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Future Imaginaries of Negative Emission Technologies and Folklore Myths in Icelandic Basalt

Provisional Order Emerges from the Possible

Magma in the Age of 'Hauntology' and Broken Time

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Abstract:

Why do we in the Western part of world today tend to believe in technology's mythical promises rather than in folklore myths? Imaginaries of the future influence political subjects' actions in the present and play a key role in composing the trajectory towards the future. I have critically applied this notion to the implementation of negative emission technologies in the climate-neutrality strategy. This thesis is a critical social science enquiry into discourses on NETs future imaginaries in Iceland and their affect on present nature and communities in Iceland. It is initiating a Spinozist-Marxist critique of NETs and argues that NETs via myths are depoliticised by stakeholders with interests in fossil capitalism, installing NETs as climate technologies sustaining green capitalism. This critique is supported by ethnographically collected data on local peoples' alienation from carbon capture and mineralisation (CCM) in Iceland — partly due to the experience of not being represented and included in decision-making processes. It is culminating in an edifying push for pluralist metaphysics channelled through storytelling, partly told by a local self-proclaimed spiritual medium.

Keywords: NETs, Desire, Green Capitalism, Imaginaries, Storytelling, Pluriverse

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3 Introduction: Phenomena studied, research questions, purpose and aim

Many possible futures swarm in the virtual sphere over the island of Iceland. Future imaginaries spring from the myths we believe in, but why do myths of technological promise tend to dominate folklore and spiritual myths? In this thesis, I have deep-dived into the magic pond of future imaginaries. Here, I discovered cases of place-based future imaginaries overwritten by future imaginaries of green capitalism. It is far from all virtual imaginaries that will ever crystallise and become real. I argue that some virtualities hold more integrity than others and thus are more sustainable for humans to believe in. As a human ecologist, I find it essential to stress this point, as all imaginaries — sustainable or not — ‘haunt’ the present and the trajectory towards a spectrum of possible climate neutrality scenarios. My use of the conception of ‘imaginaries’ is inspired by Mark Fisher’s term ‘hauntology’ and points to the virtual not-yet of the futures and how they manifest in the present moment. Four research questions generate this thesis: 1) How are NETs imaginably constructed¹ in Iceland? 2) What is the interplay between ideology and technology in the ‘actualisation’ of NETs futures in Iceland? 3) How might the imagined future of NETs in Iceland influence the material presence of carbon emissions, climate and energy policies in Iceland today? 4) How might this affect the environment, land use and communities in Iceland today? From research questions 1) to 4) the reader will find a transition from ‘the virtual’ to ‘the real’, and my particular interest in this thesis will be to investigate the ‘actualisation’ (Berardi 2017), enabling this transition. With this thesis, I wish to emphasise the importance of stories and how stories are created through imaginaries. We need to tell stories that make us believe in the world and make reality feel like itself again. This is a theory-driven thesis supported by fieldwork data collected in Iceland between September and December 2022. I will primarily be operating on a discursive plane while acknowledging the material implications of discourses.

¹ The act of constructing something in ‘the virtual sphere’, whereupon it — to various degrees — spills over into ‘the real sphere’ (my own definition).

NETs² gained prominence in international debates around 2015 when scientists observed that the Paris Agreement's 1.5 and 2 degrees Celsius targets inherently relied on large-scale removal of CO₂ from the atmosphere, concluding that it is virtually impossible to stay within the 1.5 degrees Celsius limit without developing NETs (Christiansen and Carton 2021, p. 1). Thus, in (the latest) IPCC report(s), emissions, as well as the goal of hitting 'net-zero' is calculated as 'releases of greenhouse gases from anthropogenic sources minus removals by anthropogenic sinks' (IPCC and III 2022, p. 10). NETs open the possibility to sequester and permanently store carbon that has already entered the active carbon cycle, back in the passive carbon cycle and hereby — if sufficiently scaled — lowering the concentration of carbon in the atmosphere. This sets the scene for 'net-zero' turning into a balancing act between cutting emissions and investing in and implementing NETs. Holly Jean Buck writes in her book *After Geoengineering: Climate Tragedy, Repair and Restoration*: "It's technically possible to imagine a future where the excesses of the past (our present) are tucked away, cleaned up, like a stain removed" (Buck 2019, p. 12), whereupon she critically inquires: But "is this proposed program [geoengineering] or project likely to produce a liveable world 200 years from now?" (Buck 2019, p. 31).

4 Framework for the research: Methodological approach, theoretical grounding and research methods applied

I will primarily operate on a discourse plane of technology, claiming my social scientist role as someone who 'disentangles' (Berardi 2017) discourses. This practice serves as an attempt to 1) trace out 'local knowledges' (Klonner, Usón et al. 2021), as well as 'established knowledges' in the field, to open a comparative analysis of the two, and to 2) mediate between science, technology and 'lay people'. Standing on the shoulders of Franco 'Bifo' Berardi, I have assembled my own method for discourse analysis named 'disentangling practice'. I coin this as a seismographic practice, in which you trace out vibrations fluctuating from the imagined future to interfere with the material present and apply it to my discourse analysis. I have conducted nine interviews³, of which five people can be labelled 'lay people'. The complete data selection serves as a snapshot of Icelandic NETs

² Negative Emission Technologies

³ All interviews but the one conducted in Ölfus includes one interviewee. In Ölfus three people partook in the interview.

discourses, and the material is composed of 1) NETs directives issued by the Icelandic government and international policy documents concerning NETs in Iceland⁴, 2) perspectives from local NGO(s)⁵, activists⁶, academics⁷, artists⁸ and a spiritual medium⁹, 3) a more corporate/nature-resource¹⁰ take and 4) local knowledges from local communities surrounding Hellisheiði¹¹. I have performed semi-structured interviews (some performed virtually, some in real life), listened to oral stories from local communities in villages surrounding the case site and performed qualitative analysis of survey findings. I acknowledge the limited scope of my fieldwork data and the fact that it constitutes a significant limitation to representation. I had set out to both conduct semi-structured interviews and perform transect walks as a way to apply a discourse approach to landscapes via an inquiry into the ways they are being verbalised (Duncan 2010). My dream was to invite Ragnhildur Jónsdóttir, who often goes by Ragga, a self-identified spiritual medium who can communicate with huldafólk¹² (whom I will introduce further), or someone as knowledgeable as her, to do a transect walk with me at the geothermal side in Hellisheiði around the DAC plant, but unfortunately that was not possible. I have applied 'abductive reasoning' (Peirce 1955) to a thematic analysis and coding of fieldwork data as a dialectical oscillation (Augustine, Soderstrom et al. 2019, p. 1938) between theory, literature review and fieldwork data. In the thematic analysis, I have been searching for various degrees of patterned (Clarke and Braun 2013, p. 82) response and meaning (Fugard and Potts 2019, p. 3-4) within my data set. The construction of themes is an active process, with the implication that my thematic analysis started whilst my data

⁴ Represented by *On the Path to Climate Neutrality, Iceland's Long-Term Low Emission Development Strategy*, published in October 2021 and The European Commission's *Innovation Fund, Driving Clean Innovative Technologies Towards the Market, Coda Terminal* from 2022

⁵ Represented by Landvernd (Auður Önnu Magnúsdóttir) and Friends of the Lava (Ragnhildur Jónsdóttir)

⁶ Represented by Guðni Elisson, Ósk Vilhjálmsdóttir and Ragnhildur Jónsdóttir

⁷ Represented by Guðni Elisson, Sigurður R. Gíslason

⁸ Represented by Ragnhildur Jónsdóttir (Ragga) and Ósk Vilhjálmsdóttir

⁹ Represented by Ragnhildur Jónsdóttir (Ragga)

¹⁰ Represented by CarbFix representative Sigurður R. Gíslason and a Reykjavik Energy representative

¹¹ Represented by 3 interviewees in Ölfus, 1 in Hveragerði and 1 in Hafnarfjörður

¹² hidden people, also referred to as elves

collection was still ongoing (Fugard and Potts 2019, p. 2-3), to inform what questions should be asked and to determine when sufficient data had been collected — pointing to the inherent synthesis between induction and deduction in my project. This also means that my research questions have continuously changed throughout the process.

I situate the thesis's theoretical framework in Spinozist Marxism, acknowledging that the theory in itself cannot necessarily be described as such. I identify the ways in which I have composed and applied the theory as aligning with Spinozist Marxism — situating the production of 'desire' as central to political economy (Lordon 2014). I will also make gestures to Karl Marx and historical materialism, partly through Fisher. For the discourse analysis, I will be operating through Bifo's term 'disentangling' to disassemble discursive representations of NETs future imaginaries and the myths they operate through — tracing emergence and mutations. Here, I will hint at Roland Barthe's *Myth Today*. These theories will serve as the theoretical foundation of my thematic analysis and my data coding. Drawing on Bifo's take on the role of philosophy and theory in society, I wish to highlight critical theory and critical social science's crucial¹³ role as interpreters of the world — especially in times of climate and environmental crisis. Marx writes: "The philosophers have only interpreted the world in various ways; the point is to change it." (Marx and Engels 1886). Bifo flips this statement: "In the century after Marx, philosophers changed the world in various ways; the point now is to interpret it. The interpretation of inscribed possibilities is the main task of philosophy in our time." (Berardi 2017, p. 117-63) Interpretation — according to Bifo — is a process of deciphering inscribed possibilities. I will be applying this approach to NETs future imaginaries in Iceland, performing a critical ethnographic inquiry into the ways in which possibilities of 'net-zero' scenarios are being inscribed onto reality.

¹³ In this thesis, I will be merging my background in History of Ideas with my Human Ecology practice.

5 Context for the research: Metaphysics, ontology, epistemology and positionality

My research is situated somewhere between a critical and historical realist ontology (Guba and Lincoln 1994) and serves as an attempt to push for pluralist (Escobar 2018) realism (Savransky 2021, p. 44) and metaphysics through a Spinozist Marxist theoretical framework. I undertook this study as part of a NETs research group supervised by Andreas Malm and Wim Carton as a process leading to a contribution to their book *Overshoot: Climate Politics When It's Too Late*, which will be published by Verso Books. At that time, I was based in Iceland for an internship with LungA School in Seyðisfjörður. This was my third longer stay in Iceland working with LungA, so by that time, I had already had quite a few encounters with both Icelandic culture and nature, but I cannot claim to be part of the local community — thus, I position myself as an outsider, curiously and respectfully engaging with the case. Here it is important to acknowledge Denmark's colonial past in Iceland: Iceland was subsumed under the Danish-Norwegian Crown in 1380 and became a Danish dependency in 1660. During the course of the 19th century, Icelanders strove for emancipation from Denmark. Alþingi¹⁴ was restored in 1845 as a national consultative assembly, and from 1874 Alþingi held legislative power. Home rule was introduced in 1904, and in 1918 Iceland became an independent and sovereign state (in personal union with Denmark) in a joint monarchy. Denmark remained responsible for Iceland's foreign affairs. The personal union between Denmark and Iceland was dissolved by Iceland following a referendum in Iceland in May 1944, leading to Iceland being declared an independent republic on 17th June 1944 at Þingvellir. (Denmark did not, however, repeal the law which set out the terms of its personal union with Iceland until 1950) (Karlsson 2000) (Hálfðanarson 2008). In the post-war era, industries such as fishery and power production saw economic growth in Iceland, but in 2008 the deepest and most rapid financial crisis recorded in peacetime history hit the country, with the three major banks in Iceland collapsing during the same week in October, triggering a systemic crisis, the first in any advanced economy during this episode of financial turbulence (Danielsson and Zoega 2009). The country is, to this day, still affected by this crisis. Iceland's geo-political location between North

¹⁴ The Icelandic Althing, the supreme national parliament of Iceland.

America and Europe and its unique energy profile makes it an interesting human ecology case — as all of these factors play into the country's NETs (ad)venture.

The context of my research is a world on fire, in which climate overshoot¹⁵ (Malm and Carton 2024) seems inevitable. Geoengineering promises are elicited by climate politics and policy (McLaren and Markusson 2020, p. 392) to bridge the imagined leap between overshoot and a stable climate scenario. The size of the overshoot will prove decisive for how dependent we will end up being on techno-fixes to save us, the land quantities required to realise those technologies, as well as impacts on the environment and local communities. Imagine a spectrum of different overshoot scenarios ranging from a high-emission pathway, a status-quo scenario where living standards in the global north are maintained, and energy consumption remains high and a low-emission pathway — a de-growth system change scenario. This spectrum spans from 5 to 15 gigatons of carbon dioxide removal by 2050 to stay below 1.5 degrees Celsius. (Buck 2021, p. 36)

CCS¹⁶ promises and research blossomed in the early 2000s, and the IPCC published a CCS special report (...) CCS was widely adopted in IAM pathways to optimise costs by enabling a slower transition away from fossil power generation, especially coal. But practical development of CCS got little further than research facilities while the promise of 'CCS readiness' even facilitated continued construction of new fossil power plants (...) In the models, increased future NETs contributions still replace near-term emissions cuts through the action of cost optimisation in the face of discounting.”
(McLaren and Markusson 2020, p. 395)

As a social scientist, I will focus on the discourse level of technologies, 'disentangling' (Berardi 2017, p. 53) the different ways the future, through myth-charged imagination, is being inscribed onto the present (Berardi 2017, p. 16). You will find CarbFix's 'naturalisation' of their technology a core example of discourse production, inscribing the future onto the present (section 8.3)

¹⁵ The idea that humanity temporarily can go above 1.5 or 2 degrees Celsius, then reverse the overshoot and land back in a safe zone of climate stability. In this imagined leap, the latter part, the 'reverse part' can only be called into existence by NETs.

