The Implementation of Energy Transition Measures in Historical Cities

Testing the universality and transferability of policies and interventions

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Abstract

In the face of climate change, society must attempt to adapt to renewable sources of energy. This is, however, not a challenge equal in magnitude for every person or place. In this paper, two different cases of dense, historical cities with innovative programmes in place are compared to gain insight into the universality of certain technological innovations. Their roles are explored in a context of technological transitions. A third case, featuring no innovation programmes, is introduced, and a study is made of the transferability of interventions and policies to another high density urban area. The inquiry found several key factors which inhibit the direct transfer of policies, even in the context of a predominantly enabling regime. Still, several learnings can be taken from other contexts, to improve the rate and ease with which the energy transition takes place in historical city centres. The paper is built upon a framework of theory and data collected from desk research, and features suggestions for further research in this field, as well as justification for such follow-up inquiries.

Contents

1. Introduction

For many decades now, it has been known to humanity that climate change and the pollution of the environment on a global scale are threatening the way we live (IPCC, 2007). As we strive to lessen our ecological footprint by virtue of, among other solutions, a sustainable energy economy, spatial challenges have arisen. Different climates, geographies, topographies, demographics, and economics are among the factors contributing to the spatial inequality of opportunities towards solutions (Diana et al., 2023). For example, a country like Norway can relatively easily harness the potential energy of water flowing from its higher grounds towards the ocean to power a significant portion of its economy, due to favourable geographic and economic factors. Nations like Spain, with far less ideal circumstances for this type of energy conversion, must look elsewhere for their solutions.

It is in this context that this paper aims to elaborate and explain the potential challenges and opportunities that lie in international perspectives, specifically for the Dutch energy transition in historical city centres. The Netherlands has numerous city centres with buildings dating back many centuries, when energy sustainability was not a consideration taken by planners or builders. As most of these older buildings are part of national and/or international heritage programmes, they cannot be simply torn down and replaced with modern equivalents, increasing the complexity of the problem of making these areas sustainable from an energy consumption perspective.

At the same time, these high-density urban areas tend to have high energy demands relative to their size (Kockelman & Nichols, 2015), meaning more creative solutions must be found. For this study, the city of Amsterdam was chosen as the Dutch case, as it is the largest city in the Netherlands, featuring one of the most dense city centres in the country, and is currently having troubles making itself more sustainable (Sam, 2020). International cases from which potential lessons are drawn are Evora, Portugal, and Alkmaar, the Netherlands. These cases feature innovative solutions, which may be relevant for the city of Amsterdam.

The aim for this research is to find tangible examples of energy sustainability innovations in the context of high density, historical urban areas, which carry value for the Dutch effort to grow sustainable, and reflect on the process of the technological transition in the energy sector towards sustainability. As such, the accompanying research question is ‘How can energy transition solutions in (inter)national contexts help Dutch city centres in their bid to become sustainable?’ Related as it is to the fields of energy planning and spatial design interventions, the subject fits neatly into the research domain of spatial planning and design. This paper, which aims to answer that question, features a theoretical framework, in which the outlines and concepts relevant for this inquiry are defined; a methodology describing the ways of data collection applied in the study; the results from this research; and finally a section dedicated to the conclusions that can be drawn.

2. Theoretical framework

First, it is important to define the context and workfield in which this research is conducted, being the energy transition. The transition is a global push for a reduction in emissions of harmful substances, often gases. This endeavour supersedes the energy production sector, also existing in many other fields such as mobility, construction, and food production, but for the purpose of this paper, the focus shall be on the energy production sector. This term, energy production, must also be clarified, as anyone with some knowledge in thermodynamics will be quick to point out the fact that energy cannot be created or destroyed, as described by the first law of thermodynamics. In layman's terms, the production of energy means the conversion of some form of energy, usually chemical energy in oil or gas, into a usable one, often in the shape of an electric current. For the purposes of this paper, this lay definition of energy production will be used, improving the readability and accessibility of the paper.

The eventual purpose of many environmental sustainability policies and accords is the notion of energy neutrality. This means the reduction of reliance on external, non-renewable resources, to nought (Maktabifard et al., 2020). This is not to be confused with a zero-carbon policy, which is considerably more complicated. An urban system that is completely self sufficient is thus energy neutral, though it may actually still pollute according to this definition.

The notion of exergy is strongly related to that of up- and down-stream energy transfers. Exergy is noted as the combined properties of quantity and quality of energy, as described by Hermann (2006). As such, it implies the possibility to use lower quality energy for secondary applications, such as the heating of housing, after having been used previously in for example high-intensity industrial processes. This transfer of energy to higher and lower uses is referred to as up- or downstream energy transfers, respectively, as described by Giourka et al (2020). It is this which in some of the later mentioned cases is sought to be exploited.

