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Insights for Climate Technology Transfer from International Environmental and Human Rights Law

Kim Bouwer[†]

Strathclyde Centre for Environmental Law and Governance, University of Strathclyde, Glasgow,
Lord Hope Building, 141 St James Road,G4 0LT, UK

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The transfer of technologies to support the development of low-carbon pathways - that are fundamental for the mitigation of climate change - is frequently claimed to be hindered by the protection afforded by intellectual property rights. However, there are arguably further complexities involved in the development, receipt and operation of technologies that discourage the implementation of crucial mitigation processes. This paper challenges the notion of "transfer" of technology under the international climate change regime, in light of the recognition of a focus on needs and cooperative approaches in that context. The paper analyses any unidirectional concepts behind the idea of 'transfer, building on the human right to science and the notion of fair and equitable benefit-sharing, which is a component thereof. The paper concludes with a series of considerations arising from international human rights and environmental law that could be taken into account in the ongoing negotiations on technology transfer under the international climate change regime.

Keywords: Kyoto Protocol, Technology Mechanism, Intergovernmental Panel on Climate Change, Paris Agreement,Technology Framework,Nationally Determined Contributions,UNFCCC, Universal Declaration on Human Rights, International Treaty on Plant Genetic Resources for Food and Agriculture, The Covenant on Economic, Social and Cultural Rights,Technology transfer, Benefit sharing, Inter-state technology transfer obligations

The affordable access to and ability to use efficient, low-carbon technology at scale, is fundamental for the mitigation of climate change.[1] With the rejuvenation of the international climate regime in late 2015 with the adoption of the Paris Agreement, the issue of technology transfer has taken on a renewed importance. All parties to the Paris Agreement now share the burden of a climate change response to some degree,[2] and for many nations it requires improvement in their access to and capacity to use climate change technologies.[3] Among a multiplicity of challenges, they confront the necessity of urgently making a range of relevant technologies available, at scale, to developing countries, building upon the little progress in this direction that has been made until now.[4] This paper challenges the notion of "transfer" of technology under the international climate change regime, in light of the recognition of a focus on needs and cooperative approaches in that context. In so doing, it uses some elements from the human rights literature concerning the under-recognised right to access to scientific benefits - usually called simply the 'right to science'[5] to develop an analysis based on principles of benefit sharing.[6] Benefit-sharing issues in the context of climate change are fairly distinct. There are a few specific references to benefit sharing in the climate regime,[7] and increasing attention to benefit-sharing concepts in related areas (particularly renewable energy generation).[8]

However, an enriched understanding of benefit-sharing concepts – such as what is meant and who determines a benefit, what sharing entails – can provide a helpful means by which to examine developments in the climate change regime. This approach has, thus far, theoretical rather than practical applications, many of the arguments presented in this paper are fairly abstract.[9] The purpose of the paper is to analyse the current trends and recommendations in the literature, through a benefit-sharing lens. In particular, the focus is on need-based approaches, and understandings of sharing as deep co-operation and genuine partnership-building, as having particular relevance to current trends in the low-carbon technology innovation.[10] In considering these, the notion of sharing conveys a commitment to the recognition of the voice or perspectives of 'receiver' nations, and the approaches that recognise their needs and support and respond to their input throughout

[†]Email: kim.bouwer@strath.ac.uk

these processes.[11] Approaches based on receiver country need and an ongoing relationship based on dialogue and sharing, would also strongly support 'receiver' nations readiness to adopt and incorporate new technologies as these are transferred or co-developed.

The paper is limited to a discussion of climate change mitigation technologies.[12] Any specific references to the Clean Development Mechanism, an instrument under the Kyoto Protocol, or any 'successor' mechanism,[13] or any specific and in-depth discussion of the provision of finance through the Green Climate Fund or other sources of finance are avoided.These are, of course, of key importance in relation to the transfer of technology for climate mitigation,[14] and indeed it is virtually impossible to discuss this issue without some references to financing. However, all the above raises distinct and specific issues which require dedicated discussion. For these reasons, much of what follows would apply to transfer by means of trade and licensing, under development assistance (supported by multilateral bodies such as the World Bank) and foreign direct investment,[15] or to mechanisms or processes some of which expected to be established under the Technology Framework.[16] Notably, for reasons explained below, many of these processes currently occur outside of the climate regime. The primary focus is on the transfer and deployment of technology from the Global North to South, while appreciating that this is a limited paradigm that fails properly to take account of the diversity in 'developing countries'[17] and the potential contribution that stands to be made by them.[18]

The paper is structured as follows. First, it discusses the barriers to climate-related technology transfer; then itprovides an overview of the development of the international climate change regime with regard to technology transfer, which explores the potential interplay between need- and partnership based approaches reflected in the academic literature and in the climate regime and associated initiatives. Next it considers how an approach informed by the human right to science and fair and equitable benefit-sharing could be used to challenge the unidirectional thinking behind the idea of 'transfer' of climate-related technologies and serve instead to support need-based and partnership-basedapproaches. The paper concludes by suggesting that ongoing negotiations on climate-related technology transfer consider the human right to science and lessons learnt in relation to fair and equitable benefit-sharing in other areas of international law that, with proper application, could support effective and equitable transfers of climate mitigation technology.

