THE ROLE OF A GREEN ECONOMY IN REVITALISING SHRINKING CITIES: COMPARATIVE CASE STUDIES IN FRANCE AND MEXICO

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Abstract: This paper aims to research different strategies for developing the green economy in shrinking cities. Considering urban shrinkage and the green economy as two extended concepts, a French town in post-Fordist transition and a Mexican post-mining town are selected as the most diverse/similar systems to indicate different strategies for sustainable development in shrinking cities. Embedded into different national backgrounds, including urban dynamics and support schemes for the green economy, the selected cases share the objectives of greening and regrowing strategies relying on other sectors of the green economy. The methodology applied is qualitative, including fieldwork, semi-structured interview techniques, carried out in person or remotely, and questionnaires. Findings show some positive results regarding sustainability and ecological transition in the French case, while regrowth trends were reached in the Mexican case. However, the analysis leads to uncertain scenarios for positive long-term impacts, especially due to uncertainty around future supporting policies for territorial cohesion and sustainability at national and regional levels.

Keywords: shrinking cities, green economy, sustainability, France, Mexico

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Introduction

The processes of urban shrinkage and green economy transitions are two complex ideas recognised as open concepts. The shrinking city is defined 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 economic transformations with some symptoms of a structural crisis" (Shrinking Cities International Research Network – SCIRN). Although demographics and gross domestic product are the leading indicators to detect shrinking cities, many others are involved in the study of shrinking cities, such as the employment rate, quality and quantity of building stocks, social problems or vacant spaces (Stryjakiewicz, Jaroszewska 2016). The phenomenon of urban shrinking can be variegated and takes on different types. Oswalt and Rienits (2006) identified no fewer than 21 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 the size of a shrinking city.

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Shrinking cities share common cumulative problems which are spiral: scarce or uncompetitive tangible and intangible resources (Hospers 2012), population decline, underuse of infrastructures with deterioration or financial issues for their maintenance (Moss 2008), undeveloped regional innovation systems and emerging vacant spaces devaluating the rest of the territory. Shrinking cities also tend to be less energy efficient (Liu et al. 2020) and less capable of mitigating CO_2 than growing cities because of the persistence of industrial sectors (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 shrinking towns of less than 100,000 inhabitants, which seems to be even more prone to long-term and extreme shrinkage (Restrepo Cadavid et al. 2017).

To address their sustainability problems, shrinking cities should pursue greening objectives within the framework of planned shrinkage or regrowth processes. The emerging crises in shrinking cities can be seen as opportunities with possible new resources arising for urban planning to improve liveability and sustainability (Pallagst et al. 2017, 2019). In this sense, shrinking cities can be laboratories for social (Haase, Rink 2012) and economic innovation, exploiting the new areas included in the transition to the green economy.

The term 'green economy' was introduced by Pearce et al. (1989) to be re-launched by the United Nations Environmental Programme (UNEP) in 2008 in response to the global financial crisis (Davies 2013). The UNEP offers a generally accepted definition of the green economy as "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 Green Economy Reports: A preview 2010: 4–5).

Despite being subject to different favourable or critical interpretations relatable to stronger or weaker sustainability visions (Chapple 2012; Ehresman, Okereke 2015; Loiseau et al. 2016; Gómez Rodríguez 2021), the concept of a green economy brings new insights into the alternatives available to enable new greening and/or regrowing strategies in shrinking cities. Factors and contexts driving or promoting effective regrowth involve multiple dynamics and should be studied on a case-by-case basis. Depending on the type of shrinking city and consequently, on the type of resources available, it is possible to identify several strategies that can enable shrinking cities to play an important role in green transitions.

According to Wu and Yao (2021), regrowing policies targeting external investment and enterprises seem to be more effective in shrinking cities than other policies targeting at attracting the population. Analysing the US shrinking 'stagnant' cities, Renn (2019) considers that these should already be one step ahead and establish the preconditions for taking advantage of any future positive market changes. Among the valuable interventions are financial restructuring, governance reforms and upgrades in public services.

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

Some of the approaches to stimulate innovation-led regrowth involve the creation of new industries in the most technology-based sectors. Regions specialised around a leading sector as well as peripheral areas struggle to find ways to compensate for the lack of local knowledge spillovers (Grillitsch, Nilsson 2015) and build new regional advantages (Isaksen, Karlsen 2013) since industries and companies located in peripheral regions have to deal with weak and limited systems of support for innovation and entrepreneurship. Usually inserted into the context of peripheral regions, shrinking cities miss a developed critical mass in any industrial specialisation. Considering their level of peripherality, different regions have different potential to develop innovation in the green industry (Grillitsch, Hansen 2019).

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 sustainable development paths.

On the other hand, 'greening shrinking cities', understood as investing in the local green consumption sectors to improve the quality of life, can be an indirect strategy leading to regrowth, since 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. Indeed, Haase et al.'s (2021) results show that neoliberal policies only promote economic growth, while welfare state policies refer to urban development in a more integrative way. 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 national, state, regional and local levels (Pallagst et al. 2017). Depending on the type of local perception of the urban shrinkage phenomenon, adaptive or regrowth-oriented approaches are applied (Stryjakiewicz, Jaroszewska 2016). From the adaptive approach, we move from the slogan 'smart growth' to that of 'smart shrinking' (Pallagst 2007), which is achieved by directing planning towards efficiency and sustainability so that the new conditions can be exploited to improve liveability.

Greening or green growth actions in shrinking cities can be complementary by creating public policies to establish partnerships with appropriate actors. While green growth actions aim at the creation of clean-tech manufacturing and clusters in green industries through collaboration with public and private, and even external research institutes, greening measures involve more local actors to promote sustainable practices in areas such as energy and utilities, green built environment, waste management, management of ecosystem services and sustainable tourism (Fig. 1).