Following from these descriptions of energy-related concepts relevant for this research, a short summary will be given. The global energy transition is relevant for all parts of society. A large part of said transition is the above explained concept of energy ‘production’ and consumer consumption. Energy neutrality is sought as an ultimate goal, but transition has thus far been gradual. One way to improve the efficiency of society’s energy consumption would be the application of up- or downstream energy transfers, which effectively means the use of leftover energy from another process.

The notion of a technological transition is the next relevant topic to cover here. Rotmans et al. (2001) in their paper describe the reasoning behind transitional models, and apply it to the context of the Dutch energy transition in the 20th century, when the country moved away from coal, and invested heavily in natural gas.

Rotmans et al. note that the origin of transitional models lies in biology and demography. Perhaps the most well-known example of an application of the model is the demographic transition model, which describes the evolution of a people through a phase of heavy reduction in death rates, followed by a reduction of birth rates, eventually coming to a new equilibrium at a higher total population. This model is applied to many different transitions, including technological evolution like the energy transition. It boasts three dimensions according to this article, being time, speed, and size. Whilst it would be easy to assume speed is merely the dependent variable of the other two, this is not true, as it is not average speed which this dimension refers to, but the peak rate of development. Four distinct phases in such a transition are defined: Predevelopment, take-off, breakthrough, and stabilisation.

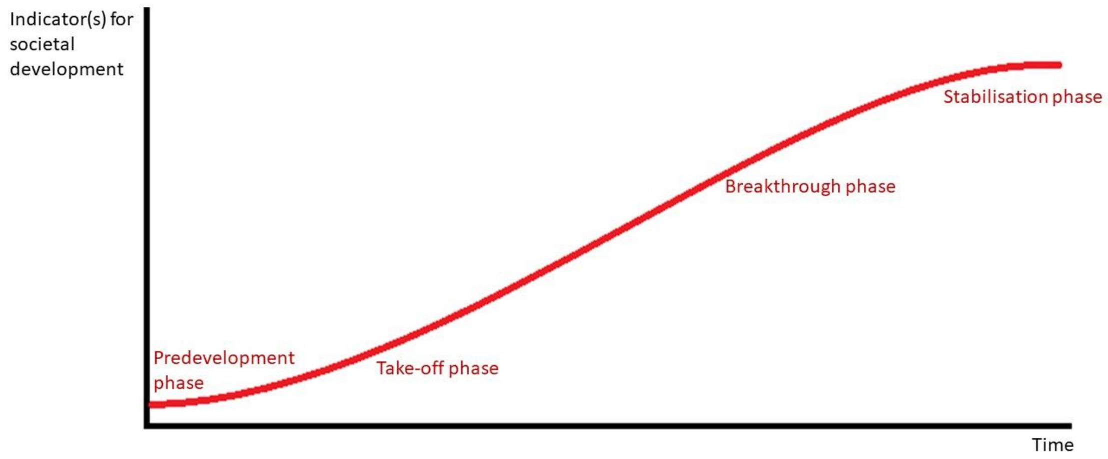

Fig. 1. General transition model with its three dimensions. From Rotmans et al. (2001)

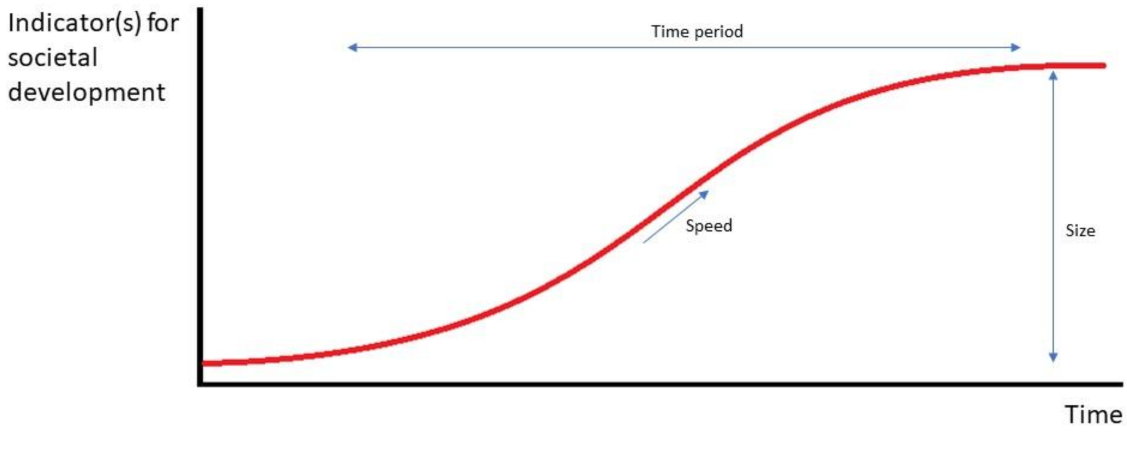

Fig. 2. General transition model and its four phases. From Rotmans et al. (2001).

