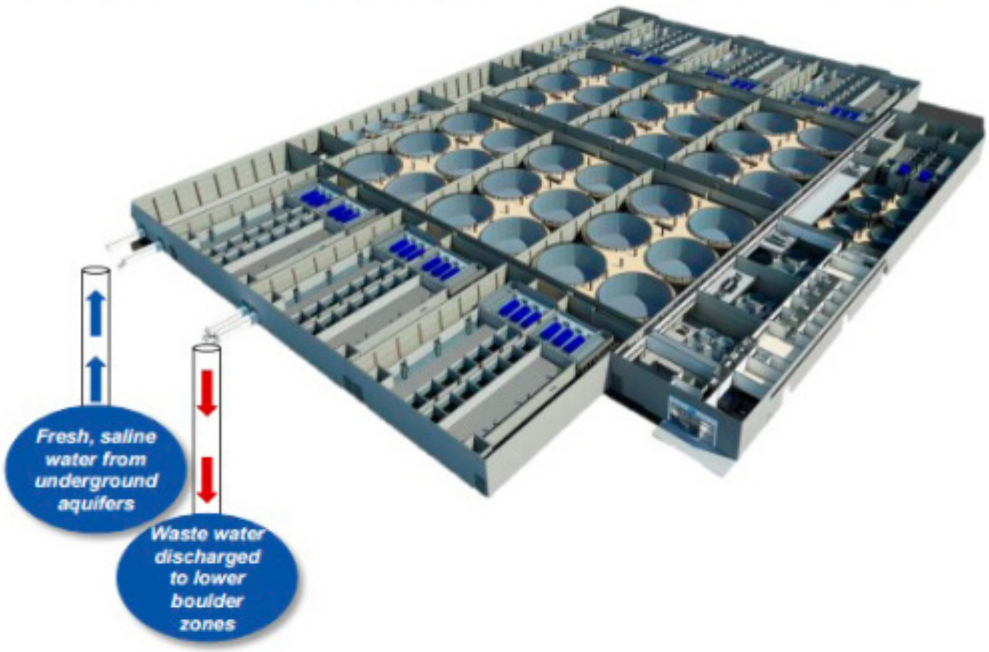
FUTURE CURRENT:

The high flow of change in salmon farming tech.

Proposed (75% drawing completion) US facility layout – Phase 1



ENVIRONMENT

Future current: The high flow of change in global salmon farming technology

With the world's leading producing nation halting all licence allocations for traditional, open-pen marine farming, there is palpable evidence of an innovation shift in the global salmon farming industry. Fresh off a successful IPO, Atlantic Sapphire has commenced construction of a major new land based facility in Miami which will produce salmon to market size on a commercial scale. DNB, Norway's largest bank, has identified planned production of 150 kilotons from land based farming systems by 2020. This growth has been aided by traditional farmers' investment in extending their land based production phase to grow larger smolt. Semi-closed and fully closed systems for ocean farming are also in advanced stages of development around the world.

So what does this mean for the future competitiveness of Tasmania's salmon farming industry? How does Tasmanian Government policy and corporate investment stack up when it comes to carving out a place at the table in future salmon markets?

This paper considers the driving forces for innovation in the global salmon sector, the development stages of new tech at commercial scale and what this means for the environmental impacts of industrial salmon farming. It includes a rating of the progress being made towards adoption of new technologies by Australia's three major salmon farming companies. There is currently zero investment in fully land based RAS in Tasmania and no investment in semi or closed containment ocean production systems. There is some investment in offshore (high wave energy) production and intermediate RAS for post-smolt.

> The driving force for change: growth constraints

Why are listed companies investing in costly systems change? While profits can be maintained in current operating systems, there is limited water for near shore expansion of production volume. Steady increases in demand create market incentive for overcoming physical limits on expansion in inshore bays and estuaries.

The heavy stocking and pollution associated with traditional open net pen systems has also created biosecurity threats that are significantly increasing operating costs. The Norwegian salmon farming sector spent upwards of NOK 5 billion combating sea lice in 2015. Cost per kg HOG has increased steadily since 2005, while volume has stagnated since 2012.[1] In Scotland, the amount of hydrogen peroxide, a chemical treatment used to combat sea lice, rose by 15 times between 2011 and 2015, reaching 42 litres of bleach per tonne of fish produced.[2] Toxic algal blooms cost the Chilean salmon farming industry $800m in 2016.[3] Warming ocean temperatures contributed to the blooms.

