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Smart territories as a driver for the transition to sustainable regional development and green economy

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ABSTRACT
Relevance. Even though there is a general agreement regarding the importance of the transition to a green economy, this process still has a long way to go, which makes the research on the role of smart territories particularly relevant.
Research objective. The study aims to describe the opportunities and areas of digital transformation of territories with a focus on the transition to a green economy.
Data and methods. The research methods include content analysis, case study, mapping, and matrix analysis. The data sources were scientific articles presented in the Scopus database, materials from the Ministry of Finance and Economic Development, the Ministry of Mineral Resources, Green Technologies, and Energy Security, materials from the Central Bureau of Statistics of Botswana, the Botswana Energy Company.
Results. Using the case of Botswana, the study showed that the establishment of a smart territory is the core mechanism of a transition to a green economy. Smart territories help regional governments to reach the sustainable development goals by using cutting-edge digital technologies.
Conclusions. The article proposes a new approach to analyzing the transition to a green economy. This approach can also be applied to reconsider the composition and roles of the drivers of territorial development. The proposed methodology can be used to create a smart contour for the development of a given territory, taking into account the region's industrial specialization, and to identify the most promising areas and "bottlenecks".

KEYWORDS
smart territory, economic development, green economy, smart energy, digital maturity, sustainable development

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Умные территории как драйвер перехода к устойчивому региональному развитию и зеленой экономике

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АННОТАЦИЯ
Актуальность. Несмотря на признание важности концепции «зеленой экономики», этому переход к ней идет достаточно медленными темпами, что делает исследование роли умных территорий в этом переходе особенно актуальным.
Цель исследования. Исследование направлено на описание возможностей и направлений цифровой трансформации территорий с акцентом на переход к «зеленой» экономике.
Данные и методы. Методы исследования включают контент-анализ, кейс-исследования, методы картографического и матричного анализа. Источниками данных являлись научные статьи, представленные в базе Scopus, материалы Министерства финансов и экономического развития, Министерства минеральных ресурсов, зеленых технологий и энергетической безопасности, материалы Центрального бюро статистики Ботсваны, Ботсванской энергетической компании.

КЛЮЧЕВЫЕ СЛОВА
умная территория, экономическое развитие, зеленая экономика, умная энергетика, цифровая зрелость, устойчивое развитие

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Результаты. На примере Ботсваны исследование показало, что создание «умной» территории является основным механизмом перехода к «зеленой» экономике. Умные территории помогают региональным властям достигать целей устойчивого развития, используя передовые цифровые технологии.
Выводы. В статье предлагается новый подход к анализу перехода к «зеленой» экономике. Этот подход можно также применить для пересмотра состава и роли драйверов территориального развития. Предложенная методика может быть использована для создания грамотного контура развития заданной территории с учетом промышленной специализации региона, выявления наиболее перспективных направлений и «узких мест».

ДЛЯ ЦИТИРОВАНИЯ
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智慧区域是地区可持续发展和绿色经济的驱动力

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摘要
现实性：尽管人们认识到“绿色经济”概念的重要性，但向它的过渡相当缓慢。这使得研究智慧区域在这一过渡中的作用尤为重要。
研究目**标：**该研究旨在描述地区数字化转型的机遇和方向，重点是向“绿色”经济转型。
数据和方法：研究方法包括内容分析、案例研究、制图方法和矩阵分析。 数据来源是 Scopus 数据库中的科学文章；财政与经济发展部、矿产资源、绿色技术与能源安全部的资料；博茨瓦纳中央统计局数据和博茨瓦纳能源公司资料。
研究**结果：**以博茨瓦纳为例，研究表明，“智慧”区域是向“绿色”经济过渡的主要机制。 智慧区域使用先进的数字技术帮助地区当局实现可持续发展目标。
结论：本文提出了一种向“绿色”经济转型的新方法。 这种方法也可用于审查地区发展驱动因素的构成与作用。转型需考虑指定地区的工业专业化，确定最有前途的领域和薄弱环节，并为其发展创建一个合理框架。

关键词
智慧区域，经济发展，绿色经济，智慧动力，数字化成熟，可持续发展

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Introduction

Initiatives for the establishment of “smart territories” are becoming increasingly common in regional policies around the world due to the growing digitalization in all spheres of economic activity and human life. The concept of “smart territories” is an umbrella category for various intelligent geographical objects – smart cities, smart regions, smart islands, etc. This concept has been widely covered in scientific research since the late 20th and the early 21st century. In recent years, it has been increasingly explored in the context of the development of “green” ecosystems and the creation of a green economy as part of the global sustainability trend (implemented at the supranational level within the framework of the UN Sustainable Development Goals), increasing social responsibility, environmental friendliness and the rising quality of corporate governance (the environmental, social and governance movement known as the ESG-transformation) (Fuente et al., 2021). The development of smart territories is the key priority for the establishment of a green economy and for sustainable development. There is, however, a lack of clarity regarding the role of intelligent digital solutions in the transition to a green economy and the place of the territory in the “smart” conceptual framework, depending on the level of its digital maturity. To answer these questions, it is necessary, first of all, to specify the concepts of “smart development” of territories in the context of transition to a green economy.

