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A Sectoral Perspective on Climate Clubs

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1 Introduction

Deliverables 4.1 (Oberthür et al., 2017) and 4.2 (Rayner et al., 2018) of this project analysed challenges to decarbonisation from a sectoral perspective as well as how international governance could help overcome these challenges. In addition, Deliverable 4.2 analysed to what extent international cooperation is already addressing challenges to decarbonisation and where there are governance gaps. This paper will further build on these findings by analysing to what extent existing governance gaps could be addressed by climate clubs.

There is a substantial body of literature that has suggested establishing climate clubs as an alternative or complement to the UN climate regime to address its deficits. This literature envisages climate clubs as minilateral institutions wherein limited numbers of states (and potentially also other actors) come together to cooperate on taking action against climate change.

To provide a theoretical grounding, this paper first discusses in general how international institutions may to address issues such as climate change. This discussion is based on the concept of governance functions introduced in Deliverable 4.1 of this project. The paper subsequently reviews existing literature on climate clubs and synthesises its main findings on why international climate policy is progressing so slowly and how climate clubs may help to remedy the situation. The overview develops a typology of clubs and summarises what tasks and features are being envisaged for clubs in the literature. This paper then compares the features of climate clubs to the governance functions introduced in Deliverable 4.1. This section will discuss generically to what extent governance functions may be delivered by clubs. In the next step, this article builds on the analysis of sectoral governance needs developed in Deliverables 4.1 and 4.2. The scope of much of the literature on climate clubs has so far been limited by casting climate policy as a collective action dilemma where all countries would be best off by cooperating, but individual countries have strong incentives to 'free ride'. Deliverables 4.1 and 4.2 have highlighted that needs for international governance vary strongly among sectors and relate not only to material benefits but also to other governance functions. This paper will synthesise the findings in the Deliverables on the electricity, land transport and energy-intensive industry sectors. On this basis, the article examines whether sectoral clubs covering various governance functions offer a promising way forward for these sectors.

2 Functions of International Governance Institutions

Deliverable 4.1 of this project identified five functions international governance institutions may perform to promote climate transition:

- Guidance & Signal: International institutions can signal the resolve of members to pursue a certain course of action such as decarbonisation. These signals derive from the principles and objectives on which inter- and transnational institutions are based and can provide direction beyond the respective international institution. For example, the objectives laid down in the Paris Agreement have been found to entail strong guidance as they signal the resolve of governments across the world to take far-reaching action on climate change.
- Rules & Standards: International institutions can set common rules to enable collective action on the issue that is to be addressed. Rules may include common/reciprocal obligations of result and standards of behaviour (obligations of conduct) such as prohibition or prescription of certain behaviour, harmonisation of (technical) standards or provision of incentives.
- Transparency & Accountability: International institutions may enhance the transparency of the actions taken by their members by collecting and analysing relevant data, and identifying and addressing problems in implementation of agreed rules/standards.
- Means of Implementation: International institutions may organise the provision of capacity building, technology transfer, and financial resources among members, including coordination efforts for effective allocation.
- Knowledge & Learning: International institutions may create knowledge as well as platforms for individual and social learning. The aim is creation and diffusion of scientific, economic, technical and policy-related knowledge on the understanding of and/or possible solutions to the problem at hand.

In the following, features and tasks of climate clubs as discussed in the literature will be related to these governance functions.

3 Review of Existing Literature on Climate Clubs

This section provides an overview of the existing literature on climate clubs. The overview first presents the basics of club theory in general and then moves on to the literature on climate clubs. Finally, the section compares the typical features of climate clubs as suggested in the literature with the governance functions introduced in Deliverable 4.1.

3.1 General Club Theory

Club theory focuses on studying so-called club goods. In economics, club goods are a type of good that are

1. excludable, which means that non-members of a club can be excluded from benefits of membership at relatively low cost, and

2. non-rivalrous, i.e. use by one consumer does limit usability by other consumers (at least up to a point of congestion where the capacity of providing the club good is exhausted) (Buchanan, 1965).

Examples for club goods are facilities such as private parks, cinemas, tollroads and satellite TV. Due their low rivalry, club goods have close to zero marginal costs, and are therefore generally provided by natural monopolies, i.e. markets with only one seller and no close substitute for that seller's good, leading to an artificial scarcity of club goods.

3.1.1 Buchanan clubs

Early literature on clubs, concerned with the provision of goods in groups of limited size, dates back to Pigou (1920), Knight (1924), Tiebout (1956), Wiseman (1957), Olson (1965) and Buchanan (1965), with Buchanan generally seen as the founder of club theory. The main goal of 'Buchanan clubs' is the production and allocation of goods produced by the club. Buchanan clubs are essentially arrangements for "consumption-ownership membership" with club members owning and consuming these goods. In Buchanan clubs, only club members paying a fee are able to reap the club's benefits (Prakash & Potoski, 2007). Such benefits may, for example, be access to a facility (e.g. a private park or beach) and access to satellite TV or tollroads.

As club size affects the utility individual members receive from the club, the central question in Buchanan's theory of clubs was that of the optimal size of membership. Later research broadened the spectrum of questions relating to club theory, e.g. to capacity constraints causing uncertain use (e.g. Sandler, Sterbenz, & Tschirhart, 1985), the cost of transactions and exclusion (Helsley & Strange, 1991), and the effect of heterogeneous populations on the formation and optimal conditions of clubs (Fraser & Hollander, 1990).

3.1.2 Voluntary clubs

In 2007, Prakash and Potoski distinguished Buchanan clubs from 'voluntary clubs', which aim at producing a public good or other benefits that lead to positive externalities such as earning the club's positive brand reputation. This can be achieved, inter alia, by requiring members to go beyond government regulations, for example, environmental standards. Private benefits and club goods may accrue, but are not the key goal of such clubs. Instead of paying a fee, members have to adopt or adhere to the membership requirements of the club (Prakash & Potoski, 2007). Voluntary clubs may require offering club goods in a wide senser to prevent free-riding and increase positive benefits to the public (Hovi, Sprinz, Sælen, & Underdal, 2016).

3.2 The Rationale for Climate Clubs

So far, international climate policy under the UNFCCC has failed to deliver the climate action required to effectively combat dangerous climate change and the impact of related agreements has been limited. This failure is the starting point of the discussion on climate clubs. Much of the literature focuses on how clubs could help resolve problems that appear to be insoluble under the multilateral process (Rennkamp & Marquard, 2017). The following therefore briefly summarises views in the climate clubs literature on why the UNFCCC has so far failed and how climate clubs could address the deficits identified. The subsequent section goes into more detail on categories and possible functions of climate clubs.

