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Socio-economic assessment of the Sotenäs Industrial Symbiosis Network

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Executive Summary

A combination of quantitative and qualitative methods was used to assess the potential socio-economic impact of the developing industrial symbiosis network in Sotenäs. Currently, the town of Sotenäs performs well under many socio-economic indicators, with low unemployment of 4.1% and a median income close to the Swedish average. Our analysis shows a strong potential of the symbiosis network to make a significant contribution to the socio-economic prosperity of the region.

Based on our conservative estimates the network has the potential to generate revenues in excess of 400 MSEK after 5 years which would be approximately 10% of the total GDP for Sotenäs (based on today's figures). After 10 years, with an expected growth in the number of companies joining the symbiotic network, the revenues are predicted to rise to approximately 1 billion SEK which could represent 21.3% of local GDP. The 100 jobs expected to be generated or saved after 5 years represent at least 1.3% of Sotenäs employment (more if only taking into account full-time employment). This may rise to 180 or 2.5% after 10 years.

Table i: Quantitative analysis of socio-economic indicators for Sotenäs, showing current impact and expected impact at 5 and 10 year periods.

	Current	5 years	10 years
1. Job retention or creation of the IS network	20	100	180
2. Number of new companies	5	25	45
3. Potential revenue of the network MSEK/year	~2	400	1 000
4. Number of visitors due to the network (persons/year)	1000	2000	4000
5. Number of hotel nights / year	700	1400	2800
6. Spending due to visitors (estimated). MSEK/year	2.1	4.1	8.2
7. Savings on waste disposal transport compared to reference model ¹ levels (MSEK)	-	164	164
8. Funding of research and development linked to network MSEK/år	6	50	20

¹ This is based on a reference model constructed for the environmental LCA analysis (see Martin 2018) that was developed to represent the current situation.



The results of the qualitative and semi-quantitative analysis also suggest an extremely positive effect on the area. A very high positive impact is expected for the social indicators of jobs, improving the local skill base, impact on R&D and local innovation, and regional identity. Community engagement efforts score less highly, but are viewed as a continuous process and an area that the Symbiosis Centre is actively pursuing. The future outlook for this indicator is therefore also positive with increasing collaboration expected through efforts with schools, colleges and the local citizens and companies.

For the economic indicators, there is a maximum score for sales value, operational efficiency, security of business resources, and impact on risk and liability as a result of industrial symbiosis. The remaining indicators of economic viability, impacts on resource costs, impact on environmental and regulatory compliance, and relationships with government and external stakeholders, also score highly (with 4 out of 5).

One of the main drivers appears to be the need of the local food processing industries to have an increased capacity, as well as choice, for wastewater treatment. The symbiosis network is therefore seen as not only a positive contribution to local socio-economic prosperity but also to strengthen the existing industry and ensure production is kept within Sotenäs.

An added strength of the Sotenäs Industrial Symbiosis Network is the active support and facilitation of the Symbiosis Centre, located at the municipality offices. This has a significant potential to increase exposure and collaboration of the network with national and international companies and research institutes, thereby increasing the likelihood of continued growth and exchanges in the network.



1 Introduction

The aim of the socio-economic analysis is to assess the potential impacts and benefits of the future development of the Sotenäs industrial symbiosis network. It is therefore based on a projection and scenario analysis assuming the planned network of IS exchanges is successfully implemented and extended in the future.

2 Method

Socio-economic analysis of industrial symbiosis networks has generally been sporadic and relatively simple, focussing on jobs and savings from reduced waste disposal (although usually only reported in tonnes and not economic terms; CECP, 2007). In general, there has also been little context provided (for example in comparison to production volumes) on the network in terms of the significance of its contribution to the local situation.

Therefore, the analysis herein starts with a baseline analysis of the current situation and key indicator trends for the Sotenäs municipality. This provides the context for the socio-economic analysis of the Sotenäs IS network.

The methodology is based on a mixture of quantitative indicators, semi-quantitative/qualitative analysis. This is utilised for several reasons including:

- Data constraints and the challenges of assessing many socio-economic indicators in a quantitative way.
- Because the analysis is based on a future projections.

Consequently, utilising a combined approach enables a more complete and robust analysis. The analysis builds on the approach suggested by CECP (2007) which adapted the seven questions framework of the International Institute for Sustainable Development (IISD) (*“Seven Questions to Sustainability: how to assess the contribution of mining and minerals activities”*) (IISD, 2002).