A transition can have different sectors in which it takes place. For example, an energy transition can be taking place in a technological, societal, economical and environmental sector, all at the same time. Rotmans et al. (2001) describe this fact too, and as a result, a transition and its three dimensions can be defined as the agglomeration of these different facets of evolution. It should be noted that the different developmental trajectories must be interconnected. The previously mentioned article notes a 'spiral, [or a system with] multiple causality and co-evolution caused by independent developments'.

Technological transitions take place at different levels of society, and different scales within the reality of this society. Geels (2002) elaborates: the three levels at which transitions can have influence are, from lowest to highest, niches, regimes, and landscapes. Geels argues that initially, radical technological advancements are created in the niches of society. This comes forth often as an answer to a problem with the relevant regime. As such, a regime will, in the early stages, work against this new development, through the implementation of counter-strategies, such as technological developments for existing tools or unfavourable policies for the niche (higher taxes for higher risks for example).

Eventually though, as the niche starts to challenge the regime, often in the form of expansion into other niches, the balance might shift. Rotmans et al (2001) note this change for the regime to a more enabling role. In this phase, multiple paradigms may co-exist. Eventually though, as the new technology becomes dominant, the regimes start to stabilise, and the change starts to creep into the greater landscape. This landscape is defined in Geels (2002) as the environment in which actors can exist and act, consisting of external factors, such as politics, migrations, and the likes. The landscape is much harder to alter than regimes are; change at this level is rare and slow as a result.

Another concept relevant for this research is gentrification. This concept is not necessarily coupled to the original research question, but comes to be significant in later analyses. It has been recognised since the 1960’s, and the definition used here is derived from Zukin (1987). Gentrification is mentioned there as the refurbishing and upgrading of existing urban areas, and the accompanying effects. Among these effects are the movement of services and job availability, the changing of the housing market in the broader area, potential spill-over effects, and, most importantly for this paper, the potential displacement of the existing population as a result of changing economic factors, including housing prices.

From these notions and concepts, combined with the themes and questions set in the introduction, a hypothesis is formulated: knowledge about the energy transition and the efficiency of different methods of achieving said transition exists in national and international niches. These niches are challenging the regime, but this transition is slow, in spite of the societal and environmental urgency of the matter.

From the concepts mentioned in this segment, a model can be distilled.

