# New approaches to closed-containment at Marine Harvest

*Trond W. Rosten*
*Group Manager Freshwater and Closed Production Technology*
*Marine Harvest ASA*

# We are a food producer!



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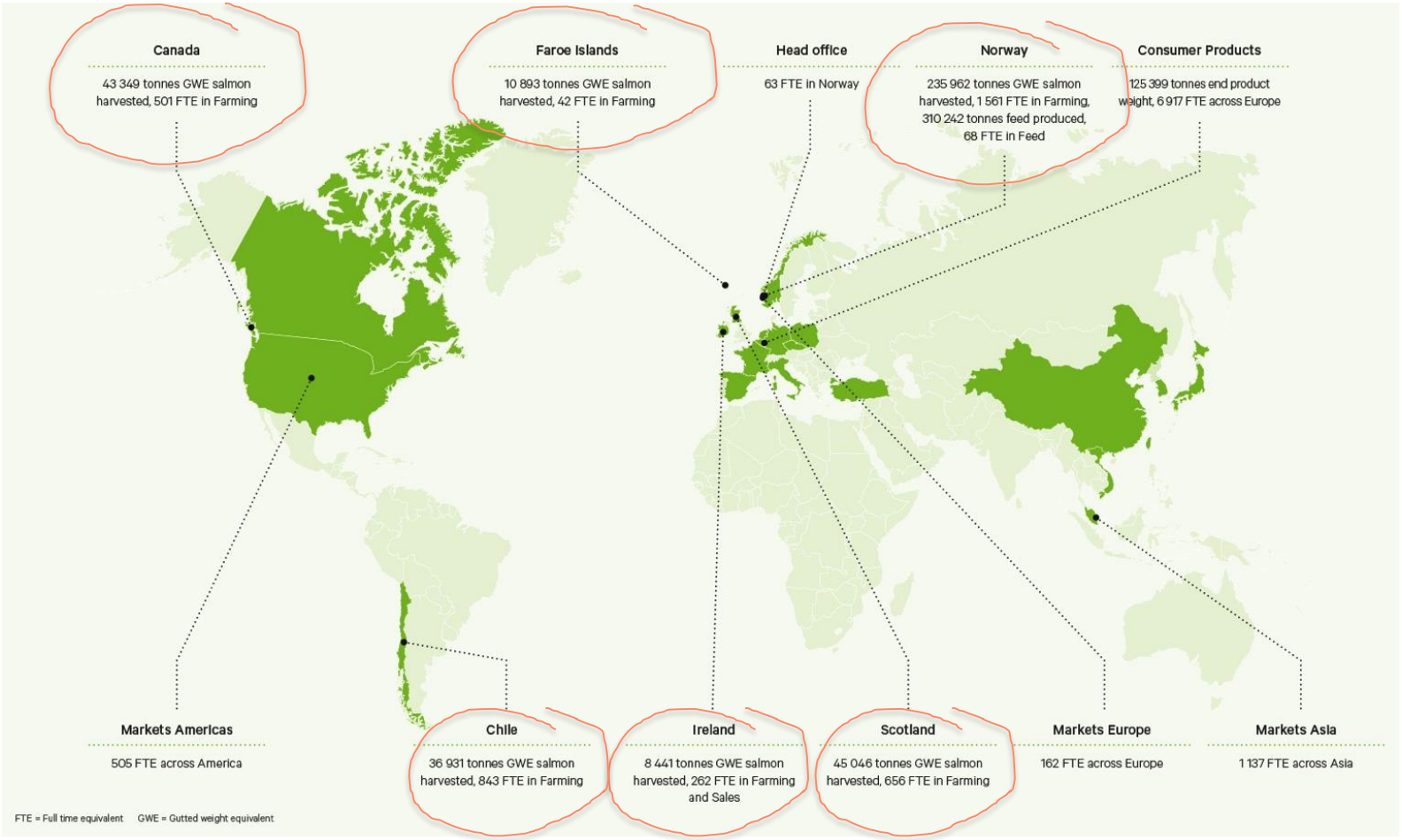
# Farming salmon is an efficient way of using resources to produce animal protein

| | | | | |
|---|---|---|---|---|
| Protein Retention | 31 % | 21 % | 18 % | 15 % |
| Energy Retention | 23 % | 10 % | 14 % | 27 % |
| Edible Yield | 68 % | 46 % | 52 % | 41 % |
| Feed Convertion Ratio (FCR) | 1.1 | 2.2 | 3.0 | 4-10 |
| Edible Meat pr 100 kg fed | 61 kg | 21 kg | 17 kg | 4-10 kg |
| Carbon Footprint<br>kg CO2/kg edible meat | 2.9 kg | 2.7 kg | 5.9 kg | 30 kg |
| Water Consumption<br>litre/kg edible meat | 2,000 litre (1) | 4,300 litre | 6,000 litre | 15,400 litre |

# Marine Harvest ASA

| *Volume produced 2016:* | *Salmon meals each day:* | *Revenue 2016:* | *Employees:* |
|---|---|---|---|
| ***381,000*** | ***5.5*** | ***EUR 3.6*** | ***12,717*** |
| *tonnes* | *million* | *billion* | *In 24 countries* |