The quantitative analysis focuses on:

- Jobs created or retained through the network.
- Number of new companies.
- Potential revenue of sales of the network.
- Number of visitors due to the network and associated economic.
- Revenue from visitors
- Savings on inputs and waste disposal.
- Funding of research and development linked to network.

Meanwhile, the semi-quantitative/qualitative analysis expands the analysis by utilising expert interviews to score the contribution of the network to a range of social and economic indicators:

Social:

1. Job retention and/or creation from synergy project implementation and operation
2. Improvement and strengthening of the local skills basis



3. Impact on R&D and local innovation
4. Regional identity/ pride /sense of value
5. Community engagement - are engagement processes in place and working effectively?
6. Community engagement efforts can benefit from the platforms and processes established for the realisation of regional resource synergies

Economic:

1. Is the economic viability of the project or operation assured and will the economy of the community and beyond be better of as a result?
2. Impact on costs for vital process inputs (including energy, water and materials)
3. Impact on sales values as a result of on-selling of by-products
4. Impact on operational efficiency and flexibility of individual operations
5. Impact on costs of environmental and other regulatory compliance
6. Improvement in medium and long-term security of access to vital business resource (e.g. land, ore, water etc)
7. Impact on company risk and liability profile as a result of resource synergies
8. Benefit from improved relationships with government and external stakeholders
9. Impact on net contributions to local economy as a result of synergy project implementation and operation

The information was gathered through a range of literature sources, as well as experts and practitioners involved in the network development.

3 Results and discussion

3.1 Baseline

This section provides a baseline overview of the current socio-economic situation of Sotenäs.

Sotenäs is a seaside community with a strong history of fishing. The current population is 9 065 (2016) and covers an area of 139 km² (Ekonomifakta 2017)². Since 1968 the population growth (measured over a three year period) has fluctuated between periods of high growth of almost 6% to declines of 3%. The latest period of 2013-2016 has recorded moderate growth of 1.5%. The municipality has a low unemployment rate of 4.2% (2016) compared to the Swedish average of 7.6%. However, the region has an aging population with an average of 49.1 years, which is the second highest in Sweden. It can therefore be a challenge for companies to find workers.

Sotenäs municipality is the largest employer with 925 employees, whilst Orkla is the largest private employer with 275 employees. The GDP per inhabitant was 411, 000 SEK in 2015, equating to a total regional GDP of 3.7 billion SEK/year.

Further information on the key socio economic indicators can be found in Table 1.

² <https://www.ekonomifakta.se/Fakta/Regional-statistik/Din-kommun-i-siffror/?compare=1®ion=1427>

**Table 1: Key socio-economic indicators for Sotenäs and recent trend**

Indicator	Sotenäs	Sweden average	Trend
Population	9065	34,466	↔
Average age (2016; years)	49.1	41.2	↑
Population growth (%; 2013-2016)	1.5	3.6	↓
Median income (SEK, 2015)	258,046	261,038	↑
Proportion of highly educated (%; 2016) (at least 3 years after high school age for age group 25-64)	17.2	26.6	↗
Percentage employed at some point during the year (%; 2015)	81.0	77.9	↗
Percentage of entrepreneurs (%; 2015)	9.6	6.5	↔
Start-up companies per 1000 people (2016)	15.0	11.8	↗
Unemployment (%; 2016)	4.2	7.6	↔
Proportion of early retirees (%; 2016)	6.7	5.4	↘
Municipalities tax revenues (SEK/inhabitant; 2016)	46,865	43,186	↑
Government grants and equalisation to the municipality (SEK/inhabitant; 2016)	9,087	8,848	↓
Local government costs (SEK/inhabitant; 2016)	52,620	50,232	↑

Key (change over time): ↔ = no change; ↑/↓ = relatively large increase/decrease; ↗/↘ = moderate increase/decrease; ↓ fluctuations
 Source: SCB and <https://www.ekonomifakta.se/Fakta/Regional-statistik/Din-kommun-i-siffror/?compare=1®ion=1427>

3.2 Socio-economic quantitative analysis

The quantitative analysis is shown in Table 2. This provides both the current status and projections for 5 and 10 years into the future. The figures were derived from interviews and consultation with key experts on the IS development at Sotenäs (primarily the development strategist for the municipality and the symbiosis developer). Figures are based on projections from the present number of jobs and companies. The figures for 5 years are based on a conservative estimate and the figures for 10 years assume continued growth of the IS network (further details can be found in Appendix 1). Table 3 provides context with the current situation in Sotenäs for 3 indicators.