The main conundrum of climate policy as seen by much of the literature on climate clubs is that the avoidance of dangerous climate change is a public good which all countries will benefit from, irrespective of whether they have contributed to combating climate change or not. In addition, many mitigation policies and measures are deemed to be costly. The combination of these two factors creates a strong incentive for countries to free ride (Hovi, Sprinz, Saelen, & Underdal, 2014; D. Victor, 2011). Barrett (2016) argues that collective action on climate change is fundamentally made difficult by the uncertainty about thresholds in the climate system, so-called tipping points, at which, when exceeded, the climate could change irreversibly and fundamentally. As it is still uncertain at which point exactly such thresholds would be reached, pressure on individuals to reduce emissions is eased, even while there is a collective sense of urgency. While implementation of a climate treaty could be incentivised by perceived threat of climate catastrophe, threshold uncertainty makes fulfilment of NDCs unlikely (Barrett, 2016). In addition, literature points to the UNFCCC's consensus rule as a problem, as it effectively provides veto powers to the least enthusiastic Party (Ott, Bauer, Brandi, Mersmann, & Weischer, 2016; D. Victor, 2011).

Concepts for climate clubs in the literature are usually focused on the problem of ambition and aim to achieve commitments from countries to limit/reduce their emissions sufficiently to avoid dangerous climate change (Rennkamp & Marquard, 2017). In particular, climate clubs are suggested to solve the free rider problem by providing club benefits and sanction (Barrett & Dannenberg, 2016; Falkner, 2015; Hovi et al., 2016; Nordhaus, 2015). Another approach is to focus activities of clubs on economic, environmental, or other non-climate objectives, producing GHG reductions as a co-benefit (R. B. Stewart et al., 2013; R. Stewart et al., 2013). In addition, the literature suggests that a small group could be much better in setting conditional commitments, facilitate dialogue and bargaining, attract membership, and provide opportunities for powerful countries to attain privileged positions, legitimizing this kind of climate regime in their eyes (Falkner, 2015; D. G. Victor, 2015).

Furthermore, small groups could better learn how to support adaptation efforts and design and implement technology strategies as well as smart border measures, enabling a better design and eliminating the risk that each country will bear disproportionate costs, thus losing competitiveness. Such an ap-

proach would also entice business to join club efforts (D. G. Victor, 2015) – which is much more difficult for an international climate treaty to do. Moreover, linking potential climate clubs to existing non-climate transnational institutions could, on the one hand, lead to learning-effects concerning transnational cooperation and, on the other hand, help capitalize on powerful nations favouring, or at least acquiescing in, such institutions' policies. Both of these effects would reduce political and institutional costs of mitigation initiatives (R. B. Stewart et al., 2013; R. Stewart et al., 2013).

3.3 Features and Tasks of Climate Clubs

3.3.1 Basic Categories of Climate Clubs

In line with the general typology of clubs outlined in section 3.1, proposals from the literature on climate clubs can be grouped into the following categories:

- Buchanan climate clubs where the actions taken are inherently attractive and emission reductions are a 'co-benefit';
- 'Voluntary' climate clubs where countries take action beyond what would maximise their direct self-interest. For such clubs to function properly, provision of incentives in the form of club goods is essential.
- In addition, some literature suggestions the formation of 'pseudo' climate clubs that yield only minimal excludable benefits and have no enforcement mechanisms.

The following will go into more detail on each of these categories.

3.3.2 Features and Tasks of Buchanan Climate Clubs

Climate clubs as envisaged by Stewart et al. would focus on economic, environmental, or other non-climate objectives, producing GHG reductions as a co-benefit (R. B. Stewart et al., 2013; R. Stewart et al., 2013). This type of club may therefore be described as Buchanan climate clubs (Hovi et al. 2016). In addition to states, dominant private actors may also form or be part of such a club, take the lead and bear first mover costs where they expect sufficient economic, strategic or reputational benefits from specific climate action. With such action, they may then entice others to join their efforts. This is referred to in the literature as a Dominant Market Actor Strategy (R. B. Stewart et al., 2013; R. Stewart et al., 2013). Ott et al. (2016) point out that with such an approach, clubs could have a positive impact on the underlying interest structure in international climate negotiations.

Stewart et al. (2013a, b) envisage an approach to climate clubs based on three institutional building block strategies for transnational cooperation. The aim of this approach is, on the one hand, to realize short and medium term mitigation as co-benefits in regimes conceptualized around non-climate benefits and, on the other hand, to advance long-term agreement on climate action by constructing and transforming transnational networks and institutions. Their approach envisages leveraging existing non-

climate transnational institutions and dominant market actors who gain sufficient advantages from climate action to become first movers as well as club goods as incentive for participation in a climate club. Suggested examples for club benefits in these clubs relate mostly to the rule-setting function outlined in section 2: They include harmonization of technical standards, collaborative R&D on renewable energy and reduced mitigation costs, as well as benefits derived from the linking of emissions trading systems. In addition, the transparency and accountability function is deemed to be of importance. Stewart et al. suggest that institutional arrangements have to be developed and commitments should be defined for relatively short periods of time in order to facilitate monitoring compliance and reactions to non-compliance (Stewart et al. 2013a, b).

3.3.3 Features and Tasks of Voluntary Climate Clubs

In contrast to Buchanan climate clubs, the main goal of voluntary climate clubs is to undertake additional mitigation action that go beyond the level that would maximise members' immediate material self-interest. Without non-climate club goods being the main incentive for membership, however, free riding becomes a key challenge. Voluntary clubs must therefore offer excludable benefits for encouraging membership and for inducing members to contribute more to the production of the public good. In the literature on climate clubs, such excludable benefits are usually referred to as club goods. Hovi et al (2016) refer to them as "club goods in the wide sense", to distinguish them from the type of club goods Buchanan had in mind ("club goods in the narrow sense") (Hovi et al., 2016).

Victor (2011) assumes that it is easiest to start such a club with a small group of "enthusiastic" countries which are willing to reduce emissions beyond what would maximize their material self-interest, depending on pledges from other enthusiastic countries. That is, such clubs would start from the rule-setting function, developing mutually dependent pledges among the member countries (Victor 2011). Hovi et al. (2014) point out that a favourable benefit-cost balance and ethical norms on fairness may be the two key sources for such enthusiasm. In their view, countries with high emissions, relatively low abatement costs and/or relatively high damage costs would be most likely to initiate a climate club, joined by countries with comparable abatement or damage costs (Hovi, Sprinz, Saelen, & Underdal, 2014). By contrast, 'reluctant' countries will only participate in clubs where the private benefits of club membership exceed their abatement costs (Sælen, 2015). Attracting reluctant countries is considered likely to be most successful with an open membership policy and exclusive club goods which are strong enough to prevent free-riding (Hovi et al., 2014; Weischer, Morgan, & Patel, 2012).

The club goods envisaged in the literature relate to the rule-setting and to the means of implementation functions. Club goods related to the rule-setting function in particular concern linkage to trade, such as low-tariff zones for low-emission technologies, international linkage of properly designed emissions trading systems and border tax adjustments to combat leakage (D. Victor, 2011). Another suggestion is

common rules concerning intellectual property rights (Hovi et al., 2016). Suggested club goods related to the means of implementation function include creating a pool of resources for emissions-reducing technology (Green, 2017), and risk-sharing and pooling of intellectual property rights (Hovi et al., 2016). Reputation effects of belonging to a club are also deemed to constitute a club good (Green, 2017; Prakash & Potoski, 2007). This aspect relates to the guidance and signal function as the reputational effect derives from the signal sent by the club that it is willing to take action.

