



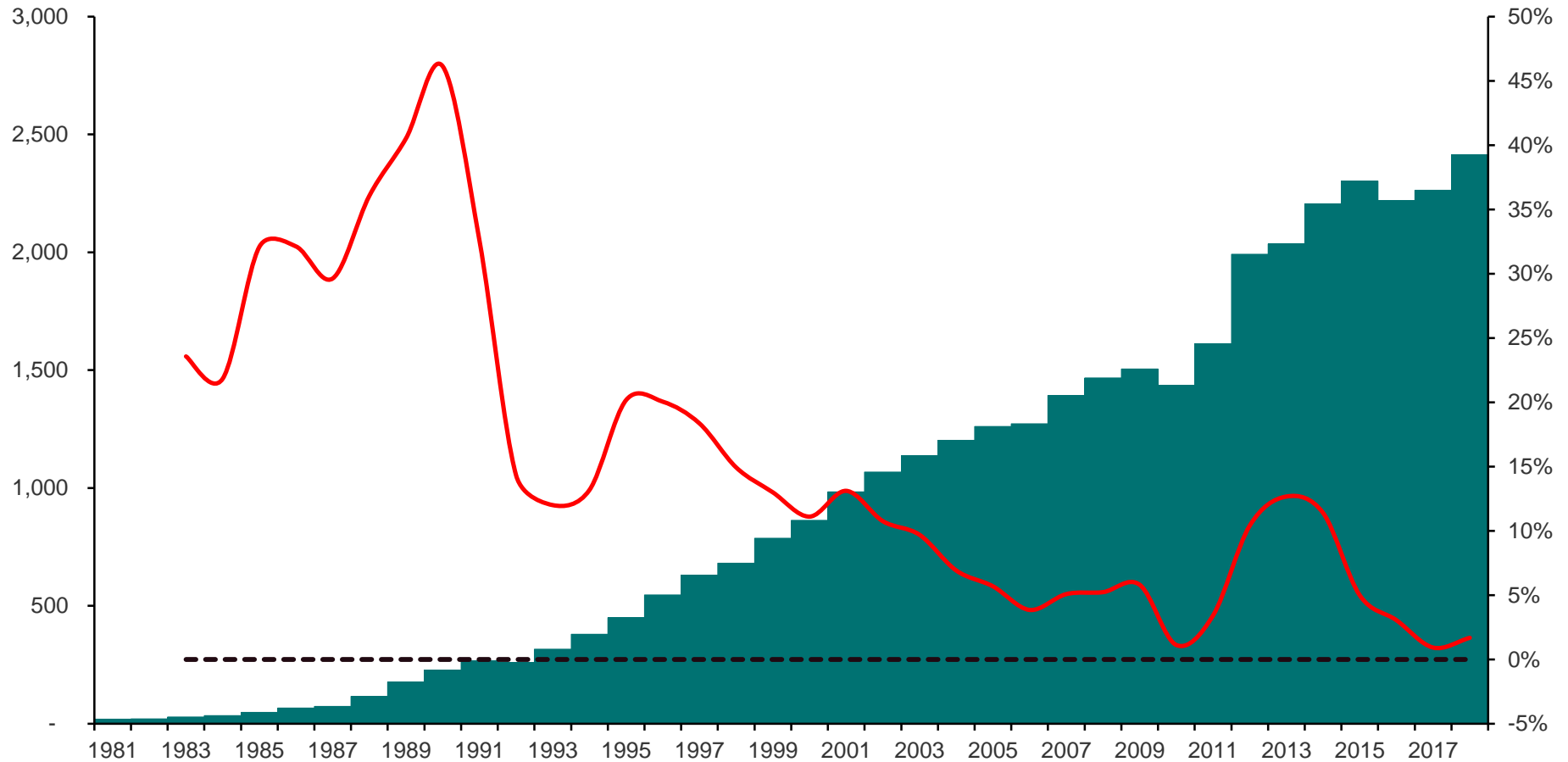
Why the world is trying to develop new farming technologies

Multiexport Foods Conference
24 April 2019 | DNB Markets

Alexander Aukner, (Analyst) +47 24 16 90 79, alexander.aukner@dnb.no

It appears traditional farming supply is struggling to grow...

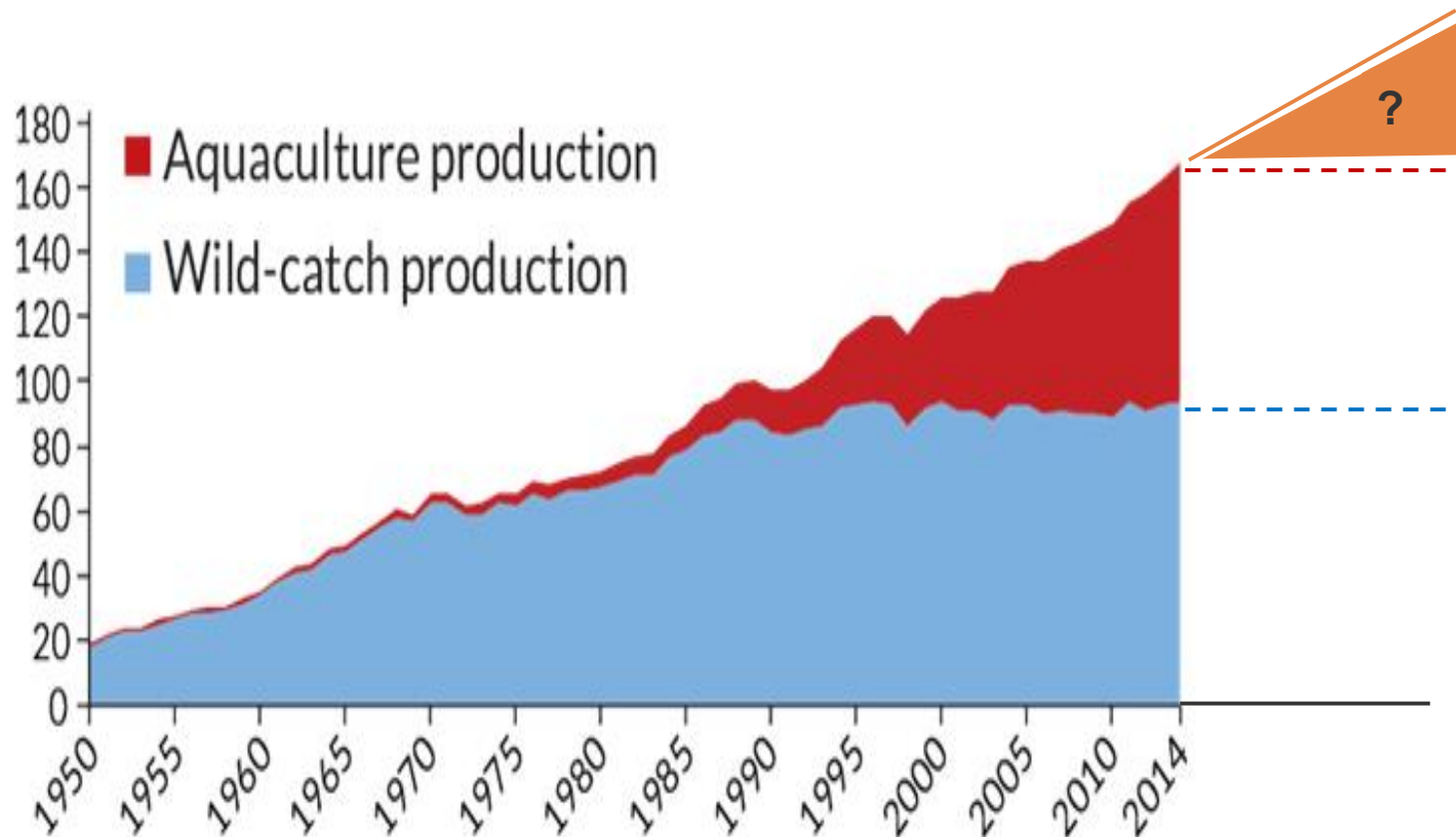
Global supply of Atlantic Salmon (tonnes, wfe), 3Y average growth



Source: Kontali (historical data) DNB Markets (further calculations)

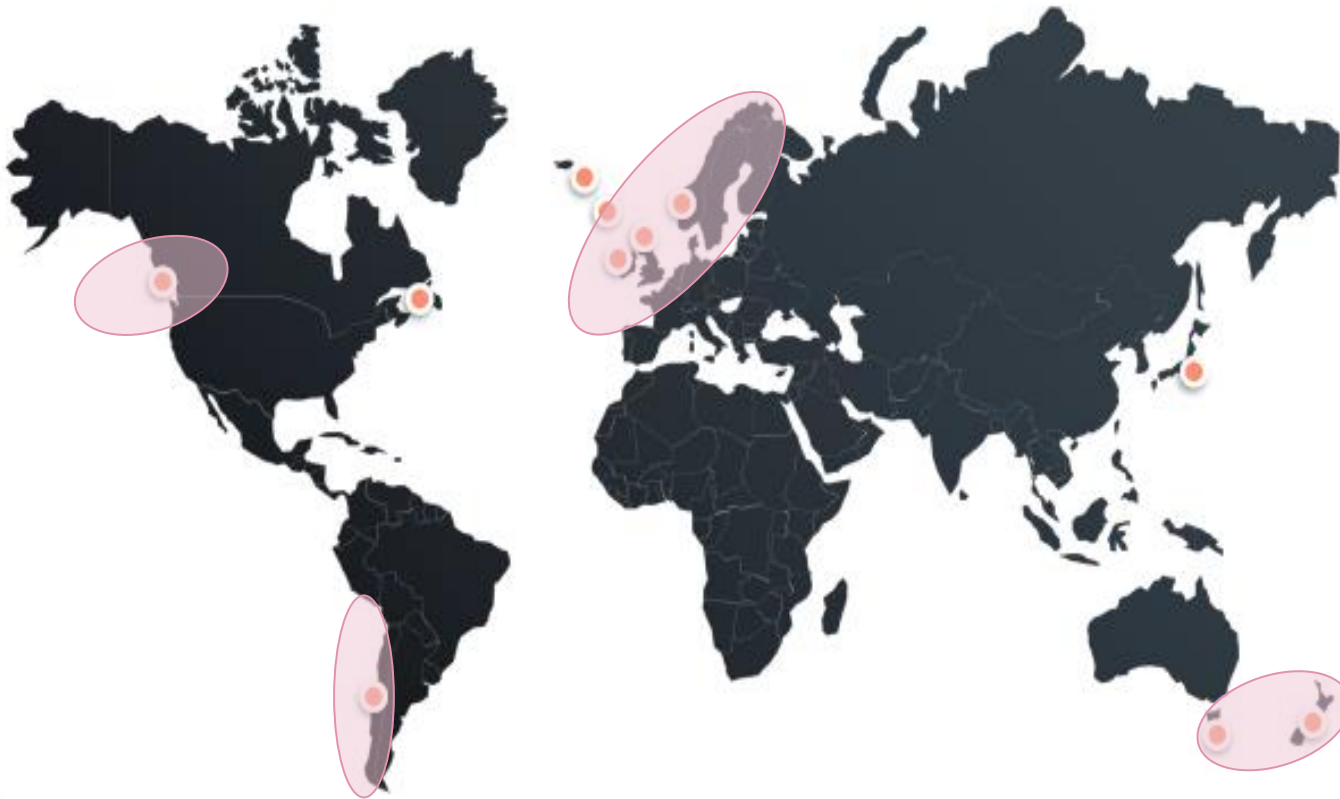
Demand will ensure new production methods emerge

Wild catch and aquaculture production (tonnes, millions)



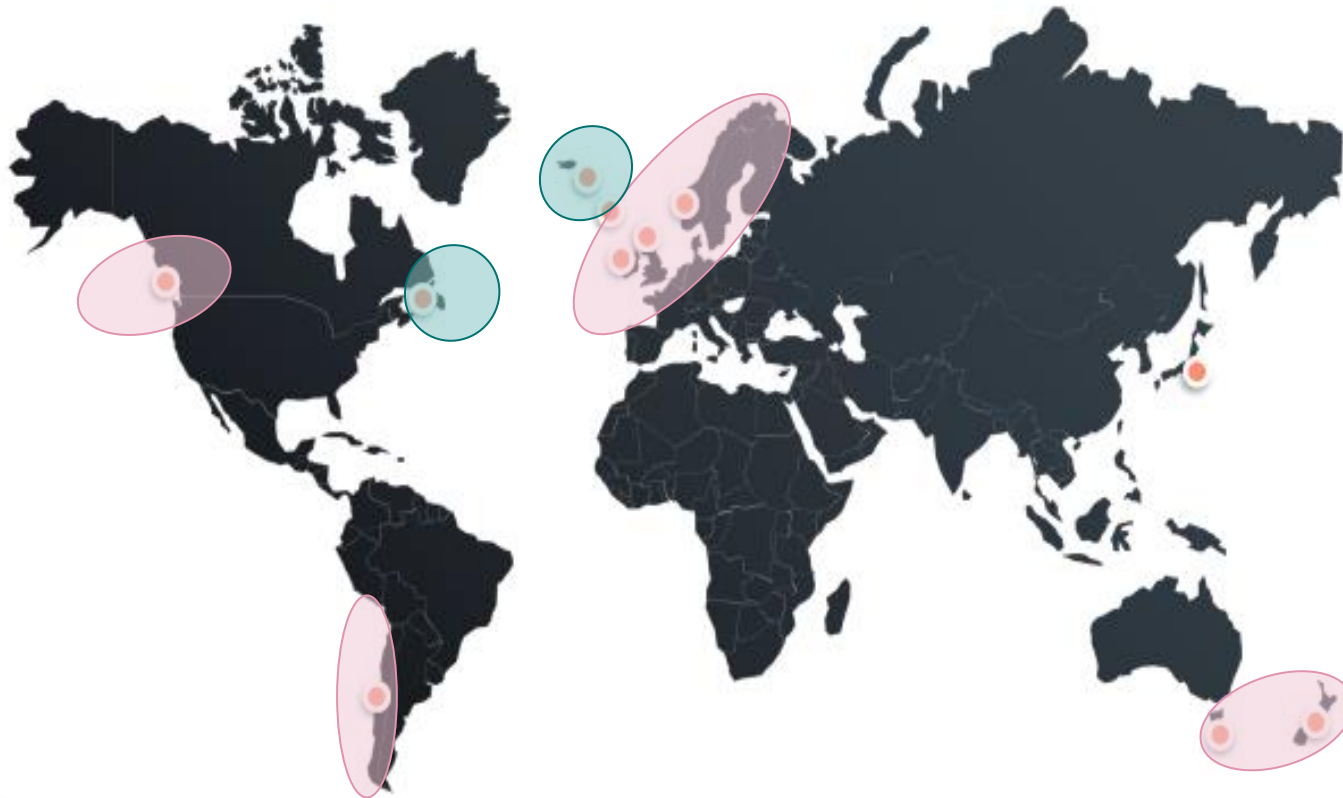
Who, where and what can replace net pen farming?

