

Journal Pre-proof

Blind Spots in Climate Finance for Innovation

Peter Warren

PII: S1674-9278(20)30019-8

DOI: <https://doi.org/10.1016/j.accre.2020.05.001>

Reference: ACCRE 171

To appear in: *Advances in Climate Change Research*

Received Date: 13 October 2019

Revised Date: 18 April 2020

Accepted Date: 12 May 2020



Please cite this article as: Warren, P., Blind Spots in Climate Finance for Innovation, *Advances in Climate Change Research*, <https://doi.org/10.1016/j.accre.2020.05.001>.

This is a PDF file of an article that has undergone enhancements after acceptance, such as the addition of a cover page and metadata, and formatting for readability, but it is not yet the definitive version of record. This version will undergo additional copyediting, typesetting and review before it is published in its final form, but we are providing this version to give early visibility of the article. Please note that, during the production process, errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Copyright © 2020, National Climate Center (China Meteorological Administration). Production and hosting by Elsevier B.V. on behalf of KeAi. All rights reserved.

Blind Spots in Climate Finance for Innovation

Dr. Peter Warren
University College London
E: peter.warren@ucl.ac.uk

Journal Pre-proof

Blind spots in climate finance for innovation

Peter WARREN

School of Public Policy, University College London (UCL), London, WC1H 9QU, UK

Corresponding author: peter.warren@ucl.ac.uk (P. Warren)

Abstract

International climate finance is a sub-set of green finance and refers to investments specifically in climate change mitigation and adaptation activities, which primarily involve public finance and the leveraging of private finance in developing countries. In addition to continued international support for scaling low carbon solutions and facilitating replicability in developing countries, there remains an important need to increase the amount of climate finance provided to innovation, particularly demonstration (for technology innovation) and pilot implementation (for policy innovation), and to channel a greater proportion of Official Development Assistance (ODA) to 'hard-to-abate' areas, such as industrial decarbonisation, international transport and cross-sectoral issues like cooling and behavioural insights, to accelerate the commercialisation and implementation of technological, financial and policy solutions to contribute to meeting the Paris Agreement's goal of limiting global warming to 'well-below' 2°C in these countries. Linking research, development and demonstration (RD&D) support with technical assistance is important in providing the route to obtain wider donor finance (concessional finance) and private finance to enable deployment through scalability and replicability.

Keywords: Climate finance; Climate policy; Paris Agreement; Official Development Assistance; Industrial decarbonisation; Sustainable cooling; Behavioural insights; International transport

1. Introduction

Climate finance is a sub-set of green finance and refers to the provision of funding specifically for climate change mitigation and adaptation activities, which primarily involves public finance and the leveraging of private finance in developing countries (Warren, 2019; Ragosa and Warren, 2019). Within the Paris Agreement (Article 9), which was signed at COP21 in 2015, and within the United Nations Framework Convention on Climate Change (UNFCCC) process (Articles 4.3–4.5), climate finance refers to the commitment of developed countries to provide financial assistance to developing countries to mitigate and adapt to climate change¹. The term, 'climate finance', is contested in the academic and grey literature and is debated further in Warren (2019). For example, within the UNFCCC process, some developing countries view climate finance as being additional and separate from Official Development Assistance (ODA) commitments from developed countries. This is an interesting area for further research.

The broader term of 'climate investment' also includes all private finance (e.g. investment banks such as the European Investment Bank, institutional investors, utilities) and third sector funding (e.g. initiatives such as Climate-KIC, communities, charities) (as well as domestic-focused public finance such as the European Commission's planned European Green Deal) that are not leveraged from public finance and are focused on meeting climate change mitigation and adaptation goals in developed and developing countries. Although climate investment has focussed on a range of sectors to date, the clean energy and domestic transport sectors have received the largest share of total climate investment and climate finance. The Climate Policy Initiative (CPI) (2019) estimates that of the 253 billion USD of climate finance channelled from developed countries to developing countries in 2017–2018 (two years), 58 billion USD went to renewables, 33 billion USD went to energy efficiency and 94 billion USD went to sustainable (domestic) transport. These figures are comparable with those reported in the UNFCCC (2018)'s Biennial Assessment of Climate Finance Flows, which draws on data from CPI, the Frankfurt School-UNEP Collaborating Centre for Climate & Sustainable Energy Finance, Bloomberg New Energy Finance (BNEF) and the International Energy Agency (IEA).

