Basic Economics of Land-Based Water Recirculating Aquaculture Systems

Brian Vinci, Steven Summerfelt
The Conservation Fund
Freshwater Institute
USA

Trond W. Rosten, Kristian Henriksen, Erik Skontorp Hognes
SINTEF Fisheries and Aquaculture
Norway

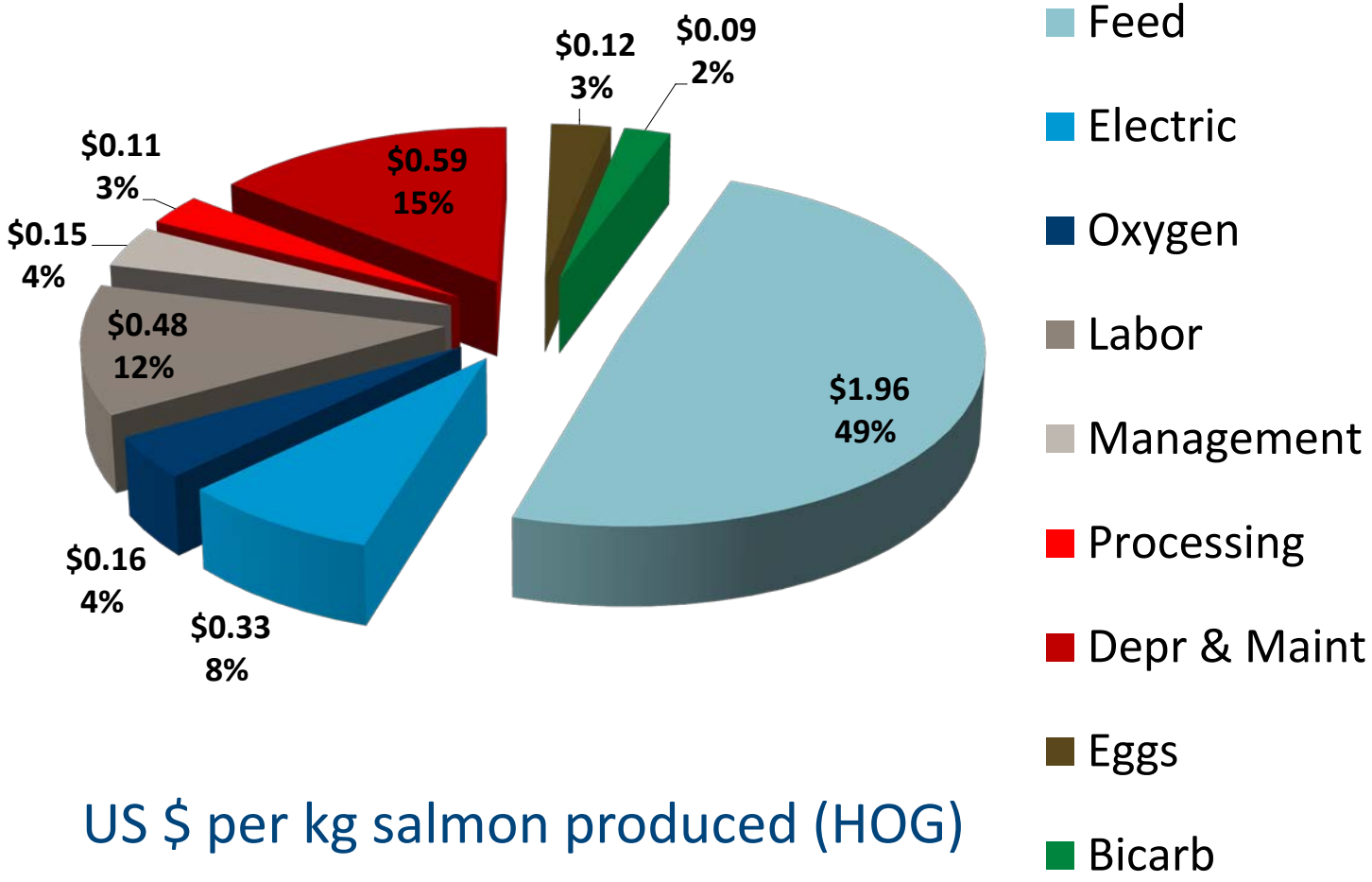
Outline

- **Basic Economic Elements of Land-Based RAS**
  - Capital Expense (CAPEX)
  - Operating Expense (OPEX)
  - Working Capital
- **Comparison of Land-Based RAS and Net-Pen Salmon Production Models**
  - Capital Expense
  - Biological Production Model
  - Production Cost
  - Cash Flow
  - Net Present Value

Capital Expenses for Land-Based RAS (CAPEX)

- **Land**
- **Rearing Tanks**
- **Buildings**
- **RAS Equipment Package**
- **Water Supply System**
- **Feeding System**
- **Backup Generator System**
- **Monitoring and Control System**
- **Effluent Treatment/Solids Management**
- **Processing Facility**

Operating Expenses for Land-Based RAS (OPEX)

