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## Article

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## Article

# Sustainable Tourism and Renewable Energy's Potential: A Local Development Proposal for the La Florida Community, Huaral, Peru

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**Abstract:** Tourism contributes 10% to global gross domestic product (GDP), yet it generates 5% of all anthropogenic CO<sub>2</sub>, while 50 to 60% of carbon emissions are indirectly related to the sector. High levels of poverty afflict rural areas in developing countries, and sustainable tourism based on renewable energy is an ideal approach to generate local development. Our objectives are thus to gauge sustainable tourism's influence on local development in the community of La Florida, Huaral, Peru and to evaluate the potential of renewable energy (solar and wind power) to propose an eco-efficient business alternative. A non-experimental, quantitative approach was used, in which 265 local residents completed a survey to ascertain their perspectives on the proposal. Moreover, the potential for solar and wind energy was measured to identify sustainable alternatives that residents might incorporate into local ventures. The results demonstrate a relationship between sustainable tourism and local development, as tourism activity enables community members to improve their quality of life and offers them the opportunity to generate new enterprises. Likewise, the assessment of renewable energy potential confirms its feasibility in this area.

**Keywords:** local community; community development; sustainable community; tourism and renewable energy



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## 1. Introduction

Tourism has become one of the fastest growing industries in the world, creating millions of jobs, increasing global income, helping to curb inflation, and spurring the development of diverse infrastructure (Khan et al. 2021). Tourism now contributes 10.3% of global GDP and 319 million jobs, meaning one in ten jobs are attributed to this sector (Li et al. 2019; Tian et al. 2020; WTTC 2021). The popularity of tourist destinations is linked to demand for various resources and to the supply of accommodation, food, and various types of services (Becken et al. 2003; Becken et al. 2001). This implies the provision of significant logistics services and especially high energy demand. The latter is a serious impediment to the development of sustainable tourism, particularly in Latin America where a high proportion of tourist centers are located in rural areas with high poverty rates and little or no access to energy resources (Gössling 2010; Carbone 2005). The Economic Commission for Latin America and the Caribbean (ECLAC) revealed that, in 2019, 30.8% of the population was below the poverty line, with 11.5% in a situation of extreme poverty (CEPAL 2019). This rate has increased considerably in response to the COVID-19 pandemic, and ECLAC estimate that in 2020 the extreme poverty rate will stand at 12.5%, while the poverty rate will reach 33.7% (CEPAL 2021).

Accordingly, our main research question is the following: How might sustainable tourism, in terms of the use of renewable energy resources, influence the local development of the La Florida community?

Researchers involved in the development of sustainable technologies have begun to propose strategies (Calderón-Vargas et al. 2019; Calderón-Vargas et al. 2021) that can eliminate barriers to sustainability and to direct their interest toward the use of renewable energy sources such as solar and wind. Alongside the development of sustainable infrastructure with an emphasis on energy demand issues (Nguyen and Su 2021), other researchers emphasize the need for tourism to be sustainable. An example of this is the use of renewable energy in tourist destinations (Nguyen and Su 2021; Gössling 2010; Le and Nguyen 2020).

Accordingly, the World Tourism Organization (UNWTO) describes sustainable tourism as a model of economic development conceived to improve the quality of life of the host community and to provide visitors with a high quality experience while maintaining the quality of the environment (Cardoso Jiménez 2006). Moreno Freites et al. (2019) argue that sustainable tourism means satisfying the needs of tourists and local development, minimizing poverty and exclusion, and ensuring the sustainable use of biodiversity without neglecting the protection of local values, customs, and historical context. Relevant strategies must thus be created to help reduce poverty. Sustainable tourism is a comprehensive scheme that must not only contribute to sustainability and present a sustainable tourism product but also generate local development.

Previous work emphasizes the importance of sustainable tourism in local development. Varisco, in his study of tourism and local development, highlighted the importance of the degree of endogeneity in tourism development processes, analyzing its impact on local development. He concluded that tourist activity contributes to local development but cannot be generated purely as an isolated activity (Varisco 2008). Likewise, Mora, in his study of local development and community tourism under globalization, examined the case of San Gerardo de Dota and concluded that the community is endowed with various types of endogenous resources that have the capacity to contribute economic value based on community capital (Mora Sánchez 2012). Consequently, Álvarez and Gil proposed tourism as an engine of economic growth in Colombia, since departmental public investment in tourism has contributed positively to GDP growth in each department (Álvarez Cáceres and Galvis 2019).

This study aims to measure the influence of sustainable tourism, in terms of the use of renewable energy resources, in motivating local development in the community of La Florida, Huaral, Peru and ensuring that it becomes a sustainable destination. It is important to note that tourism has already generated basic development in the community under study, producing both direct and indirect employment and forging an appreciation of the local customs and environment.

## 2. Literature Review

Despite the great economic benefits that tourism generates in various countries, the sector presents an environmental concern, as it gives rise to massive CO<sub>2</sub> emissions (Li et al. 2019). A study carried out by the UNWTO and the United Nations (UN) reveals that tourism contributes 5% of all anthropogenic CO<sub>2</sub>, while between 50 and 60% of carbon emissions are indirectly related to the industry (Dwyer et al. 2010; Calderón-Vargas et al. 2019; OMT-a 2019). The need thus arises to direct tourism activity using sustainability guidelines and to think about sustainable tourism. The latter must fully take into account current and future economic, social, and environmental repercussions while satisfying the needs of visitors, the industry, the environment, and host communities (UNWTON 2021). Some authors firmly believe that the sustainability of tourism development is based on the creation of a tourism product with particular characteristics that suit the present and future needs of tourists (Michalena et al. 2009). The concept of “sustainable tourism development” thus refers to economic, social, and environmental development that continually aims to improve the experiences of tourists. For others, this type of development is an additional opportunity for local communities to benefit from the products of their particular local identity and natural resources (Burns and Sancho 2003; Michalena et al. 2009). Sustainable

tourism is positively linked to economic development and has been an important source of income (Comerio and Strozzi 2019). The optimal management of sustainable tourism must take into account the principles of sustainability, encompassing the environmental, economic, and sociocultural aspects of tourism development. An adequate balance must be struck between these three dimensions to guarantee long-term sustainability.

