Policy Initiated Renewal of Norwegian Salmon Farming:

Diversity in narratives to green the Norwegian salmon farming industry

Abstract

Despite being an economic success and generating considerable profit, the Norwegian salmon farming industry face environmental challenges that need to be solved. Since 2014, all new licenses to farm salmon are labelled either “light-green”, dark-green” or “development licenses”. The industry is nevertheless characterized by the open net-pen as a hegemonic technology, and is susceptible to both cognitive and political lock-in. In the article, it is defined which narratives on “greening criteria” that are dominant and an analysis is presented on how narratives influence new licenses for salmon farming. The data is derived from 52 qualitative interviews and a broad qualitative analysis of trends and debates in the industry. From the perspective of evolutionary economic geography and the sub-concept path dependency, narratives on greening criteria for future salmon farming are divided in three categories: path extension, modest path renewal and strong path renewal. The findings reveal that although most licenses are linked to mere path extension, development licenses might disrupt this trend.

Key Words: Policy for salmon farming licenses, Green Technology, Narrative analysis

1. INTRODUCTION

The importance of greening the salmon farming industry is stressed by the official “watcher of the watcher” to the Norwegian parliament. On March 6th 2012 it is stated by the Office of the Auditor General’s investigation into the management of aquaculture, submitted to the Norwegian parliament (1):

> “The aquaculture industry in Norway has grown considerably for several years and it is an important industry and employer. The Office of the Auditor General's investigations shows that the strong growth also has a significant environmental impact, particularly in areas with extensive, high density aquaculture production.”

Since this statement, it has been more acknowledged, even in industry journals, to discuss the environmental problems of salmon farming. It is uncontroversial to assert that Norwegian salmon farming is a financial success, both for companies and for tax-receiving

municipalities and the state. The turnover of the industry grows faster than the number of new licenses for farming. The turnover growth has been 45% from 2011 to 2014, compared to 11% growth in new licenses over the same period (2). This discrepancy cannot only be explained by higher salmon prices, because the spot price for salmon increased a mere few percent over the same period. It follows logically that the productivity and density of production animals at each production site must be growing. Looking at the execution among salmon farming public limitied liability companies (i.e. stock listed companies) on the Oslo stock exchange, greening is at least not negative for the investment community. There is a trend towards more greening, even though it is arguably a slow trend. As an example: The two companies with the lowest execution of green technologies yielded lower stock returns than the average salmon firm from 2011 to 2014.

Salmon farming preconditions licenses allocated by the government. In parallel with an increasing recognition of environmental issues among most actors somehow engaged to Norwegian salmon farming, the Norwegian directorate for fisheries has defined specific and future licenses for salmon farming as “light green”, “dark green” and “development” licenses. These licenses mark a shift in the government’s attitude, both because an expansion of licenses is thus more likely to occur, and because of the overt attitude to focus on green technology. New licenses are at high demand, but low supply. The low supply of new licenses is partly the reason for consistently high salmon prices while prices of most other commodities have declined particularly in 2015. Policy makers are thus in a position to indirectly regulate salmon prices and directly to regulate which technologies that are preferred.

Criteria to green salmon farming production are widely discussed, and are in this article identified as linked to three, main narratives. The focus on sea lice and wild salmon has been emphasized for many years (3), but recently also other problems receive increased attention. Different solutions to improve the industry do not only imply different degrees of innovation, but also different levels of «greening potential». How the greening potential reside in narratives is therefore important. A bank loan or private loan may for example be very dependent on the narratives residing in the creditors. Political decisions are likely influenced not only by optimal, technological solutions, but also by narratives. Because salmon farming still operates with open net-pens as a dominant technology, it is too early to evaluate all benefits and disadvantages of different solutions. The government both supports and inhibits various, new technology trajectories in language and in practice. The aim of the article is not do define a priori what is green, but rather to analyze which narratives that compete to define and construct how green licenses are designed. From a logical perspective, high level of potential greening impact is not identical with high, potential success rate, but should nevertheless be identical to the total efficiency (output/input) of a solution, when all externalities are included in the calculation.

This article has a theoretical part, with a discussion on how green solutions are most likely to be implemented considering both industry specific path dependencies/institutions, demands of the market and government policies. The theoretical aim is to expand the traditional material/technological focus in evolutionary economic geography by analyzing how narratives contribute to political decisions on licenses, greening criteria and technology. The article also has a practical part, with an analysis that deals with how different narratives on solutions, fixes and technologies define adequate greening differently. The salmon farming industry in Norway is a particularly good case for an analysis of the influence of language and opinions on political decision making, because it is political decision making that determines the number of farming licenses and the technological preconditions of each license.

In section two, evolutionary theory is presented as a theoretical perspective which is applied to the analysis (4), (5). In section three, the methodology to analyze narratives is presented. Section four deals with how different actors part-take and construct narratives on innovations to green the industry. Various solutions to green the industry is presented and linked to a specific narrative. Section five is an analysis of the relationship between narratives and policy. Section six is a discussion relating to all of the above chapters and there are conclusions in section seven.

