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The Potential of Follow-On Innovation Financing Instruments to Support a Sustainable Transition

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I. Introduction

The transition to sustainability relies on innovation, which may have complex diffusion routes and processes. Along those routes and during those processes, intellectual property rights can hold back the transition to sustainability by blocking innovative technologies – or making it hard to access them. However, if used effectively, the same set of rights can foster private investment, knowledge exchange and shared learning. When it comes to follow-on innovation and financing, there is a need to uncover how and under which conditions intellectual property, follow-on innovation and financing models can work together towards a more sustainable world.[1]

Challenges jeopardising today's sustainable development come from all directions, where the most recent, extensive, and persistent is the COVID19 pandemic. The production and dissemination of knowledge are crucial to dealing with problems like that, where all the three dimensions of sustainability are at stake: the social, the economic and the environmental. As for the *social* layer of sustainability, it implies access to universal human rights and satisfaction of basic needs. It also includes access to resources to maintain individuals and their families and to maintain the health and security of communities, including protection from discrimination. The *economic* dimension of sustainability presupposes the resources' availability for individuals and communities to maintain their independence and have access to the resources they need, financial and otherwise, to satisfy their needs. *Environmental* sustainability is linked to maintaining the ecological integrity and balance of environmental systems at the same time as the natural resources of these systems are consumed on a daily basis. In this context, there has to be a balance between the rate of consumption and the natural capacity for self-replenishment.

The idea surrounding sustainable development prompts a re-assessment of the innovation processes and the technological changes. That gives room to a sustainability transition, i.e., a "radical transformation towards a sustainable society, as a response to a number

[1] Please note that in this chapter we will not be discussing experimentation with decentralized management of energy resources. For such initiatives in particular see Yeung, Karen, 'Regulation by blockchain: the emerging battle for supremacy between the code of law and code as law' (2019) 82.2 The Modern Law Review.

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of persistent problems confronting contemporary modern societies".[2] The transition to sustainability requires an understanding of society's risks and the development of pathways that will enable the shift towards sustainability. Such risks include resources, global warming, set up economic models and social ethics and values.[3] Sustainability transformation requires a deep understanding of emerging technologies, strong engagement with stakeholders, and a series of investments tailored to each unique organisation. Therefore, leading organisations need to think holistically and strive for speed and scale.[4]

Although country-limited, intellectual property rules, especially the patent systems, are also increasingly global. In that sense, they can further or hinder the production and dissemination of knowledge, i.e., impede both innovation and dissemination. Reforms on intellectual property regulations are ongoing in various parts of the world. They deal with innovation and the way it is incentivised, financed, organised, and disseminated. On the one hand, those reforms can lead to a scenario where the pace of innovation and its utilisation can increase. On the other hand, they can fail and favour the spread of dysfunctional systems.[5]

In this chapter, we argue that in the unpredictable and crisis-laden post-pandemic world, there is an urgent need for innovation to pursue the normative goal of sustainability. Sustainability represents a wicked problem the solution to which requires innovation inputs from numerous actors. This underscores the importance of supporting follow-on innovation by enabling open licensing of IP. Presuming scarcity, unpredictability and unevenness in the R&D funding in the post-pandemic world, we review how alternative means of funding innovation – monetization of IP assets as well as the emerging blockchain-based solutions – succeed at supporting follow-on innovation or the greater goal of sustainability.

[2] Smith A, Voß JP and Grin J, "Innovation Studies and Sustainability Transitions: The Allure of the Multi-Level Perspective and Its Challenges" (2010) 39 Research Policy 435.
[3] Carol Boyle and others, "Transitioning to Sustainability: Pathways, Directions and Opportunities" (2013) 16 International Journal of Sustainable Development 166.
[4] "Sustainability Transformation: ENGIE Impact" <https://www.engieimpact.com/sustainability-transformation> accessed 4 October 2021.
[5] See Claude Henry and Joseph E Stiglitz, "Intellectual Property, Dissemination of Innovation and Sustainable Development" (2010) 1 Global Policy 237 <https://onlinelibrary.wiley.com/doi/full/10.1111/j.1758-5899.2010.00048.x> accessed 13 December 2021.

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II. Open innovation to foster sustainability

A. Long-term accessibility

Sustainability stands for a wicked problem,[6] as does the Covid-19 pandemic.[7] First theorised by Rittel &Webber,[8] wicked problems are characterised by inherent difficulties of problem formulation as they often encompass multiple conflicting elements, therefore defying computable, optimised solutions.[9] Due to their complexity, wicked problems are thought to have "open-ended, intertemporal effects".[10] Solutions to such problems cannot be easily generalised and replicated but represent temporary equilibria of competing goals.[11]

Solutions to wicked problems will not originate from one entity but presuppose multidisciplinary, multi-stakeholder collaboration. Orchestrating such a collaborative effort requires governments to take a more active role in funding and governing mission-driven, far-sighted innovation policies that feature funding instruments fitting to mobilise a wide range of actors across sectors and disciplines.[12] Solving wicked problems requires inclusivity concerning sources of innovation. Engagement in open innovation practices that allow the recombination of innovation from various origins is necessary.[13]

Concerning intellectual property, open innovation encompasses common licensing practices ranging from bilateral technology transfer to multilateral cross-licensing agreements and patent pools, as well as unilateral decisions to provide access, for example, via pledges to open licensing of technology and licences of right.[14] A sale of IP to a company that aims to develop the technology further can also be deemed as open innovation practice.[15] IP-based open innovation

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[6] Jonathan Pryshlakivsky and Cory Searcy, 'Sustainable Development as a Wicked Problem' in Samuel Kovacic and Andres Sousa-Poza (eds) *Managing and Engineering in Complex Situations* (Springer 2013).
[7] Schiefloe, Per Morten, 'The Corona crisis: a wicked problem'(2021) 49 *Scan J of Public Health* 5.
[8] Rittel, Horst WJ and Melvin M Webber, 'Dilemmas in a general theory of planning' (1973) 4 *Pol Sci* 155.
[9] Bryan G Norton, *Sustainability: a Philosophy of Adaptive Ecosystem Management* (University of Chicago Press, 2005), 132-134, elaborating on Rittel and Webber's (n X) definition of a wicked problem.
[10] Ibid, 135.
[11] Ibid, 134-137, elaborating on Rittel and Webber's (n X).
[12] Mariana Mazzucato, 'Mission-oriented innovation policies: challenges and opportunities', (2018) 27 Industrial and Corporate Change 803, 805, 807, 811.
[13] Antti Hautamäki and Kaisa Oksanen, 'Sustainable innovation: Solving wicked problems through innovation' in Anne-Laure Mention and Marko Torkkeli (eds), *Open Innovation: A Multifaceted Perspective: Part I* (2016), 89, 91, 102-104.
[14] See Natacha Estèves, 'Open models for patents: Giving patents a new lease on life?' (2018) 21 *JWIP* 2, 3-7, Alina Wernick, *Mechanisms fo Enable Follow-On Innovation: Liability Rules vs. Open Innovation Models* (Springer 2021), 120-134.
[15] Linus Dahlander and David M. Gann, 'How open is innovation?' (2010) 39 Res pol 699, 704.

