 5.2.

The Dutch situation is entirely different. Energy suppliers are usually large privatised companies often operating internationally. Their shares are usually owned by private parties. Their primary motive is profit maximisation. This motive tends to override all other motives. Making the energy mix more sustainable is not a priority. Long term strategy is inferior to yearly dividends and share prices. Ironically it could be concluded that the EU's energy market liberalization policy contradicts its sustainable energy policy. Interestingly Dutch cities and provinces used to have local and regional energy companies. These were usually founded around the turn of the twentieth century. Over time these companies merged and became companies like the aforementioned Nuon and Essent. These larger companies were privatised. At first their shares were held by municipalities and provinces, but were sold later on to foreign energy companies. Nuon was sold to the Swedish company Vattenfall, ironically completely owned by the Swedish government. Essent was bought by the German based company RWE. This company is mostly owned by German and international institutional shareholders. Both of these companies are mostly active in the electricity market.

An advantage of the German situation is that profits will flow back to the own city, even though not necessarily in investments in the energy sector. In addition the Stadtwerke know the situation in their own cities. This makes them optimally suited to making use of local conditions. Heat is less suited to be transported over long distances than electricity. Because of these reasons it makes sense to solve heating problems locally by a local company.

In some Dutch cities local energy companies have been re-founded. Unfortunately past experiences are not helping these initiatives. In the case of Purmerend, the local district heating service which provides heat to 70% of local households, had a bad image (Van den Burg, 2011). Households that were connected to the heating system were not connected to the natural gas system. This meant that these households had no choice but to use the heating service and electricity had to be used for cooking, which is less efficient than natural gas. In addition heating prices were not lower than would have been the case if natural gas had been used. Nevertheless the service operated at a loss throughout its existence, the municipality of Purmerend had to cover the losses. Needless to say this did not motivate other municipalities or the central government to expand district heating systems. On top of this there were reliability issues. In 2008 the situation was improved and the service is currently running at a low profit (Van den Burg, 2011). The Purmerend case provides valuable lessons for future local district heating systems because it has demonstrated pitfalls for local energy companies.

In conclusion there are many obstacles holding back the adoption of German policies or more sustainable policies in the Netherlands. When they are considered on an abstract level the obstacles can be summed up as lack of political will. This lack of political will mainly manifests itself at the national level. Despite this, regional and local governments can still attempt to adopt sustainable policies of their German counterparts. After all there are cultural and language similarities and geographical proximity. In addition the European Union should use its power to force the Netherlands to adopt more sustainable policies, in other words coercive transfer would be called for. These policies do not necessarily have to be German. Danish policies for instance also have a good reputation regarding sustainable energy (Van der Slot & Van den Berg, 2011, p.6).

In the final chapter some conclusions will be drawn and recommendations given.

7. Conclusions and recommendations

7.1 Introduction

In this chapter the author will attempt to draw some conclusions based on the previous chapters. In addition the author will give some recommendations on how to increase the share of sustainable heating.

In chapter one the author wrote that land use planning can be used to influence the spatial order with the aim of attaining societal goals. For the scope of this thesis this goal has been increasing the share of sustainable heating. As was also mentioned in the first chapter, it is insufficient to look exclusively at the spatial dimension of this issue. Other dimensions such as social, economic, institutional and political dimensions have to be taken into account as well. It was decided to compare the Netherlands and Germany. Both for practical reasons and because Germany has a reputation of being a frontrunner in the field of sustainable energy. Perhaps some of Germany’s policies regarding sustainable heating could be transferred to The Netherlands to alleviate the lagging behind of this country.

7.2 Revisiting the research questions

Seven research questions were posed in the first chapter. The first was about the concept of sustainability. What does sustainability mean? The author also briefly reflected on its relationship with renewability. The concept was first discussed in general terms. Although the concept itself is fuzzy, a practical approach was found in adopting the Trias Energetica approach. This tackles the second research question: What can be done to make heating