In Tasmania, there are limited inshore sites available for expansions that offer suitable conditions for traditional net pen production. Heavy stocking in near shore areas also comes with biosecurity risks. Managing amoebic gill disease costs the industry $40 million a year in treatment and lost productivity. Increased issues with viruses such as Pilchard Orthomyxovirus, for which there is currently no commercially available vaccine, has also increased mortalities. Disease issues have led some producers to dramatically increase antibiotic use.

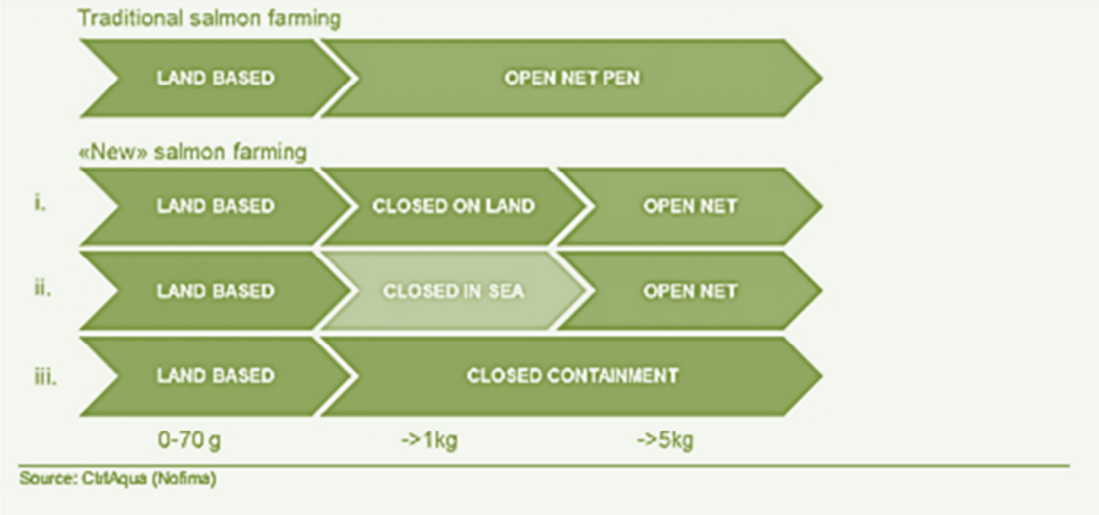
> Industry response

Globally, industry is responding to physical growth constraints and the increased production costs created through environmental damage and heavy stocking by investing in new production technologies. These range from fully land based Recirculating Aquaculture Systems (RAS) to land based post-smolt production and offshore grow-out, to semi and fully contained systems for ocean production.

[1] PwC Seafood Barometer 2017.
[2] http://www.bbc.com/news/uk-scotland-38966188
[3] https://www.theguardian.com/environment/2016/mar/10/chiles-salmon-farms-lose-800m-as-algal-bloom-kills-millions-of-fish

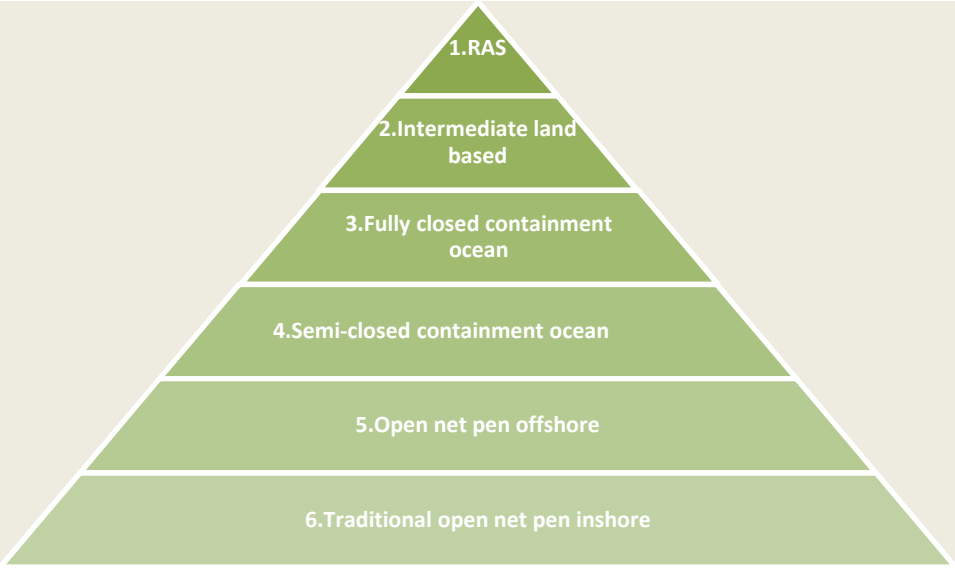
See figure 1.1 for a summary of current innovation in new production systems.