Existing regions



New regions developed with existing technology by existing players

New regions

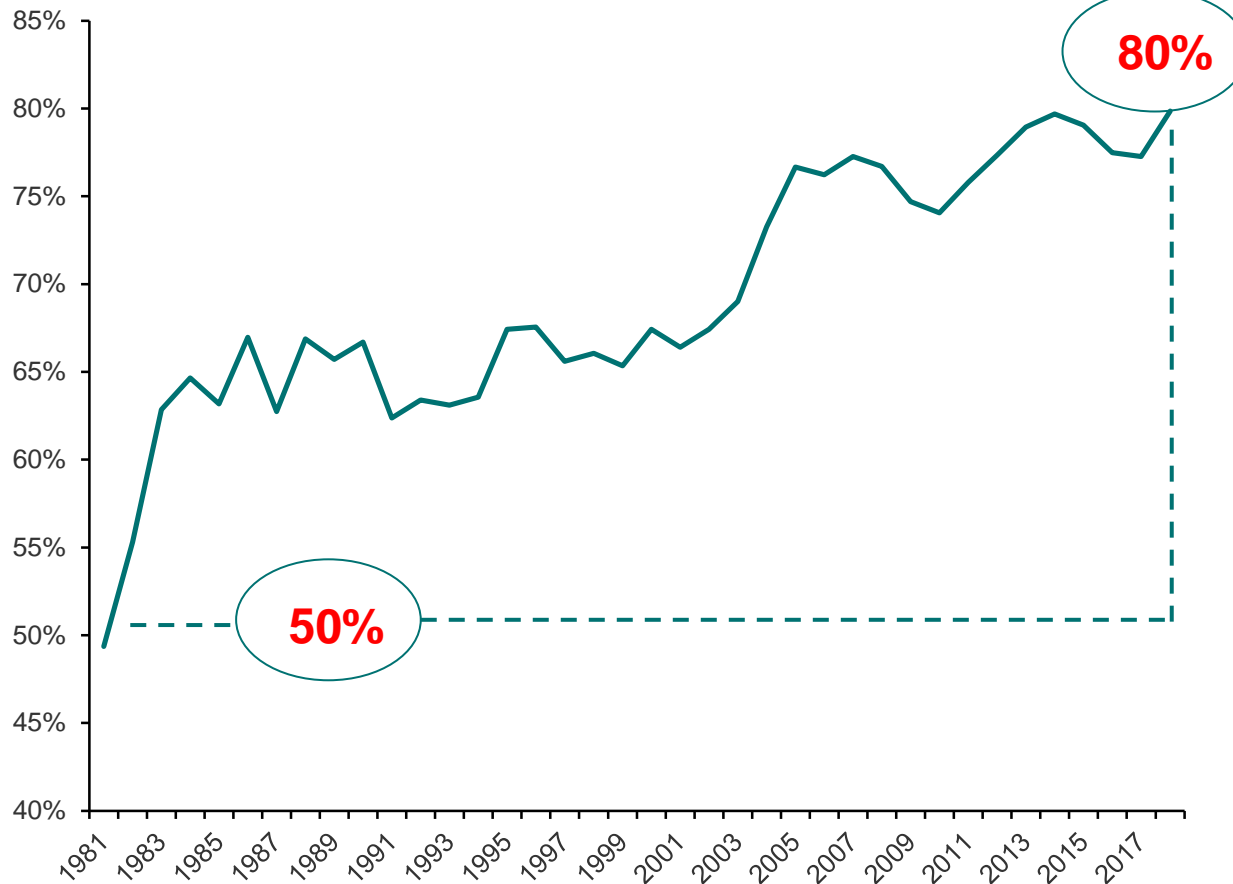


**Iceland and Eastern
Canada developing...**

**...but even when fully
developed unlikely to
represent more than
~10% of production**

New regions have not been able to capture any market share

Norway and Chile's combined market share (% of global harvest)

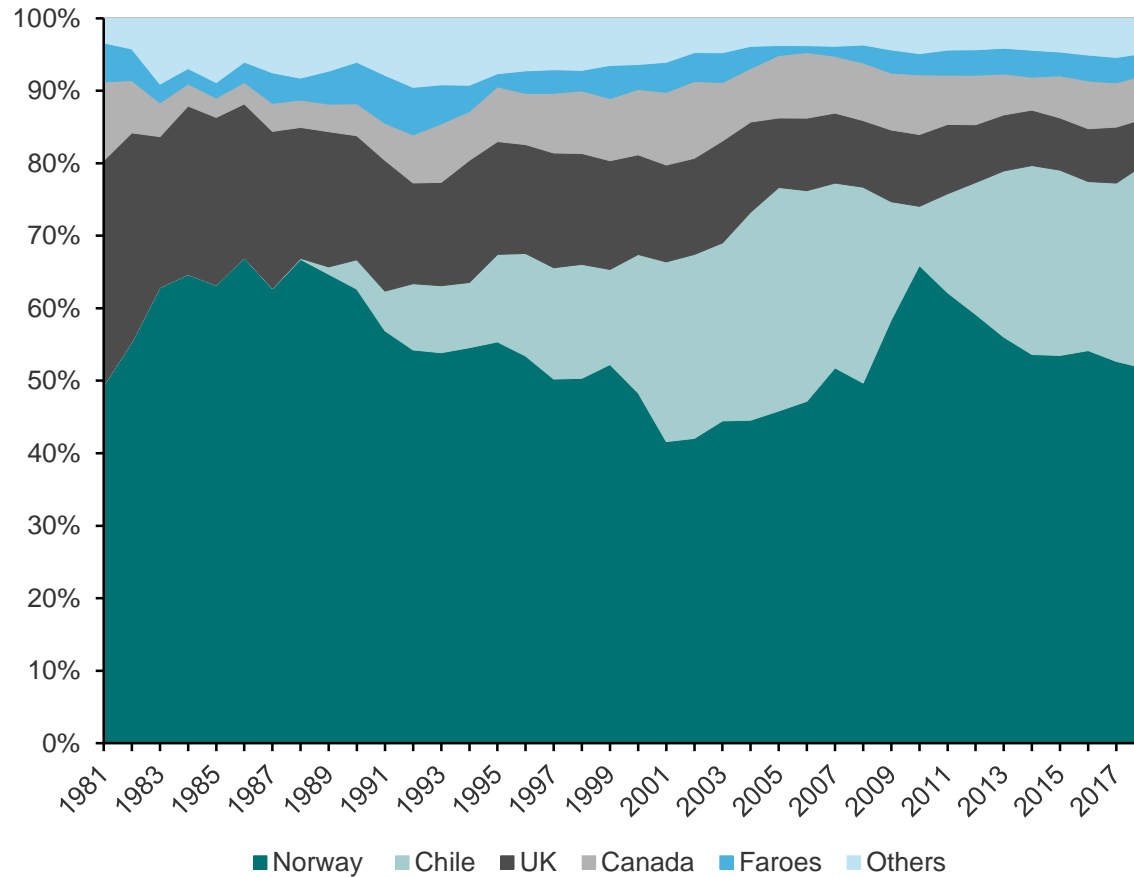


Norway and Chile have gained market share vs. new regions over the past decades

Source: Kontali (historical data) DNB Markets (further calculations)

New regions have not been able to capture any market share

Market share of producing regions

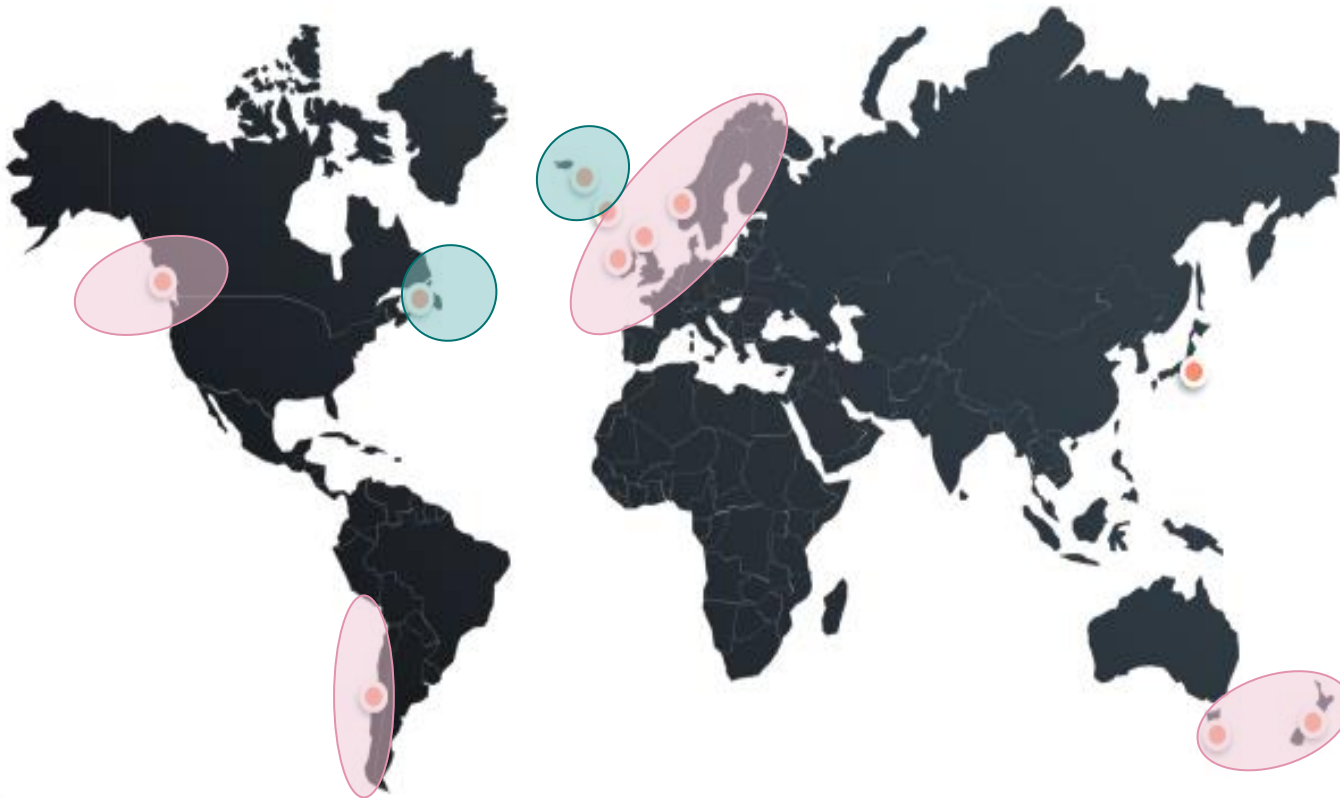


Chile is the only region to take meaningful market share in the last 20 years

With current farming technology, new regions are too small to make a difference

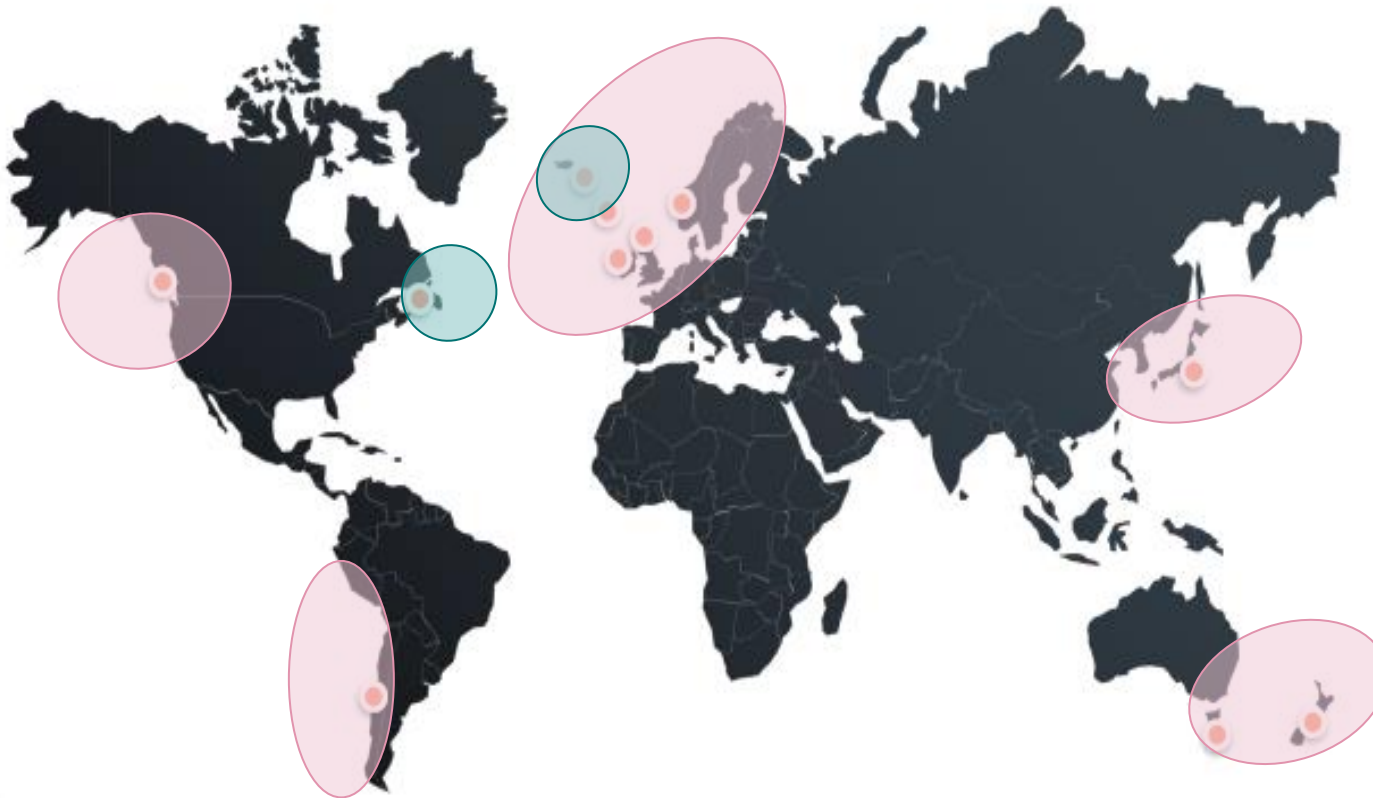
Evolution - New technology could expand existing regions...

Existing technology and farming regions



Evolution - ...and open new ones

Evolution of existing sea-based technologies

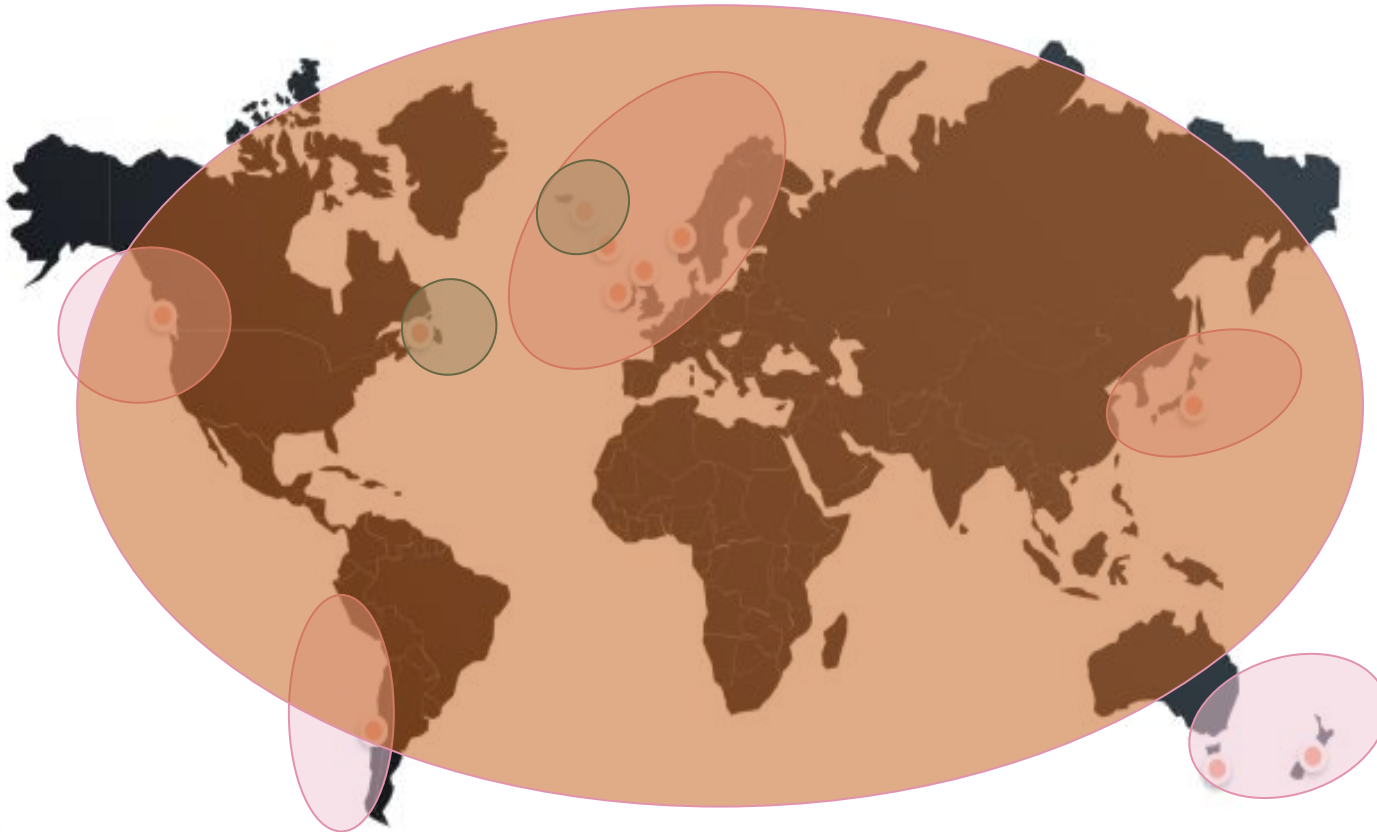


Evolution through offshore in existing regions by existing players....

However, China may become a new region

Revolution - Land based to redefine salmon farming geography

Revolution with regards to where one can farm salmon



Revolution...

No real limitations on locations...

