Proceedings World Geothermal Congress 2020+1
Reykjavik, Iceland, April - October 2021

# View of Tourists and Recreational Users on Energy Development at the Hengill Geothermal Area

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**Keywords:** tourism, recreation, geothermal development, Hengill, Hellisheiði power plant, Nesjavellir power plant, attitude survey.

## ABSTRACT

Hengill is amongst the largest high-temperature geothermal areas in Iceland and boasts spectacular natural and geological features as well as cultural remains. Located at Reykjavik's periphery, Hengill is a popular recreational area enjoyed year-round. Hengill is also home to the Nesjavellir and Hellisheiði co-generative geothermal power plants producing a combined 423 MWe and 433 MWth. Both are operated by ON Power. In 2017 an independent tourism research center conducted an attitude survey amongst recreational users at Hengill. The objective of the survey was to: 1) establish a comparison of attitudes towards energy development at Hengill and other utilization options subject to the Icelandic Master Plan for Nature Protection and Energy Utilization (Master Plan) and 2) establish an understanding of attitudes towards current energy development at Hengill and a comparison with earlier surveys conducted at Hengill, notably in 2001 and 2006. The results of the survey were in some ways unexpected and deviated from both theories in tourism and energy development and results of comparative surveys. Results from the Master Plan's surveys conclude that sites with no energy development infrastructure scored higher in satisfaction both for unspoiled nature and for stay in the area than sites with infrastructure, e.g. research boreholes. However, Hengill scored similar or higher than sites with no energy development. This is a curious contradiction as a great majority of participants noticed various structures en route. Furthermore, most participants found unspoiled nature to be a part of the attraction of the area and visited it for that exact reason. Another interesting conclusion was that 9 out 10 Icelandic participants state that energy development at Hengill does not affect their interest in visiting the area. In comparison, results from the 2001 survey, conducted before Hellisheiði was commissioned, suggested that over 50% of Icelandic participants would lose interest in visiting the area with further energy development at Hengill.

## 1. INTRODUCTION

Hengill is amongst the largest high-temperature geothermal areas in Iceland and boasts spectacular natural and geological features as well as cultural remains. Located at the capital city's periphery, Hengill is a popular recreational area with a network of 130 km (81 miles) of hiking trails, widely enjoyed year-round. Hengill is also home to the Nesjavellir and Hellisheiði co-generative geothermal power plants producing a combined 423 MWe and 433 MWth. Reykjavik Energy owns the geothermal fields and the resource but it's subsidiary ON Power operates the power plants.

In 2017 an independent attitude survey was conducted by Icelandic Tourism Research Centre amongst recreational users at Hengill. The objective of the survey was twofold

1) establish a comparison of attitudes towards energy development at Hengill and other energy utilization areas subject to the Icelandic Master Plan for Nature Protection and Energy Utilization (Master Plan)
2) establish an understanding of attitudes towards current energy development at Hengill and a comparison with earlier surveys conducted at Hengill, notably in 2001 and 2006.

Reykjavik Energy submitted four utilization options to the Master Plan's phase 3. The Master Plan is regulated by Act No. 48 from 2011 on the Plan for nature protection and energy utilization. The Master Plan's main objective is to classify power plant options into one of three categories: 1) energy utilization, 2) on hold or 3) protection. This categorization is administered by a steering committee whose role it is to advise the minister regarding nature protection and energy utilization. The steering committee receives advice from expert committees that consists of specialists in various fields. The number of expert committees varies, depending on the steering committee but phase 3 had four expert committees (EC). EC 1 gave advice on natural and historical relics, EC 2 on the utilization of natural resources other than the exploitation of energy resources, EC 3 on the social impact and public health and EC 4 on the economic aspects of power development. Expert committee 2 conducted an attitude survey surveying seven submitted power plant options around the country. Reykjavik Energy's options were not amongst those surveyed. Therefore, Reykjavik Energy decided to conduct a comparative survey to establish a comparison of attitudes towards energy development at Hengill and other energy utilization options subject to the Master Plan. Power plant options surveyed by Expert Committee 2 were both hydropower and geothermal, thereof two geothermal power plant options in the capital area's vicinity. In addition, two attitude surveys had already been conducted in the Hengill area in 2001 and in 2006 as a part of an Environmental Impact Assessment for geothermal power plants at Hengill. Reykjavik Energy wanted to establish an understanding of attitudes towards current energy development at Hengill and a comparison with earlier surveys conducted at Hengill. Since the two former attitude surveys were conducted there has been an exponential growth in number of tourists in Iceland. In 2001, 296,000 tourists visited Iceland compared to 422,000 tourists in 2006 and a staggering 2.2 million in 2017. This growth is visible in most parts of Iceland, including the Hengill area.