1.1 Technology development within salmon farming. Source: Research report prepared by DNB Markets



Major salmon companies describe concerns about the negative environmental impacts of open net pen farming as a driver for investment in alternate production systems. While this may be true for some companies, overall the major drivers appear to be commercial concerns about increasing production costs and physical limits on growth which curtail the ability to meet increasing demand. Selecting the most appropriate new technology to minimise environmental harm in the marine environment may lead to different outcomes than investment driven by pure commercial considerations. Figure 1.2 rates new technologies based on negative impacts on the marine environment.

1.2 New technology ranked from greatest to least impacts in the marine environment



This rating clearly focuses on negative impacts in the marine environment. There are additional environmental impacts that need to be considered in the operation of fully land based systems, including the sustainability of inputs including energy. Investment in renewable energy supply is being investigated to minimise the land based footprint of RAS.

>Volume is key

While Figure 1.2 rates new technologies for their potential to minimise impacts on the marine environment, no production method has no impact on the marine environment while marine ingredients are used in feed. And the potential for impact of any new technology relates to scale. While closed containment in the ocean will reduce impacts compared with open net pen offshore methods, an industrialisation of the ocean through monoculture in closed containment, and the associated biodiversity displacement, will have more impact than boutique levels of offshore open net pen systems.

>Fully land based RAS is becoming commercially viable

There is no RAS system currently producing salmon to market size at a commercial scale. But following a successful IPO from Atlantic Sapphire, analysts predict the company's Miami based RAS build will change the playing field within salmon production with the next 2-5 years. Norway's biggest bank is an investor in the project and analysts argue commercial RAS is primed for take-off, with current investments leading to production of 150 kilotons from land based RAS by 2020.

2. The top RAS investments in February 2017.

Company	Cur	Rec	Target	Price	P/E 16e	P/E 17e	P/E 18e
Austevoll Seafood	NOK	HOLD	82.00	78.25	13.5	9.0	9.4
Bakkafrost	NOK	HOLD	370.0	330.7	16.2	11.5	13.2
Grieg 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	15.8	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 Compa	NOK	BUY	10.00	9.69	63.9	10.0	7.2

