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The International Electrotechnical Commission

A 115-Year Journey of Challenges, Change, and Resilience

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15.1 INTRODUCTION

Within a few years after it was established in 1906, the International Electrotechnical Commission (IEC) became the institutional focal point for the governance of electro-technologies and has for 115 years retained this preeminence – exhibiting striking resilience. As of the end of 2021, the IEC had developed 11,200 international technical standards and standard-like documents,[1] specifying design, performance, labeling, and other aspects of millions of electrical and electronic components and products. These standards are widely used across the globe for consumer products (with implications for consumer safety, consumer choice, and market share)[2] and – even more so – in business-to-business transactions.[3] In a wide range of industries,

[*] The authors thank Panos Delimatsis, Henk de Vries, Oliver Gray, and Enrico Partiti for comments on a previous draft and Stephanie Bijlmakers for sharing several drafts of her ISO chapter. Access to all hyperlinks was last checked on June 20, 2022.

[1] IEC, Understanding Standards: IEC Publications at a Glance, www.iec.ch/understanding-standards#publications.

[2] See, e.g., A. F. Alshadafan, Energy Efficiency Standards: The Struggle for Legitimacy (January–June 2020) 18:1 *International Journal of Standardization Research* 1–23; T. Büthe, The Power of Norms; the Norms of Power: Who Governs International Electrical and Electronic Technology?, in *Who Governs the Globe?* (D. Avant, M. Finnemore, and S. K. Sell eds., 2010), 292–332, esp. 292–294; K. Imagawa, Y. Mizukami, and S. Miyazaki, Regulatory Convergence of Medical Devices: A Case Study Using ISO and IEC Standards (2018) 15:7 *Expert Review of Medical Devices* 497; K. Kazlovich et al., Open Ventilator Evaluation Framework: A Synthesized Database of Regulatory Requirements and Technical Standards for Emergency Use Ventilators from Australia, Canada, UK, and US (2022) 11 *HardwareX* 2–13; S. Moon and H. Lee, Exploring Standard Dynamics in Electronics Industry: Focusing on Influencing Factors and Revision of IEC Standards (August 2022) 69:4 *IEEE Transactions on Engineering Management* 1365–1377; T. S. Ustun and S. M. S. Hussain, IEC 61850 Modeling of UPFC and XMPP Communication for Power Management in Microgrids (2020) 8 *IEEE Access* 141696–141704.

[3] See, e.g., S. Moon, K. Chin, and H. Lee, IEC Standard Revision Dynamics: Symbiosis between Standard and Technology (2018) *Portland International Conference on Management*

they affect the functioning of markets, including market access and the distribution of costs and benefits, through interoperability, substitutability, etc. IEC standards thus ultimately govern technologies ranging from magnetics; electro-acoustics; batteries, and energy production, storage, and distribution; to information and communication technologies and various aspects of the digital economy, including artificial intelligence–supported applications and virtual/extended reality.

IEC technology governance thus is an example of private authority. The IEC exercises this authority as a nongovernmental transnational organization, along with its national member bodies (of which the most prominent ones are also mostly nongovernmental) and the overwhelmingly private-sector experts who populate its technical committees and carry out most of the technology governance functions in practice. This chapter examines the resilience of IEC private ordering.[4]

Notwithstanding the often high commercial stakes and the substantive societal importance of its standards, the IEC has attracted much less attention than its companion international standard-setting body, the International Organization for Standardization (ISO), examined in this volume in the chapter by Stephanie Biljmakers.[5] One reason why the IEC has received less public and scholarly attention is that it has deliberately steered clear of getting involved in efforts to govern broad issues such as general quality management, environmental impact assessment and management, and corporate social responsibility, which the ISO addresses through its 9000-, 14000- and 26000-series of standards, respectively. These issues are of great economic and societal importance and have created much, sometimes controversial, visibility for the ISO. The public interest in these issues has prompted ISO to set up multi-stakeholder processes that have been extensively scrutinized by scholars and practitioners alike[6] but remain atypical of the technical

of Engineering and Technology (PICMET) 848–1751; J. C. Webb, T. Neighbours, and H. Karandikar, IEC versus IEEE/ANSI MV Switchgear: Matching the Standard to the Application, 2020 IEEE/IAS 56th Industrial and Commercial Power Systems Technical Conference (I&CPS, 2020), at 1–9; M. Voytchev, R. Behrens, R. Radev, Latest Updates for the IEC Standards for Active and Passive Dosemeters (2020) 166 *Radiation Physics and Chemistry* 108–509.

[4] On the notion of transnational orders, see B. D. Richman, Firms, Courts, and Reputation Mechanisms: Towards a Positive Theory of Private Ordering (2004) 104:8 *Columbia Law Review* 2328–2367; T. Halliday and G. Shaffer (eds.), *Transnational Legal Orders* (2015).

[5] See S. Bijlmakers, "The International Organization for Standardization: A Seventy-Five-Year Journey Toward Organizational Resilience" in this volume (Chapter 13).

[6] See, in particular, J. Clapp, The Privatization of Global Environmental Governance: ISO 14000 and the Developing World (1998) 4:3 *Global Governance* 295–316; K. T. Hallström, Organizing the Process of Standardization, in *A World of Standards* (N. Brunsson and B. Jacobsson eds., 2000), 85–99; K. T. Hallström and M. Boström, *Transnational Multi-Stakeholder Standardization* (2010); P. Gibbon and L. F. Henriksen, On the Pre-history of ISO 9000: The Making of a Neo-liberal Standard and C. N. Murphy and J. A. Yates, ISO 26000, Alternative Standards, and the 'Social Movement of Engineers' Involved with Standard Setting, both in *Governing Through Standards* (S. Ponte, P. Gibbon, and J. Vestergaard eds., 2011), 130–158, 159–183; P. Catska and Ch. J. Corbett, Diffusion, Impact and Governance of

standard-setting processes in ISO and IEC (as well as the many organizations that mimic the ISO-IEC blueprint).[7]

IEC standards tend to be more strictly technical and relatively narrowly focused on issues specific to electro-technologies. Most scholarship about the IEC has accordingly been standard-specific.[8] And with very few exceptions,[9] previous work has paid little attention to the IEC's institutional resilience.

This dearth of analytical attention is unfortunate since the IEC has, over the course of its 115-year history, experienced a series of challenges to its centrality as the preeminent international body for the governance of electro-technology and a key node in the increasingly global network of electrical and electronics engineering, which make studying the IEC insightful for understanding institutional resilience. The IEC has adapted to technological changes, the rise of the consumer movement, power shifts in the world economy, and other challenges with remarkable agility, building and exhibiting resilience, often by heading off challenges before they became existential crises. Examining the pursuit of resilience in the specific case of the IEC is valuable not just because it is even more purely representative of

ISO 9000, ISO 14000, and Other Management Standards (2015) 7:3–4 *Foundations and Trends in Technology, Information and Operations Management* 161–379; R. Hahn and C. Weidtmann, Transnational Governance, Deliberate Democracy, and the Legitimacy of ISO 26000: Analyzing the Case of a Global Multistakeholder Process (2016) 55:1 *Business and Society* 90–129.

7 See T. Büthe and W. Mattli, Private Regulators in Global Product Markets, in *The New Global Rulers: The Privatization of Regulation in the World Economy* (2011), 126–161. The deliberateness of the IEC decision to steer clear of contentious issues of broad public significance was conveyed to the authors in not-for-attribution interviews with current and former members of the IEC Standardization Management Board; it may be considered part of its resilience strategy (avoiding risks to the IEC's legitimacy by getting directly involved in public controversies).

8 In addition to the work noted above (*supra* notes 2 and 3), see, e.g., M. Ianoz, H. Kunz, and D. Moehr, Standardization Activities in the Field of EMC, in *Proceedings from the 3rd International Symposium on Electromagnetic Compatibility, 21–24 May 2002* (L. Zhang and Y. Wen eds., 2002), 23–26; M. Felser and T. Sauter, Standardization of Industrial Ethernet: The Next Battlefield?, in *International Workshop on Factory Communication Systems: Proceedings* (2004), 413–420; A. Schreiner-Karoussou, Review of Image Quality Standards to Control Digital X-Ray Systems (2005) 117:3 *Radiation Protection Dosimetry* 23–25. Note, however, that electro-technology has long been understood to include electronics and hence in principle any and all issues related to gathering, storing, processing/analyzing, and otherwise using data. In the digital age of industry 4.0, it is therefore ever less obvious what issues are outside the purview of IEC standard-setting. General (brief) overviews of the IEC and its role in global technology governance are provided by J. Buck, International Electrotechnical Commission, in *Handbook of Transnational Economic Governance Regimes* (C. Tietje and A. Brouder eds., 2010), 573–584; O. Kanevskaia, International Electrotechnical Commission (IEC), in *Elgar Encyclopedia of International Economic Law* (T. Cottier and K. Nadakavukaren Schefer , 2017), 149–150.

9 T. Büthe, Engineering Uncontestedness? The Origins and Institutional Development of the International Electrotechnical Commission (IEC) (2010) 12:3 *Business and Politics* 1–62; H.-W. Liu, International Standards in Flux: A Balkanized ICT Standard-Setting Paradigm and Its Implications for the WTO (2014) 17:3 *Journal of International Economic Law* 551–600; Alshadafan, *supra* note 2.

institutionalized technical standard-setting than the ISO, but also because it offers some distinctive insights, in part due to its longer history. We therefore provide this analysis of IEC resilience as a complement to the analysis of ISO resilience by Stephanie Bijlmakers.[10]

Our analysis of IEC resilience builds on Panagiotis Delimatsis' notion of resilience as the ability to "absorb stress and reorganize after the occurrence of a disturbance that upsets" the status quo equilibrium.[11] A private regulatory body – or more generally an inter- or transnational organization – is resilient to the extent that it does not just nominally survive an exogenous (or possibly endogenous) sudden shock or gradual yet serious challenging internal or environmental changes but "absorb[s] stress," adapts, reorganizes, or in other ways responds to the "stress" on the system so as to "emerge" from the episode "resembling its former state and functionality."[12]

A conceptualization of resilience as persistence through adaptability, however, raises the – theoretically and empirically challenging – question of at what point adaptability entails so much change that it is no longer a means of resilience but rather an indication of the lack thereof, as illustrated by the long-standing conceptual and empirical debate over escape clauses in trade agreements.[13] Similarly, when EU political leaders temporarily set aside state aid rules to allow member states to subsidize their domestic firms to help businesses stay afloat and prevent mass unemployment in light of, first, the COVID-19 pandemic and subsequently the Russian invasion of Ukraine, is this indicative of the resilience of the state aid rules or indicative of how brittle European political leaders' commitment to the ordoliberal regime of controlling economic nationalist subsidies really is?[14] In Section

[10] See S. Bijlmakers, "The International Organization for Standardization: A Seventy-Five-Year Journey Toward Organizational Resilience" in this volume (Chapter 13).

[11] See P. Delimatsis, "The Resilience of Private Authority in Times of Crisis" in this volume (Chapter 1).

[12] Ibid.

