Criteria	**Criteria-VII –** Institutional Values and Best Practices
Key Indicator	**7.1.** Institutional Values and Social Responsibilities
Metric	**7.1.2** The Institution has facilities for alternate sources of energy and energy conservation measures

SUPPORTING DOCUMENTS- SENSOR BASED ENERGY EFFICIENT SYSTEMS

Researchers from KARE are also involved in developing sensor-based energy efficient systems. Resilient and Optimal Micro-Energy-grid Project (ROME) is one such joint initiative by a research group from KARE and Norwegian scientists focusing on the microgrid approach for the smart grid. This work is jointly funded by DST and the Research Council of Norway.

Registrar

ROME - Resilient and Optimal Micro-Energy-grid

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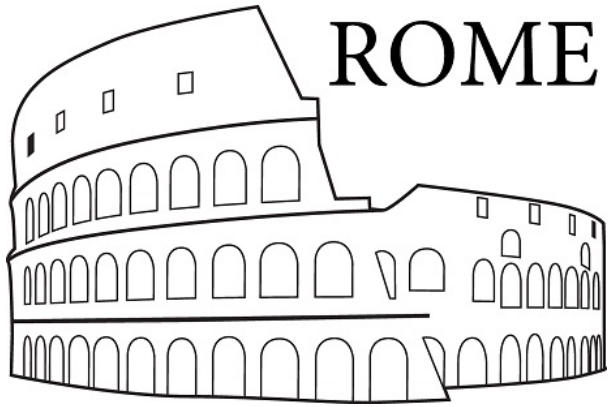
IEEE PES Seminar - Trondheim, May 2019

Outline

- ROME project description
- Norwegian Living Lab - Froan islands
- ICT infrastructure
- India-Norway collaboration
- Conclusions



ROME project description

- ROME is a joint Indian - Norwegian ICT research project running from 2018 to 2021.

With funding from The Research Council of Norway

Department of Science & Technology, Government of India

सत्यमेव जयते

ROME project description

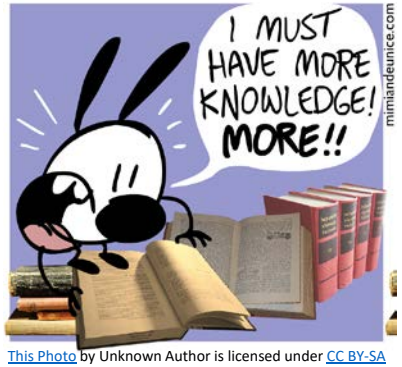
- ROME focuses on the microgrid approach for the smart grid.
- A microgrid can connect and disconnect from the main grid to enable it to operate in both grid-connected or island-mode.
- Microgrids differ from main grids by being smaller, thus being more vulnerable. Due to the rather low number of consumers to divide costs on, the economic investments must also be well considered.
- It is also a trend to reduce the use of energy production based on fossil fuels (to lower the CO2 emissions) in favour of Renewable Energy Sources (RESs). The main drawback of RESs (e.g. windmills and photovoltaic cells) is the fluctuating production of energy.

ROME project description

- Norway and India have many areas qualifying to be defined as microgrids.
  - Norway in terms of islands (about 300) along the coast with weak and old sea cables not profitable to replace if a problem occurs.
  - India in terms of rural areas with weak and often faulty tie-lines.
  - In the India context, there are almost 250 million people without access to electricity and grid extensions are proving to be infeasible in many regions due to economical, geographical and technological challenges.

ROME project description

- ROME main goals are:
  - Develop knowledge and technology (tools) for optimal planning of a smart microgrid (to be used when connected to the grid or in island-mode).
  - Develop knowledge and technology (tools) for optimal management / operation of a microgrid with active prosumers (in island-mode or with a weak tie-line to the main grid).



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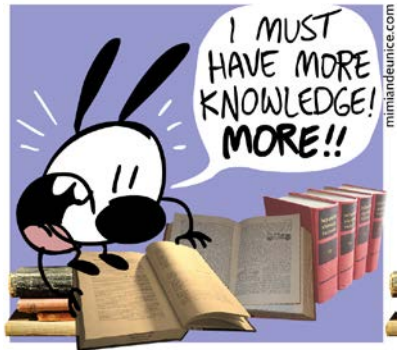
ROME project description

Steps/path to achieve the goals:

- Norwegian Living lab – Froan islands (Frøya municipality)
- ICT infrastructure for real-time* measurements
- Microgrid components models



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* real-time means as fast as the measurement are generated. Short communication delays are allowed.

