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FLEXIBLE ENERGY SOLUTIONS

The Role of Power-to-X in Solving The Problem of Affordable Renewables Integration – The Smart Energy Åland Demo

WEC Finland seminar 25.2.2019

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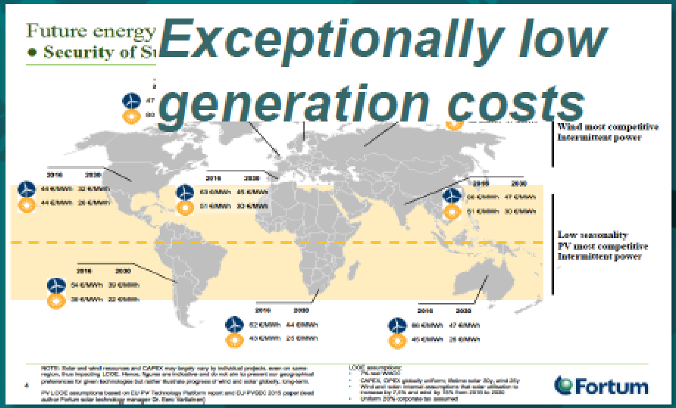
The challenge

- Integration: Smart and Efficient Use of Renewable Energy

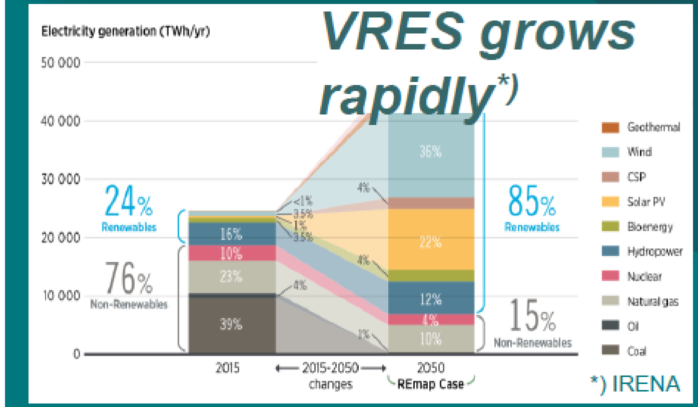


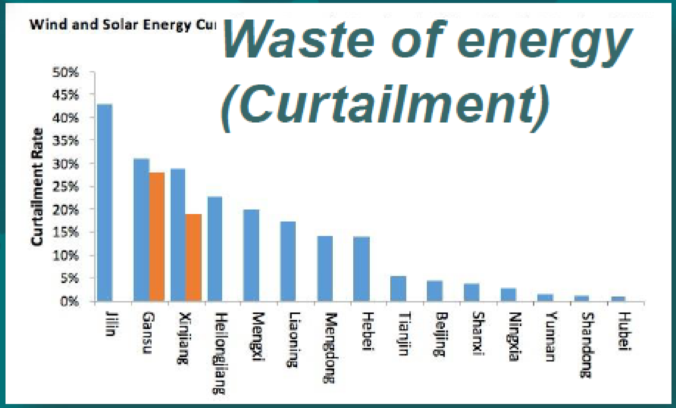
2022*)

RES generation grow by more than 30% to over 8 000 TWh

Wind and solar is 80% of renewable capacity growth

China, India and Brazil, share of VRES generation is to double to over 10%





System integration becomes increasingly important

Simultaneous increase in system flexibility

Market and policy frameworks have to evolve

**) Renewables 2017 Analysis and Forecasts to 2022, International Energy Agency 2017*

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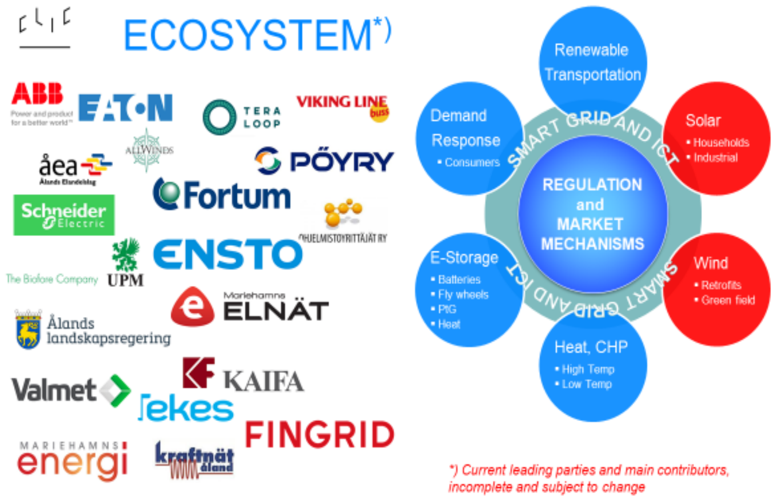
Background

- The Finnish SHOK Cleen and its successor Clic Innovation has been studying development opportunities related to energy systems and smart grids extensively

- Since 2014 the focus has been on analysing the possibilities to implement a full society scale demo on Åland Islands



