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Promoting Renewable Energy in Longyearbyen: A Sustainable Means to Prevent Svalbard's Environmental Degradation

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Abstract

This study aims to separately investigate: 1.The political reasons behind Norway's controversial decision to encourage a coal enterprise on Svalbard (an archipelago in the Arctic) and, 2.The current and future potential of wind and solar energy as untapped renewable sources, locally exploited through a hybrid wind-PV system. In doing so this preliminary study attempts to provide insights for the implementation of an alternative, sustainable strategy to keep a Norwegian year-round settlement at Longyearbyen, Svalbard, without any recourse to polluting mining operations. Such an eventuality, despite the need for further research, is promisingly described as feasible, environmentally advantageous and politically conceivable.

Author's Note

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1. Introduction

As a country with well-established traditions in environmental and climate research, it is highly surprising to learn about the controversial choice of Norway to encourage a coal industry on Svalbard, the vastest and northernmost wild area in Western Europe (Barr 1987).

Despite recent warnings launched by scientists on the increasing emission of dangerous pollutants in the extraction process of coal and in the production of energy (KLIF 2009), there is still an opposition to a full climate protection policy, an attitude that is threatening the vulnerable, local ecosystem. This circumstance seems strictly related to the interpretation of the Treaty of Spitsbergen (1920), which

formally assigns the sovereignty of the archipelago to Norway, but even so, leaves a few 'open doors' to other claimant countries, in particular Russia (Brown 2000).
Politicians, on one hand, claim the key-importance of coal to a permanent Norwegian presence on the group of islands, mandatory for maintaining their political control. In the following debate, however, I argue the existence of an alternative, sustainable strategy to keep a year-round settlement as Longyearbyen alive, which I believe can be achieved without any recourse to polluting mining operations.

From a methodological point of view, I will mainly draw on quantitative information, in particular on the emission data issued in 2009 by KLIF (Norwegian Climate and Pollution Agency), in collaboration with NILU (Norwegian Institute for Air Research) and UNIS (University Centre in Svalbard), on historical weather observations provided by MET (Norwegian Meteorological Institute), on the report on climate change in the Norwegian Arctic, freshly made public by NPI (Norwegian Polar Institute 2011), and on statistics issued by SSB (Statistics Norway).
Fundamental to the contextualization of this research has also been my extensive stay *in situ*[1], as part of a long experience in the Arctic, which gave me the unique opportunity to discuss my ideas with scientists and researchers from different parts of the world. The interaction with inhabitants of Longyearbyen also proved itself useful, especially in considering their present degree of dependence on the coal industry.

Although a minute scientific analysis is beyond the ambition of this short report, I will try to argue *why it is environmentally advantageous and politically conceivable to assume the existence of a Norwegian stable settlement on Svalbard, even in the absence of the local coal enterprise*. In the second part of the paper, *I will argue about the current and future potential of renewable sources (wind and PV) to replace the town coal-based power plant*. A preliminary assessment of the estimated investment, of the social, political, technical and environmental challenges to overcome and of the possible visual impact, will also be included in my exploratory scenario.

2. Historical overview

In the last two centuries, Svalbard has been theatre of several 'cold wars' between different countries (Norway, Great Britain, Denmark, Sweden, Russia, Holland, USA, Germany, France, Spain, Poland), that have silently fought each other, either for the monopoly on fishing and hunting, for the conquest of the North Pole, for the strategic area, for scientific reasons, or for the exploitation of mineral resources (Hoel 1925, Orheim 2006).

In 1920, the negotiations after the end of the First World War were taken as an opportunity to establish order also in this 'nobody's land'. Norway, at that time a poor country, was then granted sovereignty on it, together with the absolute authority on rules for industrial operations and on safety and protection of the environment. Despite that, Oslo never felt the complete control of the region, mainly because, according to the obsolete (and to a certain extent, unsustainable) Treaty of Spitsbergen (1920), still valid today, citizens from signatory countries can

[1] 15th February 2010 – 14th March 2010.

benefit from the same rights as Norwegians to engage in industrial activities as mining, fishing or hunting and to conduct scientific research.

