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060. Taking stock of CCS in times of low expectations - I

Low expectations and remarkable opportunities of CCS technology in Finland

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Abstract

The European Union climate and energy policy has set demanding targets for Member States to mitigate climate change. Finland is attempting to address these demands by a 80 percentage decrease from the level in 1990 to the year 2050 in GHG emissions. Carbon Capture and Storage (CCS) is a technology that is proposed to greatly reduce CO2 emissions, but the technology has not a policy in Finland and it is also held possible that no CCS facility is going to be built before 2020 although the technology may be used in some form in the industry.

The Finnish energy production palette is not the optimal context for application of CCS technology but there is high-level R&D which seeks for technological breakthroughs.

The objective is to investigate how different Finnish stakeholders frame the future of CCS as part of national climate and energy policy. Do the stakeholders live in the context of low expectations or do some of them still aim at industrial implementation in Finland? Until now no study focused on the perceptions of the Finnish stakeholders only has been published. However, earlier stakeholder studies provide information regarding conduct of interviews and typologies of CCS issues.

We suggest that by analysing the differences between the 'CCS related concerns' of the Finnish stakeholders it is possible to describe the more general frames regarding CCS. We distinguished two frames. The first one is called the 'CCS development oriented' frame, which focuses on costs, storage of CO2 (absence of storage site) and policy and regulation issues. The second one is the 'CCS skeptical' frame. It is concerned with environmental and health issues, investments (reduced investments in renewables due to CCS), public subsidies and technology issues.

Stakeholders' interviews are examined within the framework of social acceptability which refers to actors' willingness to consider the technology seriously. The paper is based on 12 stakeholder interviews conducted in Finland.

1. Introduction

Finnish society and attitudes have been considered relatively pragmatic in relation to large-scale technological decisions. A recent survey of CCS indicated that the level of awareness about CCS was low in Finland although Finland was reportedly among the countries with highest rates of CCS awareness (The Special Eurobarometer, 2011, p.74–75). As awareness of CCS is low in Finland the stakeholders of the Finnish climate and energy policy could be argued to have an influential role in relation to future attitudes towards CCS. Stakeholders can play a double role in the development of CCS technology, i.e. (1) a direct influence on the implementation of CCS projects and presumably also much better chances to influence policymaking compared to lay people and (2) indirect influence on the deployment of CCS because of their ability to shape the public opinion (van Alphen et al., 2007, p.4369).This raises the question how the Finnish stakeholders perceive CCS. Do they accept CCS technology?

Social science studies on the acceptance and acceptability of CCS can be categorized into those focused on public attitudes (e.g. Miller et al., 2007; Tokushige et al., 2007; Ha-Duong et al., 2009; Wallquist et al., 2009; Oltra et al., 2010) and those focused on stakeholder perception (e.g. van Alphen et al., 2007; Hansson and Bryngelsson, 2009; Shackley et al., 2009; Johnsson et al., 2010; Sala and Oltra, 2011). These studies apply both surveys and qualitative methods, such as different interview methods. The objective of this study is to interview Finnish stakeholders to learn their opinions regarding CCS technology. The main question is: What are the stakeholders' concerns related to CCS technology in the context of climate and energy policy?

Finland is following the targets set by the EU for reducing greenhouse gas emissions by 20% by 2020 from the 1990 level. Finland moreover strives for a total 80% reduction in emissions by 2050. CCS is discussed as one possible solution in mitigating the emissions in the future in the Government long-term climate and energy strategy (See Kojo and Nurmi, 2012, p.9), but at the moment there is no clear CCS policy in Finland. CCS is strongly related to the energy production palette. In Finland nuclear energy (26.4%), hydroelectric power (14.6%), biomass (11.9%), coal (11.8%), natural gas (10.9%), and peat (6.2%) are the most used forms for producing electricity. Imported electricity amounts to 16.4% and other forms (wind, oil and waste) cover 1.8%. (Finnish Energy Industries, 2012.)

Finland's greenhouse gas emissions were about 70 Mt CO2-eq. in 2008, of which the carbon dioxide emissions accounted for 58 Mt. The largest CO2 point sources are in the power and heat sector, which would also have the greatest potential for the application of CCS technology. Iron and steel production represented the second largest sector of CO2 sources in 2008 and oil refineries the third largest sector. (Teir et al., 2011, p.6176.)

