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Why Green deals may fail – evidence from biogas, bio-ethanol and "fossil free" steel

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Abstract

Environmental policy is no longer about imposing regulations on industry but is increasingly regarded as industrial policy. Both the EU and national governments are taking more active roles in initiating "green deals" and various technologies aimed to result in sustainable development. In this chapter we describe and discuss some recent experiences of green innovation policies. Historical examples concerning efforts in both biogas and ethanol are combined with a more contemporary description of "fossil free" steel, i.e. steel made by using hydrogen instead of coal. We argue that the presence of large public funds from different funding bodies such as the EU, various government agencies and municipalities has distorted incentives, making it rational for firms to pursue technologies without long term potential. The result has been an absence of sustainable development, mounting debt and financial problems for those actors that have been involved. We explain these results and draw policy conclusions concerning the risks related to green deals. Relatedly, we argue that the EU's current efforts into hydrogen gas face similar challenges.

Keywords: Green deal, biogas, policy failure, entrepreneurial state, directionality
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1. Introduction

A shift has taken place within environmental policies over the past decade. Environmental policy used to be primarily concerned with imposing various controls upon the emission of harmful substances. Inspired by economist Mariana Mazzucato (2015) and literature on socio-technical transitions (e.g. Geels, 2004) such policies are rooted in ideas such as Hicks' treatise on variation (1932) and Arrow's work on the public good nature of research and development (1962). Consequently, many governments as well as the European Union have taken industrial policies on a new, considerably more interventionist path, sometimes referred to as 'innovation policy 3.0'. For example, the 'EU Green Deal' aims to mobilize 1000 billion euros over the coming decade in order to accomplish a transition to sustainability. A large portion of these resources will be allocated to specific technologies such as hydrogen gas. This shift towards interventionist policies stands in stark contrast to conventional wisdom concerning the state's inability to "pick winners" (e.g. Lerner, 2009; Karlson et al., 2021) and deserve to be scrutinized in further detail.In this chapter we provide a critical discussion of this policy shift by raising a couple of cases of policy failure. The first two are historical yet fairly recent examples from the 2000s and concern biogas and ethanol from cellulose. They can both be regarded as policy failures as they 1) have not resulted in a transition to making use of resources in a more sustainable way and 2) taxpayers and publicly owned businesses have incurred significant costs and accumulated large amounts of debt.These two cases help us identify a couple of factors that together point at the downside of active industrial policies. The chapter suggests that large amounts of public money in the form of technology specific R&D support programs, soft loans and directed, supposedly "free" money distort incentives and result in malinvestments, i.e. investments that are poorly allocated. We end this chapter with a concluding remark regarding the potential risks and hazards related to interventionist industrial policies.

The insights developed from the first two cases are subsequently applied to the ongoing developments concerning the EU's efforts related to hydrogen gas and the evolution of supposedly fossil free steel. We argue that fossil free steel is in fact not fossil free, and point out the risks of these ventures and argue that they will harm both the environment and the economy.

2. Theoretical background

An emerging consensus in society is that economic growth needs to be combined with sustainable development. Historically, these two goals have primarily been accomplished by imposing taxes, subsidies and complete bans of certain emissions. The interplay between technology development and regulation has resulted in considerable advances (Porter & van der Linde, 1995). In industrialized countries like Sweden, 24 out of 26 harmful substances have been reduced since 1990, despite a GDP increase of 85 percent. For Sweden, CO_2 is down 28 percent since 1990, adjusted for GDP growth the decline is 60 percent (Grafström & Sandström, 2020).

In recent years we have witnessed the emergence of an alternative, much more interventionist approach to accomplishing economic growth and sustainability. Derived from theories on both market failure and system failure, literature on innovation systems and technological systems has argued that collective action problems may prevail concerning technology development (Jacobsson and Bergek, 2004). Uncertainties are initially high, huge investments are required, free rider problems may exist, and benefits may be distant. At the same time, investments in new knowledge may benefit the economy in the long term due to positive externalities.

Based on these theoretical arguments, scholars such as Mariana Mazzucato have advocated that the state ought to take on a more active role in advancing societal goals such as sustainability (Mazzucato, 2015; Mazzucato 2020). The term *Directionality* is increasingly used among scholars in order to emphasize the role of innovation policies in directing society towards addressing grand challenges (Schot & Steinmueller, 2018). This new idea is at times referred to as innovation policy 3.0 and stands in contrast to previous innovation policy as it is explicitly concerned with making use of science, technology development and entrepreneurship in order to address large societal challenges (Grillitsch et al., 2019).These recommendations stand in contrast to the perspectives brought forward by e.g., Josh Lerner's *Boulevard of Broken Dreams* (Lerner, 2009). In his book, Lerner describes how policies aimed for innovation and entrepreneurship have been largely unsuccessful across both developed and developing countries. Generally, calls for increased directionality are done without considerations regarding the limitations of policy, or policy-making (Mazzucato, 2015; 2018). Evidence of policy failure is scarcely reviewed, yet there are by now many studies pointing at the limited effects of more interventionist policy approaches and support structures aimed to increase innovation (Bennett, 2008; Ejermo, 2018; Karlson et al., 2021). Lerner (2009, p.5) summarized extant evidence on government interventions for innovation as: "*for each effective government intervention, there have been dozens, even hundreds, of failures, where substantial public expenditures bore no fruit*."