In this sense, well-articulated sustainable tourism contributes effectively to local development. This in turn allows a society to offer alternatives for collective well-being, using the potential of local residents to generate innovative ideas that are economically beneficial to their home community (Mendoza-Moheno et al. 2021). Vásquez Barquero classifies this as a strategy that seeks social progress and local sustainable development based on the continuous improvement of available resources, particularly historical and cultural heritage, and thus contributes to improving the well-being of the population (Vásquez Barquero 2009). Conversely, Sergio Boisier maintains that local development is an endogenous process that occurs in small territorial units and human settlements capable of promoting economic dynamism and improving the population's quality of life (Boisier 2005). Local development involves three fundamental aspects: the local economy, the process of reactivating and revitalizing the local economy, and the efficient use of an area's existing endogenous resources to stimulate economic growth, create jobs, and improve quality of life. This implies a participatory and equitable process that promotes the sustainable use of local and external resources and in which key local actors are encouraged to generate employment and income to improve the population's quality of life (Silva and Sandoval 2012). Dinis maintains that, if the environmental component is integrated into local development, one can speak of sustainable local development as socially equitable, economically viable, and environmentally friendly (Dinis et al. 2019).

It is thus necessary to consider the importance of fostering sustainable tourism that generates local development through the care and preservation of the environment. Accordingly, since several authors affirm a positive correlation between the consumption of renewable energy and economic growth (Chen et al. 2021; Apergis and Payne 2010; Omri 2013; Ozturk and Bilgili 2015), we propose a study of renewable energy and its influence on local development and sustainable tourism. Apergis's study of OECD countries reveals a long term equilibrium relationship between real GDP, renewable energy consumption, real gross fixed capital formation, and the labor force. This long term relationship indicates that a 1% increase in renewable energy consumption increases real GDP by 0.76%; a 1% increase in gross real fixed capital formation increases real GDP by 0.7%; and a 1% increase in the labor force increases real GDP by 0.24% (Apergis and Payne 2010). Tourism is a driving force for both economic growth and environmental sustainability, so the interaction between pollution and renewable energy consumption requires more attention (Sarpong et al. 2020). Tourism-related CO<sub>2</sub> emissions can be mitigated through the use of renewable energy in the tourism industry (Ali et al. 2021). Moreover, it is reported that tourists are willing to pay for activities that are likely to promote environmental quality (Sarpong et al. 2020). The regions of Central and South America have the potential to generate 100% of their electricity from renewable sources (Ben Jebli et al. 2019).

Ideally, Peru should move gradually toward "cleaner" growth that generates fewer emissions and does not compromise economic and social development, thus improving its competitiveness and productivity. This must be done, however, through the gradual implementation of clean technologies, beginning with those that offer the lowest costs (Gamio Aita 2021). It is also necessary to take advantage of the country's exceptional wind resources, great potential for solar energy, and products of its geographical and climatological characteristics (Ministry of Energy and Mines (MINEM) 2001). The Wind Atlas of Peru estimates the country to possess 20,493 MW of usable wind resources out of a total wind resource of 28,395 MW, which is of interest for the installation of wind power generation systems (MOCICC—Movimiento Ciudadano frente al Cambio Climático 2020b). Conversely, the most important technical and economic determining factor for the

installation of thermoelectric solar systems is to have an annual direct solar radiation not less than 2000 kWh/m<sup>2</sup>, while the total potential of Peru is 2860 MW ([MOCICC 2020a](#)).

### 3. Materials and Methods

A quantitative approach was used, as numerical data were collected and subjected to statistical analysis to verify the correlation of two variables, as well as the generalization and objectification of sample results. The design was non-experimental since there was no manipulation of the variables; rather, they will be examined and compared as they occur in the natural environment. The design is transverse, as data was collected only for the year 2021 ([Hernández Sampieri 2010](#)).

This research focuses on a case study of the rural community of La Florida, located in the Atavillos Bajo District, Huaral Province, Lima Department, Peru. The community is considered the base tourist center of the “Rúpac-Marca Kullpi” archaeological complex, also called “El Machu Picchu Limeño”, which was designated as national cultural heritage through National Directorial Resolution 283/INC on 25 June 1999. This archaeological site dates to 1200 CE and belongs to the pre-Inca culture of Los Atavillos ([Congreso de la República 2017a](#)). During the research process, direct contact was made with residents of La Florida to obtain information and to learn about the residents’ perspective on the relationship between sustainable tourism and local development in their area. The statistical population was delimited by a selection criterion for those over the age of majority. All individuals over 18 years of age who live in this population center were considered, yielding a total of 843 persons of undifferentiated sex. Using a simple random probability sampling under the finite population formula, given a confidence level of 95% and a margin of error of 5%, a sample number (n) of 265 inhabitants was selected. These individuals participated in a structured survey with closed questions based on the Likert scale, addressing relevant social, economic, and environmental dimensions.