CCS technology has been studied in Finland, mainly from a technical perspective, for more than ten years (Teir et al., 2011; Kojo and Nurmi, 2012, p.7).[1] However, the Finnish bedrock is deemed unsuitable on geological grounds for long-term storage of CO2. Thus, the implementation of CCS technologies is tied to the possibility of transportation by ship or by pipeline across borders. Furthermore, CCS has been considered expensive and not mature enough in comparison to other measures for reducing CO2 emissions. (Teir et al., 2011.)

The structure of the paper is as follows. In Section 2 the focus is on understanding and defining acceptance and acceptability based on the current literature. In Section 3 the identification of key stakeholders and method of interview are introduced. In Section 4 the results of the interviews are presented as a typology of stakeholder concerns. In Section 5 findings are discussed. Matti Kojo (University of Tampere) was the main author of this paper, with contributions and comments from Anna Nurmi (University of Jyväskylä).

[1] The ClimTech Program (1999 –2002), launched after the 1997 Kyoto climate negotiations, was one of the first programmes to consider the utilization of CCS in Finland (Koljonen et al., 2002).

2. The framework for studying social acceptability from the viewpoint of stakeholders

Public acceptance and acceptability have been actively discussed in relation to different controversial technologies – CCS among them – in recent years not only by the industrial actors interested in advancing the technology (e.g. CCSA, 2011; Chrysostomidis et al., 2012; CCSNetwork, 2012) but also by scholars (e.g. Huijts et al., 2007; van Alphen et al., 2007; Shackley et al., 2009; Terwel et al., 2011; Bradbury, 2012). One reason for being in the focus of attention is seen to be the lack of progress in the commercialization of technologies. For example, Gupta et al. (2011) note that public opposition to (controversial) technologies has frequently resulted in negative consequences for their commercialization. The negative consequences have served to emphasize the importance of public acceptance in the strategic development, application and commercialization of technologies. (Gupta et al., 2011, p.2.) Lack of progress and public opposition can also be seen as a result of biased approaches applied in implementation. Participatory approaches and understanding of technologies as socio-technical combinations have emphasized the role of stakeholder engagement in planning and decision-making.

Wüstenhagen, Wolsink and Bürer (2007, p. 2684) note that social acceptance is an often used term in the practical policy literature, but clear definitions are rarely given. The terms (public) acceptance and (public) acceptability have also been used frequently and extensively in relation to CCS technology, but the terms are not defined rigorously or they are used interchangeably. Wüstenhagen et al. (2007) contribute to the discussion by distinguishing three dimensions of social acceptance based on the analysis of renewable energy innovations. The dimensions included in their conceptualization are as follows:

- **Socio-political acceptance**, which is the broadest, most general level. It refers to acceptance of technologies and policies by the public, the key stakeholders and policymakers.
- **Community acceptance,** which refers to the specific acceptance of siting decisions and projects by local stakeholders, particularly residents and local authorities. The focus is on procedural and distributional justice and trust.
- **Market acceptance,** which in a wider understanding of market acceptance, refers not just to consumers, but also to investors and the intra-firm situation.

In this paper *social acceptability* is defined as a term consisting of different thematic dimensions whose priority is subject to constant societal debate and negotiation between the policymakers and the other stakeholders. Thus we adopted the categorization of dimensions from Wüstenhagen et al. (2007) but instead of acceptance, which is the term used by Wüstenhagen and his colleagues we refer to Wolfe, Bjornstad, Russell and Kerchner, who make a distinction between technology acceptability and technology acceptance. Wolfe et al. define acceptability as "the willingness to consider the technology in question as a viable alternative" (Wolfe et al., 2002, p.140) whereas as acceptance refers to the decision to deploy, i.e. to "the formal decision to implement the proposal" (Flynn, 2007, p.16).

As evidence of acceptability Wolfe et al. see willingness to negotiate about a technology which may be conditioned by different kinds of concerns. By focusing on these concerns stakeholders' ways of framing CCS can be analysed. However, the stakeholder concerns presented in the paper should not be taken as terms of negotiation, but as more general way of framing the issue. A list of stakeholders' conditions on their support for implementation of CCS is presented e.g. by van Alphen et al. (2007, p. 4371–4373). The list consists of safety, temporality and partiality, financial stimuli, simplicity, cooperation and commitment and open communication.

