Decarbonizing Antarctic Operations: best practices for renewable energy deployment at Antarctic research stations

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**Submitted by ASOC and Uruguay**

Summary

Efforts to decarbonize (reduce CO2 emissions) Antarctic operations have mainly focused on reducing fuel consumption by introducing energy efficiency measures and renewable energy technologies. However, these efforts have been highly uneven among National Antarctic Programs. While some programs have invested in stations that currently obtain 70 per cent of their energy by renewable sources, most Antarctic facilities remain entirely dependent on fossil fuels. There has been greater progress on energy efficiency, where most of the stations have introduced modifications aimed at reducing electricity consumption. Antarctic operators who have introduced clean energy technologies have reduced costs, greenhouse gas (GHG) emissions, and the risk of incidents and accidents associated with fossil fuels (e.g., spills, fires).

Decarbonizing Antarctic operations will contribute to reducing energy consumption, introducing renewable energy sources, supporting technological research and innovation, and supporting the global efforts to reach climate neutrality.

Therefore, ASOC recommends that ATCPs and as required other Antarctic operators take the following steps:

* **Conduct feasibility studies to decarbonize their operations**, **bases, and activities** with the aim of achieving a Net Zero condition and allocate funds to this objective.
* **Collaborate with public and industry stakeholders** to implement established renewable energy sources and energy efficiency practices.
* **Agree on developing a manual** that outlines the best practices for reducing carbon emissions in Antarctic operations, with a specific focus on using renewable energy and improving energy efficiency at research facilities.

Introduction

Gasoline, diesel, and jet fuel are the main sources of electricity generation at Antarctic research stations. These fuels are also used for ships, boats, and land-based vehicles. Transporting fuel and oil to Antarctica is a costly and sometimes risky exercise. Nevertheless, despite harsh polar conditions, renewable energy sources such as solar and wind have been successfully used for power generation in Antarctica for more than thirty years. The use of renewable energy in Antarctica has been the subject of several documents submitted to the ATCMs. In particular, the Council of Managers of National Antarctic Programs (COMNAP) reported on best practices in energy management, including renewable energy sources, in their operations. This paper discusses the importance of decarbonizing Antarctic operations, and introduces a recent article published in *Antarctic Science1* by researchers associated with ASOC member Agenda Antártica (attached to this IP) with an updated overview on the progress of Antarctic Treaty Parties towards reducing their energy consumption and replacing the fossil fuel system with renewable energy.

Why is it important to decarbonize Antarctic operations?

Decarbonizing (reducing CO2 emissions) Antarctic energy systems has shown multiple benefits.

1. **Fuel cost savings**

Renewable energy technologies have been shown to reduce the investment need of fossil fuels and their related transport costs.

Cargo ships, helicopters and other vehicles that are used to transport fuel to Antarctic stations are costly, representing a significant part of any Antarctic Treaty Party operational budget. Moreover, the price of oil is volatile. During 2008, the price of a barrel of oil surpassed US$100, creating large budget constraints in Antarctic operations. Renewable energy technologies, even if they involve large upfront investment, have been shown to lower costs in the long-term period and have more stable maintenance. An optimized operation strategy, compared with the original operation strategy of the system, has an 11.8% energy saving space, and the total diesel consumption of the system can be reduced by 9.6% per year in an Antarctic station.

1. **Minimize the environmental impact and the greenhouse gas (GHG) emissions footprint in alignment with national decarbonization targets**

Minimizing the carbon footprint of operations is a key goal of several Antarctic Treaty Parties. This goal aligns sometimes with the larger national efforts towards decarbonization and sustainability. By reducing the reliance on fossil fuels, Antarctic parties can not only mitigate climate change by emissions reduction by also reduce the risk of incidents and accidents related to transporting fuels including spills or fires.

