
**RESEARCH PROPOSAL**

**An investigation into the potential impact of a high-voltage electricity transmission infrastructure project on Dumfries & Galloway**

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**ABSTRACT**

The rapid expansion of renewable generation has identified limitations with many existing high-voltage electricity transmission systems and the age of these systems may mean that new infrastructure with larger capacity is required. This can cause problems for communities, particularly those with little or no previous experience of large-scale transmission systems, in accepting such infrastructure. This research proposal examines the literature surrounding how people and communities perceive these projects as well as the possible implications for business. This review suggests that a 'one-size fits all' view does not work and that particularity rather than generalisation is needed. Consequently, the proposal advocates a multi-method research approach to evaluate the economic and social impacts arising from a proposed infrastructure project in Dumfries & Galloway.

**THE RESEARCH PROBLEM**

The last decade has seen a rapid expansion of renewable generation to the point where parts of the existing 132kV high-voltage electrical transmission infrastructure in the UK are incapable of transferring the power generated from these widely distributed and remote sources to where demand exists. Consequently, as well as dealing with obsolescence issues, some sections of the UK transmission network need to be upgraded to cope with the additional capacity.

One such proposal concerns south west Scotland where Scottish Power plan to upgrade the 132kV transmission network, parts of which are up to 80 years old. This research proposal aims to investigate and quantify the various socio-economic and environmental factors which may impact on Dumfries & Galloway and its people, if such a scheme, using overhead lines and pylons, goes ahead as planned.

The need for this research is driven, in part, by the limited availability of peer-reviewed journal papers dealing with major electrical infrastructure projects from which empirical data on factors such social, economic and environmental impacts may be expected to arise. Consequently, stakeholders and those charged with overseeing and regulating such projects have little firm evidence on which to base decisions and, although the project may be strategically important, the resolution to proceed with an overhead line approach may be made in the absence of detailed knowledge of whether the proposal is good or bad for the region as a whole.

Further support for this research comes from Beauly-Denny where anecdotal and subjective evidence suggests that transmission infrastructure based on overhead lines, and blight, are synonymous. It is here that the presence of evidence could help to confirm or dispel such emotional and potentially biased views. Finally, the region of Dumfries & Galloway is unique in several respects to other parts of the UK, having distinct characteristics which may not easily accommodate a 'super-grid' approach without significant disadvantage.

For the above mentioned reasons, this research proposal is driven by the absence of firm data on which to base sound social and economic decisions, the presence of subjective and possibly biased experiential views and the unique, rich, natural resources available in Dumfries & Galloway which may make the region vulnerable to an overhead line approach. The need for such a research base is therefore considered as an essential pre-requisite before proceeding further with the current proposal, or even a derivative of this proposal.

**WHY THE RESEARCH IS IMPORTANT**

Scottish Power's proposed project is classed as a Strategic Wider Works (SWW) project under the terms of Ofgem's RIIO-T1 price control framework and is considered economic when the cost of the project is less than the cost consumers would have to pay under the counterfactual of there being no increase in transmission capability; resulting in constraint payments [1]. To give an order of scale here, Scottish Power Transmission Ltd cite cumulative additional constraint costs increasing from £2.3bn in 2021 to £16bm by 2030, unless there is investment in reinforcing the transmission network [2].

These projected payments, however, are themselves subject to significant error because of overly optimistic assumptions as to how much generation will be operational by that time, and whether such generation would attract constraint costs. At least two forms of error arise. Firstly, the method of assessing the future level of adoption of renewable energy tends to favour National Grid's Gone Green Scenario [3], a point recently highlighted as a weakness by Ofgem [4]. Secondly, the projections take no account of the recent UK Government's change of political direction in terms of removal of subsidy for on-shore wind [5].

Setting aside the economic argument associated with constraint costs as well as the likelihood of such costs being higher than what might be expected in practice there remains the issue that some degree of uprating of the transmission network from Harker, near Carlisle, through Dumfries & Galloway to Auchencrosh in south Ayrshire will be necessary. Such uprating will not only accommodate any additional capacity, but it will also address obsolescence issues. Scottish Power's proposal, when available, will be subject to a Needs Case Assessment by Ofgem who will consider, amongst other things, whether the need is justified, if the technical scope and delivery timetable is appropriate, and whether the proposal is in the interests of existing and future consumers [1].