[13] A. O. Sykes, Protectionism as a "Safeguard": A Positive Analysis of the GATT "Escape Clause" with Normative Speculations (Winter 1991) 58:1 *University of Chicago Law Review* 255–305; B. P. Rosendorff and H. V. Milner, The Optimal Design of International Trade Institutions: Uncertainty and Escape (Autumn 2001) 55:4 *International Organization* 829–857; K. Bagwell, K. and R. W. Staiger, Enforcement, Private Political Pressure, and the General Agreement on Tariffs and Trade/World Trade Organization Escape Clause (June 2005) 34:2 *Journal of Legal Studies* 471–513; K. J. Pelc, Seeking Escape: The Use of Escape Clauses in International Trade Agreements (June 2009) 53(2) *International Studies Quarterly* 349; W. Phelan, *In Place of Inter-State Relations: The European Union's Rejection of WTO-Style Trade Sanctions and Trade Remedies* (2014).

[14] See, e.g., S. Meunier and J. Mickus, Sizing up the Competition: Explaining Reform of European Union Competition Policy in the Covid-19 Era (2020) 42:8 *Journal of European Integration* 1077; I. Agnolucci, Will COVID-19 Make or Break EU State Aid Control? An Analysis of Commission Decisions Authorising Pandemic State Aid Measures (January 2022) 13:1 *Journal of European Competition Law & Practice* 3–16. For a pre-crisis account of the evolution of the regime, see T. Büthe, Historical Institutionalism and Institutional Development in the EU: The Development of Supranational Authority over Government

15.2, we therefore briefly introduce the IEC as a private regulatory body, focusing on four fundamental, defining characteristics or "attributes" of IEC-based technology governance, which would have to remain largely intact for any adaptation of this private regulatory body under changing circumstances to be considered indicative of resilience.

In Section 15.3, we then sketch the theoretical framework guiding our empirical analyses, before we identify and discuss four key challenges to the IEC's preeminence and legitimacy over the course of its 115-year history in Sections 15.4–15.7, where we examine how the IEC has responded to those challenges. In Section 15.8, we discuss whether the experience of previous challenges has increased the private rule-making body's resilience over time.

15.2 THE INTERNATIONAL ELECTROTECHNICAL COMMISSION: ESSENTIAL ATTRIBUTES

Advances in electrical engineering in the late nineteenth century motivated prominent electrical engineers from across the then-developed world to seek common terms and measurements. In creating common metrics and nomenclatures, they sought to facilitate scientific and commercial exchange, reduce safety risks in the development and operation of electrical machinery, and foster the development of electrical engineering as a new field of science and engineering without borders. The developments in electro-technology and other considerations, which prompted them to institutionalize their information exchange and standardization efforts by founding the IEC in 1906, have been examined in some detail elsewhere.[15] Rather than recap the early history of the IEC, we highlight here four essential or "fundamental attributes"[16] of the IEC. These fundamental attributes would need to remain intact in the face of stress-induced adaptation for persistence to constitute "resilience" as defined above.

The first essential attribute of the IEC is being the institutional focal point for inter- or transnational electro-technology governance – or at least being able to make a defensible claim to being such a focal point and have that claim be widely believed. Being such a focal point implies, above all, providing the institutional structure and having the technical and administrative ability for developing high-quality technical standards in its area of expertise. It also implies that those standards, once they have been developed, will be widely used across the globe, not just where

Subsidies (State Aid), in *Historical Institutionalism and International Relations: Explaining Institutional Development in World Politics* (T. Rixen, L. A. Viola, and M. Zürn eds., 2015), 37–67.

[15] Büthe, *supra* note 2, at 297–302; Büthe, *supra* note 9, esp. 16–20; J. A. Yates and C. N. Murphy, *Engineering Rules: Global Standard Setting since 1880* (2019), esp. 63–80.

[16] See P. Delimatsis, "The Resilience of Private Authority in Times of Crisis" in this volume (Chapter 1).

their implementation might be required by public laws and government regulations but also voluntarily because they are considered useful by producers and users of the products and services governed by those standards.[17] If a standards-developing organization (SDO) is widely believed to have these qualities, it will lead to a widespread expectation that this SDO will (maybe even should) be the place where stakeholders will address further standard-setting needs related to the organization's area of expertise.

As highlighted by Büthe and Mattli's typology of global regulation,[18] having such a single focal institution for technical standard-setting in a given jurisdiction or market avoids the (often drawn-out and resource-intensive) process of multiple standards competing in "standards wars" for market share *after* two or more conflicting standards have been fully developed – though at the cost of shifting the underlying conflicts of interest to the standard-setting stage.[19] It creates incentives to invest in institutionalized joint standards development before a particular technical solution gets finalized and adopted as an international standard – subject to the structure, rules, and procedures of the standards-developing organization.

A second essential attribute of the IEC is maintaining internationally broad-based input legitimacy for its role as a global governor through inclusiveness toward all legitimate stakeholders based on a structure of nominally equal national representation.[20] The creation of the International Electrotechnical Commission was preceded in the late nineteenth century by the establishment of domestic electrotechnical "societies" – professional associations of physicists and early electrical engineers – within virtually all the "advanced," industrializing countries at the time.

[17] For a discussion of the many economic, socio-political, and legal incentives to implement such "voluntary" technical standards (or at least claim compliance) even when it is not required, see T. Büthe, Private Regulation in the Global Economy: A (P)Review (October 2010) 12:3 *Business and Politics* 1, esp. 15–20; T. Büthe, Global Private Politics: A Research Agenda (October 2010) 12:3 *Business and Politics* 1, esp. 8–11; and H. Schepel, *The Constitution of Private Governance: Product Standards in the Regulation of Integrating Markets* (2005).

[18] Büthe and Mattli, *supra* note 7, at 18–41.

[19] On standards wars, see, e.g., C. Shapiro and H. R. Varian, The Art of Standards Wars (Winter 1999) 41:2 *California Management Review* 8–32; A. Augereau, S. Greenstein, and M. Rysman, Coordination versus Differentiation in a Standards War: 56k Modems (Winter 2006) 37:4 *Rand Journal of Economics* 887–909; A. A. Quark, *Global Rivalries: Standards Wars and the Transnational Cotton Trade* (2013); G. Llanes and J. Poblete, Technology Choice and Coalition Formation in Standards Wars (June 2020) 68:2 *Journal of Industrial Economics* 270–297. The classic analysis of the efficiency of cooperative development of technical standards vs. standards wars remains J. Farrell and G. Saloner, Coordination through Committees and Markets (Summer 1988) 19:2 *Rand Journal of Economics* 235–252.

[20] On legitimacy and participation in global governance institutions, see J. Pauwelyn et al., eds. *Rethinking Participation in Global Governance: Challenges and Reforms in Financial and Health Institutions* (2022); esp. M. DeMenno and T. Büthe, Voice and Influence in Global Governance: An Analytical Framework, in Pauwelyn et al. (eds.), 31–70; regarding the notion of global governors and their various possible sources of authority, see D. D. Avant, M. Finnemore, and S. K. Sell, Who Governs the Globe?, in *Who Governs the Globe?* (D. Avant, M. Finnemore, and S. K. Sell eds., 2010), at 9–14.

The highly transnationally connected individuals who started the IEC were mostly the leading figures within those domestic bodies.[21] And while they initially largely acted on their own (and often with a personal commercial stake in the matter as commercially successful scientist-entrepreneurs), they laid a claim to acting on behalf of those national bodies. The IEC then later asserted these bodies to be representatives of all legitimate stakeholders in those countries. The IEC's structure reflects this historical legacy to this day, and it is central to its claim of legitimacy based on inclusiveness toward all legitimate stakeholders via internationally broad representation. This claim to internationally broad representation means concretely that participation in IEC governance is organized by country and requires each participating country to have a domestic Electrotechnical Committee, which, upon becoming the country's IEC member body, is recognized as the country's "National Committee" in the IEC.

A third essential attribute of the IEC is its status as a nongovernmental (and therefore transnational) organization. The electrotechnical societies that were the IEC's founding member bodies were mostly nongovernmental bodies.[22] Over time, many of them have been recognized by their respective governments as private bodies with a public purpose; quite a few are also partially government-funded and/or regulated by governments; and a number of the national committees, especially from the Global South, are even government entities. The IEC, however, considers itself a strictly nongovernmental body – a defining feature that was consciously and emphatically selected already in the very beginning[23] – and governments as such have no direct role in IEC governance.[24]

The IEC's nongovernmental status has numerous important consequences. Among them is that the IEC does not have guaranteed public financial support but instead depends for its financial viability on buy-in from its – mostly commercial – stakeholders. Those stakeholders provide the IEC with expertise through their participation in standard-setting as well as financial resources, directly, by literally buying the documents that contain the technical specifications of IEC standards, as well as indirectly, via the National Electrotechnical Committees that comprise the IEC and pay membership fees. At the same time, the IEC's nongovernmental

[21] Büthe, *supra* note 2, at 297–301; D. Cahan, Helmholtz in Gilded-Age America: The International Electrical Congress of 1893 and the Relations of Science and Technology (2010) 67:1 *Annals of Science* 1–38; E. Warburg, Werner Siemens und die Physikalisch-Technische Reichsanstalt (1916) 4:50 *Naturwissenschaften* 793–797; Yates and Murphy, *supra* note 15, at 64–67.

[22] Even in cases such as Hungary, for which the delegate at the 1906 meeting officially represented the Ministry of Commerce, the body that became the IEC member body for Hungary was the nongovernmental Elektrotechnischer Verein.

[23] Report of Preliminary Meeting, London: International Elecrotechnical Commission, 1906, at 10.

[24] Büthe, *supra* note 2, at 312–314.

character constrains the usability of traditional power resources of states[25] but also means that the legitimacy of global technology governance may be much more easily challenged than the legitimacy of a traditional (inter-state) international organization.

The fourth "fundamental attribute" of IEC governance is maintaining a balance between decentralized, bottom-up agenda-setting and decision-making, on the one hand, and centralized coordination and oversight, on the other, to ensure coherence and consistency as well as maintain the IEC's ability to act in pursuit of its organizational self-interest. As discussed below (Section 15.3.2), the pursuit of this balance has been a key driver of the IEC's structure and procedures and an essential source of both its technical authority (enabling it to become the focal institution for international electrotechnical standard-setting) and its legitimacy.

15.3 EXPLAINING RESILIENCE

15.3.1 *Theoretical Sketch*

A fully developed theory of organizational resilience is beyond the scope of this chapter. Yet an explicit sketch of the theoretical ideas underpinning our empirical analysis is warranted before we turn to examining specific challenges faced by the IEC over the course of its 115-year history. Building on Büthe's proto-theory of preeminence in global private governance,[26] we posit that, for a substantively important international organization or transnational governance body, resilience – in the sense of its ability to survive shocks and environmental changes, such that it still resembles its former state and functionality as defined by its essential attributes – requires such a body to have three characteristics:

(1) **Capacity and capability for autonomous agency.** To be resilient, a global governance body needs to be set up in such a way that it is able to pursue its organizational self-interest even in cases when the body's interests are distinctive from the interests of the national-level or sub-national units that comprise the inter- or transnational body. Such capacity for agency implies a structure where the leadership and staff support does not just rotate among these "members" but has some permanence and genuinely identifies with, or has allegiance toward, the global governance body. It also requires the leadership to be authorized and incentivized to speak and act on behalf of the organization with some degree of autonomy.

[25] W. Mattli and T. Büthe, Setting International Standards: Technological Rationality or Primacy of Power? (October 2003) 56:1 *World Politics* 1–42.