¹⁶ Carbon Capture and Storage, not to be conflated with CDR (Carbon Dioxide Removal) — the latter being more directly linked to NETs.

5.1 THE ICELANDIC NETS (AD)VENTURE

OECD's Environmental Performance Reviews provide policymakers with a foundation for green policy. I have retrieved basic information on Iceland's energy profile through this review, and it lays the foundation for this section and my assessment of the link between Iceland's NETs and energy profile. Iceland has a very low-carbon energy mix. Renewable energy sources (hydrothermal-, geothermal- and wind energy) account for 85% of the total primary energy supply (in 2012), which is far more than any other OECD country. Imported fossil fuels make up the rest and are used primarily in transport and fishing. Iceland's industrial structure is energy-intensive, four times the OECD average, and based on aluminium smelting. More than a third of GHG emissions come from industrial processes, mainly aluminium smelting. Emissions have declined since 2008 because of the recession. Abundant and cheap renewable energy is one of Iceland's key economic assets, and power production capacity has expanded vastly to meet demand from new energy-intensive industries — mostly for aluminium smelting (OECD and Lives 2014, p. 4). The national goal of net zero emissions no later than 2040 was enacted in the Climate Act in June 2021, based on the Government Agreement from 2017 (Iceland and Resources 2021, p. 8). The Icelandic government presented a new Climate Action Plan in September 2018, and an updated version was presented in June 2020 (which I will return to in section 7.1). The 2020 plan contained 48 actions – 15 new from the 2018 version – aimed at reducing greenhouse gas emissions and increasing carbon uptake from the atmosphere. (Iceland and Resources 2020, p. 2) The Climate Action Plan is Iceland's main instrument to reach the Paris Agreement and the stated goal of carbon neutrality by 2040 (Iceland and Resources 2020, p. 2).

The vast amounts of renewable energy and basalt in the bedrock are said to make Iceland a unique case and are often used as an argument in favour of Iceland taking on a key role in the NETs adventure. More arguments from experts in the field go: 1) Young and fresh basalts can naturally store >100 kg of CO₂ per m³, 2) >95% of the injected gas is mineralised within two years, 3) At present, >50% of the injected carbon is fixed as carbonate minerals within months of its injection. (Snæbjörnsdóttir, Sigfússon et al. 2020, p. 93-95) The largest storage potential lies offshore (Gutknecht, Snæbjörnsdóttir et al. 2018, p. 132). According

to Sigurður R. Gíslason and his colleagues, the total storage potential in all of the world's oceanic ridges is on the order of 100.000–250.000 GtCO₂

(Snæbjörnsdóttir, Sigfússon et al. 2020, p. 93) — “orders of magnitude larger than the amount of CO₂ that would be derived from the burning of all fossil fuel.”

(Snæbjörnsdóttir, Sigfússon et al. 2020, p. 93) It is anticipated that >950 Gt of CO₂ could theoretically be stored solely within the active rift zone in Iceland, of which about 6 Gt would be in the Hellisheiði field, where the CarbFix injections take place (Gutknecht, Snæbjörnsdóttir et al. 2018, p. 132). If we presuppose that these calculations for storage potential are correct, it becomes evident that the challenges in relation to the scalability of NETs in Iceland are constituted by the energy intensity of the sequestration processes rather than by storage limitations. For a point of reference, Iceland's emissions as of 2018 were just below 3.000 kT (showcased in the graph in section 7.1). CarbFix2 is currently capturing and storing ~33% of the CO₂ emissions from the Hellisheiði power plant, or ~12.000 tonnes annually, aiming to increase injection to ~90% of the CO₂ from the plant before 2030.” (Snæbjörnsdóttir, Sigfússon et al. 2020, p. 95)

Jespersen, Rik(ke) (2022). Crystallised carbon captured in basalt. Author's own photography from fieldwork

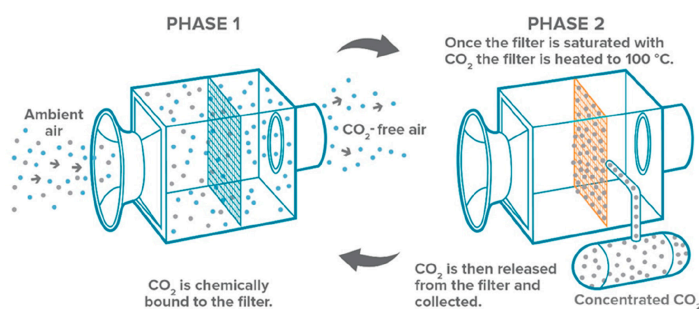


As I dived deeper into local knowledges during my fieldwork — listening to Ragga and other local Icelandic people with intimate relations to the land — I came to realise that lava and basalt rocks always have held a vital force in Iceland. In more recent times, it has, however taken on an additional role, namely that of the condition of opportunity of CarbFix's big venture, mineralisation hubs: 1) In collaboration with ClimeWorks's two DAC plants Orca and Mammoth (Gutknecht, Snæbjörnsdóttir et al. 2018, p. 130), part of the Hellisheiði geothermal power station, run by Orkuveita Reykjavíkur, named the CarbFix2

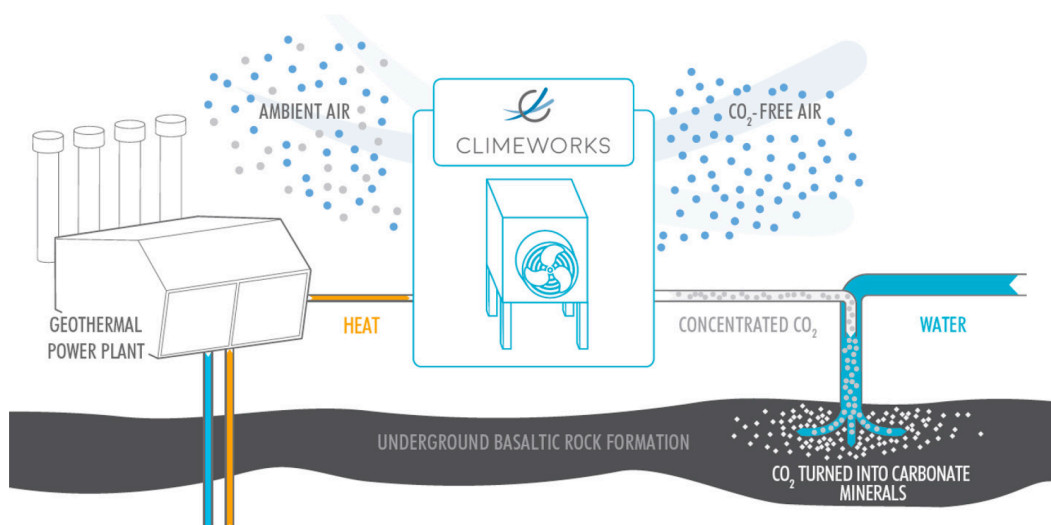
project and 2) as part of The CODA Terminal¹⁷. Via adsorption and desorption technologies on alkaline-functionalized adsorbents (Gutknecht, Snæbjörnsdóttir et al. 2018, p. 131), developed by ClimeWorks, CO₂ is being captured from the air:

Air is drawn into the plant and the CO₂ within the air is chemically bound to a filter. Once the filter is saturated, it is heated, and the CO₂ is released and collected as concentrated CO₂ gas. With DAC, such as the technology ClimeWorks has developed, the CO₂ is isolated but not permanently removed from the atmosphere, and therefore has to be combined with *safe* storage approaches, such as injection of CO₂ at carefully selected geological sites. The gases are dissolved (with water) and injected at depths below ~700 m and temperatures about ~250°C, where the gas charged-fluid reacts with the basaltic bedrock and forms *stable* carbonate minerals. (Gutknecht, Snæbjörnsdóttir et al. 2018, p. 130-32)

(Butter, Charles et al. (2019). Schematic illustration of the ClimeWorks direct air capture process (infographic). Retrieved



(Butter, Charles et al. (2019). Schematic illustration of the ClimeWorks-CarbFix injection at Hellisheidi, Iceland (infographic). Retrieved



¹⁷ which will be located in Straumsvík, Hafnarfjörður.

Re-emissions from the Orca plant have by now been lowered to less than 10%, with the goal of reducing them to 4% (Climeworks 2021). The CarbFix project was founded in 2007 by Reykjavik Energy, University of Iceland, CNRS in Toulouse, and Earth Institute at Columbia University in New York (Gutknecht, Snæbjörnsdóttir et al. 2018, p. 131). Mammoth sets out to capture 36.000 tons of carbon per year (CarbFix 2022), while the already-operating Orca captures and stores 4.000 tons of carbon per year¹⁸ (CarbFix). Via the CODA Terminal, carbon will be imported from abroad, mineralised and stored in the Icelandic bedrock. The first ship has already landed, as one of my interviewees, a representative of Reykjavík Energy, points out.

6 Welcome to (the not yet of) the future: Theories and concepts applied

The spectrum of possible overshoot scenarios laid out in section 5 (Buck 2021, p. 36), introduces the possibility of imagining several possible ‘net-zero’ futures. To navigate the discourses of these imaginaries, I would like to introduce the two central theorists of this thesis: 1) Franco ‘Bifo’ Berardi and his conception of ‘Futurability’ from *Futurability, The Age of Impotence and the Horizon of Possibility*, which I have read in conversation with his book *After the Future*. Bifo writes: “Futurability is a layer of possibility that may or may not develop into actuality.” (Berardi 2017, p. 9) In Shakespeare’s play *Hamlet*, Hamlet states that “time is out of joint” (Shakespeare 2003), after experiencing a shocking, supernatural event that fundamentally alters the way he perceives the state of the universe. For Hamlet, time is broken (Shakespeare 2003), leading me to the second central theorists of this thesis: 2) Mark Fisher and his broken-time diagnosis from *Ghost of My Life, Writings on Depression, Hauntology and Lost Futures*, in which he lays out how we today simultaneously are haunted by the past and the future (Fisher 2014, p. 25). He names this phenomenon ‘hanutology’, which together with Bifo’s ‘the virtual’ and ‘the real’, bridged by ‘actualisation’ will take on roles as core concepts in this project. The latter can be traced back to Baruch Spinoza through Gilles Deleuze and Henri Bergson. Supported by Spinozist Marxism — especially the string running through Deleuze — ‘desire’ takes on the role as of force actualising ‘the virtual’ (Gao 2013), orientating my discourse analysis towards the production of

¹⁸ both part of The CarbFix2 project

desire. Fisher flips Derrida's notion so that what haunts us is no longer only the past but also "the not yet of the futures" (Fisher 2014, p. 42). In *Ghost of My Life*, Fisher fleshes out two definitions of 'hauntology':

The first refers to that which is (in actuality is) no longer, but which remains effective as a virtuality (the traumatic 'compulsion to repeat', a fatal pattern). The second sense of hauntology refers to that which (in actuality) has not yet happened, but which is already effective in the virtual (an attractor, an anticipation shaping current behaviour).
(Fisher 2014, p. 25)

In *Futurability*, Bifo asks: "Who will decide the actualisation of one possibility or another?" (Berardi 2017, p. 12) — of one future or another. This could sound like a purely speculative inquiry, but what we will come to realise is that the ways in which we imagine the future, the ways it haunts us, influence the ways we materially structure and navigate the present. In Fisher's quote above, the present is simultaneously haunted by the virtuality of the past and the future. The process of foreshadowing the future is intimately tied to power relations, something I will return to in section 8.4 — another key argument for the relevance of this study to human ecology. 'Actualisation' is the act or process of bringing something purely 'virtual' — not yet real, yet only a potential — into reality:

Inventions ... enable the emergence of unpredictable realities, calling them from the depths of being to the phenomenal surface. (Lazzarato 2002) Future is not prescribed but inscribed, so it must be selected and extracted through a process of interpretation.
(Berardi 2017, p. 163)

I perceive stories about technologies — such as NETs — as 'actualisers' of imagined "unpredictable realities" (Lazzarato 2002), calling net-zero scenarios from the virtual sphere, glimmering somewhere in the distant future, to the present. This process takes place, potentially without the technologies themselves ever becoming 'real' yet still shaping the present. I perceive the process of the future's workings in the present as a result of the dynamics of 'the conundrum', the meeting point of ideology and technology (Berardi 2017). The conundrum can be described as a crucible for the intimate relationship between work and life, technology and automation under the conditions of a capitalist economy (Berardi 2017). I will repeatedly return to the implications of the conundrum, and it will

serve as a guiding red thread throughout the thesis. Bifo names the dominant ideology and 'container' of our time 'the paradigm of accumulation and growth' (Berardi 2017), and points to it as a shaper of social imagination and activity ('the content' of our time). Due to the intimate link between technology and ideology in the conundrum and its power over 'socio-technical imagination'¹⁹, one of my main arguments is — by virtue of Marx's quote below — that we face the risk of NETs being used as a smokescreen to maintain business as usual:

Thus extending capital's sphere of investment along with its growth; it also teaches capital how to throw back the waste from the processes of production and consumption into the cycle of the process of reproduction, and thus, without any previously outlay of capital, it creates fresh materials for it. (Marx 1976, p. 754)

In my opinion, this quote could be directly tied to the implementation of CCS within fossil capitalism²⁰. Fisher thinks of "hauntology as the agency of the virtual, with the spectre understood not as anything supernatural, but as that which acts without (physically) existing." (Fisher 2014, p. 25) He defines 'the specter' in his essay *What is Hauntology*: "What is important about the figure of the specter, then, is that it cannot be fully present: it has no being in itself but marks a relation to what is no longer or not yet" (Fisher 2012, p. 19) — here again, it is worth noticing Fisher's inspiration from Jacques Derrida (and his book *Specters of Marx: The State of the Debt, the Work of Mourning and the New International*). Fisher points out capital itself as the most ominous 'spectre of Marx'. (Fisher 2014, p. 25) These notions serve as axioms throughout this thesis. By virtue of Fisher and Bifo, this thesis insists on the material implications of the imagined futures, imagined within the episteme²¹ of fossil capitalism. It will progress towards a de-colonial stance, where the importance of storytelling will be stressed, as well as the fact that no story is innocent — drawing on Martin Savransky's book *Around the Day in Eighty Worlds*. Savransky playfully rephrases Jules Verne's famous title. In this thesis, I wish to reframe the adventures of geoengineering. The ideas and basic approaches underlying geoengineering were originally put forth by scientists in the 1970s and

¹⁹ definition in the following section

²⁰ Andreas Malm's pendant to the Anthropocene

²¹ Michelle Foucault's correspondent to the 'paradigm', in which he establishes the workings of bio-politics in a certain era.