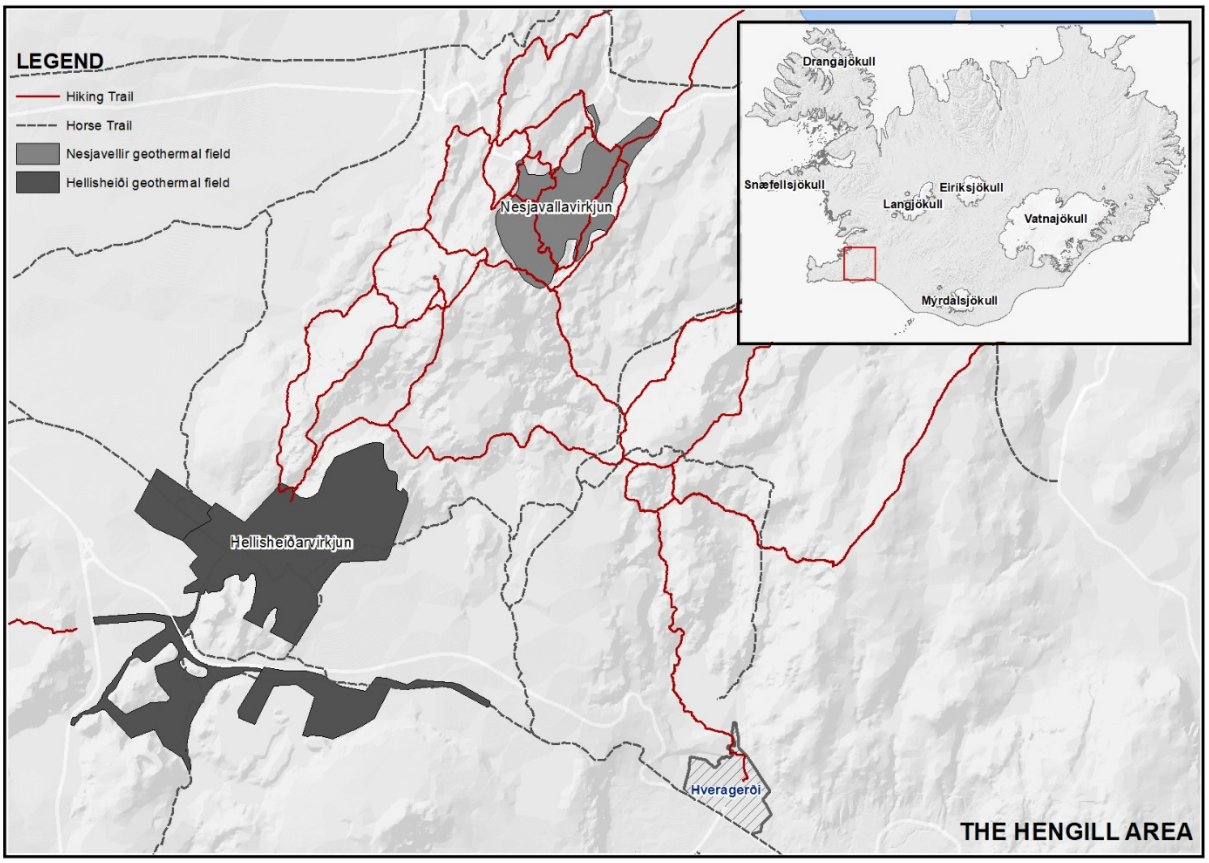


**Figure 1: Geothermal fields and hiking- and horse trail network at the Hengill area**

## 2. DATA AND METHODOLOGY

The questionnaire applied to the attitude survey has been used in previous attitude surveys for the Master Plan in various locations in Iceland. The questionnaire is designed to survey various aspects of tourists' experience and satisfaction with a specific area. Participants are enquired about their attitude towards power plants in the area and whether they notice power plant structures en route and if so which structures. Furthermore, they are asked to shed a light on the area's attraction and whether wilderness or unspoiled nature is a part of that attraction.

Responses are analyzed by background variables such as survey location, sex, age, nationality, employment, length of stay and whether participants were first time or returning visitors. In addition, variables such as time of day and weather were included. The survey was distributed in three different locations at the Hengill area: Reykjadalur, a popular tourist attraction with no visible energy utilization infrastructure, Dyradalur which is a gateway to the Hengill area especially for hiking, mountain biking and other recreational activities and lastly Konungsbrún at Nesjavellir a viewpoint overlooking the Nesjavellir power plant and surrounding geothermal field.