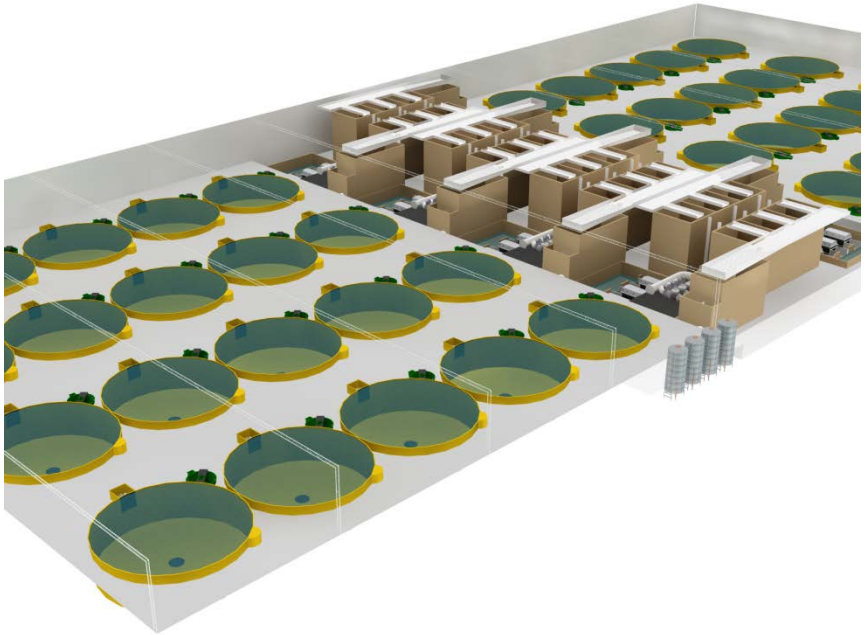


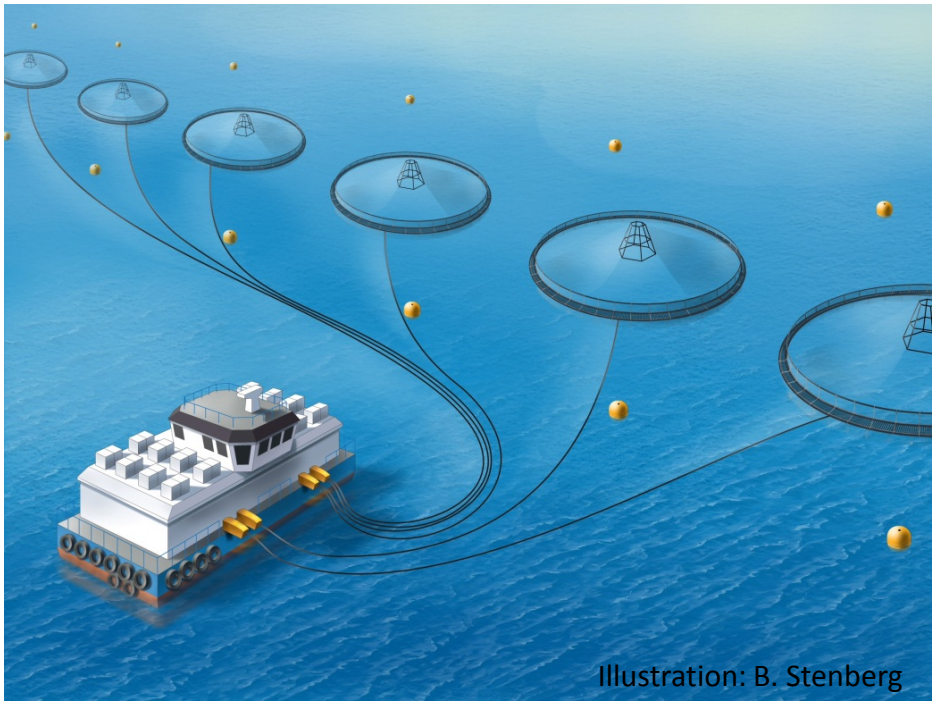
US $ per kg salmon produced (HOG)

Working Capital Requirement

- **The business requires enough upfront cash reserve to cover the expenses throughout the initial production cycle until the first harvest generates sales revenue**
  - Atlantic Salmon – 24 months
  - Rainbow Trout/Steelhead – 12 months
  - Tilapia – 6 months

Economic Comparison of Two Production Models





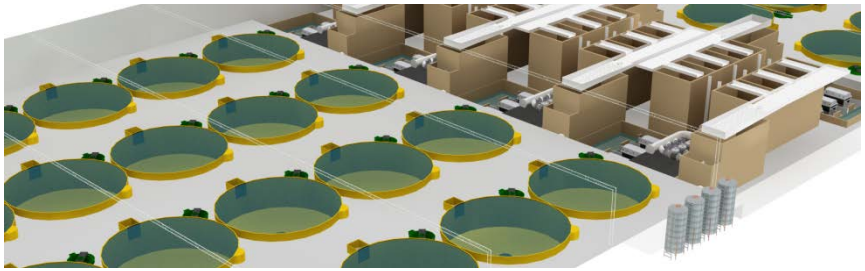
Land-based RAS farm

Producing 3,300 M.tons HOG Atlantic Salmon

Model Net Pen farm

Producing 3,300 M.tons HOG Atlantic Salmon

Capital Expense



Model Land-based RAS farm (32 million US $)

One production site

Invested equipment:

- 40,000 m^3 of rearing tank volume
- 25,500 m^2 of building area
- 2,500 m^2 processing facility
- 885 m^3/min of pumped RAS flow
  - Pumps and Piping
  - Screen filters
  - Biofilters
  - Gas Conditioning Filters
- 1.08 – 1.26 kg feed per m^3 supply water
- Feeding Systems
- Backup Generators

Investments in total: 32 M US $ - approximately 192 MNOK

Maintenance and reinvestments set equal to the depreciations

Model Net Pen farm (12.3 million US $):

Two production sites, each with six net pen cages.

- ≈587,000 m^3 net-volume
- 120,000 m^2 area footprint visible at sea
  - ≈179,000 m^2 area footprint incl. no thoroughfare zone
  - ≈463,000 m^2 area footprint incl. no fishing zone

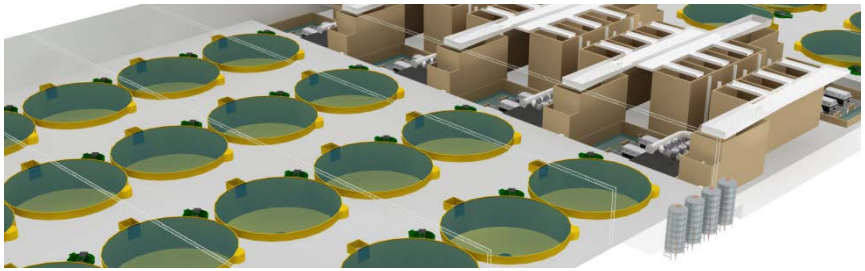
Invested equipment:

- 3 licences
- 12 Floating rings (157m Ø)
- 24 nets (25 m deep)
- 2 mooring systems
- 2 boats
- 2 feed barges (150 Mtons)
- 12 camera systems
- 12 feed distributors
- 12 power systems

Investments in total: 72.9 MNOK – approximately 12.3 M US $

Maintenance and reinvestments set equal to the depreciations

Biological Production



Model Land-based RAS farm

- One production site for all life-stages
- Four cohorts per year

- Growth based on thermal growth coefficients from Freshwater Institute growout trials, adjusted down by 10%:
  - 1.1 for Fry
  - 1.25 for Smolt
  - 1.8 for Pre-growout
  - 2.2 for Growout

- Mortality per generation 16%

- Feed conversion ratios:
  - 0.75 for Fry
  - 0.90 for Smolt
  - 1.0 for Pre-Growout
  - 1.1 for Growout
- Overall Feed to Whole Fish Produced (kg/kg): 1.09

Model Net Pen farm:

