Green tech, patents, standards: how to achieve global climate neutrality by 2050

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I. Introduction

2021 was one of the seven warmest years recorded in history.[1] At this rate, scientists warn, the first threshold of 1.5°C (global warming) will likely be reached by 2031.[2] In that event, it is believed, the ecosystems will suffer multiple risks, such as biodiversity loss and extinctions of species.[3] Moreover, with 1.5°C around 14 per cent of the population is expected to face acute heatwaves at least once every five years.[4] With 2°C the foreseen percentage rises to 37.[5] Nevertheless, one does not need to wait until 2031 to experience the impact of climate change.

While several regions in western Germany, Belgium, Switzerland, the Netherlands and central China are emerging from a catastrophic flooding,[6] Australia is becoming hotter, and more prone to extreme heat, driving to an increase in fires by at least 30% since 1900.[7] Meanwhile, households in some US

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[1] European Centre for Medium-Range Weather Forecasts (ECMWF), Review of 2021 climate places it among seven warmest on record, 10 January 2022, at https://www.ecmwf.int/en/about/media-centre/news/2022/review-2021-climate-places-it-among-seven-warmest-record. According to the Intergovernmental Panel on Climate Change (IPCC), which includes over 230 experts from 66 countries on climate change, *"[g]lobal surface temperature in the first two decades of the 21st century (2001-2020) was 0.99 [0.84- 1.10] °C higher than 1850-1900"*. See IPCC, Climate Change 2021, The Physical Science Basis, 7 August 2021, at https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report.pdf. See also National Centers for Environmental Information (NOAA), State of the Climate: Global Climate Report for Annual 2020, January 2021, at https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202013.

[2] Copernicus Climate Change Service, How close are we to reaching a global warming of 1.5°C?, 22 February 2021, at https://climate.copernicus.eu/how-close-are-we-reaching-global-warming-15degc.

[3] IPCC Climate Change 2022, Impacts, Adaptation and Vulnerability, p. 15 at https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_FinalDraft_FullReport.pdf.

[4] Oliver Milman et al., The Guardian, The climate disaster is here, 14 October 2021, at https://www.theguardian.com/environment/ng-interactive/2021/oct/14/climate-change-happening-now-stats-graphs-maps-cop26 referring to the IPCC Special Report Global warming of 1.5°C, 2018, at https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf.

[5] Global Climate Change, Alan Buis, A Degree of Concern: Why Global Temperatures Matter, 19. June 2019, https://climate.nasa.gov/news/2865/a-degree-of-concern-why-global-temperatures-matter/.

[6] Rising temperatures around the globe are "leading to a more rapid evaporation of water on land and at sea — subsequently causing more extreme precipitation events and heavier storms". See the Environmental Change Institute at the University of Oxford statements at DW, Is climate change fueling floods in Germany?, 15 July 2021, at https://www.dw.com/en/is-climate-change-fueling-floods-in-germany/a-58282637 and Kahraman, Abdullah et al., Quasi-stationary intense rainstorms spread across Europe under climate change. Geophysical Research Letters, 48, e2020GL092361, 2021, at https://doi.org/10.1029/2020GL092361. Regarding the flood in central China of 20th July 2021, the Zhengzhou meteorological station referred that the equivalent of one year of rain fell in just three days. See CNN, Nectar Gan and Jessie Yeung, 'Once in a thousand years' rains devastated central China, but there is little talk of climate change, 23 July 2021, at https://edition.cnn.com/2021/07/23/china/china-flood-climate-change-mic-intl-hnk/index.html.

[7] Van Oldenborgh et al. study, carried out by the World Weather Attribution (WWA), investigated to what extent the bushfires in Australia between 2019 and 2020 were caused by climate change. The scientists also found that the probability of a fire danger (estimated under the Fire Weather Index (FWI)) is higher than the minimum percentage indicated (30%). This is because the climate models used underestimate the extreme temperature's trend, which is one of the drivers behind the indicated increase. Van Oldenborgh G.J. et al., Attribution of the Australian bushfire risk to

cities are breathing toxic smoke from the wildfires burning in the western part of the country.[8] In India, citizens are suffering more extreme heatwaves than ever, with some cities already reporting up to 55°C in 2022.[9] Africa is undergoing heavy rainfall combined with lessen water resources and food insecurity, leading to growing population displacement.[10] These are but a few examples of the negative impact of climate change. Furthermore, the Russian's recent invasion of Ukraine has put in evidence Europe's dependence on Russian oil and gas, reinforcing the need of Europe to accelerate the transition to green power. [11]

As a result, governments around the globe are increasingly acknowledging the need to take immediate regional, national and international action.[12] In Europe the aim is to become a carbon-neutral continent by 2050,[13] in line with the international commitments undertaken under the United Nations (UN) "Paris Agreement".[14] To accomplish this, as the Organisation for Economic Co-operation and

anthropogenic climate change, Nat. Hazards Earth Syst. Sci., 21, 941–960, 2021, p. 951, at https://nhess.copernicus.org/articles/21/941/2021/nhess-21-941-2021.pdf.

[8] By the end of July 2021, the smoke from 80 wildfires in the western US spread for 2,000 miles for the second year in a row, reaching eastern cities such as Philadelphia, Washington DC, Toronto and New York. See Oliver Milman, New York air quality among worst in world as haze from western wildfires shrouds city, The Guardian, 21 July 2021, at https://www.theguardian.com/us-news/2021/jul/21/new-york-air-quality-plunges-smoke-west-coast-wildfires.

[9] The Guardian, 'We are living in hell': Pakistan and India suffer extreme spring heatwaves, 2. May 2022, at https://www.theguardian.com/world/2022/may/02/pakistan-india-heatwaves-water-electricity-shortages; Angela Picciariello et al., The costs of climate change in India: a review of the climate-related risks facing India, and their economic and social costs, ODI Literature review, June 2021, p. 10, at: https://cdn.odi.org/media/documents/ODI-JR-CostClimateChangeIndia-final.pdf.

[10] The World Bank estimates that around 86 million Africans will migrate within their own countries by 2050 due to climate change. See The World's Bank, Press Release '86 million Africans migrating within their own countries by 2050'. 28 October 2021, at https://www.worldbank.org/en/news/press-release/2021/10/27/climate-change-could-further-impact-africa-s-recovery-pushing-86-million-africans-to-migrate-within-their-own-countries; See IPCC, Climage Change 2021, The Physical Science Basis, 7 August 2021, at https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report.pdf.

[11] Germany, one of the countries more affected by such a dependency, aims to use 100 per cent renewable energy by 2035. Jacopo Maria Pepe, German Institute for International and Security Affairs, Der Ukraine-Krieg und seine Folgen: Deutschland muss seine Energietransformation neu austarieren, 2 March 2022 at https://www.swp-berlin.org/en/publication/der-ukraine-krieg-und-seine-folgen-deutschland-muss-seine-energietransformation-neu-austarieren. On the other hand, the Russian invasion is delaying the US climate agenda and facing political challenges. Coral Davenport, As Gas Prices Soar, Biden's Climate Ambitions Sputter, The New York Times, 2 April 2022, at https://www.nytimes.com/2022/04/01/climate/biden-climate-change.html.

[12] As French President Emmanuel Macron explained a few months after taking office *"[W]e must find a smooth transition to a low-carbon economy […] Let's face it: There is no Planet B*." , see Adam Wentworth, Macron tells Trump and US Congress: "There is no Planet B", 26 April 2018, at https://www.climateaction.org/news/macron-tells-trump-and-us-congress-there-is-no-planet-b. In the aftermath of the catastrophic flood of 18 July 2021 in Germany, the former Chancellor Angela Merkel declared *"[w]e have to hurry up, we have to speed up the fight against climate change*". See https://www.dw.com/en/germany-needs-better-climate-policy-merkel-says-from-flooded-region-as-it-happened/a-58304082. The Portuguese Minister for the Environment and Climate Action until March 2022, João Pedro Matos Fernandes stated that "*Climate change is not just a future threat – it is happening now*", Environment Council, Strategy on adaptation to climate change, 10 June 2021, at https://www.consilium.europa.eu/en/meetings/env/2021/06/10/. The President of the US, Joe Biden, reversing the environmental policy sustained by his predecessor Donald Trump, organised the Virtual Leaders Summit on Climate Change Opening Session of April 2021 and affirmed in his speech that "*[n]o nation can solve this crisis on our own (…). All of us, all of us – and particularly those of us who represent the world's largest economies – have to step up (…). We know just how critically important [that] is. This is the decade we must make decisions that will avoid the worst consequences of a climate crisis (…) We really have no choice*.". See BBC, Biden urges action to tackle 'existential crisis' at virtual climate summit, 22 April 2021, at https://www.bbc.com/news/av/science-environment-56845031.