1980s as hypothetical solutions to control the weather and address what was then termed “global warming” (Fleming, 2010). Here I find a funny parallel between the adventures and sci-fi-like narrative in Verne’s novel and geoengineering narratives.

6.1 SOCIAL SCIENCE CONCEPTIONS OF FUTURE-SHAPING

I wish to offer the reader three conceptions within the field of social science, capturing the future and its agency in the present: 1) *Socio-technical imagination*: “Collectively held, institutionally stabilised, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology” (Jasanoff and Kim 2015), 2) *Distant future* (distinguished from near future): “A new way of seeing the future in collective efforts (...) imagining possibilities under conditions of ambiguity” (Augustine, Soderstrom et al. 2019, p. 1930), creating ‘as-if realities’ (distinguished from pure fantasy) and hereby orienting action in the present (Augustine, Soderstrom et al. 2019, p. 1930). Augustine and Soderstrom circumscribe the following criteria for distant futures, enabling them to create as-if realities:

To orient human effort, distant futures must at the same time be seen as fictional and yet be taken seriously enough to inspire action toward realising them (...) When a distant future takes on as-if reality, people begin to see themselves in the future state, which orients their actions toward (or away from) this future. As-if reality is what distinguishes distant futures with social consequences from pure fantasy or playful imagination.”
(Augustine, Soderstrom et al. 2019, p. 1935)

An important distinction between fantasy and as-if reality is the fact that the latter is embedded in the current knowledge system (Augustine, Soderstrom et al. 2019) or episteme. Here, I wish to hint at Haraway and her heritage from indigenous scholars, emphasising that stories matter and that no stories are innocent (Haraway 2016). Even though the NETs stories we tell might never be actualised, they still matter, as they orient our actions in the present. 3) *Imaginaries*: “Relatively coherent ideas and visions about the future informed by expectations about certain techno-scientific practices, which in turn influence present-day governance of those practices” (Christiansen and Carton 2021, p. 3). Christiansen and Carton echo that “techno-scientific (such as NETs) visions and expectations (...) influence

political decisions today irrespective of whether they are fulfilled.” (Christiansen and Carton 2021, p. 2)

6.2 IPCC AND THE USE OF SHARED SOCIO-ECONOMIC PATHWAY, REPRESENTATIVE CONCENTRATION PATHWAY, INTEGRATED ASSESSMENT MODELS AND KEY SCENARIO ARCHETYPES

I would like to bring the conceptions introduced above into conversation with IPCC's use of SSP, RCP, IAMs and key scenario archetypes (IPCC and Support 2018). This will serve as a backdrop and technical context for my inquiry into NETs imaginaries in Iceland:

IAMs usually assume zero risk for most NETs (...) often operate like a black box where assumptions are unclear or unknown, and which have normalised speculative options. (McElwee 2022, p. 12-17)

The SSPs provide a multiple set of 'baseline worlds' and are, in turn, generating new RCPs, including some explicitly exploring 'overshoot' worlds in which temperatures exceed the target before being returned to that level (...) The direct linking of cumulative budgets to temperature extended modelling optimisation such that it reaches from technology choices to desired temperatures. Looking ahead, although NETs might retrospectively balance carbon budgets, delayed action would still make a temperature overshoot more likely, constructing a space for an imaginary technology that can act directly to reduce temperatures. (McLaren and Markusson 2020, p. 395)

One could suggest that the value of IAM outputs does not lie in their analytical precision or implied feasibility, but in their generation of a range of future 'archetypes' or illustrative scenarios in relation to which both historical and emergent empirical trajectories can be contextualised (...) This is particularly so insofar as each archetype is infused with a distinct storyline or 'narrative' about future socio-ecological trajectories. (Bluwstein and Cavanagh 2022, p. 7-8)

McLaren and Markusson point, in their article from 2020 “The Co-evolution of Technological Promises, Modelling, Policies and Climate Change Targets”, to a paradigm shift in global climate policies from a focus on carbon concentration in the atmosphere to temperature outcomes, with 2 °C becoming a focal point after COP15 in Copenhagen (McLaren and Markusson 2020, p. 395) — playing into the overshoot ideology. From the quotes, I particularly wish to highlight the crystallisation point of 'a range of future archetypes/illustrative scenarios' and

'historical and emergent empirical trajectories', in what McElwee in her article "Advocating Afforestation, Betting on BECCS: Land-Based Negative Emissions Technologies (NETs) and Agrarian Livelihoods in the Global South" from 2022 calls a 'black box'. This black box acts as the 'actualiser' of one narrative, one 'socio-technical imagination' over another, the inscription of one potential future over another onto the present — directed by the conundrum, I would add. As much as the implementation of NETs is politically biased, similarly so are the use IAMs and the narratives, the 'socio-tech imaginaries' (Andersson 2022) and the 'negative emission imaginaries' (Christiansen and Carton 2021, p. 1) they spark. I argue on the basis of my literature review and assessment of NETs discourses that NETs and IPCC's calculation models mutually influence each other. This is why, Bluwstein and Cavanagh in their article "Rescaling the Land Rush? Global Political Ecologies of Land Use and Cover Change in Key Scenario Archetypes for Achieving the 1.5 Degrees C Paris Agreement Target from 2022", call for future research agendas around the use of IAMs in guiding decision making. Particularly, they point to the need to open modelling to more participatory approaches and the recognition of alternative world views within them (Bluwstein and Cavanagh 2022), hinting at pluralism. (Escobar 2018)

My literature review informed me how the use of NETs comes with the imminent threat of it leading to 'mitigation deterrence'²² (Malm and Carton 2021) if it is being used as a smokescreen to avoid difficult fossil fuel emissions reductions (McElwee 2022, p. 2), as well as how land- and energy-use complications remain hidden behind numbers and graphs. NETs and geoengineering are no longer solely sci-fi imaginaries but a necessity on the trajectory towards 'net-zero' in 2050 (McElwee 2022, p. 8 + 17) for the world to stay well below 2 degrees Celsius of warming. The science is clear, and there is no doubt that NETs will play an increasingly important role. (Bluwstein and Cavanagh 2022, p. 20) Here social science has to step in to help shape that role in a just, sustainable and equitable way: "Critical social science literature is necessary to contextualise the difficulties that NETs are likely to face in deployment, whether top-down and large-scale or more community-based." (Bluwstein and Cavanagh 2022, p 20) Against the backdrop of my literature review and fieldwork, the overall discrepancy in

²² I will return to this point in chapter 8.

discourses seems to be between 1) NETs as free-floating “pure” and depoliticised technologies, 2) NETs as integrated practices, in a vast network of interests in the energy transition, with tangible consequences for land and its communities. One reason for this discrepancy is that models fail to include social factors in calculations. I argue in this paper that another important factor is social science falling short in translating and mediating between science, technology and the people.

6.3 THE MYTH OF TECHNOLOGICAL PROMISE

Rounding off this section, I wish to introduce mythology as an additional perspective on future imaginaries. To do this, I will draw on Roland Barthes' *Myth Today* from 1957. Here, he writes:

Myth is a system of communication (...) Everything can be a myth provided it is conveyed by a discourse. Myth is not defined by the object of its message, but by the way in which it uses this message (...) It points out and it notifies, it makes us understand something and imposes it on us. (Barthes 1957, p. 109-117)

Barthes characterises myth as ‘metalanguage’. I will bring this, as well as Barthes' eye for the process through which myths naturalise, historically and culturally contingent, class-specific practices, values and moralities (Duncan 2010), to my discourse analysis of NETs discourses in sections 7-8.

7 Laying out themes at play in Icelandic NETs discourses

In September 2022, I paid the Hellisheiði Power Station and the two direct air capture plants, Orca and Mammoth, a field trip visit. Orca was already up and running, Mammoth was under construction, and The CODA Terminal was only a project shimmering on the horizon. Orca presented itself as a mechanical sci-fi creature rising from a field of moss, against a backdrop of mountains, with cables transporting geothermal heat clinging to the surrounding hillsides. I entered the power station (located to the right of Orca, outside the picture frame below) and chatted shortly with the receptionist. With a human ecologist's scepticism, I curiously asked about possible consequences on the local nature and environment from the DAC plants. To this, he quite promptly answered — gesturing to the surrounding landscape — that there are no detected consequences, as there's nothing out there.

Jespersen, Rik(ke) (2022). The DAC plant Orca, part of Hellisheiði Power Station. Author's own photography from fieldwork



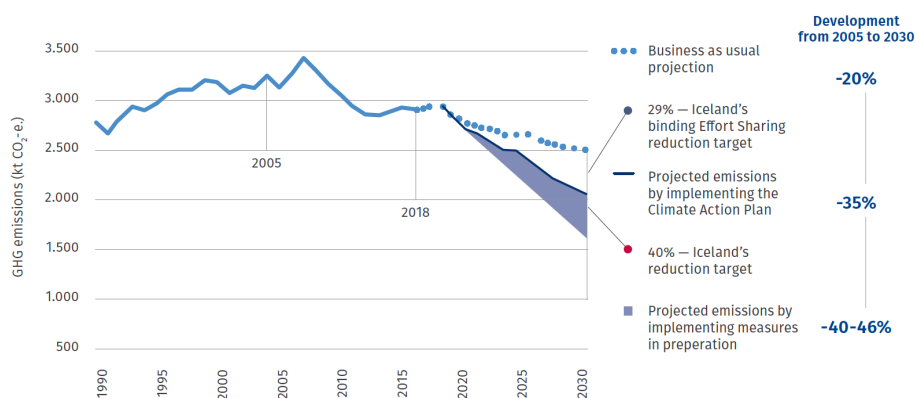
7.1 ANALYSIS OF GOVERNMENT AND INTERNATIONAL POLICY DOCUMENTS ON NETS

In this section, I had wished for an interview with the mayor or someone from the city council in Hafnarfjörður, where the first mineralisation hub tethered to the CODA Terminal will be located, but no one wished to partake. I have thus settled

with analysing government and policy documents on NETs in Iceland: 1) “On the Path to Climate Neutrality, Iceland’s Long-Term Low Emission Development Strategy”, published in October 2021, supported by 2) “Iceland’s 2020 Climate Action Plan”, published in October 2020 (the latter forms the foundation of the first) and 3) ”The European Commission’s Innovation Fund, Driving Clean Innovative Technologies Towards the Market, Coda Terminal” from 2022. I have chosen to go with these three documents, as they were pointed out as crucial by Sigurður R. Gíslason, Geochemistry Professor, co-founder of CarbFix and one of my interviewees. This quote is from the former and represents the Icelandic Government’s take on Iceland’s path to climate neutrality:

Carbon sequestration in soil and vegetation will be a key measure to achieve climate neutrality both in Iceland and globally, but also in technical solutions such as carbon sequestration, utilisation and mineralisation. Thus, Iceland’s approach to land use measures is of special importance because of the country’s *unique land use emissions profile* (...) More than one path can be taken towards a climate neutral future and there is more than one way to imagine a climate neutral society. A key aspect is the implementation and adoption of various measures to curb emissions. Climate neutrality will not be achieved only by a rapid decrease in emissions; increased carbon sequestration is necessary. A just transition, to a climate neutral society can only be achieved with all of society reaping the benefits (...) Moreover, the figure (below) shows that the goal of climate neutrality will not be reached without using removals of carbon from the atmosphere to compensate for emissions that are unlikely to be eliminated.
(Iceland and Resources 2021, p. 8-16-47, author's own italics)

(Iceland and Resources (2020). Iceland’s historical greenhouse gas emissions that fall under the Effort Sharing Regulation to 2018, and projected emissions in 2030 without the Action Plan and measures currently in preparation²³ (infographic). Retrieved



²³ Definition of measures in preparation: Preparation of the measure is underway, including situational analysis and mapping.