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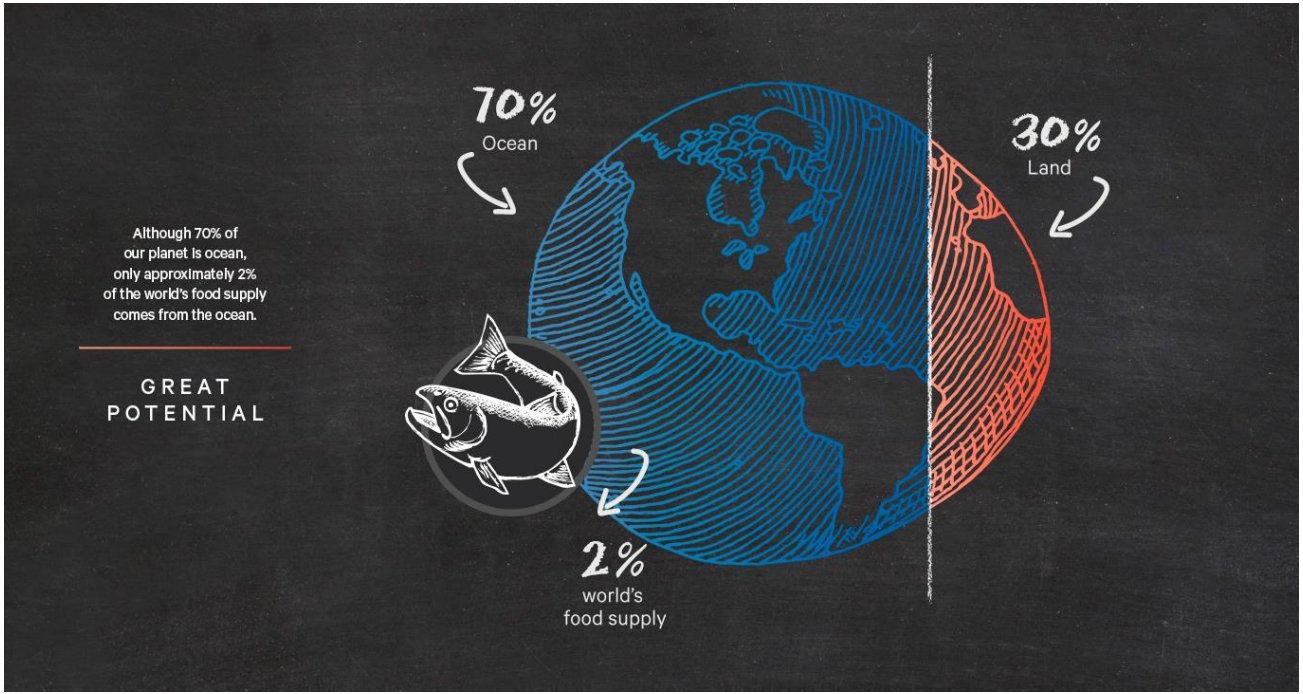
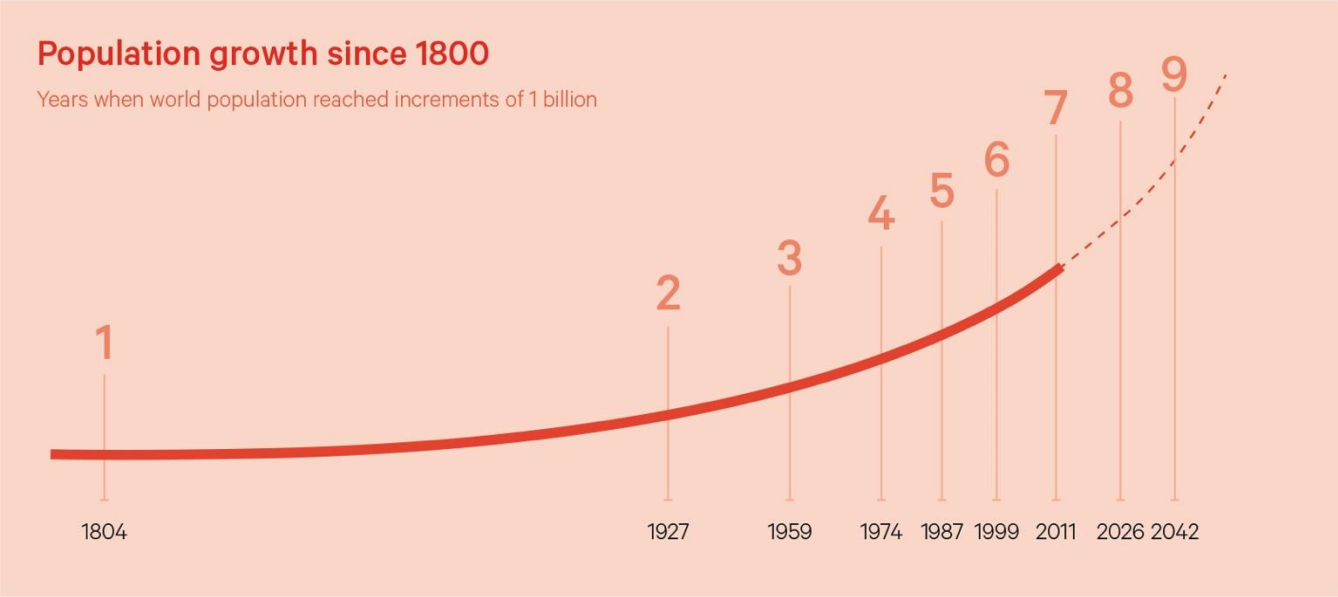
# Blue Revolution: what does it mean?



# The Blue Revolution in numbers




**9.4** 9.4 billion people on the planet by 2050 ...

**2.0** ... growing by 2.0 billion people from 2016.



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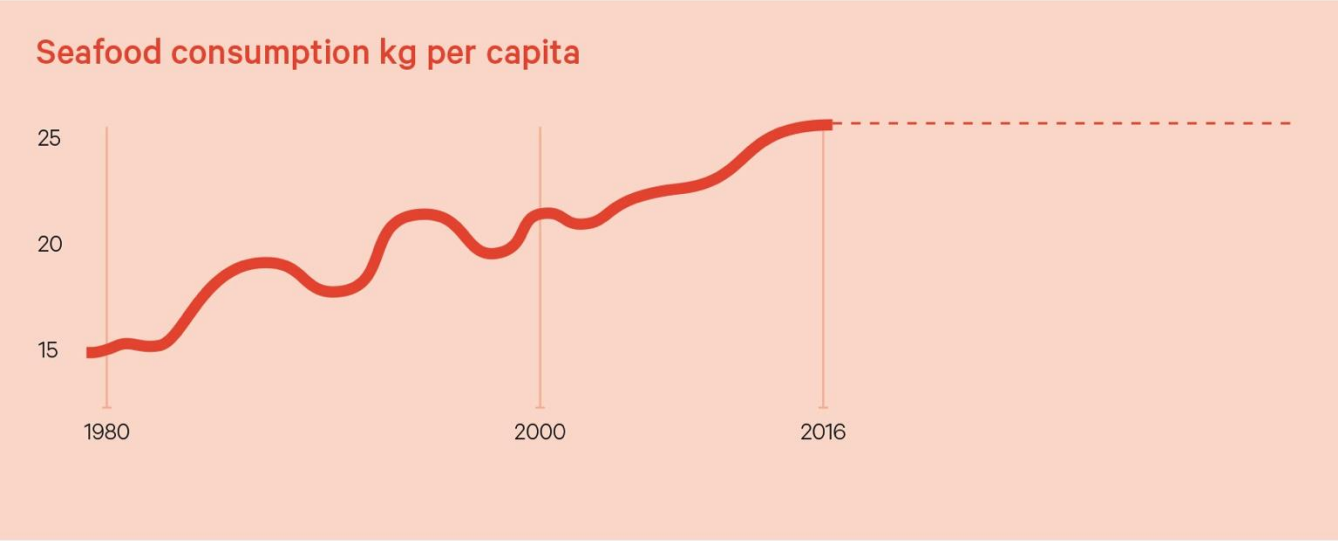
# The Blue Revolution in numbers




**23kg** 23kg seafood per capita consumed in 2016 ...

**45%** ... an increase of 45% since 1980.



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# The Blue Revolution in numbers

**47.5**

47.5 million additional tonnes of aquatic food required to maintain current consumption in 2050.

