Workshop on Exploration, Sustainable Access and Extraction of Raw Materials
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Potentials and Challenges for Sustainable Raw Materials Exploitation in Greenland

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DTU

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Sustainability in the Arctic

Critical issues in arctic raw materials exploitation

- Environmental conditions are extreme and harsh
- Infrastructure is sparse – island communities
- Nature and environment is particularly sensitive
- Population is small and vulnerable
- Culture is unique and fragile

Models and experiences on how to do things from other parts of the world generally do not apply in an arctic environment

It is necessary to progress with care – the "precautionary principle"

Not as a show-stopper – but as a driver for innovation

Raw Materials Exploitation in the Arctic

Potentials

Exploitation of raw materials and associated activities in the value chain comprise a significant potential for the arctic societies locally and the EU at a wide and broad scale:

Local arctic potentials

- Development of a "new" mining related industry sector
- Strengthening of the "knowledge infrastructure"
- Strengthening of public and private sector governance capacity
- Improvement of welfare, health and safeguarding culture
- Long term upgrading of societal infrastructure
- Long term upgrading of (sustainable)energy supply
- Strengthening/restructuring of traditional industries
- Comprising an "example" for sustainable raw materials exploitation
- Export potential for knowledge, technology, procedures, regulations

Raw Materials Exploitation in the Arctic

Potentials

Exploitation of raw materials and the associated activities in the value chain comprise a significant potential for the arctic societies locally and the EU at a wide and broad scale:

EU wide potentials

- Reliable availability (independence) of physical market raw materials
- New raw materials to the European market
- Basis for new industrial sectors and production – product export
- New "exportable" sustainable technologies and processes
- Continued and increased growth in CleanTech and GreenTech sectors
- Improved welfare, economic growth and competitiveness
- Geopolitical "foothold" in the arctic regions

Raw Materials Exploitation in the Arctic

Challenges

There are some major challenges which must be embraced.

Sustainable developments may be pursued by "appropriate decision making" – however, significant uncertainties affect the outcome of decisions and must be accounted for:

- General developments within the global economy
- Future demands and supplies with respect to raw materials
- Future effects of global climatic change
- Success of intended societal changes

The North Atlantic Raw Materials Group

Motivation - why a joint North Atlantic enganement?

- Obvious prosperity of raw materials in the North Atlantic region
- Clear market oppertunities for sustainable ”frontier raw materials” exploitation
- Traditions and competitive strengths within clean-tech and green-tech
- Advantages from long term nordic relations, collaborations and trust
- Mutual interest in arctic security and stability
- Joint interests in ensuring that arctic raw materials exploitation are sustainable