This circumstance is particularly evident in relation to the Russian claims on the area, historically considered a threat (Brown 2000), in so much as we have assisted to a case of "*environmental colonialism*" (Agarwal and Narain 1991:1, emphasis in the original), a continuous rush of Norway to exploit and occupy Svalbard, way more than any other signatory country. An onerous strategy, often economically arguable, but believed to be advantageous in case of future international resolutions (Orheim 2006).

No country is ready to give up. On one hand, despite an extremely low productivity (SSB 2005a:152), Russia unexplainably keeps running its mine in Barentsburg. On the other hand, Norway, through the Minister of Foreign Affairs Gahr Støre (2006), declared to "have initiated a number of dialogues (…) with states that have an interest in the region", but also made it clear that "there are some questions that are not up for discussion or negotiation. One of these is the question of Norway's continued jurisdiction in accordance with international law".

From a political perspective, the building of a strong Norwegian community, Longyearbyen, the strategic establishment of a campus (UNIS), the creation of a raising business around tourism and the extensive exploitation of mineral resources, make a lot of sense.

What is less clear, though, is the systematic exploitation of mineral resources in such a fragile environment, as the magic formula to resolve a political puzzle.

Robert Hermansen, the former managing director of the mining company (SNSK[2]), interviewed by Brown (2000:2), made it no secret: "To keep control of Svalbard we have to have a community here. If we left, the Russians would immediately claim it".

Yet, a careful reading of the Treaty (1920) and of the following acts[3] reveals *no connection* between mining and sovereignty. On the contrary, Hermansen indirectly confirms that what's politically needed is only a stable settlement, not a polluting mine!

In these terms it becomes quite complicated for Norway, an oil producer, to justify the subsidies given to the only coal industry of the country (Hoel 1925, WWF 2001), which until 2001 was always in economic loss (Store Norske Spitsbergen Grubekompani AS 2004:6), and together with the Russian mine, was responsible in 2007 for the emission of 52% of carbon dioxide (CO_2), 99% of methane (CH_4) and 92% of sulphur dioxide (SO_2), within the archipelago (KLIF 2009:16).

The embarrassment grows even more if we consider the plan to boost the production and open a new mine in 2013 (SNSK 2011a), an act that alone admits the

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[2] Store Norske Spitsbergen Kulkompani (SNSK) is the northernmost coal industry in the world. Established in 1916, it currently operates in two coal mines on Svalbard: *Gruve 7*, just outside Longyearbyen, and *Svea Nord* (Sveagruva), about 60 Km South of the capital. A new mine, located in Lunckefjell, is scheduled to start its operations in winter 2013 (SNSK 2011a).

[3] To the *Treaty of Spitsbergen* (1920), which recognized Norwegian sovereignty and included regulations on taxation, environmental conservation, non-discrimination and military restrictions, followed four acts: the *Svalbard Act* (1925), which made the archipelago officially part of Norway; the *Mining Code* (1925), on the exploitation of mineral resources over the archipelago; the *Svalbard Environmental Protection Act* (2001), that introduced strict laws on the protection of flora, fauna and large areas; the *Boundary Treaty* (2010), signed by Norway and Russia, on the marine boundaries between Svalbard and Novaya Zemlya (Royal Ministry of Justice 1988, Regjeringen 2001, Kramer 2010).

failure of the much advertised goal, declared in the Norwegian parliament in 1995, to make Svalbard "one of the best-managed wilderness areas in the world" (Guðmundsdóttir and Sæþórsdóttir 2009:2).

3. A Contradictory Climate Policy

When the UN World Commission on Environment and Development, chaired by Gro Harlem Brundtland, published its report, *Our Common Future*, and recognized climate change as a main issue for sustainable development (WCED 1987), Norway saw itself as "a natural leader in international environmental policy" (Hovden and Lindseth 2002:146). Its commitment in the stimulation of the 'Montreal Protocol' (NPI 2011), in the contribution to *Agenda 21* (UNCED 1993), in the promotion of flexible mechanisms before the ratification of the Kyoto Protocol (Hovden and Lindseth 2002, Torvanger *et al.* 2004), and even in the failed try to find a common agreement in Copenhagen (WBGU 2010), seems to demonstrate the same.

According to Hovden and Lindseth, though, the Norwegian position on the issue of climate change, must be accounted:

> As a product of two important considerations for any Norwegian government: the need to maintain credibility nationally and internationally as an environmental pioneer, and the fact that Norway, as a leading petroleum exporter is heavily dependent on income from its considerable oil and gas exports (2002:146).