To certify the quality of the survey’s content, it was subjected to an expert judgment process. Three specialists, in community development, sustainable tourism, and methodology, respectively, evaluated the consistency, clarity, and concordance of the questions. Regarding the statistical reliability of the survey questionnaire, Cronbach’s Alpha test ( $\alpha$ ) was applied. This test establishes a coefficient that theoretically varies from 0 to 1, distributed as follows: values from 0 to 0.2 are considered to indicate very low reliability, 0.2 to 0.4 low reliability, 0.4 to 0.6 moderate reliability, 0.6 to 0.8 good reliability, and 0.8 to 1 high reliability. If  $\alpha$  is close to 0, then the quantized responses are not reliable at all, and if close to 1 the responses are very reliable. As a general rule, if  $\alpha \geq 0.8$ , the answers are considered reliable ([Leontitsis and Pagge 2007](#)). After all the surveys had been administered, the results were processed using the statistical software SPSS version 27. To obtain test results, the following procedure was used: first select the “Analyze” option, then the “Scale” option, and third “Reliability Analysis.” Then, select the items to evaluate, and finally choose the option “Alpha Model.” Following these steps, an  $\alpha$  value of 0.8 was obtained, thus indicating high reliability according to the Alpha scale.

To carry out relevant documentary analysis, an extensive search was undertaken for scientific articles indexed in prestigious databases such as Scopus and Web of Science with the keywords: sustainable tourism, sustainable tourism and local development, benefits of local development, tourism and renewable energy. This search extended to official national and supranational organizations: World Tourism Organization (UNWTO), MINEM, Instituto Nacional de Estadística e Informática (INEI), and Peruvian Institute of Economy (INEI). Figures from accommodation associations, travel agencies and the like (AHORA), and the Ministry of Foreign Trade and Tourism (MINCETUR) have also been used to obtain tourism data and identify new trends in the national and international tourism market.

The analysis of renewable energy potential was specifically linked to the use of solar and wind energy, involving the use of photovoltaic panels and wind turbines, respectively. For this purpose, computer simulations were used to determine solar radiation intensity through SOLARGIS, a simulator belonging to the World Bank, and EnAir, a simulator that



generates energy demand and/or generation calculations (in kWh) for a given geographic location. On this basis, we performed calculations to estimate projected energy demand and contributions by the aforementioned systems, all with a high degree of precision (98.5%). Various studies have considered the use of geographic information tools to evaluate tourism resources and renewable energy potential (Valjarević et al. 2018; Rahayuningsih et al. 2016).

#### 4. Results and Discussion

In September 2015, the UN General Assembly adopted the 2030 Agenda with the aim of promoting sustainable development through an action plan that seeks to end poverty, safeguard our planet, and ensure peace and prosperity (UNWTO 2015). The SDGs that take up and expand on the Millennium Development Goals include 17 goals and 169 targets and will be the framework for the new world development agenda for the next 15 years (ONWTO Organización Mundial del Turismo 2015). It is acknowledged that each country faces specific challenges in its search for sustainable development. Accordingly, UN member states recognize that the world's greatest challenges are the elimination of poverty and the preservation of the environment (UNWTO 2015).

Within the 2030 agenda's framework, the World Charter for Sustainable Tourism +20 is recapitulated, recognizing that SDGs present an opportunity to direct tourism activity along inclusive and sustainable pathways (Naciones Unidas 2015a). The document thus stipulates that tourism must contribute effectively to reducing inequality, promoting peaceful and inclusive societies, achieving gender equality, and creating permanent opportunities for all. It also highlights that the ecological footprint of tourism can be significantly reduced, and that this process should drive innovation by developing green, inclusive, low carbon economies. Finally, it emphasizes that indigenous cultures, traditions, and local knowledge, in all their forms, must be respected and valued, underlining the importance of promoting the full participation of local communities and indigenous peoples in tourism development decisions that affect them (Urkullo 2015).

Regarding the Peruvian legislative framework, tourism activity is governed by Law 29408, the general tourism law, which aims to promote, encourage, and regulate the sustainable development of tourism activity and is mandatory at all three levels of government: national, regional, and local. This legal framework applies to the development and regulation of tourist activity, and MINCETUR is the national governing body for matters related to tourism. Article 3 of this law sets out the principles of tourism activity, which are: sustainable development, inclusion, non-discrimination, promotion of private investment, decentralization, quality, competitiveness, fair trade in tourism, tourism culture, identity, and conservation (Congreso de la República 2017a).

It is necessary to ascertain a community's conditions prior to designing an implementation of sustainable tourism that can contribute to its local development. La Florida, together with the Pampas community, is strategically located as a base location for the reception of tourists intending to visit the archaeological center of Rúpac, the traditional local festivals, the anniversary of Rúpac, the festival of San Salvador de Pampas, etc. All of these result in an increasing number of visits each year, but with very short stays. The surveys undertaken in our study reveal that 52.5% of residents believe tourists stay in the area less than a day, which is a very short time to provide opportunities for active economic revitalization.

The "Rúpac Marca Kullpi" archaeological complex belongs to the Atahuallos culture that flourished from 900 until the mid-1400s CE (IPerú 2016). It is presently called the "Lima Machu Picchu" since it is located at the top of the mountain (3580 MSL) and, despite its age, is well-conserved. The archaeological complex is a citadel with fortified vaulted ceilings and stone structures up to 10 m high. (IPerú n.d.). In 2016, Bill 1012/2016-CR was presented and passed, which made the recovery, conservation, protection, and promotion of the Rúpac Marca Cullpi archaeological site a public necessity and preferential national interest (Congreso de la República 2017a). Nonetheless, much remains to be done to ensure that the mountain range of the city of Huaral is a tourist focus for Lima. Rúpac

is not yet prepared to receive a large influx of tourists, while neighboring population centers still lack optimal infrastructure and facilities to accommodate additional tourism. The president of the Association of Hotels, Restaurants and Related—Huaral (AHORA—Huaral) has stated that approximately 10,000 tourists visit the area annually, of whom 10% are foreign (Andina 2019). Conversely, he affirms that the place has become highly attractive to national and foreign tourists because of its inclusion in the Short Routes of Lima. To reach Rúpac, one must first take a bus from Lima to Huaral, then take local transport from Huaral to the town of La Florida and Pampas, and finally undertake a walk of approximately three and a half hours to the complex. La Florida's role as a base center is the reason for this study's focus on that rural community. The town had 843 inhabitants as of the most recent census (carried out in 2017), of whom 53% were female (INEI 2017). Our surveys indicate that 58.9% of residents have completed secondary school but only 7.9% have higher education, while the remainder of the population has an educational level between primary and initial (Naciones Unidas 2015b).

