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Inter-American Development Bank
1300 New York Avenue, N.W.
Washington, D.C. 20577
www.iadb.org

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Abstract

Regulation can pose a barrier to innovation when it is unnecessarily burdensome or slow to adapt, but it can also act as a driver of innovation by providing important preconditions, such as general frameworks for finance and funding, intellectual property rights (IPRs), and ground rules for competition and consumer protection.

The “pacing problem” faced by regulation—its ability to remain relevant in the face of technological advances—has never been more prevalent due to the nature and speed of digital transformation and innovation. Regulators can opt to play a more active role in nurturing and supporting innovation by exploring the application of regulatory sandboxes and innovation testbeds as mechanisms to enable emerging innovations in sectors that were traditionally heavily regulated, such as telecommunications, health, and energy.

The study is based on an in-depth analysis of seven international case studies in the United Kingdom, Finland, the Netherlands, and Argentina. It explores the application of regulatory sandboxes and innovation testbeds as mechanisms either driven by or developed with the support of regulators, identifying key aspects of their implementation, governance, support mechanisms, and impact.

The study draws some important lessons for Latin America and the Caribbean, showing how agile and experimental approaches to regulation could be considered as part of the innovation policy mix, and how innovation agencies can play a fundamental role in implementing those types of initiatives.

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1. Introduction

1.1. Regulatory Approaches to Innovation

Traditional views of regulation as a barrier generally emphasize the administrative burden of ineffective and incomprehensible regulation, red tape, the cost of compliance, and barriers to market entry. More relevant to emerging technologies, however, is a pacing problem (Thierer, Hagemann, and Skees, 2018), that is, the tendency of regulatory frameworks to lag behind technological developments. This means that technological advancements can render regulations obsolete while disrupting the cost and competition structures of markets. In the past, this has been true for telecommunications and ICT and can presently be seen in the emergence of digital technologies. Digital innovation has created new regulatory challenges in terms of data, privacy, and security (Deloitte Centre for Government Insights, 2018), as well as enforcement, especially when new activities cross sectoral and jurisdictional boundaries. It has also blurred the usual delineation of market and sectors, as well the traditional distinction between consumers and producers (OECD, 2019).

In the contrasting view, regulation can also be seen as a driver of innovation by providing important preconditions such as a general framework for finance and funding, bankruptcy regulations, intellectual property rights (IPRs), and ground rules for competition and consumer protection. These conditions provide the stability needed for investment and planning when it comes to innovation activities. Beyond this, however, regulations can act as a push factor, catalyzing innovation through the definition of new standards and the promotion of modern techniques and procedures (EPSC, 2016). An example is the Porter Hypothesis (Blind and Manchester Institute of Innovation Research, 2012), in which environmental regulations stimulate compliance innovation and can lead to the creation of new markets.

Given this complex relationship, reconciling regulation and innovation ultimately involves a balancing act. It is desirable to have a stable system in which consumers are protected and regulation provides the ground rules for fair competition, while keeping the ability to either adapt to or facilitate the development potentially disruptive innovations, which could in turn support economic growth and address societal grand challenges.

Faced with the challenges posed by emerging technologies, there are a number of approaches regulators can take (Zetzsche et al., 2017). These range from simply doing nothing to actively reforming and developing regulation for new entrants and activities.¹

Depending on the approach, there are multiple tools and instruments available to regulators and government. These range from informal governance mechanisms such as ‘soft law’ systems and multi-stakeholder processes to restricted experimentation and adaptive regulation.² This was also identified by NESTA (Armstrong, Gorst, and Rae, 2019), which identifies three approaches to regulation on its different policy goals, desired outcomes, and stakeholders involved.

- ▶ **Advisory:** Advisory approaches are designed to make it easier for businesses with new products or services to approach regulators and work with them to test and then adapt the product or service under existing regulations. Under this approach, regulators offer guidance and testing services and support to firms to understand the regulatory environment at an early stage. Innovators benefit from temporary relaxations in the full regulatory regime to test the potential impacts of their products or services, but the final goal is to fit within existing regulation. The regulator can play a more proactive, engaged role in the development and testing of new innovations in that sector.
- ▶ **Adaptive:** Innovators benefit from temporary relaxation in the full regulatory regime to test the potential impacts of their products or services, but the final goal is to fit within existing regulation. The regulator can play a more proactive, engaged role in the development and testing of new innovations in that sector. The regulator may provide assessments of the public value of an innovation and identifies proportionate adaptation of products or regulations on case-by-case-basis.
- ▶ **Anticipatory:** The primary goal of anticipatory approaches is to better understand what the impacts of an emerging technology (which may not be developed enough for use) might be on the economy and society and, therefore, what the potential regulatory needs will be. It is more forward-facing than either advisory or adaptive approaches, meaning that regulators must deal with more uncertainty, less evidence, and a greater number of possible risks. Here the regulator is not only playing a more active role in supporting innovation but is also building an information and evidence base via direct research activities. It makes available dedicated resources for research and assessment followed by cross-sector, multi-stakeholder collaboration to prepare appropriate regulations.

¹ Deloitte Centre for Government Insights (2018) distinguishes between minimum government regulation, light precautionary regulation, and strong precautionary regulation.

² Understood by Thierer et al. (2018) as a governance process that attempts to articulate a set of soft criteria using a deliberative, consensus-based dialogue including a wide array of actors, from industry firms and public and consumer interest non-profits to government regulators and technical advisors.

Regardless of the approach, there is consensus that these must consider the effects of emerging technologies, the views of consumers and producers, and the impact of regulation on innovation.³

1.2. Regulatory Sandboxes and Innovation Testbeds

This study, commissioned by the Inter-American Development Bank to Technopolis, looks into two instruments available to regulators to support and enhance innovation in emerging areas, lift potential barriers set up by existing regulatory frameworks, or address gaps: regulatory sandboxes and innovation testbeds.

Innovation testbeds and regulatory sandboxes are policy instruments usually used in the context of adaptive or anticipatory approaches to regulation. They are part of a wider policy mix and represent a move toward ‘smart regulation’ based on “a close interaction between the regulators and the regulated companies” (Blind and Manchester Institute of Innovation Research, 2012), granting proportionate regulation to innovative firms while keeping risks to an appropriate level.

Innovation testbeds and regulatory sandboxes support innovation by reducing the time and cost of getting innovative ideas to market and providing access to finance while at the same time integrating consumer-protection safeguards (FCA, 2017). They can also be suitable for helping regulators determining *when* to regulate a given market or technology (Deloitte Centre for Government Insights, 2018). In general, the instruments are geared toward supporting a particular innovation or technology, developing a market, enhancing competition, and generating economic growth.

The regulator’s involvement is not necessarily limited to oversight, monitoring, and supervision. Rather, the regulator typically provides advice and support services to the participants. There are also few examples of systematic approaches at the regulator level, in Singapore and the United Kingdom, with funds or incentives set up at the national level to support regulators to experiment with approaches outside of their normal practice, taking either advisory, adaptive, or anticipatory approaches.

The study follows a case-study approach, covering seven international initiatives, including case studies that do not fit into those two categories but provide a good example of an instrument that supports regulatory innovation (as they encourage regulators to collaborate

³ Innovation principle: when a policy is developed, the impact on innovation should be assessed to ensure that regulatory tools foster innovation. This exercise must consider innovation affecting aspects and environmental, consumer, and health protection and technical issues. The innovation principle seeks to balance information (transparency and equal access), flexibility (allow new methods and techniques to develop within the aim of compliance), and stringency. It applies across all stages: R&D, commercialization, and recycling.

with industry on cross-cutting issues and to experiment with approaches outside of their normal practice). The case studies, developed via a combination of desk research and interviews with key stakeholders, describe the policy context and the underpinning legal or regulatory framework in which these instruments have been launched, as well as elements related to their design and implementation and emerging results and lessons learned.

The remainder of the document is organized as follows. The sub-sections below provide an overview of approaches to regulatory innovation, a definition for innovation testbeds and regulatory sandboxes, an analytical framework (developed by the study team) to describe those instruments, and an overview of the case studies. Sections 2 and 3 provide the key findings from the case studies on regulatory sandboxes and innovation testbeds, respectively. Section 4 reviews other approaches to regulatory innovation that are not easily classified as innovation testbeds or regulatory sandboxes. Section 5 presents some success factors and lessons learned that could inform the design and implementation of instruments to support regulatory innovation in Latin America and the Caribbean (LAC). The full case studies are presented in a separate report.