**~100%**

~100% has to come from aquaculture.

**?**

How many million tonnes will come from farmed Atlantic salmon?



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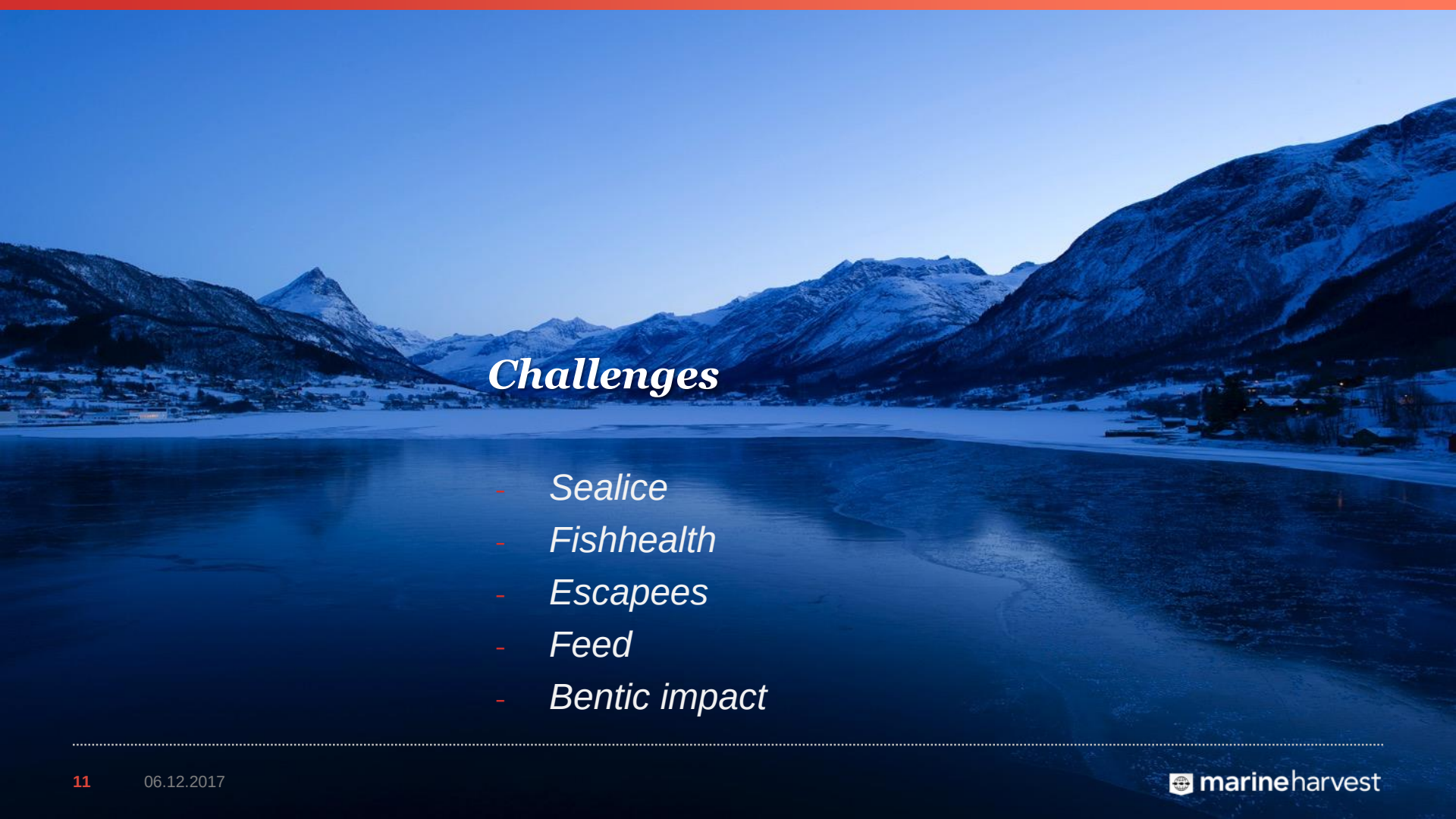
# The Blue Revolution in numbers

We believe the "questionmark" depends on the actions taken today and going forward by the salmon farming industry and the authorities

We intend to play our part in securing sustainable development of the industry and delivering healthy and tasty products for a growing world population for many years to come



# Challenges

- *Sealice*
- *Fishhealth*
- *Escapees*
- *Feed*
- *Bentic impact*

# Our R&D facilities

# GLOBAL R&D AND TECHNICAL

**Øyvind Oaland**
Global Director R&D and Technical



**Ståle Eilertsen**
Manager
System & Project support



**Siri Øvretveit**
Manager
Reporting & Biostatistics



**Jeanett Lillesalt** (01.01.18)
R&D Controller



**Catarina Martins**
Group Manager
Environment & Sustainability



**Henrik Trengereid**
Group Manager
Seawater and open production technology



**Trond Rosten**
Group Manager
Freshwater and closed production technology



**Gordon Ritchie**
Group Manager
Fish Health & Welfare



**Odd Medhus**
Group Manager
Product Quality & Processing



**Ragna Heggebø**
Group Manager
Feed & Fish Performance

**Ernst Georg Økland**
Project Engineer



**Ketil Pettersen**
Project leader
Freshwater



**Ashie Norris**
Group Geneticist



**Marit Stormoen**
Fish Health
Project manager



**Farah Manji**
Fish Health specialist



**Eirik Gravdal**
Project Engineer

**Randi Haldorsen**
Food Safety Manager



**Kurt Oppedal**
Processing Technology Manager



**Lene Norstrand Torgersen**
Seafood Trainee



**Benedicte Simensen**
Seafood Trainee





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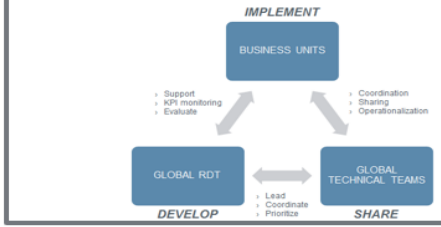
# R&D IN MARINE HARVEST 2018-2022, SUMMARY

## AMBITIONS & GOALS

- Improve the performance and competitive advantage of Marine Harvest
- Support operations in achieving goals related to commercial growth, operational performance and company reputation