At present, there is no universal agreement as to how the “smart territory” should be defined and developed. Strategies of ‘smart territorial development’ can be determined by the industrial specialization of particular regions, their socio-economic and environmental problems and needs, etc. In other words, the universal technological component of a smart territory, based on the use of cutting-edge digital technologies, may be significantly modified depending on specific regional contexts.

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Therefore, the purpose of this study is as follows: to identify the opportunities and areas of digital transformation in the transition to a green economy and to conceptualize this transition by looking at smart territories as drivers of sustainable regional development.

The objectives of the research are as follows: first, to conduct content analysis of research literature on digital transformation, sustainable regional development, and the transition to a green economy; second, to describe the role of "smart territories" in the transition to a green economy and sustainable regional development; third, to build a system of indicators to assess the level of digital development of a given territory; and, finally, to demonstrate the possibility of increasing the sustainability of regional development with the help of digital technologies (using the case of Botswana).

The hypothesis that this study seeks to test is that smart territory establishment is the core strategic area and mechanism of transition to a green economy and sustainable regional development. At the same time, it is necessary to identify areas of smart digital transformation taking into account various geographical types of territories (these types can be identified by looking at the territories' economic and non-economic functions). In addition, it is necessary to consider smart territorial specialization.

The article is structured as follows. The following section contains a review of the research literature on the problem. The third section deals with the concept of smart territory and indicators of digital development. The fourth section discusses the formation of a green economy based on intelligent digital solutions. The conclusion summarizes the results of the study.

Theoretical framework

The idea of "smart territories" appeared as a result of modern technological advances, in particular digitalization of the economy. Initially, the concept of "smartness" covered individual local objects such as a house or factory but gradually it encompassed bigger objects on the scale of a city or region (Urdabayev & Utkelbay, 2021). The concept of a "smart city" is now widely applied in various fields such as economics, computer science, energy, and transport while the concept of a "smart territory" is still largely underexplored and needs further elaboration.

In a broad sense, a "smart territory" is a geographical space that provides an opportunity to solve many socio-economic problems based on the use of modern digital technologies and tools. The objectives that were initially set at the "smart city" level have now begun to be applied to the "smart territory" level. Such an expansion of the geographical framework, as noted by Garcia-Ayllon and Miralles (2015), is more in line with the goals of ensuring sustainable regional development and the effectiveness of green "smartisation" processes.

In recent years, there has been a convergence of the concepts of green economy and smart territories. According to the Organization for Economic Cooperation and Development, "green growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies"[1]. The United Nations Environment Programme (UNEP) defines a green economy as an economy resulting in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities[2]. Because of this, the green economy always has a specific territorial binding.

The up-to-date research evidence confirms that digitalization is not only a driver of regional development, but is also a major driving force behind the transition to a green economy. Digital technologies are considered as key tools to ensure sustainable production of environmentally friendly food; access to clean and safe water; and production and use of "green" energy (Mondejar et al., 2021). Digital technologies significantly change business models and economic interactions, having a significant impact on the nature and level of resource consumption. Xu, Gong and Li (2022) demonstrate that the smart use of data sets to optimize processes provides energy savings of up to 20%. Hosan et al. (2022) argue that digitalization has a significant positive impact on the sustainability of regional development, creating a "green" economy. In their analysis Hosan et al. (2022) used annual panel data from 1995 to 2018 for 30 emerging nations, including India, China, South Korea, Russia, South Africa, etc.

Digitalization has a great potential for increasing sustainability based on the green development

[1] Towards Green Growth. Technical Report. Organization for Economic Cooperation and Development, 2011. URL: https://www.researchgate.net/publication/258260771_Towards_Green_Growth (Accessed: 07.04.2022)

[2] UNEP. Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication – A Synthesis for Policy Makers, 2011. URL: https://www.oecd.org/daf/inv/investmentfordevelopment/47678910.pdf (Accessed: 07.04.2022)

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of rural areas, recreational areas and wild landscapes (Chernova et al., 2022). The digitization of agricultural production makes it possible to increase environmental sustainability by identifying potential sources of pollution in supply chains and ensuring the rational use of water resources (Benyam et al. 2021). Digital technologies can reduce the risks of landscape fires by reducing the environmental and socio-economic vulnerability of agricultural areas to natural disasters (Pais et al., 2020). The use of smart sensors and analytical solutions, as the experience of the Southern Federal University (Russia) shows, makes it possible to create more efficient agrobiotechnologies[3]. In addition, the use of remote monitoring systems (in particular, technologies for remote accounting of aboveground and underground phytomass, rhizosphere, agrochemical soil control and greenhouse gas respiration) makes it possible to create carbon landfills for the development and testing of carbon balance control technologies[4].

Despite the advantages of the green economy model encounters, it has some significant limitations (Mealy & Teytelboym, 2020) and its implementation differs a lot in different countries and regions of the world (Licastro & Sergi, 2021). As noted by D'Amato and Korhonen (2021), the main actions that need to be implemented to establish a green economy include the assessment of ecosystem services, restoration and maintenance of ecosystems, development of nature-based solutions and green infrastructures. Currently, these actions together can be implemented on a cost-effective basis within the framework of a strategy aimed at establishing a smart territory. In other words, the development of a smart territory is seen as the main path for the transition to a green economy.

