Building on knowledge and innovation: the role of Green Economy in revitalising Shrinking Cities. Case study analysis in France and Mexico

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Summary

This research introduces the topic of the Green Economy in the context of shrinking cities. The analysis is supported by two case studies, one located in Mexico and the other in France, to identify adaptable strategies of sustainable development in different contexts of urban decline that consider significant differences in the availability of resources.

Shrinking cities suffer from problems such as depopulation, economic decline and underuse of urban infrastructure, mainly due to a regional process of economic peripheralisation. Shrinking cities can adopt two logics to address these issues: de-peripheralisation and endogenous development.

It is argued that shrinking cities can exploit emerging green markets to stimulate economic growth and enhance liveability and sustainability; however, the solutions vary depending on the available resources, local comparative advantages and national political and financial support systems. The Green Economy driven solutions in shrinking cities can follow two main strategies: one is aimed at regrowth, betting on the creation of regional innovation systems by investing in research and development and the local capture of the produced spill-overs; the other, inspired by the concept of greening, aims to improve the quality of urban life of the inhabitants by enhancing the quality of consumption sectors through ecological practices and respect for the environment. The analysis of the two case studies serves as a method to observe different strategies for the sustainable development of shrinking cities by introducing activities in the sectors of the Green Economy.

This study supports the global comparative perspective approach in urban studies focusing on urban shrinkage. The context of shrinking cities is explored in Latin America by identifying the eighteen shrinking cities in Mexico.

Kurzfassung

Diese Untersuchung führt in das Thema der grünen Wirtschaft im Kontext schrumpfender Städte ein. Die Analyse wird durch zwei Fallstudien, eine in Mexiko und die andere in Frankreich, unterstützt, um anpassungsfähige Strategien der nachhaltigen Entwicklung in verschiedenen Kontexten des städtischen Niedergangs zu identifizieren, die erhebliche Unterschiede in der Verfügbarkeit von Ressourcen berücksichtigen.

Schrumpfende Städte leiden unter Problemen wie Entvölkerung, wirtschaftlichem Niedergang und unzureichender Nutzung der städtischen Infrastruktur, die hauptsächlich auf einen regionalen Prozess der wirtschaftlichen Peripherisierung zurückzuführen sind. Schrumpfende Städte können diese Probleme mit zwei Ansätzen angehen: Entperipherisierung und endogene Entwicklung.

Es wird argumentiert, dass schrumpfende Städte aufstrebende grüne Märkte nutzen können, um das Wirtschaftswachstum anzukurbeln und die Lebensqualität und Nachhaltigkeit zu verbessern; die Lösungen hängen jedoch von den verfügbaren Ressourcen, den lokalen komparativen Vorteilen und den nationalen politischen und finanziellen Unterstützungssystemen ab. Die von der grünen Wirtschaft angetriebenen Lösungen in schrumpfenden Städten können zwei Hauptstrategien verfolgen: die eine zielt auf ein erneutes Wachstum ab und setzt auf die Schaffung regionaler Innovationssysteme durch Investitionen in Forschung und Entwicklung und die lokale Nutzung der daraus resultierenden Spillover-Effekte; die andere, vom Konzept der Ökologisierung inspirierte Strategie zielt darauf ab, die Lebensqualität der Stadtbewohner zu verbessern, indem die Qualität der Verbrauchssektoren durch ökologische Praktiken und den Respekt für die Umwelt gesteigert wird. Die Analyse der beiden Fallstudien dient als Methode zur Beobachtung unterschiedlicher Strategien für die nachhaltige Entwicklung schrumpfender Städte, die Aktivitäten in den Sektoren der Grünen Wirtschaft einführen.

Diese Studie unterstützt den Ansatz der global vergleichenden Perspektive in der Stadtforschung, der sich auf die Schrumpfung von Städten konzentriert. Der Kontext schrumpfender Städte wird in Lateinamerika durch die Identifizierung der achtzehn schrumpfenden Städte in Mexiko untersucht.

Résumé français

Cette recherche introduit le sujet de l'économie verte dans le contexte des villes en déclin. L'analyse est soutenue par deux études de cas, l'une située au Mexique et l'autre en France, afin d'identifier des stratégies adaptables de développement durable dans différents contextes de déclin urbain qui prennent en compte des différences significatives dans la disponibilité des ressources.

Les villes en déclin souffrent de problèmes tels que le dépeuplement, le déclin économique et la sous-utilisation des infrastructures urbaines, principalement en raison d'un processus régional de périphérisation économique. Les villes en décroissance peuvent adopter deux logiques pour résoudre ces problèmes : la dé-périphérisation et le développement endogène.

Les villes en décroissance peuvent exploiter les marchés verts émergents pour stimuler la croissance économique et améliorer l'habitabilité et la durabilité ; toutefois, les solutions varient en fonction des ressources disponibles, des avantages comparatifs locaux et des systèmes de soutien politique et financier nationaux. Les solutions axées sur l'économie verte dans les villes en décroissance peuvent suivre deux stratégies principales : l'une vise la repousse, en pariant sur la création de systèmes d'innovation régionaux par l'investissement dans la recherche et le développement et la capture locale des retombées produites ; l'autre, inspirée par le concept d'écologisation, vise à améliorer la qualité de vie urbaine des habitants en améliorant la qualité des secteurs de consommation par des pratiques écologiques et le respect de l'environnement. L'analyse des deux études de cas sert de méthode pour observer différentes stratégies pour le développement durable des villes en décroissance introduisant des activités dans les secteurs de l'économie verte.

Cette étude soutient l'approche de la perspective comparative globale dans les études urbaines axées sur le rétrécissement urbain. Le contexte des villes en décroissance est exploré en Amérique latine, à travers l'identification des dix-huit villes en décroissance au Mexique.

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1. Introduction- Research Questions- Methodology

1.1 Problem Statement

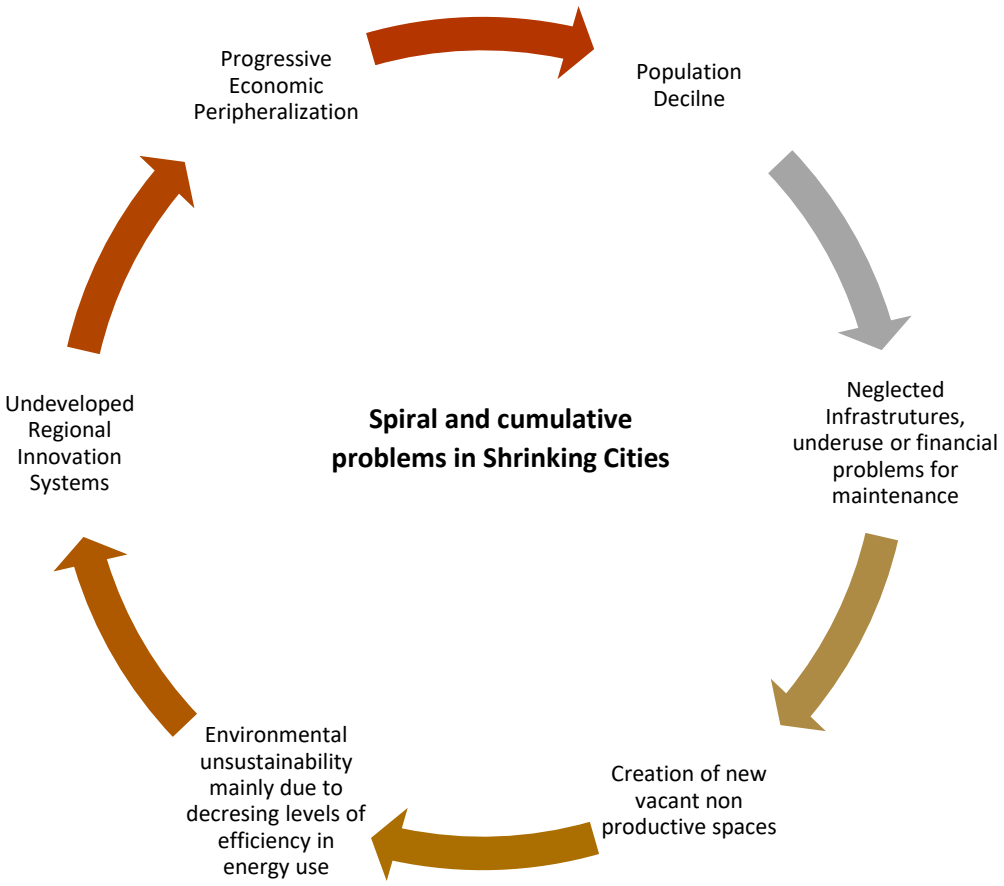
The second decade of the 21st century opened with great global uncertainty resulting from the COVID pandemic and the Russian invasion of Ukraine. These crises overlap with environmental problems caused by the scarcity or mismanagement of resources in the face of a growing population.

The market-centred development scenarios project civilisation towards a **fortress world** in which elites work to impose an authoritarian order to establish control over resources, modelling the concept of sustainability at will to legitimise business as usual (Raskin et al. 2010). In this context of growing uncertainty, accurate and organised local planning acquires greater significance in defining the future of each territory. Social and structural long-term effects of the COVID-19 pandemic and related economic crisis are still unknown: while the decrease in consumption on a global scale may lead to a general change in sustainable development policies, the limits of globalisation, highlighted by the vulnerability of the health system, could eventually promote new territorial policies aimed at limiting external dependence.

Shrinking cities are considered a negative symptom, or the **canary in the coal mine** (Audirac et al., 2010) of systematic global transformations shaping the new economic geography. Still, they are also considered a favourable ground for introducing alternative socioeconomic strategies of development and laboratories of democracy at local scales (Haase and Rink, 2012).

The problems in shrinking cities are spiral and share interdependent cumulative characteristics: scarce or uncompetitive tangible and intangible resources (Hospers, 2012), underuse of infrastructures with deterioration or financial problems for their maintenance (Moss 2008), undeveloped regional innovation systems, population decline, emerging vacant spaces devaluating the rest of the territory (see Fig. 1).

Figure 1: Spiral and cumulative problems in Shrinking Cities



Source: Author, Kaiserslautern, 2022.

Shrinking cities tend to be **less energy efficient** (Liu et al. 2020) and **less capable of mitigating CO_2** than growing cities (Xiao et al. 2019). The limited capacity to meet local demand and solve local problems in shrinking cities produces an increased dependence on external resources, especially in smaller towns of less than 100,000 inhabitants, which seem to be even more prone to long term and extreme shrinkage (Restrepo et al., 2016).

Urban shrinkage can be understood as a consequence of a **peripheralisation** process resulting from flow and capital accumulation that tend to produce temporary "fixes" in space and time (Harvey 2006, Smith 2010) and geographical inequalities (Großman et al. 2013), as it is also discussed by Lang (2012) in the context of eastern Germany. Spatial effects in urban areas are closely linked to the geography of production: post-Fordist transitions coexist with declining Fordist industrial districts, and the glocalisation of production is driven by leading industries (high technology, aerospace, electronics, financial) that are selectively localised depending on the relative global and regional competitive advantages (Audirac et al. 2012).

The most important sectors of the new post-industrial economy are highly knowledge-based, including professional, scientific and technical services, information, finance and insurance, real estate and rentals, arts, entertainment and recreation, business administration, educational services, health care and social assistance (Sassen, 2001). The growing outsourcing of the economy produces the concentration of knowledge and services in the big cities, attracting migrations in them, especially from hinterland´s younger generations, in search of better opportunities. As a result, hinterlands and less competitive cities enter within a marginalisation process, manifesting in territorial neglect and increasing socio-spatial inequalities due to fiscal crisis. In some cases, the national welfare state systems represent the last rescue anchor for the inhabitants of these territories (Fol, 2012).

The urban shrinkage phenomenon can be explained by adapting the **theory of dependency** in the World System (Wallerstein, 2004) to the urban dynamics: centre-periphery relations characterising the world economy are reproduced within national geographical scales in the competitive relationships between cities, peripheral or shrinking cities are situated in a subordinate situation, representing places of dispossession of the resources necessary to sustain the constant growth in global cities. The limited capacity to meet local demand and solve local problems in shrinking cities produces an increased dependence on external resources, shaping socio-spatial realities of shrinking towns as part of economically peripheral regions and counterpart to the accumulation of wealth, capital, knowledge and infrastructure in global or metropolitan cities (Silverman 2018).

The main driver of progressive economic marginalisation in shrinking cities is their **undeveloped regional innovation systems** since market-oriented innovation activities form the basis for creating comparative advantages and thus economic growth.

Beyond the physical infrastructure, the norms and values of local actors, connected to the external representation of their territory, are affected by the emergent crises; **the hardware, software and mindware of shrinking cities experience setbacks**, in the words of Hospers (2012). This situation would then be reproduced through the colonised mindset and subconscious processes that do not allow local actors to act in function of a proper local endogenous development. For this reason, urban shrinking processes are often treated as taboo by municipal administrations (Pallagst et al., 2017), evidencing a gap with the academic literature that, on the contrary, seeks to interpret this phenomenon as a possibility for planning paradigms, systems, development strategies or alternative cultures (Haase and Rink, 2012).

The emerging crises in shrinking cities are seen as opportunities for possible new urban planning resources to improve liveability and sustainability (Pallagst et al., 2017; 2019). Shrinking cities can pursue greening objectives to address sustainability problems within planned shrinkage or regrowth strategies.

Embedded in new global economic transformations, shrinking cities, characterised by a certain level of organisational capacity, can offer a good ground for innovative development strategies that fit into the postmodern crisis of globalisation processes, where shrinking cities can be laboratories for social (Haase and Rink 2012) and economic innovation, exploiting the new areas included in the transition to the green economy. Despite being subject to different favourable or critical interpretations, the concept of a **Green Economy** brings a new framework of alternatives for greening and re-growing shrinking cities. On the one hand, **greening** shrinking cities strategies focus on the consumption sectors of the green economy by improving sustainability in energy and utilities, green urban designs, circular and bio-economy, ecosystem services management and sustainable tourism. On the other hand, **re-growing** shrinking city's strategies focus on the most productive industrial sectors to develop regional innovation systems in green sectors such as renewable energies, cleantech R&D, manufacturing, good processing and green financial services.

1.2 General Objective

This thesis has the main objective of researching different strategies for developing shrinking cities within the framework of the **Green Economy**.

The aim is to identify complementary strategies for greening and regrowing shrinking cities, which may include different **green sectors** and **public policies**, according to the available resources and the regional and national context of the shrinking city. It is intended to conceptually divide green sectors aimed at industrial innovation that are potentially more powerful in creating employment from greening measures that include green sectors to make consumption more efficient and improve local quality of life, which indirectly could lead to regrowth.

1.3 Specific Objectives

To achieve the main objective, a number of **specific objectives** are strategically pursued:

1. Outline the main **Green Economy strategies** to stimulate greening and re-growing paths in shrinking cities.
2. **Contextualize** the Urban Shrinkage phenomenon, and Green Economy progresses in the national backgrounds of **France** and **Mexico**, where the case studies are located.

3. **Analyse** the impacts produced by the Green Economy in the two case studies, mainly focused on the ecological and energy transition sectors in Vitry-le-François and sustainable tourism in **Mineral de Pozos**.
4. Identify the **key factors** leading to Green Economy transitions in shrinking cities.

1.4 Hypothesis

In accordance with the research objectives, the following hypothesis are made:

Main hypothesis:

- The characteristics and availability of resources may stimulate different strategies of the Green Economy, enabling paths to sustainability in shrinking cities. The success of the transition to a sustainable economy of shrinking cities is embedded in the regional and national context in which they are located, therefore depending on regional systems of innovation and supporting public policy.

Specific hypothesis:

1. Generally, the transition to the green economy in shrinking cities can rest on innovation based on technologically advanced knowledge and more traditional knowledge. The lack of knowledge and limited resources are the main obstacles to deploying the green economy in shrinking cities introducing specialised industries in green sectors. These conditions, including the lack of know-how, are exacerbated in shrinking cities of the developing world, which have as an only alternative the starting up of sustainable paths with businesses and initiatives based on traditional knowledge more than high-tech innovation.
2. Urban decline is a more evident phenomenon in countries of the global North than in developing countries. This is mainly due to regional late industrialisation and higher fertility rates in developing countries.

   In France, since the 1970s, there has been a tendency for small and medium-sized urban centres to decline as an effect of the post-Fordist transition. In the Green Economy, France is among the countries with the greatest growth prospects, and energy decentralisation, in particular, is an axis of national strategy.

   In Mexico, suburbanisation affects several expanding Mexican metropolises while the possible drivers of urban shrinkage are: post-mining abandonment, natural disasters, i.e. earthquakes, presence of violence from organised crime groups, international migration,

decreasing activities in local specific sectors. In Mexico, there is a general delay in the Green Economy due to three main determinants: 1) the lack of specialised knowledge in advanced technologies can bring a situation of economic colonialism in several sectors, including green sectors, facilitated by the action of transnational companies, resulting in the phenomenon of green grabbing; 2) the need to stimulate development through accelerated economic growth relegates sustainability to a subordinate position; 3) the lack of socio-economic equality does not allow sharing costs and benefits and so approach the sustainability threshold in a space-time dimension.

3. The impacts of the energy transition in Vitry are generally positive but still insufficient to motivate urban regrowth, while more emphasis should be placed on industrial ecology. In Mineral de Pozos, the economic and spatial transformations that began in the tourism industry and continued in real estate development ensure the economic growth of the area, but new socio-environmental conflicts could arise over the availability or allocation of resources.
4. The key factors leading to the green economy in shrinking cities are: the regional context of innovation, the national support system for the green economy, the existing economic infrastructure and thus the material resources and local knowledge available.

Table 1: Objectives and Hypothesis

Objectives	**Hypothesis**
Main Objective	Main Hypothesis
Exploring the potential brought by the Green Economy concept in greening and/ or re-growing strategies in shrinking cities.	Greening and/ or re-growing strategies in shrinking cities can be pursued by applying Green Economy concepts, sectors and public tools to improve the social, economic and sustainability dimensions on a local basis.
Specific Objectives	Specific Hypothesis
Outline the main Geen Economy strategies in shrinking cities.	Shrinking cities can address their decline through social, economic, and environmental sustainability policies.
Contextualise the state of the Urban Shrinkage phenomenon and Green Economy in France and Mexico, where the case studies are located.	In areas of shrinking cities and green economy, the national and urban context of analysis influences the qualitative and quantitative potential of the green economy on a local basis.
Analyse the impacts produced by the Green Economy in the two case studies, mainly focused on the sectors of sustainable tourism and ecological and energy transition.	In the French case, the transition to the green economy can exploit comparative advantages in sectors with a more significant technological presence. In contrast, in the Mexican case, the comparative advantages are given by the cultural potential due to the presence of industrial and mining heritage.

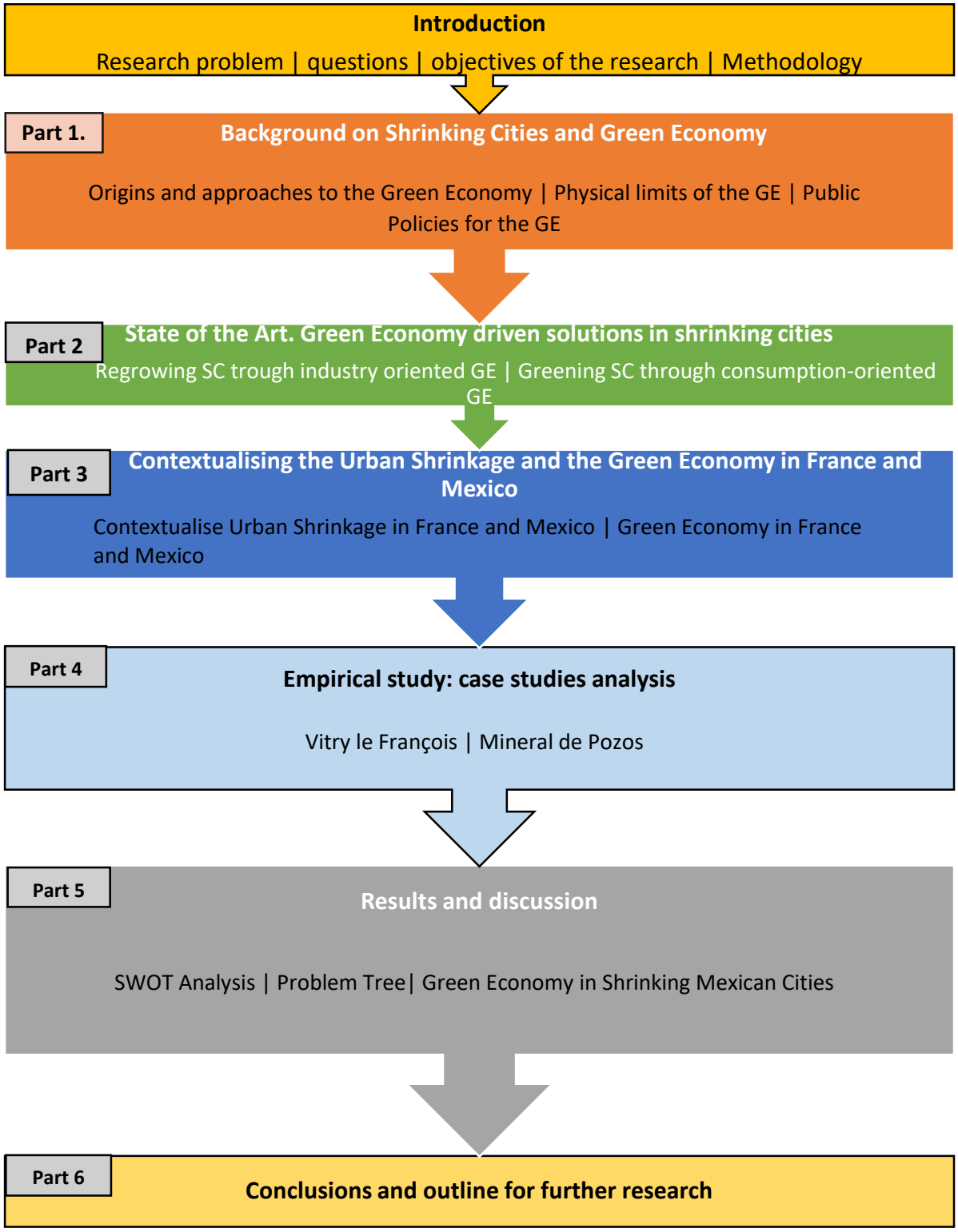
Identify the key factors leading to Green Economy transitions in shrinking cities.	The urban decline can be a side effect of the brown economy. A constellation of actors in favour of undertaking new sustainable economic paths is needed in order to support green sectors where a development strategy can be conducted in shrinking cities.

Source: Author, Kaiserslautern, 2022.

1.5 Structure of the Thesis

This work is divided into four main parts according to the following structure: the first part aims to conceptualise the Green Economy in the context of urban shrinkage by identifying different strategies for regrowth rather than greening by other sectors of the green economy. The second part seeks to contextualise the phenomenon of urban shrinkage and the state of the Green Economy in the countries where the case studies are located, namely France and Mexico. The third part focuses on the case study description, SWOT analysis and problem tree, considering the impacts on the economic, social and sustainability dimensions. The fourth part discusses the results and conceptual outcomes, identifying different possible paths to implement the green economy, and also considering concepts such as rightsizing and environmental justice.

Figure 2: Structure of the dissertation



Source: Author, Kaiserslautern, 2022.

2. Theoretical Background, Research Design and Methodology

2.1 Theoretical background

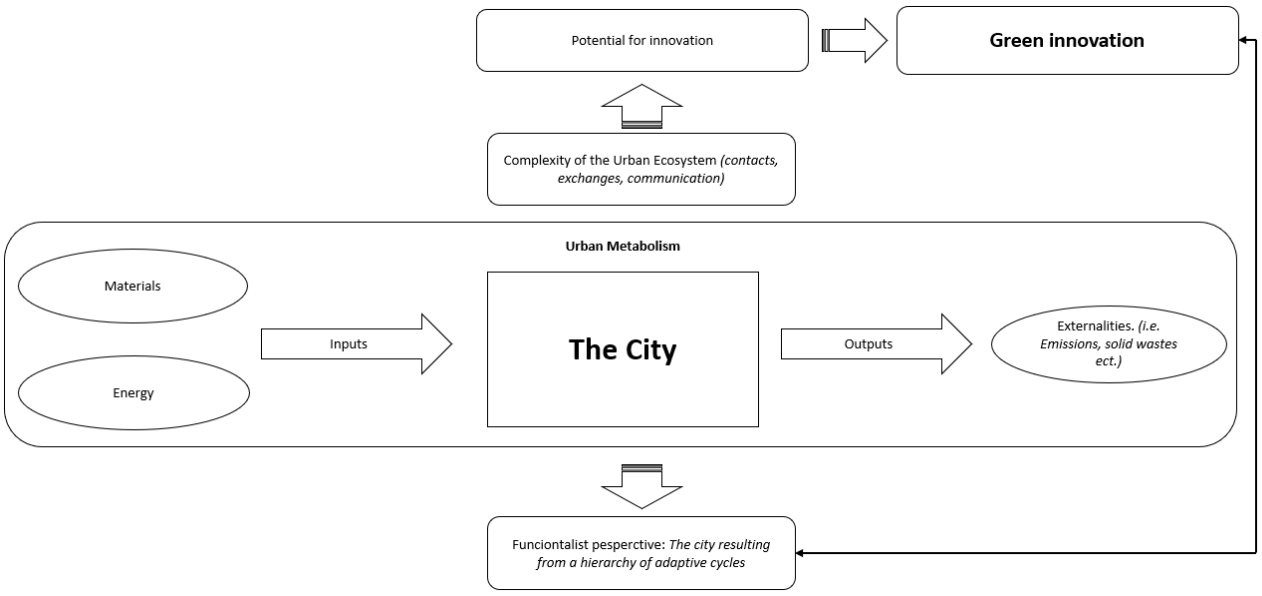
Following the principles of **ecological economics** (Martinez Alier and Roca, 2000), this research is inspired by the idea that sustainable development is an objective reachable by having a particular focus on urban metabolism standards (inputs and outputs of materials and energy), recognising that the synergy between traditional and scientific knowledge can drive innovation under a post-positivist paradigm (Phillips and Burbules, 2000), reflected in the urban space (Soja, 2000).

According to ecological criticism (Martinez Alier, 2020), the economic system is based on the **continuous externalisation of environmental costs**, which are shifted to higher space-time scales and are challenging to quantify. Seeing every financial system as a more or less complex open system, the changes brought by industrialisation involve the quality and quantity of resources extracted from nature to be introduced into the economic cycles (Martinez Alier and Roca, 2000). In this context, rural areas have more significant potential to return to sustainable development models based on organic production and local resources. In contrast, large cities are seen by definition as unsustainable due to their high levels of demand densification.

Shrinking cities used to be positioned among rural and metropolitan areas as **intermediate declining cities**. Theoretically, they can constitute a reasonable ground or laboratories for introducing new economic and social paths aimed at urban sustainability.

As well as an **open system**, the city is also seen as an **ecosystem** characterised by living beings that interact with each other (Rueda, 1998). As the number of contacts, exchanges and communication increases and these are more diverse, that is, as the complexity of the urban system increases, the **organisational capacity** increases and therefore, energy may play a minor role in the construction, maintenance and changes in the city itself through a rising potential for innovation aimed at sustainability or urban greening. Given their urban character, shrinking cities should preserve and exploit their organisational capacity to create responses to their crises.

Figure 3: From the Urban metabolism approach to the potential for green innovation



Source: Author, Kaiserslautern, 2022.

Figure 3 describes urban metabolism embedded in the complexity of the urban ecosystem and the hierarchy of adaptive cycles that should lead to the potential for green innovation. Adopting a **functionalist perspective**, society is a system of interconnected parts that work together in harmony to maintain a state of balance and social equilibrium for the whole (Mooney et al., 2007). In these terms, the idea of a sustainable city would represent an evolution of the sanitary city (Herrmann et al., 2016), prioritising the principle of decentralisation, horizontal governance, establishing bottom-up initiatives, and creating a circular metabolism capable of minimising the production of contaminating residues. In the case of shrinking cities, the particularity of the dynamics of the socio-ecological system offers the possibility of responding through active or passive changes in the use of the soil and the creation of green infrastructures, inspired by a panarchy vision that sees the urban ecosystems resulting from a hierarchy of adaptive cycles.

Cumulative causation theory is adopted (Myrdal 1957), where population decline, working on a 'vicious circle' principle, is both a cause and a result of urban shrinkage (Hospers, 2012). If new external determinants appear, the process can slow down or accelerate. Still, the critical importance for the future of many shrinking cities will be the creation of visions for their long-term development under conditions of shrinkage (Stryjakiewicz and Jaroszewska, 2016).

A critical perspective on the green economy is adopted, emphasising the importance of political, horizontal and democratic social structures to promote governance models capable of guiding the transition based on sustainability and environmental justice principles. The effectiveness of the transition towards sustainable, endogenous and long-term development is defined depending on the

dominant conception of the transition to the green economy and on the public policies put into practice.

2.2 Research Questions

The research questions are firstly descriptive, and then try to answer a rather explanatory question, as follows:

1. How are shrinking cities implementing green economy strategies in Mexico and France? *(Main Question)*
2. What sectors of the green economy are primarily present in shrinking cities? (*Descriptive)*
3. What are the main determinants for implementing green economy projects in shrinking cities? (*Descriptive)*
4. How do initial conditions and the availability of resources affect the development of green economy initiatives in highly differentiated contexts of shrinking cities? (*Explanatory)*

2.3 Research Design

The research design is aligned with the structure of the thesis. First, a literature review aims to establish the connections between the concepts of Shrinking Cities and Green Economy, outlining the main re-growing and greening strategies that lead to the prioritisation of different sectors of the green economy.

Being the context of Latin American shrinking cities under-explored, **demographic analysis** is carried out throughout the Mexican territory to identify the shrinking cities by analysing the population negative flows based on the census data. The study of the urban shrinkage phenomenon in Mexico is compared with the European situation to identify the factors at the root of urban shrinkage's various quantitative and qualitative manifestations.

The mixed quantitative and qualitative methodology is designed to answer specific questions. **Quantitative analysis** was applied, and several data were processed to detect shrinking Mexican cities and produce a mapping representation of the localities concerned by depopulation flows. This work is based on demographic variations of the individual Mexican municipalities from 1990 – to 2020. The objective of this quantitative analysis was to explore the context of urban shrinkage in

Mexico. However, the main determinants of this phenomenon are presented based on a specific information search but would require further research on a case by case basis.

The context of urban shrinkage in France and the state of the green economy in both countries are described based on a literature review. **Qualitative methods** were privileged in the case studies analysis since comparative case study analysis is applied in this research. Comparative case studies cover two or more cases undertaken over time and emphasise comparison within and across contexts and in a way that produces more generalisable knowledge about causal questions, how and why particular programmes or policies work or fail to work (Goodrick, 2014). Understanding each case is essential in establishing the foundation for the analytic framework used in the cross-case comparison. The essence of a case study, the central tendency among all types of case studies, is that it tries to illuminate a decision or set of conclusions: why they were taken, how they were implemented, and the obtained results (Schramm, 1971). Comparative case studies involve analysing and synthesising the similarities, differences, and patterns across two or more cases with a common focus or goal. Data gathering was focused on generating a good understanding of the cases and case context; methods such as documents analysis, archival records, semi-structured interviews, direct/ participant observation, physical artefacts through fieldwork visits are based on collecting the evidence through case study reports and creating study database involving time series analysis of chronological events according to the descriptive methodology by Yin (2003).

The selected strategies of inquiry are the following:

1. **Conceptualise** the Green Economy as a greening / re-growing strategy for shrinking cities. Based on the literature review, discourse is developed around the process of regrowth and greening-oriented Green Economy applications in urban shrinkage contexts. This means identifying how policies and investments in specific sectors can benefit sustainable, endogenous and durable development goals.
2. **Contextualise** the state of urban shrinking and the green economy in the national contexts in both countries of the selected case studies. Given that urban shrinkage is a relatively unknown or under-studied phenomenon in Mexico, a geostatistical analysis is applied to observe demographic movements in Mexico as a strategy for identifying shrinking based on data from the 1990-2020 census.
3. **Descriptive analysis** of case studies is based on the analysis of documents and interviews carried out remotely with the public/private stakeholders involved in the case of Mexico. At the same time, in the French case, a field study is also carried out, including participatory observation and interviews with local stakeholders.

4. **Analysis and discussion** of results focus on case studies to extrapolate general concepts regarding the role of the green economy in shrinking cities in Mexico and France. In the selected cases, the positive and negative effects of the transition to the green economy will be analysed in three dimensions: economic, social, and environmental sustainability.

5. **Analytic generalisation** regarding the role of initial resources driving different paths of success in green economy transitions driven in shrinking cities is realised and outlined for further research based on findings.

Table 2: Research Design

Research Phase	Research design	Selected methodology
1	Conceptualise Green Economy in Shrinking Cities	Literature review, state of the art on green economy applications in shrinking cities, including greening and green growth strategies
2	Contextualise the urban shrinkage and Green Economy in France and Mexico	Detect shrinking cities in Mexico through a geostatistical analysis of demographic movements over the period 1990-2020
3	Descriptive analysis of case studies	Selection of case studies Vitry le Francois and Mineral de Pozos. Historical, geographical and economic contextualisation.
4	Empirical analysis	Evaluation of impacts on the economic, social and sustainable dimensions by recent green economy developments
5	Analytic generalisation	Analysing the potential of green transitions in shrinking cities by identifying key factors that can foster them.

Source: Author, Kaiserslautern, 2022

2.4 Case studies selection criteria

Case study selection is based on the proposal of the town of **Vitry-le-François**, located in the region of Marne, France, and **Mineral de Pozos**, located in the Federal State of Guanajuato, Mexico.

The criteria adopted to establish the case studies concern the presence of sustainable development paths with green economy projects undertaken in shrinking cities. The choice of cities follows the **approach of most similar systems** (Pierre, 2005) since these are two small towns with high

depopulation rates, while the selection of countries France and Mexico, follows the **most different systems** (Otner, 2010), where diverse modes of urban shrinkage and various states of progress towards the green economy are reflected, and thus, different sectors are privileged within the selected case studies.

In both cases, the magnitude of shrinkage can be considered **extreme**; Adelaja (2010) marks out extreme shrinking cities as those cities which have lost more than 25% of the population during the last 40 years, and the presence of green economy initiatives. The depopulation processes in the two cases relate to different historical periods: while in Vitry depopulation began in the 1970s and has so far reached a magnitude of around 32%, in Mineral de Pozos depopulation it has been almost massive, falling from about 12.000 inhabitants at the beginning of the twentieth century, to less than a thousand inhabitants in the 1960 and then begin a slow regrowth.

In both cases, local stakeholders invest in measures to allow long term sustainable regional development. However, the green sectors applied privilege diverse focuses: **green technology applications** in Vitry are highly based on national funding and legal frameworks supporting cohesion policies and energy decentralisation, while in Mineral de Pozos, local recovery is based on his patrimonial industrial and natural heritage, turning it into an attraction to stimulate **sustainable tourism** and **real estate new developments**.

2.5 Data gathering

Detecting shrinking cities in Mexico was possible by analysing demographic variations using data sources from the decennial censuses produced by the Mexican National Institute of Statistics and Geography (INEGI) from 1990 to 2020. As findings, **eighteen urban areas** part of the Mexican National Urban System (SEDATU, 2018) have suffered a process of depopulation at an average rate higher than 0.15% per year (4,5% in 30 years). This statistical geographic analysis brought to the creation of a map using the geographical information system tool gvGIS.

For the case study analysis, **fieldwork** was partially **limited** by the COVID-19 crisis and related travel restrictions. In the Mexican case, data gathering was supported remotely thanks to the collaboration and availability of local Mexican stakeholders, semi-structured interviews, questionnaires and document collection was possible, together with analysis and literature review. However, **fieldwork was possible in Vitry-le-François** where green economy projects, physical artefacts such as, built/natural environment and renewable energy installations and urban life were observed, semi-structured interviews with government sectors, worker unions and representatives of private companies and civil society were carried out. In Vitry-le-François, semi-structured interviews were

conducted with **the mayor** and other local government representatives, including the **head of the local government's ecological transition**, the **head of the green space and environment service** and the head of economic attractiveness and territorial development. Interviews were also conducted with representatives of the local **CGT trade union** association and with part of the **private sector** dedicated to maintaining the wind farms. In the Mexican case, interviews were carried out electronically, particularly with the cultural, tourism and civil society sectors of Mineral de Pozos.

During the conceptualisation phase of the green economy in shrinknig cities, interviews were conducted with the project manager of Solar Park Wissenschaftspark Gelsenkirchen GmbH, to learn more about Gelsenkirchen's experience as a shrinking city, which for years has been pursuing an urban strategy of solar energy in both consumption and production.

Part I │ Background on Shrinking Cities and the Green Economy

3.1 Background on Shrinking Cities and the Green Economy

The processes of urban shrinkage and green economy transitions are **two complex ideas** recognised as open concepts whose characteristics vary according to the context of analysis. This chapter aims to introduce the background to both concepts.

The study of shrinking cities has emerged in recent decades as a **new branch of study** in urban planning for declining urban areas that need to outline alternative methods of development under the global framework of sustainability. The topic of **Shrinking Cities** began to emerge from the evident urban transformations produced by depopulation in post-Fordist American cities and massive migration from Eastern to Western Europe. More recently, their study has been extended to other geographical areas, although their study in the Global South remains relatively limited, except in China and India, where studies show a significant increasing trend of decline in some urban centres.

On the other hand, the **Green Economy** had emerged as a new global concept in 2008, when UNEP presented it as the primary viable, sustainable development strategy to reduce contaminant emissions into the atmosphere and onto the planet earth. The Green Economy is based on improving the efficiency of material and energy use, starting with the transition towards an economic model less intensive in the use of resources. Emerging as a **mainstream concept** capable of inspiring various transformations at global and local levels, the Green Economy involve new concepts, ideas, study methods and sectors that can bring about decisive changes towards sustainability.

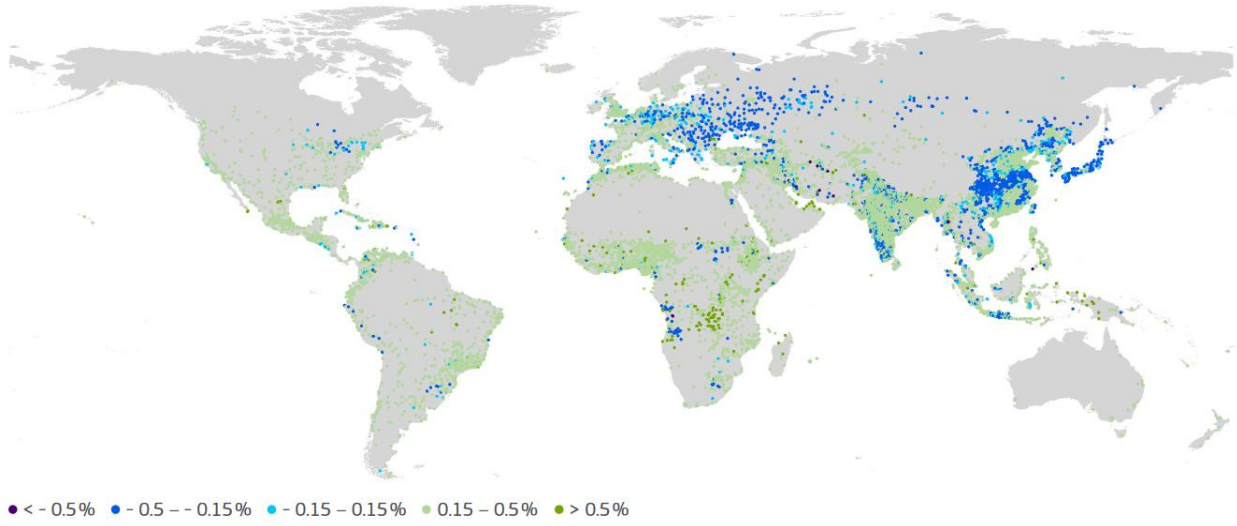
3.2 Shrinking Cities: a new branch in Urban Studies

The Shrinking Cities International Research Network (SCIRN) defines a **Shrinking City** as "a densely populated urban area that has, on the one hand, faced a population loss in large parts of it (for at least five years, more than 0.15% annually), and on the other hand undergoing an economic transformation with some symptoms of a structural crisis". From this definition, the demographic and GDP variation would seem to be the leading indicators to be applied in the study of shrinking cities. However, this is not a general rule since other indicators can be used, such as the employment rate, deteriorated building stocks, social problems, or vacant spaces (Stryjakiewicz and Jaroszewska (2016).

The phenomenon of urban shrinking can be variegated and take on different types: Haase et al. 2014 conceptualise at least six sets of theoretical explanations for urban shrinking, Oswalt and Rienits (2007) identified no fewer than twenty-one causes of shrinkage across the world, while Branislav et al. (2019) distinguish the **different types of shrinking cities** according to the economic-political reasons, the character of shrinkage duration, shrinkage timeline, the seriousness of shrinkage process, spatial level of shrinkage and size of a shrinking city.

Worldwide, **one every six cities** were shrinking between 1960 and 2005 (Turok and Mykhnrnko, 2007; Hollander et al., 2009, Pallagst 2007), with a proportion rising to one in four if we refer to the period between 1990 to 2000 (Oswalt and Rieniets, 2006). This indicates a clear upward trend.
The focus of the study of shrinking cities began with the observation of this phenomenon in the United States and later in post-socialist East Germany. The term "shrinking cities" was introduced from the 1970s onwards to denote the annihilation of American central cities by suburbanisation (Audirac 2017). The leading causes of urban shrinkage in the United States are post-industrial transformations related to a long-term industrial transformation process due to the decline of manufacturing industries (Pallagst, 2008). Four major metropolitan shrinking areas in the US are Pittsburg, Cleveland, Detroit and Buffalo metropolitan area, all situated in the Rust Belt region (Cox, 2017). Outside of the rustbelt, nine American cities are shrinking: Pine Bluff (AR); Lompoc and Seaside-Monterey, CA; Carson City and Santa Barbara Farmington, NM Brunswick, GA Pascagoula MS and New Orleans. While for the former, the causes are found in the closure of military bases or the decline in port activities, GA Pascagoula MS and New Orleans suffered from the devastations produced by Hurricane Katrina in 2008 (Cox, 2017).
As can be seen from the study on world shrinking cities by European Commission (2022, fig. 4) concerning cities with more than 100,000 inhabitants that lost population between 2000 and 2015, these are concentrated in the Eastern European region, the US rust belt region, but also in Japan, China and India. Lower concentration of shrinking cities can be found in the rest of the Americas, Africa, Western Europe, Russia and parts of Indonesia.

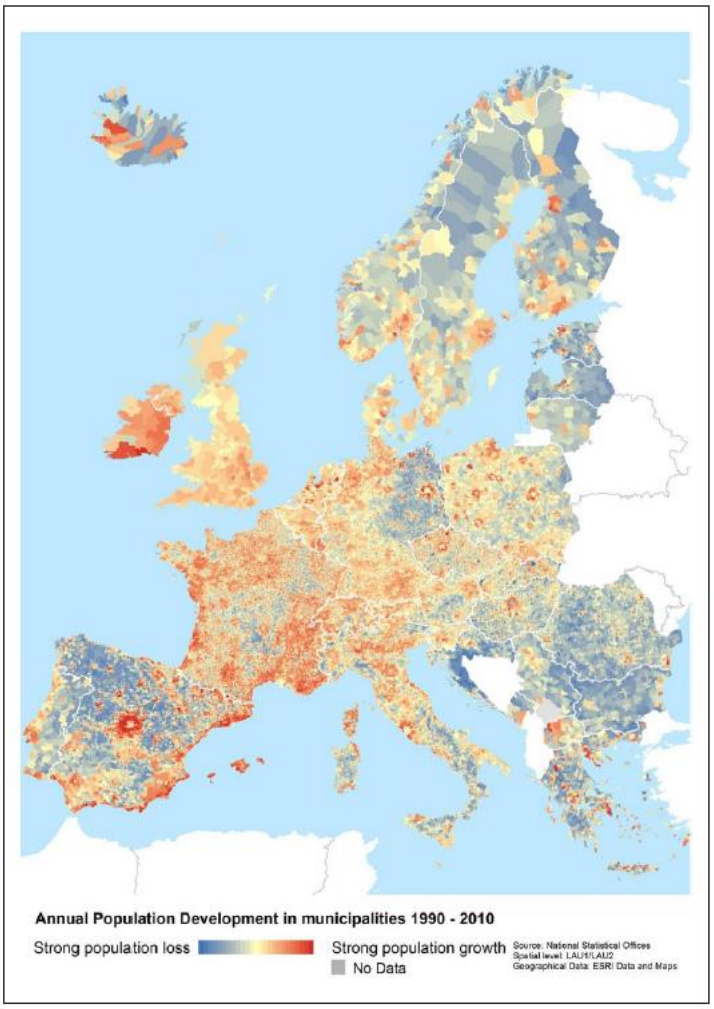
Figure 4: The annual rate of population changes between 2000 and 2015 at the FUA level globally



Source: European Commission, 2022

In **Europe,** the falling **fertility rates** are generally considered a significant driver of shrinkage. However, there is a "pluralist world of urban shrinkage" (Haase et al. 2013, p.1521), given the varieties of shrinkage in European cities. Around one-third of all European cities (with more than 200,000 inhabitants) have suffered at least once from a ten-year population decline (Kotkin et al. 2013). Some of the declining metropolitan areas affected by deindustrialisation and depopulation are Liverpool (UK), Glasgow (UK), Upper Silesia (Check Republic, Poland), Athens region (Greece) and Lodz (Poland) (Cox 2017). According to the quantitative analysis realised by Wolff et al. (2018, see figure 5) on European Shrinking cities, these are especially pronounced in Baltic and Eastern Europe. Bulgaria, Romania, the Czech Republic, Serbia and Croatia, with more than half of their cities, have experienced population decline from 1990-to 2010; Hungary or Poland's shrinking cities are slightly above the European average (25–50%). In Western European countries, Germany and France belong to a group within the range of the European average (15–25%). In most Southern European and Scandinavian countries, population loss is a significant challenge for rural areas and a few cities located in remote areas.

Figure 5: Shrinking Municipalities in Europe



Map 1. Population development in Europe 1990–2010.

Source: Wolff et al. 2013

In Germany, declining birth rates, post-industrial transformations, and the German reunification effects are the primary triggers of shrinkage (Pallagst et al., 2017). Deindustrialisation, housing vacancies, and depopulation were experienced in post-socialist East German cities at the end of the 1990s. Following German reunification, public policy efforts are applied through federal and state economic recovery and infrastructure programmes to enhance the attractiveness and competitiveness of East German cities. While Dresden, Leipzig and Jena have demonstrated their resilience capacities with population and economic recovery, other post-socialist transformation German cities of Berlin, Cottbus, Halle and Schwerin are qualified to be long term shrinking cities. In particular, Halle suffered from the most severe economic decline and large-scale population loss of almost 20 per cent (Bartholomae and Woon, 2017). The other focus of shrinking German cities is located in the country's northwest: the 'old' post-industrial transformation cities, such as Bremen and most Ruhr cities (Dortmund, Essen and Gelsenkirchen) experienced a demographic decline.

As an effect of the break-up of the Soviet Union, most Romanian cities were affected by a shrinkage process. The factors of negative natural increase, external and internal migration, and deindustrialisation were exacerbated by the liberalisation of migration for Romanian citizens in 2000, Romania's accession to the European Union in 2007 induced temporary circular migration and aggravated the shrinkage process of most Romanian cities (Shoenberg and Luminita, 2017, Eva et al., 2021).

In Estonia, even with an annual GDP growth rate of 8.8 per cent in 2011, the country took the position of a peripheral low-wage country, mainly serving Scandinavia: as a consequence of the breakdown of the military sector, the shrinking of manufacturing and agriculture, and income changes during the breakdown and part of the adaption phase, industrial clusters could not develop sufficiently. Due to the lack of urban planning, the sprawl of the two principal cities of Tallinn and Tartu led to the deterioration of city centres and urban shrinkage of the whole towns (Friedrich, Ülper and Ukrainski, 2014).

Other studies on urban shrinkage have been carried out in other parts of the world in an advanced state of the so-called **second demographic transition** (Lesthaeghe 1995; Van de Kaa 1987), such as Japan, South Korea, Taiwan and Australia.

In Japan, compact city rationale justifies a competitiveness-based rescaling of governance within Japanese metropolitan areas, which is speeding up the suburban decline, especially in the Osaka Metropolitan Area, where decline is particularly affecting its suburbs, depopulation and devitalisation are associated with the rapid ageing of its remaining residents in addition to the decrease in the manufacturing base of the area (Buhnik, 2010; 2017), as well as other shrinking cities suffering from economic peripheralisation such as Kitakyushu (Ortiz Moya, 2020) and the "Art Islands" Naoshima, Teshima and Inujima, located south of Okayama city (Fujita, 2018).

South Korea has the lowest fertility rate among the 30 OECD (most developed) nations (1.09 in 2021), its population is ageing rapidly, and its future population will decline, producing severe implications for both society and the economy with the formation of several shrinking cities (Richardson and Bae, 2017).

Taiwan's fertility rate and the growth rate of the population have declined over the past few decades. Although the existing planning paradigm in Taiwan is still growth-oriented, the shrinking cities phenomenon is increasing in small towns, where there are both pressures to be urbanised and co-opted into a larger city size or downgraded to a village. Urban shrinkage is rising, especially at the town level in Taiwan: 11 shrinking counties and 202 shrinking towns are registered in 2020. In

Keelung City and Yilan County, and Hualien County, the presence of population contraction and high housing vacancy rates are evident (Hu 2021).

In addition to declining birth rates, shrinking cities appear in Australia as resource depleted cities or post-mining cities. Unlike most developing countries suffering from this type of urban depopulation, Australia seeks to exploit available intellectual resources to convert the economic structure of the shrinking city. In the case of Mount Isa Mines, the company that took over the old mining operation invests in areas of intense technological innovation working on research and development technology for exploration, satellite imaging to the latest machinery, creating advantages of intellectual property in smelting technology and concentration for copper, collaborating with Australian authorities and public research agencies (Martinez Fernandez et al. 2012).

In summary, there is a clear trend towards an increase in shrinking cities globally, although these are more concentrated in northern countries, especially those in the advanced demographic transition.

Drivers, characteristics and types of shrinking cities are linked to the economic structure of the territory in which they are located. In some territories more than in others, there is an urgent need to find solutions to plan for urban degrowth, for which there should be coordinated action between institutions. On the other hand, where possible, efforts should be made to update the economy in order to reverse the decline in urban areas.

3.3 Green Economy: a mainstream concept for sustainability

Green Economy opens up a series of **new markets** for highly innovative products, processes and services, capable of consuming less energy, reducing the impact on the territory according to the more efficient use of natural resources, producing a progressive transition of traditional business to emerging industries, such as research in nanotechnology, manufacture of solar panels and ecotourism. It is not just about having clean energy but also technologies produced through cleaner processes and the emergence of markets for products that consume less energy (Chapple, 2008). They can be private and public investments that promote earnings and job creation through the rational use of natural and financial resources and energy efficiency that reduces contaminating emissions by preventing the loss of biodiversity and environmental services. From its origins, an **international debate** followed in which the Green Economy established itself as a general concept for transforming economic and production infrastructures with a view to sustainability. It encompasses various ideas, more or less related to ecological currents of thought or more oriented towards efficient but continuous economic growth. In practice, this translates into the application of economic sectors aimed at productivity or

improving people's quality of life, considering principles of environmental justice, as well as the adoption of public policies capable of establishing a balance between the public and private sectors.

3.4 Origins of the Green Economy

While the origins of the foundation of the Green Economy can be found in the popularisation of environmental issues in advanced industrial society in the 1960s and 1970s (Ehrsman and Okereke 2015), the term "Green Economy" was introduced in 1989 by Pearce et al. in the "*Blueprint for a Green Economy"* as a basis for sustainable development. Following on from the series of economic measures introduced by US President Roosevelt's 'New Deal' to tackle the Great Depression of 1929, the global **New Green Deal** promoted by UNEP proposes macroeconomic interventions recognising that some economic sectors are more sustainable than others (Mancilla and Carrillo, 2011). In 2008, in response to the global financial crisis (Davies 2013, 1285), the concept of a Green Economy was re-launched by **UNEP,** which in the 2011 document offers the generally accepted definition: "one that results in improved human wellbeing and social equity while significantly reducing risks and ecological scarcities. It is a low carbon, resources efficient and socially inclusive (UNEP 2011, p.4-5)" and "branch of the economy that develops and sells products, solutions or technologies that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services". With these definitions, the concept of the green economy is deliberately left imprecise in unresolved transitional tensions. This woolly concept can lead to different interpretations, including various sectors, from the most technologically sophisticated to the more traditional, from production-oriented to consumption-oriented markets (Ehrsman and Okereke, 2015).

3.5 Currents of thought in the Green Economy

Although the dispute between Green Growth and Degrowth is beyond the scope of this thesis, it is recognised that the transformations brought about by the new markets of the Green Economy can, through an appropriate territorial redistribution of the factors of production, create new and fairer economic geographies, also constituting new possibilities for improving the quality of life and liveability in peripheral intra-national and international areas, such as shrinking cities or developing countries.

Favourable and critical positions on the Green Economy are reflected in the distinction made by Ehrsman and Okereke (2015) between thin or thick conceptions of the Green Economy, which is

possible to link with a strong or weak conception of the notion of sustainability (Gómez 2021). These refer to different currents of economic thinking, such as the **neoclassical environmental** current and the **ecological current** (Loiseau et al. 2016), reflecting the struggle between Green Growth vs Degrowth concepts (Netzer and Althaus 2012).