- Now the key participants in this R&D has formed the company Flexens to implement the demo and become the "growth engine" company for the ecosystem of companies created around the concept

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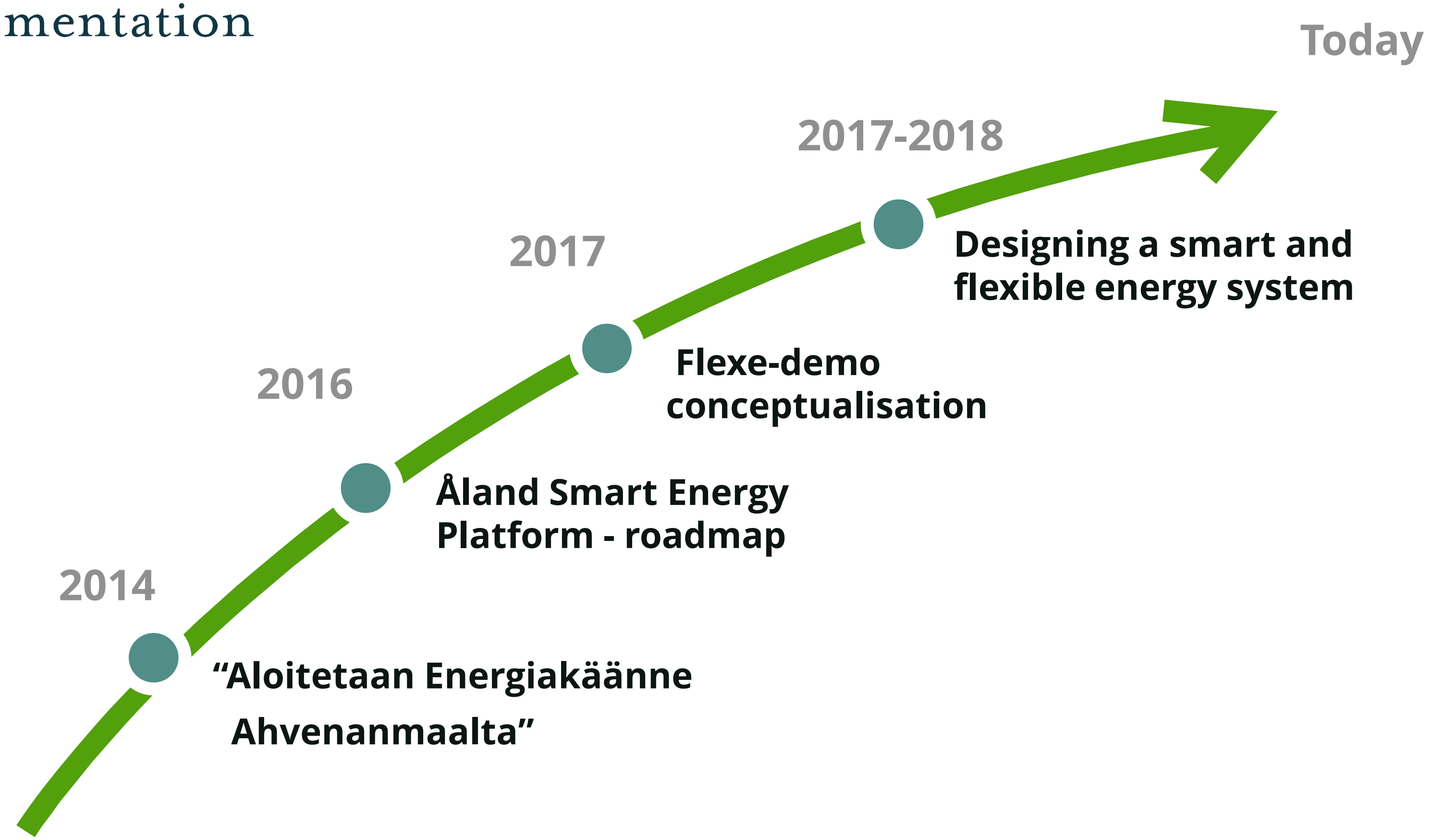
Smart Energy Åland