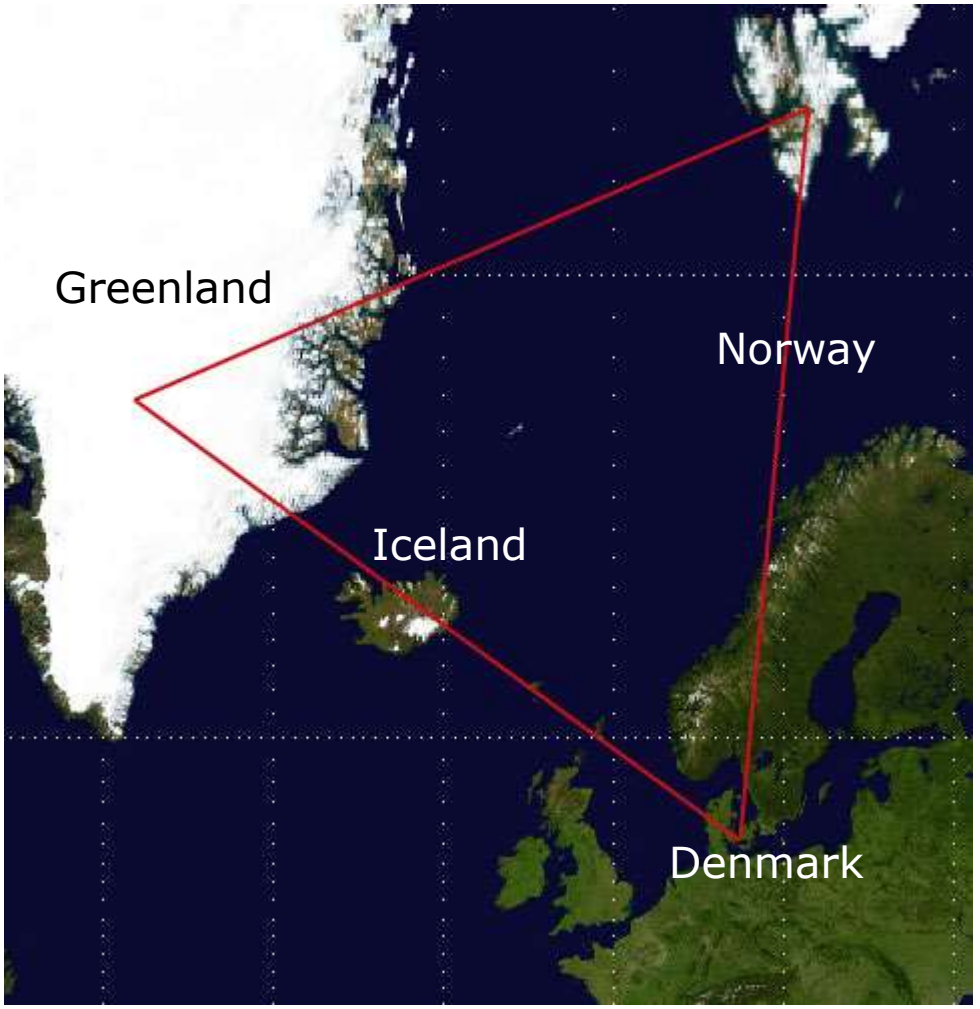
The North Atlantic Raw Materials Group

Aim

Aim of participation in the European Raw Materials Initiatives is to establish innovation and dissemination platform specifically addressing sustainable raw materials exploitation and management in the Arctic regions – the case of Greenland.

For the benefit of Europe at different scales:

- Union
- Nations
- Regions



The North Atlantic Raw Materials Group

Technical University of Denmark

DTU

DS
DANISH STANDARDS

DI
Confederation of Danish Industry

Tech College Greenland

UNIVERSITY OF COPENHAGEN

DHI

UNIS

Kalaallit Nunaanni Sulisitsisut Peqatigiiffiat
The Employers' Association of Greenland
Grønlands Arbejdsgiverforening

University of Iceland

GEUS

AALBORG UNIVERSITY
DENMARK

ILISIMATUSARFIK
University of Greenland

MTHøjgaard

NTNU – Trondheim
Norwegian University of
Science and Technology

FLSmidth

Qeqqata kommunia

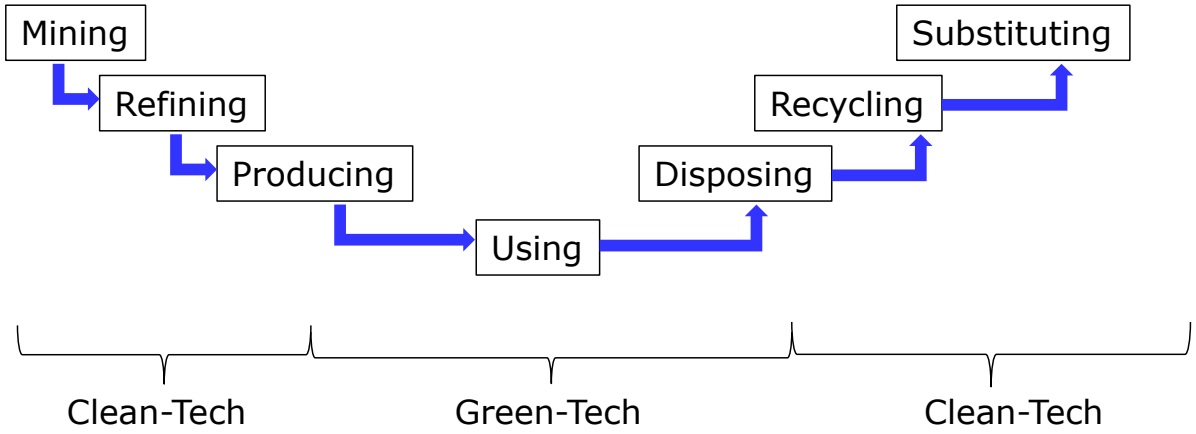
Perspective and Approach of the Group

The emphasis is on

- Reliable availability of physical market raw materials
- Environmentally sustainable extraction and exploitation technologies and processes – Clean Tech and Green Tech
- Socially sustainable raw materials extraction and exploitation activities
- Efficiency over the entire value chain (material use, energy consumption, emissions and costs)
- Recycling
- Substitution

Perspective and Approach of the Group

The approach considers the entire value chain



Innovation and market potentials should be explored and developed from a holistic perspective