[26] Büthe, *supra* note 9, at 9ff., esp. 10–12.

https://doi.org/10.1017/9781009329408.021 Published online by Cambridge University Press

Following Cafaggi and Pistor's work on regulatory regimes, Lavenex, Serrano and Büthe have recently introduced into the analysis of global governance bodies Nussbaum and Sen's distinction between capacity and capability. The latter is defined as "the ability to recognize and articulate" the organization's self-interest, even when it is not just the lowest common denominator (or some other function) of the constitutive units' self-interest but might even diverge from them. Capability thus also implies an ability to develop original, alternative proposals for how best to pursue the organization's own interests.[27] Having capability implies that the transnational body must have some permanent staff with the requisite analytical skill set, as well as financial resources that are at least in part independent of its members.

(2) **Embeddedness among stakeholders.** There is no global governance in a Hobbesian state of nature. Governance authority at the inter- or transnational level must be built and actively maintained since such authority is usually and traditionally situated at the local or national level – or at most at the level of regional common markets.[28] To be resilient, retain authority, and remain a focal point for developing standards or to govern other aspects of technology in the face of challenges, a global governance body needs to be at least sufficiently embedded among its members (and possibly other stakeholders) to ensure the continued relevance of the organization's work to those stakeholders. Particularly important in this respect is the ability to recognize and meet the needs of stakeholders who might be in a position to participate in, or even set up, alternative inter- or transnational governance arrangements – sufficiently so that it reduces the incentive of those stakeholders to explore alternatives. At the same time, meeting the particular needs of those stakeholders must not to so far that the global governance body loses the required autonomy or legitimacy in the eyes of the organization's other stakeholders.[29]

(3) **Ambition.** The combination of capacity and capability should in principle assure the active and strategic pursuit of the organization's survival

[27] S. Lavenex, O. Serrano, and T. Büthe, Power Transitions and the Rise of the Regulatory State: Global Market Governance in Flux. Introduction to a Special Issue (July 2021) 15:3 *Regulation and Governance* 445–471, at 450. See also F. Cafaggi and K. Pistor, Regulatory Capabilities: A Normative Framework for Assessing the Distributional Effects of Regulation (June 2015) 9:2 *Regulation and Governance* 95–107.

[28] P. Genschel and R. Werle, From National Hierarchies to International Standardization: Modal Change in the Governance of Telecommunications (July–September 1993) 13:3 *Journal of Public Policy* 203–225; S. Schmidt and R. Werle, *Coordinating Technology: Studies in the International Standardization of Telecommunications* (1998); M. Egan, *Constructing a European Market: Standards, Regulation, and Governance* (2001).

[29] On the notion of embeddedness, which informs this discussion, see J. Ruggie, International Regimes, Transactions, and Change: Embedded Liberalism in the Postwar Economic Order (Spring 1982) 36:2 *International Organization* 379–415; and P. B. Evans, *Embedded Autonomy: States and Industrial Transformation* (1995).

with its essential attributes intact – that is, its resilience – because the continued existence and substantive relevance can be assumed to be an essential first-order preference of any organization.[30] In practice, however, the actual active and strategic pursuit of the organization's self-interest is also a function of the skill of the organization's leadership and its ambition to ensure the organization's continued existence and importance. Institutional factors, such as career incentives and rewards for senior leaders' skillful pursuit of resilience, can increase the likelihood that the global body will exhibit such ambition and develop the skills to pursue resilience, but the idiosyncratic qualities of the individuals who fill those leaderships conditions also matter.[31]

15.3.2 *Does the IEC Meet the Requirements for the Pursuit of Resilience? Applying the Analytical Framework to the Specific Case*

Operationalizing the required characteristics for the specific case of the IEC suggests that the IEC meets (and for a long time has met) the criteria set up abstractly above, which should empower it to pursue resilience. We first discuss how the IEC assures embeddedness, which is critical to the IEC's technical expertise and authority, as well as key to the commercial usefulness of its standards. Given that electro-technology has changed tremendously over the course of the IEC's existence (and it continues to evolve over time), with innovations resulting in "new" areas of electro-technology not yet covered by the IEC's structure, maintaining (the ambition for) such preeminence also implies the ability to pursue organizational interests actively and strategically. It also implies a responsiveness to – and maintaining a reasonable balance between – major stakeholders who might otherwise have the credible option to try to "go it alone"[32] by developing competing standards outside of the IEC.[33] So does the IEC exhibit capacity and capability, as well as embeddedness?[34]

[30] T. Büthe, Historical Institutionalism and Institutional Development in the EU: The Development of Supranational Authority over Government Subsidies (State Aid), in *Historical Institutionalism and International Relations: Explaining Institutional Development in World Politics* (T. Rixen, L. Viola, and M. Zürn eds., 2016), 37–67.

[31] See J. A. Yates and C. N. Murphy, Charles Le Maistre: Entrepreneur in International Standardization (2008) 51 *Entreprises et Histoire* 10; and *supra* note 15.

[32] L. Gruber, *Ruling the World: Power Politics and the Rise of Supranational Institutions* (2000); J. Odell, *Negotiating the World Economy* (2000), esp. 47ff.

[33] A focus on practically "useful" IEC standards has been a characteristic of the IEC from the beginning, since many of the scientist-engineers that played a central role in founding the IEC were also highly commercially successful entrepreneurs. They therefore sought to bridge emphatically valued basic research and the creation of entrepreneurial opportunities for commercial applications.

[34] The ambition and skills of IEC leaders are harder to operationalize at the level of generality required for this preliminary discussion; they will be discussed as part of the empirical analyses in subsequent sections.

The IEC's structure and procedures ensure its embeddedness. As of the end of 2021, the IEC has 110 Technical Committees (TCs); some of them also have numerous subcommittees (SCs), for a total of 212 TCs and SCs.[35] Much of the technical work in those TCs and SCs is actually done in distinct working groups (of which there were 725), project teams (200), and maintenance teams (669 as of the end of 2021). This structure and the procedural norms and rules of the IEC allow for bottom-up agenda-setting, making it very easy for a small number of national member bodies to launch the development of a new standard for a product or electrotechnical phenomenon.[36] Consensus norms then give a right to be heard to all member bodies that have elected to be "participating members" (P-members) of the TC where a given standard is developed, reviewed, or revised. These norms – at least in theory – provide all stakeholders with opportunities to make alternative or compromise proposals for all aspects of the technical work. They are reinforced by procedural rules governing the IEC standards development process, which require large super-majorities in formal votes on the penultimate "Committee Draft for Voting" (CDV)[37] and for the adoption of the resulting "Final Draft" as an official IEC standard.

Balancing these decentralized elements of the IEC's institutional structure, the IEC has for a long time reserved a crucial (if mostly light-touch) centralized role for the IEC leadership, especially its Standardization Management Board (SMB) and the IEC Central Secretariat. Jointly, they provide coordination and oversight to ensure coherence and consistency as well as maintain the IEC's ability to act in pursuit of its organizational self-interest.

The IEC leadership consists of a president, three vice presidents (one each for standardization management, market strategy, and conformity assessment), a treasurer, and the IEC Secretary General.[38] Candidates for the part-time positions of

[35] For instance, TC23, devoted to "electrical accessories and related systems" for household, industrial, and other commercial uses (www.iec.ch/dyn/www/f?p=103:7:::::FSP_ORG_ID:1299) and has separate SC's inter alia for circuit breakers; plugs and socket-outlets; couplers for electric vehicles; switches for appliances; and devices for monitoring, measuring, controlling, managing, and optimizing the efficient use of AC and DC electrical energy (www.iec.ch/dyn/www/f?p=103:7:::::FSP_ORG_ID:10046).

[36] Büthe, *supra* note 9, esp. 32–34.

[37] Positive votes on a CDV committee draft can and negative votes must be accompanied by comments. This gives P-members a formal opportunity to object to any aspect of the proposed standard and to request changes as a condition for supporting the adoption of a revised version as an IEC standard. The TC in charge of the standard then has an opportunity to revise the standard one last time before submitting the resulting Final Draft International Standard (FDIS) to a vote of the full IEC membership. At the CDV stage, National Committees also have the option to provide comments while voting to "abstain," thus allowing the committee to proceed while reserving judgment on the resulting FDIS.

[38] The three vice presidents lead, respectively, the IEC Standardization Management Board (discussed separately below), the Market Strategy Board (tasked with early identification of important technological changes and market trends that might warrant an IEC response), and the Conformity Assessment Board (tasked with overseeing the IEC's four, commercially very

president or vice president(s) tend to come from the private sector and customarily have previously held prominent leadership positions in one of the largest IEC's national member bodies. They are elected for (once-renewable) three-year terms, and during this time, (vice)presidents are supposed to pursue the interest of the IEC, only, though they usually retain their private sector full-time (and income-providing) position.

Not as visible but at least as important for the IEC's capability and its capacity for autonomous agency are the Secretary General and the senior staff of the central secretariat of the IEC. They are longer-term, full-time employees of the IEC, which gives them a strong incentive to think and act in the institutional self-interest of the organization. The staff, which supports the work of the IEC leadership and administratively and technically handles most of the coordination between the IEC's many committees, is lean (much smaller than the ISO's) but readily provides the support to enable capacity and capability.

The SMB is critical to the IEC's agency, as it coordinates and oversees the work of the many technical committees, subcommittees, and working groups of the IEC. It ensures that these various groups do not work at cross-purposes, for example, by developing competing IEC standards for the same purpose where the purview of two or more committees might overlap. The SMB (similar to the other boards) comprises "automatically appointed members" (representatives of the largest member bodies in terms of their contributions to the IEC annual budget and staff support for technical committees), elected representatives of the remaining member bodies, and IEC senior staff ex officio. The elected members of the SMB are elected for three-year terms, renewable once, by the IEC General Assembly, usually in the annual meeting of the member body presidents and senior officers.

SMB oversight is supposed to ensure timeliness and high quality of the technical output – and that all IEC work follows the procedural rules and norms for IEC standard-setting and no one company or country might highjack any TC or larger parts of the organization. The SMB also may reorganize the technical work by merging TCs; it appoints TC secretariats and chairmanships; it adjudicates jurisdictional conflicts between the TCs; and it is responsible for relations with other organizations.[39] In doing so, the SMB ensures the ability of the IEC to act in the self-interest of the organization while keeping the IEC leadership grounded in the organization's member bodies – which we would expect to play an important role in the IEC's ability to exhibit organizational resilience.

important conformity assessment programs). These three fifteen-member boards are the primary management bodies of the organization, their tasks officially delegated to them from the overall IEC Board, the core executive body of the organization; see IEC, Management Structure, www.iec.ch/management-structure.