The concept of a smart territory is developing in two main directions. The first is related to scaling the concept of a "smart city" to broader geographical coverage. This approach is typical of Russian research. For example, Kubrak (2020) proposes to expand the practice of urban environment management to suburban areas and to the entire region within the framework of the national projects "Housing and Comfortable Urban Environment"; "Digital Economy of the Russian Federation"; and "Ecology". Tebekin and Egorova (2019) argue that many problems of socio-economic development cannot be solved within the framework of the concept of "smart city" and should be solved on the levels of "smart region" and "smart country". Sutriadi (2018) considers "smart territories" in their connection with the triad of "smart city – smart village – smart region".

The second direction is to juxtapose the concept "smart territory" to that of "smart city". In an economic sense, this reflects an endogenous approach to the economic development of territories. The essence of the endogenous approach to economic development is to search for sources of growth and development in the internal environment of the region (for example, regional partnerships of organizations) rather than for external sources (for example, the support from the federal government). Internal resources and development opportunities adequate to the specialization and needs of a particular territory should be concentrated and activated (Scott, 2006). It means that territories play a more active role in economic development[5]; they act as subjects capable of "independently creating" the necessary conditions for launching their development and growth processes (McCann & Sheppard, 2003; Amin, 1999).

Smart territories are considered from different methodological perspectives such as the process approach or systems approach, with an emphasis on the technological component (D'Angelo et al., 2017; Leroux & Pupion, 2022), socio-economic (Vanolo, 2015), or environmental (Leone et al., 2020) component. Regardless of the specific approach chosen, however, smart territories are associated with non-urban spaces and rural areas.

In recent years, smart territory models have received a new impetus for development in the context of transition to a green economy and resource conservation. Economic growth and the growing technologization of production require a significant amount of energy resources. Therefore, there is a need to develop alternative energy sources to preserve the world of the future (Clark, 2019). The ability to build a regional policy of smart territorial development requires a systematic approach to ensuring sustainability and solving environmental problems (Ramos, 2021).

The development of a "smart territory" is a complex process that includes changes in all re-

[3] Strategic Academic Leadership Program of the Southern Federal University ("Priority 2030"). Rostov-on-Don; Taganrog. 2021.

[4] Carbon polygons. Ministry of Science and Higher Education of the Russian Federation. URL: https://minobrnauki.gov.ru/action/poligony/# (Accessed 07.04.2022)

[5] World Cities Report 2020. The Value of Sustainable Urbanization. United Nations Human Settlements Programme (UN-Habitat), 2020. URL: https://unhabitat.org/sites/default/files/2020/10/wcr_2020_report.pdf (Accessed: 07.04.2022)

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gional subsystems associated with various technological solutions. We are talking about the creation of many innovative socio-economic ecosystems in various fields of economic activity, interacting within a network of cooperation. (Appio et al., 2019). In this context, an important research issue is the resource provision for these ecosystems, including energy resources. In this regard, the availability of unique energy resources in non-urban and rural areas (solar energy, wind energy) can compensate for the shortage of other resources necessary for innovative development, providing synergetic effects "in a technological bundle". In other words, from a number of "smart specialization" alternatives, one "smart specialization" should be prioritized depending on this or that region's development goals and potential (De Noni et al., 2021).

The success of the practical implementation of the "smart territory" conceptual model also depends on the level of digital development in the given areas. Accordingly, an important research task is to assess the level of digitalization of the given territory.

Achieving the Sustainable Development Goals is possible even with a low level of digital maturity. Nevertheless, digitalization significantly accelerates this process and gives the territory significant advantages, helping to predict possible problems and to choose the best methods of economic development.

Currently, there is a wide range of digitalization indicators based on the possibilities of obtaining data. For example, the "Digital Russia" index reflects the processes of digitalization in regions and includes the following sub-indices: regulation and administrative indicators; personnel and training programs; research competencies and technological groundwork; information infrastructure; information security; economic indicators; and social effects[6]. Despite the significant advantages of the index both in terms of the completeness and adequacy of the subindices and in terms of methodology, it has certain limitations. Firstly, the index is focused on Russian regions and has to be adjusted for other regional contexts. Secondly, it does not reflect the "green" component of digital transformation. Thirdly, it characterizes the development of smart cities only in terms of the sub-index of the social effects from digitalization, not covering smart non-urban areas and considering smart cities as an effect, not a driver. Most other smart territory assessment methodologies deal with cities in deve-loped countries. They are all, as a rule, based on the components of the "smart city" highlighted by Cohen, subsequently supplemented by J. Mathew: smart management, smart citizens, smart healthcare, smart energy, smart buildings, smart technologists, smart infrastructure and smart mobility[7]. As for the indicators of digital development of a territory, there is a significant research gap, especially for developing countries. The dominant research concerns the challenges of ensuring the technological interconnectedness of geographical space and bridging digital gaps. The same indicators of "smart development" cannot be used for cities and other territories, and especially for developing countries. From this point of view, our contribution consists in determining the spheres of formation of a smart territory depending on the specific geographical types of territories. In addition, we propose a new approach to the parameterization of a smart territory, taking into account its role in the transition to a green economy. At the same time, various geographical zones and digital solutions are considered.

