3. Transition Risk

Transition risk to a low-carbon and climate resilient future has several different angles: policy, liability and technology risk are discussed in this section. Both a 2°C and a 3°C world will require a considerable transition from the status quo**. Transitional impacts are more dependent on changes and decisions in the near term than physical impacts, highlighting the important of scenarios** to explore key future uncertainties, and to stress-test investments for low probability but high impact outcomes.

Key messages:

Current pledges under the Paris Agreement are not consistent with a 2°C target. Although the Agreement provides a strong global signal, current pledges add up to 2.8-3.4°C global warming[1] and are subject to some uncertainty in domestic implementation as well as some requirements for financing. The Agreement encourages increased ambition via a pledge and review cycle every 5 years, but increasing global ambition could prove difficult.

Further, the **availability of negative emission technology is critical** for reaching a 2°C target, e.g. biomass energy with CCS. However this technology is not yet available at scale.

Thus **2°C can be considered a low-probability scenario, and a range of carbon pricing scenarios can be useful for considering policy risk in different regions**. Carbon policy developments are continuing in a patch-work manner: domestic political and regulatory developments in key countries such as the US, China, and EU will continue to drive major carbon pricing developments, and offer different risks and opportunities. Carbon policies typically allow several years of lead time for companies to plan and adjust, so do not pose an abrupt risk.

Liability risk could increase, with potentially large financial consequences, if the policy framework on climate is not strong, and more severe climate impacts occur.

Beyond what is driven by carbon pricing, there is **uncertainty in technological development and deployment, which can represent both opportunities and risks**. IEA has estimated in their 2016 low-carbon scenario that electric cars will displace 6 million barrels per day of oil demand by 2040. Companies producing electric cars and related infrastructure would gain from this development, while it represents a major risk for oil producers. Renewable energy decreasing cost trends also offer an opportunity to align investments with a low-carbon future.

Liability Risk

Top Liability Risks	Regions most impacted[2]	Examples of sectors most impacted[3]	Potential impacts within next 5 years	Potential impacts towards 2050
The more likely severe climate impacts will become, and the less successful the implementation of the climate regulatory framework, the higher the risk for immense financial consequences from climate change liability.	All	High-emitting sectors (Energy, Utilities, Industry)	Limited but uncertain	High uncertainty

Table 1: Liability Risk

Mark Carney, Governor of Bank of England, has highlighted liability as a financial stability risk arising from climate change.[4] Scholars have for a long time discussed if those responsible for climate change should pay compensation directly to those that suffer the consequences. Legally, in addition to proving that climate change is real and caused by humans, it is challenging to establish a direct causal link between the behavior of one private or public actor causing global greenhouse gas emissions, and a particular climate change damage.[5] It might take some time before we know if any will be held directly liable for harmful climate actions. If the answer is affirmative, however, the financial consequences could be huge.

There are new studies that together draw an increasingly close link between emissions and particular climate impacts.[6] For example, probably as much as half of observed flood days over the last decade in coastal areas in the US would not have happened without human contribution to global sea level rise.[7] While currently about 18% of daily precipitation extremes are attributable to the increased temperature level, this share is expected to rise to about 40% when global warming reaches 2°C.[8] Companies' contribution to historical cumulative emissions has been traced in a study from 2014.[9] Chevron (3.52%), ExxonMobil (3.22%), Saudi Aramco (3.17%), BP (2.47%), Gazprom (2.22%) are the five top contributors among fossil fuel and cement producers.

It could be argued that a successful implementation of the Paris Agreement, including its burden sharing commitments, will soften the climate justice debate and make climate litigation less necessary. The Paris Agreement recognizes the concept of loss and damage, opening up for a more focused international dialogue on the issue. However, the language in the agreement clarifies that the article on loss and damage does not provide a basis for liability or compensation.

Regardless of litigation, climate change liability can also be established through indirect provisions e.g. a duty to report on climate risks and through commercial contracts.[10] In August 2015, France became the first country to introduce mandatory climate change-related reporting for companies (Article 173 of France's law on energy transition for green growth). In the EU, pension fund managers have to take into account ESG risks.[11] In the U.S., the Securities and Exchange Commission and state attorneys general are examining whether Exxon is adequately accounting for the plunge in petroleum prices and the prospect that governments might limit the use of fossil fuels to fight climate change.[12] According to the Task Force on Climate-Related Financial Disclosure (TCFD), in most G20 jurisdictions, companies with public debt or equity have a legal obligation to disclose material risks in their financial fillings. This also includes material climate-related risks. The task force view is that climate-related risks most likely are material risks for many organizations.