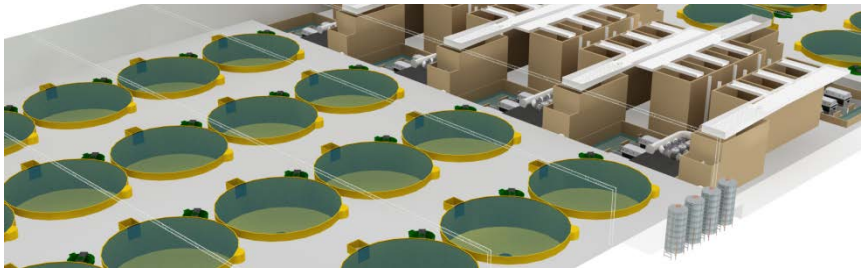
- 2 production sites & 3 licences of 780 M.tons of maximum total biomass at sea.
- Two transfers of smolts to sea annually, to one site
  - S1 at 1st of April, 100 grams, 520' smolts in three cages
  - S0 at 1st of August, 75 grams, 520' smolts in three cages

- Growth based on the Skretting table, Specific Growth Rate (SGR), adjusted down by 12 %.

- Mortality per generation approximately 16.1 % (average in Mid-Norway in 2011) (Norwegian Food Safety Authority 2011).

- Economic feed conversion ratio: 1.27 (average in Norway over the last ten years) (Directorate of Fisheries 2013).

Biological Production



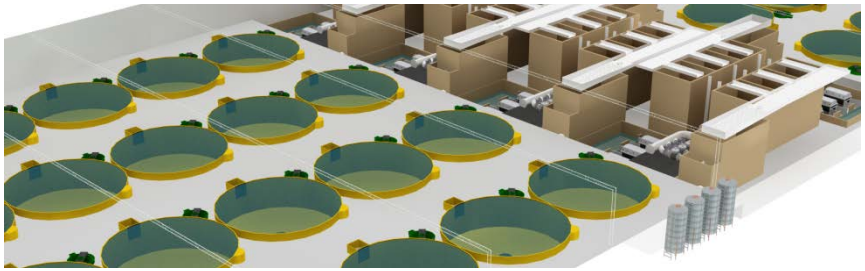
Model Land-based RAS farm

- Rearing Density
  - 80 kg/m^3 maximum
- Harvesting:
  - Time from first feeding to first harvest: 21 months
  - Harvest every week of the year
    - Each cohort harvested over 13 weeks
    - One grisle harvest at ~1.2 kg for 50% of males
  - Harvest in total: 3,947 M.tons LWE; 3,300 M.tons HOG (5 % purge loss / 12 % HOG loss)
  - Initial harvest weight (whole fish): 4.5 kg
  - Average harvest weight (whole fish): 5.1 kg
- No downtime in the bioplan

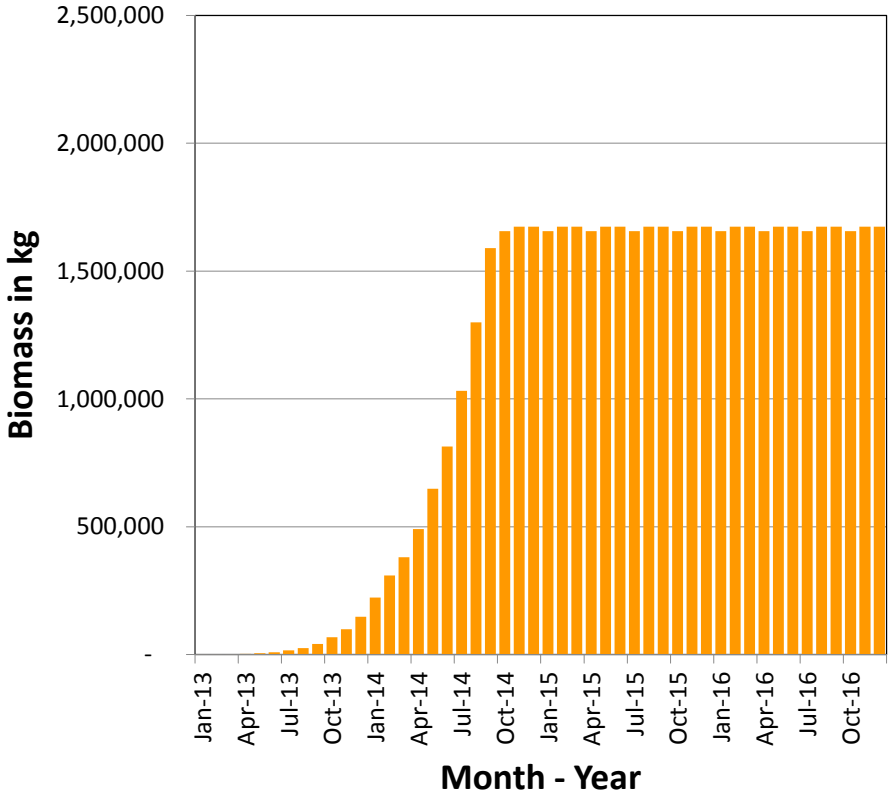
Model Net Pen farm:

- Rearing Density
  - 25 kg/m^3 maximum
- Harvesting:
  - Time from first feeding to first harvest: 24–31 months
  - Time at sea before first harvest: 16 months
  - Harvest 8 months of the year
    - Harvest S1 from July to October
    - Harvest S0 from November to February
  - Harvest in total: 3,975 M.tons LWE; 3,299 M.tons HOG (5 % purge loss /12 % HOG loss)
  - Average harvest weight (whole fish) : 4.5 kg
- Two months of fallowing between production cycles