Against this background, transmission companies, such as Scottish Power Transmission Ltd, have a statutory duty under Schedule 9 of the Electricity Act 1989 to have regard to the desirability of preserving the natural beauty and special features of any area that its lines will pass through and to take reasonable steps to mitigate the impacts of said proposals [6]. Ofgem interpret this to mean that the network plans must include reasonable measures to

avoid unacceptable disturbance to the host environment and to the people who live, work and enjoy recreation within it [7].

In practice the Scottish Minister discharges this requirement by the process of consenting, refusing or calling for mitigation measures in considering Section 37 planning applications. While the Scottish Government should have sufficient knowledge to make this judgement in balancing strategic needs against protecting the needs of the region it is unlikely Scottish Power have adequate background data at the project development stage to accurately evaluate the socio-economic and environmental impacts called for by Ofgem [8]. Furthermore, Scottish Power are only due to submit their Environmental Statement, which is meant to address these and other impacts, after applying for planning consent and this provides a mere one month window for non-statutory consultees to comment, which is too short to allow meaningful dialogue. It also occurs too late in the process.

What is missing in this process is data, both quantitative and qualitative, that can be used to inform and shape the development at an early stage as well as improve the consultation phases of the infrastructure project. Such data needs to be independently generated and recognised by all parties as providing a credible account of the situation. The research proposal therefore aims to put this missing data into the public domain.

**LITERATURE REVIEW**

There is a growing body of literature that seeks to understand what drives opposition to high-voltage transmission lines. In the last decade this research has been given fresh impetus [9], from the realisation in both developed and developing economies that the lack of transmission capacity has become the largest barrier to the development of new renewable electricity sources. This problem arises due to the remote location of many of these new forms of renewable energy sources, which therefore lack connection to a convenient transmission network [10]. Consequently, plans to overhaul, replace and strengthen network infrastructure to facilitate a low-carbon future, and secure long-term sustainability may experience countless delays and setbacks caused by the resistance of local groups to nearby projects [11].

The main thrust of this research to date has largely focussed on the broad subject of individual opposition to transmission lines. For instance, Cain and Nelson [9] examine the individual drivers of opposition in a USA context while Elliot and Wadley [12], from an Australian perspective approach the subject from a perception of risk. Other researchers, Cohen *et al*., [11] examine the issue from a social acceptance perspective while Batel and Devine-Wright [13] take the social acceptance of infrastructure further by arguing that transmission networks that are proposed, or imposed by authorities or companies on individuals and communities often assume that as far as people who do not actively oppose or contest their proposals, are accepting of them [14].

This focus on distributive justice or equity issues [13] has, from a regulatory viewpoint, sought to ensure that the benefits from proposed projects are proportionate to the costs incurred. The cost to individuals and communities, however, receive less attention but result in opposition. Here, [9] examines a range of drivers of opposition arising from effects on property prices, visual and noise impacts, land use attributes, psychological stigma and perception of risk. Drawing from the literature they cite property prices falling by 2-9% near to an overhead line while proximity to towers can cause a price reduction of 10-15%. For higher value properties this can increase to 15-20%. This upper range is also found to apply to agricultural property [15] while in the UK Sims and Dent [16] find values fall for a semi-detached house within 50m of a pylon by 19% and for a detached property within 100m by

up to 38%. On the other hand, National Grid, in line with several planning decisions, consider the effect on property values is not a material consideration [17].

Visual disruption has been identified as one of the prime sources of opposition to wind power [9] and similar findings emerge in relation to transmission infrastructure from a UK study in relation to the reduction in landscape quality [13]. In terms of residential visual amenity there is a dearth of academic research but one useful piece of commercial research [18] establishes the concept of very large-scale visual effects arising from 50m pylons when located less than 400m from a residential property, although this distance may be modified, up or down, by a range of factors.

The level of concern for landscape quality and residential amenity has been established through research conducted on behalf of the National Grid [19] which has established that consumers are willing to pay up to about 3% extra on their annual utility bills, in order to mitigate the visual impacts arising from high-voltage overhead lines, with undergrounding being the preferred option. Meanwhile, many countries in Europe have endorsed significant underground schemes, with Germany and Austria likely to approve legislation to limit high voltage transmission lines to a distance of 400m from residential or environmentally sensitive areas [20].