1.3. The Case Studies

Seven international case studies were developed for this study, each covering one initiative classified either as a regulatory sandbox or a testbed. The report also includes one case study that does not fit into those two categories but provides a good example of an instrument that supports regulatory innovation (as it encourages regulators to collaborate with industry on crosscutting issues and to experiment with approaches outside their normal practice). The major themes emerging from the analysis of those case studies are presented in the following sections. The case studies were developed via a combination of desk research and interviews with key stakeholders.

The case studies were selected from an initial long list, taking into account their potential relevance to LAC countries and their potential to generate lessons learned in the sectors/technologies of interest, as well as the progress made on implementation and availability of initial results and evidence of impact. They covered areas outside FinTech, which are less studied or underrepresented in the current academic and grey literature on testbeds and regulatory sandboxes. The six case studies, listed in Figure 1.1 and Table 1.1 below, also have a relatively good spread in terms of geography, sector/technology focus, and type of initiative. The United Kingdom is represented three times as it is one of the countries that have more experience implementing this type of instruments.

Figure 1.1. International Case Studies

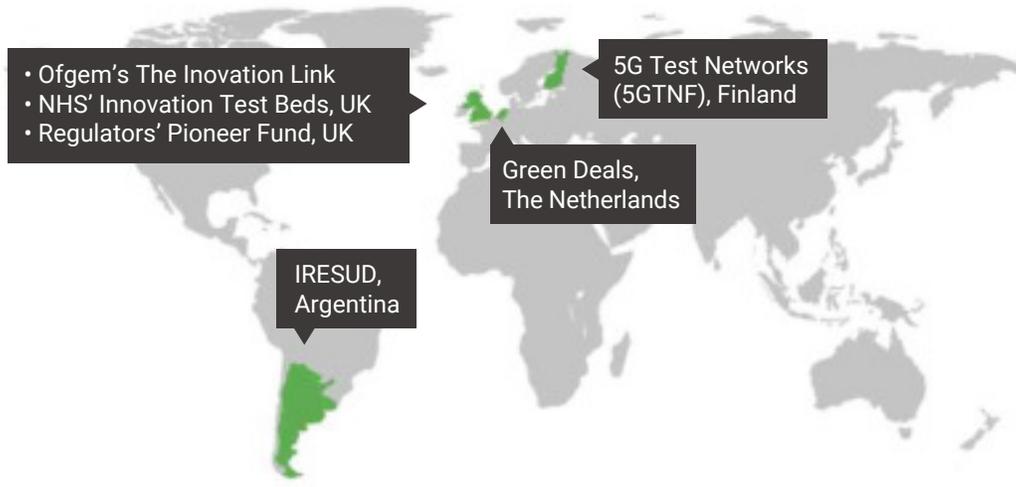


Table 1.1. International Case Studies—Description

Title	Sector	Type	Short Description
The Innovation Link energy trials ^a	Electricity generation and storage	Regulatory sandbox	Ofgem is an electricity and gas regulator in the United Kingdom. Ofgem's Innovation Link is a regulatory support program for the United Kingdom's power sector. It launched its regulatory sandbox service in February 2017. The sandboxes enable innovators to trial new products, services and business models without some of the usual rules applying. Innovation Link further offers advice on how innovative business models could fit into existing regulation via a fast-frank-feedback service.
IRESUD ^b	Electricity networks	Testbed	IRESUD is a project led by the National Commission of Atomic Energy and the National University of San Martin, in Argentina. The purpose of the project is to introduce technologies in the country associated with connection to the electricity network, in urban and peri-urban areas, of distributed photovoltaic solar systems, contemplating technical, economic, legal, and regulatory issues, to contribute to the diversification of the energy matrix in the medium term from a renewable source such as solar energy.
Green Deals ^c	Sustainability	Regulatory sandbox	The Green Deal in the Netherlands is a series of agreements which provides an accessible way for companies, other stakeholder organizations, local and regional government and interest groups to work with central government issues related to green growth and social objectives. The aim is to remove barriers to help sustainable initiatives get off the ground and to accelerate this process where possible.
Regulators' Pioneer Fund ^d	Cross-sectoral	Regulation innovation	The Regulators' Pioneer Fund (RPF) is funded by the UK Department of Business, Energy, and Industrial Strategy (BEIS) and administered by the UK innovation agency, Innovate UK. Through the RPF, BEIS is investing up to £10 million over two years in regulator-led projects. UK regulators can apply for funding to support initiatives that help businesses bring innovative products and services to market.

Title	Sector	Type	Short Description
5G Test Network Finland ^e	Telecoms	Testbed	The 5G Test Network Finland was first established in 2015 to manage the various testing facilities within the 5th Gear Programme. The program has developed academic and commercial testing facilities for advanced applications, products, and services that rely on 5G technology. By providing a platform on which to test new 5G enabled technology, the 5G Test Network Finland aims to make Finland a leader in all aspects of 5G.
5G Testbeds and Trials Programme in the United Kingdom			Similarly, the UK 5G Testbeds and Trials Programme is designed to coordinate the development of 5G services and applications in a common framework. It aims to foster the 5G ecosystem in the United Kingdom, build sustainable business cases in 5G, create the necessary conditions to exploit 5G efficiently, and promote UK leadership in 5G R&D.
Test Beds Programme ^f	Health	Testbed	<p>The Test Beds Programme is run by the National Health Service (NHS), the UK health provider which is regulated by the Medicines and Healthcare Products Regulatory Agency (MHRA) and National Institute for Health and Care Excellence (NICE).</p> <p>Seven testbeds across the UK were developed to serve as real-world sites to test combinatorial innovations that integrated new digital technologies, care models, and health informatics, as part of the NHS Five-Year Forward View (5YFV) plan.</p> <p>The technologies tested are approved and do not require approval by the regulators. However, the outcomes from the program have helped to inform regulatory gaps with respect to digital technologies (such as algorithms and digital platforms).</p>

^a <https://www.ofgem.gov.uk/about-us/how-we-engage/innovation-link>

^b <https://iresud.com.ar>

^c <https://www.greendeals.nl/english>

^d <https://www.gov.uk/government/news/projects-lay-the-groundwork-for-a-future-of-robotlawyers-and-flying-cars>

^e <http://5gtnf.fi/>

^f <https://www.england.nhs.uk/ourwork/innovation/test-beds/>

1.4. Key Elements

The seven case studies included in this report have been analyzed following a standard analytical framework developed by the study team. Two dimensions and 13 key elements relevant for characterizing innovation testbeds and regulatory sandboxes were identified. This framework is summarized in Table 1.2 and further described below.

Table 1.2. **Analytical Framework**

Arrangements of the Initiative	
<ul style="list-style-type: none"> ▶ Type <ul style="list-style-type: none"> • Testbed • Regulatory sandbox • Elements of both ▶ Legal structure <ul style="list-style-type: none"> • Legal or regulatory framework • Informal collaboration • Company • Academic/research Institution • Unincorporated association • Charity ▶ Motivation and objectives 	<ul style="list-style-type: none"> ▶ Governance <ul style="list-style-type: none"> • Legal/regulatory backing of the intervention • Implementing agency • Sponsoring/managing stakeholder or agency ▶ Financing structure ▶ Scope <ul style="list-style-type: none"> • Technology/sector focus • Technology readiness level • Timeframe (incl. exit/extension criteria) • Amount (size) of support ▶ Eligibility/access rules <ul style="list-style-type: none"> • Eligibility criteria • Entry test • Contingency plans
Targeted Beneficiaries and Range of Activities	
<ul style="list-style-type: none"> ▶ Stakeholder types ▶ Size (of the partnership or of the cohorts) <ul style="list-style-type: none"> • Small (<30), • Medium (30–100) • Large (>100) ▶ Target customers ▶ Services offered (advisory or adaptive regulatory, anticipatory) 	<ul style="list-style-type: none"> ▶ Facilities (physical or virtual) ▶ What does participation in this intervention grant? <ul style="list-style-type: none"> • Waiving of certain regulations • Access to specific consumers • Badge/seal of approval • Funding • Access to facilities/data • Other

The first set of characteristics relates to the arrangement of the initiative, including type (testbed, regulatory sandbox, or elements of both), the nature of the testing environment, and the legal structure. It also includes motivations (e.g., whether it is a call led by an individual agency attempting to get ahead of emerging technology issues or whether it has been imposed by executive action) (Thierer et al., 2018), and objectives, beyond the general objectives of testbeds and sandboxes. Governance structure is also a key element, as it defines which key stakeholders feed into the design and implementation of the initiatives (e.g., single or multiple regulators, business associations), as well as the underlying financing structure.

