



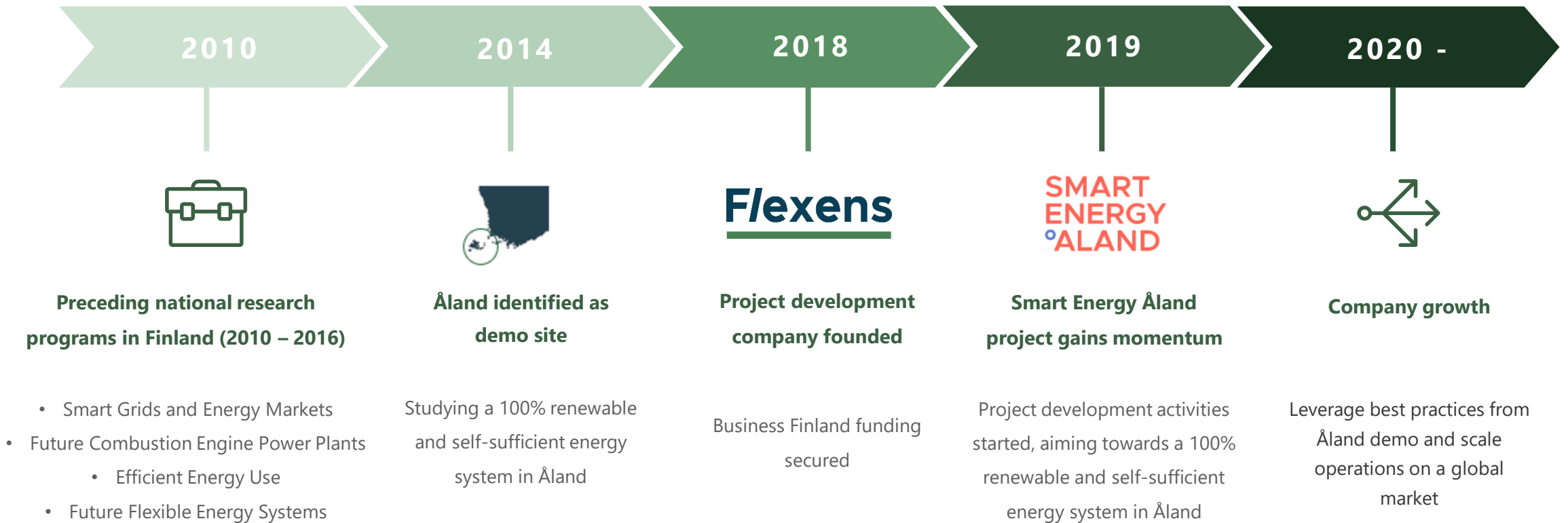
Flexens

FLEXIBLE ENERGY SOLUTIONS

Energy solutions for the archipelago

Company background

From research to implementation



Åland as the test and demo location

- **Åland – the ideal place**
 - Best wind and solar conditions in the region
 - 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