Wolfe et al. (2002, p.140) perceive their approach as a process rather than being outcomes oriented. Acceptability is seen as a continuum, not a dichotomy. Part of process-like nature of acceptability is that acceptability may change over time, positively and negatively. Acceptability as a

social process, in which actors influence each other through various types of interaction, is also emphasized by Huijts et al. (2007, p.2780). Likewise Corry and Riesch (2012, p.92) apply a research approach, which aims to go beyond this dichotomy (for or against CCS) to examine social representation of CCS. They want to focus on the level of public discourse of CCS, not on individual perceptions of CCS as such.

Thus, in our view, social acceptability consists of three main thematic dimensions (socio-political, community and market) which are in advance, but very widely defined. Main categorization was thus theory oriented, whereas sub-categorization was empirically oriented (see Section 3, Table 1). Although the analysed data does not allow to describe any long-term changes in stakeholder views, we emphasize that stakeholder views and concerns are context bound and thus social acceptability is to some extend renegotiable.

3. Method

The paper is based on interviews with twelve Finnish stakeholders representing industry, the authorities, NGOs and a research organization. Our definition of a stakeholder is based on making a distinction between different actors of the field, for example between the lay public and stakeholders (van Alphen et al., 2007) or very similarly between the professionally involved actors (experts) and lay citizens (Huijts et al., 2007). van Alphen et al. (2007) define stakeholders as agents with a professional interest in CCS. Likewise Shackley et al. (2009) distinguish between 'stakeholders' – who have a professional and/or work-related interest in CCS – and the 'public' who do not have such an interest. Renn also applies a distinction between stakeholders and different kinds of publics (directly affected public, observing public and general public). Stakeholders are "socially organized groups who are or will be either affected by or have a strong interest in the outcome of the event or the activity from which the risk originates and/or by risk management options taken to counter the risk (Renn, 2008, p.273).

The interviewees were selected based on (1) stakeholders' statements on the national implementation of the CCS Directive (2009/31/EY) collected by the Ministry of the Environment in 2011, (2) researcher's own consideration and (3) interview feedback. The stakeholder statements helped to identify the potential Finnish stakeholders, whereas the researcher's own consideration was used to confine the number of interviewees after reading the statements. Interview feedback, i.e. a snow-ball method, was applied to make sure that all potential stakeholders were identified (See Kojo and Nurmi, 2012, p.21–22).

The interviews were conducted between November 2011 and January 2012. All stakeholders accepted the interview call regarding CCS issues in Finland. The length of an interview varied a quite lot, as the shortest one lasted about 45 minutes and the longest one almost one hour and 40 minutes. The interviews were not interpreted as the official statements concerning the CCS position of the organizations that the interviewees represented. The method of the interview was based on semi-structured interview (Hirsjärvi and Hurme, 2000). The request for an interview was attached with the Factsheet of the Carbon Capture and Storage Program (http://www.cleen.fi/en/Comms/CLEEN_Factsheet_CCSP_FINAL.pdf). The sheet was the only piece of advance information on CCS technology the interviewees were provided with by the researchers. Thus very modest pre-informing took place (cf. de Best-Waldhober et al., 2009; Wallquist et al., 2010; Wallquist et al., 2012) as the idea was to study stakeholders' current opinions about CCS technology. As there are currently no on-going plans to deploy CCS technology in Finland, and as according to current knowledge there is no suitable geological formation for CO2 storage in Finland, the interviewees occasionally perceived the issue to be very speculative and distant. CCS technology was also discussed only at general level without any references to a specific technology.

In the interviews the stakeholder representatives were asked if the organization they represented had a position on CCS (cf. Shackley et al., 2007, p.5094–5095). Very few had one, but then the interviewees were asked to describe the stance of the organization towards CCS technology. Based on the information received the stakeholders were categorized into three groups: critical, neutral and positive (Table 2; see Kojo & Nurmi, 2012, 24–27).

The main research questions were the same for all the stakeholders, but some additional questions and amplifications were requested depending on the responses. The interview was divided into two parts; the main open-ended questions and specific themes that included more discussion with the interviewer.