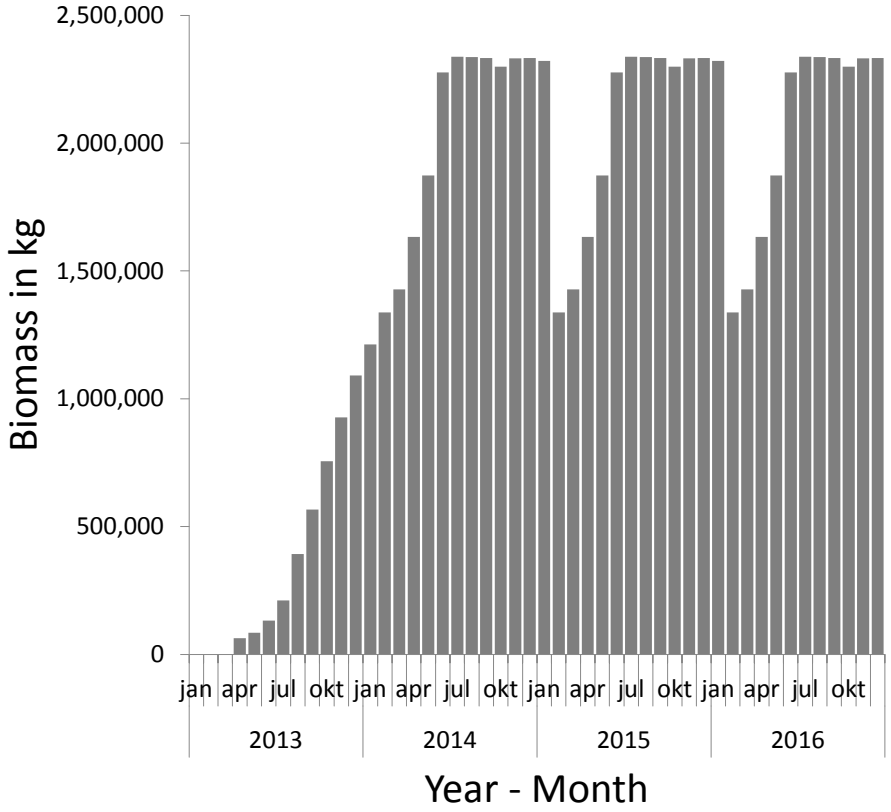
Biomass



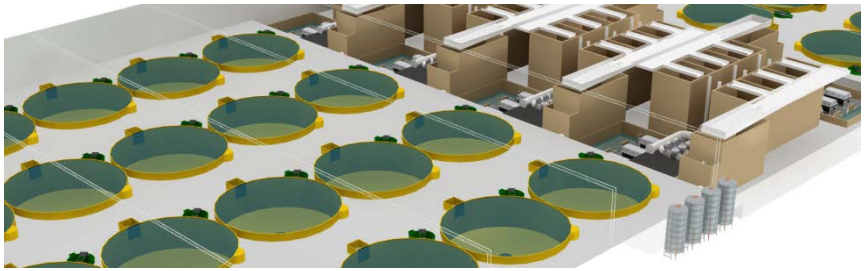
Model Land-based RAS farm



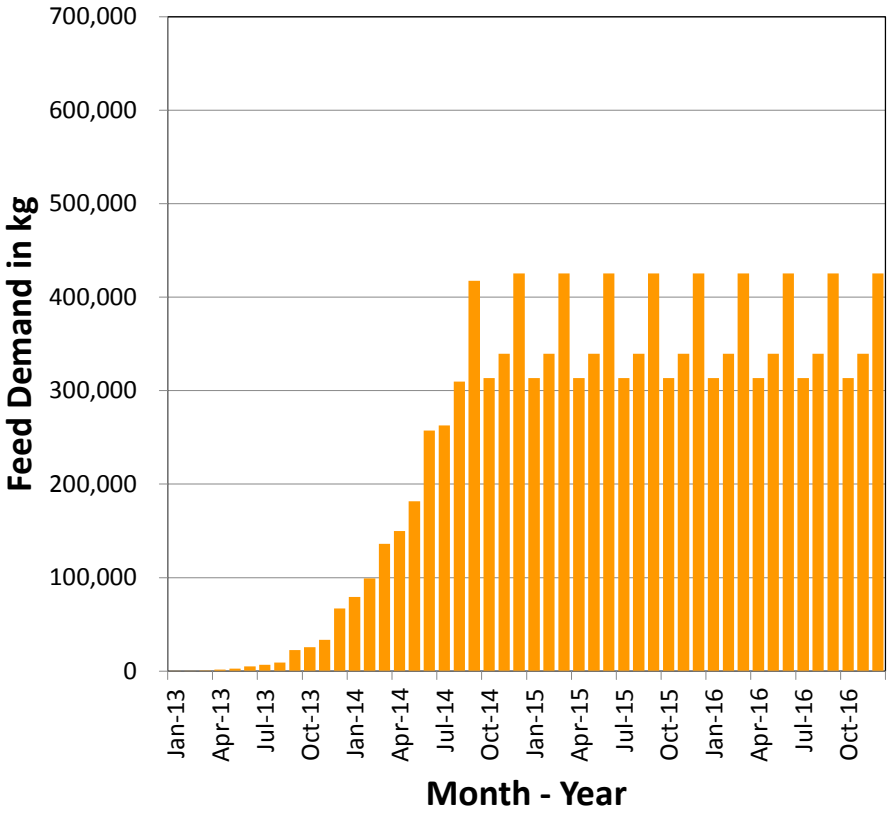
Model Net Pen farm



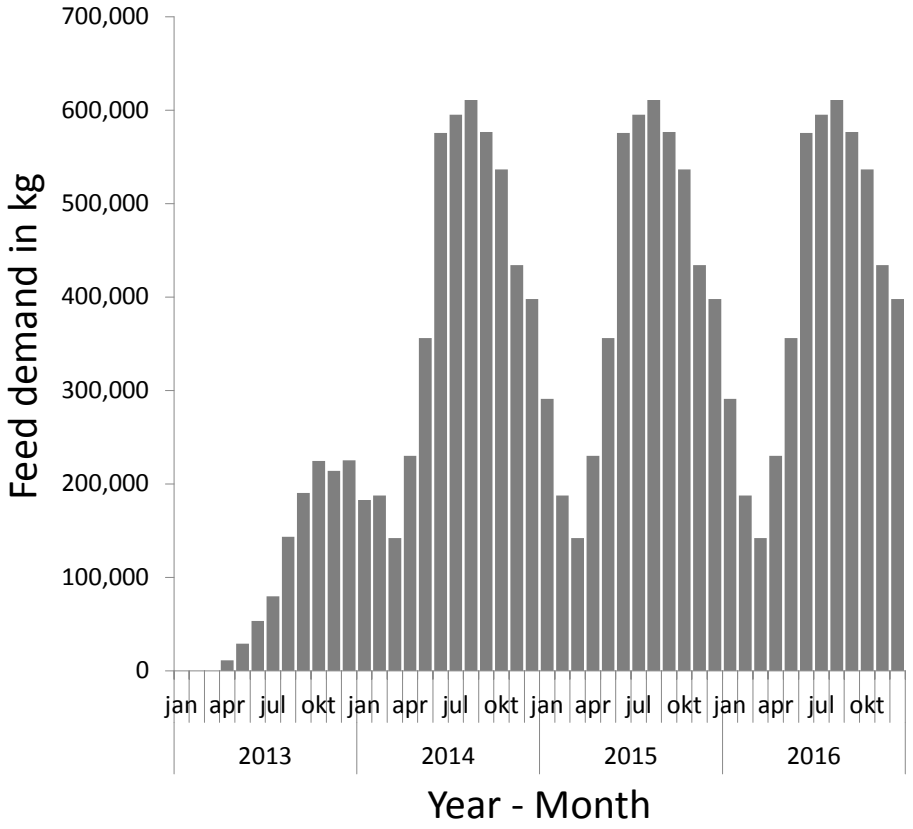
Feeding



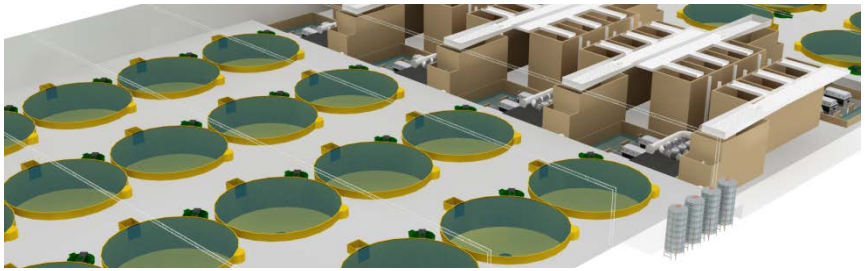