Economic theory can explain the evidence described by Lerner and other researchers. First, theories on market failure regarding innovation and technology development are theoretical arguments derived in the 1960s and 1970s (Arrow, 1962; Akerlof, 1978. Empirically, it is very difficult to quantify and locate a *market failure*, which means that attempts to correct a market failure face the risk of being miscalculated in terms of size and scope. Second, it is difficult for the state or any other single actor *to know beforehand* what technology is more likely to prevail. Selection of technologies happens through "trial and error" over time and capitalist competition can in that sense be regarded as a discovery procedure (von Hayek, 1945). If the state decides which technology should be chosen, it is very likely that such a decision will in hindsight be regarded as incorrect. Third, the presence of interventionist policies such as targeted support structures and large amounts of public money devoted to certain technologies easily *distort incentives* in the marketplace and result in opportunistic adaptation by firms such as subsidy entrepreneurship (Gustafsson et al., 2020) or corruption. These three mechanisms shed light on the risks of active interventionist policies and help us to explain some contemporary cases of failed industrial policies, e.g. solar photovoltaics in Spain (Del Rio and Mir-Artigues, 2012) targeted innovation support schemes (Daunfeldt et al., 2015). In the coming section, we provide further empirical evidence on how these factors have applied to two contemporary cases of industrial policies in Sweden: biogas and ethanol from cellulose.

3. Two historical cases of policy failure: biogas and ethanol

We here describe and discuss how efforts related to technological development and sustainability have failed. We first look at biogas in Sweden and next turn to ethanol.

3.1 Investments in Biogas

Throughout Sweden, there are many cases over the past two decades related to large scale attempts and failures to develop and manufacture biogas, i.e. gas and energy from waste. A national public investigation into the technology and economics of biogas had in 1998 identified a collection of limitations related to biogas including limited economies of scale as new sites need to be built locally. The transport of manure requires an expensive infrastructure of pipes. As the idea is to make use of biogas as fuel, these public companies are in reality competing with gasoline and diesel, fuels that are presently very competitive and subject to considerable price variations. Attempts to introduce and sell biogas are therefore a form of speculation in an increase in oil prices over time.

*The Västerås case I*n the city of Västerås, 100 kilometers west of Stockholm, a couple of municipalities joined forces in the late 1990s and formed a public company named Vafab Miljö, meaning Vafab Environment. It started with the idea for a "steel cow", i.e. an industrial plant that would make use of fertilizers from cows in order to make energy. It started with a couple of farmers and two professors at Sweden's University of Agriculture (SLU) in the 1990s.Vafab now took part in the formation of "Svensk Växtkraft AB", which can be translated as "Swedish Growth". 40 percent of this business was owned by Vafab, 20 percent by the Swedish farmers association, 20 percent by the public energy company Mälarenergi and the remaining 20 percent by 17 farmers. Early on, this initiative managed to obtain 20 million SEK [roughly €2mill.] in the form of an EU grant. Over the coming years, attempts to obtain EU grants became an integral part of the business.In the next phase, a market for the biogas needed to be identified and targeted. It started with the region's public transportation company, Västerås Lokaltrafik (VL). In 2006-2007, VL removed 40 diesel buses and replaced them with biogas buses. As these buses were not mass manufactured, economies of scale were limited and hence the buses very expensive. Biogas buses cost an additional 14 MSEK in modifications over the coming years. VL agreed that the price they paid for the biogas would not follow the price for diesel, and it was expected that diesel prices would increase seven percent annually and hence break even would be reached in 2017 as the relative price gap increased over time.