Next are characteristics related to scope. Initiatives typically tend to can focus on a sector or technology (although it has been argued that sectoral restrictions are not particularly helpful as targeted technologies or innovations may not fit neatly into specific sectors) (Zetzsche et al., 2017). Initiatives could focus on supporting technologies at different readiness levels (with sandboxes typically focusing on mature technologies that are in real-life technical environments but not real-life regulatory environments and testbeds focusing on technologies that are still at the demonstration stage).

Initiatives also vary in terms of timeframe (typically 6, 12, or 24 months) and size (overall cost of the program and funding available to participants). In some cases, extensions of the original timeframe are possible when testing has been successful for the product or service. Alternatively, additional exit criteria may be in place specifying the conditions under which participants can opt out or be forced to exit (for example, upon reaching a certain size).

Another important characteristic is eligibility, including the procedures in place to assess it. Participants are asked to demonstrate that they are active in the target sector and are offering something genuinely innovative as part of the testbed or sandbox, and that the technology, service, or activity is not currently appropriately covered by the existing regulatory framework. They are also invited to explain the products and consumer benefits and, in some cases, draft contingency plans for customer impacts in case the product fails.⁴ In some cases, entry tests may be in place to establish whether firms are qualified to participate. Such exercises typically address whether the technology, service, or activity is both innovative and appropriate, and if there is a clear need for a sandbox or testbed (i.e., where coverage under existing laws and regulations is inadequate). In some cases, the technical capabilities of applicants are also factors in the eligibility criteria.

The second set of characteristics relate to the target beneficiaries and activities covered by the initiative. Innovation testbeds and regulatory sandboxes are primarily focused on private companies who can take part as individual participants or in partnership with other companies. Participation may only be opened to authorized companies already active in the regulated market, or to new entrants.

Innovation testbeds and regulatory sandboxes differ in terms of the level of involvement and support services or facilities offered by the regulator. Furthermore, participating in the initiative will bring direct benefits to the participants, ranging from a waiver of certain regulatory requirements (in the case of sandboxes) to funding and support services.

Finally, there are often limits with respect to the customers that the sandbox participants are permitted to target. It is also important to consider the levels of customer sophistication in terms of understanding when setting up those restrictions (Zetzsche et al., 2017).

⁴ In the case of FinTech, this could refer to record keeping when transactions had to be unwound later on.

2. Regulatory Sandboxes

2.1. What Are Regulatory Sandboxes?

Regulatory sandboxes are policy instruments that facilitate small-scale, live testing of innovations in a controlled market-like environment. Sandboxes are typically employed in cases where the emerging technology is potentially disruptive. It allows the testing of innovative technologies and business models that are not fully compliant with current rules and regulations, by providing temporary suspension of certain mandatory provisions or requirements for those who participate in the sandbox.

This means that participants are not required to follow all the regulatory requirements that would normally apply outside the sandbox in the regulated market. In return for this dispensation, participants are required to incorporate appropriate safeguards to insulate the market from risk from their innovative business. This gives participants a safe space to experiment without running the risk of being punished for noncompliance while reducing liability concerns among regulators (Zetzsche et al., 2017).

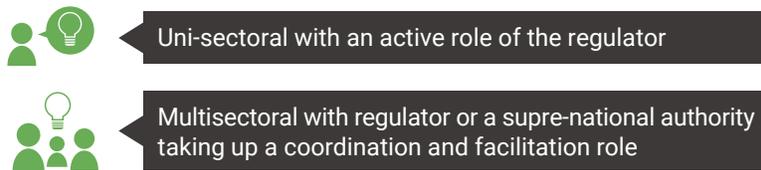
Regulatory sandboxes tend to be delivered with the strong presence of a regulator, who also provides monitoring and supervision. Another key aspect of regulatory sandboxes is the establishment of feedback mechanisms that allow regulators to gather evidence of potential needs for change in the existing regulatory framework, to facilitate the creation of more products or business models. As such, regulatory sandboxes entail an “interest in regulatory discovery” (Federal Ministry of Economic Affairs and Energy, Germany, 2019).

The definition of sandbox is used by stakeholders in a rather broad way which differs from regulator to regulator and from country to country. Two of the six case studies—Ofgem’s Innovation Link and Green Deals—can be classified as regulatory sandboxes, even though they have been implemented in different ways. These two international initiatives are presented at the end of this chapter.

2.2. How Are Regulatory Sandboxes Implemented?

The Ofgem’s Innovation Link and Green Deals case studies, and other international initiatives, show two models of implementation for regulatory sandboxes (Figure 2.1).

Figure 2.1. **Models for Implementing Regulatory Sandboxes**



The first model, represented by Innovation Link, is driven by Ofgem, the United Kingdom’s regulator for the electricity and downstream natural gas markets. It was implemented to establish new regulatory priorities to lower barriers to power system innovation and address a changing energy market. Ofgem describes this as “regulating for uncertainty,” derived from the rapid pace of the emergence of disruptive and game-changing technologies and business models and the ambition to transform the UK energy system from a centralized to a more smart, flexible, decentralized, and less carbon-based one.

The Innovation Link aims at improving Ofgem’s understanding of the regulatory challenges that innovative business models face and will face in the future. The sandbox enables innovators trialling innovative business models by providing them with temporary exemptions to rules covered in the existing regulatory framework. For instance, it allows licensed companies to test peer-to-peer energy trading (e.g., household to household), without requiring peers to fulfil the obligations of an energy company. As such, (micro) generators can be exempt from holding an electricity generation, transmission, distribution, or supply license.⁵

In this environment, the innovator then has an extraordinary commitment from the regulator about which regulation will or will not apply in their specific case. Any regulatory exemptions that are part of Innovation Link are directly named ‘regulatory sandboxes’ by Ofgem itself. The regulator oversees all monitoring of the sandboxes, which includes assessing risk management plans from the innovators and assessing reports on lessons learned, which are required from innovators.

Ofgem’s Innovation Link also offers advice on how innovative business models could fit into existing regulation via a fast-frank-feedback service, acting as a one stop shop.

⁵ Decentralized local energy generators can be given a class exemption if they have no grid connection and are below 100 MW capacity, or if they are grid-connected but provide less than 10 MW electrical power at any time.

All exemptions as part of sandboxes only apply to regulations governed by Ofgem and not the UK Industry Codes that underpin the electricity and gas wholesale and retail markets. The UK industry codes are contractual frameworks and cover, for example, technical regulations and market access. They are governed not by Ofgem but by code administrators such as the UK National Grid. Ofgem's principal role is regulation in terms of consumer protection and competition. Thus, sandboxes primarily provide relief from regulation of commercial aspects, rather than providing technical exemptions which might be needed for connecting new types of generation or storage to the grid. These technical burdens can also be a strong barrier but must be addressed through changes to the industry-led codes, which Ofgem cannot address. This highlights the fact that even within the 'uni-sectoral with an active role of the regulator' model, a level of coordination is needed to guarantee actual implementation of new business models. In the example of smart energy demand metering and peer-to-peer electricity trading, further developments will be needed with respect to financial regulation, data protection regulation, consumer protection regulation, and electricity regulation.⁶

The second model, represented by the Dutch Green deals, focuses on 'green' innovations. The Ministries of Economic Affairs and Climate Policy, the Interior and Kingdom Relations, and Infrastructure and Water Management lead the Green Deal, established in 2011. It is dedicated to addressing coordination failures to promote the development and adoption of 'green' innovations. There is no focus on a specific technology or sector. Rather, it has a thematic focus and covers nine domains: energy, bio-based economy, raw materials, construction, biodiversity, mobility, food, water, and climate.

Its main objective is to support bottom-up sustainable initiatives by addressing barriers and bottlenecks in terms of rules and regulations, creating new markets, providing advice and information, and enabling optimal partnerships, so that these can scale up. A secondary objective is to inspire similar initiatives through spin-offs and spillover effects. The deals are mutual agreements or 'covenants' under Dutch private law signed by a coalition of participants.

The Green Deal aims to be an accessible way for companies, other stakeholder organizations, local and regional government, and interest groups to work with the central government on green growth and social issues. The strong increase in interconnectivity between different technologies and sectors calls for a crosscutting rationale for establishing sandboxes. The increase in the implementation of artificial intelligence technology, for example, will require substantial regulatory changes to accommodate the increased linkages between sectors. The transport sector will require vast updates of regulation to allow

⁶ In the United Kingdom, the code administrators understood the need for a joint approach from the industry, which resulted in a new Code Administrators Code of Practice principle for innovation support. Furthermore, the Balancing and Settlement Code administrator Elexon allowed for a sandbox by raising a modification to the code.

autonomous driving in most countries. This is an area that will need a strong connection to digital services and data protection regulations, which are only partly relevant to the road transport sector, such as those related to traffic control.