Model Land-based RAS farm



Model Net Pen farm



Harvest



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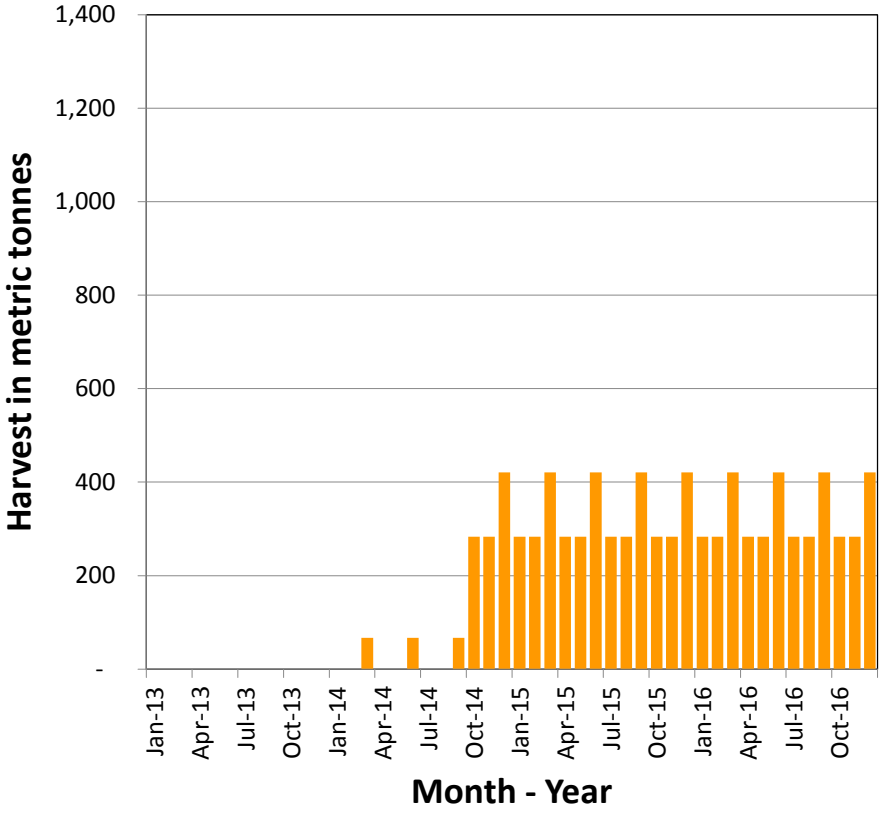
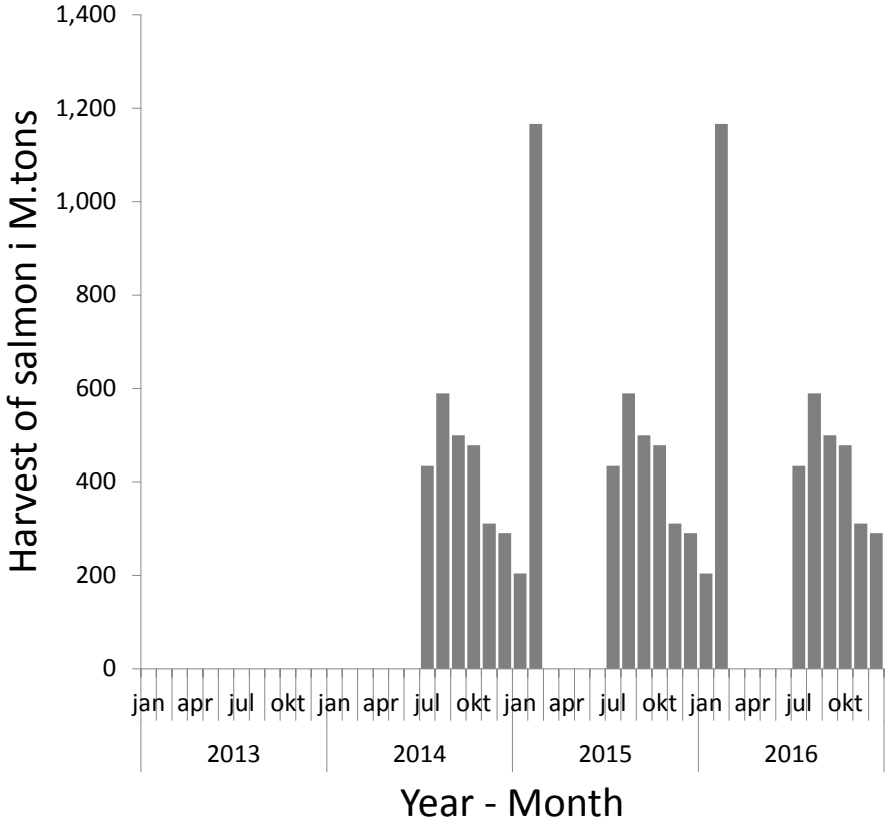
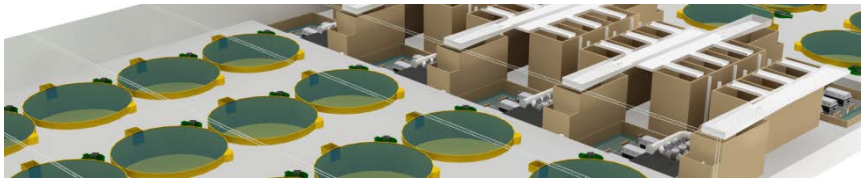