Barriers to Technology Transfer

There is something fundamentally embedded in the understanding of intellectual property rights (IPRs) as a 'barrier' to the transfer of technology.It has been argued that the neglect of technology transfer issues in the climate regime is attributable to a perception of a 'stalemate' formed around the national protection of intellectual property,[19] presenting IPRs as a fundamental barrier to transfer and innovation,[20] or to the distribution and use of needed technology by other actors and/or states.[21] Moreover, there is a common perception that restrictions created by the protection of intellectual property can inhibit the availability of necessary technologies for poorer entities or nations, because the cost of accessing these technologies are beyond what is possible.[19] While there is no validity in these claims, these fairly blanket assumptions do not adequately encompass the nuanced interactions between IPRs and climate technologies innovation and transfer.These fundamentally ideological divisions about this issue can divert attention both from the necessity of intellectual property protection, and practical and effective solutions to technology divides.[22]

It is significant that a good portion of the academic literature analysing technological innovation and transfer in the climate change context, either reject the notion of IPRs as a barrier,[23] or use them instrumentally as an dataset or indicator for analysis.[24] They might also provide a nuanced analysis where IPRs can be seen to facilitate the transfer of technologies by creating conducive (and protective) recipient environments.[25] In short, compelling arguments can be made both ways.Indeed, protection of intellectual property rights in technology is arguably necessary for continuing investment in research and innovation.Poorly formulated or enforced protection of intellectual property in receiver nations, for instance, can also be a barrier to sharing or transfer of necessary technology.This is because robust IPR protection combined with good governance can reassure IPR holders and technology investors against duplication, thus providing assurance as to returns on investment.

However, important these issues are, they are not the only factor that needs to be addressed to achieve climate change technology transfer. For one thing, not all technologies that would be useful or necessary in low carbon transitions or climate change mitigation, are subject to IPR protection.[26] The danger of a preoccupation with intellectual property issues is that it might crowd out other relevant issues that require more or at least equal attention. A lack of attention on other issues could frustrate effective technology transfer in the climate change context. In addition, a different perspective can open up possible approaches that allow collaborative approaches on IPRs.'Barrier' interpretations depend on a perception that the transfer of technology is a one-off, unidirectional process. However, it could be argued that there are further complexities involved in the development, transfer, deployment and operation of technologies.

Most of the literature which addresses technology transfer beyond intellectual property issues identifies a series of factors both in developer and receiver states that respectively inhibit the provision and receipt of technologies. On the provider side, these included high upfront capital costs of technology investment;[27] these would include both the upfront capital costs of new projects but also the 'lost' investment in technological research if the benefits of these technologies are externalised.[28]

The barriers to technology transfer and deployment at the receiver end are more complex.These seem to arise from features of receivers that would inhibit transfer – including poor regulation, inadequate standardization and regulatory uncertainty (such as, taxation problems).[29]An early report from the IPCC recorded a range of impediments to the effective transfer of technology.[30] These included high capital costs and poor resourcing from provider nations, but also shortcomings in host nation institutions, training and social factors. The document suggests an even longer list of solutions, including the establishment of technology research centres, access to substitutes, and programmes with pilot products.[31] In essence, these issues represent concerns about the viability of the receiving market for investment, whether the concerns are about the protection of property interests, or simply the long-term viability of GHG emission reduction. To recall the above discussion regarding IPRs, Latif, a leading expert, notes that although licensing restrictions questions about the protection of intellectual property are significant issues – in the sense that these issues could constitute significant barriers – these are not key determinants when it comes to the deployment of technologies.[32] Most investors were interested in the scientific infrastructure, 'human capital', favorable market conditions and investment climates.What this makes clear is that a lack of ability to fund and operate technology, and to provide reasonable assurances as to return on investment, are acknowledged to be the key barriers to the transfer of technologies at scale. As two leading scholars in the field explain:

Technology as an enabler for development has received much attention in the existing literature. Scholars have tirelessly emphasized that technology is more than just hardware [citation omitted] and that R&D is more than academic institutions or innovation ... [citation omitted]. ... [I]n reality, the rhetoric and operations of programmes continue treating mere provision of technology and associated knowledge as a universal fix [citation omitted], including in key climate sectors such as energy and agriculture. Policy changes, access to services, projects and programmes are frequently suggested or implemented by donors or UN organisations with sparse consideration for the question whether the institutions and capabilities can accommodate and govern such well-intended actions.[33]

To sum up, there are a number of specific and quite technical reasons that inhibit the transfer and deployment of climate change technologies both within and beyond the boundaries of the climate regime.This section would not be complete, however, without mentioning the overarching impediments to technology transfer: underfunding, and a prevailing lack of political will.[34] These challenges explain the need for continued and creative approaches both within and beyond the climate regime machinery, even as it is hoped the latter becomes increasingly operationalised.It is clear that a constructive approach would look beyond overcoming barriers, and focus instead on imaginative approaches that might support the delivery of technology transfer, fostering fairness and equity in ongoing relationships and seeking to avoid inequities that might result from partnerships with the private sector.[35] Further analysis will highlight two emerging themes that present new potential areas of facilitation for the transfer of technology.This will address issues around need and the potential for co-operative or collaborative.