Norway is today the world's sixth largest exporter of oil (EIA 2010:2), and the second largest supplier of natural gas to the European Union (2010:4). These data still do not collide with the environmental leadership, especially if we consider the possibility for industrialized countries to achieve the targets ratified in Kyoto, concerning the reduction and stabilisation of greenhouse gas concentrations in the atmosphere, "by action abroad, rather than at home" (Woodhouse 2000:143).

What is more surprising, instead, is the contradictory way of Norway to justify its oil business as a product "less pollution intensive than fossil alternatives such as coal" (Hanisch[4] 1990, cited in Hovden and Lindseth 2002:150), and its gas exports as a greener option than "the much more polluting coal" (2002: 152).

If coal is such an evil pollutant, and this argument is widely employed to defend the Norwegian trade around oil and gas, why is it still extracted on Svalbard? Is not the archipelago part of Norway? How worthy and necessary is it to run a polluting, often unprofitable industry, furthermore sole in the country, whose economic return is dependent on the fluctuations of an unstable market?

To both the Norwegian Pollution Control Authority[5] and the *Stortinget* (the Norwegian Parliament) goes the uncomfortable duty to provide answers to all these

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[4] Ted Hanisch, former director of CICERO (Center for International Climate and Environmental Research), in 1990 became part of the Norwegian delegation to the climate negotiations as an observer (Hovden and Lindseth 2002).

[5] The Norwegian Pollution Control Authority (SFT) "has the responsibility for controlling and licensing the Norwegian and Russian coal industry and the energy production from the coal power plants in Longyearbyen and Barentsburg" (Governor of Svalbard 2011:1).

questions, in addition to the ethical responsibility of implementing a more coherent international climate policy.

4. Environmental Degradation: A Way Out

In the last century, the temperature in the Arctic has increased twice as quickly as the world's average (IPCC 2007). According to NPI (2011:8), the mean annual temperature on north-east of Svalbard, compared to the current, may even increase of 8°C by the end of this century, a scenario that would certainly induce dramatic ecological consequences at a local and global level.

By reflecting back to space the received solar energy (albedo effect), light surfaces like snow, glaciers and sea ice, act "like a mirror" (KLIF 2009:10). Their melting on Svalbard, already in place, is not only causing sea level to raise, a shorter winter season and the release into the atmosphere of huge quantities of previously trapped GHG as methane (CH_4) or carbon dioxide (CO_2) (NPI 2011), but also more absorption of solar radiation, which is accelerating even more the ongoing process of global warming (Borroughs 2007).

As a result, also the biological diversity on the archipelago is in danger:

> Several species are dependent on sea ice, such as ice algae that grow in and under the ice, seals that need sea ice to give birth to their young, polar bears[6] that prey on seals, and several species of seabirds, as many aspects of their lifecycle are associated with sea ice (NPI 2011:11).

Although climate change in the Norwegian Arctic is mainly caused by GHG emissions in other areas of the world, local pollutants can also visibly affect the surrounding ecosystem (NPI 2011). A recent study of the University of Science and Technology of Trondheim, for example, has demonstrated how the problem of acid mine drainage in Bjørndalen (Svalbard), caused by "degradation of sulphide minerals in presence of water and oxygen" (Holm *et al.* 2003:1), is persistent in creating "damage to the local tundra vegetation" (*ibidem*), despite the fact that the mine has been closed down since 1996.

Among the scientific community, there is very little doubt that the main local contributors to Svalbard's climate change are the substantial emissions of carbon dioxide, methane, sulphur dioxide, nitrogen oxides, black carbon (soot), and organic carbon. These are all GHG and pollutants directly connected with the energy production in the coal-based power plant and with the operations of extraction, transportation and shipping of coal (KLIF 2009:15-16).