Overall in the document, CCM²⁴, as well as other CDR initiatives, are being stressed as crucial factors to reach net-zero. In the excerpt above, we see a focus on Iceland's 'unique land use emissions profile', which — according to Auður Önnu Magnúsdóttir from Landvernd²⁵ — is in itself a political statement (I will return to this point in section 7.3). Auður emphasises that similar geological conditions exist in other places as well. In the excerpt, imagination is stressed as a factor playing into what path will be taken towards a climate-neutral future. Further, we see an emphasis on the necessity of increased carbon sequestration and removal, accompanying the act of curbing emissions to compensate for what is often referred to as 'hard-to-abate'²⁶ emissions. We also see an emphasis on justice in the implementation of NETs strategies. As it is stated in the document, the CarbFix declaration was signed already back in June 2019, when “government and heavy industry in Iceland signed a declaration of intent to explore possibilities for carbon capture and storage of industrial emissions, using the CarbFix method” (Iceland and Resources 2021, p. 11), led by Reykjavík Energy and in March 2021 this was followed up by a Carbon Capture and Storage Legislation (EU Directive 2009/31/EC of carbon capture and storage), passed by the parliament of Iceland, Alþingi. (Iceland and Resources 2021, p. 33) The legislation now serves as the directive for further work on the framework for the injection of CO₂ into geological formations for storage to reach climate neutrality (Iceland and Resources 2021, p. 13). In the document, quite an emphasis is being put on the involvement of the public in decision-making processes. This act of inclusion is being done via 1) government's use of an online consultation portal and 2) the involvement of The Climate Council:

Public consultation is a key element in decision and policy making in Iceland and is conducted in numerous ways. To increase transparency and opportunities for the public and stakeholders to participate in policy making, regulatory work or public decision making, the Government uses an online consultation portal. Additionally, various other types of consultation processes are used such as informal and formal meetings with key stakeholders, brainstorming sessions, participation of stakeholders in committee work, direct invitation to comment during different work phases etc (...) The Climate Council

²⁴ Carbon Capture and Mineralisation is - according to representative of Reykjavík Energy - often used in the Icelandic context instead of CDR.

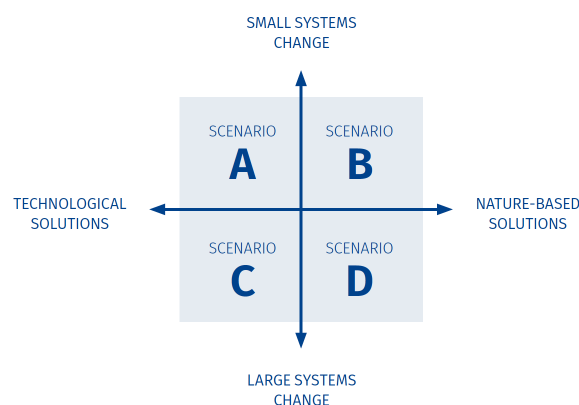
²⁵ Icelandic Environment Association

²⁶ I have made sure to put this definition in quotation marks as it is not a neutral conception.

was established in 2018 and was given a legal basis with an amendment to the Icelandic Climate Act in 2019. The Council members are various stakeholders from different economic sectors, civil society, and academia and the Council has the status of an independent body whose role is to hold authorities accountable and provide advice on policy objectives and specific measures related to climate change. (Iceland and Resources 2021, p. 37)

One of The Climate Council's tasks is to provide advice on carbon sequestration. (Council)) In 2021 The University of Iceland, together with The University of Reykjavik, conducted a research project commissioned by the government, where a randomly selected group of people was invited to participate in a survey and a consequent workshop on climate-neutral futures. Researchers identified two main themes in the discussion: 1) Technological versus natural solutions and 2) A society similar to the one we know now versus a society "where systemic changes have occurred, such as significant changes in meat consumption, travel habits and consumer habits." The exercise and researcher's analysis of it accumulated five scenarios/imaginaries for a net-zero future (Iceland and Resources 2021, p. 42): A) Technological solutions, B) Nature-based solutions, C) Technological solutions and systems change, D) Nature-based solutions and systems change and E) Combines technological and nature-based solutions and system changes. (Iceland and Resources 2021, p. 46) All the scenarios aim for climate neutrality no later than 2040, and all the scenarios succeed in reaching net zero emissions no later than 2040, but the amount of land required to reach climate neutrality in 2040 in the different scenarios indirectly reflects the effectiveness of the other mitigation measures and systems changes at play (Iceland and Resources 2021, p. 46-47).

Iceland and Resources (2021). Schematic illustration of future scenarios from the research project above (infographic). Retrieved

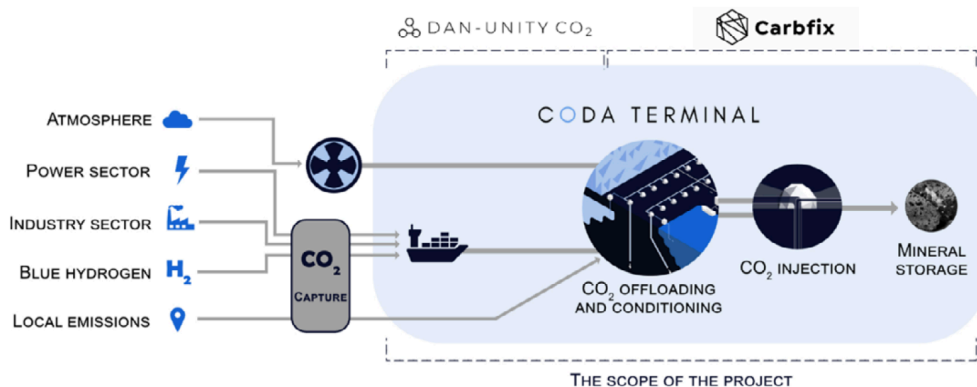


The other data point for my triangulation of governmental and international policy takes on NETs in the Icelandic context is The European Commission's "Innovation Fund, Driving Clean Innovative Technologies Towards the Market, Coda Terminal" - laying out the visions for The Coda Terminal and grants 115 million euros (Commission 2022) from the European innovation fund to the project:

Coda will geologically store, and thereby avoid, 21 Mt of CO₂ equivalent emissions over the first ten years of operation. This annually equates to over half of Iceland's yearly emissions and approximately 2.5% of reductions required across the EU by 2030 (...) Coda has an *exceptional scale-up potential*. Local opportunities include expansion of the terminal, replication sites and coupling with local sectors, such as geothermal, heavy industry, waste management and direct air capture.

(Commission 2022, author's own italics)

(Commission (2020). Schematic illustration of the scope of the CODA Terminal, Straumsvik, Hafnarfjordur (infographic). Retrieved



Here, we get an insight into how the Icelandic NETs venture is being portrayed internationally, and as we see, an 'exceptional scale-up potential' is being emphasised. In "On the Path to Climate Neutrality, Iceland's Long-Term Low Emission Development Strategy" we can read how NETs in Iceland are supposed to go hand in hand with 'sustainable growth' as well as a 'just transition' — providing synergies with goals of circular economy and biodiversity protection. (Iceland and Resources 2021, p. 27-33) Here, we also encounter the intimate link between NETs and 'climate neutrality', tied by legislation (as mentioned on p. 22).

During my interview with Gíslason, he pointed the EU Directive 2009/31/EC of carbon capture and storage out as essential to the regulation of carbon mineralisation in Iceland. This whole framework is part of The Climate Action Plan, acting as a guideline for Iceland's trajectory towards reaching The Paris Agreement.

7.2 The corporate/nature-resource take

This section will be a discourse analysis and triangulation of data gathered from CarbFix's webpage, an article and a review published by CarbFix and an interview with a representative from Reykjavik Energy. CarbFix writes on their webpage about The Coda Terminal:

Operations are set to commence in mid-2026 and full capacity will be achieved in 2031, when up to 3 million tons of CO₂ will be annually stored by permanently mineralising it underground (...) The CarbFix technology has been proven to be an economical and environmentally friendly way to permanently store CO₂ and thus prevent it from negatively affecting the climate. It is based on accelerating a natural process. The name, Coda, comes from music and refers to a concluding passage that brings the musical piece to a satisfactory close. (CarbFix 2022)

What I notice here is the highlighting of the CODA project as 1) financially sound, 2) a way to 'permanently' store CO₂ through the acceleration of a 3) 'natural process'. All of these three points influence discourse creation on NETs. We see exemplified that the mineralising and carbon-storing process — what Magnúsdóttir classifies as the disposal of pollutants (section 7.3) — also can take on the discursive shape of 'a natural process' (though generated through technological mimicry). Returning to point 2) regarding the permanence of the mineralisation and storage, I wish to bring in points a representative from Reykjavík Energy shared with me during our conversation at The University of Iceland:

What we want to do [referring to Iceland's national NETs effort], is sustainable utilisation of a resource (...) We actually want to take that fluid (in the CarbFix case it has turned into stone) and re-inject that back into the reservoir so we want to get the resource back, basically to create a circular, utilisation of the working fluid. (Energy 2022)

I have chosen this quote from the interview because I find it captures quite eloquently a natural-resource approach to NETs (CMM). The representative explains how CODA serves the purpose of making the first scaling of mineralisation hubs in Iceland as a proof of concept. The next innovation step is to substitute mineral water with seawater in CarbFix's technology. This will help reveal the potential for scalability, the representative from Reykjavík Energy points out. She explains how the idea initially is to create the hubs much closer to the source of the carbon, but until that is a reality, the carbon will have to be shipped from abroad via sustainable shipping. "The idea is to re-inject as much as almost total emissions from Iceland — excluding LULUCF²⁷, 4,7 mil. ton" (Energy 2022). She adds that there is plenty of space in the ground²⁸ and that it will be relatively cheap — only 26 dollars a ton (Energy 2022). Here it is noteworthy that the price is calculated in money rather than the value of nature. During our interview, the representative from Reykjavík Energy makes a point of conceptualising NETs in Iceland via the term CCM (carbon capture and mineralisation), thus distinguishing this practice from NETs taking place elsewhere. She gives this characteristic: "The public in general tends to be distrustful when it comes to CCS²⁹, but in Iceland — so far — the public seems to trust in CCM" (Energy 2022). The representative from Reykjavík Energy's explanation for this is the permanence of CCM, which makes it easy to convince the public that it is safe: "It [the carbon] literally turns chemically into stone. So that essentially alleviates the largest public concern with respect to the technology." (Energy 2022) In the article "Creating a Carbon Dioxide Removal Solution by Combining Rapid Mineralization of CO₂ with Direct Air Capture" from 2018, prominent people from CarbFix and ClimeWorks (such as 'head of mineral storage' Sandra Ósk Snæbjörnsdóttir, 'head of CO₂ capture and injection' Bergur Sigfusson and CarbFix CEO Edda Sif Aradóttir) present the CarbFix method and how 'solid carbonate minerals' are formed — the method representative from Reykjavík Energy refers to as CCM — and how this method differs from methods in use elsewhere (where CO₂ is injected into sedimentary

²⁷ Land use, land-use change, and forestry

²⁸ I address the storage potential in Iceland in section 5.1.

²⁹ To me her interchangeable usage of CCS and CCM seems like conflation. I would use the term CDR when comparing with CCM - as CCS arguably cannot be characterised as NETs.

basins as a separate buoyant phase anticipated to be trapped below an impermeable cap rock (Gutknecht, Snæbjörnsdóttir et al. 2018, p. 132)):

In Iceland an alternative method is being developed as a part of the CarbFix project, where the CO₂ is dissolved in water before or during its injection into porous and fractured basaltic rocks. Because the CO₂ is dissolved it is not buoyant; in fact the injected fluid is denser than the surrounding reservoir fluid due to the CO₂ and thus has no tendency to rise. Therefore, solubility trapping happens immediately and no cap rock is required. The gas-charged water accelerates the release of metals from the basalts, such as calcium, magnesium, and iron, which combine with the injected CO₂ and form solid carbonate minerals such as calcite, magnesite, and siderite, respectively, resulting in the *permanent* storage of carbon. As a part of CarbFix2, the project partners will demonstrate a *safe, economically-viable and highly scalable carbon removal technology*.

(Gutknecht, Snæbjörnsdóttir et al. 2018, p. 132-33, author's own italics)

CarbFix sets out to reach multi-megaton capacity in the 2030s, on track to deliver gigaton capacity by 2050 (CarbFix 2022). I would point to the very last sentence as decisive in CarbFix and ClimeWork's NETs discourses (Gutknecht, Snæbjörnsdóttir et al. 2018, p. 130). In their own words, CarbFix makes sure to permanently fixate the carbon by mixing it with water. I have read the article in conversation with a review written by Sigfusson, Snæbjörnsdóttir, Gíslason and their colleagues Chiara Marieni, David Goldberg and Eric H. Oelkers. Here, the same discursive characterisation of the CarbFix practice is used; "providing a safe, permanent storage solution for the captured carbon." (Snæbjörnsdóttir, Sigfusson et al. 2020, p. 95) On CarbFix's website, you will find various appealing graphics illustrating the company's practice of turning carbon into stone, highlighting that 16.1 (metric tonnes) CO₂ already have been injected today and that 91.383.8 (metric tonnes) CO₂ have been injected since 2014 (Carbfix 2023, 9th of May 2023). Further, the following points are highlighted: 1) natural, 2) low cost, 3) safe, 4) certified method, 5) unlimited and 6) permanent (Carbfix 2023), elaborated here:

CarbFix provides a *natural* and *permanent* storage solution by turning CO₂ into stone underground in less than two years (...) *Nature's way* of storing carbon in rocks ... accelerated (...) *Unlimited*; storage capacity much greater than needed for climate goals (...) *Permanent*; stable for millennia, no long-term monitoring needed.

(Carbfix 2023, author's own italics)

Here, you catch a sense of CarbFix's net-zero imaginary, implying again that NETs combined with carbon mineralisation act as an amplifier of nature's own ways. Another takeaway from my analysis of CarbFix's NETs discourse-creation is the apparent prioritising of nature's resources over nature's inherent value. In the CarbFix review, we find an elaboration of CarbFix's NETs imaginaries and how they aim to implement climate-mitigation technologies to reach the Paris Agreement:

According to the International Energy Agency, the goals of the Paris Agreement can be achieved by applying and pushing already available climate-mitigation technologies to their maximum practical limits (...) In situ mineral carbonation aims to accelerate a *natural process* — the vast storage of carbon in rocks over millions of years — at a rate fast enough to contribute to climate change mitigation.