Method and Data

The methodology of this study comprises content analysis, matrix and cartographic analysis, and case study methods. For content analysis we used scientific articles indexed in the Scopus database. To choose the indicators of territorial digital development, we followed the approach described by Cohen and Mathew, adapted to the specifics of the geographical space we define as a "smart territory". The case study is based on the empirical data on energy development and distribution of energy resources in the Republic of Botswana, including materials from the Ministry of Finance and Economic Development, the Ministry of Mineral Resources, Green Technologies, and Energy Security, materials from the Central Bureau of Statistics of Botswana, the Botswana Energy Company. A significant part of the empirical data on the Republic of Botswana were obtained when one of the authors completed an internship at the Ministry of Mineral Resources, Green Technolo-

[6] The Digital Russia Index. Center for Financial Innovation and Cashless Economy of the Moscow School of Management SKOLKOVO, 2018. URL: https://sk.skolkovo.ru/storage/file_storage/00436d13-c75c-46cf-9e78-89375a6b4918/SKOLKOVO_Digital_Russia_Report_Full_2019-04_ru.pdf (Accessed: 07.04.2022)

[7] Cohen, B. What exactly is a smart city? 2012. URL: http://www.fastcoexist.com/1680538/what-exactly-is-a-smart-city; Mathew, J. City as a Customer, 2013. URL: http://www.frost.com/c/10046/blog/blog-display.do?id=2377335 (Accessed: 07.04.2022)

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gies, and Energy Security[8] and when conducting a dissertation research in 2016–2020[9].

Digitalization is considered as a necessary condition for the sustainable development of a territory that allows regional governments to stimulate the rational use of natural resources and achieve the goals of "green" development.

The green economy is a goal that can be achieved by smart territory creation. The use of the concept of smart specialization makes it possible to revise the composition and roles of drivers and create zones of territorial development. This way regional authorities will be able to improve their decision-making and policy-making processes by implementing a comprehensive approach to the development of the green economy.

Results

Smart territory development concepts

In recent years, in research literature there has been an increasing trend of juxtaposing the concept of smart territory to that of smart city because the smart development of cities with higher growth rates can lead to a digital divide, especially in regions with a large number of small towns and rural areas (Navío-Marco et al., 2020). The smart development of territories is an opportunity to ensure inclusive economic development of the region with the involvement of peripheral geographical areas in innovative growth. By developing a "smart territory" it is possible to create new jobs, improve the quality of socio-cultural life and medical care, and enhance territorial cohesion (Kummitha & Crutzen, 2017). At the same time, digital technologies and information are considered as a key source of economic growth (Matveeva et al., 2018). Along with this, the establishment of a "smart territory" can help create significant positive synergetic effects and build a stable comfortable ecosystem for residents (Barba-Sánchez et al., 2019). The previously established paradigm of sustainable development is being transformed into "smart sustainable development" (Lyshchikova, 2021).

The advantages of smart territories lie in the fact that their creation reduces spatial inequality by involving peripheral areas with limited access to intellectual services in modernization development (Wang et al., 2019). This is especially important for developing countries, as it will incorporate numerous rural settlements in social, economic, cultural, and political activities.

By adopting the concept of a smart territory, regional authorities should realize that smart development is ensured through the integration of intelligent, environmentally friendly, and lean production. In other words, there is a need to integrate the paradigms of smart, green, and sustainable development.

The engine of economic growth for most developing countries is industry. The increase in the knowledge intensity of industry involves the use of a significant amount of energy. Sustainable development involves the optimization of production processes, the elimination of production waste based on cutting-edge technologies that need electricity. The real problem faced by the regions is to determine the balance between the increasing production and resource conservation (Kosolapova et al., 2021). In this context, the establishment of smart territories based on the integration of smart, green, and sustainable development paradigms becomes an effective solution. In addition, as noted by some researchers, it is the combination of green and smart development strategies that creates the maximum effects from the standpoint of ensuring sustainable development (Garcia-Ayllon & Miralles, 2015; Oliveira et al., 2018; Touriki et al., 2021).

In this article, a smart territory is understood as a geographical space that provides an opportunity to increase the sustainability of the socio-economic development of the territory through the creation of green ecosystems involving cutting-edge digital technologies and tools. Sustainability is associated with the ability of a territorial socio-economic system to maintain its viability, withstand external challenges, successfully adapt to new factors and conditions; to achieve a balance of social, economic, and envi-

[8] Compiled by the authors based on the information from: Annual Report – Department of Energy. Ministry of Mineral Resources, Green Technology and Energy Security Botswana. Botswana, 2018; Annual Report. Botswana Power Corporation, 2017. URL: https://www.bpc.bw/about-us/Annual%20Reports/2017%20BPC%20ANNUAL%20REPORT.pdf; Annual Report. Botswana Power Corporation 2019-2020, 2019. URL: https://www.bpc.bt/wp-content/uploads/2020/11/Annual-Report-2019-2020.pdf; Molubi, T. Power supply and transmission grid development. Botswana Power Corporation, 2017; List of identified unelectrified villages in Botswana. Department of Energy – Ministry of Mineral Resources, Green Technology and Energy Security, 2018; National Development Plan 11. April 2017 – March 2023. Ministry of finance and economic development, 2017. URL: https://www.finance.gov.bw/images/NDP_11_2017-2023.pdf (Accessed: 07.04.2022)

[9] Molapisi Lesego. A mechanism for improving energy security and balanced development of the fuel and energy complex. Dissertation for the degree of Candidate of Economic Sciences. Rostov-on-Don, 2019. URL: https://rusneb.ru/catalog/000199_000009_010176352 (Accessed: 07.04.2022)

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ronmental goals (Chernova et al., 2015). Green development is linked to the implementation of environmentally friendly and resource-saving production and economic activities. Smart development means realizing the possibilities of sustainable and green development based on the use of modern digital technologies and tools.

