Renewable energy across the Arctic:
Greenland Report
EXECUTIVE SUMMARY

Greenland has been partly self-supplying with energy since 1993 by help of hydropower plants. The national energy production is increasing, but Greenland still depends on imported oil, primarily gas oil, diesel and petrol.

Greenland has firm green ambitions – and potentials – in the energy sector. The Government of Greenland is committed to developing new hydropower plants in five communities and to invest in renewable energy for small, isolated settlements (Government of Greenland, coalition agreement 2016-2018). By pairing large-scale industry with renewable energy, Greenland can take a lead position in sustainable business.

A central driver for the Government of Greenland’s commitment to renewable energy is an urge for a self-sustained economy and financial independence from subsidies from Denmark. When replacing imported fossil fuels with national energy production, the Government of Greenland supports the national economy while reducing CO2-emissions.

Many communities in Greenland are small, and the grid comprises today 69 decentralized, stand-alone energy systems with no option for the distribution of renewable energy. However, two cities – Qaqortoq and Narsaq - are connected to the same hydro power plant in Qorlortorsuaq. Size matters in Greenland, as the country has an area greater than Mexico and with some communities very remote.

The potential for hydropower is far from exhausted. New plants are already further analyzed, developed and in pipeline for five communities: Aasiaat, Qasigiannguit, Maniitsoq, Paamiut and Nanortalik.

With more hydropower on the local grids, electric and hybrid cars can replace the use of gasoline and diesel. First-movers have already been out for some years, and more power stations are key to leverage.

In remote communities with smaller populations that traditionally depended completely on fossil fuel other solutions become increasingly relevant. Solar cells have already been well implemented and are surely scalable. Whereas wind energy has been rejected as an option for Greenland earlier, recent experiments in Greenland and studies from Alaska show how state-of-the-art wind turbines can function in Arctic conditions. Hybrid utility plants also give promising results, but further investigations and investments are needed.

There is a need for reduced energy consumption in Greenland. In communities with no hydropower plants energy is produced using fossil fuels, in communities with hydropower plants growing demand for energy challenges the production capacity of existing facilities. In 2008 a third turbine was installed in the hydropower plant near Nuuk to meet a growing demand from an increasing population, and currently work is taking place to add capacity to the Qorlortorsuaq hydropower plant. Reduced energy consumption should be reached by growing public awareness on the need for energy saving in all households by help of modern technology including improved insulation of houses, heat pumps etc.
A domestic electricity grid starting with a cable on the west coast connecting communities along the coast from the most southern city to Qasigiannguit in the Disco Bay area would make renewable energy accessible for a larger group of citizens. Also industries like mining could benefit from an electricity grid.

In the absence of cables, there is still an unexplored potential in hydrogen plants that enables the transportation of renewable hydropower energy to off-grid communities. A corporate partnership is probably needed to fulfill this.
INTRODUCTION

Greenland’s vast area is larger than Mexico but scarcely populated many places. As indeed many populations in the Arctic, the 55,847 Greenlanders enjoy highly diverse ways of life, incorporating traditional and native livelihoods with modern technology and world economy outreach. 87% of the Greenlandic population lives in 16 towns, and the rest 13% in 60 small settlements (Grønlands Statistik, 2015), and the cultural variation from the North to the South and from the East to the West is unique. Nuuk, the capital of Greenland, has grown dramatically over the last decades and currently has a population of 17,600 (2017). the second largest town is Sisimiut with 4,000 citizens. Thus, the population and energy consumption is spread over a large area in small stand-alone systems.

This report provides an overview of the current state of energy in Greenland and the potential for more renewable energy in a society in change. With the Act on Greenland Self-Government from 2009, Greenland’s status in the Kingdom of Denmark has been redefined; though both Greenland and Denmark are committed to their responsibilities in the constitutional set-up, there is a growing concern in Greenland about dependence on subsidies from Denmark. The Act on Greenland Self-Government gives incentive for Greenland to exploit its resources and to grow its extractive industry sector. This implies massive infrastructure investment and impact on daily lives for Greenlandic citizens. By pairing large-scale industry with renewable energy, Greenland can take a lead position in sustainable business and ensure a much-needed economic boost. Thus, energy planning is intrinsically linked with Greenland’s development as such.

The government-owned energy company Nukissiorfiit is responsible for delivering energy (electricity, heating) and water across the country. However, in the three communities of Kangerlussuaq, Narsarsuaq and Kulusuk the air traffic authority, Mittarfeqarfiit Greenland Airport, provides the energy. The designated roles of the parties give both the Government of Greenland and Nukissiorfiit key roles in forming the green transition in Greenland. Whereas the Government formulates the strategy, Nukissiorfiit is consulted in the policymaking and constantly involved in the search for new ways of covering Greenland’s energy need. While this report is in writing, the Government of Greenland is drafting an energy sector plan. It is the intent of this report to make the case for a sector plan that is sustainable.

