

## Capital expenditures (CAPEX) and operating costs (OPEX) for various aquaculture systems

An aquaculture system is made up of the habitat, water throughput and water treatment. The process engineering consists of machines, tanks, basin installations, pipelines and biofilter material. My specification includes manufacturers, prices, dimensions, connections, capacity, performance, hydraulics and consumption. However the costs of aquaculture systems are only around 30 % of the capital expenditure (Capex) and around 10 % of the operating costs (Opex). The other costs of the fish farm fall on the building, domestic engineering, HVAC, well water, sewage, fish feeding, fish farm staff, fish sorting and much more. I have tried to estimate these costs especially in relation to area and well water.

For equipment I have added a mark-up of 2.5 %/a on prices related to older price-lists and offers. All items contain a cost estimate for fastening material, installation time, freight and packaging. In addition, "essential replacement devices" such as recirculation pumps and blowers are included in the cost calculation. For the consumption of electricity, chemicals and oxygen, I have taken into account the operating time of the machines and processes in the operating cost calculation. For the following cost overview I have set an annual salary of 30.000 €/a for fish farm staff, 35 €/h for electrical and mechanical installation, 0.14 €/kWh for electricity and 0.16 €/kg for oxygen.

Investment costs for concrete tanks are based on project AquaOrbis (DEU, 2008). This price includes the addition of general contractor and a fixed-rate for installation. Just like for the equipment I added a surcharge of 2.5 %/a. For a price estimate that is as realistic as possible, I have interpolated a volume factor. According to my contact at KSB discount of pumps is at least 50 % on the list price. I select KSB Pumps for the time being via the product configurator. My specification for PVC pipes and fittings is mainly based on LA.RE.TER. Most prices for PE-piping are from FRANK catalogue (2013). FRANK differs discounts according article group.

Aquaculture System	Hatchery and on-growing systems for trout				Raceway systems for sturgeon		Round tank systems for fish fattening			Single tank
	LARVAE	FRY	FINGERLING	ON-GROWN FISH	CAVIAR	STURGEON	PIKEPERCH	TROUT	STURGEON	LARGE TROUT
Production yield	480000 pcs/a	0,36 t/a	4,1 t/a	40 t/a	4,0 t/a	300 t/a	90 t/a	120 t/a	80 t/a	1600 t/a
Individual size at harvest	0,05 g/pcs	0,85 g/pcs	10 g/pcs	100 g/pcs	10500 g/pcs	2000 g/pcs	1300 g/pcs	500 g/pcs	2000 g/pcs	2200 g/pcs
Individual size at stocking	0,07 g/pcs	0,05 g/pcs	0,85 g/pcs	10 g/pcs	3000 g/pcs	10 g/pcs	12 g/pcs	10 g/pcs	10 g/pcs	24 g/pcs
Stocking rate	2-fold/a	2-fold/a	2-fold/a	2-fold/a	1-fold/a	4-fold/a	4-fold/a	6-fold/a	4-fold/a	6-fold/a
