Proposed Windfarm at Volovja Reber

An independent appraisal of the likely effects on golden eagles

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Qualifications and Experience

I am a Director of Natural Research Ltd, a registered charity that undertakes independent and objective wildlife research (refer to: www.natural-research.org). I have been professionally involved with raptors (birds of prey) for over 30 years, i.e. all my working life. I have undertaken raptor studies for a variety of UK governmental and non-governmental organisations, including the Royal Society for the Protection of Birds (RSPB), Scottish Natural Heritage (SNH), Centre for Ecology and Hydrology (CEH), and the University of Glasgow.

My research interests have focussed on the foraging ecology of eagles and harriers. In 1997 I was awarded a doctorate from the University of Glasgow for work on the effects of forestry on hen harriers *Circus cyaneus*. I have written several published papers on eagles and other raptors. I have given presentations on these species at conferences in the UK, Europe and N. America. I continue to study raptor behaviour in the field and supervise studies by others, in the UK and overseas.

For the past 15 years I have been involved in Environmental Impact studies relating to the effects of windfarms on birds, specialising in the effects on raptors (and eagles in particular). I have taken a leading role in developing survey and assessment protocols that are now in common use throughout the world, including guidance issued by the UK Government (SNH 2005). I am co-author of the seminal text on the assessment of avian collision risk (Band et al. 2007). Where feasible I have sought to resolve potential conflicts between windfarm development and bird conservation, including measures to mitigate the adverse effects on golden eagles (e.g. Madders and Walker 2002). On other occasions I have advised that the effects of such measures were insufficiently certain to recommend their implementation. I have been called as an expert witness at numerous Public Inquiries in the UK, by both proponents and objectors to windfarm developments. I have designed and implemented training programmes for UK Government organisations, RSPB, wind energy developers and environmental consultants. I have been an invited speaker at conferences organised by the British Wind Energy Association (BWEA) and Scottish Renewables Forum (SRF).

Introduction

The proposed windfarm at Volovja reber has the potential to adversely affect a territorial pair of golden eagles, based on the proximity of the development to known eagle nesting sites and its location within un-afforested habitat used by foraging eagles. Baseline studies and assessment of the ecological impacts of the development were undertaken by the developer in 2003-04 (Aquarius 2005, E-NET 2005). This work concluded that the effects on eagles were likely to be small. Subsequently, information provided by Jančar et al. (2009) has cast doubt on the validity of this conclusion. Specifically, Jančar et al. refer to the results of their own surveys in 2005-07 and use these data to argue that the development, which is located in the Snežnik plateau and Pivka valley

Important Bird Area (IBA), poses an unacceptable risk to eagles in terms of displacement from important foraging habitat and collision with the turbine rotors. Part of the IBA has been designated as a Special Protection Area (SPA, see below).

Golden eagle is a protected species in Europe, listed in Annex 1 of the EU Birds Directive. Slovenia supports a modest population of golden eagles; Geister (1995) estimated there were 10-25 pairs present although more recently BirdLife (2004) considered there were 25-35 pairs. On this basis, the pair at Volovja reber represents at least 3% of the national population. In addition, the Volovja reber pair nests, in some years at least, within the Snežnik-Pivka SPA (designated for its golden eagle interest). Thus, even though the development is not located within the SPA, it has the potential to adversely affect the conservation objectives of the SPA and thereby significantly affect its integrity.

The purpose of this report is to briefly evaluate the information available on golden eagles at Volovja reber and provide an objective assessment on the likely effects of the development on the eagle interest.

BASELINE INFORMATION

The data gathered by Aquarius (2005), E-NET (2005) and Jančar et al. (2009) indicate that a single pair of eagles are present throughout the year, occupying a high karst plateau rising to over 1000 m a.s.l. that supports extensive Dinaric fir-beech forest and extensive dry karst meadows. The breeding status of the pair has been determined in seven out of the last ten years (Jančar et al. 2009), with breeding confirmed each year. During this time breeding has occurred within the SPA, approximately 2 km from the proposed windfarm, on four occasions; and immediately adjacent to the SPA, 220 m from the nearest proposed turbines, in one year at least.