A sandbox environment can help regulators identify crosscutting regulatory issues in a supervised environment which, in turn, may call for coordination with other regulators with different mandates.⁷ The complexity of regulatory derogation increases relative to the clash of potential amendments to competition and consumer protection laws. This poses additional challenges if derogation involves amendments that require action by regulators with other competencies, even if they hold the same hierarchical mandate, and it is made more difficult if it requires actions or approval from a superior regulator (such as in the case of the European Commission within the European Union). In these cases, it is often not possible to allow derogation, and the regulator will have to play a mediating role by connecting innovators with all the responsible bodies.

This has implications in terms of governance. A multi-sectoral approach requires a strong coordination body with a multi-sectoral governance mechanism. Three Ministries in the Netherlands are involved in the Green Deals. The Ministry of Economic Affairs has the most prominent role, and its Enterprise Agency (RVO) is also the primary managing agency. In addition, there are some others within the governance structure of the Green Deal program: an interdepartmental working group and a steering group consisting of representatives from the three ministries, as well as a Green Deal Board with 10 stakeholders from industry, science and research, and civil society.

In both models, there are clear advantages for businesses and innovators. The regulatory sandbox allows the testing of novel technologies and methods in a real-life situation that involves customers and regulators. This can give an innovator a stronger understanding of obstacles in regulation and with customers than, for instance, an innovation testbed that primarily allows the testing of technical issues. Moreover, the strong involvement of the regulator in a sandbox allows the business to have direct contact and to voice the need for changes in regulation through a more direct channel compared to a formal consultation, which is in many countries the traditional approach to regulatory updates.

⁷This approach multisectoral approach is also being tested elsewhere. UK Financial Conduct Authority, for example, is currently assessing the possibility of setting up a collaborative instrument across multiple regulators to actively explore challenges posed by innovations at the intersection of multiple industry sectors, which would normally be regulated by different bodies. Further iterations of the sandbox will provide a single point-of-entry sandbox to industry wanting to test innovative products or services in a controlled environment, under the supervision of multiple regulators.

2.3. Who Participates and What Support Is Provided?

A multiplicity of actors across the innovation ecosystem take part in the regulatory sandboxes, including:

- ▶ **Innovators and knowledge providers.** This group includes large, established companies, as well as start-ups and new market entries. To guarantee alignment with competition law, and in the case of Ofgem, only licensed operators are permitted to lead sandboxes, while other companies, such as technology providers, can be part of the wider consortium implementing trials or projects. A similar approach is applied to sandboxes in the FinTech area (not covered in this study).⁸ Sandboxes also encourage collaboration between industry, academia, and public and private research organizations to support research and development (R&D) activities.
- ▶ **Regulators and other government bodies,** including executive agencies and different ministerial departments (mostly for multisectoral approaches such as the Green Deal) which tend to provide monitoring and supervision, as well as advice.
- ▶ **Consumers.** Regulatory sandboxes operate in real-life environments. Consequently, they make provisions for the participation of consumers, who either opt in or are alerted that the product or service they are using is being tested in a sandbox. In the first case, consumers typically retain the right of refusal. In the Ofgem example, consumers who agreed to join the trial have the right to withdraw their agreement to participate at any point in time without any risk of increases in their energy costs. Furthermore, consumer protection safeguards are included as part of the requirements to take part in a sandbox.
- ▶ **Finally, NGOs and other civil society organizations** could also be included and can be important stakeholders to represent end users and provide oversight in terms of ethical considerations and safeguards to consumers.

In terms of eligible ideas and projects, sandboxes tend to focus on innovative ideas (products, services, and business models) with potential economic and societal benefits, in alignment with current policy priorities and needs, and whose development and

⁸ See ESMA (European Securities and Markets Authority), EBA (European Banking Authority), and EIOPA (European Insurance and Occupational Pensions Authority) (n.d.). The report looks at fintech sandboxes in six countries. In each case, participant companies either require a license or had to conform to the relevant supervisory requirements to satisfy licensing conditions.

application (at least part of it) faces legal barriers within the existing regulatory framework. Support comes in the form of:



Within this environment, companies get the opportunity to work with regulators while testing their products in a live market, for a limited number of years (typically two). Regulators, on the other hand, can develop more appropriate regulatory policies through greater visibility in new innovations. As distinct from innovation testbeds, sandboxes tend to not provide direct funding or access to testing facilities.

2.4. What Have Regulatory Sandboxes Achieved?

Sandboxes are relatively new initiatives; thus, their results and impacts have yet to be tested. However, as an independent evaluation of the Green Deals has shown, these arrangements can be effective mechanisms to adapt regulation in an agile way and lower barriers to innovation, which are their ultimate goals. Three types of impacts have been documented to date through Green Deals:

- ▶ **Success in removing structural barriers to the innovation process**, including amended rules and regulations and the provision of market incentives. Regulatory changes have emerged in the areas of bioenergy, heating, electricity, driving and smart grids, solar PV, and biofuels.⁹
- ▶ **Knowledge sharing and cooperation.** The Green Deals have generated added value for participants by stimulating agreements on knowledge-sharing, cooperation, and networking, as well as taking concrete steps toward trialing and piloting projects. They have also added significant value in disseminating expertise, experience, and best practices, which has led to the emergence of communities of practice or living labs.
- ▶ **Awareness and political buy-in.** The Green Deals have contributed to sustainability and green growth by placing key topics on the agenda in various domains of society and at various levels of government, which has created greater awareness and political buy-in.

⁹ One example of successful legal impact has emerged from the deal on Insects for Feed, Food and Pharmaceuticals, which promoted the use of insects as an alternative source of protein. Under this deal, the Dutch Insect Breeders Association (VENIK) cooperated with the government to eliminate legislative and regulatory obstacles in this area. This included the passage of the Animals Act in late 2014, which approved the use of insects as production animals.

Case Study 1: Ofgem's Innovation Link

The Initiative

Ofgem's Innovation Link is a regulatory support program for the UK power sector. It launched its regulatory sandbox service in February 2017. Sandboxes enable innovators to trial new products, services, and business models without some of the usual rules applying. Innovation Link further offers advice on how innovative business models could fit into existing regulation via a fast-frank-feedback service. It aligns with the UK Clean Growth grand challenge and the increased emphasis on the development of future smart energy systems, including local energy solutions.

Governance

Ofgem and its Innovation Link Project Team implement the initiative.

Participants and Eligibility Criteria

The initiative is solely aimed at the UK power sector. Participation in activities is limited to UK businesses which hold an Ofgem electricity generation, transmission, distribution, or supply license. However, energy generators which are non-license holders or business or academic institutions that are providing innovative tools such as software can still be in scope if they build a consortium with a license holder.

Ofgem issues calls for expressions of interest and invites businesses or consortia of businesses and academia to submit their ideas. Ofgem set up the following eligibility criteria:

Inclusion criteria:

- Innovations must be ground-breaking and benefit consumers
- Changes to regulations must be temporary and not exceed 24 months
- Current regulation (as determined by Ofgem and not by primary legislation or rules enforced by others) must represent a barrier to the realization of the innovation

Exclusion criteria:

- Ofgem is not in charge of the regulation that inhibits the business model
- The project requires permanent changes of regulation
- The project does not show prospects for benefits for customers

Ofgem has run two competitions since February 2017. It received 67 expressions of interest. Seven sandboxes have been granted so far. Most innovators who submitted an expression of interest received fast feedback support.

The sandboxes are restricted to a maximum of 24 months and cannot be extended. Ofgem agrees with the innovator on an individual approach to compliance to ensure consumer protection. All other legal, license, and code obligations toward customers which are not part of the bespoke rules of the bespoke trial continue to apply. Moreover, consumers who agreed to join the trial have the right to withdraw their agreement to participate in the trial at any point in time without any risk of increases in their energy costs.^a The procedure for how consumers consent to taking part in a sandbox depends on each trial, but consumers need to consent to participate.

Support Offered

- Waiver of certain regulations and guarantees on regulation enforcement. Ofgem responded to the needs of these projects with a number of different interventions. Sometimes the regulation derogation and action from Ofgem only impact a minor part of a trial rather than removing a substantial barrier, but in other cases it is a significant enabler of an innovation project. Exemptions are granted via non-disclosive ‘sandbox letter’ agreements with the innovator.
- Advice, directly to sandbox participants via the Innovation Link “fast frank feedback” service.