Climate Change and the Transfer of Technology

Access to mitigation technologies for the establishment of safe low-carbon pathways, are

fundamental for all countries to achieve the emissions reductions specified in their Nationally Determined Contributions (NDCs).[36] For well-worn reasons, the Global North is traditionally better equipped in the development and innovation of climate technologies and this is the paradigm largely reflected by the institutional routes to transfer through the climate regime, despite the increasing role key emerging economies are now playing in the development and diffusion of climate technologies.[37] The necessity of making technology more broadly available, for the purposes of a good climate change response, is recognised in the UNFCCC commitments.[38] Importantly, the Paris Agreement recognises that the goals for the transfer, development and use of technology are connected to and contingent on the provision of finance[39] and capacity building.[40] It also recognises the need for co-operative action.[41]

The current basis for transfers of technology in the climate regime was created with the initiation of the Technology Mechanism, in Cancun in 2010.[42] This continues as the serving mechanism under the Paris Agreement,[43] now under an overarching and overseeing Technology Framework.[44] The Technology Mechanism has two active agencies: the Technology Executive Committee (TEC) and the Climate Technology Centre and Network (CTCN).The purpose of the TEC is to provide a methodological framework for, and facilitate needs assessment done by developing countries, prepare synthesised assessments of global need and analyses of relevant policy and other issues in this area. Its role includes oversight into the preparation of Technology Needs Assessments (TNAs). As part of this framework, developing countries have been supported in the preparation of TNAs to identify state-specific crucial needs, in addition to barriers and challenges to technology transfer.[45] Significantly, many nations identified the need for financial support, enhanced capacity and improved 'enabling environments' (explained in more depth below), as well as recognising the benefit of collaborative development approaches.[46] The identification of needs is a crucial first step on the pathway towards development of Technology Action Plans, necessary to move towards full actualisation of parties' nationally determined contributions under the Paris Agreement.[47] The TEC also supports the development of National Systems of Innovation (NSI) in developing countries,[48] which feed into and supports the development of needs-based assessments.Systemic networked approaches to policy and practice of technology transfer have been used to inform the guidance and approaches to developing TNA's.[10]

The CTCN is empowered to address the implementation of actions required for achieving core goals of technological innovation and transfer and deployment.Much of its work involves the provision of support to developing nations, which includes technical assistance and support, knowledge exchange activities and the support and facilitation of collaborative approaches and networking. Despite chronic underfunding, the CTCN provides fairly significant technical support to developing country parties.[48] It facilitates a network of multilevel and multisectoral technology centres and entities; state parties participate through their nominated nationally determined entities.

This mechanism now falls under a Technology Framework, the modalities, procedures and guidelines of which are still subject to negotiations. Despite these developments, however, there is still insufficient progress or certainty of future progress in technological transfer.[49] In addition, of course, efforts towards the innovation and deployment of low-carbon technologies exist outside of the UNFCCC machinery, and it is here that significant advancements in the development, transfer and deployment of technologies have taken place.[50] Of course, it is not possible to go into the detail of all possible arrangements here. These complex webs of arrangements include multilateral and bilateral processes, and encompass a variety of kinds of actors in partnership or networks with other entities.These might include specific actions and roles taken by international organisations, for instance through trade or projects,[24] transfers conducted directly *via* multinational companies,[51] or by diffusion of technologies *via* joint ventures.[52] The latter might include transfers generated through established international innovation centres; but this also encompasses partnerships between private organisations and governments.[24]

Of course, alternative approaches raise the question of what is meant by technology and what is meant by 'transfer' in the climate context. Climate change mitigation technologies include infrastructure for the generation of clean energy, but are not limited to this.[53] Also, included would be broader know-how such as agricultural and building technologies, and

measures to ensure the health of sinks and green spaces.[9] In addition, technologies that support monitoring and accountability of various core processes will play an increasing role as states predict and try to account for their ongoing emissions.[54] This of course includes the knowledge and skills, the capacity, to operate hardware. Nygaard and Hansen explain that the complex conception of technology housed in the climate regime includes a third dimension – 'orgware' – the institutional and administrative capacity to manage received technologies.[55] These may seem like quite obvious requirements, however, the TNA process had previously been criticised for an excessive focus on hardware and lack of appreciation of the importance of knowledge-based and operational functioning.[56] These criticisms have clearly prompted adjustments and a broadening of focus, as the TNA Handbook's definitional terms now incorporate an understanding of the importance of knowledge and operational skills.[57]

Conceptions of what is meant by 'technology' inform the understanding of 'transfer'. The terminology used does imply a once-off, unilateral handing over, and indeed some developed countries tend to view technology transfers as the sale of equipment, with perhaps some operational skills.[45] In the main, the perception of technology transfer and technology needs is focused on a paradigm where developed countries or their agencies make technologies available to less developed countries in the Global South.[50] For this reason, it is commonly understood that this might be achieved either through trade, by means of the provision of finance through foreign direct investment, or *via* licensing arrangements that permit the affordable use of protected technologies.[58]

A still-relevant definition of this complex process might be found in a Special Report of the Intergovernmental Panel on Climate Change (IPCC):[15] *'[Technology transfer means] a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, NGOs and research/education institutions. It comprises the process of learning to understand, utilize, and replicate the technology, including the capacity to choose it, adapt it to local conditions, and integrate it with in-country technologies.*'[59] Thus, making equipment (which for instance might be used in the generation of renewable energy) available, is only one aspect of what has become known as technology transfer. This process certainly encompasses the provision of hardware but also involves knowledge and capacity to use said equipment, and to align its use with local needs and existing knowledge.[60] It also encompasses the process of transfer *via* collaboration or working in partnership.[61]

While this broad conceptualization is reflected in the international agreements, the processes of practice often do not give effect to this.[46] The importance of a full actualization of this approach, by exploring how deeper collaboration and understanding of actual needs can support a more constructive approach to technology transfer is emphasized by relying on the insights from the human right to science and fair and equitable benefit-sharing literature, also can inform these collaborative approaches and support a more nuanced and effective conception of technology transfer.