Golden eagles were observed on eight out of 29 days (28%) spent collecting baseline data for the Environmental Statement (ES) in 2003-04 (Aquarius 2005). Taking account of the number of birds involved on each day (i.e. one or two), the authors estimated that eagles were present in the vicinity of the proposed development on approximately 150 days per year, although they considered that eagles would be present daily in the event that breeding was successful. Although these estimates cannot be substantiated using the information that is presented, and their value is in any case questionable (since the duration that eagles are estimated to be present each day is unknown), they nevertheless reveal that the authors of the ES believe the proposed development site to be of considerable importance to the territorial eagle pair.

More extensive observations, additional to those presented in the ES, were undertaken by DOPPS (Jančar et al. 2009). In 272 hours of systematic observation from strategic vantage points (VPs) during the months May-June 2005 and August-September 2006 and 2007, golden eagles were recorded 99 times. On average, therefore, eagles were in the vicinity of the proposed development at least once every 2.75 hours. Data for 2007, when the flightlines of individual eagles were plotted, suggest that 74 out of 202 (37%) flights (recorded during systematic watches and at other times) crossed the proposed turbine string. These data indicate that (1) eagles are present regularly in the vicinity of the proposed development, and (2) eagles flying in the vicinity of the proposed development would be at potential risk of collision for more than one-third of the time.

Information Gaps

Surveys by Aquarius (2005), E-NET (2005) and Jančar et al. (2009) have focussed on the proposed windfarm and immediate surrounding area. Although these observations have shown that golden eagles use the proposed development site, it is not possible to determine whether or not the level of use is typical of other areas within the eagle's territory. In other words, despite the survey work that has been undertaken, the relative importance of the proposed development site to the eagle pair remains unknown.

Similarly, there has been no systematic evaluation of the relative importance of different parts of the eagle territory in terms of the prey resource. Therefore, it is not possible to establish whether foraging within the proposed development site is likely to be more or less profitable than in other parts of the territory.

Requirements of Golden Eagles

It has been shown across a wide geographical area that golden eagles have a strong preference for open habitats with short vegetation in rugged-terrain (e.g. Tjernberg 1985, Marzluff et al. 1997, McGrady 1997, Watson 1997, Sergio et al. 2006). Consequently, golden eagles have also been shown repeatedly to be sensitive to forest expansion and loss of open habitats (Marquiss et al. 1985, Watson 1992, Whitfield et al. 2001, 2007, Pedrini & Sergio 2001) and studies invariably find that prey of open habitats dominate their diet (e.g. Delibes et al. 1975, Tjernberg 1981, Steenhof & Kochert 1988, Watson et al. 1993, McGrady 1997, Watson 1997).

Pedrini and Sergio (2002) contrasted the breeding density and productivity of two Central European golden eagle populations, one occupying an area of predominantly open habitat and another occupying an area characterised by extensive forest with patches of open habitat. They found that breeding density was lower in the afforested area, suggesting that eagles in wooded landscapes have larger territories in order to compensate for the reduced amount of preferred foraging habitat. Productivity was also lower in the afforested area, presumably because preferred prey was less available in wooded landscapes, or foraging efficiency was lower, or both.

In mountainous areas where the distribution of open ground is fragmented by a dominant cover of forest habitats, then open areas can be used by eagles even when several kilometres from nest sites (Tjernberg 1985, Sergio et al. 2006). Thus, in the central-eastern Italian Alps, where 52% of the landscape is tree-covered, golden eagles are dependent on grassland habitats and areas of shrub vegetation, where they catch mammalian and avian prey (Sergio et al. 2006). All else being equal, eagles in forest-dominated environments range further than eagles in environments dominated by open ground, because preferred open habitats are more widely scattered (Tjernberg 1985, Whitfield et al. 2007). In high altitude habitats around the tree-line, eagles concentrate their activities in open areas, such as meadows, above the tree-line (Tjernberg 1985, Sergio et al. 2006). For example, in the Dadia forest (northeast Greece) range use observations illustrate that golden eagles concentrate their activity in relatively few patches of open habitat within the forest, and on higher altitude ridges without trees (WWF Dadia unpubl. data).

Studies in Scotland show that eagles prefer to range over ridges (McGrady et al. 2002, McLeod et al. 2002a, b), probably because wind updrafts generated by ridges increase their flight efficiency

(McLeod et al. 2002b, Fielding et al. 2003). Complimentary supporting evidence for this finding has been forthcoming from as far afield as USA (Erickson et al. 1999) and the Italian Alps (Sergio et al. 2006) and probably explains why golden eagles have widespread preference for rugged terrain.