[13] European Investment Bank, Investment Report 2020-2021, Building a smart and green Europe in the Covid-19 era, p. 1, at https://www.eib.org/en/publications/investment-report-2020.

[14] The Paris Agreement entered into force on 4th November 2016 and was adopted by 196 countries. See UN Climate Change, The Paris Agreement, at https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement#:~:text=The%20Paris%20Agreement%20is%20a,force%20on%204%20November%202016. In November

Development (OECD) rightly points out, "rapid economic, social and technological transformations" are required.[15]

For the 'green' transformation to become a reality, the use of technologies seems indeed inevitable. This may sound contradictory at first glance as many technological products cause serious damage to the environment. For instance, cars, airplanes, factories and power plants significantly contribute to pollution by producing greenhouse gasses. Greenhouse gasses, like carbon dioxide (CO_2) and carbon monoxide, absorb and reflect heat to the planet's surface, increasing global warming.[16] Cars alone were responsible for around 12% of European Union (EU) CO_2 emissions and 43% of total transport sector emissions in 2020.[17] On a positive note, technologies can be 'clean', meaning that they produce hydrogen with very low to zero carbon emissions, facilitating the successful transition towards a carbon-neutral economy. For example, electric vehicles[18] and clean hydrogen cell systems can mitigate the environmental harm generated by cars and airplanes.[19] Technologies are, therefore, 'two sides of the same coin': they are frequently considered the root of the climate change problem, but they may also become (at least part of) the solution.[20] In other words, technologies can evolve from 'polluting' to 'green'.

In this context, the paper proposes a strategy to effectively develop and deploy green technologies (green tech) globally. The structure of the paper is as follows: Part II explains green tech and offers some examples. Part III provides some insights into the international legal framework to address climate change. Part IV emphasises the need for massive R&D investment in order to create green tech and role of patents in encouraging it. Part V analyses the main elements for the success of standardisation in developing global cellular standards. Part VI concludes.

II. Green tech: Definition and examples

2019, the US announced its withdrawal, which took effect in November 2020. Nevertheless, in February 2021, the US rejoined the Agreement. See executive order signed on 20 January 2021 at https://web.archive.org/web/20210121001024/https://www.whitehouse.gov/briefing-room/statements-releases/2021/01/20/paris-climate-agreement/.

[15] OECD, Climate Action, at https://www.oecd.org/coronavirus/en/themes/green-recovery.

[16] Greenhouse gas emissions "*occur naturally (…), but human activities, such as the burning of fossil fuels, are increasing the levels of [greenhouse gasses] GHG's in the atmosphere, causing global warming and climate change*". Differently, CO_2 "is the most common GHG emitted by human activities, in terms of the quantity released and the total impact on global warming". See Matthew Brander and Gary Davis, Greenhouse Gases, CO_2, CO_2-e, and Carbon: What Do All These Terms Mean?, Ecometrica, August 2012, https://ecometrica.com/assets/GHGs-CO2-CO2e-and-Carbon-What-Do-These-Mean-v2.1.pdf Likewise, airplanes account for 3.8% of the EU's GHG. See European Commission, Make Transport Greener, 14 July 2021, at https://ec.europa.eu/commission/presscorner/detail/en/FS_21_3665.

[17] EU Commission, CO_2 emission performance standards for cars and vans, at https://ec.europa.eu/clima/policies/transport/vehicles/regulation_en; See also Yoann Gimbert, Transport & Environment , Electric car boom at risk, p. 11, 2021, at https://www.transportenvironment.org/wp-content/uploads/2021/11/2021_11_car_co2_report_final.pdf.

[18] In 2008 Tesla Inc. released the first full electric car. Nevertheless, the origin of electric vehicles goes back to the late 1880s. See Erik Gregersen and Barbara A. Schreiber, Tesla, Inc., Encyclopedia Britannica, 4 October 2018, at https://www.britannica.com/topic/Tesla-Motors and, Robert Lewis, Electric automobile, Encyclopaedia Britannica, 17 April 2019, at https://www.britannica.com/technology/electric-automobile.

[19] Zero Avia Inc, developed a zero-emission hydrogen-electric propulsion option for existing aircraft capable of flying up to 500 kilometers. According to the company, this technology offers the world's first practical, zero-emission aviation powertrain, which is powered by a hydrogen fuel cell system and linked to proprietary software/controls. For details on this and other clean technologies see the dedicated webpage of Solar Impulse at https://solarimpulse.com/efficient-solutions/hydrogen-electric-powertrain-for-aviation.

[20] World Intellectual Property Organization (WIPO), Climate change and the intellectual property system: what challenges, what options, what solutions?, An outline of the issues (informal draft consultation only), Draft 5.0 14XI.08, p. 3, https://www.wipo.int/export/sites/www/policy/en/climate_change/pdf/summary_ip_climate.pdf.

The term 'green tech' has no officially recognised definition or precise contours. Instead, it enjoys numerous interchangeable notions.[21] For instance, green tech has been used as a synonym for 'clean tech', 'climate-related technologies' or 'environmental sound technologies'.[22] Nonetheless, green tech generally has two common elements. First, it embraces a variety of technological fields such as renewable energy generation technologies, energy storage technologies or reduced pollution and emissions technologies. Second, its primary purpose is to lower the negative impact on climate change and is, therefore, considered 'environmentally friendly'.[23]

Some examples of green tech are wind energy, LED lighting, electric cars, solar power and vertical farming.[24]

III. The international legal framework on climate change

In the past, governments aimed to fight climate change by applying soft law instruments.[25] Some examples are the multiannual environment action programmes adopted by the EU,[26] decisions adopted by the 'Conference of the Parties',[27] and several OECD recommendations.[28] This strategy changed in 2015, when almost 200 parties signed the UN 'Paris agreement', the first international

[21] Hee-Eun Kim, Defining Green Technology, The Role of the Patent System in Stimulating Innovation and Technology Transfer for Climate Change, Nomos Verlagsgesellschaft mbH, 2011, pp. 15-20.

[22] A definition of the term 'environmental sound technologies' is contained in the United Nations Program of Action from Rio - Chapter 34 of Agenda 21 of 1992 in relation to the transfer of technologies. Accordingly, these technologies "*protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they were substitutes*" (art. 34.1). See United Nations Conference on Environment & Development Rio de Janeiro, Brazil, 3 to 14 June 1992, Agenda 21 at https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf.

[23] Eric L. Lane, Chapter 1: Clean Tech IP Is for Real, 2011, in Eric. L. Lane, Clean tech intellectual property: eco-marks, green patents, and green innovation, Oxford University Press, March 2011, p. 1-2, at https://ssrn.com/abstract=2000889.

[24] In vertical farming, crops are grown indoors in vertically stacked layers, using artificial conditions of light and temperature. In contrast, conventional industrial agriculture *"is responsible for 70% of the planet's water use, up to 24% of greenhouse gas emissions, and degradation of soil and groundwater pollution"*. See European Commission, Cordis project, The vertical farming revolution, urban Farming as a Service, 20 December 2019, at https://cordis.europa.eu/project/id/739479/de.