The literature on the subject indicates that wind and solar electricity generation can significantly benefit the environment. For example, wind turbines use minimal land area compared to other energy systems per unit of electricity produced. Additionally, wind turbines and solar panels have an operational lifespan of 20-25 years, during which they emit zero greenhouse gases once in operation. While some greenhouse gases are produced during the construction phase, these emissions are offset by the reduction in emissions during the first few months of operation. Additionally, complementing or replacing fossil fuels with clean energy sources will reduce the number of accidents that might occur when oil is transported. The Antarctic is more susceptible to oil spills because of the region’s extreme temperatures that reduce the structural integrity of equipment (e.g., tanks and fittings) and make fuel pumping more challenging. Oil and fuel spills are particularly hazardous in polar regions as the oil decomposes at a slower rate compared to warmer regions, causing longer impacts on the ecosystem impacts. Also, most fire accidents in the Antarctic are due to problems related to fuel handling. For example, an accident with a fuel transfer inside the Brazilian base Comandante Ferraz’s engine room set fire to and destroyed the station in 2012.

1. **Development and/or testing of new technologies.**

The development of new technologies has been one of the aims of installing renewable energy in Antarctica. The idea is to test their performance, endurance, and reliability under sub-zero temperatures and extreme weather conditions such as ice, wind, and snowstorms. Traditional renewable energy sources like solar panels and wind turbines are still a challenge when it comes to providing energy during winter months. As an example, strong, gusty winds and freezing temperatures can place enormous stresses on wind turbine rotors and cause mechanical failures. Lessons extracted from the challenging Antarctic environment can be highly valuable for the advancement of renewable energy technologies in general.

1. **Ethical duty of Parties to keep Antarctica unpolluted**

While the emissions produced in Antarctica are insignificant compared to those at the international level, the operational and economic benefits are concrete. Reducing emissions has a central symbolic importance for the protection of Antarctic values as outlined in Art. 3 of the Protocol. Developing clean energies in the Antarctic sends a message to the world: if governments can develop clean energy systems in one of the most hostile and isolated places on the planet, it can be carried out anywhere else in the world. In addition, reducing emissions from the continent is an ethical duty of parties to keep the most pristine region on the planet unpolluted. Antarctic researchers generate crucial, cutting-edge climate science for global public interest. If Antarctica is helping to save the world by understanding climate change, Antarctica must be a model in every sense.

Progress on introducing renewable energy in Antarctica

In an article recently published in *Antarctic Science[[1]](#endnote-1)*, Lucci, Alegre and Vigna (2022) provide an updated summary on the progress of Antarctic Treaty Parties towards reducing their energy consumption and replacing the fossil fuel system with renewable energy and include an interactive database. It also discusses the environmental and economic benefits of using clean energy versus fossil sources.

According to the authors, by the end of 2021, 29 facilities (out of a total of 91) have incorporated renewables in their energy systems. However, only one permanent and four summer stations use renewables to meet more than 50% of their energy needs.

Recommendations

These experiences have shown that extreme cold weather and gusty wind conditions are not a limit to the development of renewable energy systems in Antarctica. Stations designed with energy efficiency in mind, some of which have been built in recent years, have the opportunity to be a leading case for future progress. Based on the literature it is apparent that just over 30% of Antarctic facilities were using renewable energy.

In addition to actively collaborating and sharing expertise on de-carbonizationamong National Antarctic Programs, ASOC is recommending that ATCPs and as required other Antarctic operators take the following steps:

* **Conduct feasibility studies to decarbonize their operations, bases, and activities** with the aim of achieving a Net Zero condition and allocate funds to this objective.
* **Collaborate with public and industry stakeholders** to implement established renewable energy sources and energy efficiency practices.
* **Agree on developing a manual** that outlines the best practices for reducing carbon emissions in Antarctic operations, with a specific focus on using renewable energy and improving energy efficiency at research facilities.

1. Lucci, J., Alegre, M., & Vigna, L. (2022). Renewables in Antarctica: An assessment of progress to decarbonize the energy matrix of research facilities. *Antarctic Science,* *34*(5), 374-388. doi:10.1017/S095410202200030X. [↑](#endnote-ref-1)