(Snæbjörnsdóttir, Sigfússon et al. 2020, p. 90-91)

DAC may be an important approach in managing emissions that are challenging or costly to eliminate at the source [such as aeroplane emissions], and by combining DAC and CCS, it may be possible to create negative emission pathways during the latter part of the century. DAC technologies are, however, still immature and, to date, have only been demonstrated on the scale of ktCO₂ per year. The primary limitation in the implementation of DAC is the high cost, currently estimated in the range of approximately US\$90–900 per tonne of CO₂. The high cost is mostly due to the energy requirements, especially the thermal energy required for CO₂ desorption: at present, ~3.4–10.7 GJ of energy is required for every tonne of CO₂ captured.

(Snæbjörnsdóttir, Sigfússon et al. 2020, p. 98)

Here, I glimpse the risk of NETs becoming a green card/smokescreen to continue business as usual, avoiding mitigation of, e.g. 'hard-to-abate' industry — in this quote referred to as 'emissions that are challenging or costly to eliminate at the source', exemplified by aviation. We do not see the fundamental structures of a carbon-based society critically questioned, as we did in Magnúsdóttir statements: "A fossil-free community can never be a community that expands their energy demand." (Full quote in section 7.3) (Magnúsdóttir and Landvernd 2023) For CarbFix, only the high price — due to the energy intensity of the method — seems to be a real problem. From the article from 2018, we catch an elaborate insight into the two corporations' framing of the CarbFix2 project:

One of the goals of the CarbFix2 project is to combine the storage approach with DAC technology, such as developed by Climeworks, and thus create an integrated CO₂ removal

solution with a potential for global application (...) As described in this paper, an integrated and *safe* solution towards permanent CO₂ removal has been created through the combination of the CarbFix and ClimeWorks technologies. Based on the initial trial, the joint operations can be *substantially scaled-up* and further optimised in the coming years. Having such scaled up and optimised operations in place is crucial as the deployment of CO₂ removal at gigaton scale will have to start as early as 2030 in order to reach international climate targets by the end of the century.
(Energy 2022, author's own italics)

Here, we see stressed the possibility and need for a substantial scale-up, which in CarbFix's own words (as we have seen) is possible because their technology is 'safe', 'permanent', 'natural', 'unlimited' and 'economically viable'. Rounding off this section, I would like to supplement with the representative of Reykjavík Energy's take on the global potential for Icelandic NETs future imaginaries:

[In] Reykjavik Energy, we see it as our duty to spread the CarbFix Technology abroad (...) We are hoping that Iceland will ... have a role to play in the CCS CCM world, worldwide ... not as an owner of all these hubs all over the world but somebody that actually develops this technology and then distributes it worldwide.
(Energy 2022)

7.3 SKEPTICISM FROM LOCAL NGO(S)

Ragga introduced me to Landvernd, whereupon I connected with Auður Önnu Magnúsdóttir. During our interview, Magnúsdóttir made sure to puncture the common conception (with CarbFix as one of its primus motors) that Iceland is a uniquely ideal case for the global NETs adventure, with the statement: "Basalt is found many, many places on earth and there's a lot of it in Iceland, but it's not unique to Iceland" (Magnúsdóttir and Landvernd 2023). In this section, I will present Magnúsdóttir's (as representative of Landvernd) take on NETs in Iceland:

People here think it is [NETs] part of saving the world and that is one of the dangers that we see, that the projects are thought to be a solution to everything and that we do not need to do anything else. The people representing the companies, they say that they always claim that it is not the solution to everything but it is not really true. They usually forget to talk about reducing emissions as well (...) I have been following climate issues since I was a teenager, so for thirty years, and this is repeatedly happening: There is someone who says; 'hey, I have an idea and in my lab it works, so just wait and continue polluting, just continue doing all the things you have been doing as before and my solution will save everything'. (Magnúsdóttir and Landvernd 2023)

When stating the above, she draws a parallel to cold fusion as another example of a quick fix to the energy crisis within the business-as-usual *modus operandi*. Another example would be enhanced oil recovery (EOR) — a case of “NETs”³⁰ being intimately tied to fossil capitalism in a last attempt to save fossil assets (Korbański 2022). Magnúsdóttir positions herself (and Landvernd) as follows in relation to the Icelandic NETs venture:

We are not against carbon capture, we are just said that a (energy intensive) solution to a crisis that is in its core an energy crisis (...) is not *the* solution to the problem. All the direct air capture is of course insanely energy intensive and therefore — at least in my opinion — this is something we should not be focusing on. We should be focusing on trying to capture carbon from point sources, like here in Iceland; the aluminium smelters. (...) Then there is also the question of energy transition (...) Should we be using our energy to get rid of the portion [of CO₂] that Europe produces? Should we be using our land for that, or would it be better to use the energy for Iceland's energy transition (referring to the transport sector) and being an example of what a fossil-free community can look like? A fossil-free community can never be a community that expands its energy demand. (...) Reducing the energy consumption is the main point of energy transition. Without reducing energy consumption, we are not going to get there (...) We need to cool this system down and produce less (...) I totally agree that this is one of the things we should do, but it has to be with moderation.

(Magnúsdóttir and Landvernd 2023)

As a commentary to this quote, I wish to point to the environmental and health pitfall of geothermal energy production in Iceland assessed in section 8.1, pointing to the fact that intensifying energy production in Iceland for the sake of carbon capture comes with consequences. When critically assessing land and energy use in Iceland for the purpose of removing European emissions, she is, of course, referring to The CODA Terminal, questioning the legitimacy of that type of land use strategy. She adds the following points to the discussion on environmental and land use issues related to NETs in the context of Iceland:

It's so new. We do not know what is going to happen to groundwater (...) We are actually disposing pollutants and we're putting it into the ground. (...) It [the geothermal plant in Hellisheiði] stands by a small hill or a mountain and on the other side of that mountain is very unique, extremely beautiful areas that used to be used for outdoor activities, and it is so close to the capital and so close to where most of the inhabitants in Iceland live, so it is

³⁰ I have put NETs in quotation marks, to point to the fact that this type of NETs does not in reality contribute to lowering the concentration of carbon in the atmosphere.

very valuable in that sense. And the more infrastructure you build at that site, the more you reduce the value of nature, just on the other side of the mountain.

(Magnúsdóttir and Landvernd 2023)

As a commentary to Magnúsdóttir's note on possible consequences for groundwater, I wish to point to an already existing challenge linked to geothermal energy production, namely that of the discharged wastewater containing chemicals and nutrients (OECD and Lives 2014). My main takeaway from this quote is Magnúsdóttir's characteristic of 'a fossil-free community' in need of introducing drastic cuts in energy demands — guiding the reader back to Buck's description of a de-growth system change scenario (Buck 2021, p. 36). This position states a major discrepancy between discourses represented in this section and discourses represented in section 7.2.

Another important point of discrepancy between the two is the different ways of spinning discourse around crystallised carbon: What Magnúsdóttir classifies as 'disposal of pollutants', CarbFix refers to as part of 'a natural process' (check section 7.2 for quote). In addition to the critical discussion of possible consequences on groundwater from the NETs projects, I would like to add the fact that ~25 tonnes of water is needed for each tonne of gas injected to fully dissolve the CO₂ at depth (Snæbjörnsdóttir, Sigfússon et al. 2020, p. 95). It should be noted, however — as the representative from Reykjavík Energy states — that experiments are now being conducted on the use of seawater instead. Magnúsdóttir concludes on NETs in Iceland and their role in global climate policies:

I think Iceland can play a role, but basalt is found many many places on earth and there is a lot of it in Iceland, but it is not unique to Iceland. And for us to be a dump for someone else's pollution, it is not a future that is very bright, I think. For the CODA Terminal, we [Landvernd] think that — of course it is a proof of concept — but it would make much more sense to try to do this close to the emissions, not be transporting CO₂ around the world. It is just going to increase emissions, rather try to build storage facilities close to the pollution, not in Iceland (...). In principle, we are not against that [land-use in Iceland as part of the green transition] but we always think it is important that you evaluate, do an impact assessment and evaluate; what are you losing?

(Magnúsdóttir and Landvernd 2023)

Here, she hints at the risk of 'mitigation deterrence' (Malm and Carton 2021)

linked to the use of NETs, something I will return to in section 8.3. She ties points in this quote to what she calls 'small island mentality', making Iceland want to be the biggest and the most important — in this case as a forerunner for carbon mineralisation. A trick often used — as she explains — is to use 'per capita' (because Iceland is so small) in various contexts where it easily makes Iceland look like the country ranking the highest. Her call to critically question what is being lost directs me back to a quote from Holly Jean Buck's *After Geoengineering: Climate Tragedy, Repair and Restoration*: "Thus, the hard thing isn't beginning the project, but ending it: Ensuring that what comes *after geoengineering* is liveable." (Buck 2019, p. 24)

7.4 CARVING OUT LOCAL KNOWLEDGES IN THE POOL AND AT THE LOCAL LIBRARY

7.4.1 ACTIVISTS, ARTISTS AND A MEDIUM

In my representation of local knowledges in Iceland, I acknowledge that the sample size constitutes a significant limitation. I perceive these knowledge positions as examples of counter-narratives to narratives strengthened by power structures. I carve out these local knowledges (Klonner, Usón et al. 2021) in an attempt to strengthen them. I strove for reciprocity and transparency when conducting the interviews, clearly stating my positionality. I have anonymised the 'lay people' I have interviewed, and the interviewees, I name, have all consented to the quotes being shared in the context of my thesis.

"Iceland is where the earth is being born and reborn over and over again", (Vilhjálmsson 2022) is what climate activist, nature guide and artist Ósk Vilhjálmsdóttir - whom I met up with at the geothermal beach in the south-end of Reykjavik - said, when describing the nature of her country. She is of course referring to lava. Another climate activist Ragnhildur Jónsdóttir — who often goes by the name Ragga, associated with Friends of the Lava³¹ — likewise pointed to lava as the foundation of all life:

It all starts with a volcano eruption, first day of creation (...) This is the beginning and then in a few years you have a little bit of moss and then when it cools down with the

³¹ <https://www.hraunavinir.net/>

wind and the water and the birds will bring in fertiliser and seeds of some plants and then plants will grow (...) Moss can be amazing. It's the first plant and when it's growing on the lava, other plants can grow from the moss, from the little gathering of mud and soil and then birds can come in and make nests and you can have trees and this is the beginning. It is life. ((Ragga) and Lava 2022)

Both Ósk and Ragga were born and raised in Iceland. I was first introduced to Ragga during a Q&A (I facilitated between Sara Dosa³² and Ragga) after Sjón Anthropological Film Festival's screening of the movie *The Seer and the Unseen* — starring Ragga, portraying her work as an activist and medium fighting to save the elf castle Ófeigskirkja in Gálgahraun. I reconvened with Ragga in her garden in Hvalfjörður in September last year (2022). At regular intervals, our interview was interrupted by her three dogs, who all seemed to have something to add to the microphone. Ragga's garden is also home to five cats and twenty chickens. I wish to share one quote from Tyson Yunkaporta's book *Sand Talk: How Indigenous Thinking Can Save the World* from 2019 to carve out space for Ragga's quote on lava and basalt to resonate:

The majority of this earth is rock, and while water and plants make up its surface, the body of the earth, the part that keeps it all together, is rock. You can have life and creation but it will all crumble without a solid base, same with society, companies, relationships, identities, knowledge, almost anything both tangible and intangible. Like those forests and trees sitting as a skin over the rocks of the earth, without that strength inside, without that stone, it would crumble. (Yunkaporta 2019, p. 31)

He also writes about earthquakes that they are a force shaking the solid base of life, the body of the earth (Yunkaporta 2019, p. 31). As I mentioned in section 5.1, basalt rocks hold a vital force in Iceland, and reality seems less vibrant if you turn your back on that power - hinting at Jane Bennett's book *Vibrant Matter: A political Ecology of Things* from 2010, who shares a philosophical thread of vitalism with Deleuze and Bergson

7.4.2 LOCAL FOLKS

All my interviewees in this section are born and raised in Iceland. When staying in Reykjavik last September (2022) I visited Hveragerði, the town closest to Hellisheiði. Upon arrival, I spent quite some time driving around the area,

³² the director and producer of the movie

searching for someone to interview, and in the local library, I found a woman who agreed to partake in a short interview. Here, I will share some of her takes on Orca and Mammoth and Iceland's role in the global 'net-zero' trajectory. This is how she characterised her knowledge and positionality: "I am very much aware of the impact of pollution and I am very interested in the environmental problems, what *they* are doing to us." ((Hveragerði) 2022) She had heard about IPCC, but said that she was not familiar with it. She explained how she had heard about the local DAC plants (in Hellisheiði) via news she had watched on television, as well as "from people talking about it because we are so close to it here" ((Hveragerði) 2022). Here, I mainly notice how she frames the crisis as something 'they' are doing to 'us' — which makes me 1) wonder who 'they' are to her and 2) the great sense of alienation and powerlessness sitting in the way she portrays her relation to the (climate and environmental) crisis, as well as the way it is being handled. Next up, I asked about the earthquakes in Hveragerði (that representative from Reykjavik Energy informed me about), as well as other possible consequences from the DAC plants. This is what she answered:

Probably noticed a bit but more like heard of it (...) You cannot always tell which is which, the other ones and this one because we're on an active earthquake area. It could be something else so we don't know always but I experienced this last spring (2022) (...) I really cannot tell [about possible environmental consequences]. It is so new [the local DAC plants]. Suddenly it just was there. You did not know until you heard about it on the TV and it was already operating. No-one seemed to know until it was already there. I do not know [about possible consequences for the local nature and environment].
((Hveragerði) 2022)