In reality, the above meant investments in biogas could be regarded as large scale speculation in oil price fluctuations. Optimism was high, and VL made forecasts in 2011 that 90 percent of their buses would run on biogas in 2016 and 100 percent in 2020. The CEO of Vafab, Eva Myrin, argued that Vafab faced a "huge challenge" as in meeting demand in the following years where production would have to increase 150 percent per year. Thanks to an agreement with Swedish Biogas, the creation of another facility was initiated in 2011.The "huge challenge" turned out to become the reverse form of a challenge. As oil prices declined sharply instead of going up 7 percent annually, sold volumes of biogas became much smaller than expected. In 2016, production had been reduced to 1,9 million cubic meters, i.e. about 25 percent of the volumes that had been planned for. With a large infrastructure built for much larger volumes, mounting costs, debt and write-offs started to accumulate. Instead of doubling sales over five years, sales had declined substantially.*The Göteborg case* In the late 1990s, the publicly owned energy company Göteborg Energi started investing in biogas. A collection of biogas initiatives were gathered under the name "Biogas West" and funded by several municipal energy companies including Göteborg Energi. Investments continued despite mounting technological challenges. An important reason for having paid little attention to this is the opportunity to apply for and obtain public funding in the form of various targeted support programs, both regarding agriculture and climate change. Public funds from the EU were combined with national public grants and provided a continuous flow of funding over the years.

In the Göteborg case of biogas development, losses were progressively accumulated over the more than a decade, but could initially be hidden through various accounting practices. As the oil price declined sharply in 2014, large write-offs became inevitable. At some points along the way, policymakers were considering to halt the project, but continued because they had *"Klimp funds that should not be wasted"*. Klimp funding was part of a national government agency funded program for climate initiatives such as biogas and the presence of these and other funds seem to have made it rational to continue, despite a lack of potential.

3.2 Ethanol from cellulose

In Örnsköldsvik in northern Sweden, the municipality has accumulated billions of SEK in debt due to its failed investments into making ethanol from cellulose, i.e., from the forest. It all started in 1994 when the municipality inaugurated an ethanol gas station. After continued small investments over the years, efforts gained further momentum in the early 2000s. In

2004, prime minister Göran Persson took part in the formation of an industrial plant aimed to create car fuel from cellulose. The ambition was to create an environmentally friendly substitute to gasoline, which in turn would result in new jobs and a resurgence of northern Sweden in terms of competitiveness.

This vision would be driven and developed by Sekab, a firm that was owned by three municipal energy companies in the northern Sweden. Its CEO, Per Carstedt, would at times be referred to as "ethanol-Jesus". His charisma, ability to attract public funds and formulate a vision would imply that he became a very strong leader. One former Sekab employee describes his leadership in the following way:

"Carstedt was surrounded by a group of people who were not inclined to question his decisions. During long speeches, he would present completely unrealistic plans concerning how Sekab, a small publicly owned company in northern Sweden, virtually on its own would address "peak-oil" and climate change. Later on, we would also end poverty in Africa. That very few questioned him was really a worrying indication."

The rural north of Sweden has for many decades been subject to deindustrialization, a loss of jobs, depopulation and weakened welfare. Carstedt's vision of an environmentally friendly reindustrialization, lowered unemployment rates and a widened tax base was hard to resist. The same employee cited above also described the internal culture at Sekab:

"In Sekab's distorted reality, Sweden would make use of ethanol made out of trees instead of gasoline. Internally, people who questioned this idea or raised potential challenges, were often subject to ridicule by their superiors. Such voices were assumed to be bribed by big oil companies."

Sweden's Energy Agency (SEA), Energimyndigheten, had a special role in the government's enactment of its industrial policies, in this case with a special emphasis on energy and sustainability. In 2001, SEA provided Sekab with a 112 MSEK grant in order to build a pilot plant for making ethanol out of cellulose. Municipalities also took part in funding the building of this plant as well as several local universities. Considerable efforts were made to build capabilities, doctoral student projects were initiated at universities throughout Sweden and many subsequently started working at Sekab. A former employee at Energimyndigheten made the following observation: *"We used to have cake and celebrate every time we managed to spend money on a project."* This quote may seem strange from an economic perspective, why should authorities celebrate when they hand out money? It should be emphasized here that a government agency has a certain amount of resources that it is assigned to spend. The interviewee explains this as: *"if a credible application was sent to us,* *it would get funding, if we do not receive anything credible, we would give money to the most credible one that can be found."*

The process of extracting ethanol from cellulose turned out to be much more difficult than expected. A former engineer at Sekab described the situation as:

"It became increasingly obvious to us how immature the technology was, our results were in fact very poor. Carstedt made it sound like the technology was ready, but we were nowhere near the level of technological advances that would have been necessary. Calculations were unrealistic and plain wishful thinking. Climate change, the peak-oil hype, and dreams of reindustrialization and new jobs however implied that nobody wanted to question our forecasts."

As a technological breakthrough appeared to be distant, Sekab increasingly tried to create ethanol supplies abroad. These operations soon ended up far away from Sweden, Sekab started to import ethanol from Brazil, initiated the building of a plant in Poland, planned for four factories in Hungary and tried to grow sugar canes in Tanzania. Losses kept increasing and often amounted to hundreds of millions. Towards the end of 2006, the municipalities had to invest an additional 170 MSEK, primarily aimed for international expansion. Land was acquired in Tanzania, consultants were hired in Mocambique and large sums were spent in Ghana and Togo to build production capabilities there. The efforts in Hungary cost 85 MSEK, with no results at all.