Barrett (2003), points out that linkages to technology research and development have been made in existing international agreements such as the Montreal Protocol, but have nevertheless not prevented members from sharing such research and development with non-members as this would go against their self-interest. Linking climate cooperation to trade and limiting trade with non-participating countries would similarly go against countries' economic self-interest (Barrett, 2003). Hovi et al. (2016), however, counter that countries do indeed accept economic losses when they are convinced that the purpose of sanctions is important enough to do so. This kind of behaviour would also be in line with the assumption that 'enthusiastic' countries are willing to take action beyond what would maximize their material self-interest.

3.3.4 Features and Tasks of Pseudo Climate Clubs

In addition to Buchanan and voluntary climate clubs, Green (2017) suggests a concept of 'pseudo-clubs'. Pseudo-clubs are initiatives that target low-effort activities such as improving GHG measurement methodologies. Such clubs have no enforcement mechanisms and membership is fluid. Thus, pseudo-clubs may only lead to minimal reputational benefits, at best. However, they may attract a considerably wider range of participants than clubs with binding substantive commitments, may provide broad networking possibilities and may lay the foundation for implementation of stricter regulation in the future. To become effective, however, pseudo climate clubs will in the end need government action to turn coordinated measuring of emissions into cooperative emissions mitigation (Green, 2017). From the perspective of economic club theory, such types of arrangements that do not include excludable club goods would not be called 'clubs'.

3.3.5 Features and Tasks of Existing Climate Clubs

There are some studies on existing arrangements outside the UNFCCC that aim at fostering climate action. In a study of 17 so-called climate clubs, however, Weischer et al. (2012) conclude that these initiatives "often serve as a dialogue forum and/or support the development and implementation of specific strategies and projects" (Weischer et al., 2012). Similarly, after assessing initiatives such as the G20, the Asia-Pacific Partnership on Clean Development and Climate Change, the Climate and Clean Air Coalition and the Major Economies Forum on Energy and Climate, Andresen (2014) defines these more as "discussion clubs", without substantial merits for the climate, than climate clubs (Andresen, 2014). Summarizing

this issue, Hovi et al. (2016) judge that "(n)o credible climate club exists as of yet", and that therefore, "we cannot draw on actual experience" on this issue (Hovi et al., 2016). Some of these clubs may, however, be defined as pseudo climate clubs.

3.4 Interim Conclusion

Much of the literature on climate clubs sees climate change as a collective action dilemma. While the optimal outcome for all countries would be achieved if all cooperated, the costs of mitigating climate change creates a strong incentive for countries to free ride. The literature suggests Buchanan climate clubs to overcome this problem by focusing on actions that yield strong non-climate benefits and 'voluntary' climate clubs to overcome the free-riding incentive by providing access to club goods and using sanctions. The types and features of climate clubs as suggested in the literature can be related to the governance functions established in Deliverable 4.1 of this project.

Sending guidance and signal has a strong role in the literature on climate clubs. The key rationale for the formation of clubs is to induce others to follow. Following the Dominant Market Actor Strategy (Stewart et al. 2013a, b), the mere formation of a club may already have this effect by highlighting direct material rewards that may gained by climate action. The formation of voluntary climate clubs would also send a strong signal on the resolve of its members as they would explicitly take action beyond what they consider to be in their direct material self-interest. As for pseudo clubs, they do by definition not include strong rules and accountability mechanisms. Sending signals on their members' willingness to act may be therefore be the one of the few governance contribution this type of clubs could make.

Setting rules and standards is a core dimension of both Buchanan and voluntary climate clubs. The concept of these types of clubs is exactly to garner commitments from their members in exchange for club goods. These club goods may be inherent in the actions taken, such as non-climate benefits of climate actions, as envisaged in Buchanan climate clubs, or they may be further items that are also agreed as part of the club agreement. Some of the club goods discussed in the literature belong to the rule-setting functions, such as trade privileges for members/trade restrictions for non-members.

Most other club goods envisaged to be brought to bear in voluntary climate clubs belong to the means of implementation function. Privileged access to finance and technology are key items that are hoped to entice reluctant countries to join a club.

Knowledge and learning may in principle also be part of club goods, that is, access to knowledge that is being generated could be restricted to club members. However, this dimension is not being given much attention by current literature.

Transparency and accountability is a key feature of climate clubs. As club goods are provided in return for climate actions, members will want to make sure that the actions are indeed being implemented.

This function is presumably particularly relevant for 'voluntary' clubs as their members are supposed to take action beyond what would be in their direct material self-interest. Finally, enhancing transparency by improving and implementing GHG measurement methodologies is a key area of work suggested for pseudo-clubs.

4 Sectoral Governance Needs

4.1 Overview

The following section will apply a sectoral lens to the question of how climate clubs may contribute to global climate governance. As discussed in Deliverables 4.1 and 4.2 of this project, prospects and barriers for decarbonisation differ from sector to sector – and in consequence so does the need for international cooperation. The discussion will take the examples of the electricity sector, land transport and energy-intensive industries. The section will first survey decarbonisation prospects and barriers in these sectors and subsequently discuss how international cooperation may in theory help to foster potentials and overcome barriers. On this basis, the section will review to what extent international cooperation is actually already promoting mitigation in these sectors. To the extent that international governance does not yet provide the necessary support, the paper will subsequently discuss whether climate clubs may fill these gaps.

The analysis of cooperation needs, current supply, and remaining gaps in these sectors will again be based on the five key functions of international governance established in Deliverable 4.1.

4.2 Land Transport

Deliverable 4.2 of this project discusses prospects and barriers for decarbonising land-based transport in detail. In summary, the failure to rein in land transport emissions can hardly be explained by the concept of a collective action dilemma which much of the current literature on clubs is based on. The current land transport system with its focus on individual motorised passenger transport and road-based freight transport is a strong contributor to local social and environmental challenges, such as congestion, noise and air pollution. Moving towards more sustainable mobility by minimising transport volumes and shifting to public and non-motorised transport can therefore reap substantial immediate benefits for society and the economy.

In addition, technology costs of alternative propulsion systems have decreased substantially in recent years. Marginal abatement costs may even end up negative, especially if electricity for electric vehicles is sourced from low-carbon power systems. In addition, while investment requirements for establishing sustainable transport infrastructure are high, substantial investments are also required in the baseline

case. A major share of funding for sustainable transport may therefore be derived by shifting funding from unsustainable transport (Sims et al., 2014).

Institutional and political barriers are therefore much more pertinent in this sector than economic costs. The current emission-intensive way of providing mobility is deeply entrenched in policy, planning and industrial paradigms as well as physical infrastructure (Banister, 2008; Canitez, 2019; Meckling & Nahm, 2019).

In traditional transport *paradigms*, extending transport infrastructure has been seen critical as a foundation for economic development, and the increases of transport volumes have been viewed positively; increasing mobility by means of vehicles has been associated with increasing wealth (Sims et al., 2014). In addition, in many cities worldwide 'segregated land-use' is standard urban planning practice: planners have purposefully kept different types of land use (residential, commercial, manufacturing, service, recreational) separate. The result is a higher need to travel for various needs. Another practice is priority provision of urban space for automobile-friendly infrastructure, such as parking spaces and road capacities (United Nations Human Settlements Programme, 2013).