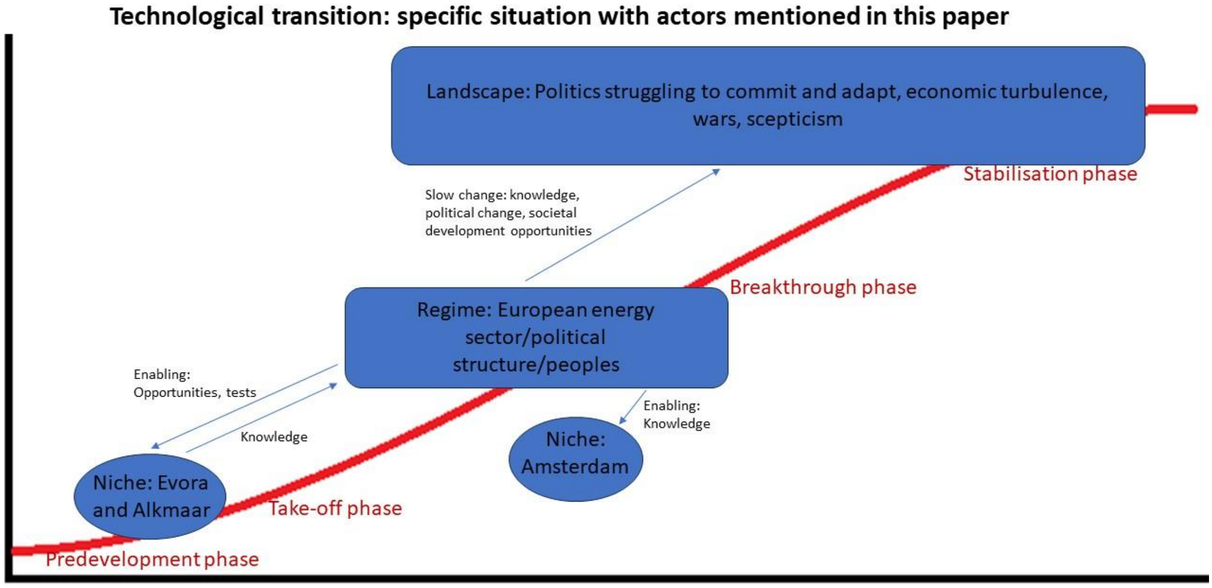

Fig. 3. Conceptual model for this research. From the Author (2023).

In this model, the placement of the different levels of society, being the niches, regimes and landscapes, is dictated by the general transition model with the four phases as described by Rotmans et al. (2001) It describes how the timing of change at the different levels coincides with the different phases of a transition. Additionally, the different actors and circumstances are filled in accordingly. In this model, Amsterdam is depicted as a dependent on the regime, and thus indirectly a dependent on the experimental niche of Evora and Alkmaar. In reality, Amsterdam has some policies in place, which could be interpreted as failing given the lack of apparent progress the city is making. Additionally, a lack of experiment gives off knowledge too, as such a case can be regarded and used as a reference case.

3. Methodology

For this research, several methods of data collection and research strategies were considered to optimise the relevance, effectiveness and efficiency of the research process.

First, an inquiry into public opinion and knowledge was contemplated. It was, however, regarded to be too specific and niche a subject to be truly eligible for that type of inquiry. This conclusion was drawn based on the notion that this specific challenge has received only limited attention in popular media, as opposed to the larger projects in the energy sector, such as windmill parks, solar farms and the likes. Additionally, it was regarded to be of little relevance to know what a specific group, with limited means, interest and influence, would know or think of these issues.

Another proposal was a study into the current state of affairs in the development of renewable energy strategies and technologies. Though perhaps more relevant as a source of information for those with an interest in the subject, but limited access to sources in the industry, this was once more rebutted on the basis of not being relevant on a large enough scale, due to the limited extent of available solutions, and the academic relevance lacking.

Thus, a third research strategy was conceived, which describes what is effectively an explorative suitability study. Two (inter)national cases are examined for their qualities, challenges and specifics, and these are reflected upon the Dutch case of Amsterdam. The relevance in this case is regarded to be higher than in the other two, by virtue of regarding several cases on an international scale, the applicability of diverse solutions in several settings, and therefore potentially helping the cause of the transition, thus creating a high societal potential gain.

This methodology requires mostly desk research, hence this is the only type of inquiry applied. It is exclusively a qualitative inquiry, as any quantitative analyses would be futile with the small sample sizes used. It means each case can be explored deeper than would otherwise be possible, and the paper can give more accurate and suitable results and advice as a result. As a qualitative research, the data collected should cover significant depth, giving enough material to not only compare different cities on a superficial level, but also go into why these differences and similarities exist. It is only this way which allows for a reasonable analysis into the transferability from the two pilot cases into the dependent case. The width of the collected data is not relevant in this study, three cases cover the bases for requirements.

Data was collected in a typical desk research manner. That is to say, a problem was identified in the real world, lay research was conducted into the existing solutions and experiments, and academic research followed to establish a strong theoretical framework, fill knowledge gaps and analyse the currently ongoing experiments and existing policies. Academic sources were not used exclusively, as some lay sources were needed too in the shape of government (municipality) documents and tools, as well as official websites of ongoing experiments.

For the purposes of this research, the main sources for the data used are the organisation POCITYF and its website, and an article by Giourka et al. for the cases of Evora and Alkmaar. Articles by Ruiter Kanamori, and Bond and Worthing, supported by an article by

Appendino, the Amsterdam municipality website for policy goals, and city council maps (originally created by Vattenfall) are used for the case of Amsterdam. The lack of POCITYF sources for Amsterdam is unfortunate, but unavoidable, given the city does not partake in the programme. These sources are considered suitable by virtue of their focus on the specific cities and specific aspects of the energy transition experimentation and policies within these cities. The POCITYF is an active party and stakeholder in the matter though, potentially allowing for biases in their provided data, but the academic article by Giourka reflects on the scheme from a neutral perspective.