Aquaculture System Type	Flow-Through System	Partial RAS	RAS	RAS	RAS	RAS	RAS	RAS	RAS	RAS
RAS Features	-	without biofilter	in basic equipment	with the extra FBBR	with full equipment	with full equipment	with full equipment	with full equipment	with full equipment	with full equipment
Fish Tank Type	Horizontal incubator	Rectangular Tanks	Round Tanks	Round Tanks	Channel sections	Channel sections	Round Tanks	Round Tanks	Round Tanks	Mega Tanks
Quantity Systems	1 pcs	1 pcs	1 pcs	1 pcs	1 pcs	2 pcs	2 pcs	2 pcs	2 pcs	8 pcs
Productive Volume	1,1 m³	23 m³	97 m³	421 m³	2880 m³	2880 m³	980 m³	780 m³	840 m³	10080 m³
Total Volume	1,2 m³	37 m³	142 m³	651 m³	3494 m³	3846 m³	1282 m³	1060 m³	1112 m³	13537 m³
Space requirement	0 m²	126 m²	320 m²	800 m²	3366 m²	3366 m²	1755 m²	1755 m²	1755 m²	4896 m²
Recirculation	0 m³/h	54 m³/h	165 m³/h	720 m³/h	1836 m³/h	2883 m³/h	1296 m³/h	1152 m³/h	936 m³/h	13824 m³/h
Total Demand Air	0 m³/h	20 m³/h	150 m³/h	680 m³/h	3798 m³/h	4481 m³/h	630 m³/h	630 m³/h	630 m³/h	6575 m³/h
Total Demand Oxygen	0,0 t/a	0,7 t/a	1,4 t/a	11 t/a	165 t/a	227 t/a	110 t/a	76 t/a	76 t/a	1383 t/a
Need for chemicals	0,0 t/a	0,0 t/a	0,5 t/a	5,6 t/a	18 t/a	32 t/a	5,2 t/a	4,2 t/a	5,2 t/a	105 t/a
Amount of feed	0,00 t/a	0,22 t/a	2,8 t/a	32 t/a	96 t/a	371 t/a	101 t/a	114 t/a	99 t/a	1767 t/a
Number of employees	0,3 manpower	0,5 manpower	1,0 manpower	1,8 manpower	6,0 manpower	6,0 manpower	4,0 manpower	3,5 manpower	4,0 manpower	18,0 manpower
Initial fish stock	564000 pcs/a				4700 pcs/a	161567 pcs/a	162317 pcs/a	499527 pcs/a	86169 pcs/a	776687 pcs/a
Well capacity	4,2 m³/h	3,5 m³/h	1,9 m³/h	12,2 m³/h	25 m³/h	38 m³/h	8,2 m³/h	5,9 m³/h	7,7 m³/h	76 m³/h
Nominal Power	0 kW	2,4 kW	10 kW	34 kW	93 kW	153 kW	57 kW	57 kW	49 kW	576 kW
Capacity water Treatment	0 kg-feed/d	5,0 kg-feed/d	40 kg-feed/d	370 kg-feed/d	370 kg-feed/d	1470 kg-feed/d	410 kg-feed/d	510 kg-feed/d	390 kg-feed/d	6800 kg-feed/d

Aquaculture System	Hatchery and on-growing systems for trout				Raceway systems for sturgeon		Round tank systems for fish fattening			Single tank
<b>Capital expenditure (CAPEX) aquaculture system</b>										
<b>Focus on process technology</b>										
I. Fish Tanks	3.986 €	21.570 €	50.985 €	136.016 €	656.412 €	662.551 €	299.369 €	234.474 €	266.840 €	1.354.745 €
II. Recirculation	0 €	22.251 €	41.981 €	121.087 €	163.605 €	249.831 €	200.280 €	164.292 €	132.412 €	519.032 €
III. Mechanical Treatment	1.177 €	18.895 €	24.974 €	56.237 €	119.723 €	153.126 €	104.094 €	104.414 €	90.279 €	807.525 €
IV. Physical Treatment	0 €	7.396 €	21.392 €	51.991 €	175.848 €	234.891 €	84.050 €	81.987 €	77.371 €	763.517 €
V. Biological Treatment	0 €	0 €	18.381 €	74.783 €	217.344 €	356.578 €	145.091 €	145.036 €	140.280 €	1.472.352 €
VI. Chemical Treatment	0 €	0 €	4.949 €	5.695 €	47.877 €	91.851 €	62.038 €	62.038 €	62.038 €	357.718 €