¹ <https://unfccc.int>

Within the energy sector, as the costs of some renewables come down in developing countries, such as solar photovoltaics and onshore wind power, the amount of climate finance directed to other areas, such as less-established renewables, energy storage and networks is increasing. Technical assistance (TA) has also been an important area for climate finance and refers to "...activities that facilitate capacity building, policy development, knowledge-sharing and project preparation to enable the deployment of technologies, actions and programmes to mitigate or adapt to climate change" (Warren, 2019).

Innovation refers to the notion of "creating new value" (Posner and Mangelsdorf, 2017), either by creating new technologies, processes, business models or institutions, or using existing technologies and mechanisms in a new way. Climate finance for innovation has primarily focused on grant-based early-stage research, late-stage demonstration support or support for innovation in business models (such as the Global Innovation Lab for Climate Finance – The Lab, 2020). International public finance for research, development and demonstration (RD&D) has primarily been delivered outside of Official Development Assistance (ODA) channels, such as through direct support from developed countries to developing countries and through bilateral collaborations. The IEA (2019) estimates that 26 billion USD was spent on RD&D for energy globally, a 5% increase on the previous year. An increasing share of this is focusing on clean energy technologies due to the pledges of Mission Innovation member countries to double spending on energy RD&D between 2015–2020². As an example, the UK's target of 400 million GBP in the 2020–2021 financial year ring-fences one quarter of this commitment (100 million GBP) through climate finance for the benefit of developing countries³.

Despite the importance of deploying existing technologies at scale to contribute to meeting the Paris Agreement's goal of limiting global warming to 'well-below' 2°C, using climate finance to accelerate the commercialisation of mid-stage promising clean technologies, the development of new business models and policy innovations (such as in governance, delivery, approaches and incentives) has a crucial complementary role in ensuring that a diversity of solutions is fostered to allow the effective adaptation of appropriate solutions to local contexts. However, the limited amount of climate finance channelled to RD&D in the 'valley of death' of Technology Readiness Levels (TRLs) (NPL, 2019), particularly TRLs 3-7, there are important 'blind spots' in the area of climate finance for innovation. TRL 3 is the experimental proof of concept of a technology, TRL 4 involves validating the technology in a laboratory, TRL 5 requires the technology to be validated in an industrially-relevant environment, TRL 6 requires the technology to be demonstrated in an industrially-relevant environment, and TRL 7 involves the demonstration of a technology system prototype in an operational environment (EC, 2014).

2. Analysis

2.1 *Blind spots*

Figure 1 summarises some of the more pressing 'blind spots' in the climate mitigation debate, which if supported, could have the potential to accelerate and transform the decarbonisation of certain sectors. Figure 1 categorises the 'blind spots' by sector and theme and highlights the type of climate finance support required to accelerate the innovations towards commercialisation and implementation in developing countries. Although the areas have extensive cross-disciplinary bodies of literature behind them, they have received limited international climate finance to date, despite the evidence identifying that the proportion that these sectors contribute towards greenhouse gas emissions is increasing. From a technological, financial and policy innovation perspective, these areas face large barriers to decarbonisation and are consequently often referred to as 'hard-to-abate'. Barriers include ODA-compatibility issues (e.g. international transport), cross-border competitiveness issues (e.g. industrial decarbonisation), and upfront capital costs and reduced efficiency (e.g. carbon capture, usage and storage (CCUS)). However, the barriers are often context-dependent.

² <http://mission-innovation.net/>

³ <http://mission-innovation.net/our-members/united-kingdom/plans-and-priorities/>

It is important to note that there are other 'blind spots' in the climate finance debate, such as greenhouse gas removal technologies and innovation in transmission and distribution networks, but this short communication focuses on key gaps from a clean energy innovation perspective that are gaining increasing attention in climate negotiations.

Sectoral	Thematic	Commercialisation & Policy		Mechanism
Cross-sectoral	Behavioural insights	N/A	-Behavioural insights units	-Policy & advisory TA
Cross-sectoral	Sustainable cooling	RD&D	-Innovation support -Cooling roadmaps	-Policy & advisory TA -RD&D grants
Industry	Carbon capture, usage and storage	Demonstration and deployment	-Demonstration support -Competition policy -Policy incentives for deployment	-RD&D grants -Concessional finance -Policy & advisory TA
	Hydrogen and fuel switching	RD&D		
International transport	Fuel switching	RD&D	-Cross-border regulations and agreements -Innovation support	-RD&D grants -Project preparatory TA -Policy & advisory TA
	Electrification	RD&D		

Fig. 1. Blind spots in climate finance for innovation. The figure is structured to be read from left to right with the 'blind spot' highlighted in the first two columns by sector and theme, the key facilitators shown in the next two columns from a commercial & policy support perspective, and the type of climate finance support required to enable the facilitators in the final column. 'RD&D' refers to research, development and demonstration activities, 'TA' refers to technical assistance activities and 'N/A' denotes that the column is less applicable to that theme.