In September 2007, a meeting was held in Örnsköldsvik where top municipal politicians formally admit that they are aware of all these activities. In Sweden it is illegal to spend a municipality's money abroad and thus, the situation became politically controversial.

Once the great recession hit in 2008 both oil and ethanol prices declined sharply. Ethanol became less and less competitive over the coming years. Despite this fact, SEA chose to provide an additional 33,8 MSEK over the coming years, aimed for developing the plant in Örnsköldsvik. A former SEA employee described the agency's reasoning as *"We never asked whether Sekab could become commercially viable."*

The primary reason for not doing so was that SEA's mission was to fund basic and applied research. Commercialization was never part of its mission. Over the coming years, more public money was poured into Sekab as losses continued to be accumulated. Despite an economic catastrophy and the absence of a technological breakthrough, investments have continued. In 2018, an additional 4 million euros were received from the EU over the coming three years. In the midst of this turmoil, Sekab has in fact also received a lot of positive PR. In 2009, the firm received the international prize "Sustainable Bioethanol Award", and Robert

Silverman from the US embassy came to visit Sekab, primarily because president Barack Obama was interested in green technologies. In 2015, Sekab received the Örnsköldsvik municipality's annual award to green business "for its efforts to supply society with sustainable chemicals and biofuels".

4. EU, hydrogen gas and "fossil free" steel

As the European Union is rolling out its "Green Deal" across member countries, new projects and initiatives take shape. New policies and support structures are currently put in placerolled out across the continent and it is important to gain insights into this process on the national level. *One* such example can be seen in Sweden, where steel manufacturer SSAB has joined forces with electricity giant Vattenfall and the mining company LKAB to develop what they refer to as fossil free steel.

Below, we provide a critical discussion of these policies in general and particularly regarding Hybrit and the Swedish experience. We argue that the supposedly green steel is actually not good for the environment and explain why it presents a real danger to the economy as it may result in electricity shortages across the country. The primary reason for the emergence of this idea is related to the massive EU funds that have been made available for such projects. Together, these funds result in distorted incentives making it rational for firms to pursue irrational technological ventures as someone else is paying a large part of the resources.

4.1 Hybrit and "green steel"

Hybrit is an attempt by three firms to jointly develop "green steel". In this case they refer to steel being made by using hydrogen gas instead of coal. Today, steel accounts for a considerable part of Sweden's carbon dioxide emissions, and if Hybrit succeeds with its plans, they calculate that the savings will amount to ten percent of Sweden's total carbon dioxide emissions per year (Hybrit, n.d.).

Hybrit has ambitions to have a large-scale industrial production ready in 2045. Their demonstration plant will be able to produce half a million tonnes per year and will start in 2026 (Nohrstedt, 2018; SSAB, 2021). Their competitor H2 Green Steel (H2GS) has plans for industrial production as early as 2024, with increased production until 2030 where they will be able to produce five million tonnes per year (H2GS, 2021). Although these ambitious plans are set to be achieved in a near future, there are major uncertainties in terms of overcoming technical obstacles with hydrogen storage, hydrogen production and not least electricity supply (SVT, 2021).

4.2 Hydrogen production

In terms of hydrogen production, there are currently three approaches. The gray hydrogen gas, the blue hydrogen gas and the green hydrogen gas. The gray hydrogen gas uses methane to separate hydrogen and oxygen from water and thus produce hydrogen gas. The by-product is finally carbon dioxide. Although this is a worse method for climate, today it is the cheaper method and it accounts for about 95 percent of the world's total hydrogen production (My Fuel Cell 2015); (Jensen, 2021). In fact, to produce one tonne of hydrogen requires two tonnes of methane and as much as five tonnes of carbon dioxide are formed in this process. The blue hydrogen, like the gray hydrogen, uses non-renewable sources to produce the hydrogen. The difference here is that emissions are reduced with CCS (geological storage of carbon dioxide) and this can reduce emissions in the process by up to 95 percent. However, CCS, like fossil-free steel, is a new and expensive technology that is not yet commercially available (Stensvold, 2018).

The green hydrogen is, as the name suggests, kinder to the climate. By electrolysis, only water and supplied electricity are used to produce the hydrogen gas. The residual product becomes oxygen and instead of using coke in the iron production, the residual product becomes water instead of carbon dioxide. (The Agility Effect, 2020a); (Hybrit, n.d.). For the hydrogen gas to be completely green, however, it is required that the electricity supplied during the electrolysis is also from renewable electricity.