Aural disruption is also reported to be one of the drivers for opposition [9] with a positive correlation between the level of disturbance and the operating voltage. In this case greater disturbance is reported by residents living close to overhead lines than to substations. However, this appears to be at odds with the Beauly-Denny experience [21].

Land use is a further factor which attracts individual perceptions of the social acceptability of or opposition to high-voltage transmission lines. Although not researched to the same extent as wind farms, the development of new pylon lines appears to elicit a greater negative response than the existence of current pylons [11]. Conversely, people living in areas with more transmission line cover are more likely to respond favourably to new lines [9].

Research into the effects of high-voltage overhead lines and risks to human health from low-frequency electromagnetic fields (EMFs) has received considerable scientific attention

for several decades, and in several studies it has been found to be one of the primary drivers for opposition to transmission lines [22]. However, despite an extensive controlled study of 29,000 cases of childhood leukemia a decade ago [23], which found a raised risk of childhood leukemia in children living within 200m of high voltage power lines compared with those living beyond 600m away, official bodies generally accept the prevailing view of the scientific community that firm evidence pointing to a risk of cancer from EMF exposure is lacking. Several UK planning authorities, in their concern for the on-going uncertainty about the possible risks associated with EMF exposure, have called upon the need for transmission operators to adopt a precautionary principal and where this has failed they resort to 50m exclusion zones on the grounds of amenity or alternatively cite a possible risk to health or safety [22].

As well as this direct potential risk to health from EMFs, other research suggests a reinforcement mechanism leading to heightened opposition. In this sense, the uncertainty about the effects of EMFs created by power lines in turn can lead to a sense of stigma that amplifies individual attitudes to raise the dislike of such infrastructure [12].

These examples of distributed justice, taking account of the potential impacts to property prices, visual and aural amenity, human health, risk, and psychological stigma, can lead to winners and losers; with losers usually being closely associated with the unwanted common good [21]. Against this background it is interesting to note that a significant proportion of the population have health concerns, with 31.4% of those surveyed reporting dissatisfaction with their health in the year ending 2013. The survey, part of the 'Measuring National Well-Being' programme, finds that positive feelings about where people live can also create a strong, inclusive community with a feeling of belonging and safety. In other words, given the time people spend at home and in their local neighbourhood, how they feel about where they live is vital to their overall well-being [24].

A further recent theme emerges from the literature concerning procedural justice [10]. Here, community actors affected by outcomes of planning processes have limited opportunities to participate in the making of decisions, where siting processes prioritise the local perception of certain areas and communities over others. In such circumstances the transmission operator's consultation practices are questioned, as 'legitimising previously

made decisions,' 'giving false hope' or a means of 'divide and conquer.' Problems are also cited due to a lack of community decision-making control because of the limited range of technological options presented. Alternatively, there may be a perception that the 'public' are unwilling or incapable of taking a strategic viewpoint due to a lack of technical sophistication; factors which exacerbate public opposition leading to mistrust and planning conflicts.

This theme of procedural justice is taken up by other authors, [24] who also contend that procedural justice, or the extent to which the public are engaged in decision making, is at odds with the traditional 'decide-announce-defend' approach followed by transmission line developers. In these circumstances outcome trumps process as the people and communities affected are often involved downstream of key strategic decisions, such as routeing corridors, key stakeholders involvement and the technical aspects of the proposal planned [10].

Another aspect of infrastructure projects explored in the literature is the character of and importance of place. There is, for example, an assumption [13], that proposals for large-scale transmission networks have a material reality unique to each community; giving rise to a particular physical, social and economic footprint. Here, the authors argue that the way in which the research is studied may not allow that material reality to be grasped. The reason they offer, based on local perceptions, is because factors associated with distributed justice may not account for the particularities associated with distinct settlements or local communities. This additional dimension, they argue, adds a perspective of how residents make sense of and take account of their feelings or relationships to those places.

A similar theme is taken up by Cotton and Devine-Wright [10] who describe how the threat of overhead lines can loosen the ties that people feel with the place in which they live; indicating a disruption to place attachment. This can introduce stigma relating to the sense of place and place values leading to economic blight as well as significant social and psychological consequences. The authors argue that these 'place identification' factors are important impacts arising from the overhead line siting process which are often overlooked by transmission operators where concerns for wildlife, visual amenity and other issues predominate.