#### 4.1. Economic Aspect

The main economic activities revolve around tourism and the agriculture sector. The predominant crops include peaches, avocados, apricots, potatoes, and corn, which are cultivated and harvested by the local community. Nonetheless, a visit to the town center revealed that the population's limitations have been improving in response to the development of tourist activity. According to community members, as recently as five years ago they lacked basic services, i.e., in the populated center there was no water, sewage, electricity, or gas service. Much was therefore needed to improve their quality of life. For example, preparation of food required the use of wood stoves, while access to water involved the local government occasionally sending cisterns to fill containers that had to last the inhabitants for a certain period. Thanks to development spurred by tourist activity, precariousness has diminished, and now the community has access to all basic services and even internet. This is a direct consequence of increased tourist activity, which has boosted the economy and attracted the interest of local and regional governments.

Economically, sustainable tourism development must take the necessary steps to maximize economic benefits to the host community while creating strong links with the local economy of the destination and with other economic activities in the environment. Thus, the UNWTO proposes that sustainable tourism should promote the creation of viable economic activities in the long term. These should provide all agents with well-distributed socio-economic benefits, including opportunities for stable employment, to obtain income and social services for host communities and to help reduce poverty (UNWTON 2021). In the community under study, the survey indicated that 32.1% of the population has tourism as its main economic activity, with restaurant and accommodation services being predominant, as 7.5% of residents are employed in each area. The second most important economic activity in the community is agriculture, which is the main occupation for 26.4% of the population (see Table 1).

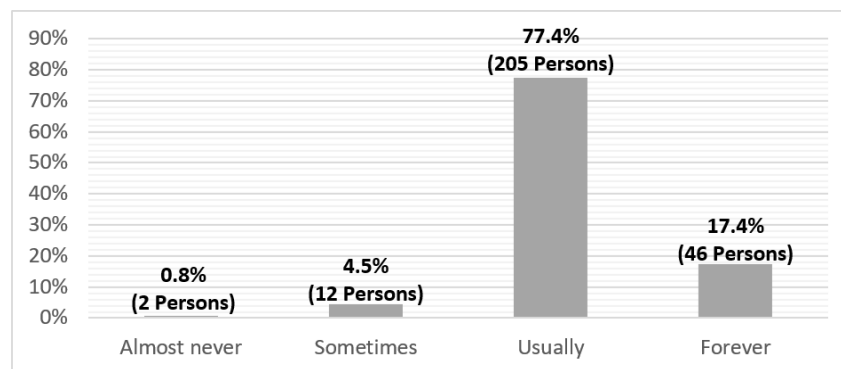
**Table 1.** Main economic activity, according to La Florida residents.

Activity	Frequency	Percentage
Tourism	85	32.1
Agricultural	70	26.4
Commerce	52	19.6
Forest	32	12.1
Construction	26	9.8
Total	265	100.0

Source: Prepared by the research team on the basis of data from the survey of La Florida's residents.

While 71.3% of residents are aware that tourist activity always generates work and continuous income, which contributes to revitalizing the economy of local households,

94.8% of residents indicate that the development of tourism activity has improved basic family income (see Figure 1). Thus, 63.8% of residents claim that before tourism development they had an average income of between 100 and 150 USD per month, whereas with the development and promotion of tourism, 87.5% of residents claim that they have now considerably exceeded this income (see Table 2).



**Figure 1.** Contribution to the improvement of basic family income. Source: Prepared by the research team on the basis of data from the survey of La Florida's residents.

**Table 2.** Monthly income after tourism development.

Monthly Income	Frequency	Percentage	Valid Percentage
100 USD–150 USD	33	12.5	12.5
More than 150 USD	232	87.5	87.5
Total	265	100.0	100.0

Source: Prepared by the research team on the basis of data from the survey of La Florida's residents.

Given the above, tourist activity has clearly helped to generate income for the community's residents, encouraging local development based on production and employment opportunities that energize and diversify the local economy. Nonetheless, much work remains, since the poverty index is still above average. Moreover, it has been noted that many informal services exist, particularly in the areas of catering and accommodation services. During contact with the population, it was observed that lodgings are provided within people's homes (rustic and improvised). When tourists visit, they stay in said houses sharing a small room with several people and paying for each bed that is used, rather than per room. A similar pattern holds true for restaurants, which are informal and scarce establishments (there are only three in the entire community) located in inhabitants' homes. Because they are rustic, these establishments lack quality and safety control for the handling and preparation of food. It is recognized that tourism-related income from informal activities can benefit a community significantly (Ketchen et al. 2014). If, however, steps are not taken to regularize this informality, challenges may arise, e.g., government regulations that limit access to resources such as capital and commercial space. Moreover, there is a latent risk that those involved may encounter problems such as low salaries, long working hours, high work intensity, poor work environment, and lack of social welfare (Tian and Guo 2021; Damayanti et al. 2017; Briassoulis 2001).