Our ecosystem

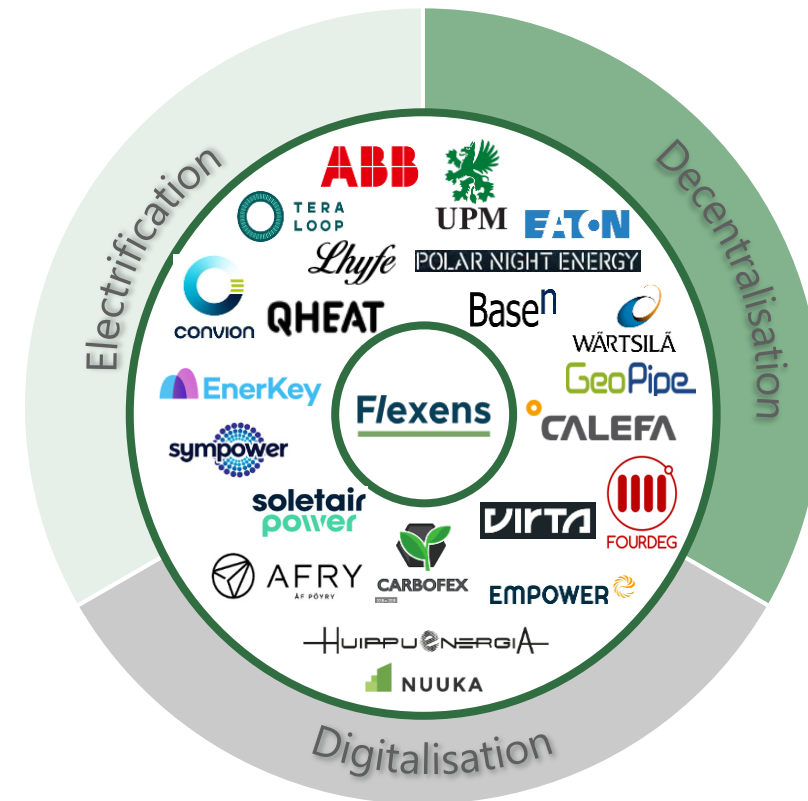
A network of cutting-edge technology providers and energy specialists

We believe in teamwork, collaboration and openness, why our growing ecosystem approach is a fundamental part of our DNA.

Within the ecosystem platform we capture the latest market and technology development, giving our customers the most suitable solution at any given time.

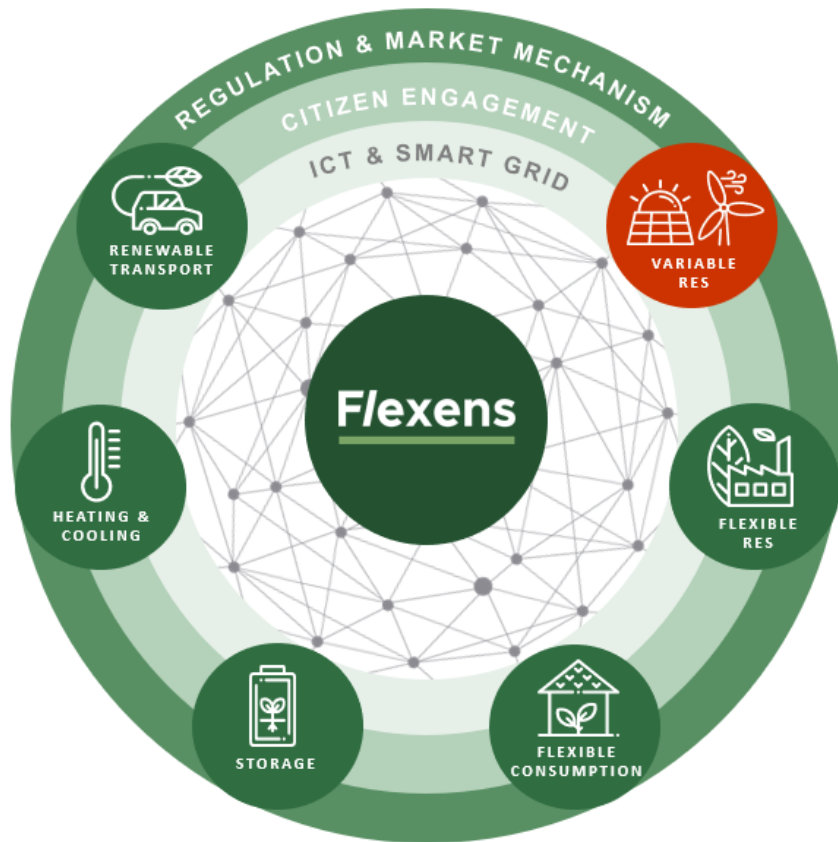
Through the ecosystem we act as a one-point-of entry, providing tailor-made solutions based on customers specific features and energy transition targets.

Currently, 23 leading technology providers are part of Flexens business ecosystem – providing cutting edge solutions for energy transition projects.