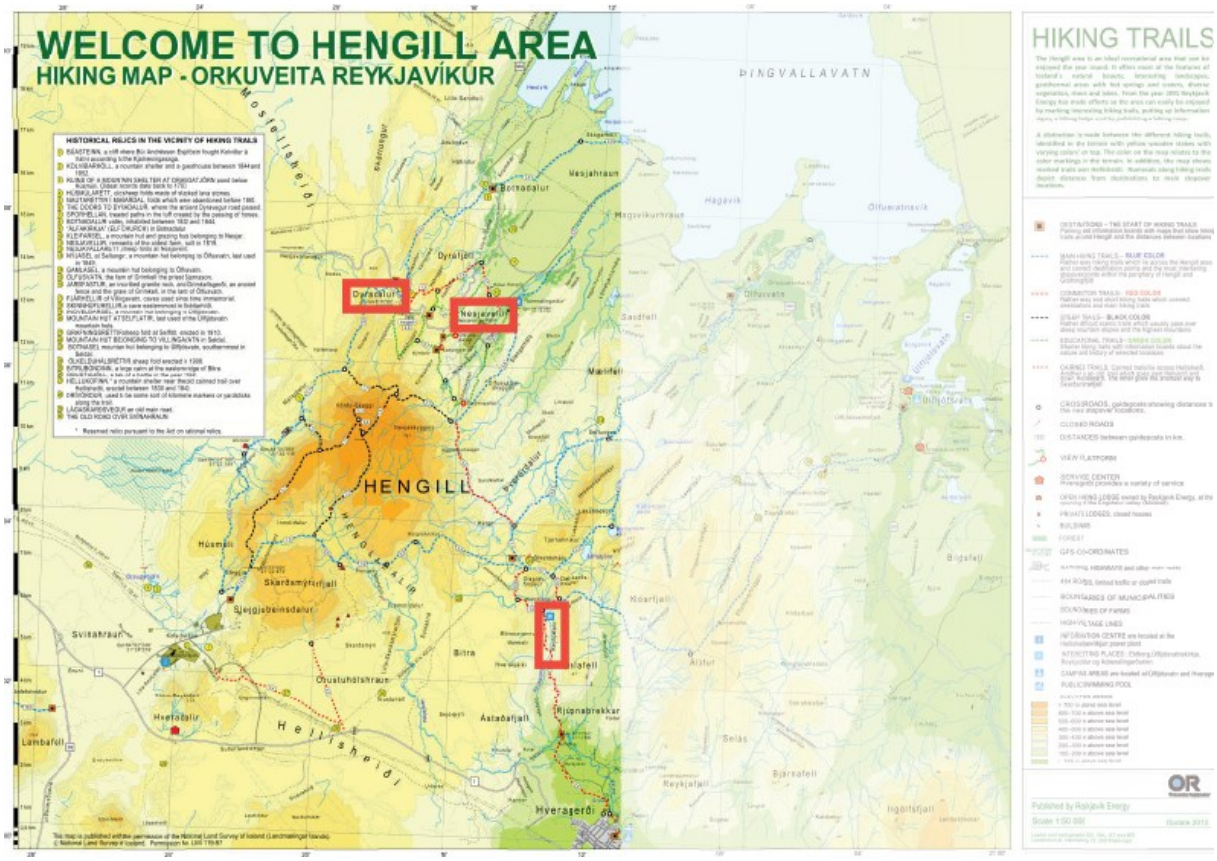


**Figure 2: A map of the survey area. The survey locations are demarcated inside the red boxes. The hiking map of the Hengill area was used to demonstrate the survey area in the questionnaire. The white washed-out area was not a part of the survey area.**

Cohort size at the survey area was estimated 10.000 people during the observation period. The target was set for 1.100-1.200 responses aiming at 60% response rate and 95% confidence level. Period of observation was June 1st to September 15th split up to three subperiods to reflect fluctuations between shoulder- and high season. Furthermore, each observation day was split up into three periods to reflect eventual changes during the day.

## 3. SURVEY RESPONSE

A total number of responses delivered for statistical processing and analysis were 1.135. Responses were analyzed against several background variables. Responses with high variability were tested for statistical significance with a t-test and ANOVA test (analysis of variance). Responses were delivered on a 5-point scale.

47,5% of participants were female and 52,5% male. Age structure amongst participants was equally dispersed with around a quarter to one fifth in each age group. Most participants were Icelandic (21%), North American (20%), German (12%), French (11%), Scandinavian (6%), UK citizens (5%) and Beneluxians (4%). Other nationalities were less common. Responses were equally dispersed over the day. Most participants held “other jobs” (37%), 34% were professionals, 16% were students and 12% held managerial positions. Most participants (41%) spent 0-3 hours in the area, 38% spent 4-12 hours and 20% 13 hours or more. 75% of participants were visiting the Hengill area for the first time. Icelandic participants stood out in this question as 81% were returning visitors.

Participants at the Reykjadalur’s survey location stayed the longest. Approximately 50% of Dyradalur and Nesavellir’s participants spent 0-3 hours while 50% of Reykjadalur’s participants spent 4-12 hours. 25% of Reykjadalur’s participants spent >13 hours compared with a little under 20% of Dyradalur and Nesjavellir’s participants.