[39] For details, see IEC, Management Structure: SMB, www.iec.ch/dyn/www/f?p=103:48:0::::FSP_ORG_ID,FSP_LANG_ID:3228,25; Büthe, *supra* note 2, at 318–320; and *supra* note 9, at 24.

https://doi.org/10.1017/9781009329408.021 Published online by Cambridge University Press

15.4 IEC RESILIENCE IN THE FACE OF TECHNOLOGICAL CHANGE

One of the remarkable features of the early history of the IEC is how few committed individuals it took to launch a transnational private body that has – for 115 years and counting – played a major, increasingly global role in the development and governance of an enormous range of electro-technologies. The entrepreneurial approach and skill of key figures – above all Charles Le Maistre, the IEC's first and long-term secretary general – surely was important for bringing the IEC into existence as an organization with its consensus-oriented structure and procedures for developing "voluntary" technical standards.[40] The relative ease of its creation may also have been a function of fortuitous temporal sequence: the IEC was the first body of its kind, set up to address functional needs and serve the (largely common) interests of key political-economic stakeholders in the early years of a new field (electro-technology).[41] Rapid technological development in this field meant that standardization tended to open up a wealth of new, profitable opportunities while foreclosing few. Standardization at that time thus resembled a coordination game with large gains from coordination and relatively small distributional effects, making distributional conflicts a second-order concern.[42]

Yet, the conditions that facilitated the establishment of the IEC in 1906 also applied to a greater or lesser extent in later cases of "new" technologies. Indeed, over the decades, the development of new areas of electro-technology – such as batteries for mobile electrical devices, digital audio and video formats, electronics, and more recently artificial intelligence – have time and again created challenges to IEC preeminence. The IEC has proven remarkably resilient in the face of these technological changes.

The IEC was initially set up to agree upon a common set of terms and measurements that would be foundational for the development of electro-technologies and electrical products – anything from light bulbs to electricity-powered heavy

[40] Yates and Murphy, *supra* note 31. Regarding the role of entrepreneurial actors in global governance more generally, see also J. F. Green, *Rethinking Private Authority: Agents and Entrepreneurs in Global Environmental Governance* (2014).

[41] On the issue of temporality and sequence for institutional development in general, see T. Büthe, Taking Temporality Seriously: Modeling History and the Use of Narratives as Evidence (2002) 96:3 *American Political Science Review* 481–494. See also P. Pierson, Not Just What, but When: Timing and Sequence in Political Processes (2000) 14:1 *Studies in American Political Development* 72–92; W. Streeck and K. Thelen (eds.), *Beyond Continuity: Institutional Change in Advanced Political Economies* (2005); C. Trampusch, Sequence-Oriented Policy Analysis (2006) 16:1 *Berliner Journal für Soziologie* 55; D. Bach and A. L. Newman, Governing Lipitor and Lipstick: Capacity, Sequencing, and Power in International Pharmaceutical and Cosmetics Regulation (2010) 17:1 *Review of International Political Economy* 665–695; E. Posner, Sequence as Explanation (2010) 17:4 *Review of International Political Economy* 639–664; O. Fioretos, T. G. Falleti, and A. Sheingate (eds.), *Oxford Handbook of Historical Institutionalism* (2015); T. Rixen, L. Viola, and M. Zürn (eds.), *Historical Institutionalism and International Relations: Explaining Institutional Development in World Politics* (2016).

[42] See Büthe, *supra* note 9, at 35.

machinery.[43] Its agenda soon broadened to include the development of standards for the design and performance of actual electrical devices. Initially, the focus was on power-generating equipment, industrial machinery, and standards for use (in scientific research and) within and between private enterprises.[44] Already by 1911, the agenda had become so broad that discussing all current projects in a single (multi-day) plenary meeting was deemed impractical, prompting the IEC to delegate the technical work to more specialized committees, known today as the IEC Technical Committees.[45] Setting standards for consumer goods was added to the IEC agenda starting in the 1920s and became an important focus of multiple TCs after World War II thanks to the widespread electrification of households throughout advanced industrialized countries and the mass-market production of electrical devices for household use.[46] And as new electro-technologies were developed, the scope of IEC rule-making broadened further.

IEC standards have remained essential to the development of a wide range of electrical (and in more recent decades electronic) technologies in part because IEC standards define elements and components used as the foundation or building blocks for innovations and technological change. The units and methods for the measurement of voltage and frequency of electrical currents, established by the IEC early on, remain a good example: using other units or methods has become literally unthinkable. Another, more recent example are sensors, which have long had various industrial and household uses, and continue to become ever more important as key parts of complex smart manufacturing and a wide variety of artificial intelligence–driven or –supported systems.[47] A variety of sensors have, for instance, been integrated into smart "wearable technologies"[48] used, inter alia, in the health-care sector. Such devices promise great improvement in patient care by tracking, recording, and (remotely) monitoring physiological processes and biomedical signals.[49] The COVID-19 pandemic brought this into focus: sensors installed in a wearable device can alert the user when changes in their metrics match those associated with COVID-19 or even track the stability and recovery of those

[43] See 1904 Declaration for the establishment of the IEC; E. B. Paxton, AIEE: A Leader in Electrical Standards (1954) 25:8 *Magazine of Standards* 242–245, at 244ff.

[44] W. H. Onken Jr., Work of the International Electrotechnical Commission (April 17–26, 1919) 73 *Electrical World* 856–857.

[45] Yates and Murphy, *supra* note 31), at 17 note 53.

[46] L. Ruppert, *Brief History of the International Electrotechnical Commission* (1956), at 6ff.; A. Raeburn, IEC Technical Committee Creation: The First Half-Century, 1906–1949 (on file with the author).

[47] Sensors can interpret analog or electrical stimuli, including temperature, sound, motion, smell, and pressure.

[48] Wearables are a class of Internet of Things devices that act as a portable computer system attached to the user's body such as smart-watches, patches, and t-shirts.

[49] S. Patel, H. Park, P. Bonato, L. Chan, and M. Rodgers, A Review of Wearable Sensors and Systems with Application in Rehabilitation (2012) 9:1 *Journal of NeuroEngineering and Rehabilitation* 21, doi: 10.1186/1743-0003-9-21.

infected.[50] The IEC plays a role in the development of all these new technologies because the sensors used are designed and manufactured according to the IEC 60747-14 "family" of standards, developed by IEC Technical Committee 47, such as the IEC 60747-14-10 for glucose sensors.[51]

Even more important is that the IEC has proven adept at adding new issues to its agenda to keep abreast of technological changes. This is partly a function of the relative ease with which a "new work item" can be added to any Technical Committee's standards development agenda. Such a proposal to develop a new standard can be put forward by any National Committee, any Technical Committee (for topics fitting its expertise), the secretary of that TC, the SMB, or the IEC leadership. The proposal is then put to a vote only among the P-members of the TC or SC specified in the proposal as the one to develop the standard. Among them, a simple majority and a commitment of at least four of them (five for larger committees) is all that is required to launch the new standards project. These procedural rules make it very easy to extend the scope of the IEC's technical authority while making it very difficult for those who do not want to see an IEC standard developed to prevent the launch of such an effort, as long as at least a small number of members share the desire to develop it.[52]

There are limits, however, to such incremental additions to existing technical committees' agenda as a response to the need for standards development, especially if this work requires distinctive expertise or involves a distinct set of stakeholders. Accordingly, the SMB added entirely new TCs to the IEC portfolio (and occasionally restructured existing TCs), including for computing and information-processing standards in the 1960s; for laser equipment in 1970s; for fiber optics (TC86), superconductivity (TC90), and wind turbines (now "wind energy generation systems", TC88) in the 1980s; for fuel cells (TC105) in the 1990; and for flat-screen panels (TC110), for nanotechnology in electrical and electronic products (TC113), and for marine energy (i.e., the conversion of tidal and other water currents into electric energy, TC114) in the 2000s. Recently established TCs include committees focused on smart grid user interfaces (TC118), wearable electronic devices and technologies (TC124), and "robotics for electricity generation, transmission and distribution systems" (TC129). Even the development of futuristic-sounding flying cars will involve IEC standardization: such urban air mobility devices will likely rely upon existing standards and standards newly developed by IEC TC100 for surround-view monitoring of the car, by ISO/IEC JTC1 for biometric interchange formats, and IEC 62668 to ensure that the electronic parts safely work together.[53]

[50] A. Ravizza, C. De Maria, L. Di Pietro, et al., Comprehensive Review on Current and Future Regulatory Requirements on Wearable Sensors in Preclinical and Clinical Testing (2019) 7 *Frontiers in Bioengineering and Biotechnology* 313.

[51] Sensors inserted under the skin can monitor diabetes and transmit the information to a device.

[52] For details, see Büthe, *supra* note 9, at 31–34.

[53] IEC, Auto Manufacturer Says Flying Cars Will Arrive in Cities by 2030, www.iec.ch/blog/auto-manufacturer-says-flying-cars-will-arrive-cities-2030; Z. Kleinman, Flying Car Completes Test

In sum, the IEC has, time and again, responded to technological change directly by extending the range of electro-technologies (by now long including in principle all kind of electronics, too) for which it claims standard-setting expertise and authority. While this has not completely prevented the creation of new, more specialized bodies for developing technical standards (see below), it has allowed the IEC to remain the preeminent forum for such activities, especially where cooperation, coordination, and interoperability with related technologies is important, as the standards for them are often already being developed or maintained at the IEC. Importantly, IEC resilience in the face of technological change was by no means coincidental but part of a conscious strategy, as occasionally documented, such as when TC111 was set up in 2004 and assigned the task to "monitor closely the corresponding regional standardization activities worldwide to become a *focal point* for discussions concerning standardization."[54]

15.5 IEC RESILIENCE VIS-À-VIS POSSIBLE COMPETITOR SDOS

Having been the first transnational body for setting electro-technology standards gave the IEC something of an incumbency advantage, making it the default focal point for subsequent initiatives to achieve coordination or even harmonization of technical standards related to any area of electro-technology.[55] From early on, however, other standards-developing organizations arose at various times, and it appears that IEC leaders quite consciously sought to head off possible challenges from potential competitor organizations by establishing more or less formal relationships with them, turning them into collaborators instead. The International Conference on Large Electric Systems and the World Power Conference, for instance, were initially set up as fora for electrotechnical standard-setting in 1921 and 1926, respectively, thus effectively threatening the IEC's preeminence for commercially very important segments of electro-technology.[56] Over time, however, their standards-developing activities were either absorbed by the IEC, or they yielded them to the IEC. Other potential competitors established a symbiotic, complementary relationship vis-à-vis the IEC, as in the case of the International Federation of National Standardizing Associations (ISA), founded in 1926 and also

Flight between Airports, BBC News June 30, 2021, www.bbc.com/news/technology-57651843; I. Bogost, When Cars Fly, *The Atlantic*, May 2016, www.theatlantic.com/magazine/archive/2016/05/when-cars-fly/476382.

[54] Original official scope of the work of TC111 in 2004, today online at TC 111 Scope, www.iec.ch/dyn/www/f?p=103:7:1100173035120 38::::FSP_ORG_ID,FSP_LANG_ID:1314,25 (emphasis added).

[55] Büthe, *supra* note 9.

[56] The empirical record of the individual motivations of the key actors and the internal deliberations within these bodies is slim (for the most comprehensive treatment, see Yates and Murphy, *supra* note 15) but appears that the pursuit of the IEC's organizational self-interest by Le Maistre and other early IEC leaders was quite conscious.

headed by Le Maistre, who ensured that its portfolio was defined as standardization outside of the field of electro-technology.

