The renewable energy of the island of Ærø

and the fully electric E-ferry Ellen

ÆRØ KOMMUNE

Ærø is powered by renewable energy

Ærø's six 2 MW wind turbines produce between 125 % and 140 % of the electricity used on the island.

Ærø's district heating plants use the rays of the sun to produce more than 50 % of the heating supplied to households in Marstal, Ærøskøbing and Rise.

Ærø is a leader in the development of renewable energy:

- When Ærø's first wind farm was built in 1985, it was the largest wind farm in Denmark.
- During the 1990s, Marstal district heating plant built the world's largest district heating solar array.
- In 2019, Ærø broke the distance world record between charges X7, when it launched the electric E-ferry Ellen.
- More than 250 households on Ærø have installed solar cells on roofs or in gardens. This is equal to 7 %, more than twice the national average.

Tip for replication:
Ærø's wind turbines are owned by locals. 640 fixed price shares funded the turbines, and create dividends to the share holders. Local ownership creates local acceptance of the installations in the landscape.

The grass around the solar panels is trimmed by sheep. This is both the most efficient and most sustainable method.

Søbygaard Castle was built around 1580, it is a popular tourist attraction

ÆRØ HAS SET AMBITIOUS CLIMATE GOALS

The Municipality of Ærø is ambitious with its climate goals. The municipality has already taken big steps in reducing its greenhouse gas emissions, and it aims to reach the goals in the Paris agreement already by 2040.

In 2021, the municipal council agreed on the following goals:

2025: Municipal use of electricity and heat is CO_2 neutral and fossil free.
2030: Municipal activities are CO_2 neutral and fossil free (excl. ferries).
The municipal district is CO_2 neutral, fossil free and self-sufficient with renewable energy in the electric and heat sectors.
2035: Municipal activities are CO_2 neutral and fossil free (incl. ferries).
2040: The municipal district is CO_2 neutral.
2050: The municipal district is adapted to climate changes.

Besides tending to its own activities and operations, the municipality has reached out to Ærø's citizens to get their help in making the whole island more climate friendly. In 2021 the municipality invited citizens to a citizen hearing to outline the areas where challenges remain, and to gather ideas and input.

ÆRØ'S RENEWABLE ENERGY GOES BACK DECADES

In 1981, a workshop was held on Ærø which outlined some of the budding renewable energy technologies being developed. A group of locals, who came to be known as the *Energists,* were keen to implement these technologies for a number of reasons: They wanted to avoid being dependent on fossil fuel from the outside, they wanted 'green' energy, and they wanted to present alternatives to the movement for nuclear energy which was gaining foothold at the time.

In 1985, they managed to erect what was then Denmark's largest wind farm, cooperatively funded and owned by locals on Ærø.

They also started experimenting with new fuel sources for heating, spawning ideas that has since been taken up by the island's three district heating plants, which supply heating for households in Ærøskøbing, Marstal and Rise.

In 2014, 7 kilometers of water to water heat pump pipes were laid in the moat of Søbygaard Castle.
The heat pump keeps the castle buildings warm during winter.

The first wind farm consisted of eleven 55 kW wind turbines. Modern turbines produce much more power, Ærø's current six turbines each produce 2 MW.

OVERVIEW: ÆRØ'S RENEWABLE ENERGY

2019: The E-ferry Ellen is put into operation on the Søby/Fynshav route

2021: The Ærø Fund installs 16 chargers for E-vehicles and 3 for E-bicycles

2014: The moat surrounding Søbygaard Castle is turned into a heat source for a large heat pump system

2013: The 'Ærø try-out' house is turned into a low impact 'green' demonstration house