The analysis in this paper covers the responses to the main open-ended questions, but not the specific themes in which structured themes regarding CCS were asked. This exclusion was done in order to better understand the authentic concerns of the stakeholders interviewed. Inclusion of the responses in the specific themes in the analysis could possibly have biased the typology of concerns. No evaluation regarding the importance or priority of any issues for the stakeholders was made.

Stakeholder concerns were classified into three main categories based on the typology by Wüstenhagen et al. (2007). Thus the main categorization was theory oriented, whereas sub-categorization was empirically oriented. As a result the typology of stakeholder concerns was defined (See Table 1; cf. Oltra et al., 2010; Wallquist et al., 2009).

The analysis of the transcribed interviews was done by content analysis in where 'an expression of concern' was used as a unit of analysis. An expression of concern was defined as an expression of criticality, uncertainty, risk, threat, concern, challenge, problem or fear by a stakeholder due the main questions in the interview. It is important to note that not all concerns necessarily have a negative meaning, i.e. there would be negative position on CCS technology behind a concern.

Table 1. Typology of the stakeholder concerns regarding CCS in Finland.

The Socio-political dimension

- Policy and regulation
- Technology and technological development
- Storage of CO2
- Environmental and health hazards and risks
- Moral issues

The Market dimension

- Costs, cost efficiency and profitability
- Investment, investment risk and public subsidies

The Community dimension

- Local impacts
- Local awareness

Table 2. Organisational positions on CCS vs categorization of stakeholder concerns in Finland (based on the author's interpretation).

	DIMENSION								
	Socio-political					**Market**		**Community**	
	Policy and regulation	Techno-logy	Storage	Environ Health	Moral	Costs	Invest-ement	Local impacts	Local awareness
Positive									
CFI	X		X	X		X			
FEI			X			X			X
Fortum	X	X	X						
Neutral									
EMA	X	X	X	X	X	X		X	
HELEN		X	X						
ME	X	X		X		X			
MEE		X	X			X	X		
Raahe								X	X
VTT	X	X		X		X	X		
Critical									
FANC	X	X	X	X			X	X	
Greenpeace	X	X		X		X	X		
WWF		X		X	X		X		X

Industry: Confederation of Finnish Industries (CFI), Finnish Energy Industries (FEI), Fortum Power and Heat Oy (Fortum), Helsingin Energia (HELEN)
Authorities: Energy Market Authority (EMA), Ministry of Employment and the Economy (MEE), Ministry of the Environment (ME), City of Raahe, Local Environment Protection Authority (Raahe)
NGOs: Finnish Association for Nature Conservation (FANC), Greenpeace Nordic (GP), World Wild Life Fund Finland (WWF)
Research organization: The Technical Research Centre of Finland (VTT)

4. Results

The Socio-political dimension

The concerns categorized as *policy and regulation* issues were related to legislation, agreements and regulations or the absence of these. As CCS technology is still in the development phase, agreements and regulation in the field are either missing or were deemed incomplete. Predictability and continuity both at the national and international level were regarded as important features of CCS policy. Uncertainty related to climate policy and emission trading, which impacts greatly on the development of CCS policy, was mentioned. The representative of the Technical Research Centre considered the time schedules of climate targets and whether there will be a global climate agreement or European regulation only. The issue was how large the market would be under coherent regulations. Would the EU remain as one market area or could there be a global climate protocol?

The main arguments of the subcategory *technology and technological development* relate to (1) uncertainty of CCS technology, (2) declined energy efficiency due to CCS and (3) path dependency. Uncertainty of CCS technology in general was raised especially by the representatives of NGOs. There was a common suspicion that, regardless of all promised emission reductions, CCS technology could miss them and be merely support for the continuation of the coal industry. One reason for skepticism was the huge amounts of gas which should be processed and stored. Declining energy efficiency was the

most general unwanted issue in relation to CCS. This issue was raised both by the representatives NGOs, energy industry and authorities.

The development of technology and its relation to regulation was also raised as an issue. The concern was that if the development and preparation of regulations and legislation were based only on certain kind of CCS technology, this might hinder innovations and the development of new kinds of technologies as the technology developers might be given a signal that new technologies are not involved in emissions trading. A kind of path dependency was feared a due to too narrow definitions and lack of incentives for further technology development.