IEC resilience was also helped by fortuitous elements of its institutional design, which allowed it to survive the hiatus of World War II largely unscathed – in contrast to many other inter- and transnational organizations. The statutes of the ISA, for instance, required the organization to hold a general meeting at the latest every three years and tied the terms of office of anyone who could claim to act on behalf of the organization to that meeting schedule. Having held a meeting in 1939 just prior to the beginning of the war, the ISA could go until 1942, but then the ISA arguably ceased to exist; it thus became a collateral organizational casualty of the war. The IEC's more minimalist rules, by contrast, allowed its secretary general to continue to serve in that role until the next meeting after the war (at which Le Maistre was confirmed once more).[57]

After World War II, the establishment of the ISO as a standards-developing organization for all industries put the IEC's preeminence or independence at risk. Yet, here again the IEC, led by Le Maistre (who continued as IEC secretary general until 1952), intervened to make certain that the ISO agenda would not clash with the IEC's. The IEC then proceeded to establish quite quickly institutional mechanisms for a division of labor between IEC and its "sister organization" and to ensure that, for any issue at the intersection of the IEC's and ISO's respective areas of specialization, they would not develop competing standards but coordinate. This cooperation has been maintained for more than seven decades – albeit with a growing set of work items assigned to various subcommittees of the rather unwieldy "Joint Technical Committee 1," which the two standards bodies manage and staff jointly.

The most serious challenge to the IEC's institutional preeminence in recent decades arose from a group of IEC "insiders" in the process of the EU Common Market initiative in the 1980s. After the failure of its attempts to achieve regulatory harmonization through inter- or transgovernmental negotiations,[58] the EU sought to overcome divergent, markets-fragmenting regulatory requirements, standards, and norms by delegating the development of technical standards to transnational, non-governmental standard-setting bodies.[59] Seeking to balance the attainment of common technical standards with the achievement of legitimate public policy objectives as defined by Europe's political (governmental) authorities through

[57] J. A. Yates and C. N. Murphy, Coordinating International Standards: The Formation of the ISO, Unpublished manuscript (on file with the authors), MIT 2006; Yates and Murphy, *supra* note 15.

[58] A. Dashwood, Hastening Slowly: The Community's Path Toward Harmonization, in *Policy-Making in the European Community* (H. Wallace, W. Wallace, and C. Webb eds., 1983) 177–208.

[59] J. Pelkmans, The New Approach to Technical Harmonization and Standards (1987) 25:3 *Journal of Common Market Studies* 249–269; K. Schreiber, The New Approach to Technical Harmonization and Standards, in *The State of the European Community* (L. Hurwitz and C. Lequesne eds., 1991) 97–112; Egan, *supra* note 28.

democratic processes, they set up a system where European policymakers specify the overarching objectives through legislative processes, then delegate finding a "consensus" technical solution for achieving those objectives (subject to international trade law and EU stipulations against discrimination, anti-competitive conduct, etc.) to the then-nascent European-level standard-setting bodies, CEN and CENELEC (corresponding to ISO and IEC, respectively). This arrangement constituted a dangerous challenge to the IEC's preeminence, given the prominent role of numerous EU countries' IEC member bodies in IEC-based electrotechnology governance.

The IEC responded to this challenge (heading it off for the most part, though not without compromising some of its autonomy) by striking the 1991 Lugano Agreement and then the 1996 Dresden Agreement with CENELEC, which sets out detailed procedures for cooperation between the two transnational SDOs.[60] For new standards, for instance, it specifies joint decisions by the pertinent TCs of both organization about whether IEC or CENELEC shall take the lead in developing the standard. If IEC takes the lead, it commits to writing a standard that allows for achieving the EU objectives, as well as completing the work on the time line necessary to meet the EU legislative mandate. If CENELEC takes the lead, it keeps the corresponding IEC committee informed, but the technical work then takes place in CENELEC, where non-European IEC member bodies do not have any automatic status. Either way, voting on the final draft standard takes place in parallel in both organizations. If adopted by both, then the often-European-made standard becomes an international standard without further technical discussion at the IEC.[61]

Notwithstanding the IEC's propensity to swiftly pick up on (market demand for transnational private governance of) new technological developments, some firms have sidestepped the IEC to develop standards for new technologies in so-called standards consortia – ad hoc groups of firms set up (sometime formally as joint ventures) to develop a technical standard for a particular use and usually with exclusive intellectual property rights claims regarding the standard and the technical expertise contained therein.[62] There are precedents for developing standards collaboratively in small, exclusive groups of firms,[63] but standards consortia became a

[60] See Egan, *supra* note 28; G. Eickhoff and B. Hartlieb, Einfluss auf Normen-Inhalte: Europäischer und internationaler Fokus, in *Normen und Wettbewerb* (T. Bahke, U. Blum, and G. Eickhoff, 2002) 172–188.

[61] See Mattli and Büthe, *supra* note 25, at 28.

[62] See T. Büthe and J.-M. Witte, Product Standards in Transatlantic Trade and Investment: Domestic and International Practices and Institutions, AICGS Policy Report no. 13, Washington, DC, American Institute for Contemporary German Studies (2004), at 32ff.; R. Werle, Institutional Aspects of Standardization: Jurisdictional Conflicts and the Choice of Standardization Organizations 8:3 (2001) *Journal of European Public Policy* 392–410.

[63] See, e.g., C. F. Cargill, *Information Technology Standardization: Theory, Process, and Organization* (1989).

distinct method of standard-setting only in the late 1980s and early 1990s, especially in the fast-changing information and telecommunications sector, where the long time required for IEC standards development (five to eight years in the 1980s) was considered particularly problematic.[64] The IEC responded to this challenge by taking various measures to accelerate the technical work in the TCs, SCs, and working groups, shortening the average time required, from the launch of a proposal for a new standard to the vote on the final draft, to less than three years by the early 2000s.

The IEC also has incorporated into its portfolio numerous standards initially developed by standards consortia (thus committing the holders of standards-essential patents to license those patents to any user on "fair, reasonable, and non-discriminatory" [FRAND] terms while usually also greatly enhancing the value of those patents). To give just two examples with particular importance to the entertainment industry: the audio CD standard, maintained since 1987 as IEC standard 60908, was originally developed by a Sony-Philips consortium in 1979/80.[65] And the Blu-ray optical disc standard, maintained since 2011 by ISO/IEC JTC1/SC23 as ISO/IEC 30193, was originally developed in 2000 by the Sony-Philips-Panasonic-led consortium in a fierce race with the Toshiba-led consortium, which had developed the competing High Definition DVD standard.[66] In all three cases (and many more like it), the IEC succeeded in gaining authority and in some sense restoring its preeminence, though at the cost of recognizing and arguably sanctifying standards developed without IEC input and without regard to the procedures and norms of IEC standardization.

Another challenge to the IEC's authority arose from governments in the context of the multilateral international trade regime of GATT and WTO. In the 1960s and 1970s, cross-national differences in technical standards (as such or when subsequently used as a basis for government regulations) were increasingly recognized as important non-tariff barriers to trade.[67] By the 1990s, their trade-inhibiting effect for manufactured goods was estimated to far exceed the effect of the remaining tariffs for such goods between advanced industrialized countries, resulting in a strong push to incorporate the previously optional GATT Agreement on Technical Barriers to

[64] R. Hawkins, The Rise of Consortia in the Information and Communication Technology Industries: Emerging Implications for Policy (1999) 23 *Telecommunications Policy* 159–173; S. Bolin (ed.), *The Standards Edge* (2002); J. Baron, Y. Ménière, and T. Pohlmann, Standards, Consortia, and Innovation (September 2014) 36 *International Journal of Industrial Organization* 22–35.

[65] See Büthe and Mattli, *supra* note 7, at 46ff.

[66] See S. Greenstein, Format Wars All Over Again (2006) 26:1 *IEEE Micro* 7, 140; Ibid., at 27ff., 34ff.

[67] R. E. Baldwin, *Nontariff Distortions of International Trade* (1971); M. Emerson (ed.), *The Economics of 1992: The E.C. Commission's Assessment of the Economic Effects of Completing the Internal Market* (1988); J. Grieco, *Cooperation among Nations: Europe, America, and Non-Tariff Barriers to Trade* (1990).

Trade into the WTO Treaty, of which it became an integral part, binding on all WTO member states. The resulting international trade law obligation to use "international standards" as the "technical basis" for regulatory measures (whenever international standards exist that can achieve the stated regulatory purposes, such as consumer health and safety) promised to be very profitable for competitive producers and to yield substantial macroeconomic gains.[68]

For the IEC, the new prominence of international standards in international trade law created unprecedented visibility (beyond the niche world of standards experts), but it also created two risks: first, it created the risk that the IEC's preeminence might be diluted through provisions in the intergovernmental agreement for the recognition of alternative transnational bodies for electrotechnical standard-setting. Second, it created the risk of overt politicization and government attempts to interfere in the work of the IEC. Working jointly with ISO, the IEC addressed these risks, first, by actively lobbying (successfully) for the incorporation of the ISO-IEC joint Code of Good Practices for the Preparation, Adoption and Application of Standards, which was written into the TBT-Agreement as Annex 3, which also gave ISO and IEC, via their joint "Information Center," an official role in the implementation of the agreement. They also successfully lobbied against any mention of other "international standards" bodies (except for the more specialized, intergovernmental ITU) in the Agreement. The exclusive recognition of IEC, ISO, and ITU does not, strictly speaking, give these organization exclusive rights, but it raised their status and made it clear that they met the requirement for WTO recognition as an international standard-setter.[69] IEC responded to the second risk by being even more protective of its nongovernmental status. In the end, the entry into force of the WTO Treaty with its TBT provisions thus confirmed and may have even strengthened the resilient IEC and its preeminence.

The most recent risk to the IEC from an SDO competitor arises from China's efforts to enhance its role in global technology governance, especially technical standardization through its Regional Comprehensive Economic Partnership and, more generally, through its Belt and Road Initiative (BRI). The BRI is an extremely broad – comprehensive, though not necessarily cohesively planned, and in parts still rather vague – initiative, sparked by Chinese President Xi Jinping in 2013, to connect China-centered continental East Asia more closely with East and South Asia, Oceania, Central Asia, Europe, the Middle East, and Africa via land and maritime

[68] K. Blind et al., Volkswirtschaftlicher Nutzen and A. Töpfer et al., Unternehmerischer Nutzen, in *Gesamtwirtschaftlicher Nutzen der Normung* (B. Hartlieb ed., 2000), 23–34; 9–22; WTO, World Trade Report 2005: Exploring the Links Between Trade, Standards, and the WTO (2005), esp. 57ff.; H. de Vries, Standards for Business: How Companies Benefit from Participation in International Standards Setting, in *International Standardization as a Strategic Tool* (2006), 131–141.

[69] T. Büthe, Agent Selection in the International Delegation of Regulatory Authority: Food Safety, Health Regulations, and Free Trade under the WTO, unpublished manuscript (on file with the authors), Duke University and University of California, Berkeley, February 2009.

networks.[70] These networks go by now far beyond the trade and transport networks of the Han Dynasty's "silk road," which is said to have inspired the BRI. It includes foreign direct investments, all kinds of development cooperation, and various forms of international, trans-governmental, and transnational exchanges (though the latter appear often high centrally directed from the Chinese side).