[25] The term "soft law" appeared for the first time in the context of international law and refers to quasi-legal instruments which are not legally binding. In the area of international law, soft law comprises *"agreements concluded between states as well as certain types of resolutions of international organizations (e.g. resolutions of the UN General Assembly).*". In the EU area, this term has been referred, for example, to codes of conduct, guidelines, notices, recommendations, or communications, but also to Green Papers, White Papers and Action Programmes. See EC Directorate General Internal Policies of the Union, Better Regulation and the Improvement of EU Regulatory Environment – Institutional and Legal Implications of the Use of "Soft Law" Instruments, March 2007, pp. 3-6 at https://www.europarl.europa.eu/RegData/etudes/note/join/2007/378290/IPOL-JURI_NT(2007)378290_EN.pdf.

[26] The EU developed eight Environmental Action Programmes (EAPs) to implement the environmental policy for the following periods of time: 1973-1976 (EAP 1), 1977-1981 (EAP 2), 1982 -1986 (EAP 3), 1987-1992 (EAP 4), 1993-2000 (EAP 5), 2002-2012 (EAP 6), 2013-2020 (EAP 7) and 2020-2030 (EAP 8). The EAPs' approach has evolved throughout the years, the environmental issues being treated initially as sectorial, turning then to an integrated and interdependent approach across EU policies. See Vasile Popeanga, Environmental Action Programmes in the European Union - Evolution and Specific, Annals Constantin Brancusi University Targu Jiu, Letters & Social Science Series, Issue 3/2013, p. 24, at https://heinonline.org/HOL/LandingPage?handle=hein.journals/ancnbt2013&div=32&id=&page=.

[27] 'Conference of the Parties' is a series of formal meetings of the UNFCCC parties. See UN Climate Change, Conference of the Parties (COP), at https://unfccc.int/process/bodies/supreme-bodies/conference-of-the-parties-cop.

[28] For instance, OECD Recommendation of the Council on Information and Communication Technologies and the Environment (OECD/LEGAL/0380) adopted on 8 April 2010, which advice members to coordinate Information and Communication Technology (ICT), Climate, Environment and Energy Policies, adopt life cycle perspectives, support research and innovation in green technologies and develop green ICT skills, at https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0258.

legally binding treaty on climate change.[29] The agreement aims to strengthen the response to climate change in the context of sustainable development, maintaining global warming to below 2°C and pushing efforts to limit the temperature increase to 1.5 °C. The purpose of the Paris agreement is a 'climate-neutral world' by 2050.[30] In October 2016 the EU ratified the agreement, allowing its entry into force the following month.

Since then, the EU has been acting as a 'climate leader'[31] regularly undertaking efforts in environmental protection.[32] For instance, back in 2019, the European Commission (EC) presented the 'EU Green Deal', a comprehensive new strategy on climate change.[33] Its action plan set out the ambitious objective of becoming the world's first climate-neutral continent by 2050. The EC envisioned economic growth via an efficient use of natural resources, while ensuring, at the same time, a "just and inclusive" transition.[34]

Despite the wide range of initiatives and policy objectives already included in the EU Green Deal, by 2020 the regulatory framework was deemed insufficient, forecasting that by 2050 only 60% of the emissions reduction aimed for would be achieved.[35] Consequently, the EC presented in September 2020 the so-called '2030 EU Climate Target Plan'[36] in which the EU sustainability goals were raised further. In its updated plan, the EC sought to reduce the 2030 emissions from the originally targeted 40% to a net 55%. It further proposed the revision of several key pieces of legislation, such as the 'Emissions trading system directive' (concerning aviation) and the 'Shared effort regulation' (related to the Member States' emissions reduction targets). Subsequently, the EU enacted the 'European climate law', which entered into force in July 2021.[37] The aim of this instrument was to regulate the

[29] As of April 2022, 193 out of 196 countries of the UNFCCC (UN Framework Convention on Climate Change) are part of the Agreement. For the status of the Paris Agreement see the United Nation Treaty Collection at https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-d&chapter=27&clang=_en.

[30] Art. 2 and 4 of the Paris Agreement. The increase in degrees of global warming is calculated measuring the average temperature of the planet at a given time, calculated through the combination of land and ocean temperature collected around the world, compared the pre-industrial levels (the reference year is generally 1880). See Myles R. Allen et al., Framing and Context in: Valérie Masson-Delmotte et al. Global Warming of 1.5°C., In Press., 2018, at https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_Low_Res.pdf.

[31] Michael Mehling et al., Climate Law and Policy in the European Union: Accidental Success or Deliberate Leadership?, 2013, pp. 509-522 in Erkki J. Hollo et al. (eds.), in Climate Change and the Law, Ius Gentium: Comparative Perspectives on Law and Justice 21, p. 511.

[32] Emanuela Orlando, The Evolution of EU policy and Law in the Environmental Field: Achievements and Current Challenges, The Transatlantic Relationship and the Future Global Governance, Working Paper 21, April 2013, at http://transworld.iai.it/wp-content/uploads/2013/04/TW_WP_21.pdf.

[33] Communication from the Commission to the European Parliament, the European council, the Council, the European Economic and Social Committee and the Committee of the Regions [hereinafter EU Green Deal], Brussels, 11 December 2019 COM (2019) 640 final, [hereinafter EU Green Deal] at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2019%3A640%3AFIN.

[34] EU Green Deal, p. 2.

[35] EC Working Document, Impact Assessment, Stepping up Europe's 2030 climate ambition, Brussels, 17 September 2020, SWD(2020) 176 final, pp. 8-9, at https://eur-lex.europa.eu/resource.html?uri=cellar:749e04bb-f8c5-11ea-991b-01aa75ed71a1.0001.02/DOC_1&format=PDF.

[36] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Stepping up Europe's 2030 climate ambition, Brussels, 17 September 2020, COM (2020) 562 final, at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0562&from%20=EN.

[37] The EC adopted the proposal of a regulation for a European Climate Law in March 2020 and revised it in December 2020 to include the new intermediate objective for 2030. The European Parliament and the Council reached a provisional political agreement in April 2021 and adopted the final text in June 2021. The regulation was published in the Official Journal of the European Union on 9th July 2021. See Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law') at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2021.243.01.0001.01.ENG&toc=OJ%3AL%3A2021%3A243%3ATOC.

mentioned political goals in legislation and to establish the framework for achieving climate neutrality. An added initiative was the package of measures presented by the EC in July 2021 to accomplish the above-mentioned 2030 target.[38]

In November 2021, under the umbrella of the UN annual global climate change 'Conference of the Parties' known as COP26, 196 countries signed the 'Glasgow Climate Pact' and agreed the 'Paris Rulebook'. While not legally binding, countries signatories of the Pact agreed to "revisit and strengthen" their climate pledges by the end of 2022.[39] The Rulebook, on the other hand, offers some guidelines on the Paris Agreement, such as delivering more transparent reports on emissions. In the same conference, the countries made additional commitments in areas related to "forests, methane, car emissions, and private finance".[40]

Although guidelines, non-binding commitments and the EU Green Deal are important steps in the right direction, innovative solutions to the international challenge of climate change requires (1) significant research and development (R&D) investment,[41] (2) intensive collaboration between universities, public research institutions, industry and governments[42] and (3) the creation and adoption of *global* standardised solutions.

IV. R&D investment fostered by patents

As recognised by the OECD, combating climate change demands innovative solutions, which are often the result of heavy R&D investments.[43] According to the International Energy Agency (IEA), to achieve the zero emissions by 2025 investments in clean energy transition need to amount to $4 trillion annually by 2030.[44]

One of the fundamental factors for companies to invest in innovation is a robust IP rights system.[45] In the case of (green) technologies, patents are particularly relevant.[46] According to a study conducted

[38] Communication from the Commission to the European Parliament, the Council, the European Economic And Social Committee and the Committee of the Regions 'Fit for 55': delivering the EU's 2030 Climate Target on the way to climate neutrality, Brussels 14 July 2021, COM (2021) 550 final, at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021DC0550. These measures expand across the different sectors and industries. Amongst them, the transportation sector, accounting for almost a quarter of the EU GHG emissions, undoubtedly represents the area that needs a profound transformation. EU Green Deal, p. 10, para. 2.1.5.