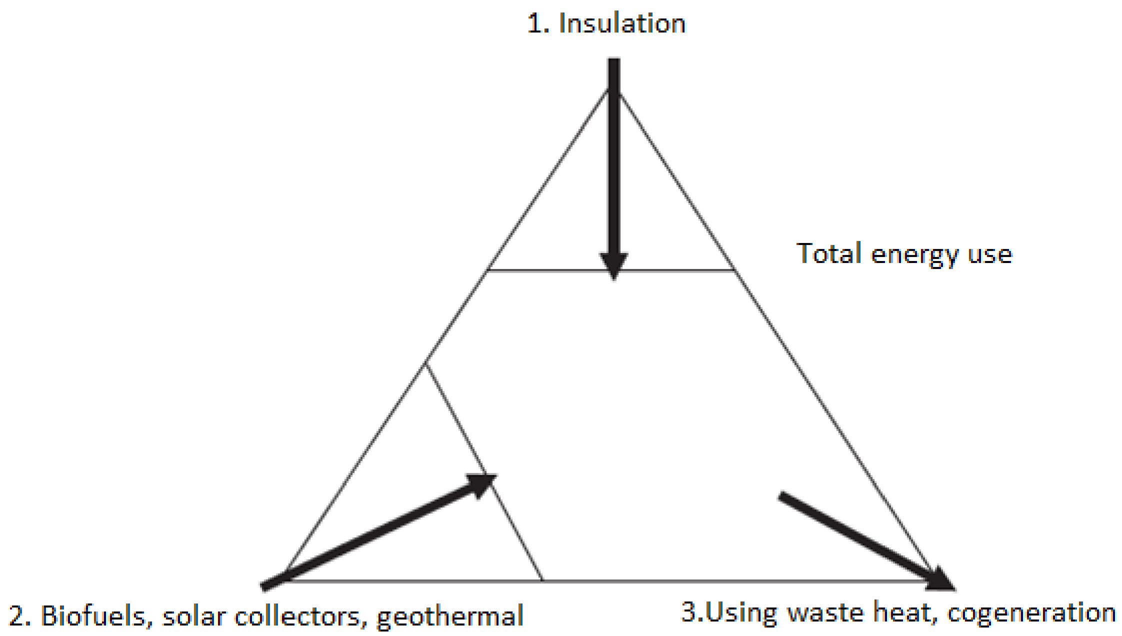


Figure 7.1 The Trias Energetica applied to heating, source: Author based on Entrop & Brouwers 2010, p. 302

systems more sustainable? This concept entails saving energy, making use of renewable energy sources and when having to use non-renewable sources use them as efficiently as possible. This approach was used to translate the general concept of sustainability to what this concept means for heating specifically, see figure 7.1.

When considering the three stages in the Trias Energetica the author argues that local circumstances are key to implementing these stages. These circumstances help to adopt the most cost-effective approach for a given location. For example a location's proximity to sources of waste heat make it useful to use this waste heat as a heating source. A location's population density is also important, in dense areas a heating network can be more cost-effectively built and maintained than in an isolated area in the countryside. After all a "network" to transport waste heat to just one isolated household would be far too costly compared to the expected results. Instead rural areas could benefit more from the use of biofuels. In forested areas this could be firewood, in agricultural areas this could be sources like manure or other fermented agricultural waste.

It is also important to ascertain if the expected benefits offset the costs. For example if a building is already well insulated, then a higher level of insulation will probably have less benefit than the insulation already in place. Conversely if a building already has a solar collector but poor insulation it would likely be better to improve the level of insulation than to construct a second solar collector. In short it can be said that the higher the level of implementation of any of the three stages the more difficult and costlier it becomes to increase this level even further, see figure 7.2 . In other words, the author argues that there is an effect similar to the law of diminishing returns. This is a 200 years old concept which states that the positive effects of investments on production taper off at a certain point.