The study is conducted on a relatively small scale given the limited number of cases. Another possibility would have been to make a study of several greater projects, networks of cities in this case. However, the eventually chosen research design has several points of merit itself. The selection of two cities in differing contexts allows for a strong view on concepts and processes that only work in specific settings. The application of these findings onto a third case allows for insights into the transferability of solutions and policies, thus creating a more holistic picture of the situation regarding the effectiveness of energy innovation programmes.

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4. Data

4.1 Evora and Alkmaar

Both the city of Evora, Portugal and Alkmaar, Netherlands face significant challenges in making themselves energy neutral. In their article, Giourka et al. (2020) describe in great detail how both cities are tackling their respective challenges.

Alkmaar, as a Dutch city, is required to achieve independence from the gas network by the year 2050, as part of the Dutch effort to meet the requirements of the Paris convention of 2015 (United Nations, 2015). The city features a high portion of older buildings, that means in this case built before 1975 (as insulation regulations were improved in that year), totalling over 23.000 units. This makes the challenge of supplying Alkmaar with the required energy levels more difficult, as demand will be higher for the purposes of heating buildings.

The city does feature a district heat network, meaning it can distribute heat more efficiently than would otherwise be possible, and it intends to expand this system. Evora does not have such a system, and neither does it have any ambition to take on such a project.

Evora, being a Portugese city, faces different challenges to its Dutch counterpart. While due to the warmer Mediterranean climate, the city features a higher potential solar energy harvesting capacity, and no immediate demand for a transition from a high intensity gas heating network, it does have the problem of more heritage regulations. Evora, according to Giourka et al. (2020) has the ambition of enabling a higher degree of energy sharing and exchange, meaning lower quality energy (as described by the exergy section before) should be transferred to other users, instead of wasted. Additionally, the concepts of up-stream and down-stream transfer of energy are to be applied.

The city has many buildings which are younger than the Dutch threshold for being problematic from an insulation standpoint, but due to lower build quality, these still feature poor heat retention characteristics. Thus, like Alkmaar, it must invest in ways to reduce the leakage of heat from its buildings to achieve its goals in energy efficiency.

Both cities have ambitions in the department of mobility. Alkmaar, and in extension the Netherlands, has a high degree of nitrogen oxides in its soil, which, even though this is mostly the result of high intensity farming, can be reduced by lowering emissions from motor vehicles. In Evora, over half (52% to be exact) of the energy consumption is in the transport sector, while in Alkmaar this is 31%, which is still a significant portion of the total consumption (giourka et al, 2020). Both cities see potential in (shared) electric vehicles to replace traditional petrol and diesel powered cars.

Another similarity between the two cities is their involvement in the POCITYF programme (POCITYF, n.d.). POCITYF is a European funded network of cities, featuring two ‘lighthouse cities’ and several other cities. The two lighthouse cities, Evora and Alkmaar, are to test innovations, and the others are supposed to attempt to introduce these solutions in their own unique context, to see if the solutions hold up in differing circumstances. These solutions exist not only in the physical realm, but the regulatory one too. Policies with environmental aims are trialled, along with the physical experiments noted above.

It should be noted that the information listed on the POCITYF website does not entirely match that of the article by Giourka et al., 2020. This could be down to developments in the last three years (as of writing). In this analysis the more conservative of the two descriptions is used, being the one from the Giourka et al. article.

4.2 Amsterdam

Considering the previous cases, there have been several specific challenges, complemented with opportunities related to their distinct characteristics. Amsterdam is in that regard no different, though it seems the challenges related to this city are similar to those found in all other cases combined.

The city is a major tourist attraction in the Netherlands. As such, the economics of the city and of the greater area are different to those of the other cases. Not only is the property value generally higher than in other cities, there is also more capital to potentially invest into sustainability. As Ruiter Kanamori (2021) states however, this does come with problems: the city being so heavily reliant on its cultural significance means spatial interventions in the historical parts of the city are nigh impossible.

This historical significance is less prominent outside the city centre. Indeed, these areas still carry a degree of cultural heritage, but regulations are less strict in these areas. The result of this is easier implementation of measures such as heat networks. The city of Amsterdam has depicted this network as it existed in 2020 based on data from Vattenfall Warmte (2022), which can be found on the Gemeente Amsterdam website, and outside the city centre this network has grown to be quite extensive. Further development of this network is ongoing, but these extensions are not within the main historical city centre.

