Rammaáætlun
Vernd og orkunýting landsvæða

The perceived impact area of renewable energy infrastructure on tourism: The tourism industry's perspective

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1 Introduction

Understanding the potential impacts of renewable energy infrastructure (REI) on tourism and estimating their spatial extent is of crucial importance for the identification of the most suitable locations for such infrastructure, as well as for ensuring sustainable development of both the energy and tourism sectors. This is especially important when considering energy development in natural areas, since as previous studies (e.g. Frantál & Kunc, 2011; Sæþórsdóttir et al., 2018; van der Horst, 2007) have shown, energy infrastructure in such areas is perceived as less desirable by tourists.

To facilitate the selection of the power plant proposals that are the most compatible with tourism and recreation in Iceland, Expert Group 2 of the *Master Plan for Nature Protection and Energy Utilization* (Ministry for the Environment and Natural Resources, n.d.) developed a method for assessing the impacts of proposed energy projects on tourism and recreation. The method, described in detail by Sæþórsdóttir and Ólafsson (2010a, 2010b), allowed them to rank the proposed power plants.

Using this method, Expert Group 2 estimated the impact areas of the proposed power plants included in the second and third phase of the *Master Plan* on tourism and recreation. During the impact evaluation process in the second phase of the *Master Plan*, the expert group divided approximately half of Iceland into 57 tourism regions. Their boundaries were defined through consideration of the homogeneity of the type of tourism involved, the infrastructure present in each region, tourist travel patterns and travel modes, naturalness of the environment, and physical features which create natural boundaries (Sæþórsdóttir & Ólafsson, 2010a). In the next step, the value of each tourism region was assessed by considering 43 attributes across five categories: experience, use, infrastructure, recreational opportunities, and future value. In the third phase of the *Master Plan* some changes to the method were made. One more tourism region was added to reach a total of 58 tourism regions. Moreover, a component analysis was conducted which revealed that same assessment results can be achieved by using a lower number of attributes, 21 in total, which can be divided into three categories: experience, recreational opportunities, and use (Gíslason, 2016). The spatial extent of the impacts of the proposed power plants on tourism and recreation was estimated by defining the construction region, which comprised all related infrastructure including power lines and roads, as well as the impact region. The impact region was estimated by taking into consideration visitor travel patterns, transportation systems in the region, and potential environmental changes beyond the local and visual impacts of infrastructure, such as reduced water flow downstream (Sæþórsdóttir & Ólafsson, 2010a). The group then assessed the value of each attribute in every tourism region if a

power plant were to be built. The original and the new values were then used to calculate the impact coefficient of each proposed power plant option. Thus, this method serves as a tool for estimating the impact areas of proposed power plants, for assessing the severity of potential impacts in each tourism region, and for ranking the proposed power plants using the impact coefficient.

The impact areas estimated by Expert Group 2 of the *Master Plan* were criticized by some stakeholders as too extensive. This pointed to the need of more insight into stakeholders' perceptions regarding the impacts of REI on tourism and their spatial extent. The tourism industry is one of the critical stakeholders in the discussion about future development of natural areas in the country since it relies on such areas as a resource. Moreover, tourism has become one of the main export sectors in Iceland over the past decade (Statistics Iceland, 2020) and an important contributor to regional development. It is expected that its importance will increase again once the travel restrictions related to COVID-19 pandemic are lifted.

This study aims to estimate the impact areas of REI on tourism as perceived by the tourism industry and to analyze what factors affect the size of perceived impact areas. To reach these aims, semi-structured interviews with tourism industry stakeholders were conducted, during which a participatory mapping software was used to draw perceived impact areas of six energy projects included in this study.

The study investigates the interrelationships of REI and tourism by using the tourism systems approach (Leiper, 1979, 1990). According to this approach, tourism systems consist of five elements: tourists and the tourism industry, along with three geographical elements which comprise tourist generating regions, tourist destination regions, and transit routes. Changes in one of them are likely to alter other elements due to their links with each other.

While discussing the impacts of REI on tourism and their spatial extent with the tourism industry, this study approaches natural areas used for tourism as socially constructed places containing multiple identities and meanings (Davenport & Anderson, 2005; Kianicka et al., 2006; Zakariya et al., 2015), shaped by mobilities of "capital, persons, objects, signs and information" (Urry & Larsen, 2011, p. 119) and as meeting points of networks of social interrelations (Massey, 2005; Simonsen, 2008). This study investigates how perceptions of tourism areas and meanings assigned to them and to REI, mobility of tourists, and other factors affect boundaries of places and consequently the perceived impact areas of REI on tourism.

2 Study areas

With the aim of investigating how various factors affect the size of perceived impact areas of REI on tourism, the areas containing one of the three types of proposed and two types of existing REI, located within or at the boundaries of the Central Icelandic Highlands, were selected as study areas (Figure 1). The existing REI included in the study was the following:

- Seven hydropower stations in the Þjórsá and Tungnaá catchment area located in the southern Central Highlands: Búrfell and Búrfell II, Búdarháls, Hrauneyjafoss, Sigalda, Sultartangi, and Vatnsfell. The oldest of these power stations, Búrfell, started operating in 1969. The total installed capacity of the seven power stations reaches 935 MW (Landsvirkjun, n.d.-b).
- Blanda Hydropower Plant (150 MW), located at the northwestern border of the Icelandic Central Highlands and harnessing the river Blanda. It started its operation in 1991 (Landsvirkjun, n.d.-a).
- Krafla Geothermal Power Plant (60 MW), located at the northeastern edge of the Central Highlands near Lake Mývatn, which started operating in 1977 (Landsvirkjun, n.d.-d).

Since presently only two experimental wind turbines have been built at the border of the Central Highlands of Iceland (Landsvirkjun, 2013), this study focused only on existing hydro- and geothermal power infrastructure.

The three types of the proposed REI included the following:

- Hrafnabjörg Hydropower Plant, three versions: 88.5 MW (National Energy Authority, 2015a), 50 MW (National Energy Authority, 2015b), or 36.5 MW (National Energy Authority, 2015c), which would be located in the northeast by the periphery of the Central Highlands and harness the river Skjálfandafljót.
- Hágöngur Geothermal Power Plant (150 MW), which would be constructed close to the Hágöngulón Reservoir west of Vatnajökull (National Energy Authority, 2015d).
- Búrfellslundur Wind Farm, which would be located at the edge of the southern Central Highlands, close to the existing hydropower stations of the Þjórsá and Tungnaá catchment area. According to the redesigned proposal (2019), the estimated installed capacity of the wind farm would reach 120 MW through around 30 wind turbines (4–5 MW each) which would be up to 150 m high at the top of the blade (Landsvirkjun, n.d.-c).

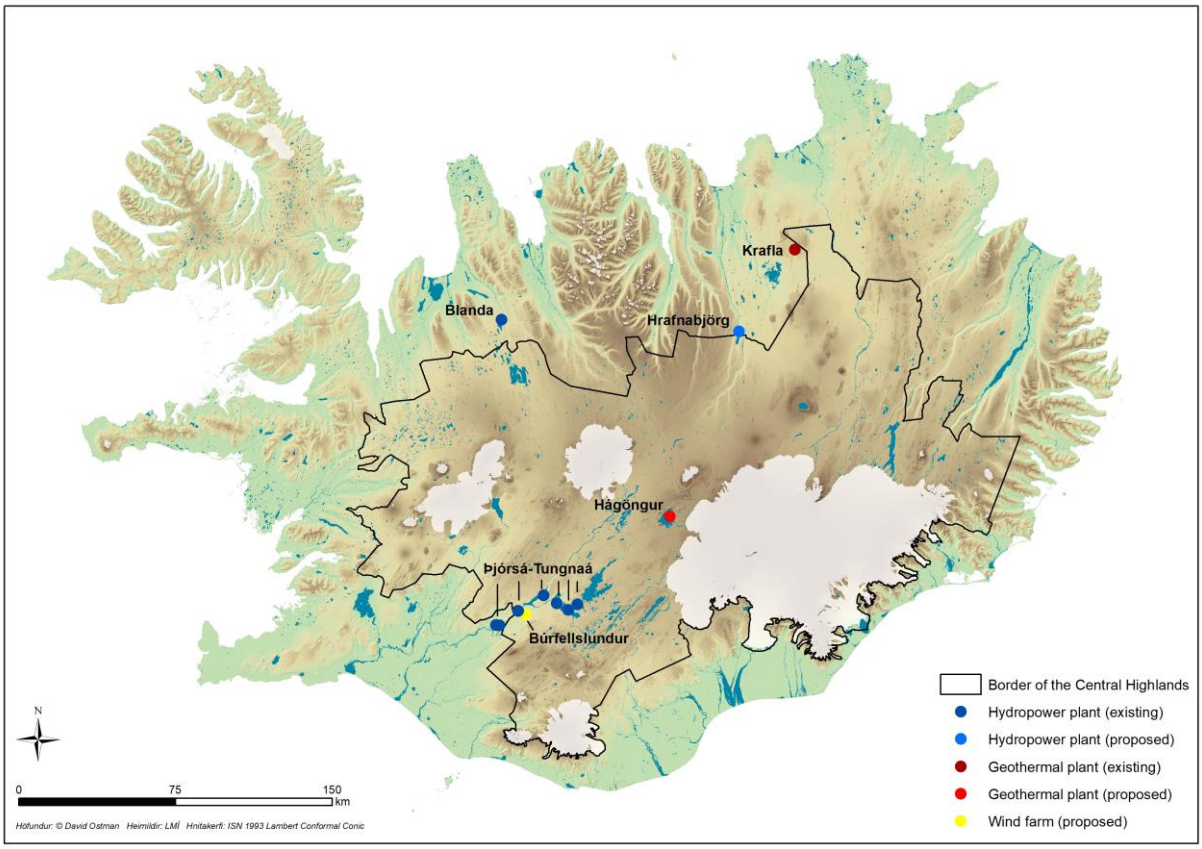

Figure 1. Existing and proposed REI included in the study.

3 Methods

3.1 Data collection

The tourism industry's perceptions of the impacts of REI on tourism and of their spatial extent were analyzed by employing qualitative research methods. Semi-structured interviews were conducted with the managers of 49 tourism businesses using the areas near the existing or proposed REI included in this study in May–August 2020. Thus, the tourism companies were selected for participation in this study through purposive sampling. To ensure the representation of a wide range of views and perspectives in this study, maximal variation sampling (Creswell, 2012) was used for the selection of participants. The interviewees represented companies offering different types of tours and other tourism services, companies receiving different types of customers with different preferences, and companies that varied in terms of size, length of operation, and location.

A total of 19 participants were operating from Reykjavik, 15 were located in northwest Iceland, 13 in northeast Iceland, and 9 in the south of the country. Based on business type, the interviewed companies can be divided into three categories (Table 1). The first group (1) included businesses offering various types of tours: travel agencies, day tour providers, touring associations, and fishing service providers. A total of 28 companies interviewed for this study belonged to this group. The second category (2) included companies which offer tours but also run accommodation near the power plants in question, with a total of 11 companies. The third group (3) included companies offering accommodation and/or food services near the areas with the energy infrastructure included in this study. A total of 10 companies belonged to the third category.

The main topics discussed during the interviews comprised: impacts of REI included in this study on the participant's business and on tourism in Iceland; the factors determining the character and the scale of these impacts; perceived impact areas of REI on tourism; and justifications for the estimated size of the impact areas. Further discussed were the type of tourism services provided by the company, preferences of their customers, areas used for their business, and main tourist attractions in the study areas and in the Central Highlands in general.

The interviews included the use of participatory geographic information systems (PGIS). While discussing the perceived spatial extent of the impacts of REI on tourism, the participants were asked to use the participatory mapping software Maptionnaire, which enabled them to map their perceived impact areas. This online software allowed the participants to draw polygons indicating the perceived impact area on one of three selected base maps to which the

infrastructure of the power plant in question was added. The impact areas were mapped by placing points which the software connected with straight lines. Some participants placed relatively few points while drawing the perceived impact areas, which resulted in less precise impact areas containing sharp angles.

While drawing the impact areas, participants were asked to discuss the reasoning behind their estimated areas. To ensure the validity of the data collected, the participants were asked to only estimate the impact areas of the energy projects located in the areas with which they are sufficiently familiar. The participants were also provided detailed descriptions of the power plants included in this study as well as photographs, maps of the study areas, and visibility maps of REI. The interviews were conducted in English and in Icelandic, depending on the preferences of the participants. The interviews lasted 82 minutes on average, with the shortest interview lasting 22 minutes and the longest 241 minutes.

3.2 Participant involvement in estimating perceived impact areas

Not all participants were willing or able to draw a map of their perceived impact areas. The various reasons included that participants did not feel knowledgeable enough or had never thought about the spatial extent of the impacts of REI on tourism before. Out of the 49 participants, 32 were willing to map their perceived impact areas of the energy projects. Of these 32, 15 of the tourism businesses represented were operating from Reykjavik, five were located in northwest Iceland, seven in northeast Iceland, and five in south Iceland. The number of estimated impact areas per participant varied greatly among the business types. Only seven participants felt they had enough local knowledge to map how they perceived the impact areas of all six energy projects. These were all operating from Reykjavik (Table 1). The five participants in the northwest estimated only one impact area per respondent, in all instances the impact area of the Blanda Hydropower Plant situated nearby. In the northeastern part of the country, one participant estimated five impact areas, two participants estimated four impact areas each, one participant estimated impact areas of two energy projects, and three participants estimated the impact area of one energy project. All five participants located in the south of the country estimated the impact areas of three energy projects each. Four of them estimated the impact areas of the three projects located in the southern Highlands: the existing Þjórsá-Tungnaá Hydropower Plants, the proposed Búrfellslundur Wind Farm, and the proposed Hágöngur Geothermal Power Plant. One participant estimated the impact areas of all the proposed energy projects included in the study, that is, Búrfellslundur Wind Farm, Hágöngur Geothermal Power Plant, and Hrafnabjörg Hydropower Plant, but none of the existing power plants.

All accommodation and food service providers interviewed for this study estimated the impact areas only for nearby energy projects, while companies offering tours also estimated the impact areas of energy projects located in other parts of the country, that is, in the areas they were using for their business and were knowledgeable about.

Table 1. Participant involvement in estimating the impact areas of REI on tourism.

Location and type of the business	Interviews conducted	Number of participants who estimated impact areas	Number of impact areas drawn by the participants					
			6	**5**	**4**	**3**	**2**	**1**
Reykjavik	**19**	**15**	**7**	**1**	**2**	**1**	**2**	**2**
(1) Travel agency/day tour provider/other	19	15	7	1	2	1	2	2
Northwest Iceland	**8**	**5**						**5**
(1) Travel agency/day tour provider/other	2	0						
(2) Travel agency/day tour provider and accommodation	2	1						1
(3) Accommodation/food service provider	4	4						4
Northeast Iceland	**13**	**7**		**1**	**2**		**1**	**3**
(1) Travel agency/day tour provider/other	7	4		1	1			2
(2) Travel agency/day tour provider and accommodation	3	2			1		1	
(3) Accommodation/food service provider	3	1						1
South Iceland	**9**	**5**				**5**		
(1) Travel agency/day tour provider/other	0	0						
(2) Travel agency/day tour provider and accommodation	6	3				3		
(3) Accommodation/food service provider	3	2				2		
Total	**49**	**32**	**7**	**2**	**4**	**6**	**3**	**10**

Thus, the perceived impact areas of the energy projects on tourism included in this research were estimated by tourism businesses located in various parts of Iceland. The highest proportion of participants who estimated the impact areas of each power plant were operating from Reykjavik, followed by the participants located close to each existing or proposed power plant (Table 2). The impact area of the Blanda Hydropower Plant was estimated by nine participants operating from Reykjavik, five participants located in northwest Iceland and three in northeast Iceland. The same number of participants operating from Reykjavik estimated the perceived impact area of Krafla Geothermal Power Plant on tourism followed by four participants from northeast Iceland. The impact area of the Þjórsá-Tungnaá Hydropower Plants was estimated by 13 participants from Reykjavik, four participants from south Iceland, and one participant operating from northeast Iceland. Similarly, the impact area of the proposed

Búrfellslundur Wind Farm was estimated by 13 participants from Reykjavik, five from south Iceland, and three participants from northeast Iceland. The impact area of the proposed Hágöngur Geothermal Power Plant was estimated by 10 participants operating from Reykjavik and five participants from south Iceland but none from the north. The same number of participants from Reykjavik estimated the impact area of the proposed Hrafnabjörg Hydropower Plant on tourism, followed by seven participants from northeast Iceland and one from south Iceland.

Table 2. Number of participants who estimated the impact areas of each energy project.

	Existing power plants			**Proposed power plants**		
Location and type of tourism business	Blanda	Þjórsá-Tungnaá	Krafla	Hrafnabjörg	Hágöngur	Búrfellslundur
Reykjavik	**9**	**13**	**9**	**10**	**10**	**13**
(1) Travel agency/day tour provider/other	9	13	9	10	10	13
Northwest Iceland	**5**					
(1) Travel agency/day tour provider						
(2) Travel agency/day tour provider and accommodation	1					
(3) Accommodation/food service provider	4					
Northeast Iceland	**3**	**1**	**4**	**7**		**3**
(1) Travel agency/day tour provider	2	1	2	4		2
(2) Travel agency/day tour provider and accommodation	1		2	2		1
(3) Accommodation/food service provider				1		
South Iceland		**4**		**1**	**5**	**5**
(1) Travel agency/day tour provider						
(2) Travel agency/day tour provider and accommodation		2		1	3	3
(3) Accommodation/food service provider		2			2	2
Total	**17**	**18**	**13**	**18**	**15**	**21**

Some participants perceived the impacts of REI on tourism as negative, others as positive, and some as both positive and negative, or neutral. Thus, the estimated perceived impact areas of each energy project on tourism were categorized into positive, negative, and mixed/neutral impact areas. During the data analysis the arguments for each impact area were investigated and the factors affecting the size of the perceived impact areas were identified. In some cases, the perceived impact areas were similar in size and based on similar arguments. In such cases impact areas were grouped into categories and described together. The cases which stood out due to their argumentation or estimated size of the impact area were discussed separately.

4 The perceived impact areas of renewable energy infrastructure on tourism by the tourism industry

4.1 Existing renewable energy infrastructure

Blanda Hydropower Plant

A total of 17 participants estimated the impact area of the Blanda Hydropower Plant on tourism. One of the participants preferred to draw two separate impact areas: one focusing on neutral impacts and the second on positive impacts. Consequently, 18 impact areas of Blanda Hydropower Plant on tourism were drawn. Most participants (10) felt the power plant had positive impacts. There was, however, considerable variation in the size of these estimated impact areas, which varied from 223 km^2 to 17,427 km^2 with a mean of 2,768 km^2 and median of 685 km^2 (Table 3). Seven participants perceived the impacts as mixed or neutral. The size range of these impact areas varied between 28 km^2 and 2,846 km^2, with a mean size of 1,012 km^2 and median of 531 km^2. One participant estimated a negative impact area of the power plant on tourism in the size of 640 km^2.

Table 3. Perceived impact areas of Blanda Hydropower Plant on tourism.