It should be noted that SDGs 1, 2, and 10 stipulate that tourism must be promoted to promote economic growth and development at all levels. Moreover, by providing income through job creation, tourism must contribute to reducing poverty and reducing inequality. Tourism is among the sectors with the most rapid economic growth and is capable of generating development at all levels and of providing income through job creation. It also contributes to rural development by giving community members the opportunity to prosper in their place of origin (ONWTO Organización Mundial del Turismo 2015). The development of sustainable tourism, and its impact on communities, can be



linked to national poverty reduction objectives. This is particularly true of objectives related to the promotion of entrepreneurship and small businesses and to the empowerment of less favored groups, particularly women and youth (ONWTO Organización Mundial del Turismo 2015; Urkullo 2015). The UNWTO affirms that tourism is an effective means for developing countries to participate in the world economy. In 2014, the least-developed countries received 16.4 billion USD in exports from international tourism, up from 2.6 billion USD in 2000. This considerable increase has made tourism an important pillar of developing economies, constituting 7% of total exports and helping some to ameliorate their condition (ONWTO Organización Mundial del Turismo 2015).

#### 4.2. Sociocultural Aspect

Socioculturally, tourism activity should be directed to empower local communities and endogenous peoples and to facilitate their participation in tourism planning and development (Urkullo 2015). The UNWTO argues that this ensures respect for the sociocultural authenticity of host communities, helping to conserve cultural and architectural assets and traditional values while contributing to intercultural understanding and tolerance (UNWTON 2021). Thus, to achieve local development, the preservation and revaluation of customs must also be taken into account. In this vein, 55.1% of La Florida's residents indicated having had positive interactions with tourists in their community, which enhances their awareness of the value of their endogenous customs. Moreover, 92.8% of residents indicated that said tourist activity in their community significantly promotes and influences the valuation of their culture and customs (Table 3). Finally, 84.2% of residents indicated that tourism in their community encourages respect and tolerance for interculturality. To this end, awareness workshops are planned to help spread their culture and traditions.

**Table 3.** Promotion of interculturality, valuation of culture, and interaction with tourists.

Valuation	Interculturality	Culture Valuation	Interaction with Tourists
Never	0.4%	0.0%	0.4%
Almost never	0.8%	0.0%	5.3%
Sometimes	3.0%	0.0%	20.8%
Usually	11.7%	7.2%	18.5%
Always	84.2%	92.8%	55.1%
Total	100.0%	100.0%	100.0%

Source: Prepared by the research team on the basis of data from the survey of La Florida's residents.

It is well appreciated that local populations take initiative to continuously undertake activities that elevate their culture, customs, and cultural manifestations, thus helping to strengthen their identity and endogenous customs and encouraging the revaluation of their traditions. The World Tourism Charter indicates that tourism activity must be directed to empowering local communities and indigenous peoples and to facilitating their participation in the planning and development of tourism (Urkullo 2015). Thus, in destination management, it is necessary to ensure the revaluation of culture. This applies in places where tangible and intangible cultural heritage coexist, which is the most important cultural tourist resource (Lin et al. 2021) and where the cultural aspect is the main inspiration of the visitor to learn, discover, experience, and consume the cultural heritage of their destination (Liu 2020). The development of a sustainable cultural tourism policy may thus be a practical way to foster a new business model that increases employment and promotes the conservation of heritage landscapes (Aquino et al. 2018). Notably, and pertinently to the alliance between tourism and culture in Peru, the UNWTO states that society, culture, and tourism maintain a symbolic relationship. Artistic and craft activities, dance, rituals, and legends that run the risk of falling into oblivion among new generations can be reactivated if tourists show great interest in them (OMT 2016).

#### 4.3. Environmental Aspect

Particular emphasis is placed on the optimal use of environmental resources, which are fundamental elements of tourism development, while maintaining essential ecological processes and conserving natural resources and biological diversity (UNWTON 2021). A wide range of economic sectors have joined strategies to reduce climate change, and tourism is no stranger. Thus, strategies can be promoted that contribute to lowering the carbon footprint through the management of sustainable destinations and the construction of ecological tourist infrastructure (Urkullo 2015). In this regard, 73.2% of La Florida's residents affirm that they always promote the social responsibility of tourists to protect natural attractions, while 9.4% do so regularly. Nonetheless, this leaves 17.4% with whom local governments must work to achieve greater awareness (Table 4). Meanwhile, 78.5% claim to actively collaborate in programs, workshops, and training for the care and preservation of green areas, while 15.5% do so regularly. Similarly, 66.8% confirm that they always take into account the conservation of local resources. They also note a commitment from the local government, in which the municipality promotes action and awareness to maintain green areas in good condition.

**Table 4.** Promotion of social responsibility to safeguard natural attractions, active collaboration in workshops, and conservation of biodiversity.

Valuation	Social Responsibility to Safeguard Natural Attractions	Active Collaboration in Workshops	Conservation of Biodiversity
Never	0.0%	0.0%	0.0%
Hardly ever	0.0%	0.4%	1.1%
Sometimes	17.4%	5.7%	11.7%
Usually	9.4%	15.5%	20.4%
Always	73.2%	78.5%	66.8%
Total	100.0%	100.0%	100%

Source: Prepared by the research team on the basis of data from the survey of La Florida's residents.

Excessively high tourist influxes are known to entail a series of negative aspects, e.g., environmental pollution, degradation of ecosystems, soil erosion, and even desertification (Drius et al. 2019). Challenges introduced by overtourism have also been reported in Barcelona, Amsterdam, and Rio de Janeiro (Brtnický et al. 2020).

Our results indicate that, while the community is positively predisposed toward the preservation and care of the environment, it needs a more concrete understanding of what environmental sustainability encompasses. The entire community must be involved in developing plans and strategies, not only in terms of local knowledge but also in taking action and implementing sustainable tourism infrastructure, since the greatest threat to the planet is the construction of new infrastructure (Davenport and Davenport 2006). The seriousness of global environmental problems now requires rapid action at the highest level to avoid catastrophic degradation (Thommandru et al. 2021). Such actions are not only the responsibility of government, but also of each individual, each district, and each community, all of whom must help in any way they can to achieve this objective (Thommandru et al. 2021).