In terms of *industrial paradigms*, many traditional car makers made substantial investment in internal combustion engines, which create technological lock-in effects (Skeete, 2017). In countries with a strong historical background as car producers, industry policy objectives inhibit the radical transformation of the sector that would be needed to move away from individual car ownership towards multimodal mobility services (Alam, Hyde, Duffy, & McNabola, 2017; Ross Morrow, Gallagher, Collantes, & Lee, 2010).

The *political influence* of incumbent companies is illustrated for example by the current diesel scandals. Starting in 2014, it was discovered that vehicles from Volkswagen and many other car makers contained software which manipulated regulatory air pollution tests. The vehicles had been programmed to recognise when the standardized regulatory emissions test was being done and to adjust engine operations to emit less during the test. The vehicles emitted much higher levels of emissions under real-world driving conditions. While US authorities have imposed heavy penalties, this has not been the case in the EU (Luhmann, 2017).

In summary, decarbonisation of land transport is to a large extent not a question of economic costs and competition between countries, but rather a question of competing interests and paradigms within countries on what transport modes and technologies to favour.

4.3 Electricity

Macro-economic prospects of mitigation action in the electricity sector are broadly similar to land transport. The economics of renewable electricity have changed fundamentally over the last ten years, with renewable energy (RE) technologies generally becoming mature and cost-competitive (Ahman,

Lechtenbohmer, Nilsson, & Schneider, 2016). The economic challenge is therefore nowadays no longer macro-economic costs, but rather micro-economic costs for those companies, regions and communities that rely economically on fossil-based electricity generation. These actors are generating substantial political resistance against the phase-out of fossil fuels. One recent example is the Australian general election of May 2019 where coal-based regions that traditionally voted Labour shifted to the Liberal Party due to concern that the former's climate policy would leave them stranded (Mathiesen, 2019).

One economic challenge that remains is the massive investments that will be required to shift the power system. In addition, while the financing requirements of conventional technologies to a large extent relate to operating costs over the lifetime of the installation, for RE the financing requirement is mostly upfront. Therefore, unfavourable investment conditions leading to high costs of capital may still render RE investments uneconomic. There may also be a negative impact on the competitiveness of industry if the transformation of the sector entails (temporary) electricity price increases (De Cian et al., 2017).

In terms of technological challenges, substantial amounts of energy storage capacity will be needed to ensure the stability of systems based largely on intermittent wind and solar energy. In addition, electricity grids need to be adapted to the needs of RE. While in systems based on fossil fuels the role of distribution networks has mainly been to connect industrial hubs and hedge against the risk of black outs, an RE-based system needs to connect centres of supply to centres of demand. This may require fundamentally different grid layouts and massive investments (IEA, 2016b).

Furthermore, in many countries, especially developing countries, the lack of necessary technical capabilities and skilled workers constitutes a bottleneck (Hirsch, 2015).

In summary, as for the transport sector, the collective action dilemma perspective of much of the current literature on climate clubs holds only to a limited extent regarding electricity. While substantial investment will be required, an RE-based power system may not be more expensive than the conventional system. There may be negative impacts on competitiveness if decarbonisation leads to higher electricity prices, but such effects will probably be temporary and can be countered by policy.

The economic balance becomes even more positive when factoring in the reduction of local pollution that results from the reduction of fossil fuel use. Similar to land transport, rather than macro-economic burdens, the economic challenge is rather one of path dependencies and micro-economic burdens at the level of affected companies and regions.

4.4 Energy-Intensive Industries

Deliverable 4.2 focused on four key industries, iron and steel, cement, chemicals and aluminium, that are responsible for nearly 70 per cent of industrial emissions globally.

In contrast to the land transport and electricity sectors, the potential of existing technologies is limited. There is a need for the development and use of new 'breakthrough technologies', such as higher levels of electrification of energy intensive processes (using renewable energy sources) and the use of carbon capture and utilization/storage. Second, and frequently related to the first option, the introduction of low-carbon substitutes for materials and fuels is required, e.g. biomass-based feedstock or use of waste gases from other industries in chemicals production. Finally, smarter design of end products to reduce basic materials' intensity, efficient consumption and a circular resource model will need to be part of the overall mitigation efforts of industry (Oberthür, Khandekar, & Wyns, 2019).

New breakthrough technologies usually have higher operational costs than conventional technologies – in particular as long as they are not fully developed and commercialized, but possibly also beyond. Another challenge is that production facilities generally require high capital expenditures and usually have lifetimes of 10-30 years (depending on the subsector). In addition, several of these sectors are subject to strong international competition. Nearly a third of all steel produced is traded internationally. Chemical and aluminium industries are also trade exposed. The only exception among the sectors considered here is cement as nearly every country produces cement and only about three per cent of global production is traded internationally (Oberthür et al., 2019).

Given the international character of steel, chemicals and aluminium, the high capital expenditure and higher operating costs of low-emission technologies are a strong barrier.

4.5 Avenues for International Cooperation

Deliverable 4.2 elaborated options for international cooperation in the three sectors discussed in this paper. This chapter synthesises the sector-specific discussions from Deliverable 4.2. It emerges that while some options are specific to the individual sectors, others may be applied to all sectors.

As for **guidance and signals**, international governance may directly or indirectly send signals on the need to change transport policy and planning paradigms towards sustainability. International governance could explicitly promulgate a new transport paradigm, that is, abandoning the traditional paradigm focusing on extending infrastructure to cope with transport demand and prioritising individual motorised transport in favour of a new paradigm focused on managing transport demand and prioritising public, shared and non-motorised transport. A more indirect approach would be to set emission targets for the individual sectors instead of looking only at aggregate global emissions. This approach may serve to highlight that transport has so far essentially been free-riding in climate policy. In the EU, transport and international aviation are the only sectors where emissions have increased since 1990, by 20% and 117% respectively. In all other sectors emissions have been reduced by between 20% and 42% (European Commission, 2018). A focus on the individual sectors would highlight this particularly bad performance

of the transport sector, which may have the effect of calling into question the dominant paradigms in this sector which have led to this outcome.

Sector-specific long-term signals would also be helpful in the electricity and industry sectors. Installations in these sectors, as well as in the transport sector, have a lifetime of decades, investors therefore need to take a long-term perspective. If countries agreed on targeting full decarbonisation of these sectors by a specific date, this would help shape investors' expectations about the viability of their investments.

In terms of politics, international agreements establish expectations regarding national policy and thereby legitimate demands of pro-compliance domestic stakeholders (Dai, 2010). In this way, international signals on the urgency to act in specific sectors may help domestic proponents of sustainable mobility counter the political influence of regime actors that are wedded to high-emission practices.

In terms of **setting rules**, the need to change existing emission-generating paradigms and practices could be made even more palpable by having sectoral emission targets not only at the international level but also at national levels. International governance could require countries to have sectorally differentiated short- and long-term climate strategies, with specific targets and measures for all sectors. In addition to sectoral targets, these climate strategies could ideally also describe current and envisaged measures to facilitate the tracking of action.