**Figure 3: Dyradalur**

**Figure 4 : Nesjavellir**

**Figure 5: Reykjadalur**

### 3.1 Satisfaction with experience of the area

Overall participants are satisfied or very satisfied with their stay in the area (91.8%) and the nature in the area (92.9%). Most participants describe the survey area as somewhat or very natural. Nesjavellir was considered the least natural and Dyradalur the most natural. The difference in responses between survey locations is however minimal as 93.7% found Dyradalur, location next to no energy infrastructure natural, while 83.2% found Nesjavellir overlooking the geothermal plant and geothermal field natural. Most participants describe the survey area as somewhat or very quiet. Dyradalur was considered the quietest (95.6%) but Reykjadalur the least quiet (82.6). Reykjadalur is probably the busiest of the three, as it is a very popular tourist attraction. Most participants describe the survey area as somewhat or very accessible (90.9%), beautiful (96.7) and impressive (94.9%).

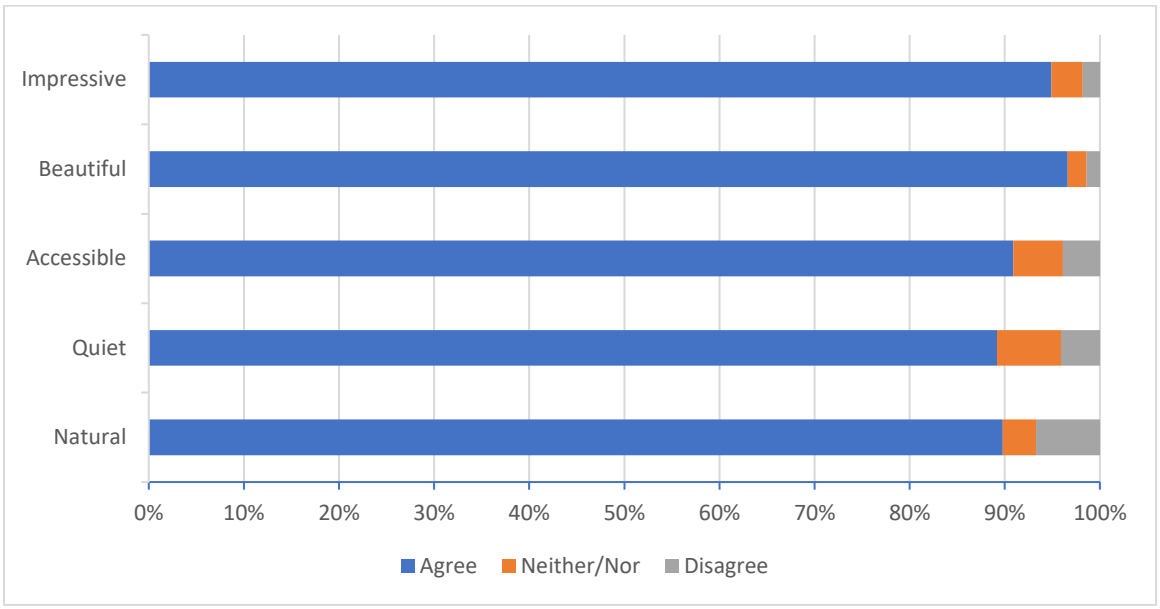


**Figure 6: How descriptive are the following words for the survey area?**

3.1.1 Opinions on geothermal power development at the Hengill area

Participants were enquired about their opinion on the two power plants in the Hengill area and geothermal development in general compared to hydropower development. The following statements provide comparison with a question previously asked in an attitude survey conducted in 2001 before the Hellisheiði power plant was commissioned.