Most of the BRI is not about technical standards at all, but many observers have reported that China has been using BRI-created or -intensified interdependence as leverage to get other countries to accept Chinese national technical standards as de facto international standards – facilitated by the hub-and-spokes bilateral rather than multilateral structure of BRI governance, which guarantees China a dominant position vis-à-vis each of its BRI partners.[71] A recent example has been the pandemic-induced demand for digital tools to fight COVID-19 to get BRI partners to adopt technologies based on Chinese standards that diverge from international ones.[72] Chinese officials have attributed such efforts (as well as occasional talk of possibly setting up BRI-based institutions for international joint development of technical standards) to the inability of Chinese – or, generally, developing and transition economy countries' – technical experts to get a fair hearing with the IEC. We therefore postpone discussion of this issue to Section 15.6.3.

15.6 IEC RESILIENCE AND THE GLOBAL SOUTH: ECONOMIC GLOBALIZATION, INTERNATIONAL POLITICS, AND TRANSNATIONAL PRIVATE REGULATION

15.6.1 *A Growing Yet Still Marginal Role for Most Stakeholders from the Global South*

From the beginning, participants in IEC standard-setting have paid their own way, which created a bias in favor of commercially successful stakeholders from rich countries. By the time World War I put the IEC on hold (eight years after it had been founded in 1906), the IEC had member bodies from only seventeen countries.

[70] See, e.g., Y. Huang, Understanding China's Belt & Road Initiative: Motivation, Framework and Assessment (September 2016) 40 *China Economic Review* 314; European Bank for Reconstruction and Development, China's Belt and Road Initiative, www.ebrd.com/what-we-do/belt-and-road/overview.html.

[71] See, e.g., T. N. Rühlig, *Technical Standardisation, China and the Future International Order: A European Perspective* (2020); R. Arcesati, Chinese Tech Standards Put the Screws on European Companies, Mercator Institute for China Studies *Kurzanalyse*, January 29, 2019, www.merics.org/de/blog/chinese-tech-standards-put-screws-european-companies; M. Ziegelmeir, *The Politics of High-Speed Rail: Understanding the Role of Intellectual Property Rights and Technology Standards for China's Overseas Rail Investments* (2020); J. C. Byrnes, Is This Belt One Size Fits All? China's Belt and Road Initiative (2020) 8 *Penn State Journal of Law & International Affairs* 723.

[72] K. Iwasaki, Covid-19 Brings New Developments in China's Digital Silk Road (October 2020) 3:9 *Japan Research Institute Research Journal* 1–12.

Most of them were European: Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Russia, Spain, Sweden, Switzerland, and the United Kingdom. Canada and United States also were among the founding members. Argentina (at the time one of the richest, most technologically advanced countries) and the quickly rising Japan were the only countries beyond the Northern transatlantic area to have national electrotechnical societies that joined the IEC before World War I.

In the beginning, this exclusionary focus was generally overtly considered desirable – as it was expected to facilitate agreement through similarities in engineering expertise, professional norms, and general needs and interests in international standards.[73] And the IEC became only marginally more diverse during the interwar years, adding mostly further European members and only five member bodies from countries beyond Europe: Australia (1927), India (1929), Egypt (1930), China (1936), and South Africa (1938). After the end of World War II, IEC membership continued to grow further but only at a very modest pace throughout the decades of the Cold War compared to other international and transnational organizations with a similarly universalist claim to global governance.[74] By the end of the Cold War in 1990, the IEC had grown to have member bodies from forty-four countries, including twenty non-OECD countries (eleven of them from the Global South).

The de facto role of stakeholders from non-OECD countries and especially the Global South in IEC-based global governance, however, remained more marginal as the membership roster might suggest: IEC National Committees from the non-OECD countries generally held participating membership in only a few IEC Technical Committees and Subcommittees; their actual participation in the process of developing new IEC standards was even rarer; and secretariats and chair positions were virtually all held by the technologically most advanced countries with the largest domestic markets (Sweden, Switzerland, and the Netherland were outliers as "small" countries regularly holding more than one of those positions).

The limited membership roster and the even more limited actual participation in standards development became a problem for the IEC in the post–Cold War period. It threatened the IEC's persistence as the focal institution for the global governance

[73] Assessment based on the founding documents and exchanges between IEC participants of the early meetings; see also C. Ainsworth, Standardization Abroad 35:12 (December 1964) *Magazine of Standards* 364–367; Büthe, *supra* note 2, at 301ff.; Yates and Murphy *supra* note 15, at 67–71.

[74] It is noteworthy, not least in light of the reaction to Russia's invasion of Ukraine in 2022, that the fluctuating tensions of the Cold War appear to have had relatively little effect on the IEC. Russia itself, as well as Romania, Serbia, and Hungary, which had become members in 1911, 1927, 1936, and 1949, respectively, all retained their full membership throughout the Cold War (and Bulgaria even joined anew in 1958), although a review of the minutes of technical committee meetings shows that the active participation of non-USSR Eastern European technical experts notably declined when the USSR tightened its control over Eastern bloc countries in the 1950s.

of electro-technology in the post–Cold War years for four reasons. (1) Intensified economic globalization in the 1990s integrated ever more countries of the Global South into truly global markets and value chains, from which they often ended up excluded or unable to reap the full benefits without adopting international standards (including IEC standards) domestically.[75] The WTO-enhanced role of IEC standards in governing market access gave many countries quite suddenly a much greater stake in IEC standards, leading them (and some observers) to make their marginalization in IEC governance an issue. (2) The explosive growth in preferential trade agreements (PTAs) in the 1990s, covering a growing range of issues, including regulatory issues and technical non-tariff barriers to trade,[76] created a risk for the IEC that standards other than IEC standards might get written into PTAs as the technical basis for trade integration – especially in the growing number of South-South PTAs – unless at least one and ideally both countries had a stake in ensuring the continued centrality of IEC standards.[77] (3) The shift from the bipolar to a multipolar international system reduced the willingness of many countries, especially in the Global South, to be deferential to a small group of Northern countries on issues such as market governance, all the more so in light of simultaneous widespread demands for more democratic participation, both domestically within many countries and in global governance.[78] This resulted in rising expectations that global governance bodies provide at least for "voice opportunities" for the Global

[75] S. M. Stephenson, Standards, Conformity Assessment and Developing Countries, World Bank Policy Research Working Paper no. 1826 (May 1997); K. Maskus, O. Tsunehiro, and J. S. Wilson, The Cost of Compliance with Product Standards for Firms in Developing Countries, World Bank Policy Research Paper no. 3590 (May 2005); J. P. Singh, The Evolution of National Interest: New Issues and North-South Negotiations During the Uruguay Round, in *Negotiating Trade: Developing Countries in the WTO and NAFTA* (J. S. Odell ed., 2006), 41–84; J. Lee, G. Gereffi, and J. Beauvais, Global Value Chains and Agrifood Standards: Challenges and Possibilities for Smallholders in Developing Countries (December 13, 2010) *Proceedings of the US National Academcy of Sciences*, doi.org/10.1073/pnas.0913714108; T. Dietz et al., The Voluntary Coffee Standard Index (VOCSI) (August 2018) 150 *Ecological Economics* 72.

[76] A. Estevadeordal, K. Suominen, and R. Teh (eds.), *Regional Rules in the Global Trading System* (2009); A. Dür and M. Elsig (eds.), *Trade Cooperation: The Purpose, Design and Effects of Preferential Trade Agreements* (2015).

[77] See R. Hartlem et al., Internationalization of Cable Standards: An Overview of the Variety of Methods and Motivations of Standards Developing Organizations around the World (1997) 17:11 *IEEE Power Engineering Review* 19–20; Büthe, *supra* note 9, 38ff.

[78] See, e.g., J. Steffek, C. Kissling, and P. Nanz (eds.), *Civil Society Participation in European and Global Governance: A Cure for the Democratic Deficit?* (2008); J. Tallberg, et al., *The Opening up of International Organization: Transnational Access in Global Governance* (2013); R. B. Stewart, Accountability, Participation, and the Problem of Disregard in Global Regulatory Governance (April 2014) 108:2 *American Journal of International Law* 211–270; A. Grigorescu, *Democratic International Organizations? Normative Pressures and Decision-Making Rules* (2015). See also R. W. Grant and R. O. Keohane, Accountability and Abuses of Power in World Politics (February 2005) 99:1 *American Political Science Review* 29–43.

South and arguably also influence over outcomes.[79] Global governance institutions that failed to live up to these expectations were increasingly subjected to legitimacy challenges.[80] (4) The economic and political transition after the end of the Cold War resulted in several countries becoming new major powers, especially China, India, and Brazil. Until the 1980s and in some areas even the 1990s, they had been "rule-takers" in global economic affairs; but from the 1990s or 2000s onward, they have increasingly demanded greater voice and real influence in the governance of the world economy.[81]

The IEC responded to these challenges with several initiatives to grow and diversify its membership, as well as some efforts to increase opportunities for substantively meaningful participation by countries from the Global South. IEC leaders worked with several Global South countries' electro-technical organizations to transform their informal relationships with the IEC into official associate (or even full) memberships. These efforts were complemented by the introduction of the Affiliate Country Program in 2001, through which developing countries can (to a limited but substantively meaningful extent) participate in IEC standard-setting without the financial burden of membership. In addition to gaining access to up to 200 standards documents free of charge (which they can then sell to interested users in their respective countries, providing them with resources they can use to strengthen domestic electro-technical standards bodies), the program gives participants access to IEC meetings and IEC trainings.

In some sense, these efforts have been tremendously successful. The IEC today has sixty-two full members plus twenty-six associate members (which pay lower fees in exchange for more limited participation rights) and eighty-six affiliate countries (which have certain voice opportunities but no voting rights).[82] The IEC membership has thus become much more global and diverse, enhancing its input legitimacy, at least formally. P-membership in the IEC Technical Committees and Subcommittees, too, has increased for many non-OECD countries, including countries from the Global South (see Figure 15.1).

As Figure 15.1 shows, however, for most developing countries, the increase is very small, and most of the long-dominant larger OECD countries have actually increased their P-memberships to the same extent or even to a proportionally larger extent. A similar pattern emerges with regard to committee chairs and secretariats, as depicted in Figure 15.2 for the (more powerful) committee secretariats: only four

[79] For a discussion of the difference, see Pauwelyn et al. and esp. DeMenno and Büthe, *supra* note 20.

[80] For a recent review of the literature, see A. Berman et al., Introduction: Rethinking Stakeholder Participation in Global Governance, in Pauwelyn et al., *supra* note 20, at 3–30.

[81] For a review, see the introduction to the recent special issue of *Regulation & Governance* by Lavenex et al., *supra* note 27.

[82] See IEC, National Committees, www.iec.ch/national-committees; and Affiliate Country Program, www.iec.ch/acp.