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practices are, at the core, based on the existence of an exclusive right, which is deliberately exercised openly[16] through the flexibility provided by private ordering.[17] This flexibility is also central to a collaborative effort to combat wicked problems and reach sustainability norms.

The quest to reach sustainability goals is long-term and ongoing. Hence, the technological solutions to reach these goals must be developed over a longer period. Innovation processes have an intergenerational, dynamic dimension, as novel innovations build on past knowledge. Access to earlier-developed technology is crucial for enabling follow-on innovation and, ultimately, solving the wicked problems of sustainability. Besides sustainability in the meaning developed above, the term is used to qualify an access regime to IP, which according to Van Overwalle refers to a constellation where knowledge resources are not only openly accessible to follow-on innovators but also where the improvements to that technology remain openly accessible on the same conditions.[18] To avoid terminological confusion, in this presentation, we will refer to the first-generational access of a patentable invention as "follow-on innovation" and multi-generational accessibility qualified by Van Overwalle as "long term accessibility". However, in this presentation we focus on the freedom to take part in open innovation and therefore express no preference for the open licensing model behind long term accessibility.

B. Bottlenecks in post-pandemic financing of innovation

Mission-oriented public innovation policy,[19] including R&D funding, is coined key in finding solutions to wicked problems, and it is already applied in the European Commission's Horizon 2020 programme, and it is also central to the European New Green Deal.[20] Governments have been observed to act fast in resource allocation for the pandemic-related R&D, but the long-term provision and focus of the funding remain

[16] Hilty, Reto, 'Individual, Multiple and Collective Ownership: What Impact on Competition?' In Jan Rosén (ed) *Individualism and Collectiveness in Intellectual Property Law* (Edward Elgar Publishing 2021), 42.
[17] Lee, Nari, Nystén-Haarala, Soili and Huhtilainen, Laura, 'Interfacing Intellectual Property Rights and Open Innovation' (Lappeenranta University of Technology, Department of Industrial Management Research Report No. 225, 2010) <https://ssrn.com/abstract=1674365> accessed 15 December 2021, 9.
[18] Geertrui Van Overwalle, 'Inventing Inclusive Patents' in P. Drahos, G. Ghidini & H. Ullrich (eds) *Kritika: Essays on Intellectual Property, vol. 1* (Edward Elgar 2015) 229.
[19] Mazzucato (n x, the paper), [803].
[20] Mariana Mazzucato (n x, the book) [111-113, 124, 140-142].

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unpredictable.[21] Furthermore, following the pandemic, states may lack financial resources for long-term support for R&D.[22]

On a positive note, although expected to suffer from the COVID pandemic, venture capital did remain strong.[23] However, if late-stage investments weathered the pandemic and "mega deals" (deals surpassing $100 million) were observed, early-stage innovation will likely suffer from the recession following the pandemic.[24] The pandemic is certainly an exceptional event, however given the future challenges humanity will have to face in the coming decades, economic downturns might become, unfortunately, more common. Hence, companies might, in the future, need to tap into new and every available financing instrument to keep liquidity as well as capacity to invest in R&D.

Here, private financing instruments, which are based on the monetisation of IP, such as IP-backed securitisation and lending may complement the public R&D funding as well as venture capital in financing R&D by SMEs. Yet, the implications such instruments have on long-term accessibility of innovation and ultimately solving wicked problems related to sustainability is unclear. For this reason, we will evaluate the funding instruments' impact on the innovators' freedom to undertake open innovation practices that enable follow-on on innovation.

[21] OECD, 'Mobilising public research funding and infrastructures in times of crisis' in *OECD Science, Technology and Innovation outlook 2021: Times of Crisis and Opportunity* (OECD Publishing 2021) 58 <https://www.oecd-ilibrary.org/sites/e96ef24b-en/index.html?itemId=/content/component/e96ef24b-en> accessed 15 December 2021.

[22] OECD, 'How will COVID-19 reshape science, technology and innovation?' (23 June 2021) <https://www.oecd.org/coronavirus/policy-responses/how-will-covid-19-reshape-science-technology-and-innovation-2332334d/> accessed 15 December 2021.

[23] See Jeffrey Grabow, 'Venture capital continues to exhibit immunity to the COVID-19 pandemic'(*EY*, 9 February 2022 <https://www.ey.com/en_us/growth/venture-capital-continues-to-exhibit-immunity-to-the-covid-19-pandemic> accessed 7 March 2022.

[24] Ramana Nanda, 'Why early-stage innovation will be a victim of the coronavirus recession' (*Imperial College Business School*, 21 September 2022) <https://www.imperial.ac.uk/business-school/ib-knowledge/entrepreneurship-innovation/why-early-stage-innovation-will-be-victim-the-coronavirus> accessed 7 March 2022. See also Sabrina T. Howell and others, 'How Resilient is Venture-Backed Innovation? Evidence from Four Decades of U.S. Patenting', NBER Working Paper, June 2021 <https://www.nber.org/papers/w27150> accessed 7 March 2022.

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III. Monetising patents to fund innovation and follow-on: classical instruments

A. Venture capital

Aside from the usual way to monetise one's patent through licensing, another common approach to raising funds is to rely on venture capital, particularly in the case of start-ups. Patents are vital in attracting venture capital as they signal innovative capacity.[25] In such a scenario, well-off investors will invest in start-ups and small companies perceived to have growth potential. The funds will help start-ups develop and commercialise their innovations. In exchange, the investors get equity in the company. Venture capital enhances the firm's financial standing without putting it into debt. Besides providing monetary support to innovative start-ups, venture capitalists also provide expertise and networks.

Additionally, venture capital acts as a positive signal not only for future investors indicating the potential growth of the start-up but also for creditors by offering a guarantee of security. For instance, banks might be less reluctant to support the firm through loans financially.[26] Venture capital is generally considered to have a positive impact on innovation.[27]

B. IP-backed finance

1. IP-backed securitisation

Securitisation turns future cash flows into tradable securities (financial contracts such as bonds or shares).[28] Securitisation enables a firm to raise financing via assets producing an anticipated cash flow such as royalty payments in the case of IPRs.[29] The famous Bowie Bonds are a

[25] Bronwyn Hall, 'Is there a role for patents in the financing of new innovative firms?' [2019] 28 Industrial and Corporate Change 657.