The above-described goals associated with sustainable and smart development should be aligned with the specialization of particular regions. Regional specialization is seen not simply as a prevalence of one or two industries or sectors but as an ecosystem of interdependencies both in a certain field of activity and in related fields (Grillitsch et al., 2018). Smart specialization contributes to sustainable regional development since it promotes socio-technical transformations aimed at involving all territories of the region (not only growth centers but also peripheral extra-urban spaces and rural areas) in innovative processes (Veldhuizen, 2020). Within the framework of smart specialization, each part of the geographical space will be able to take its place within the smart development framework, considering the available resources, the sphere of economic activity with the best potential for innovative development, and the level of digital maturity.

At its core, the concept of smart territory foregrounds both economic growth (based on smart specialization) and the development of the social sphere (the human-centered concept of a smart territory) (Chernova et al., 2020; Myslyakova, et al., 2021). The establishment of a smart territory can be represented as a process of connecting the economic, social, and environmental aspects of sustainable development with the goals of improving the quality and standards of living based on an integrated digital platform.

In our view, territories may comprise objects of the following geographical types depending on their economic and non-economic functions:

– cities-centers and agglomerations (CA) are settlements and their compact groups with a high level of socio-economic development and intensive industrial, transport and cultural ties;

– peripheral cities and urban-type settlements (PU) are settlements that are remote from the centers of economic growth and are, as a rule, characterized by a relatively low level of socio-economic development, the predominance of traditional and low-tech types of activities, and the complexity of the economy;

– rural areas (RA) are areas with a small population, mainly engaged in agriculture;

– agricultural lands (AR) are lands outside the boundaries of settlements intended for the needs of agriculture;

– nature reserves and recreational areas (NR) are areas that are used for recreation and tourism;

– wild landscapes (WL) are areas whose economic functions are not realized, these are areas of wild nature, abandoned territories.

The fundamental prerequisite for realizing the potential of various types of territories in the smart development framework is that they should have a certain level of digital maturity, according to which a combination of types of territories (cities, rural settlements, etc.), included in the smart circuit, is selected.

We propose the following list of spheres of "smart" territory drawing on the ideas of Cohen and Mathew. These spheres were adapted to the scale of the "territory" (not the city).

The following key areas of "smart" development of a territory were identified:

– smart governance (SG) means competence-based management of complex projects of smart digitalization of territories and monitoring of development indicators;

– smart population (SP) means citizens who actively use digital technologies and tools to implement a variety of interactions and transactions;

– smart energy (SE) stands for smart technologies for the transmission and distribution of energy, as well as the monitoring of its consumption;

– smart technologies (ST) are high technologies (cutting-edge technologies) characterized by a high degree of self-organization and a significant number of feedbacks that contribute to their rhythmic work and subsequent evolution;

– smart infrastructure (SA) is a set of high-tech facilities that provide digitalization of infrastructure solutions;

– smart specialization (SS) is a priority industry specialization of the region, which determines its competitive advantages based on the use of digital technologies and tools.

We propose the following set of digital maturity indicators for each type of territories for each area of smart development (see Table 1).

Assessment of the level of digital maturity of territories will make it possible to form a smart development framework taking into account the industrial specialization of the given region and to identify the most promising areas of development and "bottlenecks" that require special attention.

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In this context, sustainable development involves the use of accumulated concentrated potential as a locomotive of development and the alignment of the zones (territorial or functional) whose intellectual transformation is lagging behind. In fact, we are talking about the transition to data-based management, when more informed decisions can be made, which also involves priority support for smart regional specialization areas to increase their competitive advantages.

Transition to smart energy in Botswana: environmental and territorial aspects

Smart energy occupies a special place in the creation of smart territories and the transition to a green economy. Sustainable economic growth largely depends on the availability of clean energy. This is particularly important in the light of the fact that in 2019, global energy-related CO2 emissions reached 33.3 metric gigatons (Gt) annually, growing at a rate that is expected to raise the Earth's temperature by several degrees without intervention (Oliveira et al., 2021). The use of renewable energy sources makes it possible to simultaneously reduce the level of emissions and pollution and improve the quality of the habitat when integrated into a smart territory (Hoang et al., 2021). Accordingly, it is important not only to have an energy system that meets the needs of the economy but also to switch to renewable energy sources and increase energy efficiency. The accomplishment of these tasks depends on the characteristics of specific territories, especially the territories that are remote from capitals and experiencing significant resource shortages. Modern green energy is both a prerequisite and result of the development of smart territories. Therefore, it is necessary to take into account the current potential and features of development, as well as the specialization of the territory (determining the supply and demand of energy) and possible digital solutions in the energy sector. In addition, the creation of an energy system based on renewable sources requires adequate management support