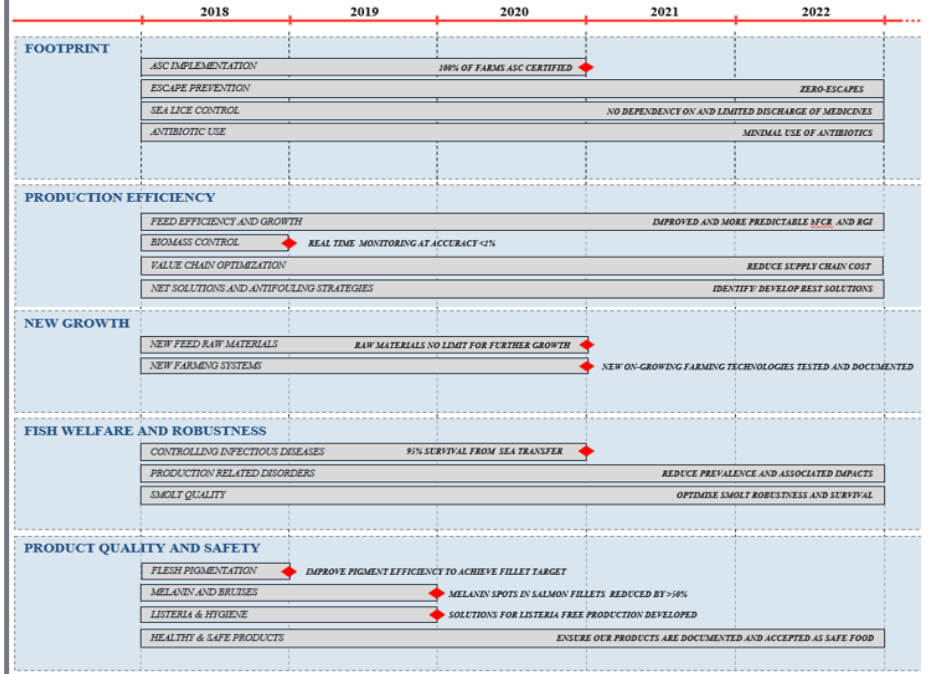
## KEY FOCUS AREAS


## THE WAY WE WORK

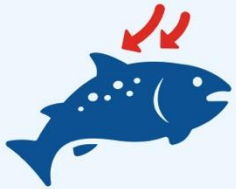




## R&D ROADMAP

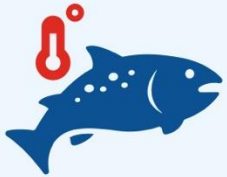


# Non-medicinal tool



### Flusher

Physical removal of lice
using jets of seawater
(FLS-flusher. Hvdrolicer)

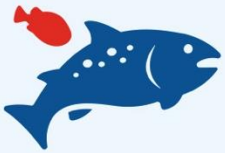


### Thermal

Physical removal of lice
using warm seawater
(Thermolicer, Optilicer)

### Freshwater

Removal of lice
using freshwater bath



### Cleaner fish

Biological control using cleaner fish
(wrasse/lumpsuckers)

**77%**

(average) of all sites used cleaner fish in combatting sea lice

**31%**

(average) of all treated fish treated using non-medicinal tools

**50%**

reduction in total medicine use



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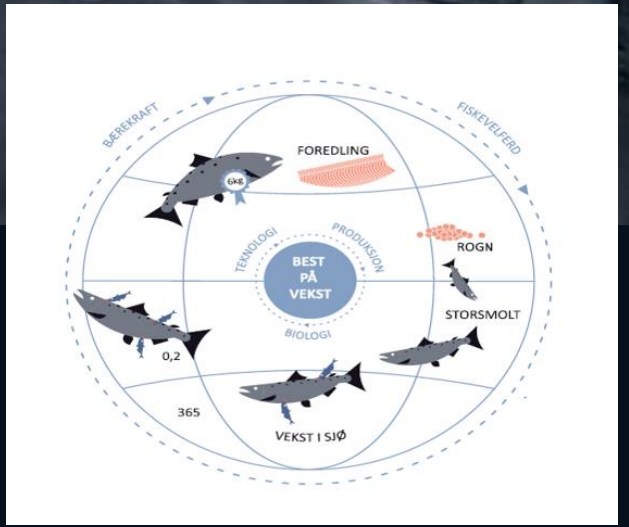
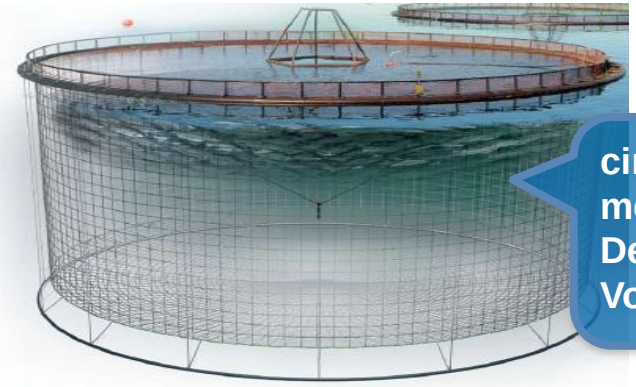
# Smoltsize vs production days