The literature review has so far concentrated on the themes of distributive and procedural justice as perceived by individuals and communities. Moving beyond this confine into broader territory there is a dearth of academic literature covering the economic impacts from transmission infrastructure arising to individuals, communities or regions. To help address this gap use is made of adjacent literature relating to wind turbines and their impact on tourism; even here though, commercially generated research tends to dominate.

In this sense, a survey of Scottish tourism conducted in 2005 [26] found that tourism depends heavily on landscape, with 92% of respondents stating that scenery was important in the choice of Scotland as a holiday destination; with the natural environment important to 89% of visitors. This importance of scenery and landscape in attracting tourists is not confined to Scotland; Failte Ireland, in their 2014 survey found similar levels of priority assigned to the natural environment by their tourists [27]. What should not be overlooked, however, is that while scenery and the natural environment are the most important attraction for visitors to Scotland, research by Visit Scotland in 2012 [28] shows that almost one third of them visit to learn about the history and culture of the region. The Scottish Government are right, therefore, to describe Scotland as having a world-class environment in which nature and culture are inextricably linked; with the principal physical asset being its land [29].

The 2005 survey of Scotland's tourists found that the highest level of negative perception arising from man-made structures arose from pylons, at 49% of those surveyed. Wind turbines, on the other hand, were fourth highest at 25% [26]. These survey figures show Dumfries & Galloway's Gross Added Value (GVA), arising from the hospitality, recreation and catering sector falling because of the negative impact from wind farms by £4.1m (£3.0m due to less tourism visits and £1.1m from reduced accommodation spending) with a consequent loss of 277 jobs. At 2005 prices these figure represent a fall of 5.9% in GVA and 5.8% in jobs.

What is not known is how these projected falls in GVA from wind farms can be extrapolated to new pylon infrastructure. What is known, however, is that pylons have a rate of negative reaction around twice that of wind farms, although whether there is a linear or non-linear association between negative perception and GVA is not known. On the other hand, it

seems reasonable to assume that the impact of pylons on tourism will be greater than that from wind farms.

In an attempt to fill this gap in the research and provide a reference base for socio-economic decision making associated with major infrastructure projects National Grid recently commissioned further commercial research [30] to evaluate the public perception of infrastructure development. This survey research was undertaken across a range of National Grid projects, including five built project (three electricity and two gas) and two proposed projects, both electricity. Two control locations were also included, with some interviewees asked about gas, and the remainder about electrical infrastructure. The survey covered two receptor groups; businesses and recreational users, including local residents as well as visitors and tourists with respondents located within 2km of the proposed or actual infrastructure.

The empirical evidence from this survey suggests that the majority of businesses and recreational users do not perceive there to be an impact from National Grid projects on either their own businesses or personal behaviour. However, the greatest levels of perceived effects were on the local area, with the main negative impact being to landscape and visual factors.

While this evidence usefully adds to the literature there are a number of challenging observations that can be levelled at the research, and especially the methodology. For instance, there is no attempt to justify sample size to the point where statistical confidence can be established. Indeed, in many instances, the report points out that because the sample size is too small it is not possible to establish statistical confidence in the results. Furthermore, non-coverage and non-response error are not addressed and there is an almost tacit acceptance that the results are representative of the broader population when clearly they are not.

What this research does, however, is to add an interesting dimension to any study of Dumfries & Galloway. In this case the choice of control locations, drawn from an area of the Yorkshire Dales and the Chilterns is particularly germane. Both share many features with Dumfries & Galloway in so far as they are predominantly rural, dominated by agriculture,

with outstanding landscapes and offering tourism and recreational facilities. As might be expected, the survey results from this group portray a different set of perceptions from those from the receptor audience, with both users and businesses being more concerned about the negative impact which infrastructure has on the region in terms of being a place to visit, a place to live and a place to do business.

Against this background, Dumfries & Galloway makes a major contribution to the wealth creating power of Scotland through tourism; an industry worth around £6bn of GDP (in basic prices) and accounting for 7.7% of employment [31]. Dumfries & Galloway, while contributing in a greater than proportional basis to this wealth, has a dichotomy of assets. In economic terms it is a relatively poor region in comparison to the rest of Scotland while in natural assets the region remains one of the few relatively unspoiled areas of the UK.