The report will identify the barriers for the transition to renewable energy in Greenland and how to overcome them. Greenland has been partly self-supplying with energy since 1993 by help of hydropower plants and waste incineration. Greenland adopted its Energy Supply Regulation No.14 from November 6 in 1997 (Grønlands Hjemmestyre, 1997), and this is still in force and forms the basis for promotion of renewable energy sources in Greenland (Mortensen 2016). The ESR from 1997 has the aim “to promote the most cost effective and environmentally friendly energy and reducing energy supply dependence on oil with the focus at economizing and savings in energy consumption, maximum security of energy supply, efficiency of production and supply system and cleaner energy production.” (Grønlands Hjemmestyre, 1997). The domestic energy production is increasing, but Greenland still depends on imported oil, primarily gas oil, kerosene and petrol (Villumsen 2016).
CURRENT STATE OF ENERGY

Hydropower is already the main renewable source that provides 60-70% of Greenland’s entire electricity needs, generated by 5 hydropower plants that provide energy to the communities of Qaortoq, Narusq, Nuuk, Sisimiut, Ilulissat and Tasiilaq (Please see info-graphic map at page 3). The rest of communities receive their energy generation through burning fossil fuels, especially diesel (Mortensen 2016). It is remarkable that 33,896 out of 55,847 the population lives in the 6 cities where energy is primarily provided by hydropower, but hydropower still does not completely cover the need for heating and in all towns you still find homes not connected to district heating but relying on private oil burners for heating. Thus, a relatively small part of the population account for the use of fossil fuels (Withdrawn draft for Landsplanredgørelse 2016 “Den nødvendige prioritering” 2016). District heating is produced on diesel generators and from waste incineration in Nanortalik, Qaortoq, Paamiut, Nuuk, Maniitsoq, Sisimiut, Aasiaat, Qasigiannguit, Ilulissat, Uummannaq, Upernavik and Qaanaaq (Grønlands Statistik 2015). Many communities in Greenland are remote, and isolated. Greenland has 70 decentralized, stand-alone energy systems with their own stability requirements with a capacity from ca. 30 kW to 45 MW that can provide electricity to 1-15,000 residents. Heating is generated by waste incineration, fossil heating plants or hydropower in the urban communities (Mortensen 2016).

Reliability of energy production is important for towns as well as for settlements. Even in the small settlements Nukissiorfiit has a power plant with two or three generators to ensure back-up. Outside areas covered by Nukissiorfiit private actors run their own generators, as there is no public heat supply in the settlements. Houses are heated by oil burners or central heating systems based on oil. At some small localities bottled gas or kerosene (petroleum) is used for heating (Villumsen 2016). As this report will show, other solutions become increasingly relevant.

Domestic energy consumption was generally increasing until 2011 but has decreased since. In 2014 the level of energy consumption was 8,481 TJ. This is 5.5% lower than in 2013 and the lowest level since 2002. 3 key factors influence the variation of the total energy consumption from year to year. First, weather conditions determine the need for heating. In northern communities like Upernavik, the average temperature in February is -20°C, but it can go even lower. Second, geological surveys in the form of oil exploration drilling along the west coast are carried out some years. This has significant impact on the overall energy consumption due to the large amounts of fossil fuels required. Third, a general downturn of the economy in Greenland has contributed to a reduction in energy consumption since 2012 (Grønlands Statistik).

While energy consumption is decreasing, the production of renewable energy has increased steadily since 1993 when the first hydropower plant was opened. In 2014, the total production of renewable energy was 1,519 TJ. This is an increase of 2.9% compared to 2013. Hydropower is by far the most important renewable energy source. The country’s hydropower plants produced 1,427 TJ of electricity in 2014. This corresponds to 94.0% of the total production of renewable energy. The country’s largest plant in Buksefjorden near Nuuk produced 899 TJ, while the plants in Tasiilaq, Qorlortorsuaq, Sisimiut and Ilulissat produced 23 TJ, 98 TJ, 168 TJ and 239 TJ respectively.
Energy Usage

Greenland’s infrastructure is very defining for the level and type of energy consumption. Because of the country’s size and the lack of roads or railways, aviation and shipping play a key role as forms of transportation. Especially aviation is a source of heavy CO2-emissions – accounting for 47%, whereas shipping takes up 31% (Grønlands Statistik 2014).