The Human Right to Science and Technology Transfer: A Matter of Benefit-Sharing?

While in the international climate change regime (as in other international environmental treaties), technology transfer is framed as a matter of inter-state cooperation (which obscures the question of private sector-held technologies), in international human rights law technology transfer is seen from the perspective of individuals and groups within a State that are negatively affected by the lack or limited inter-state cooperation to mitigate climate change. Recent efforts to conceptually clarify the human right to science have specifically pointed to inter-state technology transfer obligations under the international climate change regime,[56] arguably expressing a discontent about the current level of cooperation and hinting that non-compliance with international environmental provisions on technology transfer is a matter also of international human rights law.[62]

The 'Right to Science' is recognised in the Universal Declaration on Human Rights,[63] the Covenant on Economic, Social and Cultural Rights,[64] and in several regional human rights treaties.[65] The right to science is therefore part of the international obligations of those parties to the UNFCCC and the Paris Agreement that are also party to these human rights instruments.In addition, the eleventh preambular Paragraph of the Paris Agreement requires that parties' climate change responses should

be consistent with human rights obligations.[66] For these states, it is one of the human rights that they should respect, protect and consider, whenever they take action to address climate change, in order to protect the rights of everyone affected by climate change, but also to promote policy coherence, legitimacy and sustainable outcomes.[67] The inclusion of the right in these instruments, however, necessitates its progressive realisation by states, within the constraints of their resources and means.[68] The scope and content of the right, and precisely what progressive realisation in fact entails, remain underdeveloped.It should be noted however, that a broad understanding of 'scientific benefits' incorporates a variety of methodological and knowledge forms.[67] International processes currently underway to seek to clarify the scope and content of this human right can thus provide meaningful insights into climate change technology transfer.

The former UN Special Rapporteur in the field of cultural rights Shaheed distilled the human right to science into four elements: the right to share the benefits arising from scientific advances by everyone without discrimination; the opportunity for all to contribute to scientific research; the obligation to protect all persons against negative consequences of scientific research or its applications on their food, health, security and environment; and the obligation to ensure that priorities for scientific research focus on key issues for the most vulnerable.[69] She emphasized that developed countries carry an "*implied obligation…to comply with their international legal obligations through provisions of direct aid, as well as development of international collaborative models of research and development for the benefit of developing countries and their populations*."[70] She also emphasized the need for: "*developing countries [to prioritise] the development, import and dissemination of simple and inexpensive technologies that can improve the life of marginalized populations rather than innovations that disproportionately favour educated and economically affluent individuals and regions*. "This is a priority issue in the context of climate technologies, for instance, regarding access to low carbon energy technologies.Pointing specifically to technology transfer obligations under the international climate change regime as benefit-sharing.[71] Rapporteur Shaheed argued that the 'modalities and role' of benefit-sharing *vis-à-vis* technology transfer needed further definition.[71]

As Morgera asserts, a mutually supportive interpretation of the right to science in the context of climate change technology innovation and transfer, would need to incorporate "all four dimensions of the right to science into a concerted and dialogic process for identifying the technology to be transferred, transfer modalities and beneficiaries."[72] This could then aim to critically assess how to prevent dependency on external, ready-made solutions that may not fit particular circumstances, or may allow for the exertion of undue influence by donor countries.[73] This fully reflects the need to ensure that adopted technology suits the needs of local users.

Benefit-sharing is thus seen as a dimension of the right to science, but it has predominantly mostly studied as a tool for equity in international biodiversity law with regard to bioprospecting (research and innovation based on genetic resources), and to a lesser extent to the use of natural resources (such as, mining, forest management, and the use of marine resources).[73] Recent literature trying to distil a concept of benefit-sharing that cuts across different areas of international law has suggested that benefit-sharing implies:

…the concerted and dialogic process aimed at building partnerships in identifying and allocating economic, socio-cultural and environmental benefits among state and non-state actors, with an emphasis on the vulnerable. Even in the context of bilateral exchanges, fair and equitable benefit sharing encompasses multiple streams of benefits of a local and global relevance, as it aims to benefit a wider group than those actively or directly engaged in bioprospecting, natural resource management, environmental protection, or use of knowledge where a heightened and cosmopolitan form of cooperation is sought.[73]

Thus, as opposed to a passive role in benefitting from technology transfer, benefit-sharing rather conveys the idea of agency of "recipients" in the identification of the technologies to be transferred and their benefits, of the sharing modalities and of the beneficiaries through a concerted and dialogic process aimed at building a fair and equitable partnership among different actors characterized by different levels of power and possibly different worldviews on what technology is and what its benefits are.[73]

