# Contents

# Annexes

# 1 Introduction

Historical overview

Reports on Greenland's hydropower resources have been prepared regularly since the mid-1970s. The first report prepared was called 'Localisation of hydropower resources on the west coast of Greenland' [ACG/VBB 1975[M]], and contained studies of 16 major potential sites.

At the time of the issue of this publication, field studies concerning major hydropower stations had been initiated in several locations along the west coast. Within a few years the interest shifted from major facilities to the supply of energy to towns, and in 1979 a long list of facilities located close to towns was prepared. The potential was determined exclusively on the basis of map studies and, after feasibility studies had been made, the report entitled *'Grønlands vandkraft, Byforsying, lokalisring af vandkraftressourcer'* was revised [ACG 1981[C]].

In the 1970s the focus was on major facilities for supply to industry: Imarsuaq for the Isua iron ore mine, Johan Dahl Land for the Kvanefjeld mine, Tasersiaq for supply to energy-intensive industries at Sisimiut, etc. However, in the 1980s the interest shifted to facilities close to urban areas. Feasibility studies were intensified, and various outline and draft proposals were prepared for the most promising facilities: Taseq at Narsaq, Paakitsup Akuliarusersua at Ilulissat, Tasersuaq at Sisimiut, Buksefjord at Nuuk, Iterlaa at Paamiut and others.

Established facilities

The Buksefjord facility at Nuuk was the first facility to be constructed in 1989-1993. Subsequently it was decided in 1992 to construct Tasersuaq/SIS, but this project was stopped after tenders had been invited, the reason being new priorities for the use of the construction funds. Later, Aammangaaq at Tasiilaq was constructed and put into operation at the end of 2004, and Qorlortorsuaq, which is to supply Narsaq and Qaqortoq, is currently being constructed.

Recent localisation reports

Concurrently with the planning and expansion of facilities close to urban areas, lists of localised potential sites have been prepared on several occasions. In the mid-1980s, GTO prepared several reports on the potential sites and the relevant results of hydrological measurements: *Generelle hydrologiske bassin-informationer, GEHBI, Vandkraftmuligheder og prioritering af vandkraftudbygningen i Grønland, Nukissiorfiit March 1992, Bynære vandkraftpotentialer i Grønland, Nukissiorfiit May 1994 and Lokaliserede Vandkraftpotentialer i Grønland, Status 1995.* The report [Nukissiorfiit 1995[B]], which concerns 14 major facilities and 16 facilities close to urban areas, provides an update of the basis for potential exploitation including a brief description, sketches and data, but it is not always possible to see where the data provided comes from or how it has been verified.

Attempts have subsequently been made to localise other hydropower potential, and the report entitled *Grønlands vandkraftpotentialer* [Hydropower potential in Greenland] [Nukissiorfiit 2004[F]] provides updated information on some of the most interesting potential sites, while other potential sites are mentioned only sporadically.

Purpose of this report

The purpose of this report is to provide a complete picture of the total potential localised since 1974, no matter whether exploitation of the potential of individual sites seems realistic or unrealistic at present. The potential sites are listed in tables and shown on maps for each local authority area, the emphasis being on creating an unequivocal, comparable list with indication of the most recently published sources.

With a few exceptions, no supplementary calculations of the potential have been made, the only reference being to previously published reports. Matters such as hydrological measurements, reconnaissance and other surveys conducted after the publication of the source material have not been taken into account. For each facility there is an indication of the extent to which hydrological measurements have been made, but it has not been possible to take such measurements into account, since the results have not been publicised.

Descriptions have been prepared of several of the most interesting facilities. These descriptions may include a historical outline as well as some subjective remarks as to whether it would be realistic to exploit the potential.

Contents of this report

Chapters 2, 3 and 4 describe the assumptions and methods applied in relation to the preparation of the lists of hydropower potential, while chapter 5 contains lists of localised facilities.

Chapter 6 describes some of the most realistic facilities that future studies and surveys should concentrate on.

Chapter 7 contains information about hydrological measurements made in relation to the hydropower potential identified.