Consumers and investors are increasingly taking decisions based on green statements. Companies and their directors could therefore be held liable if they mislead about their green credentials. Climate liability also includes a duty to increase resiliency to climate change impacts based on best knowledge, but what this implies in practice is unclear. In Norway for example, there is a legal challenge on municipalities' liability for neglected pipes, questioning how to interpret liability for "inefficient maintenance", also in the light of future climate change impacts.[13]

Technology Risk

Top Technology Risks		Regions most impacted[14]	Examples of sectors most impacted[15]	Potential impacts within next 5 years	Potential impacts towards 2050
Uncertainty in technological development and deployment (beyond what is driven by carbon pricing)	CCS may not be ready for full-scale deployment	All	Energy, Utilities, Industrials	Insignificant	To reach a 2°C target, it is critical that CCS for fossil fuel and industrial sources is available much before mid-century, and BECCS is operational around mid-century
	Renewable energy costs could continue to fall faster than expected	All	Energy, Utilities	Uncertain cost trajectories but unlikely to be an abrupt change	IEA wind projections range from 550- over 900 GW installed capacity in 2030 for wind, and 800-1300 GW for solar. Projections have been consistently underestimating renewables in past years.
	Vehicle fleet could continue to be electrified faster than expected	All	Transport, Energy	Uncertain penetration rate but unlikely to be an abrupt change	IEA and oil company scenarios show a range from less than 5% to over 60% electrification rate of light-duty vehicle fleets by 2040

Table 2: Top Technology Risks

CCS: Emission scenarios consistent with keeping global temperatures below 2°C above pre-industrial levels explore key uncertainties about the future, such as delayed implementation of climate policies and the availability of key technologies. A key message from these scenarios is that carbon capture and storage (CCS), particularly when combined with bioenergy (BECCS) to remove carbon from the atmosphere, is a critical technology required to reach aggressive mitigation targets in a cost-effective manner. CCS allows the continued use of fossil fuels in the short- to medium-term, could handle carbon dioxide from various industrial sources, and when combined with bioenergy, carbon dioxide removal (CDR) in the long-term to offset earlier emissions. There has been strong critique of the dominant use of CDR in emission scenarios. First, the pervasive use of CDR may represent a methodological limitation, where perfect foresight models simply shift mitigation to the future as the discounted costs are lower than the costs of earlier retirement of fossil infrastructure. Second, if CCS and CDR do not live up to expectations, as is currently the case, then the current lack of early mitigation in the expectation that CCS and CDR will come later will almost certainly guarantee that 2°C is infeasible. The challenges are compounded by scenarios that stop in 2040 (e.g., IEA), failing to show policy makers the pervasive risks that lie beyond 2040. A clear insight of the emission scenarios is that early deep mitigation is needed to limit the exposure to climate risks in the future in the event key technologies do not materialize as expected.

There are further physical and economic constraints on all these negative emission technologies. A recent study[16] finds that deployment of BECCS at a sufficient scale to meet a 2°C ceiling would require 7 - 25 % of total agricultural area globally, and 3 % of all fresh water supplies. Another study[17] on negative emission efforts in light of global carbon cycles, finds that carbon cycle feedbacks can slow the effectiveness of negative emissions technologies. These dynamics may behave differently to past and future changes in climate and the composition of the atmosphere. However, more research and better understanding of carbon removal technologies and carbon cycle dynamics is needed.

Renewable energy: Scenarios that are available today, such as the IEA scenarios, have not captured the full range of the opportunity space e.g. faster deployment of renewable energy and electric cars. Renewable energy costs have fallen faster than expected due to improvements in efficiency of energy technologies and production technologies, as well as large-scale production, e.g. photovoltaics production in China. Thus, renewables' competitiveness to coal- and gas-based power production is steadily increasing. The de-centralized production of wind and solar energy causes challenges to the existing grid, which is designed according to large power production nodes with coal-fired, gas-fired, or nuclear power plants. A larger share of intermittent renewable energy production implies a larger need for local storage of heat or power, where one option is more battery storage. Another option is improved demand side management, which is intelligent management of power demand in private homes and industry. In any case, some base-load power from e.g. gas or biomass will be in demand. IEA scenarios show significant changes in projected renewable energy capacity year-on-year, reflecting how fast relative costs are shifting and how uncertain projections are[18].

Electric vehicles: According to IEA the worldwide stock of electric vehicles doubled from 2014 to 2015[19]. The cumulative sale passed 1.5 million in May 2016, roughly one third of this total in China, US and Europe each[20]. Vehicle fleet could be electrified faster than expected in most scenarios. Scenarios reviewed from IEA and several oil majors shows a range from less than 5% to over 60% electrification rate of light-duty vehicle fleets by 2040[21]. Demand for transport services will increase more slowly than population increase due to growth of compact and green cities, where the scope for public transportation is huge. Electrified public transportation on rail or buses running on hydrogen (fuel cells) and bio-fuels can remove greenhouse gas emissions from land transportation. There is substantial scope for reduced emissions from airplanes fueled by bio-fuels, and ships running on bio-fuels or batteries (short range). For public transportation in rural areas and private households, electric or hydrogen-fueled vehicles, as well as internet-based car-sharing services, can reduce transport-related emissions substantially.

In a recent study commissioned by Enova (a government agency to support more environmentally friendly consumption and generation of energy in Norway), CICERO developed a vision of a low-carbon and climate-robust society for Norway in 2050, based on interviews with representatives from industry, organizations, government, and research[22]. In this scenario, the respondents described an energy sector dominated by renewable energy, with only a small share for oil and gas, and all land based transportation is expected to be based on zero emission solutions in 2050 (mostly electric passenger cars and trucks running on hydrogen).

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