SDGs 7 and 9 assert that tourism activity can incentivize national governments to renew infrastructure and modernize industry. When based on the use of renewable energy sources, this can contribute to reducing greenhouse gas emissions, mitigating climate change, and implementing new and innovative energy solutions (ONU 2022).

#### 4.4. Renewable Energy Potential in La Florida as an Alternative for Sustainable Development

Given new national and international demands, it is important for any projection of tourism development to include the involvement and empowerment of local communities to boost their economy. Likewise, it must help to address climate change by aiming to

progressively reduce greenhouse gases (GHG) emissions, thereby growing in a sustainable way (Urkullo 2015). This can be achieved by implementing eco-efficient technologies and processes in all areas of the tourism industry, including buildings, infrastructure, etc., and by reducing energy consumption and using renewable sources, especially in the transport sector and accommodation. All of this can be achieved if the implementation of renewable energy sources in tourist destinations is promoted to reduce the carbon footprint of the tourism sector (Urkullo 2015).

Peru has significant potential for developing sustainable tourist destinations, since it has a diversity of geographical contexts accompanied by a variety of climates, providing the country with a range of options to take advantage of renewable energy sources. This context is addressed from a technical-professional perspective that undertakes an analysis of Peru's energy potential.

Sustainable tourism activity managed in an appropriate way can be a strategic ally to preserve the environment, generate economic growth, and safeguard endogenous customs and traditions (Calderón-Vargas et al. 2019). To this end, the Peruvian state has been supporting programs that encourage members of different local communities to establish their own businesses. As of 2017, this includes the "Turismo Emprende" program, an initiative of the Ministry of Foreign Trade and Tourism to promote the economic reactivation and reconversion of micro and small businesses (Mypes). The goal is for these businesses to promote the tourism sector by providing accommodation, food, tourist operations, travel agencies, and crafts, while improving and strengthening local businesses to enable them to adapt to current market needs. In 2020, a non-refundable 4,500,000 USD was allocated to rejuvenate the country's tourism businesses (MINCETUR 2021). Another program is the Inter-American Institute for Cooperation on Agriculture (IICA), which supports small renewable energy ventures in rural areas of Peru. To date, 35,000 homes and 191 institutions have benefited from the IICA's efforts to reduce rural poverty (El Peruano 2019). The MINEM plans to continue supporting projects that promote sustainable development through renewable energy (MINEM 2021). Finally, ENGIE "Energía Perú", one of the country's largest electricity generation and infrastructure companies, seeks to strengthen the technical and infrastructure capacities of small local entrepreneurs. These entrepreneurs are encouraged to implement proper business management practices for insertion into commercialization chains or to start their own enterprises and thus improve the standard of living and income of families (ENGIE 2021).

An evaluation of renewable energy potential was carried out, specifically of solar and wind, in the vicinity of La Florida, located in the province of Huaral, department of Lima ( $-11.308177$ ,  $-76.795476$ ). Energy demand was calculated for a total of 10 lodging houses, each containing five basic bedrooms with a maximum capacity of two people (these calculations reflect the total annual proportion of visitors to the study location). The energy demand for each basic lodging house was evaluated first, followed by the average energy contributions in kWh/month for each type of renewable energy source and the engineering design necessary to respond to demand (photovoltaic panels and wind turbines). Finally, in light of the sustainable project profile, a calculation was made of equivalent savings in CO<sub>2</sub> emission, equivalence in trees planted per hectare, and economic savings (based on local electricity cost per kWh), both for solar (photovoltaic panels) and wind power (wind turbines).