Table 2: Quantitative analysis of socio-economic indicators for Sotenäs, showing current impact and expected impact at 5 and 10 year periods.

	Current	5 years	10 years
1. Job retention or creation of the IS network	20	100	180
2. Number of new companies	5	25	45
3. Potential revenue of the network (MSEK/year)	~2	400	1 000
4. Number of visitors due to the network (persons/year)	1000	2000	4000
5. Number of hotel nights / year	700	1400	2800
6. Spending due to visitors (estimated) ³ (MSEK/year)	2.1	4.1	8.2
7. Savings on waste disposal transport compared to reference model ⁴ levels (MSEK/year)	-	164	164
8. Funding of research and development linked to network (MSEK/år)	6	50	20

Table 3: Percentage comparison contribution of network to jobs, start-ups and GDP in Sotenäs

	% contribution of IS network				Calculation based on
	Current value in Sotenas	Current network	5 years time	10 years time	
1. Jobs	7342.65	0.3%	1.4%	2.5%	Workforce employed at some point in 2015
2. Number of new companies	135.975	3.7%	18.4%	33.1%	Number of start-up companies per 1000 (based on number of start-ups per 1000 residents in 2016)
3. GDP MSEK/year	3700	0.1%	9.8%	21.3%	As % of GDP (2015)

³ See Appendix 1.

⁴ This is based on a reference model constructed for the environmental LCA analysis (see Martin 2018) that was developed to represent the current situation.



It can be seen that there is already a significantly positive socio-economic impact even though the network is still in embryonic form.

If we assume a static GDP for the area of 3.7 billion SEK (based on the figure above for 2015, which provide a conservative estimate for 5 years' time) then the combined GDP would be 4.1 billion SEK. Therefore the contribution of the network would be about 10% of the Sotenäs GDP which is extremely significant. Although this is a fairly rudimentary estimate, it nonetheless shows the potentially significant contribution that the symbiosis network can make to the socio-economic prosperity of the area. In many successful networks the number of synergies has been shown to grow over time as a collaborative culture is embedded in the region and other companies are attracted to increased efficiencies and environmental performance of production. Therefore, assuming a modest growth of the network it is predicted that the contribution of the network could develop to in excess of 1000 MSEK which is about 21.3% of the expected total GDP (based on an assumption that the total GDP of the rest of Sotenäs is close to today's value and the symbiosis network is additional to this).

In addition, the contribution to employment of 100 jobs is significant at 1.3% of the currently employed workforce (based on 81% of the population being employed at some point in the year). Since this calculation is not based on full-time employment then it is a conservative estimate and the contribution to full-time jobs can be expected to be more.

3.3 Qualitative and Semi-Quantitative Analysis

The results of the qualitative and semi-quantitative analysis are shown in Table 4 and Table 5. These illustrate a very high positive impact (a score of 5) for the social indicators of jobs, improving the local skill base, impact on R&D and local innovation, and regional identity. Community engagement efforts score less highly, but are viewed as a continuous process and an area that the Symbiosis Centre is actively pursuing. The future outlook for this indicator is also positive with increasing collaboration expected through efforts with schools, colleges and the local citizens and companies.

For the economic indicators, there is a maximum score for sales value, operational efficiency, security of business resources, and impact on risk and liability as a result of industrial symbiosis. The remaining indicators of economic viability, impacts on resource costs, impact on environmental and regulatory compliance, and relationships with government and external stakeholders, also score highly (with a score of 4 out of 5).