The present state of green sector development in shrinking cities includes the following examples: the energy and utility industry were developed in the shrinking cities of Herne and Gelsenkirchen, Germany (Jung et al. 2010; Förch, Pallagst 2019); the community energy cooperative approach was adopted in Melpignano, a shrinking city south of Italy (Tricarico 2015; Candelise, Ruggieri 2020); waste management industry was developed in the Japanese city Kitakyushu (Ortiz Moya 2020); an industrial ecology approach was also adopted in the shrinking city of Dunkerque in France (Beaurain, De Rocher Chembessi 2019); green building techniques were adopted in Leipzig, Germany (Haase et al. 2019); the management of green spaces was enhanced in the case of Osijek in Croatia (Olic, Stober 2019); agroecology and urban gardening were important areas of focus in the shrinking city of Detroit

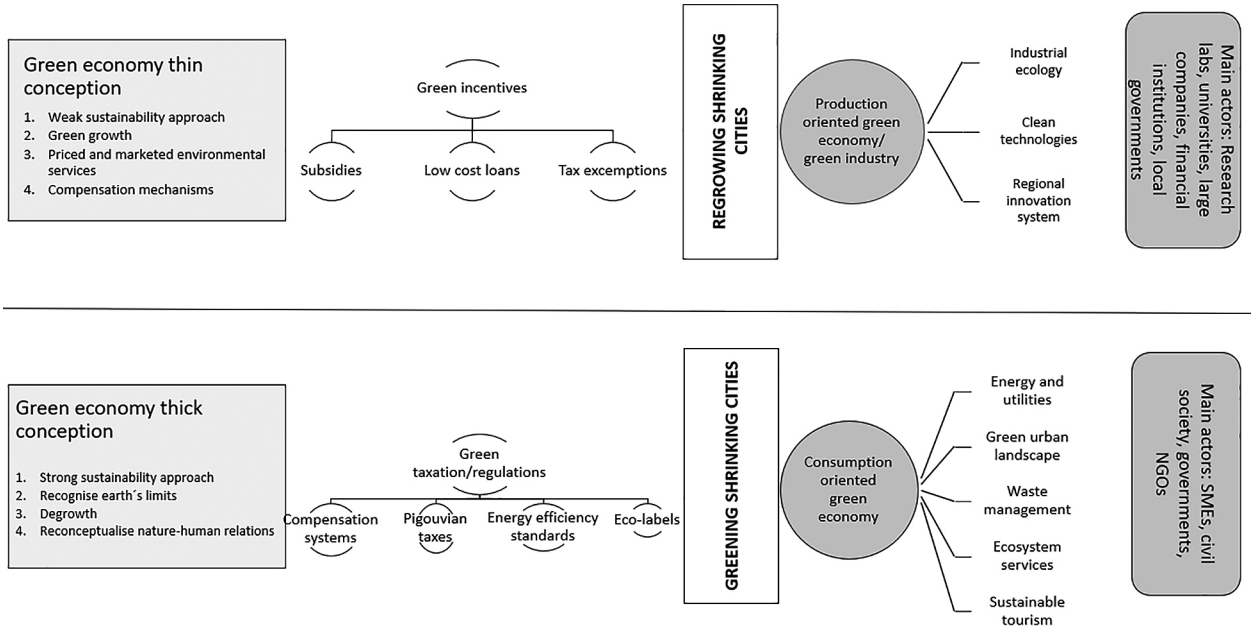


Fig. 1. Greening/regrowing shrinking cities through green economy: Conceptions, public interventions, sectors and main actors.
Source: own study.

(Herrmann et al. 2018) as well as activities of sustainable tourism in the case of 'Art Islands' Naoshima, Teshima and Inujima in Japan (Fujita 2018). The results of all these researches indicate that when projects are concerted and planned by regional public policies and public funding, the desired objectives are more easily attainable, as in the cases of the German *Energiewende* or the Japanese ecological transition; but, on the other hand, even without these, bottom-up initiatives show potential in stimulating the local economy, as the experiences of energy cooperatives in Italy and agro-ecological practices in the United States demonstrate.

Methodology

The case study selection of this paper is based on the proposal of the towns of Vitry le François, located in the region Marne, France and Mineral de Pozos, located in the Federal State of Guanajuato, Mexico.

The two case studies were selected in countries where the RE-CITY ITN PhD programme took place between 2019 and 2022.

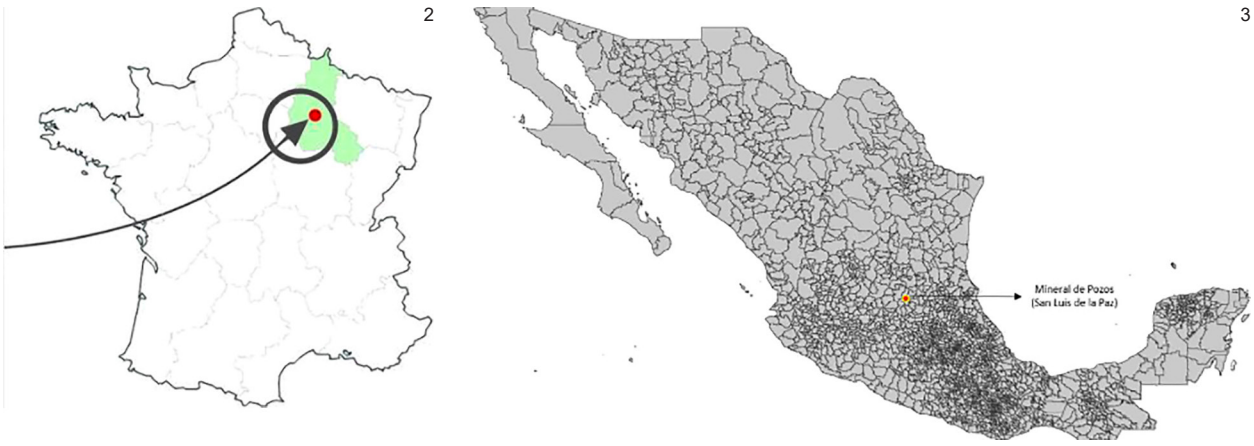
In the case studies selection process, two main criteria were prioritised: the magnitude of shrinkage and the presence of green economy initiatives. The case studies analysis is preceded by a description of the national backgrounds in France and Mexico regarding the phenomenon of urban shrinking and the green economy state of development. The descriptive analysis of the case studies is based on the analysis of documents and interviews with public/private stakeholders. Fieldwork was specifically conducted in the French case with techniques of participant observation, semi-structured interviews with different levels of the local government and civil society, as well as workers' representatives. In Mexico, the strategy was based on semi-structured interviews held remotely with representatives of the business sector, public institutions and the local community. The analysis and discussion of the results focus on the case studies to extrapolate general concepts regarding the role of the green economy in shrinking cities.