- Focusing on value generation from a societal perspective (economy, environment, health, culture,..)
- Taking basis in joint optimization over several or all links in the value-chain
- Accounting for derived effects of raw materials exploitation on other industries and society
- Facilitate stakeholder – market - driven innovation and dissemination

Perspective and Approach of the Group

The case of Greenland

Perspective and Approach of the Group

The case of Greenland

- Considerable possibilities for the European industries to engage and establish new industrial sectors within CleanTech and GreenTech
- Initiatives to sustainable mining will attract investments and establish a positive attitude in society towards raw materials exploitation
- Innovative technology and a holistic and stakeholder oriented perspective to its application has a significant potential for ensuring sustainability of mining in Greenland
- Greenland and Europe can become an example – window to the arctic communities and the world in general on how raw materials exploitation can be undertaken sustainable

Perspective and Approach of the Group

Ambitions

- Strengthen European geopolitical position/role in the arctic
- Secure raw materials for the European industry (mitigating scarcity)
- Explore new frontier mining
- Ensure global leadership of European "Clean and Green" technology
- Enhance robustness of European business, industries and societies (PPP)
- Innovation and marketing of scalable technologies and services
- Boosting and exploiting "spin-off" potential
- Capacity building, education and training to enhance sustainability

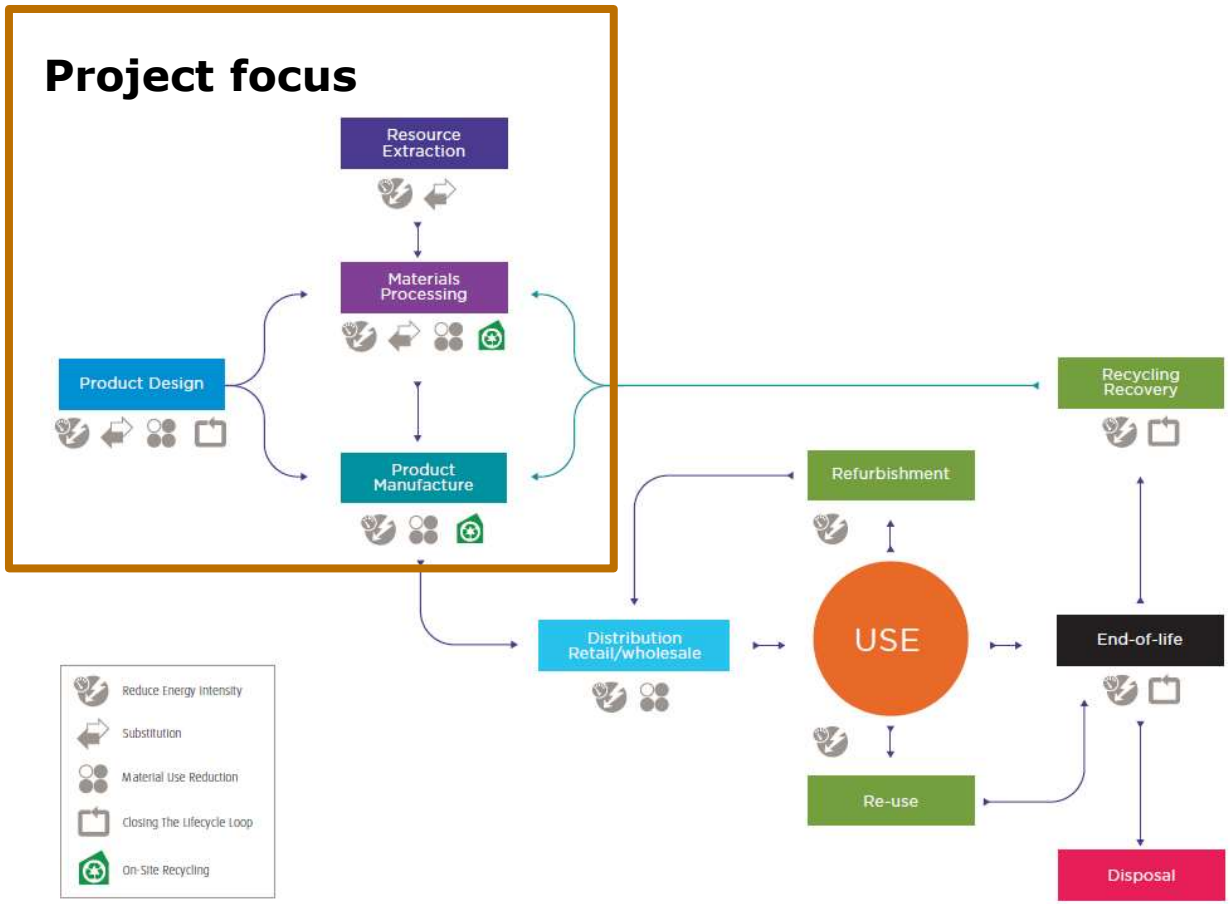
Perspective and Approach of the Group

Focus

The North-Atlantic group builds on:
Holistic societal perspective - interdisciplinary synergies