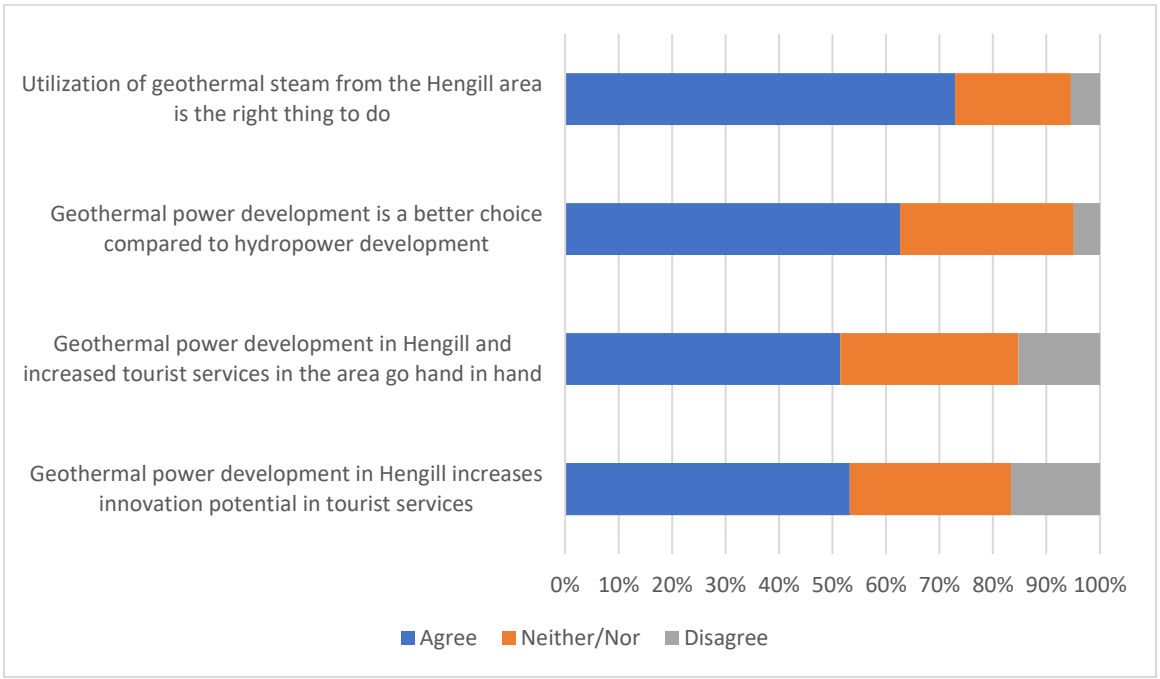


**Figure 7: Position on geothermal development at the Hengill area**

In general participants agree on the innovation potential in tourist services following geothermal development. Icelandic (44.7%), German (29.2%) and Swiss/Austrian (39.5%) participants are less likely to agree than participants of other nationalities. More participants at Nesjavellir agree with this statement (63.8%) than participants at Dyradalur (45.2 %) and Reykjadalur (50.7%). In

general participants agree that geothermal development and tourism in the Hengill area go hand in hand. Icelandic (43.8%), Beneluxian (43.8%) and German (47%) participants were less likely to agree as well as returning visitors (49,1%) compared with first time visitors (52%). Participants at Nesjavellir were more likely to agree with the statement (61.2%) than participants at Dyradalur (44.9%) and Reykjadalur (48,2%). Approximately 63% of participants agree that geothermal power development is a better choice than hydropower development. Icelandic (39.5%) and Irish/British (53.5%) participants were less likely to agree as well as returning visitors (51%) compared with first time visitors (66.7%). Lastly participants were asked whether it is right to use geothermal steam to produce electricity at the Hengill area. Most participants agree with this statement (72.9%). Participants from Iceland (59.4%) and the Visegrád (Czech Republic, Hungary, Poland and Slovakia) group (51.5%) were less likely to agree. In the 2001 attitude survey 72-85% of the Icelandic participants agreed with this statement.

3.1.2 View on further geothermal development in the lowlands, e.g. in the Hengill area

Participants were enquired on their view on further geothermal development both in the highlands (the central inhabited plateau of Iceland) and the lowlands, e.g. in the Hengill area. More participants were positive towards further geothermal development in the lowlands, e.g. in the Hengill area (52.2%) than in the highlands (42.9%). In general participants were positive towards further geothermal development in the Hengill area. Icelandic participants were less positive (40.1%) than participants of other nationalities, and the same applies to women (50.8%) compared with men (55.9%) and returning visitors (50.2%) compared with first time visitors (53.1%). Participants at Nesjavellir were more positive (61.4%) than those at Dyradalur (46.5%) and Reykjadalur (48.5%).

