

## Article

# Energy Literacy of Residents and Sustainable Tourism Interaction in Ethnic Tourism: A Study of the Longji Terraces in Guilin, China

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**Abstract:** Energy and environment form a nexus in which residents are the owners of tourism energy resources. Only a few studies have focused on the energy literacy of residents in ethnic tourism destinations and its impact on sustainable tourism. Using a qualitative research approach through field works and in-depth interviews in the Ping'an Village, Longji Terraces Scenic Area, this study explored the relationships between the energy literacy of residents and sustainable tourism in ethnic areas. The result showed that the energy literacy of the ethnic residents of Pingan village in terms of knowledge, attitude, and behavior has increased in line with the development of tourism, and both external and internal factors contribute to the improvement. Besides, the promotion of energy literacy among the residents not only has a positive impact on the tourists' behavior but also brings about effective improvements in the local energy use structure and infrastructure, thus contributing to the sustainable development of tourism. This research extends the understanding of energy literacy from the perspective of ethnic residents and changes in energy literacy in remote ethnic villages under tourism development. The results also deepen our understanding of such changes in the behavior of tourists and tourism destination sustainability and enrich the empirical research to promote energy conservation and sustainable tourism development in ethnic areas.

**Keywords:** Longji; ethnic areas; environment; ecological balance; tourism



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## 1. Introduction

Energy is the basis for human survival and development and an essential resource for enhancing socioeconomic development. With the decline in global energy reserves, the issues of energy production and consumption have become a global concern. Although humans use science and technology to create a high quality of life, they also cause increasingly serious environmental pollution [1]. Energy and tourism are closely related; energy not only becomes an attraction but also a limitation to the tourism industry, where there is an increasing trend of energy consumption in tourism catering, accommodation, and transport [2]. There needs to be a coordinated effort between residents and tourists to effectively reduce the consumption of energy and emissions from tourism activities and protect the tourism landscape and ecological environment.

Energy literacy is an important concept related to the multifaceted phenomenon of energy consumption, and it has gained attention in many related fields and applications [3]. This concept can be explained as a person who is aware of the energy consumption of the appliances in their home, how to take the necessary measures to save energy, and the relationship between energy use and climate change [1–4]. Previous energy studies have focused on the concept of energy literacy [5,6], the relationship between energy knowledge, literacy and behavior, energy literacy scales, and factors that influence energy literacy [6,7];

however, few studies have discussed the relationship between energy and other social developments from a cross-disciplinary perspective. It is not surprising that the energy literacy of residents in ethnic tourist destinations remains unclear, as well as how energy literacy affects the development of tourist destinations.

Currently, tourism is an integrated industry in modern society that drives the flow and consumption of large numbers of tourists and logistics, and the energy behavior of its stakeholders is crucial for environmental sustainability [2]. Most of the energy-related tourism studies have discussed the benefits [8,9] and the constraints [10,11] that energy poses to tourism development, as well as the energy consumption and behavior in tourism [12,13]. Yet the relationship between tourism development and the energy literacy of residents remains unclear, particularly on how the energy literacy of ethnic village residents in remote areas has changed as a result of tourism development. Previous research on ethnic village tourism has mainly focused on the preservation of ethnic and cultural heritage [14], the participation of community residents in tourism [15], and the interaction between host and guest [16], with less attention paid to the energy environment of ethnic tourism destination. However, understanding how ethnic areas can escape poverty and gain knowledge of development for local economic and environmental sustainability are important for harmonious social development. Thus, this study focused on the Ping'an Zhuang Village in the Longji Terraces Scenic Area as an ethnic tourism site to explore the impact of the energy literacy of ethnic residents on sustainable tourism development by conducting field surveys and in-depth interviews and using qualitative research methods. Two questions answered in this study are as follows: How has tourism development brought about changes in residents' energy literacy? How does a change in energy literacy affect the sustainable development of local tourism? The results of this study can increase the understanding of the relationship between energy literacy and tourism development from a transdisciplinary perspective, enrich empirical research on energy literacy from the perspective of ethnic residents, and promote energy conservation and sustainable tourism development in ethnic areas.

## 2. Literature Review

### 2.1. Energy Literacy

Energy literacy is related to the perception and consumption of energy [5]. The earliest research focused on knowledge [17], while more recently, researchers have become increasingly aware of the importance of the willingness and actions of people [18]. When an individual is energy-aware, they know the energy production and consumption in everyday life, how to save energy in their home, how to adopt economic energy-efficient behaviors, and how their energy choice may be related to climate change [1]. Although the definition of energy literacy remains unclear, most authors have accepted that literacy should consist of three domains: knowledge, attitude (affect), and behavior [1,6,7]. Knowledge is a critical element in achieving energy literacy, comprising an understanding of energy efficiency, awareness of the environment, and the social impacts of energy production, distribution, and consumption [1,6,7]. Attitude refers to people's perceptions of the impact of energy issues on their lives and energy-related beliefs that are crucial for decision-making [1,6,7]. Though the affect may be instead of attitude in different studies, it means much the same as attitude, which refers to how you think of energy use [6]. Behavior includes personal attention to environmental issues and the need for energy efficiency, the responsibility each individual feels to be a citizen worldwide, and commitment to energy efficiency [1,6,7]. Previous studies have paid more attention to the relationship between energy knowledge, attitudes, and behavior. Hungerford and Volk found that knowledge contributes to behavior because it plays an important role in environmental protection decisions [19], whereas Alp et al. indicate that the energy attitudes of elementary school students significantly influence their environmental behavior [20]. Rioux proposed that neighborhood attachment as an affection variable is a critical element in the behavior of secondary school students. Energy knowledge of people, as well as their willingness and ability to act, are important

for literacy [21]. De Waters and Powers also proposed that energy behavior and affect are more relevant than knowledge [6]. However, the traditional thinking that increasing knowledge could increase affect and result in behavioral changes has been gradually challenged by subsequent researchers. Numerous studies have reported that reasonable knowledge does not necessarily translate into sound behavior to save energy. For example, although Minnesota residents have already acquired some electricity-saving habits, they still show resistance to replacing equipment with more efficient ones and using public transport or more economical driving methods [1]. Similarly, although the Danes show a good energy knowledge level, they do not use more efficient equipment or renewable energy [22]. Chen et al. and Lee found that Taiwanese students achieved reasonable energy knowledge [23], but it did not seem to determine behavior change. University students in Portugal also showed a low level of concern and commitment to energy saving [24,25].