Character of the impact	Number of impact areas	Range of the size of the impact areas (km^2)	Mean size of the impact areas (km^2)	Standard deviation	Median
Positive	10	223–17,427	2,768	5,264	685
Mixed/neutral	7	28–2,846	1,012	967	531
Negative	1	-	640	-	-
Total	18	28–17,427	1,967	3,982	604

Blanda Hydropower Plant: positive impact areas

More than half of study participants perceived the impacts of the Blanda Hydropower Plant on tourism as positive. Estimated positive impact areas varied widely in size depending on the reasoning used by the various participants. The arguments given by the participants for the positive impact areas can be divided into four main groups: visual impacts, increased salmon fishing opportunities, improved access, and opportunities for using the power plant as a tourist attraction. Some of the participants had several of these impacts in mind while drawing the impact areas. Thus, the size of the estimated positive impact areas depended on the impacts that were taken into consideration by the participants during the estimation process.

Four of the participants drew relatively small positive impact areas (223 km^2–531 km^2) (Figure 2). Their argument was that the power plant has positive visual impacts, whereas the reservoirs look like natural lakes, add diversity to the monotonous flat landscape, and make the area more beautiful. While the area does not contain any tourist attractions and is perceived as a drive-through area, the reservoir provides an opportunity for a stop: *"People go there and look at it as a lake. We stop right there on a viewing platform west of the reservoir and people look over and say it is beautiful. They do not know how it was before."* Moreover, it was pointed out that the presence of the power plant gives guides travelling with tourists in the area a reason to talk about the importance of renewable energy in Iceland and to explain the process of hydropower production. Renewable energy is generally perceived as positive by customers and therefore positively contributes to the image of the country.

The Blanda River mostly contains glacial meltwater with a high level of sediment. Thus, the natural appearance of its water is gray and muddy, despite several spring creeks joining its stream. Damming the Blanda River and the construction of the reservoirs made the water in the Blanda River downstream of the reservoirs clear and provided improved conditions for salmon fishing. As stated by the participants, salmon fishing in Blanda attracts recreational fishermen from Iceland and from abroad, bringing economic benefits to the local community. Local farmers receive income from renting the river for salmon fishing while tourists coming to fish use the accommodation and food services in the area. One participant estimated the impact area of the Blanda Hydropower Plant by focusing on the fishing opportunities provided by the power plant and the associated economic benefits to the local communities.

Two other participants estimated somewhat bigger positive impact areas (1,020 km^2 and 3,302 km^2). In their argumentation they pointed out better fishing opportunities and associated economic benefits as well as improved access due to the improvement of the Kjölur Highland Road and of other roads in the area surrounding the power plant. According to the participants, improved roads created better access to the northern part of the Central Highlands for tourism and recreation reaching as far as Kerlingarfjöll and Hveravellir, provided more options for travelling, and resulted in higher tourist traffic north on Kjölur Road. One of the two participants mentioned that improved Kjölur Road facilitates tourist distribution from the crowded southwest of Iceland to the northwest, which has capacity to accommodate more tourists.

One participant, while estimating the impact area of Blanda Hydropower Plant on tourism, included not only the improvements of Kjölur Road and consequently the increased use of some tracks around it, but also several huts for sheep gatherers built or restored by the energy company in the area around the power plant, which are also used for tourism.

According to one participant, the area where tourism is impacted by the Blanda Hydropower Plant is only the Highland area around Kerlingarfjöll and Hveravellir, because the improved Kjölur Road made these areas more accessible from the north. Consequently, it increased the safety of visitors to these areas, which is especially relevant while travelling in winter: *"We always know we have the escape route to go to the north, because the routes are better. That was not so before."*

Several participants mentioned that the Blanda Hydropower Plant is somewhat interesting to tourists and has some tourist attraction potential. The power plant has an interesting design, and there is an exhibition inside the power station. According to one participant, the potential of the power plant as a tourist attraction could be increased by organizing more activities in it and by advertising it better.

> I just think they need some sorts of publicity, I don't believe that foreigners would not enjoy this, if there were planned trips that went there. You would drive with them down the tunnel, go up on the elevator and walk around the area. You could possibly also sell them something, coffee or something, and take them to see where the river comes into the reservoir and the dams, which are two. So, I really think this would work.

That participant estimated the largest positive impact area, stretching between Eyjafjörður in the east and Hrútafjörður in the west, encompassing Tröllaskagi, Skagi, and Vatnsnes, and stretching south of the border of the Central Highlands (Figure 2). The impact area included improved fishing opportunities due to the construction of the power plant; the creation of jobs, which made the area a more competitive destination; as well as the area within which tourists would visit the Blanda Hydropower Plant if it were better advertised and where they would be provided one more tourist attraction if the tourist potential of the power plant were maximized.

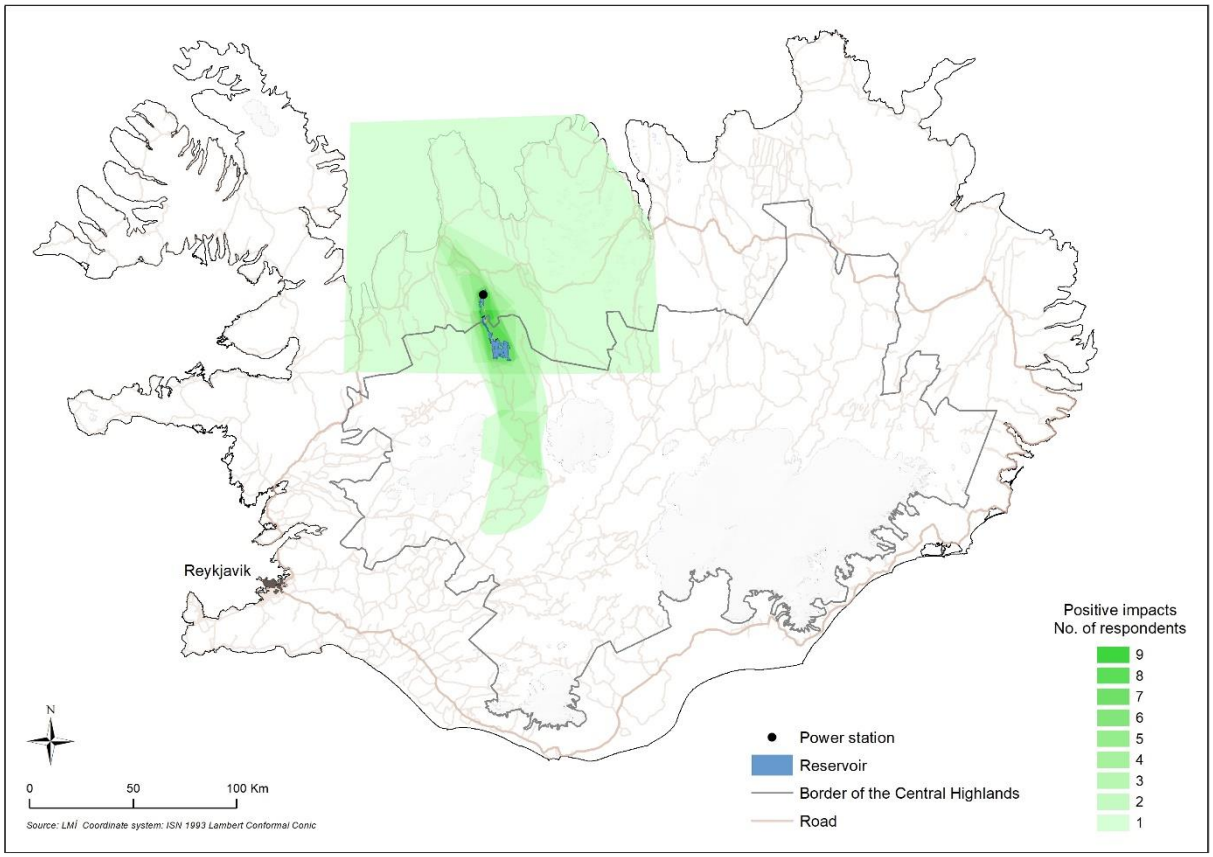

Figure 2. Perceived positive impact areas of Blanda Hydropower Plant on tourism.

Blanda Hydropower Plant: mixed and neutral impact areas

Seven participants perceived the impacts of Blanda Hydropower Plant on tourism as mixed or neutral. Of those, four participants stated that the impacts of the power plant on tourism were neutral. The size of the areas focusing on neutral impacts varied between 28 km^2 and 531 km^2, with a mean size of 349 km^2. Thus, the perceived neutral impact areas were relatively small (Figure 3). These areas included visual changes to the landscape due to the power plant infrastructure. However, according to the participants, the power plant infrastructure does not negatively impact visitor experience in the area due to its good design. They thought the infrastructure of the power plant fits well into the surrounding landscape and that its reservoirs are perceived by visitors as natural lakes. As stated by one participant, *"Blanda is quite well hidden. The lakes up there, if an Icelander goes over there now, he just thinks it has always been this way."* Moreover, the area around the power plant was perceived by the participants as a drive-through area, where few tourist activities are organized that could be affected by the power plant infrastructure. According to the participants, the landscape around the power plant is monotonous, and therefore the power plant infrastructure does not degrade tourists' perception of the landscape or their experience.

The three participants who mentioned mixed impacts of Blanda Power Plant perceived larger impact areas compared to those who estimated neutral impact areas (Figure 3). The size of mixed impact areas ranged from 1,382 km^2 to 2,846 km^2. All three participants mentioned the improvement of the Kjölur Road that resulted from the construction of the power plant. It not only changed the experience of the road users, but also led to changes in image and perceptions of tourist destinations located along the road, such as Hveravellir and Kerlingarfjöll. According to the participants, these changes were both positive and negative. Improved roads made these places easier and safer to visit. On the other hand, it led to a higher number of people using the Kjölur Road, which resulted not only in increased perceived crowding, e.g., at Hveravellir, but also in a more commercialized appearance of the place and in consequent avoidance among those who used to visit the area before the improvements to the road. One of the participants described the changes in Hveravellir brought by the improved road due to Blanda Power Plant as following:

> Hveravellir changed from being a remote kind of outpost, like an oasis in the desert, with its hot pool and small huts, and when the road was improved the first thing that changed was that they put a Coca-Cola vending machine. (…) You don't go into the Highlands to be met by a lit-up Coca-Cola vending machine. And I didn't go there for many years afterwards. It's a lot better now. But that sort of exemplifies the pitfalls that we need to really stay clear of. We're not going to put the lowlands into the Highlands, we can't do that.

Another participant pointed out that while construction of the power plant enabled recreational salmon fishing in Blanda River, the yearly overflow of the dam which happens in July–September (depending on weather conditions) makes the water muddy and thereby ends the fishing season, which leads to disappointment for the fishermen. Moreover, while the construction of the roads for the power plant made certain areas more accessible, access to the areas next to the power plant infrastructure is prohibited.

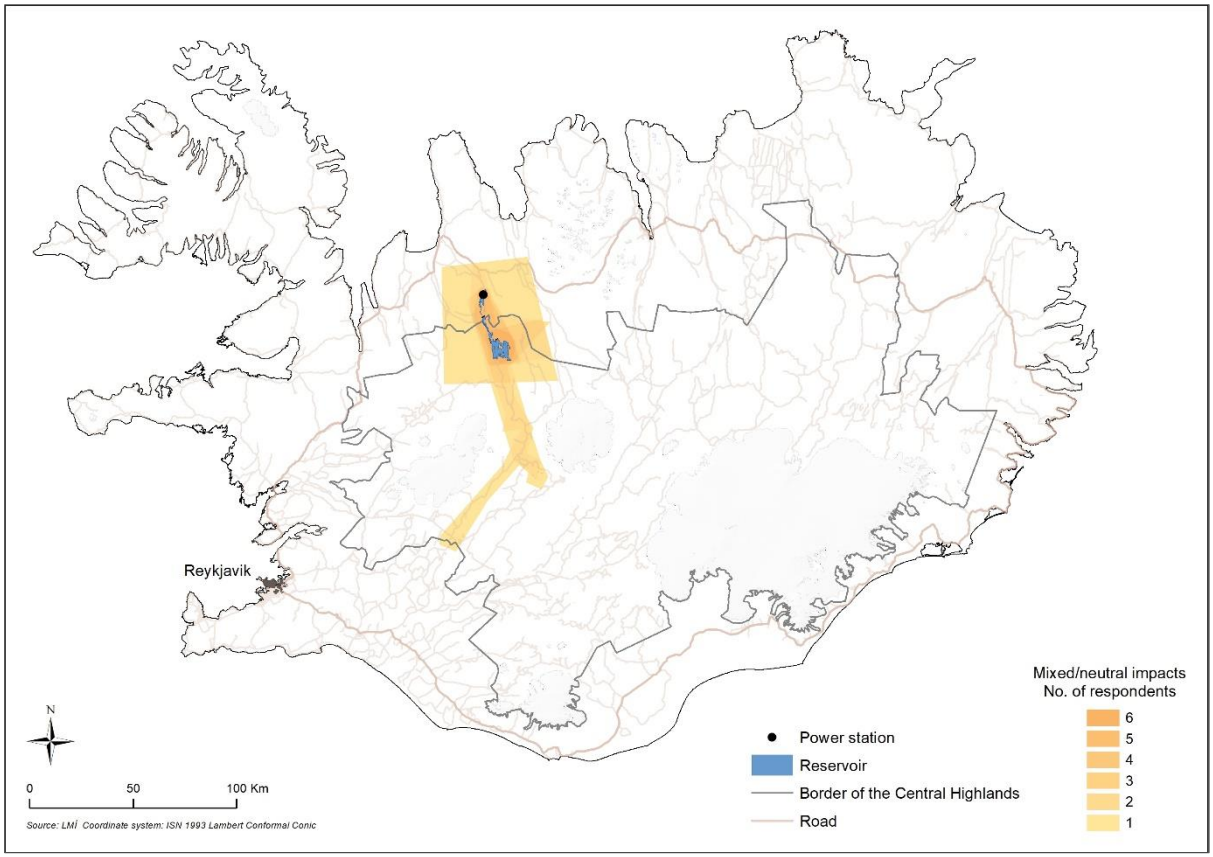

Figure 3. Perceived mixed and neutral impact areas of Blanda Hydropower Plant on tourism.

Blanda Hydropower Plant: negative impact areas

As previously mentioned, only one participant discussed only negative impacts of Blanda Hydropower Plant. His estimated negative impact area included visual impacts of the power plant infrastructure including power lines and a consequent change of the area's image from natural to industrial (Figure 4).

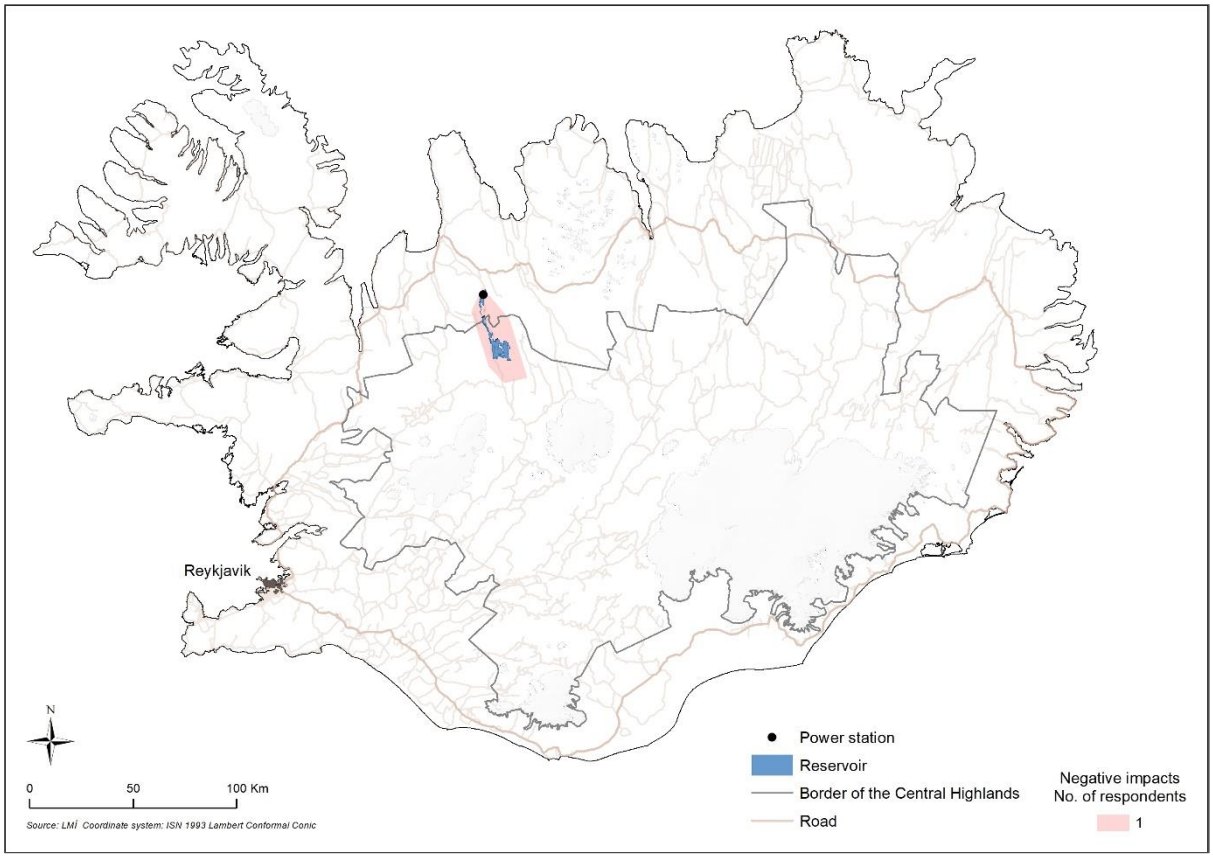

Figure 4. Perceived negative impact areas of Blanda Hydropower Plant on tourism.

Þjórsá-Tungnaá Hydropower Plants

While discussing the seven hydropower plants situated in the Þjórsá and Tungnaá catchment area, 18 participants were willing to estimate their perceived impact area on tourism. The highest proportion of participants (10) perceived the impacts as mixed or neutral. The size of these impact areas ranged from 904 km^2 to 6,800 km^2, with a mean size of 3,139 km^2 and median of 2,158 km^2 (Table 4). Five participants focused on positive impacts while estimating the impact area of the Þjórsá-Tungnaá Hydropower Plants on tourism. These impact areas ranged in size from 193 km^2 to 29,731 km^2; their mean size reached 10,284 km^2 and median 5,356 km^2. Three participants focused on negative impacts while estimating the impact areas of the Þjórsá-Tungnaá Hydropower Plants on tourism. The size of these impact areas varied between 1,907 km^2 and 8,026 km^2, with the mean size of the impact areas reaching 5,423 km^2 and median 6,336 km^2.

Table 4. Perceived impact areas of Þjórsá-Tungnaá Hydropower Plants on tourism.

Character of the impact	Number of impact areas	Range of the size of the impact areas (km²)	Mean size of the impact areas (km²)	Standard deviation	Median
Mixed/neutral	10	904–6,800	3,139	2,258	2,158
Positive	5	193–29,731	10,284	12,020	5,356
Negative	3	1,907–8,026	5,423	3,160	6,336
Total	18	193–29,731	5,504	6,919	2,778

Þjórsá-Tungnaá Hydropower Plants: mixed and neutral impact areas

Eight participants considered the impacts of the Þjórsá-Tungnaá Hydropower Plants on tourism to be mixed, that is, both negative and positive. The size of the estimated mixed impact areas of the Þjórsá-Tungnaá Hydropower Plants on tourism ranged from 904 km^2 to 6,800 km^2 with a mean size of 3,502 km^2.