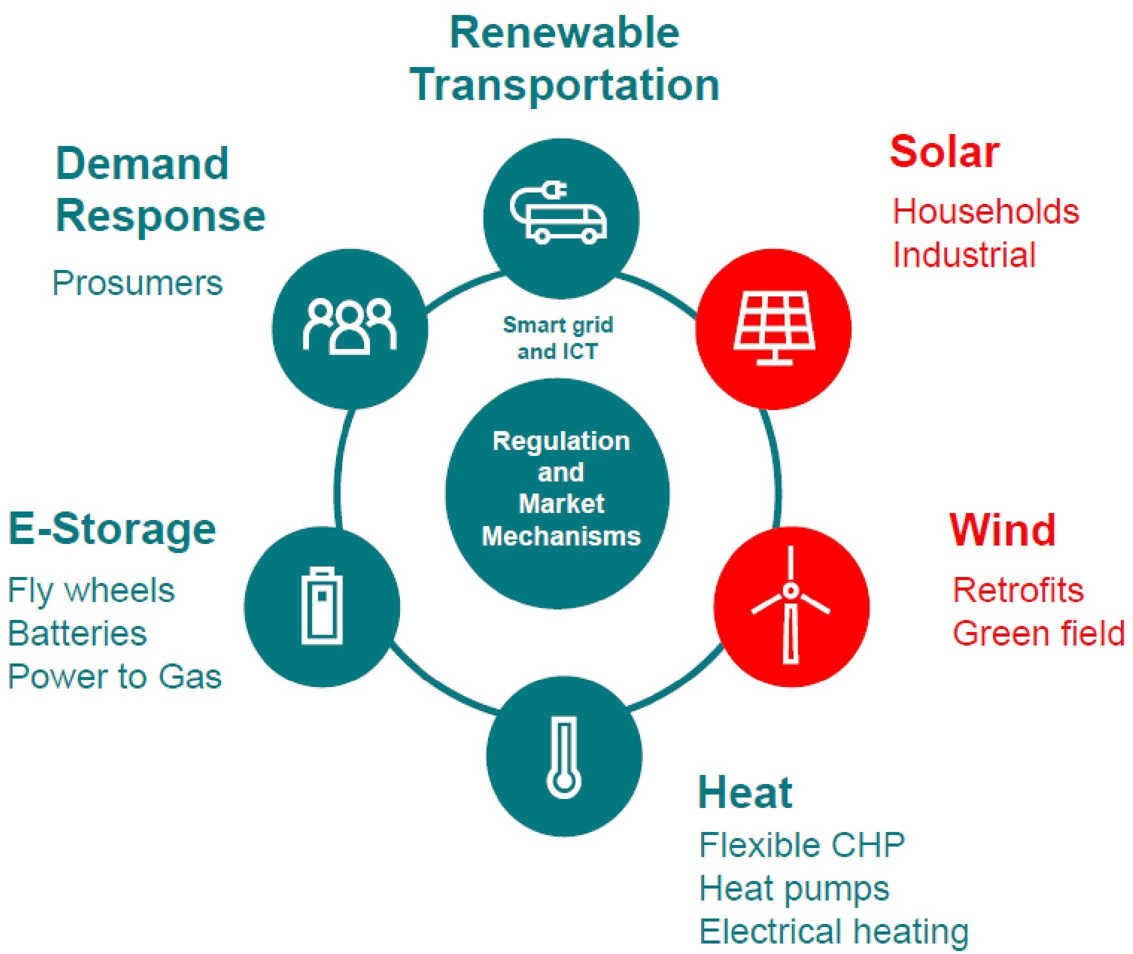
– From research to implementation



Preceding SHOK programs:
2010-2015 Smart Grids and Energy Markets
2010-2014 Future Combustion Engine Power Plants
2012-2016 Efficient Energy Use
2015-2016 Future Flexible Energy Systems

The solution

- An Integrated Renewable Energy System



The key is managing the interdependencies between subsystems

– the renewables integration challenge

To create a cost efficient energy system the integration must comprise all major subsystems

- Electricity
- Heating / cooling
- Transportation

Smart Energy Åland
Powered by Flexens

Åland – the ideal place
Best wind and solar conditions in Finland
Self-governed (own energy market regulation) and own grid area

Full society scale
30.000 inhabitants, industry & service sector - Results applicable to large markets
Operating in a deregulated environment connected to the efficient Nordpool market

Adopting future EU regulation
Current and future market models enabling investments in flexibility sources in focus