DNB Markets has produced two reports on land-based farming

SEAFOOD – SPECIAL REPORT

Deep dive into land-based farming

Prospects for non-conventional farming have never looked better, in our view, and in this report we take a look at land-based farming. Our findings suggest the technology has come further than generally expected and setting up full-scale land-based operations can, under certain conditions, yield acceptable returns. Land-based success or failure will likely depend on traditional farming's ability to resume growth, but we expect meaningful volumes from land-based farming by 2020.

Prospects have never looked better. With supply growth from traditional salmon farming dwindling due to biological concerns and tighter regulatory controls and the cost of acquiring new licences skyrocketing, the prospects for non-traditional farming, such as land-based, look better than ever in our view. With low supply growth, salmon prices are likely to stay high for the next two years, reducing the risk of a price collapse before volumes from a land-based project reach the market. At the same time, production costs for traditional and land-based farming are starting to converge as biological costs for sea-based farming increase and technological advances reduce land-based costs.

Substantial advances in recirculation technology. Recirculating aquaculture systems (RAS) have seen significant technological improvements over the past 5–10 years. Paradoxically, these advances have been driven by the large investments in smolt production made by traditional salmon farmers. The switch from 'flow through' systems to 'recirculation' has reduced water need by 90% and in recirculation the effectiveness has increased 3–4x since 2008. Research suggests production costs for land-based at NOK37/kg, close to traditional sea-based farming.

We identify 150kt of land-based projects in the pipeline by 2020. We have carried out a deep dive into land-based projects and identified planned production of 150kt by 2020 from 20+ projects around the world. About 10 projects produced a combined ~7kt in 2016. If all planned land-based expansion materialises, land-based production in 2020 would rival the output from Canada and make land-based the fourth largest 'region'.

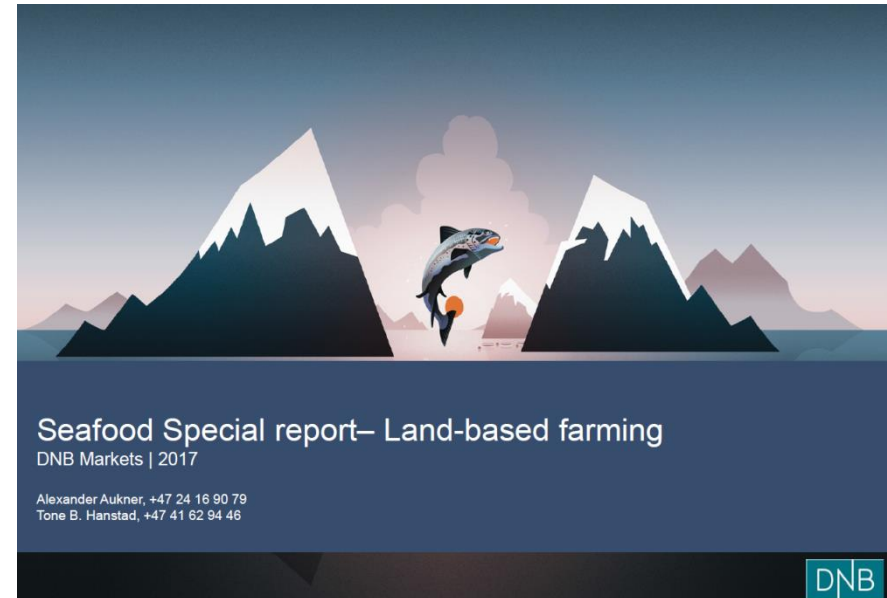
Running the numbers reveals decent risk/reward. We have made internal rate of return (IRR) calculations on land-based versus traditional farming, which suggests attractive returns for land-based projects where transport advantages exist. Spreadsheet models are only as good as their input variables, for which there are still few, hence this is our best guess based on available input. Nonetheless, we believe certain land-based projects show good enough prospects to be considered viable investments and believe meaningful volumes from land-based farming will materialise post 2020. Land-based success or failure will depend on traditional farming's ability to resume growth.

Source: Factset

Company	Cur	Reo	Target	Price	PIE 18a	PIE 17a	PIE 18a
Austevoll Seafood	NOK	HOLD	82.00	78.25	13.5	9.0	9.4
Bakkafoott	NOK	HOLD	370.0	320.7	15.2	11.5	13.2
Gregg Seafood	NOK	HOLD	80.00	73.25	12.4	7.8	8.0
Lerøy	NOK	HOLD	495.0	459.5	13.6	9.0	9.4
Marine Harvest	NOK	HOLD	165.0	154.1	15.9	10.5	10.5
Norway Royal Salmon	NOK	HOLD	190.0	197.0	16.0	13.0	13.2
SalMar	NOK	BUY	275.0	240.0	14.2	10.0	10.7
The Scottish Salmon Company	NOK	BUY	10.00	9.69	63.9	10.0	7.2

Source: DNB Markets

qualified research analysts with FINRA in the United States.



Onshore farming – Revolution or a big, expensive dead end...

Opportunities

- Industrialisation potential
- Lower environmental impact
- Improved biological security
- Lower mortality and faster growth
- Transport advantage
 - Product faster to market
 - Reduced transport cost
 - Lower CO2 footprint
- Turning waste into an asset

Challenges

- High investment need
- Energy-intensive production
- Fish welfare with high density
- Operational risk – H2S

Land-based farming – Poland, Switzerland and Denmark



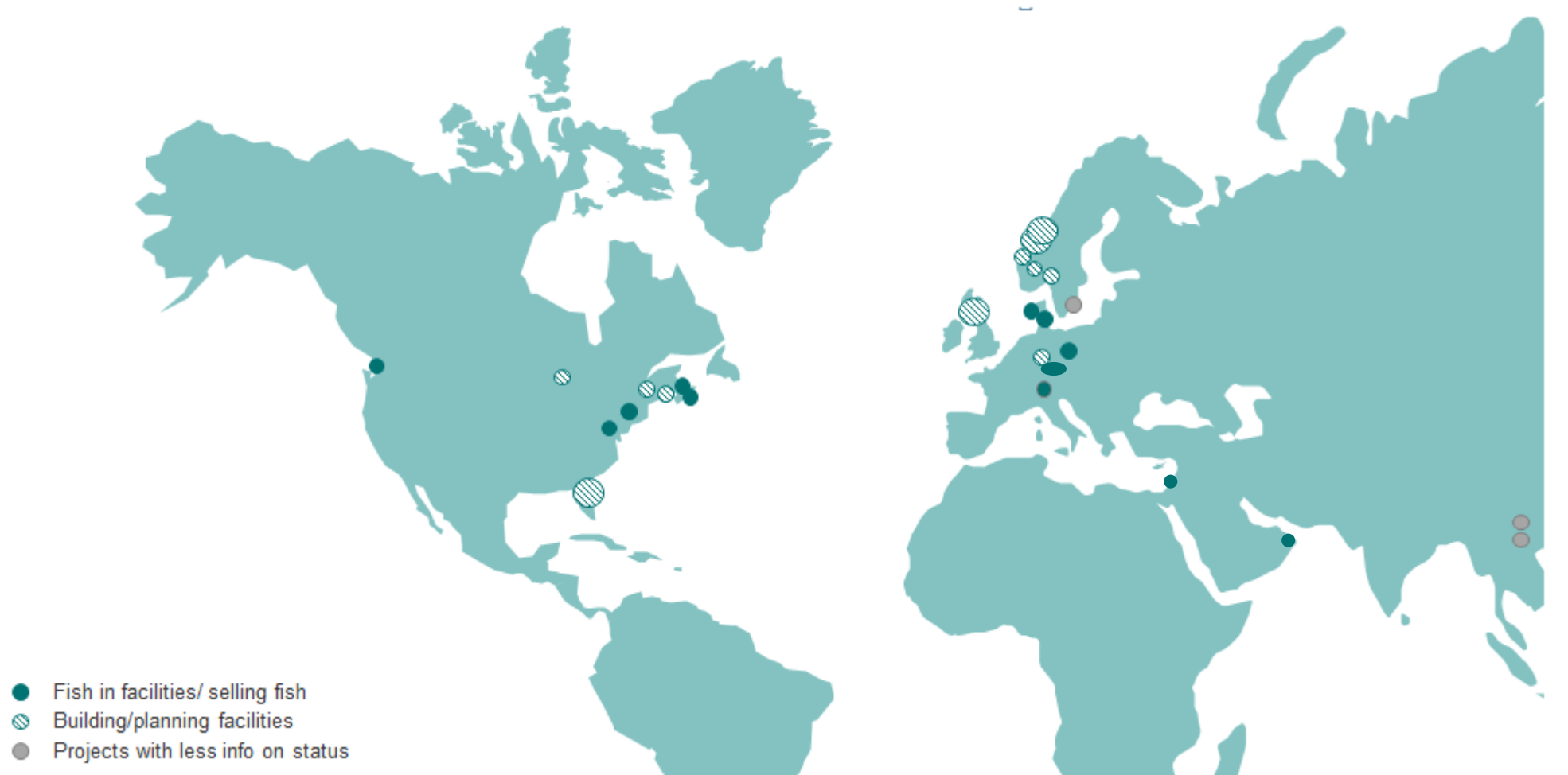
Source: DNB Markets

Land-based farming – US, Canada and Dubai



Source: DNB Markets

Overview of land-based facilities



Source: DNB Markets

Reasons for looking at land-based salmon farming, defined two years ago, are still valid

1

Improved visibility on pricing – stronger for longer means less probability of a collapse in prices before land-based volumes hit the market. We estimate a salmon price of NOK60/kg in 2019 and NOK59/kg in 2020.

2

In-sea production costs rising – NOK5/kg increase just in sea-lice-related costs. Average production costs have not come down, but look fairly 'stable and high'.

3

Increasing 'upfront investment' for traditional growth – licence prices increasing. In the latest auctions in Norway, but appetite for licences was high, with the traffic-light auction implying a figure of ~NOK120/kg.

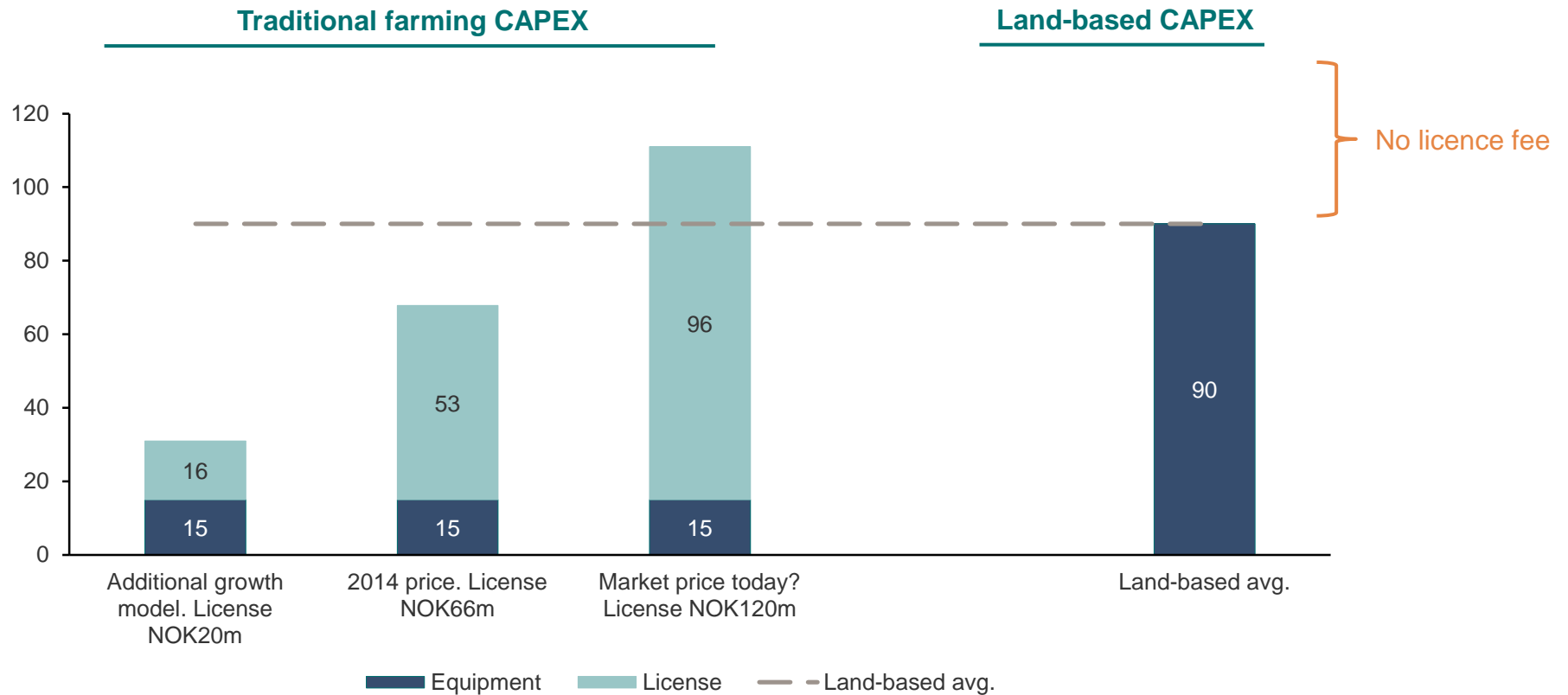
4

Improved 'new' land-based technology – enables increased scale and quality issues are addressed. The large equipment providers and salmon farmers report sizeable investments in recirculating aquaculture systems (RAS).

5

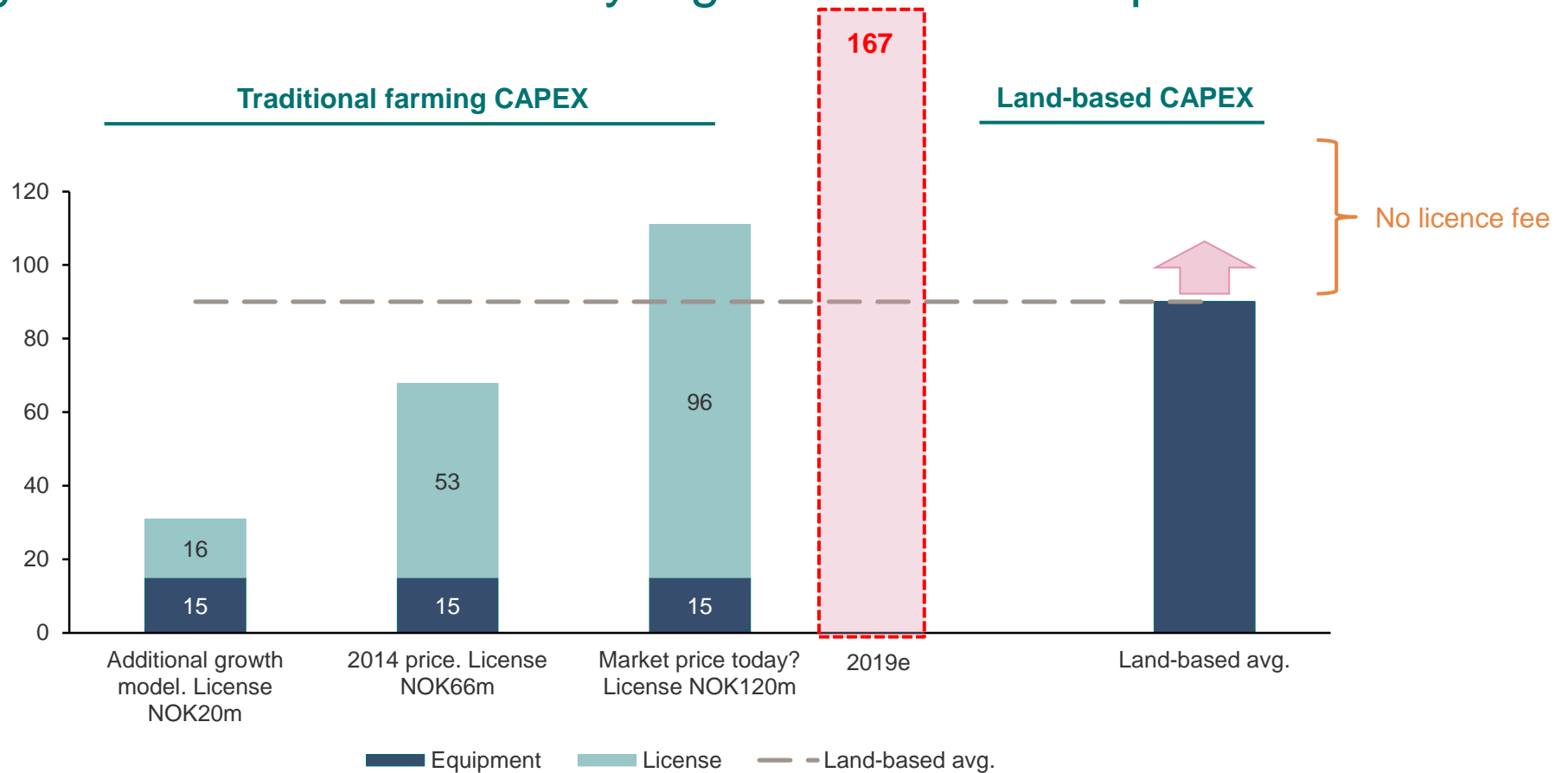
Demand in remote markets picking up – land-based farming has an advantage in transport and freshness if production is close to the end-consumer. US consumption of salmon is continuing to rise, while prices in Miami were fairly stable throughout 2018.