[39] Glasgow Climate Pact, IV para. 29, at https://unfccc.int/sites/default/files/resource/cma3_auv_2_cover%20decision.pdf.

[40] UK Parliament, House of Commons Library, What were the outcomes of COP26?, 27 January 2022, at https://commonslibrary.parliament.uk/what-were-the-outcomes-of-cop26/.

[41] In 2010 the EC was already envisioning energy investment of €1 trillion for the following ten years. Energy 2020, A strategy for competitive, sustainable and secure Energy), Brussels, 10 November 2010, COM(2010) 639 final, p. 2 at https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0639:FIN:En:PDF.

[42] OECD, OECD Science, Technology and Industry Outlook 2014, (2014), p. 22, https://read.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-outlook-2014_sti_outlook-2014-en#page23.

[43] Tomasz Kijek, et al., The Patterns of Energy Innovation Convergence across European Countries. Energies 2021, 14, 2755, p. 2 https://www.mdpi.com/1996-1073/14/10/2755/pdf.

[44] IEA, World Energy Outlook 2021, p.18, at https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf.

[45] Other factors are "*favourable macroeconomic conditions, the financial robustness of actors and markets [and] competition regulations in product and labour markets"*, OECD Science, Technology and Industry Outlook 2014, 2014, p. 23, at https://read.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-outlook-2014_sti_outlook-2014-en#page23.

[46] According to Ohlhausen, former Commissioner of the US Federal Trade Commission, "*[e]ach act of invention matters and should be encouraged. Patents can create incentives necessary to engage in further R&D, and those incentives are*

by the Joint Research Centre, applying a top-down patent analysis, between 2003 and 2014, the European private sector invested about €250 billion in R&D related to climate change mitigation technologies.[47] Companies incrementally increased the resources allocated to this kind of investments over the years in almost each European country.[48] Also, the International Renewable Energy Agency (IRENA), scrutinising data over the period 2009 to 2019, found that the filing of patents in renewable energy (including bioenergy, biothermal energy, hydropower, ocean energy, solar energy and wind energy) increased steadily over the years.[49]

However, this increase in patent filings has been accompanied by a heated debate as to whether patents could act as an obstacle (instead of as incentive) to the development and/or spreading of green tech. Specially, concerns have been raised about the fact that patents grant an exclusive right to the inventor for a limited period of time (generally 20 years).[50] Accordingly, during that time, it is not

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no less important because the invention is part— rather than the entirety— of an end product.", Maureen K. Ohlhausen, Patent Rights in a Climate of IPRs skepticism, Harvard Journal of Law & Technology, Volume 30, Number 1 Fall 2016, 11. Patented green technology is regulated under the provisions established in the 'Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreement' on an international level. The TRIPS Agreement is an international agreement signed in 1994 between all the members of the WTO. See https://www.wto.org/english/docs_e/legal_e/27-trips.pdf. TRIPS provides minimum safeguards for IPRs. Art. 27 establishes that patents can protect any inventions, in all fields of technologies, if they are new, involve an inventive step and are capable of industrial application. The subsequent provisions regulate the rights conferred to patents' owners (art. 28), the conditions imposed on patent applicants (art. 29), the exceptions (art. 30), the compulsory licenses (art. 31) and the patents' revocation or forfeiture (art. 32). At EU level, green patents are regulated by the 'European Patent Convention' (EPC). The EPC is a multilateral treaty signed in 1973. See http://documents.epo.org/projects/babylon/eponet.nsf/0/53A0FE62C259803BC12586A90058BCAD/$File/EPC_17th_edition_2020_en.pdf. The EPC establishes the rules to obtain, through a single administrative procedure, the European patent, i.e. a "bundle" of national patents that must be validated within the countries selected in the application. Mirroring the TRIPS Agreement, art. 52 EPC states that the European Patents are granted for any inventions, in all fields of technology, provided that they are new, involve an inventive step and are susceptible of industrial application. Art. 63 EPC provides that the term of the European patent is 20 years from the date of filing. Specific provisions are to be found within the international regulatory framework. Some examples are the UNFCCC of 1992 and the 'Bali Action Plan', which are mainly focused on the transfer of green tech to developing countries. In particular, art. 4.5 UNFCCC imposes on developed countries the obligation to promote and finance the access to or transfer of the "environmentally sound technologies" to other parties. The "Bali Action Plan" calls for enhanced action in this field, such as effective mechanisms for the removal of obstacles to the development and transfer of technology to developing country parties and ways to expedite deployment, diffusion and transfer of these technologies. See Decision of COP-13, 1/CP.13, 'Bali Action Plan', FCCC/CP/2007/6/Add.1, 14 March 2008, at https://unfccc.int/resource/docs/2007/cop13/eng/06a01.pdf.

[47] Between 2003 and 2014 the average R&D cost per inventive activity in the Climate Change Mitigation Technologies (CCMTs) was about €3.3 million. Francesco Pasimeni et al., Assessing private R&D spending in Europe for climate change mitigation technologies via patent data, Science Direct, World Patent Information Volume 59, December 2019, p. 4, at https://doi.org/10.1016/j.wpi.2019.101927. For an analysis of R&D investments in photovoltaics (PV) sector, see Breyer Christian, et al., A top-down analysis: Determining photovoltaics R&D investments from patent analysis and R&D headcount, Energy Policy, Volume 62, 2013, 1570-1580, ISSN 0301-4215, p. 1978 at https://doi.org/10.1016/j.enpol.2013.07.003. This study estimated that private corporations finance 90% of photovoltaics R&D, meaning around €5.7bn in 2009.

[48] In particular, enterprises based in Germany expended the most during that period, with almost €37.5 billion of investment in R&D. See Francesco Pasimeni et al., Assessing private R&D spending in Europe for climate change mitigation technologies via patent data, Science Direct, Volume 59, December 2019, https://doi.org/10.1016/j.wpi.2019.101927.

[49] For instance, the International Renewable Energy Agency (IRENA), using data from EPO PATSTAT and Climate Change Mitigation Technologies (Y02) classification by EPO over the period 2000-2017, found that filed patents in renewable energy (RE) (bioenergy, biothermal energy, hydropower, ocean energy, solar energy, wind energy) have increased steadily over the years, reaching a peak in 2011 with 63,365K applications. From 2012 there has been a slight decrease, counting 46,353K patent filings in 2017. See IRENA Technology Patents Report, at http://inspire.irena.org/Pages/patents/Patents-Search.aspx.

[50] To see Michele Boldrin and David K. Levine, Against Intellectual Property, Cambridge University Press, 2010; Stephan Kinsella, Against Intellectual Property, Ludwig von Mises Institute, 2008; Adam B. Jaffe and Josh Lerner, Innovation and Its Discontents: How Our Broken Patent System is Endangering Innovation and Progress, and What to Do About It,

possible to use or exploit the invention without the consent of the patent holder (via e.g., a licence). Therefore, some have argued, the exclusive right conferred to patent holders would lead to higher and even not bearable costs for accessing (if at all) the patented technologies.[51] For this reason, it is stated, numerous manufacturers, principally those located in developing countries, would not be able to incorporate patented green tech.[52] As a result, patents would impede the access to green tech at a fair and affordable price, thus hindering a rapid diffusion of technology transfer, which is essential for reaching the global climate neutrality objectives.[53]

To achieve free access to decisive patented green tech some have thus suggested applying the TRIPS Agreement to design a 'Declaration on IPRs and climate change' comparable to the 'Doha Declaration on the TRIPS Agreement and Public Health'. The latter allows member states to circumvent the rights conferred by patents to facilitate access to essential medicines.[54] In this regard, at first glance, the comparison between medicines and green technologies may appear accurate considering the need to urgently intervene and their 'life-saving' features. Nevertheless, the parallel has often been found weak due to the different characteristics of these fields, such as the inherent competitiveness among green technologies with a subsequent tendency to reduce prices, in contrast with the general lower competition over medicines.[55]

It has also been argued that the above-mentioned concerns do not outweigh the proven benefits of patents.[56] To start with, some information and knowledge are categorised as 'public goods'[57] due to their non-excludable and non-rivalrous characteristics, which make them difficult and costly to create but easy and cheap to replicate.[58] The patent system has been designed as a solution to this market failure, aiming at creating economic incentives in the production of information and technical knowledge.[59] Inventors are incentivised to publicly disclose their innovative ideas in exchange for

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Princeton University Press, 2004; Richard Stallman, Patent Law Is, at Best, Not Worth Keeping, 45 Loy. U. Chi. L.J. 389, 2013, at 389, at https://lawecommons.luc.edu/luclj/vol45/iss2/4/.