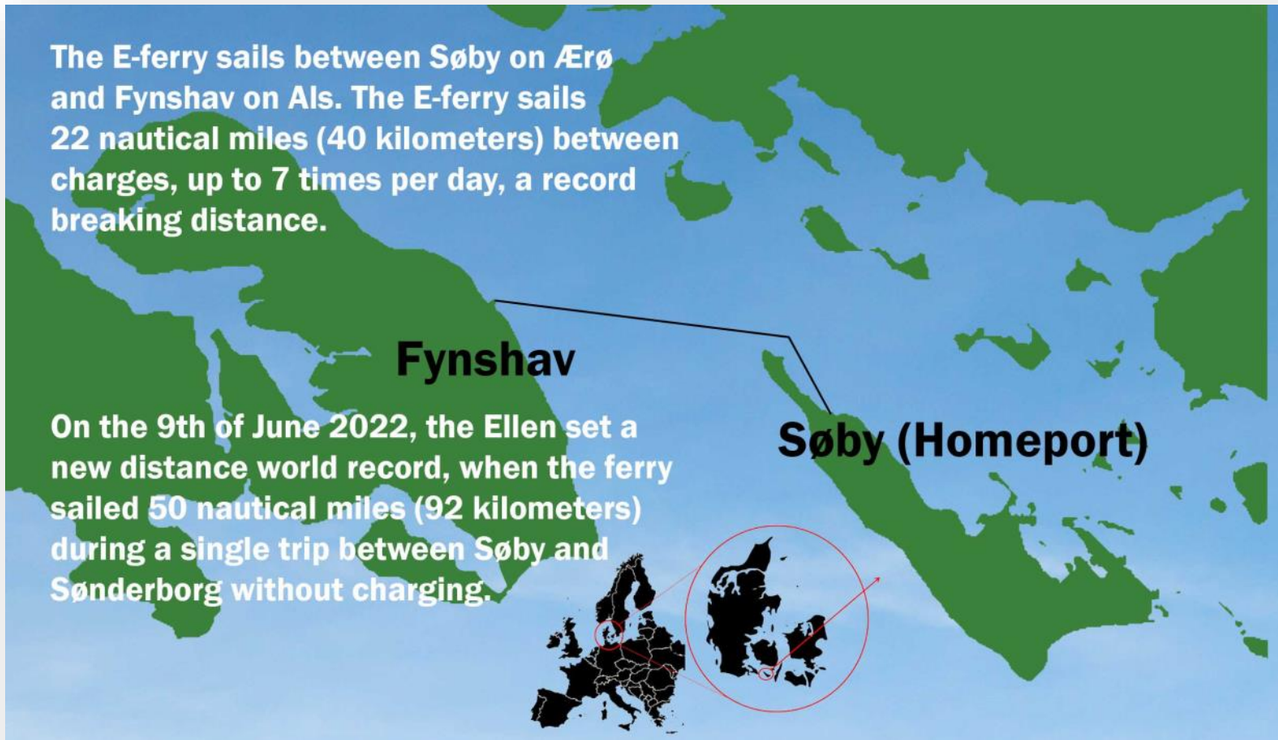
1989: Ærøskøbing Heating experiments with solar, hay and more
1998: Ærøskøbing District Heating, 4900 m² solar array is built

2001: Rise District Heating is put into operation. It is based on solar power, warm water storage tanks and wood pellets

1996: Marstal District Heating installs solar array, it gives 15 % of the heat
2002: The plant doubles the amount of heat produced with solar power
2012: Another expansion, 50 % of the heat now comes from solar power
2012: The plant builds a 75 million litre warm water storage tank

1985: The cooperative Ærø Vindenergi is founded, eleven 55 kW turbines are erected
2001: The old turbines are replaced with three new 2 MW turbines at Rise Mark
2011: Three more turbines, at Vejsnæs. Ærø now produces more power than it uses

The E-ferry sails between Søby on Ærø and Fynshav on Als. The E-ferry sails 22 nautical miles (40 kilometers) between charges, up to 7 times per day, a record breaking distance.



On the 9th of June 2022, the Ellen set a new distance world record, when the ferry sailed 50 nautical miles (92 kilometers) during a single trip between Søby and Sønderborg without charging.