Our solution

Creating and implementing fully integrated renewable energy system



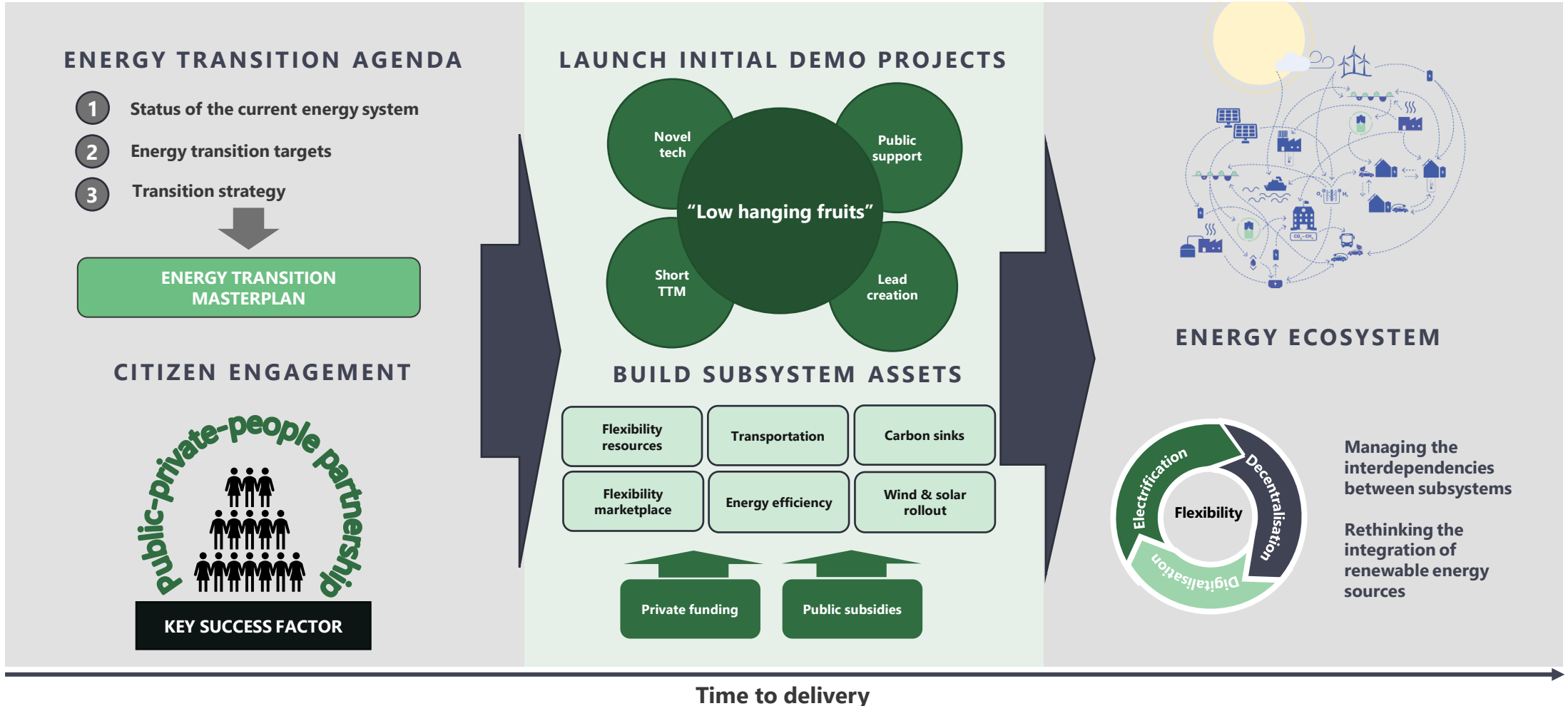
As variable energy sources is growing rapidly, the key is managing the interdependencies between subsystems – rethinking the integration of renewable energy sources.

100% renewable and distributed energy systems require novel paradigms and technologies for system management and optimization. These integrated energy systems must comprise all major subsystems:

- Electricity
- Heating / Cooling
- Transportation

As a global project developer, Flexens offers a unique integration process for implementing society-scale, multi-technology energy system-of-systems based on renewable energy sources.