Yet, data on the total emission of CO_2 within the archipelago in 2007, surprisingly account for only 1% of the carbon dioxide emitted from the mainland in the same year (2009:15). This is a very small number, as seen in these terms. If, instead, we espouse the more sustainable sharing theory of *per-capita emissions*, supported by Agarwal and Narain (1991) and Wilhite and Norgard (2004), then we

[6] A study commissioned by the US Government, has shown how long-distance swimming for a female polar bear in Arctic waters, in a year of extreme sea ice retreat, "may result in high energetic costs and compromise reproductive fitness" (Durner *et al.* 2011:1).

realise how intolerable the current situation on Svalbard is[7]. Here the per-capita emission of CO_2 in 2007 is 181 tons, 3 times more than that of a citizen of Qatar, the country with the highest per-capita emission in the world (55.4 tons); 20 times more than a Norwegian living on the mainland (9.1 tons); 36 times more than a Chinese (5 tons), and 129 times more than an Indian (1.4 tons) (World Bank 2007).

Despite the reassurance of the mine company on the priority given to safety, so to make sure that as a result of its operations "*no humans or wildlife become sick or injured nor the natural environment damaged*" (SNSK 2011b, emphasis added), the environmental impact of the coal enterprise on the local ecosystem is no longer disputable and, as mentioned above, proved by different scientific studies (Holm *et al.* 2003, KLIF 2009, NPI 2011). All of them confirm that today's local emission rates "will continue to increase in the future unless additional measures are taken" (KLIF 2009:39).

I argue that such a serious environmental alarm already constitutes a sufficient argument to justify a forced closedown of the Norwegian mines on Svalbard, a possibility that is also politically feasible, since, as demonstrated above, it would not undermine the sovereign rights of Norway on the region (Treaty of Spitsbergen 1920).

How would such a decision affect life in the Norwegian settlements of Sveagruva and Longyearbyen?

A scenario in which *Gruve 7* and *Svea Nord* are closed, is likely to cause the complete abandoning of Sveagruva, as already happened in Pyramiden in 1998, an effect of Russia's decision to closedown the local mine (Orheim 2006).

More complex, instead, appears the analysis of potential repercussions in Longyearbyen, where, since the early 1990s, "there have been major changes in working life" (SSB 2009:12). Although mining and construction, with 387 persons employed (SSB 2010b:383), are still the largest endeavours in terms of occupation (26%)[8], "all private-sector service industries have more than doubled their employment in the period 1993-2007" (SSB 2009:12), with particular reference to the fields of tourism, research and education (Guðmundsdóttir and Sæþórsdóttir 2009, SSB 2009).

Despite a large scepticism noticed among the inhabitants[9], the trend underlined by SSB statistics is very useful in considering their current degree of dependence on coal. Data suggests that a permanent community would probably survive anyway to a closedown of the mines. The other industrial sectors, in fact, appear mature and strong enough to manage the loss of direct and indirect business provided by the coal enterprise in town and to absorb a number of unemployed individuals, for instance, in the fast-growing tourist industry.

In a scenario without mines, though, the replacement of coal in the local power plant becomes a vital, as well as an ethical, issue to solve. Bearing in mind that "*things which are easy today because of the availability of suitable fossil fuels (…) will not be easy in the future*" (Ferguson 2008:137, emphasis in the original), the recourse to renewable energy seems the only viable alternative.

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[7] On 01/01/2007 Svalbard's total population was of 2,338 inhabitants (SSB 2010a:1).
[8] Calculated in relation to 1,495 persons (adult population employed in 2009) (SSB 2010c:1).
[9] The perspective of closedown of the mines appears unrealistic to most of the inhabitants, mainly for political reasons (Source: Author's informal conversations).

JAN	*FEB*	*MA R*	*APR*	*MA Y*	*JUN*	*JUL*	*AU G*	*SEP*	*OCT*	*NO V*	*DE C*
6.01	**5.97**	**5.0**	**4.84**	**4.3**	**4.28**	**4.29**	**3.79**	**4.22**	**4.98**	**5.67**	**5.83**

Table 1: Monthly wind speed average, observed at Svalbard Airport (4.8 Km North-West of Longyearbyen) in the period 2001-2010. Unit: m/s (NMI 2011:FFM).

The entire second part of this report, thus, will concern a preliminary analysis of the potential adoption of photovoltaic (PV) and on-shore wind power, as complementary substitutes of coal in meeting Longyearbyen's energy demand.

5. The Present and Future Potential of Renewable Energy in Longyearbyen: An *Exploratory Scenario*

Svalbard's abundance of wind and sun constitute the basis of the following *exploratory scenario*. Through the use of literature and statistics, I seek for ideal conditions and numerical evidence to prove the benefit of investments into the field of renewable energy in Longyearbyen.