It is possible that the earthquake referred to in this quote is linked to Orca since it happened when Orca was up and running. Here, we again catch a sense of powerlessness. Another point is the confusion about the source of the earthquakes linking to the representative from Reykjavík Energy's statements about 1) "the injections done, linked to mineralisation (by CarbFix) only making up a tiny part of the re-injection taking place within the geothermal industry" (Energy 2022), 2) earthquakes as a normal side-issue to the use and production of geothermal energy (happening in Hellisheiði), because Orkuveita Reykjavíkur is obliged to infuse by-products from the geothermal energy production back into the ground. (Energy 2022) and 3) earthquakes as a normal part of life in Iceland; "the

Icelandic public tends not to be concerned about minor earthquakes” (Energy 2022). When coding the data from Hveragerði and using it for my triangulation, I kept in mind what the representative from Reykjavík Energy told me about being “careful when asking the public with respect to risks and whether they accept a re-injection linked to mineralisation” (Energy 2022), because — as she put it — “the public cannot distinguish earthquakes provoked by re-injection linked purely to geothermal industry and on the other hand re-injections as part of the CarbFix project” (Energy 2022), due to point 1 and 2 (Energy 2022). During my interview at the library in Hveragerði, I also asked how she would describe her relation to land and nature in Iceland, and this is how she answered:

I have this special belief like many Icelanders in *álfar/huldufólk*³³ (...) I sometimes look at the mountain and see a formatted mountain looking; this might be a church. This is probably a block where many live. We take that seriously (...) It is here in Hveragerði, if you look well, you might see them because we have that kind of mountains here close to the village. That is mostly what so many Icelanders believe in. ((Hveragerði) 2022)

The way she talked about *huldufólk* made it evident to me that spirituality plays into her relation to the land and its nature. I will return to the lives of *huldufólk* in section 8.5. To wrap up the interview, I asked about the role she thinks Iceland plays/should play in global geopolitical climate policy, and this is how she answered: “I think we play a rather big role (in the green transition) (...) because of so many things we might be more suitable for this than others because we have underground so much space to put it in (mineralised carbon)” ((Hveragerði) 2022).

On that same day, I drove to Ölfus, a village located in the proximity of Hellisheiði as well. I had heard stories about Icelandic pools being the place to go for good chats, so I went to the pool in Ölfus. Here, I met three people who agreed to partake in an interview. One of them chose to leave discreetly when I asked about spirituality. When she had left the other two shared with me that she probably did not feel like talking about the topic because spirituality, for her, is a personal matter. I asked the remaining two people from the pool staff about their perceptions of the IPCC and calculations of net-zero scenarios. Interviewee A answered: “I do not know anything about it, that company (talking about the IPCC).” Then I asked about Orca and Mammoth; what they knew about the

³³ hidden people

CarbFix2 project, and interviewee B answered: “Nothing.” A answered: “I went on a tour (to the geothermal plant in Hellisheiði). They take water from the ground and give it to us, and then they put something else in the ground.” Here, I, of course, again notice the sense of detachment and alienation — both towards IPCC and CarbFix2. I assume the alienation results from lacking information and democratic involvement in the decision-making processes. I proceeded with a question regarding Iceland’s role in global climate policies, to which B answered: “Some big one”. A agreed and continued: “Yeah, big role, yeah use our technology. (...) Iceland is enthusiastic for this climate thing. Like when we are voting for government and everything, they have to say what they are, what they want to do in this [in climate matters].” ((Ölfus) 2022). Upon which B added: “I think young people in Iceland in high school want to learn something about climate, a lot of people, I think.” ((Ölfus) 2022) A summed the answers up by stating in a proud voice: “So, big role”. ((Ölfus) 2022) Here, I notice the eagerness amongst local Icelanders to play an active role in global climate policies. I moved on to questions about possible consequences on nature and the environment from CarbFix2, to which A answered: “I do not know what could happen. I think, it is just good they are taking this from the air, turning it into rock and putting it in the ground.” ((Ölfus) 2022) B agreed and added: “Yea, I think so.” ((Ölfus) 2022) My last question was an inquiry into possible parallels between land use tied to aluminium factories and DAC in Iceland, to which A answered: “For me I do not like them [aluminium factories].” ((Ölfus) 2022) B added: “I do not like them either” ((Ölfus) 2022). A: “I would rather have a company who is trying to fight the [climate] (...) yeah, than another aluminium factory (...) I do not like these aluminium things, especially because they are all from other countries.” ((Ölfus) 2022) B points out that the people working at the factories would have a hard time finding jobs elsewhere. This last point raises an interesting discrepancy in interests: What might be damaging to the environment and climate might be beneficial for workers in Iceland — and vice versa. Here, it is worth noting that the CODA Terminal will create between 130 and 260 local jobs on-site, 85 (crew), 5 (ashore) for transportation and indirectly 400 (shipyard) jobs. (Commission 2022)

The next day, I drove to Hafnarfjörður, the village where the first carbon hub for The Coda Terminal will be located. Here, I again found my interviewee at the local geothermal pool site. He answered that he probably had heard of NETs but

was not a hundred per cent sure he knew what it was. When I talked a bit more into it, he realised that he did know Orca, Mammoth and CarbFix. He stated his opinion on The CODA Terminal as follows:

I think it is a good job they are doing (...), I think it is good to use it for Icelandic energy ... factories, we can put the CO₂ to the ground from them, but not taking it all over the world. I do not think that is clever. I just want to use it [NETs] to minimise pollution locally. (...) It should be used for Icelandic companies and not a global one because then it is [the storage potential] going to be very quickly be fully used. We have so much pollution today (...) We are never going to get all the CO₂ out of the air and we are polluting more and more every year (...) Everything we do is good but we are not doing enough.
(Hafnarfjörður) 2022)

His point on local carbon from point sources aligns with Magnúsdóttir from Landvernd. A high-emissions pathway combined with NETs does not seem to count as a real solution for him. When I ask specifically about the case of Iceland, he answers:

We should think about doing our homework here; trying to take all the CO₂ from our country and minimise it, not trying to save the whole planet, we cannot do it anyways. If every country thinks like that — minimise their CO₂ [emissions] then maybe the world would get cleaner (...) The geothermal power plants are polluting, and we are taking the pollution from them into the ground. If we start taking the pollution (from) everywhere else (...) then we cannot hold on and taking it from ourselves (...) What it does when they take the CO₂ from the power plants and put it in the bedrock, it hardens and then it cannot take anymore, so I do not think it is something you can do for hundreds of years, after x years this will not be possible anymore. If they start taking it from other places, they are destroying the prospect of doing it for us in the future.” (Hafnarfjörður) 2022)

For him, CCM in relation to CarbFix2 and the CODA Terminal clearly does not take on a shape as an “unlimited” (Carbfix 2023) adventure with “exceptional scale-up potential” (Commission 2022, author's own italics). To wrap up the interview, I asked about land use in Iceland - using aluminium factories and carbon hubs as examples. He expresses his stance like this:

They do not leave such money in this country [aluminium factories], they take it all to their own countries and only pay salaries and very low taxes here (...) On the long term, it is [carbon hubs] stupid because then you cannot stay clean for yourself so why do that. I

think that is greed. We call it greed, you want to get money from someone else and you are using the land that the people own. We own this land. ((Hafnarfjörður) 2022)

Further research could be conducted on a potential relationship between the greed characterised here and Iceland's economic crash back in 2008. When talking to lay people (except the activists and mediums), I did not catch any negative sentiments directed directly towards the CCM technology itself — importing emissions from elsewhere seemed to be the trigger for resistance.

8 Main themes identified in NETs future-imaginaries in Iceland, from a local and global perspective

Here, I have fleshed out and commented on the five main themes I have chosen to highlight from my literature review and data collection and placed them in a wider context of global NETs discussions.

8.1 LOCAL LAND-USE AND ENVIRONMENTAL ISSUES: 'CONTRAPTION FALLACY' AND ICELAND AS A DUMP FOR SOMEONE ELSE'S POLLUTION

Land use in Iceland as a consequence of the NETs venture is a topic full of opposing positions. We have seen how Icelandic basalt is being charged with the potential of storing >950 Gt of CO₂. With global carbon emissions from energy combustion and industrial processes at a level of 36.8 Gt. (IEA 2022) in 2022, this means that >25 years of emissions could possibly be stored in the rift zone of Iceland. Simultaneously, the land in Iceland, for many locals, is charged with spiritual meaning and habitat of supernatural beings such as huldufólk. Pamela McElwee touches upon the delicate link between IPCC's calculation (via IAMs) of NETs' role in the net-zero strategy and how NETs are being implemented in local communities and nature: "Potential impacts from land use change like gender differentiation, rising inequality, displacement or land degradation cannot be forecasted in most IAMs." (McElwee 2022, p. 8) Another relevant term here is 'contraption fallacy' introduced by Wim Carton, Adeniyi Asiyebi, Silke Beck, Holly J. Buck and Jens F. Lund in their article "Negative Emissions and the Long History of Carbon Removal" from 2020, in which they point to the pitfall of this fallacy in the instalment of globally oriented CDR-solutions. The term points to

the fact that these instalments are often done in complex and potentially fragile local communities and environments (Carton, Asiyanbi et al. 2020), and often without the necessary knowledge about it nor sensitivity directed towards the land being used.

Through the fieldwork interviews, I caught a sense of worship of the land and its nature. The lay people who expressed relations to spirituality did not explicitly state how this specifically affected their relations to the land, but I sensed that it did play a role. Ragga was the only one explicitly expressing a relation to lava and basalt, seemingly strengthened by spirituality. My meeting with her took shape like a casual conversation rather than an interview, meaning that she got the space to deep-dive into various offsprings of my questions, of which I will present a few more in section 8.5. One major takeaway from my conversation with her — in relation to land use — was her great resistance towards the devaluation of basalt to something worthless that you can charge with carbon with no consequences whatsoever. She subscribed to the myth of land rather than the myth of NETs and insisted that basalt holds a meaning and purpose in itself that you should be careful interfering with. Generally, the lay people I interviewed did not seem to be opposed to the CarbFix technology itself, nor the process of sequestering Iceland's own emissions. They were positive towards exporting the CarbFix technology as they found it important for Iceland to be a green forerunner. Still, when it came to Iceland storing other countries' emissions, the attitude seemed to change. It was in relation to this point Auður Önnu Magnúsdóttir, representative of Landvernd, stated the worry that Iceland would become a dump for someone else's pollution. The most prominent environmental consequence from the carbon hubs detected so far is, of course, the earthquakes. Another important side-effect from geothermal energy production is increased emissions of sulphur oxides and hydrogen sulphide. Concentrations of hydrogen sulphide in the Reykjavík area often exceeded health guidelines due to the operation of the Hellisheiði plant and may have a long-term impact on health and the environment (OECD and Lives 2014, p. 5) — something Magnúsdóttir from Landvernd pointed out. This is not an environmental consequence linked directly to the running of Orca and Mammoth but to the production of geothermal energy production in general.

In the review I presented in section 7.2, we see that CarbFix consent to the fact that earthquakes have occurred as a consequence of the injections in Hellisheiði:

This requirement is especially challenging during onshore injection into volcanic rocks because these formations are often highly fractured (...) One of the main risks of CO₂ injection of any kind is induced seismicity (...) Induced seismic events have been associated with ~10% of these wells, with high injection rates being the dominant trigger for induced seismicity (...) Micro-seismicity increased immediately in the area north of the injection sites, with the largest seismic events being a sequence that included two magnitude 4 earthquakes on 15 October 2011.

(Snæbjörnsdóttir, Sigfússon et al. 2020, p. 97)

This earthquake referred to happened as a reaction to re-injections (of geothermal fluid) taking place in Hellisheiði prior to the launch of Orca (on the 8th September 2021) (Hjörleifsdóttir, Gunnarsson et al. 2020). The representative from Reykjavík Energy frames the earthquakes like this during our interview:

Whenever you re-inject into what we call a very geologically active area, that is prone to earthquakes, you may release even more earthquakes (...) Normally the earthquakes only happen when you change something. So what has happened now after we have had these earthquakes³⁴, which were seizable ones some years ago, then we have a system that we always alert the adjacent community in Hveragerði [the village closest to the plant] whenever we are changing anything. (Energy 2022)

She emphasises, however, as a continuation of her points presented in section 7.4.2: “Adding the carbon dioxide to what we are anyway re-injecting it does not change anything.” (Energy 2022) According to the representative from Reykjavík Energy, a protocol is now in place (a green light method) to prevent incidents like the magnitude four earthquake³⁵ and to alert the adjacent communities, something Sigurður R. Gíslason also pointed to during our interview. Here is the representative from Reykjavík Energy’s take on a possible environmental back-side to the coin:

There are not so many environmental downsides to it, if you are just doing the CarbFix process, there are no additives, there are no chemicals that we are putting back into the reservoir apart from what was there (...) There are a lot of uncertainties (...) But not so

³⁴ I assume she is referring to the same earthquake as the interviewee from Hveragerði.