ROME project description

Steps/path to achieve the goals:

- Microgrid planning tools
- Microgrid management/operation tools
- Prosumer management tools

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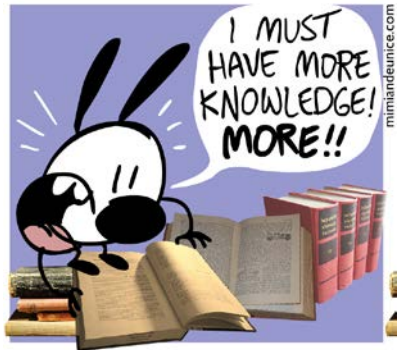
ROME project description

In this presentation we focus only on:

- Norwegian Living lab – Froan islands (Frøya municipality)
- ICT infrastructure for real-time* measurements



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Norwegian Living Lab - Froan islands

- Norway has more than 300 islands with a distance larger than 1 km from the mainland.
- These islands are receiving the electricity support from the mainland (subsea cable).
- The utility companies use relatively more resources on these islands than on the mainland installations.

Norwegian Living Lab - Froan islands

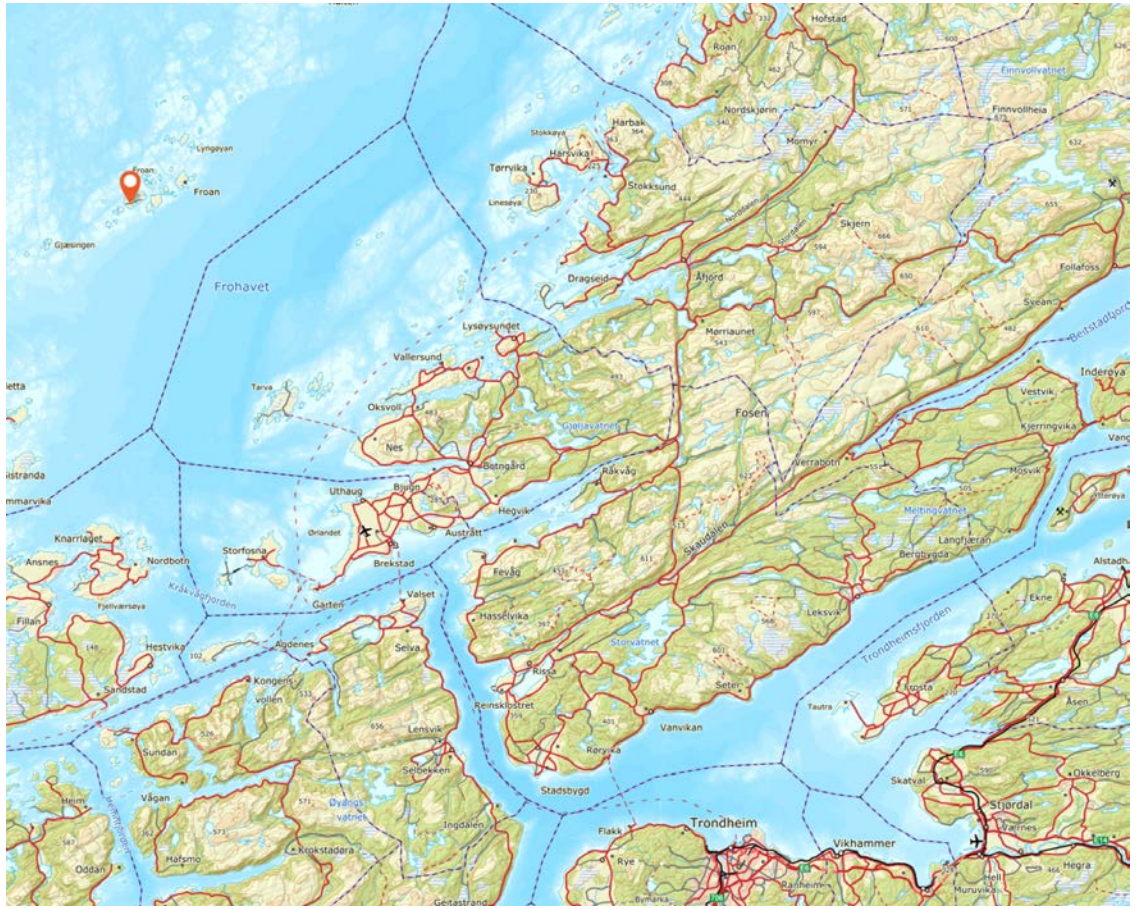
- It is estimated a cost of about 30-50 million Norwegian Krone to replace each of longest subsea cables.