[26] Jihye Jeong and others, 'The Role of Venture Capital Investment in Startups' Sustainable Growth and Performance: Focusing on Absorptive Capacity and Venture Capitalists' Reputation' [2020] 12 Sustainability <https://www.mdpi.com/2071-1050/12/8/3447> accessed 13 December 2021.

[27] See Nawab Khan and others, 'Does Venture Capital Investment Spur Innovation? A Cross-Countries Analysis' [2020] 11 Sage Open 1. <https://journals.sagepub.com/doi/10.1177/21582440211003087> accessed 15 December 2021.

[28] See James Chen, 'Securitization' (*Investopedia*, 2020) <https://www.investopedia.com/terms/s/securitization.asp> accessed 15 December 2021.

[29] For a thorough description of this mechanism see Dov Solomon, Solomon, Miriam Bitton, 'Intellectual Property Securitization' [2014] 33 Cardozo Arts & Entertainment Law Journal 125.

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good example of securitising royalty streams.[30] Securitisation requires using a special purpose vehicle (SPV) to whom the royalty income stream is assigned and who would then raise credit from investors by issuing bonds, for instance.[31] Instead of relying on a future royalty stream derived from its IPRs, the firm that initiates such a process obtains quick cash with a lump sum payment (without diluting equity), which could be used to fund further research.

In 2016, UCLA sold its royalty interest on three patents (life-saving prostate cancer drugs) for $1.14 billion to Royalty Pharma. The funds will finance further research and support undergraduate and graduate scholarships.[32] Royalty Pharma recently acquired the right to future royalties on Vertex Pharmaceuticals' cystic fibrosis treatments. The Cystic Fibrosis Foundation will use the funds to further research on cystic fibrosis.[33]

2. IP-backed lending

Patents can be used as collateral in a loan operation, much like tangible assets are. In case the borrower defaults on its loan payment, the lender can seize the collateral to sell it and cover its losses.[34] The borrower may pledge the rights to the IP itself or the licensing revenues derived from the IP.

Although patents are valuable assets, banks have traditionally been reluctant to accept them as collateral.[35] Not only are IPRs considered illiquid assets, but there is information asymmetry and risks attached to IPRs, such as potential litigation.[36] Despite the reluctance and the infrequency of such transactions, pledging patents as collateral has increased over the past decade and contributed to innovation

[30] The Bowie Bonds were backed by the anticipated royalties derived from a 25 albums catalogue composed of records royalty and publishing revenues. Bowie issued 10-year asset-backed bonds from which he raised $55 million. See Nicole Chu, 'Bowie Bonds: A Key to Unlocking, the Wealth of Intellectual Property' [1998] 21 Hastings Comm. & Ent. L.J. 469.

[31] For a description of the different actors see Dov Solomon, Miriam Bitton, 'Intellectual Property Securitization'.

[32] See Phil Hampton, 'UCLA sells royalty rights connected with cancer drug to Royalty Pharma' (*UCLA Newsroom*, 4 March 2016) <https://bit.ly/3Il2jbx > accessed 15 December 2021.

[33] See the Cystic Fibrosis Foundation, 'A message from our CEO'(Cystic Fibrosis Foundation, 2 November 2020 <https://www.cff.org/News/News-Archive/2020/A-Message-From-Our-CEO/> accessed 15 December 2021.

[34] Se Julia Kgan, 'Collateral' (Investopedia, 2020) <https://www.investopedia.com/terms/c/collateral.asp> accessed 15 December 2021.

[35] See Xuan-Thao Nguyen, Erik Hille, 'Patent Aversion: An Empirical Study of Patents Collateral in Bank Lending, 1980–2016' [2018] 9 U.C. Irvine L. Rev. 141.

[36] See Liina Tonisson, Raymond Millien, Lutz Maicher, 'Shortcomings on the Market for Intellectual Property' Working Paper 1/2016. Fraunhofer Center for International Management and Knowledge Economy (Leipzig, 2016).

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financing.[37] This trend is encouraged by IP lawyers and new firms offering valuation services.[38]

IP-Backed lending can accelerate investing in R&D. As it happens with securitisation, the firm can collect a lump sum instead of awaiting the royalties derived from the IP without diluting equity. Additionally, a secured loan tends to be cheaper than a non-secured loan (lower interest rate) and is easier to obtain.[39]

3. Sale & Leaseback

Another possibility to raise capital is a sale and leaseback agreement. The arrangement is structured in the following way: A firm (a lessee) sells an asset to a purchaser (a lessor, usually a specialised institution). The lessor leases back to the lessee the asset against payments.[40] At the end of the lease, the lessee may have an option to repurchase the asset. Along with tangible assets, patents can be the underlying asset. In such a case, the lessee sells the patent, and the latter retains the right to use the patents against the payment of fees to the lessor.[41] The advantage of such an arrangement is that the lessee can obtain liquidity by selling patents assets without losing the right to practise the patented invention.

C. Shortcomings of the classical instruments

Although these mechanisms can supply cash to innovators for further innovations, they present many limitations. Venture capital is limited in scope as it stimulates innovation in only specific sectors and may not

[37] See William Mann, 'Creditor rights and innovation: Evidence from patent collateral' [2017]. Available at SSRN: https://ssrn.com/abstract=2356015 Mann finds that the borrowed funds are used to finance R&D and used to produce more patents. 38% of US firms have pledges their patents at some point and perform 20% R&D and patenting. See also William Mann, Patent as Collateral (*Patently-O*, 1 June 2014) <https://patentlyo.com/patent/2014/06/patents-as-collateral.html>
accessed 15 December 2021. Mann indicates that that by 2012, 20% of patents held by US companies had been pledge at some point and notes that the filling of securities has exploded in recent years.
See also Miriam Rozen, 'Inventors learn to deploy their assets as collateral' (*Financial Times*, 18 June 2020) <https://www.ft.com/content/0b0e09b0-9362-11ea-899a-f62a20d54625> accessed 15 December 2021.

[38] These firms are not submitted to the same constrains as the traditional banks. See Maria Loumioti, 'The use of intangible assets as loan collateral' [2012] Available at SSRN: https://ssrn.com/abstract=1748675

[39] See Rebecca Lake, 'Secured loans' (*Investopedia*, 2021)
<https://www.investopedia.com/secured-loans-5076025> accessed 15 December 2021.

[40] See Carla Tardi, 'Leaseback' (*Investopedia*, 2020)
<https://www.investopedia.com/terms/l/leaseback.asp> accessed 15 December 2021.