Research areas

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 follows the most different systems (Anckar 2008), since France and Mexico have different modes of urban shrinkage and different states of progress towards the green economy.

Vitry-le-François (Fig. 2) is a shrinking city situated in the Marne department of the Grand Est region in France. Rivers and canals crisscross the territory, and Vitry is located at the centre of three channels linking the Marne, Rhine and Saone Rivers.

Vitry was created in 1545 at the behest of King François I. During the First World War, it served as a hospital town and in the Second World War,



Figs 2–3. Locations of Vitry le François and Mineral de Pozos in France and Mexico.

Vitry was bombed and destroyed, to be rebuilt according to the original square geometric plan.

Mineral de Pozos (Fig. 3) is located in the federal state of Guanajuato and is part of the municipality of San Luis de la Paz. The characteristics of urban shrinkage fall into the category of post-mining decline, which in this case can be considered of extreme magnitude: at the beginning of the 20th century, the city was populated by about 12,000 inhabitants (INEGI Historical Archive of Localities); it was almost completely abandoned in the 1960s and started to grow again in the 1990s.

Background information on urban shrinkage and the green economy in France and Mexico

Urban shrinkage is considered to be a 'silent process' (Cunningham-Sabot, Fol 2009) in France (Wolff, Wiechmann 2018). Out of 354 French urban areas, 69 of them (19.5%) experienced population loss between 1975 and 2007, being shrinking cities basically located in former mining and industrial areas in the north, north-east and around the Massif Central (Wolff et al. 2013). Three-quarters of shrinking French cities have fewer than 50,000 inhabitants and often specialise in economic sectors now in recession (Paulus 2004). Although these data are outdated, the validity of the results is substantially confirmed by the study of Chouraqui (2021), which integrates the 2016 census data into the analysis of medium-sized French cities (Fig. 4). Based on the analysis of census data up to 2016 (INSEE), the population of French medium-sized cities is clearly declining, with markers of fragility in their central municipality (Chouraqui 2021).

Although not without criticism (Baudin, Genestier 2006), urban shrinkage in France is mainly tackled through the 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).

As regards Mexico, the phenomenon of shrinking cities has been decreasing over the past 30 years within a national urban system characterised by the accelerated growth of small and medium-sized urban centres. Among 401 urban centres considered in the national urban system, 29 cities have a population loss between 1990 and 2020 (Di Pietro 2021), but taking into account a

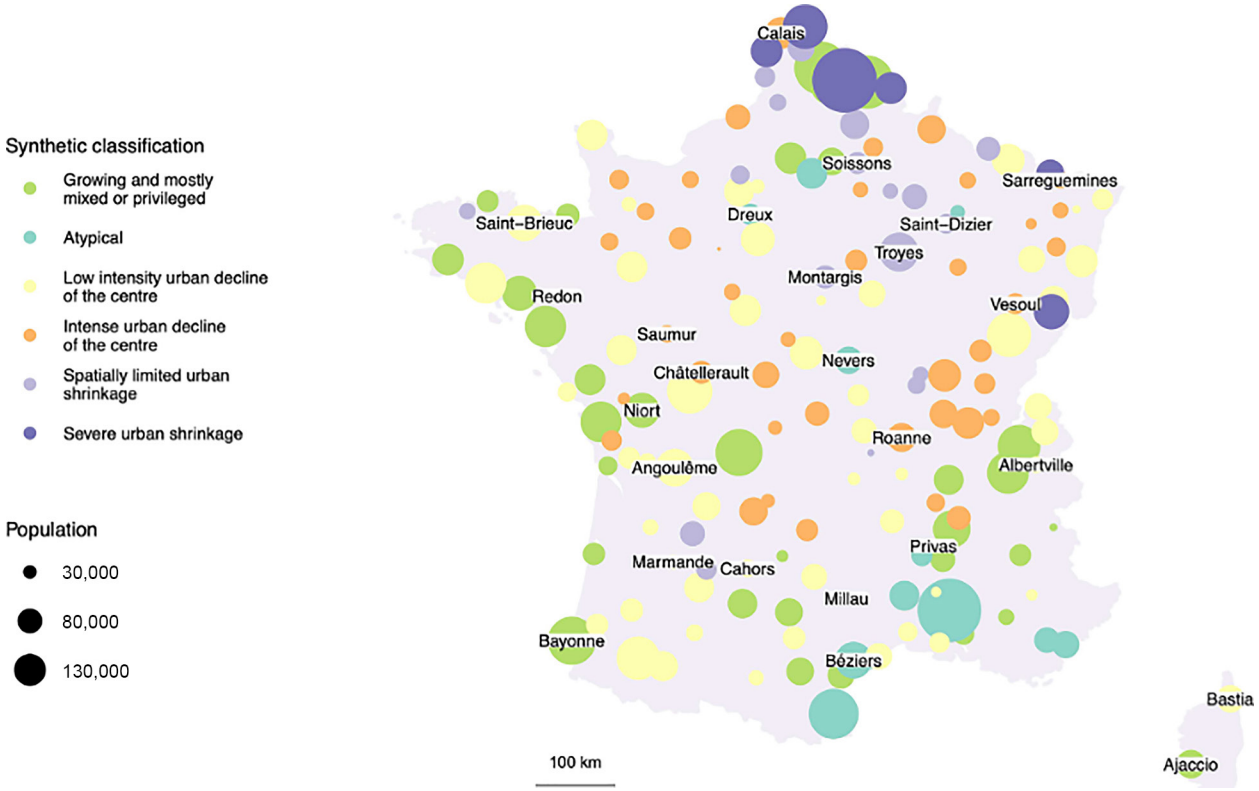


Fig. 4. Map of French shrinking cities.
Source: Chouraqui (2021).

condition for the average rate of population loss of 0.15% per year (i.e. 4.5% in 30 years), these become 18 (Fig. 5).