Examples of Projects

- Peer-to-peer local energy trading platform to allow residents to source their energy from local renewables and trade it with their neighbors using blockchain technologies.
- A project to develop different ways of generating and supplying locally generated heat and electricity to homes and commercial buildings. Includes community battery storage and innovative methods to switch a consumer’s energy supply between different generation methods.
- Simulations on running a platform where “prosumers” can sell excess electricity. It aims to develop a tool to match supply and demand of electricity.^b

^a OFGEM (2019).

^b VLERICK (2019).

Case Study 2: The Dutch Green Deals

The Initiative

A Green Deal is a voluntary agreement, or covenant, between parties such as businesses, organizations, citizens' groups, local government bodies on the one hand, and central government on the other, for the purpose of working together to develop an idea that could support green growth.

The Green Deal initiative was launched in 2011 and has its roots in the Dutch tradition of close cooperation between social partners. Under the Green Deals, any organization encountering implementation barriers that prevent it from exploiting sustainability opportunities is given the means to signal this to the government to collectively attempt to address those barriers.

As of May 2019, a total of 227 Green Deals have been signed. Of these, 169 have been completed and 58 are in progress.^a

Governance

The key responsible department of the initiative is the Ministry of Economic Affairs and Climate Policy, working in collaboration with the Ministry of the Interior and Kingdom Relations and the Ministry of Infrastructure and Water Management, and Netherlands Enterprise Agency (RVO) via an Interdepartmental working group. For each deal, the Enterprise Agency also appoints a secretary who manages administrative matters for the duration of the deal.

In addition to this interdepartmental working group, the governance structure also includes two bodies:

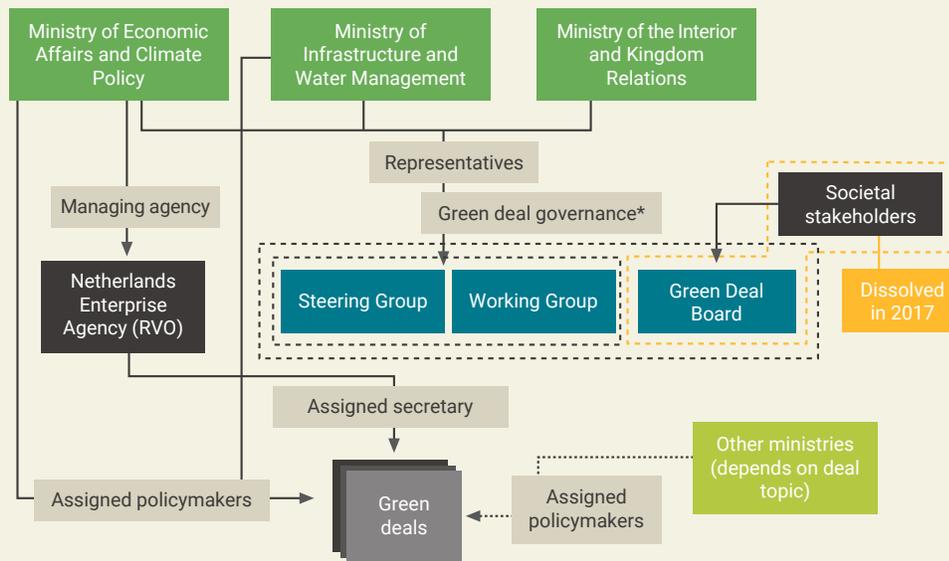
- A steering group consisting of managerial-level policy makers from the same departments as the working group. This was intended to oversee the working group.
- A Green Deal board consisting of 10 representatives from businesses, NGOs, and civil society, described as societal stakeholders.^b The members of this board act as ambassadors for one or more of the nine themes. They were involved in dissemination by drawing the attention of relevant parties to the Green Deal approach, promoting

^a For the most recent figures, see <https://www.greendeals.nl/green-deals>.

^b Ellen MacArthur Foundation (2015).

broader application of the results achieved, formulating recommendations for the approach, evaluating the results, alerting to new opportunities, identifying gaps, and challenging the formation of new deals (Figure 2.2).⁶

Figure 2.2. **Governance Structure**



* This component of the governance structure is undergoing changes.

Participants and Eligibility Criteria

Private firms, NGOs, and decentralized public bodies can all apply on behalf of an initiative focused on sustainability that is experiencing difficulties in the implementation or scale-up phase that can be addressed by the central government. Overall, the idea/proposal must be in line with the policy objectives of the Dutch government, be profitable or have the potential to become profitable in the future, and be able to demonstrate results, preferably within three years.

The Green Deals have a relatively large pool of participants. To date, 1,821 organizations have participated (some of them have been involved multiple times), including 907 private firms (50 percent), 291 public actors (16 percent), mainly provinces, municipalities, and water boards, and 245 sectoral bodies (13 percent). Other types of participants included NGOs and intermediaries, higher education or research institutes, health care providers, financial institutions, cooperatives, and government departments other than the main responsible ministries.

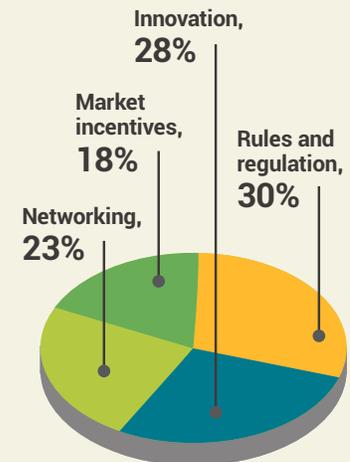
⁶ Van der Ahé (2012).

Support Offered (Figure 2.3)

The central government participates by:

- Fostering networking across actors, acting as independent party.
- Eliminating legal and regulatory barriers. This includes clarifying laws and rules, amending laws, allowing room for experiments.
- Providing market incentives, such as setting up public procurement process or providing certification and quality marking (when relevant).
- Supporting initiatives to develop innovative business cases, products, revenue models, and services that are tested together with 'launching' customers.

Figure 2.3. Distribution of Government Actions across the Green Deals



Financing is, in principle, not part of the Green Deals instrument, and funding is only provided for specific process-related aspects. Examples include funding for setting up installations for testing, communication-related aspects such as campaigns and websites, facilitating meetings between participants, and knowledge exchange activities. Government representatives also provide support by signposting to relevant sources of public funding (within existing programs).

Examples of Projects/Deals

- Temporary Nature focused on reintroducing rare and protected flora and fauna on land awaiting redevelopment. It introduced legislation to facilitate such temporary arrangements without affecting the future development of the land (Green Deal no. 066)
- Green Certificates focused on developing sustainability criteria for the certification of bio-based raw materials for use in plastic and chemicals and aims to develop a common standard at European level as well as providing guidance on the chain of custody (Green Deal no. 118)
- Insects for Feed, Food and Pharma focused on removing legal and regulatory obstacles for the large-scale production of insects for feed and food in farms using leftovers and waste in both the Netherlands and Europe (Green Deal no. 092)

Mini Case Study: Supporting Connected and Autonomous Vehicles

A number of countries are pushing ahead to support the development of connected and autonomous vehicles (CAV), including China, Germany, Korea, Singapore, Sweden, the United Kingdom, and the United States.^a This has led, in many cases, to changes to regulation and the establishment of regulatory sandboxes.

In Germany, for example, a four-year regulatory sandbox has been set up for the Hamburg Electric Autonomous Transportation project. The objective of the project is to prove that fully automated or autonomous driving can be successfully integrated into road traffic as an overall system at Level 5, that is, without a driver. The project consists of the development of a concept for fully automated or autonomously running electric minibuses in public transportation and its implementation in the HafenCity in Hamburg, Germany. The regulatory sandbox is scheduled to take place in three phases, which successively place increasing demands on the functionality of the vehicles as well as the safety and performance of the overall system. It will provide exemptions from the German Road Vehicles Registration and Licensing Regulations for the test vehicles.^b

Singapore has begun amending its laws to regulate safety in autonomous vehicle (AV) testing. The country amended its Road Traffic Act in 2017 to recognize that a motor vehicle need not have a human driver. The Minister for Transport can create new rules on AV trials, set standards for AV designs, and acquire data from AV trials. A five-year regulatory sandbox was created to ensure that innovation is not stifled, and the government intends to enact further legislation in the future.^c

Both countries are promoting the use of sandboxes across a variety of sectors, from health to environmental services.^c

^a Smart City Demonstrators (2018).