When we look at the distribution of energy consumption on different production businesses, fishing (being the largest industry today) takes up far the largest proportion of energy consumption (67%) both for fuel for the vessels, but also the service on land (Grønlands Statistik 2014).
When looking at the energy mix delivered to all communities, i.e. stand-alone energy systems, it is important to remember that with the present energy infrastructure fossil fuels are shipped in and often times sold and resold. This makes it unsure how much of the fuel is actually consumed where it is delivered. Only the renewable energy sources – hydropower and waste incineration – are surely consumed locally. Also the infrastructure of today leaves no option for registering the exact proportions of energy used for transport, heating and electricity respectively. Also some fuels have multiple usages.

There are two remarkable tendencies in the current energy mix. First, hydropower plants are set up in Nuuk (Buksfjorden 1993, increased capacity in 2008), Tasiilaq (2005), Qorlortorsuaq (Qaqortoq and Narsaq 2008), Sisimiut (2009) and Ilulissat (2010). These plants altogether account for about 60% of Nukissiorfiit energy production and contribute to a large proportion of the energy mix in these communities.

Second, the municipalities deliver energy to the district heating grids by help of waste incineration in Qaqortoq, Nuuk, Maniitsoq, Sisimiut and Ilulissat. This was initiated in 1989 in Nuuk but has not been unproblematic all the way. Municipalities have struggled to find accurate methods and technologies that support a clean burning process that does no harm neither to health, nature or environment. Nevertheless, having learned how to run the waste incineration responsibly, the municipalities now contribute to reducing CO2-emissions both by replacing oil burning and by handling the waste locally instead of shipping it out. The best solution - economically and environmentally – is different from one community and one municipality to another. Elements include distances between communities as well as capacity for handling waste as an energy resource. Kommuneqarfik Sermersooq – the municipality covering the capital of Nuuk, Paamiut and Tasiilaq and Ittoqqortoormiit on the east coast of Greenland – are currently shipping waste to feed the incinerator in Nuuk.

There is yet another growing green trend to be identified. Since 2013, the Government of Greenland has promoted private production of renewable energy by use of solar cells and wind turbines in communities with no hydropower plant. Surplus of energy production from one household, e.g. from solar panels owned by private home owners, can be

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**TYPES OF ENERGY IN USE IN GREENLAND**

*Gasoline:* Fuels cars.

*Gas oil:* Gas oil and kerosene belong to the same boiling range in the refining process and can be widely used for the same purposes, and are thus not distinguished in the energy statistics.

*Jet A-1:* A kerosene which is used in aviation.

*Kerosene:* Fuels cars but is also used for heating and other purposes.

*Heavy fuel oil:* Consists of the IFO-30, IFO-180 and HFO-380 that are all viscous fuels used for transport of goods by sea and in large fishing vessels.

*Av gas:* Aviation gas used for piston engine powered airplanes and helicopters.

*DFA:* Diesel Fuel Arctic suitable for Arctic weather conditions.

*LPG:* Liquid petroleum gas used mainly as fuel for private boats, but also useful in roof constructions.

*Waste oil:* Oils used as fuel in industry and by conversion.

*Waste incineration:* The municipalities contribute to heat production by help of waste incineration.

*Hydropower:* Classical hydropower plants delivering energy to local grids.
sold to the community energy grid (Selvstyrets bekendtgørelse nr. 21 af 9. december 2013 om levering og salg af overskudselektricitet fra vedvarende energi anlæg til forsyningsvirksomheder). Table 2 shows what Nukissiorfiit pays in DKK for receiving energy from private producers. The tendency here is a growing engagement over the past two years. This indicates that especially solar cells are well functioning and popular, whereas wind turbines are still considered less relevant in Greenland among the consumers.

TABLE 2. Private production of renewable energy sold to local community grids in kWh in the years 2014-2016

<table>
<thead>
<tr>
<th>Community/year</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nanortalik</td>
<td>-</td>
<td>-</td>
<td>23.726,15</td>
</tr>
<tr>
<td>Paamiut</td>
<td>3.845,41</td>
<td>2.176,08</td>
<td>2.135,66</td>
</tr>
<tr>
<td>Maniitsoq</td>
<td>60.653,02</td>
<td>91.535,12</td>
<td>132.271,19</td>
</tr>
<tr>
<td>Aasiaat</td>
<td>1.141,97</td>
<td>12.887,27</td>
<td>22.960,92</td>
</tr>
<tr>
<td>Oqaatsut</td>
<td>-</td>
<td>648,77</td>
<td>2.069,44</td>
</tr>
<tr>
<td></td>
<td>65.640,41</td>
<td>107.247,24</td>
<td>183.163,37</td>
</tr>
</tbody>
</table>