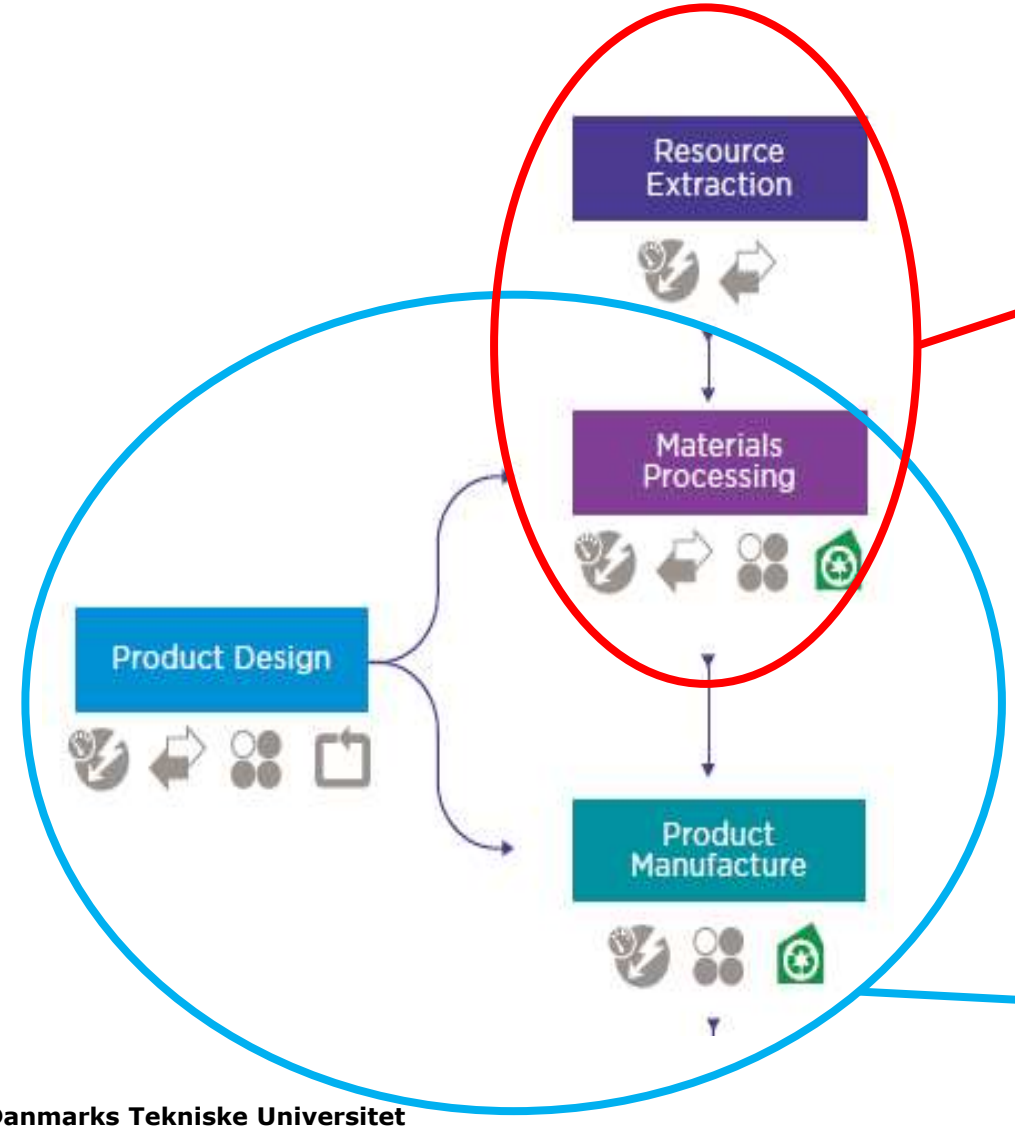
- Primary Raw Materials potential
- Extreme environments and conditions / challenge of island communities
- Strong knowledge on arctic technology – green tech and clean tech
- Collaborations among partners building on strong traditions and trust
- Unique show case for the European and the global community