Surge in land-based driven by higher traditional capex



Investments in land based used to be 2x more expensive than traditional growth. Now the situation has reversed

Surge in land-based driven by higher traditional capex



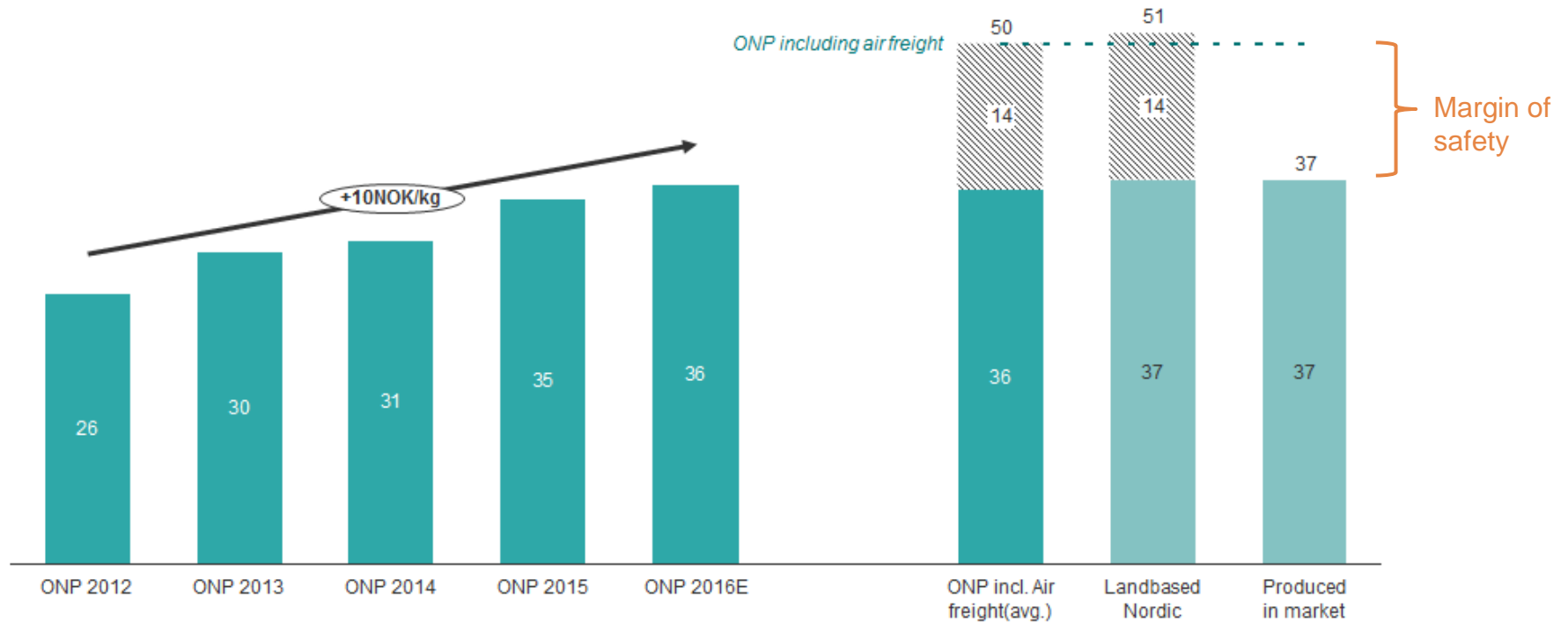
Investments in land based used to be 2x more expensive than traditional growth. Now the situation has reversed

Grieg Seafood - Investment need for traditional growth skyrocketing

Investment per kilo			
(NOK/kg HOG)	Expanding current MAB	Onshore expansion	New licences
License	-	-	122*
Smolt phase	6	6	6
Post smolt and farming phase	30	75	30
Primary processing	9	9	9
Total investments	45	90	167
Biomass/Working Capital	25	25	25
Total funding need	70	115	192

Grieg Seafood – Capital Markets Day 5th September 2018

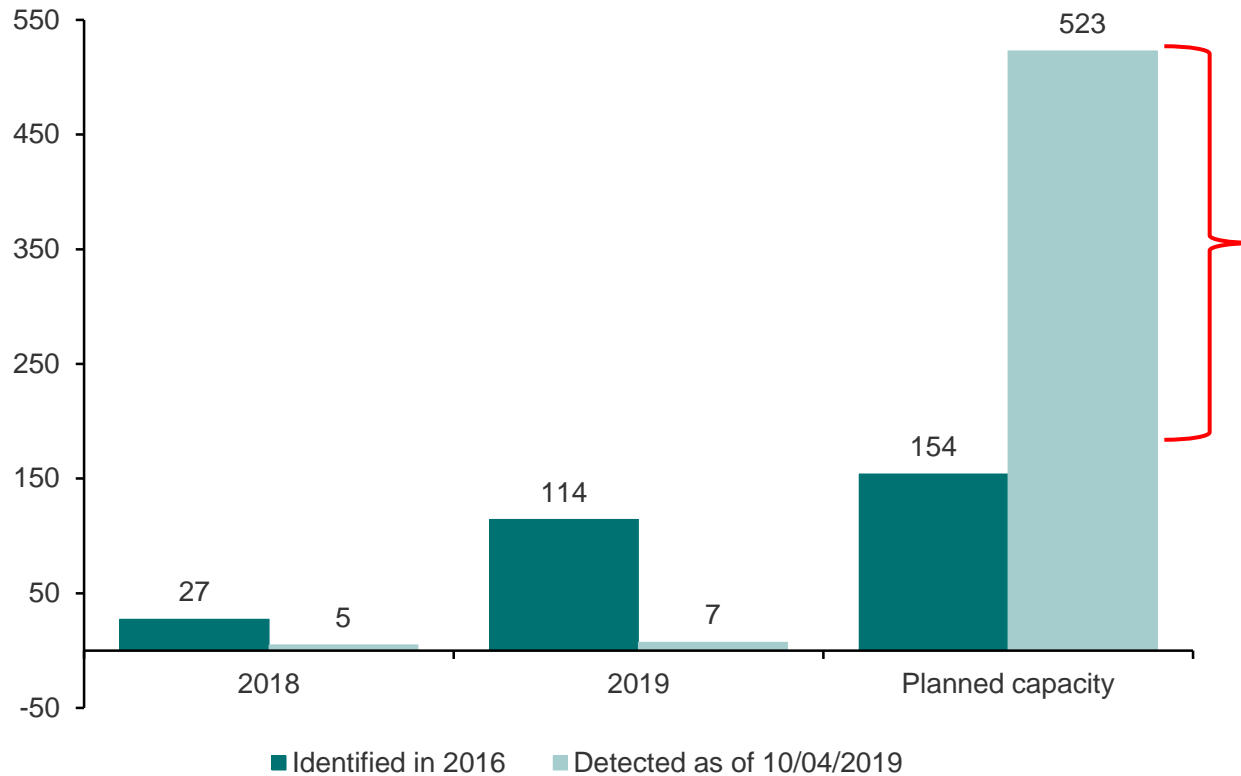
Transport advantage gives margin of safety in US and Asia



Transportation costs at NOK13–18/kg from Norway to US and Asia

Current plans versus where we were two years ago

Volume plans identified in 2016 vs 2019



Project backlog grown 3-fold in ~2 years

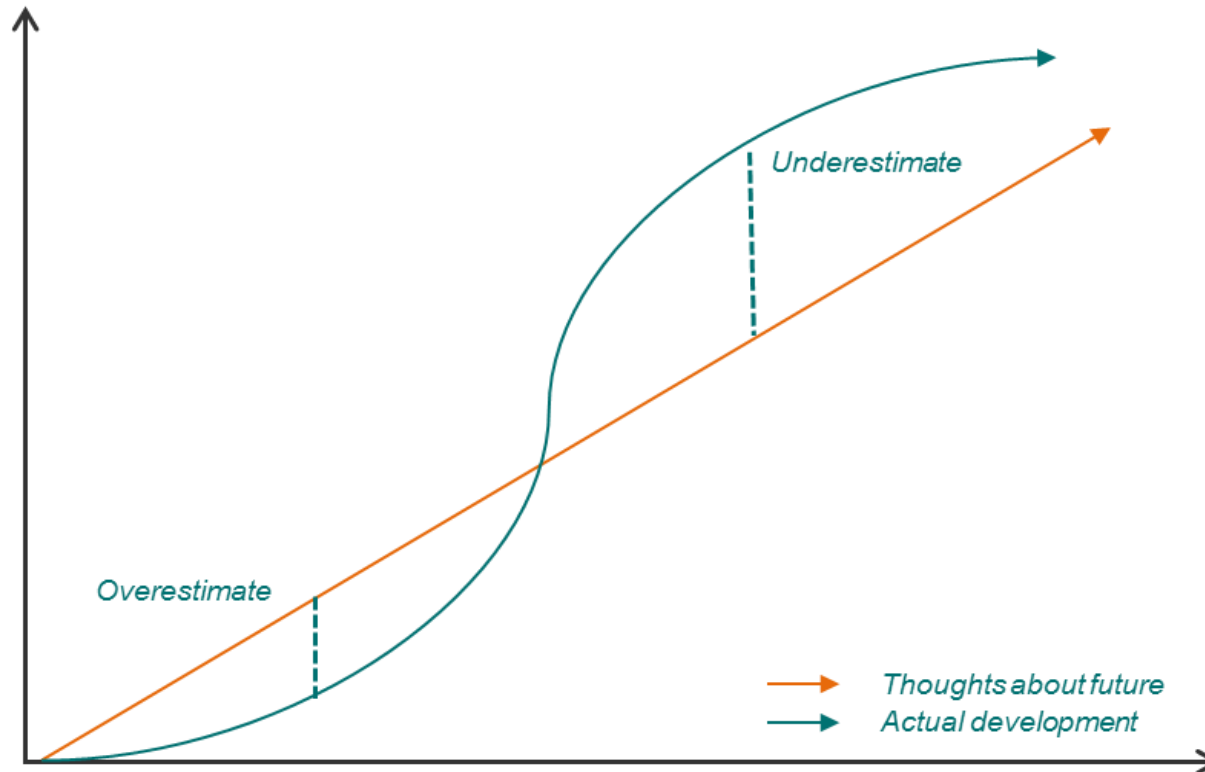
No of projects doubled (from 20 to +40 projects)

Volumes have been pushed out in time, and some projects will probably never materialise

Source: Company information (on volumes in total and distribution if available), DNB Markets (estimate on distribution if not available)

Bill Gates describes our view on the land-based salmon well

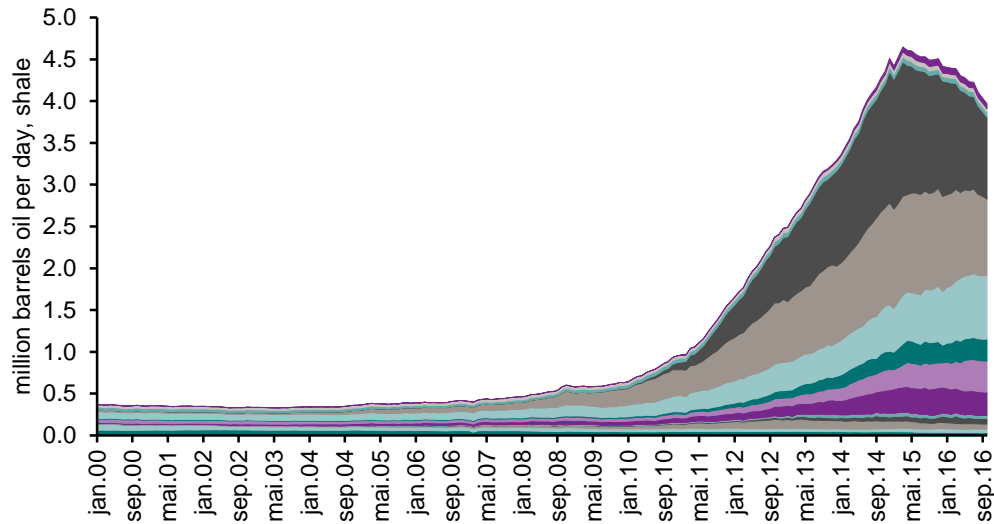
Expectations vs. change



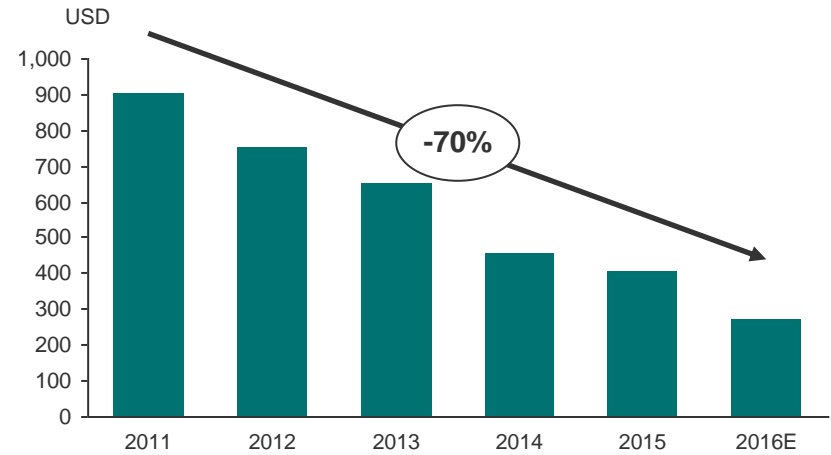
We overestimate the change that will occur in the next two years and underestimate what will change in the next ten

Source: <https://abcnews.go.com/Technology/PCWorld/story?id=5214635>

A friendly reminder from the unconventional oil supply development



- Monterey
- Austin Chalk
- Granite Wash
- Woodford
- Marcellus
- Haynesville
- Niobrara-Codell
- Wolfcamp
- Bonespring
- Spraberry
- Bakken
- Eagle Ford
- Yeso & Glorieta
- Delaware
- Utica

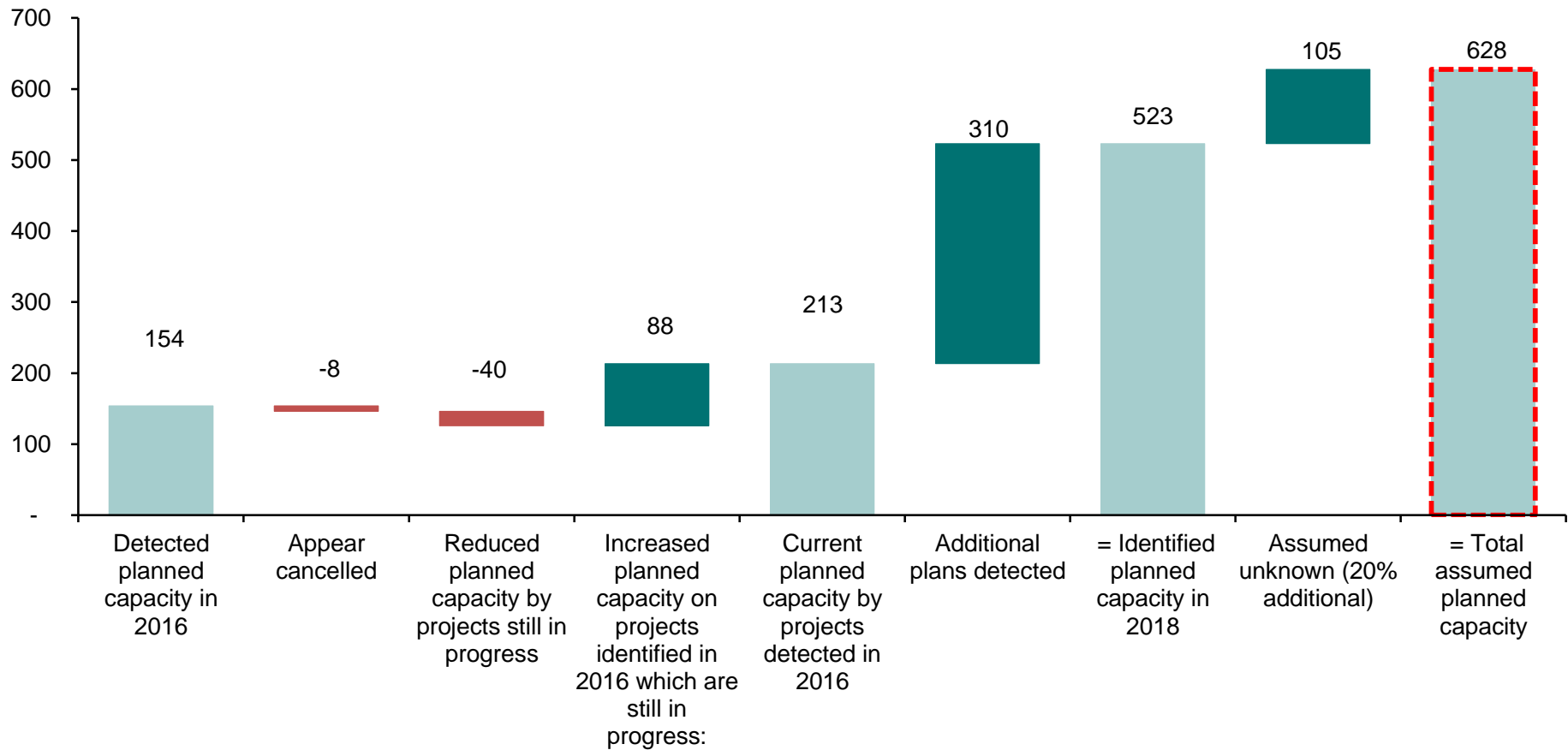


■ Drilling cost / lateral length

Step increase in volumes from take-off and improved efficiency

Source: US Energy Information Administration (EIA), Range Resources (Cost & Efficiency improvement – Northern Marcellus)