³⁵ Referring to the earthquake in 2011.

many visible, known environmental risks (...) The concern is that we are sacrificing Icelandic nature for helping the climate and is that something we want to do? That conversation is not really taking place with respect to CarbFix. (Energy 2022)

Historically, foreign interests in land use in Iceland have been a touchy subject, in particular in relation to aluminium smelters. I paid the biggest one located in Reydarflóardar, launched in 2007 (Edmonds 2007), a visit during my field trip to Iceland last year. The smelters are substituting smelters in the USA because the process is cheaper to run in Iceland, using geothermal and hydraulic³⁶ energy. Back in 2007, balancing environmental and economic trade-offs in relation to aluminium smelters was a hot potato. (Edmonds 2007). The debate even gave birth to a new green party, the Iceland Movement. The industry has been given names such as “heroin economy” (Author Andri Snaer Magnason) and “gold rush” (Ragnhildur Sigurdardóttir from ARCUS³⁷) (Edmonds 2007), tapping into the notion of greed-directed interests, as one of my lay people interviewees pointed out. I wish to make a last remark on the last sentence of the quote above, where the representative from Reykjavík Energy hints at an ongoing discussion in Iceland (not unfolding within CarbFix yet, it seems), polarising the public; between those who fight for climate and those who fight for nature. During my interview with Ósk Vilhjálmssdóttir pointed out how this debate is a hot potato in Iceland right now, something I will return to in section 8.4.

8.2 “NATURAL” CARBON MINERALISATION AND NATURAL EARTHQUAKES

Another point I have chosen to highlight from my discourse analysis is the naturalisation of the CarbFix technology performed by the company and other agencies, as laid out in section 7.2. I detected this discursive dynamic both on CarbFix’s webpage, in the review and in the article I have accessed. According to the representative from Reykjavík Energy and CarbFix, CCM has gotten a warmer welcome in Iceland than CDR/CCS has gotten in the places they are being implemented — because the storage method, dissolving the carbon in water before injecting it in the bedrock, is simply more efficient, stable and safe. I would,

³⁶ With dams causing erosion, river diversions and groundwater changes - the best example in Kárahnjúkastífla.

³⁷ Arctic Research Consortium of the United States

however, add to the discussion that the ‘naturalisation’ of the technological process, in discourses spun around it, together with lacking access to information and democratic involvement ((Ölfus) 2022) ((Hveragerði) 2022) should be taken into consideration as other important factors as well. The representative from Reykjavík Energy uses a similar discursive technique when she frames the earthquakes — in spite of whether they are a result of injections into the bedrock or of natural origin — as a natural way of life in Iceland.

8.3 A SYSTEM-PRESERVING SOLUTION: ‘MITIGATION DETERRENCE’ AND ‘PREVARICATION’

When I asked the representative from Reykjavík Energy about the possibility of facing mitigation deterrence (Malm and Carton 2021) as a consequence of the high-tech NETs future imaginaries, she answers:

I think this is not going to have an impact on the general public (...) Transforming away from the reliance of fossil fuels makes social and economic sense. It makes no sense economically and socially to continue to rely on fossil fuels (...) They will transform [the general public] over to relying on renewables simply because it makes economically sense and that is how *we* operate (...) There is however an industry that this may slow down the transformation for and that is heavy industry, because if we scrub carbon or the emission from carbon dioxide for example from the aluminium power plants, then they have less of an incentive to stop using carbon free electrics (...) This may slow down or create a disincentive for them to really get this done. (Energy 2022, author's own italics)

As we see, the representative from Reykjavík Energy draws a distinction between mitigation deterrence for ‘the general public’ and ‘heavy industry’. The risk of facing mitigation deterrence ties back to the Climate Action Plan and how its prediction of climate neutrality partly relies on ‘measures in preparation’. ‘Mitigation deterrence’ is a term often used within social science — such as in Andreas Malm and Wim Carton’s article from 2021, “Seize the Means of Carbon Removal: The Political Economy of Direct Air Capture” — pointing to the process of (directly or indirectly) slowing down the curbing carbon emissions. This is closely related to Duncan McLaren and Nils Markusson’s ‘politics of prevarication’. This term points to the deferral of political deadlines for climate action (which may, in turn, undermine societal commitment to meaningful responses) (McLaren and Markusson 2020, p. 395):

Critically, in this process, each technological promise has enabled a continued politics of prevarication and inadequate action by raising expectations of more effective policy options becoming available in the future, in turn justifying existing limited and gradualist policy choices and thus diminishing the perceived urgency of deploying costly and unpopular, but better understood and tested, options for policy in the short term. (McLaren and Markusson 2020, p. 395)

As we see, the representative from Reykjavík Energy sees it as inherent to human nature to choose the most profitable trajectory, which in her words, would be phasing out fossil fuels. Her take is that NETs — such as Orca and Mammoth — and how they operate as actualisers of futures (materially as well as discursively) will cause no such thing as ‘mitigation deterrence’ for the general public - but might cause some degree of mitigation deterrence for heavy, ‘hard-to-abate’ industry. During our interview, the Reykjavík Energy representative emphasises that the plan for the CODA Terminal is to actively partake in the carbon market, which I see as an example of CMM working as an integral part and extension of ‘the paradigm of accumulation and growth’ (Berardi 2017).

At a café in Reykjavik back in September (2022), I met with Guðni Elísson, professor of Comparative literature and Head of Faculty in the Icelandic and Comparative Cultural Studies department at the University of Iceland, as well as founder of earth101³⁸. His take on the possibility of mitigation deterrence linked to NETs goes like this:

My take would always be that while it is extremely important to pursue this (NETs), pursue all avenues, we need to be extremely careful about the way we frame negative emissions (...) because the worst thing that could happen would be that the discussion surrounding negative emissions would in some ways create apathy (...) and this belief that technology is going to save us. (Elísson, Iceland et al. 2022)

As we see, Elísson’s background in humanities grants him a focus on discourse creation and the affects/effect they spur. I argue that there lies an imminent risk within the ‘naturalisation’ of NETs (that I detected during my disentanglement of different stakeholders’ discourses) for it to contribute to apathy like Elísson points

³⁸ <https://earth101.is/en/>

to, as this discourse/tactic holds the possibility to disarm people's resistance — ultimately increasing the risk of mitigation deterrence and prevarication.

8.4 NETS THEOCRACY: TECHNOLOGY AND IDEOLOGY - WHO HAS THE POWER TO 'ACTUALISE' NETS FUTURES IN ICELAND?

In my discourse analysis, Bifo's 'conundrum' has served as an entry point to unlocking the intimate relation between ideology and technology: It is the conundrum and its features that shape and model the application of abstract technical possibilities onto the imagination of the future as well as its inscription in the present (Berardi 2017). In this section, I would like to point to possible consequences of the workings of the conundrum in 'the paradigm of accumulation and growth'. (Berardi 2017) This is something Andrzej Frelek takes under treatment in his article "Climate Change and the Critique of Technology Towards a Marxian Perspective" from 2022, in which he writes: "Through modern technology all nature becomes nothing else, but the potential energy that can be unlocked through external, mechanical extraction processes." (Frelek 2022, p. 5) My literature review, as well as my fieldwork data, point to a split between (1) valuing Icelandic nature for what it is and (2) valuing it for the energy it can provide. During my encounters with CarbFix and Reykjavik Energy, (2) was dominating, whilst (1) was prioritised during my chats with Ragga, Landvernd, Ósk, as well as with the lay people I interviewed (predominantly). During my chat with Ragga, she gave the example of a waterfall: She explained how some people would first calculate how to extract as much energy as possible from the water, whilst others would find meaning in simply staring into the water, daydreaming. In *Futurability*, Bifo argues that technique and economy today have become intimately entangled to a degree where technology seems to be supplanting God, forming what he calls a theocracy. (Berardi 2017) Bifo's response to this is: "Far from rejecting the ambiguous legacy of technology, we have to reprogram the relation between technology and life." (Berardi 2017, p. 45) This matters in questions regarding human ecology and climate crisis because technological promises — as McLaren and Markusson put it — are at least as responsible for the formulation of targets as they are a product of those target framings (McLaren and Markusson 2020, p. 395). It matters what future imaginaries we install in the present. As a guideline for constructive narrations for the future, we can skew to Augustine, Soderstrom et. al and their article "Constructing a Distant Future: Imaginaries in

Geoengineering” from 2019, in which they state: “In order to be consequential for action, perceptions of the future must be shared and reduce ambiguity about future states” (Augustine, Soderstrom et al. 2019, p. 1933).

Bifo introduces the notion of ‘abstraction’ as a consequence of the accumulation- and growth-directed conundrum (Berardi 2017, p. 88+107). This diagnosis — in my view — fits quite well with Icelandic lay-people commenting on the climate crisis as something “they are doing to us” ((Hveragerði) 2022) and NETs solutions (Orca and Mammoth) as something that “suddenly was just was there” ((Hveragerði) 2022). This process seems to have become automated, applying the logics of the governing conundrum. I perceive IPCC’s use of the ‘black box’ (McElwee 2022, p. 8-17) IAMs as one technique of abstraction and automation within the conundrum, consequently making IPCC abstain from taking potential impacts like gender differentiation, rising inequality, displacement or land degradation into consideration (McElwee 2022, p. 8). Only when these factors are left out of IAMs (in the dominant conundrum) does the application of NETs come across as non-political progress. When in fact, they are integrated practices (McElwee 2022, p. 3) embedded in power structures, impacting both people and land as a result of the discourses activating and directing them. Here is McLaren and Markusson’s take on the interplay between ideology and technology:

Each technological promise, and its articulation in modelling and so on, reflected the dominant neoliberal ideology of the entire period in which market-based and technological innovations that could sustain economic growth were actively preferred over measures that might have threatened liberal individualism, markets and consumerism, or required early scrapping of equipment or infrastructure.

(McLaren and Markusson 2020, p. 395)

The conundrum is powered by power. To distil the power structures in the ‘actualisation’ of NETs imaginaries in Iceland, I have applied Bifo’s definition of power, a continuation of the Foucauldian definition:

I call power the temporary condition of implementation of a selection among many possibilities. I call power a regime of visibility and invisibility: the exclusion of different possible concatenations from the space of visibility (...) Power is nowhere and everywhere

at the same time, internalised and inscribed in the techno-linguistic automatisms called governance. (Berardi 2017, p. 74-80)

The conundrum (in all its invisibility) and the coding of it determine who gets the power to actualise NETs future imaginaries, as well as the stories told about it, the perspectives rendered visible and invisible — on a global scale, as well as in Iceland. This is something Kirstine Lund Christiansen and Wim Carton hint at in their article from 2021, “What ‘climate positive future’? Emerging sociotechnical imaginaries of negative emissions in Sweden”: “Actors’ access to power and resources greatly influence whose imaginary becomes institutionalised (...) Visions of future socio-technical practices tend to be produced by societal elites or authorities.” (Christiansen and Carton 2021, p. 3) Augustine, Soderstrom et al. critically accesses this point as well, with the question: “who should be given the power to decide when and how to adjust the world’s thermostat.” (Augustine, Soderstrom et al. 2019, p. 1932). In the Icelandic context, we see a clear example of the conundrum of accumulation and growth (Berardi 2017) and how it gets to dictate the flows of energy into technology, as Auður Önnu Magnúsdóttir from Landvernd explains to me:

80% of all the electricity produced in Iceland goes to aluminium smelters and other heavy industry, 64% goes to aluminium smelters (...) Because we have sustainable energy, we should we have all the aluminium smelters in Iceland? (...) Land use is a huge huge discussion here in Iceland, and because we have so many tourists that come here to see Icelandic nature, it's also an economic question right now. It's not only about the heart and soul of what it means to be an Icelander and be connected to nature and the land. It's also just a *pure economic question*. (Magnúsdóttir and Landvernd 2023)

Here, Magnúsdóttir touches upon another friction in public opinion in Iceland: I already mentioned the split between ‘nature’ and ‘climate’. An extension of that polarisation is the fact that the sacrifice of nature in the name of climate negatively influences the tourist industry in Iceland. OECD identifies “potential land-use conflicts between renewable power development and nature-based tourism” as a forthcoming challenge in sustainable, green policy building, with an ever-increasing tourist industry (673.000 visitors in 2012 (OECD and Lives 2014, p. 12)) (OECD and Lives 2014, p. 3). To challenge dominating power structures, diverse representation and democratic involvement are key, which is why I have

put great effort into tracing out and amplifying 'local knowledges' (Klonner, Usón et al. 2021), imagining NETs futures in Iceland. Bluwstein and Cavanagh have inspired this practice. They write:

The more that countries act now on climate mitigation, the less they must rely on uncertain NETs later on, and research on the implications of NETs is an important part of decision-making in balancing these trade-offs. Deliberate public engagement on research for these technologies can also help bring more democratic processes in and lead to better consideration of justice in NETs trajectories for the future.

(Bluwstein and Cavanagh 2022, p. 20-21)

On a global scale, this is something we ought to do to overcome the emerging 'decarbonisation divide' between Global North and South. (Bluwstein and Cavanagh 2022, p. 4) In relation to NETs, most considerations purely concern technology and rarely social justice elements. (McElwee 2022, p. 18) Overall, McElwee concludes: "This argues for reframing the use of NETs as a potentially high-risk game with serious justice implications, given uncertainties around deployment." (McElwee 2022, p. 15) My fieldwork and data collection in Iceland has shown that some effort is being made in this regard, such as the act of establishing The Climate Council and engaging with public consultation. And justice and land use are, in fact, both mentioned in the Government's publication "On the Path to Climate Neutrality, Iceland's Long-Term Low Emission Development Strategy":

Part of the enhanced support for basic and applied research on climate change in Iceland is specifically directed at studies regarding the interplay of land use and climate (...). A just path to climate neutrality should involve all sectors, different stakeholders and the general public in the discussion and the decision making. (Iceland and Resources 2021, p. 52)

But are these measures far-reaching enough when taking into considerations the consequence on the local land and communities?