Globally, golden eagles prey predominantly on medium-sized mammals and medium-sized birds, with larger animals taken mainly as carrion (McGrady 1997, Watson 1997). In Europe, lagomorphs (hares and rabbits) and gamebirds (pheasants, partridges and grouse, *Phasianidae* and *Tetraonidae*) usually predominate as prey. In the north, gamebird prey are typically grouse (*Lagopus* and *Tetrao* spp.) and in the south they are partridges (*Alectoris* spp.) (McGrady 1997, Watson 1997), including rock partridge *A.graeca* (Pedrini & Sergio 2001).

Importance of the Proposed Development Site to Golden Eagles

As noted above (see Information Gaps), there is insufficient information available to establish the relative importance of the proposed development site, in terms of the prey resource and use by eagles. However, in the absence of this necessary information, there are several good reasons for believing that the site is likely to provide critical foraging resources for the resident eagle pair, as follows:

1. The proposed development site is located on a ridge that supports some of the highest altitude meadows in the area. As noted above, this type of open habitat is strongly preferred by foraging golden eagles and populations in many areas, including the Italian Alps, are dependent on the prey present within it. Thus, it would be expected that the proposed development site is visited regularly by foraging eagles. This expectation is consistent with the conclusions presented in the ES (Aquarius 2005); and with data presented by Jančar et al. (2009; refer to Fig 13).
2. Resident golden eagles are central place foragers (i.e. they initiate and terminate hunting trips at a defined location, such as a nest or roost site) and during the breeding period use areas close to their nests more than other parts of their territory. In years when the eagles nest close-by (e.g. within 220 m), the development site clearly constitutes the nearest area of preferred foraging habitat. Moreover, the development site is located within what is probably the largest area of preferred foraging habitat within the Volovja reber eagle territory. Therefore, in the absence of any contradictory evidence, it seems reasonable to suppose that the proposed development site is likely to be used more than any other part of the eagles' territory.
3. The distribution of preferred open-ground foraging habitat in the eagles' territory is highly fragmented. So whilst it would be expected that foraging activity declines with distance from the nest, the scarcity of suitable habitat means that eagles are likely to exploit open ground relatively far from the nest in preference to forest habitat relatively close (refer to Tjernberg 1985, Sergio et al. 2006). This suggests that even in years when eagles nest further away (e.g. 2 km or more), use of the proposed development site is likely to be high relative to many other parts of the territory.
4. The area of open-ground foraging has apparently contracted in recent times, as shrubs and other vegetation encroach (Aquarius 2005). This suggests that the value of the Volovja reber ridge and other remaining open-ground areas to eagles is greater now than previously.

5. In addition to supporting important foraging habitat, which has an otherwise restricted distribution within the potential foraging range of the eagles, the proposed development site is characterised by a ridgeline and steeply sloping ground, landscape features shown to be used preferentially by eagles (McGrady et al. 2002, McLeod et al. 2002a, b), presumably because updrafts confer increased flight efficiency (McLeod et al. 2002b, Fielding et al. 2003).
6. Finally, there is evidence to suggest that the slopes immediately below the proposed development support a population of rock partridge, a potentially important prey species (see Requirements of Golden Eagles, above). Thus, a survey in Nov 2007 located at least four rock partridge and coincidentally recorded a high level of associated eagle activity (Mihelič 2007, Jančar et al. 2009). These observations occurred in the early morning, suggesting that such activity, even if regular, was unlikely to have been detected by the VP watches undertaken by Aquarius and Jančar et al. If a potential prey species is abundant, it is invariably well-represented in golden eagle diet (Seguin et al. 2001, Whitfield et al. 2009). Therefore, in the present case, it is safe to conclude that if there is an area of open ground within the range of golden eagles where partridges occur, then this area will be favoured hunting ground.

PREDICTED CHANGES IN THE ABSENCE OF DEVELOPMENT

As noted above, the extent of open ground available to eagles is apparently diminishing (Aquarius 2005). Therefore, it is likely that the remaining open ground, especially larger areas such as the proposed development site, will assume greater importance to eagles over the short to medium terms (i.e. 5-20 years). One effect of this process is that golden eagles and some other qualifying species supported by the adjacent SPA may become increasingly dependent on the development site.