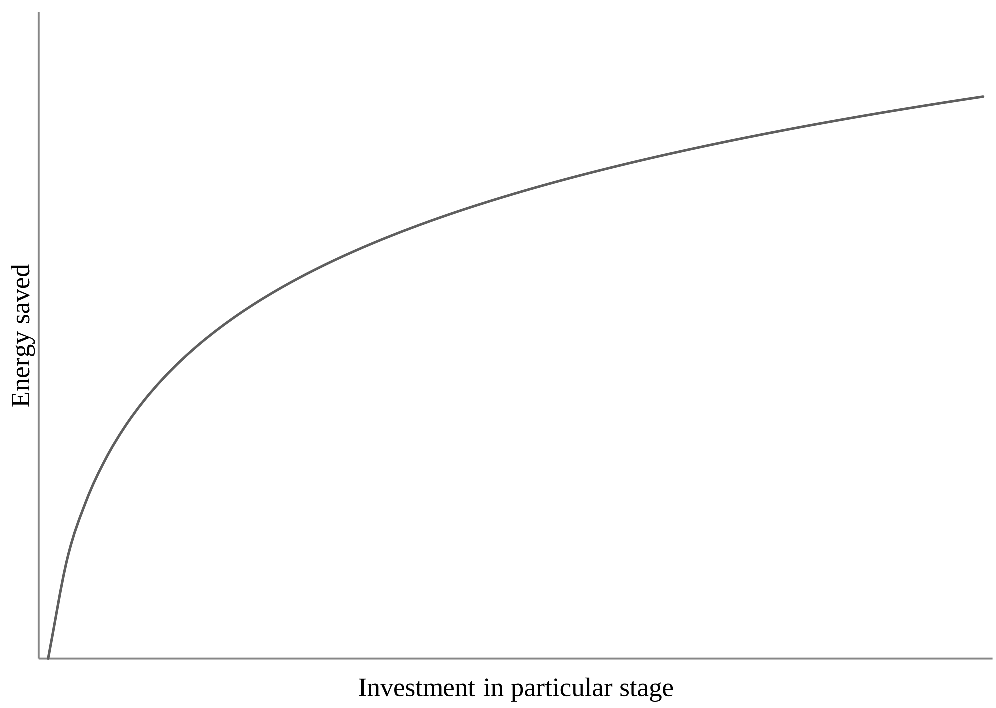


Figure 7.2 Dimishing returns, source: Author

Because Germany has a reputation of being a frontrunner in sustainable energy, the German policy regarding sustainable heating was compared to the Dutch policy. The third question concerned the historical contexts of both countries. The Dutch colonial heritage- resulting in the founding of the Shell-company- and large natural gas reserves on Dutch soil has resulted in what can be called a lock-in situation. In contrast the relatively late unification of Germany in 1871 prevented the country from establishing major colonies. It arrived too late on the world stage for that. Also Germany itself has no substantial fossil fuel reserves beyond coal. The lack of indigenous oil supplies stimulated technical innovations like the Fischer-Tropsch process used to convert coal into gasoline.

The fourth and fifth research questions covered German and Dutch policy on sustainable heating and how to compare them. Although both countries share similar objectives, namely the European commitment to increase the share of sustainable energy by 2020 their means to achieve this diverges. And although both countries have a heating law, these laws are very different. In the Netherlands its main goal is to protect consumers from unfair prices if they do not have access to other heating sources but district heating. In Germany the law states obligations about new buildings. They have to have a certain level of insulation, and or use sustainable energy sources.

A SWOT analysis was used to compare the Dutch and German situations. It was found that Germany has a lot of Strenghts; it has more jobs and expertise in sustainable technologies, district heating is already familiar, government invests heavily in these technologies, it has an important sector trade association and local utility companies. In the Netherlands an important advantage is the dense urban population density and cities are also densely clustered. In contrast an extensive natural gas network, inconsistent government policies and low government investments is holding back the development of sustainable heating in the Netherlands. It is also important to note the role of fossil fuel prices. As these prices are rising so is the profit from selling natural gas. This profit is a large source of Dutch national revenue, with an order of magnitude of billions of euros. This reduces the incentive for the national Dutch government to increase the share of sustainable energy. This would lead to smaller profits. Germany on the other hand has to import most of its energy. Here the fossil fuel prices have the opposite effect.

German policies could be transferred to the Netherlands. Considering similarities in culture, language and geographical proximity this should be feasible. However there are numerous obstacles to achieve this, these obstacles may proof formidable. The German regional state governments have more power than their Dutch counterparts. This is because Germany is a federation and the Netherlands is a unitary state. Dutch lock-in when it comes to fossil fuel is also an obstacle. Furthermore in the Dutch political constellation it is remarkable that liberal parties play a more important role and green parties a less important role. Lastly the structure of Dutch energy companies are different. They operate internationally and have recently been acquired by foreign owners, reducing the influence the Dutch public sector has on them. In Germany local citywide utility companies provide energy services. These companies are owned by the city itself. Operating locally, they are aware of the local situation and can act accordingly. This makes them more suitable to adapting to sustainable heating. Ironically it could be said that the European Union’s liberalization of the energy market - or at least the Dutch implementation thereof - which has led to Dutch energy companies moving away from the public sphere, is holding back the EU’s policy of increasing the share of sustainable energy. Lastly the fact that energy use is so closely linked with the economy does not help. Energy affects the entire society from mobility to industry and from heating to agriculture. This makes a transition to sustainable energy complex.

However despite these obstacles the author believes he can make some recommendations which will help the Dutch situation, they will be given below.