[51] Mark F. Schultz and David B. Walker, How Intellectual Property Became Controversial: NGOs and the New International IP Agenda, Engage Volume 6, Issue 2, 2005, p. 1, at https://fedsoc.org/commentary/publications/how-intellectual-property-became-controversial-ngos-and-the-new-international-ip-agenda.

[52] The Global Commission on the Economy and Climate, Better Growth Better Climate, The New Climate Economy Report, The Global Report, 2014, p. 261, at https://newclimateeconomy.report/2014/wp-content/uploads/sites/2/2014/08/NCE-Global-Report_web.pdf.

[53] Ibid p. 262.

[54] Frederick M. Abbott, Innovation and Technology Transfer to Address Climate Change: Lessons from the Global Debate on Intellectual Property and Public Health, (13 July 2009) ICTSD, Issue Paper no. 24, 2009, p. 26 at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1433579. The Doha Declaration adopted on 14 November 2001 acknowledges that *"intellectual property protection is important for "the development of new medicines" but at the same time recognises "the concerns about its effects on prices"*. It clarifies the flexibilities already available for governments in the TRIPS Agreement to protect public health, in particular compulsory licensing and parallel importing. See the Doha Declaration at https://www.wto.org/english/thewto_e/minist_e/min01_e/mindecl_trips_e.pdf.

[55] Jerome H. Reichman, et al., Overcoming the Impasse on Intellectual Property and Climate Change at the UNFCCC: A Way Forward, *International Centre for Trade and Sustainable Development*, Policy Brief No. 11, 2011, p. 3, at https://www.academia.edu/es/27317865/Overcoming_the_Impasse_on_Intellectual_Property_and_Climate_Change_at_UNFCCC.

[56] Maureen K. Ohlhausen, Patent Rights in a Climate of IPRs skepticism, Harvard Journal of Law & Technology, Volume 30, Number 1 Fall 2016, pp. 103-152.

[57] Kristina M. Lybecker and Sebastian Lohse (2015): *Innovation and Diffusion of Green Technologies: The Role of Intellectual Property and Other Enabling Factors.* Global Challenges Report, WIPO: Geneva. pp. 5-6, at https://www.wipo.int/edocs/pubdocs/en/wipo_rep_gc_2015_1.pdf.

[58] James Boyle, The Second Enclosure Movement and the Construction of the Public Domain, 66 Law and Contemporary Problems 33-74, 2003, pp. 41–42, at https://scholarship.law.duke.edu/lcp/vol66/iss1/2/.

[59] Paul A. David and Dominique Foray, Economics Fundamentals of the Knowledge Society, Policy Futures in Education, Volume 1, Number 1, 2003, p. 39, at https://www.researchgate.net/publication/23742432_Economic_Fundamentals_Of_the_Knowledge_Society

obtaining an exclusive right conferred by a patent. This trade-off permits the technological progress of society, balancing private and public interests and promoting economic growth. The public can make use of patented inventions without any cost once the patent protection has expired. In the meantime, the information disclosed provides the public with a (nearly) complete state of the technological development, potentially leading to 'knowledge spillover effects', so that everyone can benefit from each other's inventions.[60]

Moreover, patents constitute, from a private perspective, "a tremendous asset for any organisation because they provide market access, leverage in negotiations, funding and increase economic and strategic value".[61] Indeed, the limited exclusivity time ensured with patents may enable inventors not only to recoup the costs associated with the development of innovative technical solutions, but also to gain profit, by exploiting the invention, e.g., by licensing or selling the patent or by creating a product based on the patented invention and gaining a technological advantage over their competitors. At the same time, the granted right protects innovators from others' imitation or free ride, and drives companies to devote major investments to R&D.

Besides the aforementioned advantages, patents are crucial in the funding process of startups and small and medium-sized enterprises (SMEs), helping them to attract investors and receive venture capital. As a general rule, patents support companies of any size to secure patent-backed loans and access grants and subsidies.[62] For example, the patent portfolio of Kodak was used as collateral to secure a nearly $1bn line of credits, permitting the company involved in a bankruptcy procedure in 2012 to remain operative in the market.[63]

Therefore, it is important for green tech companies to build a strong patent portfolio, regardless of whether their technology is at the venture market stage (such as nanomaterials and wireless power), emerging market stage (for instance ethanol, biofuels and smart grid) or mature market stage (for example solar and wind power, hybrid vehicles and light-emitting diode (LED) lighting).[64] While patents are generally considered valuable, the role they play differ: investors in companies with technology at venture stage normally see patents as proxies signalling the quality of the technology and providing sufficient freedom to operate in the market, thus being able to guarantee their high-risk investment[65]; on the other hand, for technologies at emerging market stage, patents are used to increase the value of the company or expand the network of the users, whereas for more mature technologies, they are tools to grow market share and protect the market segment.[66]

Furthermore, patents permit to capture the value of strategic R&D investments and underpin several forms of R&D partnership, by protecting firms from the risk of knowledge leakage.[67] Thus, in the absence of patent protection, firms and inventors would be forced to rely on trade secrets and other

[60] Mirei Isaka, Intellectual Property Rights, The role of Patents in Renewable Energy Technology Innovation, Working Paper IRENA 2013, p. 12, at https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2013/Intellectual_Property_Rights.pdf.

[61] 4iP Council's "4 Reasons to Patent" infographic at https://www.4ipcouncil.com/4smes/4-reasons-patent

[62] Ibid.

[63] Bruce W. Burton et al., Financing Alternatives for Companies: Using Intellectual Property as Collateral, STOUT Report, 2014, p. 2, at https://www.hilcoglobal.com/docs/librariesprovider10/default-document-library/financing-alternatives-for-companies---using-intellectual-property-as-collateral.pdf?sfvrsn=2.

[64] Patrick Gattari, The Role of Patent Law in Incentivizing Green Technology, 11 Nw. J. Tech. & Intell. Prop. 41, 2013, p. 43, at: https://scholarlycommons.law.northwestern.edu/njtip/vol11/iss2/3.

[65] Stuart J.H. Graham et al., High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkely Patent Survey, in Berkeley Technology Law Journal, Vol. 24:4, 2009, pp. 1244-1328, p. 1306, at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=.1429049.

[66] Gattari P., cit., p. 43.

[67] 4iP Council's "4 Reasons to Patent" infographic at https://www.4ipcouncil.com/4smes/4-reasons-patent.

non-IP assets to enter the market and/or gain a competitive advantage over the rest. Moreover, companies aiming to avoid developing easily appropriable technologies would rather invest in 'difficult to reverse-engineering technologies', such as in house manufacturing or design processes, thus reducing the disclosure of knowledge to the detriment of society and innovation.[68]

Finally, in the context of the climate change field, to date there is no evidence that patents act as barriers in terms of technology transfer.[69] On the contrary, patents are generally considered to foster the diffusion of, for example, renewable energies.[70]

Consequently, where global green tech solutions are needed, a system where the sharing of cutting-edge patented technologies is fostered appears to be the preferred approach. Moreover, cellular standardisation and its virtuous circle of innovation should be incentivized in industry, research institutions and governments' future efforts.

V. Wireless Cellular Standardisation

a. Standards: Definition and Benefits

Standards are documents containing technical requirements (known as 'technical specifications) "for products, production processes, services or test-methods".[71] Thereby, standards allow for products to be compatible and interoperable. Some examples are DVD, USB, WiFi, and the Moving Picture Experts Group (MPEG) for video data compressing.