The reference to "fair and equitable" must be seen as supplementary to these complex and contextual conceptions of sharing benefits. Some scholars conceptualise this as a participatory process that

requires full informed engagement of both parties, while acknowledging that substantive participation may not be achieved in practice.[73] In most instances, what this entails, and therefore implicitly what conceptions of fairness, equity and justice might underlie the parties' dealings, is generally left to subsequent negotiations. In essence, however, the inclusion of these requirements based in equity and fairness can be understood as signalling the necessity to protect the rights and interests of all participants, with particular attention to more vulnerable ones. The choice of phrasing reflects the need for inclusion of both procedural and substantive dimensions of justice in a relationship regulated by international law that is characterised by power imbalances.[74]

In other contexts – for instance biodiversity law,[75] or law of energy and natural resource extraction[75] - it is clear that the concept of 'benefits' encompasses monetary and non-monetary benefits, and that the determination of a 'benefit' should reflect the values and priorities of those participating.[76] This surely must mean, that these should be needed and usable by the recipient parties.The ongoing relationships required for a substantial benefit-sharing approach may also challenge any unidirectional understanding of 'transfer'.[73] For instance, in this context, a narrow conception of benefit may exclude indirect or non-monetary benefits, particularly if formal approaches to benefit-sharing devalue non-monetary benefits,[77] or take account of benefits that seemed to lie beyond the scope and purpose of a project.[78] Finally, it should be noted that the other dimensions of the right to science are also relevant for present purposes. They emphasize States' obligations to critically assess whether technology transfer leads to non-discriminatory results, prioritizes the needs of the vulnerable, and factors in the need to protect against negative consequences arising from the transferred technology.

Applying the Right to Science and Benefit-sharing to Climate-related Technology Transfer

Viewing the climate change response through the theoretical and normative concept of benefit-sharing as a dimension of the human right to science, can yield interesting insights into the potential issues underlying climate change responses. Climate change yields somewhat different issues when it comes to benefit-sharing; for instance, benefit-sharing situations tend to arise predominantly in relation to responses to climate change.[79] For instance, there is an extensive literature concerning benefit-sharing in relation to REDD+,[80] and some multilateral funds that provide climate finance now make express provision for benefit-sharing in respect of funded projects.[81] Also of significance in the climate technologies context,[82] is a growing awareness of the potential of community benefit-sharing as a tool for equity and participation in relation to renewable energy projects, in particular wind farms.[83] This is not the place for a comprehensive elaboration of the scope and content of the right to science, although such work is ongoing and may be found elsewhere.[84] The focus is on two core themes of technology innovation and transfer of climate change mitigation technologies: specifically approaches that prioritise need, and collaboration, or co-operative approaches to technological development. The themes are reflected not only in the climate regime, but also in the activity occurring beyond it.

Need-based Approaches

The significance of 'needs'-based approaches informs some conceptions of benefit-sharing.[85] For instance, benefit-sharing in agricultural contexts reflect a particular recognition of the fundamental need for food security.[86] Similarly, the Convention on Biological Diversity includes, amongst others, a recognition of the importance of biodiversity conservation as meeting the fundamental needs of humankind.[87] More broadly, the right to science has been interpreted to include the necessity to recognise and prioritise the needs of the vulnerable, particularly with regard to priority needs, such as, health and food security.[88] The assessment and identification of technology needs is significant in terms of making effective transfer and deployment. There are two core issues. The first is a more general or abstract appreciation of the concept of need in the context of the climate change regime. The second relates the articulation of specific needs and why this is relevant and important in this context.

There are, of course, well worn arguments about equitable and appropriate burden-sharing in relation to climate change, and its relationship to sustainable development and energy access.[89] The recent rejuvenation of the climate regime has adjusted the technology requirements of many member states because of the inclusion of the concept of an NDC in the Paris Agreement.As a consequence, all states must now include mitigation measures as part of their climate action. This need is emphasised by the new obligations on developing countries to take positive

actions, including mitigation actions, in relation to climate change.[90] It is well known that many countries in the global South require technological and capacity support to achieve their climate mitigation aspirations; it is also clear that the ad hoc, primarily project-based frameworks for technological transfer has resulted in transfers that favour transitional economies and disfavour least developed nations.[91] The ad hoc or project-based transfers that characterised the previous phase of the regime cannot deliver necessary technologies at the scale that is now required; in many cases, it is questionable whether member states would be capable of meeting their projected reductions without significant technological (and financial) support.[92] Any international mechanisms for technology transfer should recognise that the global sharing of technologies must recognise the needs of the most vulnerable, ensuring access and fair distribution of technologies. Without due regard to needs and a rights-based focus, there is a danger that projects or processes that seek to ensure equitable distribution of technologies, prioritise other issues (for example financial viability or efficiency) over recipient needs and rights to access technologies.[92] As Plomer notes,[94] conceptions of 'access' must include developments in relation to capacity, which reflects the arguments made by scholars in the technology transfer literature, referenced above.

But there are other, more specific, arguments that might be made concerning need and the transfer of technologies. A need-based approach would take the specifics of a situation into account, focusing on the context in which technology was provided, and how needs for hardware, but also the development of local capacities and adequate and reliable financing for both, would be made available.[95] Focusing on need both allows and requires a proper analysis of what is genuinely needed before technological advances are made available. This demands a proper focus on the availability of useful technology in a specific context, but also presents challenges in terms of how recipient states might analyse their own needs in the context of limited knowledge or administrative capacity.[96] Within resource constraints, these processes are supported by the TNA process and accompanying technical support.