Perspective and Approach of the Group



Perspective and Approach of the Group

Innovation and Research



Exploration
- GEUS

Infrastructure and Energy
- MT Højgaard
- Greenland Contractors
- Nukissiorfiit
- ARTEK, DTU Byg

Support services
- Greenland Employer Association
- Industrial Raw Materials Cluster

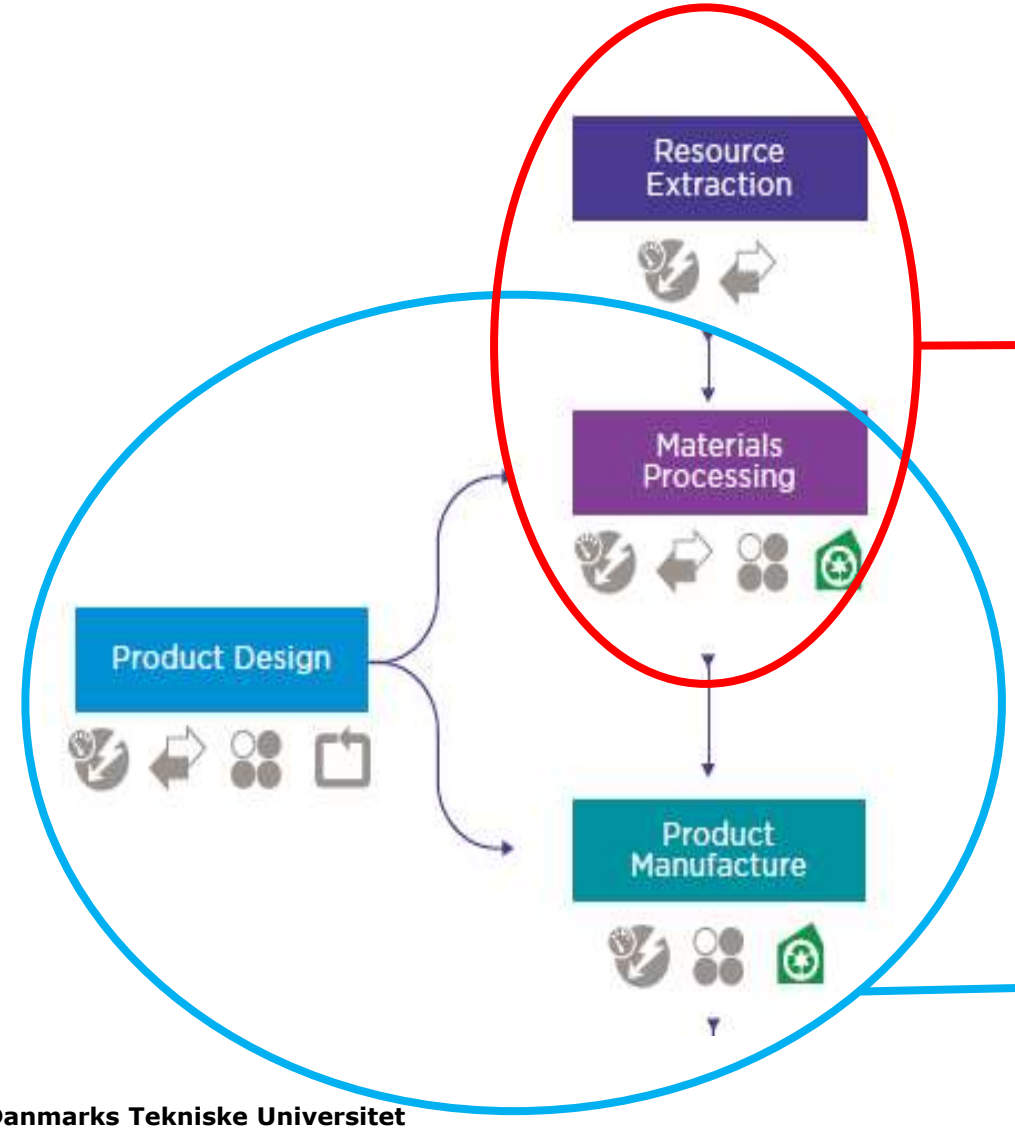
Sustainability Assessments and Planning
- Greenland NatureInstitute
- University of Greenland
- DTU ARTEK, DTU Miljø, DTU GDSI
- Danish Hydraulic Institute (DHI)
- COWI A/S
- Ramboll A/S