Energy Efficiency/ Conservation

Nukissiorfiit has stated in its CSR strategy that it wishes to contribute to lowering CO2-emissions by initiatives that raise the consumer awareness in private households as well as businesses (Nukissiorfiit annual report 2015). This is aligned with government policy, but action still needs to be taken. As the first step, Nukissiorfiit has successfully provided consumers with professional guiding on energy saving. Next, it strives to go further with an extended consumer service for tracking the household’s spending and comparing it to equivalent households in the same part of the country. The effect of the initiative is, however, still not registered anywhere (Nukissiorfiit, personal communication).

Many people live in rented apartments through the national housing company INI. The apartments typically have no individual electricity meters but share one covering a number of households and pay a share of the total energy consumption in their neighbourhood that reflects the size of the individual apartments. This leaves little incentive for each household to save energy and invest in insulation and other energy friendly technologies. In pilot projects the effects individual meters have been tested. In Sisimiut meters reduced the use of heating and warm water by 19% respectively 20%. And in a neighbourhood in Nuuk use of heating was 32% lower for homes with individual meters compared to homes without individual meters. (Rambøll report for Nukissiorfiit. Sermitsiaq.AG. Varmemålere giver store besparelser. Marts 2017). Nukissiorfiit over the years have run campaigns to raise awareness about responsible
energy behaviour, but pilot projects indicate that people must be rewarded directly for a more responsible behaviour with savings on their energy bills.

Also increasing energy prices in Greenland over years have informed the awareness on the side of the consumers who look for improved insulation of houses. Whereas many reports and researchers have pointed to a potential in this area, there is still no calculations of the total potential of energy saved in this way (Villumsen 2016).

RENEWABLE ENERGY SOLUTIONS

Technical Options

The potential for hydropower is far from exhausted

The Government of Greenland has solid green ambitions in the energy sector. While the previous Government had a vision that 90% of energy production from the national energy company Nukissiorfiit should be renewable by 2030 and new hydropower plants should be developed in five communities; Aasiaat, Qasigiannguit, Maniitsoq, Paamiut and Nanortalik (coalition agreement 2016, Nukissiorfiit). , the current coalition has erased the 2030 target, but states a commitment to developing new hydropower plants and to invest in renewable energy solutions for small, isolated communities (Government of Greenland, coalition agreement 2016-2018). A central driver for the Government of Greenland’s commitment to renewable energy is an urge for financial and, eventually, political independence. When replacing imported fossil fuels with domestic energy production, the Government of Greenland supports the national economy while reducing CO2-emissions.
Studies of hydropower potentials are carried out regularly. Most of the studies are carried out in South Western and Western Greenland up to Uummannaq and in a minor area in Eastern Greenland around Tasiilaq. A total of 16 catchment areas with an annual potential of 13,000 GWh (46,800 TJ) have been mapped. In the same area, 15 minor catchments are present, estimated to add 620 GWh/year (2200 GWh) to this value. Although the estimate is based on many years of research, the numbers are still uncertain especially due to major climatic changes through the latest years (Villumsen 2016).

The info-graphic map illustrates existing and future hydropower plants coverage. If the Government of Greenland manages to deliver what is stated in the coalition agreement, the citizens of Aasiaat, Qasigiannguit (4,785 persons), Paamiut (1,429 persons) and Nanortalik (1,264 persons), 13.4% of the population in 2016 will get access to renewable energy (withdrawn draft for Landsplanredegørelse 2016). Furthermore, Nukissiorfiit is preparing an increase in capacity at the hydropower plant in Qorlortorsuaq.

With more hydropower on the local grids, electric and hybrid cars also have a potential for replacing gasoline and diesel. The first-movers have already been around in Nuuk for some years, and Nukissiorfiit has recently opened new power stations as part of a pilot project to make this technology more accessible (Nukissiorfiit, personal communication). Hybrid cars are successful thanks to national policies that support this tendency, but there are no indications of the usage of fossil fuel and electricity respectively. Also, consumer concerns about the uncertainty of prolongation of government policies can be a barrier to further investment.