LIKELY EFFECTS OF THE PROPOSED DEVELOPMENT

Land take

The percentage of open ground lost directly to the proposed windfarm infrastructure (turbine bases, access tracks, buildings, etc) is very small in relation to the overall area available. Therefore it is reasonable to conclude that the direct land take would have little or no material effect on golden eagle foraging efficiency. No potential nest sites would be lost to the windfarm infrastructure. In view of the above, it is likely that the effects of land take on golden eagles would be negligible.

Displacement

Madders & Whitfield (2006) cite golden eagles as having high sensitivity to displacement by windfarms, with range use changing in a pair of resident Scottish eagles after a wind farm was constructed within the territory, although definitive conclusions were confounded by simultaneous habitat management in the territory (Walker et al. 2005). Similarly, Britten (2001) described complete abandonment of an eagle territory in Arizona when a road was built within 250 m of an eagle nest; there was no subsequent re-occupation of this site.

Construction Disturbance

Noise and visual disturbance due to construction works have the potential to disrupt golden eagle nesting routines or displace breeding birds into less suitable habitat. The strength of this effect would depend on the eagles' nest location at the time of construction. Thus, the development would clearly have a large adverse effect on birds using the closest known nest site, located 220 m from the nearest proposed turbine. Conversely, the behaviour of eagles occupying one of the more distant nest sites is unlikely to be materially affected. Given that (1) construction disturbance would be temporary, lasting one breeding season at most, and (2) there are several alternative nesting locations within the eagles' territory, it seems reasonable to assume that if (as seems highly likely) eagles were constrained to nest further from the development site during the construction phase then the magnitude of any effects would be both short-term and low. On the other hand, if construction works commenced after the eagles had elected to nest at a location close to the development site then construction works could potentially jeopardise breeding success, to the extent that the attempt is likely to be abandoned in that year. Moreover, disturbance in the pre-laying period can cause pairs to switch to a different nest site (D. Walker, cited in Ruddock & Whitfield 2007), and this can cause eagles to nest in less suitable locations. These potential short-term adverse effects could be avoided by scheduling construction works within the vicinity of active eagle nests to occur outside the breeding period, as proposed by Aquarius (2005).[1]

Operational Disturbance

Disturbance due to the operation of the proposed development would potentially affect golden eagles in two ways:

1. Based on a review of disturbance distances in golden eagles and other scarce birds (Ruddock & Whitfield 2007) it seems reasonable to assume that eagles are highly unlikely to nest within the immediate vicinity (i.e. 500 m or so) of the proposed wind turbines. Thus, eagles would no longer use the identified nest that is closest to the development site, or similar locations in the vicinity. This would constrain eagles from nesting close to the largest area of preferred habitat within their territory (refer to Jančar et al. 2009: Fig. 19). The nearest known alternative nests are located 2 km from this habitat and it seems reasonable to suppose that the birds would pay an energetic price for nesting this far away. For example, the alternative nest referred to above is situated in an area with very little open ground foraging; eagles nesting at this location must therefore hunt in locations further away (including, and perhaps predominantly, at Volovja reber). Thus, on average, and in the absence of evidence to contrary, we would expect eagles nesting further away from the development site to have lower productivity. It follows that the development could therefore have an adverse effect on the viability of the eagle territory.
2. Evidence from operational windfarms elsewhere in Europe (e.g. Walker et al 2005) suggests that territorial golden eagles are displaced from an area extending to at least 500 m around the turbines. At Volovja reber this would result in the loss of a substantive amount of the

[1] Note, however, that the recommendation made in Aquarius (2005) avoids disturbance during the period 01 April to 31 July only. The duration of this period is inadequate, since eagles may initiate breeding in late March and dependent young may be present until the end of August.

preferred open ground foraging available, locally and within the territory as a whole. As noted under Information Gaps (see above), the relative importance of the proposed development site to the territorial eagle pair has not yet been established, making it difficult to evaluate the magnitude of the likely displacement of foraging birds. However, studies elsewhere point strongly to the likelihood that the area from which the birds would be displaced is likely to be of very high, if not critical, value to eagles (see Importance of Proposed Development Site to Golden Eagles, above).