- Many of these cables are rather old and when a problem occurs it is very expensive to provide energy to the customers on the islands (e.g. Bring to the island a diesel generator by helicopter).

- Most of these islands have the potential to be converted to microgrids.

Norwegian Living Lab - Froan islands

- Real-time* data will be collected and used in the project to define and simulate several microgrid scenarios.



* real-time means as fast as the measurement are generated. Short communication delays are allowed.

Norwegian Living Lab - Froan islands

Cabins (Hytter)

House

Froan

House

Transformer

1 m^2 PV panel with battery

Wind anemometer (Virtual wind-generator)

Wind anemometer and wind-generator

Trondheim

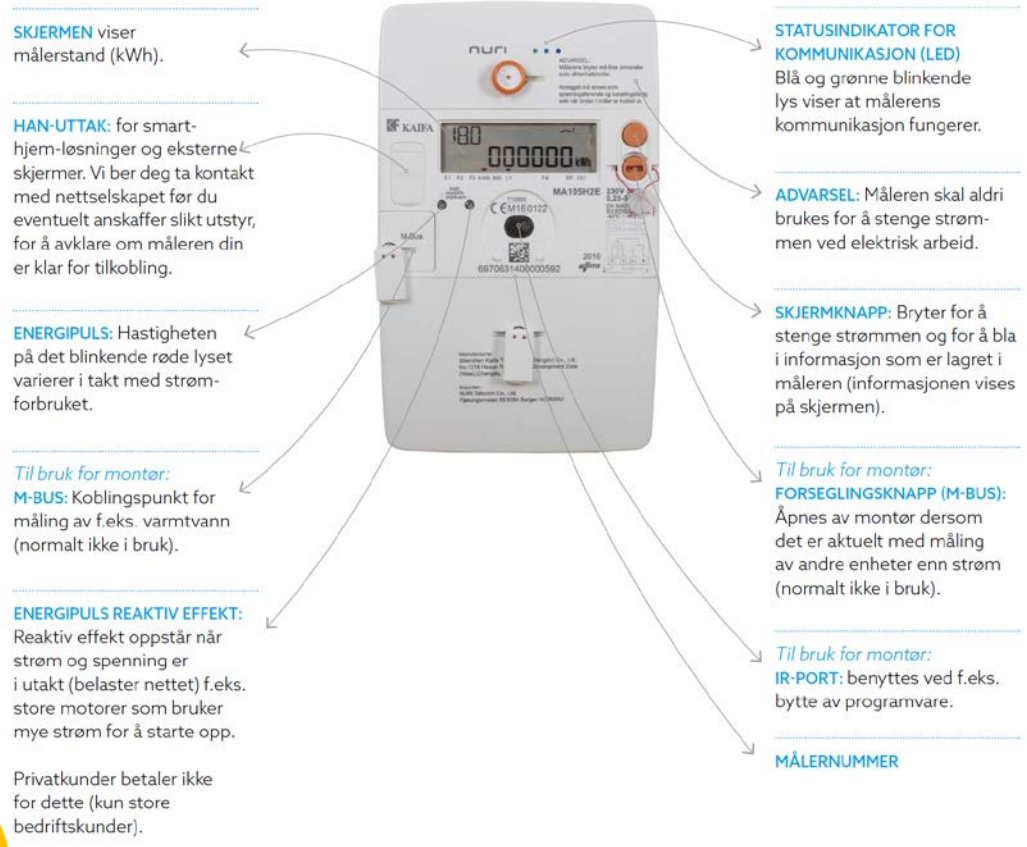
ICT infrastructure

SMART METER (AMS) and HAN port

- Frequ
  - Ac d export)
- Frequ
  - Reactive power) x 2
  - Current (A) x 3 (and L3)
  - Voltage (V) x 3 ases)