Technology and processes
- FLSmidt A/S
- DTU Chemistry ,DTU System Biology
- Aalborg university

Technology and Processes
- FLSmidt
- DTU Mechanics, DTU Chemistry
- Grundfoss A/S
- Siemens AG
- Vestas A/S
- Danish Industrial Association (GA)

Perspective and Approach of the Group

Education, Training and Capacity Building



Exploration
- GEUS
- Nordic mining school
- Nordmin

Infrastructure and Energy
- ARTEK

Sustainability Assessments and Planning
- Greenland NatureInstitute
- University of Greenland
- DTU ARTEK, DTU Miljø, DTU GDSI
- University of the Arctic

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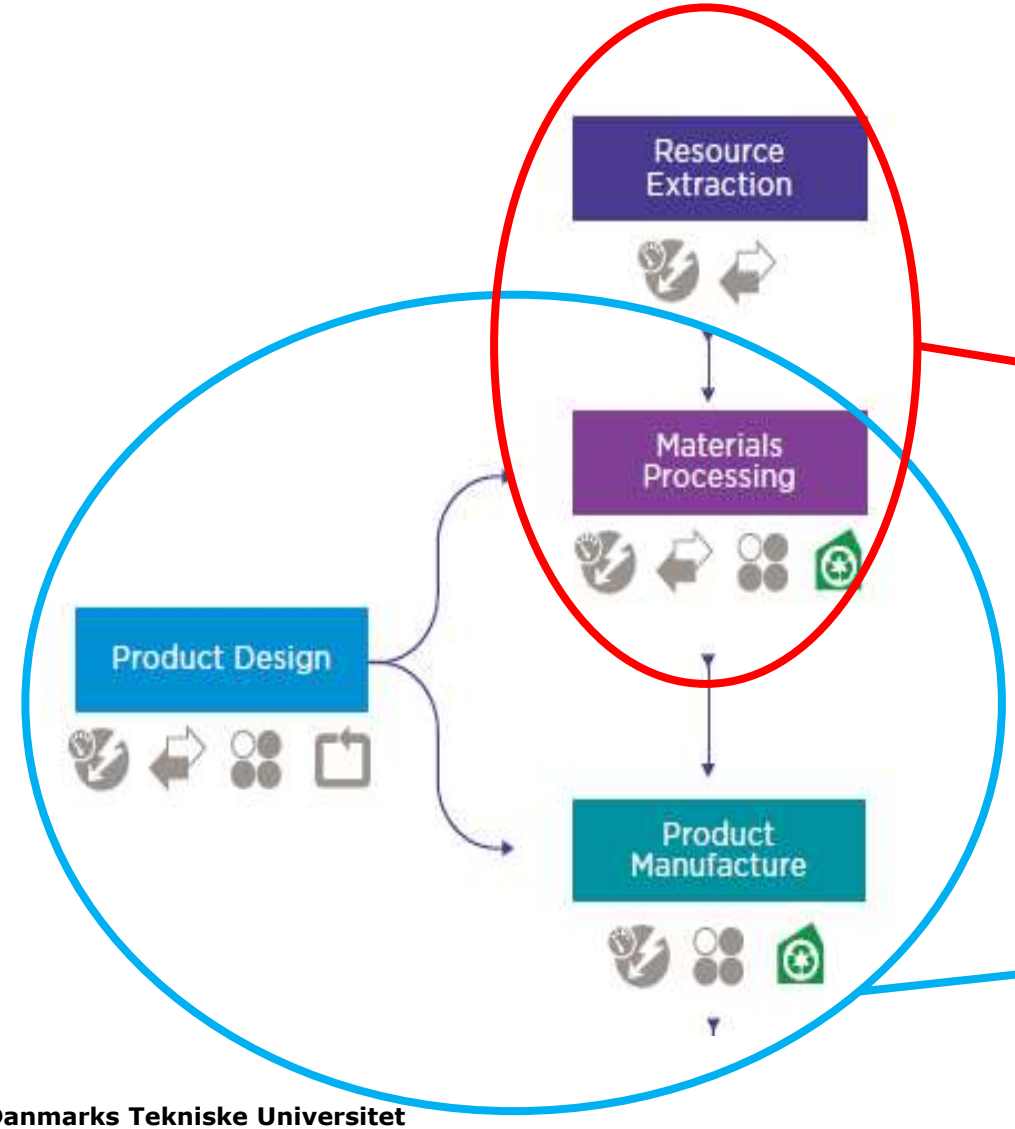
Perspective and Approach of the Group