Model Net Pen farm

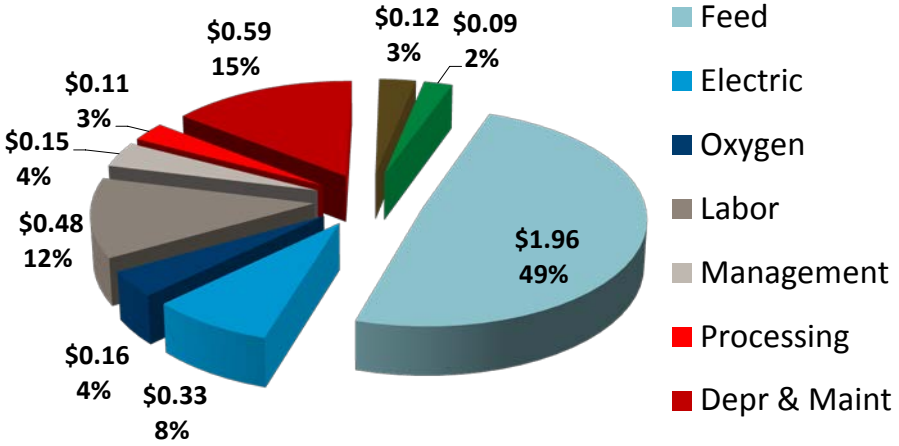


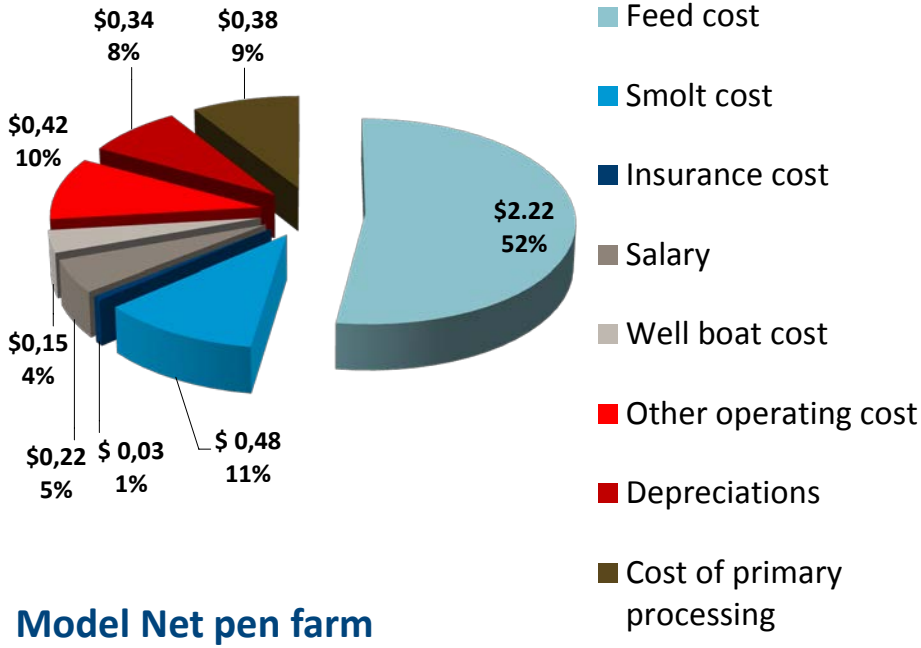
Production Cost (at steady state), USD/HOG



3.98 USD

4,24 USD





Model Land-based RAS farm

Total estimated production cost per kilo HOG: 3.98 US $

- Uses 0.05 US $ / kWh;
  Comparative Norway is 0.17 US $ / kWh

Model Net pen farm

Total estimated production cost per kilo HOG: 4.24 US $

Comments: EFCR, mortality & utilization: Model Net Pen Farm

- Not a optimal utilization of three licences!
  - It's possible to harvest as much as 1,600 – 1,700 M.tons per licence (~2 x Model)
    - Requires a more large-scale operation

- Average EFCR used in the calculation is high: 1.27
  - It's possible to achieve an EFCR more closely to 1.00
    - Top 25 % EFCR in Norway over the last ten years is 1.14
    - Top 10 % EFCR in Norway over the last ten years is 1.04

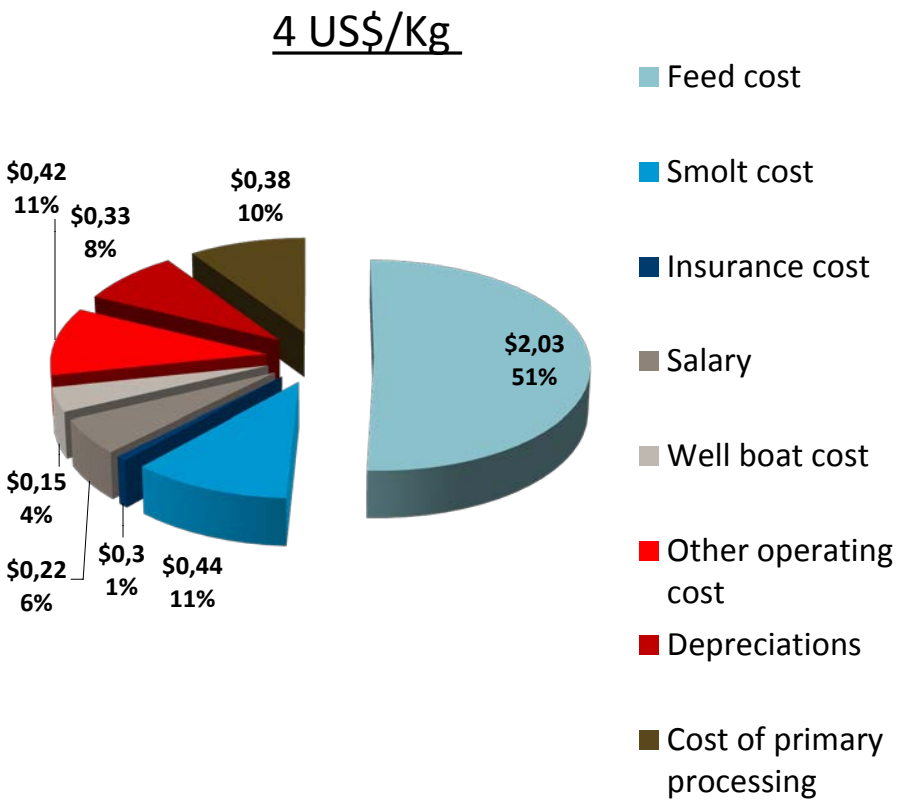
- Average mortality at 16.1 % is high
  - Some sites in Norway are now achieving only 2 – 4 % mortality
  - Then on the other side, some sites have mortality at over 30 % - mostly due to disease.