5.1. Designing a wind park.

On a global scale, wind is the result of "uneven heating of the Earth's surface combined with the rotation of the planet" (Dahl 2004a:3). At Svalbard this condition is stressed even more by the warm Gulf Stream that hits the stiff shore. The colder the coast, the stronger the winds generated. It is mainly for this reason that the windiest months of the year in Longyearbyen are those who present a lower solar irradiation (Table 1).

According to Dahl, in order to assess whether the wind can be considered a reliable option for any Polar renewable energy project, a given site must present "average wind speeds of greater than 4 m/s" (2004a:6). This is because wind velocity, due to its cubed expression, is extremely decisive in the output formula of a turbine:

$$P = 1/2\, \varrho\, A\, V^3$$

Where P is the available power from the wind (measured in Watt), ϱ the air density (Kg/m^3), A the swept area of the rotor (m^2), and V the wind speed (m/s).

An increase of any of these factors, in particular V, will lead to a considerable expansion of the final power output (Ngô and Natowitz 2009). The need to find the windiest location possible, then, is of crucial importance in the design-stage of a wind park.

Although the only official data available (Table 1) already show that all months of the year, apart from August, appear perfect to the development of a wind farm just outside Longyearbyen, there is still room for improvement, for example, by finding a location with stronger wind.

JAN	*FEB*	*MA R*	*APR*	*MA Y*	*JUN*	*JUL*	*AU G*	*SEP*	*OCT*	*NO V*	*DE C*
7.81	**7.76**	**6.5**	**6.29**	**5.59**	**5.56**	**5.58**	**4.93**	**5.49**	**6.47**	**7.37**	**7.58**

Table 2: Monthly wind speed average assumed to be found on top of Platåberget, calculated by rising of 30% the data in Table 1. Unit: m/s (Seifried and Witzel 2010:102).

Since the observations have been made near the airport, at an altitude of only 28 m (NMI 2011), and considering that wind velocities are generally 30% higher at peaks (Seifried and Witzel 2010:102), it would be much more convenient to place wind turbines on top of a hill. Thus, with the help of a topographical map (Annex 1), we may locate a perfect site, for instance, on top of Platåberget (450 m), between the airport and town.

From a morphological point of view, this plateau, with its flat and large clear area, seems ideal for hosting big turbines. At the same time, it presents the remarkable advantage of being very close to the grid of the settlement.

Following Seifried and Witzel, then, we can *presume* to meet the monthly average velocities on top of Platåberget, specified in Table 2.

As a result of such a small change in location, we are now expected to meet suitable conditions for the design of a wind park even in August. In addition to that, the annual wind speed average increased from 4.93 m/s to about 6.5 m/s, a significant difference in terms of power output.

Once located the site, the next step is to select the right type of wind turbine, in relation to the environmental conditions and to the energy demand (Dahl 2004a).
The most recent statistics available[10], relative to the year 2003, quantify in 68 GWh the annual consumption of electricity in Longyearbyen (SSB 2005b:158), a number partially explainable by the harsh weather conditions that force households and offices to keep their heating systems on, all year long. To cope with such a hostile weather, the choice of the most resistant, efficient and technologically advanced turbine on the market, is advisable.
Let us take, for example, the new *Gamesa G97* (Gamesa 2011), a medium-sized turbine with a capacity rate of 2 MW that, in relation to our wind data (average wind speed of 6.5 m/s and a supposed air density of 1.225 Kg/m^3), promises to release about 760 W of *instantaneous power* (Gamesa 2011:8).

Assuming a *capacity factor* of 40% (3500 h/year), "the percentage of its nameplate capacity that a turbine installed in a particular location will deliver over the course of a year" (EWEA 2009:445), a level of efficiency very common in new-generation turbines (Dahl 2004a), we are now able to calculate the expected annual power output of a single *G97* placed on top of Platåberget:

760 * 3500 = **2.66 GWh**

[10] The total consumption (68 GWh) also includes the electricity used in mining activities in both *Gruve 7* and *Svea*, quantified in 7 GWh. I have decided not to deduct this term from the total, in order to balance the increase in consumption, which is likely to have occurred in Longyearbyen in the years following the preparation of these statistics (2003).