2.2 Behavioural insights

Technological solutions alone will not enable the goals of the Paris Agreement to be met. Behavioural insights refers to the use of techniques from behavioural economics and social psychology to design and implement innovative policies that aim to change, adapt and incentivise consumer behaviour from high-carbon activities to lower-carbon activities by drawing on the 'wider' rationalities that consumers exhibit (Strachan and Warren, 2011). For example, consumers are influenced by a whole range of factors, such as habits, social norms, perceived hassle, the influence of peers (Granovetter, 1973), and many other factors that do not conform to the 'rational' behaviour assumed in classical economics (Warren, 2018).

To address these 'wider' rationalities, behavioural insights units have been established in some developed country governments, such as the USA, the UK, Ireland, and Japan, which have drawn on this evidence to design and implement more effective consumer policies that aim to go beyond the much critiqued 'information-deficit' model, which assumes that the provision of information through information campaigns will simply change behaviour (Warren, 2015). Despite some domestic policy examples of applying behavioural insights in a handful of countries, there are currently no existing vehicles, such as Trust Funds or programmes, channelling climate finance from donors to encourage behavioural insights approaches in developing countries. The provision

of climate finance to developing countries for the three pillars of technical assistance (TA) activities, such as for capacity building (e.g. skills development and training in behavioural insights), policy and advisory (e.g. the establishment of behavioural insights units in governments), and project preparation (e.g. feasibility studies for designing and implementing Randomised Controlled Trials (RCTs) to gather evidence and to test behavioural insights-informed policy options), is an appropriate vehicle for enabling the implementation of this policy innovation and addressing this 'blind spot'.

2.3 Sustainable cooling

One of the most important 'blind spots' of the energy debate (IEA, 2018) is cooling, which is projected to represent 13% of global greenhouse gas emissions by 2030 (GIZ Proklima, 2019) with overall cooling energy demand increasing by 90% by 2050 (7500-9500 TW h) (Peters, 2018). The Rocky Mountain Institute (RMI, 2018) estimates that increase in demand for cooling from residential air conditioners alone will increase global temperatures by 0.5° C by 2100. However, this is a cross-sectoral issue, impacting on health, agriculture, buildings, cities, energy, industry, transport and the cold chain, so access to sustainable cooling rather than access to cooling is crucial in adapting to, and mitigating, climate change. This is particularly important in the context of meeting wider Sustainable Development Goals (SDGs), as over 1.1 billion people face risks from a lack of access to cooling, which would consequently contribute to alleviating poverty, improving health and improving economic productivity (SEforAll, 2018).

Despite this, climate finance for sustainable cooling is currently just 0.04% of total Official Development Assistance (ODA) (K-CEP, 2019). Although some Trust Funds and programmes exist, such as the 15 million GBP Sustainable Cooling Innovation Fund established by the UK Government and the International Finance Corporation (IFC) in 2019, the challenge revolves around scaling donor financing and private finance to accelerate the commercialisation and deployment of sustainable cooling solutions. The Cool Coalition, which was launched at the UN Climate Action Summit in 2019, aims to raise awareness and action on cooling. However, it is too early to establish whether or not it is having a profound impact on addressing the scalability issue.

2.4 Industrial decarbonisation

Similarly, limited climate finance has been provided to the decarbonisation of fossil fuel-intensive industries, such as iron and steel, chemicals and petrochemicals, and cement. Climate finance has primarily focused on grant funding for energy efficiency activities in industry rather than the achievement of deep decarbonisation. Technological solutions, such as carbon capture, usage and storage (CCUS), fuel-switching (e.g. switching from coal and gas to biofuels or hydrogen) and electrification are possible in some industries, but there is currently limited economic incentive for industries to invest in such technologies, as it can impact on their global competitiveness in the absence of cross-border regulations and agreements. This can lead to a tension between a country's industrial (economic) goals and ecological concerns in 'greening' industry (Hildingsson et al., 2018), and thus policy innovation in competition policy and policy incentives (such as for demonstration) are important enabling factors. In addition to grant support for demonstration, climate finance for technical assistance is necessary to support the development of the policy and regulatory frameworks to incentivise their wider take-up and access to finance (for example, by creating and implementing local, regional and national roadmaps for industrial decarbonisation and altering the financial requirements on utilities to encourage investments in renewable energy generation (Pee *et al.*, 2018)). Climate finance for industrial decarbonisation is therefore both an issue of limited donor financing and scalability.