Neoclassical environmental economists have a thin conception of the Green Economy adopting a weak sustainability approach: full substitutability of natural capital would be reachable through technological progress, i.e. manufactured capital can substitute for the ecosystem services of natural capital (Gómez 2021). In the thin green approach, drivers of environmental degradation are poverty, lack of economic growth and government policies producing the inefficient use of natural resources and the undervaluation of natural capital (Borel-Saladin and Turok, 2013), while growth that does not harm the environment is possible through the correction of prices, the evaluation of nature and the promotion of socio-technical innovation, likely through the introductions of tools such as Life Cycle Assessment (LCA) carbon footprint and Cost-Benefit Analysis (CBA). Porter hypothesis (Porter and Van der Linde, 1995) argue for win-win solutions for both the economy and the environment. The logic underlying the practice is that economic growth and environmental preservation are only compatible when the environmental functions are priced and marketed correctly, as in the carbon credit schemes (Huff, 2015) of the Kyoto protocol and REDD+; the inclusion of incentives for companies to compensate environmental harm caused by industrial or mining activities or another kind of measures pursuing the triple win: achieving environmental sustainability, socially inclusive economic growth, poverty alleviation. The notion of ecological limits is rejected, arguing that all solutions will be technology-based.

On the other hand, **ecological economists** have a thicker conception of the Green Economy adopting a strong sustainability approach. Strong sustainability mainly follows the arguments of ecologists, biologists and environmental economists who, contrary to the postulates of weak sustainability, do not conceive that manufactured capital can replace natural capital (Maldonado, 2017; 2014), giving continuity to the concerns about the **limits of the earth** raised since the 1970s by the scientists of the Club of Rome (Meadows et al. 1972). They argue that, due to the compromise to neoliberal capitalism, only marginal changes can be expected under the Green Economy framework that is often seen as nothing more than a cover for business as usual that adds nothing to the conceptualising the relationship between man and nature. They consider technological improvements necessary but insufficient for dematerialisation due to rebound effects; i.e., efficiency gains may lower prices and increase consumption (Herring 2006). Consequently, structural changes within the economy and society should create a more small-scale decentralised way of life-based upon greater self-reliance to develop social and economic systems that are less destructive towards nature (Williams and

Millington, 2004).

Earth's biophysical limits would justify these changes, as current levels of economic growth cannot be maintained within the Green Economy. For example, in the transition from the brown to the green economy, one crucial aspect is the replacement of fossil fuels with clean energy sources. However, the competition between fossil and renewable energy sources is marked by the limited physical capacity of renewable sources. As an effect, there is a shifting of pressure on other kinds of limited resources, such as land. The max quantity of energy provided by biomass grown on land at a global scale is estimated at 450 exajoules, while global economy consumption is already at 500 EJ (Frediani et al., 2019). Similarly, Shellenberger (2019) argues that the **poor physics** behind renewable energy sources, so for example, "solar farms occupy 450 times more land than nuclear plants, and wind farms take 700 times more land than natural gas wells, to produce the same amount of energy", would explain that renewable energies are not suitable for the electrification of modern society, but would have the objective of transforming back society into an agricultural one. Other critics (Ferroni & Hopkirk, 2016) suggest that, depending on the production conditions, the energy invested in the manufacture of photovoltaic technologies may not be compensated by the amount of potential energy produced during their entire life cycle, given that solar electricity is very material, labour and capital intensive, while solar radiation exhibits a relatively low power density.

All these aspects shift the focus towards innovation in energy efficiency areas to avoid the waste of natural resources, considering that the economic system must be adapted to planetary boundaries to prevent further environmental imbalances.

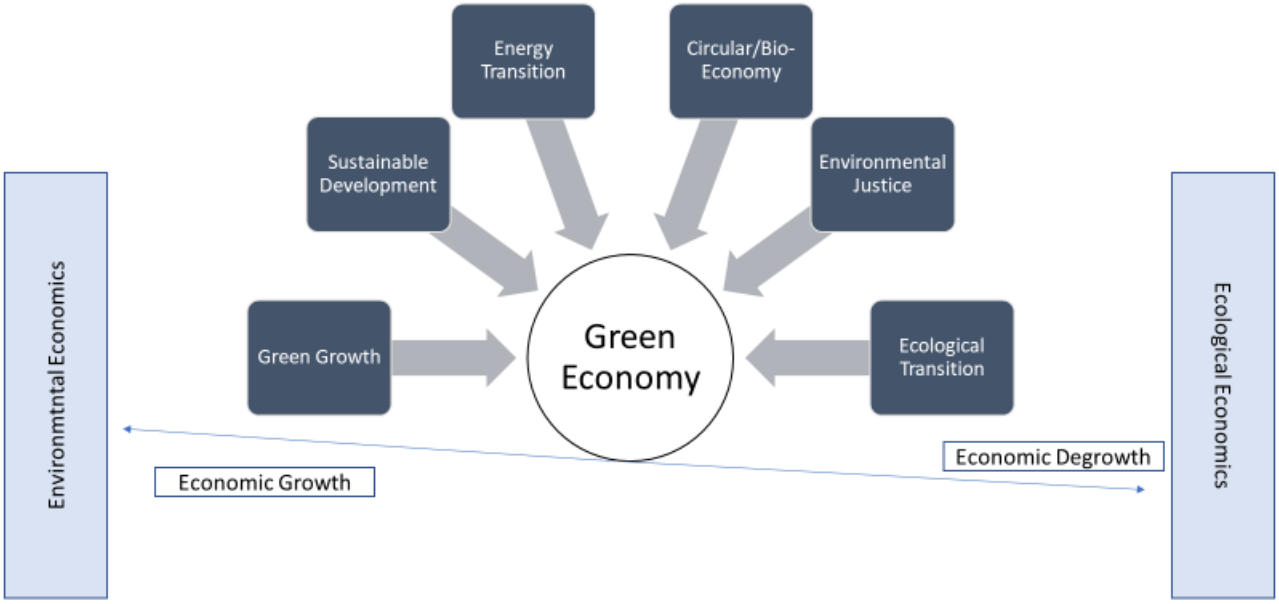
The achievement of the sustainable development goals will inevitably have to be based on substantial social and structural changes, as well as a significant re-planning of policies considering that a sustainable spatial organisation of social activities without the use of fossil fuels or nuclear energy requires enormous structural and sociodemographic changes to reduce the energy demand and adapt it to the renewable energy resources available in the territory (Ariza-Montobbio et al., 2014).

3.6 Embedded concepts in the Green Economy

Green Economy refers to a **mix of current and emerging principles** (e.g., sustainable development, resources efficiency), **activity sectors** (e.g., energy, industry, services), and **topics** (e.g., products' life-cycle analysis, economic and environmental impact assessment, policymaking, economic resilience, modelling, optimisation). It acts as an **umbrella concept**, including elements of the energy transition, circular economy and concepts of the Bio-economy, as well as other kind of solutions

based on nature (D`amato et al., 2017). The circular economy and the Bio-economy are based on resources, wherein the principle of the green economy redeems the role of ecological processes.
The following paragraphs describe and discuss six concepts embedded in the Green economy (see fig. 6).

Figure 6: Green Economy concepts and approaches



Source: Author, Kaiserslautern, 2022

3.6.1 Green Growth

In the hegemonic thought of major financial institutions, Green Growth "is qualitative growth that is efficient in its use of natural resources, clean in that it minimises pollution and environmental damages and resilient in that it explains natural hazards" (World Bank 2012); and "is about fostering economic growth and development while ensuring that the natural assets continue to provide the resources and the environmental services on which our well-being relies. To achieve this, it must catalyse investment and innovation which will underpin sustained growth and give rise to new economic opportunities" (OECD 2011).

The emphasis on Green Growth is based on the belief that technological changes can circumvent environmental constraints decoupling future growth from the production of externalities of the economic system. Consequently, greening the economy would not necessitate a change in production and consumption patterns (Netzer and Althaus 2012).

In this context, local green growth is possible by addressing barriers and regulations that impede the engagement of local industries in the low-carbon economy. The public sector has a crucial role to play in ensuring this national-local coordination and in removing policy barriers that hamper green, strengthening collaboration between businesses, trade unions, civil society, education institutions, economic development agencies and local authorities to ensure that public initiatives and programmes aimed at greening the economy are well defined, effectively implemented and meet the local needs (OECD 2012). Still, according to the OECD, local Green Growth is achievable through the completion of seven steps: a) articulation of a clear vision, b) Identifying potential local green clusters, c) Invest in green infrastructure, d) Integrate demand-driven workforce development strategies with green economic development, e) Foster creativity and innovation through collaborations among universities and research institutions, venture capital and other investors, industry innovators and government, f) Utilize the different roles of government – regulator, consumer, landowner, convenor and investor – to ensure they are aligned with green growth, g) Engage citizens, businesses and other stakeholders in developing green growth policies.

3.6.2 Sustainable Development

According to the IPCC (2015), climate change is unequivocal. The globally averaged combined land, and ocean surface temperature data from a linear trend calculation show a warming of 0.85 (0.65-1.06) ° CO_2 from 1880 to 2012. The atmosphere and the ocean have warmed, snow and ice amounts have decreased, and sea levels have risen. Since the beginning of the Industrial era, oceanic CO_2 capture has been translated into ocean acidification of oceans; glaciers have lost mass, particularly since 2002; they have continued to thaw almost everywhere.

Globally, total greenhouse gas emissions have continued to grow between 1970 and 2010, with a particular increase between 2000 and 2010, being economical. Population growth is the most critical driver of greenhouse gas growth, causing atmospheric concentrations of carbon dioxide, nitrogen dioxide, carbon monoxide, nitrogen dioxide, methane and nitrate oxide unprecedented in the last 80,000 years of population size, economic activity, lifestyles, energy use, land use, technologies and climate policies.

The principle of Sustainable Development was introduced by the World Commission on Environment and Development, in the so-called **Brundtland Report** in 1987, as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs". In 1992 the UNFCC was created as a framework of international cooperation to combat climate change, stimulating the creation of numerous conventions, funding mechanisms and instruments to

induce a reduction of CO_2 emissions in the earth's system. The most important were the Kyoto Protocol, the Clean Development Mechanism, REDD+, the Green Climate Fund.

Limiting global warming to 1.5°C by 2050 is the primary global target to avoid the deterioration of terrestrial ecosystems, loss of biodiversity and large-scale social problems. However, tensions emerge between countries over who and how emissions should be cut, with many significant countries still reluctant to do so, e.g. Russia, Australia or the US. In contrast, many developing countries stress the principle of "differentiated shared responsibility", justifying their delay in cutting emissions due to the need to achieve adequate levels of human development.

Sustainable development is a new type of functioning of the production and economic system (society, organisation, industry, etc.) that ensures strategic competitiveness over the long term (Kozhevina 2015; Aleksejeva 2016). Sustainable development implies a justification for balancing common priorities (factors) of development (resource, social, economic, environmental, legal, cultural, environmental) in a particular organisation and their harmonisation with the interests of sectoral, regional and national development. Focusing on the ideas of the process approach, sustainable development management is a set of techniques, methods, and procedures of the targeted impact that provide a qualitative transformation of the system in the conditions of evolutionary functioning (Lavrinenko et al., 2019).

Sustainable development combines consumption and production and has three major dimensions: economy, society, and the environment. All three sizes are addressed in the Sustainable Development Goals (SDGs) global framework, launched by the United Nations in 2015 and constituted a landmark in the push for sustainable development. Green Economy Coalition[1] suggests areas for further work so that economies can become more inclusive and sustainable and power the SDGs Green Economy coalition. The main concerns at the core of their analysis are the limited participation by the poorest and most marginalised groups in the design and implementation of Green Economy and Green Growth plans and processes; the most impoverished and most marginalised groups are not explicitly targeted in terms of reducing poverty and inequality and the Green Economy plans do not comprehensively recognise the limits to growth nor address the low carbon transition with the urgency it requires.

In the United Nations Conference on Sustainable Development Rio+20, 'Green Economy' was chosen as one of two central themes for the conference, building on a burgeoning body of literature on the green economy and growth (Bina, 2013). Transitioning to a green economy requires a mix of short- and long-term policies, a different mix of policies and instruments for developing countries,

[1] https://www.greeneconomycoalition.org/assets/reports/External-Reports/Green-Economy-and-SDGs-CAFOD-March-2017.pdf

and overcoming the political difficulty of implementation.

According to Barbier (2012), UNEP´s contribution as a promoter of the Green Economy leading to influencing the Rio+20 agenda as well as establishing a growing global network of debate addressing significant knowledge gaps in green growth theory and practice should have led to converting UNEP into a specialised agency, a status currently accorded to other UN agencies, such as the International Labour Organization (ILO) and the World Health Organization (WHO). This would have allowed UNEP to be adequately funded, expanding its policy advice, technical assistance, and applied capacity to support national and regional initiatives on the Green Economy.

3.6.3 Energy Transition

The energy sector is responsible for almost **three-quarters of global emissions**. Since the pre-industrial age, the global average temperatures have been 1.1 °C higher, with visible impacts on weather and climate extremes (IEA 2021). Since fossil fuels are directly associated with the emission of greenhouse gases into the atmosphere, the main contributor to global warming, the transition to Green Energy is undoubtedly one of the pillars of the Green Economy. From the Rio meeting in 1992 until Glasgow 2021, the UNFCC emphasises the transition to renewable energies, creating funding programmes at the national, regional and international levels to accelerate the phasing out of fossil fuels.

Renewable power technologies already dominate the global market for new electricity generation capacity: a record level of 260 gigawatts (GW) of renewables-based generation capacity was added globally in 2020, more than four times the capacity added from other sources (IRENA, 2021). Modern energy is inseparable from the livelihoods and aspirations of a global population set to grow by some 2 billion people to 2050, with rising incomes pushing up demand for energy services and many developing economies navigating what has historically been energy and emissions-intensive periods of urbanisation.

Since electricity will be the primary energy carrier, increasing from a 21% share of the total final energy consumption in 2018 to over 50% in 2050, the objectives envisaged by the IEA and IRENA are based on USD 131 trillion investment need to flow into the energy system over the period to 2050 that prioritises technology avenues compatible with a 1.5°C: a massive additional push for clean electrification that requires a doubling of solar PV and wind deployment relative to the APS (Announced Pledges Scenario). Hydrogen and derivatives should account for 12%, and Bioenergy will represent 18% of total final energy consumption by 2050; expansion of nuclear power where acceptable; decarbonisation efforts may require CCS (Carbon Capture and Storage) and CO_2 removal

technologies and measures; eliminate market distortions that favour fossil fuels with the necessary changes in funding structures; a drive to expand electricity use for transport and heating; relentless focus on energy efficiency, together with measures to temper energy service demand through materials efficiency and behavioural change.

By applying these measures and relying on clean energy innovation, the energy intensity of the global economy would decrease by more than 4% per year between 2020 and 2030 in the NZE (Net Zero Emission scenario).

3.6.4 Circular and Bio-Economy

Like the Green Economy, the concepts of the Circular Economy and the Bio-Economy promise to transform economies towards sustainability (D`Amato et al. 2017). Although adopting different approaches, the three concepts overlap. The Circular economy concept comes from the rethinking of the industrial processes (Frosch and Gallopoulos, 1989), redesigning the life cycle of the 'product' to have minimal input and minimal production of system 'waste' that, in any case, could be converted into a resource for a second industry, so producing a solid emphasis on inter-sectorial dynamics and cooperation.

Ecosystem services largely support the functioning of our economy and society but are often invisible or disregarded. In the Green Economy, the ecological processes can be leveraged to benefit human beings without jeopardising the sustainability of the ecosystems.

Circular and Bio-Economy are **synergic concepts** that can be understood as 'narratives', as defined in D'Amato, (2021), serving an ancillary role rather than a substitute for sustainable development (D` Amato and Kohronen 2021). In opposition to the dominant and prevailing global linear economy in terms of the physical flows of materials and energy (Sauvé et al., 2016), Circular Economy aims at supporting the development of **regenerative production-consumption systems**, where inputs and outputs are minimised by 'slowing, closing, and narrowing material and energy loops' (Geissdoerfer et al., 2017). The Ellen Macarthur Foundation defined Circular Economy as "an industrial economy that is restorative by design, which mirrors nature in actively enhancing and optimising the systems through which it operates" … "Circular economy builds on the concepts of waste prevention and resource efficiency by showing where the most significant benefits are to be realised, and by emphasising the need to consider the sustainability of the sources of raw materials, as well as their fate". The European Commission (2012, p.2) defines the Bioeconomy as "the production of renewable biological resources and the conversion of these resources and waste streams into value-added products, such as food, feed, bio-based products and bioenergy. Its sectors and industries have

strong innovation potential due to their use of a wide range of sciences, enabling and industrial technologies, along with local and tacit knowledge".

Its roots are in the ideas of industrial ecology and industrial ecosystems. In the Circular Economy, improving production processes' material and energy performance and product usage along the product life cycle would allow enhancing the value embedded in material and energy (Korhonen et al., 2018), leveraging diversity and resilience and system thinking in production-consumption processes (Lewandowski, 2016; Sauvé et al., 2016). Circular Economy implies the rethinking of product/services design so to allow for, e.g., efficiency gains; reduction of material and energy needed for production; long-term maintenance and repair; sharing, reuse, refurbishing and remanufacturing, repurposing; recycling and reclassification of waste into inorganic and biological components; and renewability of energy sources (Geissdoerfer et al., 2017; Ghisellini et al., 2016; Kirchherr et al., 2017).

Material Flow Analysis (MFA) generally refers to analysing the throughput of process chains comprising extraction or harvest, chemical transformation, manufacturing, consumption, recycling and disposal of materials (Bringezu and Moriguchi, 2002). **Cost-benefit analysis (CBA**) is a decision support tool used to assess the welfare effects of a project or an investment and has its roots in the welfare measures of producer and consumer surplus (Hanley and Barbier, 2009; Hanley and Spash, 1993; Hansjürgens, 2004; Sen, 2000).

Bio-Economy, at times also called 'bio-based economy' or 'knowledge-based bio-economy, leverages the potential of biological resources from land and sea for the development and commercialisation of goods and services. **Fossil-based activities substitution** with those based on **living biomass**, with **biotechnology** and knowledge-based innovations driving this process.

Biomass can be converted into various products through the use of technology: bioenergy, biofuels, paper and commodities, as well as textiles, chemicals and pharmaceuticals; solutions for wastewater and bioremediation; to improve crop performance using genetic manipulation; and to create new or more advanced medications (McCormick and Kautto, 2013).

The fusion of both concepts from an evolutionary perspective leads to the idea of a "Nature-based circular Bioeconomy" Palahí et al., 2020. This would serve as a framework for transforming industrial sectors, rethinking cities and land, food and health systems, and promoting participation and more equitable distribution of prosperity.

The "Natural Step Framework", or FSSD, includes many sustainability concepts, approaches, tools and indicators (Robèrt et al., 2013; Korhonen, 2004; Marshall and Toffel, 2005; Ny, 2009). The framework is complementary with the nine Planetary Boundaries (Pbs) (Robèrt et al., 2013;

Rockstrom et al., 2009; Steffen et al., 2015) and includes five interdependent levels of analysis, planning and management: focus system; goal; strategies; actions; and tools and indicators.

Genetic engineering is likely to play a vital role in further food and non-food applications. The economy has taken significant steps driven by digital solutions (Watanabe et al., 2019). Smart (digital) farming, such as innovative precision farming using ICTs extensively, is seen as key for developing sustainable agriculture. However, the use of modern biotechnology is not uncontroversial due to the implications that need to be considered for assessing impacts. Moreover, the essential resource for the Bio-economy is biomass originating from agriculture, forestry, marine environment, and waste. The majority of experts believe the competition of biomass for food and non-food use a significant conflict resulting from the increasing competition for cropland at the expense of shrinking grasslands, savannahs, and forests. This needs to be addressed by Bio-economy strategies to avoid biodiversity losses and greenhouse gas emissions (Kardung et al., 2021).

3.6.5 Nature-Based solutions

Nature-based solutions refer to "actions to protect, sustainably manage, and restore natural or modified ecosystems that effectively and adaptively address societal challenges, simultaneously providing human well-being and biodiversity benefits" (IUCN 2016). Nature-based solutions can simultaneously provide **multiple benefits** such as flood control, carbon storage, raw materials, human health and biodiversity for healthy ecosystems (Mazza et al., 2011). Implementing nature-based solutions requires designing **multifunctional landscapes** that contribute to sustainable resource management systems that foster the development of a Green Economy.

Based on other authors (Naturescot 2020; Sudmeier-Rieux et al. 2021; Keeler et al. 2019), Mabon (2021) describe Nature-based matter for global action on climate and a Green Economy: they help mitigate the extent of climate change, hence the levels of economic disruption and societal harm.

Nature-based solutions can help adapt to the effects of climate change by reducing harm and damage from extreme events such as flooding, sea-level rise and extreme heat events through ecosystem-based adaptation and ecosystem-based disaster risk reduction (Sudmeier-Rieux et al., 2021). Nature-based solutions support a resilient society meeting the equality and wellbeing aspects of green economy thinking. The main areas of application of Nature-based solutions may include flood risk management; planning for green infrastructure; ecological engineering; peatland, woodland and coastal habitat restoration; management of invasive non-native species; low-carbon and regenerative agriculture and forestry; green environmental finance and natural capital accounting (Naturescot

2020). The benefits may include biodiversity conservation as a basis for healthy ecosystems, food security, physical/mental health and social connectivity.

3.6.6 Environmental Justice

Green Economy discussions have mostly been predominantly technical and financial rather than social and political Davies and Mullin (2011); however, justice is an essential element in green transformation from a social perspective, since **environmental governance** will often create winners and losers (Boyce, 2004).

The concept of Environmental Justice emerged from the civil rights movement in the United States in the early 1980s against the disproportionate dumping of toxic and hazardous waste in low-income areas populated chiefly by people of color, mainly due to the unequal enforcement of environmental protection laws in these regions (Bullard, 1994).

The concept of Environmental Justice expanded through the years, being applied to a comprehensive set of issues, such as water, energy, food, transport, land use, and climate; in multiple geographies outside the United States; and at various scales beyond the local, at the regional, national, and global levels (Schlosberg, 2007, 2013; Walker and Bulkeley, 2006). Beyond rhetoric, technological optimism, and standard economic incentives, the Green Economy needs to embrace justice in all areas of social, environmental, and climate (Özkaynak 2019). At the same time, environmental justice might offer a comprehensive outlook of political conceptualisations.

The mainstream framework of Environmental Justice adheres to the **four dimensions**: distributional justice, recognitional justice, procedural justice (e.g., participation, decision-making), and the capabilities approach (Fraser 1995; Schlosberg 2007; Young 1990).

A more depth vision includes incorporating an **intersectional decolonial approach**, considering Environmental Justice for humans and **non-humans** a prerequisite to sustainability. Menton et al. (2020) criticise that Environmental Justice is not embedded within the language and spirit of the SDGs, while this essential institutional framework should recognise complex power dynamics interactions among injustices and listen to the different 'senses of justice': theorists, activists, and other stakeholders from the Global South.

In 2010, in Bolivia, indigenous people's worldwide representations formulated an agreement in the conference on climate change and the rights of Mother Earth. The agreement rejects trade in emissions, demands technology transfers, and asks developed countries to pay for their ecological debts to developing countries through a fund of adaption. The agreement also calls for the promotion

of small- and medium-scale agriculture. Programs like UN-REDD – the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries are seen as fostering monoculture and the mercantilistic use of nature. Establishing protection areas is contingent upon the right of indigenous peoples to self-determination. In this respect, the traditional sustainable methods used by indigenous peoples for managing nature are considered the starting point for such protection. This and related arguments are rights-based, be it universal human rights, such as the right to clean water, or the rights of Mother Earth (Toranzo and Dargatz, 2012), as part of Environmental Justice and social inclusiveness of a green transition.

3.6.7 Ecological Transition

The Ecological Transition movement is based on the concepts of **post-growth**, **post-capitalism** and deep **paradigmatic transformations**.

Starting from the statement that the capitalist economic system is by its very nature incapable of pursuing sustainable development, radical socio-economic transformations are necessary.

The sustainable degrowth movement assumes that a just and sustainable society and reduction of energy and resource use is required to re-balance the economy with the living world.

In the context of shrinking cities, Schindler (2016) analyses the emergence of a "degrowth machine politics" in Detroit, where local actors have embraced a plan that seeks to improve the quality of life for the city's residents in the context of irreversible degrowth.

The construction of a society of degrowth must pass through the demystification of GDP, the fetish index of modern wellbeing, the fight against the negative externalities of growth and the implementation of virtuous circles of voluntary simplicity Latouche 2009.

Social transformations can be inspired by paradigms and cosmovisions alternative to those of colonising Western civilisations. In this sense, new studies are developed to redeem traditional knowledge of indigenous societies worldwide, **environmentalism of the poor** (Martinez Alier, 2002), the Andean *Buen Vivir*.

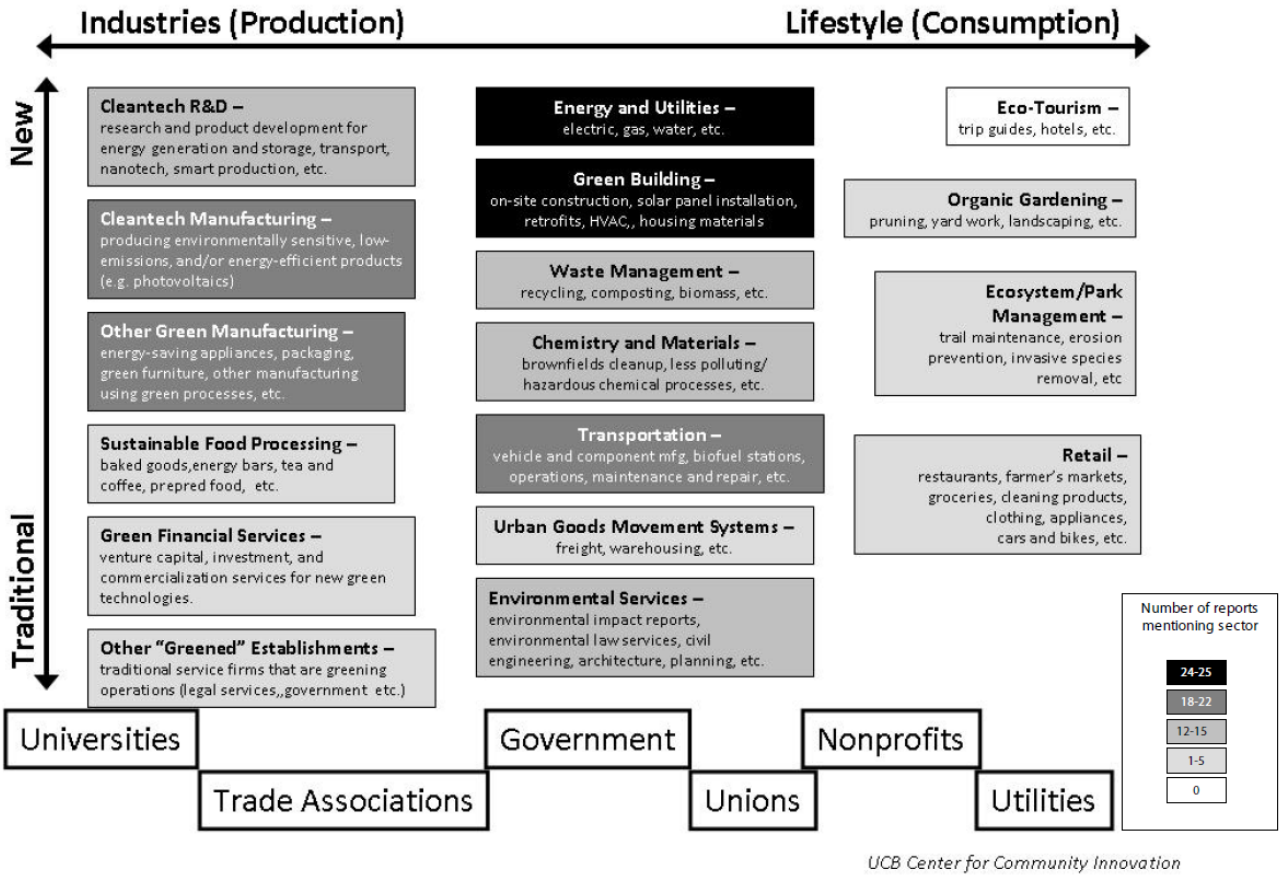
Against the Brundtland report, which emphasised environmental damages caused by poverty, the "environmentalism of the poor" (Martinez Alier, 2002) explains conflicts in which poor people defend the environment (in rural situations, but also cities) against the state or the market since nature provides their essential life-support services and diverse forms of useful physical and spiritual energy.

In the case of *Buen Vivir*, Quijano (2012) interprets it as a post-modernist and post-development survival strategy facing the nihilism of modern society in a continuous process of decolonisation of power.

3.7 Sectors of the Green Economy

According to the classification made by Chapple (2012), Green Economy sectors range from **production-oriented** to **consumption-oriented** areas, incorporating traditional or socially innovative activities (see Fig. 7).

Figure 7: Sectors of Green Economy



Source: Chapple, 2008

Great emphasis is placed on innovative industrial production sectors capable of guaranteeing the highest levels of economic return: areas related to energy efficiency, the circular economy and resource management are considered very important. Carrying out a literature review regarding the green economy sectors, Chapple (2008) finds that most of the studies focus on the following sectors: energy and utilities (electric, gas, water, etc.); green building (onsite construction, solar panel installation, retrofits, HVAC, housing materials); transportation (vehicle and components, biofuel stations); cleantech manufacturing (producing environmental sensitive, low emissions, and/or energy-efficient products); other green manufacturing (energy-saving appliances, packaging, green furniture, other manufacturing using green process).

Other sectors are waste management, chemistry and materials, environmental services, eco-tourism, organic gardening, ecosystem park management, retail (restaurants, farmer markets, etc.). The most important actors playing a decisive role in implementing green transitions are universities, trade associations, government, unions, and non-profit organisations.

3.8 Public Policies of the Green Economy

The transition to a Green Economy can be interpreted as a qualitative and structural change that can help foster innovation and improve productivity. While creating the **internalisation of new costs** that do not necessarily lead to better quality products, **green standards** and **regulations** create new capabilities that can be advantageous in terms of export and import in the transition process of markets towards the green economy as part of global economic transformations. Internalised new costs should be replaced by the **long-term social benefits** in quality of life and competitive advantages in future exportations or substitute importations.

The quality of urban life and workers will make cities more competitive. Achieving these goals will require considerable, often long-term investments, group initiatives, research and development, business incubators, marketing, transport and land use, workforce development.

The green transition requires appropriated adjustments stimulated through incentives or taxations to favour the Green Economy in the competitive race with the brown economy. Cities and states rely on economic incentives to attract and maintain businesses oscillating between production and consumption in the so-called green lifestyle economy.

Local incentives include tax exemptions, low-cost loans, small contributions or subsidies for cluster initiatives that facilitate technology transfer from university to business.

Green standards and regulations are typically aimed at greening the way goods and services are produced, spurring renewable energy, generating greater energy efficiency, or introducing recycling standards to reduce the residues created by construction and demolition, stimulating the local recycling industry (Chapple 2008).

A possibly positive effect is the retention of work in times of crisis. However, it should be considered that job creation in the green economy can cause job loss in other sectors of the economy.

A stricter approach involves the internalisation of environmental costs produced by companies. A green economy can be understood as one in which the producers internalise environmental benefits (social costs) into their production decision making (Acharya and Sequeira, 2012). These taxes give a monetary value to the ecological damage that produces an "externality" and calculates the "optimal

level of pollution" that allows the company to maximise its benefits without - supposedly - harming the rest of society. The **Pigouvian tax** attempts to value environmental damage in monetary units so that the firm pays for it until social costs and private costs are equalised.

Part II │ Green Economy driven solutions in Shrinking Cities

4.1 Green Economy driven solutions in Shrinking Cities

The type of city can be defined according to few main criteria: their position in the urban hierarchy, centrality functions, specific history and link with public policies. In the European Union, the reinforcement of metropolitan areas and their regions is preferred to enhance European competitiveness internationally (Lang et al., 2015). However, if it is not compensated by spatial development cohesion policies for other marginal territories, such policies can reinforce existing regional disparities. For this reason, several policies are promoted, including the European Union Cohesion Fund established in 2021 for investments in the field of environment.

Factors and contexts driving or promoting effective regrowth involve multiple dynamics and should be studied on a case-by-case basis. While neoliberal policies only promote economic growth, welfare state policies refer to urban development in a more integrative way (Haase et al., 2021).

It is not easy to delimit activities aimed at regrowth rather than greening since they can be **complementary**. Improving the quality of urban life could also lead to progressive regrowth by enhancing the city's image and creating attractions for the private sector; in this sense, greening shrinking cities can indirectly lead to regrowth. However, to distinguish from the perspective of public management, the variation in the level of innovative capacity inherent in the various sectors, i.e. the ability to develop **comparative advantages**, is established as an essential variable for delimiting the potential for regrowth. According to Wu and Yao (2021), re-growing approaches targeting external investment and firms seem to be more effective in shrinking cities rather than policies targeting the population.

Shrinking cities that in the past grew through comparative advantages gained around the narrow specialisation in just one or few economic sectors then went into decline as those particular sectors became archaic, losing competitiveness in the process of global economic transformation. This can be seen as a double-edged sword of the theory of comparative advantages described by Ricardo (1817). The loss of competitiveness in one sector should be quickly compensated for by the emergence of competitiveness in another industry to prevent the area’s economic decline.

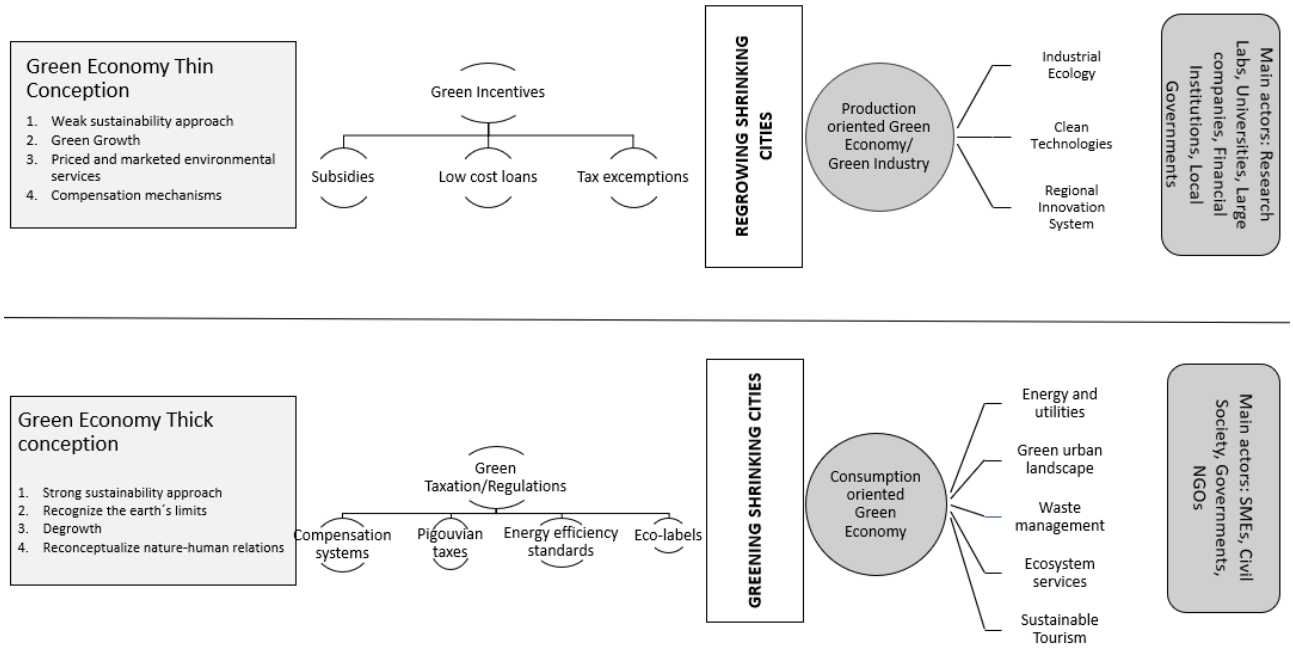
As part of peripheral regions, shrinking cities usually **miss a developed critical mass** in any industrial specialisation; despite, there may be innovative industries that depend on the exploitation of resources, regional system of support for innovation and entrepreneurship is weak and limited (Grillitsh and Hansen, 2019). Hence, the need to establish the foundations for the creation of **local knowledge** that will allow entry into the new emerging markets and stimulate local endogenous

development aimed at increasing resilience by taking measures to support local businesses in traditional sectors (Yamamoto, 2019).

Despite the sectors of the post-industrial economy favour the concentration of people in urban, mainly metropolitan areas, an **urban spread environment** is increasingly associated with more significant potential for sustainability in the context of transitions regarding the quality of exploited energy sources. Given the limited possibility of establishing clusters of technological innovation, greening shrinking cities, improving the quality of life, making them more liveable and resilient can result in a winning strategy.

Identifying the type of a shrinking city is essential to define the interventions for sustainability and can be both regrowth and greening oriented. Depending on the type of shrinking city of the kind of resources available, it is possible to identify several strategies that can enable shrinking cities to play an important role in green transitions. Figure 8 presents how, adopting a neoclassical economic vision, shrinking cities should aim for Green Growth, adopting public policies such as incentives, subsidies, low cost loans, tax exemptions and focusing on sectors such as industrial ecology, clean technologies and the creation of regional innovation systems. On the other hand, the greening strategy is more conciliatory with planned shrinkage or degrowth policies, adopting green standards and taxes, compensation systems, eco-labels and energy efficiency standards. In this case, the sectors on which green economy interventions focus are consumption sectors such as energy and utilities, green urban landscape, waste management, ecosystem services or sustainable tourism.

Figure 8: Regrowing and Greening Shrinking Cities strategies according to the Green Economy approach



Source: Author, Kaiserslautern, 2022

Referred to the contexts of urban shrinkage, the term ‘greening’ is used as a strategic approach that aims to develop green infrastructure and support environmentally and socially acceptable practices at the national, state, regional, and local levels (Pallagst et al., 2017). Operating a **good greening process** should produce convergence between the interests of environmental conservation, typically of the national level, with the interests of social and economic benefits at the local level.

Depending on the type of local perception of the urban shrinkage phenomenon, adaptive or regrowth-oriented approaches are applied (Stryjakiewicz and Jaroszewska, 2016). While the creation of regional innovation systems through public investment in **R&D** should be indispensable to produce a turnaround in the urban shrinkage process and thus is the regrowth strategy par excellence (Fogarty and Garofalo, 2014), according to Livina and Veliverronena (2019), the growth economy (which requires more and more profit, units of goods, jobs etc.) is not an adequate strategy for shrinking regions, since the application of circular economy principles provides an opportunity to decrease rising costs of services and infrastructure maintenance in them as an adaptive response to the new situation.

From the **adaptive approach**, we move from the slogan "smart growth" to that of **smart shrinkage** (Pallagst et al. 2009), which is achieved by directing planning towards efficiency and sustainability. In this sense, “the contrary of shrinkage is not growth but adaptability” (Brandstetter et al. 2005) since

the new conditions can be exploited to improve liveability.

4.2 Industry oriented Green Economy for re-growing Shrinking Cities

Analysing the US shrinking "stagnant" cities (Renn 2019), consider that these should already be one step ahead and establish the preconditions for taking advantage of any future positive **market changes**. Among the **practical interventions** are financial restructuring, governance reforms and upgrades in public services. This should go through financial restructuring to eliminate or reduce liabilities and institute consistent, sustainable, structurally balanced budgets. State interventions are suitable, while, in some cases, municipal bankruptcy may be the only alternative for reducing pension and debt liabilities. Governance reform should establish a regional authority over the specific assets while small, suburban jurisdictions with extreme stress may need to be merged or dissolved. The most critical areas for service upgrades in the public service sector are in public safety.
In the lifecycle theories (Lang, 2000), urban growth and shrinkage are deemed 'inevitable' parts of a city's life course. Analysing shrinking Chinese cities, Wu and Yao (2021) find that the correlation between investment network centrality and urban population changes is positively significant. This significance is increased after the lag period of investment network centrality is prolonged. The lack of external economic connections leads to population shrinkage, although population shrinkage also has comparatively fee effects on reducing external investments. In this regard, cities 'grow' due to their **strategic and well-connected positions** within networks of information, goods, and people between cities (i.e., 'structural advantage') (Neal 2011). **Re-growing policies** targeting external investment and firms (He et al., 2017) seem to be more effective than policies targeting the population (Ganser and Piro, 2012; Bartholomae et al., 2017; Jeon & Kim, 2019).

Know-how is the primary determinant of economic growth; this explains the phenomenon of **prosperous shrinking cities** characterised by an increase in GDP despite the decrease in population. This phenomenon depends on the location of talent and highly specialised labour (Hartt, 2019), indicating possible new paths for green growth strategies in shrinking cities.
Decoupling economic growth from resource use is advocated by the Organisation for Economic Co-operation and Development (OECD) as one of the green growth strategies pillars. Upgrading previous economic paths based on the brown economy introducing more considerable qualitative change through new sustainable technologies can enhance the green growth in shrinking cities.

While the most popular strategies among municipalities are focused on attempts to recreate growth,

for example, based on policies aimed at population growth (promote marriages), education, health (Panagopoulos & Barreira, 2012), high-quality employment-oriented policies are the most effective ones. However, suffering from the non-development and exclusion of their regional innovation systems, shrinking cities struggle in finding solutions to stimulate their economy.

Analysing the experience in Cleveland, Fogarty and Garofalo (2014) conclude that creating the **region´s innovation systems** is a key to prospects for a turnaround in urban shrinkage. This should be sustained by investments in social R&D activities to develop beneficial spillover effects, since estimates of the social rate of return to R&D, typically range from 20 to 70% (Griliches 1990), are entirely above the private rate of return on capital investment. This provides a solid economic rationale for **R&D subsidies** and suggests the importance of local infrastructure for capturing **spillovers.**

A long-run perspective and research using microdata and new methodologies to advance knowledge of the regional innovation systems role are fundamental for urban regrowth. Knowledge of eventual economic changes is also necessary for making policy decisions intended to reverse economic decline and evaluating the success or failure of regional innovation systems investments to create comparative advantages. Investments in a given technology sector should be accompanied by the presence of a critical mass around that sector, the creation of sufficient broad-based R&D spillovers and the regional capacity to capture spillovers (Fogarty and Garofalo 2014).

Encouraging the creation of **Green Innovation Areas** can be seen as a solution to attract external investments and revitalise the economy in shrinking cities (Pallagst et al., 2019) along paths of sustainable development. **ECO-innovation** is defined as any innovation that reduces the use of natural resources and decreases the release of harmful substances across the whole lifecycle (EU Eco-innovation observatory, 2011). It plays a crucial role in mitigating the adverse effects of the choices between investing in the (shrinking) natural capital and growing consumption and investments in other forms of capital (Kasztelan et al. 2020).

Some of the approaches to stimulate innovation-led regrowth involve the creation of new industries in the most technology-based sectors. However, considering their level of peripherality, different types of regions have **different potential** to develop innovation in the green industry (Grillitsch and Hansen, 2019). The latter feeds on the knowledge produced by research centres, universities, technology parks or incubators that are typically located in metropolitan areas Todtlight and Trippl (2005), as well as other development factors for regional innovation systems such as key actors and governance, strengths in radical vs incremental innovations and risk failure management (Asheim, Grillitsh and Trippl 2017).

Regions specialised around a leading sector, and peripheral areas struggle to find ways to compensate

for the lack of local knowledge spillovers (Grillitsch and Nilsson 2015) and build new regional advantages (Isaksen and Karlsen, 2013) since industries and firms located in peripheral regions have to deal with **weak and limited systems of support for innovation and entrepreneurship.**

As innovation is a knowledge-driven process, it is also dependent on geographical proximity, which favours knowledge transfer. Empirical evidence shows positive effects and high innovation potential in clusters and agglomerations (Malmberg and Maskell 1999, 2006). The tacit nature of knowledge and its inclusion in the socio-cultural and institutional context produces spillovers by establishing the spatial dimension of knowledge and creating the conditions for innovation (Grillitsch and Nilsson 2015). Peripheral companies seek collaboration with non-local actors to overcome the local lack of knowledge, but what is interesting is that peripheral companies tend to collaborate more with each other than similar companies with high access to local knowledge spillovers (Grillitsch and Nilsson 2015). This would mean that, in principle, it should be easier to establish **collaborative networks across peripheral areas** (Lam 2000) **or shrinking cities**, defying geographical distance barriers.

Building comparative advantages in small and peripheral regions with a weak regional innovation system involve establishing proactive public-private partnerships that focus on stimulating knowledge flow and interactive learning among proximate partners and, in particular, among partners with related but not similar knowledge bases (Noteboom et al. 2007, Boschma and Frenken 2011).

The **innovation modes** are STI (Science, Technology, Innovation), CCI (Complex, Combined Innovation) and DUI (Doing, Using, Interacting) (Aslesen, Isaksen, Karlsen 2012). Policy lessons for constructing regional advantage in small regions should, in general, consider the upgrading of DUI firms and stimulating extra-regional links (Isaksen and Karlsen, 2013).

Griliches and Hansen (2019) describe the four major forms of **path development**: 1) path development can simply represent growing green industries. 2) path upgrading consists of a higher qualitative change of existing industries that can rest in severe mechanisms such as introducing new technologies, organisational innovations or business models. 3) path diversification involves developing from existing to new industries to apply existing knowledge in new industries or combine existing ones with unrelated knowledge. 4) emergence of new green industries that have nothing to do with existing regional industries is another form of development of green industries.

With the lack of specialisation in the peripheral regions, green industry development policies should stimulate **upgrading and emerging paths** (Grillitsch and Hansen, 2019). This involves improving the skills of the niche of actors in the green industry through **specialised training and support programs to attract highly qualified work in specific fields of expertise**, as well as the introduction of green technologies developed elsewhere.

In peripheral regions, economic diversification based on the exploitation of knowledge and resources accumulated from one industrial specialisation to another it's harder to find (Grillitsch and Hansen, 2019) and it should be stimulated through economic policy interventions (Murdoch, 2018) that are capable of directing sustainable development through innovation, which is the real key to obtaining aggregate advantages in the external market.

Policy interventions are justified to make the innovation systems function efficient. This implies understanding the regional innovation system and addressing any deficiencies regarding the capacities of regional actors, network failures in the form of too weak or too short-sighted internal relations, internally or externally in the region. The goal of innovation policy is to help address social challenges; this requires specific attention to directionality, experimentation, articulation of demand, the ability to learn policies and coordination. Directionality points to the need to generate innovations as effectively as possible and contribute to a particular direction of transformative change. The experimentation refers to the importance of the activities, initially intended, testing new technologies and social practices and secondly to learn about the structures that inhibit their spread and how to surpass these structures.

Localised demand is central to types of green industries. Paravantis et al. 2018 find that "a typical green consumer is younger, more educated, and wealthier" while population size, as well as the presence of national environmental networks, have a strong influence on the adoption of environmental policies to address climate change. The establishment of climate planning goals are also indicators associated with the adoption of local clean energy policies (Pitt and Basset 2014). This means that strategies leading to building a green paradigm are fundamental to stimulating green demand as an essential requirement for changing consumer behaviour.

While demand articulation is less important for the green industry, producing products of lesser complexity for mass markets, addressing policy learning and coordinated change is central to complex, uncertain and long-term processes.

Evolutionary economic geography states that "firms typically diversify into products that are technologically related to their current products" (Frenken and Boschma 2007, p. 637). The emergence of new green industries unrelated to existing industries in the region is unrealistic as a new path of development, while **regions with a specialisation in contaminating industries are similar to regions with a green specialisation** regarding the nature of their industrial and economic dynamics (Grillitsh and Hansen 2019), so this could imply a more realistic chance. The evolutionary theory has to do with path development processes, in which previous events affect the possibility of future events happening. From an evolutionary perspective, path dependence does not set up deterministic developments. Various mechanisms and resources drive path development on a regional

and extra-regional scale.

New industrial innovation policies should consider place-specific preconditions, particularly the differentiation of the regional innovation and entrepreneurship system and the degree of current industrial diversification, considering the importance of promoting risk-taking behaviours and acceptance of bankruptcies.

4.3 Green Industry oriented applications in Shrinking Cities

This chapter describes some examples of path upgrading to a green economy in shrinking cities.

In the German Ruhr valley, public policy played an essential role in designated technology transfer offices tightening environmental rules by incentivising companies to minimise environmental impacts and support demonstration projects (Hospers 2010).

As a gradual conversion strategy for the coal mine region, approaches to the **production of renewable energy** are applied in the shrinking cities of Herne and Gelsenkirchen, favoured within the framework of the **German Energy Transition framework** (Energiewende).

In Herne, the **Mont-Cenis Energy Park** was promoted, consisting of a cogeneration plant, energy storage infrastructure, and one of the world's largest rooftops solar photovoltaic production plants, with the power of 1 MW (Förch and Pallagst 2019). In Gelsenkirchen, as part of the solar city strategy, a district of 100 solar energy houses (the **Gelsenkirchen-Bismark solar housing estate**) and a **Science Park** for the research, development and marketing of renewable energies were created (Jung et al. 2010).

Since the 1990s, Gelsenkirchen has driven its structural economic transformation through the key strategy **Gelsenkirchen Solar City**, which sought to combine solar-powered building projects "Gelsenkirchen-Bismark Solar Housing Estate" with a science park in charge of promotion/ dissemination, management of energy processes, research and development as a function of the PV industry. The cities of Gelsenkirchen and Herne are part of the German Ruhr region in the state of North-Rhine Westphalia, being part of the called European coalfield region.

In agreement with an interview conducted with the project manager[2] of the Science Park Gelsenkirchen, the centre has lost its role as a photovoltaic technology manufacturing cluster due to the German solar industry's lack of competitiveness compared to the efficiency standards achieved by the Asian market. However, it continues to provide jobs for more than 400 employees engaged in

[2] **Interview with Projektmanager Wissenschaftspark Gelsenkirchen GmbH realised on October 14th 2020.**

R&D, marketing and engineering education through a private-public administration. The ownership shares are divided between the city of Gelsenkirchen and the Gelsenkirchener Gemeinnützige Wohnungsbaugesellschaft GmbH.

The experience of Gelsenkirchen shows the extreme importance of R&D activities to support the production of technologies for the exploitation of solar energy capable of constantly improving efficiency standards and competitively positioning itself in the international market through public/ private partnerships.

Although both the cities of Gelsenkirchen and Herne continue to suffer from demographic loss, these examples illustrate some attempts to create green innovation in these shrinking German cities; however, the scale of these projects is not yet sufficient to create attractive businesses to reverse demographic trends.

Picture 1: Energy Park Gelsenkirchen.
Source: Solarstadt Gelsenkirchen

Picture 2: Energy Park Mont Sant - Cenis, Herne.
Source: StadtHerne

Another important case of green regrowth strategy in a shrinking city is that of the Japanese city of Kitakyushu. To recover its industrial base, the city created the **Kitakyushu Techno Park** and the Techno-Centre in 1990 and 1997, the city entered the Eco-Town national program. This program aims "to promote local economic stimulation through fostering environmental businesses that utilise the strengths of local industries and to create resource-recycling socio-economic systems by promoting local approaches for recycling and suppressing the generation of waste" (Ministry of Economy Trade and Industry 2014), providing local governments with incentives to create new industrial and business opportunities for their cities that should also stress environmental awareness and protection. Kitakyushu's eco-town used the manufacturing experience of the city to promote recycling and environmental industries. It combined "an academic research city; an experimental study area; and commercialisation capabilities" (Ministry of Economy Trade and Industry 2014, p. 29) to create the necessary infrastructure to support its future growth in green technologies (Ortiz Moya 2020).

Picture 3: Eco Town Kitakiashu, Japan.
Source: Public domain

Picture 4: Combined Cycle power plant, Dunkerque.
Source: Public domain

An industrial ecology approach was adopted in the shrinking city of Dunkerque in France, where a new **combined cycle power station** with a power capacity of 790 MW replaced the old thermal power station managed by EDF and at the end of its life cycle (Beaurain and Chembessi, 2019). Furthermore, a circular economy approach was applied in Dunkerque: through a joint venture among the companies Arcettorral and Ecocem materials, it was started in 2007 the production of **green cement** that is economical in natural resources, has a carbon footprint 34 times smaller than that of conventional cement[3]. Reducing the use of resources in production processes under an industrial ecology approach is one of the pillars of the Green Economy.

4.4 Consumption oriented Green Economy for greening Shrinking Cities

Some authors consider that maintaining a strong focus on economic growth (which requires more and more profit, units of goods, jobs etc.) is not suitable for shrinking cities (Livina and Veliverronena 2019) which instead have the opportunity to improve the quality of the natural and built environment by applying the concept of urban greening within the paradigm of green lifestyle economy.
In an interrelated manner with the grade of acceptance of population loss in the local perceptions, Danielzyk et al. (2002) describe the following typologies: 'decline as vicious circle', 'expansive strategy', 'maintenance strategy', and 'planning for decline'.
The typology '**planning for decline**' offers the most dramatic shifts in planning styles: under the new conditions, shrinking city's future development path adapts to past and future challenges under growing smaller concept, **embracing their smaller footprints**, **right-sizing** and adopting **comprehensive planning approaches** to regain liveability.

