100% Green Electrical Energy for the Faroes by 2030

Lessons for Small Islands

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Faroe Islands

• General data:
  – 18 islands (17 are populated)
  – 50,000 inhabitants
  – Area of 1,399 km²
  – Main export: Fish and fish products
Electrical Company SEV

- **Company Structure:**
  - Non-profit, founded 1st October 1946
  - 100% owned by all Faroese municipalities
  - Monopoly on grid operation *(transmission & MV/LV distribution)*
  - "De facto" monopoly on production (98%)
  - Joint and several price structure
  - Vertically Integrated Company
  - "Micro isolated system" in EU terms (< 500 GWh)

- **Directive 2009/72**
  - Derogation from relevant provisions in different chapters about unbundling, third party access etc.
Energy Mix 1954 - 2015

Source: SEV
Renewable energy duration curve 2015

Hours with renewables only: 1576 h (66 days)

Hours with renewables > 80%: 3288 h (137 days)

Hours with renewables > 60%: 5508 h (230 days)

Hours with renewables > 40%: 6810 h (284 days)
Main drivers for renewable energy in the Faroe Islands
Carbon free electricity by 2030

Assumptions:
- 2% increase in consumption annually
- Linear electrification of Heating 2016 – 2030
- Linear electrification of transport on land

Energy Mix 2015

Faroese Climate Policy from 2009
- SEV’s “Green Vision”, October 2014
- Governmental target, Sept. 2015

Governmental target:
- 100% renewable energy by 2030
Unpredictable oil expenses

- Consumption [kt]
- Oil expenses [mio. dkr]

- 4 million CAD
- 33.4 million CAD
Projected Energy Demand
Projected Energy Demand 2015-2030

Energy [GWh]

- Traditional Electricity
- Heating
- Electric Vehicles

Renewable resources in the Faroe Islands

A systematic approach to identify local resources in order to set up a technology roadmap
Assessment of local renewable resources

Average wind speed: > 10m/s

Precipitation: ~1284 mm/year (PEI: 890mm/y)

Peak tidal velocities: ~ 3.5 m/s

Average sun hours: ~ 1100 hrs/year (PEI: 1841)

source: www.gov.pe.ca

source: www.currentresults.com
Correlation between the resources

- Average Sun hours [hrs]
- Average Precipitation [mm]
- Average Wind speed [m/s]
- Average Tidal stream velocity [m/s]
Testbed for Smart Grid Technologies
Battery system in Húsahtagi
Schematic overview of battery system

Battery System

Batteries

Inverter

L-EMS
Local Energy Management System

Wind generation

Inverter output

Composit output

Grid

Wind farm
Battery system in operation

- Battery power
- Wind power
- 20 sec
Schematic overview of PowerHub

Power Management System

IT system

A box at different Industries
Testbed for Smart Grid Technologies

- Faroe Islands Testbed
  - ~ 40 MW

- Denmark
  - Small system test
  - ~ 4000 MW

- Europa
  - Large system test
Technologies supporting the 100% RE Vision
Assumptions:
- 2% p.a. increase in traditional electricity consumption
- Electrification of the transport sector
- Electrification of the heating sector (houses and buildings)
Nordic Council Nature and Environment Prize

Motivation:
“The prize goes to the Faroese electricity company SEV for its ambitious targets and innovation. SEV’s work is not only important for the phasing in of renewable energy in the Faroe Islands, but also for the European grid as a whole. Its ambitious targets and the creative nature of its efforts to reduce dependency on fossil fuels make SEV a worthy recipient of the Nordic Council Nature and Environment Prize 2015.”
Thank you!

"We simply must balance our demand for energy with our rapidly shrinking resources. By acting now we can control our future instead of letting the future control us"

Jimmy Carter 1977
Wind energy
The Neshagi Wind farm

Project specification:
- 3 pcs ENERCON E44/900kW (2,7MW)
- Capacity factor: 45%
- Annual production: 10,6 GWh
- Building phase: 2011-2012

Economical figures:
- Total cost: 5.2 million CAD
- Oil savings: 2.300 ton/year
  - more than 1.2 million CAD/year
- Generating cost: 0,081 CAD/kWh

Carbon footprint:
- Annual CO₂ reduction: 7.000 ton/year
The Húsaahagi Wind farm

Project specification:
- 13 pcs ENERCON E44/900kW (11.7MW)
- Capacity factor: 42%
- Annual production: 41 GWh
- Building phase: 2013-2014

Economical figures:
- Total cost: 20.3 million CAD
- Oil savings: 8.000 ton/year
  - approximately 4,6 million CAD/year
- Generating cost: 0,063 CAD/kWh

Carbon footprint:
- Annual CO₂ reduction: 28.000 ton/year
Other renewable resources
Hydropower

6 Hydropower plants
Total installed capacity: 37MW
Annual energy production: 115 GWh
First installation in 1921
Tidal energy

Tidal stream velocity in Vestmannasund

Max speed: 3.5 m/s
Average: 1.42 m/s
Photovoltaic

Average sun hours 2007 – 2015 (DMI)

Solar energy (Torshavn)

Solar resource from NASA
Instantaneous wind penetration

From SEVs SCADA system (BECOS32)
Challenging weather conditions
Customers

**HiddenFjord - Fútaklettur**

Salmon Farm delivering superior quality salmon. Power Hub controls the heat pump that keep the newly born salmons at the right temperature before they are send out

(35 kW heat pump)

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**Bergfrost**

Bergfrost is a cold storage where all kind of frozen marine products is kept. The cold storage is build in a mountain cave.

Care for the environment was the primary reason for blasting tunnels from the mountain for the cold store. It was felt that the blot on the landscape would be too visible if the quarry in Fuglafjørður was extended northwards. Far-sighted council members came up with the idea of going further into the mountain for stones.

(150 kW cooling compressor)

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**Kollafjord Pelagic**

Receives freshly caught fish and freeze it. The facility in Kollafjørð is one of the world's largest and most advanced processing facilities for human-consumption pelagic fish.

(4.200 kW cooling compressors)
Disconnecting flexible loads

Sudden stop of a production unit

FFDR: Fast Frequency Demand Response

Traditional generation
Disconnected consumption [FFDR]
PowerHub system topology

IT system

A box at 3 Industries
PowerHub FFDR test

Frequency drop after production trip
(12% of total system load)
PowerHub FFDR test

Frequency drop after production trip
(12 % of total system load)

Relative Frequency [dHz]

Time after Trip [s]
PowerHub FFDR test

Frequency drop after production trip
(12 % of total system load)

Relative Frequency [dHz]

Time after Trip [s]

-0.2
-0.1
-0.0
0
0.1
0.2

-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5

2.15 MW FFDR
0.62 MW FFDR
No FFDR