2. THEORY – AN EVOLUTIONARY PERSPECTIVE

2.1 Path dependence

Recently, evolutionary economic geography and the sub-concept path dependence theory has been rejuvenated and gained increased importance in studies of industries and technology development (6), (7), (8), (9). A key issue is that *"… the emergence of self-reinforcing effects steer a technology, industry or a regional economy along one path rather than another"* (10). An industry path can be defined as the course of interrelated events *"…in which one of the available technological, institutional or organizational options gains momentum in time-space"* (11). Thus, the establishment of a path is triggered by a certain event, such as, for example, the introduction of open net pens in Norwegian salmon farming in the late 1960s. The pen technology became the unifying factor reducing the search for alternative solutions and set the future trajectory of the salmon industry path (12), (13). Moreover, in addition to the technology and the firm population, an industry path includes policy arrangement, governmental institutions, research institutions, public organizations etc. The success of an industry path presupposes the presence of supporting institutions (14).

The development of an industry path includes the twin processes of continuation and change (15), (16). Some periods can be characterized by continuation, while other can be dominated by change. The continuation dimension is closely linked to self-reinforcing processes. Events that are aligned to each other foster the course of the path in an overall direction. The self-reinforcing process is driven by positive feedback, adaptations and

learning effects (17). The general trend is that an industry becomes established around specific technology solutions, taken-for-granted practice and institutionalized rules. This *may* lead the system into a state of lock in, i.e. a situation characterized by rigidity and erosion of adaptability. In such situations, a path becomes *"…confined to a single solution that does not need to be efficient"* (18). Such extreme "single solution situations" are relatively rare in real life, especially in studies of the development of industry paths (19). However, systems can have tendencies of lock-in and can be characterized by rigidity. There are different types of lock-in. One is technological lock-in, where the technological development becomes locked into a certain trajectory, even if alternative and sometimes more efficient technologies are available (20). A second type is cognitive lock-in, i.e. the development of a collective mindset within an industry that is focused on outdated solutions when confronted with new challenges, for instance linked to the need for a "greener" production. A third type is political lock-in, i.e. when political institutions are self-reproducing over time and this may slow down industry renewal (21).

The change dimension is associated with the dynamic nature of a path. Contributions within evolutionary thinking have introduced three mechanisms that may foster path evolution: *layering, conversion and recombining* (22), (23), (24). The notion of layering implies that the industry path and its institutional framework is gradually changed by the adding on of new procedures and practices. Still, the dominant technological solution is being maintained, while mode of organizing and the way it operates is being altered. The conversion mechanism is linked to the introduction of some new technological solutions and some new regulatory principles, still the new solutions are closely associated and building on existing technological paradigm. The final mechanism, recombination, provides the most radical change within a path, and is linked to the introduction of radical new technological solutions and new institutional principles. Relatedness between technologies used in different industry paths and technology development through co-evolution between industry paths where the cognitive distance is neither too large nor too small are important factors for recombination (25), (26).

In a stylistic manner, it can be argued that industries that over time are dominated by continuation and lock-in tendencies combined with some element of layering and conversion will be characterized by path extension (27), (28), (29), i.e. to a large degree "more of the same" and an development along well-established technological trajectories. On the other hand, industries with a prominent occurrence of both layering, conversion and especially recombining mechanisms will be characterized by path renewal. New technologies are introduced, new markets are being exploited and the structure of the industry and its regulation framework is changing. Thus, there is strong degree of novelty within the path (30), (31).

It is argued that 'un-locking' of an industry path can be triggered by external originated shocks or through co-evolution between related industry path sharing related knowledge

and competence (32), (33), (34), (35). Still, there is lack of theorizing of how such transformation and renewal can be triggered and facilitated through policy. Apart from a few exceptions (36), (37), (38), the importance of policy interventions has received little attention in empirical analyses of path renewal. There has also been only moderate emphasis on the role of language and narratives for the introduction and development of new, dominant technological solutions. A narrative analysis may also reveal the existence of lock-in in various actors or groups.

Path dependency is a meaningful concept in the context of salmon farming both from a macro-perspective and micro-perspective. In a macro-perspective, Norway has long traditions as a resource based economy, which would benefit salmon farming because institutions for resource industries are strong. From a micro-perspective, salmon farming has arguably developed a path dependency of giving less priority to environmental problems. As an example of the latter, there is agreement among veterinarians and biologists that *ceteris paribus* higher density of salmon at a specific location yields higher levels of most viruses and parasites (39), (40), (41), (42). Most producers of farmed salmon say that they intend to get rid of sea lice and disease problems, but with few exceptions the central aspect of less dense populations to combat the problem is not acted upon.

3. METHODOLOGY

3.1 Defining a narrative

In a narrative analysis, the scientist deconstructs arguments and put them into broader contexts of ideology or technological convictions in groups (43). Because a narrative is not inevitable in its longevity, it is meaningful to analyze it as a construction (44). It is nevertheless possible that some narratives are closer to "reality" than others (45). A statement adheres to a narrative if it gives meaning and is consistently formulated. In rational choice theory, it is assumed that if everyone had the same information, everyone would advocate the same perspective (46), i.e. relate to the same narrative. A narrative analysis, inspired by evolutionary thinking, may therefore be seen as an acknowledgement that different professions and roles yield different arguments as a consequence of dissimilar experience, background and history. Some critics claim that a narrative is much more than just variation in information, it is also a form of manipulation or power (47). A debate on what is the "greener" solution can be seen as a struggle to control or define the future of the industry. Reflecting upon all of the above, a narrative analysis therefore deserves both references to where informants work and their background, as well as specific references to their statements.