Breakdown of identified plan of production in 2016 vs. 2019 (HOG, kt)

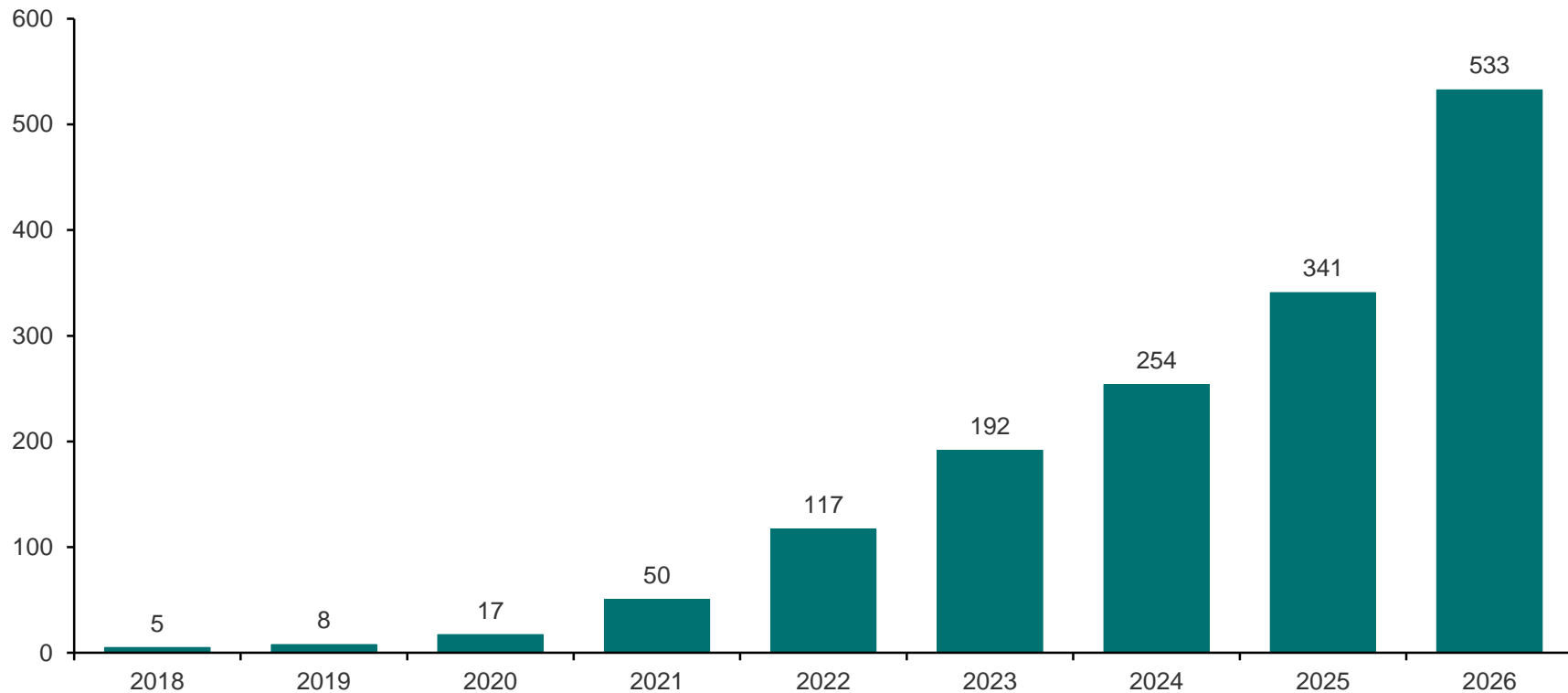


We see larger and more projects within land-based salmon farming than before

Source: Company information (on volumes in total and distribution if available), DNB Markets (estimate on distribution if not available). Please note that there are probably a large amount of projects that we are not aware of

Developments totalling ~500kt in annual production by 2026

Land-based volumes identified, kt



~530kt corresponds to ~20% of global salmon production

* Including assumed identified

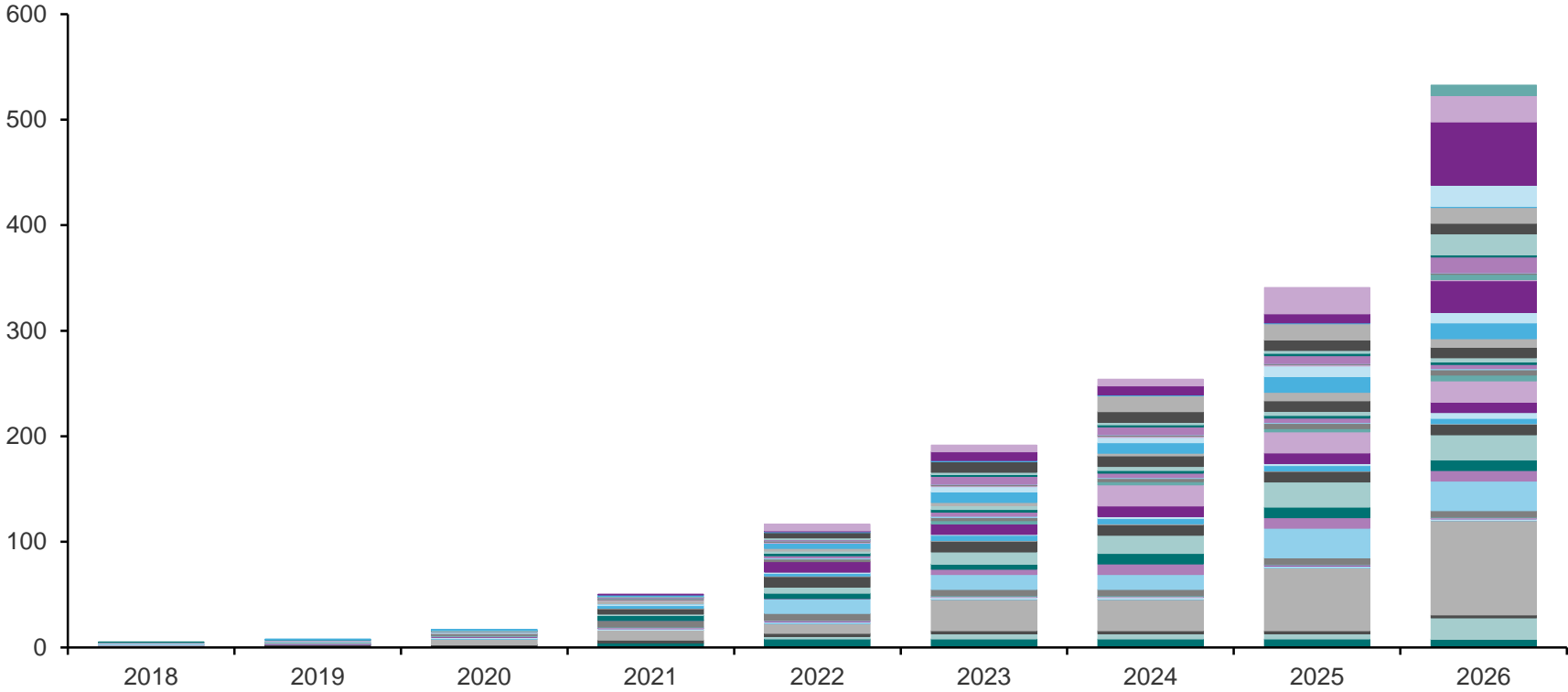
Source: Company information (on volumes in total and distribution if available), DNB Markets (estimate on distribution if not available)



MARKETS

... And larger and more 'sophisticated' projects

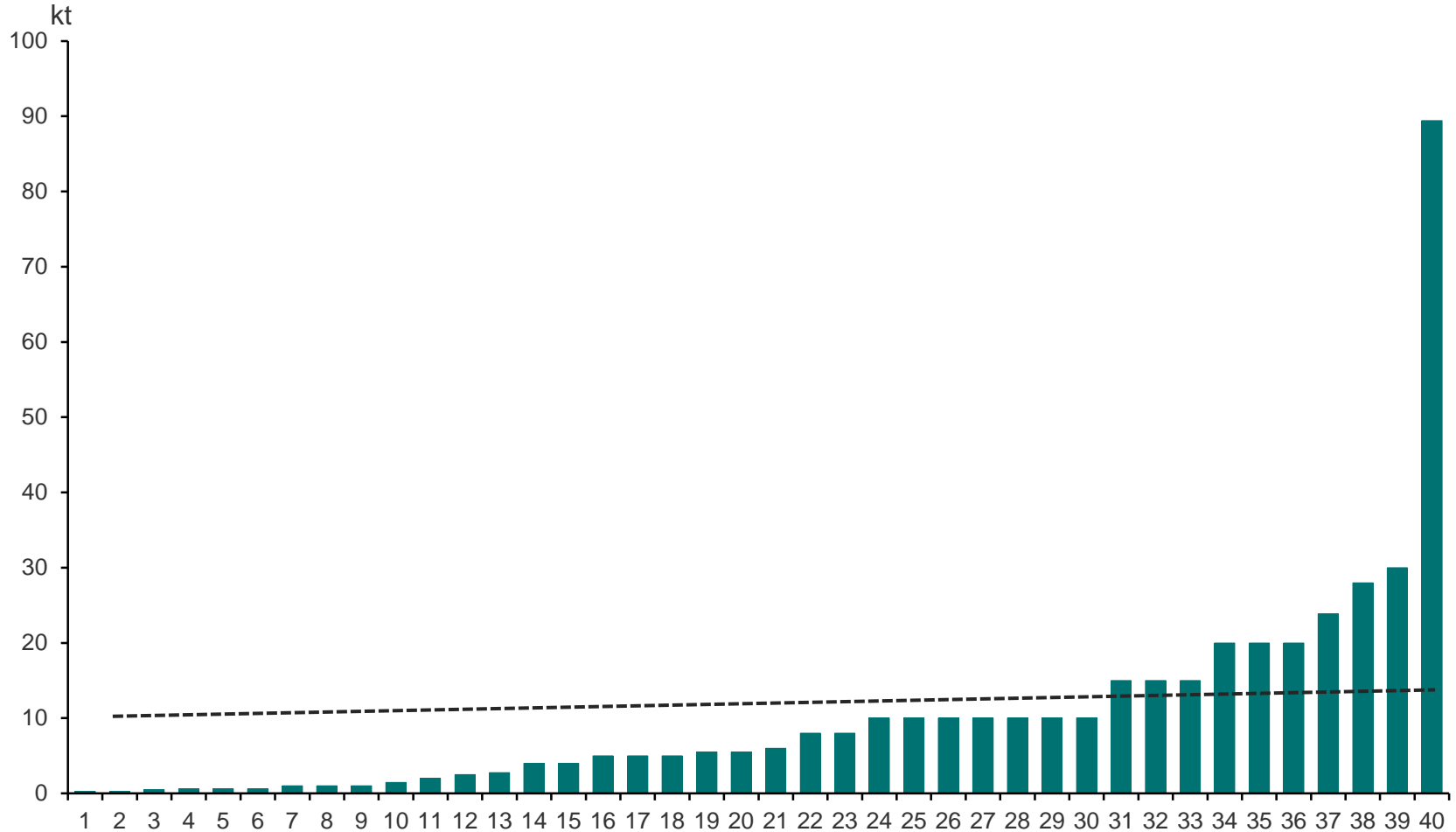
Land-based volumes identified, kt



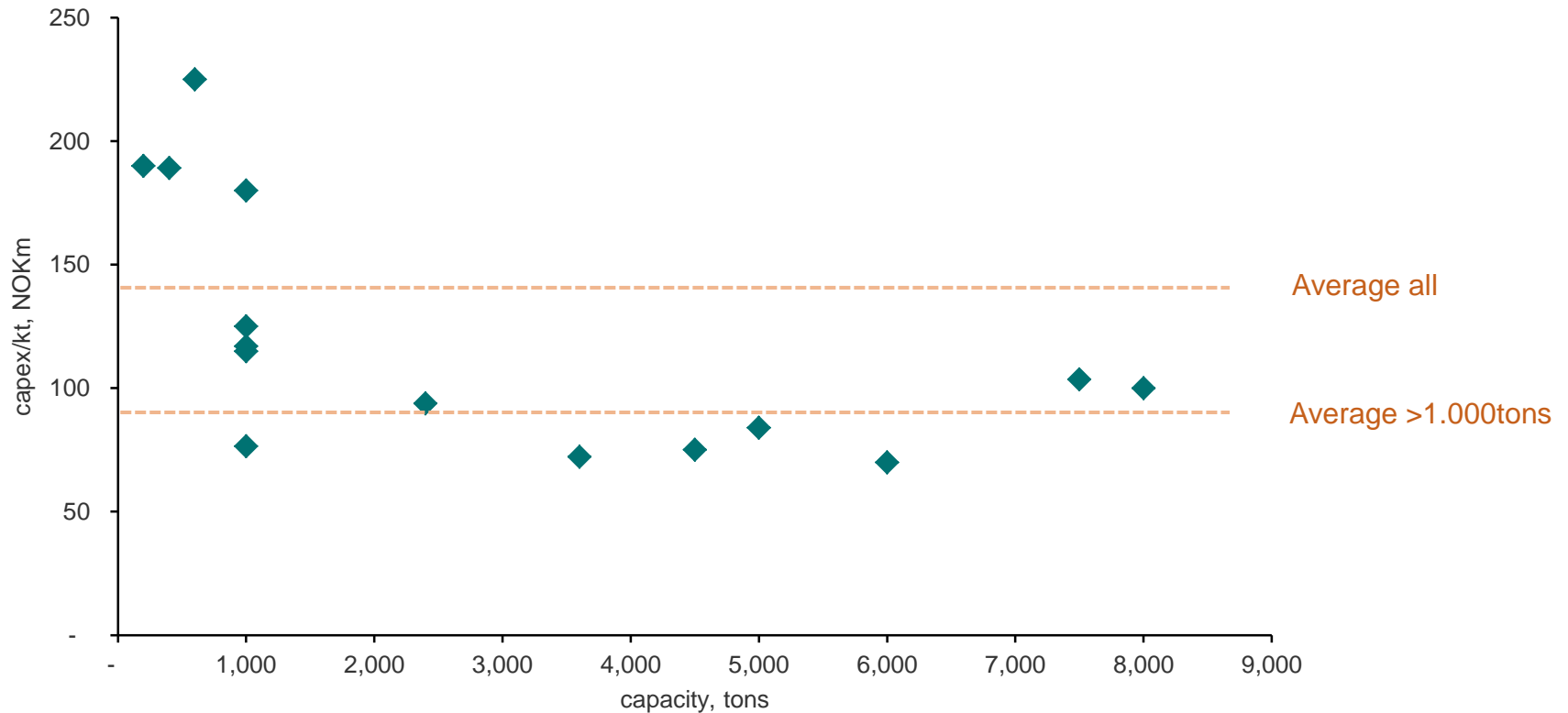
Impressive pipeline of projects

Source: Company information (on volumes in total and distribution if available), DNB Markets(estimate on distribution if not available)