7.3 Recommendations

Despite some serious weaknesses in the Dutch system there are definitely opportunities for a sustainable heating system in The Netherlands. Population density is large and distances between cities are small, especially in the south western half of the country. This provides the opportunity to setup a heating network to link up major renewable sources of supply and waste heat from industries and power plants as well as the connection to where this heat is needed, mostly in the cities and in areas with greenhouse agriculture. Let us call these nodes of supply and demand. The author has endeavoured to produce a tentative map of what such a network might look like. For this extensive use was made of heat maps, which were discussed in section 3.3.1. The goal is to try to make as much headway as possible for as little resources as possible. Picking the low-hanging fruit so to speak. This means a focus on the largest supply and demand nodes. These are plotted in a map, see figures 7.3 and 7.4.

Immediately the settlement pattern becomes clear with dense areas in the south western half. On the supply side the pattern is different. What is noticeable is the general proximity to rivers and other waterways, presumably these are sources of coolant water. The

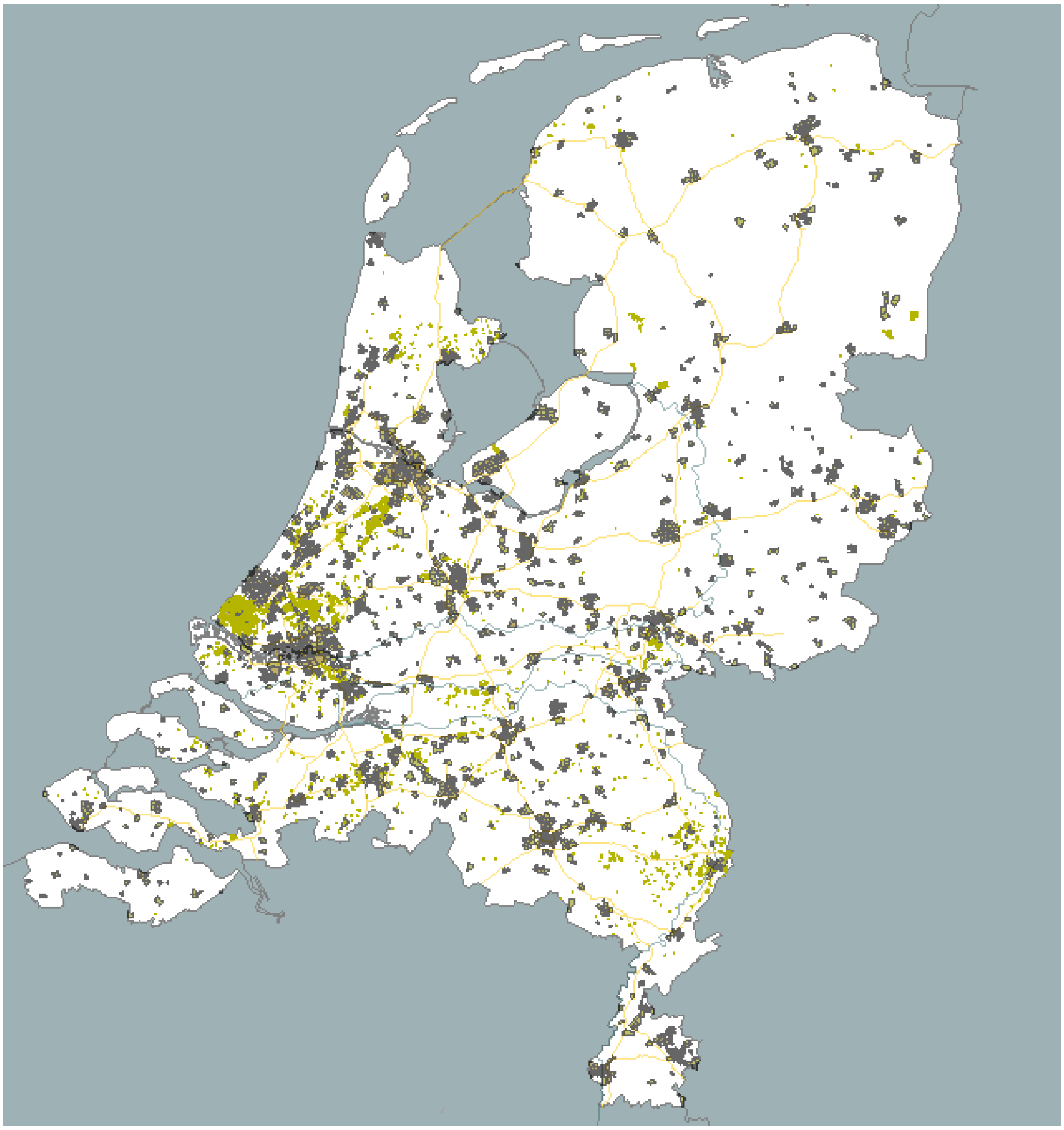


Figure 7.3 Heating demand areas, source: Warmteatlas 2012

Rhine tributaries, Meuse and IJssel stand out. The yellow stars indicate waste heat supply of under 120C and the orange stars indicate sources of 120C to 200C. Where the supply and demand is close is the best choice to start building a heating network. The author has identified four clusters which he argues as providing the most potential. First and most clearly there is the Rotterdam cluster which can roughly be thought of as being bordered by the Maasvlakte, The Hague, Breda and Tilburg. In the Rotterdam harbour area there is so much available waste heat that the stars are even overlapping.

Secondly the Limburg cluster stands out. A T-shape can be discerned here with the top of the T being Maastricht and Venlo following the Meuse river and the other side being Heerlen. Thirdly a cluster can be identified around Arnhem and Nijmegen and their suburbs, which can be thought of as a triangle with is points at Nijmegen, Arnhem and Ede.

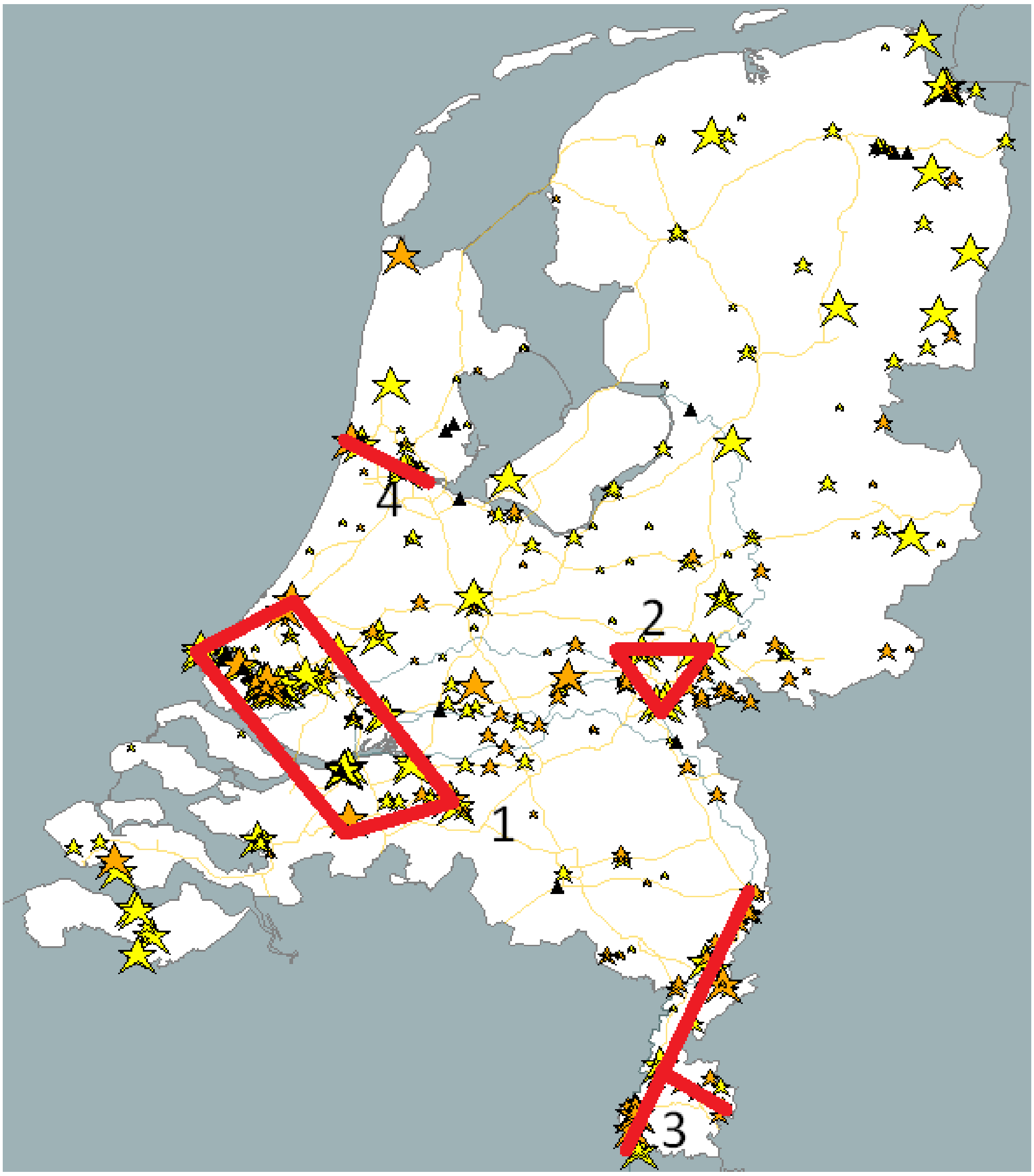


Figure 7.4 Heating demand areas and promising clusters, source: Author and warmteatlas 2012