[41] See Nicolas Binctin, *Stratégie d'entreprise et propriété intellectuelle* (LGDJ 2015) 278-280.

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necessarily target emerging firms whose innovations offer broad societal benefits[42]. Furthermore, as mentioned above, the COVID crisis will likely impact early-stage venture capital funding.[43] An important limitation is also the practicality of resorting to certain instruments. In the case of securitisation, setting up an SPV is costly and complex and, therefore, not necessarily suitable for SMEs.[44]

Although there have been some improvements and more specialised companies are working on IPRs valuation,[45] the main obstacle to IP-backed finance underlined in the literature and by practitioners is the valuation of IPRs.[46] There exist no clear or standard valuation method, and the secrecy of many transactions involving IPRs does not help.[47] Moreover, there is a lack of awareness about the value of IPRs.[48] Overall, these types of transactions remain custom-made and very exceptional.[49]

Besides valuation issues and the complexity of certain transactions, these financing mechanisms may adversely affect engagements in open innovation practices and impede access to earlier-developed technologies or deter patent holders from turning to these practices entirely.

In the case of sale and leaseback, the original patentee loses control over the IP once the IP has been sold and may only obtain a licence, exclusive or non-exclusive, depending on the lessor's will. Although the lessee might buy the IPRs back, this is not always the case. Unless the lessor is himself interested in open practices, losing control of the IPRs might prevent possible open licence practices or, more generally, classic licences that could allow for follow-on innovations as the patent

[42] Josh Lerner, Ramana Nanda, 'Venture Capital's Role in Financing Innovation: What We Know and How Much We Still Need to Learn' [2020] 34 Journal of Economic Perspectives 237.
[43] WIPO Global Innovation Index 2020. Who Will Finance Innovation, 13th Ed (2020) Soumitra Dutta, Bruno Lanvin, Sacha Wunsch-Vincent (eds) xix.
[44] See Federico Munari, Maria Cristina Odasso, Laura Toschi, 'Patent-backed finance' in Federico Munari, Raffaele Oriani (eds), *The Economic Valuation of Patents. Methods and Applications* (Edward Elgar 2011) 328.
The authors indicate that SMEs, as well as universities with consistent patent portfolios but having difficulties accessing capital markets could benefit from securitization. But the costs would be prohibitive.
[45] See for example Ocean Tomo <https://www.oceantomo.com/> accessed 15 December 2021. See also Brandstock <https://www.brandstock.com/> accessed 15 December 2021.
[46] Pippa Hall, 'Chapter 15: Intellectual Property as an Asset for Financing Innovation' in Global Innovation Index 2020, 187.
[47] Liina Tonisson, Raymond Millien, Lutz Maicher, 'Shortcomings on the Market for Intellectual Property' 19.
[48] Ibid 20.
[49] See Federico Munari, Maria Cristina Odasso, Laura Toschi, 'Patent-backed finance' 332.

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As to patents used as collaterals, in addition to the risk of default of the borrower (in which case the latter would lose the collateralised assets), the borrower may not dispose of its IPRs as he pleases. The lender will likely want a guarantee that the patents brought in as collateral will keep their value, much like tangible assets should keep theirs in such a transaction. Hence, some constraints on how the borrower may dispose of the assets are often included in the collateral agreement. The borrower will have to protect and defend the validity of the collateralised IPRs. The borrower will not be allowed to abandon its IPRs and might see some limitations on its licensing activities.[50] Therefore, once collateralised, though the borrower does not lose the property of the IPRs, his freedom of action can be considerably limited.

Lenders might be reluctant to grant a loan, in the first place, given that a patent encumbered by certain commitments might be difficult to redeploy. Indeed, in the case of pledges similar to Tesla's[51] or Google's,[52] under which a patent holder has committed not to sue potential pledge's beneficiaries for patent infringement, lenders might not see the value of a patent that is widely accessible to any interested parties without payment of royalties. Even if a pledged patent were collateralised, the lender might not ensure that the pledge goes with the patent once sold. The lenders have, in fact, not much incentive to keep the pledge running. Since it will lose control of the patent, the initial patent owner will unlikely be able to ensure the continuity of the pledge even when the pledge requires subsequent patent owners to pass on the pledge obligations to future owners. Another issue could be the nature of those who acquire the repossessed patents. It might indeed be easier for a lender, such as a bank who has no interest in practising the patent and might not know the technology well enough to find a suitable buyer, to sell the patents to NPE specialised in buying patents. Once acquired by an NPE, it is unlikely that the commitment to widely share the patents will stand, as the NPE's purpose is to assert these patents. Hence, regarding long term accessibility, such a scheme might not be suitable.

Moreover, securitising patents might limit the possibility of the patent holder entering into cross-licence agreements. Indeed, in such a case, royalties might be reduced or non-existent depending on the

[50] For examples of the constraints imposed on the borrower see the following security agreements: Intellectual property security agreement (SEC – Infinera Corporation & Silicon Valley Bank)
<https://www.sec.gov/Archives/edgar/data/1138639/000119312507049854/dex1018.htm> accessed 15 December 2021.
and GTC BIOTHERAPEUTICS, INC. and LFB BIOTECHNOLOGIES S.A.S.U. <https://www.sec.gov/Archives/edgar/data/904973/000119312508260052/dex102.htm> accessed 15 December 2021.

[51] See the Tesla Blog <https://www.tesla.com/blog/all-our-patent-are-belong-you> accessed 15 December 2021.

[52] See the Google Patent Pledge
<https://www.google.com/patents/opnpledge/pledge/> accessed 15 December 2021.

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conditions of the agreement. For instance, the patent holder may be limited when wishing to participate in a pool. Granting a royalty-free licence (whether in a cross-licensing agreement or not) would unlikely be compatible with securitisation since a royalty stream is at the heart of such transactions. Patent holders may be encouraged to keep the royalties high to attract investors into a security agreement. There might likely be fewer incentives to untangle patent thickets or cross-license technologies as foreground knowledge for collaborative R&D projects.