Those four participants who perceived the smallest mixed impact areas (Figure 5) focused on negative landscape impacts, that is, visibility of the energy infrastructure and of the environmental impacts that the power plants have caused. Among these impacts was the flooding of large areas of land and changes to water flow in the rivers. As mentioned by one participant running a business in the area:

> It is enormously sad to go up here and view down the old pathway of Þjórsá, because just this Monday it was empty for a day and a half. Have you seen Þjórsá when it is empty? It is really a sad thing, (…) here you have two beautiful waterfalls Þjófafoss and Tröllkonuhlaup, when the river is empty you have this beautiful waterfall that is empty. The thing is that I cannot do anything about it, so I have to create a positive thing about it, but it is of course a difficult thing.

Another participant pointed out that water fluctuations in the rivers and in the reservoirs cause land erosion, which continues to degrade the environment in the surrounding area: *"The dust and the wind picking the dust up that is created because we are taking the water out, this is something that has been building up more and more damage."*

Moreover, on the negative side, according to the participants, the presence of the energy infrastructure and the construction of new roads for the power plants changed the image of the area from a wilderness area to an industrial one. Especially sensitive to such changes are tourism companies that rely on customers who seek wilderness experience. As pointed out by one participant organizing backpacking tours in the Highlands, "*People that are hiking with me only know that we should cross a part of the country where there is nothing. So, each time we meet an infrastructure, it's something that is not totally in the contract."*

On the positive side, participants mentioned increased accessibility with new and improved roads and bridges built for the power plants, which opened up new areas and provided new

opportunities for tourism. As stated by the same participant offering backpacking tours in the wilderness areas of the Central Highlands:

> I have to say that I was happy to see that there is a bridge over the river [at Hágöngulón], (…) so that's a real human infrastructure that impacts the landscape at least locally, but I should admit that I was happy to meet this infrastructure. It's much easier to cross this kind of river.

The roads furthermore made it possible to use the southern part of the Central Highlands for tourism activities in wintertime. Participants emphasized that if the roads would not have been built for the power plants, many tours organized in wintertime to the tourist sites in the Central Highlands, reaching as far as Vonarskarð, would not be possible. Moreover, better access to the Highland areas allowed the organization of winter activities, such as cross-country skiing tours, in these areas.

Four other participants who perceived the impacts of the power plants as mixed drew the impact areas larger than those who emphasized the visibility of the infrastructure and the environmental impacts. One participant mentioned especially the negative impacts of power lines on tourist experience, and that they stretch long distances from the power plant itself (Figure 5). However, on the positive side, she stressed that the company used the power line roads for their business. She also pointed out that the power plant infrastructure interrupts *"the experience that you're just alone with nature"* much further than where the infrastructure is visible: *"when you see it, it remains with you for a day and the next day I don't think people are dwelling on it."* Thus, the size of the impact area depends on tourist mobility and travel patterns, both in time and space. Moreover, participants emphasized that while some tourists are disturbed by the power plant infrastructure, others are interested in it; for such tourists, the Þjórsá-Tungnaá Hydropower Plants might be an attraction.

The three participants who drew the largest mixed impact areas besides the impacts on visitor experience mentioned also the changes in tourist movement in the Central Highlands due to the road construction, which both positively and negatively impacted tourism. As pointed out by one participant:

> More people are able to go to Landmannalaugar, for example, or easily all year round. It made the area a bit more accessible. So, it's positive and it's also negative because of the impact in Landmannalaugar. Because you're seeing a lot of mass tourism there and the area cannot hold that much.

As emphasized by the participants, while some areas of the southern Highlands experienced increased visitation due to better roads or investments into the tourism infrastructure by the energy company, as in Stöng, Gjáin, and Háifoss in Þjórsárdalur, the areas located closest to the power plants are often avoided, especially by the companies aiming to provide wilderness experience to their customers. The surrounding areas as well as the areas located further away

from the power plants, where, according to the participants, tourist experience and movement was affected by the construction of the energy infrastructure and of roads, such as Fjallabak Nature Reserve, Veiðivötn and Sprengisandur, were also included into the largest estimated mixed impact areas.

One of the three participants, while estimating the impact area besides the visual impacts of the power plants as well as roads constructed for the power plants, also included the areas impacted by the power lines, such as Kerlingarfjöll, the Kjölur Road, and the Kaldidalur Road. He furthermore included areas such as Veiðivötn and Skjaldbreiður due to improved access as well as the Laugavegur hiking trail, the crossing of Fjallabaksleið, and the Sprengisandur Road due to *"impact on the overall experience of the area, which is a bit less natural and untouched than it could have been."*

Two participants defined the impacts of Þjórsá-Tungnaá Hydropower Plants as neutral since, according to them, the power plants do not affect tourism negatively due to the good design of the power stations and natural appearance of the reservoirs. Moreover, as stated by one participant, *"Sprengisandur, it's a beautiful landscape but it's pretty boring, there's not a lot of happening there"*; thus, the reservoirs do not degrade the surrounding landscapes, since their scenic quality is not high.

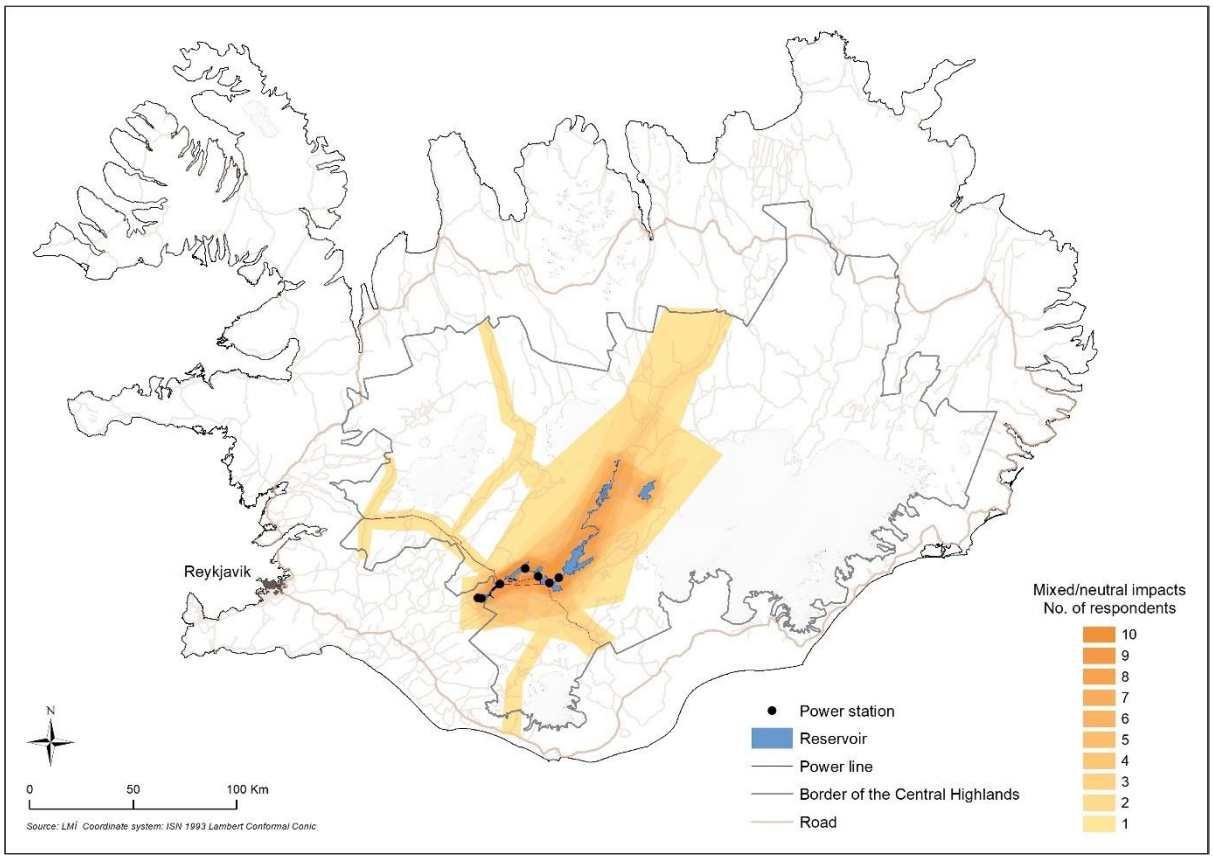

Figure 5. Perceived mixed and neutral impact areas of Þjórsá-Tungnaá Hydropower Plants on tourism.

Þjórsá-Tungnaá Hydropower Plants: positive impact areas

Five participants focused on positive impacts of Þjórsá-Tungnaá Hydropower Plants. The range in size of the estimated positive impact areas varied the most compared to mixed/neutral and negative impact areas, or from 193 km^2 to 29,731 km^2 (Table 4, Figure 6). They all focused on the road construction for the power plants and increased accessibility created in the Central Highlands for tourism. Three estimated impact areas were relatively small and included the Central Highland areas that became tourism destinations due to road improvements. Some of them also mentioned new tourist attractions that were created due to the power plants. One participant gave an example: *"There's a small gulley on the way to Landmannalaugar, basically creating a beauty spot. I can spend hours there with photographers because it's out of the way and a little place, but it was created by a water dam."* Another participant pointed out that power plants themselves serve as tourist attractions: *"If I have clients with kids, I visit the power plant in Búrfell, because it's actually a very good learning experience for families."* Furthermore, one participant mentioned that two hotels were built in the area for the construction of the power plants and were later used for tourism.

Two participants who drew the largest positive impact areas stated that, due to improved access, the places in the southern Central Highlands became part of larger itineraries and now are considered during the decision-making while planning tours in south Iceland.

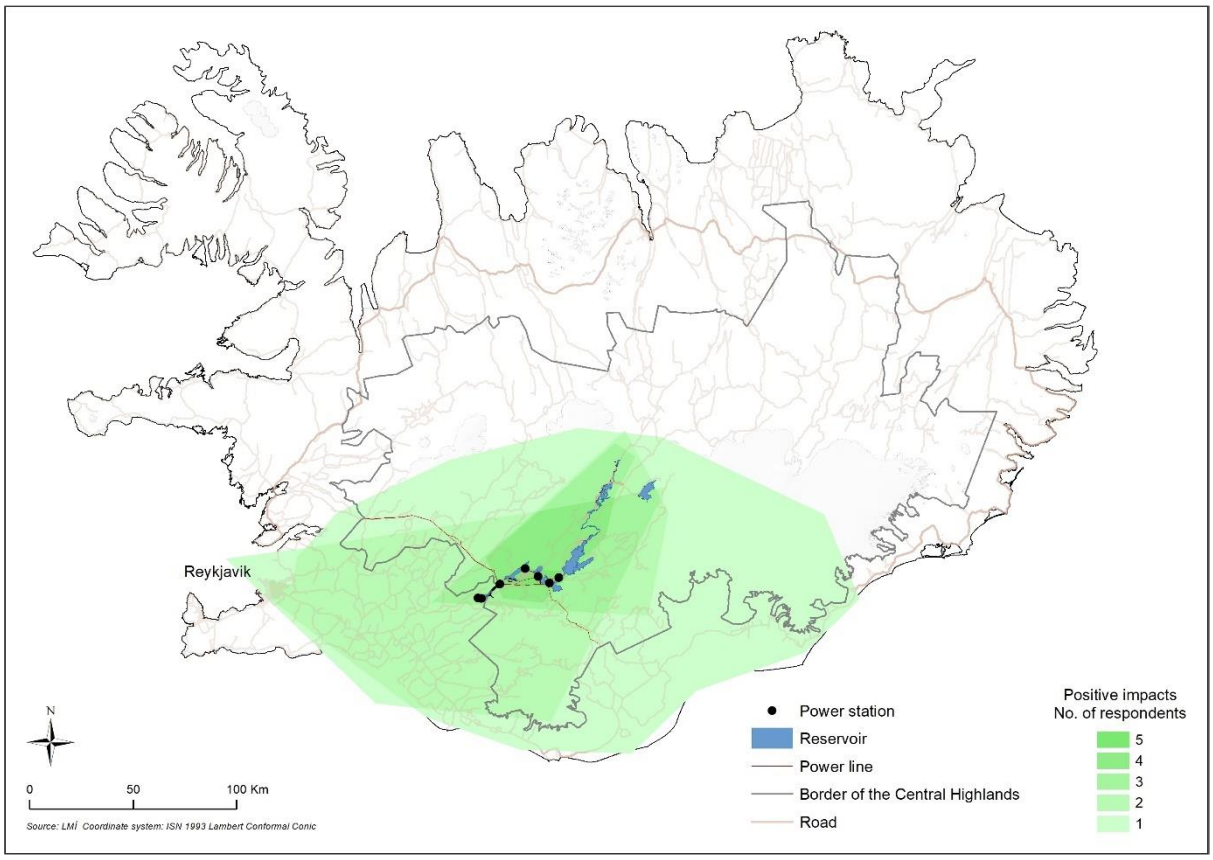

Figure 6. Perceived positive impact areas of Þjórsá-Tungnaá Hydropower Plants on tourism.

Þjórsá-Tungnaá Hydropower Plants: negative impact areas

Three participants focused on negative impacts while they mapped the impact area of the Þjórsá-Tungnaá Hydropower Plants (Figure 7). They mentioned visual impacts of the power plants and environmental changes that negatively affect how visitors experience the whole trip leading past the power plants. According to the participants, the power plants changed the image of the surrounding area from wilderness into an industrial area which is of no value for tourism: *"It's a drive-through area. There's no other development in this area, so that's the impact, it's just a drive-through area. (…) It's no longer the wilderness area it used to be."* These changes led to avoidance of the area when planning nature-based tourism activities: *"We would never consider creating a trekking from one side to another of this industrialized power plant area here. So, it draws a clear line in the landscape, we do not organize something that goes across that."* Thus, the power plants reduced opportunities for tourism in the surrounding areas.

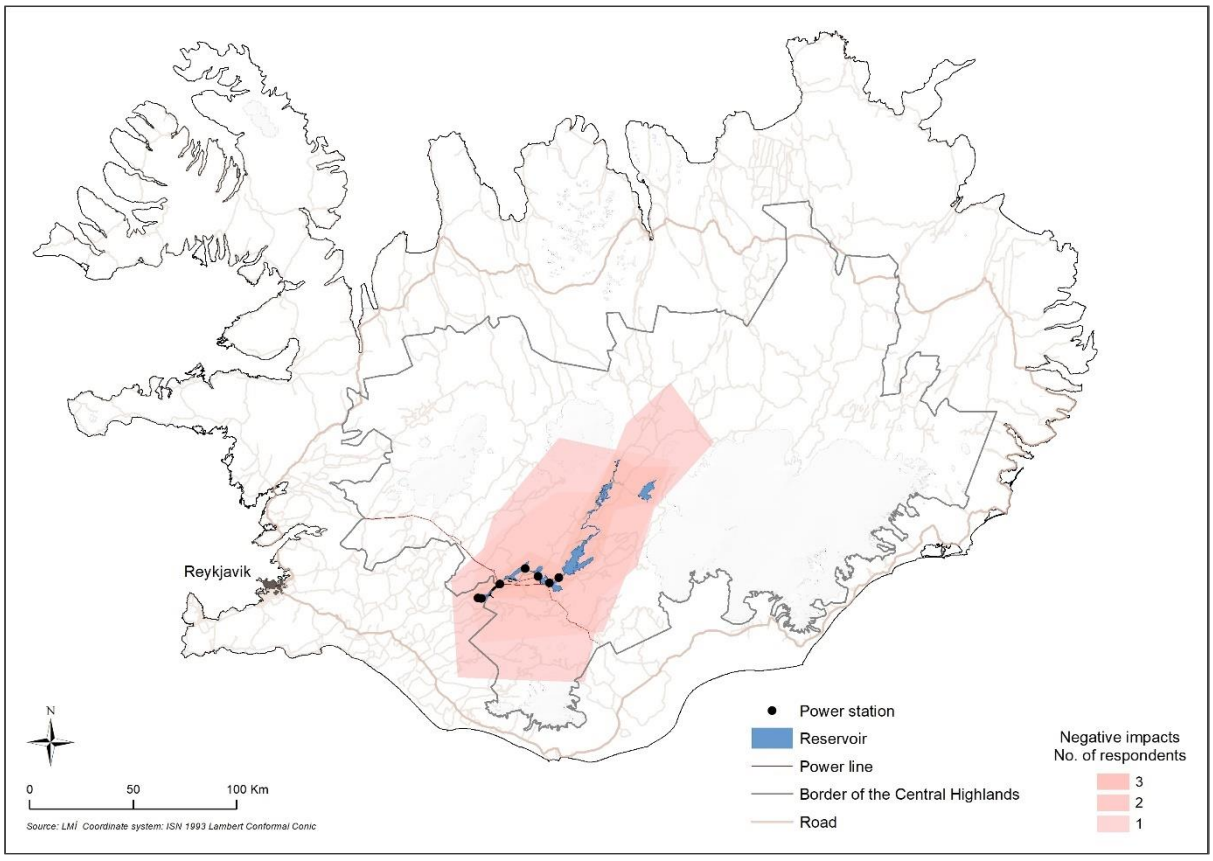

Figure 7. Perceived negative impact areas of Þjórsá-Tungnaá Hydropower Plants on tourism.

Krafla Geothermal Power Plant

The impact area of Krafla Geothermal Power Plant was estimated by 13 participants in total. Eight participants perceived the impacts of the power plant on tourism as mixed or neutral. The size of mixed/neutral impact areas ranged widely: between 4 km^2 and 2,271 km^2, with a mean size

of 765 km^2 and median of 482 km^2 (Table 5). Four participants estimated positive impact areas, which ranged in size even more, between 17 km^2 and 18,657 km^2, with the mean size reaching 4,665 km^2 and median 265 km^2. Only one participant focused on negative impacts while estimating the impact area of the power plant on tourism. The perceived negative impact area reached 548 km^2.

Table 5. Perceived impact areas of Krafla Geothermal Power Plant on tourism.

Character of the impact	Number of impact areas	Range of the size of the impact areas (km^2)	Mean size of the impact areas (km^2)	Standard deviation	Median
Mixed/neutral	8	4–2,271	765	764	482
Positive	4	17–18,657	4665	8,038	265
Negative	1	-	548	-	-
Total	13	4–18,657	2143	4,899	548

Krafla Geothermal Power Plant: mixed and neutral impact areas

Seven participants estimated mixed impacts areas of Krafla Geothermal Power Plant on tourism. Their size range varied from 4 km^2 to 2,271 km^2 with a mean size of 725 km^2.

The participant who drew the smallest impact area (Figure 8) emphasized that if the power plant is presented positively, tourists will be interested in the power plant; thus, while the energy infrastructure changed the landscape, the tourists' opinion of the power plant can also be positive. While discussing the impacts of the power plant he mentioned that it made the Mývatn area economically stronger and thereby contributed to it being a competitive tourism destination. However, while drawing the impact area, he focused on the visibility of the power plant infrastructure.

Five participants, while estimating mixed impact areas, discussed visual and aural impacts of the power plant infrastructure, including the power lines and in some cases the visibility of steam. They also mentioned changes in the image of the area from natural into industrial, as well as improved access due to the construction of the roads for the power plant. As pointed out by the participants, the power plant infrastructure is perceived by the visitors differently: *"I would say it's 50/50, some people think it's great, some people may think it doesn't fit the surrounding landscape. It's a bit like being on the moon."* Especially impactful, according to some participants, are the pipes stretching across the road and over the whole valley: *"I actually never understood why this could not go under the road. But people thought very differently when it was built than people do today."* According to the participants, the power plant changed the perception of the picturesque tourist sites located nearby, such as Leirhnjúkur:

> You know, you are at the edge of an industrial area. But you have this beautiful nature, for most people in North America or around the world to go up to a new lava field is a unique experience. So, it's still a unique experience, but you are driving through an industrial area to get there. It's not negative enough to not want to go there but we would be better off without it if we think in terms of tourism.