Use of "best-practice" inputs

- EFCR: 1.14
- Mortality: 8 % per generation

- Gives a production cost of 4 US $/kg HOG (Compared to 4.24 US $/kg)
  - Reduction in feed cost
  - Reduction in smolt cost

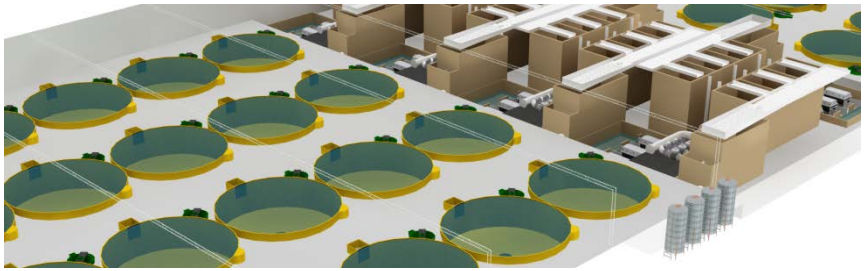
- Model Net Pen Yield per smolt: 3.44 kg
  - Model Net Pen Base Case: 3.17 kg
- Model RAS Yield Per Smolt: 3.97 kg HOG



Market and Price

- Initial test marketing in the Vancouver area and in the Washington DC area indicated that product sold at premium pricing (30% or more).
  - Basis of premium was different in different markets – sustainable (BC) and local (DC)
- Land-based RAS produced salmon is a premium product that is being sold into an incremental market that currently doesn't buy net pen salmon (Kuterra data).
- Most major retailers have sustainable seafood purchasing policies that land-based RAS produced salmon will be able to meet.

Quick Estimation of Profitability – Base Case



Model Land-based RAS farm – w/o Premium Price:

Investments:

- Investments in total: 32 M US $

Income:

- Price per kilo 34 NOK or 5.66 US $
- Total estimated income: **18.68 M US $**

Costs:

- Production cost excluding financial cost: 3.98 US $ / kg
- Total production costs (ex. finance): ≈ **13.13 M US $**

Earnings before Interest and Taxes (EBIT): 5.55 M US $

Model Net Pen farm – Conservative Performance:

Investments:

- Investments in total: 12.3 M US $

Income:

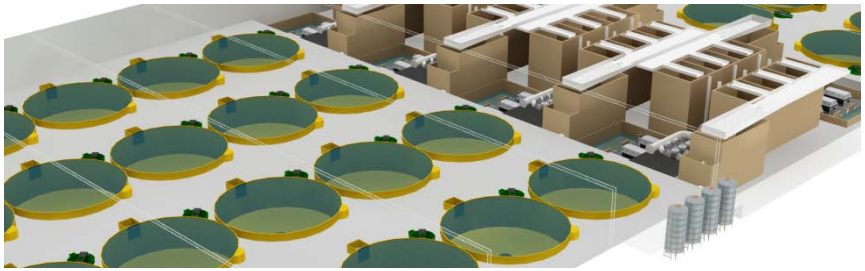
- Fish Pool forward prices
  - 2014: 35.85 NOK/kilo
  - 2015: 33.88 NOK/kilo (Jan - Aug)
- Estimated price pr kilo: 34 NOK ≈ 5,66 US $
- Total estimated income: **18.67 M US $**

Costs:

- Production cost excluding financial cost: 4.24 US $ / kg
- Total production costs (ex. finance): ≈**13.99 M US $**

Earnings before Interest and Taxes (EBIT): 4.68 M US $

Quick Estimation of Profitability – Best Case



Model Land-based RAS farm – Premium Price:

Investments:

- Investments in total: 32 M US $

Income:

- Possibility for a 30% price premium
  - Price per kilo (5.66 * 1.3) ≈ 7.36 US $
- Total estimated income: **24.29 M US $**

Costs:

- Production cost excluding financial cost: 3.98 US $/kg
- Total production costs (ex. finance): ≈ **13.13 M US $**

Earnings before Interest and Taxes (EBIT): 11.16 M US $

Model Net Pen farm – High Performance:

Investments:

- Investments in total: 12.3 M US $

Income:

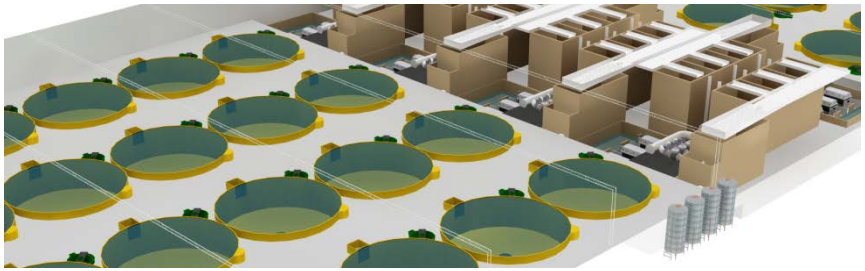
- Fish Pool forward prices
  - 2014: 35.85 NOK/kilo
  - 2015: 33.88 NOK/kilo (Jan - Aug)
- Estimated price per kilo: 34 NOK ≈ 5.66 US $
- Total estimated income: **18.67 M US $**

Costs:

- Production cost excluding financial cost: 4.00 US $/kg
- Total production costs (ex. finance): ≈ **13.20 M US $**

Earnings before Interest and Taxes (EBIT): 5.47 M US $

Cash Flow Assumptions



Model Land-based RAS farm

- Salary: ≈ 1,575,000 US $ / year
- Electricity: ≈ 21.5 mWh
  - Cost per kWh: 0.05 US $
- Oxygen: ≈ 3,000 M.tons
  - Cost per kilo: 0.2 US $
- Bicarb: ≈ 862 M.tons.
  - Cost per kilo: 0.35 US $
- Feed: 1.50 US $ per kilo
- Eggs: ≈ 1.2 million
  - Cost: 0.30 US $ each
- Management: 500,000 US $ / year
- Primary processing:
  - Salary: 375,000 US $ / year
    - 10 persons
    - Other cost included in the total calculation
- Price per kilo HOG: 5.45 – 8.77 US $