Besides hindering follow-on innovation, classical financial instruments might have adverse effects on fulfilling other sustainable development goals such as access to medicine[53] and transfer of technology to developing countries.[54] For instance, on access to medications, many critics were raised in connection with the agreement made between UCLA and Royalty Pharma. The development of Xtandi was supported by public funding.[55] Yet, the price remained very high, making it impossible to access in low-income countries. Moreover, UCLA filed a patent claim in India, impeding the development of a generic drug.[56] UCLA justified its intervention in Indian court by a contractual obligation under the agreement UCLA entered into with Medivation, its exclusive licensee.[57] According to critics, the strategy used by UCLA offers no guarantee to ensure the drug is available at affordable prices, although UCLA had signed a declaration on ethical licensing practices.[58]

Consequently, these instruments, although able to provide funding for innovators to pursue further innovation, impose many constraints on patent holders and might prevent the development of follow-on innovations through more open practices such as defensive patent pools, pledging not to enforce one's patent, royalty-free licensing, FRAND licences or taking part in coupled open innovation that requires cross-licensing. These open practices enable the sharing of patents and promote the freedom to operate for innovators, which can fuel follow-on innovations. However, because they require the patent

[53] See Sustainable Development Goal 3 <https://www.un.org/sustainabledevelopment/health/> accessed 15 December 2021.
[54] See article 7 TRIPS Agreement.
[55] See Anoo Bhuyan, 'US Students Urge UCLA to Drop Proxy Patent Battle for Cancer Drug in India' (*The Wire*, 20 March 2018) < https://thewire.in/health/us-students-urge-ucla-to-drop-proxy-patent-battle-for-cancer-drug-in-india> accessed 15 December 2021.
[56] James Peltz, 'UCLA's effort to patent a costly prostate cancer drug in India hurts the poor, critics say' (*Los Angeles Times*, 22 October 2017) <https://www.latimes.com/business/la-fi-ucla-cancer-drug-20171022-story.html> accessed 15 December 2021.
[57] See the letter of John Mazziota, Vice Chancellor UCLA Health (2017) <https://www.cancerunion.org/wp-content/uploads/2017/09/ucla2uact-7Sep2017.pdf > accessed 15 December 2021.
[58] See the AUTM website <https://autm.net/about-tech-transfer/principles-and-guidelines/nine-points-to-consider-when-licensing-university> accessed 15 December 2021.

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holder to limit its exclusive rights, they might contradict the need to keep strong exclusivity to support IP-backed transactions.

Monetising patents through licensing and assignments might remain the easiest and most practical way to fund further innovations and allow for the development of follow-on. However, markets for patents have presented many weaknesses: lack of IP awareness, unused IP, various legal systems, valuation, illiquidity of IPRs, lack of transparency, to cite only a few.[59] These shortcomings make it difficult to trade intellectual property and therefore monetise it to get further funding. Consequently, new instruments have been put forward to facilitate IP transactions and, by extension, to fund subsequent innovations.

IV. Monetising patents to fund innovation and follow-on: new instruments

A. Emerging blockchain-based instruments to fund innovation

Blockchain represents a "decentralized, peer-validated crypto-ledger that provides a publicly visible, chronological and permanent record of all prior transactions."[60] Its applications can facilitate the financing of sustainable innovation in three different ways. First, due to its immutability and the decentralized nature blockchain may enhance the trustworthiness[61] of IP ownership and provenance records and, indirectly, facilitate their monetization. Firms and IP offices have started using blockchain-based technologies to manage and register IPRs. For instance, the EUIPO has recently launched a blockchain platform.[62] The WIPO also proposed a tokenisation tool to provide evidence of intellectual property assets (WIPO Proof).[63] Private firms such as IPwe have also embraced blockchain to facilitate IPRs

[59] See Liina Tonisson, Raymond Millien, Lutz Maicher, 'Shortcomings on the Market for Intellectual Property'. On the matter of transparency related to patent ownership see Arina Gorbatyuk, Adrián Kovács, 'Patent notice (failure) in the era of Patent Monetization' (2019) Available at SSRN: <https://ssrn.com/abstract=3404128> accessed 15 December 2021.

[60] Mik, Eliza, 'Smart contracts: terminology, technical limitations and real world complexity' (2017) 9.2 *Law, Innovation and Technology* 269, 275.

[61] See Yeung (at No X) 207.

[62] See European Union Intellectual Property Office, 'EUIPO connects to TMview and DesignView through blockchain'(*EUIPO*, 27 April 2021) <https://euipo.europa.eu/ohimportal/en/news/-/action/view/8662923> accessed 15 December 2021.

[63] See the WIPO Proof website <https://www.wipo.int/wipoproof/en/> accessed 15 December 2021. The service has been discontinued in January 2022. WIPO Proof tokens were tamper-proof evidences of the existence digital files (trade secrets, data set, research results, etc.).

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management, more specifically patents, creating a global patent registry.[64]

The second relevant blockchain application is the deployment of non-fungible tokens (NFTs) to enable trade of digital assets. NFTs are defined as "a unique digital identifier that cannot be copied, substituted, or subdivided, that is recorded in a blockchain, and that is used to certify authenticity and ownership (as of a specific digital asset and specific rights relating to it)".[65] The notorious example of the use of NFTs was the auction at Christie's of the American digital artist Beeple's digital collage *Everyday: The First 5000 days*.[66] The token to Beeple's work was sold for $69 million. The rights to the underlying work are not automatically assigned or transferred via NFTs, as they only represent an underlying asset.[67] While there is a disconnect between the sale of the NFTs and IP rights to the asset, the sale of the NFT can be complemented with an assignment or a license of IP. For example, Bored Ape, a collectable series, uses NFTs to grant a licence for personal and commercial uses.[68] Another example would be the US Patent 8650126 #1 auctioned on OpenSea, the largest NFT marketplace. The licence embedded in the NFT allows the NFT owner to practise the patent up to a net sale of $5 million.[69]

The emerging market for NFT may offer a new means to finance innovation and to manage intellectual property. In April 2021, IBM and IPwe have announced that they would represent patents with NFTs to "help position patents to be more easily sold, traded, commercialised or otherwise monetised and bring new liquidity to this asset class for

[64] See IPwe, 'The Platform for the world's patent ecosystem' <https://www.wipo.int/edocs/mdocs/classifications/en/wipo_ip_cws_bc_ge_19/wipo_ip_cws_bc_session_5_spangenberg.pdf> accessed 15 December 2021.
[65] See "Non-fungible tokens". Merriam-Webster <https://www.merriam-webster.com/dictionary/non-fungible%20token> accessed 15 December 2021.
[66] See the Christie's webpage for the sale <https://www.christies.com/features/Monumental-collage-by-Beeple-is-first-purely-digital-artwork-NFT-to-come-to-auction-11510-7.aspx> accessed 15 December 2021. See the token on OpenSea <https://opensea.io/assets/0x2a46f2ffd99e19a89476e2f62270e0a35bbf0756/40913> accessed 15 December 2021.
[67] For an introduction on NFTs and questions related to property of the underlying work see Andrés Guadamuz, 'The Treachery of Images: Non-fungible Tokens and Copyright' [2021] Available at SSRN: <https://ssrn.com/abstract=3905452> accessed 13 March 2022.
[68] Bored Ape offers a royalty free usage license see the offer on OpenSea <https://opensea.io/assets/0x495f947276749ce646f68ac8c248420045cb7b5e/11155800126939543113857259097540560713959066309373171296482634297950144457294 4> accessed 15 December 2021.
[69] See OpenSea Auction <https://opensea.io/assets/0x495f947276749ce646f68ac8c248420045cb7b5e/81112078633604935895253492134577171398407062524784427816156292990811972304897> accessed 15 December 2021.