In the tempered climate zone
Heating and cooling central part of the energy mix

A platform supporting open innovation
Cooperation with leading R&D&I operator

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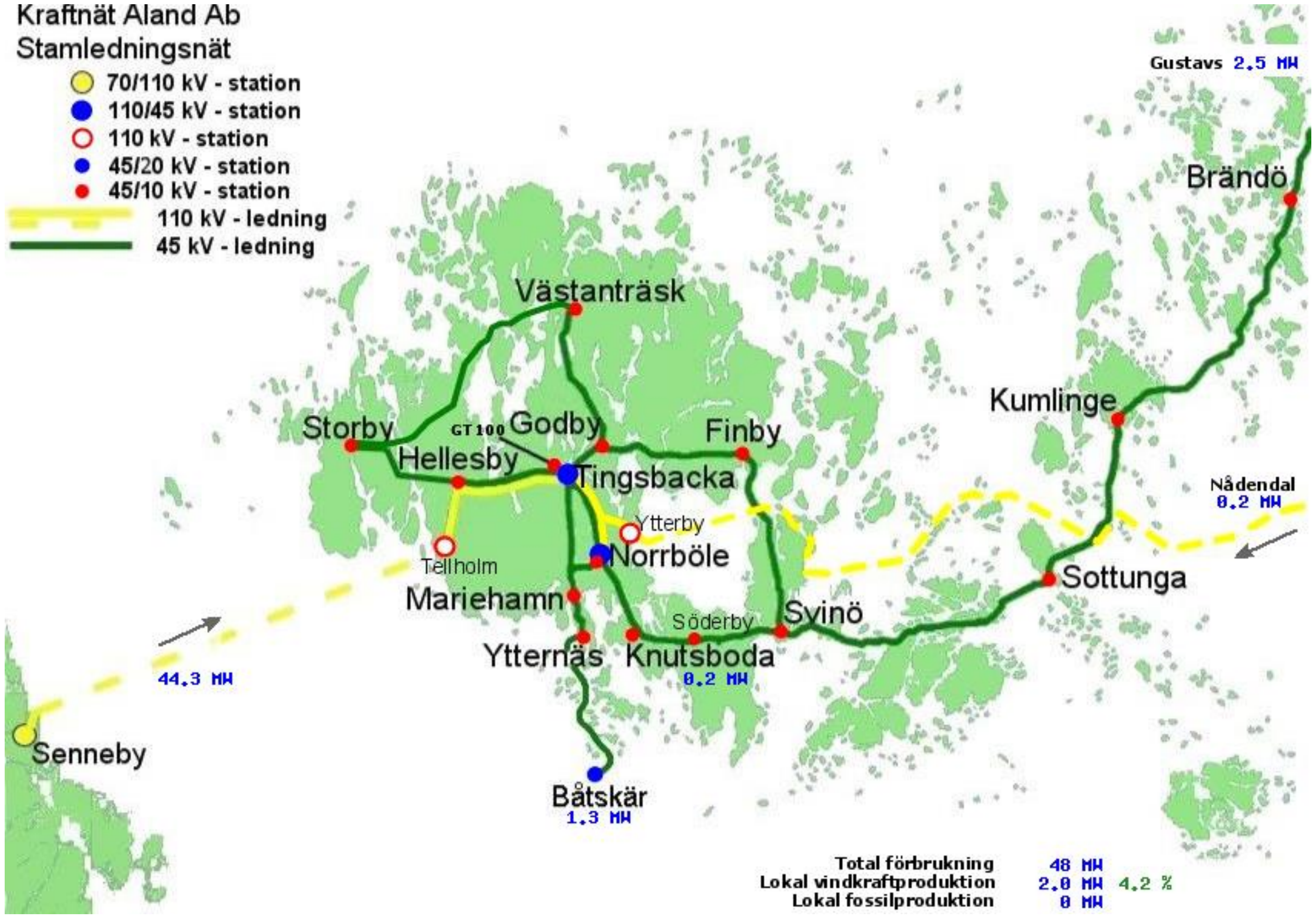
Current grid structure



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Åland Energy System Scenarios

Current situation:

- Wind capacity 21 MW
- Heat 20 MWe
- Peak 75 MW
- Total consumption 318 GWh
- Min load 16 MW
- Capacity mix
  - Import 80 %
  - Wind 20 %

Future 1:

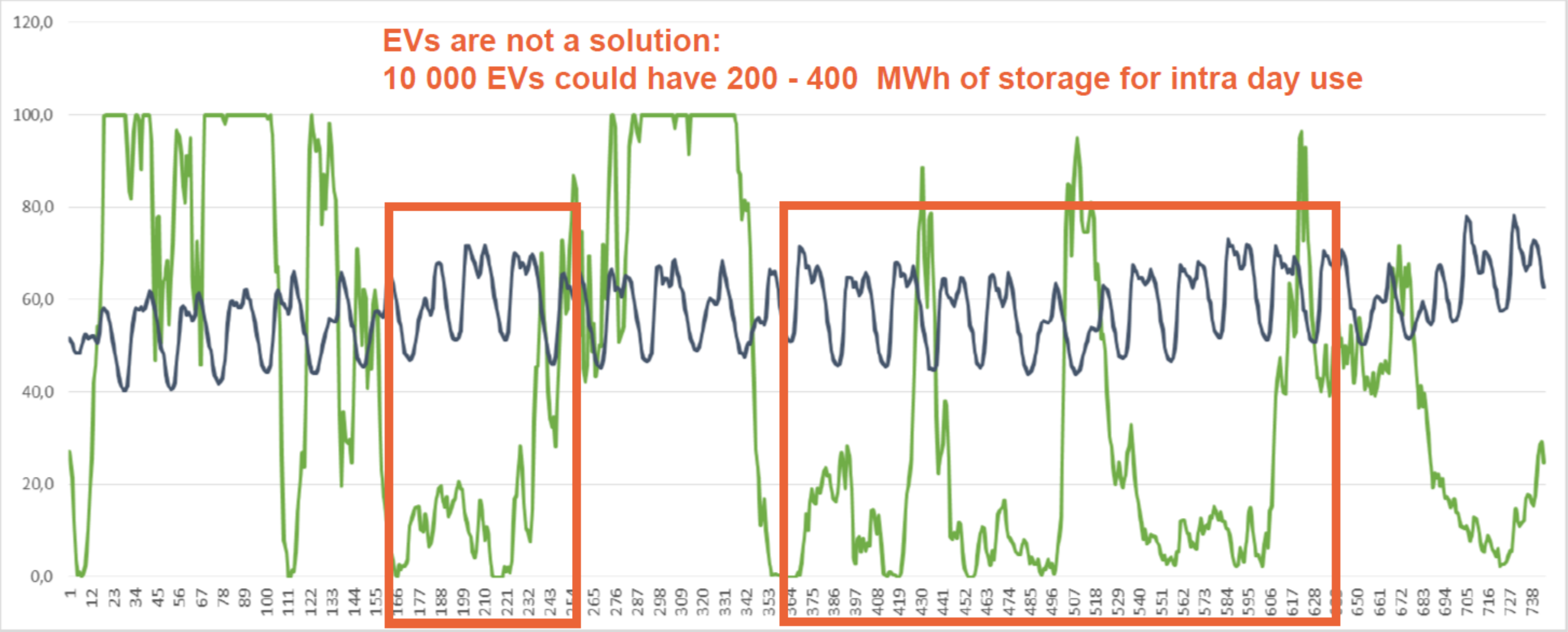
- Wind capacity 85 MW
- Heat CHP 20 MWe
- Solar 15 MW
- Peak 85 MW
- Total consumption 400 GWh
- Min load 16 MW
- Capacity mix
  - Wind 70 %
  - Solar 15 %
  - CHP 15 %