Standards offer countless benefits. Amongst others, standards foster industrial competitiveness, reduce costs of manufacturing, augment quality and efficiency in production and innovation and lower barriers to trade. Standards are also responsible for the creation and wide dissemination of innovative technologies.[72]

In particular, wireless cellular standards (known as 2G to 5G standards), by enabling interoperability of new technologies[73], have proven to successfully enhance all kinds of sectors. Each generation (G) of cellular standards provides a significant improvement on the previous generation. For example, the data transfer using 4G networks is 12,000 times faster than with 2G.[74] With 5G, citizens will enjoy amongst others smart agriculture, intelligent transport systems, smart manufacturing, and smart

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[68] Ohlhausen H. M., cit., p. 150.

[69] Jon P. Santamauro, Failure is not an option: enhancing the use of intellectual property tools to secure wider and more equitable access to climate change technologies, in Environmental Technologies, Intellectual Property and Climate Change, Edward Elgar Publishing 2013, p. 9, at: https://www.elgaronline.com/view/edcoll/9780857934178/9780857934178.00012.xml.

[70] The patent system appears to be as a *conditio sine qua non* to achieve and promote innovation. See Alfonso Gambardella, The functions of patents in our societies: innovation, market and new firms, February 2021 at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3789554. In relation to the role of IP and green technologies see also Arielle Aberdeen, Patents to climate rescue: how intellectual property rights are fundamental to the development of renewable energy, October 2020, at: https://www.4ipcouncil.com/research/patents-climate-rescue-intellectual-property-renewable-energy.

[71] EC, European Standards, at https://ec.europa.eu/growth/single-market/european-standards_en.

[72] EC, Benefits of standards: European Commission, Internal Market, Industry, Entrepreneurship and SMEs, Benefits of standards, at https://ec.europa.eu/growth/single-market/european-standards/policy/benefits_en.

[73] While the markets have remained open, consumers enjoy "the widest choice of products". See EC, ICT Standardisation, at https://ec.europa.eu/growth/single-market/european-standards/ict-standardisation_en.

[74] Wolfgang Bock et al., Boston Consulting Group, The Mobile Revolution: How Mobile Technologies Drive a Trillion-Dollar Impact, 15 January 2015, at https://www.bcg.com/publications/2015/telecommunications-technology-industries-the-mobile-revolution.

cities.[75] Some examples of groundbreaking technologies created thanks to cellular standards are intelligent transport systems, self-driving cars, remote healthcare solutions, online education platforms, and tactile robotic surgery.

Standardised connectivity brings massive income to companies. The automotive sector alone is expected to earn 30% of its revenue (i.e., around $2 trillion) by 2030 thanks to the connectivity created by cellular standards.[76] They also heavily contribute to economic growth. In 2014 mobile technologies "generated almost $3.3 trillion in revenue globally", [were] directly responsible for 11 million jobs, and "contribute[d] more than $1.2 trillion in GDP [gross domestic product]" in the U.S., Germany, South Korea, Brazil, China, and India.[77] By 2023, the Global System for Mobile Communications Association (GSMA) forecasts around 5.5 billion unique mobile subscribers and 8.5 billion mobile connections worldwide, contributing around $4.1 trillion of economic value to global GDP.[78]

While these 5G enabled technologies will significantly improve our day-to-day lives and facilitate economies of scale that drive efficiency gains and growth, they also consider their impact on the environment. 5G has been developed to increase the data traffic while reducing energy consumption.[79] In fact it is "100 times more energy efficient than earlier radio generations".[80] With 5G water usage can be monitored in real time, which permits an efficient and effective use of water, decreasing greenhouse gas emissions. It is estimated that 5G will "enable the reduction of 374 million metric tons of greenhouse gas emissions". This corresponds to around 6% of the annual emissions or an equivalent to "[t]aking 81 million passenger vehicles off the U.S. roads for one year".[81]

b. 3GPP: Creating and developing cutting-edge technologies

The tremendous success of cellular standards is the result of active participation in the standardisation process on the part of industry, research institutes and government representatives. Attracting a diversity of stakeholders with different backgrounds and business models has been possible thanks

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[75] EC, Smart Cities, https://ec.europa.eu/info/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en; Julia Ribeiro, Julia Brito, P&D, Propriedade intelectual e inovação: um círculo virtuoso para um Brasil competitivo, in Migalhas, 17 September 2021, at https://www.migalhas.com.br/depeso/351862/p-d-propriedade-intelectual-e-inovacao, English version at https://ssrn.com/abstract=3957318.

[76] According to a McKinsey Advanced Industries report, at Bowman Heiden, The Value of Connectivity in the Automotive Sector – A First Look, December 12, 2019, p.3. Available at http://dx.doi.org/10.2139/ssrn.3521488; Boston Consulting Group and GSMA expect *"the aggregate market at more than $3.5 trillion in this decade in sectors that include health care, education, environmental impact management, and financial services and economic inclusion"*. See The Future of Mobile report, March 2020, at https://www.gsma.com/betterfuture/wp-content/uploads/2020/03/GSMA_TheFutureofMobile-1.pdf and https://www.bcg.com/publications/2020/multitrillion-dollar-social-impact-opportunity-for-telcos.

[77] Wolfgang Bock et al., Boston Consulting Group, The Mobile Revolution: How Mobile Technologies Drive a Trillion-Dollar Impact, 15 January 2015, at https://www.bcg.com/publications/2015/telecommunications-technology-industries-the-mobile-revolution.

[78] GSMA, The Mobile Economy 2021, pp. 11 and 38, at https://www.gsma.com/mobileeconomy/wp-content/uploads/2021/07/GSMA_MobileEconomy2021_3.pdf.

[79] Ericsson, Breaking the energy curve. An innovative approach to reducing mobile network energy use, 2020, at https://www.ericsson.com/en/news/2020/3/breaking-the-energy-curve.

[80] Nokia, 5G and sustainable growth, Can 5G break the link between GDP growth and rising greenhouse gas emissions?, at https://www.nokia.com/networks/insights/5g-future/sustainable-growth/.

[81] Qualcomm, Environmental sustainability and a greener economy: The transformative role of 5G, p. 4, at https://www.qualcomm.com/content/dam/qcomm-martech/dm-assets/documents/5g_and_sustainability-_the_transformative_role_of_5g_-_10.4.2021.pdf.

to (1) adherence to certain principles established by the World Trade Organisation (WTO) in the field of standardisation, and (2) a balance of interests between those implementing and those creating the standards.

Cellular standards are created and developed in the 3rd Generation Partnership Project (3GPP), a collaboration of seven standard development organisations (SDOs).[82] These organisations, known as 'organisational partners', transpose the technical specifications produced in 3GPP into standards, to subsequently adopt them in their corresponding territories. In Europe, the organisational partner is the European Telecommunications Standards Institute (ETSI).[83]

To date, 3GPP has attracted over 700 individual members, which belong to at least one organisational partner, that produce the technical reports and technical specifications that delineate 3GPP technologies. These members come from companies, research entities, academia, government and public organisations.[84] Due to the complexity of developing cellular standards, 3GPP technical work is subdivided into three technical specification groups and further into 16 working groups in charge of specific functions and standard documents. The most relevant working groups are RAN1 and RAN2 (RAN stands for Radio Access Network), with 300 to 500 delegates attending each meeting.[85]

5G must "deliver significantly increased operational performance (e.g. increased spectral efficiency, higher data rates, low latency), as well as superior user experience (near to fixed network but offering full mobility and coverage). 5G needs to cater for massive deployment of Internet of Things, while still offering acceptable levels of energy consumption, equipment cost and network deployment and operation cost".[86] To reach these goals, in each working group 3GPP members submit technical proposals to achieve previously agreed technical objectives. For example, RAN1 and RAN2 working groups focus on "the interfaces and technology required over the air between the mobile device and the network infrastructure".[87]

When developing standards, SDOs generally adhere to six fundamental principles set out by the WTO in the field of standardisation. [88] 3GPP is an example of a forum where these principles have been endorsed and successfully implemented. The WTO criteria are (1) Transparency, (2) Openness, (3) Impartiality and Consensus, (4) Effectiveness and Relevance, (5) Coherence, and (6) Development Dimension. Transparency implies, amongst other things, providing participants sufficient time and

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[82] Nizar Abdelkafi et al., ETSI, Understanding ICT Standardization: Principles and Practice, 2018, p.102, at https://www.etsi.org/images/files/Education/Understanding_ICT_Standardization_LoResPrint_20190125.pdf.