^b See https://www.bmwi.de/Redaktion/EN/Publikationen/Digitale-Welt/handbook-regulatory-sandboxes.pdf?__blob=publicationFile&v=2 and https://www.erneuerbar-mobil.de/sites/default/files/2018-04/Flyer_HEAT_April2018_final%20vf%20%282%29.pdf (in German).

^c Taeihagh and Min (2019).

3. Innovation Testbeds

3.1. What Are Innovation Testbeds?

Innovation testbeds are programs that provide access to physical or virtual environments in which companies or public sector stakeholders can test, develop, and introduce new products, services, processes, organizational solutions, and business models, typically in collaboration with multiple stakeholders. They provide an environment where an innovation can be trialed in real- or near-real-world conditions and demonstrate its market viability. This is particularly relevant when innovations attempt to enter complex and regulated markets. The level of control in the environment can range from highly controlled laboratory environments to real-world environments. Often, innovation testbeds are demonstrators for sectors or technologies. This study focuses on those operating in a highly regulated market.

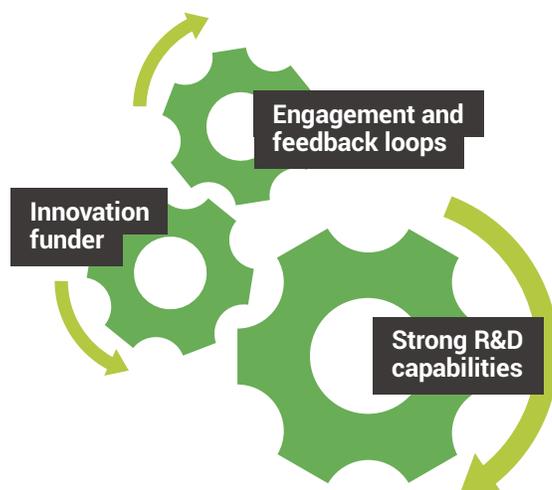
In the case of the National Health Service (NHS), the testbed is also set up to enable more rapid adoption of new solutions (in this case, in hospitals and healthcare practices). It recognizes that innovations are often implemented in isolation from each other and the infrastructure in which they expect to function; that there is a comparative lack of robust evidence about their real-world effects, as opposed to experimental or research settings; and that innovations are often introduced on top of existing working practices and infrastructure, rather than in conjunction with them. Furthermore, the program allows for the collection of evidence and building a case for regulatory changes, plus assessment of the appropriateness of the current regulatory framework to deal with the use of digital and artificial intelligence (AI) solutions in healthcare.

An example of an innovation testbed is the 5G Test Network Finland (5GTNF). 5GTNF has aimed to fill the gap between laboratory-based 5G and commercial network deployments by offering a testing infrastructure and tailored configurations, accessible to the telecom and vertical industries as well as the scientific community in Finland.

3.2. How Are Innovation Testbeds Implemented?

Like regulatory sandboxes, innovation testbeds focus either on a specific sector (e.g., application of digital solutions for healthcare by the NHS in the United Kingdom or the deployment of distributed photovoltaic [PV] systems by IRESUD in Argentina) or on enabling technologies with applications in various sectors (e.g., 5G technologies in Finland and the United Kingdom). However, as distinct from regulatory sandboxes, innovation testbeds tend to be led by a single executive agency. Overall, there are three key characteristics of how innovation testbeds are implemented (Figure 3.1).

Figure 3.1. **Characteristics of Implementation of Innovation Testbeds**



They tend to operate in areas where there are strong internal academic and industrial R&D capabilities within the country

Like most innovation programs, testbeds tend to be implemented in those sectors/markets where the country has a critical mass of R&D active universities, research institutes, and companies that could benefit from the instrument. Moreover, they may require initial (and substantial) investments to set up new or improved virtual and physical infrastructure, as well as efforts to mobilize existing research infrastructures and facilities within universities and research laboratories. Consequently, demand for the program would be a key factor to justify and sustain those initial investments.

The existence of strong internal R&D capabilities (a high-quality demand) also enables the program to support a diverse portfolio, with various solutions being tested to identify the most viable and beneficial options to similar challenges, understanding that the nature of the innovation process would mean a degree of failure. The NHS testbed, for example, was able to leverage the existence of a competent ecosystem and R&D capabilities in the United Kingdom, with participants testing a variety of innovative solutions from wearable devices linked to the internet of things (IoT), to predictive algorithms designed to predict when people are going to experience a mental health crisis.

Finland, in turn, has a long history with wireless communications technology and benefits from the presence of a big global player, Nokia. Consequently, the 5G Test Network program is leveraging knowledge and resources from the existent innovation ecosystem (including testing facilities and infrastructures) to enable further growth in the application of 5G in vertical industries (smart industry, smart cities and living, smart mobility, and smart health and wellbeing).

They tend to be allocated on a competitive basis and implemented by an executive agency

The testbeds tend to be allocated as competitive R&D or innovation grants. As such, they benefit from the leadership of a public agency or government department with the resources, knowledge and mechanisms in place to: run and assess calls for proposals (including leading early engagement with and support to potential applicants, and mobilizing relevant networks); disburse funding and provide advice; monitor progress and risks; and assess results.

Business Finland (a funding agency for research and technology development) lead the 5G Test Network Finland. The United Kingdom's Department for Digital, Culture, Media & Sport (DCMS) leads the United Kingdom's 5G Testbeds and Trials program, and Innovate UK, the UK's innovation agency, delivers and oversees the competitions. IRESUD (which aims to create technologies to introduce distributed PV solar systems into the energy grid in Argentina) was set up via the National Agency for the Promotion of Science and Technology (Ministerio de Ciencia y Tecnología, or MinCyT) in Argentina and is delivered via a public-private partnership consisting of a university and five companies.

They tend to put in place mechanisms to generate feedback loops to address regulatory barriers

Within testbeds, feedback mechanisms are set up at the governance level to include the participation of the regulator. They also collect intelligence on the limitations of existing regulatory frameworks to address new and disruptive technologies, contributing to the development of legal and technical regulations. This provides case studies that can help

identify barriers that are preventing new technologies from getting to market and being implemented on a wider scale, thus helping to inform future regulatory policy.

The Finnish Transport and Communications Agency (TRAFICOM), which provides communications regulations in Finland, is part of 5G Test Network Finland’s advisory board. It advises on the current regulatory framework and anticipates potential changes needed. TRAFICOM is also responsible for issuing licenses to the test networks for experimental 5G frequencies.¹⁰

In the case of the UK 5G Testbeds, DCMS has established a Barrier Busting Task Force, which includes Ofcom (the United Kingdom’s regulatory and competition authority for the broadcasting, telecommunications and postal industries), to identify areas where changes to existing regulation could be made and to identify and address any barriers to 5G infrastructure development.

The public–private partnership that leads IRESUD works in close coordination with the National Electricity Regulatory Body (Ente Nacional Regulador de la Electricidad, or ENRE) and the Ministry of Energy in Argentina to develop legal and technical regulations, as well as economic instruments, to promote the installation of distributed PV systems connected to the grid.

In terms of wider feedback loops, the testbeds in this study were designed with significant input from innovators, and in some instances end users, to identify funding and technology gaps as well as barriers for technology development and uptake. As examples, the 5G Test Network Finland worked with a core group of companies and research institutions to develop the physical infrastructure for the test network, and later with the wider user community to determine which vertical industries would benefit from support.

3.3. Who Participates and What Support Is Provided?

A multiplicity of actors across the innovation ecosystem take part in innovation testbeds, including innovators and knowledge providers, executive agencies, and other government bodies, end-users/consumers, NGOs, and other civil society organizations. The funds are allocated on a competitive basis and are open to any player with adequate capabilities based on the quality of their proposals and potential impact of their projects. Tens of thousands of innovators are supported across the different programs. This stimulates market competition as well as capacity building across a wide industrial base (rather than just favoring a few well-established players).

¹⁰ See <http://pilvi.viestintavirasto.fi/en/spectrum/frequenciesfordigitalexperimentation/testlicensesin3400-3800mhz.html> for more information.

In cases where licenses are needed, the regulator facilitates them. In the case of the 5G Test Network Finland, for instance, all projects are required to get a Mobile Network Code and an operator license to transmit a cellular network, which is facilitated and fast tracked by the regulator, TRAFICOM.