A CLOSER LOOK AT THE E-FERRY ELLEN

Specifications

Lenght: 59,50 m.
Width: 12,80 m.
Draft: 2,50 m.
Capacity: 196 passengers / 31 cars
Main engines: 750 kW (1000 hp)
Bow thrusters: 250 kW
Battery capacity: 4 MWh
Typical speed: 12,6 knots

Features

Fossil fuel onboard: None
Emissions: None
Range (single trip): 80 km+
Range (7 times pr. day): 40 km
CO_2 saved: 2000+ tonnes / year
Particles (PM) saved: ½ tonne / year
Noise level (salon): Living room level
Applicability: 900+ routes in Europe

Transitioning the transport sector

To become emission free, the world needs the transport sector to make a transition from fossil fuels, both on land, in the air, and at sea.

In 2021, the Ærø Fund, which is partly funded by the island's wind cooperative, installed chargers for both electric vehicles and bicycles. This will make it more attractive for locals to make the transition to electric vehicles, or to bicycle more in the coming years.

But for the island of Ærø, and many other islands, the ferries are the main challenge. Ærø Municipality made a giant leap forward when it launched the E-ferry in 2019. The next big challenge for Ærø will be to transition the remaining two municipally operated ferry routes.

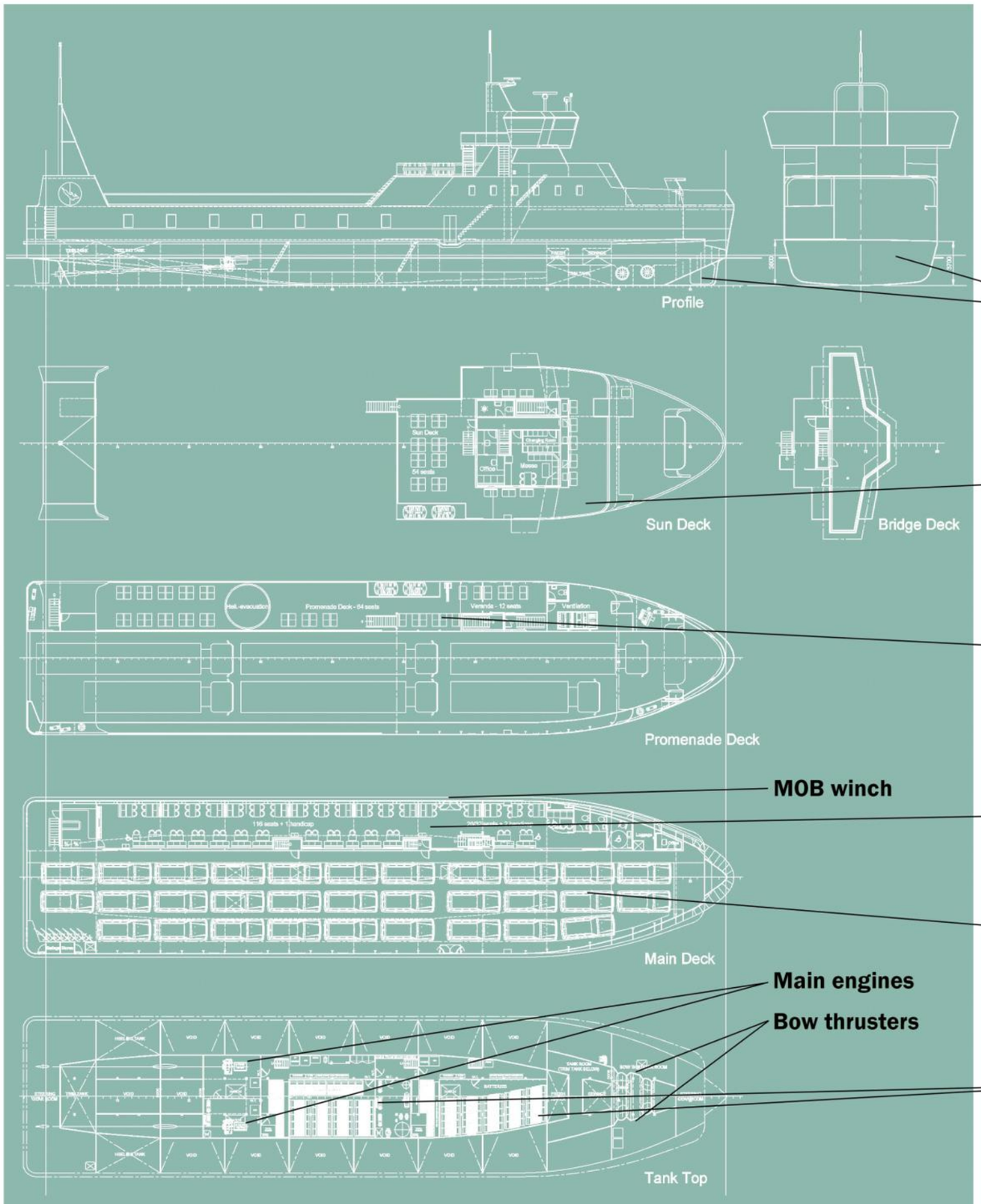
In 2022, the municipality is already busy with a new electric ferry project for the route between Ærøskøbing and Svendborg. New ferries will be designed and built during the coming years, and they will be based on the experience with the E-ferry's systems and architechture.