The scales and models of energy literacy also play an important role in energy literacy research. The foundation for developing a competitive scale for measuring energy literacy is still based on knowledge, attitude (affect), and behavior. In addition to the efforts of DeWaters to develop an energy literacy scale, Bodzin et al. developed two instruments to measure the energy literacy of middle-level education students: one related to knowledge and the other related to attitude and behavior [26]. Similarly, Kyriazi and Mavrikaki developed a scale to measure the environmental literacy of post-secondary students [27]. In general, the framework is defined as follows: (1) The knowledge dimensions refer to the influences of energy development, various types of daily energy use, basic rules of energy use, and the importance of efficient energy use. (2) The attitude dimensions refer to the influences of energy use in the daily lives of people, and the behavioral dimensions refer to the adoption of energy-efficient behaviors in daily life. Meanwhile, there are two main aspects of the discussion of energy literacy models: the education and the psychological model. The education model emphasizes the importance of acquiring energy, knowledge, and skills, which closely contribute to actions and behaviors. The psychological model encourages people to take responsibility for energy-saving actions. For example, Kollmuss and Agyeman proposed that internal and external factors are directly related to pro-environmental behavior [28].

The level of energy literacy is also related to personal characteristics and educational background; from the perspective of personal characteristics, gender is one of the most important factors. Studies have shown that although women have lower levels of energy-related financial literacy [29–31], they have higher levels of energy literacy than men [32]. Studies have also reported that the primary factors determining energy literacy are gender, going away from home to study, and the experience of energy poverty [33]. Meanwhile, age played an important role, and the results showed that children and elderly people presented lower levels of energy literacy [34]. Promoting the energy consumption habits of children has become a critical program; this includes increasing the frequency of energy-related curricular units, supplying a high level of parental education [35], and improving the practice of educational games [36,37]. Different educational backgrounds were also associated with different levels of energy literacy. As education programs can benefit students by achieving proficiency levels of energy literacy, students in different areas may have different opportunities to learn energy-saving knowledge and skills [38]. Differences also existed among students from different disciplines. For example, the results showed that students who majored in agriculture performed better than others [39]. Similarly, students of geography, earth and environmental sciences, marine sciences, engineering, and architecture obtained the broadest knowledge of energy issues from their education and are perceived to have a superior level of knowledge on the subject [40]. More recently, current research on energy literacy has been paying attention to more vulnerable energy users, suggesting that they may experience inadequate access to affordable and reliable energy services and have less financial and material resources to buffer harm [3].

Based on the above, previous studies on energy research have mostly discussed the concept of energy literacy [5,6], the relationship between energy knowledge, literacy,

and behavior [19–21], scales of energy literacy [26,27], and factors influencing energy literacy [29,30,37], as shown in Table 1. However, few studies have addressed the relationship between energy and other social developments from a transdisciplinary perspective. Tourism, as an integrated industry in modern society, involves the flow and massive consumption of people and services, and the energy behavior of its stakeholders is crucial for environmental sustainability. Therefore, it is useful to focus on energy development from the tourism perspective.

**Table 1.** The development of energy literacy review (Source: by own study).

| Review Items                        | Research Contents                                                                                                      |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| the concept of energy literacy      | the definition of energy literacy [1,6,7]                                                                              |
|                                     | relationship between energy knowledge, literacy, and behavior [6,19–21]                                                |
|                                     | knowledge does not necessarily contribute to energy save behavior [1,22–25]                                            |
| scales of energy literacy           | related to knowledge, related to attitude and behavior [26,27]                                                         |
|                                     | the education and psychological model [28]                                                                             |
| factors influencing energy literacy | Gender [29–32]; going away from home to study, and the experience of energy poverty; age [33]                          |
|                                     | Different educational backgrounds [38]; different disciplines [39,40]; energy literacy of vulnerable energy users [41] |

## 2.2. Energy and Tourism

Recent studies have shown that tourism and energy are interrelated. Energy tourism is often associated with industrial tourism to attract tourists, as some former industrial sites are still open or regenerated for tourism [8,9]. For example, decommissioned coal mining sites or New York’s Highline park [41,42]. In addition, agritourism tourism can be considered a type of energy tourism since it is often connected to energy production activities on the farm, such as producing biogas on-site, growing energy crops, or grazing sheep on the meadow of photovoltaic plants [2,43]. Along with tourism destinations, energy tourism could also play an important role in improving the energy literacy of people and changing their energy use behavior, resulting in more sustainable energy citizens [44]. New forms like environmental education, displays of new technologies, interactive science experiments, and various outdoor activities, such as cycling, camping, or hiking, could be used in various types of energy tourism, for example, in ecological education centers, observation towers, and natural trails [2]. The aim is to improve energy knowledge through tourism; however, energy may also impose restrictions on tourism. Energy facilities engaged in the extraction and processing of energy resources can have a negative effect on the character and function of many energy landscapes [2,10]. Environmental pollution and poor landscape vision may discourage visitors from visiting these locations [45,46]. Previous studies also had different views on visitors’ perceptions of different energy facilities. Some studies have suggested that visitor perceptions may vary depending on the form, location, and concentration of space; spatial closeness of the energy facility [2]; physical and social values of the local environment [47]; and the type and sociodemographic characteristics of the tourist [48]. In addition, some studies concluded that visually appealing energy facilities, such as large wind farms, may influence the choices of visitors and their intention to revisit. Similarly, studies have reported that there are no significant negative impacts of wind turbines on local tourism [49].

Tourist needs also lead to extensive consumption of energy, for example, fuels burned for traveling, heating, and cooling; chemical products for cleaning; and energy used for cooking. According to a UN report, each tourist produces 1 kg of solid waste per day.