The potential effects described above are synergistic. In other words, the anticipated displacement from foraging habitat within the proposed development site will encourage eagles to nest further away from the windfarm, closer to alternative areas that might provide (albeit limited) foraging opportunities. Similarly, displacement from nests close to the proposed development will encourage eagles to forage further away from the windfarm. It is relevant to note here that, within the potential area used by the eagle pair, although there is no reason to suppose that the availability of suitable nest locations is limiting, suitable open ground foraging is quite evidently scarce and this may make it difficult for the eagles to productively occupy alternate areas over a long period. Ultimately, the combined effects of nesting and foraging displacement will ensure that the eagles are constrained to occupy and exploit only a part of their current territory; or in the event that foraging displacement is less than 100%, incur higher energetic costs in order to continue to access a valuable part of their territory. In each case there would be an unknown, but probably substantial, effect on the eagles' foraging efficiency. This would intensify the existing adverse effects on foraging efficiency that are occurring as a result of shrinkage of open ground foraging due to vegetation encroachment (Aquarius 2005). The main consequences of this reduced efficiency would be to lower the eagles' food intake and/or fitness, meaning that the female eagle would be in poorer condition (therefore less likely to lay eggs) and both birds would be less able to provision their chicks (therefore any breeding that is attempted is less likely to have a successful outcome).

The suitability of the habitat and prey resource within alternative areas of foraging, relative to that from which eagles had been displaced, is currently unknown. ***Thus, it is not possible to determine the magnitude of operational displacement effects with any reasonable degree of confidence.***

Collision

In the event that the displacement of golden eagles due to windfarm operation is less than 100% then golden eagles are clearly at risk of colliding with the proposed turbines. Golden eagles are known to collide with wind turbines elsewhere in the world, notably in the USA where several studies have attempted to investigate the scale and causes of mortality, e.g. at Altamont Pass Wind Resource Area (WRA)(Thelander et al. 2003, Smallwood & Thelander 2004, 2008), Tehachapi Pass WRA (Anderson et al. 2004, Erickson et al. 2002), San Gorgonio WRA (Anderson et al. 2005, Erickson et al. 2002) and Foote Creek Rim (Johnson et al. 2000, Erickson et al. 2002, Young et al. 2003a, b).

Several studies and reviews have concluded that raptors appear to be more vulnerable to collision with rotating turbine blades than many other bird groups (e.g. Erickson et al. 2002, Young et al. 2003b). Consistent with this, Whitfield (2009) found that golden eagles' ability to avoid collisions with turbine rotors was similar to that of other raptor species (Whitfield & Madders 2006a, b) but lower than estimates for geese (Fernley et al. 2007) and waders (shorebirds) (Whitfield 2007).

However, there is evidently much variation in risk between windfarms, presumably as a result of differences in eagle abundance, flight behaviour and the technical specification of turbines.

There are several good reasons for believing that eagles would be particularly vulnerable to collision at Volovja reber. Firstly, as noted previously, the proposed development is located within a restricted habitat that is used preferentially by eagles. Second, the turbines would be located along a landscape feature (a ridgeline) known to attract flying eagles. This attraction is likely to be greatest at times when there are strong updrafts, i.e. windy conditions in which the turbines would be operational. Third, in the event that eagles use the nearest available nest, the proposed windfarm would be located in the area that newly fledged eagles, vulnerable to the effects of wind, are likely to practice their flight skills. This expectation was confirmed by observations in 2007 (refer to Jančar et al.2009: Fig 13).

Collision risk is assumed to be proportional to the amount of flight activity at turbine rotor height. Although there is a large discrepancy in the levels of activity recorded by the developer and Jančar et al., both sources indicate that activity levels are currently high. This is consistent with the expectation that the proposed development site provides critical resources, and is located close to nesting sites in some years.