Future 2:

- Wind capacity 170 MW
- Heat CHP 0 MWe
- Solar 20 MW
- Peak 85 MW
- Total consumption 400 GWh
- Min load 16 MW
- Capacity mix

The need for storage

January RE production vs. consumption.
System needs to overcome days of minimal RE production and have storage or DR in +3000 MWh class*



9 *Figures are based on rough estimation only and not including hourly simulation

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Other estimates put the need at up to 6 GWh

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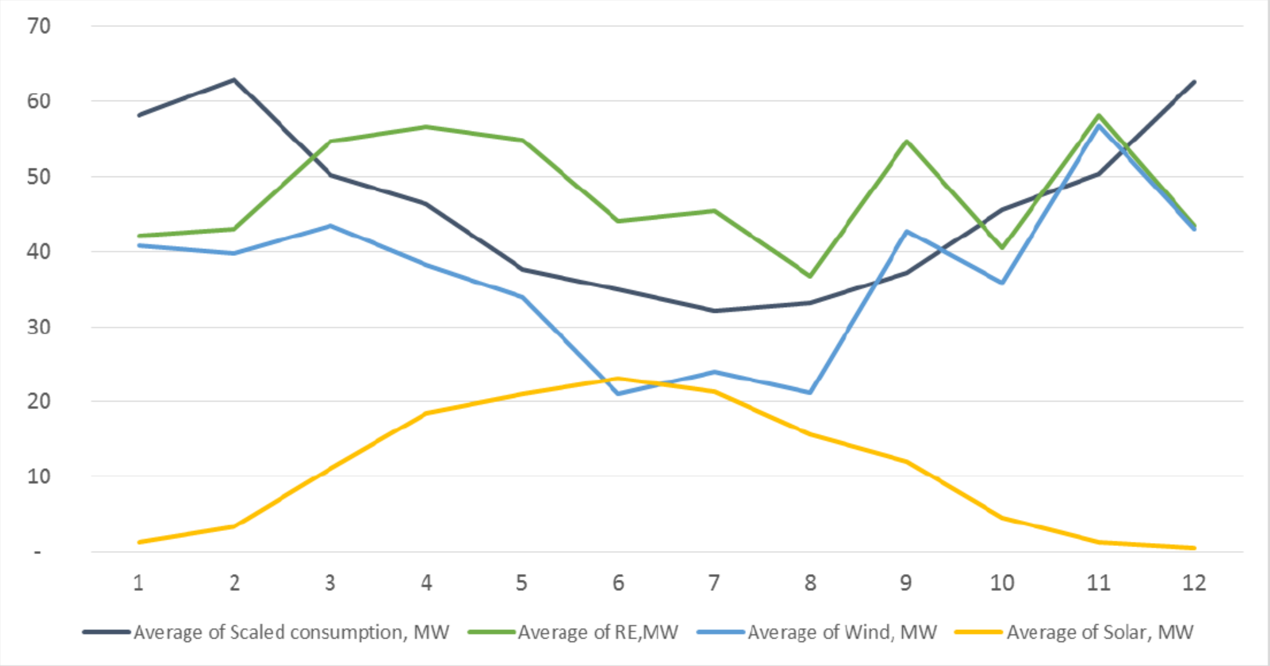
The effect of adding VRES

Average load values; increasing wind will reduce deficit in Jan/Feb and elsewhere create material surplus.