Table 1

Indicators for assessing the digital maturity of the territory for the formation of a smart framework

Areas of smart development	Types of territory					
	CA	PU	RA	AR	NR	WL
SG	Number of monitoring objects Characteristics of the feedback systems in management systems Characteristics of governance channels Availability of metadata management systems Availability of intellectual and analytical support for managerial decision-making Having a mature digital government (in accordance with the sub-indices and indicators for assessing the digital maturity of the government according to the UN methodology)*					
SP	Number of registered users on the Internet Number of mobile phones Level of digital competencies Percentage of the population with higher education			–	–	–
SE	Level of electricity consumption Share of renewable energy			Natural conditions – e.g. alternative energy sources		
ST	The number of Internet access points, including the number of wireless access points			Proximity to Internet access points, including wireless access points		
SA	Number of infrastructure facilities Infrastructure quality (availability of communication networks, data processing and transmission centers, cloud technologies, digital platforms) Intensity of traffic flows Number of broadband subscriptions per 100 residents					
SS	Gross regional product (GRP) structure Digitalization of industries and spheres of activity (availability of implemented/deployed digital technologies and cutting-edge technologies of Industry 4.0. in various fields of activity, the share of organizations using corporate information systems of various types, the share of organizations using RFID (radio-frequency identification), the number of developed and implemented advanced manufacturing technologies, the number of implemented industrial robots, etc.)					

Source: Compiled by the authors based on the information from: Cohen, B. What exactly is a smart city? 2012. URL: http://www.fastcoexist.com/1680538/what-exactly-is-a-smart-city; Mathew, J. City as a Customer, 2013. URL: http://www.frost.com/c/10046/blog/blog-display.do?id=2377335 (Accessed: 07.04.2022).

* E-Government Survey 2020. Digital Government in the Decade of Action for Sustainable Development. Department of Economic and Social Affairs. United Nations, 2020. URL: https://publicadministration.un.org/egovkb/Portals/egovkb/Documents/un/2020-Survey/2020%20UN%20E-Government%20Survey%20(Full%20Report).pdf (Accessed: 07.04.2022).

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(Jiang et al., 2021). Based on the above-described provisions, we devised some proposals and recommendations for the development of smart energy system of the Republic of Botswana with a focus on renewable energy sources, the specifics of the districts, and areas of smart transformation.

Botswana was chosen as a model example of an emerging economy experiencing an acute shortage of energy resources, which is trying to build a model of sustainable development by using digital technologies and increasing resource efficiency. This country also has significant regional disparities. In addition, one of the authors, Lesego Molapisi, has accumulated a significant empirical data on the transformation of the country's energy sector[10].

Based on the analysis of the ten districts in Botswana, the population and resource distribution, the levels of energy access, and the assessment of the location of the national transmission grid (Molapisi, 2018), mapping was used to demonstrate the geographical allocation of resources and technologies for bridging the gap between energy supply and demand in Botswana.

The combined development of digital (primarily mobile) and energy technologies is recommended for the country. As of today, the mobile technology coverage in Botswana is broader than that of electric networks. Settlements near nature reserves or in agricultural areas can be transformed into "smart" villages to ensure environmentally friendly development.

We believe that the country's smart energy system should possess the following characteristics. Energy efficiency technologies and standalone systems should be used in all of the districts to reduce electricity consumption and to minimize the pressure on the grid network, which is expanding at a slow pace. Mini grids are used in all of the 10 districts except for the 3 with over 70% households, where only the Botswana Power Corporation (BPC) distribution grid extension and standalone systems are required. The BPC is the only state-owned electricity generation, transmission and distribution company in Botswana. It should be noted that Botswana's national transmission network does not cover some areas of the country. In the west and north-west of Botswana, where there is an active exploration and mining activity, there is no electricity transmission network (and its creation requires significant investment). In these regions, mini grids can be created.

The extension of the transmission grid in Chobe district is important as it is currently the only district without a major transmission line, to assist other infrastructure developments and to create a link to countries north of Botswana for power trade. In addition, transmission extension is also required in Kweneng district to facilitate the connection to a new independent power producer coal power station in the district, and in Gaborone, the capital, to support the high urbanization and increasing electricity demand. Similarly, demand side management should be used in major cities where the demand for electricity is growing and in districts containing 70% of the households. Demand side management refers to initiatives and technologies that are designed to influence the level of consumer demand for electricity. Its purpose is to encourage consumers to use less electricity, especially during peak periods, or to shift periods of increased energy consumption to non-peak zones.

R&D centers need to be established in all the districts for monitoring, assessment and information collection. This will improve the quality of services based on market insights. In Gaborone, the University of Botswana has the Renewable Energy Department that conducts research on the country's technological development.

As special projects, the airports of Maun and Kasane in Ngamiland and Chobe districts should be converted into 'green airports' operating on 100% renewable energy to promote green tourism in the regions with nature reserves.