[3] https://france.arcelormittal.com/developpement-durable/economie-circulaire.aspx

Urban Greening, understood as a tool for improving the quality of built, natural and living environment (Dukic et al. 2018), has recently become a new planning paradigm (Pallagst et al., 2017) in growth and shrinkage urban contexts. Compared to growing cities, shrinking cities would have more significant potential to transform their old disused industrial infrastructures and vacant spaces into resources for creating new paths of sustainable development by implementing green practices or technologies that can drive economic transitions. Referred to the contexts of urban shrinkage, the term 'greening' is used as a strategic approach that aims to develop green infrastructure and support environmentally and socially acceptable practices at the national, state, regional, and local levels (Pallagst et al., 2017). Operating a good greening process should produce convergence between the interests of environmental conservation typically of the national level, with the interests of social and economic benefits at the local level.

From the adaptive approach, we move from the slogan Smart Growth to that of Shrinking Smart (Pallagst et al. 2009), which is achieved by directing planning towards efficiency and sustainability. In this sense, "the contrary of shrinkage is not growth but adaptability" (Brandstetter et al. 2005), since the new conditions can be exploited to improve liveability. Considering that size and density are the strongest drivers of unhappiness in the city (Okulicz-Kozaryn and Mazelis 2018), shrinkage leading to a smaller, less dense environment, should also contribute to making residents happier (Hartt 2019).

In literature, a particular focus is dedicated to sustainability problems in shrinking cities but no works are specifically dedicated to the green economy in urban shrinking contexts. A series of related topics are treated: sustainability in shrinking cities (Herrman et al. 2016), circular economy in shrinking cities (Livina and Veliverronena 2019), green spaces in shrinking cities (Pallagst et al. 2019), biodiversity and ecosystem services (Haase 2013), in addition to the theorisation of greening and/or re-growing shrinking cities strategies (Haase et al. 2018).

Conceptually, urban growth concentrated in a few ever-expanding metropolitan centres creates a densified demand whose satisfaction depends on the production capacities of other territories. Small/medium urban centres would have a greater capacity to exploit the surrounding territory in terms of food, energy and production resources in general, making it possible to achieve better sustainability standards, create local endogenous development models, and reduce external dependence by creating local value chains.

Compared to the concept of economic regrowth involving R&D activities aimed at innovation, which in principle favours large companies that are already technologically specialised, the greening sectors, i.e. not based on high technological innovation, could favour a type of economy characterised by the development of **SMEs,** to enhance the **economic resilience**.

Markets in shrinking cities, are often not competitive and business owners tend to have oligopolistic rents, so business incentive policies will not always encourage innovation. Still, they will instead increase the rents of current business owners (Yamamoto 2019). Since the local economy cannot be sustained if residents' income is low or funds continue to leak out of the area, it makes sense to support local SMEs to revitalise local economies. SMEs in **primary industries** like manufacturing, agriculture, or even tourism can be the key to sustaining and developing the local economy.

The circular economy in shrinking rural areas has the biggest potential to contribute to the social field by integrating new mobility solutions such as ride-sharing, renting rooms or houses for visitors in short term or long term for a living (Livina and Veliverronena 2019). The challenging precondition for sharing economy is established close cooperation among people in and outside the community. New workplaces are created, restructuring existing jobs with new use of unused resources.

New disused **vacant spaces** or infrastructures can be **converted into new resources** for greening strategies. While vacant spaces are also seen as non-productive spaces that can be even more difficult to regenerate if disconnected and small/irregularly shaped parcels (Newman and Kim, 2017), to embrace the new smaller footprints, actions should primarily focus on their re-use for the common benefit (Pallagst et al. 2017). The rationale behind this practice is that the abandonment of vacant lands reproduces the devaluation of the territory including the properties of the inhabitants, while the re-use, even temporary of them, can constitute a resource for the economic recovery and the revitalisation of the territory.

Sustainability problems in shrinking cities are considered a direct consequence of their increasingly marginal economic situation: having to face financial and environmental issues; shrinking cities risk becoming increasingly unsustainable; this is why the general goal for sustainability in shrinking cities should be "aligning a city's-built environment with the needs of existing and future populations by adjusting the amount of land available for development" (Shilling and Logan 2008).

Whether shrinking cities are associated with more or less carbon emission is inconclusive, empirical evidence shows that shrinking cities tend to be less energy efficient (Liu et al. 2020) and less capable of mitigating CO2 than growing cities (Xiao et al. 2019). For this reason, cases are described negatively when rejecting the context of declining population size; sparse urban growth continues to be planned, as in the case of Ostrava in the Czech Republic, where long term unsustainability paths are being created (Slach et al. 2019).

On the other hand, attention is focused on the case studies in which shrinking cities adopt successful strategies for sustainable development, as a brief review of these follows in this chapter.

4.5 Energy and Utilities in Shrinking Cities

The energy implications remain an important area to be explored in shrinking cities. The **reductions in urban energy use** are likely to be counterbalanced by the effects of potentially larger residential floor space available for the remaining population as well as **increases in transport energy use** associated with lower population density (Grubler et al. 2012).
Analysing the context of urban shrinkage Hornebeck and Schwarz (2009) contemplate the advantages of **adequate energy planning** in shrinking cities to optimise supply about a small population also by introducing decentralised renewable energy production systems, as a particularly favourable option in European shrinking cities, where there is a generalised energy deficit compared to the US context.

A Green Economy substitutes renewable energy and low-carbon technologies for fossil fuels. The importance of reaching development models capable of decreasing the use of non-renewable resources is recognised as socially desirable, bringing to the analysis of some important variables: the degree of **integration between energy and urban planning** as a determinant of efficiency in terms of land and energy uses; the presence of **renewable energy production**; the presence of measures for the **efficiency in energy consumption**. Implementing renewable energy production in urban systems represents one of the main strategies to achieve sustainable development. Space has become an important resource to allow a clean energy transition in modern society, due to the low energy intensity of renewable resources compared to fossil fuels. Considering the presence of **low-cost vacant land**, shrinking cities could represent key places for renewable energy production, introducing decentralised small-scale energy production. This requires coordination at the level of innovative and complex national economic policies, oriented towards urban planning to control and optimise energy demand. Urban spatial planning would improve energy planning as an essential aspect to enhance local metabolism and make it less dependent on any external shocks, increasing the urban system's resilience and redundancy.
Each type of energy system has its specificities and potentialities, including social and spatial dimensions that can drive a balanced and inclusive energy transition at local and trans-local levels (Balest et al., 2019). Energy transitions are intertwined with the historical, contemporary and material dimensions of territorial politics (McEwan 2017), resulting in three emblematic themes: the uneven spatial development of energy transitions, the scalar changes of energy governance, and the spatial materiality of energy transitions (Becker et al. 2016).
Replacing fossil fuels with renewable energies means mobilising resources closer to consumers, but the potential for exploitation of renewable sources is also heterogeneous, depending on the

morphology of the territory, the climatic conditions and the land use applied in it; whereby rural areas are also seen as green energy exporters to meet urban demand. Thus, **new relationships arise between rural and urban areas**, highlands with potentially more intense renewable energy resources and lowlands, as well as new intermediaries between production and consumption in urban areas (Balaye et al. 2018). This phenomenon is involved in creating the so-called "new ruralities", rural areas that are assuming the characteristics of urban centres and peri-urban areas conserving rural characteristics.

The transition towards the consumption of renewable energy should, by its very nature, be accompanied by a demographic dispersion that allows optimising the use of resources and increasing the importance of small to medium-sized urban centres. On the other hand, global cities, less able to satisfy their demand through spatially near production, are less sustainable, unless efficiencies in energy transport and storage are significantly improved, which in any case faces natural limits. Local renewables can supply urban energy in niche markets but can provide less than 1 per cent only of a megacity's energy needs (Grubler et al. 2012). While local renewables in large cities are at best marginal niche options, the potential to meet local demand improve in small, low-density cities. IIASA (2011) found that about 21 per cent of final energy demand in western Europe is below the supply density threshold of 1W/m²; this indicates the potential for increasing decentralised energy systems to meet this demand.

In all densely populated, highly urbanised regions, the majority of renewable energy supply has to come from areas of low population and energy demand densities, where renewable energy flows can be harnessed and transported to the urban energy-use centres, which represents a formidable infrastructure challenge (Grubler et al. 2012). Theoretically, this opens up market opportunities for renewable energy sellers that shrinking cities could exploit in cases where a legal framework facilitates this type of business. Due to vast low-cost vacancies, shrinking cities could represent key locations for renewable energy production.

The inclusion of shrinking cities in energy transition processes can follow **three main schemes**: research and development in green technologies; energy transition plans with an integrated approach through public-private partnerships; local energy production through community cooperatives or individual prosumers. While the first two assume top-down management, the third strategy involves bottom-up mechanisms facilitated by the inclusion of appropriate rules. The technology production strategy is a potentially successful strategy depending on the ability to attract investments to create innovation in highly advanced and competitive sectors.

McDougall (2007) connects energy problems with declining populations in Europe, but Hornebeck

and Schwarz (2009) carry out a deeper discussion, firstly identifying a strong difference between the declining cities of Europe and North America: the **energy deficit** is much more pronounced in **Europe**, so policies may redirect towards promoting the spreading of energy demand, while in the United States, where energy gaps are much less common, cities that have lost population and industries could have a power generation capacity that exceeds demand.

From a more business perspective, several conditions must be considered to fully exploit the potential of decentralised production systems: complex and sometimes expensive technologies, business models for a viable value redistribution, and a restrictive regulatory framework (ENEA 2018). Depending on the maturity and complexity of a Microgrid, its energy production, distribution and storage assets, as well as smart grid equipment, may require significant initial investments, for which local production of green and more affordable energy should, in some cases, be applied in a non-island mode, which requires a regulatory framework in favour of this type of system. For example, PV installations smaller than 15 m² are usually regarded as economically unprofitable. The rate structure of the network, the origin of the annual peak demand and the availability of renewable resources are the three significant dimensioning factors in the economic optimisation of said network.

Recent developments in technology such as the diffusion of smart meters, li-ion batteries, peer to peer trading platforms and electric vehicles are opening up a range of new post-subsidies business models (Brown et al. 2019). Regulatory financing and institutional governance landscape are inhibiting these emerging business models due to the progressive reduction of feed-in tariff systems, so the prosumer business model needs to evolve and prove to be competitive even in a post-subsidy environment. So far, the business models of small renewable energy producers have benefited from national subsidy systems, however, post-subsidy business models after the process of regression following generous FIT schemes are necessary. Peer to Peer models are predicated on removing the energy supplier as an intermediary in trading distributed electricity generation (Brown et al. 2019).

The particularities of the specific actors facing regional energy transition issues have to be considered. Energy systems are the product of many forces, including socio-economic factors, availability of resources, technological capabilities, and political aspirations. There are processes of **technological and social change** that make territorial planning more complex, considering many dimensions of the territory as a socio-spatial entity in which many actors operate. Sustainable urban energy systems are usually systemic. The government paradox is that policies are more challenging to implement, requiring policy fragmentation and uncoordinated, **dispersed decision making** (Grubler et al. 2012). Different legislation might work better for different geographical locations; in all cases, municipalities have a vital role, being the administrations closest to the people who make decisions in the energy sector. At the local level, public authorities face specific issues; for example, in Europe,

the Covenant of Majors Sustainable Energy Action Plans or Sustainable Energy and Climate Actions Plans include directives for local authorities. Municipal administration links the government on the national level and real estate developers on the building level.

The **prosumer phenomenon** is characterised by actors who both produce and consume energy. This is being advocated in the EU with several initiatives from the European Commission (EC 2018, L328/103) introducing the figure of renewable self-consumer 'who generate renewable electricity for its consumption and may store and sell self-generated renewable electricity, provided that, for non-household renewable self-consumers those activities do not constitute their primary commercial and professional activity. It can include household, commercial or industrial actors, as customers storing energy on-site and using that storage both to support distributed generation and provide services to the grid (Jacobs 2017).

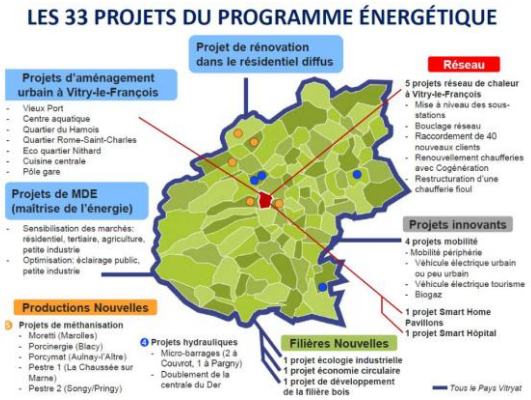
Current **regulatory frameworks**, including Use of System (UoS) pricing methodologies, codes surrounding supplier and generation licences, access to wholesale, balancing and ancillary service markets, were all designed with the centralised large-scale actors in mind (Bray et al. 2018). Therefore, a change favouring small and medium decentralised producer must gradually take place to avoid vulnerabilities in the electricity system.

As well as the production of green technologies, the cities of Gelsenkirchen and Herne have invested in the installation of large-scale renewable energy to meet their local energy demand.
In Herne, the Mont-Cenis Energy Park was promoted, consisting of a cogeneration plant, energy storage infrastructure, and one of the world's largest rooftops solar photovoltaic production plants, with the power of 1 MW (Förch and Pallagst 2019). In Gelsenkirchen, as part of the solar city strategy, a district of 100 solar energy houses (the Gelsenkirchen-Bismark solar housing estate) was created (Jung et al. 2010).
In **France**, the transition to renewable energies is increasingly becoming a strategy for developing shrinking cities, as in the cases of Loos-en-Ghoelle and Vitry le François. Loos-en-Gohelle is a small town of 7,000 inhabitants located in the North of France. The city, just like its surrounding area, was deeply affected by coal mining industries, active from the 1850s until their closure in the 1980s. Thanks to strong political support from its mayors, the town has since chosen the road towards renewable energy sources and strong citizen involvement in the cities' future. It is considered as a "pilot city for sustainable development" in France, and in 2015 it joined the network "100% **Territoires à énergie positive**" (100% RES communities) aiming to have 100% of its electricity

coming from renewable energy sources by 2020 and to rely 100% on renewables by 2050 (Renewables Networking Platform).

Résidence Chenelet. Credits: Mairie de Loos-en-Gohelle

Picture 5: Sustainable Housing in Loos and Gohelle



Picture 6: thirty-three energy projects in Vitry-le-François

Sources: Public domain

The case of Vitry-le-François is analysed in more detail in the second part of this thesis. Regarding the aspect of decentralised energy production, a series of thirty three energy projects are in progress in Vitry, including biomass heating system, industrial ecology, renewable energy production, production of hydrogen as a transport fuel, energy efficiency and waste management; these are being implemented also thanks to the partnership established with the private sector, in particular with the French energy company *Electricité De France* (EDF), which can use this territory as an experimental laboratory for future large-scale changes with a view to sustainable development (Miot and Rousseau 2019).

In the case of Vitry-le-François, the greening strategy based on energy transition manifests itself as a true survival strategy with the result of creating a new course of action that extends beyond energy sectors creating effects on all local public policies (Miot 2021).

In renewable energy sectors, the type of governance and actors involved in the energy transition process is crucial to identifying the scaled-up distribution of benefits.

Shrinking cities are laboratories not only for actual urban developments but for democracy on a local scale (Haase and Rink 2012), where the energy transitions and the new governance that will guide them can constitute a pillar for democratic participation and the management of common resources.

By reducing overall consumption and environmental impacts, decentralised energy systems emphasise decentralisation and small and medium-sized renewable power plant installations in the urbanisation process and spatial dimension of urban energy metabolism who describe the energy flows within an urban system (Wolman 1965). **Cooperative models** in renewable energy production

have the potential to enhance the social cohesion of a territory through the involvement of all or most citizens. The paradigm of **Community Renewable Energy Ecologies** seems to be the most inspiring to keep the benefits at the grassroots level (Siamanta 2021).

According to the REScoop (Renewable Energy Sources Cooperative)[4] network, an increasing number of over 1,900 energy cooperatives are already operating across Europe.

This business scheme, based on the creation of community businesses managed through a horizontal type of governance, seems to be particularly advantageous as a development and community benefit strategy in small and declining towns. Smaller shrinking cities seems to be even more prone to long term and extreme shrinkage (Restrepo et al. 2017), for this reason, the system of energy cooperatives can be an alternative way of keeping these centres alive, creating new opportunities for subsistence (Di Pietro 2021).

An example of this is the small town of Melpignano, located in the southern area of the region Apulia in Italy, a region characterized by substantial demographic stability for many years and with projections of a strong demographic decrease of 26% in the next fifty years, according to the Regional Agency for Technology and Innovation (ARTI, 2019).

Picture 7: Rooftop photovoltaic energy in Melpignano.
Source: Marina Moioli

Melpignano is one of the small towns in the south of Italy characterized by a non-specialized primary economy, poor exploitation of resources and/or potentials, social and economic inactivity, conservative and traditional territorial organisation and ways of life: these features are common to a large part of the thick Italian settlement plot, rich in small-sized centres (with less of 5,000

[4] https://www.rescoop.eu/

inhabitants), but which are showing a growing openness to local development policies in search of sustainability, looking with hope beyond the decline and change tack, without shutting off from the rest of the world (Rinella 2019).

The case of Melpignano is one of the emerging energy communities in Italy that are benefiting from national support for renewable energy, which is progressively shaping the Community Energy sector in Italy (Candelise and Ruggieri 2020). The Melpignano Cooperative Community was created in 2011 by an agreement of 71 founding members (then reached 127), under the Cooperative Community scheme. Similar to the formula of the Social Cooperative, the Cooperative Community institution is regulated in the Apulian regional law n. 23/2014, to pursue the development of the reference community. The initiative was born from the collaboration between Legacoop and the local administration, to manage a solar energy production network through photovoltaic panels placed on the roofs of public or private buildings. According to his statute, the community cooperative of Melpignano has the responsibility to install the systems and provide for their maintenance, manage the production of energy with metering appropriate to the needs of users and resell the surplus on the market (Tricarico 2015). The construction of the decentralised energy system in Melpignano worked thanks to more extensive building typologies and, therefore, numerous roof owners, who transferred their use to the cooperative for 20 years, receiving free energy.

4.6 Green Urban design in Shrinking Cities

While the energy and utility sectors focus on greening supply, the green urban landscape sectors focus on making demand more efficient to avoid energy wastes.

The term "**green built environment**" concerned the application of the principles of green architecture and the urban spatial design in a way that minimises resource consumption and negative ecological footprint (Abdelaal and Sallam 2019). Greening the built environment can be achieved through many approaches, as **compact urban design** to improve mobility and reduce the carbon footprint, and through green spaces protection for decreasing the impact of pollution and waste on human health besides improving societal welfare by enhancing recreation and social interaction opportunities. Increasing interactions can have positive effects on improving social capital and increasing organisational capacity, which can, in turn, bring innovations of an economic or social nature, given the increased complexity of the urban ecosystem through increased exchanges and contacts (Rueda 1998).

Cities tend to increase their **organisational capacity** over time together with contextual complexity. Cities can grow or shrink following a **compact or fuzzy logic**, where this last consumes larger

amounts of resources such as energy, land, materials, and so on, without obtaining an increase in equivalent complexity, understood as social interactions. In recent years, a fairly broad consensus has been established on the importance of promoting urban processes in a logic of **compacting settlements**, to maximize the use of urban land. Planning visions such as **polycentric urban form** and **compact cities** are often regarded as ideal-typical urban patterns and associated with environmental sustainability; these directives are also presented in the UN-Habitat Urban Agenda (2016).

Existing cities are captives to their history and struggle to escape path dependency without massive capital investment, because of this, 'the ongoing international research finds the necessity for a unique, social-ecological system with new challenges to sustainability science, ecology, and their application to urban planning for shrinking cities' (Herrmann et al. 2016, p. 2). The given solutions and approaches in urban planning to deal simultaneously with urban shrinkage and environmental and ecological problems are usually costly, but with long term and multifaceted benefits. Shrinking cities might offer a **paradigm shift** from growth centred planning to a more careful and place-based approach **towards more liveable cities** (Hollander et al. 2009).

In Europe, according to the EU document Clean planet for all (EC 2018, p. 72): 'the use of renewable energy sources has to exceed 60 per cent by 2050', for which EU members need to ensure that all newly constructed buildings consume nearly zero energy and that their energy needs are produced locally as much as possible and with renewable sources, under the concept called zero energy buildings.

Discussing **Energy problems** in urban declining contexts, Hornebeck and Schwarz (2009) propose **three alternatives:** eliminating part of the energy infrastructure, reducing the costs of public lighting, and increasing decentralised energy generation systems from renewable sources.

The economic viability of urban transport and energy infrastructures in shrinking cities may also be challenged, but on this aspect, no data or studies are currently available.

Declining cities are usually characterized by the presence of uninhabited or abandoned houses. In some of these cases, **demolitions** or **retrofits** of the infrastructure are carried out producing vacant spaces that can then be used for common uses, while, in the case of retrofits, these might also be carried out to improve energy efficiency, under the concept of passive zones. Since the forms of **urban settlements** have a **clear relationship with the use of energy** in buildings (Mulligan 2014), the construction of vertical buildings for multi-family dwellings makes it possible to contain per capita energy consumption, even if this logic supports the dynamics of centralized control in energy

generation, by reducing the interurban potential of energy generation and the potential for bottom-up governance.

Firstly, the different **architectural geometries** and their positioning affect the use of energy, affecting the potential of passive zones, the implementation of technologies for the production of renewable energy, and contribution to the urban heat islands effect. Maximising the use of daily light and natural ventilation by increasing the size of the windows or taking advantage of the solar heat thanks to good positioning of the facades, are some of the techniques that contribute to energy efficiency through planning. In this sense, the reduction of urban densities could have positive effects if the equilibrium point is determined at which it is possible to increase the potential for intra-urban renewable energy generation in combination with the use of passive areas by new or undergoing rehabilitation. New construction techniques that consider the concepts of passive areas and deployed potential of renewable energy generation can be implemented in the built environment.

Lower density bioclimatic buildings have minor positive/negative effects on air filtration, carbon storage and air cooling because is normally accompanied by some greenery around the building (Haase et al. 2019).

Picture 8: Low density green housing in Leipzig.

Source: Haase et al. 2019

In the case of declining cities, the most sensible policies have to do with the search for a balance that guarantees efficiency in consumption and the possibility of implementing decentralised energy generation systems. This can be pursued by compacting the settlements, minimising fragmentation and the presence of non-productive spaces that run the risk of devaluing the rest of the territory. Reaching the desirable levels of urban density according to the climatic characteristics of the territory would also minimise the effect of urban heat islands. Recommendations vary considerably depending on the uses of the buildings (housing, commerce, industry, services) and the geographical location (for example temperate or tropical climates). This approach aims to guarantee greater energy efficiency, increasing social interaction and reducing devaluation linked to deterioration of buildings

and urban areas.

Successful interventions will depend on the numerous dynamics resulting from the constant interaction between actors who establish and modify the structure and morphology of settlements (Sánchez 2013). Uncoordinated processes of compaction of the city run the risk of creating a new dynamic of polarization, inequality (Buhnik 2017; Fol 2012) or urban gentrification (Audirac et al. 2012), therefore, municipalities should implement the best urban planning alternatives to minimize negative social effects by pursuing a balance between local energy supply and demand.

The case of Ostrava illustrates how the problem of **inefficient infrastructure** operation and maintenance in already fragmented urban structures is exacerbated by the growing size of urban areas (low intensity in land use) in combination with the declining size of the population (Slach et al. 2019). This land use development constitutes a great challenge for a city's future structure.

Potentials for sustainability, image and quality of life of the urban space of the shrinking city of Köthen in Saxony-Anhalt are described by Lüther and Meinberg (2008). As described in this case, improving old and new buildings energy efficiency by reducing their energy demand, effectively utilizing the passive solar gains and daylighting, as well as using a larger fraction of renewable energy sources integrated into the urban context is necessary to create a more sustainable urban environment.

4.7 Circular and Bio Economy in Shrinking Cities

The bioeconomy seeks for the use of **renewable biological resources** as industrial inputs with research and innovation enabling the transformational process (Bugge et al. 2016; Kleinschmit et al. 2014; Pfau et al. 2014). The forestry and agriculture sectors play the most important role in providing bio-based substitutes for non-renewables (Ollikainen 2014; Roos and Stendahl 2015).

The traditional development model of resource-based cities which relies on the extensive exploitation of resources (characterised by low efficiency and high pollution) to realise industrialisation and modernisation is no longer sustainable. Unlike a traditional linear chain, adopted by resource-based cities, which takes resources from nature and returns waste to nature (Mathews and Tan 2011), a circular economy converts **waste into an input** to another process.

The situation is crucially urgent in resource-depleted cities, which need to balance their economic development with the scarcity of raw materials and resources and also environmental pollution.

The application of circular economy principles provides an opportunity to decrease rising costs of services and infrastructure maintenance in shrinking cities and regions (Livina and Veliverronena 2019). Franconi et. al (2016) name three key factors for circular business models: resource use,

service lifetime, and economic value creation. A good match is when the service life is higher and the economic value is higher. In the case of shrinking cities, the main challenges to increase circularity may be associated with the underutilisation of infrastructures, leading to what is called structural waste, and reduced opportunities to create agglomeration economies (Ekins et al. 2019). At the other end of the spectrum, hedge cities face the challenges associated with competition between different land uses, which may displace activities with lower added value by spatial units, such as productive spaces, recovery/repair activities or waste management facilities, compared to premium residential and commercial spaces. It may also create pressures on green and blue infrastructure that provides ecosystem services to the cities (Williams 2019).

The concept of industrial ecology is one of the most promising to favor more efficient production processes through the reuse of resources. In the French shrinking city of Dunkerquee, the company ArcelorMittal is one of the few in the steel group to consume more than 15% recycled materials in all of its supplies, with growth of one point each year[5]. The French government has announced an investment of EUR 1.7 billion into multinational ArcelorMittal's decarbonisation programme in France[6].

Picture 9: Recovered materials in steel
View aerial factories.
Source: Public domain

Picture 10: ArcerlorMittal Dunkerque
Source: Laurent Grandguillot

The initiative ECOPAL (Economy and Ecology partner in local action) is located in Dunquerke at the heart of the Port industrial basin in full transition. It is an association that functions as an observatory of flows and the search for synergies allowing the connection of public and private actors of Dunkerque who work in the circular economy[7].

[5] https://lecho-circulaire.com/recyclage-et-reseaux-de-chaleur-chez-arcelormittal-dunkerque/
[6] https://www.energytech.com/energy-efficiency/article/21216134/steelmaker-arcelormittal-receives-government-support-for-decarbonization-at-french-sites
[7] https://www.ecopal.org/

4.8 Ecosystem services in Shrinking Cities

Conservation of ecosystem services in shrinking cities is part of ecological and/or agroecological approach advocated in Hermann works (Herrmann et al. 2016, 2018). Ecology for the city is the framework for social-ecological understanding to shape urban form and function along sustainable trajectories. An improved understanding of the connections between urban structure and function has positioned practitioners and researchers in the ecology community to further expand to ecology for the city: shaping city form and function to create better outcomes for people and places (Herrmann et al. 2016).

Ecology for the shrinking city, therefore, acknowledges that urban transformations to sustainable trajectories may be quite different in shrinking cities as compared with growing cities. Shrinking cities are well poised for transformations because shrinking is perceived as a crisis and can mobilize the social capacity to change. Ecology is particularly well suited to contribute solutions because of the extent of vacant land in shrinking cities that can be leveraged for **ecosystem-services provisioning**. A crucial role of ecology for the shrinking city is identifying innovative pathways that create locally desired amenities that provide ecosystem services and contribute to urban sustainability at multiple scales).

Ecosystem Management, "an integrated process to conserve and improve ecosystem health that sustains ecosystem services for human well-being" (UNEP 2009), places particular emphasis on integrating human needs with conservation practice and recognizes the inter-connectivity between ecological, social-cultural, economic and institutional structures in developing solutions (UNEP 2019).

Ecosystem services are advocated as an important component of the transformation to a sustainable city, and vacant land in a shrinking city is a great opportunity to leverage transformations toward sustainability through ecosystem services (Haase et al. 2014). Vacant lands, as available space hold the potential to provide and enhance ecosystem services in cities (Nassauer and Raskin 2014). Using vacant lands to provide ecosystem services such as food provisioning or the mitigation of pollution, stormwater runoff, and urban heat-island effects can help leverage urban transformations to sustainable cities, making cities less dependent on technological solutions.

Water and wastewater infrastructure systems have unique characteristics that restrict their responses to the dynamics present in shrinking cities. Shifting the paradigm in infrastructure planning toward examining the life cycle of a city to incorporate possible options, such as decommissioning or razing infrastructure, may stabilize or reduce the costs of operating and maintaining water and wastewater infrastructure systems, improve the services provided, and potentially move water and

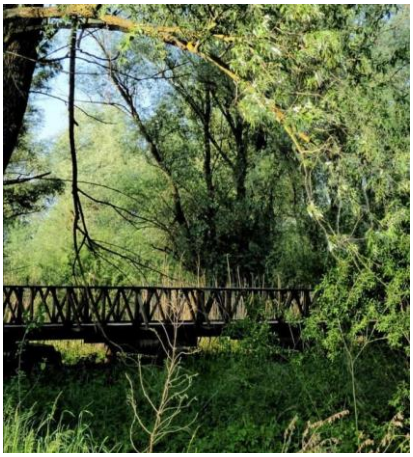
wastewater infrastructure in shrinking cities from states of disrepair to sustainable levels of operation (Faust et al. 2015). A very sensitive area is the **drinking water system** since they are typically designed for growth, not shrinkage. The less water demand, oversized water treatment and distribution systems can have drinking water sit in their old and corroded distribution system pipes longer than desired (Love et al 2019). In other cases, such as in Flint, the industrial legacy has resulted in water contamination and the infrastructure had to be renewed by replacing lead and galvanised steel lines (Hummel 2019).

Within the ecological framework, the concept of **agroecology** can help to develop food sovereignty in shrinking cities. Agroecology is a holistic, dynamic, and evolving approach to developing sustainable agricultural food systems. Agroecology considers agricultural systems to be complex ecosystems and management of ecological processes and linkages to be the key to productive and functional systems. The human and cultural dimensions of agroecology create the potential for social-ecological innovations that can support sustainable transformations in shrinking cities (Herrmann et al. 2018).

Cities have often been conceptualized under the modernist or sanitary-city model, which is dominated by the use of technical systems to manage urban structure and function (Pincetl 2010). In this model, the primary acknowledged the role of green and blue space (i.e., vegetated and aquatic land cover, respectively) is related to **liveability** (e.g., aesthetics, recreation). But scientists have outlined and quantified a significantly broader role that natural systems can contribute to the structure and function of cities, such as stormwater management (Shuster et al. 2014), food provisioning (Schwarz et al. 2016), and wildlife habitat (Herrmann et al. 2012).

Preserving and/ or restoring ecosystem services can be a good tool for shrinking cities, contributing to limiting heat island effects, increasing biodiversity and so improving the quality of urban life.

The management of green spaces, agroecology and urban gardening activities are the best applications of this approach. The management of green spaces is deepened in the case of Osijek in Croatia (Olic and Stober 2019) where the city maintains density standards of green spaces well above the threshold of 9 square meters per person established by the World Health Organization; in particular, ecologists collaborate with urban planners, landscape architects, city residents, engineers, artists, and city government officials to design liveable urban spaces and promote desirable ecological functioning.



Picture 11: Green Areas in Osijek, Croatia.
Source: Public domain

Picture 12: Urban gardening Detroit, US.
Source: Stephanie Held

In shrinking cities, ecologists working in collaboration with other professions and communities can contribute to ecologically informed and innovative solutions that help shrinking cities capitalize on the advantages of existing and emerging open spaces (Green et al. 2016).

Decreasing the degree of competition for physical space, urban shrinkage provides the potential to increase ecosystem services provisioning through the existence of vacant (built, sealed, or open) land Haase and Rink (2014).

Ecosystem services improve the quality of life (Kabisch, et al. 2015) through the newly provided sites, e.g., local climate regulation, air cooling and recreation potential by new green infrastructure or stormwater retention by spontaneous vegetation at vacant sites, but at the same time increase land prices in such upgraded areas (Gruehn, et al. 2012).

4.9 Sustainable Tourism in Shrinking Cities

The tourism economy represents 5% of the world Gross Domestic Product (GDP), so Green Tourism has the potential to create **new green jobs**. As travel and tourism are human resources intensive, employing directly and indirectly 8% of the global workforce, tourism development can be designed to support the local economy and reduce poverty (UNEP 2012).

There is increasing evidence that more sustainable tourism in rural areas can lead to more positive **poverty-reducing effects** by investing in the greening of tourism: reducing the cost of energy, water and waste and enhancing the value of biodiversity, ecosystems and cultural heritage. Tourists are increasingly demanding the greening of tourism, so the private sector, especially small firms, can and

must be mobilized to support green tourism. Much of the economic potential for green tourism is found in **small and medium-sized enterprises (SMEs**), which need better access to financing for investing in green tourism. The majority of tourism businesses are SMEs with the potential to generate greater income and opportunities from green strategies. Destination planning and development strategies are the first steps towards the greening of tourism. In developing tourism strategies, local governments, communities and businesses need to establish mechanisms for coordinating with ministries responsible for the environment, energy, labour, agriculture, transport, health, finance, security and other relevant areas. Government investments and policies can leverage private sector actions on green tourism.

Tourism in the Green Economy refers to tourism activities that can be maintained, or sustained, indefinite in their social, economic, cultural, and environmental contexts: "sustainable tourism". Sustainable tourism is tourism that takes full account of current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities. Thus, sustainable tourism should: make optimal use of environmental resources; respect the socio-cultural authenticity of host communities, conserve their built and living cultural heritage and traditional values and ensure viable, long-term economic operations, providing socio-economic benefits to all stakeholders that are fairly distributed (UNDP).

Conceptual and operational framework for sustainability in tourism business can follow the **Global Sustainable Tourism Criteria (GSTC).** Tourism-related energy use and associated emissions of GHGs can be organized into three subsectors: transport to and from the destination, accommodation and activities. The contribution of these three sub-sectors to global anthropogenic CO_2 emissions in 2005 has been estimated at 4.95% (UNWTO, UNEP, WMO 2008). After travel to and from the destination, the **hotel sector** is one of the tourism industry's most energy-intensive sectors. Energy use in accommodation includes heating and/or cooling, lighting, cooking (in restaurants), cleaning, pools and, in tropical or arid regions, the desalination of seawater. A **general rule** is that the more luxurious the accommodation, the more energy will be used; a fact explicable by greater room space, higher heating and/or air conditioning standards, the existence of facilities such as pools or spa and/or wellness areas, as well as a greater range of electric appliances in the room. Total energy consumption account for 32% air conditioning, 12% for lighting, 5% for lifts and escalators, 23% for other systems and/or appliances, and 28% for cooking and water heating.

Hotel constructions should seek to be **passive or even plus-energy structures**. Any systematic approach to reducing emissions in the tourism sector must understand the sources of emissions within the sector, the major drivers of those emissions and their near-term trends and varied potential of

technological and social change to alter those emission trajectories toward more sustainable pathways, consistent with the climate policy objectives of the international community. Few studies appear to directly compare water use in tourism with local consumption.

While **water** is used by tourism. In such areas, it can increase pressure on already diminished water resources and compete with other sectors as well as the subsistence needs of local populations. It is also clear that various tourist activities can add to water use. The most important activity in this regard is golf, which can greatly enhance overall water use (Rodriguez–Diaz et al. 2007).

It is important to have the following **dynamics involved** in sustainable tourism: local initiative and involvement; building capacity through information and training; public and private sector investment partnerships: connections need to be made with the tourism industry, either directly or via intermediaries such as tourism authorities, governments, NGOs, academic institutions and others.

Sustainable tourism can be a lifeline for shrinking cities that manage to exploit the available resources and convert them into tourist attractions.

A case of mismanagement of the natural tourist heritage can be glimpsed in the case of Niagara Falls, where the tourism sector has been affected by the demolition of the Falls Street Downtown for a failed modernist urban renewal development, creating significant environmental contamination and the downtown concentration of vacant land contributing to the city shrinkage (Hartt and Warkentin 2017). In 2019, Niagara Falls city council has given approval for the development of a landmark 72-storey, mixed-use building with 456 hotel units and 275 dwelling units on Stanley Avenue[8].

On the other hand, the conversion of old infrastructure with works of cultural and artistic value becomes an opportunity to create tourist attractions, as in the case of "Art Islands" Naoshima, Teshima and Inujima, located south of Okayama city in Kagawa Prefecture, Japan.

Picture 13: Urban development project in Niagara Falls
Source: Dena Fehir

Picture 14: "Art Islands" Naoshima, Teshima and Inujima, Japan
Source: Hortense Travel

[8] https://canada.constructconnect.com/dcn/news/projects/2019/12/niagara-falls-council-approves-72-storey-build

The islands are host to residents, some industry, and a multitude of art-related projects by the Fukutake Foundation, the non-profit wing of Benesse Holdings, Inc. The art-related projects range from a fibreglass bubble bike storage building by SANAA to a 9' tall yellow polka-dot pumpkin on a pier sculpted by Yoyoi Kusama, to "art houses" which are 462Open: Urbanism installations by architects and artists in abandoned houses, to epic museums by Tadao Andoa, Ryue Nishizawa and Hiroshi Sambuichi. Every three years an art Triennale is held on the islands attracting more than a million people annually (Fujita 2018).

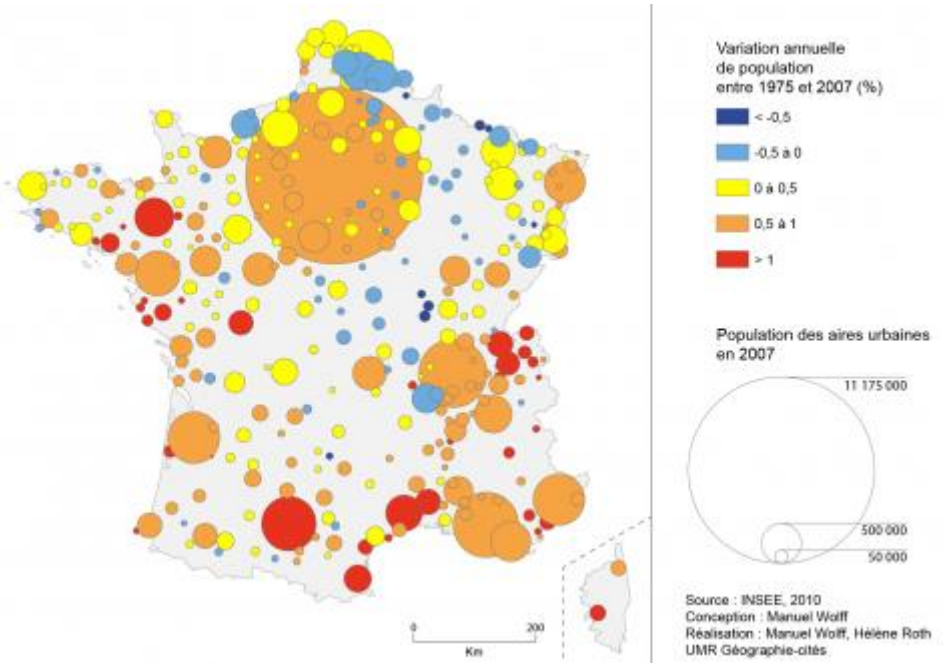
Summarising this chapter, the main areas of intervention that can be implemented in shrinking cities within greening or green regrowing strategies have been mentioned. The difficulties for shrinking cities to embark on innovative industrial paths due to their peripheral situation have been discussed, however, for those with an advanced industrial base and established production and business systems it is easier to establish a progressive conversion to green industry sectors.
It has been seen that within each greening sector there are a **variety of subsectors** to be considered, for example in the **energy sector**, consideration must be given to decreasing demand, increasing low-cost vacant land, dependence on national or regional legislative systems and new interactions with rural areas and urban design. **Green urban design** favours the compact form of cities in order to increase efficiency in the use of resources, increase organisational capacity. Buildings can be integrated with ecosystem services through bioclimatic designs, using passive zones, reducing heat islands and using appropriate materials. Many shrinking cities must inevitably undertake investments to adapt their urban form to the smaller population. The **circular economy** and **bio-economy** aims to reuse discarded materials for industrial and production processes, so shrinking cities could facilitate this transition process by establishing specific partnerships with their industries. Green infrastructure and **ecosystem services** serve primarily to improve the quality of local life. An ecological approach can be used to create experiences of agroecology in shrinking cities, restoring ecosystems and water infrastructures. **Tourism** is a sector which, if applied with sustainable practices, can provide jobs and the creation of local SMEs through environmentally friendly activities.

Part III │ Contextualising the Urban Shrinkage and the Green Economy in France ad Mexico

5.1 Shrinking Cities in France

Urban shrinkage is considered to be a **silent process** (Cunningham-Sabot and Fol 2009) and a limited phenomenon in France, compared to the situation in other European countries (Wolff and Wiechmann 2017). Out of 354 French urban areas, 69 (19.5%) experienced population loss between 1975 and 2007. Shrinking french cities are located in former mining and industrial areas in the north, north-east and around the Massif Central (Wolff et al. 2013, see figure 9). Three-quarters of French shrinking cities have fewer than 50,000 inhabitants and are often specialized in economic sectors now in recession (Paulus 2004).

Figure 9: Annual population change in France, 1975-2007



Source: Wolff and Roth based on INSEE 2010.

According to the study from Chauchi-Duval et al (2017), 283 out of France's 771 Functional Urban Areas (FUAs) have resident populations that were lower in 2011 than in 1990. The most common is that of **continuous decline**, where the population has diminished at each successive census. This concerns the FUAs of Le Havre (in Normandy), Saint-Dizier (in Grand Est), Le Creusot (in Burgundy) and Vitry-le-François (also in Grand Est).

Urban shrinkage affects primarily **medium-sized cities** in France but also in many other countries, as being in an in-between position: they are neither metropolises nor small towns (Chouraqui 2021). The industrial sector is **shrinking overall** in France, with a 22.6% reduction in the number of manufacturing jobs between 1990 and 2011, this reduction affected declining urban areas especially acutely: after the crises of the 1970s and 1980s, these areas have experienced a new wave of deindustrialization over the past 30 years. In average, urban areas affected by severe or limited urban shrinkage are characterised by very high rates of workers in the late 1960s, which suggests they were industrialised during the Fordist era. Moreover, these cities have displayed markers of decline **since 1975.**

In growing urban areas, the economically active population increased by 16.8% between 1990 and 2011, whereas it fell over the same period by 3.3% in declining urban areas Chauchi-Duval et al 2017. Increasing employment in some declining urban areas is linked above all to rising numbers of jobs in periurban areas (+23.1%, compared with +5.9% in urban cores) given by suburbanization, which is the other evident phenomenon in French urban dynamics.

In France, **urban sprawl** started during the 1960s in large cities, and in other cities after 1970 (Haran/Garnier 2018) provoking a pauperisation and demographic decline of urban cores, because of the departure of middle and upper classes who are able to access homeownership in the peripheries and weakness of the central areas of medium-sized cities. More than half of medium-sized cities display markers of **fragility in their central municipality**: even in cities affected by a decline of the centre, social structure is on average more similar to growing and socially privileged cities. In France, the focus on re-equilibrium and territorial equity has become progressively less significant, and spatial policies favouring competitiveness have gained more and more importance (Santamaria 2012; Artioli 2017). Case studies of French medium-sized cities (Alençon, Périgueux, Douai, Lens, Saint-Brieuc, Roanne) reveal that local public policies aiming to **revitalise the city centre** have been implemented since the 2010s.

Although not without criticism (Baudin and Genestier 2006), urban shrinkage in France is tackled through **urban renewal approach**; for this, the National Program for Urban Renewal (PNRU) was introduced in 2003 together with the National Agency for urban renewal (ANRU) (Béal et al. 2019). During 2018, the "**Action Cœur de ville**" (PACV) programme was launched to support 222 medium-sized towns in France through a series of financial and technical measures. **Revitalisation strategies** facing both shrinking cities and declining urban cores have a strong focus on **residential attractiveness**, systematically include public space re modelling and housing improvement actions. The development of cultural infrastructure and support for shopkeepers are other common measures (Gauthier 2016; Dinh 2018; Frel-Cazenave 2019; Lledo 2019).

5.2 North/ South perspective on Shrinking Cities

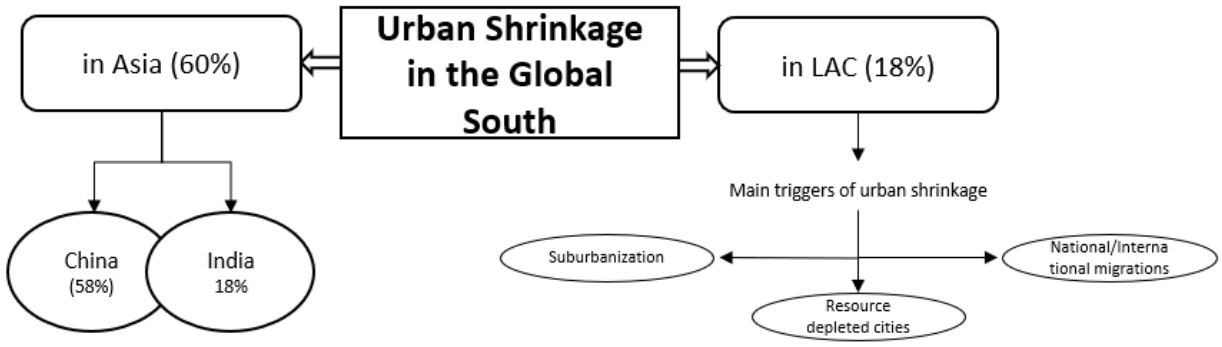
It is necessary to recognise the **different paths** in the topics of urban shrinking and green economy between Mexico and France, which in turn also reflect the differences between the Latin American and European regions. Comparing one case study in France with another in Mexico, require a comparative approach and present a **first conceptual problem** to be solved: while urban shrinkage is a particularly evident phenomenon in the countries of the global North, the causes, dimensions and characteristics of this phenomenon vary in substance if we move to the developing world. The problems of urban areas are often of a different nature and public policy interventions are often limited by scarce financial resources and the reduced capacity of national and local governments to intervene. For example, urban regeneration in Leipzig based on massive public investment would not have been possible in most developing countries.

Few studies recognize and document how urban shrinkage is manifested in cities of the **Global South**. A reference document in this aspect is the UN-Habitat 2008, while others such as World Bank (2020) predicts a future of shrinking cities due to decline in fertility rates in some countries of the global south showing the first signs of demographic transition. **Total fertility rates** are an important factor in assessing the phenomenon of shrinking cities in the North/South global comparative terms: in the 1990–2000 period, 40 % of northern cities with more than 100,000 inhabitants were declining, against 10 % in the Global South (UN-Habitat 2008; Moreno 2008).

Declining birth rates are not sufficient to justify the phenomenon of urban shrinkage in the Global South, the drivers of which are rather to be found in suburbanization, migrations, end of extractive cycles in resource-based cities and, to a lesser extent, in deindustrialisation processes in specific sectors. Given the **late industrialisation** of developing countries, shrinking cities are usually concentrated in **post-mining cities** or cities whose economy was based on primary sectors or **traditional industries** that have lost competitiveness.

While very few shrinking cities (only ten) can be found in African countries, 60 per cent of shrinking cities of the developing world are located in Asia. Paradoxically being considered a populous developing country, China accounted for the major share (58 per cent) of the declining cities in Asia, India accounted for a smaller share (18 per cent) (UN-Habitat 2008).

Figure 10: Urban Shrinkage in the Global South



Author, Kaiserslautern, 2022, based on Moreno 2008.

In India, most of the urban policies are oriented towards addressing rapid urban growth problems, especially in large cities. The Indian shrinking cities phenomenon is more broadly apparent in small towns, where there are both pressures to be urbanized and co-opted into a larger city size or downgraded to a village, however, the municipal cores of the mega-cities of New Delhi, Kolkata, and Mumbai are also facing depopulation due to industrial obsolescence, or old built-up areas that are dilapidated (Ganapati 2014).

According to Long and Wu (2016), 180 shrinking cities are identified in China in the period 2000-2010 including one provincial capital city, Urumqi. In China, 31.1 million people live in 50 shrinking cities, mostly resource depleted cities (He 2017). China's economic development is based on the intensive use of resources creating a national urban landscape in which 17% of cities can be considered resource-based cities, mainly dedicated to mining and forestry cities. The dependence on one main industry produces fluctuant populations, an unbalanced industrial structure, economic downturn, unemployment, and environmental pollution (Yu et al. 2008; Zhang and Kong 2003) which progressively worsen as the resource depletion level is approached (Martinez Fernandez et al. 2012).

5.3 Latin American perspective on Shrinking Cities

Latin America and the Caribbean (LAC) is considered as the **most urbanized region in the world**, with 80% of its population (633 million) living in urban centres (UN, 2019) and the second region in the Global South with the largest share of shrinking cities (Moreno 2008). According to the World Bank (2020), as an effect of the decline in the regional fertility rate, Latin America faces an **imminent new reality** of ageing and shrinking cities, which will manifest itself especially after the population

peaks expected around 2050. Uruguay and Chile are so far the Latin American countries at the forefront of this demographic transition, showing the first symptoms of an ageing population (Chackiel, 2006).

In Latin America the phenomenon of urban shrinkage has specific causes and characteristics: at a glance, it can be observed that the most common types of urban shrinking areas are the result of the suburbanisation of metropolises, resource depleted cities and repeated migration flows. **Three major drivers** of urban depopulation in Latin America are metropolis suburbanization, post mining abandonment and international migrations. While industrialised countries are characterized by lower rates of fertility and long industrial trajectories that have led to a reallocation of economic activities, producing the various transformations in land use, southern countries have demographic growth trends, often supported by phenomena of massive metropolisation. North-South global economic integration has historically existed for many years; as well as migration and urban shrinkage phenomena increase, especially in countries of the global North, the impact of globalisation on the suburbs of the global South is contributing to the expansion of squatter settlements (Audirac et al. 2012).

Today's Latin American urban landscape and dynamics must be read through the historical lens that considers the processes of **colonisation and global economic integration** since it would be difficult to understand the actual urban morphology of Latin American cities without considering the direct line between the first indigenous imperial cities and subsequent colonial and modern cities. While in principle, urban planning was a public activity decided by the state identified in the theocracy and ruling elite of indigenous civilizations, the colonizing powers implemented architectural styles, building techniques and land uses that reflect their previous experiences (Hardoy 1978).

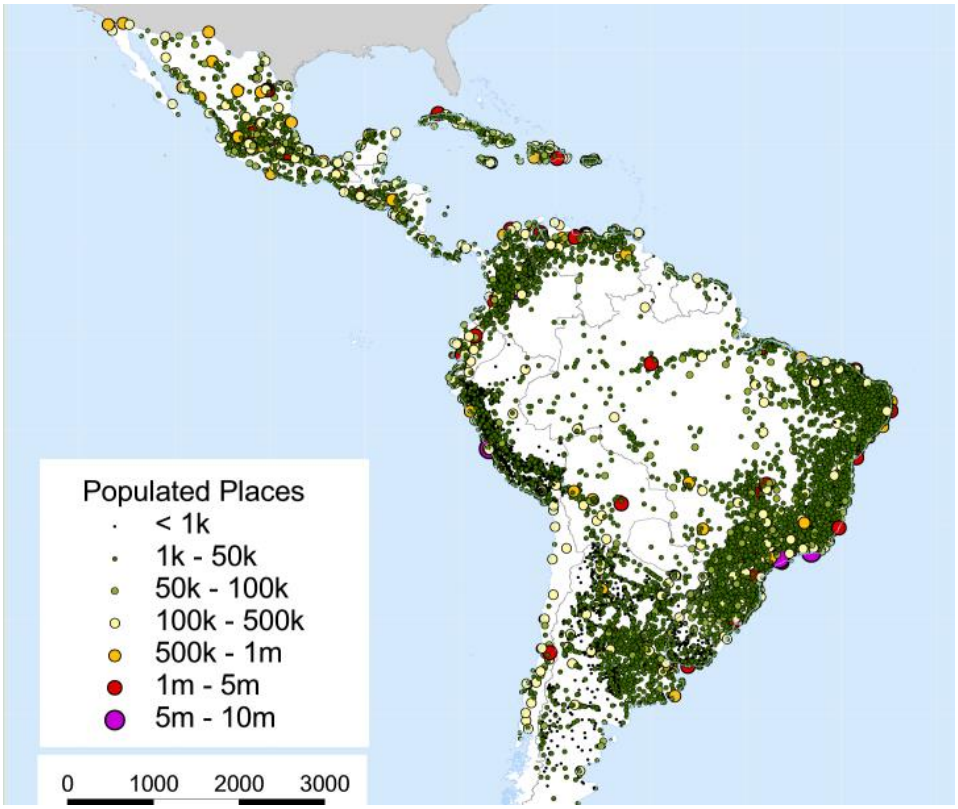
The Hispano-American city model is easy recognizable for the simplicity of the layout, developing on quadrilateral and linear planes, and the location of the hierachical elements: the Cathedral, the house of the cabildo and the government house around the main square (Hardoy 1974).

Although the new overseas authorities legislated to introduce a norm in the spatial organization of the new Spanish cities in America, many times in practice the pre-existing was taken advantage of, for which cities were drawn up and churches built on pre-Hispanic settlements and temples. In this way, the colonizers themselves involuntarily preserved that millenary tradition that today we can still recognize in some Mexican cities (Galindo 2013).