The main lines of development of the green economy in France are described in the Energy Transition for Green Growth Act (2015), indicating the general policy pathways towards low carbon economic development establishing ambitious energy and climate targets covering multiple sectors and timeframes. Mechanisms, green innovation incentives and retrofitting subsidies are set with the aim of achieving the 'factor of four' targets to reduce CO_2 emissions by 75% by 2050, compared with the levels in 1990, including a reduction in nuclear energy production, which currently accounts for three-quarters of the French energy mix (Hölscher, Jensterle 2018). The French targets align 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 restoring biodiversity and reducing pollution in Europe.

France already achieved a total CO_2 emissions decrease (CITEPA 2012) because of the implementation of the nuclear power programme and other actions such as consumer energy savings campaigns that have made it possible to reduce emissions generated by energy conversion from the electricity production subsector by 25.7% between 1960 and 2009.

In France, the circular economy and eco-innovation have continued their development in industrial symbiosis and the social and solidarity economy (European Commission Eco-innovation index 2019). France ranks among the top eight countries globally for the ability to export complex green products according to the green complexity index ranking designed by Mealy and Teytelboym (2022).

Mexico is one of the largest and most diverse Latin American economies with a high potential in renewable energy. Yet, its economic structure has traditionally relied on a brown economy, that is, one strongly associated with the exploitation of fossil fuels. Between 2003 and 2014, the total costs of natural resource depletion or degradation in Mexico increased by 40% (SEMARNAT 2015).

Transitions to the green economy in Mexico face several socio-economic structural barriers such as the following: the lack of specialised knowledge of advanced technologies favours a situation of neocolonialism or green grabbing; the need to stimulate accelerated economic growth relegates sustainability issues to negligence; the lack of socio-economic equality does not allow a fair distribution of benefits and externalities preventing to approach sustainability threshold in a —spatio-temporal dimension.

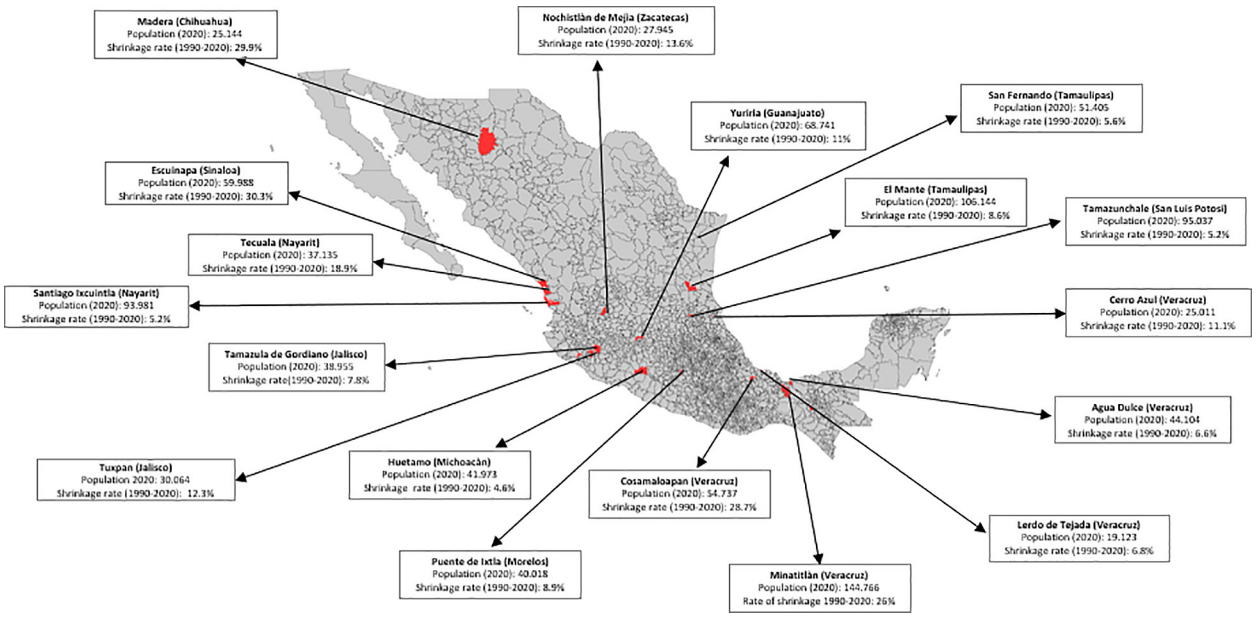


Fig. 5. Map of 18 shrinking cities of Mexico.
Source: own study.

In 2016, the Mexican Congress ratified the commitment to reduce greenhouse gas emissions by 50% compared with emissions in the year 2000, into the year 2050, as described in the INDC of Mexico (Mexico – Government of the Republic 2015) presented to COP21. According to Sarmiento et al. (2019), these targets are fragile and do not deviate much from the projections of scenarios without climate policies. One of the most critical aspects of the Mexican green economy is the traditional subsidies that Mexico applies to fossil fuels (Grunewald, Martínez 2014). The previous government, Mexico's so-called '4T' or fourth political transformation, also followed in this vein, including the entry in functions of the country's largest refinery 'de Dos Bocas' in the state of Tabasco, with a refining capacity of 340,000 barrels/day. This was in parallel to the decrease in the budget allocated to environmental protection institutions during the environmental crisis in Mexico.

Mexico's energy transition has been referred to as part of neo-colonial green grabbing practices or as a Trojan Horse of capitalism, particularly in the region of the Isthmus of Tehuantepec (Siamanta, Dunlap 2019). Currently, the share of renewable energy in the Mexican energy supply is around 9.5% (Grunewald, Martinez 2014), which is considerably low given the natural potential of the country. Doubling of energy consumption in Mexico is projected by 2050 (IRENA 2015). The National Energy Secretariat (SENER 2016) estimates an annual increase in consumption of 3.4% until 2030, of which the majority would be 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 20 countries globally 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) shows the significant differences between the north and south of Mexico, with the production and commercial space being located more in the north.