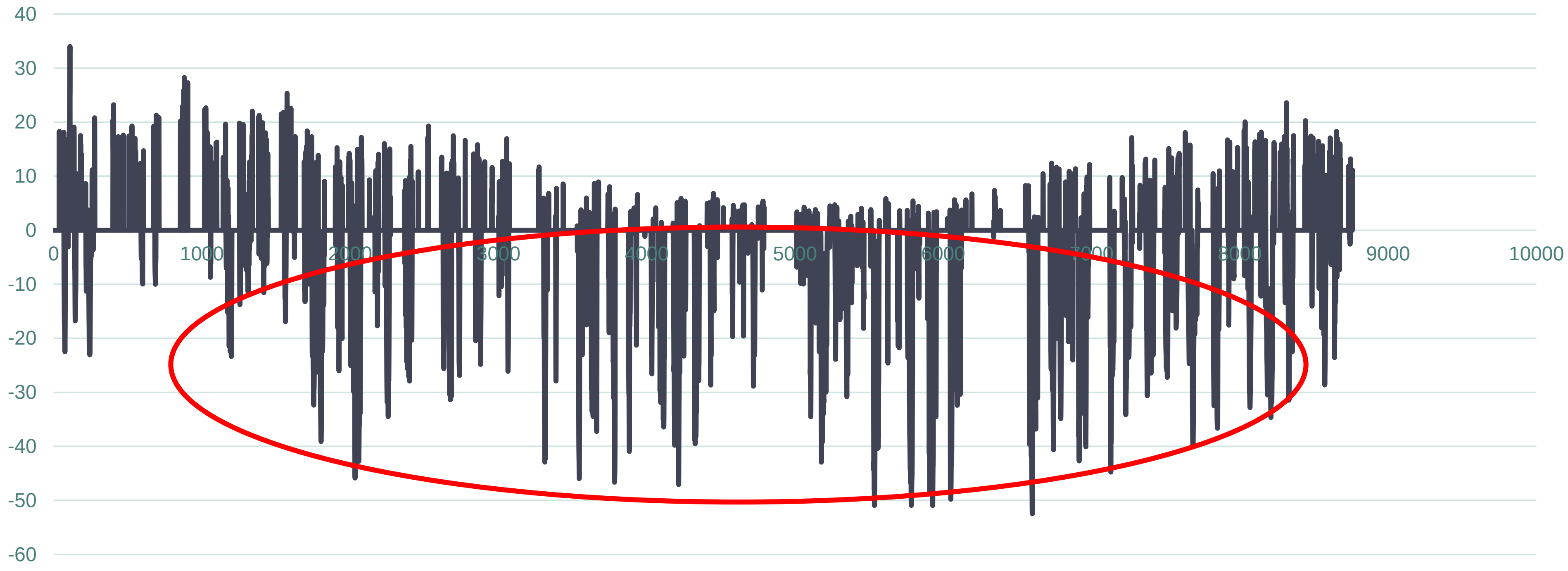


Options are:

- Radically increasing VRES capacity and use the material surplus to create X
- Or build baseload capacity with some other renewable source of energy
  - Biowaste availability limited
  - Woody biomass available but coal sinks are important too; the heating system does not need the heat from CHP

*Figures are based on rough estimation only and not including hourly simulation

Power to heat potential



Example case/ Future 1:

- Wind 85 MW, PV 15 MW with CHP in power mode (10/20 MW)
- Basic heat gap sum 40 GWh

- Positive value means heat gap
- Negative value means potential for heat storage (through power-to-heat)

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X = What are the required/preferred uses

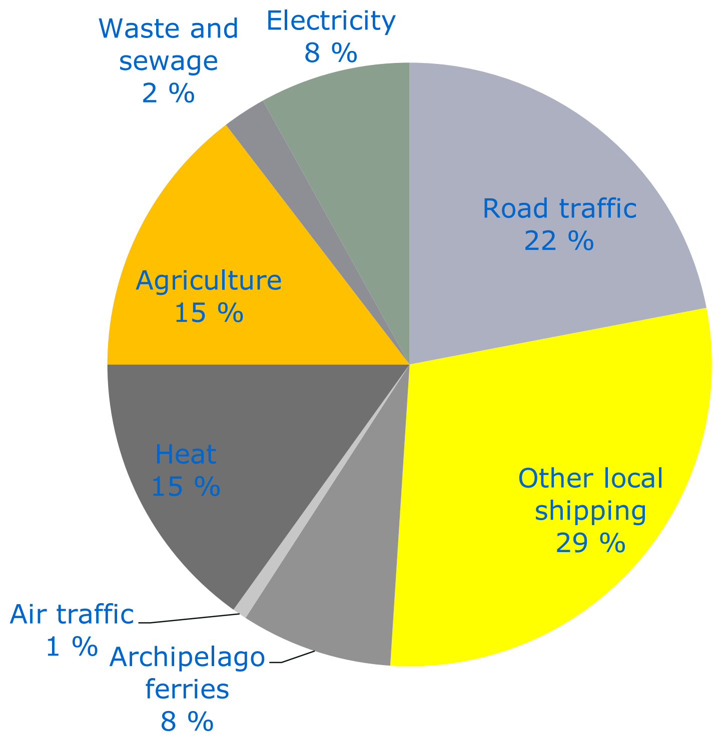
Electrical power needed (up to 6 GWh seasonal storage need)

Too minimise CO2 emissions transportation sector use may be more attractive

With radically diminishing solar and wind generation costs the most cost efficient route to reduced CO2 emissions may be P2X

250 000 ton CO2-eq

Greenhouse gas emissions in Åland 2015



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X = Hydrogen, Methane or something else?