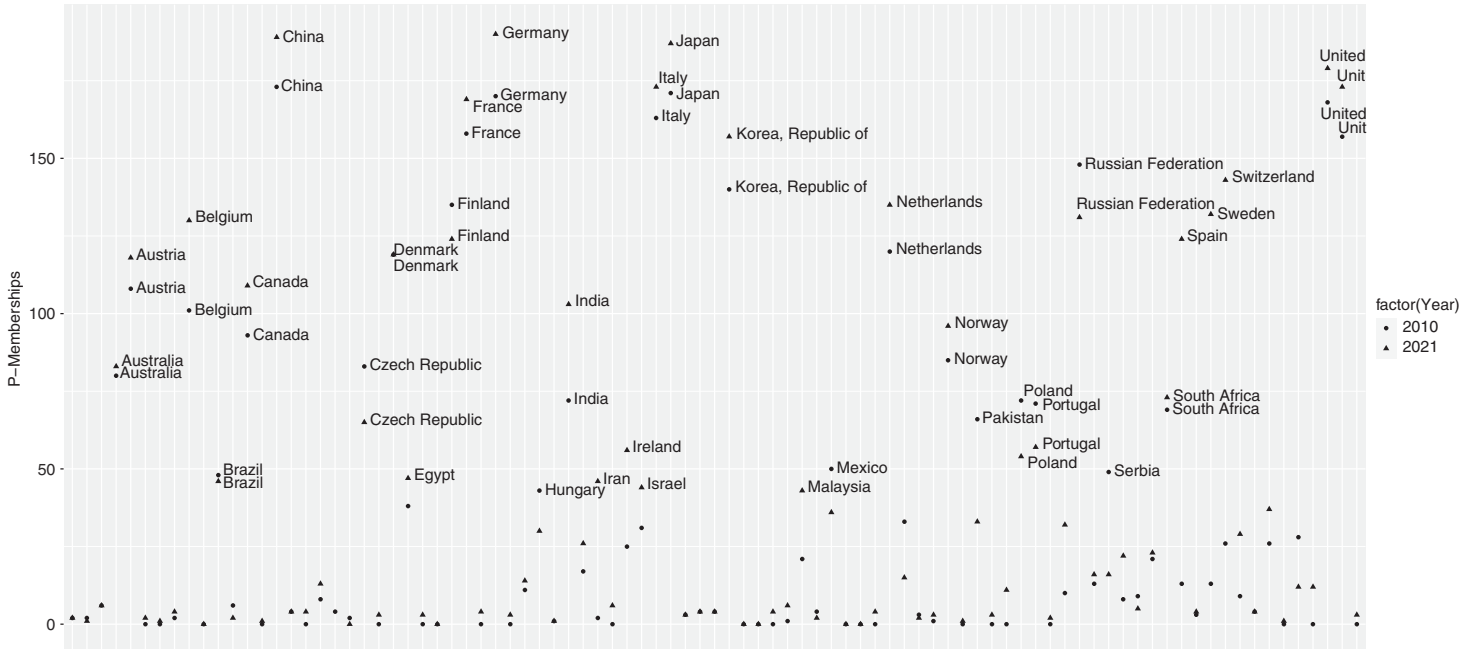

FIGURE 15.1. IEC P-Memberships 2021 vs. 2010.
Source: Authors' original work based on publicly available data from the IEC website October 2010 and January 2022

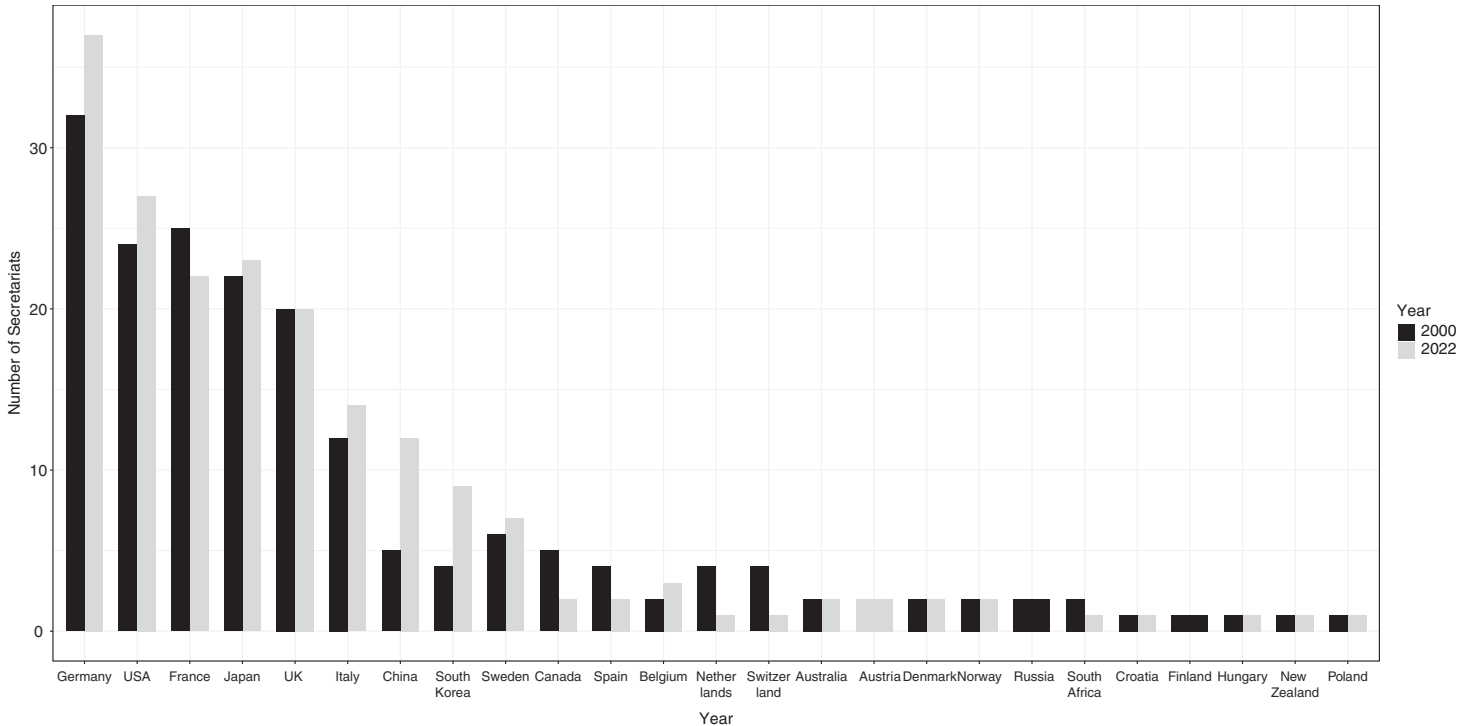

FIGURE 15.2. IEC TC Secretariats 2021 vs. 2000.
Source: Authors' original work based on publicly available data from the IEC for January 1, 2000 and January 1, 2022

non-OECD countries hold any committee secretariats today. Russia, which used to hold one such secretariat in 2000, holds none anymore; the number of South Africa's secretariats has shrunk from two to one; and EU members Croatia and Poland each hold one (unchanged even when considering the longer twenty-year time span for which this data is available). The striking exception to this overall pattern is China, which has significantly increased both its P-memberships and the number of secretariats held (from five to twelve).

Complementary qualitative evidence supports this interpretation of the quantitative evidence summarized in the figures: with the exception of Chinese participants, experts from the Global South report in interviews that they are still facing challenges in participating in IEC standard-setting. Participants from affiliate countries, in particular, report insufficient advance awareness of IEC work to be able to make substantive contributions to the development or revision of standards, and several of them indicated that much more training and advance preparation would be needed for them to be able to understand how the IEC works as an SDO (despite the IEC offering some training opportunities on just these issues already).[83] Our evidence aligns with a recent internal survey conducted by the IEC.[84] Additionally, our data show that, since the introduction of the affiliate program, only 59 comments on standards proposals have been submitted by more than one hundred affiliate-participants over the period 2004–2020, during which thousands of IEC standards were developed or revised.

15.6.2 *The Rise of China as a Special Challenge for the IEC*

Recent decades have not only seen a greater role of the Global South in the world economy. Distinctly – even when compared to the other "rising" BRICS powers – China has risen to the status of an economic superpower, demanding a greater voice and real influence in global economic governance, including in the governance of technology.

Communist/mainland China's standardization regime emerged in the early 1950s. Under strong influence from the Soviet Union, it was characterized by top-down state control and widely considered ineffective in supporting Chinese industrial and technological development.[85] Beginning in the 1980s and accelerating in

[83] Not-for-attribution telephone and online interviews, mostly conducted by Abdel Alshadafan, July 2020–January 2022.

[84] www.iec.ch/blog/affiliate-country-programme-survey-results. What we observe, moreover, matches the experience of developing countries in international standardization more generally, see P. C. Mavroidis and R. Wolfe, Private Standards and the WTO: Reclusive No More (January 2017) 16:1 *World Trade Review* 1.

[85] W. Ping, W. Yiyi, and J. Hill, Standardization Strategy of China, Achievements and Challenges, 2010, EAST-WEST Center Working Paper no. 107 (January 2010); R. Suttmeier and C. A. O. Cong, China's Technical Community: Market Reforms and the Changing Policy Cultures of Science, in *Chinese Intellectuals Between State and Market* (M. Goldman and E.

the 1990s, China introduced a series of reforms, which made technical standards, including international standard-setting, a central element of China's national development policies, initially with the primary aim of reducing dependence on foreign technologies and the respective intellectual property rights.[86] These reforms included massive state funding to boost engineering education, structural changes in the Chinese domestic standards-developing institutions, specialized training courses for technical standards development, as well as numerous incentives to encourage Chinese stakeholders to increase their participation at the international level, resulting in increased Chinese presence across a broad range of inter- and transnational SDOs.[87]

Having superseded the United States as the largest patent applicant in the world, China is now capable of developing domestically sophisticated alternative technical standards to many international ones. This can already be observed in its pursuit to establish, among other others, a homemade satellite navigation system (as an alternative to GPS) and a Cross-Border Interbank Payment System (as an alternative to SWIFT).[88] These developments have posed a major challenge to the IEC as the focal institution for electrotechnical standard-setting, for at least three reasons. First, China internationalizing its technical standards outside the IEC's institutional framework directly undermines the IEC preeminence and status as the focal institution for electrotechnical standard-setting. Second, China has occasionally hinted at establishing competing international bodies to allow stakeholders that are traditionally marginalized at the IEC to have better representation. This might prompt such stakeholders to leave the IEC to join the China-led institutions. Finally, China-centered competing institutions threaten established powers' ability to keep tabs on newly developed standards and technologies. This is important, not least because they are particularly skeptical of Chinese activity in the area of digitalization and data protection.[89]

Gu eds., 2004), 138–157; Y. Zhou and X. Liu, Evolution of Chinese State Policies on Innovation, in *China as an Innovation Nation* (Y. Zhou et al. eds., 2016), 33–67.

[86] M. Murphree and D. Breznitz, Innovation in China: Fragmentation, Structured Uncertainty and Technology Standards (2013) *Cardozo Law Review De Novo* 196.

[87] D. Breznitz and M. Murphree, The Rise of China in Technology Standards: New Norms in Old Institutions. Research Report Prepared on Behalf of the U.S.-China Economic and Security Review Commission (2013); M. C. Gamito, From Private Regulation to Power Politics: The Rise of China in AI Private Governance Through Standardisation (2021), https://ssrn.com/abstract=3794761; S. Hoffmann, D. Lazanski, and E. Taylor, Standardising the Splinternet: How China's Technical Standards Could Fragment the Internet (2020) 5(2) *Journal of Cyber Policy* 239.

[88] N. Godehardt, *Wie China Weltpolitik Formt: Die Logik von Pekings Außenpolitik unter Xi Jinping* (2020).

[89] B. Bartsch and A. Laudien, *Survey: Europe's View of China and the US-Chinese Conflict* (2020).