Decentralised energy systems in planned urban shrinkage: The case of Vitry-le-François

Currently, Vitry le François has 11,743 residents (INSEE 2018), 30% less than in 1968; the ageing population index is 18% higher than the average of the Marne region (Department of territories urbanism service).

Depopulation and ageing in Vitry are 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. Between 1982 and 2012, the total number of jobs decreased by 9%, while the number of industrial employment fell 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 Francois is 22% lower than the national average (INSEE 2019). The economic and social structure has historically been based on industrial sectors such as wood, construction, agri-food, plastics and metalworking (Miot, Rousseau 2019). According to the interviews carried out with the representatives of a local trade union, while the COVID-19 pandemic had exacerbated the situation of job losses in local industries in 2020, the metallurgy and plastics sectors are experiencing more significant job losses due to the general decline of the automotive industry.

In institutional terms, the territory is structured on two levels: an inter-municipal authority—the Vitry, Champagne of communes Vitry, Champagne et Der (CCVCD), 25,000 inhabitants—of which almost all services are shared due to the importance of the central town; and a 'country' made up of three communities of communes in a competitive situation. Traditionally run by right-wing liberal administrations, since 2008 the administration has been led by left-wing political currents, which are playing an essential role in transition projects and the gradual change from Fordist approaches to urban management (Demazière, Daviot 2011; Édouard 2014).

The main local stakeholders are the municipal government, the single social landlord owning most of the housing stock, traditional private enterprises and the new small and medium-sized

enterprises (SMEs) recently formed in the green transition process.

Already part of the national network 'Positive Energy Territories' (Territoires á Energie Positive, TEPOS) managed by CLER (Comité de Liason Énergies Renouvelables) gathering together French territories heading toward energy autonomy, Vitry le François was among the beneficiaries of the national funding programme called 'Positive Energy Territories for Green Growth' (Territoires à énergie positive pour la croissance verte, TEPCV) through which the French government awarded 550 territories between 2015 and 2017, and each received between €0.5 million and €2 million in aid (Nadaï et al. 2015). 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" (Ministère français de l'écologie et de l'énergie). This initiative sought to transform the context of French energy policy, historically centralised and dominated by electron-nuclear technology.

The energy and ecological transition programmes 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.

In 2016, Vitry produced 13% (255 GWh) of the energy consumed from renewable energies (ATMO Grand Est, air quality monitoring association). However, as most final energy consumption is captured by the manufacturing local industry, the production of renewable energies per inhabitant (10 MWh/inhabitant) is higher than the average in the region (7 MWh/inhabitant). Within this production, 202.4 GWh comes from wind energy, 30.8 GWh from biomass heat, 10.7 GWh from aerothermal heat pumps and 4.1 GWh from photovoltaic production.

Inside decentralised energy system projects, efforts were initially concentrated on constructing wind farms and adapting the biomass heating system.

According to the interviews with local authorities, wind energy production is set to increase by at least 25% with new ongoing concessions to power companies. The benefits coming from wind energy are mainly due to taxes applied to the inter-municipal electricity network and obtained via the ERDF (French manager of the electricity distribution network). However, job creation in the wind sector is limited and is concentrated on the installation phase of wind farms and the associated maintenance services, which leads to the creation of small local enterprises.

The Biomass Energy System of Vitry was created in 1985, consisting of a 15.6 MW biomass heating plant, three oil-fired heating plants of 4 MW, 5 MW and 8 MW; 18 km of the network; and 43 stations, which makes 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% was bark, 20% forestry chips and 30% offcuts from woodworking companies. A total of 55% of the tonnage was supplied within a radius of less than 100 km, with the remainder coming from the area between 100 and 200 km. 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. The heating plant of Vitry is among the lowest costs in France (Douard 2014). In 2016, the public-private mixed economy company SEM 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 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.

Historically, the spatial segregation of the working classes in the suburbs, especially in the Hamois suburb, favoured the emergence of social housing owned by a social landlord called 'Vitry Habitat', which was holding 54% of the housing stock. A demolition to rebuild strategy has been operating in this area since the early 2000s, tackling the economic and demographic crises by improving the urban built environment by considering the improvement of energy efficiency standards.

In agreement with the French ANRU, the reconstruction of only two-thirds of the demolished buildings was planned, leading to a planned shrinkage process in Vitry-le-François.

Despite this fact, encountering difficulties that no longer allowed it to fully assume its mission as a social landlord, in 2021 Vitry Habitat was forced to merge with the group 'Le Foyer Rémois'.

The urban redevelopment is aimed 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 and green spaces and intended to be a place for retirement, tourism or residence.

The question of how to use the land freed up by these demolitions remains unresolved. According to the interviews conducted, the main problem is the timing of urban renewal. If it does not proceed quickly, there is risk of increasing the problem of vacant spaces and underused infrastructures already evident in the city. On the other hand, what is worth noting is the commitment to the redevelopment of some old industrial buildings that are being converted for new activities in the services sector, such as the La Fabrique business centre, where municipal offices and environmental businesses are now located.

The green areas are managed through a special community service by the public authorities, through the support of external landscapers' designers. The principle of a diversified management plan inspires the service according to three types of zones: zero, medium and strong acceptance of spontaneous vegetation. This approach is optimal for a shrinking city: the creation of spontaneous vegetation spaces has the potential to optimise ecosystem services by boosting biodiversity and reducing maintenance costs in the context of diminishing resources and personnel availability.

The objective is the development of an urban forest and pedagogical yards for the safeguarding of old vineyards by adopting permaculture techniques.

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

The VEOLIA EAU group manages blue Infrastructure in Vitry; given the presence of several companies with contaminated waterways, the city is furnished with a water treatment plant,

Fig. 6. Clockwise from top left: la Salamandre neighbourhood; Spontaneous vegetation; Haffner Energy pilot unit; Biomass Heating Plant.
Source: Photos taken by the author and Haffner Energy.

which means that the local water is considered to be of average quality.