In the Åland case availability of CO_2 is a challenge – basically only Hydrogen can be produced cost efficiently; total potential to produce methane is 500 -1000k Nm^3 according to various studies

- Converted to electricity in the range of 1-2 GWh only

The same is likely to be true on a full society scale anywhere, except in special and limited cases

A cost efficient hydrogen to electricity technology would solve the problem; also hydrogen propulsion systems for marine and heavy road transportation would fit the Åland picture

- Current cost of fuel cells still to high for the electricity market

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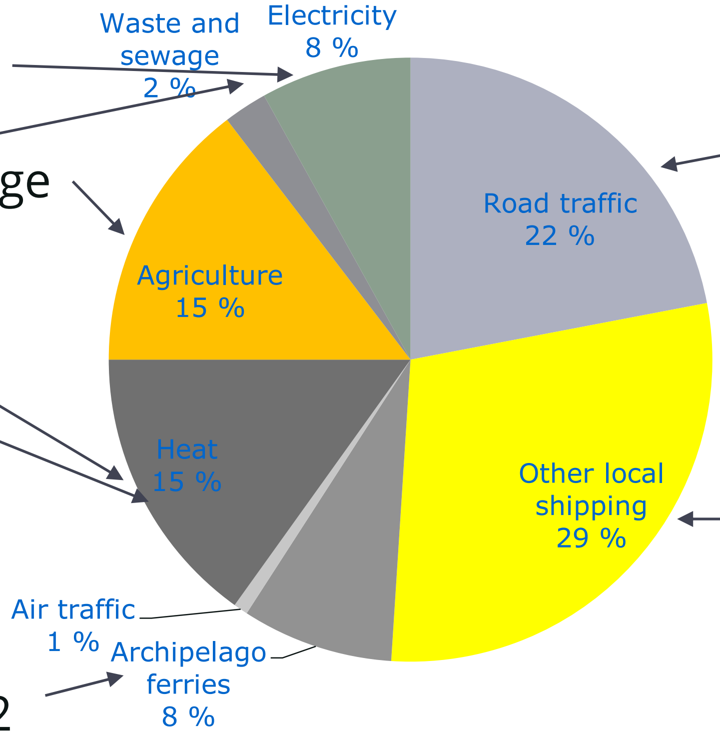
Where to use the X; case Åland, scalable?

Greenhouse gas emissions in Åland 2015



VRES+ P2G(Hydrogen)?

Micro CHP?

Challenge

Battery power for passenger cars
Biogas/ P2M for heavy duty road vehicles?

Power to heat, cost efficient to store

The 1000000 $ question

Battery power?

Fuel cells running on H2

250 000 ton CO2-eq

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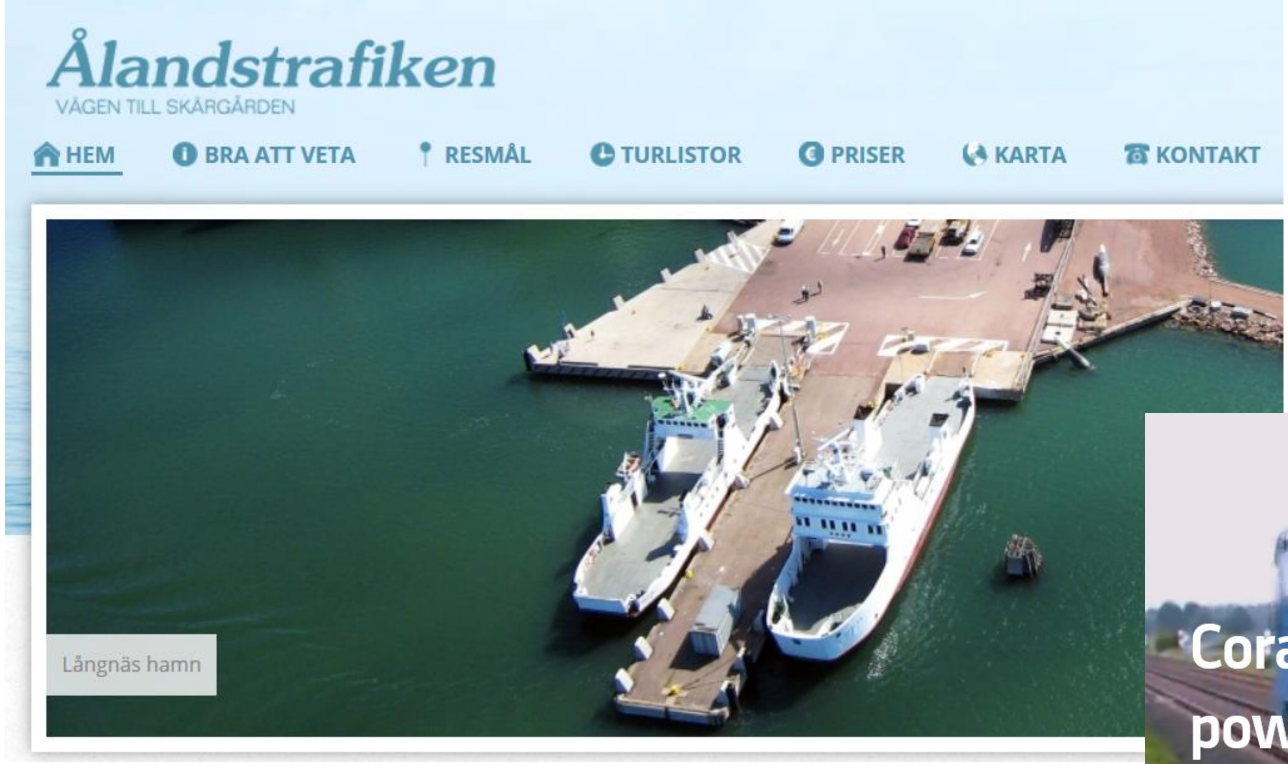
The hydrogen ferry
- an interesting option on Åland