Used by the utility companies for automatic reading of the energy consumption and to calculate the energy bill

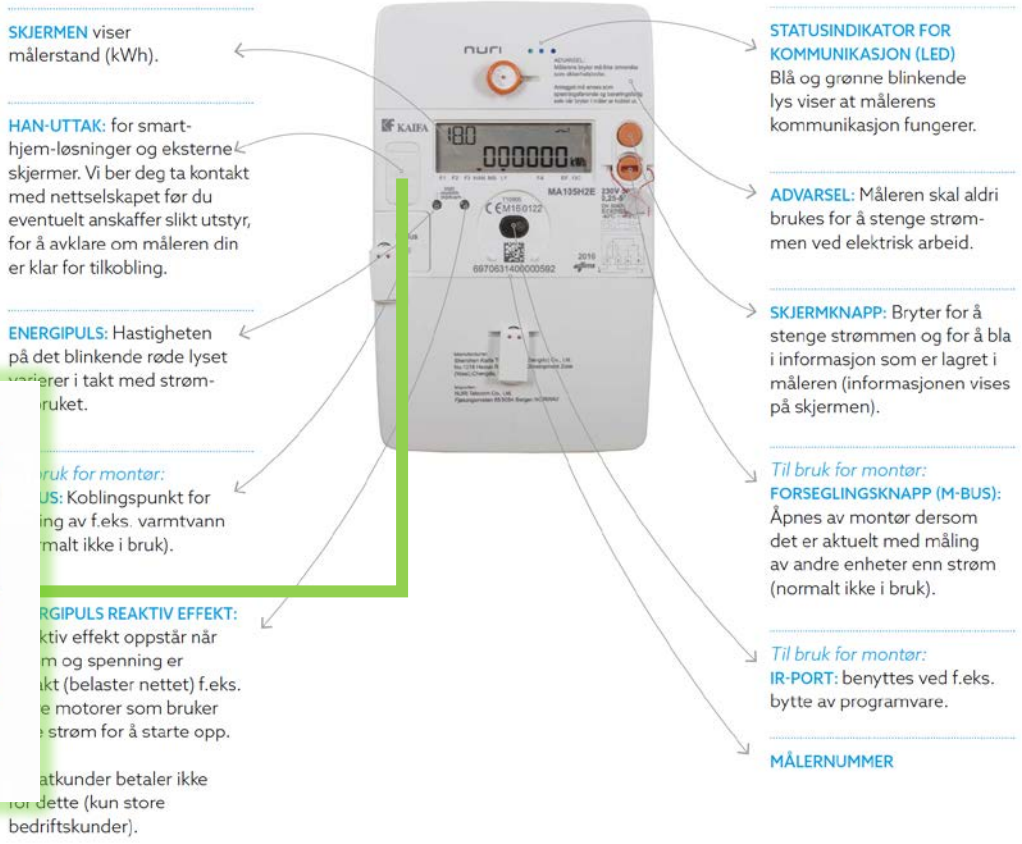
- Frequency = 1 hour
  - Active energy (kWh) x 2 (= import and export)
  - Reactive energy (kVArh) x 2
  - Time and date



M-BUS (EN 13757-2) is used as electrical interface
RJ-45 (ISO/IEC 8877) is used as plug/contact

ICT infrastructure

- **SMART METER (AMS) and HAN port**
  - Frequency = 2.5 second
    - Active power (kW) x 2 (= import and export)
  - Frequency = 10 second
    - Reactive power (kVAr) x 2
    - Current (A) x 3 (L1, L2 and L3)
    - Voltage (V) x 3 (all phases)
  - Frequency = 1 hour
    - Active energy (kWh) x 2 (= import and export)
    - Reactive energy (kVArh) x 2
    - Time and date



M-BUS (EN 13757-2) is used as electrical interface
RJ-45 (ISO/IEC 8877) is used as plug/contact

ICT infrastructure

Cabin

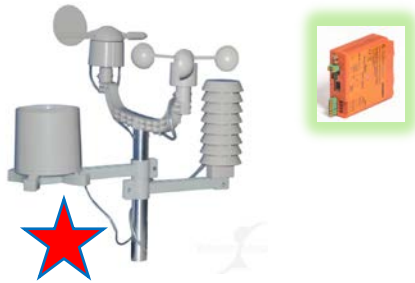
House

Froan

House

Transformer

1 m^2 PV panel with battery



Wind anemometer (Virtual wind-generator)