At the junction of three canals, Vitry-le-François still has a shipyard and a marina, the second-largest destination on the Marne. Each year, it welcomes more than 300 boats and 700 yachters of all nationalities. 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 the capacity, the number of cycle paths has increased in Vitry le François and the surrounding area. 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 a company based in Vitry-Le-François to install a hydrogen production unit from biomass on its territory and thus supply a fleet of vehicles. This company is finalising its product for market launch having already two pilot stations (the other in Strasbourg); the one in Vitry-Le-François has a 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. They 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 total production cost for mobility will eventually be €3/kg, equivalent to that of tax-free fossil fuels (French domestic tax on petroleum products and value-added tax – TIPP and VAT), while at present, the production cost of other technologies, particularly water electrolysis, is around €10/kg at the pump[1]. In the case of Vitry, there is a lot of expectation for developing this 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 quickly. Since 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 considered later.

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

A post-mining shrinking city re-growing: The case of Mineral de Pozos

Today, the city has 2,856 permanent residents (INEGI, 2020) and around 400,000 visitors each year (Guanajuato State Tourism Observatory; Esquivel Rios, Villaseñor Ramírez 2022).

It was a former settlement of Chichimeca culture; the first foundation was built in 1576 by the Jesuit missionaries of the Society of Jesus, who taught the tribes European processes and the benefits obtained from the extraction of the mineral from the mines (Jesuit smelting furnaces dating from 1595).

The city often changed its name: originally called Palmar de la Vega, it was called Ciudad Porfirio Diaz towards the end of the 19th century, however, it has always been better known as Mineral de Pozos or Pozos, as the inhabitants commonly call it.

Its period of most extraordinary splendour was towards the end of the 19th century when the demographic growth led to increased cultural activities attracting essential companies such as Fabricas de Francia, Plaza de Toros, Railways and Hotels. In 1893, the Modelo School and the Municipal Building were built; the railway was completed. The temples date back to the 16th and 19th 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 Perlon, all have Baroque architecture style. The struggle of the Revolution of 1910, and the Cristero rebellion movement in the 1920s in Guanajuato, broke the economic charm bringing Mineral de Pozos into decline. The consequence was the suppression of the municipality of Mineral de Pozos in 1928, leaving part of the municipality of San Luis de la Paz. After losing the municipality, Mineral de Pozos was transformed and could no longer

decide about its own path of progress. This loss of rights and privileges led to its sudden collapse: in 1930, during the international economic crisis, the last substantial capital was retained, causing the abandonment of the most important mining companies. 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 complete abandonment.

Since ancient times, 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 avoiding pollution through the use of concrete and reducing the consumption of annealed red brick, which emits large quantities of polluting gases into the atmosphere during its manufacture. The local stone material called 'caliche' is used for construction.

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*, as the furnaces were also known, were used to melt silver, which was produced with the help of quicksilver or mercury. They were sent to different coin mints for later distribution throughout Europe and Asia.

The National Institute of Anthropology and History has issued a prohibition to modify houses without authorisation and without respecting the architectural canons.

Since the foundation by the Jesuits, more than 300 mines were opened and more than 1,200,000 tons of ore were extracted till 1926, which is the period of closure of the last shot (López Quevedo 2016).

Fifty-two properties date back to the 19th century; among heritage properties with historical and cultural value, the old triangle mine, the old municipal presidency, the old model school, the old municipal grocery store, the old bullring, the

Fig. 7. Clockwise from top left: San Pedro Apóstol church; El Triangulo Mines; Chacuacos furnaces; Cinco Señores mines.
Source: public domain photos.

old hacienda del beneficio la Purisima, the old Cerrillos factory and the old radio station are all built in the rustic Mexican Colonial architectural style, with Eastern influences reminiscent of Neoclassical, Mudejar and Gothic styles.

Seven buildings date from the 20th century, three of which were initially 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.

Most of the sites, which, because of their historical and identity character, are tourist references, are managed by private individuals. 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 as it contains infrastructure that can generate economic benefits through tourism. The community land 'Ejido Pozos' has 1,471 ha, 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 that are spaces that belong or belonged to the ejido.

The ruins and the desolate character of the town have been a great attraction for several cultural activities. Since 1966, Mineral de Pozos was the perfect location for various films and several artists went to live there. In particular, a group of artists called 'Tribu' began to promote various activities, including the Festival de la Toltequidad and the production of pre-Hispanic music instruments, such as the *teponaztli*. In 1982, the federal government issued a decree classifying Mineral de Pozos as a 'Zone of Historical Monuments', a first step in protecting the heritage site, and today an indispensable requirement for a locality to be considered within the Magical Towns Programme. Since 2012 it has been nominated as one of the five magic towns of the federal state of Guanajuato.

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 investments 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.

According to the interviews, the tourism phenomenon undoubtedly benefits local commerce, dedicated to groceries and food supplies, miscellaneous stores, shops, greengrocers and butchers, established or itinerant restaurants, and the sale of handicrafts and souvenirs. Mineral de Pozos is promoted as first sustainable *pueblo mágico*: the Modelo 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. In the agro-ecological area, there is a lavender ranch for beauty oil or food products; farms adopting lombricomposting techniques and the sustainable production of mezcal liqueur from local products are detachable.

The results of citizens' perception of tourism in Mineral de Pozos, within the diagnosis of competitiveness and sustainability of Magical Towns (Secretaria de Turismo Michoacan 2014), show that 60% of the interviewed inhabitants consider that tourism benefits this municipality thanks to the creation of employment. However, the small- and medium-sized traders' sector is characterised by the emergence of tensions 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.

The attention to real estate developments in Mineral de Pozos began after the visit of Mexican President Vicente Fox in 2003 (Hiernaux-Nicolas 2015). The real estate market incrementally dynamised after that visit: high-end residences were 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, involved actors outside the community, including Americans, Australian citizens or foreign babyboomers within a circle of amenity tourism migration looking for a specific rural utopia associated with an imaginary 'good life' (Yi-Fu 1986). The real estate sector takes advantage of tourism to promote sustainable development

in the Ejido Pozos, which consists of high-value subdivisions with a sustainable approach, subdivisions and use of vacant spaces considered historical heritage, sustainable use of existing resources, attracting investment in the locality, as well as the management of services.