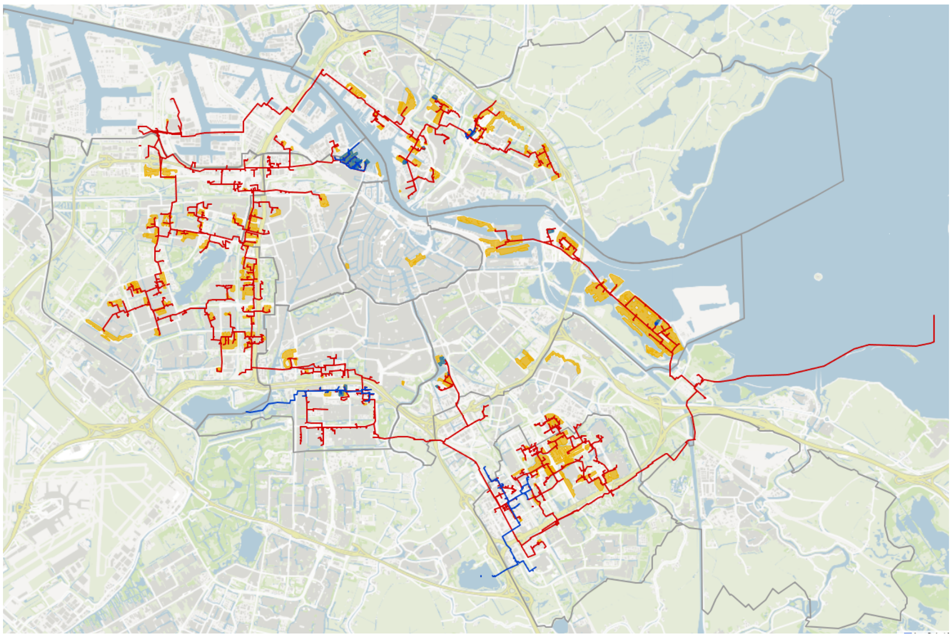

Fig. 4. In this map of the city of Amsterdam, the red lines are heat transport connections, blue lines depict cold transport, and the yellow and blue areas represent interconnected areas for heat and cold exchange. Note the near total lack of such networks in the inner city. Retrieved through the Amsterdam municipality, https://maps.amsterdam.nl/stadswarmtekoude/.

Most of the buildings inside the canal district date back to the seventeenth century, and as a result, feature poor insulation, reliance on materials and resources which are not renewable, and are generally difficult and thus expensive to refurbish. Additionally, many of these buildings are in some shape or form protected by cultural heritage programmes, not unlike in the case of Evora.

As Ruiter Kanamori (2021) outlines in his paper, the cultural significance of the inner city of Amsterdam is difficult to define, as heritage can often not be expressed in money. However, they do recognise the notion that it is primarily the exterior of the buildings, in the specific setting of the Amsterdam public space, that constitutes the cultural heritage. Secondary to this is the interior of these buildings, which have indeed in many cases been (subtly) modified to accommodate newer times. An example of this would be the incorporation of electricity in buildings that were originally made before the discovery of the properties of electricity.

This opens up opportunities for the improving of the sustainability of these buildings. The first measure in limiting the total burden on the environment is the reduction of demand of harmful and/or finite resources, in this case by insulating properties to reduce heating energy requirements. Still, because of the strict rules around UNESCO heritage sites, it is difficult to make even this work. Additionally, due to their cultural status, these buildings may get exemptions from efficiency and sustainability regulations (Bond and Worthing, 2016).

This practical impasse for the development of the city centre to accommodate modern guidelines and efficiency levels might have further consequences for the area economically. Appendino (2017) points this out, stating it is paramount for lively urban areas to actively pursue sustainability in order to remain relevant over time. Thus, Amsterdam must seek ways to make its inner city sustainable in spite of tight regulations opposing the modification of historic properties.

It remains a fact though that some 52% of gas usage in the city comes from the heating of residentials (Ruiter Kanamori, 2021), making this a priority target for sustainability improvement measures. There are certainly opportunities in the interior of the buildings, but there are no centralised institutions for the coordination of these upgrades. This means any sustainability improvements, including heat pumps, low-temperature floor heating, or even the installation of better insulated windows, must be both initiated and financed by the owner of the property. This follows from the roadmap towards a sustainable city the municipality of Amsterdam made in 2020, in which it is stated that only if private parties do not satisfy the desired gains, the municipality will step in with stricter regulations regarding sustainability developments. Thus, there are high up-front payments, personal financial risks, and generally no scale-related advantages to be found, all of which make these house owners refrain from investing into sustainability. Solar panels have similar issues. While the suitability of the roofs in central Amsterdam for the installation of solar panels is generally good (Amsterdam municipality, see fig. 4 below), the costs up front and in maintenance are high, not enticing homeowners to invest.