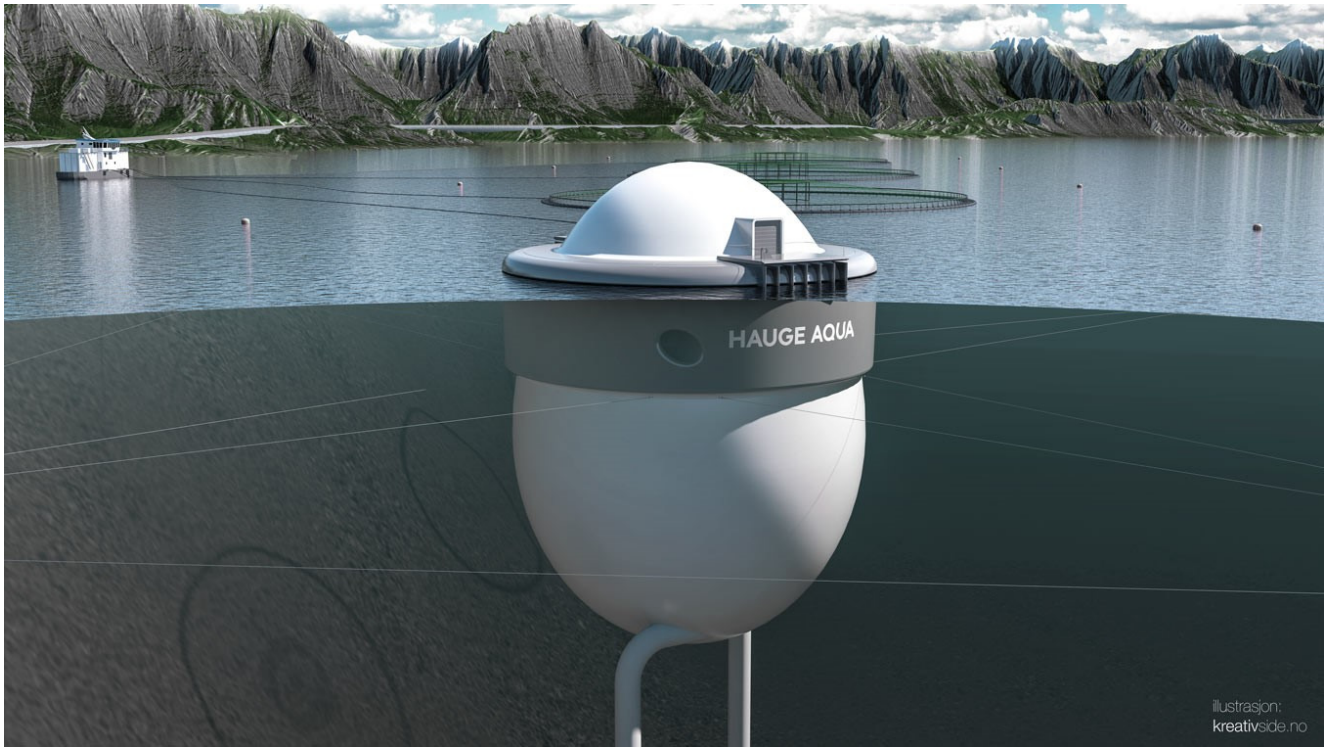
Source: DNB Markets

The impact on investment of the Norwegian Government's halt to licence allocation for traditional net pen systems cannot be underestimated. In addition to RAS, major projects in development phase include sophisticated semi-closed and full-closed floating containment systems.

Semi-closed systems are largely focused on filtering water for sea lice – a major biosecurity cost in the northern hemisphere. But fully closed systems are also capturing and treating organic waste, which helps prevent damage to the sea floor and increased phytoplankton abundance triggering toxic algal blooms. This leaves habitat modification as the key environmental challenge to be managed in fully closed open systems.

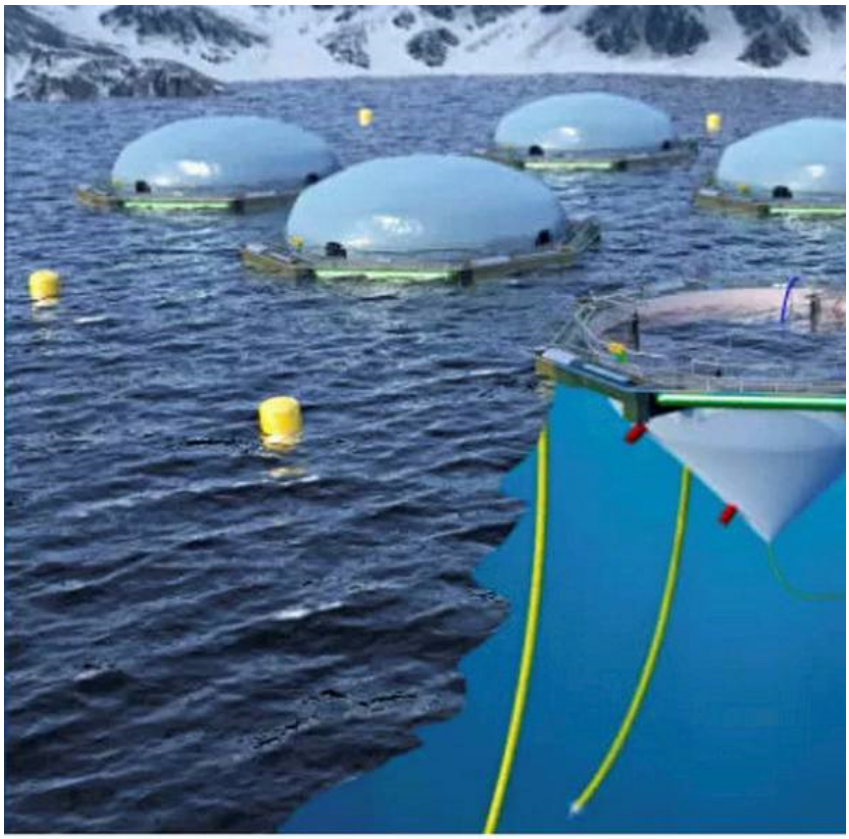
Many semi and fully closed ocean systems are still on the drawing board, but some are built and being tested for the second and third time. Terjesen (2017) found 9 different S-CCS being tested and over 14 different more designs planned. Both flexible fabric and hard structures in glass-reinforced plastic are being tested.