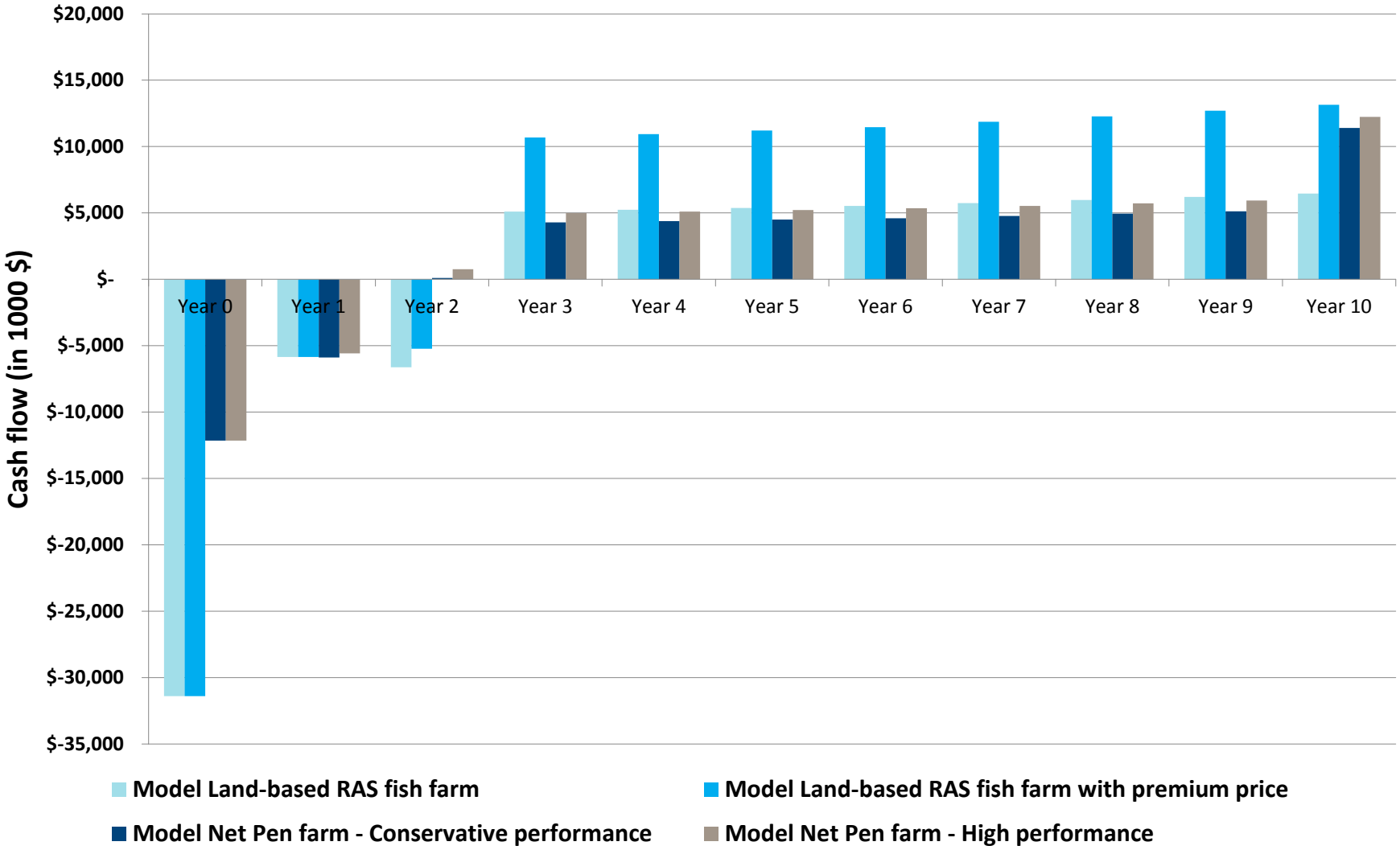
Model Net Pen farm

- Salary: ≈ 750,000 US $ / year
- Primary processing ≈ 0.38 US $ / kilo HOG
- Well boat 0.92 US $ / kilo HOG (includes smolt and slaughter transport)
- Insurance premium ≈ 0.8 % of the value of the biomass
- Feed: 1.48 US $ per kilo
- Smolts: Conservative performance 1030'/year
  High performance: 960'/year
  Cost: ≈ 1.53 US $ each
- Other production cost (Ex. Electricity, de-liceing etc.) ≈ 0.43 US $ / kilo HOG
- Price per kilo HOG: 5.45 – 6.75 US $

- Licences not depreciated and is sold after 10 years

Both:
2 % inflation first 6 years; 3 % inflation four last years
Value of equipment/buildings etc. set to 0 after ten years

Ten Year Cash Flow



Net Present Value Analysis

- Rate of return calculated to 8.91 %. (6 % loan interest, 28 % tax, 27.23 % required return on equity before tax, 30/70 private equity/loan)

Risk free return	3.23 %
Commercial risk	10 %
Financial risk	10 %
Liquidity premium	4 %
Required rate of return before tax	27.23 %
Tax (28%)	7.63 %
Estimated required rate of return on equity	19.61 %
Estimated required rate of return on total capital	8.91 %

Net present value at 8.91 % required rate of return

Model Land-based RAS farm:

- NPV: -16 M US $
- NPV & NO Required Rate of Return: 1,810,000 US $

NPV is for 10 years

Model Land-based RAS farm with premium price

- NPV: 13.33 M US $
- NPV at 0, at a required rate of return of: **≈ 14.35 %**

Model Net Pen farm - Conservative performance

- NPV: 7 M US $
- NPV at 0, at a required rate of return of: **≈ 15.07 %**

Model Net Pen farm - High performance

- NPV: 11.39 M US $
- NPV at 0, at a required rate of return of: **≈ 18.67 %**

Net present value at 8.91 % required rate of return

Model Land-based RAS farm:

- NPV: -16 M US $
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Model Net Pen farm - Conservative Performance

- NPV: 7 M US $
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Model Net Pen farm - High performance

- NPV: 11.39 M US $
- NPV at 0, at a required rate of return of: **≈ 18.67 %**

Brief Conclusions

- Production: Model Land-based RAS farm has a more consistent production than the Model Net Pen farm
- CAPEX: Model Land-based RAS farm capital cost is greater per unit of annual production than Model Net Pen capital cost per unit of annual production
- OPEX: Model Land-based RAS farm operating cost is slightly lower than Model Net Pen farm operating cost (within this analysis)
- NPV: Model Land-based RAS farm and Model Net Pen farm have similar net present value for the expected case