The region is a predominantly rural area [32] with a greater propensity for micro and small businesses, dominated by declining primary industries, especially agriculture [33]. Furthermore, the fundamental indicators of economic well-being are weak with the area classified as 'less-developed' within the European Union [34], with a GVA growth rate predicted to lag increasingly behind other parts of Scotland and the rest of the UK [35]. Additionally, business start-up rates for the region lag behind comparable regions, and business closures in 2012 exceeded the start-up rate by a large margin, while for Scotland as a whole the reverse held true [36].

To add to matters, in the past, up to 2010, inward migration – helping bring a fresh source of entrepreneurs into the region – exceeded outward migration, but a reversal occurred in 2011. In the three years to 2013 the loss of young people leaving the region looking for jobs and seeking education exceeded the gain from older people moving to the region [37]; a trend projected to continue over the coming decades culminating in an expected 6.1% population fall against an increase of 8.8% for Scotland overall by 2037 [38].

Existing estimates also suggest there are about 5500 people currently out of work and seeking employment; a figure that has doubled since 2008 and is higher than the rest of Scotland and other comparable regions. However, more recent statistically generated

model data indicates the number of unemployed may have fallen to around 3800 [39]. Of those out of work the region is one of the worst for unemployed young people [40].

On the other hand, the region is rich in natural resources as well as historic and cultural assets; the sort of qualities that make the area so attractive for people to visit but which need protection from adverse development. These qualities offer growth opportunities for increasing GVA [41] and associated employment from a growing tourism sector which, in 2009, contributed £270m or 11% to the economy [42] compared with just 8.5% for Scotland's tourism sector overall [43]. Tourism is therefore an increasingly important component of Dumfries & Galloway's rural economy, both in terms of jobs and wealth creation, with income in 2014 rising for the first-time beyond £300m and attracting more than 2,000,000 visitors [44]. In coming years numbers are expected to increase even further, having recently won the Countryfile Magazine Best Holiday Destination in Britain Award [45].

Dumfries & Galloway has a further attraction and that is in 2014 the region had the lowest carbon emissions per capita of any of the 406 Local Authority Areas in the UK. Indeed, the figure was so low, at 0.3te$CO_2$, compared with a figure of 8.2te$CO_2$ for Scotland as a whole, that it could reasonably considered as being 'carbon neutral' [46]. The region is therefore well placed to capitalise on its 'green' credentials by attracting increasing visitor numbers to the region from the multi-billion pound wave of eco-tourism sweeping the world. Given that a recent poll of 60,000 visitors ranked Scotland as the top European eco-destination, and ninth in the world [47], then if Dumfries & Galloway can nurture and protect its natural assets it has the potential to become the eco-destination of choice in both Scotland and Europe.

Figure 1 shows a theoretical framework that emerges from the literature which helps to describe the evidence base. As each region facing the prospect of new infrastructure will have its own uniqueness, the framework identifies the various sensitivities that can influence the perception of impact.

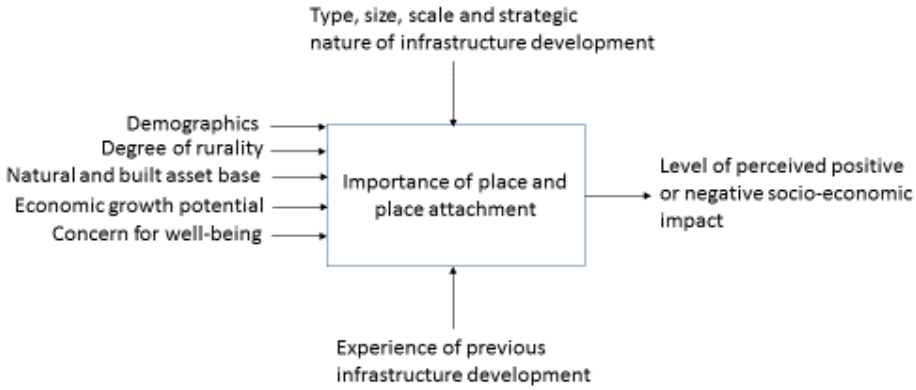
At the core of the theoretical framework is the recognition that location and how people attach themselves to that location are important factors in the formation of local perception

making. Landscape supports location and government recognise it must work with and not against the environment in which people live, work and enjoy recreation to strengthen further its contribution to society [29]. Ranged against this is the impact of infrastructure development, whether it is a road, railway, wind farm or an electrical transmission network. Here, it may be a small road or a motorway and there may be more than one new road or set of developments. Furthermore, it may simply be a repair or replacement, or a new development that is strategically important either to the region, the country, or both.