Previous research on the environmental impact of energy consumption in tourism has been broadly discussed. Research showed that new recreational facilities and accommodations had been built to compete with more tourists, leading to more energy consumption [50]. Guests in hotels tend to use more towels, have longer showers and generate more waste than at home; plastic particles such as bags and bottles are discarded in scenic areas [51]. Becken et al. argued that the duration of visitor stay is the main variable affecting total energy use [52], but energy efficiency appears to rise with increasing stay [53]. While these actions are not necessarily caused by malicious intent, they could incur additional management costs, disturb residents, and endanger the ecosystem [54,55]. Furthermore, Becken and Simmons suggested that accommodation in tourism has a low energy consumption of fossil fuels while burning wood is a potential threat to the environment [56]. Fuelwood collecting is one of the prime causes of forest cover loss in remote tourism destinations [57], which may cause landslides and air pollution. Recently some scholars also stated that tourism could have negative externalities such as climate change and air pollution [58]. Similarly, Qureshi et al. confirmed that both environmental variables and air pollution are significantly associated with health services in Malaysia [59]. Some studies also found that economic growth and energy consumption influenced carbon emissions as more tourists arrived [60]. In addition, some studies have also discussed energy saving and pro-environmental behavior in tourism. Given the impact of tourism consumption on the environment, some researchers explored the factors that encourage more sustainable behavior, as these factors may bring about changes in visitor behaviors [61]. Such as pro-environmental behavior are actions that minimize harm or even benefit the environment [62], and pro-environmental tourists refer to those who try to alleviate their negative effects on the environment by adopting energy-saving behaviors in their trip [63]. Studies point to factors such as moral, affective attitudes, and environmental awareness are important to the formation of pro-environmental behavior [64]. Scholars also developed a scale to measure the pro-environmental contextual force that affects urban tourists' PEBs [51].

More recent studies also paid attention to energy literacy in tourism. Studies have shown that tourists are less aware of energy literacy at hotels than at home [65,66]. As previously mentioned, higher energy literacy contributes to energy protection; therefore, it is not surprising that energy literacy has recently gained increasing attention in tourism research. For example, Teng et al. discussed the impact of knowledge and the effect of hotel employees on energy literacy [13]. In addition, some studies have investigated the energy literacy characteristics of peasant households in rural tourism destinations. Zhang also found significant links between the energy knowledge, affect, and behavior of tourism farmers [4]. It has also been suggested that energy feedback is crucial in energy behavior change, and personal values and energy literacy also have an impact on changing energy consumption behavior [67].

Tourism results in a significant increase in energy consumption, which, in turn, leads to an increase in CO<sub>2</sub> emissions and climate change in the long term [68]. Hence, because of the close links between energy consumption and carbon emissions, some studies share significant similarities in carbon and energy literacy in terms of research targets. The reduction in CO<sub>2</sub> emissions depends on the social ethics and responsibility of tourists. Several studies indicate that enhancing carbon literacy is important for reducing carbon emissions and promoting public conversation [69,70]. Juvan and Dolnicar emphasized the crucial role of efficient communication in the low-carbon decisions of tourists [65].

Some researchers have considered energy and carbon literacy. Horng et al. developed a measurement scale for energy-saving literacy and carbon reduction in the tourism and hospitality industries. They also found differences between Taiwanese and Malaysian students in terms of knowledge, ecological concepts, attitude, sensitivity, locus of control, action intention, and action strategy [12]. Similarly, Teng explored the energy and carbon literacy structures in hospitality and tourism practices in Taiwan [71]. Some studies have also suggested that energy-efficient policies are indispensable for tourism. As such, im-



proving energy efficiency and reducing energy waste through energy literacy is important for the sustainable growth of tourism.

Existing energy-related tourism research has primarily discussed energy tourism as a tourist attraction [44], energy facilities' impact on tourists' energy literacy [44], and the constraints that energy imposes on tourism development [10,11,45]. Some studies have also highlighted that tourism is associated with significant energy consumption, while others have discussed the energy literacy of hotel employees [12], types of energy literacy of residents in rural tourism destinations [4], and links between energy and CO<sub>2</sub> emissions [12,13,69,70]. More recently, current research on energy tourism has been expanded to measure the relationship between economic activities and energy consumption in ethnic regions [72]. Some researchers also suggested cycling in ethnic areas is means of low-carbon and fashionable traveling for sustainable tourism [73]. Similarly, the use of renewable energy and locally developed energy-saving technologies is increasing in tourist lodges in Nepal's ethnic region [74]. Luo also found that the absolute total emissions per visitor to one of China's ethnic tourism destinations have reduced slightly [75]. However, few studies have adequately discussed the relationship between tourism development and the energy literacy of residents. Ethnic areas need to break out of poverty and gain knowledge in development to promote local economic and environmental sustainability; these are important issues that require attention in the context of harmonious social development.

### 3. Research Methods

#### 3.1. Case Introduction

The Longji Terraces are located in Longsheng and Guilin, China. They are among the most beautiful terraces in the world, as shown in Figure 1. According to historical records, they were built in the Qin Dynasty, shaped in the Ming Dynasty, and completed in the early Qing Dynasty nearly 2300 years ago. The terraces are charming and beautiful year-round. Ping'an is the central village of the Longji Terraces Scenic Area, towering over the spine of the Terraces. Since 1993, it has been developed for tourism for nearly 29 years and has attracted amounts of tourists. The village is in a subtropical monsoon climate zone with an average annual temperature of approximately 17.1 °C, with no heat in summer or cold in winter. The rainy season in Ping'an is from April to August, which accounts for almost 72% of the annual rainfall. This area is well watered, and the exposed hills are mostly sandy rocks, which are mostly dark green.



**Figure 1.** Ping'an village and Longji Terraces (Source: Photo provided by villagers).

The Ping'an village comprises traditional pile-dwelling wooden buildings with typical stilt-style architecture and a "zigzag" stone path running through the entire village. Residents of Ping'an village enjoy glutinous rice, bacon dried fish, and sour bamboo shoots, and they have their own elegant ethnic costumes with strong folklore. In terms of beliefs, there are land gods, thunder gods, frog gods, cows, ancestor worship, and Taoist gods, which are mainly related to the cultivation of terraced agriculture. Presently, the village is still dominated by the original Zhuang ethnic group, and participation in the tourism business has become a major source of income for them, with a total of 108 large and small hotels and dwelling houses, two bars, three Zhuang herbal footbaths, six external operators, and two cafés.

Compared to other ethnic tourist destinations, which rely on folk culture and natural scenery, Ping'an Village is more attractive for its terraced landscape. These terraces come from ancestors who reclaimed the land in front of deep mountains in order to survive. It shows the world the strong will of humanity to survive in nature, the wisdom and strength in understanding nature, and building a homeland.