The 'Senores de Pozos' subdivision will cover 1,112 ha and is presented as a project for a sustainable community with urban living and coexistence habits. The project will be carried out on part of the Ejido Pozos. The ejido is an irregular polygon that currently consists of 1,470.61 ha with the following boundaries. According to the plan for sustainable tourism development in the ejido Pozos (SEMARNAT), the Señores de Pozos urban development involves an investment of $18 million and has a development time of 30 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 land occupancy and use coefficients: Country-residential: Coeficiente de Ocupacion del Suelo 50%; Coeficiente Uso del Suelo: 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 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. The project presents, among others, objectives such as environment and natural landscape protection and restoring, safeguards and restoring 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, 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 is based on contour lines and built on the natural ground level covered with a level of natural soil covered with earth. It favours 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 plants along the course of the gully; soil improvement and terrace shaping; construction of filtering dams; modular waste water treatment and reuse system; solid waste collection and recycling centre are also considered within the project as an integral part of the sustainable tourism development in Ejido Pozos.

Discussion

In Vitry-le-François the energy transition project is supported by an ecological vision that seeks to improve urban metabolism and a transition of the productive matrix, from traditional to the 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 for new projects operated on a national scale through the French Ministry of Ecological Transition.

The projects (Fig. 8) launched at 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); 'Action heart of the City' (Coeur de Ville), 'Incentive Taxation' and 'Regional Food Project' (Project Alimentare Territorial, PAT). The problem tree (Fig. 9) 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, a circular economy and energy efficiency, which also expands through urban renewal, transforming the crisis of the local social housing system.

On the other hand, looking back over its history, Mineral de Pozos went from being an important mining centre in the colonial period, with the founding of the town around 1600 by the Jesuits, to a boom in production and development in the 19th century. The cessation of the 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. 10).

The problem tree (Fig. 11) of Mineral de Pozos interprets urban devaluation due to the decline of mining activities in the transition to the 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.

Whether culturally motivated or mass-market, tourism is becoming a fundamental protagonist in territorial dynamics and 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 latest economic and social prospects opened

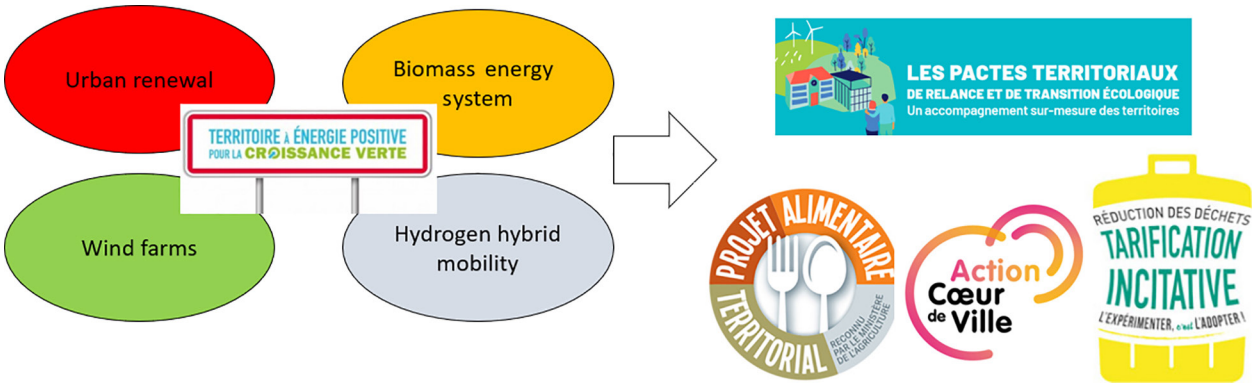


Fig. 8. From TEPCV to the new projects being implemented in Vitry-le-François.
Source: own study.
TEPCV – Positive Energy Territories for Green Growth.

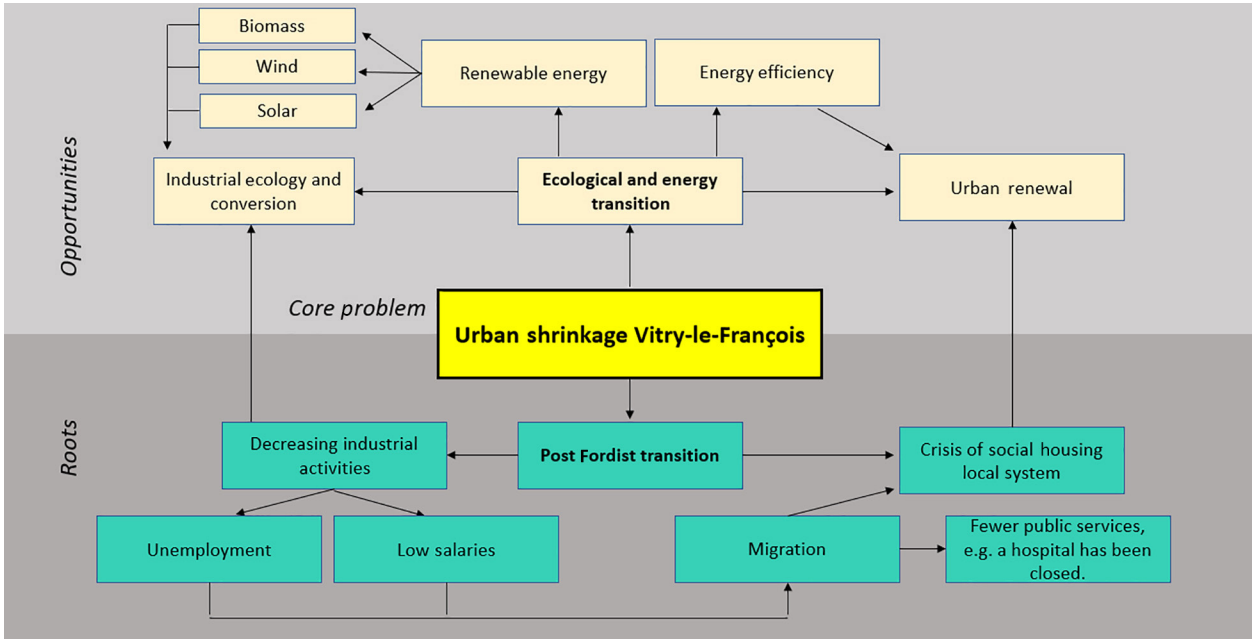


Fig. 9. The problem tree of Vitry-le-François.
Source: own study.