Furthermore, international governance could require countries to implement a "climate budget reform". Countries could be require to tally all levies they are imposing on high-emission activities and all subsidies they are providing to low-emission activities on the one side, and all levies they are imposing on low-emission activities and all subsidies they are providing to high-emission activities on the other side, and to commit to progressively shift resources from the latter to the former (Verbruggen, 2011). Countries could also be required to reform priorities and criteria for funding transport infrastructure. The Global Commission on the Economy and Climate (2015) recommends that countries and finance institutions should commit to making all infrastructure policies, plans and projects consistent with their climate targets and long-term ambitions, and that these should be able to be justified in the context of the internationally adopted temperature goals.

Coordination on carbon pricing, international regulations and/or standards could be particularly helpful regarding energy-intensive industries to address competitiveness concerns. These could target the production processes (e.g., CO2 emission limits per tonne of production) or the consumption side (limit on emissions embedded in final products). Regulating emissions embedded in final products could help create a level playing field between global industrial producers because it would not discriminate between domestic and foreign production (but it does require reliable information on emissions across these producers). In general, commonly accepted regulations and standards (such as procurement policies, cus-

toms exemptions, labelling schemes) could help provide a global level playing field, so that competition could be directed towards decarbonisation (Oberthür et al., 2019).

In terms of setting agendas for vehicle manufacturers, fleet emission standards and fuel economy standards are a commonly used policy instrument. They set future target values well in advance and thereby allow manufacturers to develop and deploy the technologies needed to meet the respective target level (Damert & Rudolph, 2018). They may thus help re-orienting industrial paradigms and realigning incumbent regime actors towards climate protection. To accelerate such shifts globally, international governance could work to have all countries introduce such standards, and to have them converge globally over time.

Transparency and accountability requirements will be needed to enforce compliance with such rules. International governance may establish requirements to provide sectorally differentiated accounts of national emissions, measures taken and their impacts. To ensure that any international emissions standards or a carbon price are effectively implemented, reliable common monitoring, reporting and verification (MRV) standards and metrics for emissions, preferably even including the whole supply and value chain, will be required.

In terms of politics, international transparency provisions and review processes provide pro-compliance stakeholders with information and political fora to appeal to public opinion and exert pressure on governments (Dai, 2010). Thereby, transparency requirements may help stakeholders to generate pressure for changing high-emission paradigms and practices.

The role of **means of implementation** is to help overcome capacity and financial constraints. Despite the generally favourable economic prospects of the electricity sector transition, provision of material benefits and means of implementation as envisaged by much of the literature on climate clubs will likely still be required for many countries with low capacity. In order to maintain a chance of limiting global warming to well below 2°C, investments in the order of USD 20 trillion need to be shifted from fossil fuel infrastructure to renewables and energy efficiency between 2015 and 2050, and an additional USD 27 trillion needs to be attracted compared to current levels of investment (IRENA, 2018). In addition, highly capital-intensive investments may not be feasible wherever high prime lending rates and other investment barriers prevail. International institutions could facilitate the provision of some form of guarantee or security, which in turn could help bring down lending rates in developing countries (Schwerhoff & Sy, 2017; Sweerts, Longa, & van der Zwaan, 2019).

Global cooperation on finance and technology can also help address barriers related to costs, high capital expenditure and technology risks in industry. According to the IEA, holding temperature increase to well below 2°C will require OECD countries to transfer innovative technologies for industry to non-OECD countries very soon to avoid carbon lock-in/stranded assets (IEA, 2017).

The provision of support may also be used as a lever to change high-emission paradigms and deprive incumbent regime actors of resources. Commitments to 'climate budget reform' as discussed above could also extend to the international provision of means of implementation. That is, international governance could require that all provision of support must be aligned with the objectives of the Paris Agreement.

Finally, international governance can create **knowledge** and provide platforms for collective **learning** by collecting and aggregating relevant data and information. Such data and information may to be large extent be made available through transparency provisions as discussed above. However, reporting does not by itself ensure that lessons learned are taken up. International institutions may therefore work to synthesize information on current trends and sustainable transport policies, practices and technologies and organize collective appraisal of this information (Rayner et al., 2018).

5 Existing International Cooperation

5.1 Overview

Having synthesised the demand for international governance in the decarbonisation of land transport, electricity and energy-intensive industry, this section will discuss to what extent these demands are already being met by existing institutions. To answer this question, Deliverable 4.2 established a database of international institutions that are active on at least one of the governance functions introduced in Deliverable 4.1.

Generally, large numbers of institutions are active in the land transport and electricity sectors. They include a number of UN organisations, the multilateral development banks and several city networks. However, while there is substantial number of actors, hardly any of them emerge saliently as hubs or core institutions in what appears to be a relatively fragmented governance landscape. In contrast, to land transport and electricity, there are only few institutions that are active on the energy-intensive industries.

5.2 Guidance and Signal

There currently are no multilaterally agreed targets to decarbonise either of the three sectors. The Paris Agreement in Article 4.1 aims at globally peaking GHG emissions as soon as possible and achieving net zero emissions by the second half of the century. Given that current emission trends are widely out of step with these objectives, the Paris Agreement thereby signals that strong mitigation action is needed (Obergassel et al., 2016). However, there is no explicit breakdown of the global ambitions to the individual sectors.

Agenda 2030 sends more specific signals. Both Agenda 2030 and the New Urban Agenda emphasise the role of an integrated policy approach to sustainable mobility, focusing on access and mobility for all. SDG 9.1 sets a target to "[d]evelop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all." SDG 11.2 aims to "[b]y 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, (…) notably by expanding public transport, with special attention to the needs of those in vulnerable situations (…)" (United Nations, 2015). The New Urban Agenda (NUA) developed by UN Habitat spells this out further and focuses on providing better public transport, tackle urban challenges, increase public spaces and takes in integrated policy approaches (United Nations, 2016).

Other institutions are sending signals that are specific to transport, but these have limited reach and authority. In 2016, the ITF launched the Decarbonising Transport project to help decision makers establish pathways to carbon-neutral mobility (ITF website, 2019). However, this is mainly a knowledge-building exercise, not a target-setting process, and the ITF has generally no mandate to take legally binding decisions. In addition, two transnational initiatives explicitly stipulate that transport sector emissions should be net zero by 2050: the Paris Process on Mobility and Climate (PPMC), and the Transport Decarbonisation Alliance (TDA) (PPMC Website, 2018a, 2018b). While such initiatives may contribute to shift paradigms, their pledges have no legal standing and their membership is limited. The TDA is especially small, comprising Costa Rica, Finland, France, Luxembourg, the Netherlands, Portugal, the state of California, five cities and eight companies (Transport Decarbonisation Alliance Website, 2019).