By pairing large-scale industry with hydropower, Greenland can take a lead position in sustainable business. The idea of combining hydropower and industry goes back almost a century to the cryolite mine in Ivittuut (Steenfoss & Taagholt 2012). After the energy crisis in 1973 the idea came up again and was really the backbone of the first regular hydropower potential studies carried out from 1975 and onwards first by GTO (Grønlands Tekniske Organisation) and now by Nukissiorfiit in cooperation with Asiaq (Greenland Survey) and GEUS (Greenland Geological Survey). In the first years, the intention was to identify the biggest potentials for energy demanding industries such as mining, production of fertilizers and aluminum. In the 1980-ties focus was on “community-near potentials” and minor basins that could replace or supplement diesel burning in the Greenlandic communities (Villumsen 2016). In the light of global climate change the question is timelier now than ever. By pairing large-scale industry with hydropower energy, Greenland can take a lead position in sustainable business. This is interesting for heavy energy consuming industries such as smelters and extraction of aluminum of ammonia (Steenfoss & Taagholt 2012). Corporate and industry partnerships are needed to establish an infrastructure for transmission of hydropower energy. Two remarkable options have been considered so far, but no partnership has been established yet:

1) The Government of Greenland and Alcoa signed a Memorandum of Understanding to develop an aluminum smelter connected to hydropower and a domestic electricity grid starting with a cable on the west coast with the communities of Nuuk, Maniitsoq, and Sisimiut. This would make renewable energy accessible for a large group of citizens, but such cables require massive investment. A cable connection between Greenland and its neighbouring countries has also recently been discussed but is not considered to be realistic in the nearest future. The business case for a cable connection is dependent on a large demand to support investments at such scale as well as technical experience. Neither is present at the moment. (Villumsen 2016) (Nukissiorfiit, personal comment).

2) In the absence of cables, there is still an unexplored potential in hydrogen plants that would enable transport of renewable hydropower energy to off-grid communities. Inatsisartut, the parliament of Greenland, have just decided on
a project make renewable energy accessible to small and isolated settlements. The challenge is that the Paakitsoq hydropower plant produces more energy than is needed in Ilulissat and that the hydropower plant cannot be connected to other communities without large infrastructure investments. The project idea is to use hydrogen for storage and transport of renewable energy to small, isolated communities currently dependent on energy from diesel generators (Inatsisartut, FM2017/182).

Other solutions are needed – and accessible

With 69 decentralized, stand-alone energy systems some of them in remote and scarcely populated communities, hydropower is not a realistic supplier for all communities as long as there is no transmission grid. Meanwhile, other solutions have proven relevant and applicable in Greenland.

**Biomass** is not widely available in Greenland and not considered relevant. Experiments with **geothermal energy** are initiated during 2015. **Tide- and wave energy** are still not in use but undergoing tests and research (Nukissiorfiit, Mortensen 2016). **Waste incineration** can also be up-scaled now that municipalities have identified how to run it responsibly. In the 1980-ties there were experiments with **mini hydropower plants** and still today you find small facilities that provide energy from streams to local sheep farms in South Greenland, but none of the sources interviewed for this report have thought of this as a scalable solution (Steenfos and Taagholt 2012).

There has been a widespread idea that **wind power** will not work in Greenland because the winds are blowing either too little, too rarely or too strongly (Mortensen 2016). Whereas wind energy has been rejected as an option for Greenland earlier, recent experiments in Greenland and studies from Alaska show how state-of-the-art wind turbines can function in Arctic conditions. The company Pars in Ilulissat also has experimented with wind energy as an alternative to solar energy (Langhoff & Christiansen 2014), and the entrepreneur LED Solar Greenland has since 2015 tested 10 wind turbines on different locations along the coast of Greenland. The entrepreneur finds that modern wind turbines work very well and without problems related to icing, but the inverter component needs to be appropriated for local conditions. A new inverter is identified and will be tested in 2017 in a **hybrid utility plant** in Igaliku currently under construction (LED Solar Greenland, personal communication; Nukissiorfiit).

The hybrid utility plant in Igaliku is Nukissiorfiit’s latest development project. Igaliku was chosen as the test location for a number of reasons. The community’s energy consumption is continual over the year and has many sunshine hours. Also Igaliku is accessible in relation to transport of heavy elements and high-qualified operations staff needed for troubleshooting and servicing. It is a complex installation that integrates wind and sun with a battery bank as a storage device and a diesel generator for back-up. The purpose is to test promising new technology with relevance particularly for the smaller communities (Nukissiorfiit, personal communication). Also other experiments with hybrid technologies have been initiated. In Sisimiut, Center for Arctic Technology (ARTEK) has installed a solar heating system in a high school. In Uummannaq and the settlement Sarfannguaq different research projects regarding solar, wind and hydropower take place. The Governmental Fund for Renewable Energy sources and Climate (VEK-puljen) supports such innovative projects (Mortensen 2016).