Participants emphasized that when presented in a positive light as a source of renewable energy, Krafla is usually perceived positively; moreover, people tend to be interested in geothermal energy since it is relatively rare in other countries. However, entering Krafla power plant is not always possible. One participant stated:

> I try to show everybody the power plants we have because we have renewable, clean energy, and people want to learn about it. I take people and show them Bjarnaflag, the oldest one. And then we go to Krafla, but sadly the visitor center is rarely open, and we don't have any access to it. It would be much better to frequently go into the visitor center. If we had a key, we could go there any time and show them.

Improved access due to construction of the roads, as pointed out by the participants, impacted tourism both positively and negatively. On one hand, better roads provided opportunities to visit some unique tourist sites which previously were difficult to access. On the other hand, people do not expect a paved road while driving through this area, and it takes away from their experience: *"People just say 'what', if they see the paved road after driving up Geldingadalur from Heiðarbær in Reykjahverfi and then all of a sudden what, asphalt, up in the mountains. (…) I don't think they are excited about this."*

The participant who estimated the largest mixed impact area of the Krafla Geothermal Power Plant on tourism considered negative visual impacts of the power plant including the power lines. He also took notice of the tourist sites located nearby, such as Gjástykki, Leirhnjúkur, and Víti, which became more accessible due to construction of the roads for the power plant. According to this participant, while the area became less natural due to the construction of the power plant, it also became more accessible: *"by increasing the access to these attractions, it increased the interest in the area as a whole, so it's also having an impact on Dettifoss. And to a larger extent on this Diamond Circle, which is basically this Akureyri-Goðafoss-Mývatn-Dettifoss [tour]."* Therefore, the impact area perceived by this participant follows the travel route of this tour and has a doughnut shape (Figure 8).

One participant estimated a neutral impact area reaching 1,049 km^2. According to him, Krafla Power Plant is one more site to see for tourists visiting the Mývatn area, identified by the participant as the impact area of the power plant. According to the participant, the power plant is usually visited on the way to Víti or Leirhnjúkur, but is not a tourist destination in itself and therefore has a neutral impact on tourism.

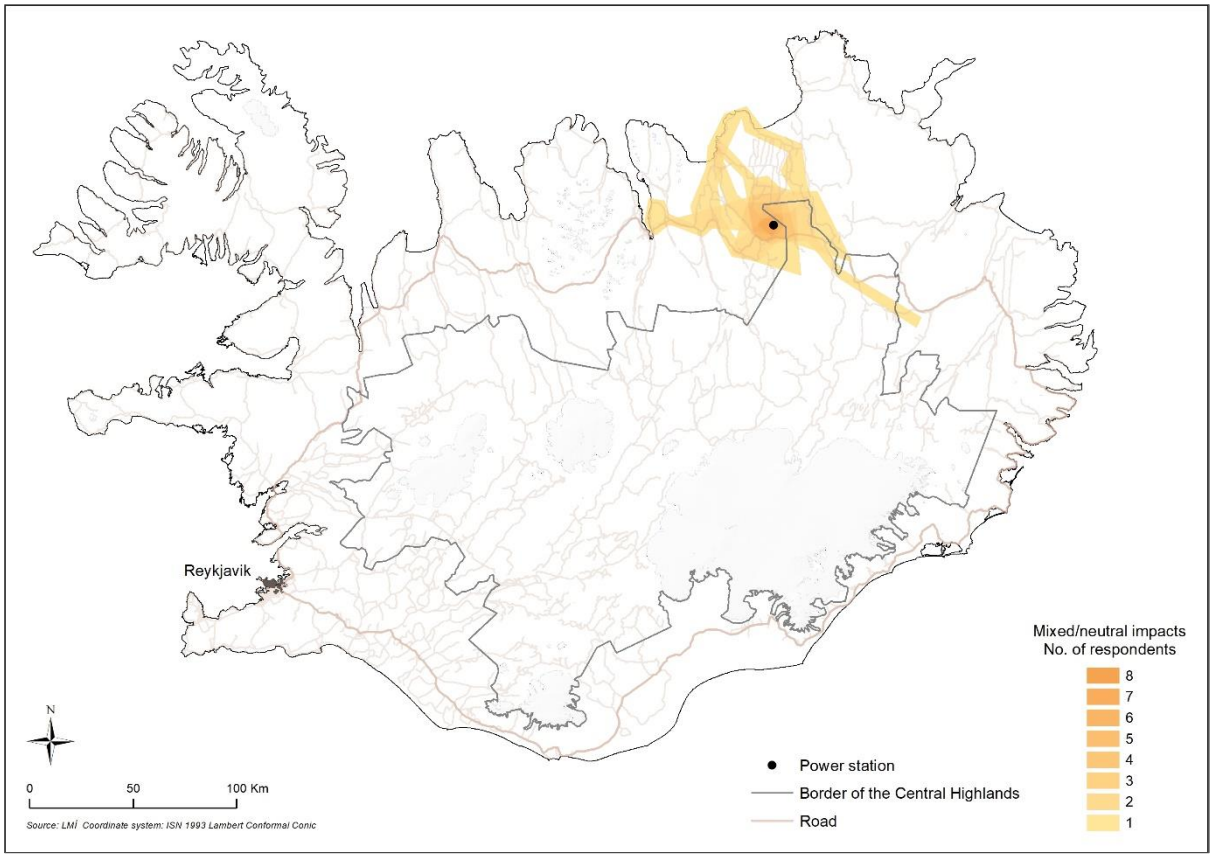

Figure 8. Perceived mixed and neutral impact areas of Krafla Geothermal Power Plant on tourism.

Krafla Geothermal Power Plant: positive impact areas

The four participants who estimated positive impact areas of Krafla Geothermal Power Plant on tourism (Figure 9) emphasized that the power plant is to some degree a tourist attraction with an interesting history and is a good addition to the tours operated in the area. Two of them estimated relatively small impact areas of similar size (17 km^2 and 18 km^2). The reasoning behind them, however, was different. The smallest impact area focused on the visibility of the power plant infrastructure and on impressions it leaves on visitors: *"You just drive underneath the pipe that's there, it's kind of surreal… surrealistic experience."* As pointed out by the participant who estimated this impact area, the power plant is located in the valley and is only visible at a short range, therefore its impact area on tourism is rather small.

The participant who estimated the second smallest impact area decided to focus on the immediate impacts of Krafla Power Plant on tourism, which, according to him, included improved access to Víti and Bjarnafell. However, he mentioned that the impact area could be extended to the whole Mývatn area:

> You could say that the existence of Krafla is the reason for existence of Mývatn partially, so better roads and etc. following the power plant is the impact area on Mývatn. (…) It made it stronger. We had stronger infrastructure in place when tourism picked up because we had the power plant.

The area around Lake Mývatn was perceived as an impact area by the third participant. The arguments for it, however, differed from the previous case. According to this participant, tourists do not learn about Krafla and the power plant until they come to the Mývatn area because the area contains bigger attractions. Once they are in the area, they have one more stop to visit and an opportunity to learn the history of Krafla since *"there are information signs about the power plant and the history of Krafla fires."*

The participant who estimated the largest positive impact area stated: *"I am rather proud of Krafla Power Plant. (…) It's a rather small power plant with a small but very compact exhibition in several languages, and we always receive good service there."* According to this participant, the visitors find the design of the power plant infrastructure with external cooling systems fascinating and are interested in learning more about the power plant. The power plant has a high educational value since it provides visitors the opportunity to observe the process of geothermal energy harnessing. Thus, according to the participant:

> It is a good addition to the area. I don't think people would put a lot of effort to go there. It is so short from the Road 1, if you are coming from Egilsstaðir then it is an option to see the power plant.

As pointed out by this participant, Krafla Power Plant has positively contributed to the attractiveness of the whole area and has become a part of the attraction network in the area.

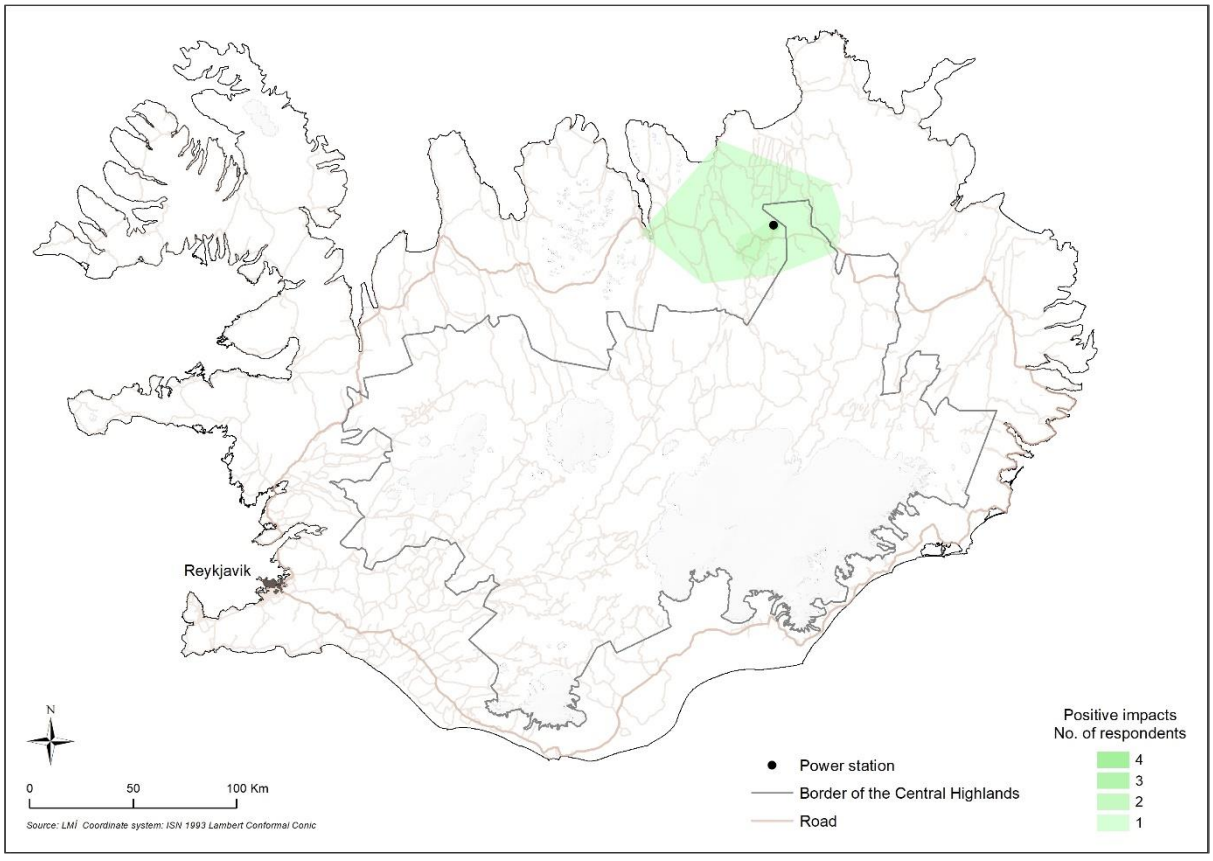

Figure 9. Perceived positive impact areas of Krafla Geothermal Power Plant on tourism.

Krafla Geothermal Power Plant: negative impact areas

One participant focused on negative impacts on tourism while estimating the impact area of Krafla Geothermal Power Plant (Figure 10). The arguments for the perceived impact area included changes in the perception and image of the Mývatn area:

> I think it puts more industrial stamp on the whole area, and it's totally opposite to the lake experience. When you're around the lake you get this nature feeling with the farms and places like Dimmuborgir where you have absolutely unique phenomena – then this is kind of… It's a little bit of a Mad-Max world, actually, it's like the industrialized area from a crazy movie.

Moreover, the perceived impact area included the impacted trekking tours from Ásbyrgi to Mývatn as well as impacts on the experience of tourists visiting Leirhnjúkur and other tourist sites nearby.

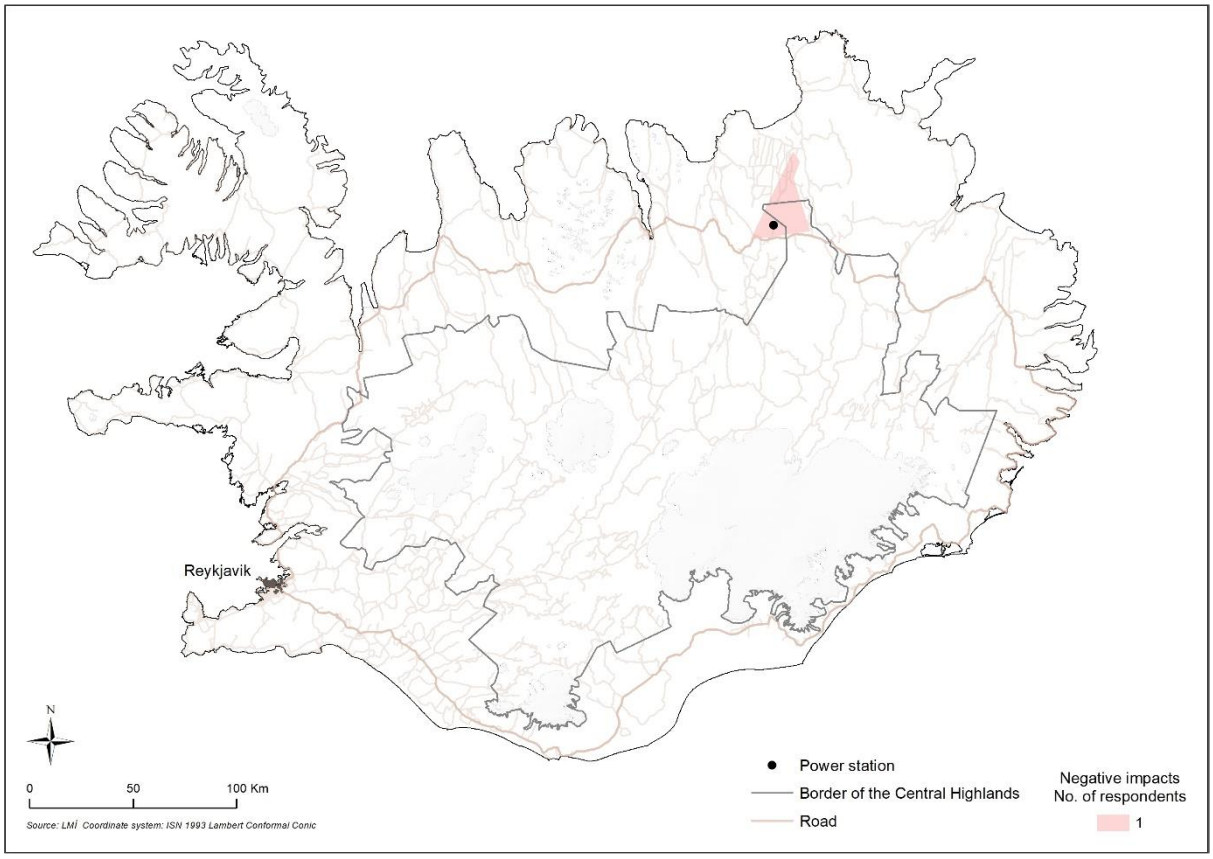

Figure 10. Perceived negative impact areas of Krafla Geothermal Power Plant on tourism.

4.2 Proposed renewable energy infrastructure

Hrafnabjörg Hydropower Plant

A total of 18 participants estimated the impact area of the proposed Hrafnabjörg Hydropower Plant on tourism, thereof two preferred to draw two impact areas. One participant drew separate impact areas for positive and negative impacts, while the other drew separate impact areas for

mixed and negative impacts. Thus, a total of 20 perceived impact areas were defined. The majority (16) of the impact areas included negative impacts of the proposed Hrafnabjörg Hydropower Plant on tourism. The size of negative impact areas varied greatly, between 18 km^2 and 35,580 km^2 (Table 6). Their mean size reached 4,361 km^2 and median 1,447 km^2. Three impact areas included mixed impacts and ranged in size between 6,866 km^2 and 7,446 km^2, with the mean size of 7,244 km^2 and median of 7,419 km^2. Only one participant drew a positive impact area, which was relatively small and covered 36 km^2. That participant also mapped negative impacts on a separate map.

Table 6. Perceived impact areas of Hrafnabjörg Hydropower Plant on tourism.

Character of the impact	Number of impact areas	Range of the size of the impact areas (km^2)	Mean size of the impact areas (km^2)	Standard deviation	Median
Negative	16	18–35,580	4,361	9,432	1,447
Mixed	3	6,866–7,446	7,244	327	7,419
Positive	1	-	36	-	-
Total	20	18–35,580	4,577	8,514	1,560

Hrafnabjörg Hydropower Plant: negative impact areas

The reasoning the participants used while describing the negative impacts of the proposed Hrafnabjörg Hydropower Plant can be grouped into four categories.

The first type of arguments was about the visibility of the proposed power plant infrastructure and of the environmental impacts which would negatively affect tourist experience. These arguments were the basis of six of the smaller perceived impact areas (18–1,898 km^2) (Figure 11). Among the environmental impacts which would affect tourism, participants mentioned reduced waterflow in the waterfalls, as the proposed Hrafnabjörg Hydropower Plant would reduce the waterflow in two to four waterfalls depending on the version of the proposal. One of these waterfalls, Aldeyjarfoss, was described by the participants of the study as a very important tourist attraction in the area, while another waterfall, Hrafnabjargafoss, was mentioned by several participants as a waterfall of increasing importance for tourism. Thus, waterflow reduction in them would highly impact their attractiveness and consequently tourism in the area: "*If the water is very much reduced in the waterfalls, then that would definitely be a negative impact because people actually want to see the waterfalls.*" The participant who estimated the smallest negative impact area included in this category (18 km^2) assumed that it should be possible to manage the waterflow in the waterfalls to make sure there would be enough water during daytime in summer months in order to please visitors. This idea was not shared by any other participant. Other environmental impacts identified by the participants, the visibility of which would negatively affect tourism,

included potential changes to ecosystems such as the flooding of a large bird habitat as well as water fluctuation in the reservoirs, which is likely to visually pollute the area. Participants also pointed out that the power plant infrastructure would visually impact the surrounding landscape, which is currently perceived by the participants as wilderness greatly valuable for tourism. Instead it would be transformed into an industrial area with limited value for tourism. As pointed out by one participant, such wilderness area is not suitable for energy development: *"Anything done there is a big no. Stick to the areas where you have already done something. This is in fact the only area in Iceland that is not managed at all."*

The second type of arguments included the environmental impacts downstream of the site in addition to the visibility of the power plant infrastructure and of the environmental impacts around the power plant. This type of arguments was used by four participants. The size of these impact areas was somewhat larger than the areas in the first category and ranged between 1,403 km^2 and 2,087 km^2.

The third type of arguments, tourist mobility, was used by four participants. They pointed out that the impacts of the proposed Hrafnabjörg Hydropower Plant on tourist experience would extend further than the visual impacts, and the spatial extent of the impacts depends on tourist mobility, geographical distribution of attractions, and tourists' travel patterns. These estimated impact areas varied greatly in size and ranged from 422 km^2 to 35,580 km^2. The three smaller negative impact areas belonging to this category included surrounding attractions, local businesses which currently receive tourists visiting the waterfalls, as well as tourist infrastructure. Improvements on Sprengisandur highland road and other roads that would negatively affect the experience of tourists were also included. Furthermore, a hiking route with high future potential along the Skjálfandafljót down to Vonarskarð was also mentioned. The power plant infrastructure was perceived as especially disturbing for hikers, since they are usually sensitive to such constructions. According to the participant who drew the largest negative impact area, the proposed power plant might negatively affect the Central Highlands as a holistic tourist destination and would not fit with the idea of the Central Highlands as a national park which is currently under discussion in Icelandic society. Thus, it would negatively affect how people feel while travelling in the estimated impact area.