Although many colonial cities were built on top of the ancient indigenous cities, others were born for the extraction of raw materials, or as places of transit to the port cities who became the most important

centres of commerce, concentrating the higher population growth rates in the coastal areas. Still today, most of the largest Latin American metropolises such as Buenos Aires, Lima, Guayaquil or Sao Paulo are the result of this demographic concentration process linked to commercial traffics established since the colonial period. In addition, coastal regions also offer ecosystems that are more adaptable to urban needs than the wilder and more inhospitable Amazonian or high Andean ecosystems.

Figure 11: Population density in LAC region



Source: CIESIN, Columbia University.

From a conceptual point of view, **modernity was imposed in America**, as part of a deliberate policy to lead to modernization (Gorelik 2003) however the presence of shanty towns or *villas miserias* indicate that an antiurban sensibility remains (Hardoy 1978) contributing to the segregation of urban space.

It is possible to glimpse a relationship between **late motorization** and the typical characteristics of the dispersed Latin American city. While in developing countries the growth of has slowed or decreased notably, accompanying their entry into the post-industrial city, risky and the demand for environmental protection, in developing countries vehicle parks are increasing without apparent brake. In this way, the economies and cities of developing countries become escape valves, as well as repositories of some of the grossest dysfunctionality of the industrial age. It is enough to note that

between 2002 and 2007 the vehicle fleet in the Latin American region increased by around 50% compared to 20% in the Asia-Pacific area, 2.6% in the European area and 2.9% in North America (Covarrubias 2013).

In Latin America, urban shrinkage and the widespread suburbanization results from a **land occupation model** for the most part carried out under illegal practices (**informal settlements**) producing low densities and urban sprawl; recurring periods of instability or economic crisis that, in addition to affecting real estate dynamics, position the **land as a form of investment** for small and large amounts of capital, even of illicit origin, as a money-laundering strategy; wide disparity (polarization) of economic income between social groups **(segregation**); multiplicity of agents that intervene formally and informally in the production of spaces (**patrimonial norms**); coexistence of different land ownership regimes (for example "Los ejidos" in Mexico: the regime of **communal lands**), notably social or collective properties; the erratic and diminishing participation of the state in urban and social policies (**lack of governability**); little or no regulation of the authorities in the processes of occupation of space (Pérez and Mínguez 2014).

Decentralization and central city depopulation started in Mexico City and Caracas in the 1950s and by the 1990s this process was so pervasive that Latin American central cities were declared in decline (Gilbert 1996). As an effect of suburbanization, in some of the historic centres of Latin America housing use weakened. For example, between the years 1990 and 2000, the historic centre of Quito lost 31,4% of its inhabitants (Carrión 1999), while in Buenos Aires the percentage was 20% (Clichevsky 1999). In Mexico City, only one area of the city centre lost 2.320 housing units between 1990 and 1995 while Guadalajara had in 2000, 2.478 vacant lots with services and 4.000 wasted hectares that is 26,6% of the municipal area (Rábago 2001).

Irregular and unplanned urbanization processes produce large portions of vacant land in Latin American cities. In Latin American metropolises, the percentage of vacant land could vary from less than 5% to 44% of the urbanized area (Clichevsky 1999).

In the 2000s, São Paulo in Brazil, Santiago in Chile and Buenos Aires in Argentina, were characterized by high-end residential development and the suburbanization of elite groups, while the central city and southern peri central neighbourhoods decayed and lost population (Kanai and Ortega-Alcázar 2009). Regeneration strategies for shrinking Latin American central cities driven by new urban renewal mega developments such as Puerto Madero in Buenos Aires' docklands or Torre Mayor in Mexico City's historic centre smaller-scale, are inspired by large-scale redevelopment projects in the Global North, aiming to achieve global city status. However, these projects are locally resisted and highly contested (Cuenya and Corral 2011).

Suburbanization processes can be linked with problems of environmental unsustainability, social polarization, abandonment of historic centres and decay of heritage and historical architectural devaluation, creation of vacant lands and a discontinuous and irregular urban landscape. Carrión (1999) identifies six types of vacant lands: lands which are the result of speculative processes; semi-agricultural lands that have been absorbed by urban expansion; those that constitute family savings reserves or that have not been developed due to lack of resources; communal lands, whose property regime presents restrictions for its sale; the lands affected by the norms that indicate restrictions for their construction; the lands owned by public institutions.
Urbanization is accompanied by the widening of territorial inequalities in terms of income, infrastructure and connectivity. The phenomenon of urban sprawl is accompanied by the segregation of space with closed condominiums and two cars per family and that of the squatter settlements. This contribute to unsustainability, since the consumption of water, energy and material resources in the rich suburbs is significantly higher than in the city centre and peripheral suburbs, despite they can even improve their environmental quality, exporting their pollution (Martinez Alier 2002).

In Brazil, the problem of urban shrinkage does not follow the patterns found in Europe or the US. An unfair territorial dynamic generated by Brazilian land oligopoly, the government´s incapacity to produce jobs, the highly speculative real estate market, the lack of housing subsidies for low-income workers, and the inadequate use of land policies have led to the emergence of empty rural towns, emptied and decaying (or sometimes gentrified) metropolitan areas, and swollen slums or metropolitan outskirts (Torres 2013). Approximately 7% of Brazilian cities showed an urban decline, representing a loss of 9% of inhabitants between 2000 and 2010. Many Brazilian shrinking cities have to be considered as satellite cities: cities losing residents to nearby cities that are better equipped with public services. The sharp drop in the birth rate can be added to all these causes since, after 2025, the age pyramid will be inverted and the Brazilian population will become older (Biscalchim and Barreira 2020).

The other diffused typology of Latin-American shrinking city is the **resource depleted city** or post mining cities. Despite Including 6 of the 17 megadiverse countries of the planet and the highest bio-capacity per capita in the world, the material intensity rate in Latin America is also greater than the global average and 4,5 times greater than in North America (UNEP 2018), which indicates that the economy is still based on the exploitation and exportation of primary resources, in the so-called "unequal ecological exchange" (Moran et al. 2013).
The processes of late industrialization, despite the impulse of the **import substitution policies** recipes promoted by ECLAC (1950), particularly widespread since the 1960s, have not always led to the

desired economic achievements, ending up obliging to pursue economic growth through new neoliberal re-opening.

According to several authors, the silver and gold of the Americas was the main trigger of Globalisation at his begins. Over the years, the expression "“**natural resource curse**” has been consolidated referring to the paradox of Latin American countries, whose territories are rich in natural resources (minerals, oil, gas, etc.) but tend to have poor economic performance and low levels of development (Rosser, 2006).

The extraction of raw materials has given rise to multiple processes of change in the territory: urban expansion of **cities closes to mines**, creation of new enclaves, involuntary resettlement, creation of new population centres, a decline of certain cities, etc. Mining development tends to take place in areas far away from large cities and is therefore rather associated with secondary towns in predominantly rural areas. Many Latin American cities have historically grown up around the extraction of raw materials or directly created by private companies. Among these, some have managed to mitigate the economic effects of mining fluctuations while others have shown less economic resilience.

Two historical cases in which mining activities created the basis for urban development that continued after the decline of mining activities around the concept of “**mining urbanisation**” are Potosi, in Bolivia and Zaruma, in Ecuador. Potosí was one of the most important silver mining centres in colonial America. His morphology was directly conditioned by the mining activity that took place there: by the social structure of the inhabitants (indigenous workers and slaves and a Spanish elite in segregated neighbourhoods) and by the evolution of the extraction and transformation techniques of the minerals, which led to the development of water supply infrastructures Leggett (2006).

Potosí is located in a context where natural conditions made it very difficult to develop other complementary activities (agriculture) that the city needed to exist. Multinational companies, which today operate with capital-intensive technologies and are linked to global flows, have new territorial strategies that aim to take advantage of pre-existence and create relatively few links with local spaces. Taking up the concept of "mineralised urbanisation" (Gonzales 2017), the spatial and urban production that comes from mining has become indirect. Consequently, several other urban centres developed based on productive or commercial activities that allowed Potosí to be supplied generating a regional network of roads and the subsequent decline of mining activites in Potosí did not mean the decline of the other centres, so the city has managed to survive.

Zaruma´s gold extraction dates back to pre-Hispanic times, colonial times and as the independent Republic of Ecuador. The wealth generated by gold created unique features reflected in the material heritage: urban design, architecture, the natural and cultural landscape so much so that it was included

in the UNESCO World Heritage List[9]. The technological updating of mining production by transnational companies has been replaced by indirect economic activities, including tourism (Calle and Sánchez 2020), which is expanding thanks to the architectural heritage located in the historic centre, characterised by architectural solutions, mixing folk values with foreign influence, and incipient urban planning and zoning, having created a local and regional style.

On the other hand, **post-mining depopulation** processes are particularly evident in some cities in Chile. An emblematic case was the great expansion of the town of Sewell at the beginning of the 19th century due to copper mining and then the total depopulation after the impossibility of continuing operations (Solminihac 2003). One of the most important cities in post-coal mining shrinkage in Chile in the city of Lota which has been progressively marginalised and abandoned after more than 150 years of productivity (Rodríguez and Medina 2011; Reyes et al. 2014).

Another major driver of urban depopulation in Latin America is **international migration**. Currently, the global economic integration processes with free trade, export-led development, foreign direct investment, and massive North-bound emigration and South-bound remittance flows contribute to establishing the urban landscape of LAC. To be used only for consumption, remittances create a series of structural distortions that were reflected, among other things, in the structural distortions, in the exacerbation of "social conflict, economic disparities and price inflation, and fostered price inflation, and fostered a vicious circle whereby emigration led to more emigration and emigration generated further emigration" (Binford 2003). The World Bank, the IMF and the IDB, have emphasised the need to direct remittances towards the creation of small and medium-sized enterprises (Ratha 2003) and other uses that promote capital formation (ECLAC 2008).

5.4 Exploring Shrinking Mexican Cities. Geostatistical analysis on demographic variations 1990-2020

In Mexico, urban shrinking is an **under-explored phenomenon**, even when treated as a depopulation process. Rural depopulation was approached from a geographical perspective by Segundo and Bocco (2012), identifying the state of Michoacán as one of the most affected by this phenomenon. According to Arroyo (2010), in Mexico it is possible to identify areas that are losing population, but not for this is arguable with certainty that the shrinking trends of Europe and the United States will be replicated. Certainly, **two factors** play against urban shrinking in Mexico: higher fertility rates and late

[9] https://whc.unesco.org/en/tentativelists/6089/

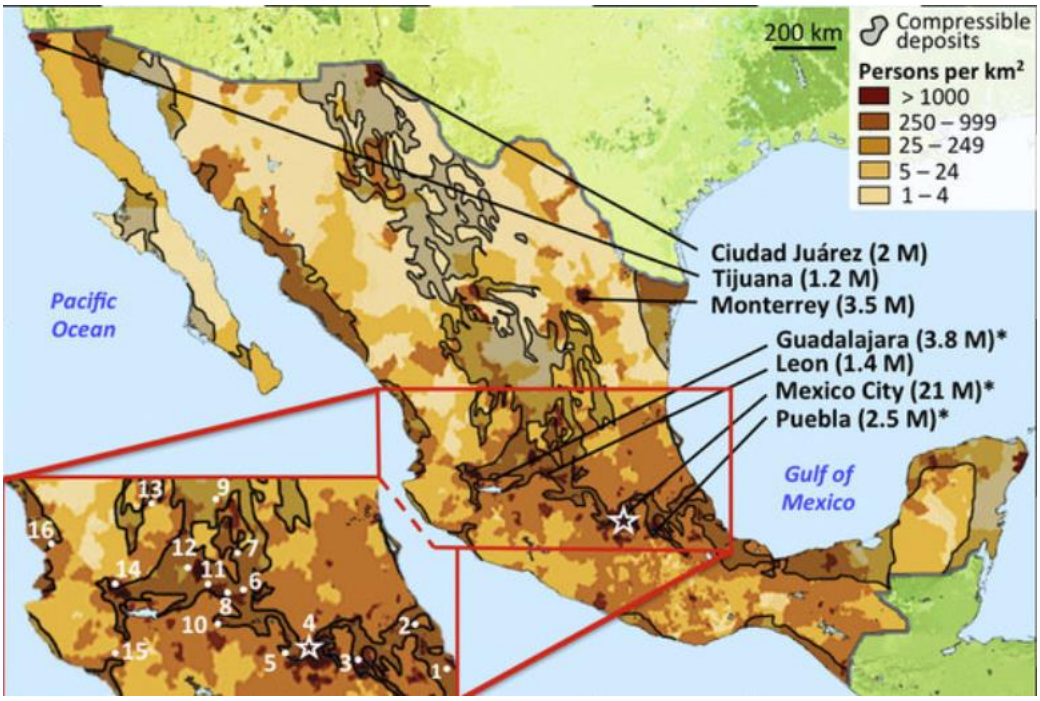
industrialization processes. The Mexican total fertility rate is 2.22 (Centre for Strategic and International Studies), above the generation turnover rate; for this reason, the differential growth of the cities of Mexico is not due to notable inequalities in birth or mortality rates, or the age profile, but to the mobility of the population, mainly due to migration (Garrocho 2013).

Mexico adopted the policies of **industrialization by substitution of imports** (ISI) until the 1980s creating subsidies for local industries in sectors dependent on foreign goods, imposing strong barriers to their importation. The effect was to generate a decline in agricultural commodities and therefore an exodus from rural to urban areas. The failure of ISI policies and the **new neoliberal opening**, including the strong participation of international trade agreements, produced a new shock in rural areas forced to adapt rapidly to the challenges of competition in a globalized environment (Arroyo 2010). Although on the one hand, in Mexico there are processes of post-Fordist transition as in the automotive industry sector (Lima 1994), on the other hand, the lack of specialization of the working mass and the following availability of low-cost work, leads to a weak relationship with processes of eventual urban shrinking given by post-Fordist transitions, strengthening the service sector or the informal economy.

Cities in Mexico represent almost **three-quarters of the population** (72 per cent) and it is projected to grow from 117 million to over 160 million in 2050 (with 88 per cent of the population concentrated in urban areas). During this period, the number of **cities with populations of more than a million** people is estimated to **almost double**, increasing from eleven to twenty cities with more than a million inhabitants. Cities are the main engines of economic growth: in Mexico, 93 cities (with more than 100,000 inhabitants each) represent 88 per cent of the country's GDP. Therefore, it is foreseeable that the cities of Mexico will experience demographic and economic growth that will translate into higher energy consumption (SENER 2018).

The population density of Mexico is largely concentrated in the seismic region of the centre of the country (see Fig.12, Chaussard et al. 2014). Most of the areas with over 250 persons per km2 (dark orange colors) are located in an east–west oriented belt in central Mexico surrounding the Transmexican Volcanic Belt (TMVB). In fact, according to the results of this study, **earthquakes** are one of the reasons why shrinking cities can be created in the central part of Mexico, as in the case of the municipality of Puente de Ixtla, which, following the destruction caused by the 2018 earthquake, is entering a progressive and possibly irreversible decline.

Figure 12: Population density of Mexico and compressible deposits

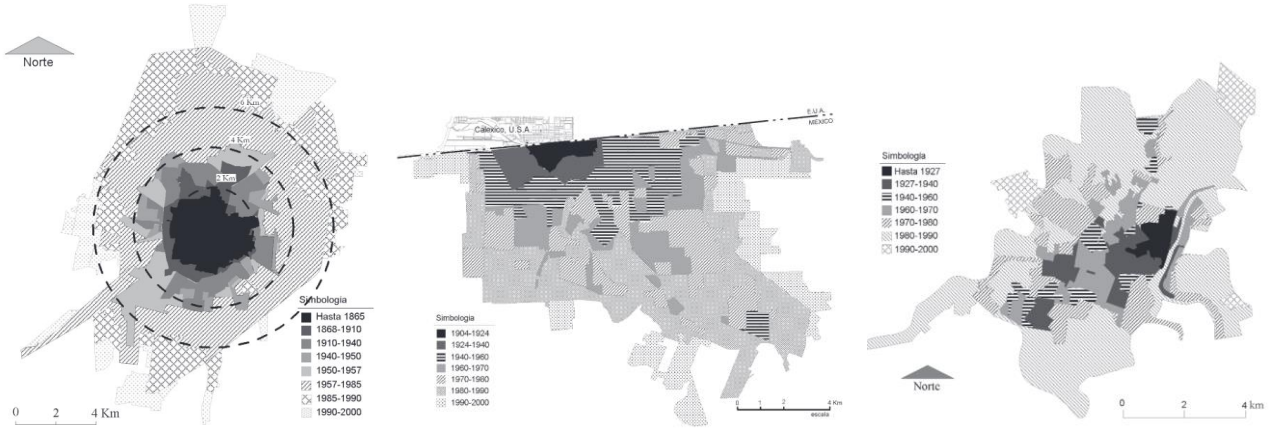


Source: Chaussard et al 2014.

The dynamics of Mexican cities have shown processes of **physical expansion**, the concentration of urban equipment and population that account for the formation of an eminently urban country. In these, 92.6 million people reside in urban areas, representing 74.2% of the national population. The process of continuous urbanization is due to the transfer of resources from primary to secondary and tertiary activities. The population of the country of Mexico residing in urban locations grew at a faster rate than the population as a whole; therefore, the degree of urbanization increased in 50 years from 37% in 1940 to 77% in 2010 (SEDATU, 2018).

Urban forms of the structure of Mexican cities cannot be explained only by a monocentric model. (Alvarez de la Torre, 2010, Fig. 13).

Figure 13. Concentric, Semi concentric and no concentric spatial models of Mérida, Mexicali and Villahermosa



Source: Alvárez de la Torre, 2010

Currently, there are **401 cities** being part of the **Urban National System** in Mexico (SEDATU, 2018): 74 metropolitan areas, 132 conurbations, and 195 urban centres.

- *Metropolitan areas* are the grouping in a single unit of complete municipalities that share a central city and are highly interrelated functionally.
- *Conurbation* is defined as urban structure resulting from the physical continuity between two or more geostatistical localities or urban centres, constituting a single urban unit of 15.000 inhabitants. They can be inter-municipal and interstate when their population ranges between 15.000 and 50.000 inhabitants, and intra-municipal even exceeding this population range.
- *Urban centres* are cities with 15.000 or more inhabitants that do not meet the characteristics of a conurbation or metropolitan area.

It should be noted that in the 1970s, it was the formal start of the regulations, to influence the territorial ordering (Sousa 2013). In agreement with Baños and Cardenas (2014), the Mexican federal system has a solid structure for urban planning based on articles 27, 73, and 115 of the Constitution of Mexico, but it **does not apply** for three reasons: intergovernmental relations conditioned by Mexican federalism; lack of clarity regarding the competences and attributions of the different government orders in the matter of urban planning; due to the social and political context, especially the municipality that prevents urban control and planning. As a result, urbanization processes are **driven by the real estate market** to the detriment of the community and collective values.

The urban and territorial planning in Mexico, as well as in the United States (Pallagst et al. 2017), can be labelled as "**market-oriented**" and based on the **intensive exploitation of a large number of materials, energy and land resources.**

Urban planning in Mexico has been influenced by racial criteria promoted by the Athens Charter[10] favouring, since 1970, the realization of large-scale plans (Gutiérrez 2017). The Regulatory Plan and zoning, have prevailed for decades as normative and control instruments for occupation but was surpassed by the reality that characterizes Mexican cities in the early 1990s when a reform of government housing finance agencies in Mexico led to an explosion of credit for housing. Through that measure, a majority of houses are now built by private companies on speculation and purchased with mortgages, rather than through the incremental process that previously governed urban development (Monkkonen 2015).

5.4.1 Methodology description

The management of Latin American urbanization processes requires constant monitoring of urban dynamics and their particular characteristics. This chapter aims to provide a macro view of the dynamics of urbanization in Mexico through the analysis of urban shrinkage and suburbanization processes. The applied methodology is based on the identification of demographic variations at the municipal level using as sources the census data produced by the **National Institute of Statistics and Geography** (INEGI) from 1990 to 2020. Given the unavailability of data on GDP variations for all Mexican municipalities, the simplifying methodology was to focus on the demographic aspect. Municipalities are identified in three categories: growing, shrinking or extremely shrinking. Although the term most used in literature is that of long-term shrinkage, the term extreme shrinkage is preferred as it stands out on the magnitude of the process.

With a predilection for areas considered as urban, an attempt is made to identify the main determinants of urban shrinking on the one hand and to establish the proportions of the phenomenon of suburbanization on the other. Although the main causes and the differences between urban dynamics remain to be investigated more specifically, it is concluded that urban shrinkage and suburbanization are both **decreasing phenomena** in Mexico.

To measure the phenomena of suburbanization, an average of the demographic percentage variations in the **central metropolitan municipalities** was calculated and compared with the average of the demographic percentage variations of the **peripheral metropolitan municipalities**. Development

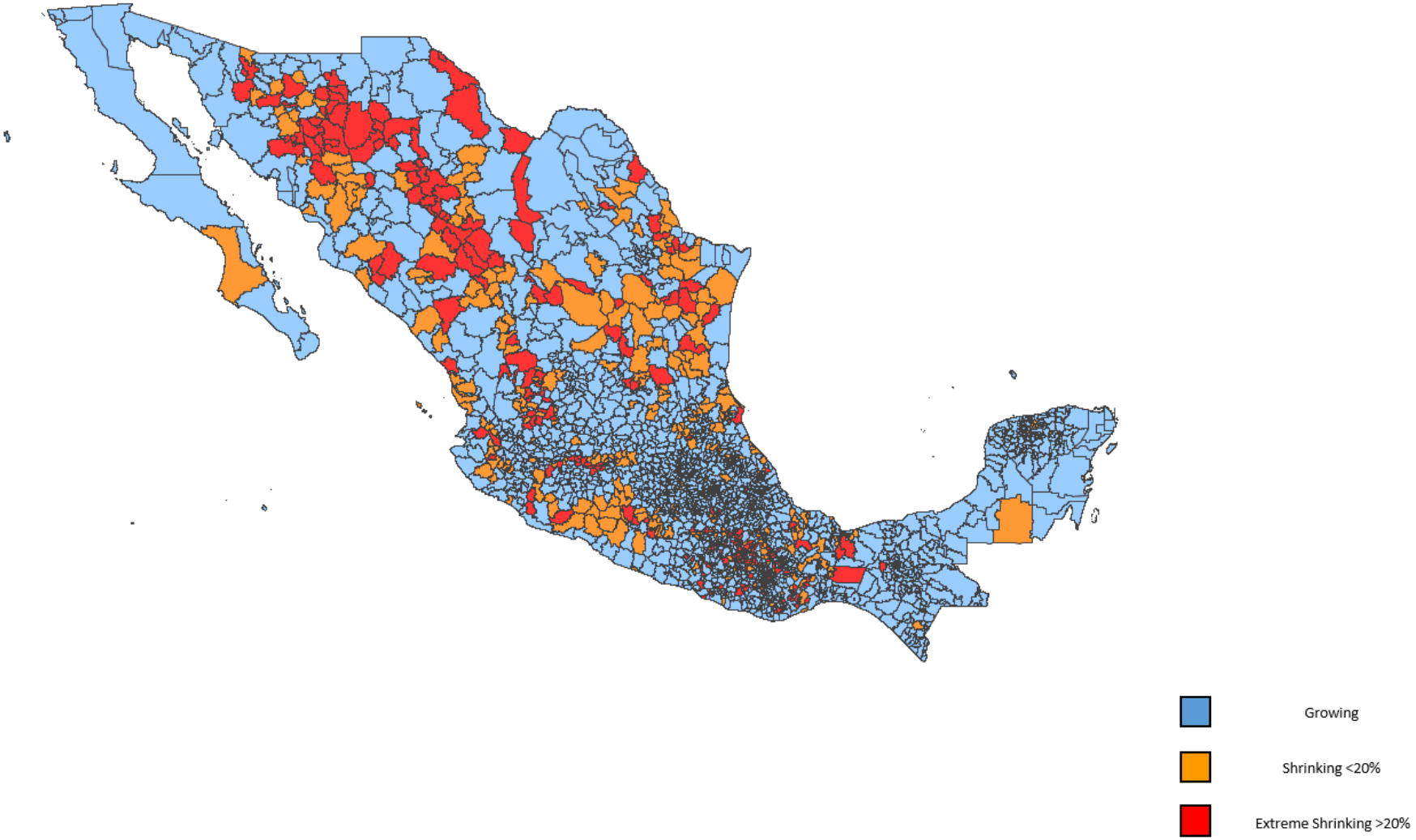
[10] The modern urban planning vision of the Athens Charter (1938) promoted the zoning of neighbourhoods and buildings according to the functions performed within the city.

trends are also established in both phenomena, analysing decades of time intervals. The 29 shrinking cities of Mexico are identified in the thirty years 1990-2020 and the ten-years demographic variations of the metropolitan municipalities are analysed, detecting an ongoing catch-up trend among the growth rates of the central and peripheral metropolitan municipalities, even if the difference is still significant. This trend indicates an ongoing stabilization trend of urbanization processes in Mexico after the boom of the 1990s.

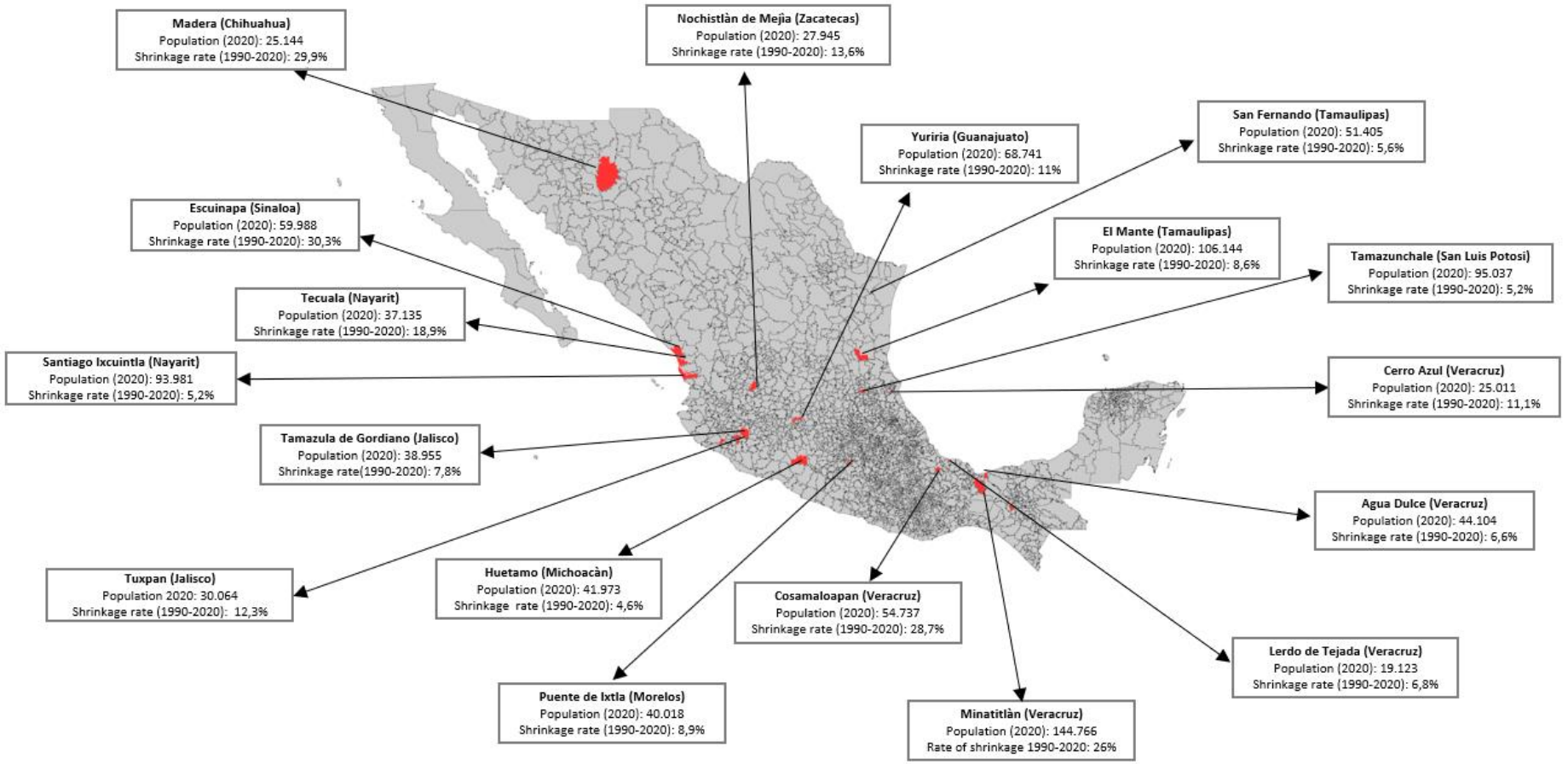
5.4.2 Results and Analysis

The phenomenon of shrinking cities has been slightly **decreasing** in Mexico over the last 30 years, within a national urban system characterised by the accelerated growth of small and medium-sized urban centres. Among the 401 considered urban centres in the national urban system, **29 cities** have a population loss between 1990 and 2020 (Di Pietro 2021), but considering as a condition the average rate of population loss of 0.15% per year (i.e. **4.5% in 30 years**) then these become **18 (**Map 2).
As a result of this work, the thirty years demographic variations show that as many as **27.7% of Mexican municipalities** have had negative changes or processes of depopulation in the last 30 years. This indicates that the development process in Mexico is extremely heterogeneous in the context of an extremely different territorial morphology, which is also a condition of an unequal distribution of resources. Map 1 indicates in red the municipalities affected by extreme urban shrinkage (> 20%); in orange shrinkage (<20%); in blue are the growing municipalities. Most of the affected territories are located in the north-central area of the country, partly semi-desert areas, also characterized by the presence of activities linked to organized crime, but above all closer to the border with the United States, an aspect that facilitates migration.

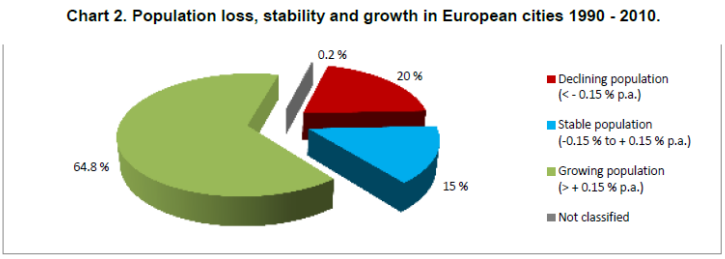
Map 1: Thirty-year demographic variation by the municipality in Mexico. Source: Author, Kaiserslautern 2022, based on INEGI Censos de Población y vivienda.



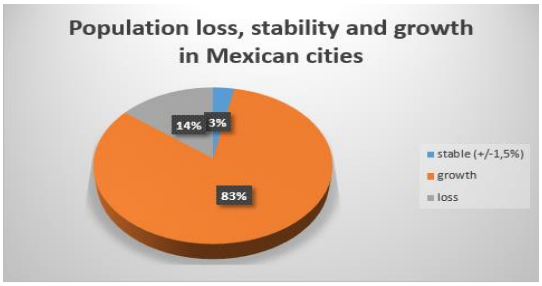
Map 2: Eighteen Mexican shrinking cities with more than 4.5% depopulation between 1990 and 2020.
Source: Author, Kaiserslautern, 2022, based on INEGI Censos de Población y vivienda 1990–2020.



Compared to Europe, which had 20 per cent of cities in depopulation and 15 per cent with a stable population, Mexico had 14 per cent of cities in depopulation and only 3 per cent with a stable population (Fig. 14, 15). In total, 684 of 2.468 Mexican municipalities show population loss over the period 1990-2020. Between them, 200 have a population greater than 10.000 inhabitants, while 340 have a population loss of over 20%, therefore being in extreme shrinkage (Fig. 16).



Figures 14: Population loss, stability and growth in Europe.
Source: Wolff et al. 2013



Figures 15: Population loss, stability and growth in Mexico.
Source: Author, Kaiserslautern, 2022

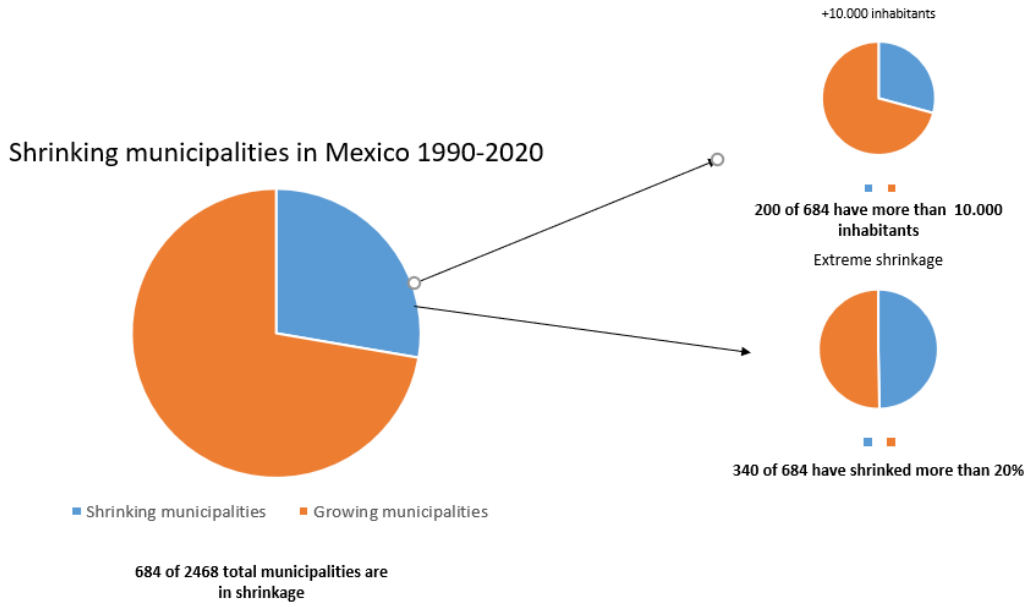


Figure 16. Pie chart of Shrinking municipalities in Mexico 1990-2020.
Source: Author, Kaiserslautern, 2022, based on INEGI Censos de Población y vivienda.

Most of the shrinking municipalities show high rates of vulnerability, extreme poverty and lack of access to basic services such as water, electricity, sanitation systems[11].

[11] Information consulted on https://datamexico.org/

However, this is not the only reason that pushes people to migrate, therefore the main determinants of urban shrinking in Mexico should be investigated more specifically, prioritizing the following areas: structural lack of economic possibilities in marginal territories, migration to the United States, end of the extractive cycles, natural disasters, presence of criminal activities. A case study seems to be the most appropriate methodology, for this purpose.

Of all the shrinking municipalities, only 29 are part of the National Urban System, which means that the phenomenon is primarily affecting rural areas.

Table 3 describes the situation of the 29 shrinking cities belonging to the 401 cities included in the National Urban System (SEDATU, 2018), which means 7,2%.

Table 3: Shrinking Cities in Mexico 1990–2020.

City	Federal State	Population (2020)	Rate of shrinkage (1990-2020)	Possible shrinkage determinant	Extreme Poverty[12]	Category[13]
Moroleón	Guanajuato	47.261	1.9%	Crisis of the textile industry	3.32%	1
Minatitlan	Veracruz	144.766	26%	Decrease in L. Cardenas refinery operations/ Environmental contamination	10.1%	1
Salvatierra	Guanajuato	94.126	3.6%	The structural trend of migration to the US	7.07%	2
Tamazula de Gordiano	Jalisco	38.955	7.8%	Mechanization of sugar cane cutting ("Tamazula Ingenio" company)	2.96%	2
Jiquilpan de Juárez	Michoacán	36.158	1.5%	The structural trend of migration to the US (Aguilar Ortega, 2011)	7.16%	2
Tuxpan	Nayarit	30.064	12.3%	Tobacco workers migrate to the US (Madera & Hernández, 2016)	4.67%	2
Matias Romero Avendano	Oaxaca	38.183	1.5%	Decrease in rail system operations	17.7%	2
Tamazunchale	San Luis Potosi	95.037	5.2%	Contamination by mining	22.4%	2
Cerro Azul	Veracruz	25.011	11.1%	Decrease in oil production	8.22%	2
Cosamaloapan de Carpio	Veracruz	54.737	28.7%	Sugar industry crisis	8.45%	2
Agua Dulce	Veracruz	44.104	6.6%	Decrease in oil production	7.6%	2
Madera	Chihuahua	25.144	29.9%	Presence of organized crime activities	9.2%	3

[12] Percentage of population in situation of extreme poverty. Source: Datamexico.org

[13] National Urban System (SEDATU) established the following categories: (1) metropolitan; (2) conurbation; (3) urban center

Acámbaro	Guanajuato	108.697	3.3%	The structural trend of migration to the US	4.8%	3
Yuriria	Guanajuato	68.741	11%	The structural trend of migration to the US	8.59%	3
Teloloapan	Guerrero	53.817	3%	Presence of organized crime activities	21.4%	3
Huetamo	Michoacan	41.973	4.6%	The structural trend of migration to US/ Public insecurity	17.7%	3
Puruandiro	Michoacán	69.260	2.3%	The structural trend of migration (Garcia & Delfin, 2012)	16.8%	3
Tepalcatepec	Michoacán	24.074	4.1%	The structural trend of migration /Public insecurity	9.03%	3
Puente de Ixtla	Morelos	40.018	8.9&	Natural disaster, earthquake 2018	18.4%	3
Santiago Ixcuintla	Nayarit	93.981	5.2%	Productive reconversion of tobacco (Madera & Hernández, 2017)	5.67%	3
Tequila	Nayarit	37.135	18.9%	Presence of organized crime activities (Meza et al. 2012)	4.27%	3
Loma Bonita	Oaxaca	40.934	2.4%	The structural trend of migration to the US	11.5%	3
Cardenas	San Luis Potosi	38.317	3.8%	Decrease in rail system operations	8.4%	3
Cerritos	San Luis Potosi	22.075	2.7%	Lack of economic opportunities	7.46%	3
Escuinapa	Sinaloa	59.988	30.3%	Public insecurity	4.87%	3
Benito Juarez	Sonora	21.692	0.6%	Public insecurity	5.1%	3
El Mante	Tamaulipas	106.144	8.6%	Sugar industry crisis	3.9%	3
San Fernando	Tamaulipas	51.405	5.6%	Public insecurity	12.8%	3
Lerdo de Tejada	Veracruz	19.123	6.8%	Sugar industry crisis	5.03%	3
Nochistlán de Mejía	Zacatecas	27.945	13.6%	The structural trend of migration to the US	4.96%	3

Source: Author, Kaiserslautern 2022, based on INEGI Censos de Población y vivienda

Based on the results obtained, some cases of shrinking Mexican cities have as **major determinants** the economic crisis of some sectors that lose competitiveness in the globalized market, such as textiles, the production of sugar, tobacco, even if more generally, situations of violence due to the presence of organized crime and the structural lack of economic opportunities seem to be the major determinants.

There does **not seem to be a direct relationship between levels of extreme poverty and rates of depopulation**, this is probably also due to the statement made in the Human Development Report

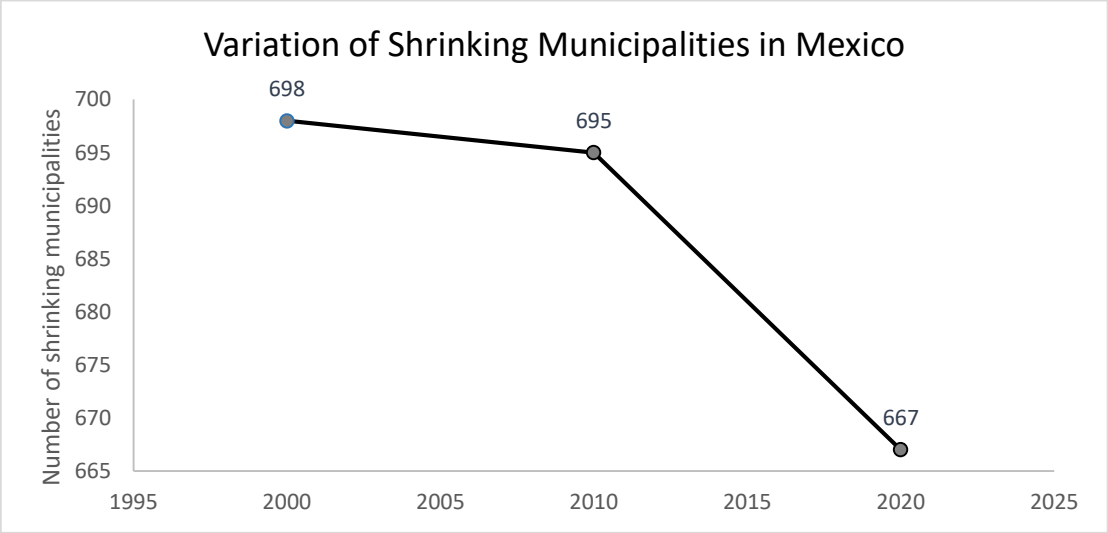
(UNDP, 2009) that groups with higher levels of incomes and human development seem to be more prone to migrate.

The shrinking cities considered metropolitan area (category 1) are Moroleón and Minatitlán. Moroleón in Guanajuato had a flourishing textile industry concentrated in small, medium and large workshops (Vangstrup, 1995) disappearing due to competition from imported products (Tinoco & Gúzman, 2009), in particular from Chinese piracy (Torres, 2007). The Mexican city most affected by shrinkage (26%), considering the size of its population, is Minatitlán, in the federal state of Veracruz, where a decrease in "L. Cardenas" refinery operations and the environmental contamination linked to regional extractivism leaves few options for the population other than to migrate. The depopulation of Minatitlán is probably related to the decrease in operations of the oil and gas refinery, which operates at 29% of capacity compared to the 1980s (Sosa, 2019). Most other shrinking cities are considered conurbations (category 2) and small urban centres (category 3).

The map 2 identifies the eighteen Shrinking Mexican cities that have suffered average depopulation of more than 0.15% per year in the last thirty years, (equal to or greater than 4.5%), thus showing a higher magnitude and long-term depopulation trend.

However, when analysing the decennial sections on a national scale, the municipalities with depopulation are decreasing. Figure 17 indicates the decreasing trend of the number of shrinking municipalities during the three analysed decades, which indicates that the depopulation phenomenon is slowing decreasing.

Figure 17: Variation of shrinking municipalities in Mexico.



Source: Author, Kaiserslautern, 2022, based on INEGI Censos de Población y Vivienda

At least three branches of reasons that push people to leave cities can be identified: end of economic cycles in certain sectors, repeated migratory flows, public insecurity. The presence of migratory flows towards the United States in Mexico is very strong and widespread, also guaranteeing the possibility of developing the territory through international remittances. This could also be a strategy for local development in some shrinking cities, especially in the state of Guanajuato. In the case of Puente de Ixtla (Morelos), the city has not yet managed to recover after the strong 2018 earthquake, so in this case, a natural disaster proves to be another determinant of urban shrinkage.
On the other side, the main determinants of urban shrinking in Mexico should be investigated more, especially in the following areas: structural lack of economic possibilities in marginal territories, migration to the United States, end of the extractive cycles, natural disasters, presence of criminal activities.

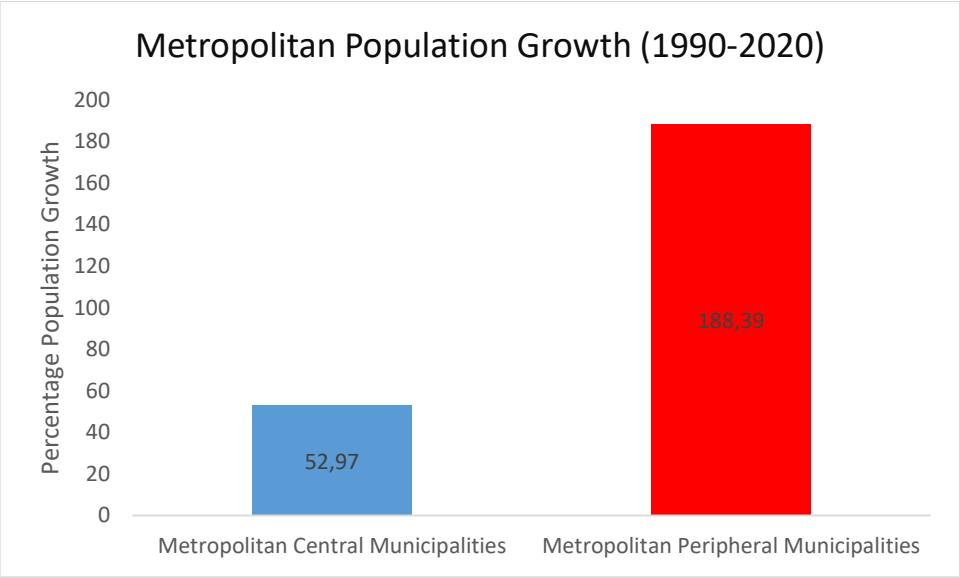
5.4.3 Suburbanization in Mexico

In Mexico, since 1990, the large metropolitan areas decrease their population growth in favour of urban localities located in their area of influence. The rapid and intense urbanization is an integral part of very deep changes in the Mexican territory, which have been taking place, especially in the last three decades. The profound transformation of rural Mexico also stands out, where urban and rural areas come closer and differ less and less within the so-called rur-urbanization or peri-urbanization (Luiselli 2018

Medium or intermediate cities are characterized by being the new urban centres with the highest demographic growth (Alvarez de la Torre 2011). In the case of older metropolises such as Guadalajara, Mexico City, and Monterrey, **suburbanization is particularly evident**, where the historic centres suffer progressively abandonment similar to other Latin-American central metropolises. This is probably due to the less space available, advancement of the service sector to the detriment of residency, real estate speculations and regulations for the preservation of colonial architectural heritage. On the other side, the main determinants of urban shrinking in Mexico should be investigated more specifically, prioritizing the following areas: structural lack of economic possibilities in marginal territories, migration to the United States, end of the extractive cycles, natural disasters, presence of criminal activities.

Figure 18 shows the thirty-years relationship between the population growth trends of the 74 metropolitan municipalities considered central and 282 metropolitan municipalities considered peripheral.

Figure 18: Suburbanization in Mexico, Metropolitan population growth in last 30 years.



Source: Author, Kaiserslautern, 2022.

In addition to Moroleón y Minatitlán, the central metropolitan municipalities that show negative demographic variation in the thirty years are Coyoacán (-4%); Yuriria (-11%) and Guadalajara (-16%). The third most important metropolitan area Monterrey, has a growth of only 6.9% in its central municipality, with only 0,7% in the last decade. This means that the three most important cities in Mexico have in common the progressive abandonment of central areas for residential purposes.

In Guadalajara, Mexico City, and Monterrey, suburbanization is particularly evident, where the historic centres or consolidated municipalities (municipality of San Nicolas de la Garza in Monterrey) suffer progressively abandonment similar to others Latin-American central metropolis. This is probably due to the less space available, advancement of the service sector to the detriment of residency, real estate speculations and regulations for the preservation of colonial architectural heritage. Younger generations should be the main actors in the abandonment of historic centres and displacement should be inversely proportional to the age of the population according to Sousa (2007).

The **most pronounced case** is Guadalajara, whose depopulation can at least in part be explained by the commercialization of the central areas. According to Arroyo (2010), Guadalajara has no more space to grow and has become a commercial area rather than a residential one: people prefer to live in other municipalities, but they work in Guadalajara. The uncontrolled suburbanization of the metropolitan area of Guadalajara has contributed to the reduction of the quality of life of the inhabitants in several aspects, increasing the distances travelled by large sectors of the population, impacting on vehicular traffic, environmental pollution, equipment coverage urban (water, drainage, electricity, communications), public transport and even in public health, by increasing physical

inactivity, obesity, traffic accidents, residential energy use, emergency response, destruction of social networks or social capital (Ewing et al. 2014).

One of the effects with the greatest impact is the change in land use: the invasion of the best productive lands, the transformation of the ecosystems and its consequent environmental deterioration. Orozco and Ávila Ramírez 2013 state that this series of environmental changes on a regional scale is evident in the consumption of resources, with the eminent loss of natural resources as a source of electricity, water and the territory suitable for urbanization. On the other hand, many urbanized square meters have been left empty: forgotten important buildings, underutilized lots, small areas of empty land in the centre of the blocks, disused office buildings; these spaces become urban voids over time. Only in the municipality of Guadalajara, which has an approximate area of 15,037 hectares practically fully urbanized, the Municipal Development Plan of Guadalajara 2000 indicates 4,000 hectares as waste, which would comprise 516 of urban reserves, more than 2,478 vacant lots that have services; that is, 27% of the municipal area. at least 3,106 unused industrial hectares that have basic infrastructure and that are located in the Guadalajara Metropolitan Area or neighbouring municipalities. (Pérez and Mínguez 2014).

For the municipality of Guadalajara, the dynamics of living has been the main factor for the generation of segregation and reinforcing social disparity. In recent years, remote and fractional urbanizations have been sought.

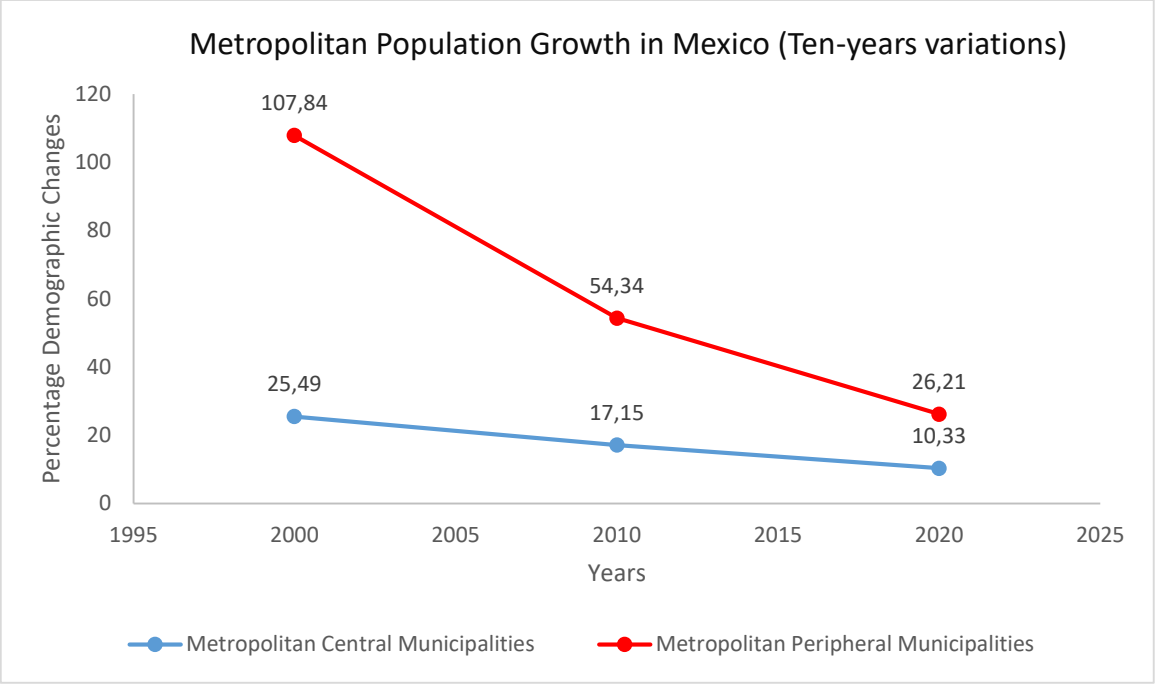
In Morelia, the metropolitan administrative division with only one municipality does not allow to observe the progressive abandonment of the historic centre for residential use described by Ettinger and Mercado (2019).

Similarly, in the case of the historic centre of Puebla depopulation is documented (Ortíz Rodríguez 2005), but cannot be effectively appreciated through the data analysis.

Ciudad Juárez shows processes of abandonment in central areas, a product of the territorial extension and creation of new areas, this is due to dynamics of commercial, industrial and housing movement (Herrera 2014). Data show that abruptly stopped its growth rate: from 53% in the period 1990-2000, to 9% in 2000-2010, caused by possible transformation of central areas.

Figure 19 shows the relationship based on ten years variations between the population growth trends of the 74 metropolitan municipalities considered central and 282 metropolitan municipalities considered peripheral.

Figure 19: Suburbanization in Mexico, Metropolitan population growth trend for decades



Source: Author, Kaiserslautern, 2022.

Demographic variations of the metropolitan municipalities are analysed, detecting an ongoing catch-up trend among the growth rates of the central and peripheral metropolitan municipalities although the latter still grow at more than double rates. Although the achievement will never take place, this indicates an **ongoing stabilization trend of urbanization processes in Mexico** after the boom of the 1990s. This means that the phenomenon of suburbanization, like that of urban shrinking, is present but in a decreasing phase. This is probably caused by a stabilization following the strong suburbanizing push of the 70-90s, given by real estate speculation.

The **Ejido system based on communal land** in Mexico was partly transformed to private ownership due to neoliberal trends since the 1990s (Schumacher et al. 2019) giving more resources to the perpetuation of this culture of ungoverned planning, where the free forces of the real estate market, which is made up of individuals seeking their benefit, do not consider equilibrium in urban development.

Although the results indicate a progressive catching up underway between the decreasing growth of central and peripheral municipalities, the **main challenges for urban planning** in Mexico remain: guaranteeing processes of urban homogenization, reversing the trends of expansive urban growth, neglect and deterioration of central areas and protect peripheral green areas.