In terms of eligible ideas and projects, testbeds focus on innovative ideas, from products to services. The projects are expected to demonstrate potential economic and societal benefits, in alignment with policy priorities and needs, and the need for testing innovations in real environments and at scale. In terms of maturity, the projects sit at the development stage within the Technology Readiness Level (TRL) scale.¹¹ This may mean that further R&D investment is needed to bring products and solutions to commercialization or final use, after the project ends. Even the NHS testbeds program, which supports mature technologies, focuses on solutions that need further evidence (collected by testing applications with a large cohort of patients, in real settings) to evolve and arrive at innovations that are ready for commercialization in the NHS system and nationally.

Support comes in the form of:



Testbeds tend to include substantial investments and provide direct funding. The NHS Test Bed Programme had public funding of £16.5 million, with projects ranging from £500,000 to £1.5 million, depending on their scale. The UK 5G Testbeds and Trials Programme has a budget of £200 million for 2018-2022, and projects have ranged in size from £2 to £5 million. Testbeds also require co-investment from participants. Private investments are in-cash but also in-kind (including the time of key staff, or knowledge sharing and infrastructure). Funding contributions are often scaled, requiring large corporations or foreign entities to pay a larger percentage of their costs than academic institutions, research institutes or small and medium-sized enterprises (SMEs).

¹¹ The development stage includes TRL4-5 (Component/subsystem validation in laboratory or relevant environment) and TRL6-7 (System/subsystem model or prototyping demonstration in a relevant end-to-end or operational environment).

Testbeds facilitate access to virtual and physical infrastructure (to participants and end users). This ranges from supporting the installation of test sites (such as PV systems for analysis, testing, and qualification of system design and components, as in the case of IRESUD), to providing access to real-life environments (such as hospitals or medical practices, as in the case of the NHS), to supporting the development of new testing infrastructure (such as the test frameworks and networks in the case of the 5G program in Finland).

The testbeds also provide access to expertise. In the case of the NHS, this support includes matchmaking (during the proposal stage), advice on legal requirements (such as navigating any issues related to data sharing, storage, and protection), and advice on access to markets (via dedicated workshops with opportunities to pitch innovations to NHS leaders). In the case of IRESUD, technical support was provided for the design, operation, and installation of PV systems.

Finally, testbeds also provide support in terms of coordination and facilitation. This materializes in helping potential participants identify partners (to promote business-business and business-academia collaborations and create new partnerships when relevant), as well as in identifying barriers that need to be addressed by the regulators.

3.4. What Have Innovation Testbeds Achieved?

The testbeds analyzed in this report have been operating for around five years and have in many cases achieved a variety of short-term outcomes specific to each program. However, overall, the testbeds have led to:

- ▶ **Innovations.** Testbeds have led to the development of new or improved products and services. However, in most cases, external and internal evaluations of the testbeds programs have revealed that other barriers exist—beyond testing at large scale and addressing regulatory impediments—to the final commercialization and adoption of new solutions. Sometimes they reveal the need for further research and investments, or the need to provide further stimulus to adoption, which can be risky or require considerable changes in consumer behavior or organizational change. These would fall outside of the remit of testbed programs and may call for other interventions, driven by different ministries, and may depend on policy priorities.
- ▶ **Changes to regulatory barriers.** IRESUD provides the best example of contributing to changes in regulatory barriers. It led to the development of at least eight new standards and regulations that would help to increase the adoption of PV systems in Argentina. In all other cases assessed, evidence pertaining to regulatory barriers has been collected, but it less clear if testbeds lead to changes in regulation.

- **Credibility/seal of approval.** Participation in the testbeds allows an innovator to send a positive signal to the market as potential customers are reassured that the innovation has undergone due diligence and robust evaluation, and thus any evidence of benefit is reliable.

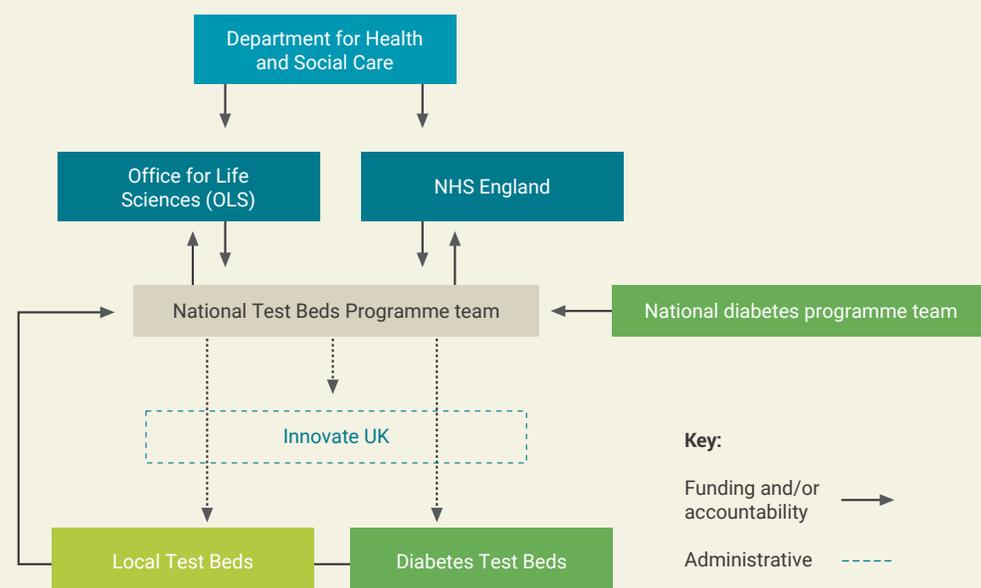
Case Study 3: National Health Service Test Beds Programme

The Initiative

The Test Beds Programme brings together organizations within the NHS in England and industry partners to test combinations of digital technologies and redesign pathways in real-world settings. The aim is to tap the potential of novel digital technologies and transform healthcare delivery for patients and caretakers. Innovations to be tested must be market-ready and address a clearly defined health and care challenge, bearing in mind that their application in a real-life setting will lead to further development and innovation. Innovations also must be combinatorial, integrating new digital technologies, care models, and health informatics. So far, two waves of the program have been commissioned (Figure 3.2).

Governance

Figure 3.2. NHS Test Bed Governance Structure (wave 2)



This is the first time that the NHS has pursued innovation testbeds on a national level. The NHS Test Beds Programme is funded jointly by the Office for Life Sciences (OLS) under the auspices of the Department of Health and Social Care (DHSC), and NHS England and NHS Improvement (NHSE/I). Funding is provided through Innovate UK, the UK's innovation agency. Individual testbeds report to Innovate UK and the National Test Beds Programme Team (based across both OLS and NHSE/I) which in turn reports to senior responsible officers (SROs) at both OLS and NHSE/I.

There is no formal legal structure either at the program or testbed level. A testbed is defined as a partnership between businesses and NHS organizations that may also include academia, local government, and the third sector. Testbeds set out a framework agreement, describing the terms of collaboration, relationships, responsibilities, and risks held by each party. This testbed agreement needs to be signed off by InnovateUK to release funds.

Participants and Eligibility Criteria

Any type of UK and international business can be involved in a testbed, but only UK-based SMEs are eligible for funding. Links with the local health and care economy (e.g., with general practitioners and local councils) are encouraged, as well as participation of wider stakeholders. There is no minimum or maximum number of participants in a testbed. While the number of partners per testbed is often small (<30), the number of participants who are testing innovations at each testbed is often in the thousands. Selected testbeds are expected to share the following four key features:

- Effective cross-party leadership
- Governance frameworks that enables rapid decision making
- Capacity to share data among participating bodies
- Populations in excess of 1 million people

Support Offered

Participation provides access to funding, access to subject matter experts, support from the National Programme Team, partnering with organizations that bring different skills, and national exposure. Another benefit is the rare opportunity to test and evaluate products in a highly regulated environment, at scale and in

real-world settings. Seven testbeds were funded in each wave, with the following support offered:

- Wave 1: around 30 months; £9.5 million from public funding plus £15 million from industry
- Wave 2: 18 months; over £7 million from government; no estimates of industry investment to date

The program does not offer a guarantee to participants that innovations tested in the testbed will be later procured by the NHS for wider deployment.^a

Examples of Projects

In addition to supporting new digital technologies, Wave 1 had a focus on IoT solutions, while Wave 2 has a focus on diabetes-related innovations. Examples include:

- Predictive algorithms to manage patients' risks and to monitor risk of crisis: For example, a predictive algorithm to predict when people are going to experience a mental health crisis, tested on 33,000 patients, and involving a hospital trust, a Clinical Commissioner Group, an Academic Health Science Network, local police and ambulance services, and two innovators.
- Data aggregation to facilitate operational, clinical, and patients' self-management decision making: For example, IoT devices tested on thousands of people with dementia and their caretakers, comprising wearables, monitors, and other devices to monitor health at home.