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investors and innovators."[70] NFTs could also be used to support funding where the IP system could fail to secure it. Arguably, NFT's may function as a form of code-based de-facto, sui generis IP for resources unprotected by IP law.[71] One example would be the auction launched by UC Berkley in June 2021 for NFTs on patent disclosure documents related to two Nobel Prize-winning inventions to raise funds for further research.[72]

Through an NFT, a patent could be recorded on the blockchain, and the associated token could carry a self-executing contract or organising an assignment of the patent or licences. Using smart contracts to assign or license IPRs can help reduce costs, speed up transactions, and ease payment administration.[73] For example, the smart contract of the Foundation, an online NFT marketplace for digital creators, is designed to pay the artist a 10% royalty for all the subsequent sales of the NFT on the secondary market.[74]

The third means for blockchain applications to facilitate innovation funding is through decentralized autonomous organizations (DAOs). A DAO is defined as "a blockchain-based system that enables people to coordinate and govern themselves mediated by a set of self-executing rules deployed on a public blockchain, and whose governance is decentralised (i.e., independent from central control)." [75] DAOs allow the exchange of cryptocurrency or work or even intellectual property[76] to tokens that entitle to voting rights or ownership of DAO's assets.[77] With attractive causes, DAOs can collect considerable source of funding for their operations. For example, Spice

[70] See IBM Newsroom, 'IPwe and IBM Seek to Transform Corporate Patents With Next Generation NFTs Using IBM Blockchain' (*IBM Newsroom*, 20 April 2021) <https://newsroom.ibm.com/2021-04-20-IPwe-and-IBM-Seek-to-Transform-Corporate-Patents-With-Next-Generation-NFTs-Using-IBM-Blockchain> accessed 15 December 2021.

[71] Lee, Edward, 'NFTs as Decentralized Intellectual Property' (2022); Available at SSRN: <https://ssrn.com/abstract=4023736> accessed 13 March 2022.

[72] See Robert Sanders, 'UC Berkeley will auction NFTs of Nobel Prize-winning inventions to fund research' (*Berkley News*, 27 May 2021) <https://news.berkeley.edu/2021/05/27/uc-berkeley-will-auction-nfts-of-nobel-prize-winning-inventions-to-fund-research/> accessed 15 December 2021.

[73] Julia Hugendubel, 'Blockchain Technology and Intellectual Property – A Basic Introduction' [2021]. Available at SSRN: <https://ssrn.com/abstract=3917801> accessed 15 December 2021.

[74] See The Foundation <https://foundation.app/about> accessed 3 March 2022.

[75] Hassan, Samer, De Filippi Primavera (2021) 'Decentralized Autonomous Organization' (2021) 10 Internet Policy Review 1,2.

[76] El Faqir, Youssef, Javier Arroyo, and Samer Hassan (2020) 'An overview of decentralized autonomous organizations on the blockchain.' Proceedings of the 16th international symposium on open collaboration, 2-4; Golato, Tyler, Kohlhaas, Paul (2021) VitaDAO Whitepaper V1.0 <https://raw.githubusercontent.com/VitaDAO/whitepaper/master/VitaDAO_Whitepaper.pdf> accessed 3 March 2022.

[77] Jentzsch, Christoph, 'Decentralized autonomous organization to automate governance – White paper' (2016).

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DAO succeeded at collecting millions of funding for a production of a science fiction TV series inspired by *Dune*.[78]

DAOs could also be employed to mitigate market failures in R&D funding, particularly in the early-stage research. One interesting example could be the first "IP-NFTs" transfer realised by Molecule, a collaborative platform for biopharma[79] and VitaDAO.[80] Molecule proposes to connect researchers and potential investors (including patient communities who would benefit from certain drugs developments) by turning IPRs into liquid assets via NFTs. As for VitaDAO, the latter is focused on funding early-stage longevity research. In this context, Molecule created IP-NFTs (a legal contract and a smart contract cross referencing one another) to the benefit of the Scheibye-Knudsen Laboratory at the University of Copenhagen conducting research on longevity. VitaDAO acquired the NFTs after its members voted to purchase it.[81] Through this first IP-NFT transfer, $250,000 has been raised to fund preclinical studies on longevity therapeutics led by the Scheibye-Knudsen Lab. Molecule and VitaDAO complement each other as Molecule created the IP-NFT and VitaDAO acquired it to fund research. Both entities propose to address the so-called phenomenon of the "Valley of Death" by funding early-stage research. Molecule and VitaDAO are planning on realising similar transactions in the future. Following VitaDAO white paper,[82] VitaDAO will own the IPRs resulting from the research projects it will fund, and the members of the DAO (Vita token holders) will decide collectively how to manage these assets. VitaDAO plans to develop a portfolio of assets represented by IP-NFTS. Beside engaging in transaction involving such instruments, the DAO also plans to license or sale its IPRs to pharmaceutical companies or biotech companies through more classical licensing and even commercialise themselves the technologies

[78] Robertson, Adi, 'They Spent $3 Million on a Dune Script Bible – Now What?' (*The Verge*, 28 February 2022) <https://www.theverge.com/2022/2/28/22950868/spice-dao-crypto-jodorowsky-dune-bible-collective-writing-contest> accessed 3 March 2022. Due to faulty communications, the Spice DAO's actions, such purchase of Jadorowsky's script for Dune were initially viewed to represent a gross misjudgement on the scope of copyright protection. Ibid.

[79] See Molecule website <https://www.molecule.to/> accessed 7 March 2022.

[80] See VitaDAO website <https://www.vitadao.com/> accessed 7 March 2022.

[81] To become a member of VitaDAO one must acquire Vita tokens either through funds or by contribution work or IP to the DAO. See <https://www.vitadao.com/> accessed 7 March 2022.

[82] See VitaDAO White Paper.

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resulting from the funded research projects.[83] A second transfer of IP-NFT was realised in December 2021.[84]

DAOs may also be used to facilitate sustainable innovation in the absence of IP. For example, Colony is a platform for establishing DAOs where voting tokens are only granted in exchange of work contributions and where the DAOs can be sub-divided to facilitate modular work on a scale.[85] This suggests that blockchain could be employed for commons based-peer production of innovations similarly to free and open source software.[86] It is worth exploring whether DAOs could organize collaborative innovation efforts for sustainability goals and whether the design of the initiatives can foster sustainable innovation.