Society scale energy transition roadmap



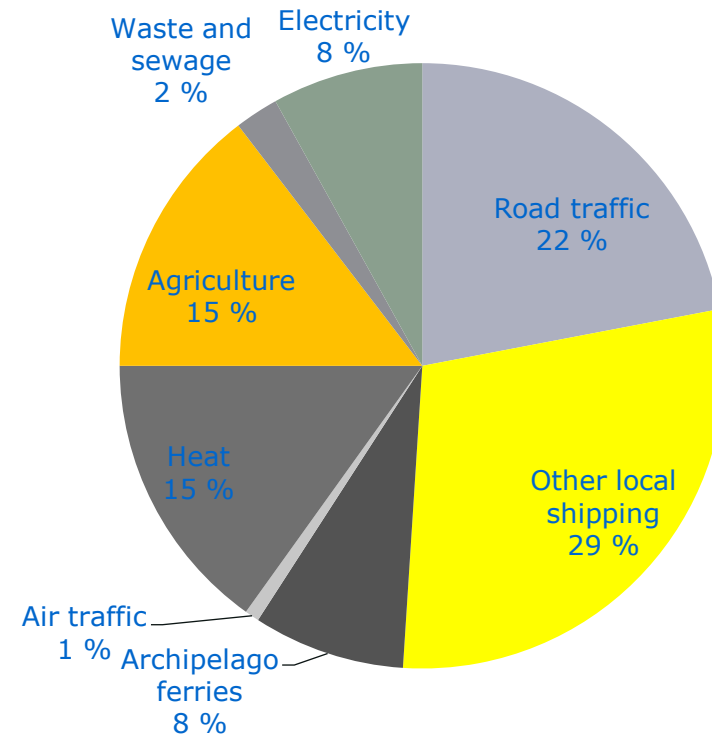
A CO2 free energy system

The Åland view

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

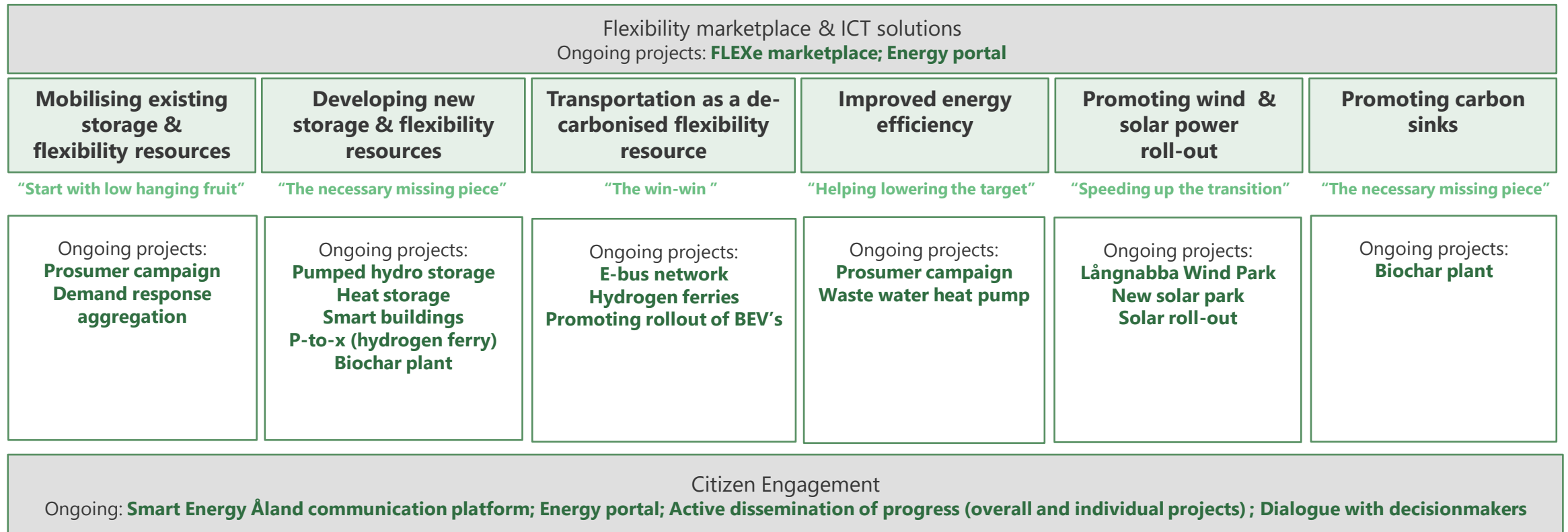
250 000 ton CO2-eq

Greenhouse gas emissions in Åland 2015



How to run a whole society on 100% renewables

Implementing key subprojects on Åland to support the overall energy transition masterplan



Citizen engagement

User-friendly website and Facebook page– *availability and inspire to action*



smartenergy.ax

Vi skapar världens första
energismarta samhälle.
Vill du hänga med?

Vi håller dig uppdaterad

Det här är Smart Energy Åland

Du kan göra skillnad

Varför på Åland?



Master Thesis in Sustainable Development

SMART
ENERGY
ÅLAND

- Which drivers enable a full scale societal transformation for a 100 % renewable and flexible energy system on the Åland Islands?
- Who is regarded as key stakeholders and/or major societal influencers?
- "Who's in charge here?": - A case study of municipal leadership within energy transitions on the Åland Islands, Finland
 - Häger, Anna
 - Linköping University, Department of Thematic Studies.
- <http://liu.diva-portal.org/smash/record.jsf?pid=diva2%3A1459589&dswid=-8209>



Smart Energy Åland

Wide range of technologies considered

- Flexibility Marketplace
 - Energy communities
 - Energy portal
 - Solar PV
 - Solar thermal
 - Wind power (incl. small scale)
 - Heat pumps
 - Mid-deep geothermal
 - Pumped hydropower storage
- Heat-to-heat storage
 - Waste heat recovery from water treatment
 - Heat recovery from the sea
 - Electrolysers & CHP fuel cell
 - Demand response (private houses, industrial consumers)