There are a number of ways in which benefit-sharing, as a dimension of the right to science, can deepen a substantively equitable understanding of need, and a needs assessment process under the climate regime. The recipient of technology must have a voice and be in a position to articulate its needs through shared knowledge of what is possible, as well as sufficient agency to be able to participate fully in the process;[97] the identification of needs and requirements can not be conducted in a scientific vacuum.[98] This can be fully actualised through the TNA process, where countries identify their own needs, with appropriate technical and scientific support and information.The focus on needs entails that recipients should define their own needs, values and priorities in order that their requirements – both for hardware, software and 'org-ware' – are properly formulated and articulated. Such an approach might support the notion of technology transfer as a 'benefit' – ensuring that transferred technologies are desired and required and useable by the recipients – rather than driven by market priorities or by 'dumping'.[99]

Cooperative Action

As explained above, both the climate regime and commentators have progressively identified the potential for collaborative approaches to respond to technology needs. Such possibilities are picked up in different formulations in the literature – and may occur as part of or independently of states and/or multilateral processes - however most authors conceive of a variety of relationships which might foster and encourage innovation between state parties, potentially with the involvement of private parties or non-state actors.[100] In the wake of Bali, de Coninck and others explored a range of contractual possibilities, or technology-oriented agreements.[101] These ranged from specific mandates for sharing technology or knowledge, technology transfer agreements (including by necessity financing provisions), to deep collaborative partnerships aimed at collective research and development.[28] Ockwell and others, in their analysis of collaborative potential, make less specific distinctions concerning the underlying contractual relationships, but begin the process of identifying how needs-based approaches could inform policy around sites of collaboration for technology research and development.[102] They identify both that collaborative approaches could go a long way towards meeting identified needs, if properly structured around those needs. There are clear and obvious reasons why need-based approaches are necessary and helpful in such contexts.Collaborative approaches can be better

designed to identify and respond to local needs,[57] but also ensures continued attention to local needs and vulnerabilities, which may otherwise be overridden given commercial realities and power imbalances within partnerships.[3] In addition, they motivate how collaborative approaches might simultaneously overcome several barriers to transfer – for instance, that the patterns of collaborative working might support the development of technical and organisational capacity that are needed properly to give effect to new innovation.[94] These are considerations that should be kept in mind by developed and developing countries alike, as they participate in technology-transfer endeavours under the international climate change regime.

Finally, it should be noted that the international climate regime has moved towards and embraced models of collaborative working towards technology innovation. Climate Innovation Centres (CICs) or Climate Relevant Innovation Builders (CRIBs) reflect conceptual possibilities for true collaboration in climate change research and development. These centres are established in developing countries on a trial basis and aim to foster innovation and the building of capacity in that context.[57] The concept of such centres challenges the 'unilateral' conceptions of transfer as a 'handing over' of equipment and hardware. These approaches rely on ongoing relationships between 'donor' and 'receiver' parties, ensuring that both maintain presence in the research and development of significant technologies. In addition, these partnership-based processes facilitate the development of much of the true operational capacity required by the 'receiver' state for the optimal local operation of the technologies in the relevant state. It should also be noted that, CRIBs accommodate south-south co-operation, which overcomes the unidirectional assumptions commonly associated with technology transfer.[16]

Viewed through a benefit-sharing lens, many of these functional models reflect great potential to foster long-term partnerships and foster knowledge exchange and dialogue between involved parties. This understanding is informed by a process-based conception of sharing, as a continuing dialogue, in which both parties have agency and act as partners in a process.[103] Informed by the right to science, these sharing approaches not only favour the sharing of benefits arising from scientific advances, but also provide an opportunity to realize other dimensions of the right to science, such as contributions to scientific research and the setting of scientific research priorities on key issues for the most vulnerable. Not least, long term iterative development of technology helps in the development of full awareness of local needs, and the risks and benefits of new technologies.[73] This goes beyond simply 'access' or permission to receive;[10] but can involve a proper partnership-building process developed over time.

How Much can be Achieved?

Of course, these approaches do stand to make some progress in terms of the development and deployment of climate technologies that I have discussed in this article.Co-operative approaches focused on need could contribute to the alleviation of some barriers to technology transfer, and sidestep some of the more pervasive and overarching problems that have slowed down the transfer of technology through the climate regime.

It should be clear, however, that these approaches are not an absolute panacea. There are suggestions that the collaborative approaches, applied in functioning centres, do not always reflect or apply the collaborative or productive approaches envisaged in the academic literature. For instance, de Coninck and Puig comment that existing CIC's do not substantially reflect Sagar's broad vision, focusing predominantly on 'services related to business acceleration, market development, access to finance and entrepreneurial incubation.'[104] These are doubtless necessary, but cannot replace the development of all aspects of a good transfer of technology. If not established in a robust way, it may be questionable whether established or future collaborations could address the scientific or technical capacity issues that represent a significant challenge for 'receiver' states, whether for cultural, regulatory or other reasons.[105] Developing economies also face challenges related to brain drain, market uncertainty and governance problems, which create ongoing challenges with capacity and investor confidence. Of course, the informed yet contextually sensitive approaches to the identification of 'needs' could overcome some, but not all, of these issues.