Import Addition (7,5%)	387 €	5.258 €	12.200 €	33.436 €	103.561 €	131.162 €	67.119 €	59.418 €	57.692 €	395.617 €
Purchase Discounts (-5%)	-258 €	-3.506 €	-8.133 €	-22.290 €	-69.041 €	-87.441 €	-44.746 €	-39.612 €	-38.461 €	-263.744 €
Unforeseen (10%)	516 €	7.011 €	16.266 €	44.581 €	138.081 €	174.883 €	89.492 €	79.224 €	76.922 €	527.489 €
Earthworks	-	1.190 €	2.949 €	16.285 €	20.763 €	45.707 €	29.221 €	24.159 €	25.339 €	442.377 €
<b>CAPEX Aquaculture System</b>	<b>5.900 €</b>	<b>80.100 €</b>	<b>186.000 €</b>	<b>517.900 €</b>	<b>1.574.200 €</b>	<b>2.013.200 €</b>	<b>1.036.100 €</b>	<b>915.500 €</b>	<b>890.800 €</b>	<b>6.376.700 €</b>
CAPEX Aquaculture System	0,012 €/pcs	221,44 €/kg-fish	45,58 €/kg-fish	12,95 €/kg-fish	394 €/kg-caviar	6,71 €/kg-fish	11,51 €/kg-fish	7,63 €/kg-fish	11,14 €/kg-fish	3,99 €/kg-fish
<b>Capital expenditure (CAPEX) aquaculture system</b>										
<b>Focus on functional groups</b>										
Tanks and Basin Installations	3.986 €	38.029 €	95.429 €	202.768 €	896.078 €	1.037.828 €	421.901 €	366.686 €	398.581 €	2.839.168 €
Machinery	0 €	24.669 €	45.360 €	115.873 €	229.236 €	311.653 €	216.844 €	216.844 €	194.454 €	1.467.148 €
Pipelines & Fittings	791 €	4.515 €	12.197 €	12.197 €	141.321 €	218.418 €	152.357 €	119.125 €	96.530 €	443.980 €
Biofilter Material	0 €	0 €	2.227 €	17.742 €	49.511 €	89.727 €	26.440 €	27.315 €	24.601 €	324.515 €
Labor costs assembling	385 €	2.899 €	7.449 €	30.428 €	64.664 €	91.203 €	77.379 €	62.270 €	55.054 €	200.077 €
Import Addition (7,5%)	387 €	5.258 €	12.200 €	33.436 €	103.561 €	131.162 €	67.119 €	59.418 €	57.692 €	395.617 €
Purchase Discounts (-5%)	-258 €	-3.506 €	-8.133 €	-22.290 €	-69.041 €	-87.441 €	-44.746 €	-39.612 €	-38.461 €	-263.744 €
Unforeseen (10%)	516 €	7.011 €	16.266 €	44.581 €	138.081 €	174.883 €	89.492 €	79.224 €	76.922 €	527.489 €
Earthworks	-	1.190 €	2.949 €	16.285 €	20.763 €	45.707 €	29.221 €	24.159 €	25.339 €	442.377 €
<b>CAPEX Aquaculture System</b>	<b>5.900 €</b>	<b>80.100 €</b>	<b>186.000 €</b>	<b>517.900 €</b>	<b>1.574.200 €</b>	<b>2.013.200 €</b>	<b>1.036.100 €</b>	<b>915.500 €</b>	<b>890.800 €</b>	<b>6.376.700 €</b>
<b>Capital expenditure (CAPEX) fish farm</b>										
Building for aquaculture system	-	100.800 €	256.000 €	640.000 €	2.692.800 €	2.692.800 €	1.404.000 €	1.404.000 €	1.404.000 €	3.916.800 €
Social, technical & storage rooms	-	18.900 €	48.000 €	120.000 €	504.900 €	504.900 €	263.250 €	263.250 €	263.250 €	734.400 €
Well water	-	8.750 €	4.869 €	30.528 €	62.047 €	95.833 €	20.398 €	14.708 €	19.317 €	190.818 €
Wastewater	-	11.375 €	6.330 €	39.686 €	80.661 €	124.583 €	26.518 €	19.120 €	25.112 €	248.063 €
Electrical system	-	2.798 €	7.525 €	26.593 €	73.082 €	112.711 €	41.540 €	40.884 €	36.795 €	382.563 €
Heating, Ventilation Air Conditioning	-	6.300 €	16.000 €	40.000 €	168.300 €	168.300 €	87.750 €	87.750 €	87.750 €	244.800 €