A complete list of literature registered by Nukisisorfiit and Greenland Resources is given in Annex 19.

# 2 Categorisation of hydropower projects

The localised hydropower facilities are categorised on the basis of their purpose, degree of regulation and size. The degree of regulation depends on the extent to which it is possible to create a reservoir that is sufficiently large to store water from years with an abundance of water to years with scarcity of water.

The category is indicated by means of an alphanumeric code, eg B1, which indicates that the facility is a facility for the supply of an urban area with annual regulation.

The following codes are used:

### Based on purpose

A. Industrial hydropower (> 100 MW)
B. Urban hydropower (1-50 MW)
C. Settlement hydropower (< 100 kW)

### Based on degree of regulation

0. Unknown
1. Annual regulation (Reservoir able to store water from wet years to dry years)
2. Seasonal regulation (Reservoir able to store water from wet periods to dry periods)
3. Unregulated

No codes are used for size categories, but hydropower facilities are normally divided into the following categories:

- Large facilities > 10 MW
- Small facilities < 10 MW
- Mini facilities < 1 MW
- Micro facilities < 100 kW

## Planning stage

The planning stage indicates the extent to which the hydropower facility in question has been investigated as stated in the table below. It is not always possible to state the planning stage unequivocally and the remarks are therefore indicative only. Further information may appear from the detailed description of selected facilities and the remarks on the most promising urban facilities given in chapter 6.

| Stage | Planning stage | Hydrological data | Map material | Geotechnical surveys | Other |
|---|---|---|---|---|---|
| I | Map localisation | | | | |
| II | Reconnaissance | Theoretical calculations and/or estimate | Existing map | None | On-site visits to assess run-off conditions and reservoir |
| III | Outline design | A few years' measurements and/or theoretical calculations, possibly based on measurements in neighbouring areas | Existing map | None | Construction estimate |
| IV | Outline proposal | A few years' measurements supplemented by correlations with neighbouring areas or model calculation based on meteorological data | Map, at least 1:50000 and aerial photos | Geological assessment | Construction and operations estimate |
| V | Preliminary design | 10-25 years' hydrological time series, measured or generated | Special maps drawn | Geophysical surveys for construction work | As conceptual design and simulation of operations |
| VI | Decision | 25 year's hydrological time series of at least ten years' measurements | As preliminary design | As preliminary design | As preliminary design – plus cost/benefit analyses |
| VII | In operation | | | | |

# 3 Calculation of potential

The potential of hydropower facilities is often calculated in the documentation to which reference is made. However, different assumptions may have been applied as regards possible storage.

If no information is available, the following data will be applied:

Hydrology: Estimated or measured precipitation/ablation Q $hm^3/a$.

Reservoir size: Estimated on the basis of the best maps available

Degree of regulation: The ratio of reservoir volume to mean annual run-off Q

Regulation factor: The ratio of the unused water volume Q' to the mean annual run-off Q. If the size of the reservoir is known, the regulation factor will be calculated on the basis of the table below:

| Degree of regulation | Regulation factor |
|---|---|
| 0.5 | 70% |
| 0.7 | 80% |
| 1.0 | 85% |
| 1.5 | 95% |

Theoretical potential: Calculated using the following formula:

$$E = \eta \times \gamma \times \frac{Q' \times h_n}{f}$$

where:

E = energy potential ex works (kWh/a)
$\eta$ = the efficiency of the power station (here set at 0.87)
$\gamma$ = the specific gravity of water (here set at $9.81 \times 10^3$ $kN/m^3$)
Q' = the regulated (used) volume of water ($m^3/a$)
$h_n$ = net (effective) head
f = factor for conversion between units ($3.6 \times 10^6$ Ws/kWh)

Effect: If there is no specific calculation of the effect installed, the nominal effect is calculated on the basis of the time of use:

- Industrial hydropower: 8000 h/a
- Urban hydropower: 5000 h/a
- Settlement hydropower: 4000 h/a

Updating of hydrological basis: Generally the hydrological basis stated in the documentation mentioned will be used. In relation to some hydropower potential, where the rate of flow has been measured after the date of the documentation in question, the potential