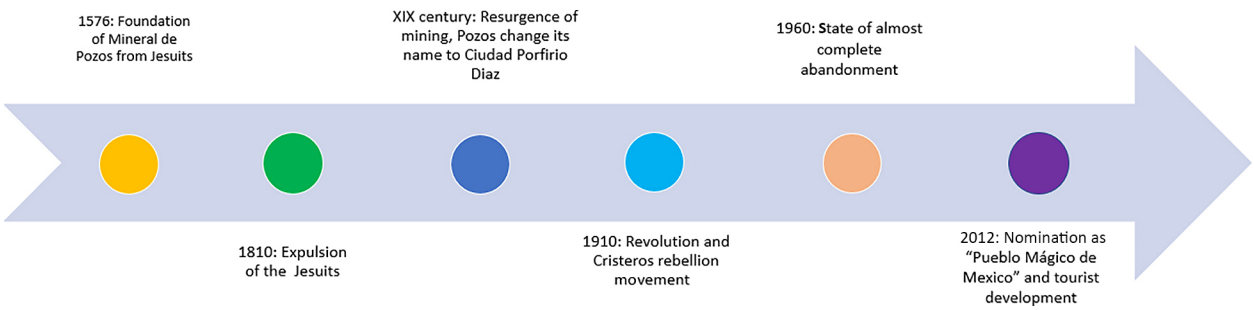


Fig. 10. Timeline of Mineral de Pozos.
Source: own study.

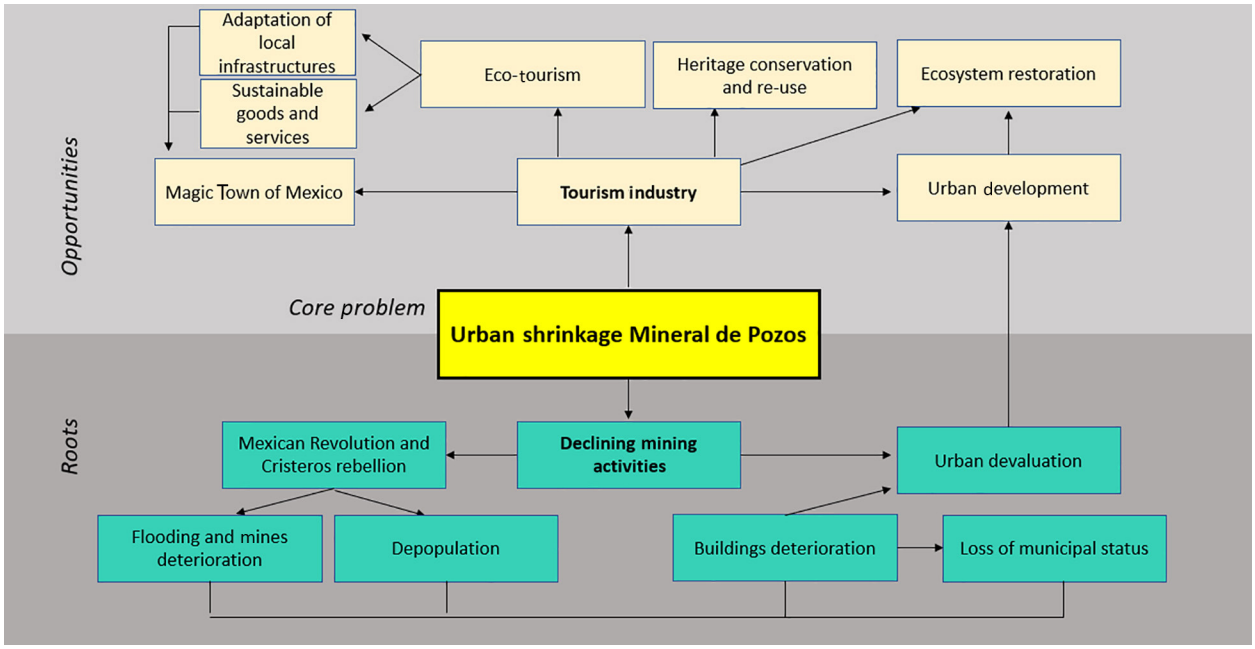


Fig. 11. The problem tree of Mineral de Pozos.
Source: own study.

up by tourism (López Quevedo 2016). 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.

Its inclusion in the '*Pueblos mágicos* de Mexico' national programme in 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, and water decontamination and ecotourism. However, with a more critical approach, the tourist development of Mineral de Pozos linked to the absence of planning approaches from public institutions is leading to a risk of real estate speculation that distances the development project from sustainability standards in the long term, promoting new unsustainable patterns in the use of resources.

Conclusions

The purpose of this paper was to highlight different strategies for developing shrinking cities within the framework of the green economy. Shrinking cities that are regrowing strategies led by green transitions have a potential to stimulate turnover in urban decline: for the shrinking city with a solid industrial base it makes sense to invest in progressive technological conversion; however, they will have to start interventions in specific sectors of the green economy where they have a greater chance of success. This

may be given by national and regional contexts in which the shrinking city is located, including the presence of financing and innovation support schemes, influencing the ability to embark on solid green economy paths.

In this paper, French energy decentralism and Mexican sustainable tourism are identified as examples for key strategies to develop declining small- and medium-sized cities along sustainable paths.

The outline for further research includes researching these aspects in shrinking cities, especially in shrinking cities in developing countries, which so far are less well known. Indeed, from an economic point of view, shrinking cities of developing countries can be seen as the 'peripheries of the peripheries' within the global economic system. They face many crises in the context of weakness or even lack of state intervention, while local responses tend to be based on private or community initiatives. Here, it is the major outcome of this case study comparison: political support for the green transition in shrinking cities allows for higher investments and the search for long-term effects, while the market-based local economy seeks short-term effects and looks at green economy sectors simply as new emerging markets but without any concerted effort towards sustainability.

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