The fourth type of arguments was used by two participants who focused on changes in tourist travel patterns due to reduction of tourist attractions if the waterfalls would be destroyed by the power plant. These impact areas differed largely in size. The larger area was the second-largest negative impact area of Hrafnabjörg Hydropower Plant (18,657 km^2) and reached Akureyri to the west, Húsavík and the surrounding areas in the north, included the Mývatn area

to the east as well as Askja and part of Sprengisandur to the south. The smaller impact area (978 km^2) included Bárðardalur and the Mývatn area. According to these participants, a lesser choice of attractions in the region would lead to less time spent there by visitors, a lower demand for accommodation and other tourism services in the indicated area, and consequent economic losses:

> Tourists just go to places where there is something to see. So, taking things from us that they could see, means less money from tourism and harder life in rural areas. Less economy, less services, and it's just, all falls down like a house of cards.

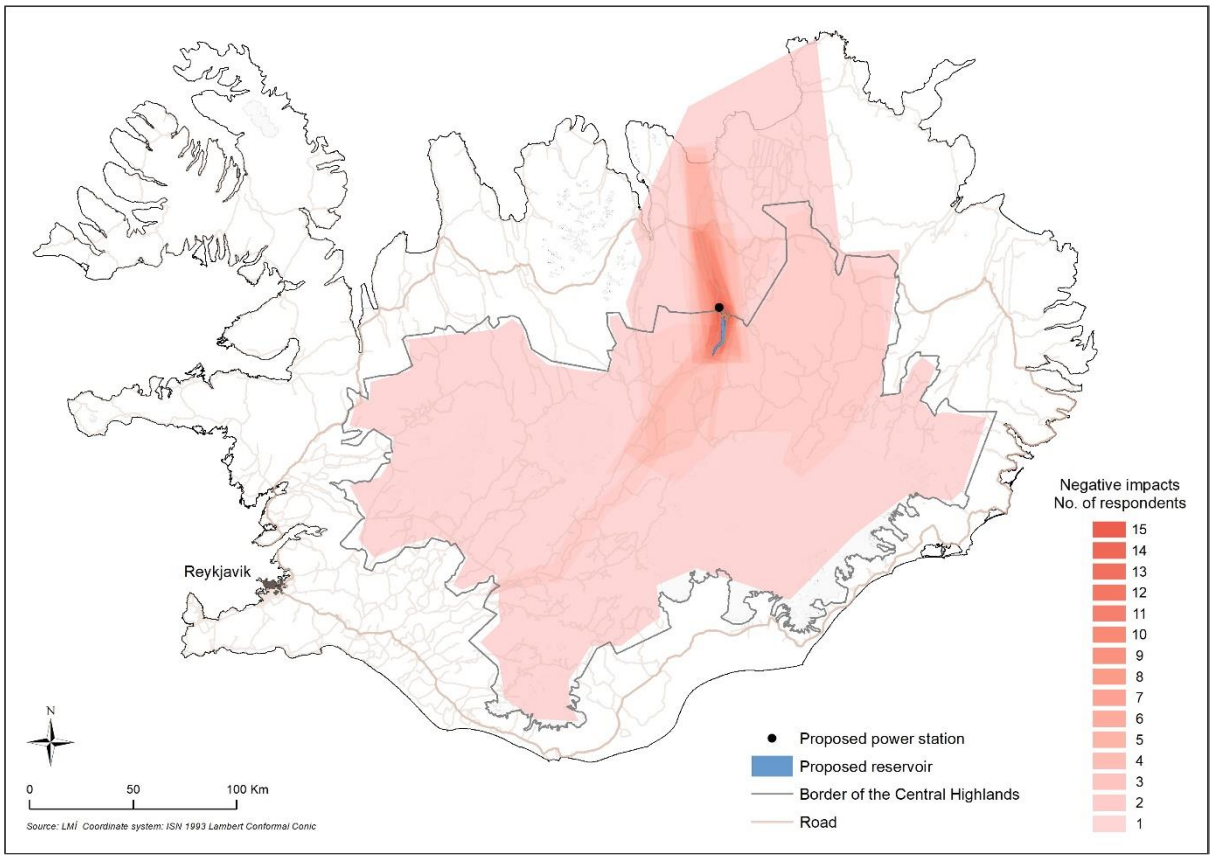

Figure 11. Perceived negative impact areas of Hrafnabjörg Hydropower Plant on tourism.

Hrafnabjörg Hydropower Plant: mixed impact areas

Three participants discussed mixed impacts of the proposed Hrafnabjörg Hydropower Plant on tourism (Figure 12). Two of them pointed out that the type of tourism would change due to improved access to the waterfalls and to surrounding areas which were previously difficult to access. Improved access would be beneficial for mass tourism, but it would lead to increased crowding, change the perception of the area, and therefore negatively impact more specialized tourism:

> We like to take people to areas that are less inhabited, where you have to drive on tough roads to get somewhere, and it is a bit of an adventure. If it becomes a tarmac highway to Aldeyjarfoss, then Aldeyjarfoss will be visited like never before, and will people enjoy it? It's not a development that we welcome, that we support, but I think my cold assessment is that it

> will increase tourism. And if we are just talking about money and increased tourism, it's going to end with Mývatn and Akureyri because people might stay longer since it might require one more day tour.

The third participant who estimated a mixed impact area focused on the changes to visitor experience, which would be degraded if the power plant would be built, especially the experience of repeat visitors who come to the area for unspoiled nature. She also mentioned the changes in the image of the area due to environmental impacts of the proposed power plant. On the other hand, the participant stated that the road improvements made for the construction of Hrafnabjörg Hydropower Plant might lead to higher satisfaction of tourists, since currently some visitors to the waterfalls are not satisfied with the condition of the roads.

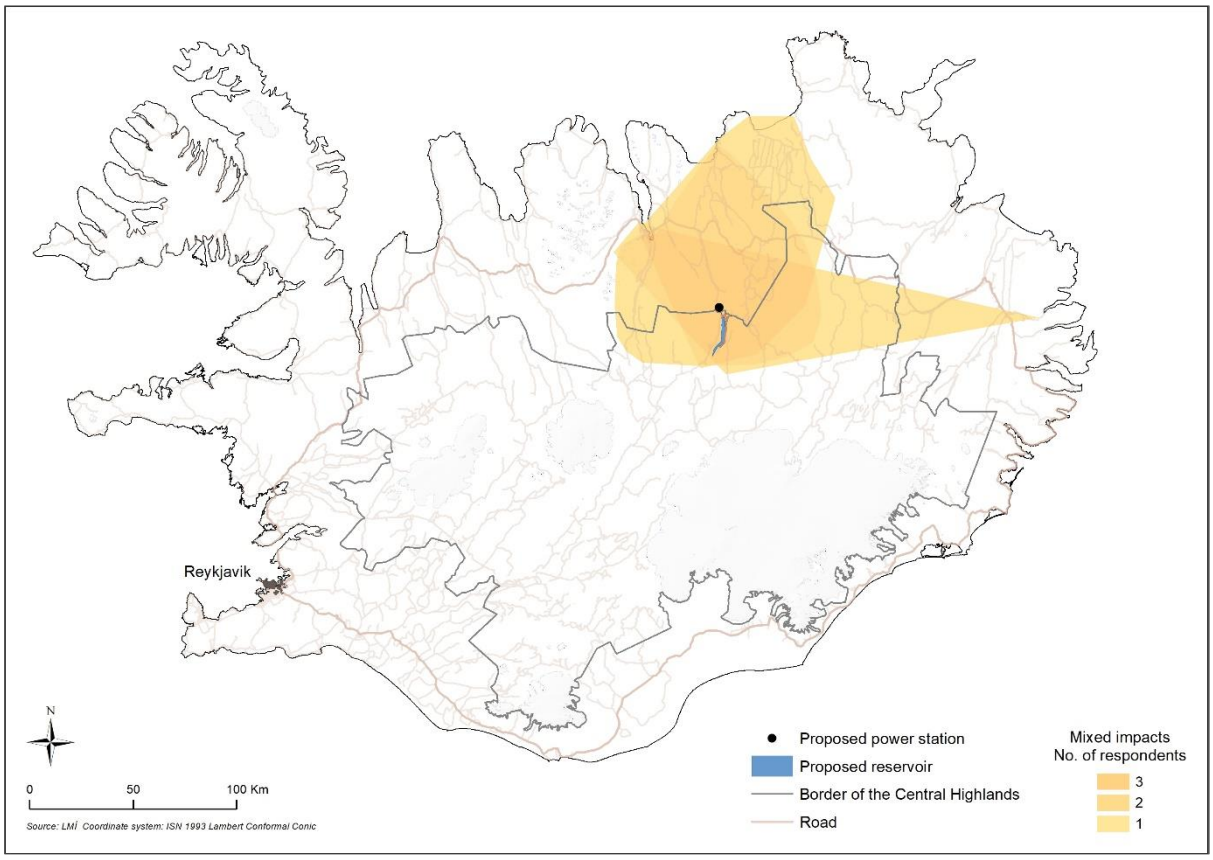

Figure 12. Perceived mixed impact areas of Hrafnabjörg Hydropower Plant on tourism.

Hrafnabjörg Hydropower Plant: positive impact areas

One participant drew both a positive impact area as well as a negative impact area of the proposed Hrafnabjörg Hydropower Plant on tourism. The positive impact area was relatively small (36 km^2) (Figure 13), and the argument used was that the power plant would lead to an improved road, which would provide more opportunities for tourism in the area.

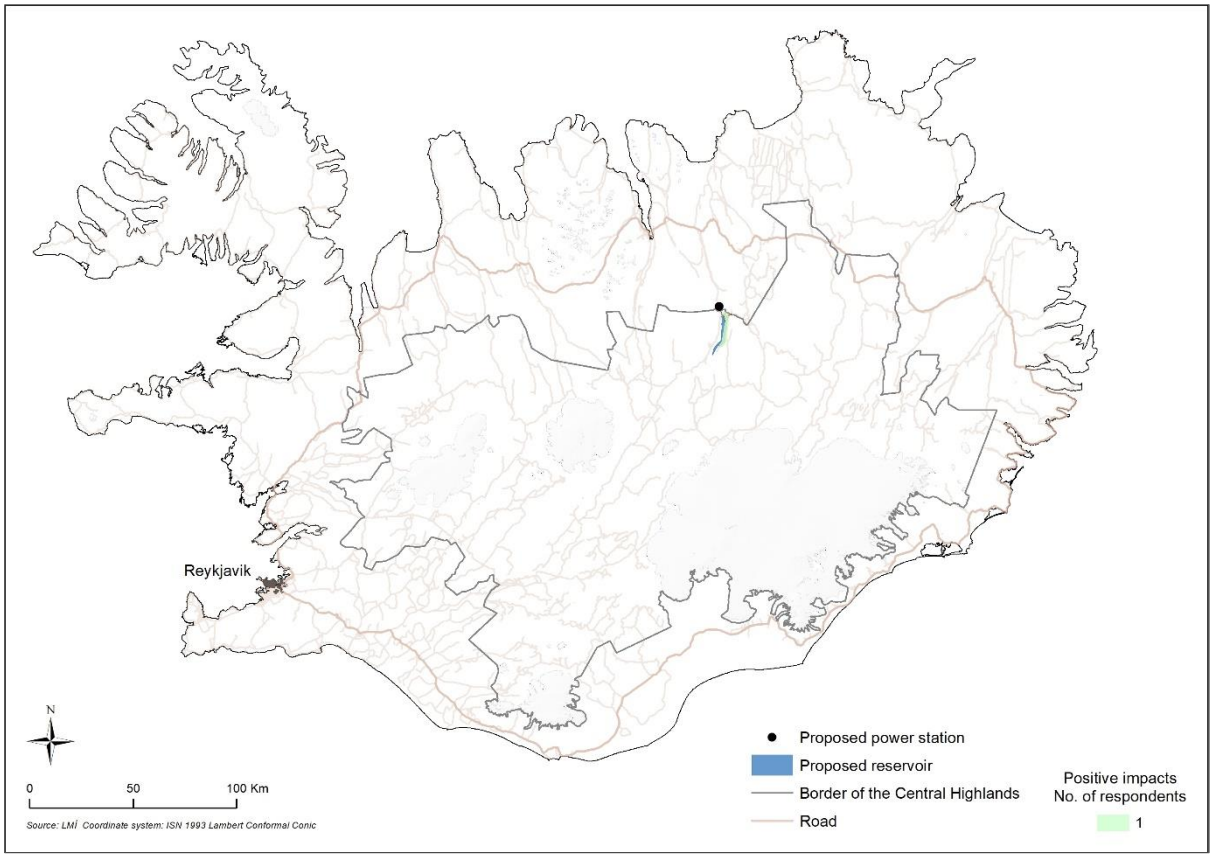

Figure 13. Perceived positive impact areas of Hrafnabjörg Hydropower Plant on tourism.

Hágöngur Geothermal Power Plant

A majority of the participants (12 out of 15) perceived that Hágöngur Geothermal Power Plant would have negative impacts on tourism. The size of the perceived negative impact areas ranged between 298 km^2 and 12,052 km^2, with a mean size of 3,238 km^2 and median of 2,729 km^2 (Table 7). Two participants estimated positive impact areas in the size of 324 km^2 and 1,996 km^2, while one participant perceived the impacts of the proposed power plant as mixed or neutral. The size of the mixed/neutral impact area reached 6,983 km^2.

Table 7. Perceived impact areas of Hágöngur Geothermal Power Plant on tourism.

Character of the impact	Number of impact areas	Range of the size of the impact areas (km^2)	Mean size of the impact areas (km^2)	Standard deviation	Median
Negative	12	298–12,052	3,238	3,312	2,729
Positive	2	324–1,996	1,160	1,183	1,160
Mixed/neutral	1	-	6,983	-	-
Total	15	298–12,052	3,211	3,215	2,540

Hágöngur Geothermal Power Plant: negative impact areas

Out of the 12 participants who estimated negative impact areas of Hágöngur Geothermal Power Plant on tourism, seven participants focused on the visibility of the power plant and of other infrastructure following it, such as roads and power lines (Figure 14). According to the participants, such infrastructure would radically change the image of the area into industrial and negatively affect tourist experience, since the area is presently perceived as wilderness despite the Hágöngur reservoir located nearby. Most participants perceived that the infrastructure of the geothermal power plant would have much more impact on the surrounding landscape than the natural-looking reservoir.

As pointed out by one participant, the visual disturbance of such a power plant on the surrounding landscape would also be very high because, due to harsh weather conditions in this remote highland area, the new infrastructure should be especially sturdy:

> I know how absolutely crazy the weathers can be there and just having some kind of infrastructure there, like houses, buildings, power lines and stuff, it has to be done in a really proper way and to do it in a really proper way you have to do really proper damage to nature. You have to make a massive road system there, you have to make the roads much higher than they are today even though they are pretty good.

Some of the participants took into consideration the visibility of the steam emitted by the proposed power plant, making its negative impact area relatively large: *"You have the steam rising from the geothermal power station, it'll be visible from hundreds of kilometers. So, in that sense it's a huge impact area."* Moreover, as pointed out by the participants, the open landscape of the Sprengisandur area would contribute to the vast visual impact of the steam.

Five other participants emphasized that the impacts of the power plant on tourist experience would last even when the power plant would no longer be in view. Thus, their perceived impact areas were affected by the current and potential future tourist mobility in the area. One of these participants estimated a relatively small negative impact area of the proposed power plant. The argument for that was the current low visitation of the area:

> I think tourists are not going to the Highlands to look at energy projects, so, it would be best for tourism if everything would be natural, at least not a large project. So, the effect on tourism is negative of all energy projects in the Highlands. But I think there is not a lot of tourists going into that area, so, I think the effect is not very big.

Others, however, emphasized that while the area is currently little used for tourism, building the proposed power plant would destroy the future potential of the hiking and skiing route crossing the Central Highlands and the whole country from coast to coast. Two participants pointed out that the interest in such big crossings is increasing internationally, and this route has a high future potential, it just needs some additional tourism infrastructure along the route. These participants included the impacts on the potential of the route into their

estimated impacts areas, which were among the largest mixed impact areas of Hágöngur Geothermal Power Plant on tourism. Other impacts included in the largest impact areas were impacts on the experience of tourists driving the Sprengisandur Road, as well as of visitors to nearby Vonarskarð and other surrounding areas.

As pointed out by the participants, the construction of a geothermal power plant and a new road in such a wilderness area would strongly impact how visitors experience and perceive the nearby areas valuable for tourism and recreation, such as Vonarskarð. One participant stated:

> For me Vonarskarð is kind of sacred. It is a nook in between two glaciers, it's geothermal heat, it's the rhyolite, amazing vegetation in this kind of height. (…) If you get this road here, you are just cutting it way too close. And this area would lose all its mystical properties. It's so remote and it has this hidden valley behind glaciers and mountains and it's really inaccessible. But if you go there and you pay the price of going there, it rewards you. And this would just make it like Reykjadalur or something.

Several participants emphasized that the construction of the power plant would contradict the closure of the 4x4 track in Vonarskarð, which was done for the preservation of the sensitive nature and the wilderness quality of the area.

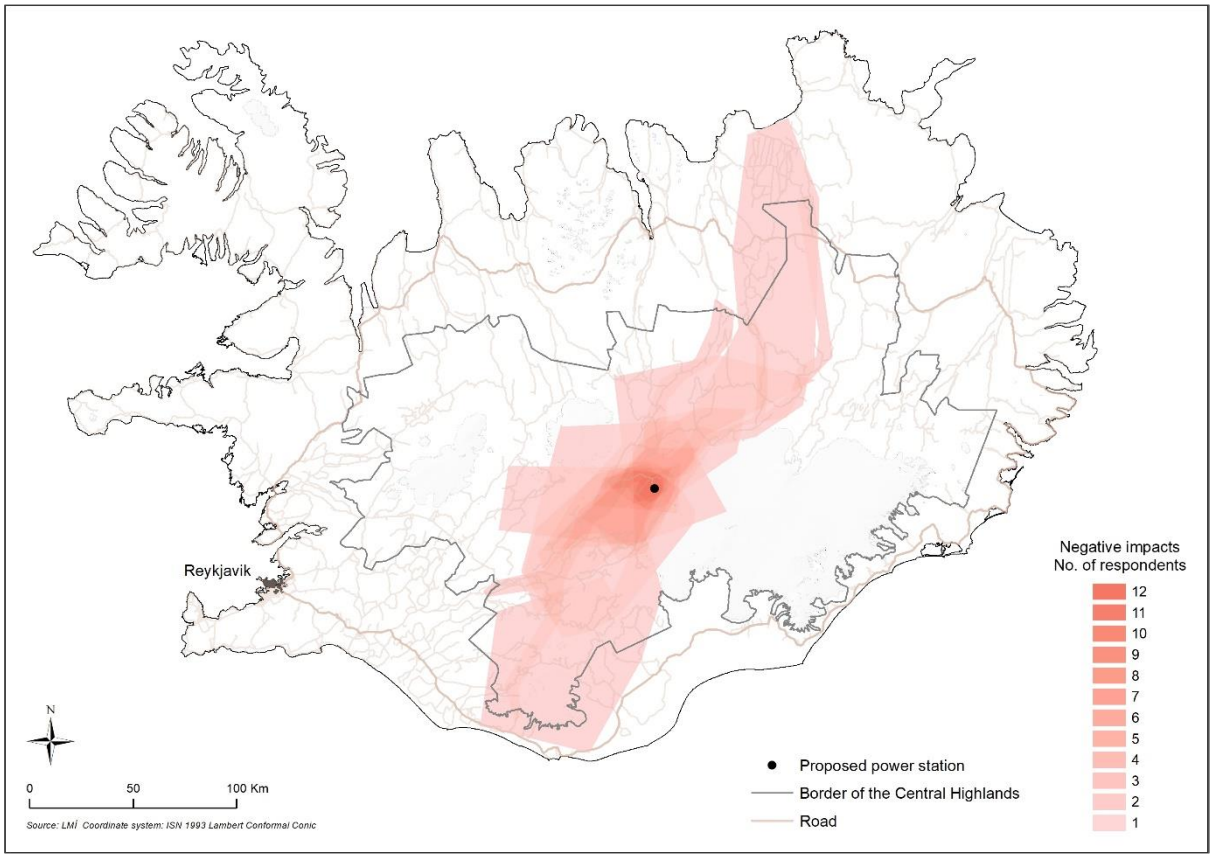

Figure 14. Perceived negative impact areas of Hágöngur Geothermal Power Plant on tourism.