To hypothesize the number of turbines of this kind needed to meet Longyearbyen's energy demand it is sufficient to divide the annual consumption of electricity by the expected output of a single turbine:

$$68 / 2.66 \approx \textbf{25 turbines G97-2MW}$$

This preliminary assessment, whose demanding investment would add up to € 80,000,000 (Viva Energie 2011, private correspondence), due to lack of precise data from the chosen location, does not claim to be scientifically accurate. What is important, instead, is only to identify the potential of a still unexploited renewable resource.

Yet, developing wind energy on Svalbard, might be a demanding task. A series of technological, environmental, financial and social challenges still need to be addressed.

First of all, it is very difficult to make a heavy turbine stand upon the unstable thawing permafrost. The rise in temperature, caused by climate change, heavily affects permafrost by bringing changes in its form and consistency over time (NPI 2011:36). To master this problem and stand above the surface, houses and research stations in Polar Regions have adopted elevated, adjustable foundations (Dahl 2010). *Would it be possible to implement the same kind of system on weighty wind towers?*

Another big issue related to permafrost is the storage of power. Even in Longyearbyen, despite a certain constancy, the wind does not blow with the same force all year long. Historical observations highlight days of absolute calm (on average 10-11 days/year), and prolonged windy periods, with gusts that exceed 35 m/s (NMI 2011). On such days, in normal conditions, there would exist different ways to store considerable amounts of electricity. Pumped storage plants and compressed air energy storage, for example, are systems able to make the overproduced power available in periods of low production (Seifried and Witzel 2010:156).

Yet, in Longyearbyen, due to the impenetrability of permafrost, these systems cannot be used. *How to store the exceeding energy then? Is it conceivable an outdoor storage system?*

Solutions to these and other similar engineering matters have already been found on a small scale, where renewable technologies (wind-powered turbines, photovoltaic panels and solar thermal collectors), together with ingenious storage systems, allow citizens and researchers in Polar Regions to reduce environmental and financial costs, operating with zero-emission approaches.

Remote examples as the city of Kotzebue in Alaska (CADDET 2001), or the research centres of Summit Station in Greenland (Dahl 2010), and Princess Elisabeth Station in Antarctica (Polar Power 2011), have the realistic potential to develop useful applications in places like Longyearbyen, where issues of the same kind are required to be solved on a larger scale.

Other concerns, though, in addition to technical and logistic ones, might also prevent investors from running smoothly a wind project at Svalbard.

Wind turbines, for instance, have a very short service life, generally between 4 to 10 years (Dahl 2004a:7), require continuous maintenance and are not exempt from bringing environmental and social threats. *Will the investment be able to pay-off in the long run? Will local people refer to the visual changes in landscape as "fascinating symbols of progress"*

(Seifried and Witzel 2010:100, emphasis added)*, or will they think in terms of environmental degradation and noise pollution* (Lorinc 2011)*?* And again: *Could a wind park be dangerous for local wildlife, in particular for rare, migrating species of birds directed to the protected sanctuaries in the north of the archipelago* (Pimentel 2008:5)*?*

The impression is that we will not be able to produce any detailed and rigorous scenario on the implementation of wind turbines in Longyearbyen, until we provide reliable answers to all these questions. For that to happen, though, it is essential to sustain scientific research, develop small-scale examples and make them available to larger communities as Longyearbyen.

5.2. PV: A Ready-made Solution.

Since the issues connected with the exploitation of wind power on Svalbard still need time to be overcome, the direction of our attentions to other renewable resources like sun, capable of stemming GHG emissions right from the beginning, is fundamental.

Although solar energy in Longyearbyen, in terms of significant power output, is available only for four-five months a year (from April to August), the almost nonexistent cloud coverage, scarce level of precipitations (NMI 2011), low temperatures (NSIDC 2011), and land availability, make me think that the archipelago is a perfect place for the implementation of mono-crystalline PV panels. The efficiency of this kind of solar cells, proved around 14-17% in Polar applications (Dahl 2004b:2, Seifried and Witzel 2010:52), is the highest on the market. It means that on a cloudless summer day, when at solar noon about 1,000 W/m^2 hit PV panels placed perpendicular to the sun (Dahl 2004b:11), the output converted into electrical power will be of 140-170 W/m^2.

The promotion of energy generated from PV is already a feasible project in Longyearbyen. Unlike wind turbines, in fact, this silent, durable and fully recyclable technology (Seifried and Witzel 2010:54), does not require storage, transportation, special maintenance or additional research to be installed at Polar latitudes.