Some narratives can be dominant and be shared among both industry actors and policy makers, while others can be subordinated and weak and lack substantial support. Finding dominant narratives across groups, the analysis unveils statements and omittances that are manifested also in the political process. Arguments for both continuation and change are

emphasized. There are narratives that either drive or inhibit change, which is related to how a narrative is founded in technical and/or ideological arguments. If narratives are constructed, and not just a "random walk", actors who produce knowledge and/or put capital into the industry will play a part in the construction. If policy makers contradict either knowledge production, industry actors or external capital, there could be an inflection point were narratives compete, and the outcome is unclear. The methodological perspective is a pluralist one – deductive in the approach to narrative methodology, but inductive in the approach to technology. It is implausible to infer from current technological regimes what is actually the optimal "green" technology.

On the popular debate forum of Norway's largest news source for finance and industry (www.hegnar.no), scientists may find an indefinite data material for a narrative analysis of Norwegian industry and companies. Generally, people who use the forum are serious participants with endogenous knowledge of the industry they discuss. Below is an excerpt from one of the less highlighted environmental debates of salmon farming. The example illustrates that two diverging narratives may be very strong, and it is difficult – if not impossible – to conclude which narrative (if any) sits closer to reality:

Person A: *There is almost no shrimp in the fjords of Northern Norway in 2015. It is the sea lice medications from salmon farms that kill of all shell fish. We need to do something serious about the regulations on salmon farming's use of medications.*

Person B: *I have closely observed the development of shrimp fisheries since the early 1980ies. It has developed from small boats to large trawlers, who "wash" the sea bed clean. The shrimp fishermen and companies can blame only themselves. The reduction in shrimp populations along the coast has little or nothing to do with salmon farming.*

Several studies show that specific chemical sea lice treatments kill off shellfish in a relatively large radius from salmon farms (48), (49). However, it is hard to determine the extension of this problem because of the cost and natural obstacles of performing long-term empirical science under water. The debate above is therefore left to a mere debate with no conclusion, where the narratives compete. Policy makers, however, have to move between narratives to make decisions. It is likely that the stronger a narrative is rooted in the actors of an industry, the easier it is to adhere to it in decision making. That said, it is difficult to analyze to what extent the salmon farming industry exerts influence on politicians and or even the general opinion/media.

3.2 Data

To identify narratives, 52 semi-structured interviews have been performed. The selection of informants was qualitatively selected with regard to the explicit power position and/or formal knowledge of the informant. In line with research in political ecology, it is likely that narratives are primarily constructed by actors with either power, capital, industry interest or specific knowledge about the industry (Blaikie 1999). The obtained data is applied both in

chapter four, five and six. The 52 informants were: 4 informants from the Norwegian department of fisheries; 19 informants from both formal and independent research organizations; 12 informants from salmon farming production firms (including large and small firms and with informants with diverse roles and backgrounds, from CFO's in central offices to blue-collar "keepers" on smaller production sites; 7 informants from suppliers of salmon farming technology; 4 informants from retailers, 3 informants from NGOs; 3 informants from private equity investment companies, and one key informant from a large bank which is particularly exposed to salmon farming.

A second set of data is derived from a broad qualitative analysis of trends and debates in the industry. Included here are ongoing public debates on the greening of the salmon farming industry in national, regional and industry newspapers from 2011 to 2015. Job advertisements, lists of participants at technology seminars or political seminars, vision statements and detailed creditor status of local and regional banks provided narrative insights into dominant narratives on salmon farming. Also, sponsorships at big fish-events signal which actors who intend to define the future of the industry, including definitions of "green" technology.

3.3 Challenges and limitations with a narrative analysis

Radical and disruptive innovations are often attacked by sceptics. It is a challenge to distinguish between reasonable, skeptical arguments and those skeptical arguments that are skeptical out of cognitive lock-ins, such as status quo bias (always preferring the present (50) and the naturalistic fallacy (if something is profitable in the present, it must be profitable in the future).

Generally, one must look at financial and technological efficiency, together with biological components, when one analyzes the plausibility of an innovation argument. Narratives linked to different technological solutions are often more crude than this, but no less effective in their bargaining power, such as when a representative for one of the dominant industry actors conceded in a major newspaper: "I would not let my children swim or go fishing anywhere nearby the average production site. There is too much bad stuff in the water." Implicitly, he asks the "opinionated" share of the population to advocate for deregulation of licenses, so that the company can increase their currently maximized share of total licenses. He implies that the company is large enough to make the necessary environmental investments to reduce pollution. There can thus be a multitude of motives for taking environmentalist positions, which is important to have in mind as a potential limiting factor in a narrative analysis (51).