Hágöngur Geothermal Power Plant: positive impact areas

Two participants perceived the impacts of the proposed Hágöngur Geothermal Power Plant as positive (Figure 15). Both emphasized that improved roads would benefit tourism by making the

area more accessible. Moreover, a geothermal power plant has a potential to become a tourist attraction:

> We like the steam. We think it's cool, the tourists think it's super cool to see this thing and this is a place which is really hard to reach. I mean, you always have to have a special vehicle to get there but if the road is better you can actually take them there, you can actually take them a little bit off the beaten track. Then there are less tourists in the crowded places, so it's better to let us take them somewhere else. Not all at the same place. Spread them out a little bit.

Thus, making new areas more accessible to tourists might increase opportunities for people travelling in the area and reduce environmental pressure on popular tourism destinations in the Central Highlands.

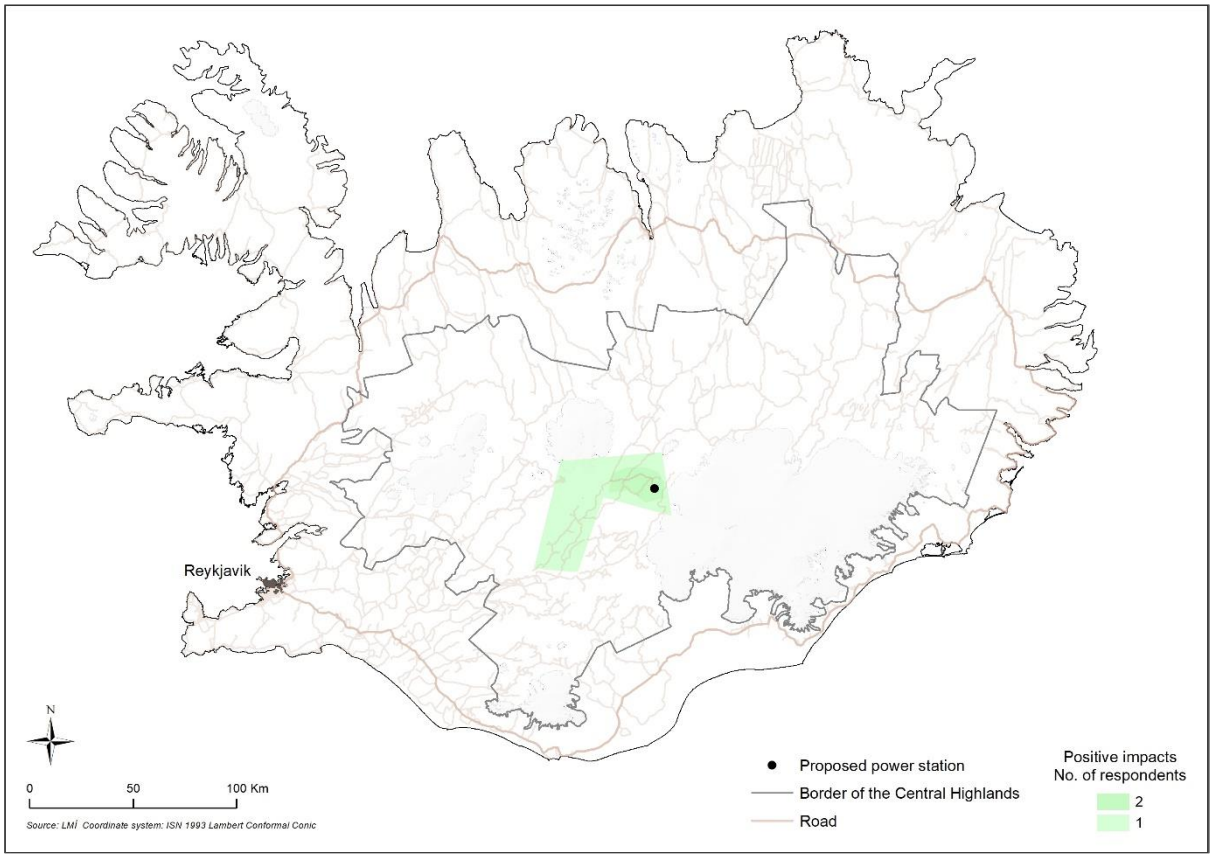

Figure 15. Perceived positive impact areas of Hágöngur Geothermal Power Plant on tourism.

Hágöngur Geothermal Power Plant: mixed/neutral impact areas

One participant described the impacts of the proposed Hágöngur Geothermal Power Plant as mixed (Figure 16). The impact area estimated by this participant included the area in which tourism travel patterns would be changed due to the construction of the power plant: *"People who are travelling around Hella and Selfoss in the south, they will venture further inland, so they will probably stay at accommodation options in this area. I think it will have a positive impact for accommodation providers."*

On the other hand, the participant questioned the need for one more power plant in the Central Highlands and the purpose of energy production, and emphasized that it affects tourists' attitudes toward power plants in Iceland:

> I think any power plant built just to support heavy industry is a net negative because we don't need it. It's not for tourists and it's not attractive and again, because we were always honest with people telling them how it works, then they are disappointed in our approach to energy. But the side effects of the roads and being able to visit new places are going to be positive. So, I fall somewhere in the neutral zone.

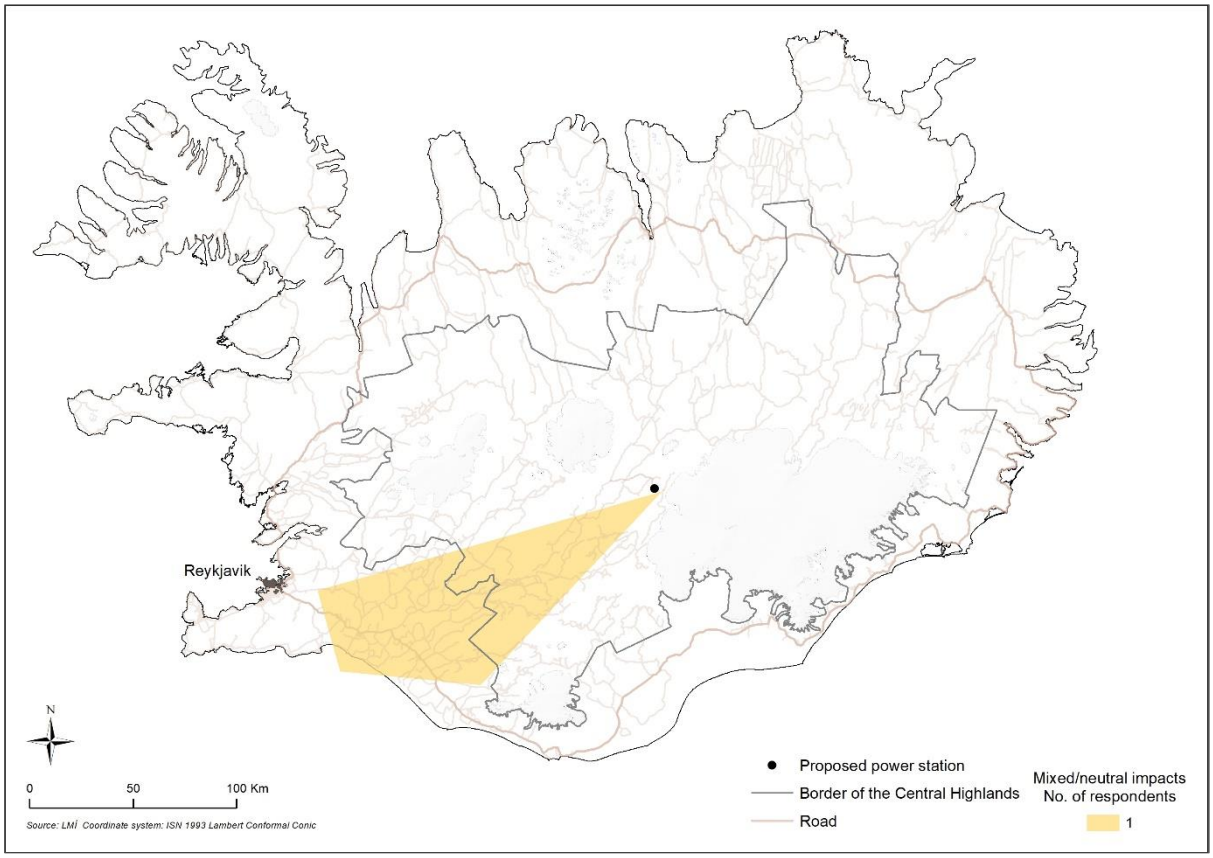

Figure 16. Perceived mixed/neutral impact areas of Hágöngur Geothermal Power Plant on tourism.

Búrfellslundur Wind Farm

The largest proportion of all participants, a total of 21, estimated the impact area of the proposed Búrfellslundur Wind Farm on tourism. A majority of them (18) perceived the impacts of the proposed wind farm as negative. The size of the perceived negative impact areas varied widely, from 70 km^2 to 8,366 km^2, with a mean size of 2,559 km^2 and median of 2,247 km^2 (Table 8). Two participants estimated mixed impact areas. These areas were very similar in size at 304 km^2 and 316 km^2. One participant focused on positive impacts while estimating the impact area, which was 131 km^2 in size.

Table 8. Perceived impact areas of Búrfellslundur Wind Farm on tourism.

Character of the impact	Number of impact areas	Range of the size of the impact areas (km²)	Mean size of the impact areas (km²)	Standard deviation	Median
Negative	18	70–8,366	2,559	1,838	2,247
Mixed	2	304–316	310	9	310
Positive	1	-	131	-	-
Total	21	70–8,366	2,229	1,886	2,219

Búrfellslundur Wind Farm: negative impact areas

A total of 18 participants perceived the impacts of the proposed Búrfellslundur Wind Farm as negative (Figure 17). Although the wind farm would be built close to the existing Þjórsá-Tungnaá Hydropower Plants, numerous participants emphasized the high visibility of the wind farm which would negatively affect the wilderness experience of visitors. So, despite being located in the area with existing hydropower plants, due to its high visibility the wind farm would change the appearances of the landscape to a far greater extent:

> There are several things in there, there're powerlines and there are canals with water for the power plants. But it's mostly on the surface and the powerlines are now the highest structures. With the wind farm, you have up to 150-meter high constructions. So, it's going to be much more visible, so it's definitely going to disturb the tourism that is now going on at the edge of this area.

Participants using the nearby areas for their business emphasized that visual and noise pollution caused by the proposed wind farm would degrade the experience of their customers, lowering the value of these areas and reducing the opportunities for the tourism industry:

> It would be something man-made destroying the options of this area and it's actually quite a valuable area because of Háifoss and Gjáin and all that. It's an important destination for us and I would be very much against this being put there and I would be very sad to hear thirty windmills in this area because it's in the Highlands.

Moreover, participants who drive their customers though the area with the proposed wind farm also emphasized that the wind farm would be visible for a long time on the way to popular tourism destinations of the Central Highlands such as Fjallabak Nature Reserve. That would reduce the quality of the tours they are selling which rely on nature experience, and therefore the proposed wind farm would not fit with the product they are offering.

Visibility of the proposed wind farm was the main argument for eight participants while estimating the negative impact areas of the proposed Búrfellslundur Wind Farm on tourism. While all these participants agreed that the wind farm would negatively impact visitor experience and the attractiveness of the area, some of them were not sure whether those impacts would be strong enough to lead to the avoidance of the area. Several participants, however, stated, that this would be the case, since nature experience is their main product and it would be destroyed in the

surrounding areas if the wind farm would be built. One participant emphasized that the impact area she estimated is the area which would be avoided due to visual impacts of the wind farm:

> If it turns out to be really ugly and I can feel from my clients that I get negative feedback, I will avoid it. I will still go to Landmannalaugar but I will choose a different way to get there. (…) But we also have a lot of clients that stay 10 to 12 days that are just high-end VIP clients that are driving and want to see everything, then I would take them there. Then it would be part of the trip, just to show them how stupid this is.

For ten participants, the negative impacts of the proposed wind farm would stretch much further than its visual impacts. Many of them drew an impact area stretching over a large part of the southern Highlands and two participants included large parts of the Sprengisandur Road (Figure 17). According to nine participants, the size of the impact area would depend on tourist mobility, since the impacts of the proposed wind farm on the visitor experience would reach further than visual impacts. One participant stated that the impacts on the experience would last for a day:

> I think the whole big area would be affected because it is not that people are driving to one place to see it. On a whole day people could visit the area, then this will always be a part of what they discovered on the day. (…) I think it would change and spoil the experience of people visiting this unspoiled nature so far.

Other participants emphasized that the experience of the whole trip would be affected. According to them, the proposed power plant would be located *"at the entrance to the heart of the Highlands."* Many popular tourism destinations and recreational areas in the Central Highlands are accessible via the road which would pass by the proposed wind farm. Thus, the tourist flow in the area is relatively high and visitor experience in many of these areas would be negatively affected:

> [The impacts] would reach the ones that are going up from Búrfell definitely – the ones that are going to Gjáin, to Háifoss, the ones that are going across to Sprengisandur and over to Fjallabak Nature Reserve which is the Landmannalaugar area, the ones that are going for a trip up Hekla, both Hekla and Veiðivötn and all of that area. It would definitely affect the people going to these areas.

As pointed out by the participants, the wind farm would change the image of the tourism destinations in the Central Highlands, the visitors of which would need to travel past the wind farm. One of such popular places is Fjallabak Nature Reserve: *"I think it will impact what we think of Fjallabak. And, you know, probably further north, further south. If you come from this area into the Fjallabak area, there will be impact."*

Some of the participants pointed out the impacts the wind farm would have on hiking tours in the area. They stated that the wind farm would not fit the unique nature experience hikers have in the surrounding areas. They mentioned the famous Laugavegur hiking trail, which starts or ends in Landmannalaugar, usually accessed by driving past the area of the proposed wind farm:

> Tourists, I don't know in how many tens or hundreds of thousands hike the Laugavegur. People come here just because they have read on Lonely Planet about the Laugavegur Trail. (…) People come to the area on the way to this magnificent nature experience, and the first thing they experience on their trip when they get up above Búrfell for the next 45 minutes is a giant wind farm. (…) What happened to nature?

Laugavegur Trail would not be the only hiking route which would be negatively affected by the proposed wind farm. The Hellismanna Trail would, for example, be seriously damaged and probably the first day would simply be cut off, as it is too close to the wind farm. As emphasized by the participants, the hikers would feel that they are hiking in an industrial area if the wind turbines would be in sight. Such infrastructure would even destroy the experience of the entire hiking route. Another of such routes, according to one participant, is the hiking trail that starts in Keldur in Rangárvellir, stretches via Áfangagil and Landmannahellir, and ends either in Landmannalaugar or in Dalakofinn.

One of the nine participants who based their argumentation on tourist mobility while estimating the impact area of the wind farm included part of south Iceland. According to him, most tourists visiting the southern Central Highlands do so as part of the south Iceland tour; thus, the experience of the entire tour would be affected. Moreover, the participant emphasized that such a wind farm would also affect how tourists remember their trip and would be reflected in their discourse of the destination after the trip.

The reasoning behind one negative impact area was based on the changes to tourists' travel patterns that the wind farm might bring. Besides visual impacts which might lead to avoidance, the participant also considered roads which might potentially be improved in the surrounding areas due to construction of the wind farm. The participant emphasized that improved access and higher traffic to the nearby areas such as Gjáin would lead to negative environmental impacts, since Gjáin is very sensitive to trampling.

Several participants emphasized that once the wind farm is built, it is likely to be extended, so the impacts on tourism would most likely increase in the future: *"And we know that they will want to make it bigger. Once they have this installed, it will grow."*

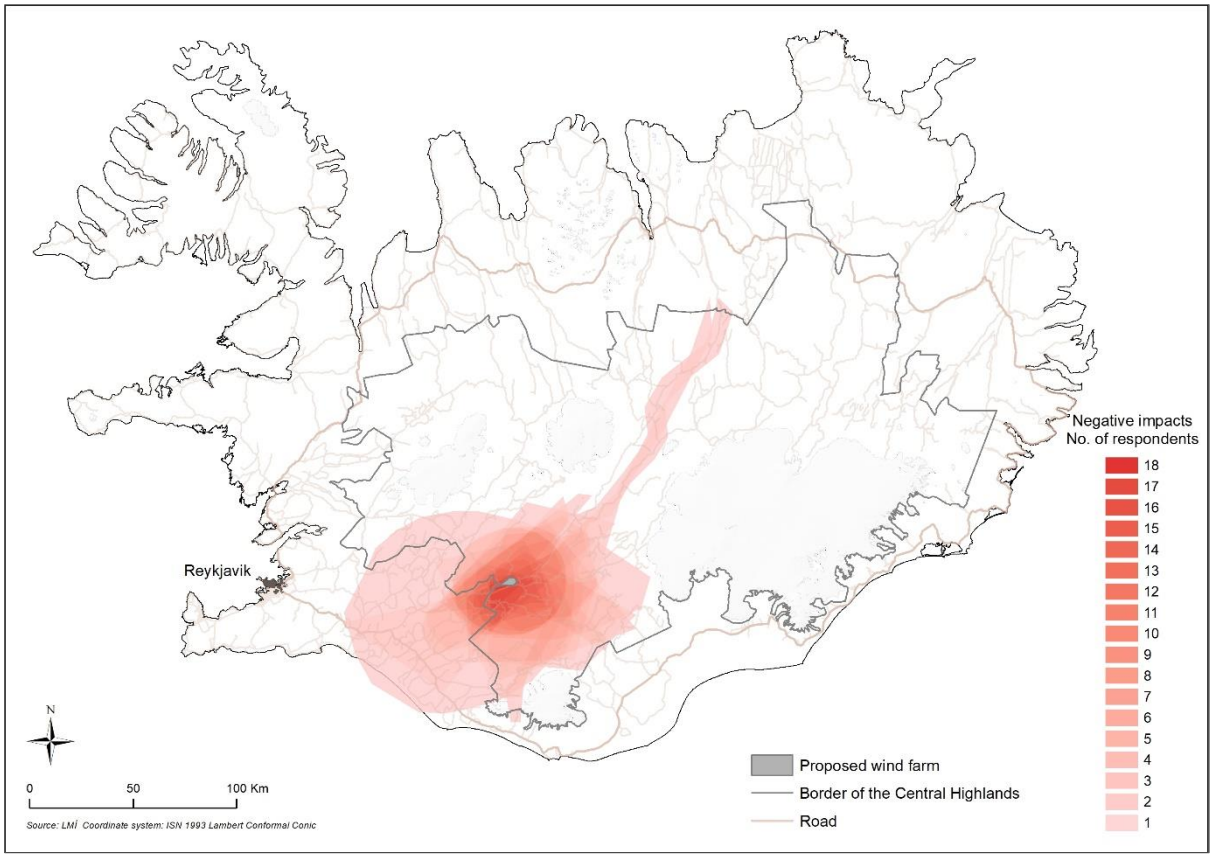

Figure 17. Perceived negative impact areas of Búrfellslundur Wind Farm on tourism.