40+ projects with average planned output of 10kt

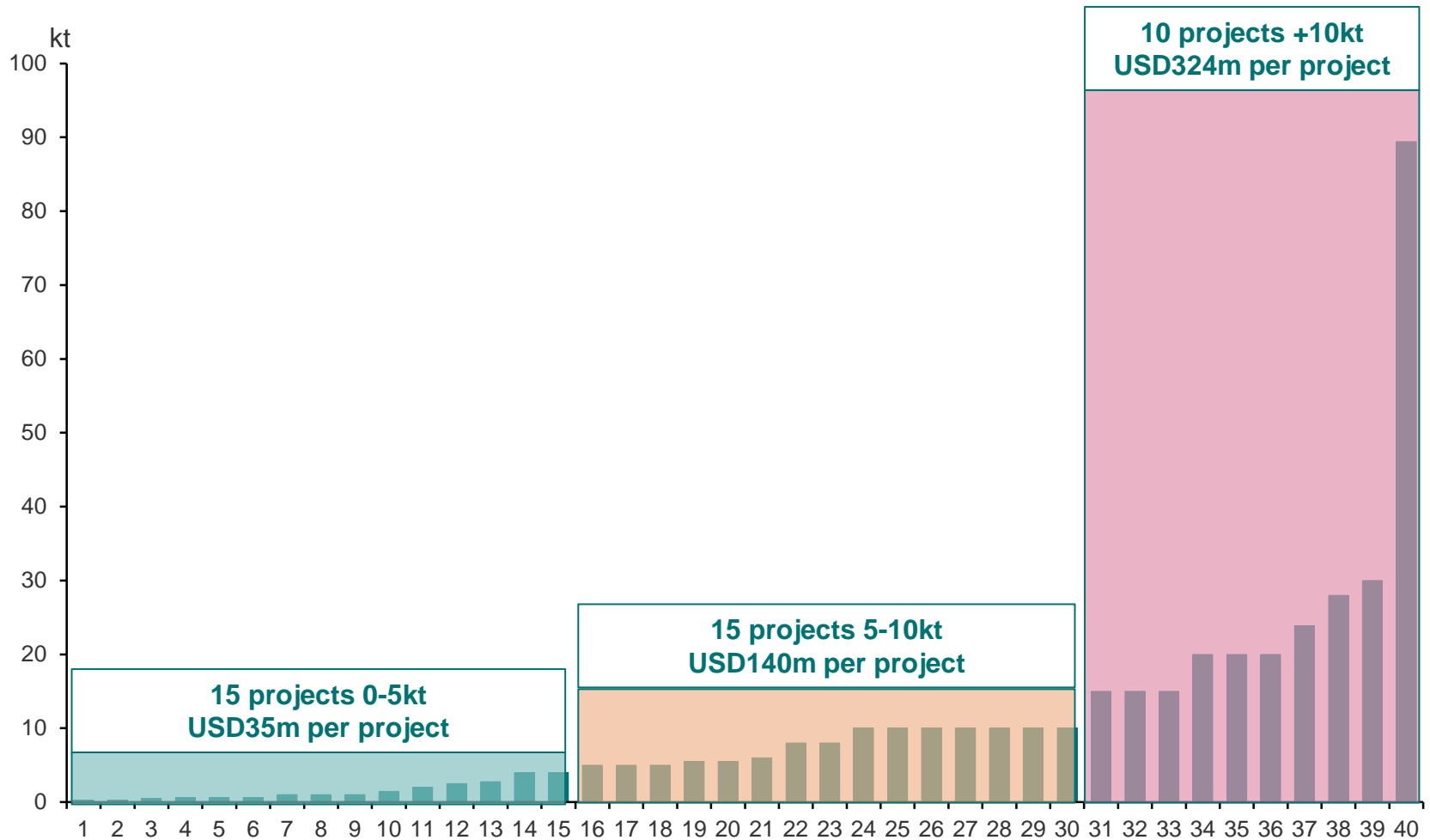


Land-based - Scale lowers the investment cost per kg



Scale important for both production and investment cost per kg

We have identified +40 projects with a planned output of 523kt



Source: DNB Markets (own research and own estimates)

From PowerPoint presentations and excel sheets to reality....



We see a handful of projects with ambitious volumes whereof one has started construction

But 10 years from start-up to commercial-sized harvest volume



Source: Atlantic Sapphire

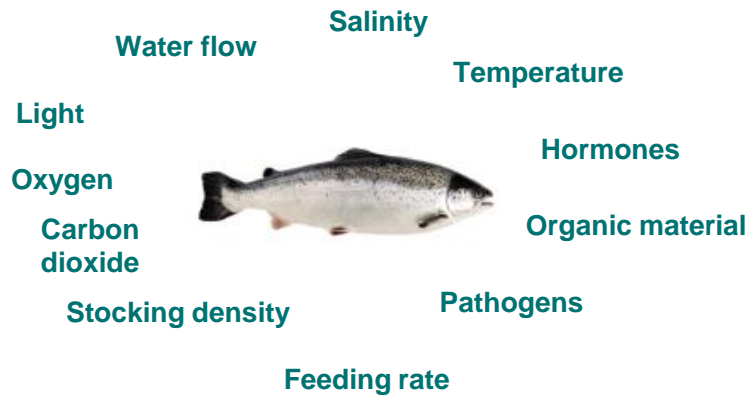
Atlantic Sapphire in US: Fish moved to start-feeding in Feb. 2019



Source: Atlantic Sapphire

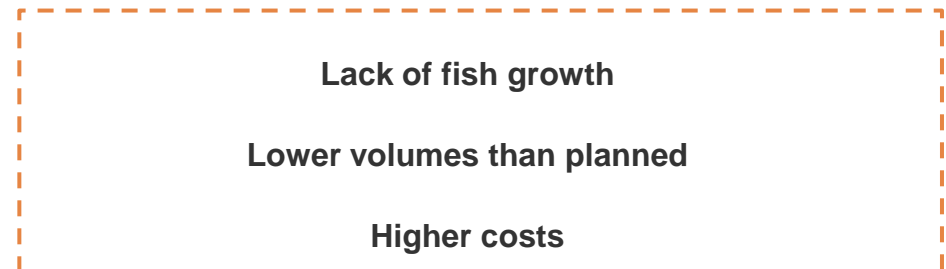
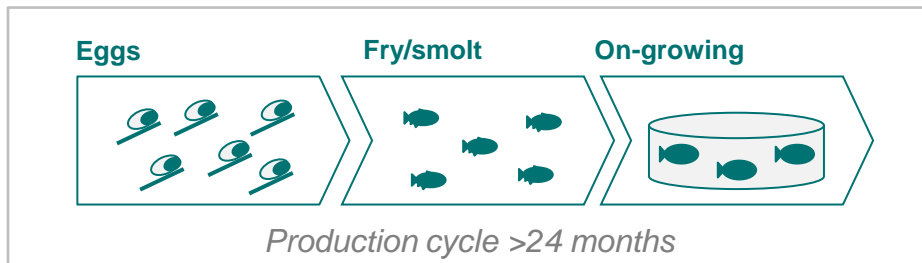
Land-based farming is complicated

Numerous factors impacting the salmon...

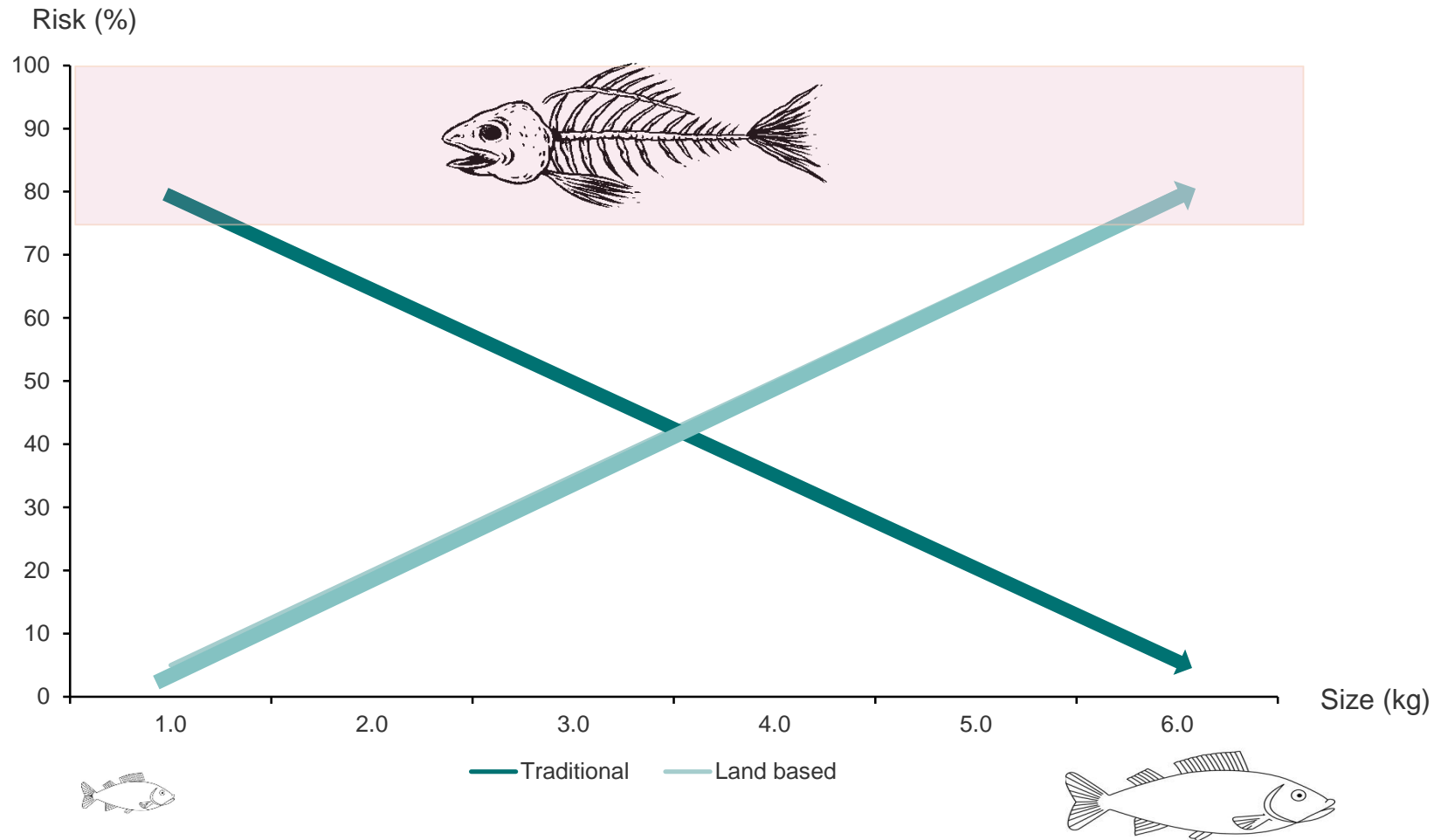


...have led to challenges

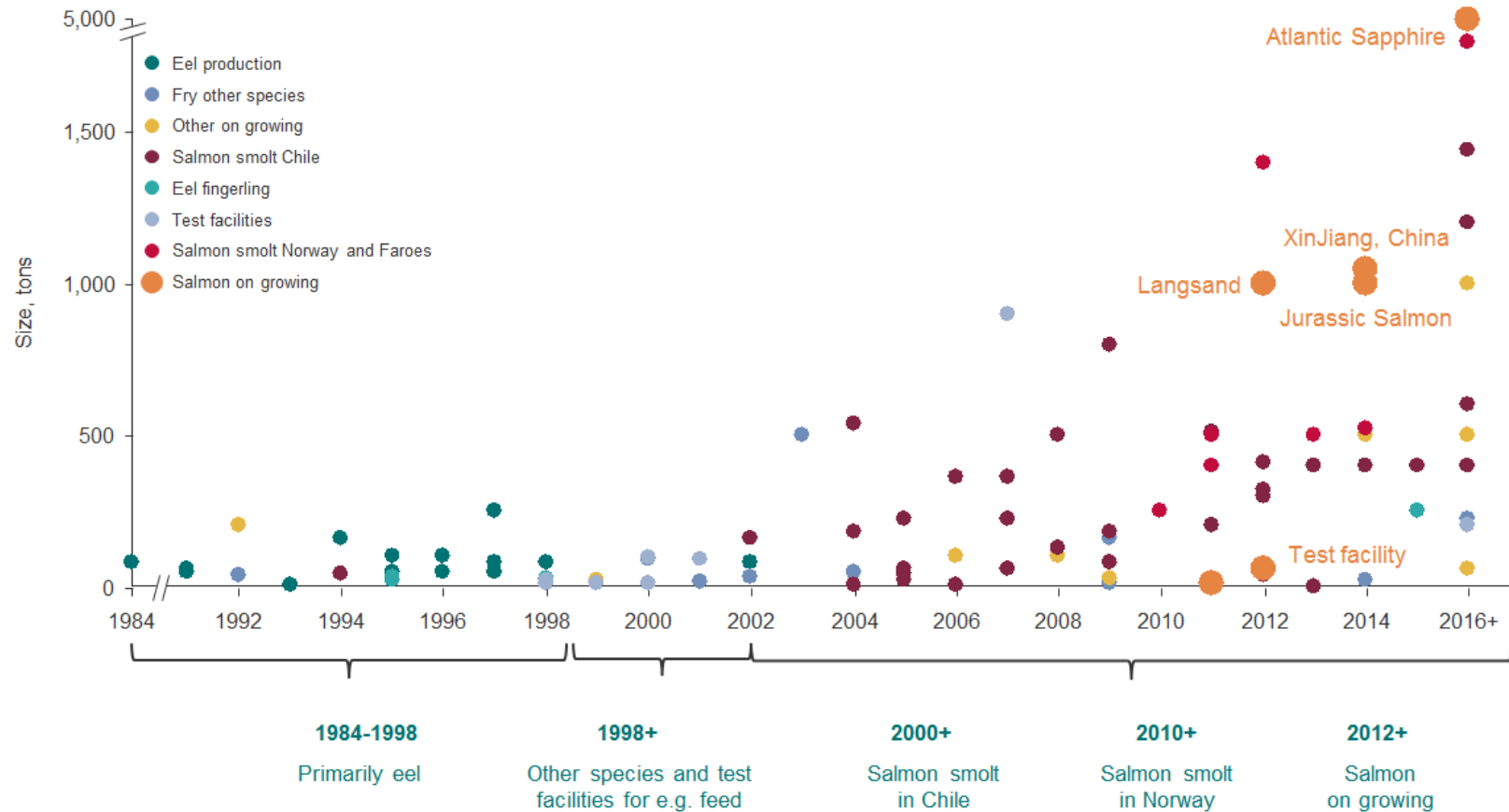
1	Bacteria and disease
2	High CO2 level
3	Early maturation
4	Water quality and clarity
5	Off flavour
6	Component failure



Different risk profile vs. traditional farming



RAS development from other species to full-size salmon



Source: Billund aquaculture(projects), DNB Markets (estimate on size on some of the facilities when confidential)

Offshore farming – Evolution rather than revolution



Source: SalMar

Offshore farming – Evolution rather than revolution

Opportunities

- Limit impact on coastal environment
- Increase the available areas for aquaculture production
- Better dispersion of biological waste
- Less challenges with sea-lice
- Improved biological security (greater distance between farms)
- Lower ‘proof of concept’ risk compared to e.g. land-based farming
- More natural farming environment for the salmon

Challenges

- Harsher weather requires tougher equipment
- Higher investment cost compared to near-shore equipment
- Higher logistics cost
- Still exposed to weather, sea temperatures and other ‘uncontrollable factors’
- * Possibly higher production cost than near-shore farming

*We assume the absolute cost should be higher due to longer supply distance, more advanced equipment and higher requirement for safety features on the facility. However, improved growth/yield due to better farming conditions may mitigate the higher absolute cost, leading to similar or even lower production cost per kg than we see in traditional farming nearshore.