Implementation and Demonstration

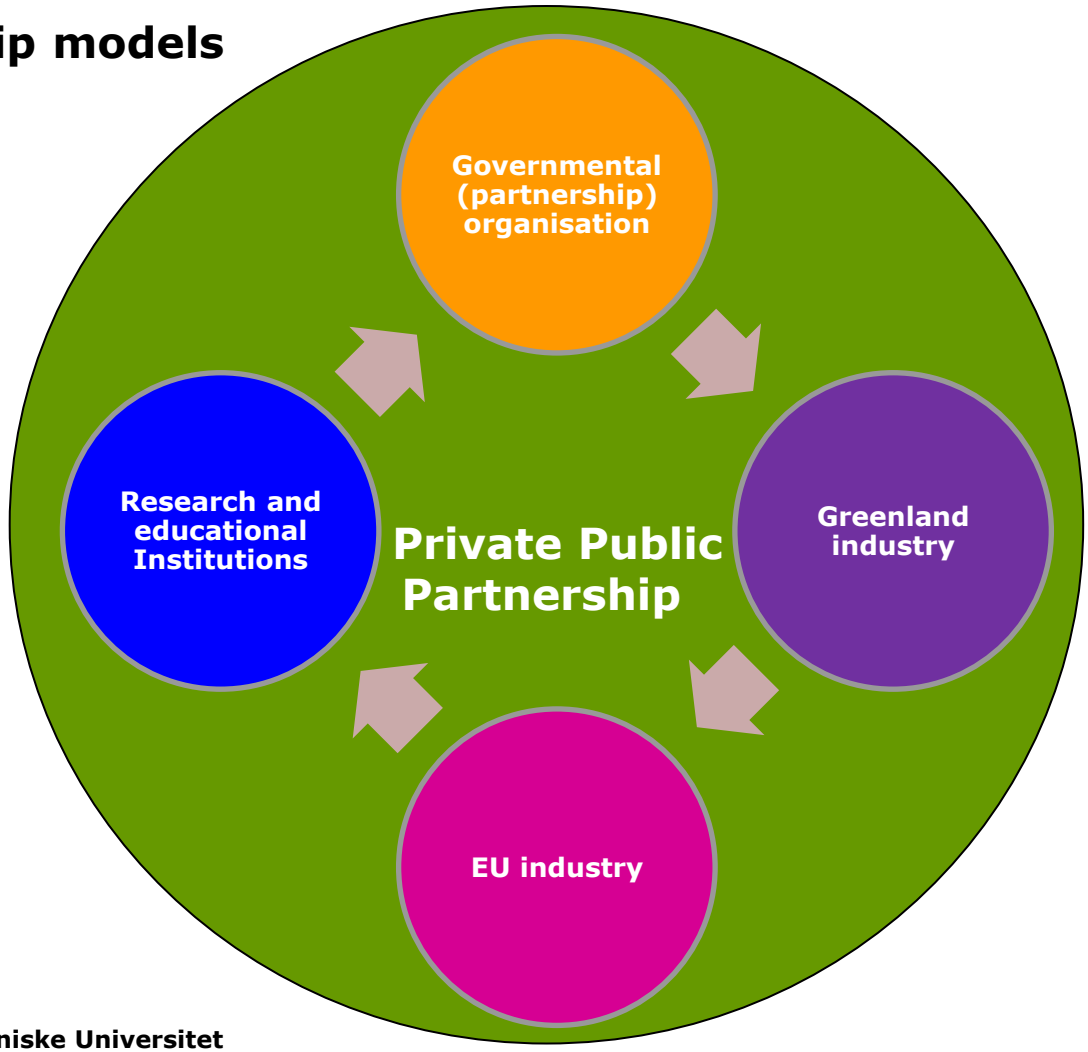


Regional Implementation and Demonstration
- Queqqata Kommunia (Sustainability 2020)
- Greenland Self Rule / ARTEK (Vision 125)
- University of Greenland (Raw Materials Center)

Regional Implementation and Demonstration
- DTU Green Competition
- Region Hovedstaden DK
- Confederation of Danish Industry