**Solar power** is a promising energy source that already has been well implemented and surely is scalable as indicated in table 4. The level of radiation varies throughout the year, but at the bottom line there is as much radiation in Greenland as other places on the world where solar power is eagerly implemented (Villumsen 2016). So far, only a few solar panels are fitted with **battery banks**. This means that the energy produced needs to be either consumed instantly
or sold to the Nukissiorfiit grid. In public buildings like offices and schools this is unproblematic. For private households it lowers the gain, as people often times are out of their homes in the sunny hours when the solar cells generate power. LED Solar Greenland has searched for updated technology that satisfies the need for a battery that can function also with very low temperatures as in Greenland. This has recently been found and will be implemented in January and February 2017. When selling solar installations, the entrepreneur often also sells heat pumps. By help from a heat pump the energy produced can be used not only for electricity, but also heating. In addition to this, the heat pump improves the indoor climate and is therefore popular. When dimensioning a solar power installation, the entrepreneur calculates how long it takes to return the investment. On average this is 4.5 year for public buildings and 7 years for private buildings where a battery is not included (LED Solar Greenland, personal communication).

Case Studies

Solar panels at the rooftop of the bank GrønlandsBANKEN in Aasiaat have proven to be a very good investment

GrønlandsBANKEN has branches across Greenland. The bank has decided to install solar panels in order to cut down its emissions of CO2.

- Installed in February 2015, the panels in Aasiaat have produced 19.626 MWh so far – and thereby saved 14 t of CO2.
- The connected power of the solar cells is 16.5 kW.
- The yield varies from month to month and cannot completely replace other sources. However, over a year the total yield has proven very satisfying in 2015 and 2016.
Pilot project in Igaliku tests promising new technology with relevance for small communities

This complex installation has been launched in 2016 and starts running in 2017. It benefits from both wind and sun and has an integrated battery bank and a back-up diesel generator:

- The solar panels and wind turbines supply the battery bank with energy via an inverter device that adapts the energy produced and transmit it to the local grid.
  - 400 pieces of 260 Wp polycrystalline solar panels with a total output of approximately 100 kW on an area of 650 m²
  - 70 LWS micro turbines model WCG14-300 W with a total impact of approximately 20 kW. The turbines start producing energy when the wind is at 2 m/s, and they produce their maximum at 10.8 m/s
- The diesel generator system should only be used when the energy consumption exceeds what is accessible from the solar panels, wind turbines or battery bank.
- The diesel generator is in operation when needed, but only for a period until the battery bank is fully charged.

While not a part of the project, surplus energy can be used in hydrogen production. As the transportation issue is still not solved, hydrogen can only be used locally.

TABLE 13. Components of hybrid utility plant
Source: Nukissiorfiit

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BARRIERS

And how to overcome the obstacles

Financial Barriers

An important barrier for investment in solar panels, heat pumps, insulation etc. in small communities is low household incomes in communities where people largely depend on small scale fishery and harvest of marine mammals (Mortensen 2016). Entrepreneurs find that their bargaining position in price negotiations with foreign suppliers gets better as the attention and demand for their products grow in Greenland (LED Solar Greenland, personal communication).

Energy pricing heavily influences the incentive for investment. Environmental taxes have been added to fossil fuels since 2011, but these are not regulated from year to year. Over the last years the energy price has been stable or even seen a slight reduction, while the price for heating as seen an increasing trend following the increase in the world market price for oil.

The most important principle and a major concern for the Government and Nukissiorfiit is to ensure energy supply safety everywhere – no matter what. There have been earlier attempts to get rid of energy subsidies so that consumers pay a price reflecting the cost of energy production. This, however, proved to be extremely expensive in some settlements, and the result today is a complex system of different prices in each community and a politically defined maximum and minimum price. The current coalition of Siumut, Inuit Ataqatigiit and Partii Naleraq is committed to energy prices that ‘are based on solidarity and justice with the purpose to create equal conditions for families across the country. All land-based production facilities must pay equal prices for energy, water and heating to further development of new businesses across the

On 1 January 2011 a new law on environmental tax on energy products came into force. Since then, environmental taxes accounted for:

- 0.10 DKR per liter of gas oil and diesel.
- 0.10 DKR per liter of kerosene / jet A-1.
- 0.10 DKR per liter of motor gasoline and aviation gasoline.
- 113.80 DKR per ton of fuel oil.
- 110.40 DKR per Nm$^3$ gas of any kind, not bottled.
- 73.40 DKR per ton of coal of any kind.
- There is no taxation of bottled gas.

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country’ (Government coalition agreement 2016-2018, WWF translation). A reform of the current energy pricing model in Greenland is being prepared by Government (Nukissiorfiit, personal communication).