A pitfall of a narrative analysis is that actors do not believe what they say (52). This pitfall can be partly redeemed by looking at what the same actors do in practice. There are many different levels of production, and each level could constitute different environmental challenges. Upstream to production is e.g. environmental narratives related to the extraction

of marine feeds for raw materials; additives as fish feeds conservatives; fairtade issues as well as GMOs and antioxidants (noteably ethoxyquin) in fish feeds. At the production level, narratives are more related to technology, disease, pollution to the local environment and animal welfare considerations. Downstream from production, narratives explore transportation issues and the health effects from eating salmon. For the sake of this article, the analysis is limited to "production", but it does not follow that the greening also of "upstream and downstream" is not important, or that a specific innovation will not solve a problem across these levels. A technical solution is not necessarily isolated to one level.

4. EMPIRICAL ANALYSIS: TECHNOLOGY, NARRATIVES AND POLITICS

4.1. Technological solutions for greening of the industry

An innovation can relate both to new or existing solutions and technologies – its property as an innovation is when it is commercialized. More important than concepts, though, is the potential implications of narratives for the realization of technology. The so-called "best available technology" principle is embedded in the Norwegian Law on Pollution, meaning that if there exists technology that reduces pollution at a price that is no more expensive than the current technology, the industry is obliged to incorporate the technology. This is an important point and seemingly often overlooked by policy makers. As a complementary point to emphasize the importance of greening criteria, at the so-called Sundvolden government declaration of 2013, it was decided that "the polluter pays principle" prevails. However, if an influential narrative suggests that a green technology does not reduce pollution, it is very hard to argue for policies that force implementation.

Below are greening criteria for salmon production outlined. The respective criteria and solutions are linked to narratives in section 4.2:

- *Medical and chemical treatments of fish*
- *Smart biology solutions such as "cleaner fish" (various species), reduced fish density and stronger currents to boost immune systems*
- *Longer smolt phases on land*
- *Closed containers at sea*
- *Ecological salmon (better feeds and less medicine)*
- *Ocean farming*
- *Land based farming*

4.2 Main narratives

We have found that narratives on the greening of salmon farming are divided into three main types:

i) *Path-extension narrative*: Pursue the existing open net-pen based technology, and promote fixes rather than novelty. This implies layering processes that contribute to minor changes of the industry-path.

ii) *Modest path-renewal narrative*: Pursue new solutions that are linked to existing technology and geography. This implies layering, conversion and even some recombination processes.

iii) *Strong path-renewal narrative*: Pursue technology that extends beyond the current industry path. These technologies are linked to processes of recombination and can contribute towards disruption and a more substantial technological change of the entire industry.

4.2.1 Path Extension Narratives – fix symptoms within existing technology paradigm

The main solutions linked to this narrative are:

a.) Use current methods and extend research on more advanced vaccines and medicines. Fix symptoms rather than the cause of the disease problem. It is not considered important to solve the underlying problem of producing dense salmon populations in net pens. Medicine, vaccines and genetic engineering is perceived as more plausible to develop stronger fish than technological renewal. This will contribute also to value creation for the pharmaceutical sector.

Potential Greening Impact: Low or none

b.) Holistic practices to fix, rectify or combat symptoms, which could possibly solve some underlying problems. Holistic arguments entail several suggestions on how to mix natural systems and species for more optimal production, but within the current technological regime of open sea based net pens. Examples of holistic measures are applications of various species of so called “cleaner fish” in the net pens; utilizing stronger currents; utilizing waste for fertilizing the ocean and so on. The narrative thus promotes alternative solutions within the current technological regime.

Potential greening impact: Low or medium

Key informants speaking in or against the path extension narrative:

Most current approaches relates to a path-extension narrative, and entails solutions within the present technological paradigm. Cleaner fish is already widespread, and a collection of veterinarians from Oslo, Trondheim, Harstad and Bergen recently argued that using cleaner fish rather than chemicals to get rid of sea lice breaks animal welfare considerations, and that the law of animal welfare should trump sea-lice as a more important greening issue. As displayed in a discourse analysis (53), greening criteria are susceptible to contradictions, where one environmental problem can grow larger from the rectification of another.

Among the informants, several pronounced serious criticism towards mere path extension, such as a Professor of food security and infection biology. He argued that a dramatic (seven-fold) increase in chemical sea lice treatments since 2008 causes resistance: “There is no hope to get rid of sea lice with chemical treatments. We need innovative moves.” A senior marine scientist confirmed this position: “we know too little about the environmental effects of chemical sea lice treatments”. However, path extension narratives also include more holistic measures, and a Professor at a well-known research institution argued that: “A lot speaks for that in the near future, we will enhance new combinations of species in Norwegian aquaculture. Polycultures reduce environmental impacts both in aquaculture and agriculture.” The professor spoke of initiatives to produce several new species for consumption in the new, local eco-systems generated by salmon farming. These initiatives have also been supported by national and global NGOs, and the industry has generally greeted the projects with verbal enthusiasm (albeit with few results so far).

A director at Norway’s largest retailer, claimed that “the customers don’t care about the health of salmon only how many calories that is in the fish”, and implied that greening is not important to the consumers, and hence not to the industry or even retailers. The claim was reaffirmed by a key person within the EU, a category manager of fresh fish from Belgium: “Most European consumers don’t know that salmon is farmed. Greening of the industry is not important to European consumers”. For these actors, path extension is sufficient.