In theory, blockchain applications may also undertake the role of innovation prizes[87] that may incentivize mission-driven interdisciplinary innovation.[88] For example, Horesh has proposed that governments could issue tradable social policy bonds tied to specific social goals, such as environmental sustainability.[89] Relying on blockchain, the idea of social policy bonds could also be initiated and implemented in a decentralized manner. Tokenisation and tradability of a certain measurable environmental goal could foster innovation to reach and monetise it.[90] It should be investigated whether crowdfunding and reward system solutions based on blockchain to finance innovations

[83] It is important to note that this initiative is quite recent and still experimental according to its authors and many questions remain as underlined in the VitaDAO White paper. The success of such an initiative relies on a dynamic community that is still the making. To our knowledge, two IP-NTFs transfers were realized so far. As to the exact nature of the rights encompassed in the IP-NFTs it is not clear to us what they precisely are.

[84] See the video of the transfer: <https://www.youtube.com/watch?v=9nJZE0DYIqc> accessed on 7 March 2022.

[85] El Faqir, Youssef, Javier Arroyo, and Samer Hassan (2020) 'An overview of decentralized autonomous organizations on the blockchain.' Proceedings of the 16th international symposium on open collaboration, 2-4.

[86] Rozas, David and others 'When Ostrom Meets Blockchain: Exploring the Potentials of Blockchain for Commons Governance' (2021) SAGE Open, 11(1), 2.

[87] See Steven Shavell and Tanguy Van Ypersele, 'Rewards versus intellectual property rights' (2001) 44 JLE 525-547.

[88] Mariana Mazzucato (n X) [125]

[89] Ronnie Horesh, 'Make Social Impact Bonds Tradeable' (13 June 2018) Alliance Magazine for Philantropy and Social Investment Worldwide (AMPSIW); Ronnie Horesh, 'Injecting incentives into the solution of social problems: Social Policy Bonds' (September 2000) 20 EA 39.

[90] See Olli Tiainen, 'DIOs – Decentralized Impact Organizations for the Climate' (2021) <https://mirror.xyz/olli.eth/149Q5LjUJzioXp-mC-8gazh5gbfqF5gEP9RpXIh1Kzc> accessed 15 December 2021.

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align with climate[91] or other sustainability goals, especially where the system can record the sustainability impact.[92]

B. Blockchain-based financing for sustainable innovation

Blockchain-based instruments offer new tools to monetise IP as well as alternative channels to finance innovation. Can these emerging also support follow-on innovation or the greater goal of sustainability?

Transparent recordation of IP provenance and NFTs on public ledger could also have the benefit of facilitating technology diffusion. The use of NFT's may also enable more precise valuation of patent NFTs since the publicly available transaction history would help make comparisons between the different transactions (prices, litigation history, etc.) instead of valuating patents in a vacuum.[93] Blockchain could be used to record commitments made on patents (classic FRAND commitments, or patent pledges such as Tesla's and Google's). Indeed, as of now, these types of commitments only appear on the corporate website of firms pledging their patents for open usage but do not record or publish, which beneficiary firms make use of such commitment. Immutable recordation of a pledge and the those benefiting from it through a license or and assignment would facilitate long term accessibility of patents. Keeping records of patent pledges on the blockchain could be executed with or without NFT's and could also involve smart contracts executing the commitment made by the patent holder to share its patents openly. When thoughtfully designed, blockchain-based solutions may foster trust in the reliance in patent pledges by making it more difficult for the pledger to withdraw from with an effect of supporting follow-on innovation.

Yet, blockchain-based instruments feature a number of risks that have the potential to outweigh their benefits. The records on the blockchain are immutable, and therefore very difficult to correct errors retrospectively.[94] Smart contracts, being immutable and self-executing, must be error-free and coded ex-ante to accommodate all future events, as abstract principles of semantic contracts cannot be expressed in

[91] Leonardo Paz Neves and Gabriel Alexio Prata, 'Blockchain Contributions for the Climate Finance: Introducing a Debate' (Christian Hübner 2018) <https://www.kas.de/c/document_library/get_file?uuid=ea6109a2-7677-9bfa-d4d0-6cbae35ebcc7&groupId=252038> accessed 15 December 2021,52.

[92] Yushi Chen and Ulrich Volz, 'Scaling Up Sustainable Investment through blackchain-based project bonds' (April 2021) ADBI Working Paper Series <https://www.adb.org/sites/default/files/publication/696276/adbi-wp1247.pdf> accessed 15 December 2021.

[93] See Michael Fainberg, Michael Scarpati, Mohammad Zaryab, 'Rejuvenating Patent Monetization Using NFTs' (*Arent Fox*, 13 August 2021) <https://www.arentfox.com/perspectives/alerts/rejuvenating-patent-monetization-using-nfts> accessed 15 December 2021.

[94] See Mik (at No X) 281.

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code.[95] The risks expand further whenever the execution of smart contract is dependent on data or events that take place off-chain.[96] Is such technology suitable to facilitate innovation that targets wicked problems, that by their definition,[97] escape computable solutions? It may be difficult to predict in advance, under which kind of licenses the IP in question can bring the most value for sustainability. However, due to their decentralized nature, the combinations of solutions discussed – NFT's, smart contracts, DAO's – may also prove sustainable in highly volatile environments where traditional institutions are deteriorating.[98] For example, in a crowdfunding campaign organized by UkraineDAO, an NFT of a Ukrainian flag collected 6,7 million dollars to support a foundation supplying Ukrainian civilians and army. The donors owned the NFT as a collective.[99]

The alignment of NFT's and smart contracts with contract and IP law heavily debated.[100] The IP licensing conditions of blockchain based initiatives are often difficult to make sense of. Due to their decentralized nature, it is also unclear how DAO's could protect their IP against infringers or respond in the event of infringement claims.[101] Compliance with other fields of law, such as data protection law and tax law may also be an issue.[102] Finally, blockchain-based solutions are not immune to hacking[103], and are based on cryptocurrencies, vulnerable to the fluctuation in value.[104]

Though they may indeed bring better ways to monetise patents, NFTs, and more generally, the use of blockchain-solutions to facilitate patent transactions and the diffusion of technologies, remain complex tools added to a challenging system, particularly for SMEs who already find the patent system difficult to navigate.[105] There is a danger that the