In addition, the terraced landscape and tourism development in Ping'an village are closely linked to energy sources. As a tourist attraction, the terraces require a high level of water conservation. If construction waste from B&B and tourist waste leads to the contamination of local water sources, this may affect the terraces and ecological sustainability, as well as the sustainability of local water resources and hydropower generation. Traditional pile-dwelling wooden buildings are also posing a safety hazard in terms of fire use, and the development of tourism requires a large amount of energy. Therefore, this village represents a typical case for discussing how ethnic tourism village residents balance tourism development and energy use, which is a concept that needs to be explored in further detail.

### 3.2. Data Collection and Analysis

The data for this study was mainly obtained from three ongoing field surveys that were conducted from May–July 2022, and the data acquisition methods use an omnibus strategy, including web-based information, participatory observation, and in-depth interviews, the most cited format for qualitative research [76,77]. It is an approach that contains a mixture of information-gathering techniques that include diverse forms of observation [78].

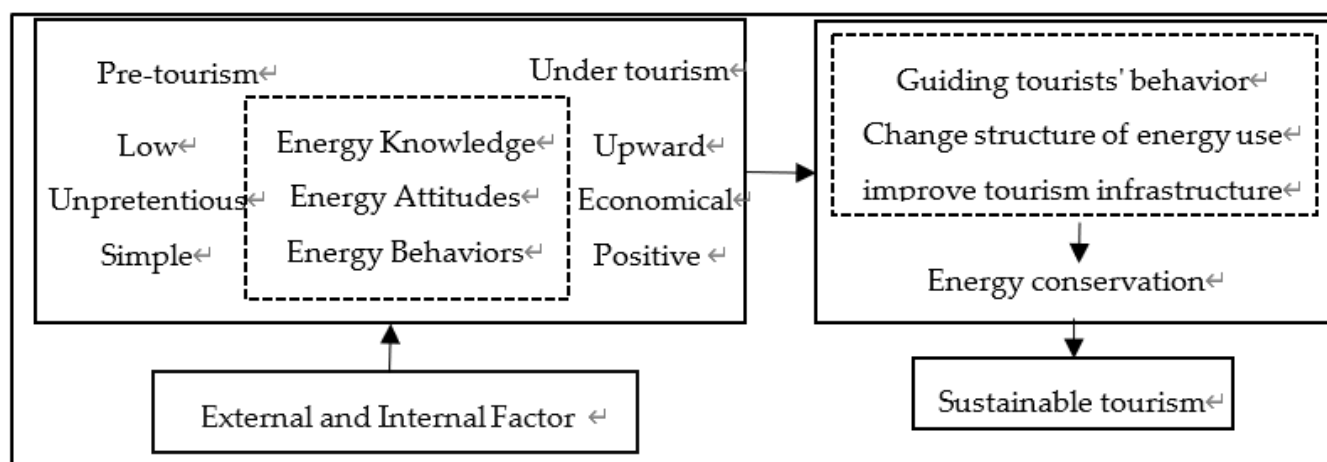
The first stage of this research was conducted in May 2022 through a field pre-survey and web-based information collection [72–78]. The purpose of this stage was to understand the basic situation of the natural environment, tourism resources, infrastructure, and development status of the Longji terraces. The second stage of the research was conducted in June 2022, and a total of 21 in-depth interview samples were obtained through a convenience sampling method due to typical interviewees being more informative and contributing to a deeper understanding [72–79]. The third stage was conducted in July 2022. Based on the collation and analysis of the pre-interview data and reflection, a total of five in-depth interview samples were obtained using a purposive sampling method because typical interviewees with rich information helped to understand the case in greater depth. At the same time, to better understand the research context, the research team followed up on the energy use of tourism in the village using participant observation to understand the perceptions of the residents and their related behaviors towards energy in the field. The semi-structured questions included the knowledge of local residents on energy, the environment, and energy use before tourism development; energy consumption by households after tourism development; energy consumption by tourists related to water, electricity, transport, gas, waste, and sewage; the relationship between energy and resources related to the tourism landscape; residents' perceptions of tourists' energy use; and their own evaluations of energy awareness and opinions about the future of the tourism landscape, environment, and energy use in harmony. The interviews and on-site observations complemented each other during the study until the relevant material was nearly saturated. All Interview recordings were transcribed into text and came to around 174,000 words. In addition, 21,000 words of memo notes were taken, as well as 475 photos that were related to energy literacy and sustainable tourism.

The combined three studies resulted in a sample of 26 in-depth interviews, all of which were within ~0.5–1.5 h and recorded with the consent of the other party. Of these, 15 were male, and 11 were female. There were 23 local people and 3 external local businesses: Two tourism managers in the village, 24 people directly involved in tourism (operating different grades of B&Bs and tourism catering), one person working in tourism transport-related jobs, and one student. As there are 108 households in Ping'an Village, the 26 interviewees involved in the in-depth interviews are all from different households, and they come from different types of businesses such as restaurants, accommodation, bars, souvenir selling,

and transportation, etc., and three of them are engaged in the management of both the scenic spot and the village, so they have an in-depth understanding and information of the village. The qualitative research is committed to finding the right interviewees in relation to the theory in the field, and our interviewees are typical, basically representing the different types of business and demographic characteristics in the villages. Also, our third author is of Zhuang ethnicity and knows the ethnic language of this village, enabling us to conduct interviews in greater depth.

Finally, all collected material, including transcribed interview data, web material, field notes, and photos, were stored in memos in NVivo 11 software for analysis [68]. Once the data collection was complete, the authors attempted to obtain the main ideas and key messages by reading transcripts of all observation notes and interview transcripts and then analyzing and qualitatively interpreting all the material using Thematic analysis [79,80]. The data was analyzed and coded based on how the energy literacy of the residents changed before and after tourism development; what contributed to the changes in the energy literacy of the residents; and how the energy literacy of the residents brought about changes in tourism destinations and tourists, thus contributing to the sustainable development of local tourism.