Providing technical assistance to support industries directly is important from a scalability perspective, particularly through capacity building, skills development, knowledge-transfer and encouraging greater openness in innovation to allow wider replicability. For example, the UK Government's international CCUS programme, which provides 70 million GBP of ODA through the Asian Development Bank's CCUS Fund and the World Bank's CCUS Trust Fund to support developing countries to develop the technical and institutional knowledge necessary to enable the deployment of CCUS, is one of the few sources of climate finance for CCUS globally (UK Government, 2019). Despite the existence of a small number of existing vehicles for international

climate finance for CCUS, a large increase in donor financing and private finance is required if the technology is to scale-up and deploy on a meaningful level to contribute to decarbonising industrial sectors in high-emitting developing countries and emerging economies. Total investment in CCUS since 2007, covering all sources of finance (beyond just climate finance to include wider public and private finance) has been limited at just 28 billion USD globally (IEA, 2018). This compares with 750 billion USD provided to renewables in 2017 alone globally (IEA, 2018). CCUS is at a later stage of development along TRLs towards commercialisation in industry, but alternatives, such as hydrogen and fuel switching, are at an earlier stage of development and consequently the provision of climate finance for technology innovation for industrial decarbonisation should focus on RD&D for these (and other) options, in addition to technical assistance.

2.5 International transport

Transport, accounts for 28% of global final energy demand and 23% of CO₂ emissions from fuel combustion (IEA, 2017). Within this sector, the final 'blind spot' discussed in this short communication is international transport (aviation and shipping), which has received the least attention from international climate finance compared with the other areas visualised in Fig. 1. Aviation alone is estimated to represent 2% of global greenhouse gas emissions (IATA, 2018) and the proportion is growing as other sectors are decarbonised more rapidly, such as the power sector. From a technology innovation perspective, progress is being made in fuel switching and electrification, but this primarily remains in the lower TRLs range and has been tested for shorter travel distances rather than long-haul distances and not at the scale required to be commercially viable. Policy innovations, such as cross-border agreements and regulations beyond carbon offsetting are required, but have historically been challenging to implement in climate negotiations due to current impacts on competitiveness and costs if all countries and airlines are not included.

Despite aviation and shipping both being high on the international policy community agenda, such as through the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO), there is limited climate finance support to developing countries to decarbonise these sectors through dedicated Trust Funds or programmes focused on supporting technological, financial and policy innovations (beyond carbon markets and carbon offsetting). As with the other 'blind spots' in climate finance discussed previously, donors are usually risk-averse and have historically focused on the more established sectors, such as renewables in the power sector, rather than 'hard-to-abate' sectors. Grant-based climate finance for technology RD&D coupled with support for pilot project preparation, undertaken alongside policy and advisory-based technical assistance (TA) activities, has an important role to play in increasing the development of innovative technological, financial and policy solutions in aviation and shipping in developing countries. This initial grant-based assistance for RD&D and TA activities is important in leveraging private finance and wider donor financing to accelerate the development and scaling of technological, financial and policy solutions.

3. Conclusion

In conclusion, this short communication argues that there is an important need not only to increase the amount of climate finance provided to innovation, particularly demonstration (for technology innovation) and pilot implementation (for policy innovation), but to channel a greater proportion of the ODA to 'hard-to-abate' areas, such as industrial decarbonisation, international transport and cross-sectoral issues like cooling and behavioural insights, to accelerate the commercialisation and implementation of technological, financial and policy solutions to contribute to meeting the Paris Agreement's goal of limiting global warming to 'well-below' 2° C in high-emitting developing countries and emerging economies. Linking RD&D support with technical assistance is important in providing the route to obtain wider donor finance (concessional finance) and private finance to enable deployment through scalability and replicability.

Acknowledgments

The author would like to thank the Editors for their helpful comments.

Declaration of competing interest

The author declares no conflict of interest.