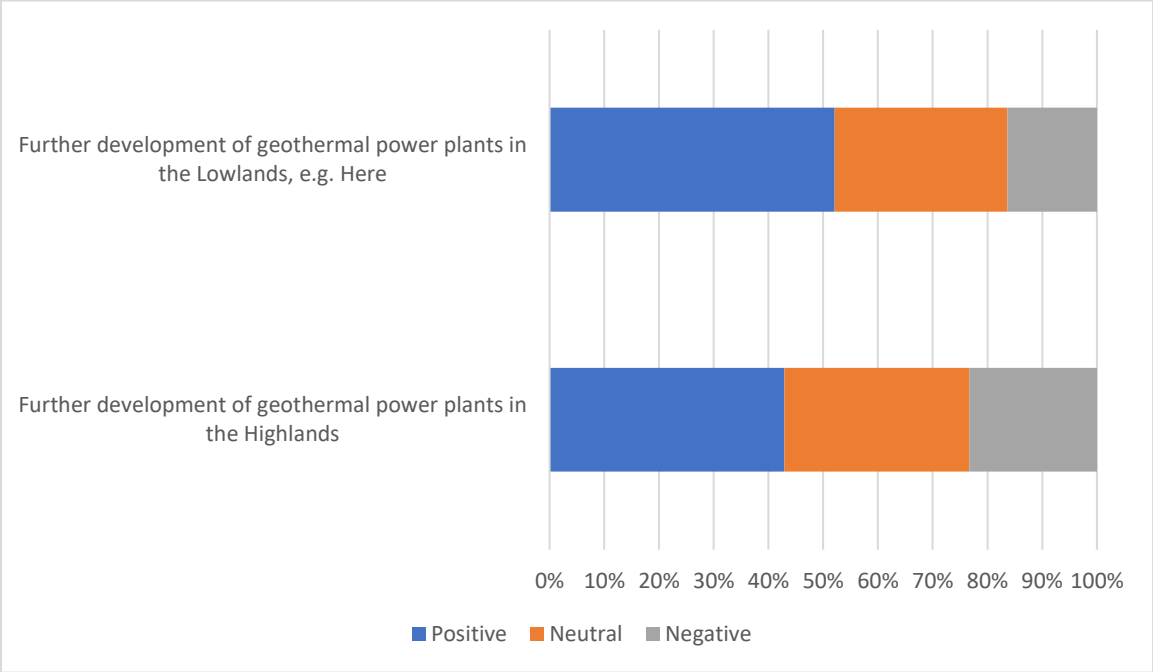


**Figure 8: Opinions regarding further geothermal development.**

### 3.2 The impact of infrastructure in the survey area

Most participants (86.8%) noticed structures en route at the survey area. Men were more likely (88.6%) to have noticed structures than women (84.6%). Participants at Reykjadalur were less likely (77.5%) to have noticed structures than participants at Dyradalur (90.5%) and Nesjavellir (93.8%). More than half of participants were not affected by noticing structures en route. Participants were predominantly negative towards industrial debris and transmission lines. Power station buildings, cooling towers, boreholes and steam pipes were also somewhat negatively viewed, while roads and discharging geothermal steam wells were somewhat positively viewed.

Participants were asked to rate their opinion on certain structures and/or facilities in the area, independent of whether they had noticed them en route or not. The results are shown in a table showing structures/facilities with more than 33% appropriacy or inappropriacy. Some structures/facilities end up in both columns demonstrating mixed views on their appropriacy.

**Table 1: Appropriacy of structures/facilities in the area in no particular order.**

| Inappropriate structures/facilities in the area | Appropriate structures/facilities in the area |
|---|---|
| Transmission lines | Gravel roads |
| Windmills | Built-up gravel roads |
| Hotels | Asphalt roads |
| Shops/restaurants | Roads passable year-round |

| | |
|---|---|
| Gas stations | Signs |
| Industrial debris | Geothermal power plants |
| Radio masts | Windmills |
| | Mountain huts |
| | Campsites |
| | Shops/restaurant |
| | Gas stations |
| | Toilets |
| | Visitor centers. |

The fact that there is are power plants in the Hengill area had no effect on the interest of most participants (66.9%) in spending time outdoors in the area. Merely 11% found it negative and 22.1% found it positive. Participants at Nesjavellir were likelier to find a power plant to have a positive effect on their interest in spending time outdoors in the area (33.6%) than participants at Dyradalur (17.2%) and Reykjadalur (15.7%).