A new return to the historic centre of Latin American cities is a likely scenario. The rich urban architectural legacy that characterizes the old central areas in many cases represents a resource to promote tourist activities or in other cases gentrification processes, promoted in some cases by the

so-called North American retired baby boomers (Delgadillo 2008). Different stages of metropolitan nation exist among Mexican metropolises and they should be understood to plan the use of available resources. Mexico faces several problems related to climate change, in particular the lack of water availability. On the other hand, the decreasing fertility of the land due to buckets and excessive use of chemicals can be another aspect that creates new waves of abandonment in rural areas.

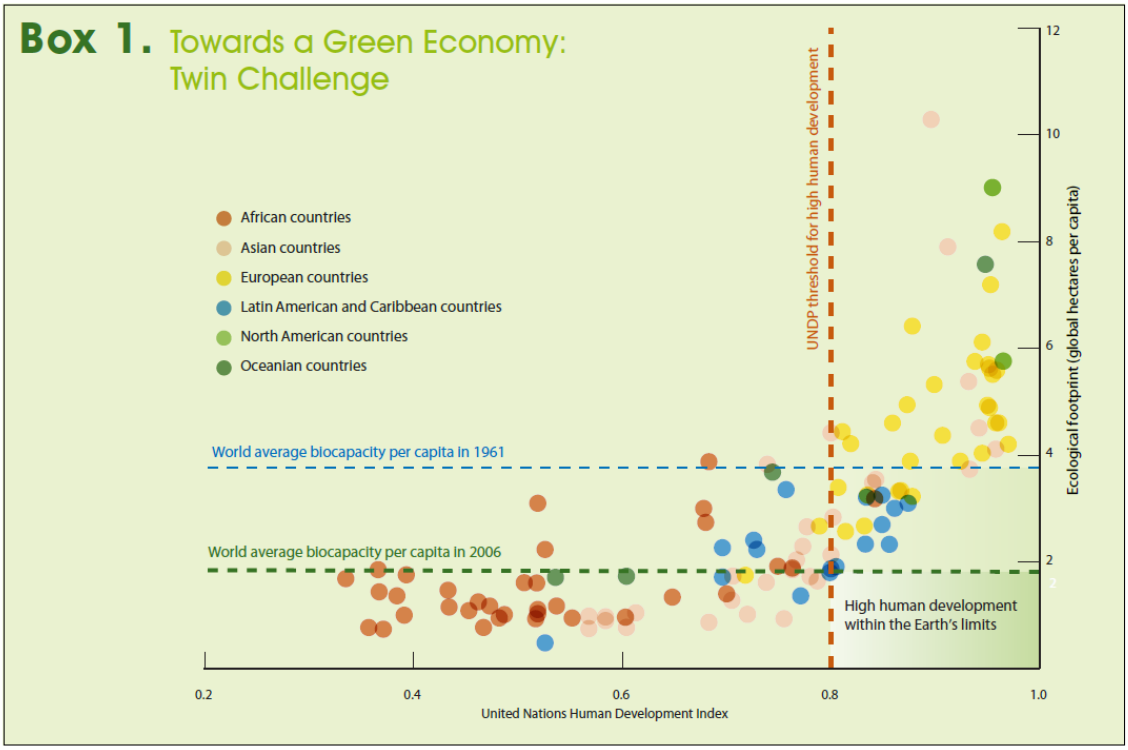
6.1 Green Economy in France and Mexico

Comparing a French case study with one in Mexico requires considering the different green economy contexts in the two countries, including a mention of their trade-offs in reducing contaminant emissions, their economic and energy structure, the innovation activities carried out, and their ability to export green products. In the following chapters we present an overview of the green economy in the international perspective and specifically in France and Mexico.

6.2 International perspectives on Green Economy

The global economy is almost five times the size it was half a century ago (European Commission 2011). Since 1980, global extraction which equals global consumption has been growing by an average of 2.8 % annually (Dittrich et al. 2012). The Gross Domestic Production (GDP) is increasingly questioned as an indicator of economic success if not complemented by consideration of improved well-being and the environmental footprint per capita. As indicated in the graph that relates economic growth to the ecological footprint (UNEP 2011) much still needs to be done to transform the world economic structure towards sustainability.

Figure 20: International Perspective on Green Economy



Source: *The Ecological Wealth of Nations: Earth's Biocapacity as a New Framework for International Cooperation. Global Footprint Network (2010), p. 13; Human Development Index data from Human Development Report 2009 – Overcoming Barriers: Human Mobility and Development.* UNDP (2009).

Source: UNEP, 2011

The advancement of the Green Economy is very **heterogeneous** in the world characterised by great economic and developmental differences. The transition to a green economy will vary considerably between nations, as it depends on the specifics of each country's natural and human capital and its relative level of development UNEP (2011). Countries having attained higher levels of human development often did it at the expense of their natural resource base, the quality of their environment, and high GHG emissions, while other countries still maintain relatively low per capita ecological footprints, but need to deliver improved levels of services and material well-being to their citizens.

On the energy demand side, higher levels of consumption per capita among countries correspond to higher GDP, reflecting and reproducing the disparities in the development processes. While the biggest concern in northern countries is securing resources to ensure thermal comfort, many global southern countries face extreme energy poverty situations, such as a lack of fossil fuel for cooking (Day et al. 2016). Another similar issue is the quality of the fuels used, where this is significantly lower in poor countries causing high pollution rates with harmful effects on health.

Brinkley (2014) detect the nine countries that have so far managed to decouple their economic growth from declining carbon emissions in a steady, consecutively downward trend over four years. The nine countries that showed both increased GDP per capita and decreased CO2 emissions were as follows: Belgium (steady CO2 decrease with GDP increase since 1996), Denmark (1996), France (1979),

Guinea (1982), Hungary (1984, 1996), the Netherlands (1996), Switzerland (1978, 1997), Sweden (1970), and the UK (1979, 1992). However, deindustrialization and commodity trading account for the majority of carbon emission reductions in wealthy nations, thereby distorting the true per capita carbon footprint (Davis and Caldeira 2010; Davis et al. 2011; Hertwich and Peters. 2009;). Considering the **physical aspects** and in terms of environmental impact, rich countries import far more tonnes than they export, implying a net inflow of materials Schutz et al. 2004). In this way, the so-called dematerialisation (the use of a smaller flow of materials and energy per unit of production) of Northern economies is realized, which is caused by a transfer of resource-intensive production from North to South. Considering that contaminating emissions affect the planet as a whole, one of the fundamental steps towards sustainability should be to limit the external demand for materials in northern as well as southern countries.

Contrasts can be found: while for some countries the Green Economy has a strong focus on agricultural development, others take a more high-tech approach, aiming for green industrial development.

In Europe, the **European Green Deal**, introduced in 2019 as an action plan to boost the efficient use of resources by moving to a clean, circular economy and to restore biodiversity and reducing pollution in Europe. A pillar of the European Green Deal is a commitment to be climate neutral by 2050, passing through the EU target for a net domestic reduction in greenhouse gas emissions of at least 55% by 2030, compared to 1990 levels (Kougias et al. 2021). Beyond all this, the effects of the economic crisis linked to the COVID-19 pandemic are still to be understood and the speed up or slowdown of the green transition processes is still uncertain.

Green Economy understanding as a luxury that only wealthy countries can afford is a myth according to the UNEP (2011) since there are a plethora of examples of greening transitions taking place in various sectors in the developing world, which deserve to be emulated and replicated elsewhere.

The concept of **Green Development** adds a strong focus on the third, social, pillar of sustainable development, changing concepts of welfare and wellbeing indicators. The main challenge in developing countries is to reconcile sustainable development with the aim of poverty reduction. Developing countries still need economic growth to combat the poverty that afflicting broad strata of the population and to ensure fulfilment of basic needs, such as access to modern energy supply. The initial investment costs are high, a problem that can be overcome only through massive financial and technological support from industrialized countries. According to Netzer and Althaus, 2012) this would imply the need for institutional and structural settings by design need to prevent “green protectionism” in the form of eco-labelling, eco-taxes and customs, patents and intellectual property regulations and other trade barriers.

6.3 Green Economy in France

The main lines of development of the Green Economy in France are described by Hölscher and Jensterle (2015) indicating the general policy pathways toward low carbon economic development establishing ambitious energy and climate targets covering multiple sectors and timeframes. Mechanisms, green innovation incentives and retrofitting subsidies are established to achieve the **'factor of four'** targets to reduce CO_2 emissions by **75% by 2050** compared to 1990 levels, including a reduction in nuclear energy production which currently accounts for three-quarters of the French energy mix. The French targets are in line with the European Green Deal, introduced in 2019 as an action plan to boost the efficient use of resources by moving to a clean, circular economy and to restore biodiversity and reduce pollution in Europe. Even with sectoral increases in transportation (9%), land-use change (61%), and waste (67%) between 1990 and 2009, France already achieved a total CO_2 emissions decrease (CITEPA, 2012)[14] ranking among the nine countries able to **decouple GDP growth from total CO_2 emissions** (Brinkley 2014). Much of this success is due to the implementation of the **nuclear power program** and to other actions such as consumer energy savings campaigns, that have made it possible that emissions generated by energy conversion from the electricity production subsector declined by 25.7% between 1960 and 2009. Historically, **nuclear energy** has been a source of controversy and division in Europe. In 2022, the European Union officially included the atom in the green taxonomy[15], despite opposition from several countries, including Austria and Germany. In this way, nuclear power is increasingly taking on the status of renewable energy, and can benefit from green funding.

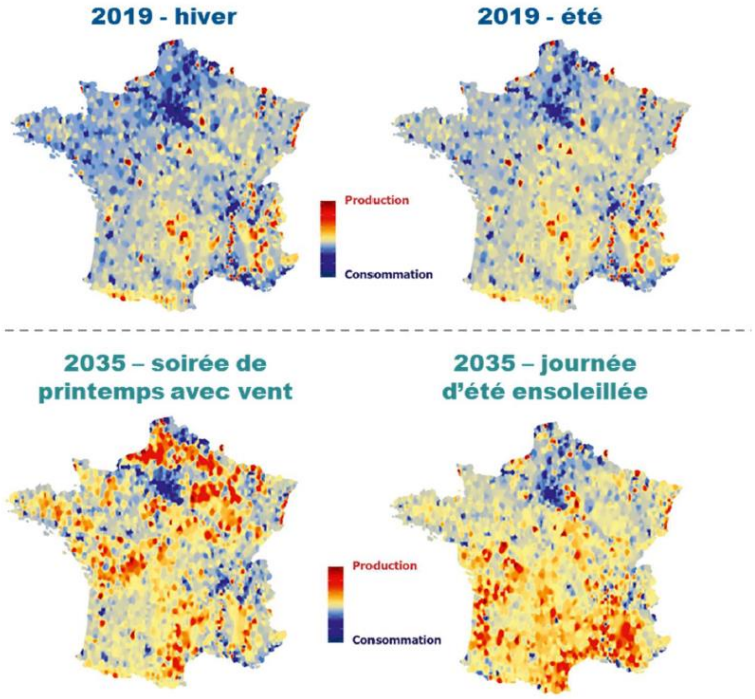
According to the projections made by the French Transmission System Operator RTE, energy decentralisation is expected to increase massively in France until 2035 (see figure 21).

[14] https://www.citepa.org/fr/

[15] https://www.leparisien.fr/economie/le-nucleaire-classe-energie-durable-pourquoi-la-filiere-francaise-peut-souffler-02-02-2022-SST2SYRLO5ASXMO7D35BYCJ33Q.php

Figure 21. Change in geographical distribution of electricity generation/ consumption

Figure 74: Change in the geographical distribution of electricity generation/consumption (source: RTE)



Source: Réseau de Transport d'Electricité (RTE)

In France, circular economy and eco-innovation have continued their development in the areas of industrial symbiosis, and social and solidarity economy (European Commission Eco-innovation index 2019)[16]. The role of French small and medium-sized enterprises in taking resource efficiency measures is more relevant than other countries, but only a few are developing a distinctly green profile and generating more than half their turnover from green products and services. France ranks among the top eight countries in the world for the **ability to export complex green products** according to the green complexity index ranking designed by Mealy and Teytelboym (2020).

Despite all the achievements, the decentralisation of energy production based on renewable sources envisaged by the **Multiannual Energy Plan**, as well as the creation of programs such as **Positive Energy Territories for Green Growth** contributes to add ambiguity in French policy localism according to Nadai et al. (2015), stimulating resistance and emerging conflicts around green infrastructure according to Dunlap (2020).

[16] https://ec.europa.eu/environment/ecoap/indicators/index_en

6.4 Green Economy in Mexico

Mexico is one of the largest and most diverse Latin American economies with high potential in renewable energy, but its economic structure has traditionally relied on a brown economy, strongly associated with the exploitation of fossil fuels.

Pérez Hernandez et al. (2021) recognise that the **dominant paradigm** in Mexico is strongly associated with the **brown economy** and that a paradigm shift to the green economy is necessary for gradual, but constant and exponential changes to repair the environmental damage caused by overexploitation of national resources perpetrated in recent decades. Between 2003 and 2014 the total costs of natural resource depletion or degradation in Mexico increased by 40%[17] (SEMARNAT, 2015).

Transitions to the green economy in Mexico face several **socio-economic structural barriers**: the lack of specialized knowledge in advanced technologies provoke a situation of neocolonialism or green grabbing in depending high tech sectors; the need to stimulate accelerated economic growth for the moment relegates sustainability issues to a subordinate position; the lack of socio-economic equality does not allow a fair distribution of benefits and externalities preventing to approach sustainability threshold in a space-time dimension.

Historically, some efforts have been made to introduce **green policies**: major initiatives can be traced back to the Public Electricity Service Law (1975) implemented to provide electricity more efficiently and incorporate the electricity from renewable energy (Grunewald and Martínez 2014); the first Pro Aire project (1990) launched to find a way to reduce traffic and therewith pollution; the National Biodiversity Strategy (2000); the National Program of Payments for Ecosystem Services (2003); the National Ecological Land Use Plan (2012), and the Sector Program for Environment and Natural Resources (2013). In 2016, the Mexican Congress ratified the commitment to reduce greenhouse gas emissions by 50% compared to the emissions of the year 2000, into the year 2050, as described in the INDC of Mexico (Mexico - Government of the Republic, 2015) and presented to COP21. Goals include a commitment to unconditionally reduce GHG emissions by 22% by 2030, a conditional reduction of 36% also by 2030, and a maximum of 320 MtCO2eq by 2050. According to Sarmiento et al. (2019), these targets are very weak and do not deviate much from the projections of scenarios without climate policies, while the optimal share of renewables for the generation of electricity should be 80%, that is, 30% higher than current commitments in the national strategy for the promotion of clean fuels and technologies. The 2014 **Mexican energy reform** reintroduces the participation of multinational private companies in the exploration phase of new fossil resources in the country, to

[17] https://apps1.semarnat.gob.mx:8443/dgeia/informe15/tema/pdf/Cap1_Poblacion.pdf

gradually offset the balance of fuel imports Aguilera Gómez et al. (2016). One of the most critical aspects of the Mexican green economy is the traditional subsidies that Mexico applies to fossil fuels, which encourages people to buy and use cars (Grunewald and Martinez 2014). Despite the institutional rhetoric[18], Mexico's so-called '4T' or **fourth political transformation** is showing clear limits in aspects of environmental sustainability. The latest government administration (2019-2025) seems to want to continue in this vein with various actions: including the enter in functions of the country's largest refinery "de Dos Bocas" in the state of Tabasco with a 340,000 barrels per day refining capacity[19]; in parallel with the decrease in the budget allocated to environmental protection institutions amid the environmental crisis in Mexico[20].

The General Law on Climate Change from 2012 allows producers of renewable energy sources to access the grid and feed in renewable energy, this regulatory framework is then reinforced by the Mexican energy transition law (2015) set the target of 50% renewable energy production by 2050. These measures, on the one hand, have favoured large foreign companies and, on the other, have created vulnerabilities in the national electricity system, as a result of which the Federal Energy Commission has had to stop the procurement of renewable energy in 2021 due to overproduction[21]

Similar to other developing countries, Mexico's energy transition has been referred to as part of **neo-colonial green grabbing** practices or as a trojan horse of capitalism, in particular in the region of the Isthmus of Tehuantepec (Siamanta and Dunlap 2019). Currently, the share of renewable energy in the Mexican energy supply is around 9.5 per cent (Grunewald 2015) that is considerably low given the natural potential that the country has to generate electricity from renewable sources. Doubling of energy consumption in Mexico is projected by 2050 (IRENA 2015), National Energy Secretariat (SENER 2016) estimates an annual increase in consumption of 3.4% until 2030, of which the majority renewable, but also almost 40% of conventional technologies so that although there will be greater investments in renewable energy, there will be augmented energy production from fossil fuels.

Mexico ranks among the top twenty countries in the world for the ability to export complex green products according to the green complexity index ranking designed by Mealy and Teytelboym (2020). Considering the creation of more complex green products with high revealed comparative advantage, the analysis of the **green complexity index** carried out by Pérez Hernandez et al. (2021) reveals the

[18] https://www.gob.mx/semarnat/articulos/la-politica-ambiental-de-la-cuarta-transformacion?idiom=es

[19] https://actualidad.rt.com/actualidad/390136-mexico-acabar-exportar-petroleo-crudo-importar-gasolina

[20] https://es.mongabay.com/2021/01/deudas-ambientales-mexico-2020-balance-ambiental-pandemia/?fbclid=IwAR2vbQ7cZwu2pIbvdYgmlq1P1YD8Ba6QPCK_OPqdHutBxmbJlmcL70GT5_U

[21] https://www.forbes.com.mx/negocios-mexico-bloqueara-energia-renovable-empresas-privadas/?utm_source=nora-push&utm_medium=push-notifications&utm_campaign=new-nora-push

great differences between the north and south of Mexico, with the production and commercial space being located more in the north.

According to the International Labour Organization (ILO 2013), about **4.5% of the workforce** in 2011 was employed in the green economy in Mexico considering nine sectors: sustainable agriculture, sustainable forestry activities, renewable electric energy, clean industry, sustainable construction, waste management, sustainable tourism, public mass transport, federal government activities. In addition to investing in the exploitation of its energy potential, Mexico should strengthen its research and development sectors to achieve comparative advantages in the green economy.

The strong inequality existing in the structure of Mexican society and the territorial imbalances require that the **innovation paradigm** be expanded (Burgos and Bocco 2020), including traditional and local knowledge as a collective body of knowledge, innovations, and practices of indigenous peoples and local community's (Davies and Ebbe 1995).

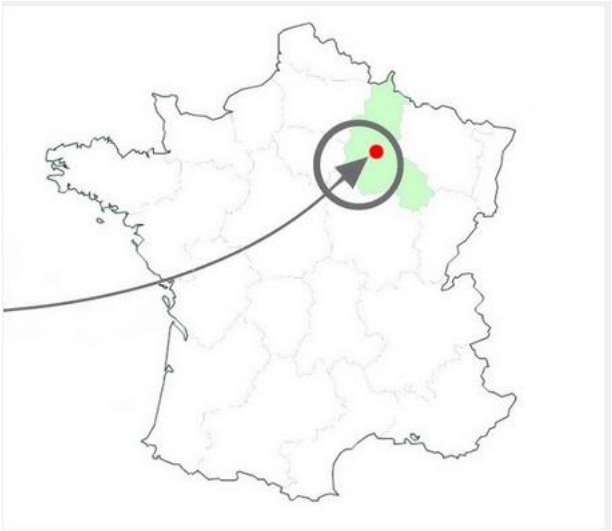
Part IV │ Empirical study: case studies analysis

7.1 Case 1. Vitry-le-François

The case of Vitry-le-François was selected as an example of a small/medium size central European city characterized by post-industrial transformations undertaking energy and ecological transition projects through the use of public funding schemes, strategically allocated to boost the French energy decentralisation process, in accordance with major national objectives.

Vitry-le-François is a French shrinking city situated in the Marne department, located within the Gran Est region. The territory is crisscrossed by rivers and canals, and Vitry is located at the centre of three canals linking the Marne, Rhine and Saone rivers.

Figure 22: Location of Vitry-le-François

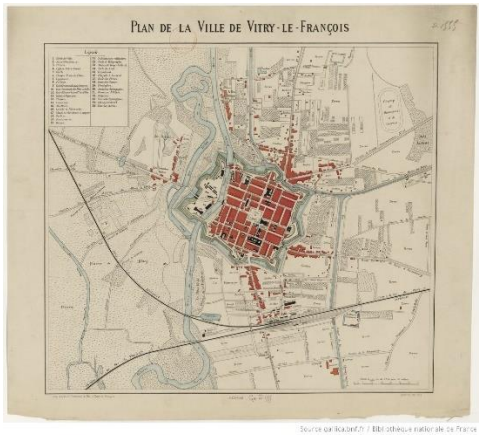


Source: ADEVA, Vitry le François

Vitry's economic structure can be considered to be in **post-Fordist transition**: the collapse of the main industrial sectors presents in the area, such as plastic, metallurgy, cement and food processing, and the subsequent decline in the demand for workers has led to progressive continuous depopulation since the 1970s and has characterised this locality by one of the lowest average wages in France. The local political transition towards a left-liberal party that has been underway since 2008 is trying to guide Vitry's economic transition towards environmental sustainability by implementing various initiatives with the support of regional and national institutions and external actors.

7.1.2 History of Vitry-le-François

Vitry was created in 1545 at the behest of King François I (Boitel 1841). The city was planned by the Italian military architect Girolamo Marini and built according to a square geometric chessboard plan.



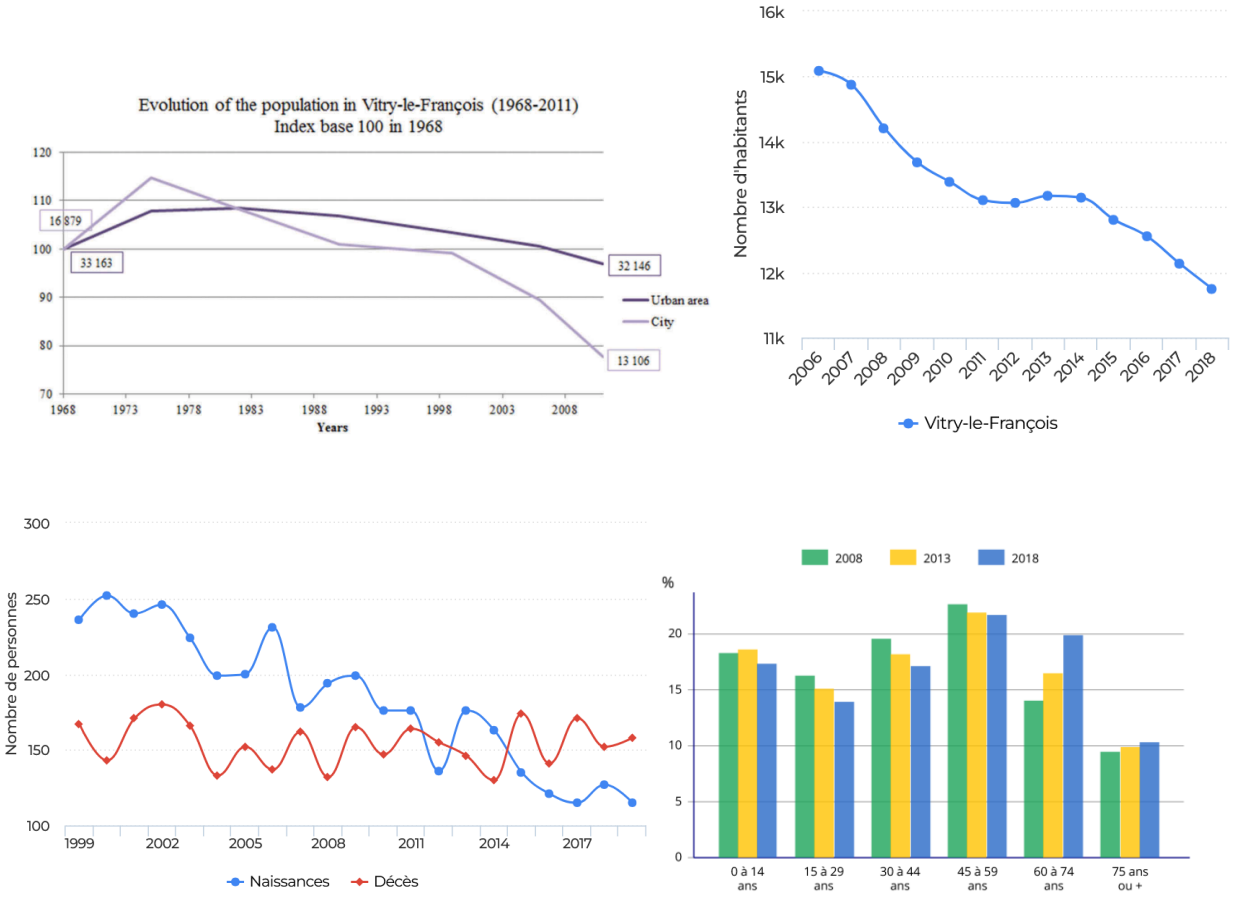
Figures 23: City Plan Vitry-le-François
Source: gallica/bnf/fr Biblioteque Nationale de France

Figures 24: Aerial view Vitry-le-François
Source: Archives Municipales de Vitry le François

The protestant persecutions and the revocation of the edict of Nantes in 1685 provoked the exile of about 2,000 inhabitants out of the 8,000 that the town had and did not find that number of inhabitants until 1950.
During the First World War, it was occupied by the Germans and served as a hospital town (Nottin 1917). During the Second World War Vitry was bombed and destroyed, to be then rebuilt according to the original geometric plan.

7.1.3 Demography in Vitry-le-François

Vitry-le-François is a town of around **11,808 residents** situated in the Grand Est region. In this formerly industrial area, demographic shrinkage above all concerns the core town of Vitry-le-François, where the **population fell by 32%** between 1975 and 2014 (Béal et al. 2019). This process is linked to the strong migration originating from the deindustrialisation typical of the post-Fordist transition and only partially offset by the creation of new jobs in the third sector.



Clockwise from top left: Fig. 25, 26: Evolution of population in Vitry-le-François. Fig. 27: births and deaths overtake. Fig. 28: population by age. Source: INSEE

Currently, Vitry-le-François has 11,808 residents (INSEE 2020)[22], 30% less than in 1968. The population is ageing in the community as a whole, the ageing index is 18% higher than in the Marne region average (DDT Urbanism Service). Furthermore, there is a downward trend in the average number of families and cohabitations.

7.1.4 Economic and Spatial urban structure in Vitry-le-François

The economic and social structure has historically been based on **industrial sectors** such as wood, construction, agri-food, plastics and metalworking (Miot and Rousseau 2019), in particular, a large part of the local economy revolves around the sectors of cement, malt production, meat processing. According to interviews carried out with representatives of a local trade union, while the **COVID-19**

[22] https://www.insee.fr/fr/statistiques/2011101?geo=COM-51649

pandemic has exacerbated the situation of job losses in local industries in 2020, the metallurgy and plastics sectors are experiencing greater job losses due to the general decline in the automotive industry.

Between 1982 and 2012, the total number of jobs decreased by 9% while the number of industrial jobs has fallen by 50%, producing a situation where 21% of economically active individuals are **unemployed**, and 27.5% of residents live below the national poverty line (Béal et al. 2019). Currently, the **average salary** in Vitry-le-François is 22% lower than the national average (INSEE 2019).

Historically, the city has developed spatially by the **differentiation of economic activities**, with suburban residential neighbourhoods located between the urban centre and industrial and manufacturing zones such as the Haute-Voie Economic Zone, the Artisanal Zone of Bois Legras, the Artisanal Zone de Frignicourt, visible as purple areas in the figure.

Within the spatial division of economic activities large and medium **groups and companies** are set up: *Malteurop France* is dedicated to the production of malt from spring and winter barley is one of the largest plants in terms of production capacity in Europe. The company is one of the world leaders in the malt market, ECOVADIS Sustainability rating. Other important groups are present in the secondary sector: *Hidelberg Cement AG* (Cement production); *Nobel Plastiques* and *Tricoflex*, (Plastic industry); *Salzgitter Mannesmann*, (Metal work); *Groupe Bigard*, (Meat processing industry); *Elivia* (Meat processing industry with sustainability); *JST France*, (electronic components manufacturer).

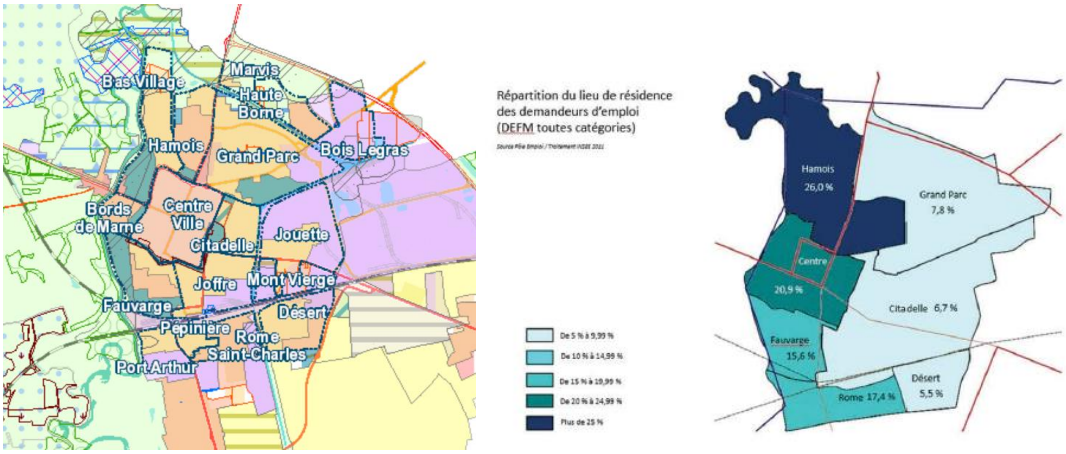


Figure 29: Neighborhoods of Vitry-le-François, source: SIG CCVCD**. Fig. 30: Unemployment rate by neighbourhoods**. Source: Béal et al. 2019 based on INSEE

Socio-spatial segregation reflects the economic disparities with the working classes in industry concentrated in social housing in the Hamois neighbourhoods where 26% of the unemployed are concentrated (see Figure 29).

7.1.5 Institutions and stakeholders in Vitry-le-François

In institutional terms, the territory is structured on two levels: an **inter-municipal authority** the "Vitry, Champagne of communes Vitry, Champagne et Der" (CCVCD), with 25,000 inhabitants. The three communities of communes are in a competitive situation, however almost all services are shared due to the importance of the central town.

The main local stakeholders are the **municipal government**, the single **social landlord** owning most of the housing stock, the private sectors of traditional enterprises and the new ones recently formed in the green transition process.

Traditionally run by right-wing liberal administrations, since 2008 the administration has been led by left-wing political currents which are playing an important role in transition projects and the gradual change from Fordist approaches to urban management (Demazière and Daviot 2011; Édouard 2014). Although still dominated by a top-down approach in which the participation of civil society is still marginal, the energy transition in Vitry is contributing to important political changes by shifting the focus away from traditional local industries and creating new local dynamics aimed at endogenous redevelopment while also pursuing environmental and social objectives. In this sense it remains to be analysed whether the developments will create "alternative" endogenous development model rather than a simple update of classic entrepreneurial policies (Miot and Rousseau 2019).

Historically, the **spatial segregation** of the working classes in the suburbs, especially in the Hamois

suburb, has favoured the emergence of social housing owned by a social landlord called "Vitry Habitat" who owns 54% of the housing stock. This group was taken over by LE FOYER-REMOIS in 2021.

New stakeholders participating in the energy transition are energy and farming cooperatives, small and medium-sized enterprises, specialised NGOs and engineering offices, all working for the energy transition approaching energy issues with political, strategic and systemic commitment aimed at local development (Nadaï et al. 2015). External stakeholders for the contribution in planning and technical support in the energy transition project have been *Electricité de France* EDF and *Agence de Trasition Ecologique* ADEME.

7.1.6 Decentralised Energy System of Vitry-le-François

Already part of the national network “Positive Energy Territories” (Territoires á Energie Positive, TEPOS) managed by Comité de Liason Énergies Renouvelables (CLER) gathering together French territories heading towards energy autonomy, Vitry-le-François was among the beneficiaries of the national funding programme called "**Positive Energy Territories for Green Growth**" (Territoires à Ènergie Positive pour la Croissance Verte, TEPCV). Surfing the ongoing political structuration of TEPOS, the French government awarded 550 territories between 2015 and 2017 and each received between €500,000 and €2 million in aid (Nadaï et al. 2015). A TEPCV was defined as ‘achieving a balance between consumption and production of energy at the local level [and promoting] energy efficiency and targeting the deployment of renewable energies in its energy supply’ (FR, 2014b: 1). This initiative was seeking to transform the context of French energy policy, historically centralised and dominated by electron-nuclear technology. Figure 31 shows the conceptual model of a positive energy territory indicating all the sectors potentially involved in the transition.

Figure 31: TEPCV conceptual model

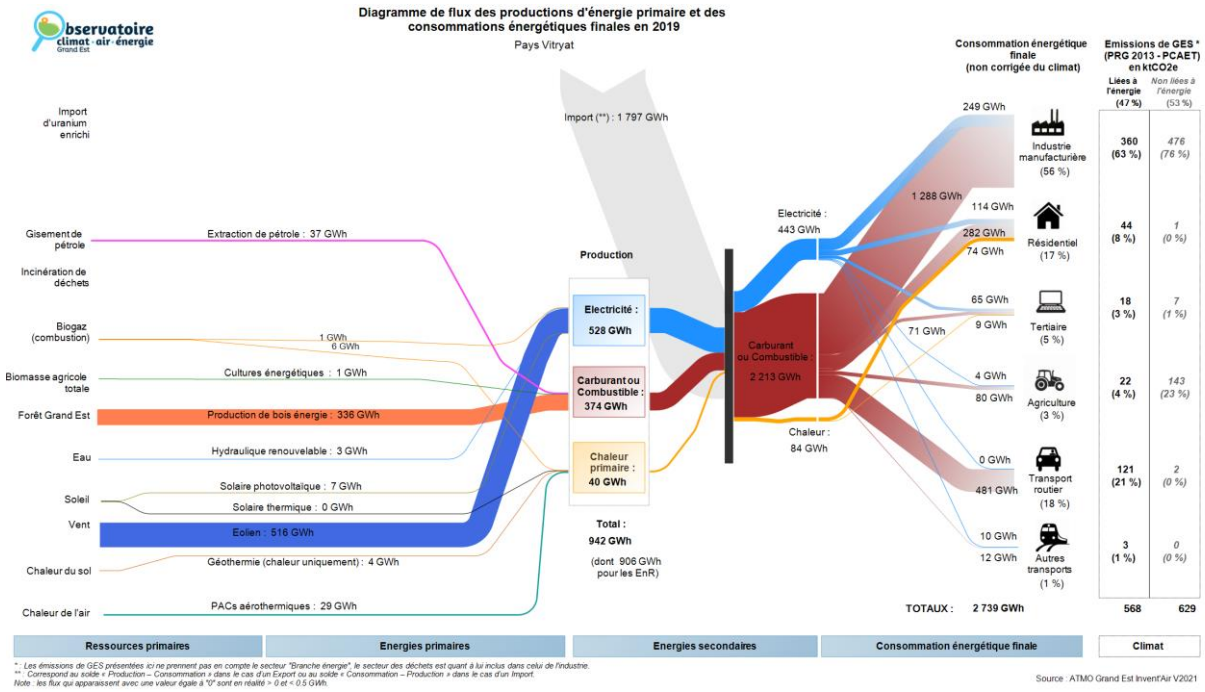
Source: ADEME

The energy and ecological transition programme in Vitry were designed through the technical support of *Electricité De France* (EDF) and *Agence de la Transition Ecologique* (ADEME): with the view of a decentralised energy system, a series of **33 projects** were established, including heating network, urban development, innovative projects and mobility, new energy sources, energy management and renovation of buildings. The objective was to use the territory of Vitry as an **experimental laboratory** for future large-scale changes with a view to sustainable development (Miot and Rousseau, 2019).

According to data elaborated by ATMO Grand Est, in 2016, the territory produced 255 GWh of energy from renewable energies, i.e. **13% of the energy consumed** (20% for the region and 16% for France). However, as most final energy consumption is captured by the manufacturing industry, the production of renewable energies per inhabitant is higher in the territory: 10 MWh/inhabitant in Vitry, while in the region is 7 MWh/inhabitant. Within this production, 82% of the energy produced locally is in the form of electricity and 18% in the form of heat: 202,4GWh come from wind energy, 30,8

GWh from biomass heat, 10,7GWh from aerothermal heat pumps and 4,1GWh from photovoltaic production.

Figure 32. Primary energy in Vitry-le-François



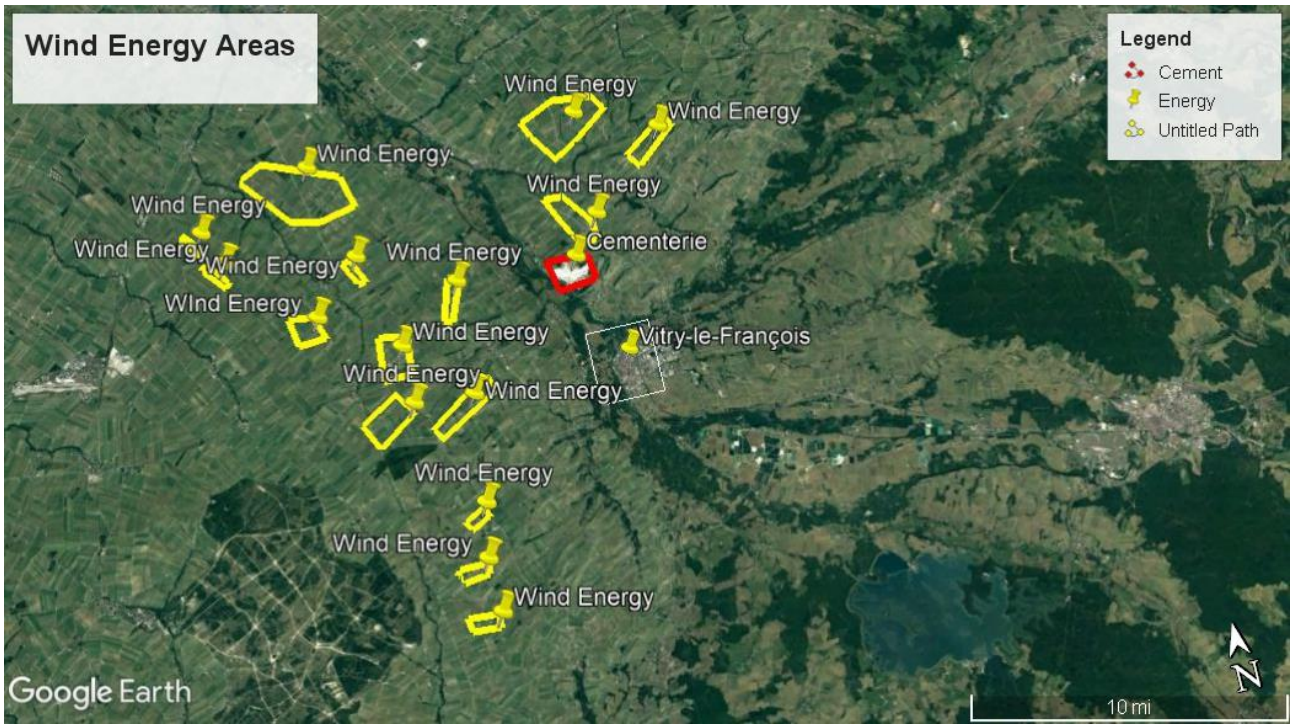
Source: ATMO Grand Est Invent`Air V2021

Inside decentralised energy system projects, efforts were initially concentrated on the construction of **wind farms** and the adaptation of the **biomass heating system** initial owned by the social landlord but managed by a semi-public company since 2016.

According to interviews with local authorities[23], wind energy production is set to increase by at least 25% with new ongoing concessions to power companies. The benefits for the Vitry area are mainly due to the income generated through taxes on the inter-municipal electricity network, obtained via the ERDF (French manager of the electricity distribution network), while the job creation in the wind sector is limited and concentrated on the installation phase of wind farms and the associated maintenance services, which lead to the creation of small local enterprises. The figure shows the areas in which wind power installations are concentrated, benefiting from south westerly currents as shown by the wind rose in the figure.

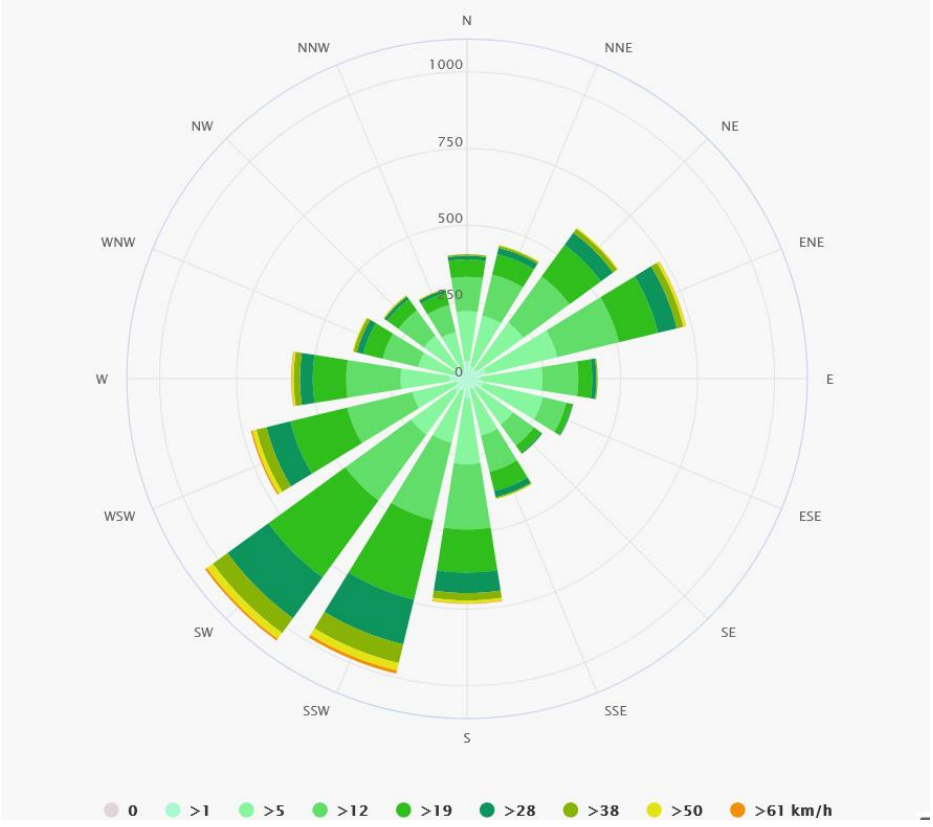
[23] **Interview with the mayor of Vitry-le-François and office in charge of ecological transition**

Figure 33: Location of the main wind farms on the outskirts of Vitry.



Author, Kaiserslautern, 2022.

Figure 34: Wind Rose Vitry le Francois



Source: Meteoblue

The **Biomass Energy System** of Vitry was created in 1985 when the social local landlord Vitry-Habitat replaced 18 collective oil-fired heating systems with a central wood-fired heating system.
The Vitry-le-François heating network consists of a 15.6 MW biomass heating plant, 3 oil-fired heating plants of 4,5 and 8 MW; 18 km of the network; 43 stations, which make it possible to save 15,000 tonnes of CO_2 each year (Ville de Vitry le François).
In 2014, the supply of wood to the central heating plant was around 25,000 tonnes per year, of which 50% is bark, 20% is forestry chips and 30% is offcuts from woodworking companies, with 55% of the tonnage supplied within a radius of less than 100 km, with the remainder coming from the area between 100 and 200 km. Being the cost of biomass heating is 36.81% lower than the cost of oil heating, and 11.96% lower than the cost of natural gas heating, position the heating plant of Vitry among the lowest in France (Douard 2014).

Picture 15: Wood-fired heating plant
Vitry le François.
Source: Frédéric Douard

Picture 16: Wood storage area.
Source: Author, Vitry le François, 2021.

In 2016, the public-private mixed economy company S.E.M. Vitry Energies took over the management and launched a call in 2017 for a concession for the renovation, modernisation, extension and operation of the heating network that is now ongoing. While the biomass heat system has so far covered social housing and municipal buildings, its extension should bring its capacity to cover the heat needs of about 8,000 of the city's inhabitants.
Following the award of the public service delegation concession in April 2018, Dalkia, a subsidiary of EDF, (through its company Vy'Energie) has undertaken major work to modernise, develop and make reliable the infrastructures of the heating network of S.E.M. Vitry Energies. A new biomass boiler room was built to replace the old central wood-fired boiler room, the first installation of its kind in France. Equipped with an 8.5 MW biomass boiler, manufactured in the Puy-de-Dôme region, it has been supplying the 4,300 housing equivalents of the S.E.M. Vitry Energies heating network

since 6 October 2020. Thanks to the new biomass heating plant, the network is supplied with over 70% renewable energy (wood energy). The rest of the heat production is provided by the Fauvarge and Désert heating plants, which have been completely renovated and modernised. With the realisation of this large-scale project, 7,310 tonnes of CO2 will be avoided each year the price of energy becomes more competitive and allows users to benefit from a reduced VAT rate of 5.5%[24].
The objective is to better respond to current ecological and economic issues while providing a relevant solution adapted to the needs of users.

7.1.7 Urban Renewal in Vitry-le-François

The ongoing **demolition to rebuild** strategy operated since the early 2000s is an important first step towards tackling the economic and demographic crisis by improving the urban built environment in Vitry le François.
The crisis of the single social landlord due to the increasing vacancy rate of its housing stock led in 2002 to the start of an urban renewal project to improve the structure of the built environment considering the improvement of energy efficiency standards. In agreement with ANRU (the French National Agency for Urban Renewal), a process of demolition with the reconstruction of only two-thirds of the buildings was planned, leading to a **planned shrinkage** process in Vitry le François. The planned demolition of 844 out of 1,350 dwellings in one neighbourhood refocusing construction on the core town of Vitry. The renovation of the urban infrastructure with the demolition of very energy inefficient towers for the construction of dedensified buildings is carried out in collaboration with the social local landlord and partly by trying to reuse the materials of the destroyed buildings.
Up to 2012, the social housing vacancy rate continues to rise to 35% forcing the institution to seek the assistance of the Social Rental Housing Guarantee Fund (Caisse de Garantie du Logement Locatif Social, or CGLLS) in 2012, to avoid bankruptcy (Miot and Rousseau 2019). Encountering difficulties that no longer allowed it to fully assume its mission as a social landlord, in 2021 Vitry Habitat is forced to merge with Le Foyer Rémois group Global Habitat.

[24] **https://www.dalkia.fr/inauguration-de-la-nouvelle-chaufferie-biomasse-a-vitry-le-francois-un-systeme-de-chauffage-urbain/**

Picture 17: Demolitions in Le Hamois neighbourhood.
Source: Elodie Vergelati.

Picture 18: Remaining buildings in Le Hamois.
Source: Author, Vitry le François, 2022.

The urban regeneration programme has been partially financed through the Sustainable Cities of Solidarity (Ville Durable et Solidaire) component of the government's Future Investments Programme (Programme Investissement d'Avenir) (Miot and Rousseau 2019).

Listed in 2014 as part of the NPNRU (New National Renewal Program), the district has already undergone a first phase of works including the demolition of 241 dwellings in 2017, and the creation of the "Lieutenant Pichard barracks" for the national gendarmerie. Since 2020, a second phase is underway. It consists of the demolition of seven buildings, i.e. 391 dwellings, including three of the largest towers in Vitry-le-François. Various types of work will be carried out as part of this second phase: precursor removal, asbestos removal, cleaning, demolition of the superstructure and demolition of the infrastructure. The objective pursued by the urban renewal of the Le Hamois district is to obtain the Label EcoQuartier (Eco-Neighbourhood) issued by the Ministry of Ecological Transition[25].

The urban redevelopment aims at creating lower residential buildings, following the model of the new area built very close to the municipal building called DOMITYS la Salamandre, equipped with a media library, green spaces and intended to be a place for retirement, tourism or residence.

[25] http://www.ecoquartiers.logement.gouv.fr/le-label/

Pictures 19, 20, 21: DOMITYS La Salamandre neighbourhood.

Source: Author, Vitry le François, 2021

The question of **how to use the land** freed up by these demolitions remains unresolved. According to the interviews conducted, the main problem is related to the timing of urban renewal. If do not proceed quickly; the risk is of increasing the problem of vacant spaces and underused infrastructures already evident in the city.

Pictures 22, 23, 24: Disused infrastructures and vacant spaces in Vitry le François.

Source: Author, Vitry le François, 2021

However, it is worth noting the commitment to the redevelopment of some old industrial buildings that are being **converted** for new activities in the service sectors, such as the La Fabrique business centre, where municipal offices, as well as environmental businesses, are now located (see pictures 25 to 27).

Pictures 25, 26, 27: Converted buildings, Business Centre "La Fabrique" in Vitry le François.

Source: Author, Vitry le François, 2021

7.1.8 Management of ecosystem services and agroecology, Vitry-le-François

The management of the ecosystem services of Vitry le François is managed through special community service by the public authorities through the support of external landscapers' designers. The service is inspired by a **principle of differentiated management** plan according to three types of zones: zero, medium, strong acceptance of spontaneous vegetation.

Pictures 28, 29, 30, 31: Differentiated management of green areas in Vitry le François.

Source: Author, Vitry le François, 2021.

This approach is optimal for a shrinking city: the creation of spontaneous vegetation spaces has the potential to optimize ecosystem services by boosting biodiversity and reducing maintenance costs in contexts of diminishing resources and personnel availability. In other words, the lack of staff and material difficulties do not allow for optimal management with obsolete conventional methods.

In Vitry-le-François, pilot sites such as the European alleys are intended to become showcases of the change in the practices of the community, where different reorganisation of the maintenance methods can be carried out in a first stage, before extending the reflection and practices to the whole territory. The objective is the development of an urban forest and pedagogical yards or for the safeguarding of old vineyards by adopting permaculture techniques such as: avoid obstacles in the mown areas, do not rake the foliage, avoiding architectural pruning, letting the mineral surfaces heal gradually, cuts should be less than 7cm. mown paths – a decorative spiral or a play labyrinth.

In the **agri-food sector**, there are large enterprises around livestock breeding, rapeseed, sunflower and rape production, part of whose waste is used to feed the biomass production plant. On the other hand, the presence of small producers is limited, although it is possible to find initiatives such as community greenhouses and 24h sales services for organic products.

Pictures 32, 33: Community greenhouses and automated sales machines for organic products.

Source: Author, Vitry le François, 2021

Blue Infrastructure in Vitry is managed by the *Veolia* group; given the presence of several companies with contaminated waterways, the city is furnished with a water treatment plant, which means that the local water is considered to be of average quality.

7.1.9 Green transportation, Vitry-le-François

Green transport in Vitry is based on **three areas**: the revitalisation of river transport activities, the extension and promotion of cycling and the creation of a cluster around the production of green hydrogen for mobility, the most significant and ambitious project.
At the junction of three canals, Vitry-le-François still has a **shipyard and a marina** which is the second-largest destination on the Marne. Each year, it welcomes more than 300 boats and 700 yachtsmen of all nationalities.

Pictures 34, 35: Channels navigation; bike route and green hydrogen pilot unit production.
Source: Author, Vitry le François, 2021

A **green belt and a bike route** link Vitry to the Lac de Der, a place where migratory birds pass through, among them the grey cranes. Although there is no precise data on capacity, the number of cycle paths has been increased in Vitry le François and the surrounding area, and several landscaped cycling routes have been created to promote their use among the population.

The main project launched in Vitry-le-François to revolutionise the transport sector, capable of supporting an innovative green industrial supply chain with the potential for starting up a cluster of new businesses, is the production of **green hydrogen**. Haffner Energy is the company based in Vitry-Le-François to install a hydrogen production unit from biomass on its territory and thus supply a fleet of vehicles. The company earns four million EUR annually with its staff of nearly 30 employees. The company is finalizing its product for market launch having already two pilot stations, the one in

Strasbourg with a capacity production of 650 kg a day, which can fuel 1,100 cars daily for a distance of 15,000 km with the other in Vitry-Le-François, with a smaller capacity of 112 kg a day for 260 vehicles. The idea is to connect the biomass production plant with the hydrogen chain to produce 'green' hydrogen through the so-called thermolysis process to exploit the competitive prices of local heat production and keep hydrogen production costs down, making them more competitive than the conventional hydrogen production process from water hydrolysis. The full production cost for mobility will eventually be €3/kg, equivalent to that of tax-free fossil fuels (TIPP and VAT) while at present, the production cost of other technologies, particularly water electrolysis, is around €10/kg at the pump[26].

Picture 36: Haffner Energy Headquarters in Vitry le François.
Source: Author, Vitry le François, 2021

Picture 37: Hydrogen production Pilot unit.
Source: Haffner Energy.

In the case of Vitry, there is a lot of expectation for the development of a hydrogen production chain, since the technologies involved are very sophisticated and the potential is to create new industrial clusters around this sector. However, the question of how to improve efficiency levels in the storage phase remains open, as hydrogen is a very volatile gas that tends to disperse into the environment very easily. Since only prototypes have been tested and the production phase has not yet started, it is too early to evaluate the results and the possible impact of this development strategy on the territory will be evaluated later.

[26] http://hydrogenium.eu/2018/09/15/la-thermolyse-une-nouvelle-forme-de-decentralisee-dhydrogene/

7.2 Case 2. Mineral de Pozos

Mexico has a long history of extensive mining since the mid-sixteenth century when the prolific seams of gold and silver in many parts of the country were easily exploited, resulting in prosperous communities and thriving towns. The decline of the mining industries from the mid-nineteenth century, however, meant that many of these same communities have become ghost towns, though many remain important historic sites.