Potential mitigation of this impact lies in the extent to which the region has suffered blight through previous infrastructure development, in which case there appears to be greater tolerance of further development. Where there is little previous experience the negative perception is heightened.

There are also other, specific, factors that influence perceptions towards infrastructure development as shown on the left of the framework. In this case the degree to which these factors are correlated, or interact, is unknown. There may be additional factors. For example, age appears to be an influence; young people tend to have a lower negative perception from that of older people. Rural environments tend to have a heightened perception and, as the ERM study [30] shows, where the natural assets have been preserved and exploited by encouraging tourism, the negative perception is raised further. Potential for further economic growth, and the impact this may have on employment prospects and inward migration, also feed through to perceptions, as does the view of personal well-being – formed, in part at least, by how people feel about where they live. Thus, perception towards infrastructure projects is also shaped and influenced by life-style choices.

Figure 1 Theoretical Framework






**RESEARCH QUESTIONS**

The literature review and the emerging theoretical framework suggest that it is not possible to arrive at a 'one-size fits all' explanation for perception towards infrastructure development. There are, instead, many factors that can influence decision making in how people respond to external stimuli. Research therefore needs to be specific in order to appreciate better the particular sociological and economic factors that shape and inform thinking.

In general terms, any research should seek to quantify the likely impact on the economy of the region, including employment and inward migration, over a time horizon equivalent to the asset life of the overhead line proposal. In less objective terms, data is also needed to evaluate the perception of impact on the natural and built assets of the region arising from the various external environmental factors associated with overhead lines, pylons and substations. In addition, there is a need to appreciate how those who live and work in the region, as well as those who visit it, perceive their continued enjoyment of the region's

assets in the face of an infrastructure project and to what extent this may have consequences for the health and well-being of residents.

With this in mind the aim of this research proposal is to explore and quantify the future impact on residents, visitors, inward-migration and businesses within Dumfries & Galloway, of plans put forward for new high-voltage electricity transmission infrastructure.

Against this background the particular questions which this research seeks to answer, are:

1 What will be the impact on the region's economy, both positive and negative, over the infrastructure depreciation lifetime of 45 years?

2 What is the likely contribution to Question 1 above arising from the tourism, hospitality and recreation sector?

3 What percentage of the capital value of the project will be spent in the area?

4 How will the infrastructure project affect short and long-term employment prospects in the region?

5 How are any changes to long-term employment prospects likely to be distributed between part-time and full-time employment?

6 What is the likely impact from any new infrastructure on the economic value of the built environment?

7 To what extent might new infrastructure impact inward migration?

8 How is new infrastructure perceived by community groups within the region?

9 To what extent do perceptions change depending on the location and nature of community groups in geographic proximity to new infrastructure?

10 How do individuals perceive new infrastructure impacting their lives?

11 To what extent are individual perceptions towards new infrastructure influenced by a range of demographics factors?



**METHODOLOGY**

This section is intended to be developed further by the Crichton Institute.

While it is appreciated that several factors such as the size, scope and location of any new infrastructure will each, to varying degrees, influence the overall impact on a region the overall aim of the research is to evaluate, taking account of both objective and subjective measures, the capacity of that region to absorb such infrastructure. To aid this discovery process it is suggested that the research might consider two scenarios. The first is a minimum impact scenario with infrastructure that seeks to replace the existing network with sufficient capacity to satisfy the renewable generation likely to be in operation by end of 2020. The second scenario should consider the proposal put forward by Scottish Power in June 2015, and now temporarily withdrawn.

It is expected that the methodology will make use of mixed-method research and will comprise a sufficiently large sample size so that statistically significant conclusions can be drawn in relation to the likely costs and benefits from financial, economic, social and environmental perspectives. In addition, however, the methodology should also support the generation of a general equilibrium model whereby the impacts of the project on the local and national economy, employment, revenue and key productive sectors such as tourism, industry, farming, construction and real estate from inward migration, can be simulated.



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