Regarding the electricity sector, SDG 7 explicitly sets the goal to increase the share of renewable energy. This signal is being echoed and amplified by a range of other institutions such as Sustainable Energy for All, the Covenant of Mayors for Climate & Energy, the Carbon Neutral Cities Alliance, and the 100% RE initiative. By contrast, there is no clear signal for the phase-out of fossil fuel use. The Powering Past Coal Alliance is the only institution that clearly signals its intention to end the use of one fossil fuel. However, among the founding members are only countries that have limited coal generation capacity already. Other institutions like the World Bank are also supporting the phase-out signal indirectly by turning away from new investments in fossil fuel related activities. Yet, the pipeline of coal power plants is still extensive. Were all these plants to be built, global average temperature rise would exceed the 2°C limit (Pfeiffer, Hepburn, Vogt-Schilb, & Caldecott, 2018).

Regarding industry, the Cement Sustainability Initiative (CSI) contributes to providing a signal and guidance to the cement sector by having established a collective GHG emission reduction target of 20-25 percent by 2030 and a roadmap (elaborated in 2009) towards a 50 percent reduction of emissions by 2050. However, the CSI accounts for only about 30 percent of global cement production and the targets

fall short of full decarbonization. In addition, the emission reduction target and roadmap are aspirational and non-binding (Oberthür et al., 2019).

5.3 Setting Rules

Article 4.2 of the Paris Agreement requires Parties to submit NDCs and Article 4.19 invites them to develop long-term climate strategies. However, there are currently no requirements for these documents to have a sectoral breakdown.

There has been some movement on fiscal reforms. The G20 in 2009 agreed to "phase out inefficient fossil fuel subsidies". The G20 also introduced a peer review process wherein pairs of countries review each other's subsidies. According to a 2018 tally by the IEA and the OECD, fossil fuel subsidies had actually increased in 2010-2012 despite the phase-out pledge and then started declining. However, the decline was in large part due to the decline of the international oil price, which reduced the gap between international and regulated domestic prices, and thereby the resources needed to be spent by governments to compensate for this gap (IEA/OECD, 2018).

To a limited extent, the lack of multilateral international rules is covered by minilateral and transnational institutions that collect pledges to various policies and measures from their members. For example, the TDA requires its members to formulate ambitious short- (2020), medium- (2030-2040) and long-term (2050) action plans to decarbonise transport (Transport Decarbonisation Alliance, 2019). For electricity, the PPCA has declared ambitious targets, but whether these will be translated into formal rules remains to be seen. In addition, several city networks, such as C40 and the Global Covenant of Mayors, similarly require their members to aim for certain emission reductions, develop climate strategies and/or implement specific measures. However, as none of the pledges are legally binding, this effect may in practice be limited.

While there is no international coordination on carbon pricing, the number of countries that implement corresponding policies at the national level is ever increasing (World Bank, 2018). This trend already to some degree addresses competitiveness concerns. Article 6 of the Paris Agreement provides potential avenues for countries to engage in "cooperative approaches" which may further facilitate the proliferation and harmonization of such instruments. To date, however, there is no real international coordination on carbon pricing.

5.4 Transparency and Accountability

The UNFCCC and the Paris Agreement require Parties to provide transparency on national emissions, measures taken, and their impacts in the form of national emission inventories, national communications and international expert reviews. However, while inventories and reporting on policies and measures are broken down to the level of individual sectors, no particular attention is being paid to this

sector-level information. There is no singling out of good or bad performers at sector level. This means that while sector-level information is being generated, it is not being used to create pressure to change unsustainable paradigms and practices at sector level. In addition, the current regulations do not require reporting on or review of long-term strategies. Finally, there are no penalties for bad performance.

Outside the UNFCCC, there is a strong focus on measuring and reporting developments in the two sectors. For electricity, the IEA, IRENA, World Bank and REN21 provide substantial amounts of information on electricity sector developments in individual countries. For transport, the World Bank-led Sustainable Mobility for All (Sum4All) initiative is developing a global tracking framework and the Agenda 2030 process has developed a global indicator framework for the SDGs. Both the Sum4All framework and the UN SDG indicator framework include the proportion of the population that has convenient access to public transport as indicator. The UN framework in addition also has the indicator passenger and freight volumes by mode of transport (SUM4All Website, 2019; United Nations, 2017a). These frameworks thereby provide the potential to track to what extent high-emission and low-emission transport modes are being used within countries and thereby support a paradigm shift towards public transport. However, the SDG indicator framework is explicitly a voluntary and country-led instrument. That is, the decision which indicators to monitor is at the discretion of countries (United Nations, 2017b).

Furthermore, the CSI and the International Council of Chemical Associations (ICCA) have elaborated guidelines and tools for their respective membership. The CSI developed a CO2 Protocol and tools to measure emissions of the cement industry and involves a commitment by members to report on their emissions accordingly. Similarly, the ICCA has developed guidelines for assessing and reporting avoided GHG emissions (Oberthür et al., 2019).

5.5 Means of Implementation

Multilateral financial flows for decarbonisation are well established. UNFCCC Art. 4 requires the traditional industrialised countries to provide financial, technological and capacity-building support to developing countries. At the Copenhagen conference in 2009, developed countries pledged to increase their financial support to USD 100 billion annually by 2020. Under the UNFCCC, activities may receive financial support through the financial mechanism (which is operated by the Global Environment Facility and the Green Climate Fund). Donor countries may also use the multilateral development banks (MDBs) or provide bilateral support to fulfil their obligation to provide means of implementation.

However, the role of the MDBs is not unambiguous. They have been accused of impeding the process towards sustainable energy systems by continuing to fund fossil fuel projects (Kim & Urpelainen, 2013; Wright, Holmes, & Barbe, 2017). But this has started to change, as evidenced by the World Bank's 2017 commitment to stop funding upstream fossil fuel investments (World Bank, 2017). Regarding transport, at the Rio+20 conference in 2012, eight MDBs (African Development Bank, Asian Development Bank,

CAF–Development Bank of Latin America, European Bank for Reconstruction and Development, European Investment Bank, Inter-American Development Bank, Islamic Development Bank, and the World Bank) pledged to provide US$175 billion of loans and grants for more sustainable transport in developing countries by 2022. They also developed common arrangements for measuring and monitoring their transport projects (World Bank Website, 2015).

At COP24, the MDBs announced that they will develop a joint framework for working towards Paris alignment of their operations, including by making their operations compatible with the mitigation objectives of the Paris Agreement (Multilateral Development Banks, 2018). What exactly this means is yet to be worked out and can therefore not be assessed at this stage.

Furthermore, while it may be easy to determine which investments are Paris-aligned (for example integrated urban and transport planning or infrastructure for non-motorised and public transport), it is not so easy to judge which transport investments are misaligned. Larsen et al. (2018) consider that only transport infrastructure built solely for the transport of fossil fuels can clearly be classed as misaligned. For road infrastructure, diesel rail and rolling stock and port infrastructure, it depends on the characteristics of the individual project. To the knowledge of the authors there exists no such project-by-project assessment of the MDBs' lending portfolios.