Quantitative assessment of golden eagle collision risk demands empirical data on flight activity per unit area and time. These data can only be generated from time-budget data gathered during systematic surveys covering the entire turbine array over the calendar year. In other words, to construct a collision risk model one must first be able to reliably estimate how many seconds per year eagles spend flying within the volume of air swept by the turbine rotors. No information is presented in the ES to suggest that such surveys have been undertaken as part of the baseline assessment. Jančar et al. has undertaken some detailed surveys, including time-budget observations in 2007. However, even the 2007 data suffer from numerous and potentially serious spatial and temporal biases. ***Therefore, based on the information currently available, it is not possible to undertake a meaningful evaluation of collision likelihood.***

A simplistic collision risk assessment is presented in the ES (Aquarius 2005), based on a Threat Index (TI) calculated from data for the Altamont Pass WRA. However, neither the TI nor the subsequent estimation of eagle mortality at Volovja reber that employs the TI use metrics based on flight activity. Rather, the TI is based on the proportion of a sample of eagles that were killed at Altamont (regardless of their level of exposure to risk), whilst the Volovja reber estimate uses the frequency of occurrence within the risk area (as estimated from a small sample of data that may or may not have been representative). This method of collision assessment is fundamentally flawed and therefore the results are unhelpful in determining the likely magnitude of risk.

The absence of a reliable method to estimate collision mortality, for the reasons explained above, means that it is not possible to determine the effects of the development on the local, regional or national eagle populations. This would in any case require information on the survival and productivity of the affected populations, and this information has apparently not yet been collated. Thus, uncertainties relating to the additional mortality that would result from the proposed windfarm are compounded by uncertainties relating to the consequences of any additional mortality at a population scale. This is particularly worrying given the small size of the Slovenian golden eagle population and the apparent absence of information on its growth trajectory. In these circumstances, it is plausible that a reduction of just a few percentage points in adult survival rate would be sufficient to switch the Slovenian eagle population from a situation of stability to one where the population was headed towards extinction.

Finally, it should be noted that collision mortality has the potential to reduce the survival rates not only of resident adult birds, but also any wandering sub-adults that may enter the territory (a situation more likely to occur if the territory is temporarily occupied by only a single bird, e.g. as a result of collision). Furthermore, loss of a breeding bird is likely to have negative implications for productivity, exacerbating the population effects.

Proposed Mitigation / Enhancement

Given that the magnitude of the two main potential adverse effects (displacement and collision) cannot be established reliably using the data that are available currently (other than to say that both effects are almost certainly substantial), it follows that the ameliorating effects of any mitigation measures cannot be judged. Therefore the proposal set out in the ES (Aquarius 2005) to manage an area of grassland on the southern slopes of the Volovja reber and prevent encroachment by shrubs and other vegetation is premature. Moreover, other information would also be necessary before the benefits of such a scheme could be evaluated. For example, it would be necessary to quantify its current value to the eagles, estimate how this is likely to change in the absence of management, and predict what effect the management would have on the prey resource. Finally, thought would need to be given to how the managed area might modify eagle flight patterns – specifically, whether it is likely to encourage birds to fly over windfarm (and therefore further elevate the risk of collision).

Conclusions

The ES does not adequately evaluate the magnitude of the likely effects on golden eagles. Ultimately, this is because the data necessary for such an evaluation have not been collected, namely (1) an evaluation of the importance of the development site in relation to the eagle territory as a whole, and (2) quantification of the amount of time that eagles spend flying within the airspace swept by the proposed turbine rotors.

As noted above, further studies are required before the magnitude of the likely effects can be adequately assessed. Until such time, and in the absence of any evidence to the contrary, a rational and precautionary assessment must inevitably conclude:

1. Displacement due to the Development would have a material effect on the capacity of the area to support breeding eagles. The anticipated strength of this effect is potentially sufficient to prevent successful breeding and may cause the territory to be abandoned. This would result in a long-term loss of at least 3% in the productivity / size of the national breeding population. By any reasonable measure this would be considered an effect of <u>high magnitude</u>.
2. In the event that substantial displacement did not occur, there would be a high risk of mortality due to collision with turbine rotors. This would result in a long-term reduction in the ability of the Volovja reber territory to support breeding birds, and a material reduction in the productivity and survival of the national population.

The displacement and collision effects summarised above are not mutually exclusive, although clearly eagles cannot be vulnerable to both effects simultaneously. The predicted effects are likely to be long-term, and possibly permanent and irreversible (since if the national population is sent into decline then it is unlikely there would be surplus birds available to re-colonise Volovja reber after the windfarm is removed). In summary, the proposed development is likely to have a significant adverse effect on the regional and, potentially, national golden eagle population. The effect would also have significant adverse impact on the conservation objectives (and therefore integrity) of the nearby Snežnik-Pivka SPA.

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