[83] The other standard development organisations partners of 3GPP are The Association of Radio Industries and Businesses in Japan (ARIB), The Alliance for Telecommunications Industry Solutions in the USA (ATIS), China Communications Standards Association (CCSA), Telecommunications Standards Development Society in India (TSDSI), Telecommunications Technology Association in Korea (TTA), and the Telecommunication Technology Committee in Japan (TTC). See 3GPP, Partners at https://www.3gpp.org/about-3gpp/partners.

[84] 3GPP Membership at https://www.3gpp.org/about-3gpp/membership.

[85] Ericsson, Estimating the future 5G patent landscape, October 2018, p. 9, at https://www.ericsson.com/4a79f3/assets/local/patents/estimating-the-future-5g-patent-landscape.pdf. As stated by 3GPP, "3G systems should be based on new wideband, multimode, flexible radio access. This approach will ensure that systems based on 3GPP specifications will be capable of rapid development and deployment of competitive service offerings while still enabling global roaming.". See 3GPP, Specifications Groups at https://www.3gpp.org/specifications-groups

[86] ETSI, Why do we need 5G?, at https://www.etsi.org/technologies/5G.

[87] Ericsson, Estimating the future 5G patent landscape, October 2018, p.9.

[88] World Trade Organization, Technical Barriers to Trade: Standards. Principles for the Development of International Standards, Guides and Recommendations, at https://www.wto.org/english/tratop_e/tbt_e/principles_standards_tbt_e.htm. Technical barriers to trade (TBT) are *"mandatory technical regulations and voluntary standards that define specific characteristics that a product should have, such as its size, shape, design, labelling / marking / packaging, functionality or performance"*. The WTO TBT Agreement aims at preventing *"discrimination or arbitrary restrictions on international trade"*. See EC, Technical barriers to trade, at https://trade.ec.europa.eu/doclib/docs/2013/april/tradoc_150987.pdf.

chances for written comments, and an effective distribution of crucial information. Moreover, membership has to be "open", meaning participation is allowed (at least for all WTO Members) in every phase of standard development (e.g., in the technical discussions or when reviewing or voting standards). Also, the development process should not give "privilege to, or favour the interests of, a particular supplier/s, country/ies or region/s". Furthermore, the views of all parties concerned must always be considered with the aim "to reconcile any conflicting arguments" (i.e., no decision is adopted if there is sustained opposition). In addition, standards must be "relevant" and address "effectively regulatory and market needs, as well as scientific and technological developments in various countries". In addition, SDOs should be coherent and avoid any overlap or duplication amongst themselves of the work performed. Finally, the challenges faced by developing countries must be addressed, e.g. by offering technical assistance so that they can participate in the standard development.[89]

Another important aspect in 3GPP is that of all technical contributions (technical specifications) submitted to each of the working groups, only the best solutions, based on the technical merits, are selected to be incorporated into the standard. Consequently, each participant, independently of its size, business model or nationality can participate in this collaborative effort and compete on an equal footing. This framework is particularly important for innovative startups and SMEs, which otherwise may have difficulty in competing against large companies. According to a study analysing technical contributions made in 3GPP during the years 2000-2014, a higher number of SMEs and startups' contributions to 3G and 4G standards was accepted (34.42%) than when contributions were made by larger companies (28.91%).[90]

However, developing these ground-breaking technologies requires massive financial resources. To illustrate, 3GPP members spent over 3.4 million working hours in meetings during approximately nine years,[91] and submitted more than 260,000 technical contributions to develop 3G and 4G standards.[92] Of those submissions, less than 17% (28,460) were incorporated into the standards.[93] In other words, contributors commonly invest significant financial and staff resources without any guarantee that the proposal will be selected. Therefore, they typically protect their risky R&D investments by patents in the hope they may be chosen to be incorporated in the standard. In those cases where a technical specification approved by 3GPP members is covered by a patent, this may become a standard-essential patent (SEP). In simple terms, a SEP is a patented invention that is necessary to comply with a technical standard.

To promote widespread adoption of the standard and address the potential risks deriving from the exclusionary right of SEP holders,[94] SDOs commonly encourage those members owning SEPs to

[89] On the relevance of these principles, see Elisabeth Opie and Haris Tsilikas, Why Open RAN's closed standards setting body could be bad for wireless innovation, 8 December 2021, IAM Magazine, https://www.iam-media.com/frandseps/why-open-rans-closed-standards-setting-body-could-be-bad-wireless-innovation.

[90] Kirti Gupta, The Role of SMEs and Startups in Standards Development, July 12, 2017, at http://dx.doi.org/10.2139/ssrn.3001513.

[91] Justus Baron and Kirti Gupta, Unpacking 3GPP standards, Journal of Economics & Management Strategy 27(3):433-461, September 2018, p. 443.

[92] Signals Research Group, The essentials of intellectual property, from 3G through LTE Release 12 May 2015, p. 2.

[93] Ibidem.

[94] At least in theory, once the standards are incorporated into products or services, some SEP holders could make use of the exclusionary right of patents, blocking access to the standard via an injunctive relief, or demand excessive royalties in the licence to their SEPs (hold-up). Another even more concerning danger would occur if companies that adopt the standards engage in delay tactics to avoid paying for the technologies they are using or until the SEP holder agrees to receive an unreasonably low compensation, thus disincentivising (re-)investment in future generations of the standard (hold-out). As explained by the former Attorney General for the US Department of Justice, Makan Delrahim, "*[t]he hold-out problem arises when implementers threaten to under-invest in the implementation of a standard, or threaten not to take a license at all, until their royalty demands are met*", and represents "*a more serious risk*" than hold-up. See Remarks

make them available on Fair, Reasonable, and Non-Discriminatory (FRAND) terms and conditions.[95] FRAND balances the interests of contributors and implementers. On the one hand, SEP users obtain access to the standardised technology on reasonable terms. On the other hand, SEP holders are fairly and adequately rewarded, thus being encouraged to (re-)invest in the next generation of the standard.[96]

FRAND is to be determined in bilateral good-faith licensing negotiations between the parties.[97] On rare occasions where parties cannot find a FRAND agreement, they may end in litigation. If so, the SEP holder typically asks for an injunction to be granted, while the SEP user may raise a FRAND defence (trying to avoid the injunction). In the EU, injunctive relief for an SEP for which there is a FRAND commitment can only be granted within the framework established by the Court of Justice of the European Union in *Huawei v ZTE*.[98] According to the Court, to obtain injunctive relief the SEP holder must (1) notify the infringement, and (2) provided the SEP user expresses its willingness to conclude a FRAND offer, present a specific FRAND offer to the SEP user, explaining the royalty and the method of calculation. The SEP user can only raise a FRAND defence if (1) following the infringement notification, it expresses 'without delay' its willingness to conclude a FRAND offer, (2) diligently responds to the SEP holder's offer (either accepting it or presenting a FRAND counteroffer), and (3) provides a security should the counteroffer be rejected as well as render accounts for past uses.[99]

at the USC Gould School of Law's Center for Transnational Law and Business Conference, Los Angeles, CA, 10 November 2017 at https://www.justice.gov/opa/speech/assistant-attorney-general-makan-delrahim-delivers-remarks-usc-gould-school-laws-center.