Both the production of hydrogen by electrolysis and long transport distances for electricity are associated with energy losses. For example, it is estimated that approximately 30–40 of the energy used in electrolysis is lost (My fuel cell, 2015). Transmission losses are also estimated today to be a problem with large amounts of energy, which is why the need for expansion of new high-voltage networks is considered to be large (SSAB, 2021). In both areas, technology is being developed to overcome these energy losses, but this also means that technology is also expensive (My fuel cell, 2015); (Alpman, 2020).

The green hydrogen gas is used to a small extent today and the primary reason for this is that it is expensive. Producing one kilogram of green hydrogen currently costs five euros, which is comparable to the price of gray hydrogen of 1.5 euros for one kilogram (The Agility Effect, 2020b). Alpman (2020) explains, for example, that green hydrogen gas today is far too expensive to produce and that it is not adapted for large-scale production. Problems such as the cost of electricity varying with the weather and the need for new types of membranes and catalysts must be overcome in order to reduce prices. The own industry organization Jernkontoret also describes that the production and storage of green hydrogen is the biggest technological obstacle at present for projects such as Hybrit (Jernkontoret, 2020).

Hydrogen has been praised by many. For example, the then Bush administration invested $ 1.2 billion, in 2003 dollars, in research to develop hydrogen-powered cars with the ambition of replacing fossil fuels (Macfie, 2003). They were convinced that the new technology with fuel cells would be cheap enough to be used commercially in cars around the year 2010. It did not turn out to be a reality due to energy losses and expensive costs, but the hope is still alive. Today, the EU has taken over the dream and has now invested € 430 billion until 2030 in its "EU Hydrogen strategy" (Vätgas Sverige, 2020).

4.3 Hydrogen steel and electricity consumption

Hybrit and H2GS are estimated to consume 67–72 TWh in 2045, unless H2GS expands its production from 2030 (Dickson & Törnwall, 2021). To put this in context, Sweden's electricity consumption in 2020 was 134 TWh (Swedish Energy Agency, 2020). That is, only these two projects would account for an increase of just over 50 percent in 2020 consumption, all other things being equal.

Today, Sweden has a surplus of electricity during almost every day of the year. In 2020, 159 TWh was produced and after consumption, this left 25 TWh in surplus which was exported to neighboring countries (Swedish Energy Agency, 2020). Note that exports are measured in net, exports and imports occurs all the time due to transmission losses over long distances. Furthermore, there is an opportunity cost of using the otherwise exported electricity in terms of emissions.

To some extent, the otherwise exported electricity can be used to supply these projects with electricity, but for the remaining parts, production needs to be developed. This raises a potential problem in the form of new high-voltage-networks having to be built. Svenska Kraftnät explains that these new high-voltage-networks take about 12 years to complete and that they often involve delays (SVT, 2021). We ask ourselves whether this is compatible with H2GS being up and running with industrial production in less than 3 years.

5. Analysis and Discussion

Both the biogas and the Sekab ethanol experience can be regarded as contemporary illustrations of the ongoing shift towards a different form of environmental policy. Sustainability is no longer about legislation, taxes on emissions or subsidies to certain technologies. It is also about the state taking on an active, interventionist role, providing considerable financial and educational resources for the formation of new technologies and related firms. In this sense, the state has acted in line with the arguments brought forward by Mazzucato (2015), taking on genuine Knightian risk and increasing levels of directionality. The case descriptions above, however, stand in contrast to the positive effects of such an "entrepreneurial state" (Mazzucato, 2015) and rather seems like another example of Josh Lerner's *Boulevard of Broken Dreams* (2009). Lerner (2009) points at the combination of information and incentive problems in innovation policy and explains why government efforts in technology are often misguided. Despite high expectations, billions of SEK in public money and considerable investments in new technologies, no widespread diffusion of a more efficient and environmentally friendly use of resources can be observed. At the same time, taxpayers have incurred large costs, resources that could have been used for other purposes.

As cases of failed interventionist policies, the biogas and Sekab experiences provide an opportunity to identify important insights into the mechanisms of interventionist policies and how "the entrepreneurial state" can fail. Below, we elaborate on these insights.

5.1 Public funds and the economics of incentive distortion

As can be seen in both the biogas and ethanol cases, the presence of large public funds for specific technological efforts seems to have paved the way for the persistence of these efforts, despite that technological breakthroughs and commercial viability seemed rather hopeless.

Public money seems to have made these firms immune to risk. The biogas initiatives were built on a business case where oil prices were assumed to increase 7 percent annually. Effectively, these municipal companies were using billions of taxpayer money to speculate in oil price fluctuations. Speculating in natural resources is inherently risky, but nobody seems to have questioned these efforts. The combined presence of large, public funds available both regionally, nationally and on the EU-level seems to have created an environment where it is not only possible, but also rational to allocate vast resources to risky and technologically impossible ventures. Consider the following hypothetical example: If someone would give you a million euros but in return ask you to destroy something, what would be the total value of goods and services that you would be willing to destroy? The hypothetical answer would be 999 999 euros, as you would then theoretically earn a euro.