From a different angle, but with the same narrative towards low greening, the CFO of a global salmon farming company emphasized that “It is a perverse situation if Norway gives away its comparative advantage of producing salmon in perfect sea water temperature, we need to hold on to the technology of producing in open net-pens in fjords.” This argument was reproduced by most actors within a path extension narrative. A respondent from a large Norwegian bank claimed that land based salmon farming is identical to the destruction of Norwegian salmon farming, and that the industry should fix problems reactively within the current, technological regime. An executive at a Seafood Organization made a similar point: “Norway has a regional specialization of producing salmon – and we lose the advantage if salmon is produced on land. Closed containers on land means that one might produce salmon everywhere in the world.” Note that the arguments above do not consider greening as particularly important, relative to maintaining a Norwegian position as the world leader in salmon exports.

A keeper at a salmon farm criticized the government, and argued that a singular focus on treatments to combat sea lice shadowed other greening criteria: “The government seems to prefer sea lice as the main sustainability measure – this is too narrow-minded.” The keeper had large, technological innovative ambitions for salmon farming, but conceded that he was a mere keeper, and unable to reach beyond “mere extension” of the current path. A respondent from a Norwegian company that provides technology for improved discharge solutions at salmon farms claimed that everyone who touches discharge from salmon farms

get sick, and he blamed both the companies and the regulations: “Salmon farmers don’t intend to invest in sustainable discharge solutions in fjords because the environmental regulations are very loose except for sea lice abatement. The waste is externalized to the ecosystem rather than internalized and controlled,” he said. Also discussing waste, a professor of Life Sciences argued that “Norway has larger challenges in salmon farming than in other agricultural animal productions, and it is impossible to solve the problems with only reactive solutions to current technologies.” Even though a path extension narrative is widespread, then, several actors with endogenous knowledge contradict the premises.

4.2.2 Modest Path Renewal Narrative – Reorientation of existing technology

Several solutions are presented through path renewal narratives. Some imply mere layering and others elements of conversion:

a.) Develop solutions for longer smolt phases on land and a correspondingly shorter sea water phase, with layering of existing net pen technology. This will alleviate some environmental problems, albeit will not eliminate them. The analysis shows that this is one of the stronger greening narratives at present, and the technology is already commercialized.

Potential Greening Impact: medium

b.) Conversion to modest technology changes. In this modest path renewal narrative, there are two main technological solutions.

i) Various forms of closed containers at sea (CCS-systems). The closed containers will utilize the area of the sea, while simultaneously avoiding typical environmental issues such as escape and sea lice.

ii) Ecological Salmon with improved feeds, no chemical solutions and less fish per net pen. This responds particularly to consumers demanding safer and better salmon meat, and those who find a correlation between better feeds and improved fish health.

Potential greening impact: medium

Key informants speaking in or against the modest path renewal narrative:

At a conference in Bergen in January 2015, where most upcoming executives for salmon farming companies participated, an apparent consensus was established by the speaker to inhibit debate: a longer smolt phase on land or closed systems at sea suffice as green solutions. This arguably indicates path dependence that hinders optimal market selections. Rather than having a pluralist mind-set towards innovations, the conference “was supposed to” part-take in this, specific narrative.

A marine scientist argued that a longer smolt phase on land reduces mortality substantially, and is sufficient as an incremental step towards greener salmon farming. This is confirmed in commercial production by a successful, large salmon farming company, namely that larger smolt equals reduced risk of premature mortality. Indeed, this company presented the best financial margins of any salmon farming company in 2014, suggesting that lower mortality has a positive effect on financial results.

Another marine scientist suggested that greening is always local, not global, in its purpose, and said that modest renewal is sufficient, but that: "Farmers should pay much higher municipality taxes for the environmental externalities they inflict, because the environmental externalities are primarily local."

A company veterinarian at a large salmon farmer argued that modest renewal is the most plausible measure, and claimed that: "we have production sites were we have not used any chemicals for the last three years. Salmon Farming has enormous potential. We need to improve, but the debate is too polarized. The disaster in Chile was due to lack of strong government control. The ASC-standard (Aquaculture Stewardship Council) is adapted by two large, stock-listed companies, and it will lead so some good innovations, such as long smolt phases on land."

An organization critical of salmon farming made a more subtle point to demand better eco-feeds: "a new European Union law allowing for higher levels of the toxin endosulfan in salmon feed is being introduced into Norway. This should be illegal, but is seemingly hidden as an environmental issue because of all the sea-lice discussions"

A professor of marine biosystems complained that there is: "a knowledge gap between the keepers at the farms and the administration at most salmon farms. A lot of lost profits, bad animal welfare and lack of trust is buried in this knowledge gap. When the administration determines form of technology, transportation, dates for treatment and moving the smolt to sea, it frequently happens in disharmony with what is biologically plausible and reasonable. It is frustrating to the employees at production sites, and it is frustrating to us veterinarians external to the companies." He thus advocated more consistent applications of at least modest technological innovations.