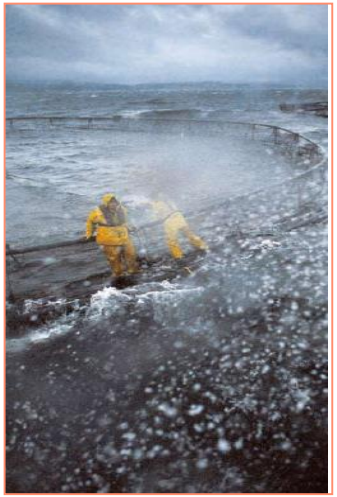


# Net pens : our most important technology

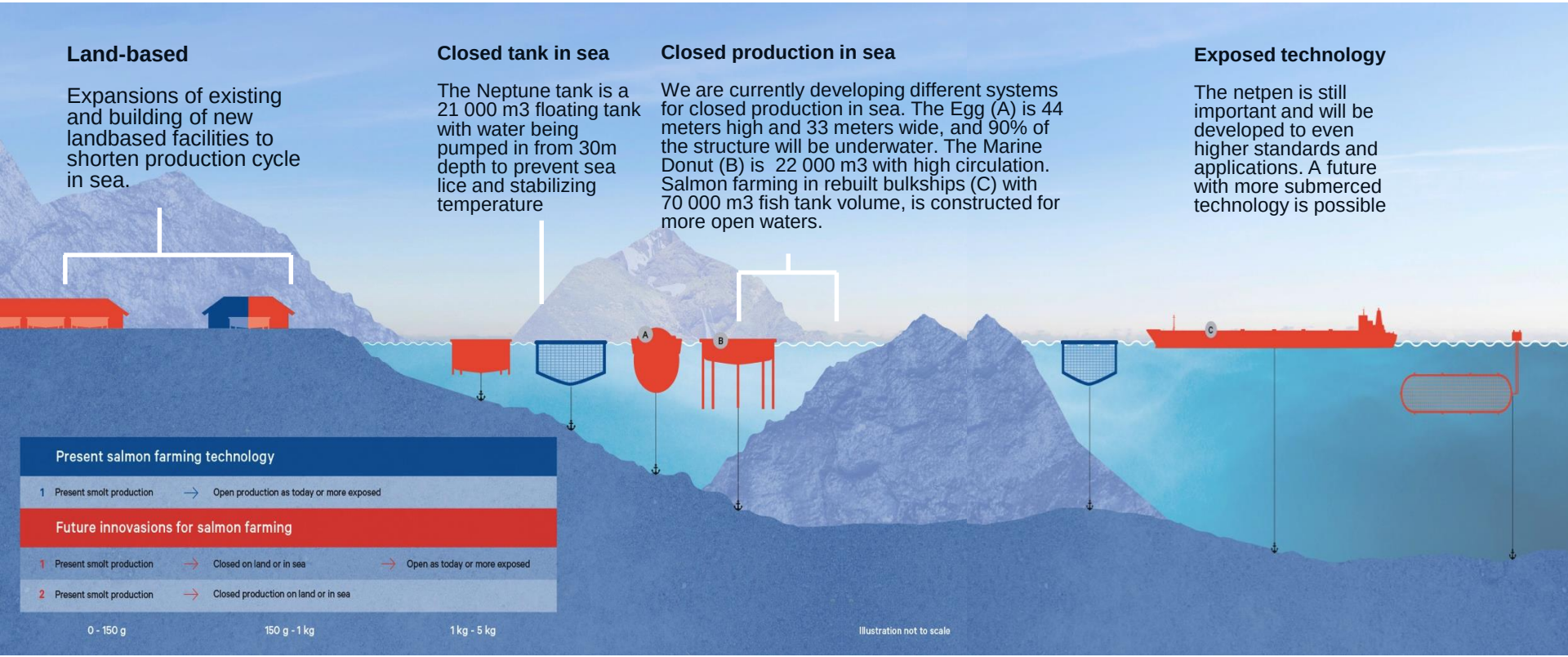
- *97,5% water at the highest density right before harvest*
- *700-800 tons*
- *5,5 million portions à 130 g*
- *flexible and predictable technology*



**circumference: 157 meter/ diameter 50m**
**Depth: 30 meter**
**Volume: 60 000 m³**



# Future production systems in salmon farming



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# Building new modern smolt facilities, running projects

Steinsvik in West Norway – 2015
(mowing bed)

Fjæra in South Norway – 2017 (fixed bed)



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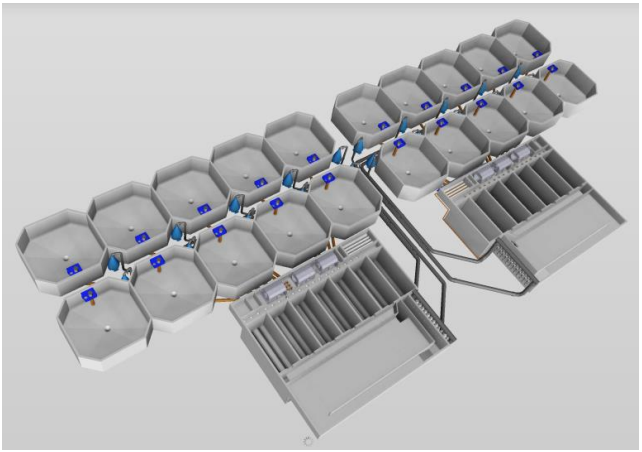
# Postsmolt on land - MH Nordheim, running project

# Postsmolt on land - Laxa MH Faroes, running project

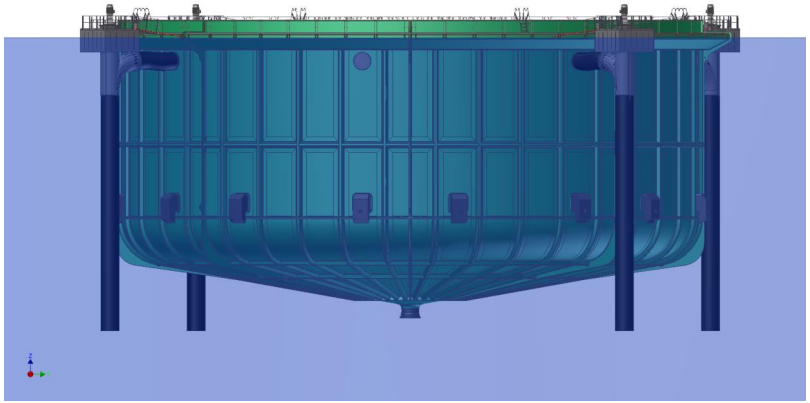


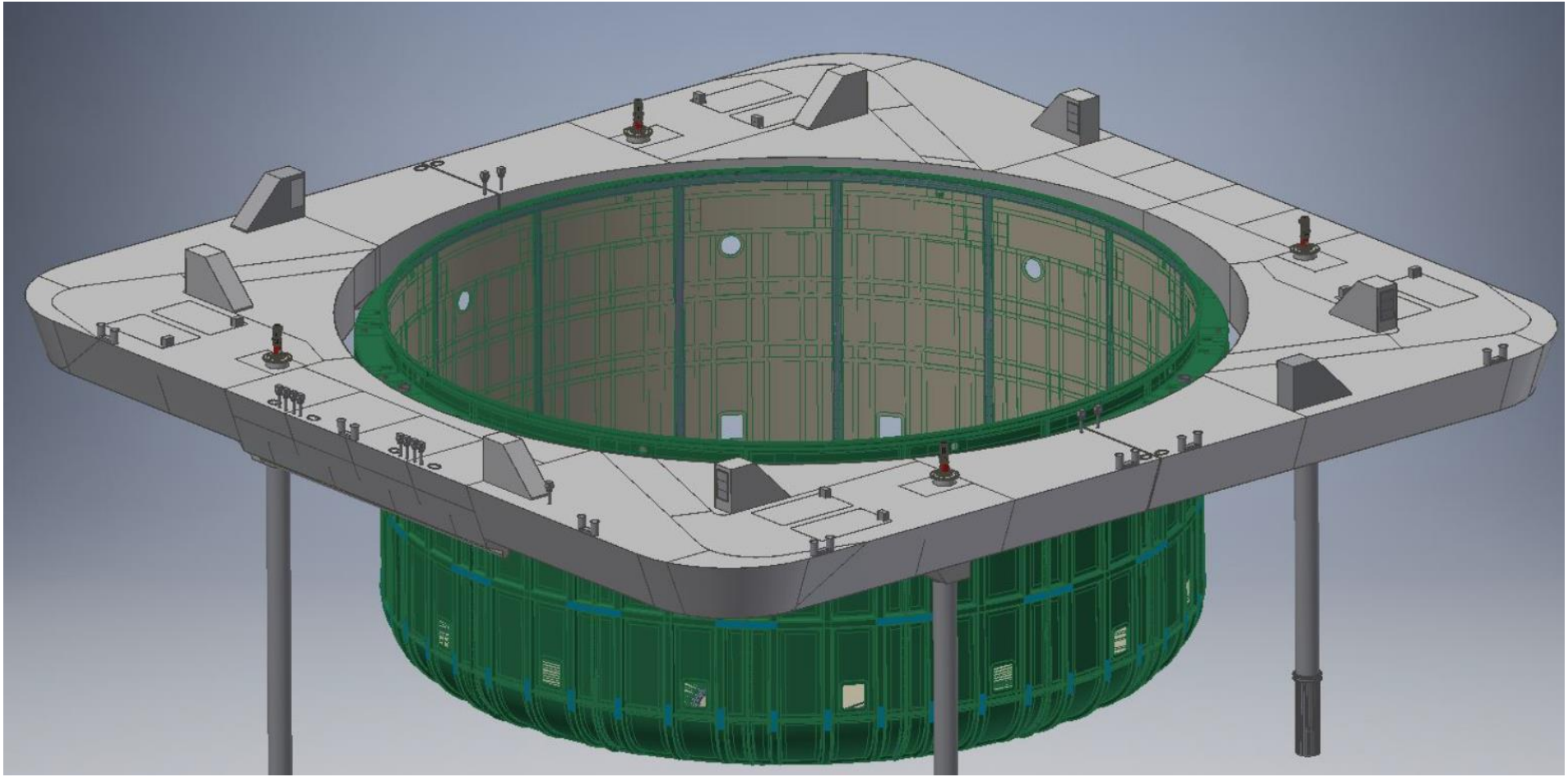
- Fixed bed
- 2.8 mill fish annually á 650 g