Oxygen	-	2.160 €	4.300 €	9.100 €	36.160 €	35.060 €	18.650 €	18.450 €	18.650 €	49.960 €
Outdoor area	-	12.050 €	26.355 €	59.314 €	225.167 €	225.167 €	122.057 €	122.057 €	122.057 €	321.749 €
Fish Grading	-	500 €	37.375 €	77.875 €	47.000 €	39.500 €	115.250 €	115.250 €	39.000 €	127.750 €
Fish Feeding	1.600 €	2.400 €	3.000 €	6.000 €	14.400 €	14.400 €	13.200 €	10.800 €	12.000 €	83.000 €
Monitoring	-	7.667 €	7.667 €	17.000 €	17.000 €	20.000 €	20.000 €	20.000 €	20.000 €	38.000 €
Planning costs	-	11.976 €	29.813 €	77.322 €	299.759 €	318.858 €	164.847 €	158.211 €	157.081 €	591.682 €
Import Addition (2,5%)	40 €	4.342 €	10.436 €	26.419 €	98.038 €	100.831 €	53.315 €	52.907 €	51.198 €	158.448 €
Purchase Discounts (-15%)	-240 €	-26.055 €	-62.613 €	-158.514 €	-588.227 €	-604.988 €	-319.892 €	-317.440 €	-307.190 €	-950.685 €
Unforeseen (10%)	160 €	17.370 €	41.742 €	105.676 €	392.152 €	403.325 €	213.261 €	211.627 €	204.793 €	633.790 €
CAPEX Aquaculture System	5.900 €	80.100 €	186.000 €	517.900 €	1.574.200 €	2.013.200 €	1.036.100 €	915.500 €	890.800 €	6.376.700 €
<b>CAPEX Fish Farm</b>	<b>7.500 €</b>	<b>261.500 €</b>	<b>622.800 €</b>	<b>1.625.600 €</b>	<b>5.697.500 €</b>	<b>6.264.500 €</b>	<b>3.280.300 €</b>	<b>3.137.100 €</b>	<b>3.044.700 €</b>	<b>13.147.900 €</b>
CAPEX Fish Farm	0,016 €/pcs	722,93 €/kg-fish	152,62 €/kg-fish	40,64 €/kg-fish	1424 €/kg-caviar	20,88 €/kg-fish	36,45 €/kg-fish	26,14 €/kg-fish	38,06 €/kg-fish	8,22 €/kg-fish
<b>CAPEX Aquaculture System</b>	<b>79 %</b>	<b>31 %</b>	<b>30 %</b>	<b>32 %</b>	<b>28 %</b>	<b>32 %</b>	<b>32 %</b>	<b>29 %</b>	<b>29 %</b>	<b>48 %</b>

Aquaculture System	Hatchery and on-growing systems for trout				Raceway systems for sturgeon		Round tank systems for fish fattening			Single tank	
<b>Operating costs (OPEX) aquaculture system</b>											
<b>Focus on process technology</b>											
II. Recirculation	0 €/a	266 €/a	2567 €/a	9733 €/a	25325 €/a	50650 €/a	21462 €/a	21462 €/a	15453 €/a	257544 €/a	
III. Mechanical Treatment	0 €/a	160 €/a	232 €/a	691 €/a	2113 €/a	2383 €/a	1404 €/a	1307 €/a	1341 €/a	19786 €/a	
IV. Physical Treatment	0 €/a	454 €/a	2279 €/a	11269 €/a	32328 €/a	43387 €/a	22491 €/a	17520 €/a	15924 €/a	231676 €/a	
V. Biological Treatment	0 €/a	0 €/a	1558 €/a	9590 €/a	51612 €/a	88802 €/a	24101 €/a	22021 €/a	22388 €/a	270966 €/a	
VI. Chemical Treatment	0 €/a	0 €/a	164 €/a	1156 €/a	15045 €/a	29449 €/a	12487 €/a	12172 €/a	12502 €/a	115178 €/a	
Unforeseen (10%)	0 €/a	88 €/a	680 €/a	3244 €/a	12642 €/a	21467 €/a	8195 €/a	7448 €/a	6761 €/a	89515 €/a	
<b>OPEX Aquaculture System</b>	<b>0 €/a</b>	<b>1000 €/a</b>	<b>7500 €/a</b>	<b>35700 €/a</b>	<b>139100 €/a</b>	<b>236200 €/a</b>	<b>90200 €/a</b>	<b>82000 €/a</b>	<b>74400 €/a</b>	<b>984700 €/a</b>	
OPEX Aquaculture System	-	2,96 €/kg-growth	2,02 €/kg-growth	0,99 €/kg-growth	3,48 €/kg-growth	0,79 €/kg-growth	1,01 €/kg-growth	0,70 €/kg-growth	0,94 €/kg-growth	0,62 €/kg-growth	