 - EVs and other land traffic alternatives
 - Marine transportation (battery powered and fuel cell ferries)
 - Oil (side product from biochar production)
 - Electricity-to-heat storage (Polar Night Energy)

Smart Energy Åland subproject overview

Flexibility marketplace
 Stage: **Planning** (design)
 Role: New market models

Energy portal for energy transition monitoring
 Stage: **Project Development**
 Role: Energy transition, citizen engagement

Energy community demo (Village)
 Stage: **Planning** (design)
 Role: New market models

Geothermal heating well
 Stage: **Planning** (design)
 Role: Flexibility resource

Långnabba Wind Park
 Stage: **Project development**
 Role: VRES rollout

Hydrogen ferry ecosystem
 Stage: **Feasibility study**
 Role: Transportation

Smart building demo
 Stage: **Completed**
 Role: Energy efficiency & Flexibility resource

Biochar plant
 Stage: **Planning** (feasibility)
 Role: Carbon sink & Flexibility resource

Thermal heat storage
 Stage: **Planning** (design)
 Role: Flexibility resources

Smart building demo
 Stage: **Project Development**
 Role: Energy efficiency & Flexibility resource

District heating decarbonisation
 Stage: **Planning** (design)
 Role: Flexibility resources

Waste water heat recovery pump
 Stage: **Planning** (design)
 Role: Energy efficiency

Electric bus line
 Stage: **Planning** (design)
 Role: Transportation

Smart island energy community
 Stage: **Energy system design**
 Role: Flexibility resource & market models

Electric bus demonstration
 Stage: **Completed**
 Role: Transportation

Underground pumped hydro storage
 Stage: **Feasibility study**
 Role: Flexibility resources