The absence of *storage for captured CO2* in Finland was also one major concern among the stakeholders. It was feared preventing the full-scale application of CCS technology in Finland as only CO2 capture, transportation and temporary storage are possible. Furthermore, it requires that the Finnish actors join in an international storage project or plan if they wish to move forward. It might also slow down development and the application of CCS technology in Finland, as actors in other countries are able to implement demonstration projects more quickly.

Three different types of concerns regarding the *environmental and health risks* of CCS were identified. These were: (1) leakage, (2) effects on climate change and (3) transportation. Most interviewees commented on leakage concerns, where the thought was that the CO2 would leak from the container or during transfer. Leakage was seen as a health hazard for those near the possible leakage area. The possibility of leakage was also seen as a risk such that efforts at carbon capture would be useless, if the carbon would in any case leak out somewhere. The NGOs commented on the risks of CCS that by focusing on the development of CCS technology the development of renewables would suffer and it would be very harmful for the environment. Transportation of CCS was seen to possibly cause environmental risk during ship transport because of leakage, but also because of an increase in traffic. If a pipe system were to be the mode of transportation, the construction of the pipes might also harm the environment.

Moral aspects were also touched on in the interviews. A question was raised if it is morally right to export captured CO2 elsewhere as it is produced in Finland. CO2 export was equated with the transportation of waste across borders.

The market dimension

Costs related to the application of CCS in Finland were a major concern for the stakeholders. Above all were the transportation costs of CO2 and impaired energy efficiency. The main point was the huge volumes and ensuing costs.

One interviewee noted that the whole idea of emissions trading is to steer emission reduction measures to those measures that are the most cost-efficient. From this perspective it was deemed good if CCS measures were also available for Finnish industry. Another interviewee was slightly concerned about the over-confidence of certain actors – especially those (sitting) in Brussels – regarding declining costs of CCS technology in the future. It was also feared that costs due to deployment of CCS would be perceived as an extra burden by laypeople, which could decrease the acceptance of climate policy.

Stakeholders' attitudes towards the investments, investment risk and public subsidies needed for CCS were classified into three categories: (1) Negative and critical attitudes against investing in CCS above all. This includes both investments in implementation and in R&D funding. The main concern behind this was that investments in CCS development could displace limited investments in other mitigation measures seen more efficient and sustainable than CCS. (2) Investment in CCS only on market terms, meaning that an investor should have a chance to choose between feasible options. This attitude excluded any major public investments in CCS as the financial situation was deemed so bad. (3) The third attitude was a concern about national means to arrange and share the investment risks in CCS.

A representative of an NGO expressed the fear that if companies invest in CCS technology they would have less resources for investing in energy efficiency and renewables. This would mean a continuation of business-as-usual and thus energy production based on fossil fuels. This is a frequent concern in relation to the CCS debate (Anderson and Chiavari, 2009, p.4813). In relation to public R&D funding the representatives of NGOs interviewed had adopted slightly different lines as two of them were more critical, whereas one was of the opinion that the amount of public R&D funding was of minor importance and that it was important that different measures are studied.

On the other hand, a representative of a state authority did not share this concern. The argument was that as long as the investment were made by the company and based on market action in which one has the option for emission trade, nobody should have any objections. The representative was very convinced that the state would not be able to afford the development of CCS technology. The development of the technology was considered expensive and the discontinuation of the Meri-Pori retro-fit CCS facility was taken as an example of high costs which a company was also unwilling to pay.[2] Thus, technology development should be based on others' funding.

The Finnish energy market without a state owned energy company which could take this kind of economic risks was compared in general to other countries with this possibility. Although this concern was expressed, the interviewee noted that the Finnish energy market is as a deregulated market in which all energy forms compete against each other in economic terms. She also stated that the boiler manufacturers working in Finland are at a great advantage for CCS related R&D in Finland. The representative of the Ministry of Employment and the Economy had a different view on the home (national) market and CCS as he noted that there were no guarantees that CCS technology suppliers would be Finnish if it is compared with the case of biofuels.