There is some resonance with empirical studies concerning the challenges of implementing benefit-sharing approaches in real-world contexts.It has been noted that, even with formal benefit-sharing arrangements in place, these structures often do not achieve their goals in practice, or do not result in net

gains for intended beneficiaries.[21] The potential for benefit-sharing approaches to be eroded by power imbalances or other challenges,[106] even when formal obligations exist, give some indication of the difficulties ahead. There are also specific challenges arising from the use of contracts for benefit-sharing purposes. At least, however, all these challenges and the efforts that have been put in place in international environmental law to overcome them may provide useful lessons learned for the ongoing discussions on climate mitigation-related technology under the climate regime. Interestingly, in other international processes related to technology transfer, a trend is emerging towards increased multilateral institutionalisation to benefit-sharing that can provide the infrastructure for integrated implementation of information-sharing, capacity-building and technology transfer obligations, while at the same time assessing progress and monitoring effectiveness of supported interventions, and brokering opportunities for collaboration.[107] For instance, under the International Treaty on Plant Genetic Resources for Food and Agriculture, a platform for the co-development and transfer of technologies has brought together a network of public and private institutions that collaborate in delivering a combination of information sharing, capacity building and technology co-development and transfer. The party-led initiative contributes to identifying real needs of targeted beneficiaries, assembling technology packets that could include training and other activities instrumental to fostering technology absorption capacity, as well as developing standardized conditions that can help with some of the challenges related to the use of contracts.[108] These developments could provide food for thought for the ongoing negotiations of the Technology Framework under the international climate change regime.

Conclusion

The paper sought to start a conversation concerning the potential of growing concepts in international environmental and human rights law, to illuminate and interrogate developments in climate change technology transfer. Specifically, it was argued that employing normative concepts based on the human right to science and fair and equitable benefit-sharing might support a deeper and more nuanced understanding of progress in technology transfer that fosters the agency of recipient states and pays systematic attention to the needs of vulnerable groups within that State. This argument stemmed from an appreciation that intellectual property rights were not the only or even predominant inhibitor of technological transfer, and that various factors had potential to support or undermine these processes. While not the focus of this article, it should be also noted that, where technology transfer is framed as a deep form of cooperation it could result in shared ownership of intellectual property, which is in effect as a form of benefit-sharing under international biodiversity law.[109]

The main conclusion drawn after thorough analysis is that the need-based and partnership-building approaches are two core elements reflected in both the international climate change regime, and of activity outside that regime. These elements can draw from the dimensions of the slowly developing human right to science, as well as incorporating conceptualizations and experiences related to benefit-sharing in international environmental law. A recurring theme in the analysis is the necessity for the recognition of the recepients' voice and meaningful agency, or the appreciation that active developing country involvement is crucial for fairness and equity in technology transfer through the interrelated and mutually interdependent need-based and partnership-building approaches. These priorities are reflected in the climate change regime; deepening these processes will support equity and fairness in all avenues of technology transfer.

As progress in relation to technology transfer under the international climate regime has been very slow, but progress towards implementation of the Paris Agreement continues. States involved in devising modalities, procedures and guidelines properly to operationalise the Technology Framework, and to implement the obligations contained in the Paris Agreement, could benefit from giving consideration to the conceptualisation of benefit-sharing under international biodiversity and human rights law, to the challenges in putting it into practice, and any practical approach developed to address such challenges. There is still potential to frame current climate negotiations in a normatively rich way that could bring about both equitable but also effective transfer of essential climate change technology in light of the human right to science, working around any barriers relating to IPRs.

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6 Chapman A, Towards an understanding of the right to enjoy the benefits of scientific progress and its applications, *Journal of Human Rights,* 8 (2009) 6, Interpreted broadly, 'science' in this context can include methods, knowledge acquired thereby and even the cultural practices underlying these processes.

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9 So for instance, key mitigation technologies might include renewable energies, efficiency technologies, active and public transportation, and passive building technologies, to name but a few.

10 Monterosa I, *Technology Mechanism After Marrakesh: Enhancing Climate Technology Development and Transfer to Developing Countries* (CUTS 2017) emphasises the need for and increasing relevance of such approaches.

11 [D]iscussion in Parks L &Morgera E, The need for an interdisciplinary approach to norm diffusion: The case of fair and equitable benefit-sharing, *Review of European, Comparative & International Environmental Law,* 24 (2015) 353.

12 Of course, challenges around technology transfer present themselves in loss and damage and adaptation challenges as well, as much as the climate change challenge and legal framework extends beyond mitigation.As I explain above, for simplicity I have chosen to limit my discussion to climate change mitigation technologies.I have not explored the applicability of much of the discussion to adaptation technology, although it is likely that many of the observations made here could be applied more generally.

13 We refer here to the mechanisms envisaged in Article 6 of the Paris Agreement (n 2).

14 Olbrisch S *et al.*, Estimates of Incremental Investment for, and Cost of, Mitigation Measures in Developing Countries, in Haites E (ed), *International Climate Finance* (Routledge 2013). Although technology transfer is not a function of the CDM *per se*, it has played a significant role.Murphy K *et al.*, Technology transfer in the CDM: An updated analysis, *Climate Policy,* 15 (1) (2015) 127.