Fig. 5. In this map (retrieved through Amsterdam municipality, https://www.zonatlas.nl/amsterdam/ontdek-de-zonatlas/) the green properties are very suitable for solar panels, yellow properties suitable, and red properties are labelled unsuitable.

4.3 Common issues

There are several problems with an energy transition that is dependent on consumer initiative and/or capital. Wealth is not equally distributed among the people in any of the three cities, and neither is the problem of energy over-usage. Social housing, which makes up a significant portion of the more critical buildings of Alkmaar in the transition, are occupied by people with little to no resources to afford sustainability upgrades to their houses. This means there is a real chance of unintended gentrification, or at least a significant imbalance in the burden carried by individual citizens. Central Amsterdam does feature a relatively large amount of capital at the disposal of its home-owners, but the problem persists if the costs of renovation prove high. Rotmans et al. (2001) also mention this aspect in their article, as a factor to evaluate and learn from.

Another issue that exists for all three cities, and in extension many other cases globally, is the problem of centralised approaches versus consumer driven, spontaneous approaches. The urgency of the situation is fairly high given the goals set out in climate conventions such as Paris 2015. Yet, as a government in the modern world, it is difficult to obtain full control of such a transition, and a middle ground between the two notions must be found by successful governments. This conflict is also elaborated on by Rotmans et al (2001), who come to a conclusion that a mixture of top-down and bottom-up approaches should be ideal in most cases, however the exact rates of both, as well as the shape these approaches take on, are uncertain and unique for any given context.

Energy transition challenges and opportunities		
Alkmaar	Evora	Amsterdam
Identified specific problems		
Time pressure; independence from gas by 2050	High volume of existing heritage regulations	Major tourism; more variable economy
Many older buildings with poor insulation	Poor build quality means newer buildings still lack insulation	Many old buildings, reliant on non-renewable resources
High degree of nitrogen in soil		Poor insulation
		Expensive to renovate
		High degree of heritage protection
		Many individual owners, no central policy
(Potential) specific solutions		
Features a heat network	Energy transfers	Significant capital of the owners
General problems and solutions		
EV sharing schemes		
Heat pumps		
Potential socio-economical upsets, e.g. gentrification		
Obscurity concerning best government roles		

Fig. 6. A summary of the specific challenges and solutions of the cities, as well as some of the shared problems and applications. Compiled from Giourka et al, POCITYF, Ruiter KanamoriBond and Worthing, municipal sources, and own input. From the author (2023).

5. Analysis and Findings

It is evident from the high variety in solutions that there are many different potentially competing ways to improve sustainability in the current-day setting. The strategy best suited for each specific region is highly susceptible to environmental factors, as well as social and economic ones.

This research aimed to find how (inter)national cases of energy related innovation by cities can help the Dutch city of Amsterdam, and in extension other cities from international contexts. In other words, it explored the effectiveness of pilot cities in the energy transition process. As such, several key differences were determined that influence the transferability of solutions in this regard.

The first significant difference is the climate. It has firstly got a large impact on the effectiveness of solar panels and farms in the relevant areas, meaning cities in warmer, sunnier regions can rely more on solar power to cover their part of the energy transition. Secondly, it influences the need for either heating or cooling, or both, through the span of a year. Warmer areas obviously consume less energy for the heating of their residentials, and areas with more stable temperatures may be able to create more efficient systems to regulate inside temperatures.

Then there are variances in the economic properties of regions. This has historical aspects, inevitably so, but even in the current situation exclusively, different levels of wealth mean different opportunities, often skewed towards the better off regions. This means that the burden of the energy transition for a wider region may be more or less bearable for the smaller local area. Additionally, the renovation of existing properties, especially in the case of rental (social) housing, may lead to unexpected and potentially unwanted consequences. Gentrification may occur when the burden of the energy transition is laid upon those without the means to bear it, e.g. in the situation of a rental house being renovated, increased in rent rate, thus becoming unaffordable for the current occupants, and these inhabitants having to move elsewhere, likely to another place without the renovations. This could lead to what is effectively a constant chase for the dwindling offering of affordable housing, until the sustainability upgrades are sufficiently affordable for the (indirect) investors, meaning the potential displacement of citizens, which cannot be part of the intended set of results and consequences of the sustainability measures.

Then, Amsterdam can take significant learnings from the other cases presented in this research. Though its climate is less suitable to the implementation of solar power, the geographical location not ideal for hydro power, and the regulatory framework too strict for sweeping, powerful interventions, there is scope for improvement in the sustainability policy of the city. First, it is important to recognise the importance of staying modern in certain key areas, among which sustainability, even for cultural heritage sites such as the historical city centre. The heat and cooling network initiatives around the city prove there is room and opportunity in Amsterdam for these improvements, but they will need to be carefully planned to be able to be implemented in the tightly regulated cultural site.