4.2.3 Strong Path Renewal Narrative

There are two solutions linked to strong path renewal narratives. These imply recombinations with both technological and locational shifts

a.) *Offhore farming:* Establish salmon farms in ocean environments rather than in fjords, which also implies regional branching with the offshore- as well as the ship-building industry. At present three large companies have the architecture and finance plans ready to develop ocean farms.

Potential greening impact: medium or high

b.) *Land-based farming*: Move the entire production, including grow-out processes, on land. It is argued that this will benefit municipalities due to higher income from property taxes, unlike the current regime, where the water (commons) is in practice privatized by the installation of net pens. Several trial-centers are up and running, but the production is yet to be commercialized beyond small scale start-up companies. Internationally, land-based production of other species of fish is common.

Potential greening impact: medium or high

Key informants speaking in or against the path renewal narrative

An entrepenour of land-based systems argued that "The key for land based salmon farming is to utilize the waste. When this is organized, it will be more cost efficient than production at sea, considering that we do not need well-boats, and we are closer to the infrastructure and so on. In other words, the only main advantage of farming in fjords is that they can easily externalize the waste to the seawater." Contrary to this picture is what a start-up company in Denmark recently experienced, namely that unintended bacteria can destroy all the fish in a land based container within short time. This problem with land based salmon farming was also emphasized by a scientist who has worked with an official land based trial center in Norway. He argues that the technology is too immature to be commercialized for a while, and that a large salmon farming company in Norway has bought the rights to the research material for their project with longer smolt phases on land. What started as a research project for permanent land based salmon farming has thus been reduced to longer smolt phases on land. Correspondingly, another scientist from a well-known research organization claimed that "salmon on land for the whole production process makes no sense. It is never going to be commercialized." Deconstructing his argument, it is hard to tell whether he speaks out of qualified opinion, or out of a technological-lock in perspective. Contrary to the former claim, a private equity investor explained that he invests in land based technology because he sees the potential of producing salmon independent of sea temperature close to markets in the Unites States and in southern-Europe.

Another executive at a Norwegian Private Equity company consider ocean salmon farming intriguing: "The downside of offshore salmon farming is bad weather, upside is elimination of most environmental problem", he said. A representative for the alliance of animal welfare is also intrigued by offshore solutions: "offshore is better than closed systems for animal welfare. Disease issues will be substantial also in closed containers." A scientist at an official research organization for marine technology claims that it is "possible to produce 10 million tonnes of salmon per year in 2050 if moved offshore. Incremental growth is not an option if Norway intends to maintain its comparative advantage hegemony." He thus made a strong path renewal argument.

A scientist of water research argued from a path renewal narrative, but does not conclude what technology is better: “The discharge of Nitrogen from Norwegian salmon farms has increased from 10 000 tonnes to 60 000 tonnes over the last 20 years. One needs to move the farms away from the fjords somehow.” An industry executive is very antagonistic towards land based salmon farming: “Closed containers on land means that the entire coast must be filled with concrete-structures. Closed containers at sea is extremely susceptible to collapse.” Distinguishing between closed containers at sea and closed containers on land is of course important in this debate on technological options.

An engineer at a salmon farming company claimed that “Waste disposal at land might be even tougher environmentally (due to lack of infrastructure) than waste disposal at ordinary net pens. Offshore farming, on the other hand, has almost none environmental impact – the ocean is deep and large and the currents are strong.” A marine scientist, on the other hand, says that: “Land based salmon farming is as cost-efficient as sea based salmon farming if externalities are included. Without externalities, it is 5 NOK,- per kilo max more for land based than sea based farming. The salmon farming companies must realize that they are at a point where larger investments in technology is absolutely necessary.”

A respondent from a successful private equity company in an oil-dependent region said: “Some argue that the offshore technology is too vulnerable to bad weather, particularly in terms of maintaining well-boat schedules and secure delivery of salmon. However, offshore farming is likely the only way to reach high production growth in salmon farming in the future. We look for the right projects to invest in.” Another informant contended that the most important reason for path renewal is an ongoing animal welfare tragedy at three out of four salmon farms, and that this tragedy is closely related to the current low level of greening.

5. FROM NARRATIVES TO POLICY

The next step is to analyze the link between different narratives and explicit policy initiatives for greening of salmon farming. In 2014, ten “dark green” licenses were handed out by the government at 10 million NOK as a predetermined price per license. The current market prices for a salmon fish for food license is as high as 70 million NOK (54), depending slightly on geographical location. The dark green licenses of 10 million NOK each are therefore a subsidy of specific green technologies, and thus a policy initiated move for renewal (It should be noted that the first net-pen based licenses which are still operating in the present were practically handed out for free throughout the first decades of salmon farming, even though they manifested a privatization of the commons).

In addition, 35 “light green” licenses were distributed at closer to market price. The technologies that were prioritized in the distribution of green licenses could indicate which narratives have been more dominant in the competition to define what adequate greening criteria are.