Thus, based on the analysis of the country's energy potential, smart technologies, and the specifics of the regions, the matrix of the energy sector transformation technologies was compiled (see Table 2). Table 2 demonstrates, the current level of electrification of all the 10 districts and the availability of coal powered stations in different districts. The table also contains the proposed solutions for the creation of smart energy systems in the regional context.

Taking into account the country's geographical characteristics, using the mapping method, proposals have been developed for the establishment of the smart energy sector in the territorial context. The mapping of the distribution of energy resources and energy technologies by districts in the Republic of Botswana is shown in Figure 1, which illustrates the spatial distribution of the technological solutions listed in Table 2 above. The cartographic images are shown in Table 3.

[10] Molapisi, Lesego. A mechanism for improving energy security and balanced development of the fuel and energy complex. Rostov-on-Don, 2019. URL: https://rusneb.ru/catalog/000199_000009_010176352 (Accessed: 07.04.2022)

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Table 2

Matrix of the energy sector transformation technologies

District	Energy Access (Household)	Coal Powered Station	Transmission line expansion	Renewable energy Mini-grid	Isolated solar systems	Demand side management	Energy efficiency technologies	R&D center	Green Airport
Central	59.52	+		+	+	+	+	+	
Chobe	54.99		+	+	+		+	+	+
Ghanzi	38.57			+	+		+	+	
Kgalagadi	48.94			+	+		+	+	
Kgatleng	75.31				+	+	+		
Kweneng	51.66	+	+	+	+		+	+	
Ngamiland	46.63			+	+		+	+	+
North-West	72.90				+	+	+	+	
South-West	72.46		+		+	+	+		
Southern	53.44			+	+		+	+	

Source: Compiled by the authors based on the information from: Annual Report-Department of Energy. Ministry of Mineral Resources, Green Technology and Energy Security Botswana. Botswana, 2018; Annual Report. Botswana Power Corporation, 2017. URL: https://www.bpc.bw/about-us/Annual%20Reports/2017%20BPC%20ANNUAL%20REPORT.pdf; Annual Report. Botswana Power Corporation 2019–2020, 2019. URL: https://www.bpc.bt/wp-content/uploads/2020/11/Annual-Report-2019-2020.pdf; Molubi, T. Power supply and transmission grid development. Botswana Power Corporation, 2017; List of identified unelectrified villages in Botswana. Department of Energy – Ministry of Mineral Resources, Green Technology and Energy Security, 2018; National Development Plan 11. April 2017 – March 2023. Ministry of finance and economic development, 2017. URL: https://www.finance.gov.bw/images/NDP_11_2017-2023.pdf; Molapisi, Lesego. A mechanism for improving energy security and balanced development of the fuel and energy complex. Rostov-on-Don, 2019. URL: https://rusneb.ru/catalog/000199_000009_010176352 (Accessed: 7.04.2022)

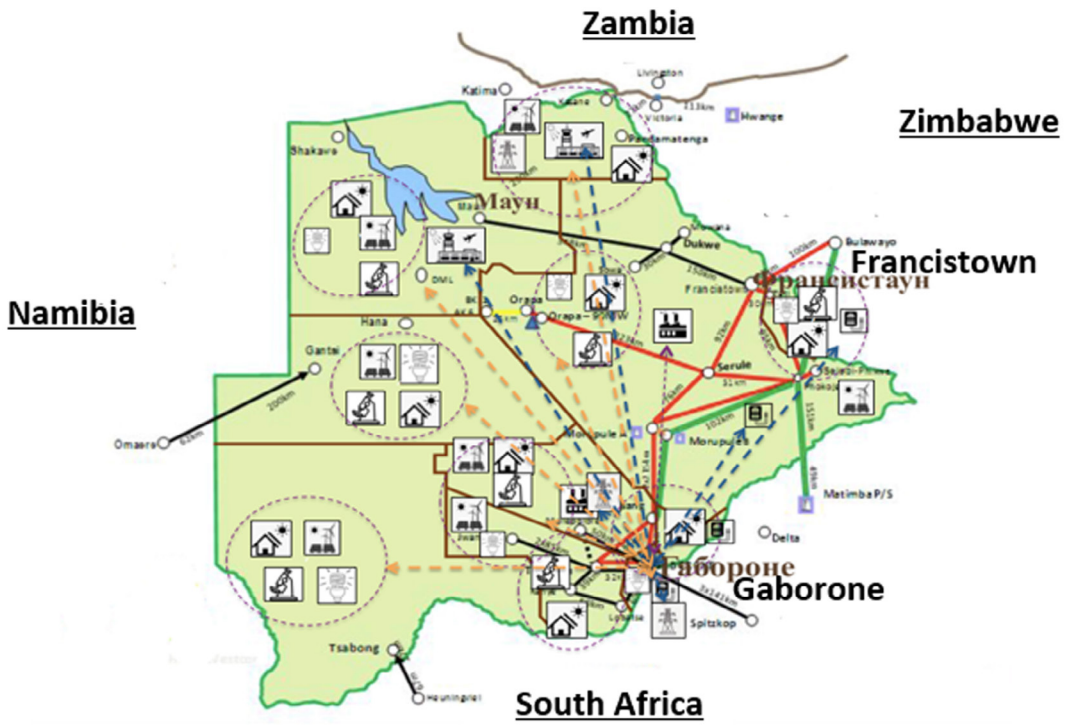

Figure 1. *Distribution of energy resources and technologies by districts in the Republic of Botswana*