Figure 3. Hauge Aqua with Marine Harvest “the egg”



This is the closed containment system considered closest to commercialisation. The 44-meter tall structure will hold up to 1,000 tons of salmon.

Figure 4. The FlexiFarm from Cermaq.



Cermaq have applied for 13 development licences for their FlexiFarm which have the capacity to grind and remove sludge as well as filter water for sea lice and other viruses and bacteria.

>Tasmanian industry response

The Tasmanian salmon industry faces the same level of biosecurity threats and physical limits on growth as the global industry. However, there is currently no investment in fully land based RAS or semi or fully contained ocean production systems in Tasmania. There is investment in offshore technology and RAS for post-smolt in Tasmania.

Tasmania's second largest operator, Huon Aquaculture, has led the way in trialling offshore open net pen production and has committed to intermediate land based production or RAS for post-smolt, investing in production of larger smolt on land to 500-600g by 2019.

Commentary on developments in the Tasmanian industry regularly raises the risk of capital flight to land based production sites closer to markets. Whilst this is an obvious consideration, resisting inevitable technology advances will only undermine Tasmania's ability to carve out a space in future markets.

While the industry currently features provenance based marketing, there is no evidence that marketing based on provenance necessitates a marine grow-out component. If consumers demonstrate a preference for ocean grow out it will be crucial that the Tasmanian Government regulates for a boutique tonnage that minimises the negative environmental and fish welfare stories that have plagued the industry to date. Without investing in genuinely sustainable production, the industry will undermine the value of Brand Tasmania which confers the very provenance benefits claimed.

With no investment in fully land based RAS or closed containment in ocean systems, below is a review of progress from Tasmania's top 3 towards intermediate RAS and offshore ocean grow-out. Here 'offshore' is being defined in line with industry definitions of high median current speed, high wave energy and wide fetch. It is important to recognise that many stakeholders, including major tourism and native fishery operators, argue that the definition of 'offshore' should include a distance from shore measure, to ensure industrial salmon farming does not interfere with reef based fisheries or tourism amenities.

Figure 5. Progress from Tasmania's top 3 towards high wave energy and RAS for post-smolt.

	Current operation high wave energy	Investment in RAS post-smolt
Tassal >	Zero	Zero
Huon >	200 hectares Storm Bay off Trumpeter	Whale Point 500-600g by 2019
Petuna >	Zero	Zero

Note: This figures rates current operations for offshore. Commitments have been made by Tassal to develop high wave energy leases in Storm Bay West of Wedge Island. Huon Aquaculture have also made commitments to additional leases in Storm Bay off Yellow Bluff.

>Implications for Tasmania

With no end in sight for biosecurity threats or physical constraints on growth, innovation and change in global salmon farming methods is inevitable. While the Tasmanian Government has stated its commitment to an "oceanic" future for industry production, is has failed to provide a clear policy position or regulatory incentives for investment in new technology. Without a clear vision for embracing new technology, the Tasmanian Government risks the industry being slow off the mark in response to global innovations.

Failure to regulate even traditional net pen systems to avoid biosecurity threats and environmental damage also leaves the Tasmanian industry vulnerable, flagging a high volume low price future, rather than a low volume high quality product produced with full social licence using the latest technology available.