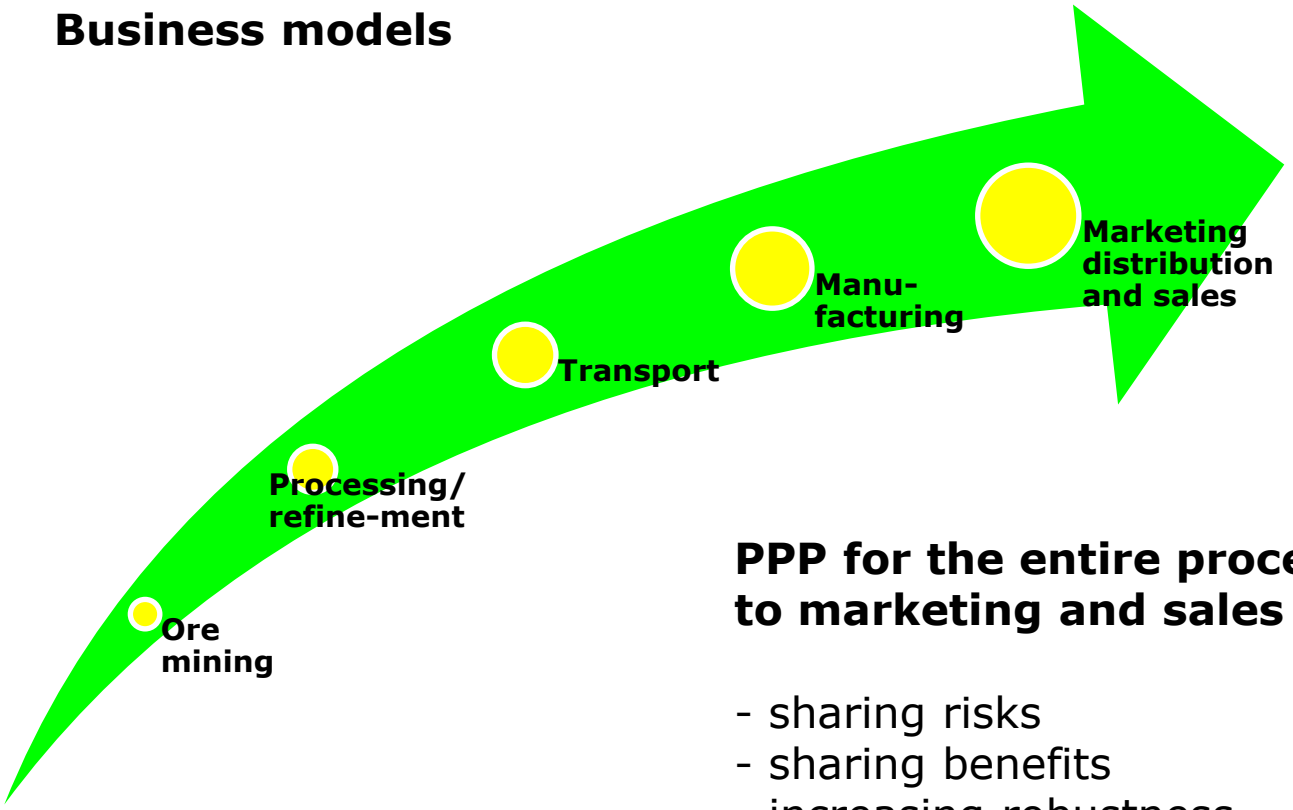
Perspective and Approach of the Group

Partnership models



Perspective and Approach of the Group

Business models



PPP for the entire process from exploration to marketing and sales

- sharing risks
- sharing benefits
- increasing robustness
- enhancing sustainable developments

Invitation for Collaborations and Partnering

We would like to invite stakeholders:

- **Industry**
- **Public authorities**
- **Universities**
- **Other project groups**

in Europe and abroad to engage in collaborations with the North Atlantic Group

Thanks for your Attention!

Michael Havbro Faber

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DTU

Project Catalogue - Illustrative

Sustainable production in Greenland of primary Aluminum from Alumina extracted from Anorthosite/Anorthite (AAA project)
Lead: Benny Raahauge FLSmidth, Flemming Jappe Frandsen

Biological solutions for a more sustainable mining industry in Greenland
Lead: Lene Lange, Aalborg University

Development of methods, tools and decision support systems to assess and manage environmental and economic risks related to Arctic mining projects
Lead: Morten Birkved, Technical University of Denmark

Bioremediation and high value mineral extraction
Lead: Waleed Abu Al-Soud, University of Copenhagen

Project Catalogue - Illustrative

Assessment of mining activity effects in Greenland on terrestrial ecosystems

Lead: Riikka Rinnan, University of Copenhagen

Response of freshwater ecosystems to exploration, extraction and processing of raw mineral resources in Arctic Greenland

Lead: Kirsten Seestern Christoffersen, University of Copenhagen

Technosphere mining

Lead: Lisbeth M. Ottosen, Technical University of Denmark