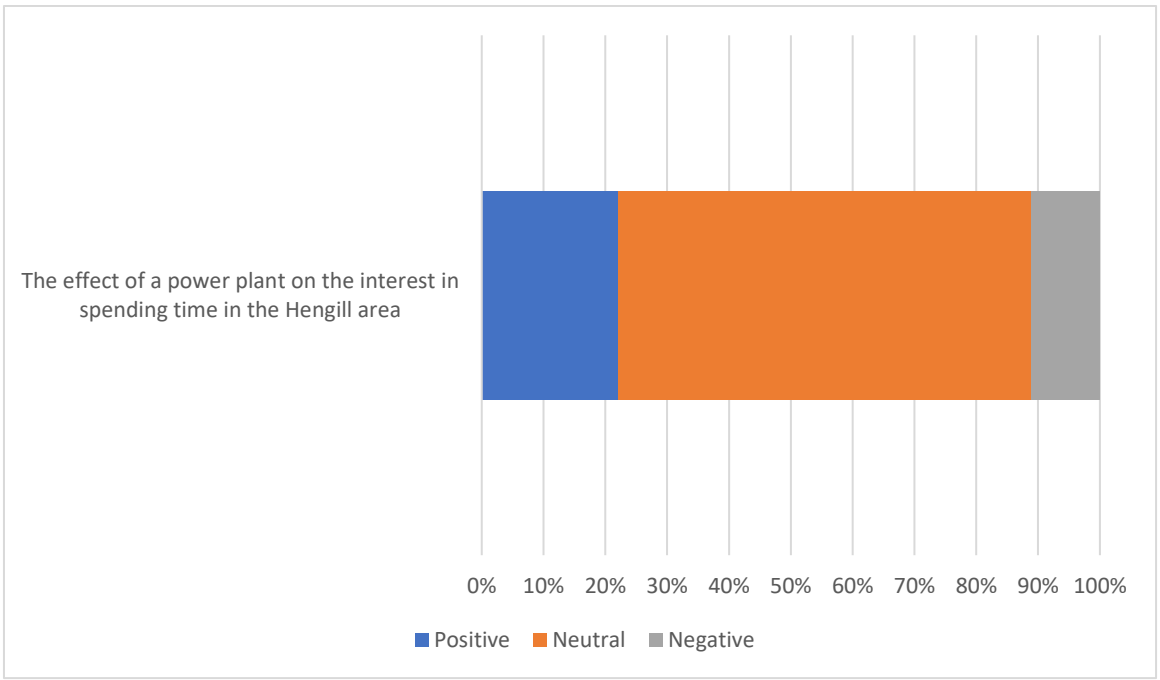


**Figure 9: The effect of a power plant on the interest in spending time in the Hengill area**

### 3.3 The Hengill area as a wilderness/unspoiled nature

Almost all participants (97.4%) think that wilderness/unspoiled nature play a part in the area's attraction, independent of background variables. Furthermore, almost all participants (88.8%) visited the area purposely to experience wilderness/unspoiled nature. However, Icelandic (83%), French (83.7%) and Swiss/Austrian (81.8%) participants were less likely to answer this question positively. Likewise returning visitors (82.1%) compared with first time visitors (90.7%) and participants at Nesjavellir (81.3%) compared with participants at Dyradalur (89.8%) and Reykjadalur (94.5%).

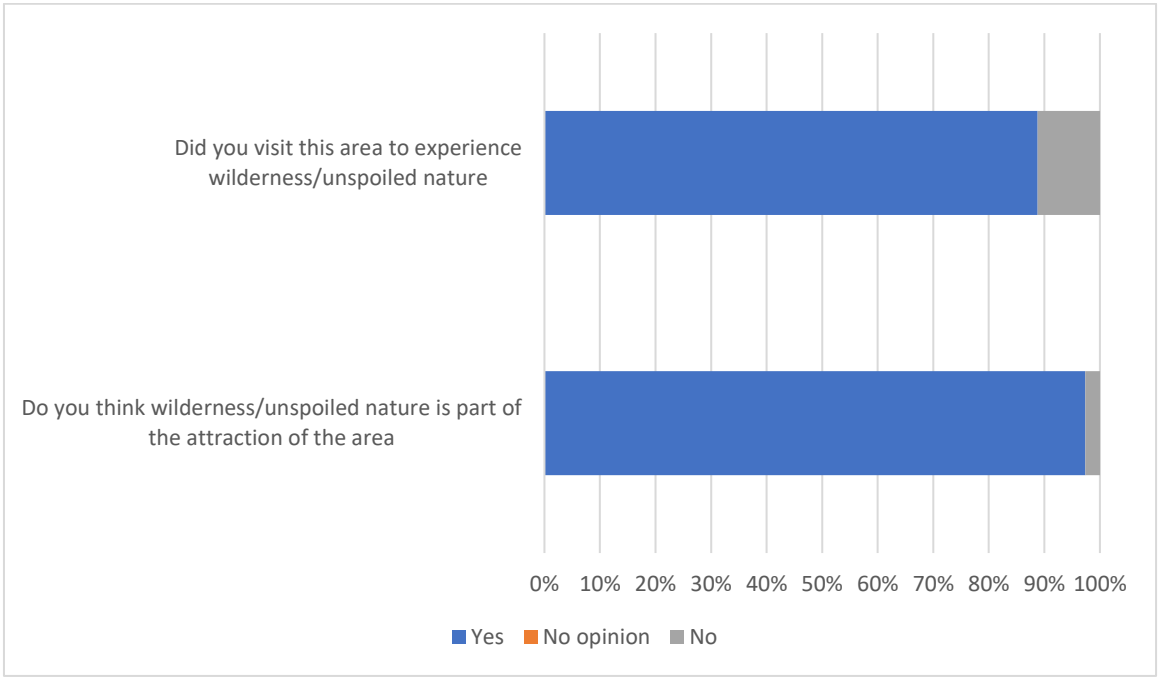


**Figure 10: The Hengill area as a wilderness/unspoiled nature**

Nearby structures that participants know of, but do not see have little (31.8%) to no (41.3%) effect on the wilderness experience of most participants. Merely 7.1% of participants were much or very much affected by nearby structures they know off but did not see. Participants from Iceland (9.7%) and the Visegrád group (9.4%) were likelier to be much or very much affected than participants of other nationalities as well as returning visitors (9.7%) compared with first time visitors (6.2%).

The last question regarding the Hengill area as wilderness/unspoiled nature asked participants about their opinion on which of the listed structures may be present in an area for it to be considered wilderness. Participants could mark as many structures as they felt appropriate. Perhaps the most surprising finding is that three out of four participants (73.7%) that marked that nothing may be present in an area for it to be considered wilderness noticed structures while en route. Since almost all participants (97.4%) think that wilderness/unspoiled nature play a part in the attraction of the area it seems clear that most participants experience the Hengill area as wilderness/unspoiled nature despite noticing structures en route.