The ever-present demands for co-financing in EU projects along with the presence of government funds in reality makes it rational to destroy capital. Elementary economics teaches that firms will produce as long as their marginal revenue is higher than their marginal cost. Put differently, if the next unit a firm considers making does not generate revenues that match the marginal cost, firms will not make it. Applying such elementary microeconomic logic helps to understand why destruction of capital is likely to prevail. Marginal revenues equal at least the public funds received for e.g. investing in biogas, and municipalities can invest almost a similar amount of money as their marginal cost and the efforts would still make sense. Put differently, the presence of large external, public funds and the demand for co-financing makes it rational to destroy capital.

This argument may seem like an overly cynical theoretical construct. Unfortunately, it has a lot of applicability and explanatory power. Revisiting the case of biogas above, the quote concerning *"Klimp funds that should not be wasted"* indicates precisely such a logic. At the point when it has become clear that the project is futile and needs to be shut down, there are still strong incentives to continue as doing so is connected with a marginal revenue in terms of obtaining more public money.

The story about Sekab and cellulose from the forest provides further illustrations of such a pattern. Despite that the technology seem underdeveloped and lacked potential, investments continued and became increasingly esoteric. The fact that Sekab still continues to attract millions of euros in EU money many years after it has broken municipal laws, created debt for taxpayers and not made any economic advances indicates how the presence of large public funds make it very difficult to shut down initiatives.

5.2 Indirect and hidden costs

Organizations applying for public money may obtain large funds, yet at the same time they face an opportunity cost. The time and effort spent in order to search for, apply for, obtain, administrate and report cannot be neglected. These efforts can be quantified but are rarely taken into account. It is harder to estimate the effects from lost opportunities, as these opportunities by definition will never be realized. Time, and attention is a scarce resource and if it is spent on one activity it is not spent on another activity.

In rural parts of Sweden, the sum of all public funds from that state and from the EU amount to at least 1000 euros per inhabitant. As such vast resources trickle down into the local economy a considerable portion of the economy will be devoted to dealing with these funds instead of building other ventures. While the need for real, significant reforms is pressing in most European economies, such efforts are put to a halt when entire regions become dependent on external funds.

5.3 Public sector inefficiencies and risk for corruption

The two cases described above also illustrate how the financial logic of public funds tends to be focused on cost rather than value. A government agency has a certain amount of money assigned to distribute over a year. If they do not spend that money in a year there is an apparent risk that they will miss out on that money in the next year. The quote concerning "celebrating by having cake together" at one government agency illustrates this effect.

Questions related to corruption need to be addressed within the scope of this chapter. The Sekab case covered how a firm owned by municipalities was in fact spending its money in illegal ways as it was doing business abroad. Moreover, it is impossible to assess how resources have been spent, e.g. the consultant fees in Mozambique or the 85 MSEK spent in Hungary on building a plant. There are also plenty of traces of corruption in the biogas cases.

Again, the effects of public funds on the incentive structures need to be discussed. When receiving a public grant, the funding agency imposes certain demands concerning accounting, co-financing etc. If an organization receives grants from several different funding bodies on different levels, the level of administration, reporting procedures etc increases exponentially. Dealing with all these layers of money naturally leads to the creation of different subsidiaries and a variety of different organizational forms. An internal bureaucracy of large proportions has been created. A fertile soil for creative accounting and corruption has been created.

The Sekab case illustrates how political and commercial priorities may conflict and that when public funds are present, the former tends to gain the upper hand. Despite being an economic catastrophe that has received a lot of attention in Swedish press, Sekab kept receiving positive media coverage as well. Sekab received various awards, both locally and internationally and it was visited by people from the US embassy. For the involved politicians, Sekab might have been a success story. Policymakers could appear as visionary and decisive, combating climate change with initiatives that resulted in new pilot plants and new jobs in the short run.

5.4 Hydrogen steel – a risk for both the environment and the economy

As stated above, hydrogen steel requires large amounts of electricity. The supposedly fossil free steel will make use of 67-72 TWh of electricity, totaling more than 50 percent of Sweden's annual electricity production today.

The opportunity cost for such amounts of electricity cannot be neglected. According to professor Björn Karlsson at the university of Gävle, 15 TWh could be used in order to transfer electricity to countries like Poland or Germany where coal plants emit a lot of greenhouse gas. Making use of 15 TWh in this way would mean that 15 million tonnes of CO2 could be removed. As "fossil free" steel will make use of 67-72 TWh we estimate that at least ten times more CO2 emissions could be removed if making use of electricity in this alternative way.