The arrangement from 2013 that allows private producers of renewable energy to sell surplus of energy to the community energy grid was an important step. There has, however, been some confusing about the impact on energy prices at community level. When one household no longer pays to the public grid, the prices go up for neighbouring households, the argument goes. The challenge is that the energy price locally reflects the costs of keeping the local generator running, paying staff and fuel. When energy demand is decreasing because people in the community invest in solar panels that provides energy for their home and maybe even excess energy they can sell to the local grid, the total price per produced kWh goes up as many of the costs of keeping the local generator running are fixed. In communities that pay the maximum price in Nukissiorfiit’s pricing system this of course is not the case. But in communities with lower prices members investing in solar panels could increase the price for energy paid by others still relying on the public energy production. There is a need to scrutinise this pricing system to make a reform to support green investment.

The Governments fund for green investments (VEK-puljen) that supports innovative climate initiatives has played a key role in some of the pilot projects that form the basis of the learning we have today. The budget is limited though, and it cannot support the full transition in the implementation phase.

The two banks GrønlandsBANKEN and BankNordik have an important stake in the impressing results with solar cells the past two years. The banks provide advantageous green loans for investments in solar panels. The conditions of the loans make investments accessible and attractive to many households. This is an example of very good synergies that will only get better if promoted.

Political and Legal Barriers

To succeed in major infrastructure change, there is need for foreign investment – along with know-how. The Government of Greenland and Nukissiorfiit have looked for partnerships to ensure finance of: 1) more hydropower plants, 2) a cable grid, and 3) a hydrogen pilot project that includes also transport in relation to the Ilulissat hydropower plant.

One thing is major infrastructural change and large-scale hydropower. As this is still not in the nearest future, it is important meanwhile to have policies in place that support sustainable local solutions. There is a need for flexibility to ensure that consumers whether they are private households, businesses or public organisations can take advantage of and implement all relevant technologies.

Whereas there is generally much political will to deliver on the stated goal of energy independence in Greenland, there is still some reluctance related to the investment risk involved. In 2010 Nukissiorfiit had its first experiments with a hydrogen plant. The company in corporation with DTU Technical University in Denmark found that the technology was too complex, underdeveloped and not appropriate for Greenland at the time. Ever since, Nukissiorfiit follows a principle
of “standing on the shoulders of others”. This means that pilot projects in Greenland should be based on technologies that are well tested somewhere else. The size of Greenland and ditto economy makes even small investments relatively bigger and risky (Nukissorfiit, personal communication).

The smaller entrepreneurs working with renewable energy technology in Greenland play a key role in finding and testing applicable products. The entrepreneur LED Solar Greenland made its first solar installations in 2012, and since 2014 installations with an effect of 1 MW has been added. Other entrepreneurs also try to enter the market, but the product is very niche and requires expertise specialisation in Arctic conditions. Knowing today that a number of products have been tested and are highly useful in Greenlandic communities, time is ready for implementation.
NEXT STEPS

The short term and the long term

In the long term Greenland has enormous potential even as an Arctic energy export nation. However, in its strategic energy considerations Greenland needs to differentiate between the short and the long term and address them differently. Right now, there are two levels of action that need different focus 1) search for opportunities to establishing hydropower and developing the grid, and 2) enabling implementation of local solutions with solar and wind power, batteries, heat pumps, better isolation and other energy efficiency measures in communities outside the scope of hydropower plants. Different approached are needed.

New plants and development of the grid can be reached with the commitment of foreign corporations. The pressure from global climate change makes Greenland an attractive partner for energy extensive industries. However, dependence on big business to engage in Greenland constitutes both a risk and a great opportunity. Greenland is vulnerable when depending on foreign capital and know-how. The Government of Greenland has worked intensively with these dilemmas and opportunities for the past years. From a WWF point of view, it is very positive that the government is aware of both opportunities and risks. It is important to keep this focus and also include civil society and civil society organisations in the decision-making processes.

When it comes to the implementation of better local solutions, we know from experience from both Greenland and other Arctic communities that a number of things can be done – here and now – to enhance already existing solutions.
Concrete Actions

Federal Government

Scrutinise the pricing model

As indicated in this report, the pricing system on energy in Greenland is complex and has a history of antagonistic considerations. To find the right balance between prices reflecting the cost of energy production and supply safety for all communities is a highly political and often very difficult issue. The result today is different prices and a lack of political awareness and commitment to providing incentive for investment in renewable energy and energy saving.