Project with LOI
 Project under concept development

20+ subproject leads in pipeline

Case study: Underground pumped hydro storage

Project overview

An underground pumped-hydro storage (UPHS) to be build in an abandoned mine on a small island in direct connection with an existing wind park

- Filling the caves with water running through a turbine at periods of light winds <-> Pumping the water out at periods of strong wind
- The first plant of PHS technology implemented in an old mine

Major benefits from UPHS:

- Absorb excess power in the grid particularly when balancing energy produced by wind & solar plants
- Absorb base load production particularly from nuclear and coal plants



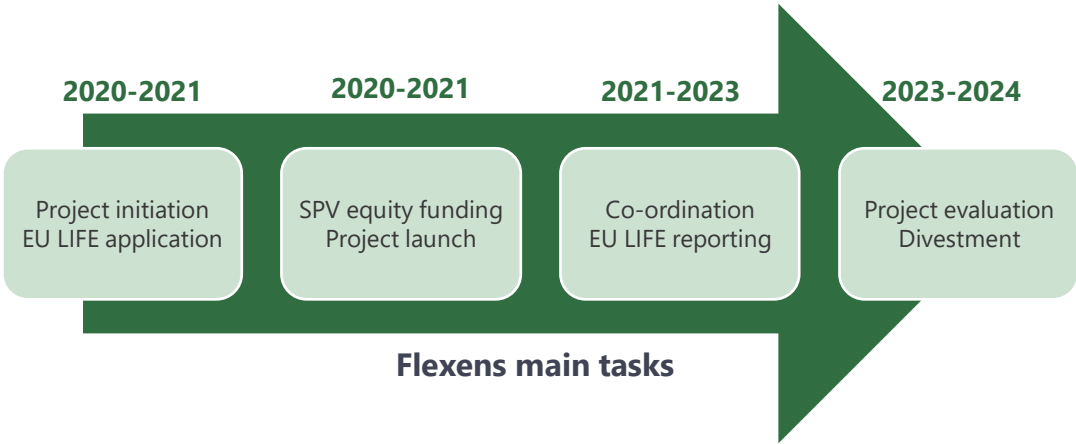
Power capacity: **2 MW**
 Storage capacity **8 MWh**
 Commercially viable by: **2023**

Funded by the EU LIFE programme

The overall objective of the LIFE UPHS project is to demonstrate a new, highly innovative method for large scale underground energy storage that enables storage with 70-80% round-trip efficiency.

The LIFE UPHS project include the following sub-objectives:

- 1 Verify the innovative concept and full operating conditions
- 2 Develop and verify a scalable standard design concept
- 3 Perform a fast replication and commercialization



Case study: Hydrogen ferry network

Current activities

During summer 2020 the Government of Åland appointed Flexens to launch the study and design phase of hydrogen ferries:



Ferry comparison

Assess rough cost estimates and operation of single hydrogen ferry on a specific route in Åland archipelago
Results: Hydrogen ferry cost estimate EUR 24m vs hybrid ferry EUR 20m



Hydrogen production and logistics

Goal: Assess rough cost estimates, scaling and operation of hydrogen in the Åland region
Results: Hydrogen production unit investment 10,5 M€ (14,5 GWh annually for two ferries)

Emerging technology integration

Wind power

Hydrogen production

Hydrogen ferry

Building a hydrogen ferry network requires integration of multiple emerging technologies with the developing energy system through a public-private partnership.

Due to excellent wind conditions in Åland, locally produced renewable hydrogen is the ideal fuel for archipelago ferries improving also sector coupling and grid flexibility. The demo will cover the whole hydrogen value chain and opens several business and investment opportunities for Flexens.

The project's total investment need, if replacing all diesel ferries, exceeds EUR 300m where a large portion needs to be financed through green deal vehicles such as EU Innovation Fund.



The hydrogen ferry ecosystem demo is of significant strategic value to Flexens.

Transportation to and from the island is generally the biggest CO2 emitter in islands societies, why creating capabilities in the art of building hydrogen ferry ecosystems is highly attractive and scalable on a global market.