Alongside the MDBs there are numerous other institutions that provide financial means. For the electricity sector, these include, for example, the Africa Renewable Energy Initiative as well as Mission Innovation and the Breakthrough Energy Coalition, the latter two of which focus on research and innovation. But are the available means sufficient to meet the enormous investment needs to transform global power systems? While the current growth rate of renewables is in line with the required pace to embark on a 1.5°C compatible pathway (see Kuramochi et al. 2018), it is unclear whether this high level of growth (25-30% annually over the last decade) and the corresponding investments can be sustained and for how long.

5.6 Knowledge and Learning

Governance supply for this function may be rated as medium, many institutions contribute in one way or another. For example, under the UNFCCC, the Technical Examination Process (TEP) convened a series of expert meetings to collate and synthesise good practice policies for a variety of sectors including electricity and transport (UNFCCC Secretariat, 2018). The Decarbonising Transport project of the International Transport Forum explicitly aims to build knowledge in order to help decision makers establish pathways to carbon-neutral mobility (ITF website, 2019). Another example is IEA's Technology Collaboration Programmes (TCPs) focusing on the advancement of different vehicle propulsion technologies: Advanced Fuel Cells TCP, Advanced Motor Fuels TCP, Clean and Efficient Combustion TCP and the Hybrid and Elec-

tric Vehicle TCP. Their main activities focus on research, studies, information exchange, policy recommendations and establishing pilot projects (IEA Website, 2019).

With the Global Stocktake, the Paris Agreement has established a process for collectively appraising the latest science and progress in climate action globally every 5 years. However, the modalities for the Global Stocktake recently agreed in Katowice (UNFCCC, 2018) do not envisage a sectoral breakdown. This limits the potential of the Stocktake to promote learning about sector-specific challenges and solutions.

6 Potential Entry Points for Clubs

6.1 Transformation Challenges and Cooperation Gaps

The previous sections have synthesised findings on decarbonisation challenges, governance demand and current governance supply in the sectors land transport, electricity and energy-intensive industries. This section will summarise these findings and on this basis discuss the potential for climate clubs in these sectors.

The collective action dilemma perspective of much of the current literature on climate clubs holds only to a limited extent regarding land transport and electricity. While substantial investment will be required to decarbonise both sectors, very high investments will also be required in the baseline to meet transport and electricity demand. Marginal abatement costs may even end up negative. The economic balance becomes even more positive when factoring in the reduction of local pollution that results from the reduction of fossil fuel use. According to the World Health Organisation (WHO), health savings from reduced local pollution alone may more than compensate for the mitigation cost of keeping global temperature increase below 2°C (WHO, 2018).

Rather than macro-economic burdens, the economic challenge is rather one of path dependencies and micro-economic burdens at the level of affected companies and regions. However, the transition is seen as costly as these micro-economic burdens play a very strong role in political discussions, as evidenced for example in the recent election in Australia. In addition, large volumes of capital will need to be mobilised, which may be beyond the capacity of many developing countries

The picture is different for energy-intensive industries. Low-emission technologies have higher operating costs and require high capital expenditure. As parts of these industries are highly trade-exposed, this creates a strong barrier for countries to move ahead on decarbonisation without international coordination.

Despite these differences, there are strong parallels in the governance demands and existing governance supply in the three sectors:

- All three sectors feature long investment cycles and would therefore strongly profit from clear long-term signals. International agreement on sectoral emission targets would also set new standards for state behaviour and thereby support domestic pro-enforcement stakeholders in overcoming the resistance by incumbent regime actors. However, while the Paris Agreement includes a long-term net zero emission target, this target is not broken down to the individual sectors. While Agenda 2030 and the New Urban Agenda promote the scale-up of renewable energy and a new mobility paradigm, there are no internationally agreed zero-emission or phase-out targets.
- There are no rules requiring sector-specific targets and strategies at national level. In particular, there are no requirements to implement a 'carbon budget reform' in general or carbon pricing in particular. While the distortions created by fossil fuel subsidies are relevant in all three sectors, coordination on carbon pricing or standards is particularly important in the industry sectors due to the competitiveness concerns.
- While governments are required to provide transparency about emissions and actions taken at sector level, this information is not used to highlight which sectors are performing well or badly. In addition, there are no penalties for failing to reduce emissions. Global governance is therefore exerting little pressure to change high-emission paradigms and practices at sector level.
- As for means of implementation, there is progress in aligning the provision of public finance to the objectives of the Paris Agreement but currently public finance is still flowing into fossil fuels. Generally, it is not easy to judge to what extent portfolios are aligned or misaligned.

Given the cooperation gaps that have been identified in the preceding analysis, clubs in these sectors could have a number of features that could be common for all three sectors. Other features could be different to account for sectoral specifics. Functions which could be common for all three sectors include:

- To send strong signals, clubs could set themselves ambitious targets, such as reducing emissions to zero by 2050 at the latest, preferably earlier.
- To back up the signal by actual action, the individual members could be required have ambitious individual sectoral targets according to their respective circumstances, with developed country members aiming for earlier zero emission dates than developing country members.
- The members could be required to regularly report on the actions they are taking and the impact of these actions; and to have these reports undergo international review. In particular, members could be required to provide transparency on their fossil fuel subsidies and to shift resources from high-emission to low-emission investments.

- The members could be required to completely stop all support for fossil fuels and high-emission transport infrastructure in third countries, to scale up support for sustainable investments, and to use their influence in multilateral financial institutions to make them adopt analogous policies.
- Developed country members of the club could commit to privilege developing country members in the provision of means of implementation. Recipient countries could be required to in parallel shift their own resources from funding high-emission to low-emission investments.

The following sections will discuss features that could be different for the three sectors.

6.2 Potential Entry Points for Electricity Transition Clubs

Given the low mitigation costs and strong non-climate benefits that may be reaped in the electricity sector, the sector may at first glance be suited for the formation of a Buchanan club that take actions that are inherently attractive and yield emission reductions as a 'co-benefit'. However, micro-economic costs for affected companies and regions are substantial, which creates strong political resistance and contributes to a perception that climate action in the sectors is highly costly overall.

The signal function of international cooperation may therefore be particularly relevant. If some actors moved ahead with strong action in this sector, this might contribute to changing the cost-benefit perceptions of other actors. The example set by frontrunners might also serve as political support for pro-climate stakeholders in recalcitrant countries. Club members may also find it to be to their direct benefit to collaborate on outstanding technical questions, such as grid integration and storage of renewable electricity.

However, there are also barriers to the global electricity transition that may not be addressed from a Buchanan perspective of maximising direct material benefits. In particular, many developing countries may not have the capacity to mobilise the amounts of capital that will be required. International support may also be required for regions in developing countries that will be hard hit by the climate transition, such as coal mining regions.

Addressing those issues would require the formation of a 'voluntary' climate club of actors that are willing to contribute more than would be required to maximise direct material benefits. It would in particular require a number of 'enthusiastic' donor countries willing to provide means of implementation to be part of the club.

Given that there already is a plethora of institutions active in the electricity sector, the question is whether an additional club is needed, or whether these functions could be delivered by existing institutions. Considering its stated ambition of phasing out coal, the PPCA may be a good candidate. However, currently, it is rather a 'pseudo club', with ambitious objectives but no club goods, no accountability, and a limited membership.