- Much has changed in Greenland since a new pricing model was drafted the last time. It should be considered to scrutinise the existing pricing model and draft a new one from scratch that includes recent experience with private renewable energy production.
- In Government work with the energy sector plan currently in writing, it is recommended to include the price structure aspect to ensure that subsidies and price policies do not counterbalance the incentive for making green investment.

Promote electric car driving

Hybrid cars have been tested for years in Nuuk and are successful, but more actions are needed:

- It is time to scale up electrical car driving in all hydropower communities. More power stations like the ones recently opened in Nuuk are part of this.
- It is key for private investment in hybrid cars that consumers and car sellers are sure about the legal framework. Therefore it is critically important that a government decision to prolong support in form of tax exemption for hybrid cars is taken now and not postponed to 2018 when the existing agreement expires.
Support local solutions

People living off a hydropower grid have started investing in solar energy. This is an important first step that needs support. Green loans, more sales in the renewable energy sector and the integration of a battery component will help reduce the costs, but there is still a barrier for people with low incomes. Actions that can be taken to support this positive development includes:

- Promotion meetings where the banks, energy entrepreneurs and consumers who invested in alternative technologies share their experience with communities and households who consider investing as well.

More research is needed

The experience with wind turbines, batteries and solar panels the past two years illustrates the importance of keeping up with the development in the energy sector. These are technologies that have been rejected earlier but are considered useful today. As there are more actors on the energy scene, it is important to keep track of how the experience of all partners can best be used.

- When drawing conclusions about the experience from the hybrid project in Igaliku, it is important that both Nukissiorfiit and smaller energy entrepreneurs can take advantage of the learning outcome.
- The Government of Greenland should be sure to keep the dialogue open with foreign energy companies who believe they have technical solutions at hand that can function in Greenland. Following the principle of “standing on the shoulders of others” and using technologies that are well tested somewhere else is a good strategy for Greenland, but it should never become an alibi for lacking behind.

Support consumer awareness

The potential for improving energy efficiency is far from exhausted whether looking at the towns or settlements. Nukissiorfiit’s initiatives in the area of consumer awareness should be backed up with much more concrete actions and reach out to other relevant stakeholders. This could include:

- Partnership with the national housing company INI to ensure that all households have individual incentives for saving energy. First, INI and Nukissiorfiit should let all households have individual electricity meters. Second, INI should implement energy-saving measures such as insulation, windows, heat pumps and the like.
- Nukissiorfiit’s communication platform can be refined with a look to nudging strategies and experience from local solutions elsewhere in the Arctic that have helped promote energy savings.
Partnership with a Greenlandic civil society actor and the youth network of Klimaambassaden at CONCITO in Copenhagen could form the basis of energy awareness among school children and teenagers. Klimaambassaden in Denmark has been a great success and has promising potential in Greenland as well.

Civil Society/WWF

Raise public awareness

In line with the industry effort to raise consumer awareness civil society organisations like WWF can promote already existing and engage in new cross-partnerships for energy awareness:

- This report can help WWF demonstrate how solutions used in other areas of the Arctic may work in Greenland.
- Partnership with a Greenlandic civil society actor and the youth network of Klimaambassaden at CONCITO in Copenhagen could form the basis of energy awareness among school children and teenagers. Klimaambassaden in Denmark has been a great success and has promising potential in Greenland as well.
Key Players/Partners

Authorities

- Government of Greenland
- The five municipalities of Greenland

Greenlandic business society

- Nukissiorfiit
- Mittarfuarfiit
- Royal Arctic Line
- INI
- GrønlandsBANKEN
- BankNordik
- CSR Greenland
- LED Solar Greenland
- Private importers of cars

Foreign companies

- Alcoa
- Siemens

Others

- CONCITO Denmark
- WWF Verdensnaturlfonden (DK)
CONCLUSION

A central driver for the Government of Greenland’s commitment to renewable energy is an urge for self-dependence. This implies a need to bring down the expenses on energy and a need to diversify Greenland’s economy with growth in new industries. This makes a number of stakeholders essential to the realisation of Government ambitions. Therefore, Greenland’s energy strategy must take a holistic approach and include all relevant national, regional and international partners both from public and private sectors as well as civil society.

Many years before the colonisation of Greenland, train oil from whales was used for heating and lighting. After centuries of dependence on imported energy, Greenland today has an exceptional chance to take advantage of its unique sources of renewable hydropower energy. Because of the unique ways of life and a strong sense of belonging also in the small settlements, it is crucial in both a social and an environmental perspective to provide sustainable solutions also for the communities that are currently not in the scope of a hydropower project.

The Greenlandic society is in change, and much will depend on the ability to develop an infrastructure that supports sustainable development for all.
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