# Postsmolt in sea, running project

Floating semi-closed tank at Marine Harvest Norway site “Molnes”

The tank is 21 000 m3, water being pumped in from 26 m depth to reduce risk of sealice and stabilizing temperature

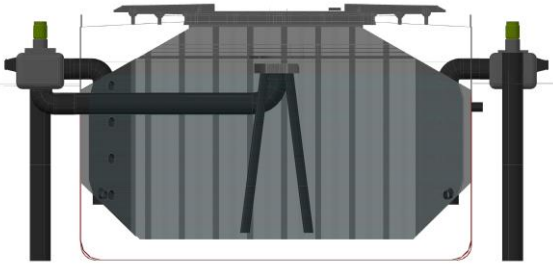




# The Egg – semiclosed farming system

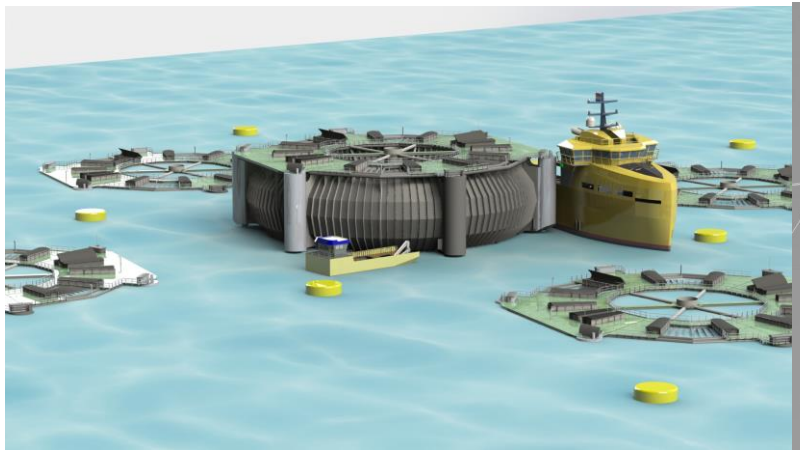
- One egg ~ 20 000 $m^3$ or 1 000 tonnes biomass
- One farm – 10 cages or 14 licenses

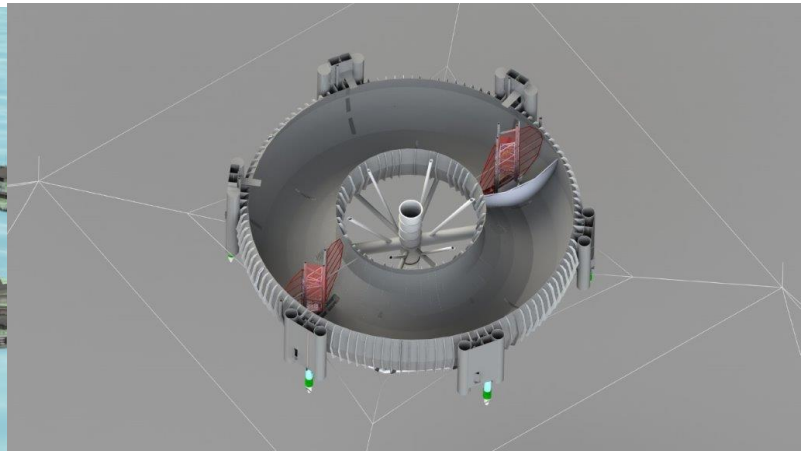
# The Ship

- Closed system- farming in tanks
- Escape proof and protects fish from sea lice and other pathogens
- Re-use of obsolete ships gives a good environmental footprint
- Application for 6 development licenses