References

- CPI (Climate Policy Initiative), 2019. Global landscape of climate finance 2019. <https://climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2019/>
- EC (European Commission), 2014. Technology readiness levels (TRL). Horizon 2020 – Work Programme 2014-2015. https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf
- GIZ Proklima, 2019. Green cooling initiative. <https://www.green-cooling-initiative.org>
- Granovetter, M.S., 1973. The strength of weak ties. *Am. J. Sociol.* 78 (6), 1360-1380
- Hildingsson, R., Kronsell, A., Khan, J., 2018. The green state and industrial decarbonisation. *Environ Polit International Air Transport Association (IATA) 2018. Climate Change & CORSIA.* https://www.iata.org/pressroom/facts_figures/fact_sheets/Documents/fact-sheet-climate-change.pdf
- IEA (International Energy Agency), 2017. Energy technology perspectives. <https://www.iea.org/reports/energy-technology-perspectives-2017>
- IEA, 2018. World energy investment outlook 2018. <https://www.iea.org/wei2018/>
- IEA, 2019. World energy investment 2019. <https://www.iea.org/wei2019/>
- K-CEP (Kigali Cooling Efficiency Program), 2019. Why cooling. <https://www.k-cep.org/why-cooling/>
- NPL (National Physical Laboratory). 2013. Written evidence submitted by Comments from the National Physical Laboratory (NPL). UK Parliament. <https://publications.parliament.uk/pa/cm201213/cmselect/cmsctech/348/348we15.htm>
- Pee, A.D., Pinner, D., Roelofsen, O., *et al.*, 2018. How industry can move toward a low-carbon future. <https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/how-industry-can-move-toward-a-low-carbon-future>
- Peters, T., 2018. Global clean cooling landscape review. University of Birmingham, UK
- Posner, B., Mangelsdorf, M.E., 2017. Twelve essential innovation insights. *MIT Sloan Manag. Rev.*, Fall 2017
- Ragosa, G., Warren, P., 2019. Unpacking the determinants of cross-border private investment in renewable energy in developing countries, *J. Clean. Prod.* 235, 854-865
- RMI (Rocky Mountain Institute). 2018. Solving the global cooling challenge how to counter the climate threat from room air conditioners. https://rmi.org/wp-content/uploads/2018/11/Global_Cooling_Challenge_Report_2018.pdf
- SEforAll, 2018. Chilling prospects: providing sustainable cooling for all. SEforAll and Kigali Cooling Efficiency Program). https://www.seforall.org/sites/default/files/SEforALL_CoolingForAll-Report.pdf
- Strachan, N., Warren, P., 2011. Incorporating behavioural complexity in energy-economic models. UK Energy Research Centre Conference on Energy and People: Futures, Complexity and Challenges. 20-21 September 2011. Environmental Change Institute, Oxford, UK
- The Lab. 2020. The global innovation lab for climate finance. <https://www.climatefinancelab.org/>
- UK Government, 2019. International carbon capture, usage and storage programme Annual Review 2019. Department for Business, Energy & Industrial Strategy (BEIS). <https://devtracker.dfid.gov.uk/projects/GB-GOV-13-ICF-0001-CCUS>
- UNFCCC (United Nations Framework Convention on Climate Change), 2018. Biennial assessment of climate finance flows, December 2018. <https://unfccc.int/topics/climate-finance/resources/biennial-assessment-of-climate-finance>
- Warren, P., 2015. Demand-side management policy: mechanisms for success and failure. PhD thesis. University College London, UK
- Warren, P., 2018. Demand-side policy: global evidence base and implementation patterns. *Energ Environ-UK.* 29, 706–731
- Warren, P., 2019. The role of climate finance beyond renewables: demand-side management (DSM) and carbon capture, usage and storage (CCUS). *Clim. Policy.* DOI: [10.1080/14693062.2019.1605330](https://doi.org/10.1080/14693062.2019.1605330)

Sectoral	Thematic	Commercialisation & Policy	Mechanism
Cross-sectoral	Behavioural insights	N/A	-Behavioural insights units -Policy & advisory TA
Cross-sectoral	Sustainable cooling	RD&D	-Innovation support -Cooling roadmaps -Policy & advisory TA -RD&D grants
Industry	Carbon capture, usage and storage	Demonstration and deployment	-Demonstration support -Competition policy -Policy incentives for deployment -RD&D grants -Concessional finance -Policy & advisory TA
	Hydrogen and fuel switching	RD&D	
International transport	Fuel switching	RD&D	-Cross-border regulations and agreements -Innovation support -RD&D grants -Project preparatory TA -Policy & advisory TA
	Electrification	RD&D	

Conflicts of Interest

There are no potential conflicts of interest with respect to the research, authorship and/or publication of this article. This research did not receive any specific grant from funding agencies in the public, commercial or non-for-profit sectors.

Journal Pre-proof