5.1 Light-Green Licenses

For the 35 licenses there were more than 200 applications. The following production solutions were prioritized:

- 7 licenses: Larger smolt/longer smolt phase (modest path renewal)
- 26 licenses: Cleaner Fish/new sea lice protection kit, i.e. "*luseskjørt*" (path extension)
- 2 licenses: Eco-nets (modest path renewal)

26 out of 35 light-green licenses are linked to a path extension narrative of fixing symptoms rather than problems. Even though the licenses are merely defined as "light green", it signals the strength of a mere path extension narrative among decision makers over the last years.

5.2 Dark-Green Licenses

There were 122 applications for the 10 licenses, and the policy makers have been in a path-forming position.

Nine out of the ten licenses were given to closed container systems - some for a mere longer smolt phase on land and some for the entire production process in closed containers at sea. The 10th license was distributed to a research project for land based fish for food technology. However, this license is later retracted by the applicant in wait of possibly free licenses for land based systems. Implicitly, it is stated in these licenses that the government at the point of execution worked within a narrative where longer smolt phases on land and possibly closed containers at sea are perceived as "sufficient greening".

5.3 Development Licenses

Another policy initiative toward greening was "free development licenses", which was launched by the Directorate of Fisheries in the summer of 2015. In February 2016, it was announced that the first eight development licenses goes to ocean farming. The directorate's argument for ocean farming was primarily financial, i.e. that more capital is drawn to ocean farming than to other radical green technology solutions, and they find it plausible to assume that the more capital that is put into a new technology, the more likely it is that it will succeed. The flow of money is arguably also a type of narrative. Other arguments for handing free development licenses to ocean farming are the technological and social pipelines to the ship-building and offshore industry, as well as arguments of moving production away from sensitive fjord areas that are particularly sensitive. Reflecting upon the recent "crisis" in the oil and gas sector starting in 2014, offshore salmon farming is perhaps particularly attractive from the government's perspective, due to the potential

positive effects of shifting labour and equipment from oil and gas to offshore salmon farming.

6. Discussion

Until recently, there seems to have been a dominant narrative in the government that a longer smolt-phase on land and partly also closed containers at sea suffice as path renewal – to the expense of other solutions. Two representatives from the department of fisheries responded in an interview with the authors of this article that it is likely that more radical innovations will obtain licenses without paying any fee. Some months later (February 2016), development licenses were actually handed out for offshore technology, signaling that the government's approach is at least partly pluralist.

Concequently, a wave of innovative technology projects suddenly enveloped the industry after the development licenses were launched. Companies are thus pushed to innovate in order to obtain entirely new licenses below market prices. New projects with creative names such as "Aquatraz", "Marine Donut" and "The Egg" could be linked to a similar wave of creativity in the oil and gas sector some 10-20 years back. It is yet to be seen if the creativity is qualified more by name or by execution. Innovation history displays that it is difficult to know what technology will prevail in the future (55)). Insight from the evolutionary perspective has pointed out that in a process of disruptive change and renewal, single decisions can have far reaching consequences ((56). Those technologies that are initially given priorities by the authority in their greening policy may generate their own self-reinforcing processes and eventually steer the future development of a technology along a selected trajectory (57). Selections of criteria for licenses in the present may therefore have large influence on future developments.

Narratives do not necessarily include innovation processes or the amount of time needed to reach plausible, new technology. A so-called status quo bias approach will therefore seem more reasonable before than after an innovation is implemented with success. This is an important point to be noted for policy makers, because what seems implausible today might seem mainstream tomorrow. When focusing on the role of policy formulations and the government in a study of path renewal, it is valuable to assess whether the regulation regimes promote efficient modes of organizing or whether it hampers the organizational innovation that is needed to create and implement new and greener technology trajectories. The market may be a better selector than policy makers in "deciding" whether the present technology is sufficient for greening the industry, or whether a technological shift is necessary (58). The empirical theory building in the social sciences is conflicting on this issue, some show evidence that it is necessary with a strong policy foundation to abate environmental issues, while other, large research projects, particularly in the Austrian Economics tradition, show the inverse, namely that weak policies enable the creative destruction of ingenious entrepreneurs, which is good when one desires a new technological regime. A solution to the debate above are industry policies that (59) "actively promote

pluralism… on processes within a non-equilibrium self-organization framework…" In addition to promote pluralism and variation an evolutionary inspired industry policy should also focus on retention (60), (61)). Policy makers need to take existing competence in the industry and in relevant R&D institutions as a building block for facilitating new technological solutions. Consequently, policy makers should neither be too weak, nor be too decisive, in their formulations. Rather, they should find ways to promote both pluralism and retention in times where path renewal is needed.

The system level (62) exhibits that path dependence theory is a suitable point of departure to analyze how different narratives yield different perceptions on what is sufficient as a technological shift. The development licenses to ocean farming witness more pluralism than what was seen among the commentators residing in the industry, and displays that there is more pluralism both in the directorate of fisheries and among some capital powers, than among the average actor in the industry. It is an interesting turn from the directorate that they use the size of invested capital as a primary argument for handing out the eight first development licenses to ocean farming. As a confirmation of the importance of pluralism, it is interesting to note that the range of creative and disruptive solutions to innovations in salmon farming has been rampant since development licenses were announced.