Vargas Hernandéz (2009) identifies **post-mining abandonment** as one of the main determinants of shrinkage in small urban centres in Mexico whose economy fluctuates in tandem with mining levels. In some localities the mining production has fluctuated but is still present thanks to the arrival of new foreign companies, mainly Canadian, who are revitalising the mining streams with new and more sophisticated technologies; this is the case for example of such as Cerro San Pedro in San Luis Potosi (Stoltenborg and Boelens 2018, Vargas Hernández 2009) or Chalchihuites in the state of Zacatecas (Fenoglio 2011).

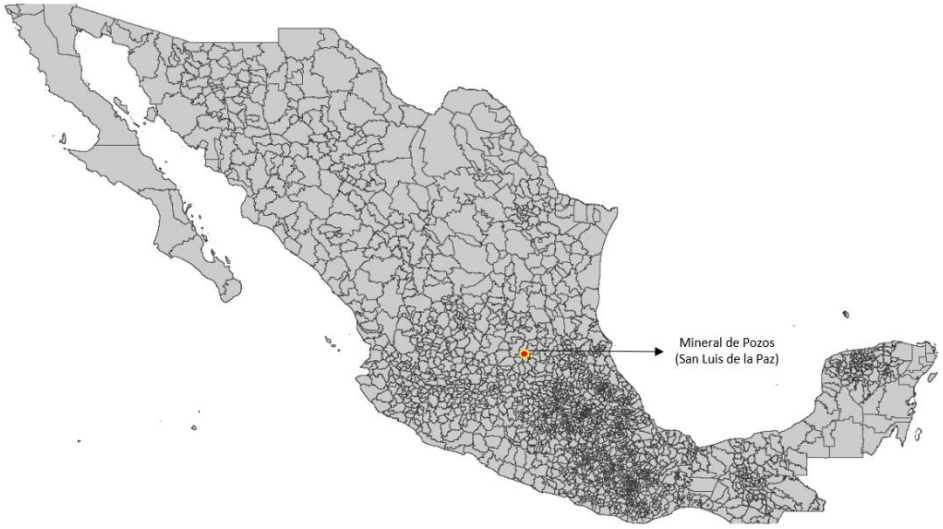
Other post-mining towns in Mexico, have gone through decades of neglect, and have only recently managed to revitalize their local economy by transforming the old mining infrastructures into a tourist attraction redeeming the urban architectural heritage. These are the cases of the town of Real de Catorce in the state of San Luis Potosi (Álvarez 2019) and Mineral de Pozos in the state of Guanajuato, also benefiting from the inclusion in the national program "Pueblos Magicos de Mexico". Among these cases, Mineral de Pozos has been selected as case study because of his right characteristics to become the first sustainable magical town[27]. Its projects in the areas of land use change, urban development, cultural activities aimed at sustainable tourism, create a suitable potential for converting historical and cultural heritage into a source of development for the whole community.

Mineral de Pozos is located in the **region known as Sierra Gorda**, which includes the municipalities of San Luis de la Paz, San José Iturbide, Doctor Mora, Tierra Blanca, Victoria, Santa Catarina, Xichú, and Atarjea. Figure 35 show the location of Mineral de Pozos in the **Mexican federal state of Guanajuato** and belonging to the **municipality of San Luis de la Paz**.

The settlement has been catalogued as urban and occupies a total area of 4.782 hectares, which represents 2.35% of the total area of the municipality of San Luis de la Paz1. It is a locality considered with a medium degree of marginality and with a very low social backwardness. The locality has a kindergarten, primary, secondary and high school. It also has a public health centre, although it does not have a hospital.

[27] https://www.eluniversal.com.mx/destinos/mineral-de-pozos-el-primer-pueblo-magico-sustentable

Figure 35: Location of Mineral de Pozos in Mexico



Source: Author, Kaiserslautern, 2022.

Mineral de Pozos is classified as urban centre and occupies a total area of 4,782 hectares, which represents 2.35% of the total area of the municipality of San Luis de la Paz (SEMARNAT 2011). It is a locality considered to have a medium degree of marginality and very low social backwardness.

7.2.1 History of Mineral de Pozos

A former settlement of Chichimeca culture, this city often changed its name: originally called Palmar de la Vega, it was called Ciudad Porfirio Diaz towards the end of the 19th century, although it has always been better known as Mineral de Pozos or rather Pozos as the inhabitants commonly call it.
The history of Mineral de Pozos began in 1540 with the discovery of the mines in Zacatecas, and so, in order to bring the riches extracted from the mines to the Mexican capital, the road called "La Ruta de la Plata" (The Silver Route) was built. In 1576, in the north-east of the state, the **first foundation** was built by the missionaries of the **Jesuit missionaries** of the Society of Jesus (Jesuits). The Jesuits taught the tribes European processes and the benefits obtained from the extraction of the mineral from the mines (Jesuit smelting furnaces dating from 1595).
To Palmar de la Vega was given the name of **San Pedro** after the patron saint of the miners brought from various ethnic groups[28]. In early 1600s, the name was changed to Pozos due to the opening of several mining wells and their extraction of metals, mainly gold and silver. Around **300 mines** were opened, all of which had their own **national and foreign owners**.

[28] http://www.elclima.com.mx/historia_y_fundacion_de_mineral_de_pozos.htm

In 1810 the **Jesuits were expelled** by the Hichimecas, so production declined, although not entirely. The **maximum splendour** of Mineral de Pozos was achieved towards the end of the 19th century under the **government of Don Porfirio Díaz**, period during which it changed its name to Ciudad Porfirio Díaz. In that period of economic magnificence, the demographic increase led to the emergence of cultural activities, tourism and accommodation, the contributions to the municipality achieved great social advances, being the educational sector and social welfare the most important ones. In 1893, the Modelo School and the Municipal Building were built, the railway was completed, linking Mineral de Pozos with the station La Petaca Rincón. The temples date back to the XVI and XIX centuries: the parish church, the temple of Señor de la Misericordia, the oldest church Nuestra Señora de Guadalupe, the Casa Santa and the temple of Señor de los trabajos, the church of Nuestra Señora del refugio, the chapel of Santa Cruz on the top of Cerro Pelón, all have baroque architecture style. The place flourished to such a degree that it became more overhanging than Guanajuato capital attracting important companies such as Fabricas de Francia, Plaza de Toros, Railway, Hotels, etc. The **struggle of the Revolution** of 1910 and the **Cristero rebellion movement**[29] in the 1920s in Guanajuato, broke the economic charm bringing Mineral the Pozos into decline. The consequence was the **suppression in 1928 of the municipality** of Mineral de Pozos, leaving part of the municipality of San Luis de la Paz. After losing the status of municipality, Mineral de Pozos was transformed and could no longer decide for itself the path of its progress, this loss of rights and privileges led to its sudden collapse: in 1930, during the international economic crisis, the last strong capital was retained, causing the abandonment of the most important mining companies. In 1940 was the great end of Pozos, the lack of capital and the technical problems of the mining industry caused a massive exodus, the entire infrastructure was dismantled and sold, giving way to an almost complete abandonment. Since the 1990s Mineral de Pozos began to manage and implement projects oriented towards **tourism** activity by different actors and interest groups.

[29] **Cristeros, Gabano Radio: https://fb.watch/aKgykUpm7h/**

Figure 36, 37: location of Mineral de Pozos and Magics Towns of Guanajuato

Source: INAFED, SENER

Since 2012 it is nominated one of the seven **Magic towns** of the federal state of Guanajuato (see figure 37), producing drastic spatial transformation, together with changes in the social dynamics of the inhabitants, which are referenced in the resistance of the population to defend their daily activities and the use of spaces that previously had no added value (Hernández 2013).

7.2.2 Demography in Mineral de Pozos

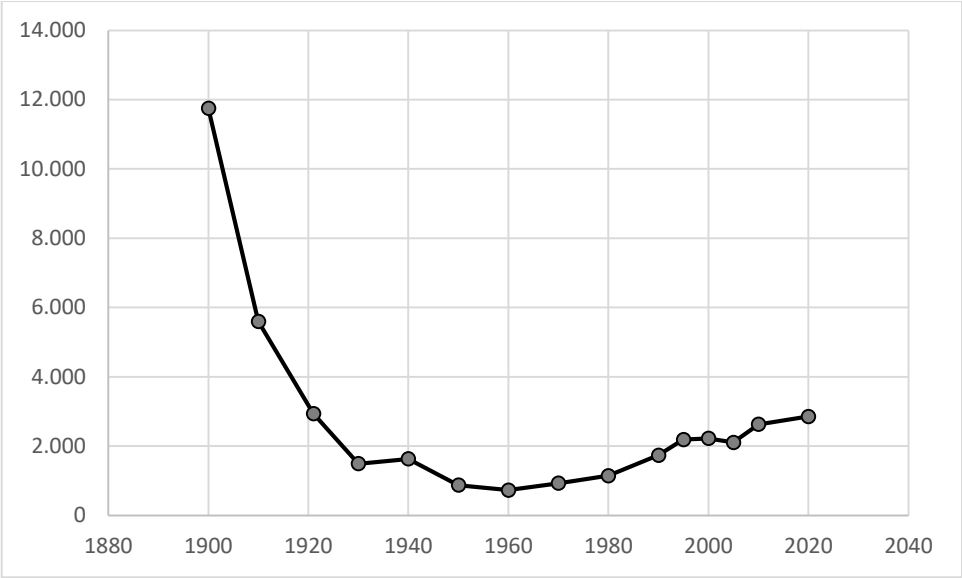
The characteristics of urban shrinkage fall into the category of post-mining decline which in this case can be considered of extreme magnitude. Mineral de Pozos was hosting a not well defined but wide large number of people towards the end of the XIX century: 8,000 according to Mendoza y Terán (1994), 30,000 according to Hiernaux (2015) or even 80,000 people according to López (2016). The historical archive of localities of the INEGI[30] registered 11,571 inhabitants at the beginning of the century in Mineral de Pozos. Suffering from an extreme depopulation of 94%, it reached 728 inhabitants in 1960 and then began a slow growth (fig. 38).

Today, according to the 2020 census data, the inhabitants of Mineral de Pozos are 2,856, however, based on interviews carried out remotely[31], the inhabitants would be more, considering the fluctuating community of foreigners who have come to reside in Mineral de Pozos recently. In addition, Mineral de Pozos hosts a flow of around 500,000 tourists a year Esquivel and Villaseñor 2022.

[30] https://www.inegi.org.mx/app/geo2/ahl/

[31] Interview with private stakeholders in the tourism and cultural sectors

Figure 38: Evolution of Population in Mineral de Pozos.



Source: Author, Kaiserslautern, 2022, base on INEGI Historical Archive of Localities

The destination of **migrants** has been mainly the United States, although in the first decades of the 20th century, migration also took place to Mexico City due to the working conditions in this city.
From the second half of the century onwards, migration took place to medium-sized cities, to the neighbouring country to the north and, to a lesser extent, to Mexico City. According to estimates based on statistics from INEGI and CONAPO, it is estimated that in the 1990s, between five and five million people left the municipality. This phenomenon has had an impact on the growth of the population, the economy and, above all, on the living conditions of the city's inhabitants. The population that currently resides in the municipality and was born elsewhere represents 7.0%: 6.8% comes from other entities, and 0.2% from another country.
Migration to the United States is a dynamic process in which a variety of historical, economic and social factors interact. Those that currently drive the migratory flow either to work or to settle. The cultural impact of this phenomenon is the return of migrants with new customs and habits, fostering the hybridisation of the culture of their places of origin.
The density of Mineral de Pozos in the year 2000 went from 10.2 inhabitants per hectare to 13.1 inhabitants per hectare is considerably low due to the fact that more than 50% of the area is either abandoned, vacant or with old buildings and constructions in a neglected state.

In the last three decades the population of Pozos has been increasing from the 2,060 inhabitants of 1990 (Municipio de San Luis de La Paz, Gto., 2014). According to the population growth trend, the population of Mineral de Pozos will increase by around 47% by 2025. The generation of jobs and the

degree of accessibility to services generated around tourism and urban development, will decrease the rate of expulsion of population of productive age.

In Mineral de Pozos the percentage of illiteracy is 9.65% (194 people), which involves people aged fifteen years and older. In educational aspects, only 23 persons out of 100 have completed secondary school, 24 out of 100 persons aged 18 and older have some degree of post-basic education This indicates that the average level of education of the population is 5.64, in Pozos it is 7.21 (Programa de Desarrollo Urbano y de Ordenamiento Ecológico Territorial del Municipio de San Luis de La Paz, Gto., 2014)[32].

7.2.3 Economy in Mineral de Pozos

Mineral de Pozos participates in 5.1% of its economically active population in activities of **primary sector** including first use and make the first transformation of natural resources (Agriculture, livestock, forestry). These activities are mainly located at the gateway to the Sierra Gorda reserve of biosphere. The main cyclical crops are corn and beans while the livestock production is precarious, with a predominance of cattle, sheep, goats and poultry; the latter with production farms for the company Bachoco. As for pigs, during the period 1995 - 1997, the pig population (heads) increased by 38%, from 915 to 1.4 million head, from 915 to 1.4 million head.

Secondary sector comprises production of food, beverages and tobacco; industry of metal products, machinery and equipment of metal products, machinery and equipment; the wood industry; the non-metallic mineral products industry; and the textile industry. Mineral de Pozos participates in this sector with 59.2%. This share is estimated to be high compared to the municipal output, which is 41% (SEMARNAT, 2011). The predominant economic activity in Pozos is **tertiary** (commerce and services) which represents 99% of the total economic units, of which 66.67% are commerce and 27.08% are services and 6.25% are mixed use which is commerce and services (Programa de Desarrollo Urbano y de Ordenamiento Ecológico Territorial del Municipio de San Luis de La Paz, Gto., 2014). The average salary in Mineral de Pozos is around 4,500 Mexican pesos (200 $).

32 https://portalsocial.guanajuato.gob.mx/sites/default/files/documentos/2014_SAN_LUIS_Programa_de_desarrollo_y_o_ordenamiento_ecologico_territorial.pdf

7.2.4 Spatial urban structure of Mineral de Pozos

Mineral de Pozos is divided into seven neighbourhoods, of which the ones with the largest number of monumental buildings are the Plaza neighbourhood and the Chimenea neighbourhood. The urban fabric of Mineral de Pozos has a regular shape; a road divides it into two large sections and makes it the backbone of the fabric. Another major thoroughfare, through the plaza, forms a cross with the first; the streets are narrow and tend to be straight but set on a terrain of steep and uneven terrain that makes circulation difficult. The crossed arteries are reminiscent of the Roman road layout, i.e. the cardo and the decumanus.

The **population density** (according to the plan) is concentrated in the centre of the site while the peripheries are under-utilised, the phenomenon corresponds to the fact that the central area is "more touristic", and businesses have been established which allow its sustainability. The peripheries such as La Estación neighbourhood, La Nave neighbourhood, La Chimenea neighbourhood, are neglected, while it is important to implement measures that stimulate the development of these neighbourhoods to avoid the excessive growth of housing and precarious infrastructure (Hernández 2013).

For the most part, all ancient building techniques in Pozos employ caliche stone. In previous centuries, adobe was quite common and the architectural legacy of historical and cultural value: self-construction techniques have been used with adobe, blocks composed of clay soil, coarse aggregate and manure, which only require a process of mixing the components with water, the blocks are produced and exposed to the sun for drying and consolidation. Nowadays, self-built adobe houses using the local stone material called "caliche" is used for construction are still common: many families use it to build their homes, moderately cheap, easy to make and widely used as a contemporary architectural trend. The limestone caliche is used for the construction of foundations, load-bearing walls and even as a wall covering to give texture and appearance. This avoids pollution through the use of concrete and reducing the consumption of annealed red brick, which during its manufacture emits large quantities of polluting gases into the atmosphere. It is worth mentioning that, among its many benefits, it favours the acoustics of the spaces and generates thermal environments. In Mineral de Pozos is observable the integration and influence of the preceding building trends with the paradigms in contemporary fashion, setting parameters that assimilate ancient constructions and using adobe and caliche.

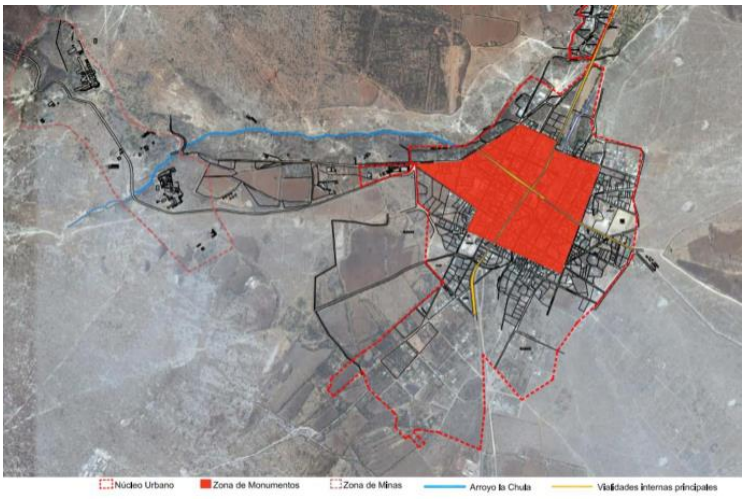
In 2017 the reconstruction works of the **Model school** were completed. The complex is divided into two buildings is intended for music and dance didactic activities, with spaces for cultural exhibitions. The complex comprises 6.100 square metres and was restored with 54 million Mexican pesos (about

2.6 million USD). It will be able to receive more than 100 students simultaneously and will generate direct employment for 48 people and indirect employment for 120 people[33].

According to the partial urban development plan for the locality, 45% of the urbanised area is in ruins and of the 52 buildings with heritage value, 30% are in ruins, another 30% are unused, and 40% are used for housing (Fonatur 2009).

In the urban nucleus residential use predominates, followed by commercial use. The deterioration of the buildings has led to devaluation. Despite the **norms for conservation of built heritage**, the new constructions sometimes lack criteria of integrated construction with the context (Cinta 2017).

The **religious architecture** plays an important role not only in the use of resources but also in the foundation and expansion of the city. The location of the church of San Pedro built by the Jesuits in 1657 is strategic because it is on the edge of the main axes of the city while the construction of the following chapels of Santo Entierro, Guadalupe and San Antonia da Padua, in the form of a cross, define the trajectory from which the rest of the city develops (Pérez 2009).



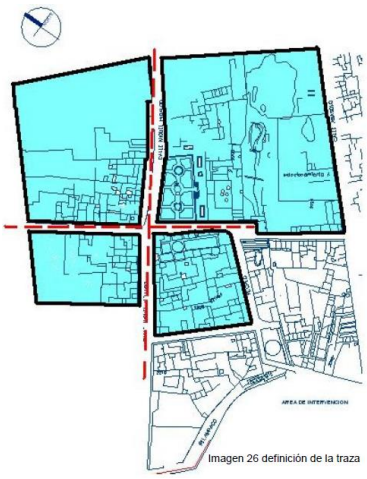


Imagen 26 definición de la traza

[33] https://www.pressreader.com/mexico/periodico-am-express-irapuato/20170702/281767039244290

Clockwise pictures: Monument zone delimitation (Fig.39), cardo and decumanos (Fig.40), urban development hypothesis in agreement with religious architecture (Fig.41), calle Ocampo (Pic. 38). Source: Pérez, 2009

The **mining area** of Pozos is located outside the urban centre of the village, in the **ejidal zone**, where there is a predominance of land without construction, and crops and vegetation predominate.
Since the inclusion of Mineral de Pozos as a Pueblo mágico (Magic Town), some **remodelling and modifications** were necessary: the alignment of the height of the houses, as well as the maintenance and uniformity in the color of the walls in of the houses, in ochre tones with tones of wear and tear; in addition, the few businesses that existed had to also had to homogenise their signage on metal advertisements in shades of the miscellaneous shops, the pharmacy and the taco stand have an aged face on their façades. The widening of the road has also been modified, with the installation of signage, the widening of the space to and from the road, and the paving of the road with ball to give an appearance in keeping with the former ghost town. The avenue was also covered with street lighting (Hernández 2013).

7.2.5 Industrial mining and cultural heritage, Mineral de Pozos

The International Committee for the conservation of industrial Heritage (TICCH) defines the **Industrial heritage**: "it consists of the remains of an industrial culture that have a historical, technological, social, architectural or scientific value. These remains consist of buildings and machinery, workshops, mills and factories, mines and sites for processing and refining, warehouses and shops, places where energy is generated, transmitted and used, transport and all its infrastructure, as well as places used for social activities related to the industry such as housing, religious worship or education" (TICCIH, Charter of Nizhny Tagil 2003). **Industrial Archeology** is the discipline that is responsible for studying the industrial heritage: "it is an interdisciplinary method for the study of

all evidence, material or immaterial, of documents, artefacts, stratigraphy and structures, human settlements and natural and urban terrain, created by or for industrial processes. Industrial archaeology makes use of the most appropriate research methods to better understand the industrial past and present" (TICCH).

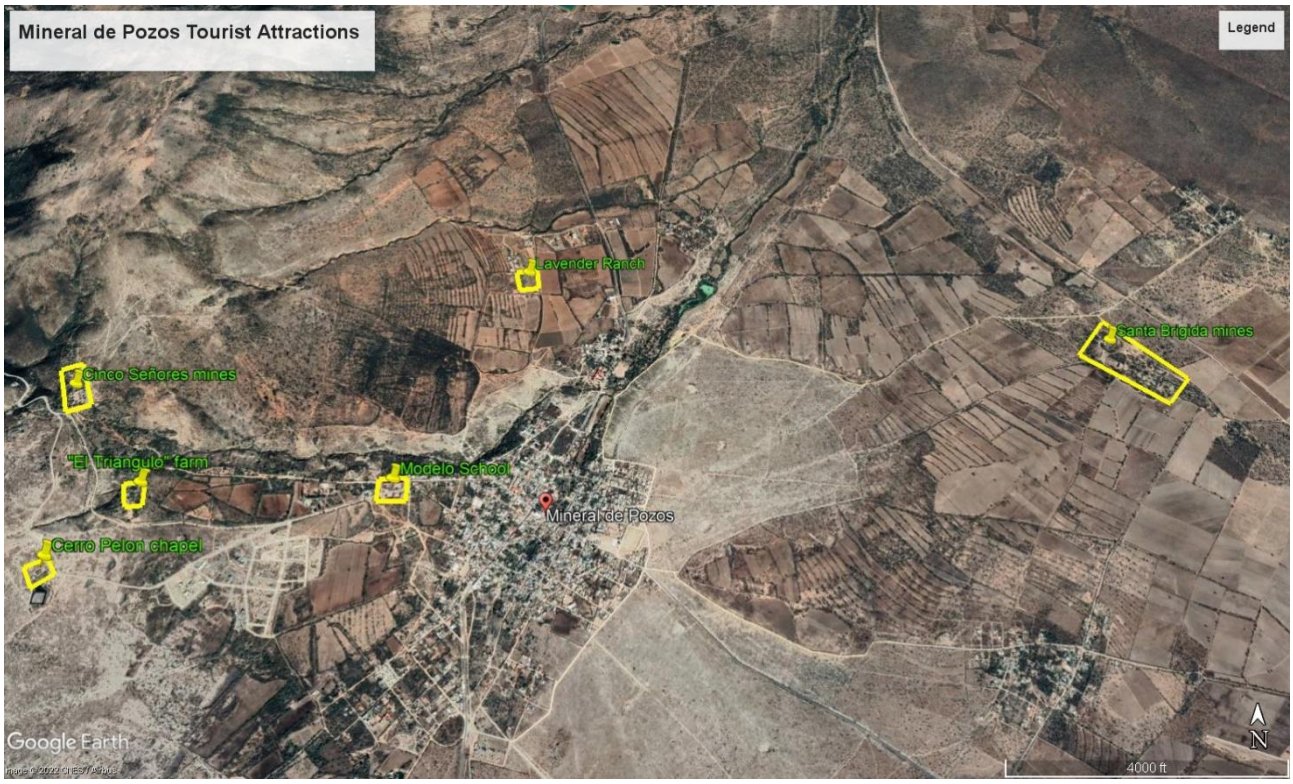
According the TICCH, preservation in situ of the industrial heritage should be considered a priority: recycling of an industrial site is acceptable, as long as it ensures its preservation, except in the case of sites of major historical importance; adapting and reusing industrial buildings enhance efficient energy consumption and favours sustainable development, however, any intervention should be reversible and with minimal impact. Reconstruction should be considered as an original intervention that is appropriate only if it enhances the integrity of the entire site (Vergara 2011).

However, the surest way to conserve and protect industrial heritage is through appreciation of its values, public interest and public affection: museums and industrial sites are the two most important means of protecting and interpreting industrial heritage (TICCIH, Nizhny Tagil Charter 2003). Tourism, whether culturally motivated or mass tourism, is becoming a fundamental protagonist in territorial dynamics, as well as an opportunity to introduce improvements and new formulas for exploitation and economic benefits. Sustainable tourism development offers ways to reconcile heritage conservation (natural and cultural) with the new economic and social prospects opened up by tourism (López 2016).

Mineral de Pozos is considered an **Archaeological Monument by presidential decree**, and the National Institute of Anthropology and History has issued a **prohibition to modify houses without authorisation and without respecting the architectural canons.** In 1982, the federal government issued a decree classifying Mineral de Pozos as a "Zone of Historic Monuments" (fig. 39), a first step in the protection of the heritage site, today an indispensable requirement for a locality to be considered within the Magical Towns Programme (Pueblos Mágicos de Mexico).

In Mineral de Pozos, there were more than 300 mines in which some mines had at least 11 levels and are more than 200 metres deep. It is estimated that since the foundation of the town by the Jesuits, more than one million two hundred thousand tons of ore were extracted up to 1926, which is the closure of the last shot. Approximately 47.5 ounces of silver and less than a third of an ounce of gold were extracted per tonne of ore mined until the overexploitation of the deposits caused the excavations to exceed the water table, which caused most of the mines to flood (López 2016).

Figure 42: Places of tourist attraction outside the historic centre



Source: Author, Kaiserslautern, 2022.

Among the **places of tourist attractiveness** (fig. 42) with historical and cultural value, are the old "Hacienda El Triangulo", the old municipal presidency, the old Modelo school (pic. 41), the old municipal grocery store, the old bullring, the old Hacienda del beneficio la Purisima, the old Cerrillos factory, and the old radio station are all built with the rustic Mexican Colonial architectural style, with Eastern influences reminiscent of Neoclassical, Mudejar and Gothic styles.

Fifty-two properties date back to the 19th century, of which eight had the original use of the chapel, one of a priest's house, two temples, a shop, the railway station, the small hospital, a hotel, one with the original use of market and warehouse, an inn, the bullring, the bridge of the Constitution, one of habitation and commerce, twenty-three houses, seven mining companies (San Baldomero, Angustias, Dolores and Antofagasta, Gto; Angustias, Dolores y Anexas; El Triángulo, La Trinidad, Coloso, Potosí', and Cinco Señores); the hacienda de beneficio La Purísima and the municipal house. Nine properties date from the 19th-20th centuries, of which five were originally used as dwellings, one as a mill, the electrical substation, the house of the landowner and the mining hacienda in Santa Brígida. Seven buildings date from the 20th century, three of which were originally used for residential purposes, the Santa Cruz chapel, the Benito Juárez Garden, the Guadalupe Sanctuary and the unfinished chapel of the Señor de Los Trabajos (López 2016).

During the time of splendour of the mines, of their bonanzas, the image **Señor de los Trabajos** (pic.40) was acquired and a Sanctuary was ordered to be built, as big as the contributions made by the miners of the area. The construction of the new Sanctuary began in 1897, but when the mines and the city of Porfirio Díaz collapsed, the revolution began and the temple remained unfinished the veneration of the image was already rooted in the area. The Christ was deposited in the original site, the old chapel, later it would pass to the Parish of San Pedro (pic. 39). During the month of May, Mineral de Pozos hosts one of the oldest celebrations of the town: pilgrims from different cities gather in the parish church of San Pedro Apóstol to give thanks and pray before the image of Jesus Christ. Its feast is on Ascension Thursday, the tradition says that at the beginning of the Novena, the image is taken down to be cleaned, then it will begin its pilgrimage through the town to return to the Parish the day before the feast.[34] In 1595 the Jesuits built the famous adobe furnaces in the form of quadrangular pyramids, which today serve as the most repeated symbol of Mineral de Pozos. The "**Chacuacos**" (picture 45), as the furnaces were also known, were used to melt silver, which was produced with the help of quicksilver or mercury. In this way, they were sent to the different coin mints for later distribution throughout Europe and Asia.

[34] http://vamonosalbable.blogspot.com/2017/08/el-senor-de-los-trabajos-de-mineral-de.html

Pictures: San Pedro church (39), Señor de los Trabajos (40), Modelo School (41), Railway Station (42), Cinco Senores mines (43), Aerial view (44), ruins and furnaces of the Santa Brigida mines (45). Source: Union Guanajuato[35]

The ruins and the desolate character of the town have been a great attraction for several cultural

[35] **https://www.unionguanajuato.mx/2021/04/28/50-fotos-mas-espectaculares-de-mineral-de-pozos/**

activities. Since 1966 Mineral de Pozos was the **location for films** such as "Pedro Paramo"[36], "Furia bajo el cielo[37]", "Cenizas de un diputado[38]", "La candida erendira" and "Fray Tormenta", up to the inclusion in the recording of the popular Masterchef 2017 programme[39].

Several artists went to live there: a musical group called “Tribu” exponents of the revival of **pre-Hispanic music instruments**, such as the teponaztli (pic. 47), the slit drum known in several Mesoamerican cultures. To date, there are five producers and sellers of these instruments in the locality; they have thus become a national and international reference in the field of pre-Hispanic instruments and ethnomusicology. The artist is, or at least feels, a creator of urban life, a rescuer of the local at the same time as an artistic creator, and this is how he presents himself to his public and followers. The elaboration of pre-Hispanic instruments attracted a type of tourism known as "hippie" tourism, despite the pre-Hispanic instruments are not recognised by the local population.

About 25 years ago, the group Tribu promoted the **Festival de la Toltequidad**[40] celebrating the resurgence of Mexican identity and the ethnic, linguistic and heritage identity of the communities of Mesoamerica. The identity reference to Toltec culture is part of an imaginary that seeks to sustain itself in a mythical past to establish its actions in national history and grant them recognition.

[36] https://www.youtube.com/watch?v=-9j45h78JeI
[37] https://www.imdb.com/title/tt0273620/
[38] https://www.imdb.com/title/tt0328936/
[39] https://www.youtube.com/watch?v=yxjopUwF1OE
[40] https://www.youtube.com/watch?v=0thh-Htxqss

Clockwise pictures: Casa Venado Azul (46), Teponaztli instruments (47), Mina el Triángulo (48), Festival de la Toltequidad (49). Source: Public domain

Two trends coexist in Mineral de Pozos: conversion and re-use of the built heritage and new urban real estate development.

The lack of appropriation of the industrial heritage, lack of budget for maintenance and conservation leads to the progressive deterioration of the historical and cultural heritage, for which several authors (Cinta 2017; Hernandez Miranda 2013) mention the **re-use approach** as a desirable strategy in Mineral de Pozos. The re-use approach is based an intervention and enhancement of the built heritage that seeks to prolong the life cycle of matter and memory through the occupation and habitability of the built space.

In Mineral de Pozos many of the adobe houses of the poorest people gradually disappeared with the passage of time and the inclement weather, the most important buildings and the residences of the wealthy groups were also affected by the looting of their useful parts: doors, ironwork balconies, lintels and door frames made of calicha, the local limestone, were soon "recovered" both by the inhabitants who remained in the town, and by looters from outside the town in search of valuable architectural elements for their own first or second homes. This process took place continuously since the 1960s, as "ant" looting, the urban counterpart of small-scale clandestine exploitation of some mining estates.

One of the major tourist infrastructures works generated after the designation as a pueblo mágico is the reconstruction and rehabilitation of the old Modelo school. This school operated during the years of the mining boom during the Porfiriato period, being a school for young ladies, who learned letters and trades of the time.

The investment generated for the restoration of this space amounts to 55 million pesos, 29 million from the federal million from the federal government and 25 million 65 thousand pesos from the

government of the state of Guanajuato. This complex has now been converted into a school of art, which is supposedly oriented to education, rescue and diffusion of culture among the local children. It hosts a range of workshops such as painting, drawing, serigraphy, dance, among others, as well as a film library, library, museum and an area for tourists where souvenirs are sold.

To solve the progressive deterioration of the ruins of the most important buildings, proposals of intervention from Cinta (2017) include the re use of "ex Hacienda el Triangulo" as a conservation teaching centre; the "Ex hacienda Cinco Señores" as a hacienda for events; the improvement of Centenario street and highway 57; the inclusion of shared street for pedestrian, cyclist and vehicular use; the use of Antiguo Abasto and Hacienda San Rafel;; the Old train station as a bus terminal; the conversion of "Ex Hacienda la puerisima" and Fabrica de Francia as a Pozos arts centre and the inclusion of a border free of construction.

7.2.6 Institutions and stakeholders in Mineral de Pozos

The decline of the mining industry in the region produced the economic debacle of the population of Mineral de Pozos. After losing the status of municipality, Mineral de Pozos was transformed and could no longer decide for itself the path of its progress. As a consequence, economic resources for the development of Mineral de Pozos passed to the administration of the municipality of San Luis de la Paz and currently, Mineral de Pozos is not entitled to internal elections but a **municipal delegate**. This situation involves a rising tensions for the lack of financial and political autonomy.

Stakeholders constellation is rather complex in Mineral de Pozos: it includes the municipality of San Luis de la Paz, residents' committee, Pueblo Mágico committee, cultural and artistic organisations, small and medium private traders, real estate developers, ejidos.

The arrival of foreign inhabitants and the growing tourist activity has generated **uncertainty** among the local inhabitants, who on the one hand seek to benefit economically from the demand for products and services, and on the other hand do not want to lose the quiet environment and essence of the town, as well as the concern for the scarcity of water in the locality. In the face of possible gentrification, the preservation of the cultural heritage of Pozos is at greater risk. It is essential to regulate urban growth and control the urban image, otherwise, buildings will continue to be constructed that do not fit in with the context.

The results from citizen perception of tourism in Mineral de Pozos, within the **diagnosis of competitiveness and sustainability of Magical Towns** (2013), show that 60% of interviewed

inhabitants consider that tourism benefits this municipality thanks to the creation of employment.
Mineral de Pozos is considered an archaeological monument by presidential decree, and the National Institute of Anthropology and History has issued a prohibition to modify houses without authorisation and without respecting the architectural canons.
Small and medium-sized traders' sector is characterised by the emergence of t**ensions** between formal and informal sectors concerning the regulation of commercial activities. There is a clash against this provision mainly in the order of the **right to space**.
Within the planning and urbanisation provisions for the tourist infrastructure in Pozos, order and aesthetic appearance were contemplated as a fundamental part of the planning and urbanization, which was based on the regulation of commerce, mainly in the first square and the main avenue.
The businesses "formally" established in the town's first square benefitted from these modifications, seeing an increase in their sales and tourist occupancy. However, the same was not the case for the street vendors and for the stalls set up on the outskirts. These provisions, which assumed an official character, were not well received by shopkeepers, since employment in the town is scarce and for their families the informal sale of products represents an economic income. With the opening of tourism with more affluence, some families tried to obtain self-employment by offering their own food to the tourists, they moved from their homes and set up their stalls on the sidewalks.
The arrangement and ownership of the public spaces came into tension as people were using and exercising rights over it before the urban redevelopment.
Beyond these modifications achieved in the physical and aesthetic aspect of the town, territorial dynamics were also affected in the social and economic sense. The urban redevelopment, such rights over space were exercised not only in commercial practices, but also in religious practices.

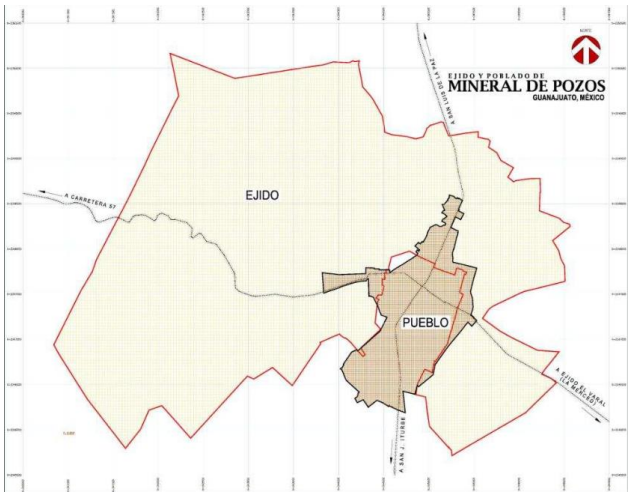
Tourism management is largely controlled by the ejidatarios who retain control over the mining sites. There are several mines and haciendas located within the ejido zone, which is why this space has become a space of power, since it contains infrastructure that can generate economic benefits through tourism. The **Ejido Pozos** (fig. 43) has 1,471 hectares, almost all of which are located in the eastern part of Mineral de Pozos, which is currently linked to tourism development.
The ejido has ceased to fulfil its agricultural vocation and has become linked to economic growth, with the opening of sites of interest which are spaces that belong or belonged to the ejido.
The main actors involved in the conflicts over the mines are the ejido and private individuals. The main problem lies in the fact that the ejido claims that the mines located on the eastern side of Pozos belong to the communal political figure of the ejido. The state has been a fundamental part of granting authority to the ejidatarios, as they have achieved an alliance that has brought benefits to both parties,

however, there are resistance movements that oppose the ejido's intentions. The Hacienda 5 Señores has been the scene of various disputes over its space, as it is one of the Haciendas that receives the most tourists, and also the one that offers the most expensive tours in the area.

The conflict is that one part belongs to the ejido, while the other belongs to a private owner, who has been the victim of dispossession by the ejidatarios. At present, in the locality of Mineral de Pozos, a small group of the 30 ejidatarios people have established themselves as authority figures in Mineral de Pozos on the basis of the power they have over the spaces.

Their desires to expand the ejido or sell private properties, which formed the basis of their sale of private properties that were once part of lands known as smallholdings.

Figure 43: Ejido land in Mineral de Pozos



Source: SEMARNAT, 2010

This new area is distinguished and recognised by the inhabitants as the “Pozos VIP”, due to the fact that people with a high level of purchasing power stay here including celebrities of Mexico and the world.

The new residential construction boom sees the appearance of high-quality hotels, and opening of art galleries completing the picture. In this sense, the artists end up granting themselves an almost magical power that is not only an artistic movement but also an act of salvation or rescue (salvage) of the urban environment in which they are located.[41]

The house of El Venado Azul, is in charge of organising the annual Festival de la Toltequidad. The community of artists has been present since the 1960s when the musical group called "Tribu" decided to start cultural activities in Mineral de Pozos and lived there for a few years. The proposal of this

[41] https://www.youtube.com/watch?v=xUjiDPvAlWc&list=TLGG0zMq2ksgVpcwMjAyMjAyMg&t=3s

group, an exponent of the revival of pre-Hispanic music, revolved around the reactivation of indigenous cultures through the manufacture of pre-Hispanic musical instruments, running in parallel the promotion of the Festival de la Toltequidad, which is attended by groups and amateurs from all over the country and has been maintained over the years.

Events such as the annual Señor de Los Trabajos fair and festival de la Toltequidad constitute a large part of the economic resources.

Plaza Zaragoza is linked to this type of public and to the Toltequidades Festival, this space was referred to for the practice of activities that were not acceptable according to the authorities in view of tourism, such as street vending or the rehearsal of dances, which generated a space that was on the margins of tourist practices. Other artists went settle in the site; such as the Canadian sculptor John Osmond, who shows a great interest in pre-Hispanic sculpture, have achieved international renown; Dan Rueffert (painter) and Geof Winningham (photographer) are also part of the community of artists who have settled, part-time or permanently, in the locality.

Civil society has had active participation in the problems that afflict Mineral de Pozos. The problem of drinking water is a major concern for Pozos as the water supply has often to be rationed.

7.2.7 Tourism in Mineral de Pozos

Tourism is described as a **lever for Mexico's economic and social development** by the Sectoral Tourism Programme (PROSECTUR) 2013-2018. Mineral de Pozos is part of a regional development model based on tourism. Similar to San Miguel de Allende Mineral de Pozos has been configured as an area of intellectual tourism.

Tourism investment in Mineral de Pozos began in the mid-1990s. The establishment of the first hotel in 1996 and the opening of a restaurant in 1998 gave Mineral de Pozos its first commercial impact. These first investments were of a national nature, while 2000 saw the first foreign investment with the opening of another restaurant.

The opening of these businesses produced an initial local resistance: people did not agree with the implications that a tourism project would generate in the locality. It is said that the village priest, who represented one of the most important the town's priests, who was one of the most important figures of authority, called in his Sunday sermons for the faithful not to generate problems with foreigners or outsiders. By the end of the 1990s, foreign and national capital in the hands of individuals began to focus on Pozos as a tourist destination. Mineral de Pozos did not receive any investment or care from the municipality of San Luis de la Paz or the state government of Guanajuato, until the end of the first decade of the 21st century, while foreign capital became present. From this moment on, the place was

projected as a place of rest and comfort that was offered to the comfort offered to American retirees. It is important to point out that during these years, the main buyers were American veterans who were American veterans who were looking for a place to rest and comfort in Pozos. Some of them came from the city of San Miguel de Allende.

The process that took place in Pozos reveals a process of redevelopment or reoccupation of spaces, but also a process of gentrification in the classic sense of the term, in which the original population is displaced from the centre of the city towards the peripheries (Vergara 2013). It is true that there has been a displacement of some families and groups to the peripheries and that the owners of the old houses are people not born in Pozos, and that many of the owners took possession of the land in an undue manner, the place was almost totally unoccupied before the coming of the vacant influx of tourist supply and demand.

Clockwise: Pueblo Mágico label (Fig. 44), SPA las Minas (Pic.50), Posada las Minas hotel (51), La Casona Minera hotel (52). Source: Public domain

The sale of objects stolen in looting of haciendas became common practice with the arrival of private investment in the last decade of the 20th century. Part of the **abandoned infrastructure is been redeemed and converted** for accommodation purposes or restaurants. There is more than a **dozen**

small medium accommodation centres in the heart of the small town of Pozos: among them Posada de las Minas, Casona de Minera, Mineral del Cielo, Hotel Secreto, Posada Casa Reina, Hotel la Villa de Pozos, Posada Colibrí, Hotel Casa Mexicana, hotel SPA las Minas. Some boutique hotels offer relaxation services such as temazcal (traditional saunas), massages and beauty treatments using local herbs including nopal, sports facilities, horse and bicycle hire.

The local company dedicated to the **production of mezcal liqueur** offers the possibility of doing a mezcal tasting tour and teaching the production process[42].

Mineral de Pozos is promoted as **first sustainable pueblo mágico**[43]: The model school proposes an **Eco Village Project** comprising seven hectares with floriculture and artistic residences and other aspects related to the environment. The project includes the preservation of local cultural features, as well as water conservation, rainwater harvesting and waste management. However, these measures must also and above all be implemented in the tourism sector. Accommodation facilities must align with these objectives reducing daily water consumption (currently, 300 lts per day consumed per hotel room are recorded) energy efficiency and renewable energy production.

Tendency towards luxury tourism should be alleviated in Mineral de Pozos, since a general rule is that the more luxurious the accommodation, the more energy will be used; a fact explicable by greater room space, higher heating and/or air conditioning standards, the existence of facilities such as pools or spa and/or wellness areas, as well as a greater range of electric appliances in the room.

7.2.8 Urban Development in Mineral de Pozos

According Hiernaux (2015) the potential for **tourism development and real estate profits** of Mineral de Pozos started to expand after the visit in 2003 of the then-president Vicente Fox. It is reported that he visited Mineral de Pozos accompanied by prominent national and local businessmen, including Emilio Azcárraga Jean, owner of Televisa, Mexico's largest television company, and the actress Verónica Castro, among others. The Mexican bourgeoisie has always looked for secluded places where it can both conduct important business and take advantage of the amenities of the place for second home tourism. On the other hand, the high poverty of the resident population forcing the people to sell their land and houses in order to survive: the locality is classified by official indicators as "highly marginalised". Thus, particularly in the central area of the town around the Central Garden and the Plaza Mayor and its adjacent streets, a rather rapid process of property transfer to tourist

[42] http://rutaculturaldelmezcal.com/?fbclid=IwAR0ax-Y19ZK0RlLAIE2FPd6FCDgn0vFiOH2eZ6GC2sKx-KWAOqlLtwTBCzA
[43] https://www.eluniversal.com.mx/destinos/mineral-de-pozos-el-primer-pueblo-magico-sustentable

investors, foreign residents and second homes of nationals has been observed. The properties also began to be marketed and became more valuable and many people who sold their land before the 1990s for two or three hundred pesos regretted it when the cadastral value raised to up to 3, 4 or 5 million pesos. Available information from the real estate market shows that high-end residences have been built or rebuilt, some of them offered for sale at exorbitant prices compared to the general state of the locality. This process essentially if not exclusively involves actors outside the community including Americans, Australian citizens or foreigners babyboomers within a process of amenity tourism migration looking for a certain rural utopia associated with an imaginary "good life" a la Yi-Fu Tuan (1986).

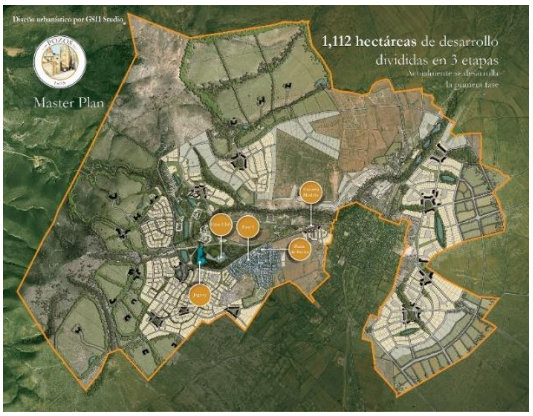
The **tourism and residential projects** are the real intentions behind the remodelling and heritage development for tourism purposes in Mineral de Pozos (Hiernaux 2015). However, urban growth in Mineral de Pozos faces negative legacies of mining development: aquifers are at great depths as a result of overexploitation by mining activity, and soils are contaminated by various heavy metals resulting from mining processes. In the context of water supply problems, the imaginary context of the construction of a golf club and luxury subdivisions that are prone to high water consumption may stimulate a conflict on the horizon that is reminiscent of the one that took place around the Tepoztlán golf club[44].

The Partial Urban Development Programme takes up the hackneyed expression "detonating projects", used by the federal tourism authorities: in this case, the "Santa Brígida Integral Tourist Project" and the "Cinco Señores Project". The first, 3.5 km from the town centre, is a project with a 60-room themed hotel, a 'Club House', an area for country residences on 330,000 square metres, an equestrian park and other works on a tract of land to be purchased from an alleged Parkman family resident in Guanajuato (Fonatur, 2009). The Cinco señores project is of the same style, located on land in the ejido of Mineral de Pozos, and is presented as a second housing development area, again without reference to the number or density of homes.

The **"Senores de Pozos" subdivision** will cover 1,112 hectares and is presented as a project for a sustainable community with urban living and coexistence habits.[45] The project will be carried out on part of the ejido Pozos (Fig. 44, 45). The ejido is an irregular polygon that currently consists of 1,470.61 hectares with the following boundaries.

[44] https://medium.com/the-reynolds-media-lab/tepoztl%C3%A1n-no-se-vende-a-small-town-in-mexico-resists-91a2cc40e93
[45] http://www.pozos.mx/elproyecto.php

Figures 45, 46: Master Plan for urban development in Mineral de Pozos



Source: Pozos.mx

The real estate sector takes advantage of tourism to promote sustainable development in the Ejido Pozos, presents the project as high-value subdivisions with a **sustainable approach**, use of vacant spaces considered historical heritage, sustainable use of existing resources, attracting investment in the locality, as well as the management of services.

According to the plan for sustainable tourism development in the ejido Pozos (SEMARNAT) [46], The Señores de Pozos urban development involves an investment of $18 million and has a development time of **thirty years.**

The vocation of this project is eminently high-quality tourist-oriented. A series of components are programmed to provide accommodation, recreation and a wide range of activities and attractions, in harmony with the environment, the natural landscape and the historic legacy of the area's mining estates. The project will offer different types of accommodation and high-quality tourist services; the use of the land for both the country houses and the hotel will be with the following coefficients: Country-residential: COS 50%; CUS: 1.5; Hotel COS: 70%, CUS: 2.0.

A zone of **macro-lots for small ranch-style country houses** is contemplated, with local architecture and materials, under a high-quality hotel management, a boutique hotel zone in the mining area. The construction of country houses would be done with local materials without walls and on a single level, in accordance with the construction criteria of the regulations to be drawn up for the tourist-residential zone.

[46] http://sinat.semarnat.gob.mx/dgiraDocs/documentos/gto/estudios/2011/11GU2011FD073.pdf

The project presents, among others objectives such as **environment and the natural landscape protection and restoring**, **safeguards and restores the ruins** as the main tourist attraction of the tourist development, commercial, lodging and recreational walkways around the village to offer cultural, art and health events, social activities, events and conventions for small groups, ecotourism, sports and recreational activities, ecotourism, sports and recreational activities, hiking, trekking, mountain biking, equestrian and ecotourism tours, among others, as well as the enjoyment of the attractions of the region and the village. Construction of internal roads based on contour lines, built on natural ground level covered with a level of natural soil covered with earth, to favour the infiltration of rainwater or its runoff to the barriers and living fences.

Within the activities for the recovery of natural areas, the following are contemplated: reforestation with native species, mainly agaves of different species and cactus cactus plants along the course of the gully; Soil improvement and terrace shaping; construction of filtering dams; Modular Waste Water Treatment and Reuse System, 4 modules of 5 lps each; Solid Waste Collection and Recycling Centre are also considered within the project as an integral part of the Sustainable Tourism Development in Ejido Pozos.

Table 4: Impact analysis of urban development, Mineral de Pozos

CLAVE DEL IMPACTO	SUBCOMPONENTE	ATRIBUTOS	ACCIONES DEL PROYECTO	FASE DEL PROYECTO	ELEMENTO DEL PROYECTO	CARACTER DEL IMPACTO	E	D	I	S	IMPACTOS AMBIENTALES SIGNIFICATIVOS	R	M	RESIDUALIDAD
C1	CLIMA	Temperatura	Desmonte y Despalme	URBANIZACIÓN ETAPAS 1 A LA 5	CONTRUCCIÓN	-	1	4	2	1	0,58			0,58
C3		Temperatura	Desmonte y Despalme	CAMPO DE GOLF	CONTRUCCIÓN	-	1	4	2	4	2,33	4	3	0,29
G1	GEOLOGÍA Y GEOMORFOLOGÍA	Fisiología y Unidades de Paisaje	Desmonte y Despalme	URBANIZACIÓN ETAPAS 1 A LA 5	CONTRUCCIÓN	-	3	4	2	1	0,75	2	3	0,28
G2		Fisiología y Unidades de Paisaje	Nivelación y excavación de pistas y lagos a nivel de terracerías y rellenos definitivos	CAMPO DE GOLF	CONTRUCCIÓN	-	1	4	1	1	0,50	1	3	0,25
S1	SUELO	Morfógenesis de los suelos	Desmonte y Despalme	CENTRO DE ACOPIO Y RECICLADO DE RESIDUOS	CONTRUCCIÓN	-	1	4	1	2	1,00	2	2	0,50
S2		Morfógenesis de los suelos	Desmonte y Despalme	URBANIZACIÓN ETAPAS 1 A LA 5	CONSTRUCCIÓN	-	2	4	2	2	1,33	2	2	0,67
S3		Morfógenesis de los suelos	Desmonte y Despalme	SISTEMA MODULAR DE TRATAMIENTO Y REUSO DE AGUA RESIDUAL	CONSTRUCCIÓN	-	1	4	1	1	0,50	2	3	0,19
S4		Morfógenesis de los suelos	Nivelación y excavación de pistas y lagos a nivel de terracerías y rellenos definitivos	CAMPO DE GOLF	CONSTRUCCIÓN	-	2	4	1	2	1,17	2	3	0,44
S5		Grado de erosión	Construcción de terrazas	URBANIZACIÓN ETAPAS 1 A LA 5	CONSTRUCCIÓN	+	2	4	4	2	1,67			1,67
HS1	HIDROLOGÍA SUPERFICIAL	Cuenca Hidrológica	Construcción de terrazas	URBANIZACIÓN ETAPAS 1 A LA 5	CONSTRUCCIÓN	+	2	4	4	2	1,67			1,67
HS1	HIDROLOGÍA SUBTERRRÁNEA	Cuenca Hidrológica	Construcción de terrazas	URBANIZACIÓN ETAPAS 1 A LA 5	CONSTRUCCIÓN	+	2	4	4	2	1,67			1,67

V1	VEGETACIÓN TERRESTRE	Región Ecológica	Selección y marcaje de la vegetación que será conservada y protegida	GENERALES PARA TODAS LAS ETAPAS	GENERALES PARA TODAS LAS ETAPAS	+	2	3	4	2	1,50			1,50
V2		Región Ecológica	Construcción de Terrazas	URBANIZACION ETAPAS 1 A LA 5	CONSTRUCCIÓN	+	2	4	4	2	1,67			1,67
V3		Distribución de la vegetación	Rscate de vegetación y rescate de fauna	GENERALES PARA TODAS LAS ETAPAS	GENERALES PARA TODAS LAS ETAPAS	+	2	3	3	2	1,33			1,33
V4		Distribución de la vegetación	Preparación de viveros provisionales y permanentes	GENERALES PARA TODAS LAS ETAPAS	GENERALES PARA TODAS LAS ETAPAS	+	2	3	3	2	1,33			1,33
V5		Fragmentación de la Vegetación	Desmonte y Despalme	CENTRO DE ACOPIO Y RECICLADO DE RESIDUOS	CONTRUCCIÓN	-	1	4	3	2	1,33	2	3	0,50
V6		Fragmentación de la Vegetación	Desmonte y Despalme	URBANIZACIÓN ETAPAS 1 A LA 5	CONSTRUCCIÓN	-	2	4	3	2	1,50	2	3	0,56
V7		Fragmentación de la Vegetación	Construcción de Terrazas	URBANIZACIÓN ETAPAS 1 A LA 5	CONSTRUCCIÓN	+	2	4	3	2	1,50	2	3	0,56
V8		Fragmentación de la Vegetación	Desmonte y Despalme	SISTEMA MODULAR DE TRATAMIENTO Y REUSO DE AGUA RESIDUAL	CONSTRUCCIÓN	-	1	4	3	2	1,33	2	3	0,50
V9		Fragmentación de la Vegetación	Nivelación y excavación de pistas y lagos a nivel de terracerías y rellenos definitivos	CAMPO DE GOLF	CONSTRUCCIÓN	-	2	4	3	2	1,50	2	3	0,56
F1	FAUNA	Riqueza y Abundancia de especies	Rscate de vegetación y rescate de fauna	GENERALES PARA TODAS LAS ETAPAS	GENERALES PARA TODAS LAS ETAPAS	+	2	3	2	2	1,17			1,17
F2		Especies protegidas	Rscate de vegetación y rescate de fauna	GENERALES PARA TODAS LAS ETAPAS	GENERALES PARA TODAS LAS ETAPAS	+	3	2	2	2	1,17			1,17
P1	PAISAJE	Calidad paisajistiva	Construcción de Terrazas	URBANIZACIÓN ETAPAS 1 A LA 5	CONSTRUCCIÓN	+	2	3	1	1	0,50		2	0,38
P2		Fragilidad visual	Construcción de Terrazas	GENERALES PARA TODAS LAS ETAPAS	GENERALES PARA TODAS LAS ETAPAS	-	2	3	2	2	1,17	2	2	0,58
CP1	CARACTERÍSTICAS	Actividades Económicas	Selección de personal	GENERALES PARA TODAS LAS ETAPAS	GENERALES PARA TODAS LAS ETAPAS	+	3	4	2	2	1,50			1,50

Source: SEMARNAT, 2010

According to the impact tables generated by SEMARNAT (table 4), twelve beneficial impacts were identified; these correspond to works, activities and actions considered within the project that will prevent or mitigate environmental impacts and even improve environmental conditions.
Actions considered within the project that will prevent or mitigate environmental impacts and even improve the current conditions on the site, as well as the economy and quality of life of the population. the current conditions on the property, as well as the economy and quality of life conditions of the population, which includes not only the ejidatarios, but also the nearby communities.