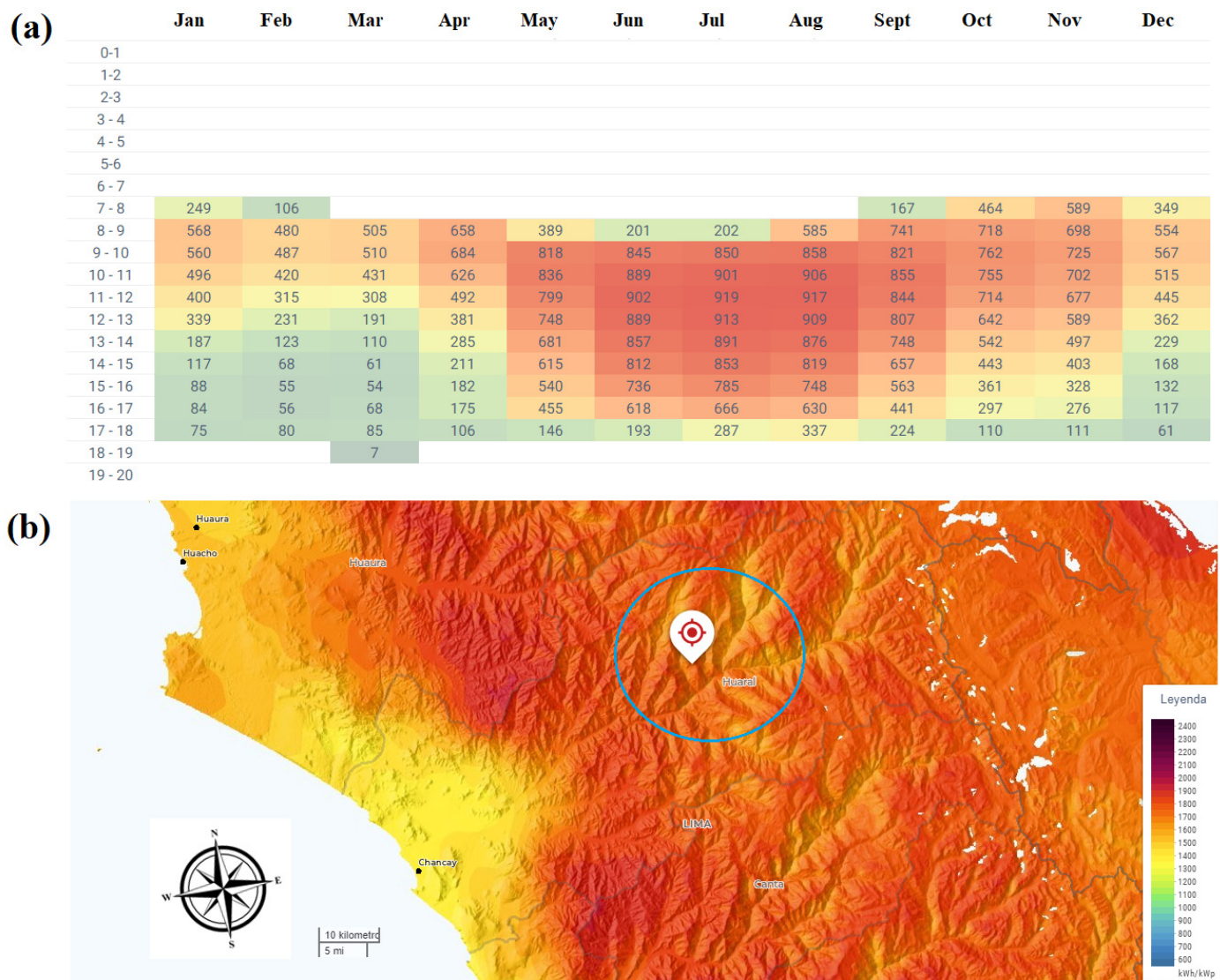
Table 5 shows values for average daily solar photovoltaic electric potential (PSEP) based on the electric production of a solar photovoltaic (PV) plant of 1 kWp (generation capacity of a solar panel) as evaluated with two types of software (EnAir and Solargis). For this purpose, precise coordinate values were used for the study location. Averaging the figures provided by the two programs yielded a solar electric potential of around 4.40 kWh/day, which is within the desired range.

**Table 5.** Solar radiation intensity in La Florida.

Source	Photovoltaic Solar Electric Potential (kWh/Day)
EnAir	3.8
Solargis	5.012
Average	4.406

Source: Data from EnAir and Solargis simulators.

Because the town of La Florida is located within a rugged and mountainous geographical context, it has good conditions in terms of average hours of sunshine per day (9 h), from roughly 8:00 to 17:00, with the highest intensity being from May to September. Figure 2 presents the relevant values in a heat map, with red representing the maximum values reached and light blue the minimums.



**Figure 2.** (a) Average hourly profiles of direct normal solar irradiation ( $\text{Wh}/\text{m}^2$ ), (b) Solar resource map at the study site. The circumference shows the location of the La Florida community. Source: SOLARGIS.

Table 6 presents detailed values for solar irradiation characteristics, which are necessary for determining the engineering design of photovoltaic electrical systems. The units,  $\text{kWh}/\text{m}^2$ , represent values of energy and time specifically related to electricity generation



by a 1 kWp photovoltaic system. Note the similar values for direct and inclined normal solar irradiance, typical of altitudinal sectors that do not impose limits on the configuration of photovoltaic (PV) systems.

**Table 6.** Characteristics of solar irradiance.

Solar Potential and Air Temperature: Annual Average	
Global horizontal irradiation	5.556 kWh/m <sup>2</sup>
Direct normal irradiation	5.012 kWh/m <sup>2</sup>
Diffuse horizontal irradiation	1.881 kWh/m <sup>2</sup>
Slanted global irradiation	5.754 kWh/m <sup>2</sup>
Air temperature	18.3 °C

Source: Solargis.

As for wind potential, the geomorphological characteristics of the area are a main factor supporting the use of this type of energy. Table 7 provides figures for the wind potential of La Florida, assuming the introduction of a basic wind generation system (wind turbine) with an energy production of 200 kWh/day. Such a design would meet the basic energy demands of, e.g., a lodging house, given an operating range based on wind speeds of 8–11 m/s.

**Table 7.** Average wind potential in La Florida.

Wind Potential	
Wind energy	4.2 kWh/day
Average output potential	180 W
Annual energy	1522 kWh
Average monthly energy	127 kWh
Average wind speed	1.2 m/s

Source: EnAir.

The characteristics of the wind turbine system are based on the energy generated (described above). A wind turbine with three blades would require a diameter of 9.8 m, with a lateral length for the blade system and generator of 2.3 m, a total mass of 1000 kg, and an active regulation system by vane (aerodynamic orientation). A three-phase generator configuration is needed: 500 V direct transmission, nominal speed of rotation 120 rpm, and inverter.

Table 4 set out the basic energy demand (kWh) and design of a lodging house with five bedrooms and capacity for a maximum of 10 people. The total energy demand is 186.2 kWh, with an equivalent cost of 40.51 USD.

Based on these results, the use of a single PV system generates 114 kWh/month, while a wind turbine system produces 126 kWh/month, yielding an available total of 240 kWh/month. This exceeds the necessary demand per home (186.2 kWh/month) (Table 8).

Figure 3 displays the monthly variation in energy contributions for each system installed in a lodging house. Note the greater degree of contribution of PV systems. When designing a hybrid system (solar—wind), it is necessary to adapt to meet energy demands. While an alternate scenario might consider a purely PV system, for a period of five months the solar irradiation is inadequate (Figure 3); therefore, a hybrid design is suggested.