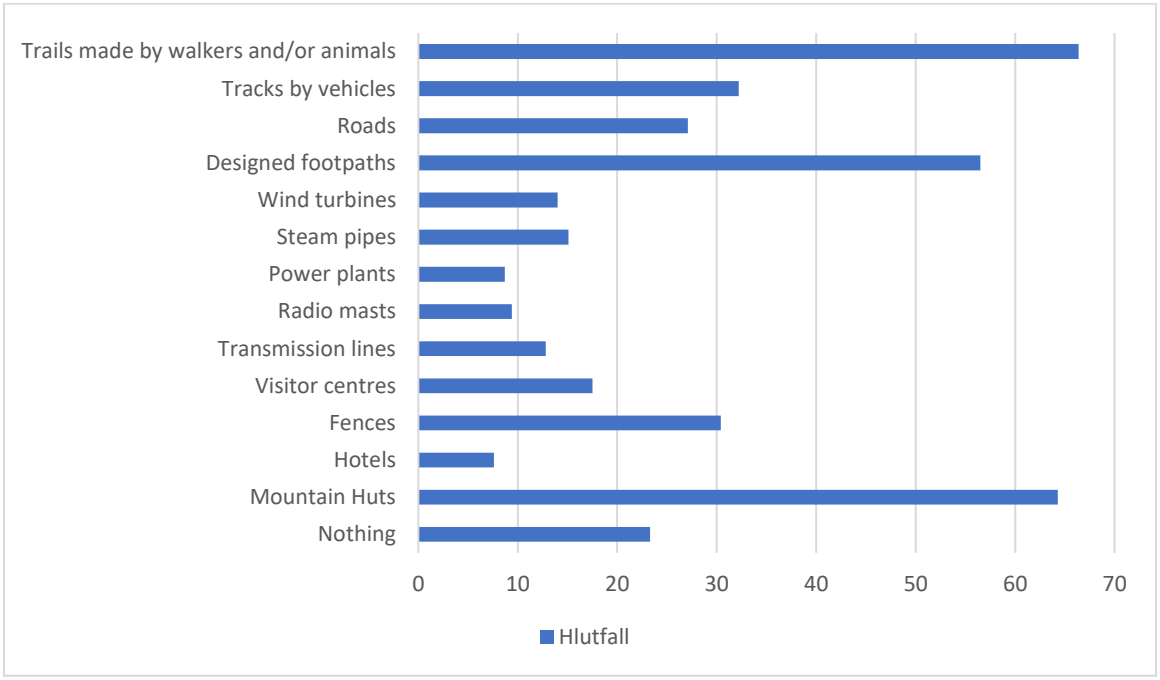


**Figure 11: List of structures that may be present in the area for it to be considered wilderness/unspoiled area**

## 4. CONCLUSION

The main objective of the Hengill area attitude survey was to acquire data on the views of specific target groups, tourists and recreational users, on geothermal development and geothermal structures at the Hengill area and their effect on participants'

experience of the area. A strong emphasis was put on the comparability with previous surveys conducted in the Hengill area and other utilization options in the Master Plan.

The results of the survey are comparable with a Master Plan attitude survey conducted at Trölladyngja, a utilization option on the Reykjanes peninsula. Trölladyngja is a geothermal field with moderate infrastructure, such as roads, research boreholes etc. but no power plant. 80% of participants were satisfied with the nature and their stay in the Trölladyngja area. Recreational users in the Trölladyngja area think that wilderness/unspoiled nature is a part of the area's attraction and purposely visit the area to experience wilderness/unspoiled nature. At the Hengill area 91.8% were satisfied with their stay and 92.9% were satisfied with the nature in the area. The fact that there is a power plant in the Hengill area does not affect the interest of close to nine out of ten participants (89%) to spend time outdoors in the area. Furthermore, 88.8% of participants visit the area purposely to experience wilderness and unspoiled nature. Nearby structures do not interfere with that experience. In fact, considerable traces of human imprints and structures may be present without spoiling the participants' experience of the area as a wilderness and unspoiled nature.

Previous surveys have communicated the need for a comparative study demonstrating how tourism and tourists' views change with further geothermal developments in areas. In the Hengill area this comparison is partly possible since the current survey can be compared with a 2001 survey conducted before the commission of the Hellisheiði power plant. 67% of Icelandic participants in the 2001 study said that Hellisheiði power plant would not affect their experience of the area compared with 84% of Icelandic participants in 2017. In 2001 5% of Icelandic participants said they would visit less frequently compared with 6% of Icelandic participants in 2017 and 27% of Icelandic participants in 2001 said they would visit more frequently compared with 9.9% Icelandic participants in 2017.

One paradoxical finding of the survey revolves around wilderness as a part of the cultural landscape. Previous surveys in the Icelandic Master Plan conclude that participants located at somewhat developed areas like Trölladyngja are less satisfied with the nature and their stay than participants located at natural areas like Skagafjörður and Aldeyjarfoss with next to no infrastructure where over 90% were satisfied. Those results are however comparable with the Hengill area which is home to two power plants. In fact, almost nine out ten participants said that power plants at Hengill have no effect on their interest in spending time outdoors in the area. Most participants (86.8%) noticed structures en route in the Hengill area but they still experience the area as wilderness and unspoiled nature (97.4%) and visit the area for that exact purpose (88.8%). This paradox is however an independent study topic outside the topic of this survey and revolves around the definition of wilderness in people's mind and their expectations towards nature and human imprint on nature.

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