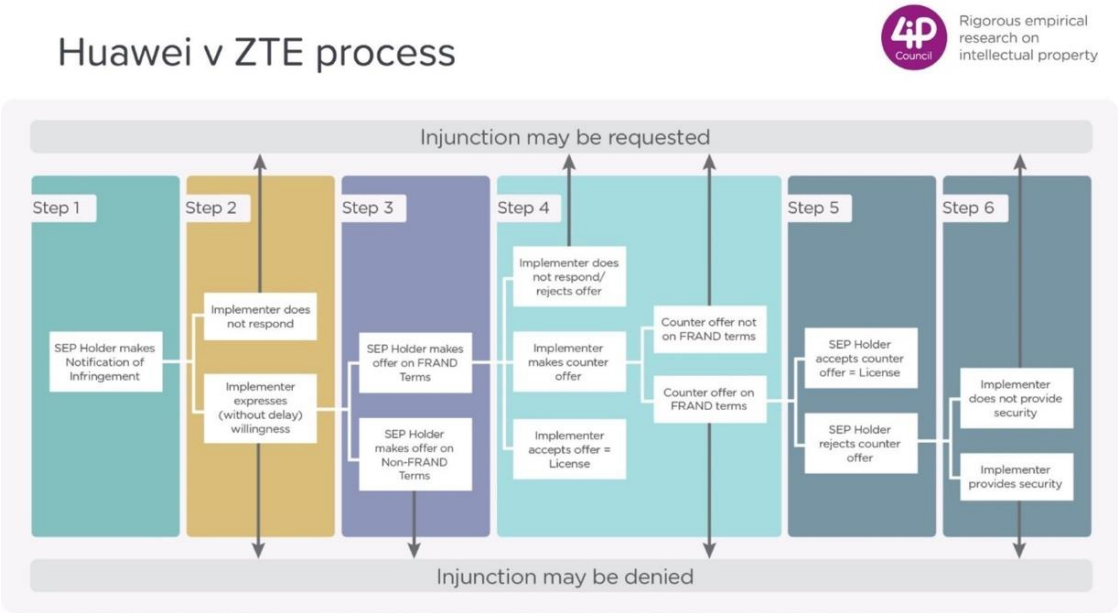
[95] ETSI IPR Policy, available at https://www.etsi.org/intellectual-property-rights. Please note this does not mean a commitment to license to all under FRAND terms, but rather to make them accessible. See Juan Martinez, FRAND as Access to All versus License to All. GRUR Int. 2019, 633, July 2019 & Journal of Intellectual Property Law & Practice, Volume 14, Issue 8, August 2019, pp. 642–651. The value remains the same independently of where in the value chain the SEP is licensed, Bowman Heiden et al., The Value of Standard Essential Patents and the Level of Licensing, 23 October 2020, at http://dx.doi.org/10.2139/ssrn.3717570.

[96] ETSI, IPRs at https://www.etsi.org/intellectual-property-rights.

[97] Luis Herranz and Claudia Tapia, Good and Bad Practices in FRAND Licence Negotiation (chapter) in Resolving IP Disputes, Zeiler/Zojer (eds), pp. 49 -68, 2018. On the contractual nature of FRAND see Eleftheria Stefanaki and Spyros Makris, Das Vertragsrecht der ETSI FRAND-Erklärung, Mitt. Heft 4/2022, 147-157.

[98] *Huawei Technologies Co. Ltd v. ZTE Corp*, Case C-170/13, judgment dated 16 July 2015, para 71. See a summary of the court ruling as well as how national courts interpreted it at 4iPCouncil, https://caselaw.4ipcouncil.com/ and https://caselaw.4ipcouncil.com/guidance-national-courts.

[99] *Huawei Technologies Co. Ltd v. ZTE Corp*, Case C-170/13, judgment dated 16 July 2015, para. 71. See Sisvel v Haier, Federal Court of Justice, judgment dated 5 May 2020, Case-No. KZR 36/17. See summary at 4ip Council, at https://caselaw.4ipcouncil.com/german-court-decisions/federal-court-of-justice-bgh/sisvel-v-haier-federal-court-justice-bundesgerichtshof. See a summary of the CJEU ruling as well as how national courts interpreted it at 4iP Council, https://caselaw.4ipcouncil.com/ and https://caselaw.4ipcouncil.com/guidance-national-courts. See also, Luis Herranz and Claudia Tapia, Good and Bad Practices in FRAND Licence Negotiation, Gerold Zeiler and Alexander Zojer (eds), Resolving IP Disputes (NWV Verlag 2018).



Source: 4iP Council, National Courts Guidance[100]

VI. Proposed strategy and conclusions

Climate change is one of the greatest global challenges of our century. Hence, a multitude of initiatives have been set on an international level to reach a carbon-neutral world by 2050. However, for the green transformation to become a reality three main requirements are to be fulfilled: (1) large investment in R&D, (2) strong collaboration between universities, public research institutions, industry and governments and (3) the creation and adoption of global green-tech solutions.[101]

As shown in the paper, standardisation can deliver high quality and affordable global solutions to the climate-change problem. Thanks to standards, companies and research institutes can engage in early investments in R&D, which can lead to the creation of cutting-edge technologies. Despite being frequently protected by patents, these technologies, if selected to become part of the standard, are typically available under FRAND terms, allowing for wide dissemination while fairly and adequately compensating innovators. The latter permits boosting reinvestment in the next generation of the standard, thus starting again the circle of innovation.

The importance of standards for environmental protection has been already recognised by the EU.[102] Consequently, in the EU Green Deal, the Commission promised to work on new standards "for sustainable growth and use its economic weight to shape international standards that are in line with EU environmental and climate ambitions".[103] The ways in which standards can be used in support of the EU Green Deal have been analysed by the European Environmental Citizens' Organisation for

[100] See https://caselaw.4ipcouncil.com/guidance-national-courts.
[101] Despite all the benefits of Europe's ambition to "become more sustainable, resilient, regenerative and circular", the world needs global solutions. See European Commission, ESIR 2020-2021, Main achievements, 24 January 2022, at https://op.europa.eu/en/web/eu-law-and-publications/publication-detail/-/publication/3c1d7eca-7cc5-11ec-8c40-01aa75ed71a1.
[102] EU Green Deal, par. 2.1., p. 4.
[103] EU Green Deal, par. 3, p. 22.

Standardisation (ECOS)[104] and by CENELEC.[105] These studies show how the development and implementation of standards can support the EU Green Deal in a wide range of fields, such as plastics, textiles, construction,[106] waste and finance. Also, standardisation is decisive for the optimisation of the sustainability of product design, making high-environmental-impact sectors (such as steel, cement and chemicals) greener. In addition, it would allow to rethink production processes or methods, improve packaging design and measurement methods for the determination of recycled plastic content in products, or assess the durability and recyclability of textiles.

To encourage standardisation, some initiatives could be taken. For example, governments could guarantee tax benefits for 'environmentally-friendly' patents, and patent offices could offer, thanks to government financial support, reduced renewal fees for green tech patents. These tax benefits and reduced renewal fees should, however, only be granted if these patents are contributed and selected to be part of the standard. Analysing 3GPP, this paper has shown the importance of an open, transparent, consensus-based and balanced framework in the standardisation process, as well as in any decision related to the IPR Policy of the standard development organisation. By endorsing these (WTO) principles and offering access to essential (green) technology under fair, reasonable and non-discriminatory terms, effective technical solutions to fight climate change can be successfully created and disseminated around the globe.

[104] European Environmental Citizens' Organisation for Standardisation (ECOS), Standards in the time of the European Green Deal – How standards can support the environment, April 2020, at https://ecostandard.org/wp-content/uploads/2020/04/ECOS-PAPER-Standards-in-the-time-of-the-European-Green-Deal.pdf.

[105] CEN-CENELEC, Standard for Environments, 2020 at https://www.cencenelec.eu/news/publications/Publications/2020-1112-BrochureEnvironnementCenCenelec-5.pdf. ; CEN-CENELEC, Standards in support of the European Green Deal Commitments, at https://www.cencenelec.eu/CEN-CENELEC Green Deal Position Paper.pdf.

[106] For a case study in the construction sector see Maj M. Andersen and Lourcenço G. D. Faria (2015). Standardization and Green Economic Change - the Case of Energy Efficiency in Buildings, *Proceedings of the EURAS 2015 Conference* European Academy for Standardisation e. V. at https://www.researchgate.net/publication/298790297_Standardization_and_Green_Economic_Change_-_the_Case_of_Energy_Efficiency_in_Buildings.