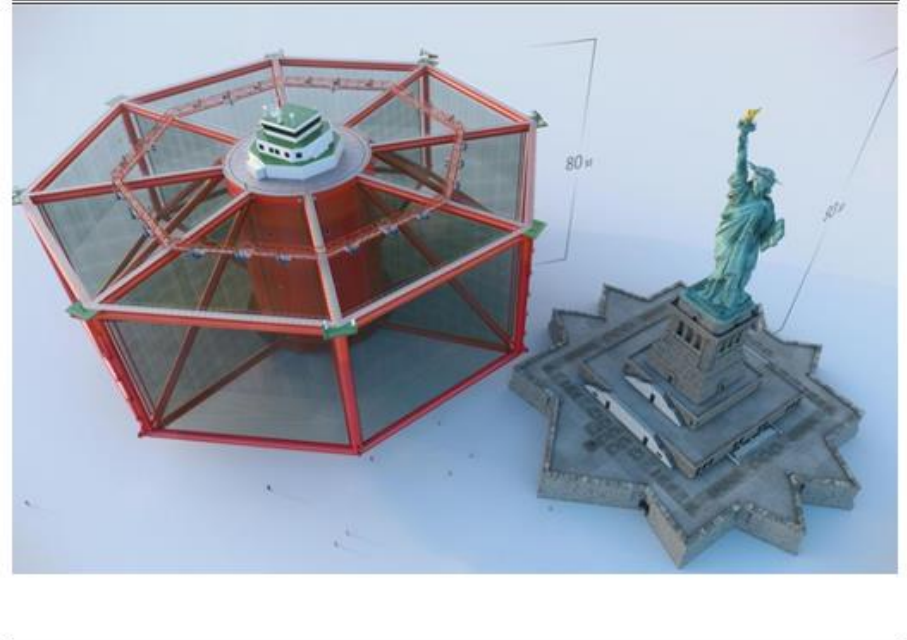
Offshore farming works in Norway...

Figure 47: SalMar - Ocean Farm 1



Source: DNB Markets

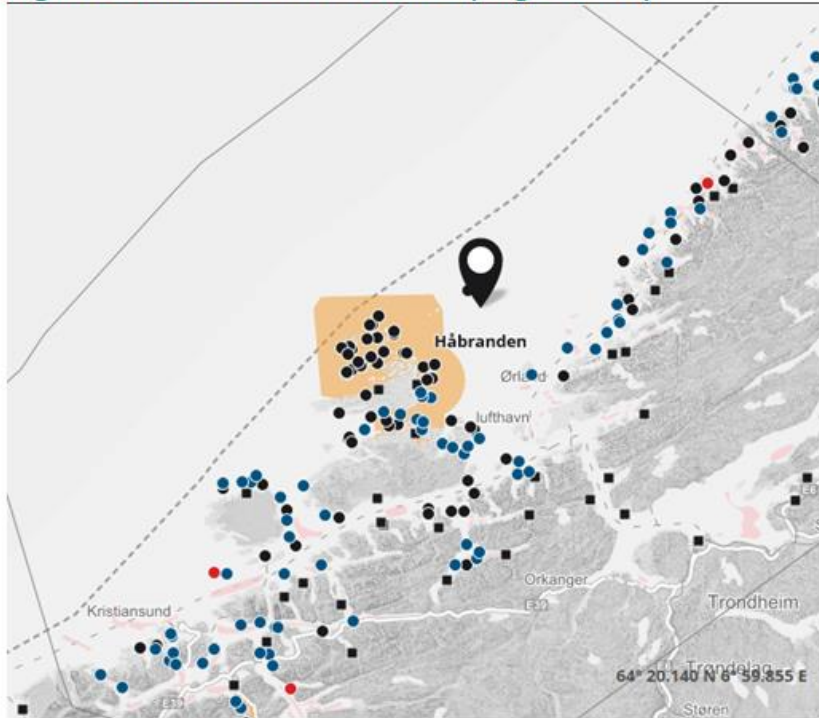
SalMar - Smart Fish Farm



- Successful completion of first production cycle with 1 million individuals
- 2nd bigger unit, 'Smart Fish Farm' to be built following award of eight development licences
- 'Smart Fish Farm' capable of holding 3 million salmon, 2x the capacity of 'Ocean Farm 1'

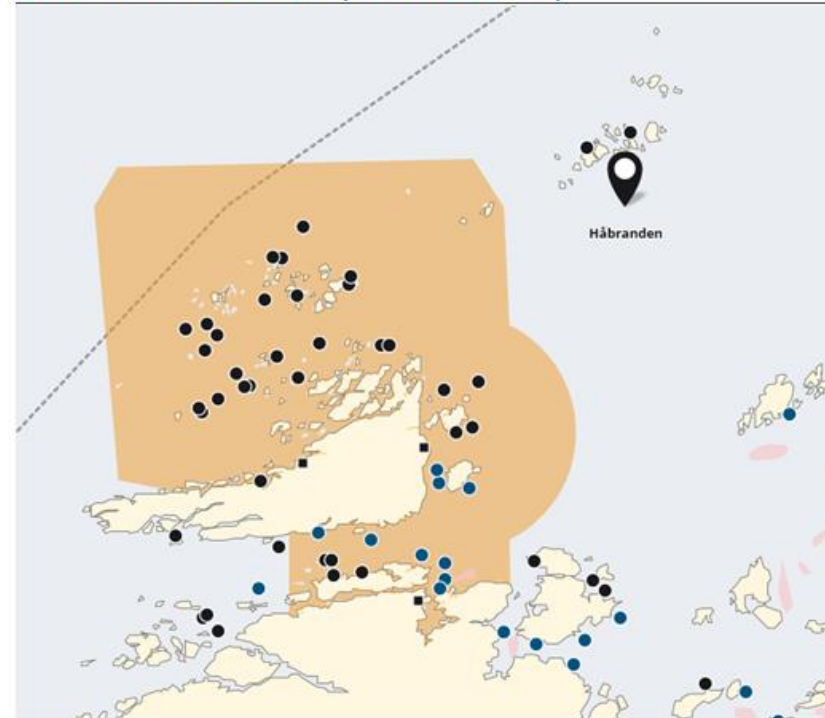
...but many of the traditional challenges remain

Figure 48: Ocean Farm 1 location (large format)



Source: www.BarentsWatch.com

Ocean Farm 1 location (detailed format)



Source: www.BarentsWatch.com

- Operates close to the coast
- Escape due to human error (~16.000 fish)
- Sea-lice present, but no need for lice treatment
- Suspected ISA
- OceanFarm design may not be what SalMar picks going forward...

Offshore farming also works in China

Figure 49: Shenlan 1



Source: CGTN, www.youtube.com

Shenlan 1



Source: www.cccisc.com

- Successful completion of first production cycle
- China Construction and Communication Company CCCC won the tender to build a second unit, Shenlan-2, “Laying the foundation for further development of marine fishery resource development”

...but there are also challenges here

Figure 49: Shenlan 1



Source: CGTN, www.youtube.com

Shenlan 1

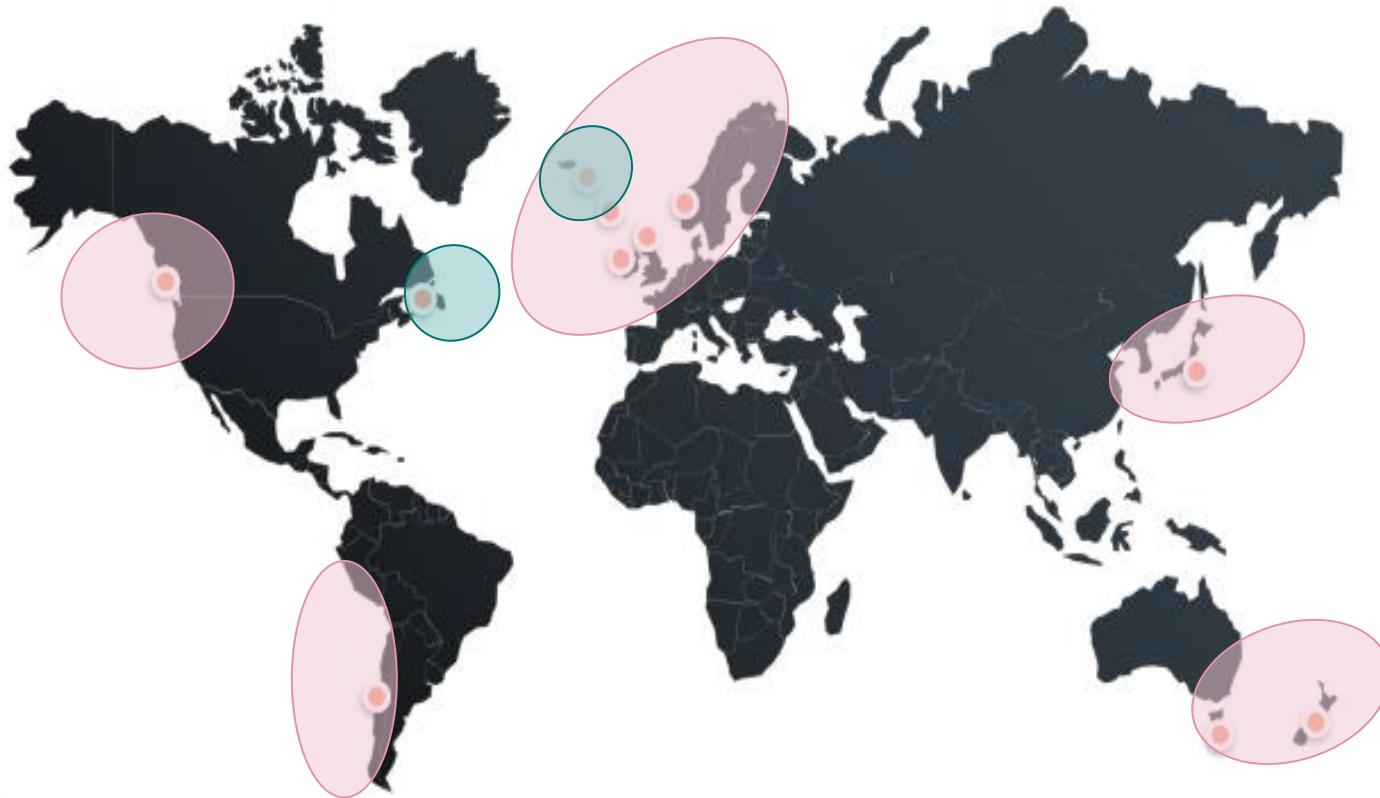


Source: www.cccisc.com

- Towing to site and mooring delayed due to weather
- Volatile feeding due to high water temperature and other fish swimming into cage
- 2nd smolt stocking with higher density planned

Offshore growth in existing regions due to infrastructure advantage

Evolution of existing sea based technologies



... but China may become a new region

Offshore farming in China



- **Bottom cages in Yellow Sea (rigs)**
- **Deep water from South China Sea (vessels)**
- **North/South Korea**

Offshore farming – What else is being developed?

	Applicant	MAB	Type	Status
1	SalMar - OceanFarm	6,240	Offshore Rig	Approved
2	Nordlaks	16,380	Offshore Vessel	Approved
3	Norway Royal Salmon	5,990	Arctic Offshore Rig	Approved
4	SalMar - Smart Fish Farm	6,240	Offshore Rig	Approved
5	Måsøval Fiskeoppdrett	3,900	Semi submersible facility	Pending
6	Pelaqua Farming	22,620	Offshore Fish Cage	Under review
7	Unitech Salmo Solar	3,120	Floating in exposed locations	Under review
8	Mowi	28,080	Aqua Storm' Offshore subsea	Under review
9	Floating Fish Farming Unit	7,800	Offshore farming	Under review
10	Gigante Offshore	6,240	Offshore Vessel	Rejections
11	Gifas Marine	3,120	Submersible cage	Rejections
12	Lerlow	6,240	Semi-offshore	Rejections
13	Mowi 1	4,680	Beck cage offshore	Rejections
14	Bremnes Seashore	4,680	Offshore concept	Rejections
15	Mowi	4,680	Farming in vessels	Rejections
16	Viewpoint Seafarm/Nordlaks	15,600	Modular Oceanfarm	Rejections
17	Erko Seafarms	12,480	Bottom structure offshore	Rejections
18	Nova Sea	3,120	Closed offshore facility	Rejections
19	Gigant Offshore	7,020	Offshore cage	Rejections
20	Mowi 2	4,680	Beck cage offshore	Rejections
21	Roxel Aqua	10,920	Submersible in Offshore	Rejections
22	Offshore Salmon	5,460	Submersible Offshore	Rejections
23	Mohn Drilling	4,680	Autonomous oceanfarming	Rejections
24	Wilsgård Fiskeoppdrett	8,580	Offshore tank fleet	Rejections
25	Evna	7,800	Wave Master	Rejections
26	Inocap/Subsea farming	4,680	Farming in exposed areas	Rejections

Development licenses

- 26 offshore project applications in Norway...

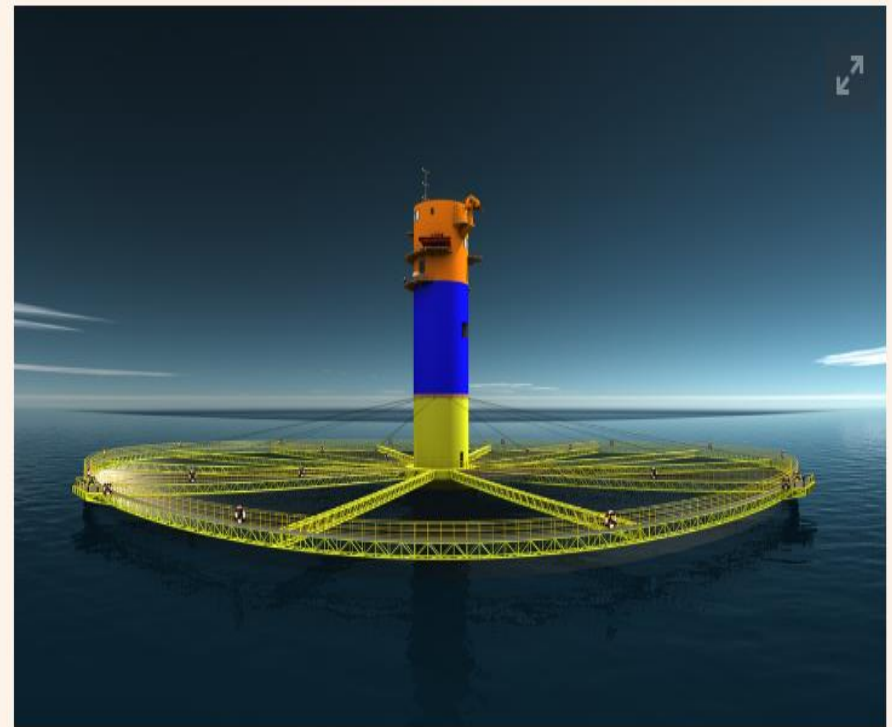
- Projects may be rejected in Norway but still relevant in other regions

Offshore farming – What else is being developed?

Offshore projects



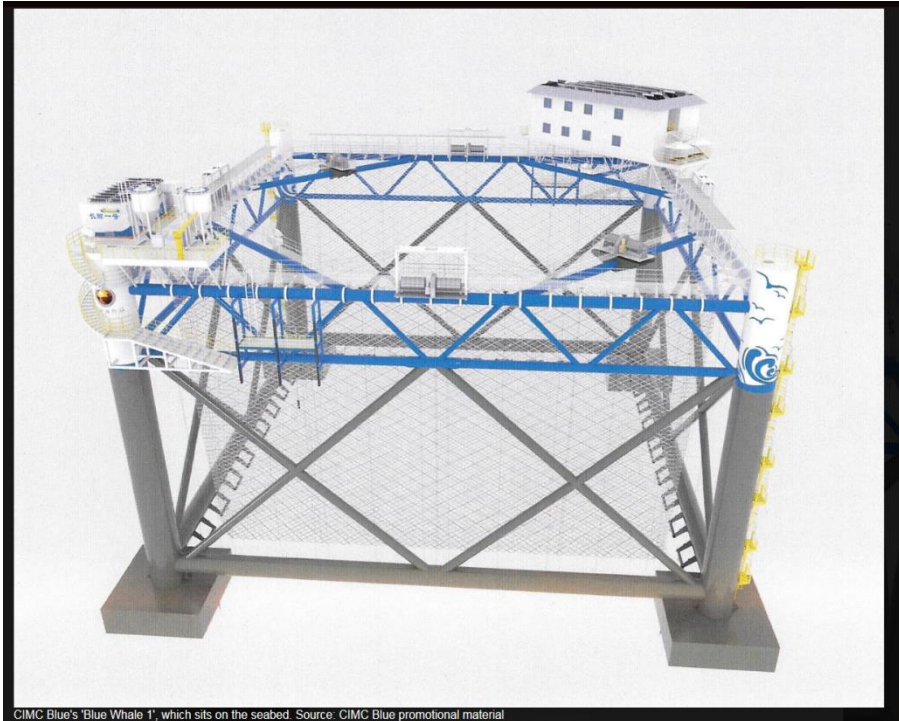
Another key feature of De Maas' design is it is submersible; before a storm arrives, the pen submerges so that it gets out of the 'wave zone', where the force of waves acting on the pen is strongest.