7.2.9 Decentralised Energy System in Mineral de Pozos

The electrical infrastructure has existed in Pozos since the days of mining to light the underground tunnels. Currently, only 92.5 % of the population has an electricity supply. Since the overhead lines hinder the visibility of the facades and the poles the circulation on pavements is more than 90 % this is not adequate if we refer to the urban image, so it is necessary to implement measures to reduce the visual impact of installing underground lines.

Although renewable energy production has not been developed, there is high potential for that, Hernandez Miranda (2013) suggests some measures: taking advantage of the strong winds that are latent in the area, the location of a wind farm would be an optimal solution to provide electricity to the town of Mineral de Pozos; solar radiation present in the area creates the potential for the installation of solar farms; the use of solar luminaires would be the optimal solution for open spaces; carbide lamps that were used in the mines can still be used in the housing. The introduction of

alternative energy generation systems is very important to create environmental awareness in the community and be part of the tourist attraction of the site and the structure of the Modelo School could be partially converted into a study centre for renewable energies.

7.2.10 Ecosystem Services and Bio economy in Mineral de Pozos

The town is located in the region known as Sierra Gorda, it is settled on a terrain of lomerío, which together with its scarce rainfall of 413 mm, and for being located at 2,305 metres above sea level, provides it with a temperate climate tending to coolness.

Its ecology is typical of semi-arid zones: the flora of the region is mainly composed of nopal, cardon, maguey, garambullo, pitahayo, juapilla, biznaga, palm, mesquite, huizache, pirul, saúz, pingüica, and cactus. The fauna includes coyote, badger, fox, rabbit, tlachucahe, tuna, squirrel, cattle, horses, pigs, sheep, rattlesnake, snakes, scorpion, vulture, crow, thrush, sparrow, hawk, tecolote, and a great diversity of insects. The territory was originally inhabited by the Chipicuáro culture dedicated to cultivating maize, beans and squash in the gardens of the Lerma River in the Upper Preclassic (400-500 BC).

In the north of the town of Mineral de Pozos there is a **lavender ranch**[47] for both tourist and production purposes. The production of lavender grass for beauty oil or food products has been introduced, six varieties of lavender are grown and processed to extract its delicate essence and sale products such as soaps, lotions, cooking and bath salts, as well as moisturising creams.

Agro-ecological techniques such as l**ombricomposting** are also promoted The Tellus Agroecological Centre, located next to the San Rafael Mine in Mineral de Pozo[48]s, Guanajuato. There is a special field where worms are cultivated and which constantly receives organic waste to keep the insects nourished so that they can develop and create fertiliser. When the humus is ready, it can be sold as organic fertiliser, contributing to the economy of the region's inhabitants and at the same time taking care of the environment by making intelligent use of the waste generated every day. It is common for citizens to generate backyard gardens, in their homes.

One of the most important and sustainable productions is the **production of mezcal liqueur** from local products. Local small company “Mezcal Cuanax”[49] received Biosphere tourism certification for sustainability of his product.

[47] https://escapadas.mx/atractivos/camina-entre-campos-de-lavanda/
[48] http://www.2000agro.com.mx/biotecnologia/la-lombricomposta/
[49] http://www.cuanaxmezcal.com/?fbclid=IwAR1K0mWgyojQIY2K3R_VJJPBovtcnJCi7Yy1tEyfS0rrcvuxzz9l3k5D1Vg


Picture 53, 54: Mezcal Production in Mineral de Pozos. Source: Mezcal Cuanax

The process of preparation of mezcal liquor is made from the cooking of the maguey plant typical of the area, using a sustainable techniques and infrastructures such as traditional hoven and grinder. The magueys bake for three days in the chamber of the clay masonry oven, fed with wood and dried maguey. Fermentation is the process by which the sugar is converted into alchol, the fibres of the cooked pineapples are torn to squeeze out a juice rich in sugars, also called "mosto". The fermentation takes between 4 and 7 days in a wooden vat, the bacteria generate an aroma characteristic of the area. Tahona is the milling plant added in the process. Finally, distillation is done by means of an equipment called alembic with a process of evaporation of its compounds by heating and subsequent condensation by cooling. It can be distilled two or three times to give a higher quality.

The water use is recorded to be 152 lts per day consumed per inhabitant. According to INEGI data, only 85.9 % of the population has a water supply. Due to the irregularity of the public drinking water service, rainwater is stored during the rainy season and treated against dengue mosquitoes. Drainage systems, which are not currently used more than for rainwater drainage, are located at a certain distance from each other and can be easily accessed by the inhabitants of this area. In the past, water was obtained from cisterns that were built inside the houses, and those who did not have them used the streams that always carried water and the reuse of soapy water. The use of eco-techniques is intended to equip housing and public buildings with eco-techniques that allow the intelligent use of natural resources such as the capture and storage of rainwater.

Still, according to INEGI data, there is just a 57.4 % of the sanitary demand covered. There are two discharge points where the sewage disposal pipes, formerly crossed the river, a septic tank is commonly used, however, it is essential to regulate this situation, as most of the waste could be disposed of in biodigesters, and the wastewater is used to transform polluted water on the outskirts of the village into gas. This would prevent the contamination of the river, which would have to be revitalised in the long term, as well as prevent sources of infection.

Reforestation and the use of these areas for eco-tourism purposes would make possible to protect the landscape value of the site. Among the various proposals, the use of solar heaters, biodigesters to meet daily gas needs and septic tanks which in turn could fertilise fruit gardens. The climate on the site in the early morning and late evening is cold and conducive to the generation of fog, for that reason it is proposed to use fog collectors, elements that could be made with synthetic or natural fibres using the craftsmanship of the site; helping to capture water for human consumption. It is estimated that each fog collector stores up to 100 litres of water per night (Hernández Miranda, 2013).

Clockwise pictures: Typical fauna (55), cold temperatures (56), and lavender ranch (57). Source: Public domain

At the municipal level, there is a waste treatment plant: solid waste is transported to the sanitary landfill in the municipality of San Luis de la Paz, which is in the process of being closed, as a new landfill is being negotiated where the waste management can be used for energy production. Education for solid waste separation is important for this purpose, as it would also be essential for the community to contribute to the generation of less organic waste by creating compost, which could improve the quality of the soil, especially in private gardens. The culture of recycling and the conscious separation of solid waste should also be promoted.

7.2.11 Green transportation, Mineral de Pozos

Mineral de Pozos is easily accessible by private vehicle or taxi service but it has an inefficient public transport system, with only a few buses connecting with San Luis de la Paz.
Mineral de Pozos has not developed a real sustainable mobility system. Cycle tracks are placed mainly on tourist routes in and out of the town.


Pictures 58, 59: Rural biking in Mineral de Pozos. Public domain

A 23.5-kilometre track designed for mountain bikers to ride among the ruined haciendas. The new "Via Verde" will be built between the former F.F.C.C. stations, both in Mineral de Pozos and San Luis de La Paz[50] . One of the main features of this cycle path are the solar panels that are charged during the day to illuminate the cycle path at night[51].

[50] https://www.ngenespanol.com/traveler/bicicleta-por-antiguasminas/
[51] https://www.turespacio.com/aventura-en-bici-por-mineral-de-pozos-guanajuato/

Part V │Results

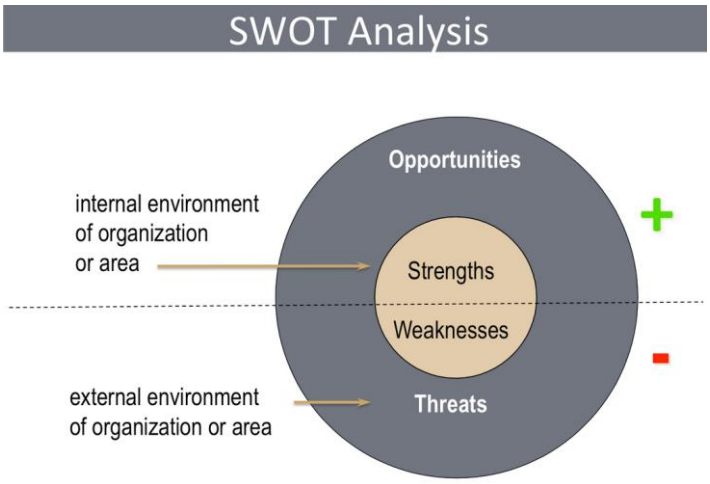
8.1 Descriptive and SWOT analysis

In this chapter, the two case studies are analysed in the light of a more profound descriptive methodology including the application of **SWOT analysis** and **problem tree**.

Descriptive questions ask about how things are and what has happened; causal questions ask whether or not, and to what extent, observed changes are due to the intervention in question. It is discussed whether the intervention made a difference and to what extent, for whom and in what way it made a difference, and whether it can be replicated elsewhere with the same results.

A SWOT analysis is an analytical method which is used to identify and categorise significant internal (Strengths and Weaknesses) and external (Opportunities and Threats) factors faced either in a particular arena, such as an organisation, or a territory, such as a region, nation, or city.

Figure 47: Basic SWOT analysis set up



Source: Cities Alliance

Strengths of the city involve the advantages, what the city do well, and relevant resources; **weaknesses** are what the city is doing bad, what can be impoved or should be avoided; the **threaths** are the obstacles to achieving objectives, negative changes in the economic or environmental situation, for example. **Opportunities** include good prospects and interesting trends that can bring positive changes.

The SWOT anaylsis is a support tool for the formulation of relevant strategies, programs and projects and prioritizes all of these for implementation. A 'problem tree' is used to take the SWOT analysis further and link through to setting objectives and opportunities.

8.2 Vitry-le-François. Descriptive, SWOT Analysis and Problem Tree

In Vitry-le-François the energy transition project is supported by an ecological vision that seek to improve urban metabolism and a transition of the productive matrix, from traditional to green industry. Vitry-le-François was one of the beneficiary territories of the TEPCV being now in a post-subsidy transition phase. The green transition is on track, although it is passing through a phase of subsidy reduction. The Vitry administration's strategy for continuing to promote the transition to a Green Economy is to secure new institutional and financial support from the French central administration by signing up to **new projects** operated on a national scale through the French Ministry of Ecological Transition.

The projects (fig. 47) launched at the national level as territorial cohesion policies, particularly focused on small medium towns are: the "**National Pact for Ecological Transition recovery contract and ecological transition and territorial cohesion" (PTRTE)**[52]; "**Action heart of the City**" (Coeur de Ville)[53], "**Incentive Taxation**"[54] and "**Regional Food project**" (Projet Alimentare Territorial, PAT)[55].

The Territorial Recovery and Ecological Transition Pact (PTRTE) are a transversal tool for the revival of the territories, which is intended to be a long-term project for the duration of local mandates. It is an approach specific to the Grand Est to pool funding from State-Region partnership through enabling the mobilisation of stimulus credits, common law policies and European funds. Some of the projects eligible to be included in this new funding schemes are supported for rural and urban centralities, digitalisation/modernisation of shops, territorial anchoring of activities and jobs, structuring of sectors, support for local community life, energy renovation of public and community buildings, development of renewable energy, support for major tourism investment projects, support for network structures in the field of culture.

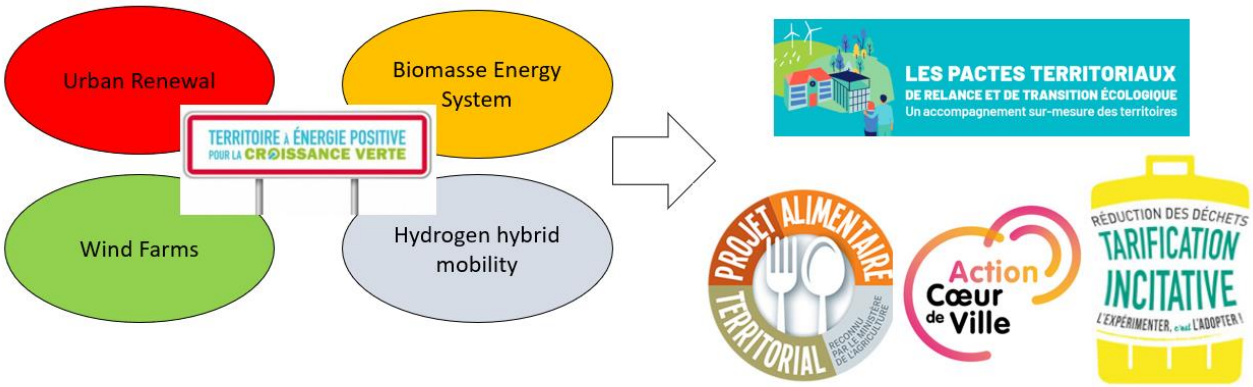
[52] https://www.grandest.fr/pactes-territoriaux-de-relance-et-de-transition-ecologique/
[53] https://agence-cohesion-territoires.gouv.fr/action-coeur-de-ville-42
[54] https://abonne.lunion.fr/id341472/article/2022-02-12/en-route-pour-la-tarification-incitative-des-ordures
https://www.ademe.fr/dossier/modes-financement-service-public-gestion-dechets/tarification-incitative-ti
[55] https://agriculture.gouv.fr/quest-ce-quun-projet-alimentaire-territorial

Developed in consultation with local elected officials and economic players, the Action cœur de ville plan aims to facilitate and support the work of local authorities, to encourage housing and urban planning players to reinvest in town centres, and to encourage the maintenance or establishment of activities in town centres in order to improve living conditions in medium-sized towns.

Incentive Taxation on waste allows the application of the principle polluter-pays to users of the service. It considers the level of waste production in order to bill the user, who is then financially encouraged to behave in a virtuous manner.

Territorial food projects (TAPs) aim to relocalise agriculture and food in the territories by supporting the installation of farmers, short circuits or local products in canteens. Resulting from the Law on the Future of Agriculture, which has encouraged their development since 2014, they are developed collectively on the initiative of local stakeholders (local authorities, agricultural and food companies, craftsmen, citizens etc.).

Figure 48: From TEPCV to the new projects being implemented in Vitry-le-François



Source: Author, Kaiserslautern, 2022.

Although still dominated by a top-down approach in which the participation of civil society is still marginal, the energy transition in Vitry is contributing to important political changes by **shifting the focus** away from traditional local industries and creating new local dynamics aimed at endogenous redevelopment while also pursuing environmental and social objectives, in this sense it remains to be analysed whether the developments will create "alternative" endogenous development model rather than a simple update of classic entrepreneurial policies (Miot and Rousseau 2019).

The strategic projects that have embarked on the green economy seem unlikely to turn back, but the **timeframe** may be long and undermine the positive results in the short term. The process of urban renewal should proceed faster to allow repopulation to take place in tandem with the emergence of new economic initiatives in the green economy. The economic benefits for the town cannot only be

based on public subsidies and land concessions for wind energy. The creation of clusters around renewable energy such as green hydrogen is highly strategic for the future development and transformation of the productive matrix.

According with the table 5, descriptive analysis in Vitry le Francois is carried out:

Table 5: Description of resources in Vitry-le-François

Vitry le François	
Description of Material/Immaterial resources	
Vacant Spaces	Unused plots and abandoned buildings are visible in the city, some of these spaces will be re-used for the urban renewal plan, while other require more attention from local stakeholders.
Infrastructures	The city has many green areas and the transport networks are adequate to reach the rest of the Marne and Paris in a short time. The possibility of creating a development chain around renewable energies and the urban renewal plan emerge as the main challenges.
Raw materials	Locally extracted primary materials are in the agri-food sector whose waste is used in the biomass plant for energy production. Other soil materials are extracted in the quarry north of the city for cement production.
Investment aversion/attraction	The city attracts investment in both traditional industries and renewable energy. Some of the industries are already owned by German or Indian groups, although the French presence is predominant. The creation of jobs in the green sectors will depend on the outcome of new projects such as the green hydrogen production sector.
Planning culture	The city has historically developed in a monocentric manner. Planning activities are centralised and divided between various levels of the state apparatus. Various nationally managed programmes are followed to influence the urban development of small and medium-sized French cities.
Green Economy Transition Strategy	
Business Model	Business to Business: wind energy production in the Vitry area is mainly sold to EDF through sub-companies. Business to Consumer: heat production from biomass serves the needs of public and private buildings in Vitry. Consumer to Consumer: few initiatives exists around organic food production and sales.

	Prosumers: The renewable energy production by consumers is not very significant. It should be promoted, especially in industries.
Governance Model	Governance of the green transition process in Vitry is typically top-down. There is a consensus around the green transition project shared at both national and local level, however there are few bottom-up initiatives within Vitry.
Public Policies	Public policies include public participation in the biomass energy system, concessions for wind energy production, energy-efficient urban regeneration. New actions on the way to becoming effective are the Incentive Taxation of waste, Regional Food project, Heart Town Action and the PTRTE subscription.
Social Inclusion and Environmental Justice	Major socio-environmental conflicts are not registered in Vitry le Francois. The most contaminating company is the cement plant, which should adapt by introducing less contaminating production practices and reducing the use of resources in the production process.

Source: Author, Kaiserslautern, 2022

8.2.1 Dimensions analysis

Economic: The horizon of regrowth in Vitry-le-François is far away. Declining traditional industries do not ensure significant economic continuity. The **economic benefits** of the transition to a Green Economy are for the time being limited to the supply of energy at lower costs than the national average, especially with regard to heat energy produced from biomass through the Biomass Energy Station. The land concession contracts for wind energy production allow the city to obtain interesting profits improving the finances of the municipality but the most important aspect is how these resources are reinvested. Greening the city by improving its urban appearance, managing green areas and accelerating urban remodeling are certainly effective strategies to create the basis for regrowth. On the other hand, it is important to encourage the development of strategic projects that are economically able to bring comparative advantages to the region and establish new sectors in the green economy as part of the strengthening of the regional innovation system. In this sense, the sector of green hydrogen production seems to be the most promising area, although there are uncertainties regarding the feasibility and solidity of a medium-small company with branches in other parts of the country, while Vitry-le-François is not the main site of this company. The recommendation in this sense is to continue to encourage the activities of Haffner Energy in Vitry-le-François but at the same

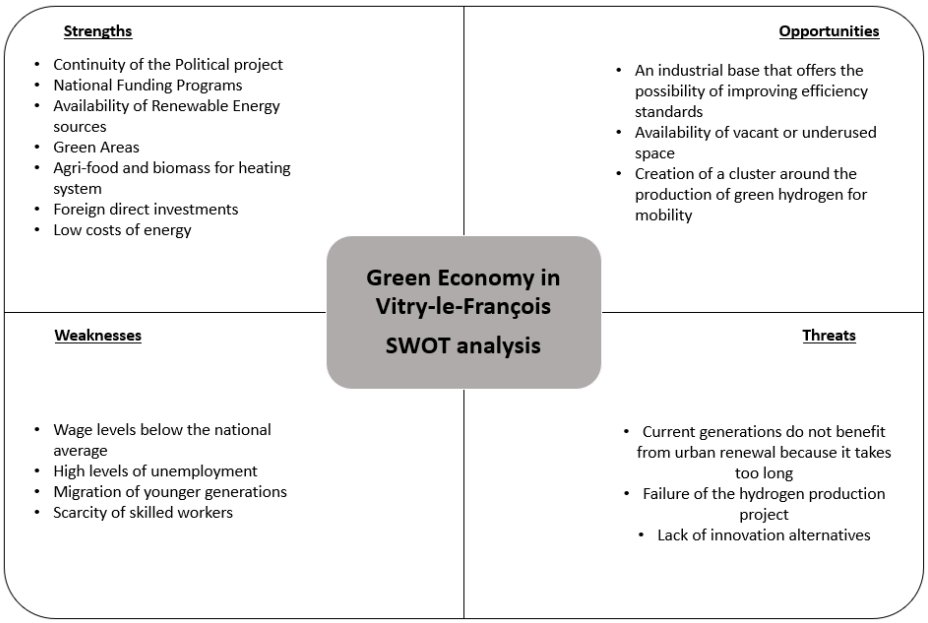
time diversify the research and development by increasing the green complexity of local products, for example by facilitating the arrival of new companies capable of creating production plants of wind or solar technologies, small-scale hydro. The presence in Vitry of small local companies operating maintenance activities of renewable energy stations already offers a small potential of trained personnel in these engineering areas, which could be expanded through the creation of jobs in the green economy.

Social: Vitry-le-François transition to a green economy is a process that will take time and require good choices to ensure long-term **social benefits** for the population.
One of the objectives of the urban regeneration project is certainly to improve the quality of life of the residents, particularly in the le Hamois neighbourhood, but the long timescale envisaged for the reconstruction of the new houses, risks worsening the conditions of the current generations of residents. Among the social benefits for the moment is the start of agro-ecological projects, although these are only just beginning, such as the Regional food project. There is no network of urban gardening and these are only private gardens in low-density houses with a piece of land, mainly located in the northern area of the city, near the river Marne. Other social benefits brought by the Green Economy are the low energy costs, particularly for heating, thanks to the production provided by the biomass energy system. In the long term, the improvement of the quality of air and water could be expected, as an effect of the green economy progresses in the hydrogen mobility system and the possible closure or conversion of the city's most contaminated factories, including cement production.

Sustainability: The biomass energy system is not only economical but also saves 15,000 tonnes of CO2 each year. According to the study carried out by ATMO Grand´Est, the main sources of CO2 emissions in the Vitry-le-François area are the manufacturing industry 360 ktCo2e (63%), which also accounts for 58% of the city's energy consumption, and road transport with 121 ktCo2e (18%). These sources of contamination cannot be removed as they are important economic sources for the city of Vitry. However, the transition to the green economy is expected to stimulate a progressive conversion of manufacturing activities to the areas of sustainability with adaptation and reduction of emissions also by the most contaminating economic sectors.

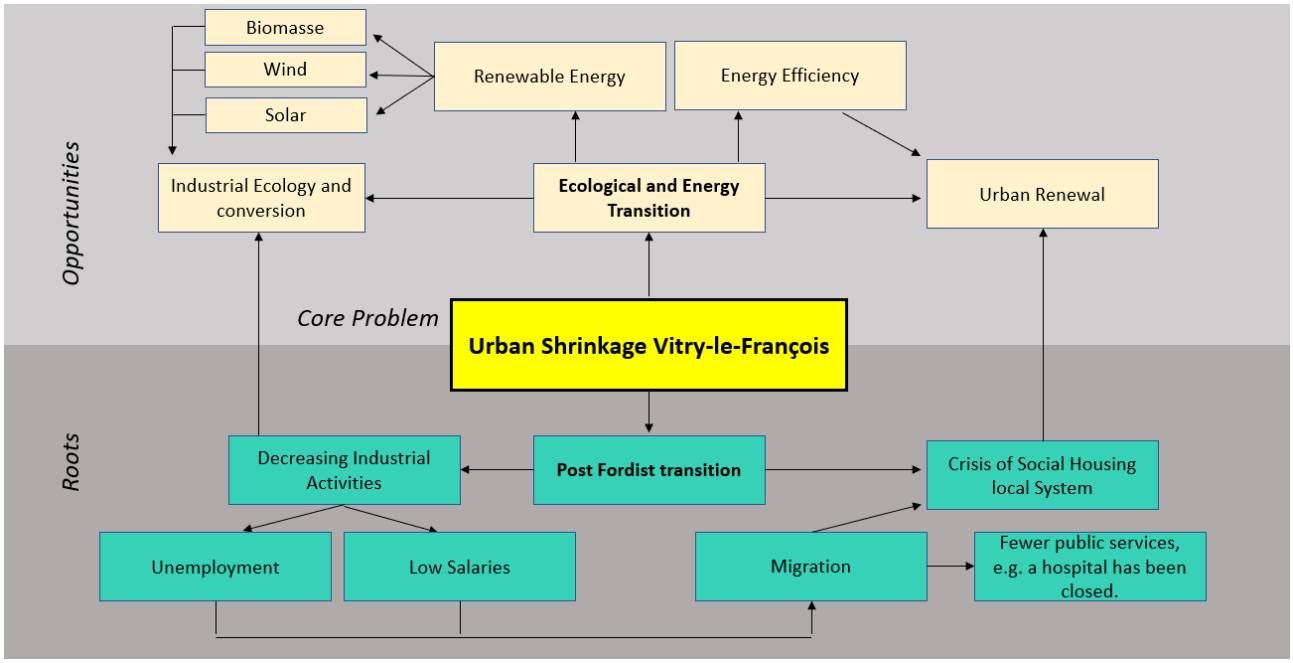
8.2.2 SWOT and Problem Tree Analyisis Vitry-le-François

Figure 49: SWOT analysis Green Economy in Vitry-le-François



Source: Author, Kaiserslautern, 2022

Figure 50: Problem Tree Vitry-le-François



Source: Author, Kaiserslautern, 2022

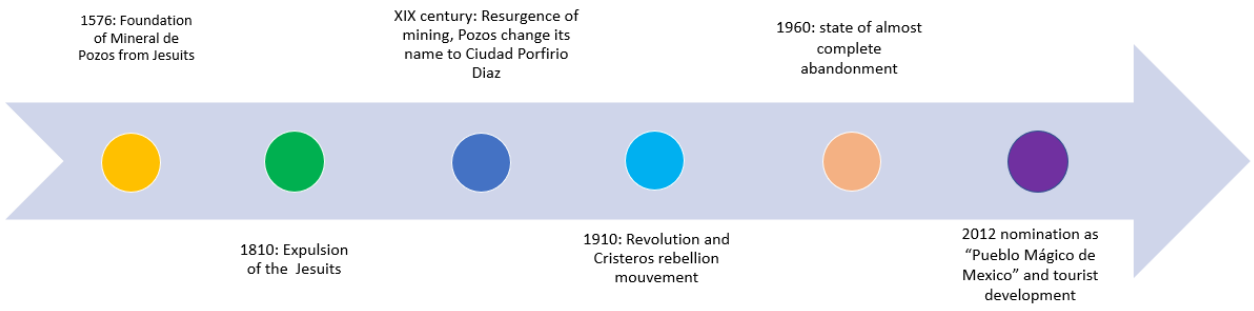
The SWOT (Fig. 48) analysis regarding the green economy in Vitry-le-Francois suggests that it should exploit its strengths such as its established green transition support system, industrial base and policy continuity to expand sustainability measures. The greatest opportunities lie in **industrial greening measures,** (industries use almost 60% of the energy consumed locally) and **hydrogen production** around which a local supply chain of technologies could potentially be created, including for example hydrogen storage and hydrogen vehicles.

The problem tree (fig. 49) shows the shift from the root of the problems of urban shrinkage to the opportunities for industrial conversion that includes the use of renewable energy, circular economy, and energy efficiency, which also expands through urban renewal, transforming the crisis of the local social housing system.

8.3 Mineral de Pozos. Descriptive, SWOT Analysis and Problem Tree

Looking back over its history, Mineral de Pozos went from being an important mining centre in the colony period, with the founding of the town around 1600 by the Jesuits, to a boom in production and development in the nineteenth century. The cessation of activity in the 20th century led to an almost complete decline until the 21st century, when new tourist activities led to the resurrection of Mineral de Pozos, which now qualifies as a place of high cultural and patrimonial value, the perfect place for recreational, artistic and leisure activities (fig. 50).

Figure 51: Timeline of Mineral de Pozos.



Author, Kaiserslautern, 2022

Confined in the mining bonanza it was not thought that the mining activity would come to an end. The exploitation of the mines by numerous concessionaires, both national and foreign, generated a bonanza that resulted in the flow of metals abroad but did not allow for the establishment of a

sufficient and diversified urban base to maintain itself despite the decline of the activity.

The **urban reactivation** of Mineral de Pozos can be explained by the concurrence of several imaginaries, perhaps contradictory in appearance, but associated in a certain way (Hiernaux, 2015). His inclusion in the "Pueblos mágicos de Mexico" national program since 2012, made it a renowned tourist destination, enabling economic recovery by offering resources to carry out architectural restoration work, the creation of quality green spaces, water decontamination and ecotourism.

Tourism is a factor that triggers the arrival of services, infrastructure and urban equipment that can mainly benefit the local population, but for a tourism product to be successful, it is necessary to prepare the territory and the society, avoid urban and/or infrastructure interventions that are driven only by economic interests and that have repercussions on the collective interest, in this case, the mining heritage. It is important to take into account the environment in which the mining activity takes place from its origins, and adapt it to the social needs of both the inhabitant and the tourist; that is why landscapes form a very important part of these mining projects and the analysis of these types of contexts (economic, social, cultural, demographic, functional, etc.) is vital to develop a sustainable territory, where the quality of life of the residents and the tourism activity is a balanced complement and result in social prosperity (Pueblos Mineros, 2014).

According to Hiernaux (2015), the state discourse that endorses the magic that surrounds Mineral de Pozos has become an **official discourse** that circulates publicly in travel magazines, tourist agencies, radio and television programmes but it can be corroborated: the total bet on the tourist complex, can influence negatively on the harmony and agreement among the inhabitants producing waste of benefits for the common good.

Mineral de Pozos is a case of a town of extreme poverty and few options for local development, suddenly put in the sights of officials, investors and tourists in search of amenities but also of a certain rural utopia associated with an **imaginary of "good life**" (Yi-Fu Tuan 1986). Several imaginaries that are not necessarily congruent with each other coexist (Hiernaux 2015), as well as re-appropriation and gentrification dynamics. The **re-appropriation,** which began less than fifteen years ago, recovers residues of a past economic boom, transforms ruins into heritage. The revitalization and the opportunities for sustainable development are supported thanks to the historical and archaeological heritage, however, stands out the risks of real estate speculation leading to environmentally unsustainable projects. In Mineral de Pozos the urban redevelopment is supported through the enhancement of historical and cultural heritage by converting resources into tourist attraction. There is a sustainable development approach, but it finally remains weak within the measures adopted. The predominance of private initiative over public risks increasing gentrification and spatial segregation. The sustainability of the productive matrix depends on the local willingness and ability to strengthen

the harmony between growth and landscape conservation. The urban development project has a frame of thirty years. During this period, institutions must constantly monitor the adoption of measures that benefit the community, including the restoration of ecosystem services and the creation of jobs for the resident population. The economic benefits of strengthening the services sector in Mineral de Pozos must be the trigger for economic diversification, which is already underway with the urban development project, but which must be geared towards sustainability, strengthening urban services and maintaining a level of liveability and quality of life as part of an ongoing greening strategy.

The subsequent interest generated uncontrolled residential tourism dynamics. The **tourism model** conceptualised by new residents in search of local amenities and the authorities leave few options for population bottom-up development. The main tensions arise in relation to the **grabbing of resources**: conflicts over selling space, especially during festivals and fairs, competition with external sellers from San Luis de la Paz, management of tourist resources, water availability and rationing, and also increased levels of insecurity. An increase in **socio-economic segregation** is to be expected as an effect of the urban development project with the arrival of new residents from outside.
New urban development must carefully consider a number of factors including **water availability and soil quality.** The water supply is therefore scarcely available, in an imaginary context of the construction of a golf club and luxury subdivisions that are prone to high water consumption: a possible conflict is on the horizon that is reminiscent of the one that took place around the Tepoztlán golf club. Urban growth also faces negative legacies of mining development: aquifers are at great depths as a result of overexploitation by mining activity, and soils are contaminated by various heavy metals resulting from mining processes. This problem could affect public health and create environmental justice issues, so at the very least the local health system needs to be strengthened with new units and infrastructure. Politically, Mineral de Pozos is **not entitled to internal elections** but a delegate, the relations between the municipality and the delegation had a difficult time. The region's alternatives for development are limited given the geographic conditions and the impoverished economic situation. However, until the benefits brought by tourism are not reinvested in sectors aimed at local development, tourism itself leaves a fluctuating economic situation and is vulnerable to external factors, such as it was during the COVID-19 pandemic, for example.

Descriptive analysis in Mineral de Pozos is carried out:

Table 6: Description of resources in Mineral de Pozos

Mineral de Pozos

Description of Material/Immaterial resources	
Vacant Spaces	Due to their historical and identity character, vacant spaces in Mineral de Pozos are tourist references. Despite managed by private individuals (ejidatarios), there are projects for their "re-use", through intervention strategies, so that they are preserved, restored, conserved and at the same time rehabilitated for new purposes different from their original uses without altering their essence of ruin, of a trace of the past. A clear example of this is the former mining industrial infrastructure dating back to the 19th and 20th centuries, which plan to be adapted as a university campus, community cultural centres, etc. On the other hand, there are a few sites such as the old railway station, the old cemetery, or the old chapels, which, although they are privately owned, it is possible to manage them in order to adapt them for the development of different activities under the aforementioned criteria.
Infrastructures	The infrastructure is concentrated in the tourist and residential offer. It would be beneficial to take advantage of the revenue from tourism to direct it towards local sustainable development. Water and waste management, full coverage of electricity and sanitation services, energy efficiency measures, are the areas where action needs to be taken as soon as possible.
Raw materials	The extraction of minerals is no longer feasible due to the exhaustion and flooding of the mines decades ago. In addition, restarting mining would break the tourism-oriented path.
Investment aversion/attraction	The city attracts national and foreign investments, especially in the tourism and real estate development sectors.
Planning culture	Like the rest of the country, urban growth follows a market-oriented model, albeit within the limits and canons established by law to preserve the historical and cultural character of the locality.
Green Economy Transition Strategy	
Business Model	Business to Consumer: formally established businesses sell directly to tourists by offering various products and services. Consumer to Consumer: Informal sales activities for subsistence purposes.
Governance Model	In Mineral de Pozos there is no real governance of a transition process towards a green economy. The re-use of the historical and cultural heritage of the mining era to stimulate development based on tourism is to be seen as a normal market behaviour.
Public Policies	Public policies are adopted at the municipal level by San Luis de la Paz, and by national institutions as in the case of the Pueblos Magico programme. It would be necessary to establish a local government apparatus in addition to the municipal delegate in order to increase

	the managerial and financial autonomy of Mineral de Pozos.
Social Inclusion and Environmental Justice	The social benefits of the Mineral de Pozos tourism and urban project are rather indirect, linked to the flow of money from outside. Socio Environmental conflicts could arise eventually, from the urban development project in Mineral de Pozos. The most important aspect concerns the management of resources, in terms of water availability and fair redistribution of tourist resources.

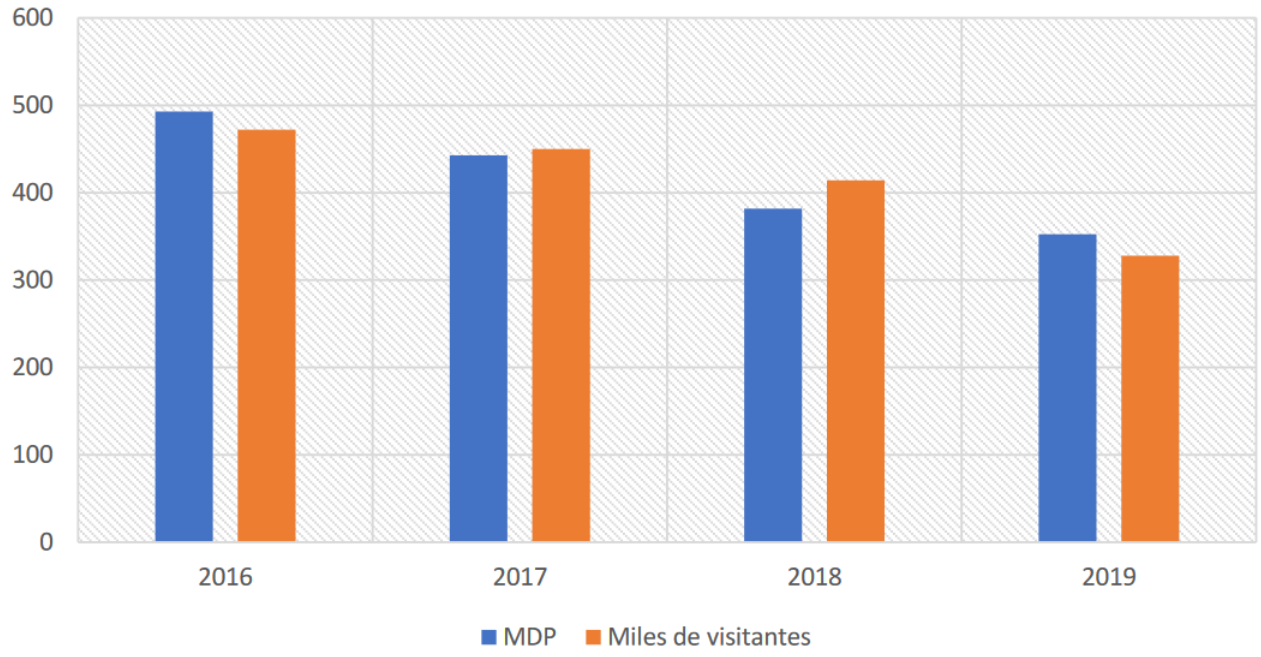
Source: Author, Kaiserslautern, 2022

8.3.1 Dimensions analysis

Economic: The expansion of tourism and real estate over the last twenty years in Mineral de Pozos has established a solid basis for regrowth, whereas previously the town had been almost completely abandoned. The new economic flows resulting from tourism benefit the whole population, although to a greater extent the owners of shops forcibly established in the city centre, particularly the hotel sector. However, a number of indirect jobs are created in the service sector, food production, tourist excursions, etc.

Although the visitor crisis in 2020 is easily understandable, the causes of the **decrease in visitors** until 2019 need to be carefully assessed.

Figure 52: Fluctuation in Tourism Activity



Source: Esquivel and Villaseñor 2022 based on data from Guanajuato State Tourism Observatory.

The figure 51 shows how the number of tourists and economic revenue has varied in the destination since 2016. In 2016, a total of 472,000 visitors visited the destination, leaving economic revenue of 493 million pesos. In 2017, the total number of visitors was 450,000 (decrease of 22,000 people), with a turnover of 442.9 million. In 2018, the decrease in the number of visitors was even more, with a total of 414.1 million visitors with an economic revenue of 381.8 million pesos. Finally, in 2019, 328,000 visitors arrived at the destination, with an economic revenue of 352.5 million pesos. 352.5 million pesos. In 2020, tourism activity was paused due to the sanitary contingency caused by the COVID-19. by COVID-19. It is currently in a period of activation in order to rebound again among the most visited destinations in the state of Guanajuato (Esquivel and Villaseñor 2022).

Social: The governance of the green transition process is neither clear nor established, as the process seems to be mainly market-driven. Compared to the French case, there are no extensive public funding programmes to support or direct this process. Tourism promotion activities are based on **marketing techniques**. The urban transformations brought about by inclusion in the "Pueblos Magicos" programme are rather superficial, while the major urban development project is left to private initiative. The only measure of a public nature is the regulation of the preservation of the city's heritage, but there must be constant monitoring to ensure that it is respected. With the arrival of new economic resources, the quality of life in the locality has improved, and the presence of cultural and artistic activities as well as the calm and charm of the locality should contribute to the quality of life in the utopian imagination of rural life. However, it is essential to evaluate the urban development project in the long term. The project presented in 2011 includes a series of activities of natural conservation, restoration of ecosystems, increase of green areas, introduction of different economic activities in services. The proper implementation of these projects will have a very important impact on the quality of life and social inclusion in the locality. On the other hand, if these measures are not implemented for the benefit of the community, a situation of environmental injustice could easily arise, in which economic segregation is compounded by conflicts over resources, mainly water, but also land, space and economic activities.

Sustainability: Mineral de Pozos is recognised as a sustainable destination by Biosphere Tourism[56]. There are no particular studies for this location on CO_2 emissions or other externalities, but the tourism-related sectors are certainly the ones that maintain the activities with the greatest impact on the use of resources such as water and energy.

[56] https://www.biospheretourism.com/en/entity/parador-turistico-mineral-de-pozos/451

According to the survey realized by Esquivel and Villaseñor (2022) on the perception of the inhabitants on environmental sustainability, 47.8% of the respondents affirm that the destination has a sustainable approach, while 52.2% say it does not. Among the sustainable actions practised by service providers, are the cleaning of public places, the creation of organic gardens, reforestation and awareness campaigns, use of solar panels and recycling of materials.

Table 7: Sustainable destination criterias

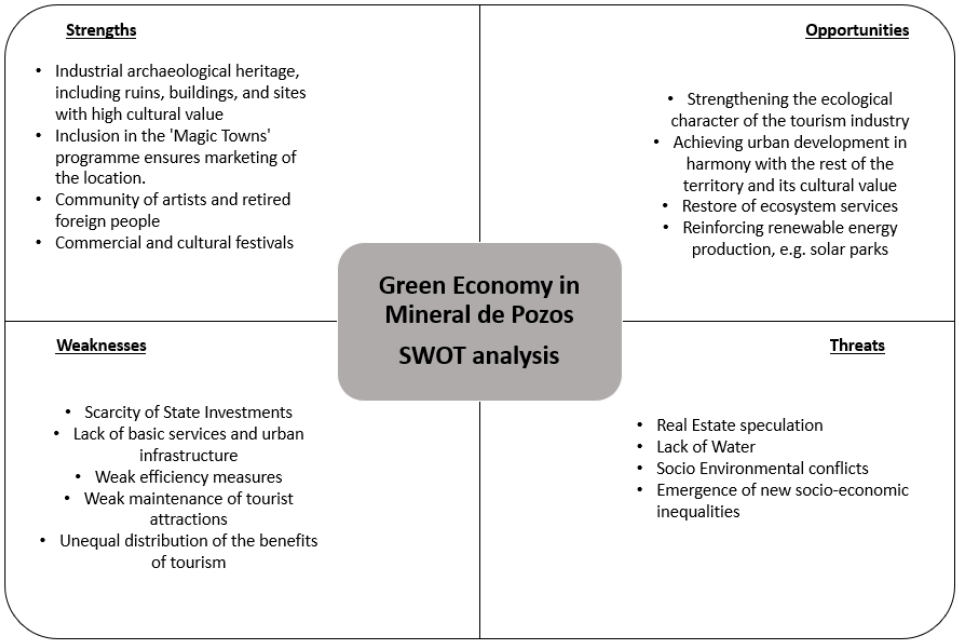
SECTION A: Sustainable management	**SECTION C: Cultural sustainability**
A(a) Management structure and framework	C(a) Protecting cultural heritage
A(b) Stakeholder engagement	C(b) Visiting cultural sites
A(c) Managing pressure and change	
SECTION B: Socio-economic sustainability	**SECTION D: Environmental sustainability**
B(a) Delivering local economic benefits	D(a) Conservation of natural heritage
B(b) Social wellbeing and impacts	D(b) Resource management
	D(c) Management of waste and emissions

Source: Sustainable Tourism Global Council.

Considering the Sustainable Tourism Global Council's criteria for a sustainable destination, it can be argued that in Mineral de Pozos there is a particular emphasis on cultural sustainability, with special laws designed to conserve the unique character and historical and landscape heritage. However, the criterion of environmental sustainability can and should be strengthened through the introduction of various measures. In particular, the hotel sector should make greater efforts to reduce the environmental footprint of its operations by introducing water and electricity efficiency measures. A number of public works can also be carried out through private urban development involving a large part of the city, such as reforestation, improvement of ecosystem services, water and waste treatment, introduction of renewable energy, among others.

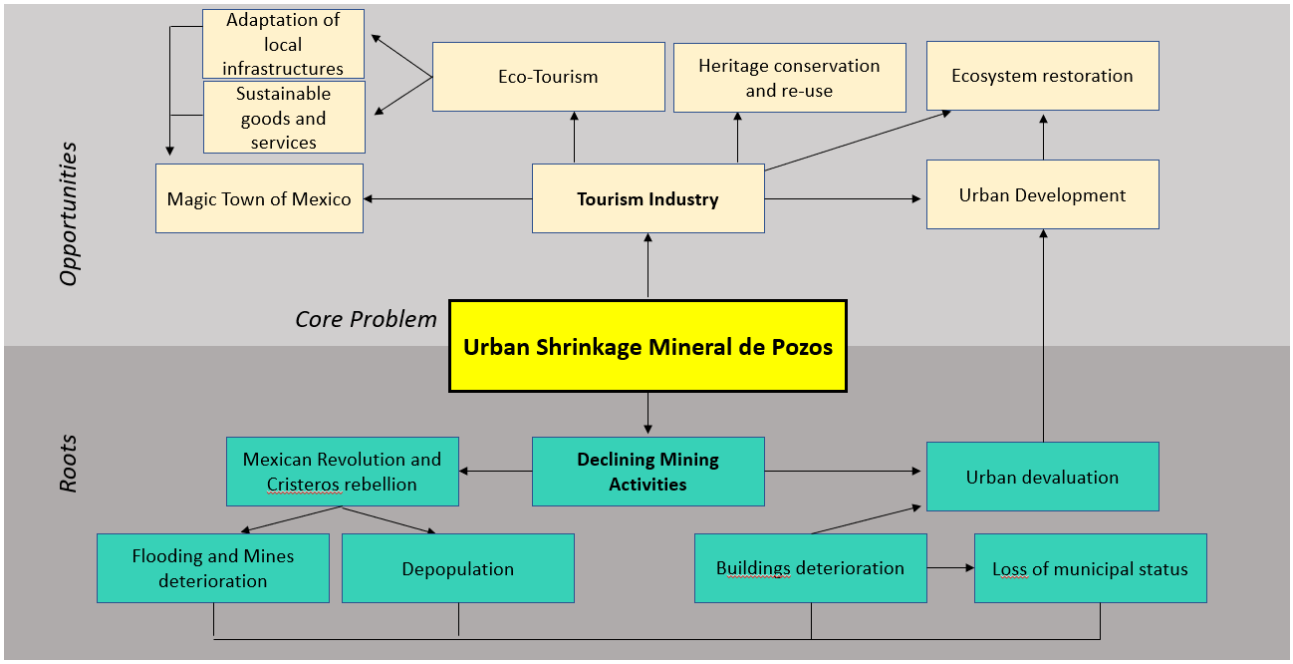
8.3.2 SWOT Analysis and Problem tree Mineral de Pozos

Figure 53: SWOT analysis Mineral de Pozos



Source: Author, Kaiserslautern, 2022

Figure 54: Problem Tree, Mineral de Pozos



Source: Author, Kaiserslautern, 2022.

The SWOT (fig. 48) analysis regarding the green economy in Mineral de Pozos, the city should exploit its strengths such as a valuable landscape and the arrival of external actors such as pensioners or artist communities present to strengthen the ecological dimension of the tourism industry, to ensure that the urban development project "Señores de Pozos" maintains harmony with the rest of the area, preserving the cultural value of the locality. Take measures to avoid threats such as: socio economic spatial segregation, real estate speculation, lack of water that could produce socio environmental conflicts.

The problem tree in Mineral de Pozos interprets the urban devaluation due to the decline of mining activities in the transition to development driven by the tourist industry. Resources derived from tourism can be reinvested to improve urban services, restore ecosystems and strengthen the eco-tourism character through the provision of sustainable products and services and the adaptation of local infrastructure.

Part VI │Discussion

9.1 Learnings from the case studies

Learnings from the case study analysis of Vitry le Francois and Mineral de Pozos suggests that shrinking cities in France and Mexico have **different characteristics and different approaches** to setting up sustainable development strategies in the Green Economy sectors. France has more favourable conditions in the **technological sectors**, in particular the energy transition process relies on an increasing mix of nuclear and renewable energy with an initiated energy decentralism that is expected to have effects also on the national urban structure. In addition, there are a number of nationally orchestrated projects for small and medium-sized cities, including urban renewal and the management of ecosystem services.

Vitry-le-François is one of the medium-sized towns in the north-eastern part of France, which is seeking revitalisation through the Green Economy. In this sense, the inclusion in national programmes aimed at territorial cohesion is positive, as it provides financial resources to create a more liveable environment and improve the quality of life of its inhabitants. At the same time, it is useful to continue to support economic diversification in green industry sectors, such as the production of green hydrogen for mobility and the improvement of heating infrastructure based on biomass, which in turn promotes the recycling of local agro-industrial waste.

On the other hand, in Mexico there are fewer resources and public capacities to manage territorial and economic processes. Mexico is a very heterogeneous country and is generally highly driven by market dynamics. The processes of depopulation on Mexican territory seem to involve more the north-western area, probably due to morphological, but also economic and political reasons.

Green technological innovation in Mexico is supported by a number of clusters mainly located in the country's first three metropolises. However, most of the green technologies come from foreign transnational companies and some sectors such as large-scale renewable energy has been practically oligopolised, not guaranteeing the necessary benefits for the local population and the Mexican state. Faced with this situation, shrinking cities in Mexico are conforming as places of exploitation or as places where sustainable alternatives are sought in sectors mainly related to tourism, bioeconomy and sustainable agroecological practices. Although these do not present a great potential for creating comparative advantages, they can nevertheless offer viable alternatives for local development, quality of life improvement and sustainable management of local resources. The case of Mineral de Pozos is indicative of a valorisation of the historical heritage under the banner of sustainable tourism.

However, a paradigm shift in Mexico also seems necessary to promote a green and ecological transition. As in the rest of the American continent, Mexican society favours very resource-intensive lifestyles. In the case of Mineral de Pozos, hotel services and urban development risk favouring the reproduction of intensive lifestyles in the use of resources, diverting us from the town's official discourse, which is rather one of tourism aimed at sustainability.

The cases of Vitry-le-François and Mineral de Pozos illustrate how the phenomenon of shrinking cities is very diverse and whose typologies address distinct problems in the North and South of the world. The study of shrinking cities in the South can be deepened and linked to economic, social and cultural differences that also influence the planning culture in national contexts. High income inequality and spatial segregation is a typical phenomenon in developing countries, so shrinking cities may be desirable territories to try to palliate this phenomenon, laboratories of economic integration reflected in urban space. However, this is only possible through public policy efforts that can progressively based on public capacity building and a paradigm shift involving all social sectors. The goal of reducing social inequalities and environmental justice are some of the pillars of the Green Economy. Cities and processes related to them undergo a never-ending transformation which makes the model of city management change too, as reflected by the transition from government to governance (Bailey 1993). Today local governance is understood as a flexible decision-making model based on loose horizontal links among various actors (public and private) (John 2001). Citizens can more effectively protect the environment if they can rely on the three pillars of the Aarhus Convention: access to information; public participation in decision-making; and access to justice in environmental issues. It is of crucial importance to public authorities, the public and businesses that environmental information is shared efficiently and effectively. Public participation allows authorities to make decisions that take public concerns into account. Access to justice is a set of guarantees that allows citizens and NGOs to use national courts to protect the environment including includes the right to bring legal challenges (legal standing).