15.6.3 *IEC Responses to the Rise of China*

China has repeatedly emphasized that it has no desire to overthrow the current standardization regime and that it only seeks to ensure that its interests are taken into account similarly to those of the other major, technologically most advanced countries.[90] The IEC's response has taken these Chinese assurances seriously and has attempted to accommodate China to a greater extent, so as to give it a greater stake in the continued functioning and preeminence of the IEC – in sense of what we have defined as resilience in the introduction.

Concretely, the IEC has facilitated China becoming one of the most active and prominent member countries. Since 2011, China has been recognized as one of the leading members, entitled to an automatically appointed seat on the SMB and the other IEC decision-making bodies. China also holds two IEC "ambassador" positions (responsible for representing the IEC interest in IoT and cyber security). And in 2019, the IEC elected Yinbiao Shu, chairman of one of China's five largest state-owned electricity generation enterprises, as its next president; his three-year term started on January 1, 2020.

Already a P-Member of most TCs, China has increased its formal participation even further with P-memberships in now 90 percent of the IEC TCs. At least as importantly, the volume and quality of Chinese delegates' contributions to the technical discussions at the committee and working group level has notably increased. China has also substantially increased the number of TC secretariats held by its delegates. Working with some of the traditionally leading member bodies (especially Germany's DIN/DKE), IEC has also attempted to address what are widely seen as key reasons for Chinese experts' arguably often limited success in IEC committees, including language skills and lack of understanding the norms and procedures of IEC committee work.[91] Interviews with a former secretary general (CEO) of the IEC confirmed that these changes were a conscious response to the rise of China, seeking to elevate its status in the IEC in accordance with its increased status in the world economy.

[90] Y. Kuang, China in Global Technology Governance: Experimentation, Achievements, and Uncertainties, in *China: Champion of (Which) Globalisation?* (A. Amighini ed., 2018), 81–100.

[91] An interviewee highlighted, for instance, incidents whereby Chinese delegates attempted to push their position by asking high level IEC decision-makers to intervene. This created concerns within the IEC, that such behavior might trigger clashes with other member countries. The IEC offered special training sessions to familiarize some Chinese nationals with the relevant internal procedures and practices and explain that without the approval of the other member countries (achieved via negotiating, compromising, lobbying), China's proposals would not be successful. Regarding the China–Germany link, see D. Fuchs and S. Eaton, Diffusion of Practice: The Curious Case of the Sino-German Technical Standardization Partnership, https://ssrn.com/abstract=3723303.

15.7 UNRESOLVED CHALLENGES

15.7.1 *Democratic versus Expertise-Based Legitimacy: The Rise and Resurgence of the Consumer Movement*

The IEC has always maintained that it welcomes the input and seeks balanced participation from all who have a legitimate stake in the development of electrotechnology.[92] The IEC Code of Conduct for Technical Work also requires the national member bodies to represent all interests at the national levels. In practice, however, stakeholder representation has been (with rare exceptions) limited to technical experts whose participation is funded by private sector employers with an immediate commercial stake in the issue at hand.

This predominance of private sector experts is consistent with the IEC's reliance, from the start, on the expertise-based authority of the IEC, its national member bodies, and the individual participants in its technical committees for the legitimacy of IEC governance.[93] The IEC's expertise-based authority has in recent decades been supplemented by delegated authority, especially since WTO member states designated ISO and IEC standards (in the WTO's TBT-Agreement) as a way to achieve legitimate public policy objectives without setting up unnecessary technical barriers to trade through divergent national standards.[94] The consumer movement, however, increasingly calls into question the IEC's reliance on little more than expertise-based and delegated authority.

The IEC started to develop standards specifically for consumer products – and explicitly acknowledged consumer safety and welfare as objectives of IEC regulatory governance – starting with the lamp socket standards it developed in the 1920s.[95] But the question of whether consumers needed to be incorporated into the standard-setting process to safeguard the IEC's centrality and legitimacy was only brought to the fore by the rise of the consumer movement in the late 1960s and the 1970s,[96] as well as the broader shift toward post-materialist values across most advanced capitalist democracies.[97] To be sure, consumer interests are far from assured voice or

[92] Yates and Murphy, *supra*, note 15, at 73.
[93] Avant et al., *supra* note 20, esp. 12ff.; Büthe, *supra* note 2, at 296, 302ff., 305.
[94] Büthe, *supra* note 2, at 304ff.
[95] A. Raeburn, IEC Technical Committee Creation: The First Half-Century (1906–1949), www.iec.ch/history/first-50-years.
[96] L. Cohen, *A Consumers' Republic: The Politics of Mass Consumption in Postwar America* (2003); M. Hilton, Social Activism in an Age of Consumption: The Organized Consumer Movement (May 2007) 32:2 *Social History* 121.
[97] See, e.g., R. Inglehart, *The Silent Revolution: Changing Values and Political Styles among Western Publics* (1977); and *Culture Shift in Advanced Industrialized Society* (1990); R. Inglehart and C. Welzel, *Modernization, Cultural Change and Democracy* (2005).

influence over policy – even in democratic political systems,[98] which might be due to organized opposition from producer interests[99] or difficulties in discerning consumer preferences.[100] Research on the political consequences of post-materialism also yields mixed findings regarding the relationship between post-materialism and political consumerism or, more generally, willingness and forms of political participation. Yet the dearth of consumer representation (and more generally the representation of noncommercial interests) in IEC technology governance[101] has consequences for the contents of IEC standards and increasingly has come to be seen as a threat to the IEC's legitimacy.[102]

In response, IEC (and ISO) in 2019 created the ISO/IEC Guide 59, which mirrored the "Six Principles for the Development of International Standards, Guides and Recommendations," articulated in 2000 by the WTO TBT Committee as part of its Code of Good Practice: transparency, openness, impartiality and consensus, relevance and effectiveness, coherence, and ensuring de facto opportunities for participation by stakeholders from developing countries.[103] ISO/IEC Guide 76:2020 also calls for taking consumers' inputs in consideration in developing service standards.[104]

To implement the Guides, the IEC sought to facilitate noncommercial stakeholders' participation in standard-setting, for instance, by allowing "liaison organizations" participation (differentiating between three types with different participation rights).[105] Moreover, the IEC has increased its use of digital tools to boost participation. Beginning in 2001 already, it required all comments to be submitted online and started to introduce electronic voting on technical work. More recently, the IEC introduced to its website a tool to allow the public to submit comments online, and it has continued to increase opportunities for remote access to documents and standard-setting activities – including through the "online authoring tool," introduced to enable participants to work on a given document simultaneously. All of

[98] T. Betz and A. Pond, The Absence of Consumer Interests in Trade Policy (April 2019) 81:2 *Journal of Politics* 585. Regarding voice and influence in global governance more generally, see M. DeMenno and T. Büthe, Voice and Influence in Global Governance: An Analytical Framework in *Rethinking Participation* (J. Pauwelyn et al. eds., 2022).

[99] See, e.g., S. Eckert, *Corporate Power and Regulation: Consumers and the Enviroment in the European Union* (2019).

[100] D. Vogel, When Consumers Oppose Consumer Protection: The Politics of Regulatory Backlash (October–December 1990) 10:4 *Journal of Public Policy* 449.

[101] B. Farquhar, Consumer Representation in International Standards (January/February 2006) 16:1 *Consumer Policy Review* 26; C. Hauert, Where Are You? Consumers' Associations in Standardization (2010) 8:1 *International Journal of IT Standards and Standardization Research* 11.

[102] Alshadafan, *supra* note 2.

[103] See www.wto.org/english/tratop_e/tbt_e/principles_standards_tbt_e.htm; also P. Delimatsis, Global Standard-Setting 2.0: How the WTO Spotlights ISO and Impacts the Transnational Standard-Setting Process (2018) 28 *Duke Journal of Comparative and International Law* 273, at 311.

[104] www.iso.org/obp/ui/#iso:std:iso-iec:guide:76:ed-2:v1:en

[105] www.iec.ch/global-partnerships

these steps aim to lower the costs of participation (which had been frequently noted as an important impediment for noncommercial stakeholders).

Regrettably, however, the limited publicly available information – as well as interviews with IEC insiders with access to performance data for the IEC-internal systems – suggest that all of these efforts have yielded little actual participation by consumers so far. The public commenting tool, for instance, has registered a small number of records only.

15.7.2 *Gender Equality in IEC Standard-Setting*

The IEC has also been repeatedly criticized for the lack of women participants in its work.[106] Recently, the IEC admitted the existence of the problem, having examined it through an internal survey.[107]

The IEC has, so far, responded to this, above all, by promising to take corrective action. It also joined the United Nations Economic Commission for Europe, supposedly to ensure representation of women in TCs. Additionally, the IEC has partnered with the ISO under the stewardship of the Joint Strategic Advisory Group to develop guidance to help TCs ensure they are developing gender-responsive standards. These efforts, however, have only recently begun, and it remains to be seen whether they are effective, given the continued strong gender imbalance in most engineering fields.

15.8 CONCLUSION: LEARNING RESILIENCE?

Over the course of its 115-year history, the IEC has exhibited remarkable resilience in the face of numerous and diverse challenges to its preeminence – challenges that have arisen from technological change, the emergence of alternative institutions for developing electrical and electronics standards, and geopolitical upheavals and related power shifts in the world economy, including two world wars, decolonization, the end of the Cold War and the arrival of new, rising powers in the world economy. In this chapter, we have provided a sketch of this resilience and examined its drivers (as well as its limitations).

We started by identifying (in Section 15.2) four essential attributes of the IEC, which, we suggested, would have to remain intact in the face of otherwise

[106] See, e.g., M. Parkouda, *When One Size Does Not Protect All: Understanding Why Gender Matters for Standardization* (2020); P. Heß, SDG 5 and the Gender Gap in Standardization: Empirical Evidence from Germany (2020) 12:20 *Sustainability* art.8699. For compelling examples of the – likely unconscious yet consequential – biases that result from such underrepresentation, see T. Betz, D. Fortunato, D. Z. O'Brien, Women's Descriptive Representation and Gendered Import Tax Discrimination (2021) 115:1 *American Political Science Review* 307–315.

[107] www.iec.ch/blog/disappointing-results-gender-survey-technical-committees.

https://doi.org/10.1017/9781009329408.021 Published online by Cambridge University Press

extraordinary adaptability to head off challenges to its predominance and legitimacy, if we are to consider the IEC's continued existence indicative of genuine resilience. We then sketched a theory of resilience, extending Büthe's proto-theory of organizational preeminence in light of Delimatsis' analytical framework for this book. The empirical account of IEC resilience in light of a variety of challenges that it has encountered over the course of more than a century show time and again the central importance of the IEC's autonomous agency in pursuit of its organizational self-interest – while largely maintaining the inclusive, participatory governance structures and procedures on which its legitimacy is in large part based.

At the same time, the IEC cannot be said to have (yet) successfully addressed all challenges to its preeminence, raising questions about the extent to which resilience can be "learned." To be sure, some changes made by the IEC in response to earlier challenges, such as its creation of the Standards Management Board (originally set up in the 1920s as the Committee on Action to coordinate the work of its then-fifteen Technical Committees), have lastingly enhanced its ability to combine autonomous agency with legitimacy-enhancing embeddedness of the IEC leadership in the community of member bodies. Yet the ultimate test of resilience arises from having to respond to shocks that are different from prior ones, necessarily limiting the extent to which past resilience might predict future resilience.