While this calculation may seem a bit theoretical, the opportunity cost nevertheless needs to be taken into consideration. Referring to green steel as green or fossil free is only correct as long as there is no better alternative use of green electricity. In the foreseeable future, there are many much more efficient ways to cut emissions. Moreover, according to Tobias Persson at Tillväxtanalys, there is already considerable competition from recycled steel, which amounts to 40 percent of all steel consumption today and makes use of 75-95 percent less energy than conventional steel (FTI, 2009).

Making use of hydrogen gas is also associated with substantial losses of energy throughout the process. 30-40 percent of all energy is lost in the process of electrolysis (My Fuel Cell 2015). If so large amounts of energy are lost along the way and the total amount used is 70 TWh, about 21-28 TWh will be disappear. This amount corresponds to 15 percent of Sweden's electricity production and all energy that is used by the Skåne region, with its 1,4 million inhabitants and 600 000 jobs. How can it be regarded as sustainable to implement a process which effectively wastes 30-40 percent of all green electricity in Sweden?

A threat to the economy and free competition?

The Swedish electricity system is presently at times running on maximum capacity. In southern parts of Sweden, electricity prices are already high, and there is presently mounting concern regarding the long-term supply of electricity.

When looking at the Swedish electricity system, it is clear that it is not in its current shape ready for an expansion of more than 50 percent over the coming decades. While some of the otherwise exported electricity can be used to supply these projects with electricity, supply will nevertheless have to increase considerably. This raises a potential problem in the form of new high-voltage-networks having to be built. According to Svenska Kraftnät, new high-voltage-networks take about 12 years to completion and that they often involve delays (SVT, 2021). We ask ourselves whether this is compatible with H2GS being up and running with industrial production in less than 3 years. Creating such an increase in the need for electricity without any serious plans regarding how this can be accomplished is clearly to take a gamble with the country's economy.

As described above, the Hybrit initiative has already received considerable public support. Not only billions of cheap loans, EU funds and funds from the Swedish Energy Agency, but Hybrit also requests access to the vast amounts of green electricity mentioned above. All these benefits raise important questions concerning effects on competition. Can competition be fair and on equal terms when one actor receives so many billions of state support?

So far, EU's novel approach to sustainability with its 1000 billion euros that are largely borrowed, targeted hydrogen gas money, taxonomies and emerging CO2 tariffs have not been discussed regarding their effects on the market economy and the notion of free enterprise.

The presence of large public funds in the form of cheap credits, conditioned loans, research funding etc also result in an indirect yet significant steering of the economy. In Sweden, steel manufacturer SSAB is increasingly controlled by the state and other state owned companies. The other two firms involved in Hybrit (Vattenfall and LKAB) are 100 percent owned by the state already. This is not a coincidence.

70 percent of the "private" and "entrepreneurial" venture H2GS is funded through "green project credits", a form of unconditioned loans that can be written off. Out of 25 billion SEK that will be raised, 17,5 billion will be such green project credits. Is it meaningful to speak of H2GS as a private initiative at all?

The past century of economic development across the world strongly suggests that high levels of state involvement in the economy are not compatible with development or freedom. Large interventions have large effects on free enterprise and the dynamics of a market economy. The shift that has taken place is alarming and deserves to be discussed more seriously.

5.5 Repeating the mistakes of biogas and ethanol

The biogas and ethanol cases covered previously in this chapter provided insights into how public funds distort incentives of firms. The cases reviewed both illustrate how billions of money were wasted by publicly owned firms in a process where their own resources could be matched with public funds, effectively making it rational to destroy capital. On numerous occasions it was clear how these firms were realizing the futility of continuing their efforts but chose to do so anyway, for the simple reason that they could obtain public grants for doing so. Hence, the presence of a multitude of different public funds for different purposes create an environment where organizations effectively become immune to risks.

We argue that a similar form of distortion, albeit on a larger scale, has been created by the EU Green Deal and that the Hybrit case constitutes an alarming illustration of this pattern. Investments are huge, the technological risks regarding steel production using hydrogen and the storage of hydrogen are considerable. Positive effects on the environment are questionable and the indirect effects on the Swedish economy must not be underestimated bearing in mind the risks for an electricity shortage in the coming years.

The discrepancy between this reality and the public debate in Sweden concerning Hybrit is striking. Despite the issues raised above, no one within the political or economic establishment beyond the authors have raised any concerns. To the contrary, the Hybrit firms are heralded as environmental heroes by the media, the Swedish prime minister inaugurated Hybrit's pilot plant in 2018 and state press has referred to Hybrit as a "great leap" and as "the greatest improvement to steel production in 1000 years".