To protect the privacy of the interviewees, the interviewees were coded as “S+ interview No.”. The research data were analyzed using a thematic analysis approach, firstly by open coding the original data, labeling and classifying the data sentence by sentence, making initial naming, and marking them as free nodes. Secondly, concepts of similar incidents were gathered to further abstract the free nodes that had previously been marked; then, axial coding aims to put concepts and categories back together by making connections between them. Based on situational understanding, 10 main categories were developed in a long process of continuous breaking up and stitching together of all the material and codes: low level of energy knowledge, unpleasant energy attitude, simple energy behavior before tourism; upward energy knowledge, economic attitude towards energy and positive energy behavior after tourism; external and internal factors; guiding tourist’s behavior, change the structure of energy use and improve tourism infrastructure. In the open coding and categorical coding process, the three authors first read all the data materials separately and then open-coded them according to the main research questions; then, the three authors exchanged coding results and made coding decisions after thorough discussion. Finally, based on the coding decisions, all authors discussed the data in context and further analyzed the relationships between the 10 independent clusters to develop the conceptual framework. The overarching concepts and categories that emerged from this process are shown in Figure 2.



**Figure 2.** Conceptual Framework of the relationships between energy literacy and sustainable tourism (Source: by own study).



## 4. Results and Discussion

### 4.1. Changes in the Energy Literacy of Residents under Tourism Impacts

#### 4.1.1. Energy Literacy of the Ping'an Village Residents in Pre-Tourism

As shown by the field data, based on the perceptions of the residents and their memories of their previous energy awareness during the interviews, energy literacy before tourism development can be described as a low level of energy knowledge, unpretentious energy attitudes, and simple energy behaviors.

##### Low Level of Energy Knowledge

Before tourism development, knowledge of energy was largely ignored by the residents of the Ping'an village. Their knowledge of energy was still limited to traditional energy sources, such as water, electricity, and fire, which are essential to their lives. In particular, their awareness of new energy sources, the renewable status of traditional energy reserves, and the impact of the use of energy on the environment were still insufficient. For example, before the development of their tourism industry, villagers used to cut down trees in the hills to produce firewood for cooking, and they were not fully aware of the other types of energy for catering; they only prioritized the appearance of the wooden houses in which they lived. Therefore, residents' cognition of energy was at a low level before tourism was undertaken, lacking systematic and profound cognition.

##### Unpleasant Energy Attitudes

Residents did not give much thought to their attitudes towards energy use nor a sense of responsibility for energy conservation. For example, before the tourism drive, there was no charge for water use in the village. The cost was the main consideration for electricity; an important issue of concern was regarding the use of fire. As the whole village lived in wooden houses, if they were not careful, not only could the wooden houses burn down, but they would also pose a threat to the entire village.

##### Simple Energy Behavior

For Ping'an village residents, the energy behavior they showed was generally simple before tourism development, particularly with regard to the use of water and electricity. Even though there were no tariffs imposed on water, and they were less aware of the importance of water as an energy source in the overall ecosystem, they do not waste water because of their thrifty habits. Meanwhile, since water is fundamental in rice cultivation in the terraces, village residents took an active interest in the use of water in the terraces during the different seasons. For example, they created simple water storage facilities at the top of the hill to irrigate the farmland during the dry season to prevent damage to the rice harvest. In addition, the village did not have a unified sewage treatment site, and the sewage generated by living organisms could only be treated through septic tanks built by the villagers themselves. As the residents S16 mentioned in the interviews:

*"Before there was no sewer pipe, we built a septic tank, divided into two to three septic cells. The sewage flowed straight into the septic tank discharge. When it was full, we took it out to water the vegetables."*

#### 4.1.2. Energy Literacy of the Ping'an Village Residents during Tourism Development

Under the influence of tourism, the living standards of the Ping'an village residents have greatly improved, and their awareness and energy consumption are changing. With the development of local tourism, the level of energy literacy of the residents has greatly improved through their daily and continuous tourism practices.

##### Upward Energy Knowledge

As the data shows, residents are knowledgeable about their energy. For example, regarding water use, residents are familiar with the price of water and know the approximate

amount of water they can use in their homes in a month, which can change during the low- and high-tourist seasons and the number of visitors. Regarding electricity consumption, most residents were aware of the price of electricity (RMB 0.56/kWh). Households in the tourist business are also aware that their monthly electricity consumption varies depending on the number of guests. For example, they are clear about the cost of electricity in their homes during the low and high seasons, which is nearly 2000–3000 RMB in the high season and 500 RMB in the low season. Residents are aware of the appliances that consume a large amount of electricity in their homes, such as refrigerators, air conditioners, water heaters, and other appliances that operate continuously (in addition to lighting and cooking). With regards to the use of fire, due to the safety hazards in wooden houses, residents are aware of the dangers that a fire can bring to the village. Each household has someone who knows how to use fire extinguishers, and all households are very careful about the use of fire. Furthermore, 19 out of 26 respondents are aware that the local electricity is generated from hydropower and have a better understanding of the various new energy sources, such as air heating, environmental oil, and other energy-saving products. They are also aware that energy consumption and pollution can affect the natural environment, and they even understand new energy sources that are not suitable for the area. They also mentioned that because of the large number of tourists arriving, if they all drove into the scenic spot, the carrying capacity would exceed the limit, and there would be too many exhaust emissions, which would have a negative impact on the environment.

#### Economic Attitude towards Energy

Residents can clearly recognize the problems that exist in their villages that require change because of tourism promotion. Twenty-three out of 26 respondents in the interviews mentioned issues that were related to the development of tourism that had occurred, such as excessive consumption of gas for tourist restaurants and excessive household water waste; the excessive use of electricity in their hostel, particularly during the tourist golden week where the village had even experienced power cuts due to the overload of electricity consumption, excess littering of non-biodegradable waste brought by tourists, and lack of road lights in the village, which made it difficult to consume and move around at night. In addition, they can actively seek ways to change, which is important in making decisions to change energy use. For example, when residents realize that the arrival of tourists brings high electricity bills along with economic income, they actively consider whether there are possibilities to reduce their electricity bills and find new energy sources. Water use is a concern for residents in terms of sewage and waste disposal. Concerning the use of water, residents are more sensitive to the disposal of sewage and waste because of the need for clean water for the terraces, the core landscape resource of the area, and the need to maintain the environmental cleanliness of the area. When 15 out of 26 respondents recalled that there was an unpleasant smell resulting from excessive hotel water waste, they mentioned the attitude and sense of responsibility of the scenic residents who took the initiative to push for a solution when faced with the problem. For example, S24 mentioned,

*“We asked the government and developer for a long time, hoping to build a sewage treatment station . . . we also take turns to do cleaning for the whole village... and rubbish is transported out daily from the village. It cannot be left in the village because it is not good for the soil and water; it affects the terraces.”*

Residents are also more aware of the environmental impact of excessive waste disposal and actively address this issue. The positive attitudes of residents towards energy are often more based on awareness of the need for sustainable tourism and more economical energy consumption and less on attitudes towards energy conservation.