9.2 The role of resources in the Green Economy Design

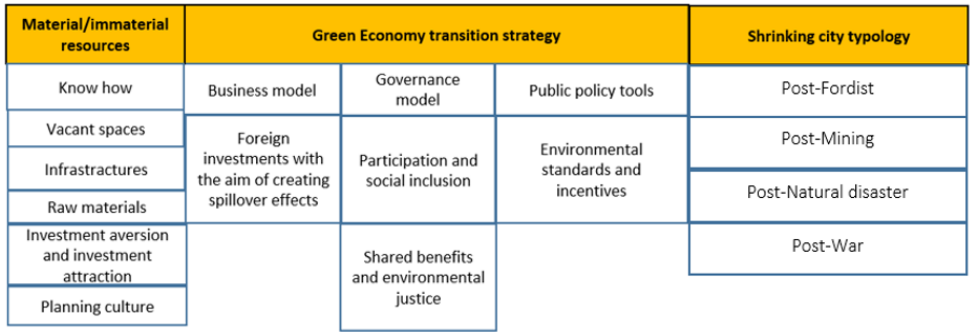
The two case studies demonstrate that srinking cities can adopt holistic visions of transition to the green economy by starting with interventions in **specific sectors** where they have a greater chance of success.

Development strategies for small and medium-sized urban centres often rely on **nationally orchestrated initiatives**, as in the case of TEPCV in France and Pueblos Magicos in Mexico. On the

basis of this **institutional support**, they can obtain technical and financial support to design actions at local level. The type of shrinking city is important for defining the action to be taken within the green economy: where there is an **industrial base** with production systems and policies for them, the potential for conversion to green industry and the application of industrial ecology principles is greater. Other types of shrinking cities can take actions in **greening consumption** sectors and improve the local quality of urban life.

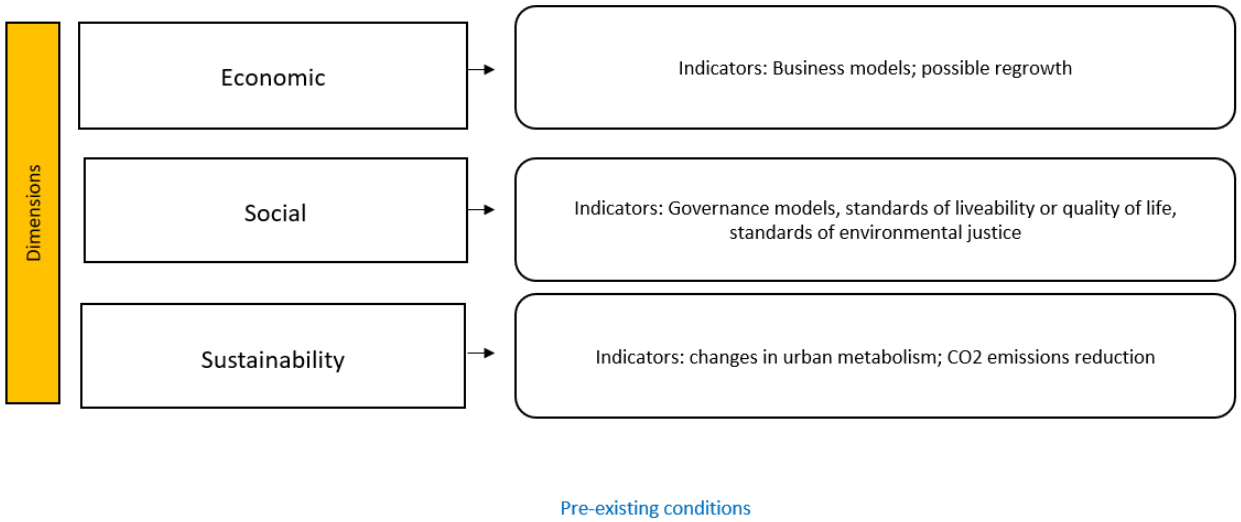
The available **resources** are fundamental to designing the Green Economy strategy in shrinking cities. Among these, know-how, vacant spaces, infrastructures, raw materials, investment attractiveness, and planning culture are among the main crucial points to consider. According to the available resources, the transition to the green economy can be designed through different business models, governance models and public policies. In this way, **targets** can be set such as the creation of local spillovers in green industries or activities, the degree of social participation and inclusion, and the environmental standards to be pursued. In turn, this will depend on the type of shrinking city and how it fits into the regional and national context. The following schemes (Fig. 54) present some of the main aspects or key resources for designing transition strategies to the green economy in shrinking cities.

Figure 55: From available resources to Green Economy design



Source: Author, Kaiserslautern, 2022

Figure 56: Impact indicators and dimensions analysis.



Source: Author, Kaiserslautern, 2022.

In order to achieve a successful transition process to a green economy, shrinking cities should try to improve at least the economic, social and sustainability indicators described in the figure 55.

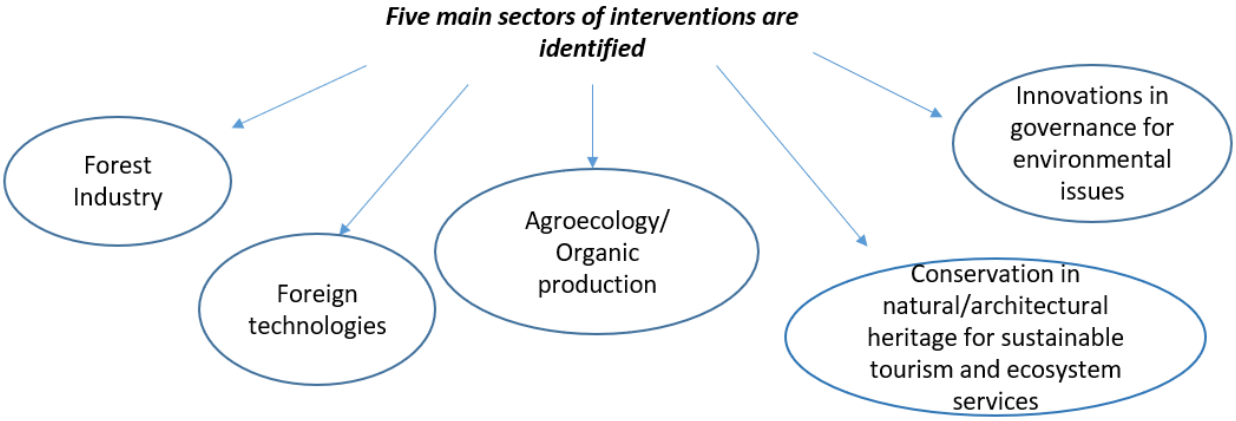
9.3 Green Economy in Shrinking Mexican Cities

During the exploration of green economy projects in the identified shrinking cities and municipalities in Mexico, it was possible to identify the sectors that are important in order to encourage sustainable initiatives in both rural and urban areas. These are then presented as a basis for a reflection on the state of declining urban and rural areas in Mexico and the real possibilities for them to undertake paths of sustainability.

In this section, the methodology applied in the analysis of demographic changes in each municipality according to 1990-2020 census data is complemented by a search for specific information for each location taken into consideration. The objective is to outline a general picture of the situation of Shrinking Mexican areas and their Green Economy potential.

Shrinking Mexican municipalities with at least 10,000 inhabitants were considered for this study, the presence or absence of sustainable development projects linked to green economy initiatives was researched. This leads to the identification of **five areas of intervention** (fig. 56).

Figure 57: Green Interventions in Shrinking Mexican Cities



Source: Author, Kaiserslautern, 2022

Table 9 (see the appendix) describes the index of green economy interventions in Mexican municipalities in shrinkage.

Table 10 (see the appendix) describe other shrinkage municipalities continuing to face deep socio-environmental crises related to soil erosion by agro-industrial activities, climate change, petroleum or mining contamination, and the presence of armed conflicts. The causes and the actors involved are described in detail: for example, the contamination by oil affected Chicontepec (Federal State of Veracruz), by gas in San Fernando (Federal State of Tamaulipas), by gold in Concepcion del Oro (Federal State of Zacatecas). The deterioration of soils due to excessive agro-industrial activity in El Oro (Federal State of Durando) or the climate change with sea level rise in Tlacotalpan (Federal State of Veracruz).

In shrinking cities areas of Mexico, there is no holistic approach to green economy transition projects. Findings show that few municipalities are investing in green technologies, mainly of foreign origins, such as renewable energy production or water decontamination. Other types of innovations are applied in primary sectors such as organic or community production, reforestation or conservation of ecosystem services. Other shrinkage municipalities continue to face deep socio-environmental crises related to soil erosion by agro-industrial activities, climate change, petroleum or mining contamination, and the presence of armed conflicts.

9.4 The risk of Green Grabbing in Mexico

Top-down programming for Green Economy often occurs without guidance on means of assessing the potential for conflicts, trade-offs, costs and synergies to arise as projects are implemented. Outcomes for local development and ecosystems are uncertain, while many projects and certification schemes lack transparency (Huff, 2015). In this sense, it is essential to coordinate action between governments and local organisations by involving different social sectors.

Especially in developing countries, there are many cases of green grabbing, i.e. large-scale private appropriation of resources that are justified on environmental grounds but do not create any kind of local development; on the contrary, they end up triggering major socio-environmental tensions and conflicts with local communities. These can be partly justified temporarily by an attempt to create spillover effects that would accelerate the economic transformation of the area by increasing local and national know-how, however, this is only the case if there is effective dissemination of the technology, including in situ production of the technology using local skilled labour.

Under bad management or government, interventions of the green economy can be experienced as **Trojan horses of capitalist accumulation** in Latin America (Siamanta and Dunlap 2019; Sánchez De Jaegher 2018).

Similarly, to other developing countries, Mexico's energy transition has been referred to as part of neo-colonial green grabbing practices or as a trojan horse of capitalism (Siamanta and Dunlap, 2019). Despite the introduction of public policies to open up the energy sector and meet Mexico's commitment to the Paris Agreement, Mexico faces major **structural vulnerabilities** such as corruption and social unrest. New vulnerabilities have emerged since 2018 as the Federal Government, through President Andrés Manuel López Obrador, has suspended a series of public policy changes that have refocused Mexico's energy transition and investment in renewable energy (Rousseau 2021). The aim is to drastically reduce concessions to private foreign companies in order to encourage nationalisation and strategic public investment in lithium exploitation[57].

In this context, predictions show that Mexico **will not meet its emissions reduction targets** for 2020 and 2030 and will need to implement additional policies and reverse the direction on coal exploitation to do so. (Climate Action Tracker 2018[58]).

Competition for arable land to produce bioenergy feedstock has disrupted existing land-based economies and the livelihoods upon which they are based leading to economic disruptions and social tension. In Mexico, protests against large scale infrastructure and resource projects have increased

[57] https://lexlatin.com/reportajes/reforma-electrica-amlo-litio-energias-verdes-cfe
[58] https://climateactiontracker.org/countries/mexico/2018-11-30/

over the last decade (Jenss and Lehman, 2019). Among the over a hundred energy projects held back by social conflict in Mexico[59], the most emblematic and debated case in this respect is undoubtedly that of the **Isthmus of Tehuantepec**.

The Isthmus of Tehuantepec (Istmo) is one among seven principal geographical regions in the state of Oaxaca, the second poorest state of Mexico after Chiapas (CONEVAL, 2015), predominantly rural and with the highest concentration of 'ejidos' community land. The Mexican agrarian reform of 1992 (Stephen 2002), which opened up to the privatisation of the ejidos, allowed the exploitation of the wind potential of the energy companies, transforming the region into the largest wind farm in Latin America. More than 90% of the installed wind farms belong to the private sector for self-consumption, 65% managed by the companies Acciona and Iberdrola. The energy produced is exported to Guatemala, the United States or used in Mexico to power the mining and construction sectors. Furthermore, many of these wind parks are integrated into the Clean Development Mechanism (CDM), which creates Certified Emissions Reduction (CER) credits based on the Kyoto Protocol (1997) (Siamanta and Dunlap, 2019). The strong interests circulating in this area have led to the emergence of corruption, clientelism and the use of 'coyotes', intermediary people who reserve or insure land for wind companies.

In this context, local communities are marginalized, contracts for the transfer of their land in exchange for financial compensation are often not respected by the companies, leading to a series of socio-environmental conflicts and recourse to the Inter-American Court of Human Rights[60].

All this is part of a system in which costs and benefits of the wind farms are so far highly unevenly distributed and who gets what depends on the class position, race, gender and generation, but also on the disposal of technology, political networks, and bank loans (Lehman, 2018).

Just as this interplay of interests is happening in central Mexico, 36.7% of Mexican households live in energy poverty, finding that the economic goods "thermal comfort", "efficient refrigerator" and "gas or electric cooker" are those with the highest levels of deprivation (García and Graizbord 2016). Currently, the share of renewable energy in the Mexican energy supply is around 9.5 per cent (Grunewald, 2014) that is considerably low given the natural potential that the country has to generate electricity from renewable sources. The potential of renewable energy calculated by the Inventory of Renewable Energies is the following (Del Carmen and Ileana):

Table 8: Potential of Renewable Energy in Mexico

[59] https://www.eleconomista.com.mx/empresas/Conflictos-sociales-amenazan-proyectos-de-energia-20170219-0087.html

[60] https://www.proceso.com.mx/reportajes/2021/4/21/el-mayor-parque-eolico-de-latinoamerica-debe-la-renta-262440.html?fbclid=IwAR3VuQOhq-NFQSmHLcinBezTfu3v_yw5C2M9Zhe_n0iq3dzp78Isfa-l9vg

Recurso	Geotérmica	Hídrica	Mini-Hídrica	Eólica	Solar	Bioenergía
Posibles recursos	7422 MW	9243 MW	670 MW	50000 MW	5000000 MW	3642 MW

Estas cifras no tienen en cuenta la viabilidad técnica o económica y sólo están destinados a reflejar la queza del país en recursos potenciales.

Fuente: Inventario Nacional de Energías Renovables, Http://iner.energia.gob.mx/

Source: National Renewable Energy Inventory

Much of the investments are made in the **renewable energy** products sector and **wastewater treatment** and **water purification** plants, however, Mexico should strengthen its research and development sectors to achieve better comparative advantages in the global green economy.

According to the International Labour Organization (ILO), about 4.5% of the **workforce** in 2011 was employed in the green economy in Mexico considering nine sectors: sustainable agriculture, sustainable forestry activities, renewable electric energy, clean industry, sustainable construction, waste management, sustainable tourism, public mass transport, federal government activities.

However, when considering the creation of more complex green products with high revealed comparative advantage, the analysis of the green complexity index carried out by Pérez Hernandez et al. (2021) reveals the great differences between the north and south of Mexico, with the production and commercial space being located more in the north. In particular, the states of Nuevo Leon show a higher green complexity index.

The strong inequality existing in the structure of Mexican society and the territorial imbalances require that the innovation paradigm be expanded to bring about a transformational change in all areas of the country, to build a more equal development process that provides opportunities for the fulfilment of a large part of the population that is currently excluded. The measurement of innovation based on patents and technological prototypes has shown important weaknesses and certainly does not apply to foster innovation processes other than those of the market (social, environmental, solidarity economy, institutional). It is essential to define alternative measurement schemes (Burgos et al. 2016).

Developing countries face the difficult task to find the balance between a high rate of growth in national production, greater production of the environment and conservation of resources. The concept of green development extends the idea of a simple greening of the existing economy with a strong focus on the third pillar of sustainable development trying to make justice to the different circumstances of industrialized, emerging and developing countries looking beyond the models of the Western world and draws an inclusive picture of the Green economy (Acharya and Sequeira, 2012). Green Economy can include economic activities with different levels of specialization or advanced knowledge. Traditional knowledge assumes particular importance in the perspective of sustainable rural development and the new territorial articulations established between the

countryside and the city. The World Bank (1993) recognises the contribution of traditional knowledge to sustainable development, in this sense, the rediscovery of traditional knowledge can play a role in the concept of green development. Traditional and local knowledge is the collective body of knowledge, innovations, and practices of indigenous peoples and local communities worldwide (UN 1992). In this context, "traditional" implies that the knowledge is gained through extensive experience in a specific place, landscape, or ecosystem and carried from one generation to the next (Curci 2010; Kohsaka and Rogel, 2019).

According to the World Intellectual Property Organization (WIPO) (2010:2–3), **traditional local knowledge** is present in different contexts and embedded in traditional systems and processes, including:

- Architecture and building techniques
- Methods and designs in woodwork, stonework, metalwork, and crafting jewellery and other accessories
- Textile techniques, such as weaving and dyeing, and materials used in the process
- Methods and materials used in body decoration and modification, cosmetics, other products for use on the body, and aromatics
- Methods in birthing, bone setting, and Spiritual Healing
- Medicinal use of materials derived from plants, minerals, and animals
- Methods in preserving, processing, and preparing food and drinks
- Farming and agricultural knowledge
- Skills in hunting, fishing, and gathering
- Management of the environment and sustainable to use of natural resources
- Knowledge of plant and animal species and weather patterns
- Customary laws and traditional systems in conflict management and decision-making

In Mexico, there are 56 ethnic groups spread over most of the national territory part of the national territory, which have different forms of land use, folklore, social relationships and ways of life (Noriero et al., 2012). Considering that 50% of Mexican land is still rural, more than 22% of the population is indigenous (INEGI) and increasing relations between rural and urban areas traditional local knowledge can be seen as a resource for promoting sustainable development.

Organic or agroecological agriculture deserves special attention, given the changing times we live in.

There is criticism manifested under the term biopiracy, related to the exploitation of traditional knowledge by innovations registered through the patent system, considered a considerable gap in the Nagoya Protocol (Robinson 2012).

However, it is recognized that scientific and traditional innovation systems can interact in mutually beneficial ways. What is important is that the terms of the exchange between different parties are 'fair and equitable.

Advanced bioeconomy exists about a modern fossil fuel economy indicating a transition from fossil fuels to biomass as the underpinning natural resources base for socioeconomic activity. Within the idea of circular economy, biological resources are used at a rate that is consistent with the rate at which they are regrown.

Innovation systems can be created from typical local products such as the production of nopal-based biogas in Mexico (Espinosa et al. 2018). For instance, traditional local knowledge holders can help address local challenges that are also global concerns, such as biodiversity conservation, climate change adaptation and mitigation, and agricultural innovation, with support from stakeholders in other sectors and input from other knowledge systems (Kohsaka and Rogel, 2019)

Part VII │Conclusions and outline for further research

10. Conclusion and outline for further research

The purpose of this thesis was to highlight how different strategies for developing shrinking cities within the framework of the **Green Economy**. These were outlined through a theoretical explanation, illustrated through a review of the state of the art, and explored through two case studies that elucidated the key factors important in establishing green transitions in shrinking cities.
Some **difficulties** were overcome: the lack of in-depth studies on shrinking cities in Mexico led to the exploration of the dynamics of depopulation at a national level with results that can certainly form the basis for new research. In addition, the COVID-19 pandemic affected the possibility of carrying out detailed fieldwork, leading to the modification of some qualitative methodologies initially planned, especially in Mexico.

As a **conclusion**, taking up the initial hypotheses, some of them can be confirmed through the following statements:

1. **Regrowing shrinking** cities through technology-based green transitions have a potential to stimulate turnover in urban decline. They are more feasible in post Fordist shrinking cities whose declining industries can be converted to green production, with business and management systems remaining similar. Greening shrinking cities can focus on greening consumption sectors, making them more efficient, sustainable, and aimed at increasing livability. Sectors to be considered are energy and utilities, urban green designs, ecosystem services management, waste management and sustainable tourism.
2. Exploration of the phenomenon of **urban shrinkage in Mexico** has led to the identification of eighteen urban areas as shrinking cities. The main drivers of urban shrinkage in Mexico are post-mining abandonment, natural disasters, i.e. earthquakes, the presence of violence from organised crime groups, international migration, and decreasing activities in local specific sectors.
3. Shrinking cities will have to start interventions in **specific sectors** of the green economy where they have a greater chance of success. The national and regional context in which the shrinking city is located, including the presence of financing and innovation support schemes, influences the ability to embark on solid green economy paths in shrinking cities.

4. Given that renewable energies are highly dependent on space and considering the presence of **low-cost vacant land**, shrinking cities could represent key places in energy decentralism everywhere. Sustainable tourism is a good sector for shrinking cities, especially those that can offer unique attractions to visitors. In particular, it has the effect of supporting local SMEs by sustaining consumption and maintaining jobs.
5. The **key factors** leading to the green economy in shrinking cities are: the regional context of innovation, the national support system for the green economy, the existing economic infrastructure and thus the material resources and local knowledge available.

The sectors of the green economy primarily present in shrinking cities are definitely those related to liveability and energy efficiency. Depending on the conditions and dimensions of shrinking cities, urban remodelling can be based on the densification or sprwaling of the urban form, in order to ensure greater efficiency in the use of resources, the introduction of renewable energy systems, the adaptation of service infrastructures, the introduction of spaces for public use, reuse of vacant spaces. Management of ecosystem services and urban gardening activities benefit from the quality of urban life through a particular focus on green areas and their harmonization with the built space.

Secondly, shrinking cities can have an R&D focus to create green product supply chains and guarantee themselves comparative advantages that can stimulate long-term economic growth. These activities can be led by private or public companies or by strengthening local SMEs, to ensure the maintenance in the territory of any economic benefits by stimulating local consumption.

Business or innovation networks can be orchestrated at the regional level to create a robust and resilient regional innovation system capable of responding to market changes.

The main determinants for implementing green economy projects in shrinking cities depend on the type of resources available, the business and governance models applied in the transition process. For example, in the case of Vitry-le-François, the material and non-material infrastructure, the workforce and the insertion in the regional and national context make an economic conversion towards green sectors propitious. The creation of local SMEs for the maintenance of the renewable energy infrastructure, the maintenance of a biomass energy system with private public participation and the urban renewal process guarantee jobs in the Green Economy. The green hydrogen project, in the case of starting a local production on Vitry, could establish a promising supply chain for green transport, with the creation of new types of hybrid vehicles, thus revolutionizing the economic role and the size of the city.

Although France and Mexico share the problem of suburbanization in part, the rest of the problems generated by urban dynamics are highly different, and so are the applied responses.
French energy decentralism and Mexican sustainable tourism are identified as two key strategies to develop declining small and medium-sized cities along sustainable paths.
the French energy decentralisation process is offering new development strategies for these localities, which can exploit the land resources available for concessions to install production fields for wind or solar power, biomass intended to be a low-cost fuel especially for urban heating systems, and offer services at advantageous costs for companies that decide to establish their bases for R&D activities. On the other hand, measures to increase greening, livability and quality of life can easily be adopted: agro-ecological projects, management of ecosystem services and green areas, urban renewal with densified housing and more contact with nature, availability of lower costs of energy produced from renewable sources.
The degree of green transition in urban areas can be given at least by the set of four quantifiable elements: the creation of industries aimed at the production of green technologies, the adoption of decentralized renewable energy production systems, the adoption of measures aimed at efficient energy consumption, the adoption of other measures to reduce the use of fossil fuels.
In France, the increasing dynamics of energy decentralisation can create a strong stimulus for green transition in shrinking cities, an interesting case to analyse could be that of Loos-en-Ghoelle in the Pas-de-Calais department.
Although there is also local resistance in the green energy sector, such as in the case of l`Amassada in the department of Aveyron, in the south of France, these are sporadic and not so frequent as to imply a rethinking of energy decentralism policies, although it is important to analyze them and take them as a starting point to design projects that are capable of avoiding all sorts of socio-environmental conflicts.

The urban context in Mexico is highly based on the market economy while the national governance of urban processes is weak and limited by lower capacities of the state generating weak responses to local problems. The support system towards the green economy is weak and the present government administration continues to see the brown economy as the main strategic sector for the development of the country. Technological innovation in green industries is concentrated in the three main metropolises but it seems rather unlikely to be able to create this type of alternatives in Mexican shrinking cities, at least for the moment.

Shrinking cities in developing countries can be seen as the periphery of the periphery of the global

economic system. They face many crises in the context of a lack or weakness of state intervention. Local responses are based on private or community initiatives. In the Mexican case, the community management of public areas, historical monuments, including mining infrastructures are part of the ejidos communal lands, through their redemption sources of income have been established for many people, however, it will be necessary to evaluate the new developments resulting from the growing private initiative, in the context of the absence of real local governance.
Some Mexican shrinking cities are showing economic and social resilience starting from sectors based on tourism, and on sustainable techniques for the production of biomass, often deriving from traditional knowledge also by the different ethnic groups present in the country.

Outline for further research includes researching these aspects in shrinking cities and especially in shrinking cities in developing countries, which so far are less well known.
Outline for further research on green economy in Mexican shrinking cities would definitely involve the analysis case studies detected and introduced in this thesis. In the Mexican case, this study aimed to provide a list of urban areas facing depopulation crises over the last thirty years. Other case studies can be explored in the Mexican context, such as the depopulation of Minatitlán in the state of Veracruz or the municipality of Madera in the state of Chihuahua.
It is also recommanded to maintain an analytical approach in the fields of governance of green transitions and environmental justice, looking for the possible presence of new socio-environmental conflicts emerging in both green and brown economy projects in shrinking cities.

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List of Abbreviations

4T - Cuarta Transformación

ADEME – Agence de la Transition Ècologique

ANRU – Agence Nationale Pour la Rénovation urbaine

APS - Announced Pledges Scenario

AR - Arizona

ARTI - Agenzia Regionale per la Tecnologia e l´Innovazione

ATMO – Fédération des Associations de surveillance de la qualité de l´air

CA - California

CBA - Cost-Benefit Analysis

CCI - Complex, Combined Innovation

CCS - Carbon Capture and Storage

CCVCD - Vitry, Champagne of communes Vitry, Champagne et Der

CGLLS - Caisse de Garantie du Logement Locatif Social

CGT - Confédération générale du travail

CITEPA - Centre technique de référence en matière de pollution atmosphérique et de changement climatique

CLER - Comité de Liason Énergies Renouvelables

CO_2 – Carbon dioxide

CONAPO – Consejo Nacional de Población

COP21 – Conference of Parties 21

COS – Land Occupation Coefficient

COVID -19 - Coronavirus SARS-CoV-2

CUS – Land Use Coefficient

DDT - Direction départementale des Territoires

DUI - Doing, Using, Interacting

EC – European Commission

ECLAC – Economic Commission for Latin America and the Caribbean

ECOPAL - ECOnomie et ECOlogie Partenaires dans l'Action Locale

EDF - Électricité de France

EJ - Exajoule

ERDF – European Regional Development Fund

EU – European Union

EUR - Euro

FONATUR – Fondo Nacional de Fomento al Turismo

FFCC - Ferrocarriles

FSSD - Framework for Strategic Sustainable Development

FUAs – Functional Urban Areas

GA - Georgia

GDP – Gross Domestic Production

GHG – Greenhouse Gas

GIS – Geographic Information System

GSTC - Global Sustainable Tourism Criteria

GW - GigaWatt

GWh – GigaWatt hour

IDB – Interamerican Development Bank

IEA – International Energy Agency

IIASA - International Institute for Applied System Analysis

INSEE - Institut national de la statistique et des études économiques

ILO – International Labour Organization

IMF – International Monetary Fund

INDC - Intended Nationally Determined Contributions

INEGI - Instituto Nacional de Estadística y Geografía

IRENA – International Renewable Energy Agency

IUCN – International Union for Conservation of Nature

LAC – Latin America

LCA – Life Cycle Assessment

Lps – Litres per person

MFA - Material Flow Analysis

MS - Mississipi

$MtCO_{2eq}$ - Metric tons of carbon dioxide equivalent

MW - MegaWatt

MWh – MegaWatt hour

NGOs – Non-Governative Organizations

NM – New Mexico

NPNRU – Nouveau Programme National de Rénovation Urbaine

NZE – Net Zero Emissions

OECD - Organisation for Economic Co-operation and Development

Pbs - Planetary Boundaries

PACV – Plan d´Action Core de Ville

PROSECTUR – Programa Sectorial de Turismo

R&D – Research and Development

REDD+ - Reducing Emissions from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries

RESCoop – Renewable Energies Cooperatives

RTE - Réseau de Transport d'Electricité

SANAA – Sejima And Nishizawa And Associates

SCIRN – Shrinking Cities International Research Network

SDGs – Sustainable Development Goals

SEDATU - Secretaría de Desarrollo Agrario, Territorial y Urbano

SEM – Societé d´Èconomie Mixte

SEMARNAT - Secretaría del Medio Ambiente y Recursos Naturales

SENER – Secretaría de Energia

SMEs – Small-Medium Enterprises

SPA – Salus per Aquam

STI - Science, Technology, Innovation

SWOT – Strengths, Weaknesses, Opportunities and Threats

TMVB - Transmexican Volcanic Belt

TEPCV - Territoires à Ènergie Positive pour la Croissance Verte

TEPOS - Territoires à Ènergie Positive

TICCH - International Committee for the conservation of industrial Heritage

TIPP – Tax Interieure su les produis petroliérs

UN -United Nations

UN-Habitat - United Nations Human Settlements Programme

UNDP – United Nations Development Programme

UNEP – United Nations Environmental Programme

UNESCO - United Nations Educational, Scientific and Cultural Organization

UNFCC – United Nations Framework for Climate Change

UNWTO – United Nations World Tourism Organization

UoS – Uso of System

US- United States

USD – United States Dollars

UK -United Kingdom

VAT – Value Added Tax

W/m2 – Watt per square meter

WHO - World Health Organization

WMO -World Meteorogical Organization

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Appendix

Table 9: Index of Green Economy interventions in Mexican Shrinking cities

Municipality	Depopulation rate 1990-2020	Green Economy intervention	Leading Actor	Category of intervention
Canatlán (Durango)[61][62]	9,5%	Solar Farm (269 MW)	Risen Solar Technology (China)	Renewable energy power plant
China (Nuevo Leon)[63]	19,9%	Wind Farm "Los Dolores" (244 MW)	Enel Green Power Mexico (Italian)	Renewable energy power plant
Tamazunchale (San Luis Potosi)[64]	5,2%	Combined Cycle Power Plant (1.179 MW)	Iberdrola Mexico (Spanish)	Sustainable energy Power Plant
Jerecuaro (Guanajuato)[65]	4,7%	The residual water treatment plant	Municipality of Jerecuaro (Mexico)	Sanitation
Zacualpan (Mexico)[66]	6%	Wastewater treatment plant	National Water Commission (CONAGUA)	Sanitation
Llera de Canales (Tamaulipas)[67]	23,3%	Wind Farm "3Mesas" (149 MW)	Sigma Alimentos S.A. (México)	Renewable energy power plant
San Fernando (Tamaulipas)[68]	5,6%	Wind Farm "Los Vergeles" (160 MW)	Environmental Agency for the sustainable development of Tamaulipas	Renewable energy power plant
Salvatierra (Guanajuato) [69]	3,6%	Organic production of nopal	Urireo Community	Sustainable and innovative practices in the first sector

[61] https://apps1.semarnat.gob.mx:8443/dgiraDocs/documentos/dgo/estudios/2019/10DU2019ED047.pdf

[62] https://www.jornada.com.mx/2020/10/17/estados/023n3est

[63] https://www.eleconomista.com.mx/estados/Inicia-construccion-parque-eolico-en-municipio-de-China-20181211-0083.html

[64] https://www.iberdrolageneracionmexico.com/ciclo-combinado-tamazunchale/

[65] http://sinat.semarnat.gob.mx/dgiraDocs/documentos/gto/estudios/2008/11GU2008HD038.pdf

[66] https://www.perriodismo.com.mx/2014/06/28/entregan-rehabilitada-la-planta-de-tratamiento-de-aguas-residuales-en-zacualpan/

[67] https://www.nadb.org/our-projects/infrastructure-projects/tres-mesas-wind-energy-project-in-llera-de-canales-tamaulipas

[68] https://www.evwind.com/2009/07/31/avanza-el-parque-eolico-en-los-vergeles-san-fernando-mexico/

[69] Negrete et al. 2016, La transicion hacia la sustentabilidad: el caso de las microempresas de nopal en la comunidad de Urireo, Salvatierra, In: El desarrollo regional frente al cambio ambiental global y la transición hacia la sustentabilidad. Asociación Mexicana de Ciencias para el Desarrollo Regional, A. C., México.

Tecpatan (Chiapas)[70]	37,8%	Organic milk certification	"La Pomarroza" Community	Sustainable and innovative practices in the first sector
La Huacana[71] [72]**(Michoacan)**	13,3%	Jamaica cultivation and other organic products with polyculture systems	Sustainable Agriculture Programme of Michoacán	Sustainable and innovative practices in the first sector
Rodeo (Durango)[73]	9,8%	Production of compost based on oregano residues (experimental)	Technological University of Rodeo	Sustainable and innovative practices in the first sector
Tlahualilo (Durango)[74]	22,3%	Irrigation infrastructure for sustainable agriculture	Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food	Sustainable and innovative practices in the first sector
Villamar (Michoacán)[75][76]	27%	Agro-ecological techniques in maize production and environmental conservation	Municipality and Secretariat for Rural Development and Agrifood	Sustainable and innovative practices in the first sector
Tecuala (Nayarit)[77]	18,9%	Ecosystem-based fisheries adaptation in biosphere reserve "Mariposa Monarca"	Fisherman´s cooperatives	Sustainable and innovative practices in the first sector
Playa Vicente (Veracruz)[78]	20,7%	Conservation agriculture	Syngenta (Germany)	Sustainable and innovative practices in the first sector
Tepeyanco (Tlaxcala)[79]	21,3%	Family garden farming system	Local community	Sustainable and innovative practices in the first sector

[70] Toral et al. 2014, Innovación en el proceso de conversión y certificación de la leche bovina con productores de Tecpatán Chiapas: un pilar del desarrollo rural sustentable

[71] https://www.quadratin.com.mx/sucesos/milpa-en-la-huacana-con-agricultura-sustentable/

[72] Burgos A.L. 2019, Conservacion y produccion organica, en: La biodiversidad en Michoacán, Estudio del Estado 2, vol. III, CONABIO, Mexico, pp. 109-114.

[73] Cordero Villa et al. 2018, Producción de composta a base de residuos de orégano, (tallo y hoja) en el Municipio de Rodeo, Dgo. Revista del Desarrollo Urbano y Sustentable Vol.4 No.10 17-21

[74] https://www.gob.mx/agricultura/regionlagunera/articulos/entregan-proyecto-para-la-conservacion-y-uso-sustentable-de-suelo-y-agua-a-productores-de-tlahualilo?idiom=es

[75] http://proam.michoacan.gob.mx/busca-ayuntamiento-de-villamar-el-resarcimiento-ambiental-del-municipio/

[76] https://www.quadratin.com.mx/municipios/destacan-en-villamar-casos-de-exito-de-agricultura-sustentable/

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[78] http://www.anacmexico.org/index.php/8-ultimas-noticias/23-agricultura-de-conservacion-en-playa-vicente-veracruz

[79] Monctezuma Pérez S. 2013, Cambios y continuidades en el manejo de huertos familiares del suroeste de Tlaxcala, Mexico

Teul de González de Ortega (Zacatecas)[80][81]	45,4%	Agave and mezcal production/ Pueblo mágico program/ Water infrastructure "la Ticuata"	Tequila industry/ Municipality/ Tourism Secretary	Sustainable and innovative practices in the first sector/ sustainable tourism
Tlazazalca (Michoacán) [82]	47,3%	Wastewater treatment plant	Michoacán Federal State	Sanitation
Viesca (Coahuila de Zaragoza)[83]	4,4%	Management program of the "Villa de Bilbao" voluntary natural reserve	Ejidos owners	Conservation of natural resources
Armeria (Colima) [84]	0,6%	Reforestation	Pronatura Mexico/ EUROCLIMA+	Ecosystem-based adaptation to climate change
Metztitlán (Hidalgo) [85]	2,1%	Biosphere reserve "Barranca de Metztitlán"	National commission of natural protected areas	Conservation of natural resources/ Sustainable tourism
Catorce (San Luis Potosi) [86]	20,2%	Inclusion in "Pueblos magicos" program of post mining town	Tourism Secretary of San Luis Potosi	Conservation of historical and cultural heritage/ Sustainable tourism
Yuriria (Guanajuato)[87]	11%	Inclusion in "Pueblos magicos", ecotouristic development plan	Tourism secretary of Guanajuato	Conservation of historical, natural and cultural heritage
Escuinapa (Sinaloa) [88]	30,3%	Sustainable tourism project "Playa Espiritu"	National Tourism Development Fund	Conservation of natural resources/ Sustainable tourism

[80] https://biblat.unam.mx/es/revista/revista-de-geografia-agricola/articulo/produccion-de-maguey-y-mezcal-estrategias-de-desarrollo-rural-en-teul-de-gonzalez-ortega-zacatecas

[81] http://www.sectur.gob.mx/gobmx/pueblos-magicos/teul-de-gonzalez-ortega-zacatecas/

[82] https://agua.org.mx/michoacan-avanza-tlazazalca-con-obras-de-agua-y-saneamiento-quadratin/

[83] http://www.coahuilatransparente.gob.mx/disp/documentos_disp/PROGRAMA_DE_MANEJO_VILLA_BILBAO1.pdf

[84] https://euroclimaplus.org/actualidad/noticia-bosque/852-municipio-de-armeria-implementa-acciones-de-adaptacion-basada-en-ecosistemas

[85] https://elsouvenir.com/reserva-de-la-biosfera-barranca-de-metztitlan/

[86] http://www2.inecc.gob.mx/publicaciones2/libros/360/slp.html

[87] http://sinat.semarnat.gob.mx/dgiraDocs/documentos/gto/estudios/2008/11GU2008TD100.pdf

[88] https://www.gob.mx/sectur/prensa/presenta-fonatur-proyecto-turistico-sustentable-en-playa-espiritu-sinaloa

Chontla (Veracruz)[89][90][91]	7,6%	Restoration and environmental protection/ use of 'Sierra Odontepec' medicinal plants/ backyard agricultural production	Fundación Pedro y Elena Hernández A.C./ Local community	Conservation of natural resources
Tamiahua (Veracruz)[92]	26%	Conservation of Humedal ecosystems Ramsar site	Municipality and Veracruz State	Conservation of natural resources
Juchipila (Zacatecas)[93]	9,5%	"El Ranchito" dam	"Three for one" national programme for remittance management	Innovation in governance for environmental issues
Azoyú (Guerrero)[94]	53,7%	Sustainable Community Tourism	Local community	Sustainable tourism
Moroleón (Guanajuato)[95]	1,9%	Municipal Planning Institute of Moroleon	Municipality	Innovation in governance for environmental issues
Siltepec (Chiapas)[96]	12,5%	Municipal Sustainable Development Plan	Municipality	Innovation in governance for environmental issues
Angostura (Sinaloa) [97]	6,8%	Sustainable Development Council	Municipality	Innovation in governance for environmental issues
Agua Dulce (Veracruz) [98]	6,6%	Reforestation	Municipality	Conservation of natural resources
Madera (Chihuahua)[99]	29,9%	Forestry Industry	Ejido el Largo y Anexos	Ecosystem services

Source: Author, Kaiserslautern, 2022

[89] Domínguez-Barradas et al. 2015, "Plantas de uso medicinal de la reserva ecológica "Sierra de Odontepec", Municipio de Chontal Veracruz, Mexico", CienciaUAT vol. 9n. 2

[90] https://www.pedroyelena.org/programas/veracruz.html

[91] Sánchez-Galván et al. 2019, Backyard Agricultural Production as a Strategy for Strengthening Local Economy: The Case of Chontlaand Tempoal, Mexico, Sustainability 11, 5400

[92] http://www.tamiahua.gob.mx/wp-content/uploads/2018/08/PLAN-MUNICIPAL-DE-DESARROLLO-TAMIAHUA.pdf

[93] http://www.fao.org/3/ca0922en/ca0922en.pdf

[94] Anzaldúa-Soulé et al. (2020), "Turismo Comunitario Sustentable en la Microrregión Costa Chica-Montaña, Guerrero, México", Revista Venezolana de Gerencia, vol. 25, núm. 90, pp. 546-562, 2020

[95] http://www.implanmoroleon.gob.mx/wp/bienvenidos/

[96] https://docplayer.es/22952394-Plan-municipal-de-desarrollo-sustentable-de-siltepec-chiapas.html

[97] https://www.entreveredas.com.mx/2019/03/angostura-cuenta-con-consejo-de.html

[98] https://imagendelgolfo.mx/coatzacoalcos/arrancan-programa-de-reforestacion-en-agua-dulce/439733

[99] https://ejidoellargo.com.mx/

Table 10: Socio Environmental Crisis in Shrinking Mexican Cities

Municipality	Depopulation rate 1990-2020	Crises determinant	Leading Actor	Category of crises
Chicontepec (Veracruz)	10,6%	Oil extraction	PEMEX (Mexico)	Environmental contamination
El Oro (Durango)[100]	29,9%	Agroindustry	Programme of Direct Support to the Countryside (PROCAMPO)	Socio-Environmental impact
San Fernando (Tamaulipas)[101]	6,8%	Shale gas extraction	Iberoamericana de Hidrocarburos S.A.	Socio-Environmental impact
Concepcion del Oro (Zacatecas)[102]	9,6%	Mineral Ores and Building Materials Extraction	Macocozac S.A.	Socio-Environmental impact
Tlacotalpan (Veracruz) [103]	18,9%	Sea level rise	Climate change	Vulnerability to climate change
Nochistlán de Mejia, (Zacatecas)[104]	13,6%	Lack of governance in ecological issues	Local institutions	Weak institutions
Chachihuites (Zacatecas)[105]	31,2%	Social conflict with mining company	Panamerican Silver (Canada)	Socio-Environmental impact
Tempoal (Veracruz)	1,2%	Social armed conflict with organised crime	Organised crime organizations	Insecurity

Source: Author, Kaiserslautern, 2022.

[100] Ríos Rentería, I., & Rivera, P. (2020). Impacto socioeconómico y ambiental del PROGAN y el PROCAMPO en el municipio de El Oro, Durango. Agricultura Sociedad Y Desarrollo, 17(1), 143-170.

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[102] https://www.ejatlas.org/conflict/minera-macocozac-concepcion-del-oro-zacatecas-mexico

[103] Tovar et al. (2019), Vulnerabilidad socioeconomica, cambio climatico e incremento del nivel del mar en Tlacotalpan, Veracruz, JAINA Costas y Mares ante el cambio climático 1(1).

[104] https://www.monografias.com/trabajos93/condiciones-fisicas-economicas-y-sociales-nochistlan-mejia-zacatecas/condiciones-fisicas-economicas-y-sociales-nochistlan-mejia-zacatecas5.shtml

[105] https://www.jornada.com.mx/2017/01/31/estados/025n1est

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PROFESSIONAL SUMMARY

Reliable and dedicated professional with expertise spanning political science, urban research, global team collaboration, strategic planning, and project management success for leading organizations

A dynamic and motivated professional with the educational background and proven work ethic to guide and support policy analysis, strategic planning, research, and more. A dedicated team member who is known for producing impactful publications, with the skillset to analyze complex information, establish strategic partnerships, and lead diverse individuals. Out-of-the-box thinker who is comfortable working in global teams or independently to ensure solutions consistently meet or exceed business goals. Exceptional training and academic qualifications, including PhD in Spatial and Environmental Planning; M.A. in Socio-Environmental Studies; M.A. in Science of Development and International Cooperation; M.E. in Renewable Energies; B.A. in Political Sciences.

- Political Science
- Research Design
- Geographical Analysis

CORE COMPETENCIES

- Policy Analysis
- Project Management
- Stakeholder Engagement
- Capacity Building
- Team Leadership
- Strategic Planning

PROFESSIONAL EXPERIENCE

UNIVERSITY OF KAISERSLAUTERN, KAISERSLAUTERN, GERMANY, APR 2019 TO MARCH 2022
Early Stage Researcher

- ESR within the Reviving Shrinking Cities Innovative Training Network (RE-CITY ITN) project funded by the EU Horizon 2020, MCSAction agreement number: 813803. https://www.uni-kl.de/re-city/about-re-city-itn/
- Conduct advanced scientific research into planning and policymaking related to urban shrinkage and depopulation; develop the research design and scientific, theoretical, and methodological framework
- Fieldwork, leverage of documents, interviews, economic and spatial data analysis for empirical research
- Generate key insights through research and outline policy recommendations, related to urban planning, administrative capacity, social and economic policy
- Gain additional experience and expand skills by participating in workshops, scientific conferences, and events, including scientific conferences
- Compose and publish scientific papers
- Research stays at the University of Guadalajara, Mexico (one year)
- Secondment at Energy Agency Rhineland Palatinate (one month)

FLACSO, QUITO, ECUADOR, OCT 2016 TO MAR 2019
Research Fellow

- Research collaboration activities in the Department of Socio-Environmental Studies
- Academic and institutional events within the Intercultural Laboratory of the Department of Socio-Environmental Studies
- Organization of databases in the FLACSO ANDES bibliographic system
- Urban gardening in FLACSO building
- Attendee the master's program in Socio-Environmental Studies maintaining a grade average above 8/10

PONTIFICAL CATHOLIC UNIVERSITY OF ECUADOR, QUITO, ECUADOR, JULY 2015 TO DEC 2017
Associated Teacher (part-time)

- Lecturer of the course "COP21: New commitments with the Environment" within PUCE´s Specialization Studies program. The course aimed to address the new mechanisms developed at the United Nations climate summit for global climate change adaptation plans
- Lecturer of Italian language in the Faculty of Languages, Linguistics and Literature

INDOAMÉRICA UNIVERSITY, QUITO, ECUADOR, OCTOBER 2016 TO MAR 2016
Associated Teacher (part-time)

- Lecturer of English language in the School of Languages

FUNDACIÓN DESARROLLO SOSTENIBLE, MURCIA, SPAIN, JULY 2014 TO JAN 2015
Project Officer

- Reports of economic viability for Solar Photovoltaic Installations projects
- Maintenance of databases and indicators of the campaign "!Cut the cables: self-sufficiency is possiblei"
- Monitoring of photovoltaic installations
- Networking activities, Communication and Social Media management

UNIVERSITY LA SAPIENZA, ROME, ITALY, APR 2012 TO APR 2013
Administrative Assistant
- Administrative office of the Faculty of Political Science
- Computer support services of the faculty
- Department Library Services

FUNDACIÓN APRENDIZAJENACCIÓN, SANTA CRUZ DE LA SIERRA, BOLIVIA, OCT 2012 TO DIC 2012
Intern
- Peace culture workshops for children at the "San Carlos" Public School
- Meetings and planning of the activities of the Foundation
- Fundraising

HUNGARIAN ART ACADEMY, ROME, ITALY, NOV 2011 TO DIC 2011
Intern
- Organization and promotion of Arts Events
- Poster Design

EDUCATION AND CREDENTIALS

DOCTOR OF PHILOSOPHY (PH.D.) IN SPATIAL AND ENVIRONMENTAL PLANNING, 2022 (MAGNA CUM LAUDE)
University of Kaiserslautern, Kaiserslautern, Germany
Doctoral Thesis: Building on knowledge and innovation. The role of Green Economy in revitalizing shrinking cities. Case study analysis in France and Mexico

MASTER OF ARTS (M.A.) IN SOCIO-ENVIRONMENTAL STUDIES, 2019
Latin-American Faculty for Social Sciences (FLACSO), Quito, Ecuador
Master's Thesis: Relevant elements for the discourse of Good Living in Andean Pre-Hispanic society

MASTER OF ENGINEERING (M.E.) IN RENEWABLE ENERGIES, 2015
Polytechnic University of Cartagena, Cartagena, Spain
Master's Thesis: Climate change in Ecuador, the ENSO phenomenon and perspectives in view of the Paris summit

MASTER OF ARTS (M.A.) IN DEVELOPMENT SCIENCE AND INTERNATIONAL COOPERATION, 2013. (CUM LAUDE)
University of Rome la Sapienza, Rome, Italy
Master's Thesis: Yasunì-ITT project: an opportunity for change.

BACHELOR OF ARTS (B.A.) IN POLITICAL SCIENCES, 2011
University of Rome la Sapienza, Rome, Italy

EXCHANGES
Technological University of Santa Cruz de la Sierra, Bolivia (3 months)
Balassi Institute, Hungary (1 month)
University of Montpellier1, France (ERASMUS, 10 months)

TRAININGS
"Map Academy: get mapping quickly with QGIS", Udemy
"Capacity Development: concepts processes and tools", GIZ Academy for International Cooperation
"Cultures and geographies of energy transitions" Central European University
"State, Politics and democracy in Latin America", Escuela de Estudios Latinoamericanos y Globales
"Inequality", Colegio de México
"Conceptual basis on climate change", Ministry of Environment and Sustainable Development of Colombia

PUBLICATIONS

- Di Pietro, S. (2017). Acuerdo de París: ¿Nuevos compromisos con el Medio Ambiente o nuevas oportunidades de negocio? *Cooperativismo & Desarrollo*, 25(111). https://doi.org/10.16925/co.v25i111.1874
- Alarcón, P.;Rocha, K.; Di Pietro, S. (2018). Die Yasuní-ITT-Initiative zehn Jahre später. Entwicklung und Natur in Ecuador heute, *PERIPHERIE*, 1-2018, S. 55-73. https://doi.org/10.3224/peripherie.v38i1.03
- Di Pietro, S. (2018). Energía y buen vivir: alternativas de producción descentralizada de la energía. *Vía Iuris*, 24, 1-29. https://doi.org/10.37511/viaiuris.n24a8

- Di Pietro, S. (2019). Economic Policies in Latin America and the Transition Economies. Different patterns of the Washington Consensus approach application, and their effects on material domestic extraction rates. *Eunomia* VIII n.s. n. 1, 23-48. DOI: 10.1285/i22808949a8n1p23
- Di Pietro, S. (2019). Tello, Golte y Dussel: tres visiones sobre el desarrollo de un sustrato cultural común en los Andes. *Chakiñan, Revista de Ciencias Sociales y Humanidades*, 8, 88-100. https://doi.org/10.37135/chk.002.08.06
- Di Pietro, S. Implementing Energy-as a Common approach in the revitalization of shrinking cities. *Belgeo* [En ligne], 1 | 2021. https://doi.org/10.4000/belgeo.49525
- Vargas-Hernández J.G., Di Pietro S. (2021) Urban Green Innovation: public interest, territory democratization and institutional design. In: Dhiman S., Marques J. (eds*) Handbook of Engaged Sustainability.* Springer, Cham. https://doi.org/10.1007/978-3-319-53121-2_54-1
- Di Pietro, S., 2021. Urban Shrinkage and Suburbanization in Mexico: A View Based on the Last Census Data. *Iberoamericana – Nordic Journal of Latin American and Caribbean Studies*, 50(1), 63–74. http://doi.org/10.16993/iberoamericana.519
- [In press]. Vargas-Hernández J.G., Di Pietro S. (2022) Green Economic Growth based on Urban Ecology and Biodiversity. In: Dhiman S., Marques J. (eds*) Handbook of Engaged Sustainability.* Springer, Cham.
- [In press]. Di Pietro, S. (2022) Procesos de la transición urbana a sistemas autónomos descentralizados de energía renovable. *Estudios Demográficos y Urbanos* (https://estudiosdemograficosyurbanos.colmex.mx/index.php/edu/pages/view/enprensa)
- [In press]. Di Pietro, S. (2022). *Utilizing Solar energy and technology production-oriented strategies in Shrinking Cities*. Elgar handbook on Shrinking Cities.
- [In review]. Di Pietro, S. (2023). The role of a Green Economy in revitalising shrinking cities. Comparative case studies in France and Mexico*. Journal of Latin American Geography*

CONFERENCES

- May 2019. XLI International Convention of Americanistic studies, 7-12th may, Perugia, Italy. Presentation of Paper: "Tello, Golte y Dussel: tres visiones sobre el desarrollo y de un sustrato cultural común en los Andes".
- May 2019. Seminar on Methodology Research and Practice, 24th may 2019, University of Guadalajara (MX), Centre for Administrative and Economic Studies, Master of International Business and Studies. Presentation of "Analysis of feasibility for the production of solar energy in the condominiums of the city of Guadalajara as a development strategy for shrinking cities".
- August 2019. VIII Sociology Conference, University of Buenos Aires, presentation of paper: "Green Economic Growth based on Ecology and Biodiversity". http://jornadasdesociologia2019.sociales.uba.ar/wp-content/uploads/ponencias2019/71_20.pdf
- September 2019. 12th CITTA International Conference on Planning Research. Spatial Planning for Change. Presentation: "Urban Green Innovation: public interest, territory democratization and institutional design".
- July 2020. Scientific Conference "Energy communities for collective self-consumption: frameworks, practices and tools" organized by University of Grenoble Alpes. Presentation: "Energy-as a Common in Shrinking Cities Energy Transitions". https://www.youtube.com/watch?v=WbmPuz_Hcew
- December 2020. Guest Lecture at Department of International Planning Systems of Technische Universität Kaiserslautern
- March 2021. Presentation "Suburbanization and shrinking cities phenomena in Mexico. A view based on 2020 census data" at Scientific workshop PIVOT: Revisioning Peripheral Geographies: strategies for resilient urban development in the global south. Session of Mexico https://pivotfrontiers.com/workshop-mexico/
- April 2021. Presentation "Suburbanization and shrinking cities phenomena in Mexico. A view based on 2020 census data" at American Association of Geographers, Annual Meeting.

ADDITIONAL INFORMATION

Languages: Italian (Native), English (C2), Spanish (C2), French (C2), German (A1),
Technical Proficiencies: Microsoft Office Suite (Word, PowerPoint, Excel, Outlook), QGIS, Mendeley, AtlasTi, Google Workspace
Others: Work visa in Ecuador; Driving License B; Collaboration as referee of the following journals: Environmental Research Letters doi:10.1088/issn.1748-9326; Environmental Research Communications; Revista IUS E-ISSN 1870-2147; Revista Derecho del Estado ISSN digital: 2346-2051; Revista VIA IURIS 2500-803X.
Interests: Politics, Travels, Sports, Arts & Music