Table 4: Impact of Sotenäs symbiosis network on social indicators

Social	Sotenäs example or description	(-) Impact (+)				
		1	2	3	4	5
1. Job retention and/or creation from synergy project implementation and operation	There are several new companies and jobs at the large food companies are more secure due to the improved diversity (e.g. in water treatment) due to the network. There is potential for further job creation from within the three existing food processing companies, as currently they have reached the limits of wastewater treatment capacity. There is a risk that these may move away if no treatment is found, due to a desire for production expansion.					x
2. Improvement and strengthening of the local skills basis	Key skills are expected to be developed and retained in the region. There has been an increase in the business skills ranking of the region, which is perceived as being due to the symbiosis network. Due to the innovative nature (with land-based aquaculture and algae growth and innovative usage) of the network there has been many new skills brought into area. There range from manual skills to intellectual. There has also been cooperation with Phd students e.g. in the circular economy and industrial symbiosis.					x
3. Impact on R&D and local innovation	The Sotenäs Symbiosis Centre (“Symbiosentrum”) is seen as essential part of the network in guiding cooperation, knowledge transfer, business brokerage and dealing with a high number of visitors and researchers to the network. An increasing level of innovation is expected due to inspiration from the network, and through, such collaboration and knowledge transfer both within the region and externally, In addition, there is continued research on both the symbiosis network structure and collaboration; and also the potential and technologies required to utilise by-product materials, energy and water. Connections to research institutes and universities enable research on policies, organisational aspects, innovation, as well as practical implementation.					x
4. Regional identity/ pride /sense of value	There has been a perceived uplift in the regional identity, and a branding for the whole municipality as an innovative and environmentally conscious region. The strong local connection with fishing industry is expected to be enhanced and strengthened.					x
5. Community engagement - are engagement processes in place and working effectively? Community engagement efforts can benefit from	This is a continuous process and it is hoped that engagement can be enhanced by industrial symbiosis processes. The Symbiosis Centre is a key node, but structure and methods for effective community engagement are still developing. A main mode of engagement has been schools visiting and presentations on symbiosis at schools, with tasks being set for the			x		



the platforms and processes established for the realisation of regional resource synergies	children.					
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Table 5: Impact of Sotenäs symbiosis network on economic indicators

Economic	Sotenäs example or description	Impact					
		(-)	1	2	3	4	(+)
6. Is the economic viability of the project or operation assured and will the economy of the community and beyond be better off as a result?	<p>Some of the symbioses are driven by other reasons than direct economical. E.g. collecting fishing waste from the sea.</p> <p>The symbiosis has the potential to reduce the risk of the large companies moving from the area, due for example to the increased options for wastewater treatment, and a reduced environmental impact of operations for sustainability branding. There is also a significant and measureable increase in employment due to increased spending due to increased productivity and increased visitors to the areas.</p> <p>There are many different types start-ups due to the symbiosis which reduces the risk due to diversity, although the unproven nature of these start-ups also represents a risk also.</p>					x	
7. Impact on costs for vital process inputs (including energy, water and materials)	In some symbioses the cost is the same as before, but the companies get others values (branding etc). In general the large companies will pay the same, but materials (e.g. biomass) will be derived and used locally.					x	
8. Impact on sales values as a result of on-selling of by-products	Generally viewed as good for marketing. Orkla is turning into a Green Factory and the symbiosis aids this goal. Salmon prices are expected to a premium price.						X
9. Impact on operational efficiency and flexibility of individual operations	<p>The process has started but few are implemented so far.</p> <p>New water treatment plant will make treatment more efficient, may provide another option.</p> <p>There will be less transportation, for example fish feed will be produced locally in the future for further increases in efficiency.</p>						X
10. Impact on costs of environmental and other regulatory compliance	This is the main impact for the food companies and the municipality. (waste water treatment etc.)					x	



	Costs will remain the same or less overall because a new water treatment plant is not required. There will also therefore be more spare capacity in the municipality treatment plant.					
11. Improvement in medium and long term security of access to vital business resource (e.g. land, ore, water etc.)	Land and sea resources will be used in a more optimal way in the network. Utilisation of the water by-product in the future.					x
12. Impact on company risk and liability profile as a result of industrial symbiosis	It is anticipated that there will be less risk for companies due to the new waste water treatment plant and biogas plant. The aquaculture also represents a more sustainable method of fish production. There is reduced risk from becoming more sustainable due to increasing requirements of markets.					x
13. Benefit from improved relationships with government and external stakeholders	As an increasingly recognised and prominent network, which the Symbiosis Centre represents, there is increased leverage to discuss legal barriers with government and external stakeholders. Companies and municipality discussing development together – improved collaboration for future developments. In addition, there is much improved relationships and collaboration with other external stakeholders such as through connections to universities and the SIUS network, as well as other companies.				x	
14. Impact on net contributions to local economy as a result of synergy project implementation and operation	Expected to be very positive contribution. Many resources are derived and utilised within the municipality/region. There will be increased revenue and skill in the area, with potential of continued growth of the network and its diversity.					x

4 Concluding remarks

In conclusion, the potential socio-economic impact of the industrial symbiosis network in Sotenäs is shown to be extremely positive. Based on our conservative estimates the network has the potential to generate revenues in excess of 400 MSEK after 5 years which would be approximately 10% of the total GDP for Sotenäs (based on today's figures). After 10 years, with an expected growth in the number of companies joining the symbiotic network, the revenues are predicted to rise to approximately 1 billion SEK which could represent 21.3% of local GDP. The 100 jobs expected to be generated or saved after 5 years represent at least 1.3% of Sotenäs employment (more if only taking into account full-time employment). This may rise to 180 or 2.5% after 10 years.