E-FERRY PARTNERS:

- Danfoss
- The Danish Inst. of Fire and Sec. Tech.
- Hellenic Inst. for Transp. (CERTH/HIT)
- Leclanché
- Jens Kristensen Consult. Naval Arch.
- Søby Shipyard
- Danish Maritime Authority
- Tuco Marine Group
- The Municipality of Ærø

The E-ferry project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No [636027].

THE E-FERRY DESIGN AND SYSTEMS



The passenger salon is decorated with pictures taken by the winners of the 2017 E-ferry photo competion

The E-ferry is a fully electric regional ferry. The E-ferry has no fossil fuel onboard. The long and slender hull allows the E-ferry to glide through the water with minimal resistance, a major factor in keeping the energy consumption low.

The popular sundeck is a great place to enjoy the views in good weather. The emission-free ferry allows passengers and crew to enjoy a smog free experience without inhaling unhealthy sooty particles. The low noise from the engines gives the impression of sailing on a sailing ship, the wind and the breaking waves are the dominating sounds.

There are plenty of seats on the veranda and promenade deck for passengers to enjoy the beautiful trip through the Western Baltic. The seating arrangement is made from recycled materials, underlining the environmentally sound design philosophy.

The passenger salon is at the same level as the car deck. This means that no energy consuming elevator is needed, passenger access to the salon is immediate. This also means less risk of passengers becoming seasick, as they are sitting close to the waterline. Noise in the salon is at living room level.

The open car deck keeps the weight down, which helps keep the energy consumption low.

The two battery rooms are completely seperated, electrically. One battery room powers one engine and thruster, the other battery room powers the other engine and thruster.
If one of the two electrical systems needs to be stopped, the E-ferry can still sail home on the other system. The dual-system approach gives the redundancy required for safety reasons.

E-ferry design: Jens Kristensen Consulting Naval Architechts (Marstal, Ærø)

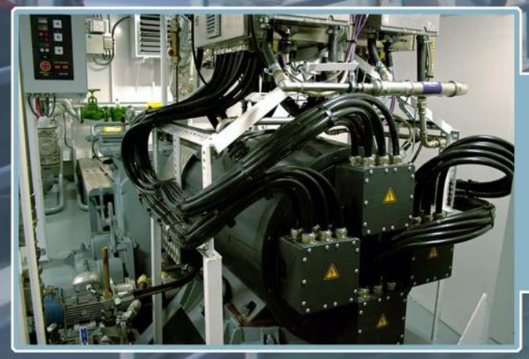
E-ferry build: Søby Shipyard (Søby, Ærø)

Operating the E-ferry

The ferry connects with the charger in Søby.
Peak charge: 4 MW
Amperes: 4 x 1200

Electricity is filtered before it reaches the lithium-ion batteries, holding 4 MWh.

The liquid-cooled batteries are stored in two seperate rooms, each room holds 420 battery modules.