15 Peterson S, Greenhouse gas mitigation in developing countries through technology transfer: A survey of empirical evidence, *Mitigation and Adaptation Strategies for Global Change,* 13 (2008) 283.

16 Ockwell D & Byrne R, Improving technology transfer through national systems of innovation: Climate Relevant Innovation-System Builders (CRIBs), *Climate Policy,*16 (7) (2016) 836.

17 There is, of course, no clear definition or category of 'developing countries'.Because of the abstract nature of many of the arguments made, it is not necessary to do so here.Of course, under the UNFCCC, the terms "Parties not included in Annex I" and "developing countries" were used interchangeably.These terms are not used in the Paris Agreement and it arguable whether the situation in1992 should continue to determine a party's membership to a specific category.

18 Similarly, the discussion centres predominantly on transfers of technology at state level; specific issues relating to local and regional access and distribution are beyond the scope of this paper.Having said this, I am aware that very real issues exist concerning intra-state distribution of and access to technology, to which a benefit-sharing lens could also be applied.

19 Clémençon R, The Bali road map, *The Journal of Environment & Development,* 17 (2008) 70, 82.

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21 Olawuyi D, From Technology Transfer to Technology Absorption Addressing Climate Technology Gaps in Africa, (Centre for International Governance Innovation 2017) 5.

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24 Glachant M &Dechezleprêtre A, What role for climate negotiations on technology transfer? *Climate Policy,* 26 (2016) 1.

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26 Dechezleprêtre A *et al.*, Symposium: Technology transfer and climate policy - invention and transfer of climate change-mitigation technologies: A global analysis, *Review of Environmental Economics and Policy,* 5(1) (2011) 112.

27 Protection of intellectual property does feature, although this is one of many factors.

28 de Coninck H *et al.*, International technology-oriented agreements to address climate change, *Energy Policy,* 36 (2008) 335.

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31 WMO/UNEP IPCC Climate Change: The IPCC Response Strategies (1990).

32 Latif A *et al.*, Overcoming the impasse on intellectual property and climate change at the UNFCCC: A way forward, *ICTSD Programme on Innovation, Technology and Intellectual Property,* Report 11, November 2011, 5.

33 de Coninck H &Sagar A, *Technology in the 2015 Paris Climate Agreement and Beyond*, (ICTSD 2015) 42,11.

34 de Coninck H and Sagar A, Technology Development and Transfer (Article 10) in Klein D *et al.* (eds), *The Paris Agreement on Climate Change: Analysis and Commentary* (Oxford University Press) 2017, 274 – 6.

35 Of course, this is not to dismiss the very valuable contribution made by private sector organisations in this context; however, it should be recognised that private entities will have financial or market-driven priorities that may take precedence over emissions reductions and meeting parties' needs for technologies: Chapman A, Towards an understanding of the right to enjoy the benefits of scientific progress and its applications, *Journal of Human Rights,* 8 (2009) 9.

36 These are the contributions by which parties to the Paris Agreement are to communicate their intended contribution under Article 3 Paris Agreement(FCCC/CP/2015/L9/Rev1).

37 Corvaglia M A, South - South Technology Transfer Addressing Climate Change and Its (Missing) International Regulatory Framework *CCLR*[2014] 125.

38 Article 4.5 of the Convention requires developed countries to "take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to environmentally sound technologies and know-how to other Parties, particularly developing country parties to enable them to implement the provisions of the Convention". Article 12(3) (Communication of Information Related to Implementation) requires that 'details of measures' taken in accordance with, *inter alia*, Article 4.5, should be included in communications.It can and has been noted that the commitments under Framework Convention are very qualified, requiring that transferred technology be simply 'environmentally sound' rather than innovative or 'best available' – Singh Ghaleigh N, Barriers to Climate Technology Transfer – The Chimera of Intellectual Property Rights, *CCLR,* 2 (2011) 220, 223. He suggests that stronger obligations were left out because developing countries would have to 'create a climate' for IPR protection.

39 Article 10.5 and 10.6 of the Paris Agreement

40 Article 11 of the Paris Agreement.

41 Article 10.5 - Article 10 of the Paris Agreement sets out the shared vision for the development and transfer of technology. The lengthy article also reflects the need for increased co-operative action on technology development (Article 10.2).

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43 Article 10.3 of the Paris Agreement.

44 Article 10.4 of the Paris Agreement. The establishment of the Technology Framework was seen as instrumental towards establishing clear linkages between technology and finance under the Agreement – de Coninck H and Sagar A, Technology Development and Transfer (Article 10) in Klein D *et al.* (eds), *The Paris Agreement on Climate Change: Analysis and Commentary* (Oxford University Press) 2017, 264 – 266.

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52 Hansen U E *et al.*, R&D Offshoring in Climate Technologies to Emerging Economies: Opportunities and Challenges for Europe, *CARISMA Working Document Series No.* 6 (2017).

53 Lindner S *et al.*, International R&I Collaboration on Mitigation: Examples of International Climate Change Mitigation Research and Innovation Collaboration between the European Union and Developing Countries, *CARISMA: Innovation for Climate Change Mitigation* (2017).

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