### Positive Energy Behavior

Residents of the village take positive actions in their energy use to solve the problems mentioned earlier, thus saving and conserving energy. Firstly, new energy sources are used; for example, the widespread use of air heaters is associated with new energy technologies by residents who operate hotels, which largely reduces the cost of electricity. As resident S01 described:

*“Compared to electric water heaters, air energy water heaters are more energy efficient; air energy heaters compress air to generate heat. In terms of price, electric water heaters demand more power, reaching three to four thousand watts; if the wattage is too high, the circuit cannot withstand it, and fire safety hazards are also present. However, the wattage of air energy is not very high, it is up to more than thousand watts. Using an electric water heater is equivalent to two or three air energies, and the capacity of air energy is much more affordable than the electric water heater.”*

The descriptions from the residents further confirm that they are more concerned about energy costs and willing to use new energy products and technologies in their tourism services. With the use of new energy sources, residents have also influenced each other to form a culture of energy conservation, such as the popularity of air energy use in the village. In addition, streetlamps using solar electric panels in scenic areas have solved the problem of lighting streetlamps at night, and villagers have used environmentally friendly oil instead of gas for cooking, reducing gas consumption.

From a water perspective, the village needs to tackle sewage and maintain clean water sources. In terms of sewage disposal, the entire village is built on a unified sewage pipe, which has centralized the treatment. At present, the water in small ditches in the villages is clean after sewage treatment.

Another requiring attention from the data shows that five large cisterns were established for successive classification at the top of the hill for living, terrace irrigation, agricultural production, and fire safety use, as shown in Figure 3. Meanwhile, to prevent fires in wooden houses, the village has built fire hydrants in front of each house, which is connected to the pipes of the cisterns used for fire safety. Finally, during tourism activities, residents are also willing to influence tourists to behave in an energy-saving manner, such as in the use of air conditioning in rooms, raising the temperature to the most energy-efficient level in obvious places, and remembering to turn off lights and air conditioning when going out.



**Figure 3.** One of the Cistern and Sewage Treatment Centres in Ping'an (Source: by author 1).

#### 4.1.3. Factors Affecting Resident's Energy Literacy Change

Along with the development of local tourism, locals have acquired more energy literacy in their daily tourism practices. According to the field data, the factors influencing residents' change in energy literacy are multiple. Both external and internal factors contribute to the improvement of residents' energy literacy in tourism development. On the external side, economic development, communication with external tourists, diversified access to knowledge, and government support are all factors that have contributed to the change in energy literacy among Ping'an residents. Specifically, economic development has

offered more possibilities for residents to choose new energy sources; communication with external tourists, especially pro-environmental visitors, has allowed them to understand that only sustainable environments can attract more tourists; the widespread use of mobile phones has also enabled residents to learn more about energy knowledge from the internet; as for government support, it includes investment in tourism infrastructure, attracts investment from outside, promotion resident's energy knowledge, and other related policy. For example, the local government's continuous promotion of energy knowledge in villages, such as fire and electricity safety, knowledge of energy conservation and environmental protection, etc. All these external factors have contributed to the improvement of residents' energy literacy.

In addition to these extrinsic reasons for promoting energy literacy, the key incentive for local people to become more energy-literate lies in their initiative in tourism development, also referred to as internal factors by residents. First, the goal of achieving better tourism development and poverty alleviation has led them to take the initiative to address the local energy problem. Before tourism, Ping'an Village was extremely isolated and poor. Up until 1992, it was still dependent on relief to survive; the income of residents was mainly from farming and working outside the village [66]. Since the development of tourism from 1993, tourism has gradually become the main source of economic income, including catering, accommodation, shopping, tour guide services, and ticket dividends [66]. By 2002, the villagers' annual per capita income reached about 2000 RMB. Up to 2011, it rose to 13,200 RMB [81]. By 2019 the villagers' annual per capita income had reached 5000 RMB just from the ticket income dividends, with some medium hotel annual income may reach 200,000 RMB. In this process, in order to get out of poverty and achieve wealth through tourism, they made efficient use of a combination of external resources, such as the government, developers, and new sources of energy in technological development, which helped them solve local problems effectively.

Second, the initiatives of residents have a positive impact on their energy literacy. As residents take the initiative to identify various energy problems that exist in local tourism, they actively seek information from the outside to solve local problems. By taking the initiative to learn and communicate with the outside, their energy literacy is enhanced. Such as the resident manager S17 mentioned,

*"In the off-season, several of our village committees have gone to other scenic spots around the country to learn, to see how others are doing, to see how people are solving the problems we have, and we often go out to see, which is very helpful to us. Sometimes we also watch Tik Tok and read a lot of relevant knowledge on the internet. We also have two people in the village who specialize in live-streaming terraces, they introduce our beautiful terraces to people outside, and sometime also share and show the balance of our natural ecosystem here."*

#### 4.2. Influence of Energy Literacy on Tourism Development in Ethnic Villages

##### 4.2.1. Effect of Residents' Energy Literacy on Tourists' Energy Literacy

The host-tourist relationship has always been central to the tourism development process. Along with tourism growth, energy consumption for restaurants, accommodation, and transportation has shown a growing trend. To properly reduce energy consumption and achieve energy savings and emission reduction in tourism activities, it is necessary for residents and tourists to focus on the input and use of energy products in tourism activities. Ethnic residents are the main actors in the operation of tourism activities and local culture, particularly in ethnic tourism areas. As hosts, the improvement in the energy literacy of residents can have a positive effect on the behavior of tourists.

##### Guiding Tourists to Focus on Energy and Acquiring Energy Knowledge in Tourism

As residents become more energy-literate, they apply their energy-related knowledge to tourism activities, allowing visitors to gain energy-related knowledge while enjoying the tourist landscape. For example, warning signs stating "please protect water sources" have

been installed at prominent locations in the terraced landscape. In the tourist accommodation, there are various warning signs about water and electricity conservation and attention to fire prevention to ensure tourists are aware of the importance of traditional energy sources, such as water, electricity, and fire, to the village during their activities. In addition, residents use their own energy knowledge to guide tourists about energy concerns. For example, they remind tourists about fire in their communication with them; they also caution them about most of their houses being wooden structures and the consequences a fire can have on their village. To reduce costs, residents are actively concerned about the consumption of water, electricity, and other energy sources and, therefore, proactively use new energy-related products to save energy and reduce emissions in tourism. Residents who provide tourist accommodation S05 mentioned,

*“It’s cooler here at night, so locals don’t use air conditioning, but tourists do, and they wouldn’t stay without it, so we have to install air conditioning in every room and remind them to turn it off when they go on tours.”*

In these ways, tourists can also feel the concern of the locals in conserving energy and, thus, understand the importance of energy use for water use in the terraces and for tourism in the villages, which essentially also raises their own energy awareness.