# Marine Donut – closed farming in the end of production cycle

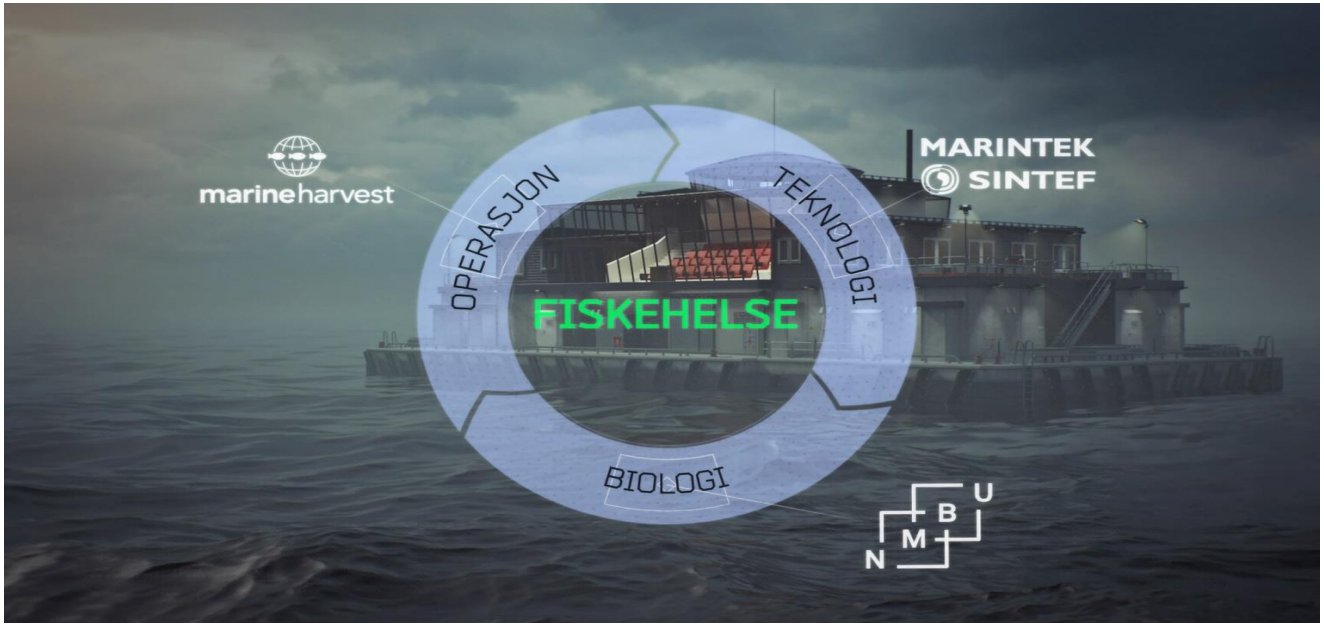




Robust closed concept protecting fish from sea lice and other pathogens, certified for up to 3 meters wave height

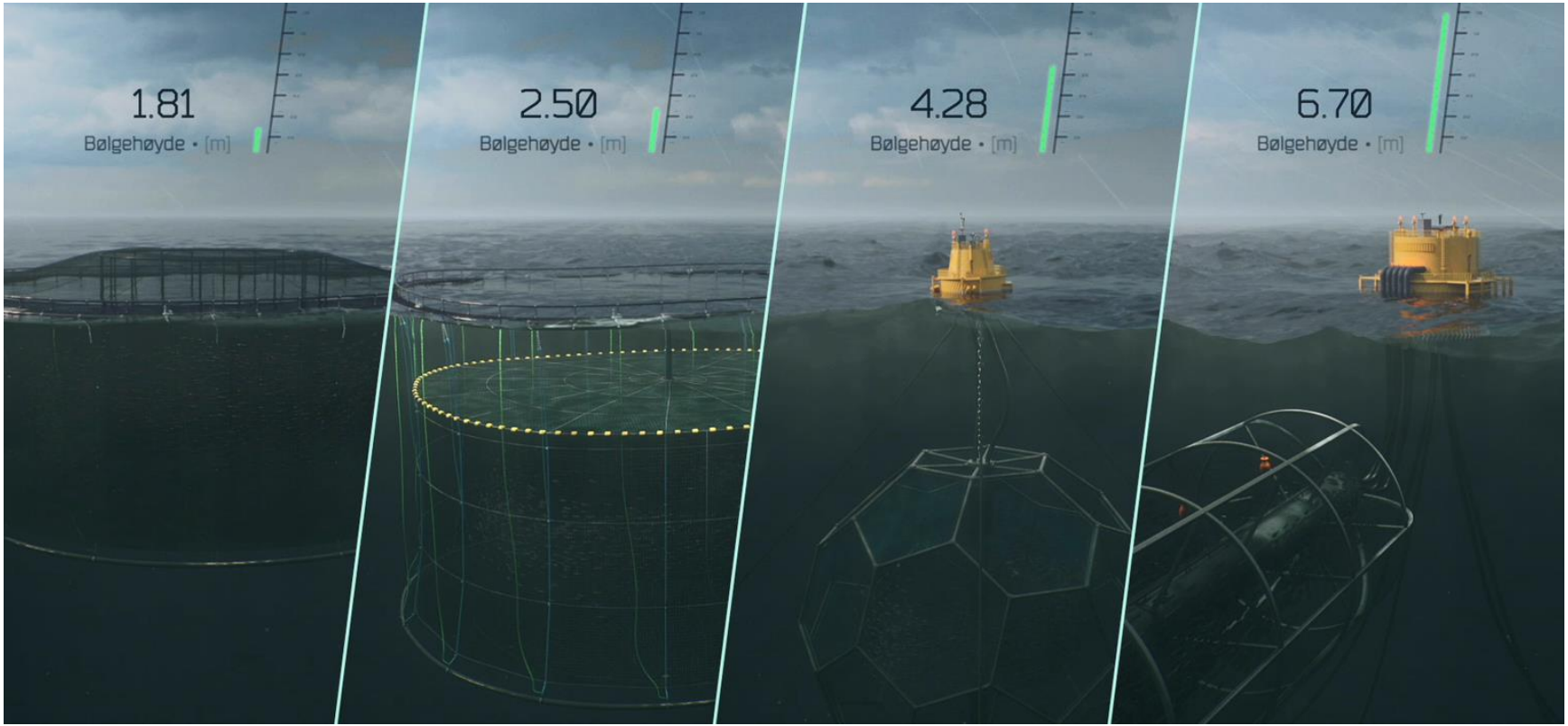
- Flow concept exercising fish for improved quality and fish welfare
- Produced of HDPE a 100% reusable material
- Application for 8 development licenses

# R&D license application - Blue Revolution Centre (BRC)




- Developing technological solutions for optimal fish welfare
- Application for 6 R&D licenses

# Developing new production platforms & new areas to farm



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# Leading fishfarming into the future


## 2016 at a glance

EUR 51.3 million

**R&D spending**

EUR 51.3 million spent on R&D in 2016, an increase of 95% compared to 2015 due to expanded activity in general and increased stocking at Centre for Aquaculture Competence.

BRC

**Blue Revolution Centre**

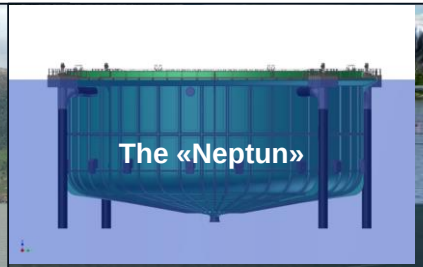
SINTEF Ocean AS (formerly MARINTEK) and the Norwegian University of Life Sciences (NMBU) joined forces to establish the Blue Revolution Centre (BRC).