Source: DNB Markets, Undercurrent News

Offshore farming – What else is being developed?

Offshore projects



CIMC Blue's 'Blue Whale 1', which sits on the seabed. Source: CIMC Blue promotional material

Meanwhile, the firm has also built 26 'mini jack-ups' for farmers to reside on or store farming equipment next to near-shore or offshore aquaculture pens, and which resemble mini-rigs. CIMC Blue was promoting all three designs at CFSE in early November.



Source: DNB Markets, Undercurrent News

Offshore farming – What else is being developed?

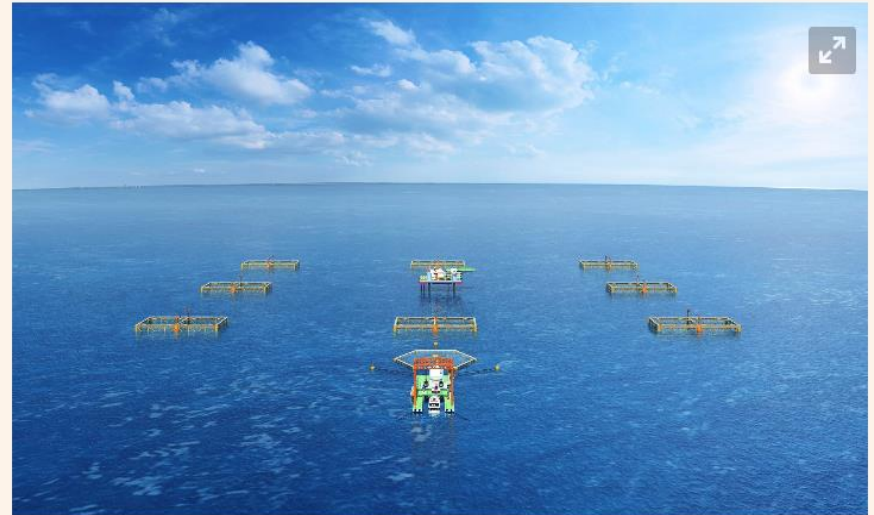
Offshore projects

“GengHai 1#” Intelligent and Bottom Supported Offshore Cage



CIMC Blue's Genghai 1, bottom supported offshore cage. Source: CIMC Blue

Another offshore pen concept aiming to exploit cold water mass in the Yellow Sea is Chinese firm Neptune Blue Ocean Development's (NBOD) offshore salmon farm near Weihai. Established by entrepreneur Wang Lingyu, NBOD plans **eight semi-submersible pens** built at a cost of \$150 million to farm salmon.



Source: DNB Markets, Undercurrent News

Offshore farming – What else is being developed?

Offshore projects



Source: DNB Markets, Undercurrent News

Offshore farming – What else is being developed?

Offshore projects



Source: DNB Markets, Undercurrent News

First release of fish by summer 2020 (2mill individuals)

Offshore farming – What else is being developed?

Offshore projects

CHINA EXPO 2018 ATLANTIC SALMON ASIA

Why China is a hub for building offshore aquaculture pens

By Louis Harkell Oct. 2, 2018 09:13 GMT



Salmor's Ocean Farm 1 under construction in Qingdao, China. Credit: People's Daily

Hyundai studies Nordlaks Havfarm model as it considers entry into aquaculture

By Matt Craze Jan. 4, 2019 10:31 GMT



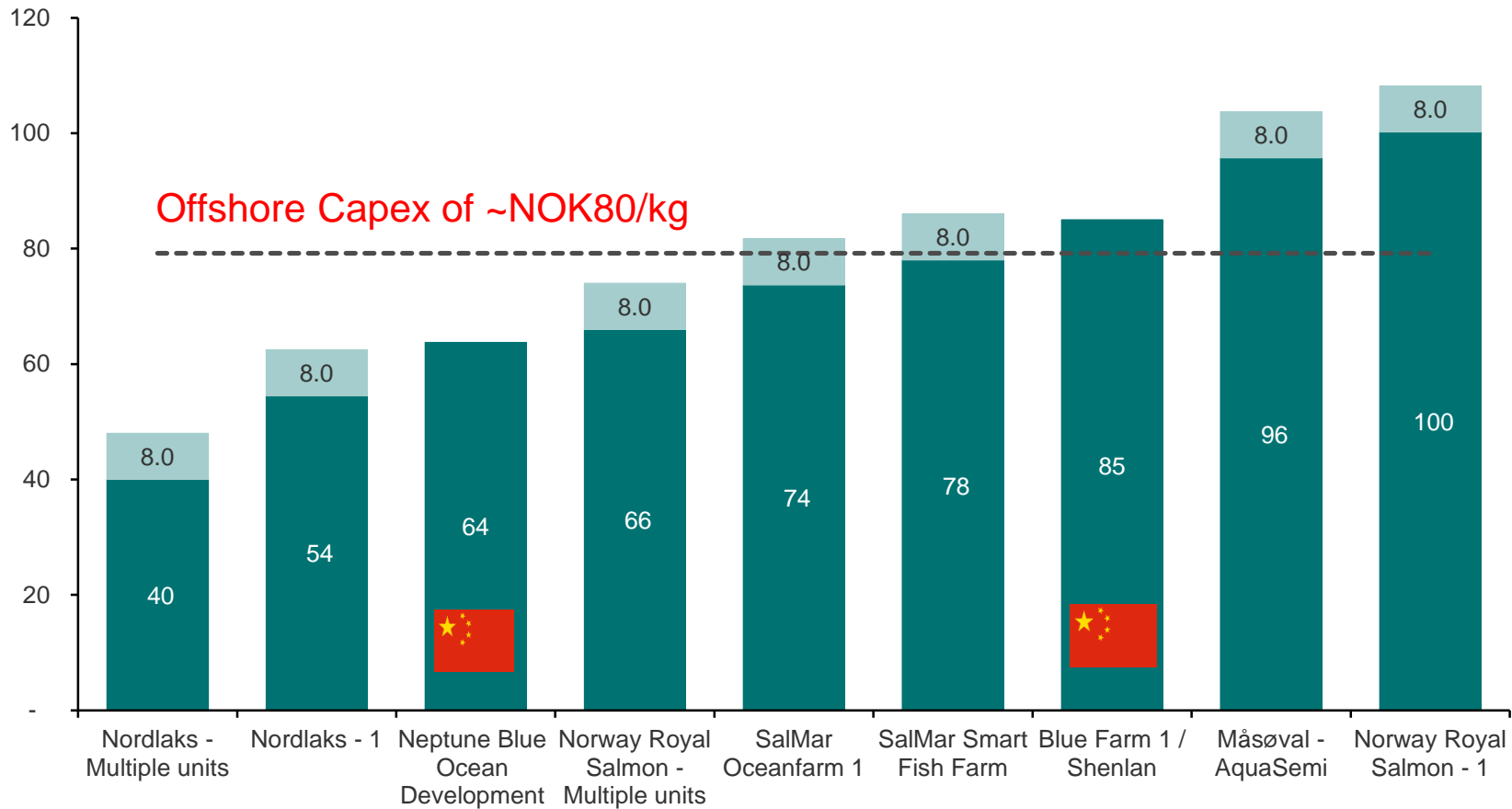
Credit: NSK Ship Design

A ————— A      Comment

Hyundai Heavy Industries, the world's largest shipbuilder, is considering venturing into aquaculture and has taken inspiration from a Norwegian design to store fish on a huge ship.

Offshore farming – What else is being developed?

Estimates Offshore Investment cost - NOK/kg (wfe)



Source: DNB Markets, Directory of Fisheries, Undercurrent News

What do the numbers tell us?

Per kg (wfe, NOK)	New technology		Traditional	
	Land based	Offshore	Ex - license	Incl. License
Investment	100	80	45	167
Required return	10%	10%	10%	10%
Required EBIT/kg	10	8	5	17
Production cost	40	35	35	35
Required salmon price	50	43	40	52

What do the numbers tell us?

Per kg (wfe, NOK)	New technology		Traditional	
	Land based	Offshore	Ex - license	Incl. License
Investment	100	80	45	167
Required return	10%	10%	10%	10%
Required EBIT/kg	10	8	5	17
Production cost	40	35	35	35
Required salmon price	50	43	40	52

Per kg (wfe, NOK)	New technology		Traditional	
	Land based	Offshore	Ex - license	Incl. License
Required salmon price	50	50	50	50
Freight	0	10	10	10
Price from farmer	50	40	40	40
Production cost	40	35	35	35
EBIT/kg	10	5	5	5
Investment	100	80	45	167
Return on Investment	10%	6%	11%	3%

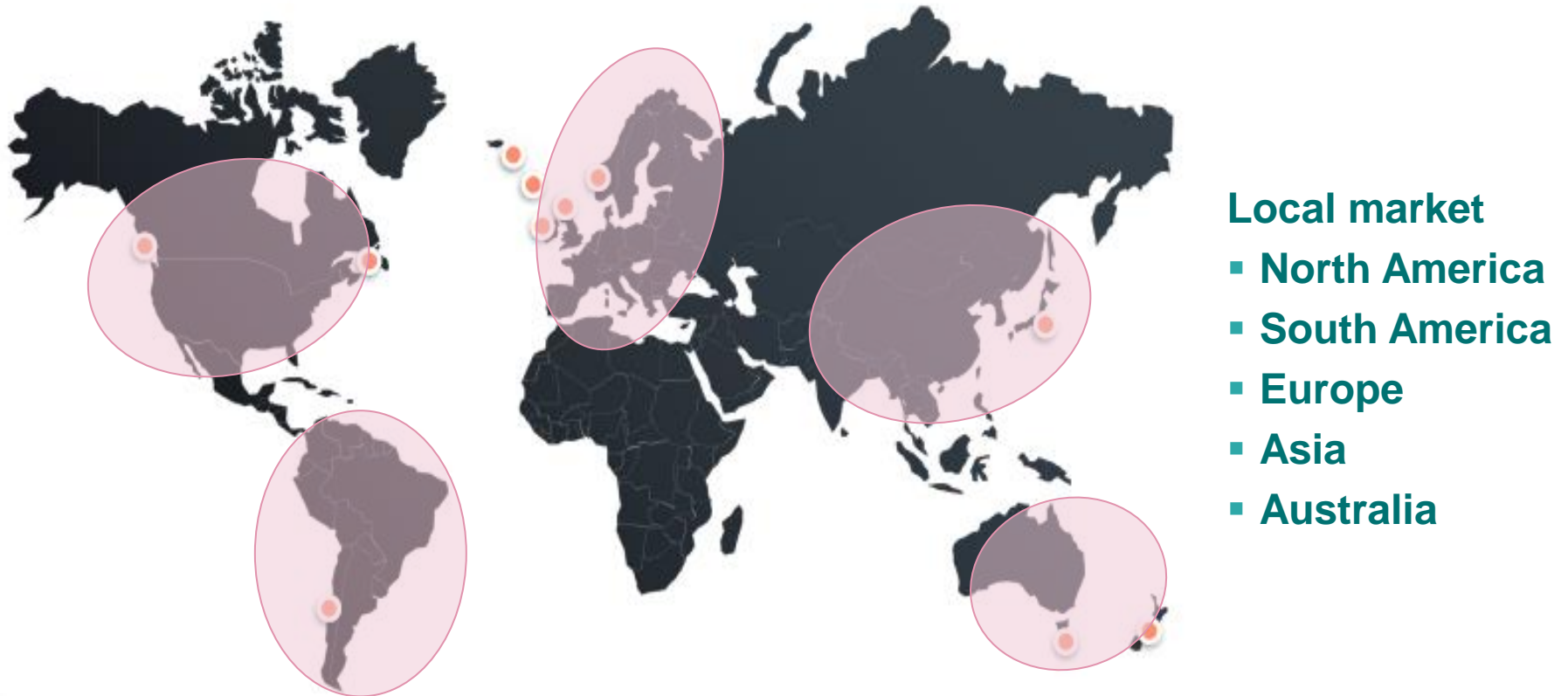
What do the numbers tell us?

Per kg (wfe, NOK)	New technology		Traditional	
	Land based	Offshore	Ex - license	Incl. License
Investment	100	80	45	167
Required return	10%	10%	10%	10%
Required EBIT/kg	10	8	5	17
Production cost	40	35	35	35
Required salmon price	50	43	40	52

Per kg (wfe, NOK)	New technology		Traditional		
	Land based	Offshore	Ex - license	Incl. License	Ex transport
Required salmon price	50	50	50	50	50
Freight	0	10	10	10	0
Price from farmer	50	40	40	40	50
Production cost	40	35	35	35	35
EBIT/kg	10	5	5	5	15
Investment	100	80	45	167	167
Return on Investment	10%	6%	11%	3%	9%

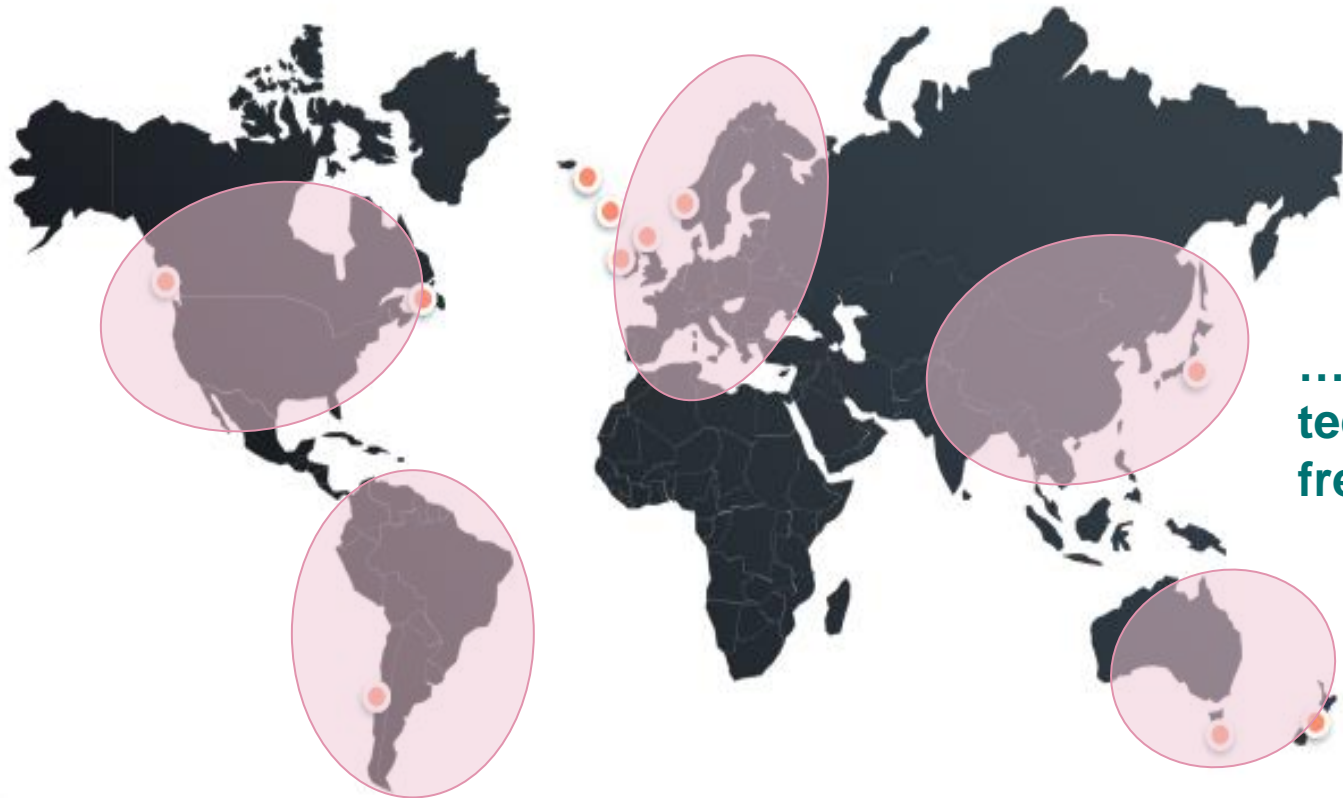
New technology could lead to local markets due to freight cost

Regional market development



New technology could lead to local markets due to freight cost

Regional market development



... our could new freezing technology disrupt the freight advantage?

Concluding remarks

- **If traditional growth fails to satisfy demand, new technology will emerge**
 - **Norway and Chile still essential in supplying the market**
 - **Offshore is evolution – existing regions, low risk, but still challenges**
 - **Onshore is revolution – new regions, but still with high risk**
 - **New technology will create local markets for commodity products**
 - **Brands, origin and quality to play a more important role**
-
- **Key to success is ability and willingness to adapt if the rules change**

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