Finally a line can be drawn from Amsterdam to IJmuiden. Other areas have a less matching supply and demand. For example in Zeeland and Groningen there is a lot of supply but less demand, or the demand is too far away which is the case in Groningen. In areas such

as Friesland there is a low supply. For these areas a good approach is to make custom small scale solutions using local heating networks and making use of area supplies instead of nodal supplies, for example biomass.
A second recommendation could be the re-establishment of local energy companies. This has already started but they remain small compared to mainstream power companies. These initiatives are sometimes private and sometimes public. In the latter case it is advisable to give local and regional governments more tools to set-up these local companies. For instance give them more abilities to levy taxes. Unfortunately with the sale of mainstream energy companies to foreign investors it would be very difficult to achieve this. The energy supply of society should be brought back into the public realm. The European Union – who advocated the liberalization of the energy market – could change its mind about this and help push the supply of energy back into the public realm. Considering the increasing public aversion to neo-liberal politics over the past years, this might not seem so far-fetched.

The role of the European Union brings the author to his final recommendation. The EU should be more ambitious. Goals have been set for 2020, but that is already in eight years. Plans should be made for the future past 2020 and these plans should be binding and specific. In short, a bit of 'coercive transfer' would not be a bad thing. The EU could use the best practices of its member states. This does not necessarily have to be Germany, Denmark for instance also has a solid reputation in the field of sustainable energy. National interests like the profit from the sale of fossil fuels do not coincide with the European interest. After all these fossil fuels are sold to European neighbours. In this way it is a zero sum game for the EU as a whole. Interestingly when confronted with large financial troubles the national sovereignty of European countries has come under pressure recently. In countries like Greece, Ireland, Spain, Portugal and Italy this is already the case. As such a move towards a federal Europe can be seen. For sustainable heating this is not a bad thing. A federal, more powerful Europe can tackle the Union's energy problems as well as its financial ones. For example in southern Europe the EU can promote solar energy, providing sustainable energy for Europe as a whole and at the same time providing a needed boost to these countries' economies.

Appendix 1

The number of cities within a 50 km radius was calculated as follows. For the Dutch case data of the statistics bureau (CBS) was used to determine the one hundred largest urban settlements (*bevolkingskernen*). These are not the same as individual cities. In some cases cities have grown together over time, these cities are considered part of the same urban settlement. For instance the city of Delft is considered part of the *kern* Greater The Hague.

The reverse may also be true. Some cities are comprised of multiple geographically separated units. For example this is the case in Almere.

In the CBS dataset the geographical location was also given in the form of triangulation coordinates. The triangulation system is a national system (*Rijksdriehoekmeting*) in kilometres. The origin of the coordination system is to the southwest of the Netherlands in order to avoid negative coordinates.

Using these coordinates and Pythagoras' theorem a matrix was made in MS Excel to calculate the distance between every pair of cities. The result is a 10,000 cell distance matrix. Excel's "count" command was used to determine the number of distances lower than 50 km for every city. Finally the average count was calculated, this was 19.3

For Germany there was a complication. The dataset of the one hundred largest *Städte* in Germany did not include geographical coordinates. The names of the cities were manually input in Google Earth. The resulting .kml file was imported in Excel and the latitude and longitude data extracted. To convert the latitude and longitude coordinates to kilometres the latitude data were multiplied by 111.2 which is the number of kilometres equivalent to one degree latitude. For the longitude data this is more difficult. This is because the closer to the poles the fewer kilometres equal a degree. To correct this the cosine of the latitude is multiplied by 111.2 and this in turn is multiplied by the number of degrees. The result is a coordinate system similar to the Dutch one but with its origin in the equator and Greenwich Meridian. The remainder of the process is the same which results in an average city count of 7.6. It should be noted that by using professional software the process of obtaining longitude and latitude coordinates can be automated. This is a process called batch geocoding.

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