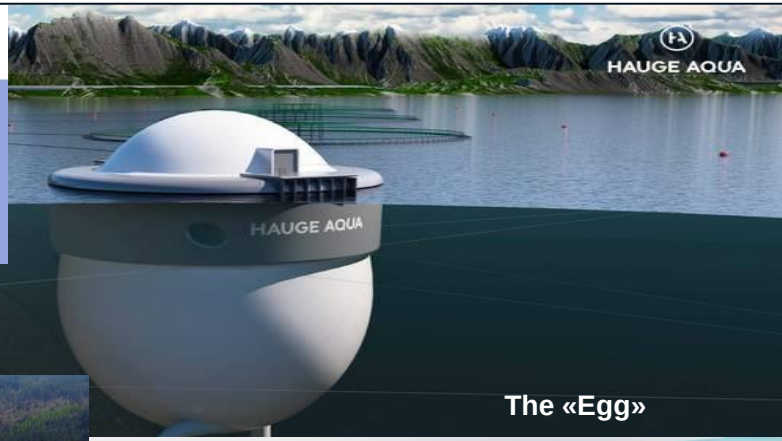
**Development licenses**

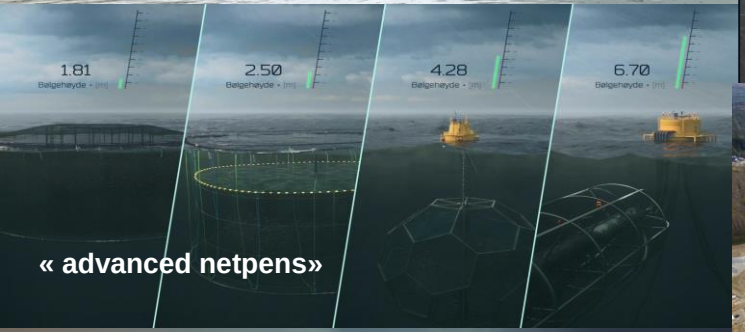
Application for development licenses for the innovative closed-containment 'Egg' and 'Donut' concepts both qualified for further evaluation by the Norwegian Department of Fisheries.

Source: Marine Harvest Annual Report 2016

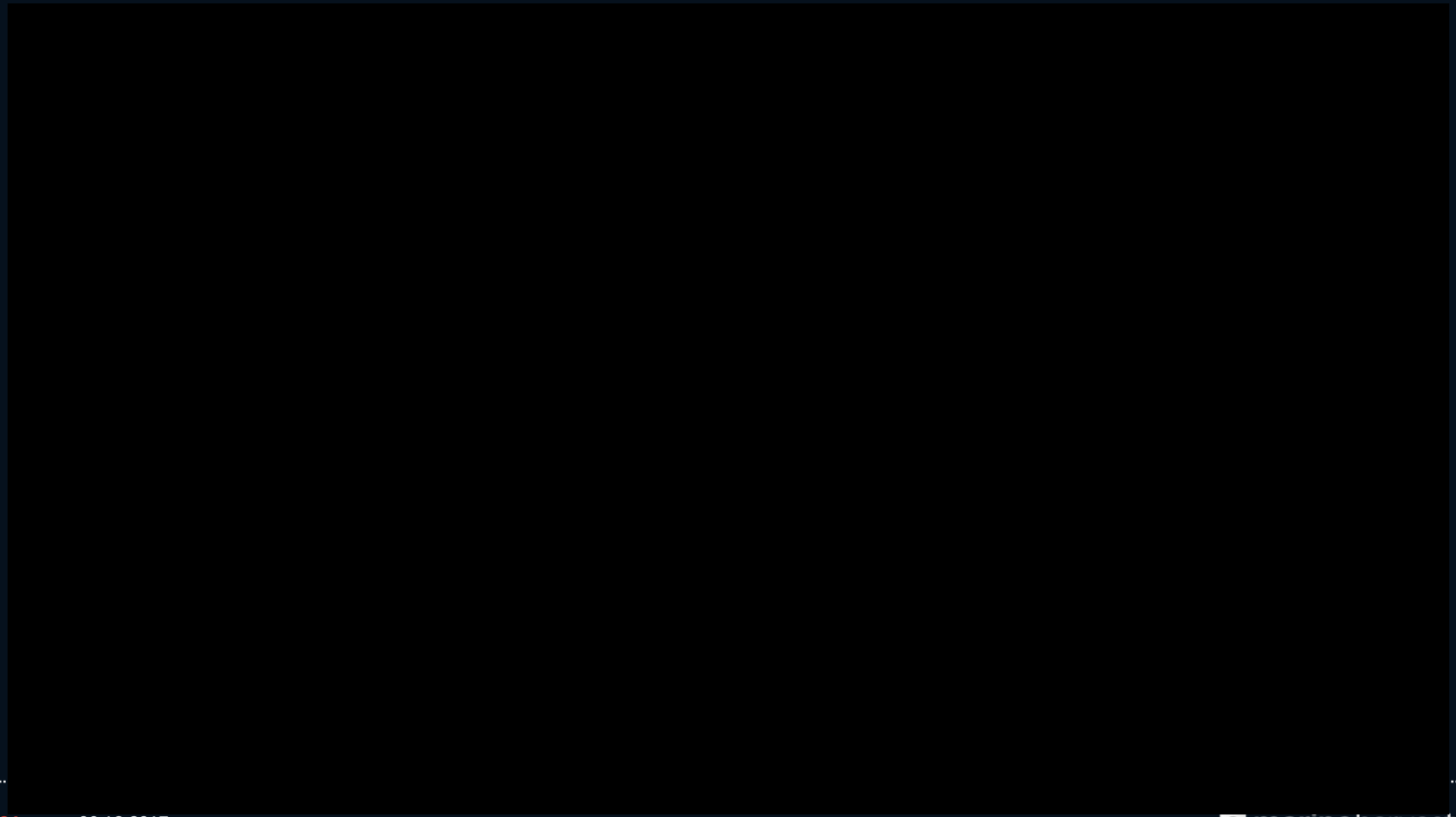
# New technology platforms for growth and solutions to sustainability challenges

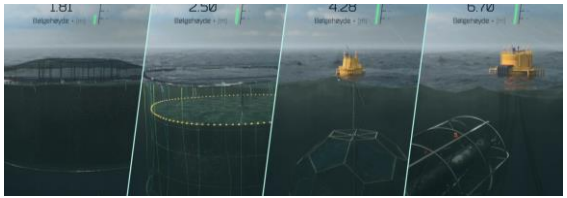







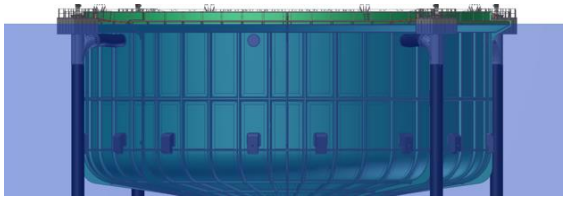

# Marine Harvest Molnes

# Wrap up - technology



*Net pens*

*RAS*



*S-CCS*



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Leading The Blue Revolution