When 320 billion of EU money are up for grabs for making use of hydrogen gas and when funds can be matched, combined and re-combined into a pseudo-economy where economic laws of scarcity no longer exist, no one has any incentives to question the process. Risky and reckless ventures are perceived and discussed as "opportunities" for the simple reason that someone else is taking all the risk. These funds result in large scale subsidy entrepreneurship that make destruction of capital rational as it is much easier to put up your own money if you obtain public funds for doing so. In this sense, the Hybrit case and the large scale experimentation with hydrogen gas that is currently taking place in Europe resemble the painful and expensive experiences regarding biogas and ethanol from cellulose described previously. There are many examples of how such policies have turned into veritable disasters, we hope that our concerns are exaggerated and that we will be proven wrong.

5.6 EU funds result in environmental nationalism

Ironically, the presence of large EU funds for innovation and sustainability seem to result in a form of environmental nationalism. Hybrit and similar initiatives in Sweden state boldly that their aim is to contribute to Sweden becoming an economy that is completely free of fossil fuels. While this may sound like a noble cause, most environmental problems including air pollution and climate change are after all global problems, which require coordination between different countries. If one country lowers its emissions at the expense of a substantially lower cut in emissions elsewhere, the net contribution of such an initiative is in fact negative. We may end up with a form of environmental nationalism, where countries pride themselves in optimizing emissions on the local or national level while the overarching effect is negative.

The funds available from EU for different member states and firms to apply for result in precisely this form of suboptimization. Ironically, the presence of pan-European support structures lead to a form of environmental nationalism that leads to the absence of sustainable development.

6. Conclusion

This chapter has reviewed and discussed two historical examples where interventionist innovation policies have failed: biogas in Sweden and ethanol from cellulose (Sekab). These cases stand in stark contrast to ideas about an "entrepreneurial state" successfully taking on Knightian risk and pursuing new opportunities.

While it is clear from the descriptions above that the presence of public funds has initiated risk taking and ventures into new technologies, it is also clear that this has been done in an unsuccessful way. Interestingly, an important reason for this seems to be that the studied cases in fact contained *too much risk*. The presence of a combination of large, public funds, seems to have made these organizations immune to risks. Biogas and ethanol from cellulose were in reality poorly calculated speculations in oil price fluctuations using hundreds of millions of taxpayer's money. Once it became clear that potential was in fact limited, activities were not closed down. To the contrary, investments continued more than a decade later as public money could still be obtained for doing so.

Public funds create a peculiar incentive structure which, in reality makes it rational to destroy once's own resources. Elementary microeconomics teaches that investments continue as long as marginal revenues exceed marginal costs. This investment rule is distorted by public funds which provide a marginal revenue that effectively nullifies the costs and risks.The hidden costs, however, are very real as we see the crowding out of other economic activities. Also, the presence of multiple, large public funds to apply for on the local, regional, national and EU levels in the long run create a fertile ground for corruption.

The combined effect of multiple funds available on different levels and for different ends (social, regional, environmental and economic) need to be discussed among both scholars and policymakers. The evidence provided in this chapter provides insight into mechanisms that are alarming. As the EU has moved further towards interventionist policies with regards to sustainability, there is great risk that the failures described in this chapter will increase in magnitude over the coming years.

Having observed and described the government failures related to biogas and bio-ethanol from cellulose, we have subsequently taken these insights and applied them to the contemporary case of hydrogen steel and the EU's current efforts related to hydrogen gas. Our case descriptions and discussion concludes that Hydrogen based steel is not good for the environment and that it has potentially detrimental effects on the economy.

Green electricity has a considerable opportunity cost as it can save much more CO2 emissions by being used in other ways, estimations indicate that up to ten times more CO2 can be saved by making use of green electricity in other ways. Hydrogen gas is associated with 30-40 losses in pure energy waste. Combining this with large technological uncertainties would arguably imply that when adjusting for risks, the net environmental benefits are questionable.

The effects on the Swedish economy may turn out to be disastrous. Expanding Sweden's use of electricity by 50 percent in the coming 20 years requires a huge expansion of the country's energy production. As there are both operational and political bottlenecks related to doing so, we see large risks of an electricity shortage if Hybrit is scaled up. H2GS alone wants to take 15 TWh into use for its potential 1500 jobs created in northern Sweden. This amount of electricity is enough to satisfy the needs of the entire Skåne region, with 600 000 jobs and 1,4 million inhabitants. In sum, these efforts seem to be poorly thought through, but nevertheless they have been met with a remarkable positive consensus among both industrialists and policymakers in Sweden. An important explanation for this discrepancy is most likely that the EU has made billions of euros made available as "free money". These public funds related to hydrogen is part of EU's green deal.

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