Another question is which countries may be candidates for starting or joining clubs. Literature suggests that countries with low mitigation costs and/or high exposure to climate impacts are the most likely to initiative formation of clubs. Given that climate action is lagging even in sectors with a beneficial cost-benefit ratio such as electricity and land transport, this assumption may be altered to the effect that countries with weak path dependencies and correspondingly low perceived mitigation costs may be most likely to initiate clubs. This assumption is borne out by the membership of the PPCA, as all of its members have a low share of coal in their electricity supply. The PPCA might therefore be accused of being an exercise in low-cost signalling.

To provide added value to the institutions that are already active in the electricity sector, an electricity transition club could therefore include in particular the following elements:

- An unequivocal joint commitment to reduce electricity sector emissions to zero, not just to phase out coal;
- Respective individual commitments by the individual members as well as commitments to 'climate budget reform';
- Strong transparency and accountability on progress towards these commitments.
- To make a tangible impact, members should include countries that currently still heavily rely on coal. Attracting such members may require preferential access to means of implementation.

6.3 Potential Entry Points for Land Transport Transition Clubs

Considerations for land transport are broadly similar to those for electricity. Action in the sector has the potential to reap strong non-climate benefits, the sector may therefore at first glance lend itself to the formation of a Buchanan club. However, here as well there is strong political resistance against moving beyond fossil fuel use and the investment volumes required may be beyond the means of many developing countries. So here as well a 'voluntary' climate club may be required to make a real difference.

Also similar to electricity, here as well there is already a plethora of institutions being active. Considering its stated ambition of reducing transport emissions to zero by 2050, in particular the TDA may appear as a good candidate for filling the existing cooperation gaps. However, similar to the PPCA, the TDA is currently rather a 'pseudo club', with ambitious objectives but no club goods, no accountability, and a very limited membership.

An initial list of club functions to provide added value to the institutions that are already active in the sector could look very similar to the electricity sector:

- An unequivocal joint commitment to reduce land transport emissions to zero;
- Respective individual commitments by the individual members as well as commitments to 'climate budget reform';

- Strong transparency and accountability on progress towards these commitments.

A further area for cooperation could be to promote market formation for zero-emission vehicles. While there already initiatives targeting for example the uptake of electric vehicles, value might be added by coordination of fleet vehicle emission standards. Countries might also take a step further and fully ban sales of conventional vehicles from a certain date. There already is some movement in this direction, China, France, India, the Netherlands, Norway, and the UK have decided to phase out or even outright ban sales of new diesel or gasoline vehicles starting from 2025 to 2040 (Chrisafis & Vaughan, 2017; Stumpf, 2017). There may therefore be a basis for a club having the full phase-out of conventional vehicles as one of its targets.

6.4 Potential Entry Points for Industry Transition Clubs

In contrast to the electricity and land transport sector, decarbonising energy-intensive industries will entail significant costs. A Buchanan club is therefore not an option in this area, these industries would require the formation of one or several 'voluntary' climate clubs.

As decarbonisation of these sectors is not inherently attractive, international cooperation is particularly salient. A common decarbonization target and roadmaps could provide important guidance to actors in these sectors. Joint rule-setting on carbon pricing and standards could help to address competitiveness concerns. Cooperation could also include coordination of R&D efforts and pooling of resources to develop and transfer new breakthrough technologies. Without development of new technologies, GHG emissions of energy-intensive industries cannot be reduced to (net) zero.

A key feature of these industries is that they are highly concentrated in a few countries and in terms of industry structure. Clubs would therefore require membership of only a limited number of countries and possibly companies. 94 steel companies accounted for almost 60 per cent of global crude steel production in 2015. Similarly, only 10 companies produce almost half the world's aluminium and more than half of the top 50 chemicals companies are headquartered in just 18 countries. Generally, China, the EU, the US, Japan and India dominate these industries (Oberthür et al., 2019).

7 Conclusions

The international community has so far failed to adequately address climate change. A substantial body of literature suggests that climate protection could be accelerated by the formation of clubs of countries and potentially also other actors complementing the UNFCCC. This paper has surveyed available literature on clubs. Generally, three types of clubs are identified:

- Buchanan clubs where the actions taken are inherently attractive and emission reductions are a 'co-benefit'.

- 'Voluntary' climate clubs where countries take action beyond what would maximise their direct self-interest. For such clubs to function properly, provision of incentives in the form of club goods in the wide sense is essential. Suggestions for club goods include joint technology research and development, linkage to trade and border carbon adjustments to counter carbon leakage.
- 'Pseudo' clubs yield only minimal excludable benefits and have no enforcement mechanisms. However, due to the low entry requirements they may attract a considerably wider range of participants, may provide broad networking possibilities and may lay the foundation for implementation of stricter regulation in the future

On the basis of this literature survey, this paper has sought to generate additional insights by taking a sectoral perspective on what are barriers to decarbonisation and how international cooperation in general and clubs in particular could help overcome these barriers.

One finding is that the assumption that climate change mitigation is costly, which is the starting point of much of the current literature on clubs, does not hold for all sectors. In particular mitigation action in the electricity and transport sectors may yield substantial non-climate benefits at the macro-economic level such as reduction of local air pollution and attendant improvement of public health. According to the WHO, health savings from reduced local pollution alone may more than compensate for the cost of keeping global temperature increase below 2°C.

A main barrier in these sectors is rather that there will be losses at the micro economic level, in particular at the level of companies and regions that currently strongly depend on use of fossil fuels. The prospect of these losses generates political resistance that contributes to a perception that climate action is highly costly overall.

The situation is different in the energy-intensive industries. Here, there will indeed be macro-economic costs as new technologies will need to be developed that will have higher operating costs than conventional production processes. In addition, investments in these industries are highly capital intensive. Finally, in particular steel and chemicals are subject to strong international competition.

On this basis, the potential contributions clubs could make also vary among the three sectors considered. The decarbonisation of energy-intensive industries requires more effort than would be warranted by immediate material self-interest. A club would therefore need to be of the 'voluntary' type, creating rules and club goods to address the free rider problem. Energy-intensive industries could strongly profit from international coordination on carbon pricing and standard setting in order to address the competitiveness issue. Countries could also engage in joint R&D and pooling of resources to promote new breakthrough technologies.

By contrast, the main point of strong commitments on electricity and land transport may the signalling function. If relevant actors decided to take strong action, this might induce other actors to revisit their cost-benefit assumptions. Such types of actions fit with the definition of a Buchanan club. However, many developing countries will probably require support in mobilising the capital needed to transform these two sectors. A meaningful club would therefore require membership of 'enthusiastic' donor countries, so in the end 'voluntary' clubs may also be required in these two sectors in order to make a meaningful difference.

This paper has sought to enrich the literature on climate clubs by zooming in on decarbonisation potentials, barriers and the potential contribution clubs may make at the sector level. However, this work has only be able to give a rough indication of where clubs could go beyond the international cooperation that is already taking place. Further research might address more in detail what international cooperation already exists in the different sectors and how clubs might add value. In addition, this paper has addressed only three sectors, so further work might expand this approach to other sectors.

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