[95] See Sklaroff, Jeremy M. "Smart contracts and the cost of inflexibility." *U Pa L Rev.* 166 (2017): 263. 277-286, 291–300, 302-303; Mik (at No. X), 281-282.
[96] Mik (at No. X), 294–295.
[97] Norton at No X. 132-134.
[98] See Cifuentes, Andres F., 'Bitcoin in troubled economies: the potential of cryptocurrencies in Argentina and Venezuela' (2019) 3 *Latin American Law Review* 99.
[99] Holland, Oscar 'NFT Backed by Pussy Riot member raises $6,7 million for Ukraine' (*CNN Style*, 3 March 2022) <https://edition.cnn.com/style/article/ukrainedao-pussy-riot-nft-flag-war-fundraising/index.html> accessed 6 March 2022.
[100] See Mik at No X, Sklaroff at No X; Guadamuz at No X; Lee, E. at No. X.
[101] See Robertson at NO x.
[102] See Schröder and others, 'Non-Fungible Tokens (NFTs) — Memes for the Mega-Rich or a Real Business Opportunity?' (*Hanness Snellman Blog*, 11 February 2022). <https://www.hannessnellman.com/news-views/blog/non-fungible-tokens-nfts-memes-for-the-mega-rich-or-a-real-business-opportunity/> accessed 7 March 2022.
[103] Mik at No x, 300.
[104] Srokosz, Witold, T. Kopciaski, 'Legal and economic analysis of the cryptocurrencies impact on the financial system stability' (2015) 4.2 *Journal of Teaching and Education* 619, 626-627.
[105] Commission, Making the most of the EU's innovative potential COM (2020) 760 final.

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initiatives fail to truly bring added value and only introduce an "extra layer" of complexity to technology transfer. Transactions could also be better recorded on the existing databases (in the case of patents). In May 2020, the USPTO launched a web-based intellectual property marketplace platform to facilitate the licensing of patents (initially limited to Covid related technologies).[106] The French IP office INPI proposes a platform where potential licensors and licensees can meet,[107] and many more patent marketplaces exist.[108] Is blockchain technology necessary to achieve such goals if this is a matter of transparency, recordation, and traceability? Could the existing registries improve enough to offer the same benefits?

Notwithstanding that their proponents insist on their incredible potential, the blockchain-based solutions discussed here represent an emerging and still marginal phenomenon, with a lot of experimentation as well as abandoned projects. It is difficult to say whether they would become a reliable way to monetise patents or to fund further innovation. The initiatives presented here are still in their infancy. The Global Patent Market proposed by IPwe and running on the IBM blockchain has not yet implemented tokenisation. The Molecule initiative has just been launched. The WIPO tokenisation program will be discontinued in February 2022.[109]

Among the uncertainties attached to recent initiatives presented in this paper, environmental concerns are of extreme importance. NFTs, more broadly blockchain technology, and more concrete open innovation ecosystems such as the Molecule initiative might play an important role in achieving sustainable development[110] by overcoming its limitations to meet social needs. However, those tools using blockchain technology are energy hungry.[111] NFTs like bitcoins use enormous processing power, and as the electricity used to process such calculation comes primarily from fossil fuels such as coal, the process

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[106] See USPTO, 'USPTO launches platform to facilitate connections between patent holders and potential licensees in key technologies'(*USPTO*, 4 May 2020) <https://www.uspto.gov/about-us/news-updates/uspto-launches-platform-facilitate-connections-between-patent-holders-and> accessed 15 December 2021.

[107] See the INPI website <https://bourse-brevets.inpi.fr/?/> accessed 15 December 2021.

[108] IP Marketplace, Ocean Tomo, Google's Patent Purchase Portal, RPX, etc…

[109] See the WIPO Proof <https://wipoproof.wipo.int/wdts/> accessed 15 December 2021.

[110] See United Nation Climate Change, 'The Good, The Bad and The Blockchain' (*UNFCC*, 17 May 2021) <https://unfccc.int/blog/the-good-the-bad-and-the-blockchain> accessed 15 December 2021. See also United Nations, 'Sustainability solution or climate calamity? The dangers and promise of cryptocurrency technology' (*UN News*, 20 June 2021) <https://news.un.org/en/story/2021/06/1094362> accessed 15 December 2021.

[111] See European Environment Agency, 'Blockchain and the environment' (*EEA*, 25 March 2021) <
https://www.eea.europa.eu/publications/blockchain-and-the-environment> accessed 15 December 2021.

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generates carbon emissions.[112] Despite some initiatives to make blockchain technology "greener", those new tools remain, for the time being, extremely dependent and high consumers of energy. It is evident that the path, although technology-development oriented, is far from sustainable. However, society and governments are aware of the energy consumption drawback in that technology context. An example from China illustrates that concern. The country, which powers 80% of the global trade in cryptocurrency, recently banned cryptocurrency mining in the Inner Mongolia province because of the use of a large amount of energy.[113] In a world with limited natural resources and renewable resources that imply high costs, complexity or negative environmental impacts, those new instruments might need to develop their working mechanisms further. Once this challenge is achieved, they might provide a viable and sustainable way to facilitate the monetisation of patents and the diffusion of technologies as well as to fund innovation.

V. Conclusion

Although technological innovations will not be enough to face the challenges ahead, they will play a critical role. Solving wicked problems such as sustainability calls for more inclusiveness, which open innovation practices can offer through reciprocal licensing, cross-licensing agreements, patent pools, and pledges.

While classical instruments might provide the innovators with the necessary funds to continue innovating, these instruments may negatively impact the freedom to choose how to use their patents. Innovators might be torn between getting the much-needed funds and choosing an open innovation approach. Additionally, even if those instruments would not limit the choices of the patent holders, they still are exceptional, tailor-made, and the issue of valuation remains a major hindrance.

Blockchain-based technologies purport to offer a solution to the shortcomings of the classical instrument (transparency, swiftness, openness, valuation). The few initiatives presented in this chapter should be closely followed. However, although presented as promising, new instruments such as NFTs are yet to show how beneficial and worthwhile they could be to help fund innovations.

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[112] The share of renewables in global electricity generation is only 28%. See International Energy Agency, Global Energy Review 2020. See International Energy Agency, 'Global Ebergy Review - Report Extract Renewables' <https://www.iea.org/reports/global-energy-review-2020/renewables> accessed 15 December 2021.

[113] See Muyu Xu, Shivani Singh, 'China's Inner Mongolia to end cryptocurrency mining, ban new steel, coke projects'(*Reuters*, 1 March 2021) <https://www.reuters.com/article/us-china-climatechange-energy-idUSKCN2AT1YY> accessed 15 December 2021.

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Even if NFTs, and more broadly blockchain technology, might eventually play an important role in sustainable development and open innovation ecosystems, blockchain technology tools remain power-hungry. Thus, these new instruments might not - just yet - supply a viable and sustainable way to facilitate the monetisation of patents and the diffusion of technologies.

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