The community dimension

It was surprising how few comments the stakeholders made regarding the community dimension. As local impacts, pipelines (land use), increased transportation, milieu and CO2 leakages with severe health impacts were mentioned. The stakeholders seemed to share the view that a possible CCS facility would be inbuilt as part of an existing industrial facility thus there would be fewer problems with fitting in. The stakeholders were surprisingly optimistic, as they saw almost no local problems in the deployment of CCS technology in Finland. The findings might reflect the Finnish pragmatic attitude towards new technology and a kind of an aquiescent tolerance. The reader should also note that only one of the twelve interviewees represented an organization which acts mostly at the local level. The others represented more or less the 'higher' national or policy level. The improbability and temporal remoteness of any application of CCS technology might also have affected concerns.

The sub-category of local awareness reflects both the problem of storing CO2 and the difficulty of gaining local acceptance and at the same time the awareness and capability of local residents to take into account general principles and equality questions. A good example is that the representatives of the City of Raahe perceived that in a licencing process the local residents would be interested in ensuring that the rights of people living near the storage site would not be violated. However, local awareness was also described ironically as one interviewee pointed out that local awareness could be described as a general attitude of "as far as the loader and the crane are not hanging over my backyard, people will feel pretty safe". This duality can be seen as reflecting the diverse local opinions on new technological projects.

[2] The Meri-Pori Retro-fit Project 2008–2010 was the first and so far the only CCS demonstration project in Finland. The demonstration project FINNCAP was a joint project of the power companies Fortum and Teollisuuden Voima (Iso-Tryykkäri, Rauramo and Pekkanen, 2011).

5. Conclusions

Currently CCS technology is not a burning issue in Finland. The stakeholders interviewed stated that they followed the development of the technology at some level, but their main interests are elsewhere. Due to the current energy production mix in Finland, the absence of storage sites in Finland, the high costs and impaired energy efficiency, the deployment of CCS technology was seen as unrealistic in the near future. Hence we argue that deployment of CCS technology in Finland is framed with low expectations at the moment. However, there are differences in ways of framing the CCS issue in Finland.

The two frames identified in the study can be outlined by looking at the rough overview of the differences between the 'CCS related concerns' of the Finnish stakeholders (see Table 2, p.5). When the concerns of the stakeholders with a positive position on CCS are compared to the concerns of those with critical views, it seems that the former are more concerned with issues related to costs, storage of CO2 (absence of storage site) and policy and regulation issues, whereas the latter are concerned with environmental and health issues, investments (reduced investments in renewables due to CCS), public subsidies and technology issues (immaturity of CCS technology). We call the former as the 'CCS development oriented' frame and the latter as the 'CCS skeptical' frame.[3] These frames, although general, could help one to understand different views on CCS e.g. in preparing CCS policy or project measures.

If compared between the thematic dimensions, the stakeholder concerns are focused on the socio-political dimension, which included five sub categories. Of these 'technology and technological development' issues were those most stakeholders mentioned whereas 'moral issues' were considered less frequently. The fact that community dimension seems to be quite rarely a subject of a stakeholder concern may in part be due to the selection of the stakeholders, where the focus was on national level actors.

As CCS technology is still in the development phase in Finland agreements and regulation in the field are either missing or were deemed incomplete by the stakeholders. Predictability and continuity in the environmental politics both at the national and international level were regarded as important features of CCS policy. The same concern is evident when evolving the CCS issue from a national level to a global level e.g, climate targets and whether there will be a global climate agreement or European regulation only were issues that raised some questions. It is a question of market size. Would the EU remain as one market area or could there be a global climate protocol? The absence of storage for captured CO2 would also require that the Finnish actors join in an international storage project or plan if they wish to move forward. It might also slow down development and the application of CCS technology in Finland, as actors in other countries are able to implement demonstration projects more quickly.

However, the acceptability of CCS technology is conditional. For example, safeguarding development and investments in the renewables in energy policy are required. From this perspective the Finnish NGOs concerns are similar to those expressed in other countries (Anderson and Chiavari, 2009, p.4813).

The fact that there are currently no on-going plans to implement CCS in Finland could offer a chance to be proactive and to give the stakeholders and the public opportunities to exert influence on the framing of CCS policy in Finland. In practice, there could be interaction in relation to energy and climate policymaking but also to research and the development of CCS technology as these studies already began a decade ago.

[3] Although NGOs have taken a critical position on CCS, one should note that e.g. according to the Finnish Association for Nature Conservation CCS technology is needed in the long run (Kojo and Nurmi, 2012, p.25).

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