A PV project might be carried out either in a big plant outside the settlement or, alternatively, on the roofs of houses and offices in town.
Despite the benefits related to the higher power output, the first option, as for the design of a wind park, could end up looking like an 'environmental monster' for someone.

The visual impact, yet, might not be the only shortcoming. The very "low energy density" (2010:26) of solar panels, together with the limited access to solar resource, would constrain to maximise the production in the 127 days of perpetual daylight (NMI 2011). In order to do that, the requirement of an automated tracking system, capable of orienting the panels always perpendicularly to the sun, could be a demanding technology to build in such a windy location (Dahl 2004b:11, NSIDC 2011).

Much easier and free of drawbacks, instead, would be the installation of PV on the roofs of the houses. In such a scenario, strongly dependent on the willingness of the inhabitants to accept the new technology, households provided with grid-connected panels would take full economic advantage of their own 'micro-production'.

If all 816 households in Longyearbyen (SSB 2005c:54) accepted it on their roofs, a drastic reduction in consumption of coal-based electricity and a drop of local GHG emissions is likely to be expected in summer.

The quality of PV projects in Polar environments has already been tested. Summit Station in Greenland (Dahl 2010), and most of the research stations in Antarctica, for example, use photovoltaic panels as a complementary source of wind turbines to enhance reliability in less windy or dark periods. Together, these renewable technologies feed common battery banks in so called "*hybrid* systems" (Dahl 2004a:3, emphasis in the original).

6. Conclusion

Demonstrating that the local extraction, transportation, shipping and burning of coal are responsible of worsening the ongoing effects of global climate change on Svalbard (Holm *et al.* 2003, KLIF 2009, NPI 2011), in this paper I have argued the urgent need to closedown such activities to respect the amenity of Svalbard's environment.

A decision like that, though, is very likely to cause the loss of a considerable number of jobs, hence the depopulation of Longyearbyen and the consequent political risk for Norway to lose sovereignty of the archipelago. To get around these threats and incentive an alternative option to the coal-based power plant, I have proposed large investments into the field of renewable energy.

My *exploratory report* has highlighted big untapped resources of wind and sun on Svalbard, reciprocal assets that, if implemented in a hybrid, grid-connected wind-PV system, might have the potential to free the town from its energy dependence on a polluting and finite fossil reserve[11].

At the moment, PV is the only practicable renewable technology on Svalbard, although only for a few months a year. Even if alone it will hardly reach the same potential of wind to meet Longyearbyen's energy demand, it can still play an important role in terms of immediate reduction of local GHG emissions. Thus, I argue the need to prioritise its diffusion as soon as possible.

Of course, a new climate strategy, more focused on investments in research and development of small-scale renewable solutions, would be required to complete the process. Such a policy should support the local community of Longyearbyen in particular, whose involvement and conviction in the overall project could prove essential to its final success (Adams and Hulme 2001, WBGU 2010).

According to Torvanger *et al.* (2004:13), if achieved, "early actions" have the power to bring relevant environmental, political and economic effects.

Considering the *environmental* impact first, a reduction of local GHG emissions may slow down Svalbard's ecological degradation, buying precious "time for humans and other species to adapt to climate change" (*Ibid.*).

Political measures (i.e. economic incentives to households who provide their roofs with PV panels), in addition to implement a more coherent Norwegian climate policy, might bring the loss of the world record of CO_2 per-capita emission, which

[11] With the current extraction even at 2.5 million tons/yr, coal reserves will allow operations for only 25 more years (KLIF 2009:39).

cannot be considered a good image for a country that sees itself as a leader in the fight against global warming (Hovden and Lindseth 2002).

Lastly, the whole local *economy* may take advantage of a huge renewable project. Lower bills for households, new job opportunities, new markets for industrial sectors, an impulse to research, innovation and technology and huge savings in energy consumption[12] would be just some of the possible positive effects.

If we agree not to compromise even more of Svalbard's environmental ability "to meet present and future needs" (WCED 1987:43), there is no other way than to bring green energy to Longyearbyen and to make it a reality.

Keeping alive the local tradition connected with coal seems neither environmentally, nor economically sustainable.