Source: Compiled by the authors based on the information from: Annual Report- Department of Energy. Ministry of Mineral Resources, Green Technology and Energy Security Botswana. Botswana, 2018; Annual Report. Botswana Power Corporation, 2017. URL: https://www.bpc.bw/about-us/Annual%20Reports/2017%20BPC%20ANNUAL%20REPORT.pdf; Annual Report. Botswana Power Corporation 2019–2020, 2019. URL: https://www.bpc.bt/wp-content/uploads/2020/11/Annual-Report-2019-2020.pdf; Molubi, T. Power supply and transmission grid development. Botswana Power Corporation, 2017; List of identified unelectrified villages in Botswana. Department of Energy – Ministry of Mineral Resources, Green Technology and Energy Security, 2018; National Development Plan 11. April 2017 – March 2023. Ministry of finance and economic development, 2017. URL: https://www.finance.gov.bw/images/NDP_11_2017-2023.pdf; Molapisi Lesego. A mechanism for improving energy security and balanced development of the fuel and energy complex. Dissertation for the degree of Candidate of Economic Sciences. Rostov-on-Don, 2019. URL: https://rusneb.ru/catalog/000199_000009_010176352 (Accessed: 07.04.2022)

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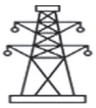
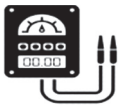
Table 3

Cartographic images of the distribution of resources and technologies by districts

Cartographic representation	Resource and technologies	Cartographic representation	Resource and technologies
	Coal Powered Station		Energy efficiency technologies
	Transmission line expansion		R&D center
	Renewable energy mini-grid		Green Airport
	Isolated solar systems		Information flow Public-Private-Partnership information flow (PPP)
	Demand side management		Private sector investment
66 кВ 132 кВ 220 кВ 440 кВ			Existing Power Lines

Source: Compiled by the authors based on the information from: Annual Report-Department of Energy. Ministry of Mineral Resources, Green Technology and Energy Security Botswana. Botswana, 2018; Annual Report. Botswana Power Corporation, 2017. URL: https://www.bpc.bw/about-us/Annual%20Reports/2017%20BPC%20ANNUAL%20REPORT.pdf; Annual Report. Botswana Power Corporation 2019-2020, 2019. URL: https://www.bpc.bt/wp-content/uploads/2020/11/Annual-Report-2019-2020.pdf; Molubi, T. Power supply and transmission grid development. Botswana Power Corporation, 2017; List of identified unelectrified villages in Botswana. Department of Energy – Ministry of Mineral Resources, Green Technology and Energy Security, 2018; National Development Plan 11. April 2017 – March 2023. Ministry of finance and economic development, 2017. URL: https://www.finance.gov.bw/images/NDP_11_2017-2023.pdf; Molapisi, Lesego. A mechanism for improving energy security and balanced development of the fuel and energy complex. Rostov-on-Don, 2019. URL: https://rusneb.ru/catalog/000199_000009_010176352 (Accessed: 07.04.2022)

The proposed recommendations can help the regional and national governments of Botswana and associated agencies to establish a complex of smart territories, since at present the country is facing the lack of electricity, which is the main constraint for its socio-economic development and intellectual digital transformation. It is necessary to develop the energy sector by using innovative digital solutions tailored to the characteristics and needs of specific territories. The proposed solutions are just beginning to be implemented at present. Given the systemic nature of the transformations being carried out, the actual effects of these measures can be assessed only in a few years.

Conclusions

This study focuses on the concepts of green economy and smart territory. The convergence of these concepts makes it possible to combine key approaches, priorities, and tools of regional development for the digital transformation of the economy. We show that the formation of a smart territory is the main strategic vector and mechanism of the transition to a green economy and sustainable regional development, since it enables regional governments to combine cutting-edge technologies with organizational and economic solutions and thus to achieve a perfect balance of social, environmental and economic goals.

Using the example of Botswana, we have demonstrated the possibilities of increasing the sustainability of regional development through the smart transformation in the energy sector. The presented case demonstrates the need to take into account the specific regional context when forming a smart contour. The analysis of the regional potential and regional smart specialization in combination with the assessment of the technological capabilities of territories lead us to the conclusion that all regions have the potential for a smart transformation, but the mechanisms of such transformation can differ.

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This study has some limitations. Even though the theoretical part of the study encompasses international research literature, the empirical part focuses only on the case of Botswana. However, even this example shows that smart digitalization should take into account the specifics of sectoral and socio-economic regional development in order to get positive effects (theoretically possible for smart territories). At the same time, it should be noted that in our recommendations for the formation of smart energy systems as core elements of smart territories, we focus on emerging economies, and not on digital leaders. In addition, the insufficiency of the existing statistical observations on the green economy and smart territories can be cited as a limitation, which makes the testing of conceptual provisions more difficult.

These findings can be of interest to policy-makers and regional governments seeking to implement smart territory projects for the transition to a green economy and achievement of sustainable development goals.

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