8.5 DOES THE LAND SPEAK TO YOU?

In this section, I wish — against the background of my critical social science assessment of NETs future imaginaries in Iceland — to push for radical pluralism (Escobar 2018) within the stories we tell. Savransky diagnoses: "In the wake of the

mass tangled catastrophes of capitalism, colonialism, and extractivism, the mass disqualification of differences through which the modern world was born has radically devastated the very conditions of liability of myriad human more-than-human worlds in this world” (Savransky 2021, p. 4), and asserts the possibility of other stories, ongoing and unfinished, constantly in-the-making (Savransky 2021, p. 1) as a fundamental prerequisite for the world. Savransky channels Gilles Deleuze and Felix Guattari, who state that the most urgent and most difficult task before us today is to believe in the world: “We have lost the world”. (Deleuze and Guattari 1991) Savransky writes:

There is this world where elves are real, living underneath rocks. Meddling in human affairs, they're called huldufólk, and often force modern infrastructural development projects to slow their pace and change course. (Savransky 2021, p. 2)

In Sara Dosa's movie *The Seer and the Unseen*, we witness highway constructions being blocked and stalled to save an elf castle Ófeigskirkja. I will not spoil the movie here but reveal that the movie showcases a clear case of myth and the spiritual sphere interfering with reality, actualising potentialities here. Savransky describes how these spiritual creatures “just feel like themselves” (Savransky 2021, p. 2) and how they were never ‘enchanted’ to begin with. (Savransky 2021, p. 2) We ought to tell stories that make us believe in the world and make reality feel like itself again — then perhaps time will fall back into joint.

No story can disentangle itself from what it omits, any more than it can distance itself from the consequences it precipitates, to the difference it might be liable to make. Each involves a risk, a wager on the worlds we might seek to weave. Which is why it matters how stories are told. (Savransky 2021, p. 13)

As a final remark, I wish to channel and echo a story told by Ragga, inspired by Sara Dosa *The Seer and the Unseen*:

They have not called me up there [huldufólk in Hellisheiði], so I do not know in that actual area, but everything that we do affects them. Just like for us some places are really sacred, like that elf church [Ófeigskirkja] in Gálgahraun, like in the film³⁹. I think, when Icelanders came here a thousand years ago, they were both Christian and heathen, or you

³⁹ Dosa, S. (2019). *The Seer and the Unseen*.

know the Ásatrú, the old Norse religion, with all the elves and giants and the nature beings (...) with the old nature gods, and then the Norwegian king wanted us to become Christian, so it was like a political decision (...) I think politically, we decided to call it churches because a Christian king cannot destroy or be against a church, so they would leave elf churches alone. If the elves are Christian, how can you be against them?
(Ragga) and Lava 2022)

9 Conclusion

This thesis portrays the myth-charged construction of net-zero future imaginaries, evolving from a case study of the two CCM projects in Iceland, CarbFix2 and the CODA Terminal. I have disentangled NETs discourses spun by different stakeholders to shed light on the ‘naturalising’ and depoliticising powers of myth. Throughout this process, I found different accentuations — some rendered more visible by power structures than others. To boil the disentangling practice performed down to a Maggi cube: One thread tied to local people, artists (including Ragga), NGOs and activists put forth a more local perspective, seemingly with closer ties to the land and its inherent qualities and energies. Most of these interviewees accepted CCM and NETs in general as a necessary means to reach the Paris Agreement but stressed the importance of impact assessments of consequences for the land and its communities to accompany the implementation. Another thread tied to CarbFix and Reykjavík Energy (and, to some degree, the government and international policy papers I have accessed) put forth a more global perspective, emphasising energy and capital potentials inherent to the uniqueness of Iceland and its nature. Through the application of the conundrum to my disentangling practice, I found that these discourses, to a large degree, are puppeteered by theocracy. Theocracy holds the power to actualise net-zero future imaginaries and inscribe them onto the present. Within activist and NGO discourses, I have detected fear of mitigation deterrence as a consequence of virtual NETs future imaginaries actualising less ambitious climate policies today. If we ask Reykjavík Energy, this is only a risk we face in terms of heavy industry. The main consequence of CCM I have detected is earthquakes. Through the act of echoing local Icelandic stories, I have aimed at pushing for pluralism and a more diverse take on CCM and NETs in general. I argue that the only way to sustainable, responsible and just implementations of NETs (Carton, Asiyambi et al. 2020) goes through critical social science, bringing justice to the centre of the discussion of NETs instead of treating it as an afterthought. I argue that if social

science does not take on the mediating task between technology and people, we risk (intentionally or unintentionally) confusing, misleading and misrepresenting lay people and letting natural science and technology studies dictate the (green) transition to the future. Inspired by Bifo's take on debt, I argue that NETs can be seen as a technique to disguise climate debt directed by the hunt for profit within the paradigm of accumulation and growth, acting as a smokescreen to maintain business as usual. To counterweight this horror story, I believe that the power to decarbonise should come from diversified and democratic 'social imagination' (Buck 2021), including both practices of lay people, activists, artists, academics, mediums and politicians grounded in a pluralist worldview.

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11 Appendix

11.1 LIST OF INTERVIEWEES

1. Local NGO(s): Represented by Landvernd (Auður Önnu Magnúsdóttir) and Friends of the Lava (Ragnhildur Jónsdóttir)
2. Activists: Guðni Elisson, Ósk Vilhjálmsdóttir and Ragnhildur Jónsdóttir
3. Academics: Guðni Elisson, Sigurður R. Gíslason
4. Artists: Ragnhildur Jónsdóttir (Ragga) and Ósk Vilhjálmsdóttir
5. A spiritual medium: Ragnhildur Jónsdóttir (Ragga)
6. CarbFix representative Sigurður R. Gíslason and a Reykjavik Energy representative
7. Local knowledges from local communities surrounding Hellisheiði: Represented by 3 interviewees in Ölfus, 1 in Hveragerði and 1 in Hafnarfjörður

OBS: Some interviewees appear several times since they identify with several of the categories.

11.2 QUESTIONNAIRE

Purpose

Gain “local knowledge” (Klonner, Usón et al. 2021) on global solutions/strategies in response to the climate crisis, focusing on impacts on:

1. local communities
2. local environment
 - 2.1. local nature
 - 2.2. local biodiversity

Informing the interviewees about the wider research-context the questionnaire plays into

1. Fieldwork for my Human Ecology master's thesis with the title:

An inquiry into NETs' (negative emission technologies) role in the “overshoot ideology”

— Focusing on DAC (direct air capture) and jarðbinding at the Orca and Mammoth Plant, Hellisheiði Power Station

Locating the interviewees

1. Are you a resident in Iceland? (Only do continue the interview if the answer is “yes”).
2. How would you describe your relation to Iceland's nature?
3. Would you describe yourself as spiritual?
4. (If you answered “yes” to the above-mentioned question) Does that influence your relation to Iceland's nature?
5. What's your profession?/What do you do for a living?

NETs questions

1. Do you know what “negative emission technology” is? (If yes, feel free to briefly describe your impression of and opinion on it.)
2. Do you know the term DAC - direct air capture? (If yes, feel free to briefly describe your impression of and opinion on it.)
3. Do you know Orca and Mammoth? (If yes, feel free to briefly describe your impression of and opinion on it.)
4. Have you experienced any changes since Orca started operating? If so, please share how.

5. What's your reaction to these technologies? (Both if you already knew about them, as well as if you only just heard about them now, as I shared this with you.)
6. What's your reaction to the fact that they are part of IPCC's plan for reaching zero emission? (Both if you already knew about them, as well as if you only just heard about them now, as I shared this with you.)
7. Do these technologies and the ability to sequester Carbon influence how you imagine a zero-emission future? If so, please share how.

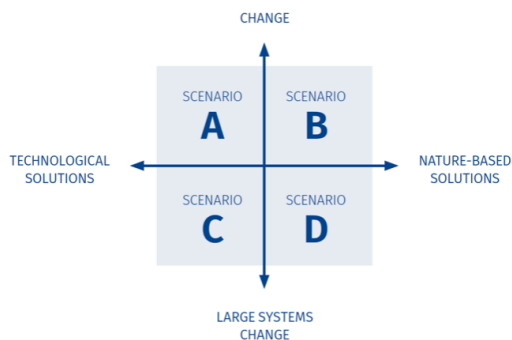
Land-use questions

8. What role do you think Iceland play/should play in the global tackling of climate crisis?
9. Do you see global-scale solutions in response to the climate crisis - such as Orca and Mammoth - having possible consequences on the Iceland, its environment and nature?
10. Do you have knowledge on any consequences specifically related to the construction and the running of Orca and Mammoth?
11. (If you answered "yes" to being spiritual) Do you think Huldufólk, elves and trolls could possibly be affected/disturbed by Orca, Mammoth?
12. What's your opinion on this type of land-use?
13. Do you reckon any parallel to the history of aluminium industry in Iceland?

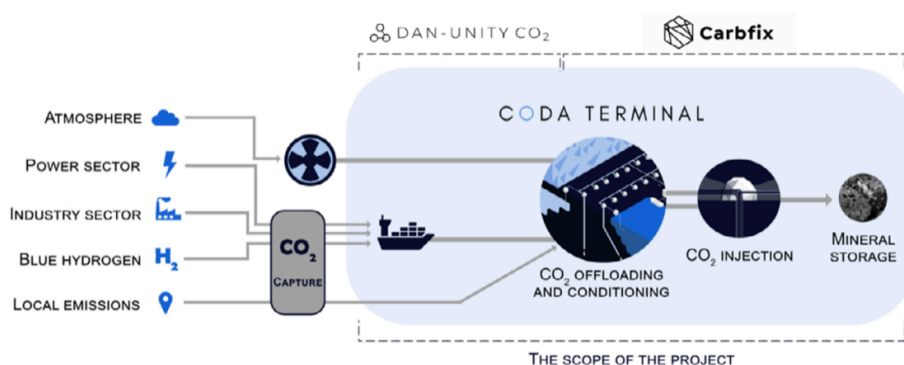
OBS: I used the same questionnaire for different target groups to get an insight into how interviewees from completely different fields — professionals or lay people — would respond to the same questions. When interviewing professionals, I did, however skip the basic questions about NETs technology as well as the question regarding spirituality. Instead, I asked explicitly about their organisation's stance on NETs and its role in climate policies. During the conversation with Ragga, we diverted from the questionnaire and I invited her to take the lead as I wished to explore her worldview.

11.3 INFOGRAPHICS

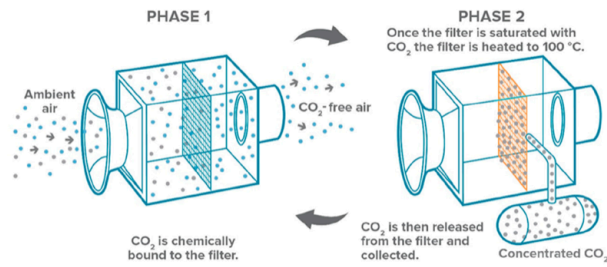
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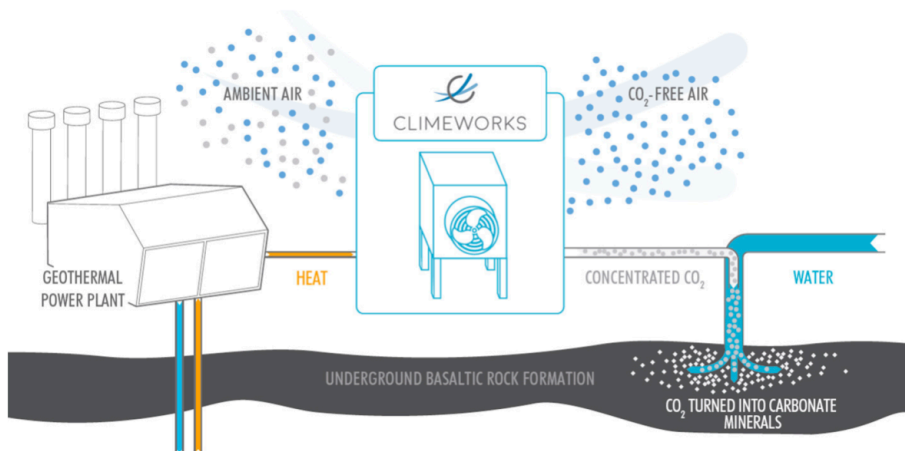
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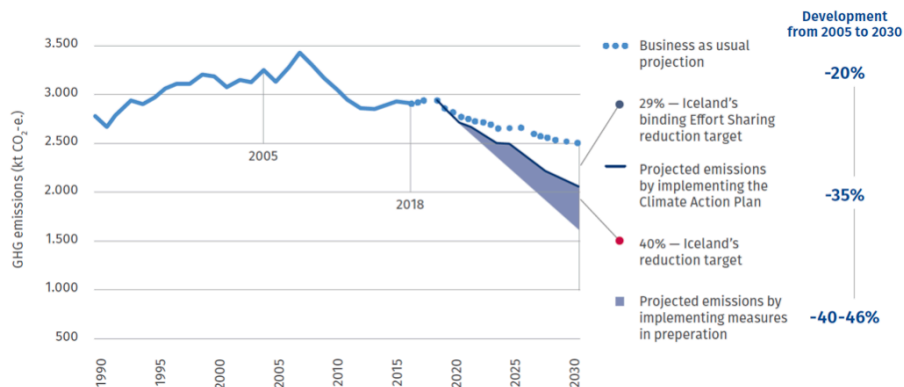
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11.4 FIELD WORK PHOTOS

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Jespersen, Rik(ke) (2022). The DAC plant Orca, part of HELLISHEIÐI Power Station. Author's own photography from fieldwork