Additionally, the implementation of EV policies in the other cities shows this measure has merit, especially given the implementation in the equally Dutch city of Alkmaar. The Netherlands features a relatively well developed infrastructure for electric cars already (I am

Expat, 2021), which is set to expand in the future, making this a significant opportunity to improve sustainability characteristics in the department of mobility in the city.

Placing these findings in the context of the theoretical framework established earlier, it is most apparent that Amsterdam is indeed in its own niche as defined by Geels (2002), featuring its own factors and challenges with regards to the energy transition. It does not directly benefit from the Evora and Alkmaar innovations, but rather lags behind as a result of being mostly dependent on the overarching regime, a phenomenon described by Geels. Additionally, the energy transition in European urban areas can be considered to be in an early stage of development within the context of the by Rotmans et al. (2001) model of technological transitions, given the data regarded by the Paris convention of 2015. This coincides with the notion that these niches experimenting in an attempt to overthrow the existing regime are most prevalent in the early stages of a technological transition.

6. Conclusions

The research of this paper has given scope for opportunities in the Amsterdam setting, inspired by international examples of cities aiming to improve their own sustainability characteristics. It does not give concrete advice or draw definitive conclusions as to the optimal way to make the city of Amsterdam carbon-neutral or gas-free, as is the long term ambition in the Netherlands. It does address some issues in the institutional framework that is currently in place, which does little to encourage investment into sustainability, despite this being an important development factor for the city.

As such, no definitive answer is given to the research question. The main findings from this inquiry consist of the notion that some policies may be transferable, some physical solutions may be applicable, but no general fail-proof set of interventions exist to solve all environmental problems with. Technological transitions are complicated by nature, the energy transition is no exception to this rule. The existence of niches is paramount for the development of society beyond incremental improvements (Rotmans et al, 2001), and the enabling of these niches by, in this case, the European government body, is a positive fact in itself. The existence of these niches allows for the development of solutions to problems of the greater regime, which over time will help solve the landscape scale problem of sustainability development.

This paper boasts no strong, clear answer to its research question, partly because it was established exclusively on the basis of desk research. Problematic in this sense is the fact that the research gap, which this research was meant to fill, still exists. International experiments still take place in the shape of, among others, the POCITYF programme, and this paper has done little to establish a clear understanding with regards to the effectiveness of not only such programmes, but the specific experiments as well.

However, it can be concluded that based on the general trends observed, the technological transition that is the change towards renewables and environmental sustainability is still in its infancy. From the dynamic, or lack thereof, between Evora and Alkmaar, and Amsterdam, can be concluded that the niches have yet to definitively topple the existing regime of EU energy sectors and political actors. This means that cities without their own innovative niche, like Amsterdam, are still under the rule of the old status quo, and therefore can hardly be expected to be far along with becoming sustainable, as is depicted in the theoretical model from the autor, based on Rotmans (2001) and Geels (2002). Amsterdam would have to either wait for the regime to change to a sustainability-focussed context, or create its own niche innovations. As of yet, the latter is difficult to realise as a result of the tight regulations, while the former may leave the city vulnerable to falling behind in economic and cultural relevance, as outlined in the Amsterdam part of the Data section earlier in this paper.

Thus the author expresses the hope for further research to be conducted in this field. Schemes like POCITYF are full of politics and biases, therefore it is important that objective eyes gaze upon the process at a regular interval. A suggestion the author would like to make is the comparison between several different such schemes, as there are several similar programmes currently in operation, and a true comparative study could prove highly valuable, from both an academic relevance perspective and a societal relevance one.

7. Reflection

The author expresses a degree of worry based on the findings of this research, with regards to the lack of progress within the technological transition model of the energy sectors in the studied cases. As it is evident the transition is still in its first phases in the context of historical city centres, the urgency of the situation seems to be missed by too many relevant people and parties. It should be noted however, that this research is by no means conclusive and all-inclusive. Several factors can still be explored further, including the involvement of active actors in the studied cases such as policy makers. This research was conducted in too explorative a manner, which has led to a lack of structure in the process of gathering and analysing the data, a deficiency which has also become apparent in this report. Future researchers are advised to avoid such loose explorative methods, instead opting for clear boundaries of the studied object. The theoretical framework to support such studies should define the limits of the extent of the data, and the research aim should in turn be leading in the extent of the theoretical framework.

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