The results of the qualitative and semi-quantitative analysis also suggest an extremely positive effect on the area. A very high positive impact is expected for the social indicators of jobs, improving the local skill base, impact on R&D and local innovation, and regional identity. Community engagement efforts score less highly, but are viewed as a continuous process and an area that the Symbiosis Centre is actively pursuing. The future outlook for this indicator is therefore also positive with increasing collaboration expected through efforts with schools, colleges and the local citizens and companies.

For the economic indicators, there is a maximum score for sales value, operational efficiency, security of business resources, and impact on risk and liability as a result of industrial symbiosis. The remaining indicators of economic viability, impacts on resource costs, impact on environmental and regulatory compliance, and relationships with government and external stakeholders, also score highly (with 4 out of 5).

One of the main drivers for initiating the network is the need of the local food processing industries to have an increased capacity, as well increased options, for wastewater treatment. The symbiosis network is therefore seen as not only a positive contribution to local socio-economic prosperity but also to strengthen the existing industry and ensure production is kept within Sotenäs.

An added strength of the Sotenäs Industrial Symbiosis Network is the active support and facilitation of the Symbiosis Centre, located at the municipality offices. This has a significant potential to increase exposure and collaboration of the network with national and international companies and research institutes, thereby increasing the likelihood of continued growth and exchanges in the network.

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Appendix 1: Calculation methods

The visitor generated revenues are based on recent figures for the number of visitors per year to the Sotenäs Symbiosis Centre and those that stay in the local hotels. Estimates were then made for the number of visitors in 5 years and 10 years based on recent trends. The spending of these were based on those of an average cruise tourist given by SVD (<https://www.svd.se/kryssningsturister-snalar-i-hamn>) of 1000 SEK per day. Additional revenue is then assumed for hotel guests of 1500 SEK/night.

Algae

Revenue comes from the sale of silicon for cosmetics and solar panels, organic biomass fraction goes to fish feed or fuel and fertilisers.

Production site (m²)	25	300	3000
Silicon scale (kg/year)	1,3	42	1073
Biomassproduktion (kg/year)	9,2	302	7665
Organisk fraktion produktion (kg/year)	7,9	259	6592
Lipid fraktion (kg/year)	1,6	52	1318

Current production of silicon is valued at 24 MSEK/year. As per the environmental analysis it is assumed that the biomass and lipid goes to fish feed. The nominal price for fish feed is assumed to be 20 SEK /kg. Assuming the production site reaches 3000 m², then revenue from feed = $(1318+7665) \times 2 = 17,966$ SEK/year.

It is not known how much of the silicon scale will be sold for at higher rates.

Salmon

Salmon price 58,52 NOK/kg as of week 1, 2018. (<https://www.ssb.no/laks>). The average price in 2016 was 63.1 NOK/kg. We therefore use an estimate of 60 NOK/kg which equates to 61 SEK/kg.

As per conversation with Peter Carlsson of the Symbiosis Centre, price of Smögen salmon will potentially be 25% more, due to its premium rating. There will be an anticipated 5000 tonnes of salmon produced per year. Revenue from this is therefore $61 \times 5000 \times 1.25$ (25%) = 381 MSEK/year.

Total Revenue

Total revenue is therefore expected to be more than 405 MSEK.

If an increase of algae sales to high value business increased from 15 kg to 150 kg then total revenue from these two products alone would be excess of 600 MSEK.

Transport of waste

Assume that gate fees will remain the same. From Rena Hav report 20,000 tonnes will be used for the biogas plant. However, according to our environmental report calculations the tonne-km will



be reduced from 12.16 Mtonne-km to 3.03 Mtonne-km, which equates to 48.7 kT and 12.1 kT (based on a distance of 250km). Hence the mass of reduced transport tonnage is 36.5 kT.

From Avfall Sverige (2011) report – we use a figure of 4500 SEK/ton (pg 21) for transport of between 200 and 300 km.

That equates to $36,500 \times 4500 = 164$ MSEK per year.



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