Búrfellslundur Wind Farm: mixed impact areas

Two participants estimated mixed impact areas of the Búrfellslundur Wind Farm (Figure 18). The argument for the size of the impact area for both of them was the visibility of the proposed wind farm. They emphasized that due to high visibility, the wind farm would impact tourism, but the character of these impacts would depend on various factors. According to one participant, Icelanders are likely to be more impacted since foreign visitors are more used to wind farms than Icelanders:

> I guess the impact area would be around Hekla and Búrfell, simply where you start to see them. But to be honest, I think that it would have more impact on Icelanders than on foreign visitors, because most of them are very used to windmills and windmill yards.

Another participant pointed out that foreigners do not come to Iceland to see windmills, they come for nature. Both participants, however, agreed that the perceptions of the proposed wind farm by tourists would strongly depend on how the wind farm would be presented by their guide:

> I would explain we are simply using the areas that have already been managed with power plants. We had everything in place, the power grid is in place, and it's an area heavily managed by humans, so… Let's go for it. And the fact is that windmill yard works beautifully with the water dams and hydropower plants, and when the windmills are producing full blast, the power company can save water in the water dams. So, less need for water gathering, means more

> water in the rivers. We have beautiful waterfalls down river in Þjórsá, Tröllkonuhlaup, and Þjófafoss. Last week they were dry, both of them.

One participant also emphasized the importance of making information about renewable energy harnessing in Iceland available to independent tourists travelling in the country to ensure a positive experience of the wind farms and of other energy infrastructure in the country. Such information should be available online: *"I think we should use internet to express our views, it is not done on paper anymore."*

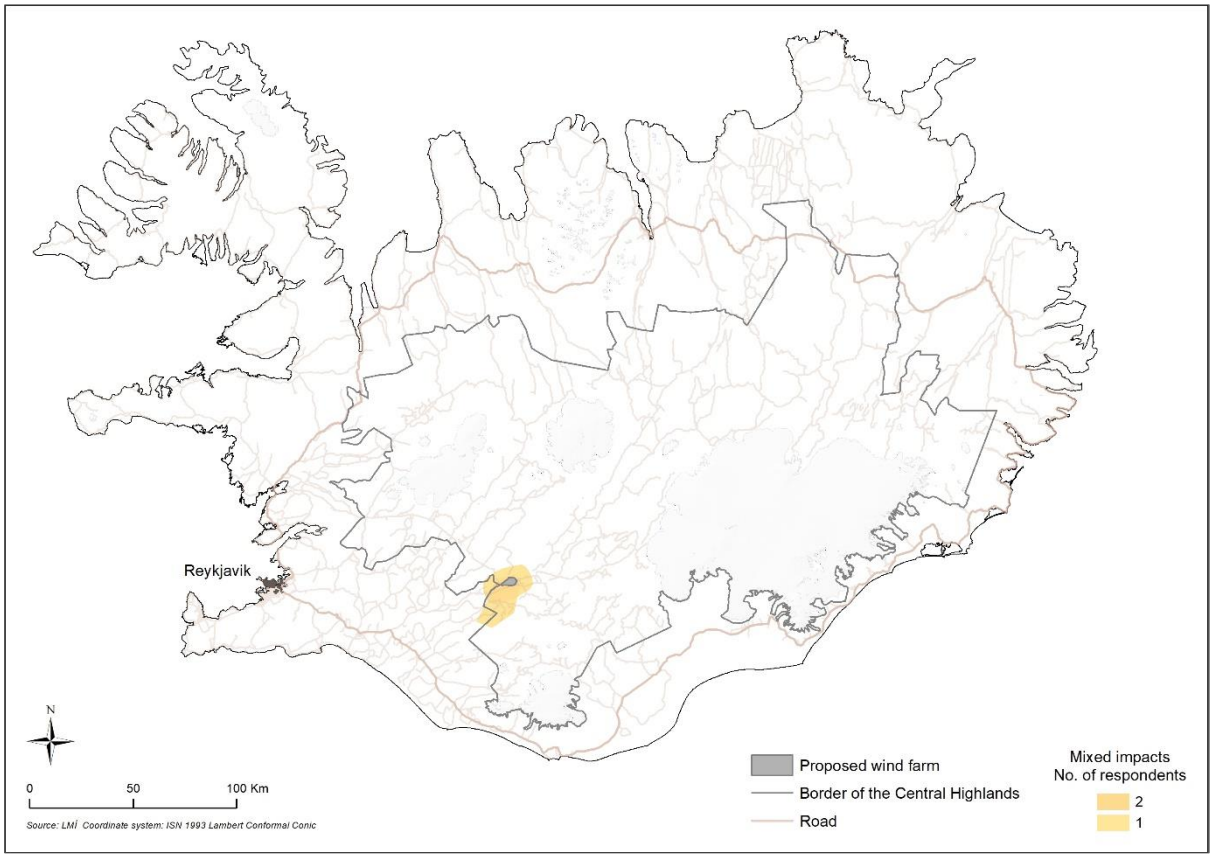

Figure 18. Perceived mixed impact areas of Búrfellslundur Wind Farm on tourism.

Búrfellslundur Wind Farm: positive impact areas

One participant perceived the impacts of the proposed Búrfellslundur Wind Farm on tourism as positive (Figure 19). The argument for his perceived impact area was the visibility of the wind farm, which, according to him, would not have negative impacts on visitor experience:

> Probably with 150-meter-tall structures it would be visible from quite far. But I don't think it's in any way obstructing the view. I think it actually could be an interesting sight on its own, especially for Icelanders. And there are so much manmade structures around, I don't think it would bother anybody. Adding on top of what is there, I don't think it's going to make a huge difference. Plus, you have just come from the farmlands down there in Þjórsárdalur and further up there are more manmade structures, the Highland Centre and other energy plants, so I think people are well aware that they are in boundaries of the electric grid.

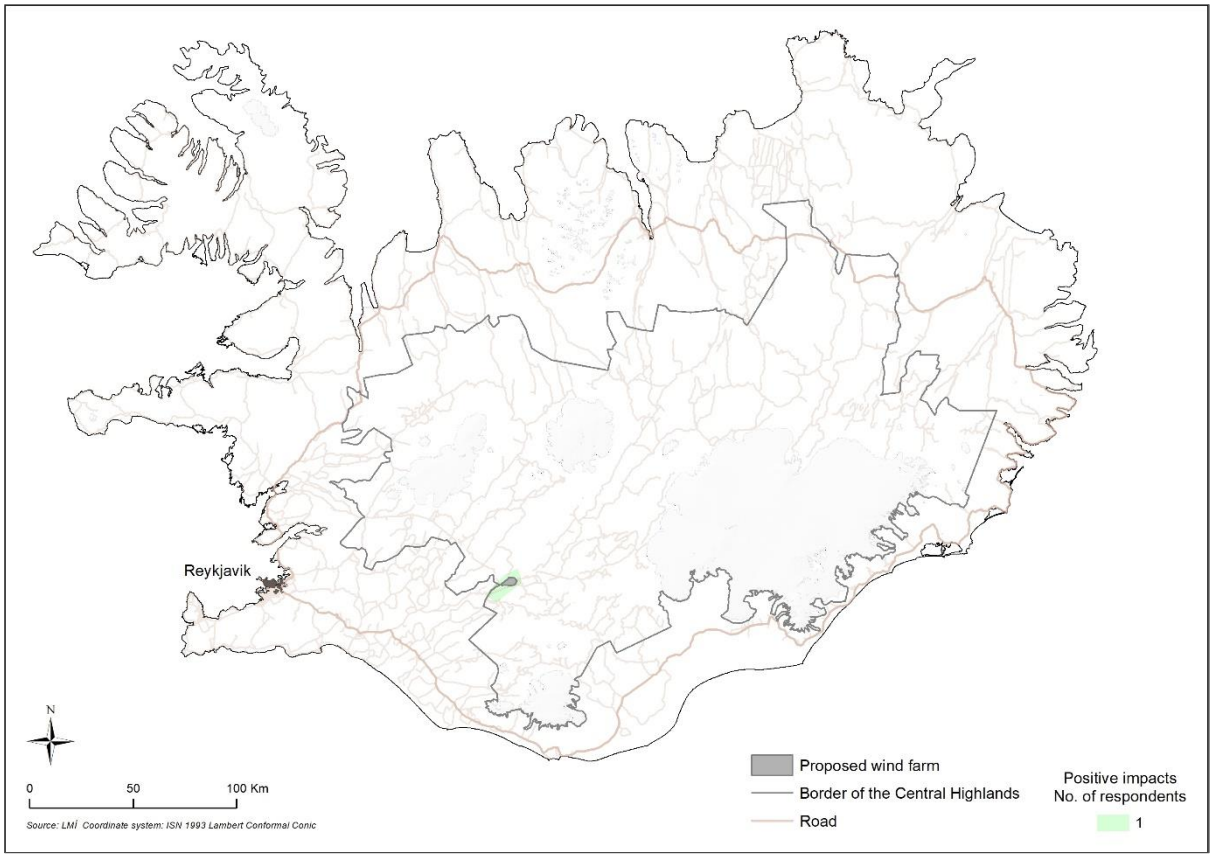

Figure 19. Perceived positive impact areas of Búrfellslundur Wind Farm on tourism.

4.3 Factors affecting the character and the spatial extent of the perceived impacts of renewable energy infrastructure on tourism

4.3.1. Factors affecting the character of the perceived impacts of renewable energy infrastructure on tourism

The interviews revealed that the impacts of proposed energy projects on tourism were perceived by the tourism industry as more negative than the impacts of the existing power plants. The proportion of participants who described the impacts of proposed power plants as negative was 80% or higher, depending on the project. These numbers were much lower while discussing the impacts of the existing power plants. The proportion of participants who perceived impacts of existing power plants as negative ranged between 6% and 17% (Table 9).

As pointed out by some participants, the existing power plants are already there, so people have to accept them. Moreover, in most cases the existing power plants were constructed before the participants started operating their tourism businesses. Therefore, participants adapted their businesses to the existing energy structures. Several main ways of adapting to the existing power plants were pointed out by the participants: avoidance of the area if possible, use of the roads and bridges built for the power plants, presenting the power plants to their customers as a source of

renewable energy, essential for Iceland's environmental sustainability, and including power plants in the tours for educational purposes. Some of the participants use all these adaptation strategies. How they deal with REI depends on numerous factors, including the length of the tour (participants stated that they are more likely to include visits to power plants during longer tours), interests and preferences of the customers, and weather (during bad weather, a power plant's visitor center might become a valuable feature of the tour).

While discussing the negative impacts of the proposed power plants, most participants questioned the need for further energy development in natural areas of the Central Highlands and the purpose of increased energy production. According to the participants, these aspects are important to their customers, and they might be decisive in how tourists would perceive the new energy projects. Moreover, participants emphasized that it is hard for them to positively present energy projects to their customers when they themselves are not informed about why such projects are really needed. As stated by one participant:

> If I have a day tour, for example, I would maybe focus more on the nature. But if I have a multiday tour I might squeeze in the educational part with the windmills and drive through and tell them why we did it, why we needed it. But if I don't have the why I can't sell it. Then it would just be a negative talk on my side. I can do it with the existing hydropower plants there because I know that we need them, but it's a hard thing for me to sell if I don't know the reason why we are putting it up.

The discussion about how the tourism industry deals with the existing and proposed REI was well summarized by a participant running an accommodation and touring company close to one of the existing energy projects. He emphasized that there is no pressing need for more energy production, which allows for better planning of future energy infrastructure development:

> We don't have any other alternatives than to accept [the power plants] like they are there, same with the tourists. It's easy to answer of course, why is Reykjavík so clean, why do you never see any smoke? It is because we have clean energy and we heat our houses either with electricity or hot water and then the next question is of course, where is the energy coming from? But today we have enough energy and we can afford to be careful how we plan the future.

Another important factor affecting how the participants perceived the impacts of REI on tourism was the character and the image of the surrounding areas. The vast majority emphasized that the impacts of REI on tourism are most profound in natural areas perceived as wilderness. Power plants transform natural areas into industrial areas, reduce their attractiveness to visitors coming for wilderness experience, and their value for tourism businesses. Participants stated that wilderness areas are steadily decreasing, which makes them extremely valuable for the tourism industry. According to the participants, REI situated close to developed areas is likely to be perceived more positively by tourists. For example, while discussing the Krafla Geothermal Power Plant, one participant emphasized how the location close to a village affects people's perception of the power plant and of the picturesque tourist sites located nearby:

> People going into Leirhnjúkur don't leave Leirhnjúkur with a bad perception of the area even though they had to drive through an industrial area, but then again it's at the doorstep of a little village, and there is a lot of development in the area, so the perception of the area is not that we are in the wilderness area. It is just a developed area. And that, you know, when you go into Hágöngur, it's a different story, and if you go into Þeistareykir, it's a different story.

Participants' perception of suitability of the proposed Hágöngur Geothermal Power Plant in the planned location was very different, since the area was described by the participants as wilderness: *"That is a terrible idea, because it is a very isolated area, it is remote. We should think about areas that have already been damaged in some sort. We should not put power plants in unspoiled areas."*

While discussing the impacts of the existing power plants on tourism, a higher proportion of participants (56%) perceived the impacts of Blanda Hydropower Plant as positive, 31% estimated positive impact areas of Krafla Geothermal Power Plant, and 28% of Þjórsá-Tungnaá Hydropower Plants (Table 11). One of the reasons for high acceptance of the Blanda Hydropower Plant besides the improved salmon fishing opportunities was the location, thought as optimal due to the monotonous landscape of the surrounding areas and the absence of unique tourist attractions. Thus, beauty, diversity, and uniqueness of the landscape of the area are important factors affecting the character of perceived impacts of REI on tourism. The power plants were perceived by the participants as more suitable in monotonous landscapes of low scenic value, while picturesque areas containing diverse or unique landscape features were perceived as needing to be protected from energy infrastructure development.

The participants pointed out that the three types of energy infrastructure impact tourism differently. Participants mentioned that hydropower plants in Iceland are generally well designed and fit well into the surrounding landscape, thus their visual impacts are relatively low. Moreover, reservoirs are often perceived by visitors as natural lakes. However, waterfalls may disappear, and power plants require flooding of large areas, thus their environmental impacts, which might affect tourism, are rather high. Some participants also pointed out that hydropower plants tend to have lower tourist attraction potential than the geothermal power plants, since tourists coming to Iceland are more likely to be familiar with hydropower from their home countries.

Geothermal power plants, on the other hand, were perceived by the participants as highly impacting the surrounding landscapes due to their intrusive infrastructure stretching over large areas in addition to the steam which might be visible from far away. Their tourist attraction potential, however, was often described as relatively high:

> These geothermal power plants have a kind of that special status. You don't have geothermal power plants all around the world. There are in some places and there are here. So, it's kind of exciting to see one, but when you've seen ten, you know, it changes. So, as long as they are not too many, they are kind of exciting to see.

The high visibility of the wind turbines, which change the scenery and perception of surrounding areas for many kilometers, was the main concern regarding development of wind farms in the Icelandic landscapes in the future. Due to the importance of the natural appearance of landscapes for the tourism industry, some participants were worried that if a wind farm would be built, it would later be extended. The participants did not think that wind farms in Iceland have high potential to become tourist attractions since tourists are used to seeing them in their home countries. There was, however, no general agreement as to whether foreign visitors familiar with wind turbines from their home countries would have a higher or lower acceptance of wind farms in Icelandic landscapes.

4.3.2 Factors affecting the size of the perceived impact areas of renewable energy infrastructure on tourism

The data collected during the interviews did not reveal any connection between the size of the perceived impact areas and specific power plants or the type of energy infrastructure (Tables 9, 10, 11). No differences in the size of the perceived impact areas were observed among different types of businesses or their location. Thus, the size of the perceived impact areas of REI on tourism estimated in this study depended on the participants' perception and on the reasoning behind the perceived impact areas. The arguments used while estimating the impact areas, whether they were seen as negative, mixed/neutral or positive, were partly different and partly overlapping. The arguments common to all three types of impact areas included visibility of the power plant infrastructure and of its broader environmental impacts, tourist mobility, and changes in tourist movement/travel patterns brought about by REI.

The impact areas which were solely based on the visibility of REI and of its environmental impacts were in most cases relatively small. The perceived size of such impact areas depended on the type of REI, the design of the power plant and the parts of the infrastructure which were taken into consideration. For example, participants who considered visual impacts of the power lines or of the steam emitted by a geothermal power plant tended to estimate larger impact areas than those who only focused on the visibility of the power plant infrastructure located on site. The type and topography of the surrounding landscape was also taken into consideration by the participants, since it affects how far from the power plant its infrastructure can be seen and consequently the size of perceived impact area. Participants who used visibility as an argument while estimating negative impact areas stated that REI visually impacts the surrounding landscapes and changes the areas from natural to industrial. These changes degrade tourist experience, alter the perception of the areas, and consequently reduce the tourism industry's opportunities in the surrounding areas. According to the participants who used visibility as an

argument while estimating mixed impact areas, REI alters the surrounding landscapes; however, whether REI and the changes it brings about are perceived positively or negatively by tourists depends on various factors, including tourists' familiarity with the type of REI and the narrative used by the guide to communicate information about sustainable energy production in Iceland. Participants who estimated positive impact areas based on visibility stated that such infrastructure adds diversity to the landscape.

Some of the participants who stated that the impacts of REI on tourism extend beyond visibility took into consideration tourist mobility. According to the participants who estimated negative impact areas based on tourist mobility, REI affects visitor experience for an entire day or during the entire trip. Moreover, participants stated that the perception of tourist sites reached by driving through areas containing REI is also likely to be altered. Thus, the impact areas depend on where tourists are going, and what kind of experience they are looking for. Especially affected by such infrastructure is the experience of hikers passing REI. Accordingly, if a power plant is built in the middle of a long hiking trail, the image, value, and future potential of the whole trail is likely to be negatively affected.

Therefore, REI is likely to lead to changes in how and where tourism companies organize their tours. According to participants who estimated negative impact areas, power plants are likely to reduce the attractiveness of tourist sites located nearby; consequently, tourists have fewer attractions to visit, which might lead to shorter stays, less demand for tourism services in the region, and subsequent regional economic losses. Participants who considered changes in tourist movement and travel patterns while estimating positive impact areas mentioned improved access due to the construction of roads for the power plants, which opens up new areas for tourism and allows more people to visit nature destinations that were previously difficult to access. However, participants who estimated mixed impact areas stated that improved access, besides its benefits for tourism, might also have a negative side: increased visitor numbers put more environmental pressure on natural areas and are likely to change the perception of such areas. Some participants who estimated positive impact areas considered the tourism attraction potential of the power plant in question. They included in their estimated impact areas the regions wherein tourists would have one more site to visit during their trip. Another argument related to changes in tourist movement, used by the participants who estimated positive impact areas of Blanda Hydropower Plant, was the improved opportunities for salmon fishing which attract foreign and Icelandic fishing enthusiasts. Thus, construction of a power plant can also bring unexpected changes to the surrounding areas which can affect tourism in various ways.