#### Guiding the Attention of Tourists to the Impact of Energy Consumption Based on Energy Attitudes

Given the ecological fragility of terraces, it is important to understand the impact of energy consumption on terraced-tourism development. Residents have a clear understanding of the environmental impact of excessive energy consumption, such as the impact of cleaning chemicals on water sources and, consequently, food production. Therefore, they try to reduce the use of cleaning products or frequency of cleaning and guide visitors to replace items, such as sheets and towels, as little as possible during continuous stays or send these washed items out of the resort. Because residents recognize that plastic products are harmful to the soil and water supply because they cannot degrade, they guide visitors to reduce the use of plastic products in tourist catering to reduce the impact on the soil on which the terraces depend.

#### Guiding Tourists to Save Energy and Reduce Carbon Emissions through Tourism Behavior

Residents guide tourist behavior mainly in the provision of tourist accommodation, transport, and other tourist services. In terms of tourist accommodation and catering, air conditioners were installed in rooms provided by the residents. In order to save electricity, the residents provide signage near the air conditioners or on the remote control stating, “To save electricity, it is recommended to turn it on to 26 degrees” to guide tourists. In terms of tourism transport, in the Longji Terraces resort, the tourism management, and residents are aware of the impact of car emissions on the local air and have consciously chosen electric vehicles for their tourist transport services. However, owing to geographical constraints, the lack of motive power of electric vehicles makes them difficult to use in local tourist transport; therefore, tourist transport is mostly available by sightseeing vehicles and buses that burn petrol. Residents involved in tourism management S17 at the resort company mentioned,

*“The cars we use now still burn petrol, and the electric cars do not have enough power to go up the mountain, so it’s hardly to use them, and burning petrol will definitely have an impact on the air, but we have more trees here, so the impact will not be big.”*

Nevertheless, the scenic area continues to guide tourists to reduce the use of private cars to drive directly to the scenic area but rather take a scenic bus at the entrance of the scenic area to reach the village, thus, reducing carbon emissions by reducing the amount of vehicle travel.



#### 4.2.2. Transforming the Structure of Energy Use for Sustainable Tourism

Energy consumption relies on outsourcing instead of self-sustaining household energy consumption. Before the onset of tourism, the energy consumption of residents was minimal for basic subsistence use. However, when there was a large influx of tourists, a substantial amount of energy was consumed for food and beverage, accommodation, and transport. For example, leftovers generated by local hotels and restaurants were routinely thrown out by owners into the rubbish collection pond at the entrance of the village at least once a day during the high season and once every two–three days during the low season. The waste was then transported out of the village daily to the rubbish disposal center. The laundry of local hotels was sent to a professional cleaning company in Guilin city during the high season, and used sheets were replaced once or twice a year during the high season.

New energy sources have been used instead of traditional energy sources. Electricity consumption is an important type of energy consumption; before tourists arrived, the villagers primarily used electric lighting. As tourism has grown, the demand for electricity has been constantly increasing with the rapid rise in electricity use for lighting, night landscape creation, air conditioning in tourism lodges, etc., which puts a higher demand on the supply of electricity. Thus, power outages occurred from time to time, which created negative experiences for tourists. To change the excessive demand for electricity, new energy resources, such as solar streetlights and air energy heaters, have been adopted by residents to reduce the reliance on traditional electricity. In particular, the use of air-energy water heaters has effectively improved the problems of long usage time, high replacement frequency, and high-power consumption caused by electric boilers.

A specialized sewage treatment system is used instead of direct discharge. Initially, the sanitary sewage flowed freely into the village ditches; however, as the tourism industry began developing, the ecosystem was no longer able to absorb domestic wastewater. Now, the use of a sewage treatment system has improved the drainage route by separating wastewater and clean water to effectively protect the ecological balance between the terraces for irrigation and the daily use of hostels. As resident S14 said in the interview:

*“Water was used to meet the needs of the tourists instead of the irrigation of the terraces earlier, so that many terraces were deserted. Later, the abandoned terraced fields were gradually re-farmed through the construction of the cistern. Before this was done, some of us connected the water pipes randomly, similar to the discharge pipes.”*

In addition, to avoid damage to vegetation and soil from the use of pesticides, the use of herbicides has been banned instead of manual weeding. In addition, the number of cisterns has increased from one to five, and the function is divided into irrigation for terraces and water for fire protection.

#### 4.2.3. Improved Infrastructure for Sustainable Tourism

Due to the need for tourism development in the village, residents and the management committee, formed by themselves, are constantly appealing to the government and developers for infrastructure changes. For example, traditional streetlights are insufficient, posing safety hazards to tourists at night. The electricity costs were unevenly shared and unmanaged. Improper treatment of sewage affects the irrigation of the terraces, which has environmental and health implications. The improper management of traffic can lead to congestion for visitors as well as excessive exhaust emissions that affect the ecological environment. As owners of the resources, residents are constantly engaging with developers and the government to improve the infrastructure of the village, thus promoting the sustainable development of tourism sites.