Key tasks for Flexens during 2021

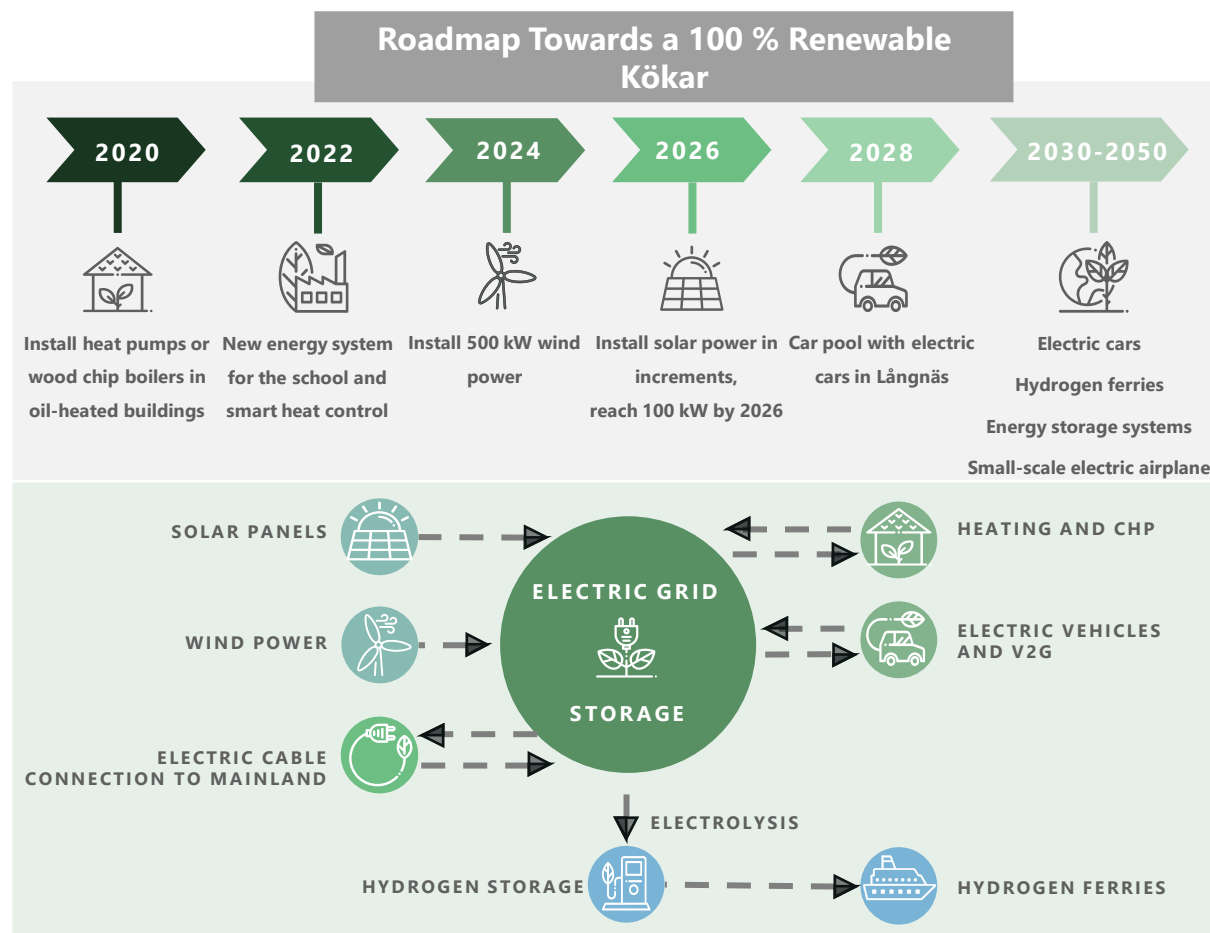
- 1 Secure funding from EU calls for preparation of investments
- 2 Create and manage consortium of technology providers
- 3 Create detailed project implementation and business plan