4G mobile network

ICT infrastructure

Cloud services

Cabin

Cloud storage

4G mobile network

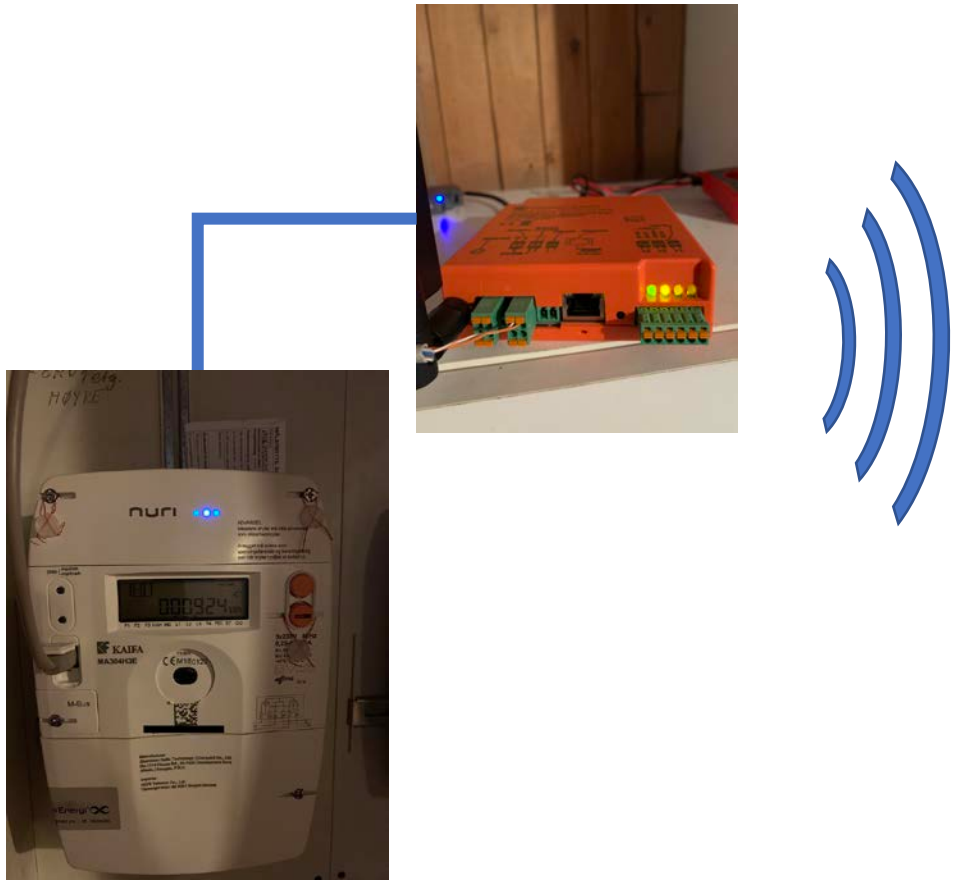
Customers

Researchers

Wind anemometer (Virtual wind-generator)

ICT infrastructure

- First version of ICT infrastructure up-and-running



India-Norway collaboration: SINTEF visiting KLU, India


ROME

ROME: WORKSHOP

Sept 29-Oct 4, 2018

Abstract

This document describes the deliberations during the 1st workshop of ROME held at Kalasalingam Academy of Research and Education during the visit of Norwegian experts of the project.

ROME Team

India-Norway collaboration: KLU visiting SINTEF, Norway

- During the second half of June 2019 the Prof. Seshadhri Srinivasan from KLU will visit SINTEF (~2 weeks)

- Activities:
  - Visit to Froan Pilot
  - Workshop (we are considering to have an open session)

Conclusions

- ROME is focusing on resilient microgrids.
- Microgrids could be an interesting approach to address problematic scenarios for the electrical grids both in India and Norway.
- The project is on its first year. The main focus so far has been on:
  - Preparing the Norwegian Pilot and deploying the ICT infrastructure.
  - Modeling the microgrid components (not part of this presentation).

Thank you for your attention.

With funding from The Research Council of Norway

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