<b>Operating costs (OPEX) aquaculture system</b>											
<b>Focus on consumables</b>											
Electricity	0 €/a	772 €/a	6151 €/a	28553 €/a	83326 €/a	142733 €/a	48971 €/a	48874 €/a	41979 €/a	503674 €/a	
Oxygen	0 €/a	108 €/a	221 €/a	1785 €/a	20817 €/a	25024 €/a	14938 €/a	9827 €/a	9531 €/a	173113 €/a	
UV Fluorescent Tubes	0 €/a	0 €/a	329 €/a	1096 €/a	1315 €/a	2630 €/a	1096 €/a	1096 €/a	877 €/a	10521 €/a	
Chemicals	0 €/a	0 €/a	97 €/a	1005 €/a	20966 €/a	44285 €/a	16941 €/a	14684 €/a	15221 €/a	207842 €/a	
Unforeseen (10%)	0 €/a	88 €/a	680 €/a	3244 €/a	12642 €/a	21467 €/a	8195 €/a	7448 €/a	6761 €/a	89515 €/a	
<b>OPEX Aquaculture System</b>	<b>0 €/a</b>	<b>1000 €/a</b>	<b>7500 €/a</b>	<b>35700 €/a</b>	<b>139100 €/a</b>	<b>236200 €/a</b>	<b>90200 €/a</b>	<b>82000 €/a</b>	<b>74400 €/a</b>	<b>984700 €/a</b>	
<b>Operating costs (OPEX) of fish farming</b>											
Fish Feed	0 €/a	884 €/a	5623 €/a	42139 €/a	153920 €/a	482755 €/a	170981 €/a	142584 €/a	128735 €/a	2120989 €/a	
Fish Farm Staff	7500 €/a	15000 €/a	30000 €/a	52500 €/a	180000 €/a	180000 €/a	120000 €/a	105000 €/a	120000 €/a	540000 €/a	
Initial fish stock		28200 €/a				141000 €/a	29082 €/a	146086 €/a	59943 €/a	15510 €/a	186405 €/a
Electricity Buildings, Wells, Sewage	413 €	947 €	1.559 €	8.085 €	35.347 €	43.324 €	15.607 €	14.264 €	15.352 €	75.159 €	
Heating, Ventilation Air Conditioning	306 €	707 €	1.372 €	9.677 €	25.584 €	31.536 €	11.740 €	15.925 €	27.894 €	119.799 €	
Chemicals Wastewater	-	24 €/a	301 €/a	3468 €/a	10293 €/a	39734 €/a	10762 €/a	12205 €/a	10596 €/a	189122 €/a	
Office, laboratory, social	500 €/a	1000 €/a	2000 €/a	3500 €/a	12000 €/a	12000 €/a	8000 €/a	7000 €/a	8000 €/a	36000 €/a	
Depreciation (Ø-Service life 15 a)	520 €/a	16089 €/a	38107 €/a	99840 €/a	343929 €/a	382443 €/a	200480 €/a	190933 €/a	184773 €/a	827723 €/a	
Unforeseen (10%)	3744 €/a	3465 €/a	7896 €/a	21921 €/a	90207 €/a	120087 €/a	68366 €/a	54785 €/a	51086 €/a	409520 €/a	
OPEX Aquaculture System	0 €/a	1000 €/a	7500 €/a	35700 €/a	139100 €/a	236200 €/a	90200 €/a	82000 €/a	74400 €/a	984700 €/a	
<b>OPEX Fish Farming</b>	<b>41200 €/a</b>	<b>39200 €/a</b>	<b>94400 €/a</b>	<b>276900 €/a</b>	<b>1131400 €/a</b>	<b>1557200 €/a</b>	<b>842300 €/a</b>	<b>684700 €/a</b>	<b>636400 €/a</b>	<b>5489500 €/a</b>	
OPEX Fish Farming	-	116,06 €/kg-growth	25,38 €/kg-growth	7,71 €/kg-growth	28,29 €/kg-growth	5,22 €/kg-growth	9,46 €/kg-growth	5,83 €/kg-growth	8,00 €/kg-growth	3,45 €/kg-growth	
OPEX Fish Farming	0,09 €/pcs	108,37 €/kg-fish	23,13 €/kg-fish	6,92 €/kg-fish	283 €/kg-caviar	5,19 €/kg-fish	9,36 €/kg-fish	5,71 €/kg-fish	7,96 €/kg-fish	3,43 €/kg-fish	
<b>OPEX Aquaculture System</b>	<b>0 %</b>	<b>3 %</b>	<b>8 %</b>	<b>13 %</b>	<b>12 %</b>	<b>15 %</b>	<b>11 %</b>	<b>12 %</b>	<b>12 %</b>	<b>18 %</b>	