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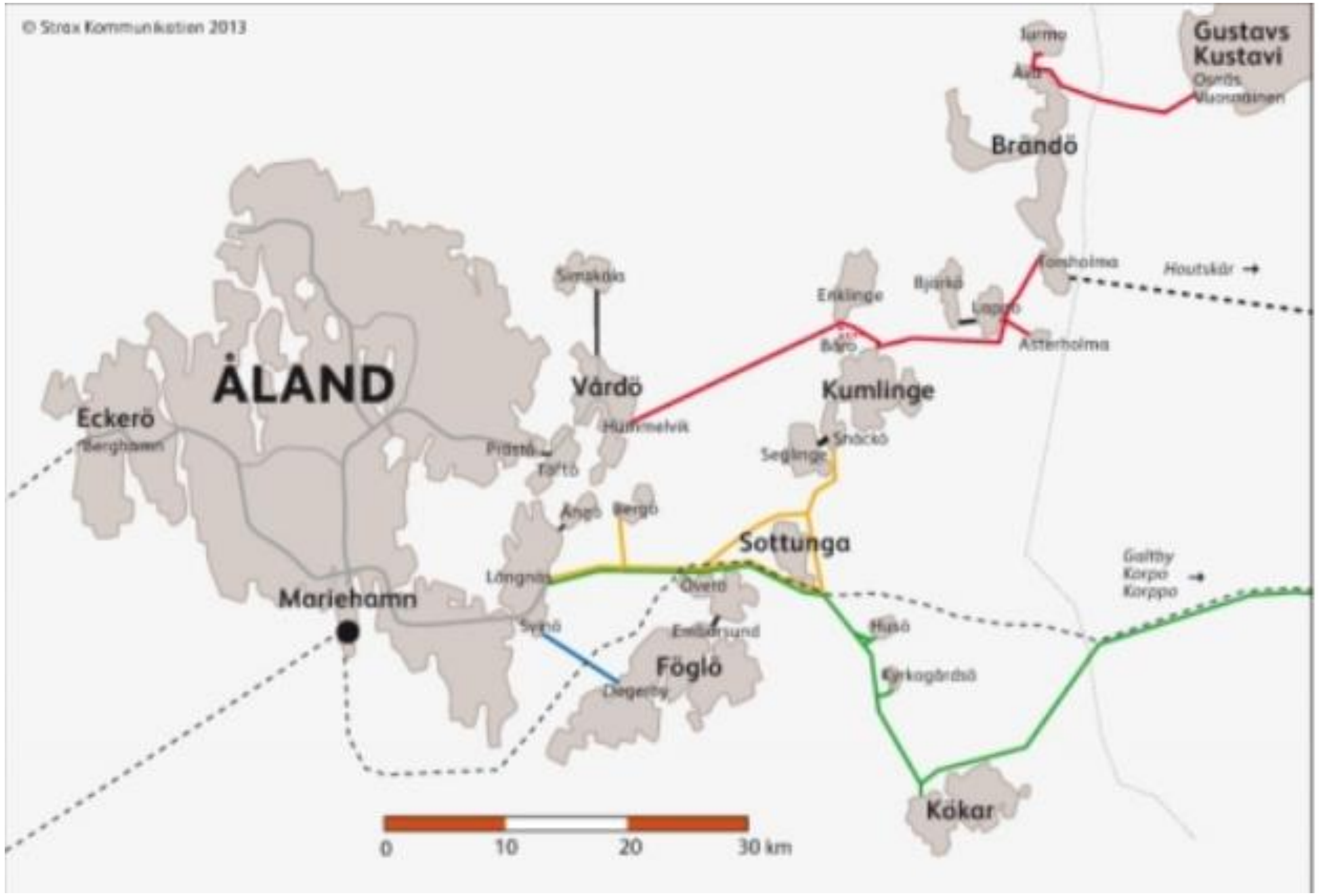
The archipelago ferry network



Conclusions so far

Power to heat + heat storage is an attractive way to handle the heat component of seasonal storage needed

Power to gas on Åland would need advances in cost efficiency of hydrogen-to-electricity solutions, as long as cheap electricity can be bought from the market over interconnectors; Micro CHP is considered as a part solution

An emerging need for hydrogen powered transportation can be identified, justifying excess investment in VRES production capacity

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Thank You !

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