In the evolutionary perspective, branching of industries is a central concept. In 2016, there have been joint ventures between supply boat companies for oil and gas and salmon farming companies. This implies that the plausibility of offshore salmon farming works as a strong narrative among executives in both sectors. Interestingly, the salmon farming company that is given the first, eight development licenses had previously issued complaints to the Department of Fisheries that offshore ocean farming technology was not preferred as a dark green technology in the distribution of green licenses in the year 2014, and that the government thus implicitly subsidized existing technology to the expense of "ingenuity" and "creative destruction".

The secretary of state at the department of Fisheries said in 2014: "we will eliminate obstacles to new technology. It is too early to say if offshore or land based is the best "green" solution". In 2016, some obstacles have indeed been removed, and much more capital is put into offshore farming than land based farming. It shows that the government to a larger degree leaves it to the market to decide what major innovations that will succeed. This is important because narratives among regulators and those who influence regulators are thus less powerful than a few years ago, which is a good development if one recognizes the potential pitfalls of a cognitive or political lock-in.

Figure 1 below categorizes elements from the analysis and discussion:

	Path Extension Narrative	Path Renewal Narrative	Strong Path Renewal Narrative
Change Dimension	**Layering:** Fixes within the current, open net-pen technology, as well as some holistic practices.	**Layering**: Longer smolt phases on land **Conversion**: Closed Container Systems as well as attempts of deeper Ecological Salmon production	**Recombination**: Offshore salmon farming as well as land based salmon farming
Connection to licenses	Existent licenses and light-green licenses	Light-Green and Dark-Green	Dark-Green (maybe) and Development Licenses
Potential Greening Impact	None, low and medium	Low and Medium	Medium or High

7. Conclusion

In the evolutionary perspective, market and policy priorities are discussed (63), yet the perspective lacks a deeper understanding of the mechanism for policy initiated renewal and its connection to narratives that reside in the language and consciousness of actors – both actors with and without endogenous knowledge of salmon farming. This article brings narratives into evolutionary economic geography to improve understanding of what technological innovations prevail in a resource based industry as salmon farming. What technology is selected and what technology is not selected is not only dependent on optimal market mechanisms, but also on policy makers, and thus by actors who directly or indirectly influence policy makers. Narratives are important means in a process where actors are influenced by different ideas and thoughts on technology. In a selection process, a cognitive lock-in (or what behavioral economists would call status-quo bias) can be maintained or broken dependent on what narratives that are most dominant. Note that the flow of money is also a form of narrative. The article is also a contribution to ongoing policy discussion on how to deal with the environmental impact of resource based industries, and salmon farming in particular.

Path dependencies and lock-ins are maintained or broken through language and in political and individual actions. Narratives in this context is how the impact and potential of new technology is written and talked about, as well as implicitly acted upon or not acted upon (64). The way greening criteria are promoted and spoken of likely influences both the government's selection of specific licenses, the level of innovative and risk seeking capital for innovations, and ultimately also the future path of the industry. Some firms are first movers and early adapters of new technology. First movers vs. conservative players create the interesting inflection point of capital as risk seeking versus capital as rent seeking.

The analysis brought to light that policy in theory is not identical with policy in practice. As an example, the law on animal welfare is consistently broken among many actors, and it is not acted upon by the authorities, nor included as a “greening” criteria in the narratives that have dominance. It follows that it is not only policy decision making, but also informal institutions, that determines the speed and types of renewal. Arguably, policy making until the release of development licenses was, in general, more about fitting with the needs of a slow changing industry complex, than promoting disruptive innovation and a renewal of the sector. It is yet to be seen how many development licenses that will be handed out, which will be a signal about the relative strength of strong path renewal narratives.

Institutions are very seldom completely abandoned, but remains in weaker or stronger form in the habitus of a system. The ideas of the emerging system and the extent these represent a true institutional innovation (or change), or “an old institution in disguise” (65), (66) are central in the analysis. The change to a new regime will always inherit residues of structure, rules and procedures from previous regimes (67). Modest changes in technology are perceived by many conservative players as large changes in the narratives that come with the technology solution, arguably because of cognitive lock-ins, or worse, constructed narratives by power-holders. Path renewal is therefore possibly perceived by many actors as more extreme than it is, because in a cognitive lock-in situation, it is hard to imagine things very different than they are in the present.

2014 marked a policy shift towards a more explicit, green policy attitude. The analysis displayed that in selections on light green and dark green licenses, a modest path renewal narrative on greening works as an important selection mechanism. However, the average actor with stakes in the industry engages the most in a path extension narrative, somewhat in a modest path renewal narrative, and less in a strong path renewal narrative.

However, an interesting finding is that private equity capitalists external to the industry seem to engage the most in a strong path renewal narrative, as they arguably look at the salmon farming industry through less path-dependent lenses.

With some exceptions, light green licenses are examples of path extension, dark green licenses as modest path renewal and development licenses as strong path renewal. Judged by the relative size of different categories of new projects, the industry is still in a path extension phase, and what appears as a radical greening shift for some conservative players stands as only modest shifts in the broader discourse. Considering the turn towards very ambitious technology plans among several actors after policy makers launched development licenses, an evolution towards more substantial greening is suddenly more likely.

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