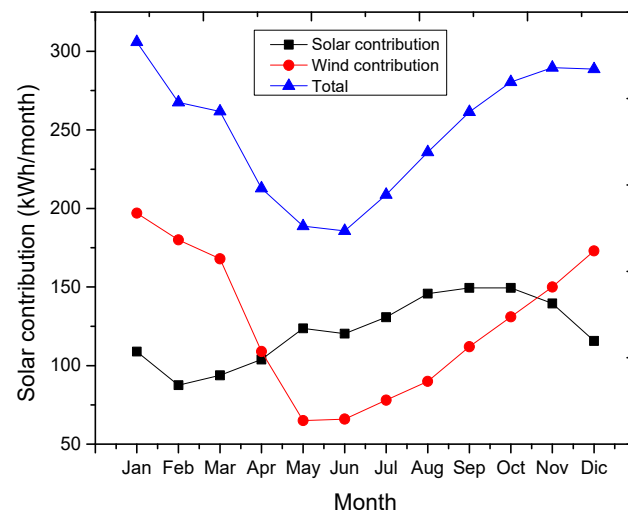
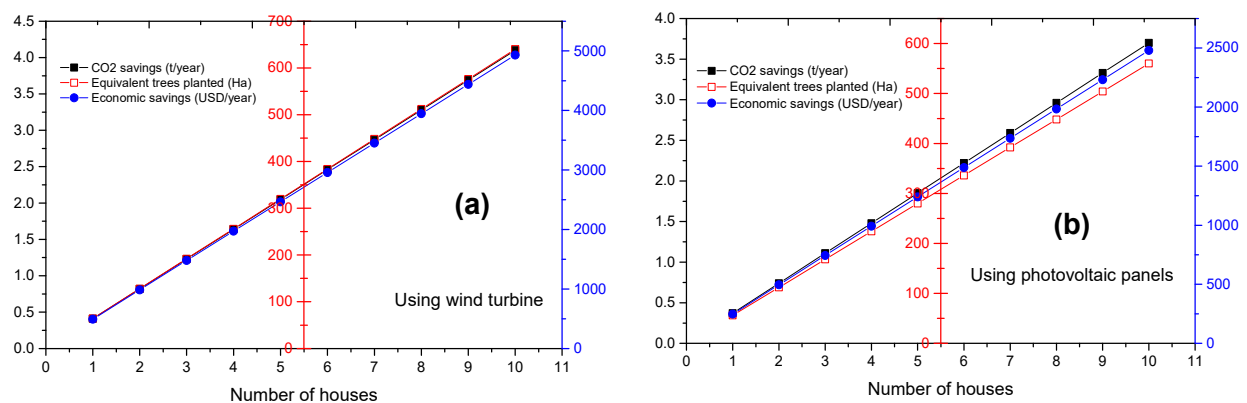
As discussed, the application of systems that meet energy demand through renewable sources can also help contribute to sustainability. Thus, Figure 4 displays a directly proportional relationship between the number of houses with such systems installed and sustainability measures such as reductions in CO<sub>2</sub> emission, equivalence in trees planted per hectare, and annual economic savings (in USD). Figure 4a treats wind turbine systems while Figure 4b is for the PV systems.



**Table 8.** Basic demand and monthly cost per lodging house in La Florida.

No. Elements	Artifacts	Power (W)	Monthly Use (Hours)	Consumption/Month (kWh)	Monthly Cost (USD)
5	TV	575	60	34.5	6.21
10	LED lighting	150	150	22.5	4.05
1	Computer	300	40	12	8.52
1	Inverter refrigerator	70	720	50	9
1	Microwave	1100	60	66	11.88
1	Inverter washing machine	30	40	1.2	0.852
Total				186.2	40.512

Source: Adaptation of data from the Ministry of Energy and Mines—Peru.

**Figure 3.** Monthly contributions of solar, wind, and total energy available in La Florida. Source: adapted from EnAir and Solargis data.**Figure 4.** Contribution to reduction in CO<sub>2</sub> emissions, equivalence in trees planted/ha, and economic savings/year based on the number of houses (a) with a wind turbine system and (b) with a photovoltaic (PV) system. Source: Authors' calculations, based on data from EnAir and Solargis.

## 5. Conclusions

Tourism was identified as a main focus for economic activity in La Florida, with more than 32% of the population employed primarily in this field. Moreover, the degree of

influence between sustainable tourism and local development was found to be at a medium level. Thus, as tourist activities develop gradually, they contribute to improving the quality of life of locals, providing better job opportunities and entrepreneurship, and generating an economic boost. Nonetheless, it was noted that existing development is premature, since it is evident that income from tourism is below the average, with 12% of inhabitants not generating an income greater than 150 USD per month.

Environmentally, the inhabitants were found to exhibit a positive awareness of the issue, since they have been undertaking activities to conserve their natural environment. The influence of professionals is needed, however, to help direct the community toward sustainability and to take advantage of natural sources of renewable energy. This might support the creation of sustainable accommodations, which would in turn increase the likelihood of tourists staying longer than one day. This would result in an increase in income to the inhabitants.

The evaluation of local renewable energy potential revealed the existence of sufficient solar and wind energy for the generation of electricity through the use of photovoltaic systems and wind generators. It would easily be possible to meet the energy demands of a house-lodging in the study site, thus consolidating an alliance between tourism and the sustainable use of clean energy sources. This in turn has implications in reducing the fixed and variable costs associated with energy supply.

It is worth mentioning that this research faces some limitations. Care must be taken when comparing our results with studies of other countries whose populations' standards of living, national legislation, geographical conditions, etc. may differ. Moreover, the carbon footprint linked to tourist activity in the study location is unknown. However, this work is presented in hopes of stimulating further research elsewhere to validate the tourism—renewable energy binomial and thus to motivate the practice of sustainable tourism in rural communities.

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