Table 9. Negative impact areas of all six energy projects on tourism.

	Power plant	No. of impact areas	No. of all impact areas	%	Mean size	Standard deviation	Median
Existing	Blanda Hydropower Plant	1	18	6%	640	-	-
	Krafla Geothermal Power Plant	1	13	8%	548	-	-
	Þjórsá-Tungnaá Hydropower Plants	3	18	17%	5,423	3,160	6,336
Proposed	Hrafnabjörg Hydropower Plant	16	20	80%	4,361	9,432	1,447
	Hágöngur Geothermal Plant	12	15	80%	3,238	3,312	2,729
	Búrfellslundur Wind Farm	18	21	86%	2,559	1,838	2,247

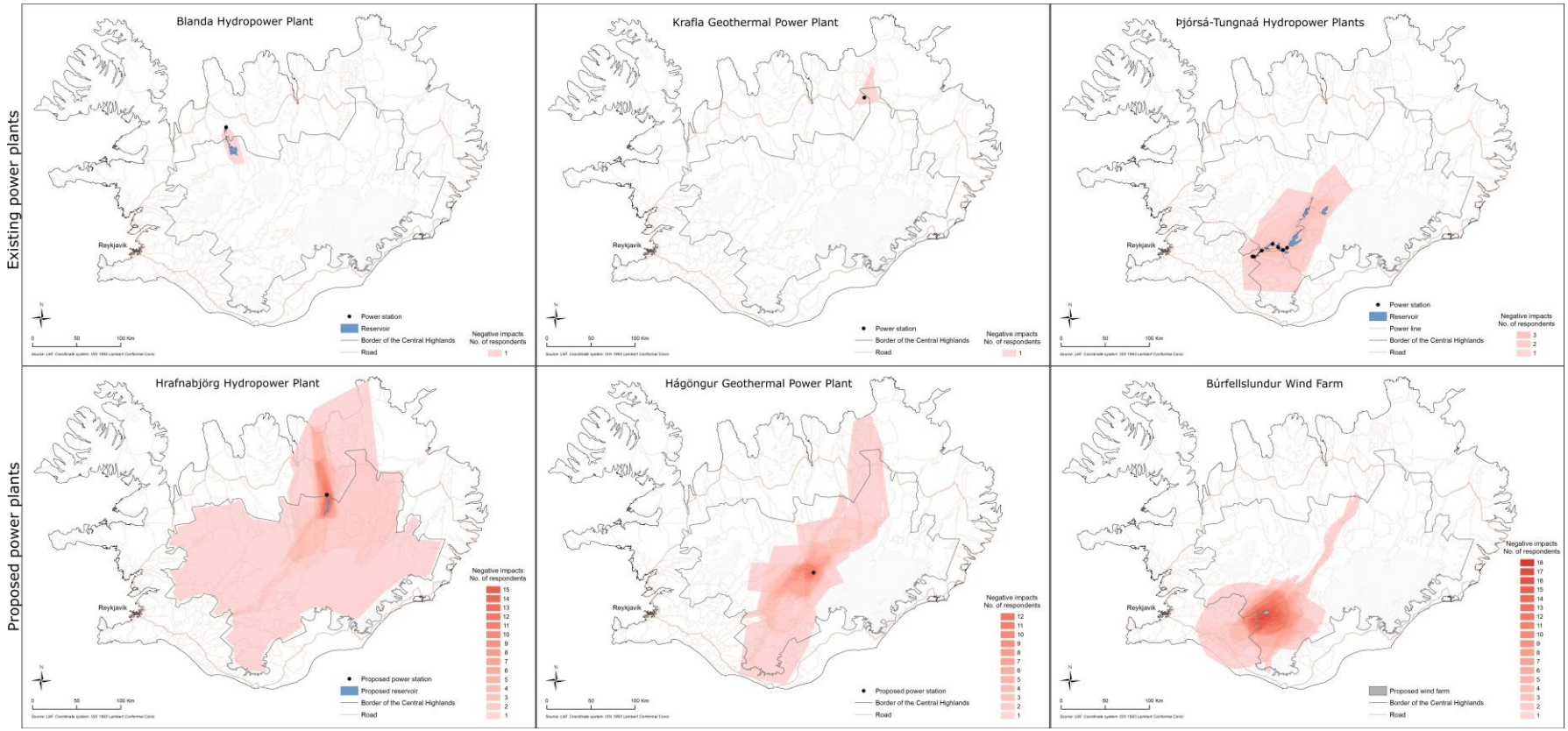

Figure 20. Negative impact areas of all six energy projects on tourism.

Table 10. Mixed and neutral impact areas of all six energy projects on tourism.

	Power plant	No. of impact areas	No. of all impact areas	%	Mean size	Standard deviation	Median
Existing	Blanda Hydropower Plant	7	18	39%	1,012	967	531
	Krafla Geothermal Power Plant	8	13	62%	765	764	482
	Þjórsá-Tungnaá Hydropower Plants	10	18	56%	3,139	2,258	2,158
Proposed	Hrafnabjörg Hydropower Plant	3	20	15%	7244	327	7,419
	Hágöngur Geothermal Plant	1	15	7%	6,983	-	-
	Búrfellslundur Wind Farm	2	21	10%	310	9	310

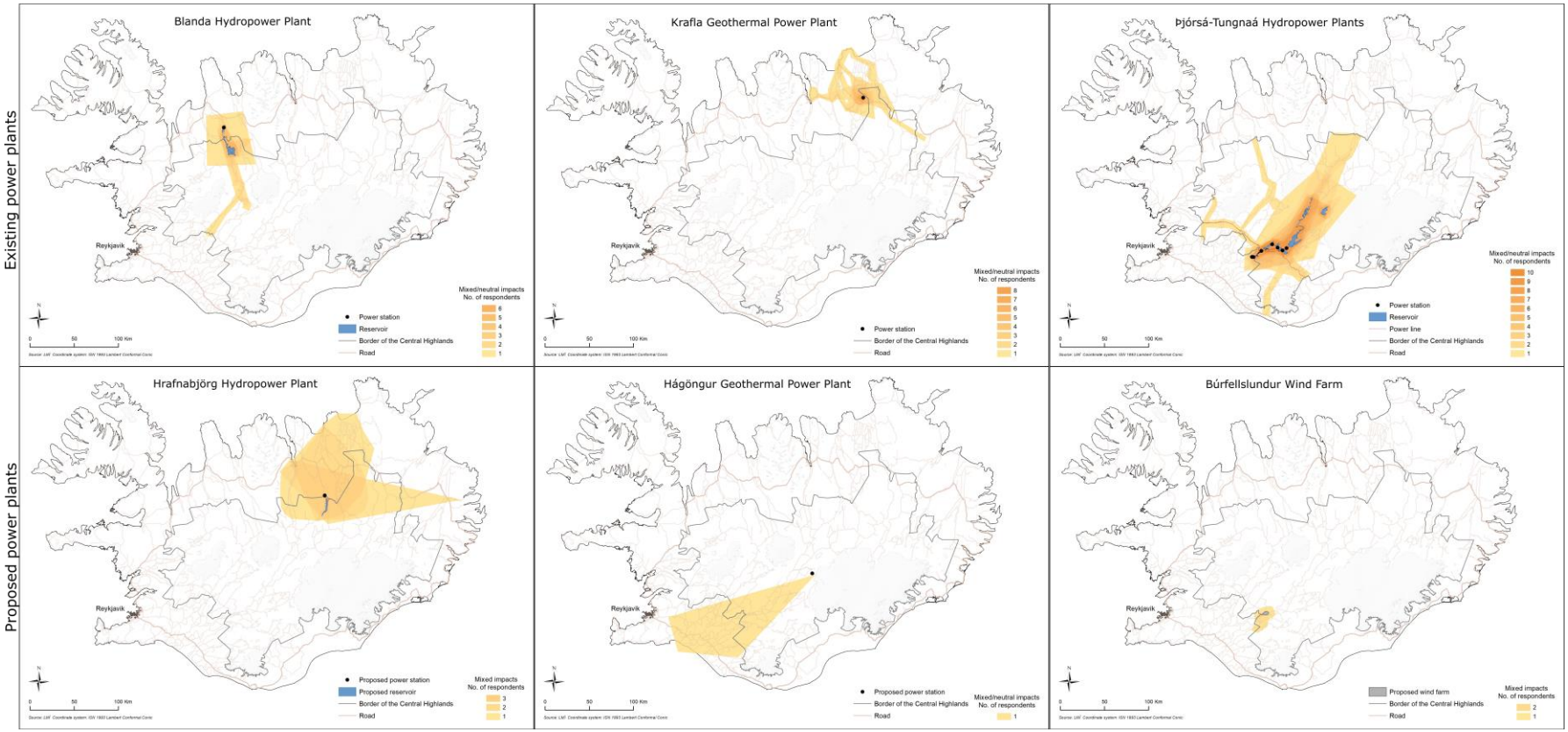

Figure 21. Mixed and neutral impact areas of all six energy projects on tourism.

Table 11. Positive impact areas of all six energy projects on tourism.

	Power plant	No. of impact areas	No. of all impact areas	%	Mean size	Standard deviation	Median
Existing	Blanda Hydropower Plant	10	18	56%	2,768	5,264	685
	Krafla Geothermal Power Plant	4	13	31%	4665	8,038	265
	Þjórsá-Tungnaá Hydropower Plants	5	18	28%	10,284	12,020	5,356
Proposed	Hrafnabjörg Hydropower Plant	1	20	5%	36	-	-
	Hágöngur Geothermal Plant	2	15	13%	1,160	1,183	1,160
	Búrfellslundur Wind Farm	1	21	5%	131	-	-

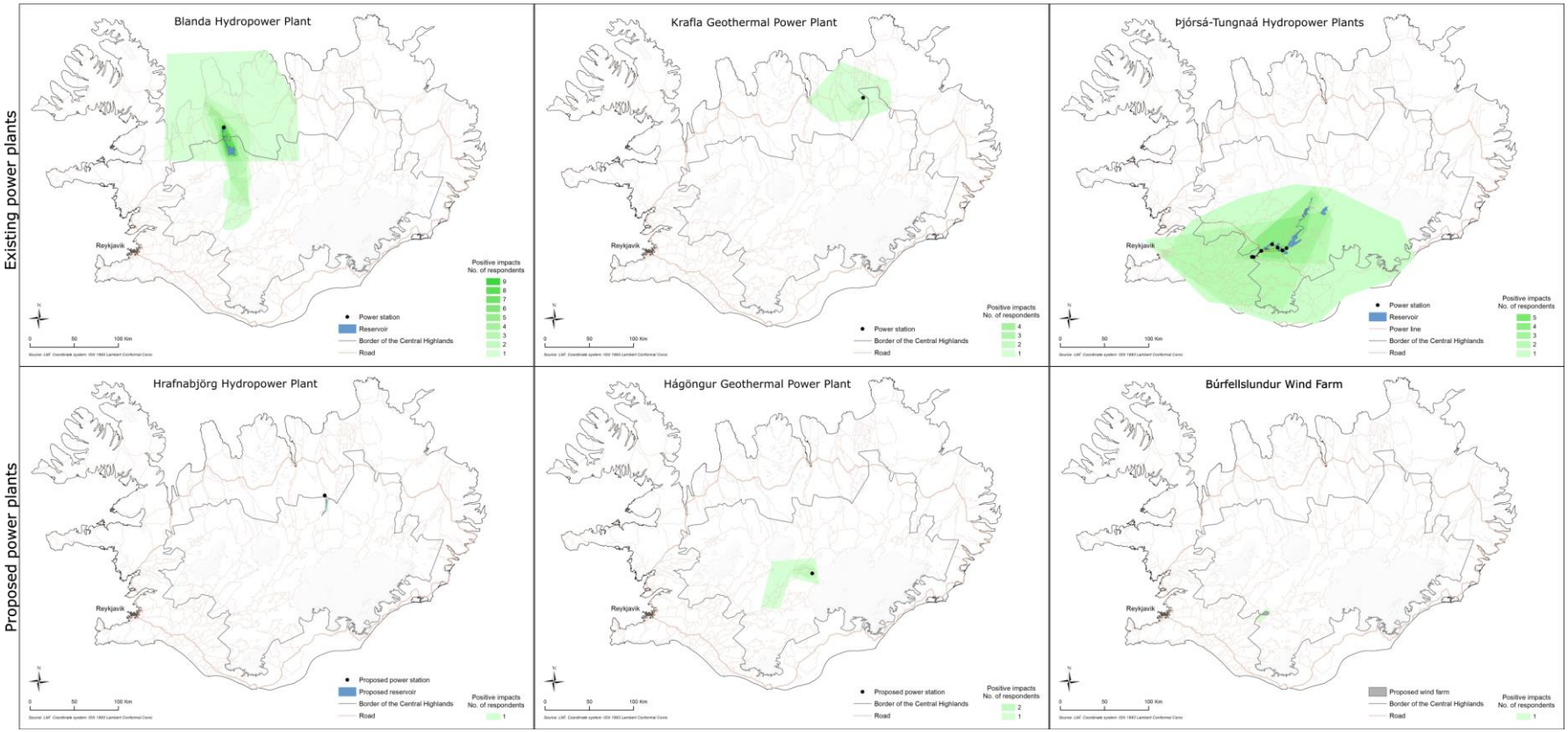

Figure 22. Positive impact areas of all six energy projects on tourism.

5 Discussion and conclusions

The present study provided in-depth knowledge on the perceptions of the tourism industry regarding the spatial extent of the impacts of REI on tourism. This was achieved by incorporating the use of participatory mapping software into interviews conducted with the managers of tourism companies operating near the areas of the existing and proposed power plants. Various researchers have pointed out the benefits of using participatory GIS for the mapping of stakeholder perceptions and meanings assigned to places (Moore et al., 2017; Ruiz-Frau et al., 2011) as well as the mapping of potential conflict areas (Brown & Raymond, 2014). Thus, participatory GIS has been proven to be a valuable tool for tourism planning (e.g. Kantola et al., 2018). In this study, it allowed participants to map perceived impact areas of REI on tourism while discussing the reasoning behind such maps. Although the participants who estimated the impact areas were very knowledgeable about the areas they use for their businesses and were aware of the impacts of REI on tourism, estimating the spatial extent of these impacts was new to them and often not easy. It required identification of the factors which participants perceived as affecting the size of the impact areas of REI on tourism. The arguments given by the participants which affected the size of the perceived impact areas can be roughly divided into three main categories: visibility of the REI and its environmental impacts, tourist mobility, and changes in tourist movement and travel patterns brought about by REI. The size of the impact areas based on visibility was affected by factors such as the type (hydro, geothermal, or wind) and design of the power plant infrastructure as well as characteristics of the surrounding landscape affecting the visual impacts of the power plant. The size of the impact areas based on tourist mobility depended on the tourists' expectations and preferences, mode of travel, the routes they take, the tourist sites they visit, the tourism infrastructure they use, and other factors which define where visitor experience would be altered due to encounters with REI and where perception of the areas would be affected. The size of the impact areas based on the changes in tourist movement and travel patterns depended on areas where tourist traffic and consequently the demand for tourism services would decrease due to degradation of the tourist sites, or conversely, would increase due to improved roads or visits to the power plant as a tourist attraction. Some estimated impact areas included both negative and positive changes in tourist movement and travel patterns, for example, avoidance of certain degraded areas and visits to new areas which opened up due to the roads and bridges constructed for the power plants. Thus, the impact areas

of REI on tourism estimated by the tourism industry are site- and project specific and depend on the arguments used by the participants.

The study further revealed that the conflicts between REI and tourism are more likely in natural areas which are perceived as wilderness. Scenic areas of high wilderness value containing important tourist attractions were viewed by the tourism industry as the least suitable for REI development. According to the participants, the perception of such infrastructure in wilderness areas would be the most negative due to dramatic transformation of the landscape and of the image of the area. Participants emphasized the importance of large wilderness areas for the quality of the tourist experience, and majority of them stated that REI would be more suitable in already developed areas of an industrial character where no wilderness value would be destroyed. Such findings are supported by previous studies analyzing the preferences of tourists and locals regarding the placement of energy infrastructure (Frantál & Kunc, 2011; Ólafsdóttir & Sæþórsdóttir, 2019; Sæþórsdóttir et al., 2018; Tverijonaite et al., 2019; van der Horst, 2007).

The present study contributed to the existing knowledge regarding the character of the perceived impacts of REI on tourism and the factors affecting it. The results showed that the attitudes of the tourism industry toward proposed but not yet built power plants were much more negative than attitudes toward existing power plants. These findings are in line with previous research showing higher acceptance of existing power plants among visitors compared to plants which would be built in the future (Brudermann et al., 2019; Sæþórsdóttir & Hall, 2018; Sæþórsdóttir et al., 2018). Brudermann et al. (2019) suggested that this can be explained by the phenomenon of *status quo bias* (Samuelson & Zeckhauser, 1988), meaning that people tend to prefer the current state of affairs over change. This phenomenon can partly be explained by the *loss aversion bias*, or people's tendency to assign more importance to not losing something they have than to gaining something new (Samuelson & Zeckhauser, 1988). Such an explanation seems reasonable in the case of the attitudes of the tourism industry toward existing and proposed power plants. Participants of the study emphasized the importance of natural areas for their businesses and stated that REI transforms natural areas into industrial ones and degrades visitor experience; therefore, they tend to oppose the future development of such infrastructure.

The interviews revealed differences in the perception of the hydropower, geothermal, and wind power infrastructure by the tourism industry. While hydropower plants are likely to be perceived as suiting the surrounding landscapes, their environmental impacts due to flooding of large areas, as well as reduced waterflow in the rivers can strongly impact tourism. In line with other studies viewing geothermal power plants as tourist attractions (e.g. Beer et al., 2018), this study revealed that the tourism industry perceived the geothermal power plants as the most

interesting to tourists among the three REI types due to their rarity and interesting infrastructure, allowing visitors to observe the processes of geothermal energy harnessing. Moreover, this study provided needed knowledge regarding interrelationships between geothermal energy infrastructure and tourism, showing that intrusive infrastructure and high visibility of steam of such power plants makes them hardly compatible with nature-based tourism aiming for wilderness experience. In more developed areas, however, the impacts of such infrastructure on tourism are likely to be perceived by visitors as less negative. The wind farms are the newest type of energy infrastructure in Iceland, and while the opinions of participants diverged regarding which visitor groups would be the most affected by the wind turbines, participants agreed that their high visibility is likely to degrade the experience of visitors to natural areas.

The participants of the study emphasized the important role the tourism industry plays in introducing foreign visitors to Icelandic nature and culture and in shaping tourists' attitudes toward the power plants they encounter during their travels. As further emphasized by the participants, if presented positively and in an interesting fashion as part of Icelandic history and an important contribution to the sustainable development of the country, REI is likely to be perceived positively by tourists. An important condition for that is the support of the tourism industry for such development. This points to the importance of stakeholder inclusion into the REI planning process, which would provide local knowledge on each area where REI has been proposed, thereby facilitating the identification of the most suitable locations for REI as well as the most acceptable power plant proposals. Stakeholder inclusion would also reduce the likelihood of conflicts between the tourism and energy industries and increase the social acceptance of energy projects.

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