The landscape lighting system has been improved in the village. The use of solar-powered streetlights saves electricity while solving the previous situation of no public lighting system in the village at night as well as the apportion of the electricity bill for

streetlights. It also creates a beautiful night landscape that enhances the tourism experiences of visitors. As villager S16 said:

*“We didn’t have enough streetlights before as well as no illumination in the tourist attractions. However, the streetlights are now quite good. Whether it is a rainy or sunny day, solar streetlamps can be bright for a few hours to improve the convenience and safeguard for tourists at night.”*

The construction of the sewage treatment system, water storage, and firefighting systems has promoted tourism sustainability. The construction of the sewage system in the village was conducted from 2012–2014 near the village. The completion of the sewage system solved the problem of the increasing domestic sewage resulting from the increasing number of tourists, and it ensured irrigation of the terraces and residents’ daily use. Its original sewage piping was the first sewage system built in the county. The water storage system was constructed in batches. Before tourism, residents built a cistern at the top of the hill for terrace irrigation. As tourism gradually developed, the villagers then pooled together their money to build two cisterns to meet the need for tourism development and to increase the number of tourists. When the tourism industry grew further, two other cisterns were built with the help of the government and developer near the hiking area for tourists, as well as to increase the firefighting facilities and equipment in the village. More than 300 fire hydrants have been built throughout the village. Regarding safety, as most houses are wooden and brick structures with fire hazards, residents are equipped with fire extinguishers in their tourist accommodation, and the village committee supervises autonomy to ensure the safety of tourist accommodation. Thus, the construction of the water storage system and firefighting system not only ensured seasonal water usage for terrace irrigation to increase tourist attractiveness by maintaining the integrity of the terraced landscape but also ensured the safety of the residents.

Traffic facilities for tourists have been improved and preserved in scenic areas. The construction of car parking at the main entrance of the scenic area and the extension of sightseeing cars and new energy trams has effectively alleviated congestion and excessive energy consumption for tourists. The buses are outsourced to Revitalize Sightseeing Ltd. for their operation. Generally, group visitor cars with more than seven seats must be replaced with scenic buses. The scenery now consists of 30–40 oil-burning vehicles, with six or seven new energy trams added over the years. In addition to car parking at tourist entrances, multi-story car parking has also been built at village entrances. After parking at the gate, tourists are required to hike into the village. Only a few tour buses are available for transporting day trippers to the viewing platform. These measures reduce the energy consumption of the traffic load.

## 5. Discussions

Rather than the traditional discussion of households [1–5,17] and students [20,23,24], this study extends the understanding of energy literacy from the perspective of ethnic residents and discusses the changes in energy literacy in remote ethnic villages in the context of tourism development. Previous studies of energy literacy have tended to discuss the relationships between knowledge, attitudes, and behavior [6,19–21], focusing on the synchrony perspectives [22–25], with less understanding of energy literacy from diachronic perspectives along with the changing external environment. This study examines how the energy literacy of ethnic minority residents has changed during the development of tourism and the main reason for the changes. In contrast to previous studies that have considered ethnic minorities as a vulnerable group in terms of energy use [3], this study empirically demonstrates that tourism development in ethnic minority areas may also contribute to the transformation of residents from a vulnerable group in terms of energy use to a more energy literate group, thus contributing to the sustainability of tourism.

This study also deepens the understanding of the implications of such changes for local tourism sustainability from a cross-disciplinary perspective and enriches empirical research

to better promote energy conservation and sustainable tourism development in ethnic areas. In addition, classical literature on energy and tourism has tended to discuss the impact of energy resources as tourism attractions [8,9,42,43] or aim to improve tourists' energy literacy through tourism [2,10,45], yet how residents influence tourists' energy behavior remains unclear. Our research extends the understanding that an increase in residents' energy literacy can also lead to an increase in visitors' energy behavior. Furthermore, beyond the traditional relationship of host and guest in ethnic tourism research [16], we find that increased energy literacy among residents can also contribute to the structure of energy use and infrastructure development in tourist destinations, which further enhances the understanding of how energy literacy can influence the sustainable development of tourist destinations.

## 6. Conclusions and Policy Implications

This study proposes a theoretical framework for understanding the relationship between the energy literacy of residents and sustainable tourism development in ethnic areas and highlights the important role of the initiatives of residents in improving their energy literacy in tourism development. The conclusions of this study are as follows:

As the tourism industry in the village has developed, the energy literacy of the residents has changed. Prior to the development of tourism, the energy literacy of Ping'an village residents could be summarized as a low level of energy knowledge, unpleasant energy attitudes, and simple energy behavior. With the development of tourism in Ping'an, the energy literacy of residents has changed to upward energy knowledge, economic attitude towards energy, and positive energy behavior. Both external and internal factors contribute to the improvement of residents' energy literacy in tourism development. External factors contain economic development, communication with external tourists, diversified access to knowledge, and government support. The key reason for this improvement is the internal factors that form the initiative of residents in Ping'an to seek self-change by developing tourism in order to get out of poverty and achieve wealth through tourism. This positive determination to change the backward village has led to a greater increase in the energy literacy of the residents in the village.

The improved energy literacy of the residents affects tourist behavior and sustainable tourism destinations. In Ping'an village, residents guide tourists in three main areas, guiding them to pay attention to energy and gain energy cognition in tourism; in energy attitudes, guiding them to be concerned about the impact of energy consumption; and in tourism behavior, guiding them to save energy and reduce carbon emissions. Moreover, increasing the energy literacy of residents also impacts the sustainable development of the tourist site mainly by changing the structure of energy use and improving the infrastructure of the tourist site.

This study also has implications for policy makers and managers of tourist destinations. When considering how to make public policy on energy literacy in tourist areas, the initiative of residents can be used as a point of regulation. Before providing energy education, in addition to attracting tourism investment, it would be useful to motivate residents to seek their own initiative for tourism development. Only if residents can actively seek tourism development on their own will they be better able to promote their demand for energy literacy improvement. Meanwhile, in the process of training in energy literacy related to tourism, it is also necessary to provide guidance on the energy attitudes of residents until they are internalized in their daily energy behavior, thus encouraging them to optimize their energy use. For the managers of tourist resorts, they should also recognize that improving the energy literacy of residents will contribute to guiding the energy behavior of tourists, which will better protect local tourism resources and promote sustainable tourism development. Therefore, resort managers should take the initiative to cooperate with residents, identify the energy-related problems in the process of tourism development, and guide the resources of various stakeholders to solve the corresponding problems, so that the resort can obtain sustainable development.

Although this study is based on a survey of Ping'an residents, the findings can be extrapolated to other ethnic tourism areas and tourism products that are somewhat dependent on energy and environmental requirements, such as ecotourism, mountain tourism, and rural tourism. Due to the limitations of the research conditions, the research efforts of the researchers, and the overall sample size of the village residents, this study mainly collected data based on qualitative research through field surveys and in-depth interviews to provide a relatively in-depth understanding of the energy literacy of ethnic residents and sustainable tourism. However, it is also worth using quantitative research in the future to measure the energy literacy of the perspectives of tourists to discuss the impact on local, sustainable tourism.

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