Kökar Energy Transition agenda

ESDS report for an Ålandic Island

Kökar municipality has a comprehensive and ambitious sustainability plan within some EU funding schemes. Flexens Oy conducted a survey of the energy system at Kökar and proposed a development plan that increases renewable energy production and decreases carbon emissions. The following technologies were included in the transition agenda:

- Solar PV
- Wind power
- Ground-source heat pumps
- Smart Heating control
- Micro-CHP
- Battery storage
- EVs
- Carpool
- Hydrogen ferry
- Electric boats



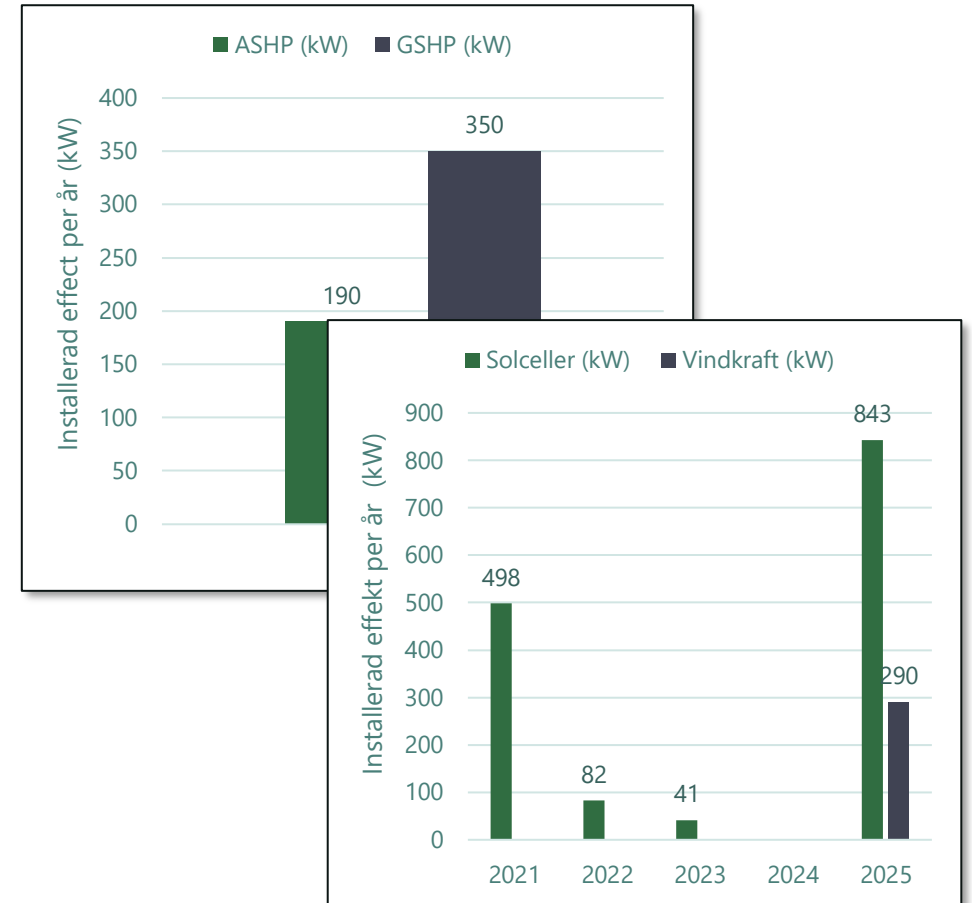
Ämnäs energy community

First step in creating an energy community – an ESDS report

Flexens is helping the community of Ämnäs in its steps to a smart energy community. In the first phase, Flexens provides ESDS report for Ämnäs. The goal is to find the best alternatives for Ämnäs in different climate targets.

The following small-scale technologies are used in the comparison:

- Solar PV
- Wind power
- Air-source heat pumps
- Ground source heat pumps
- Heat storages
- Lithium-ion batteries





Flexens

FLEXIBLE ENERGY SOLUTIONS

Thank you

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