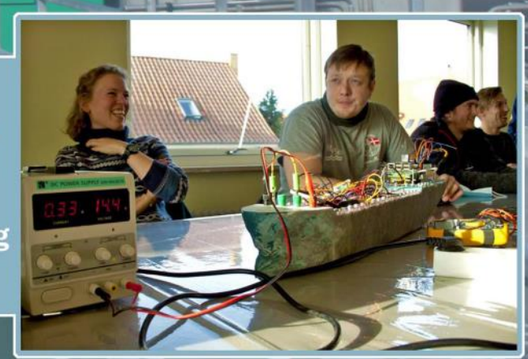


The batteries power the two main engines and bow thrusters.
Main engines: 750 kW
Thrusters: 250 kW

The E-ferry's unique battery and power management systems inform the crew about everything related to the electrical systems.

The electric engines respond immediately to control input, making navigation more predictable. The captains love sailing fully electric.

Marstal School of Navigation trains E-ferry crew members and offers courses in electric operations. The school has built an E-ferry simulator.



Navigation students build their own electric vessels at Motorfabrikken Marstal, an official MIT FabLab. They become experts at operating the vessels of the future.

Awards and recognitions

The island of Ærø has been awarded many times over the years, for its renewable energy achievements. For instance, when the small island built the world's largest district heating solar array.

Likewise, when Ærø put the world's longest sailing fully electric ferry into operation, it was noticed around the world. People recognized that Ærø and its partners had produced a true maritime game changer and that the Ellen presented a new solution for the transport sector.

In 2021, the European Commission awarded Ærø the *RESponsible Island Prize 2020*. The EC recognized that Ærø's desire to lead the way in reducing greenhouse gas emissions is ingrained in the island's modern history.

Responsible Island Prize 2020

Members of the Commitee for Renewable Energy (UBE) and the municipality's energy office with the 500.000 EUR prize.

Danish Design Award 2020

The E-ferry was awarded the *Danish Design Award* in 2020 in the category *Game Changer.*

The prestigious *Danish Design Award* hangs in the E-ferry passenger salon next to the partner plaque.

European Solarprize 2020

In 2020, the E-ferry also won the Municipality of Ærø the *European Solarprize*.

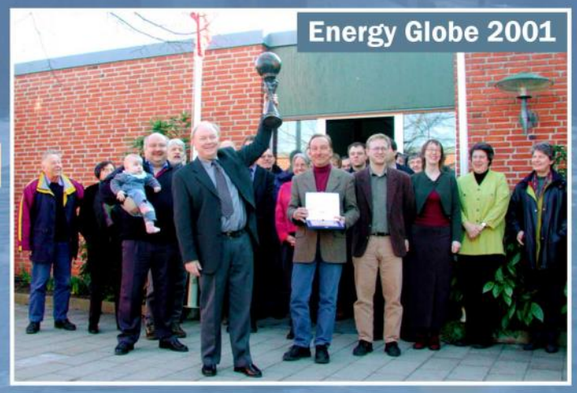
The award resides in Ærø EnergyLab, the municipality's energy office.

EUROPEAN SOLARPRIZE WINNER 2020

Energy Globe 2021

Ærø was awarded the international *Energy Globe Award* in 2001 for its sun-powered district heating. Ærø was awarded the national award in 2021 for the E-ferry Ellen.

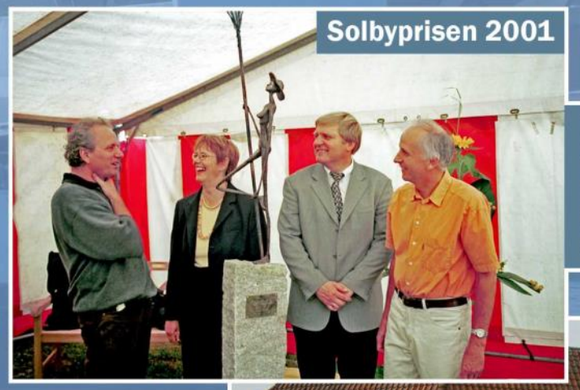
Energy Globe 2001



Best Renewable Energy Partnership 2001

Ærø received the *Sol Ø* award in 2000. In 2001 the EU Commission awarded Ærø for being home to the *Best Renewable Energy Partnership*.

Solbyprisen 2001



The artist Jens Galschiøt presents the beautiful 2001 *Solbyprisen*.

Sol Ø 2000

ÆRØFÆRGERNE

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Ærø EnergyLab

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