How paradoxical, though, that making the political decision to break such a 'black tradition', appears today harder than to overcome scientific obstacles to the implementation of a wind park. But, after all, this is only one of the many contradictions peculiar to the Norwegian climate policy.

[12] The Norwegian mines are currently consuming 7 out of 68 GWh of electricity produced (SSB 2005b:158).

Appendix

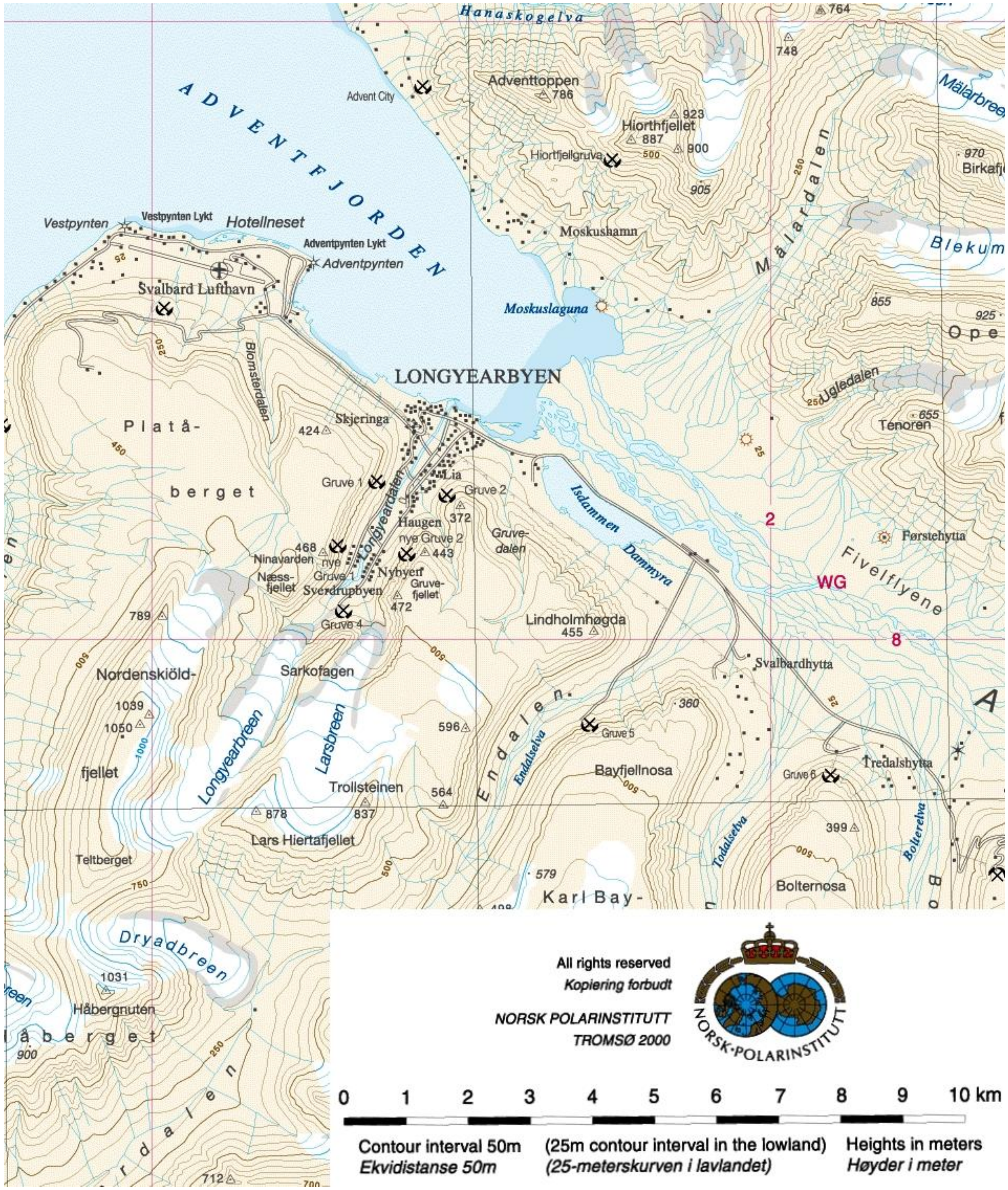

Figure 1: Topographical map of Longyearbyen (NPI 2000).

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