^a NHS England (2018).

Case Study 4: 5G Test Networks Finland (5GTNF)

The Initiative

The 5GTNF is a network of testing sites with 5G-capable networks to test new 5G applications and services in a controlled environment prior to commercialization. The program aims to provide an ecosystem of testing and research facilities and to coordinate regulatory and technical work in Finland to ensure that there is a cohesive approach to 5G development. There are 60 partners across different projects that operate as part of the 5GTNF ecosystem. Finland has a long history with communications technology and is a frontrunner both in terms of innovative telecoms businesses and usage of mobile telecommunications networks.

Governance

The 5GTNF is a collaboration between industry, academia, and the Finnish government. It is managed and operated by Business Finland, the national innovation agency. Business Finland worked with TRAFICOM, the regulatory body, to ensure that the necessary testing frequencies and licenses were available to the participating testers. TRAFICOM sits on the advisory boards of the 5GTNF to both advise and anticipate potential regulatory changes that may be required. They are also responsible for issuing licenses to the test networks for the experimental 5G frequencies.^a

Participants and Eligibility Criteria

The targets for participation in the 5GTNF are individuals, companies, and academic research institutions working in wireless communications and/or seeking to use 5G spectrum technologies. Participants who received funding from Business Finland were required to establish 5G test networks for others to use. To be granted a test license, the regulator required technical specifications on the radio transmitters that will be deployed, prior to the issuance of a test permit. These testbeds are open to the public for anyone who needs to test on an operational 5G network.

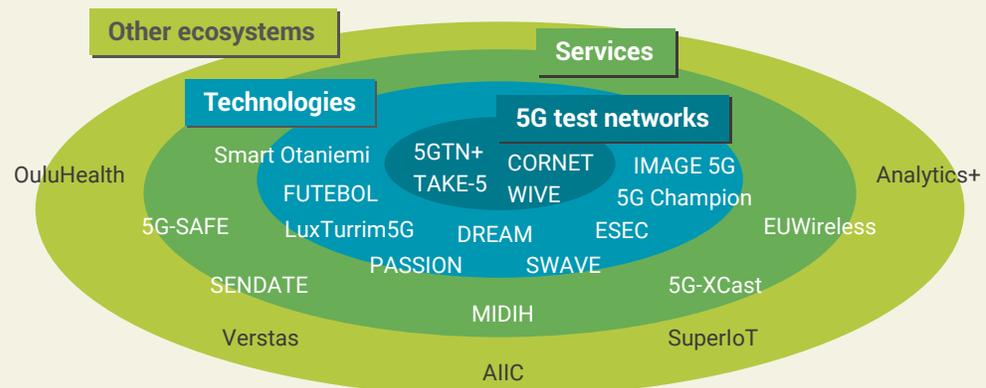
^a <http://pilvi.viestintavirasto.fi/en/spectrum/frequenciesfordigitalexperimentation/testlicensesin3400-3800mhz.html>

Users submit proposals to the test networks to ensure that the objective of their test would be feasible and compatible with the networks. The operators of the test network are capable and willing to make alterations to its functionality at the request of users, but because of high costs, not all requests were granted. Test networks retain the right to refuse potential users.

Support Offered

The project focused on the development of 5G networks that are capable of providing proving grounds for other users of 5G. Test networks provided the physical infrastructure and the data management servers necessary to handle the high volumes of data that are transferred over 5G frequencies. The projects generally receive funding for a two-year period. Funds are drawn from the 5thGEAR program, which had a budget of €100 million euros over five years (2015-2019). 5GTNF test networks target different parts of the 5G ecosystem (Figure 3.3).

Figure 3.3. **5GTNF Ecosystem Portfolio 2016–2018**



Participation in the 5GTNF grants partners and users access to test frequencies in the 5G spectrum, as well as a wealth of knowledge. Participants gain access to cellular base stations, a pop-up network with simulation capabilities, expert advice, tailored laboratory measurements, and a summary of report and test results.^b These facilities operate in closed environments, isolated from the rest of the network. For academic partners, participants also benefit from having portions of their research costs covered by Business Finland. By collaborating in the 5GTNF, participants can de-risk their transition to 5G and the development of new commercial solutions.

^b <https://services.5gtn.fi/>

Examples of Projects

- 5G VIIMA: Development (and testing) of 5G applications for industrial purposes (including sensor systems and stand-alone devices). Practical experiments in a factory, an indoor/outdoor industrial campus, and energy networks in three cities. Partners: 6 universities, 1 technical institute and 22 companies.
- Priority: Research, development, and testing of critical communications solutions for authorities and companies located in remote/rural areas. Includes research into broadband service in extremely remote locations, quality differentiation, communications security, and network interoperability.
- 5G-SAFE: Developed multi-access edge computing with low latency for autonomous vehicles.

Case Study 5: UK 5G Testbeds and Trials Programme

The Initiative

The 5GTT is designed to coordinate the development of 5G services and applications in a common framework. It aims to foster the 5G ecosystem in the United Kingdom, build sustainable business cases in 5G, create the necessary conditions to exploit 5G efficiently, and promote UK leadership in 5G R&D.

The development of applications for 5G communications technology is expected to lead to increased investment in 5G infrastructure, thereby supporting the larger 5G ecosystem. The 5GTT will develop testbeds in numerous sectors and verticals, providing places where trials of new technologies can be tested before going to market (Figure 3.4).

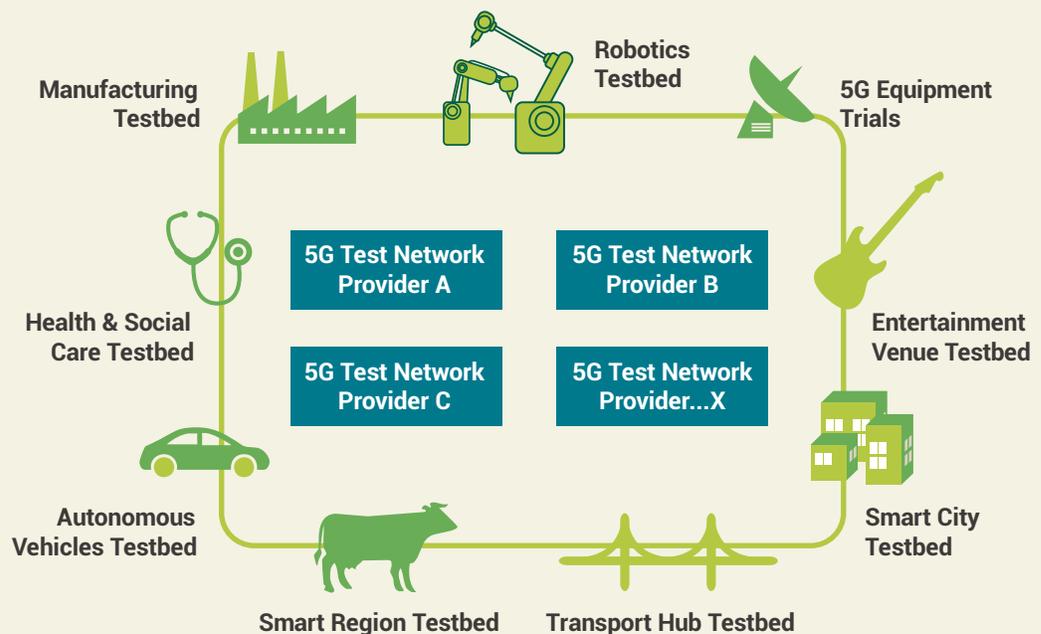
Governance

The 5GTT exists within the Department for Digital, Culture, Media & Sport (DCMS) legal structure as the government department responsible for digital technologies. To change regulations, DCMS must petition Ofcom, the UK regulator. DCMS has established a Barrier Busting Task Force to identify areas in which

changes to existing regulation could be made. Ofcom is also preparing the available spectrum for 5G use, benefiting from the experience of DCMS and the 5GTT.

DCMS made the conceptual decisions about the structure and format of 5GTT and is responsible for management and operation of the program. Innovate UK, the national funding agency, with its history of running complex public grant competitions, provided DCMS with assistance in the early stages of the application process. The funds for the 5GTT originate National Productivity Investment Fund (NPIF), a £37 billion investment fund to improve worker efficiency and productivity in the United Kingdom, of which £740 million has been allocated to digital infrastructure.^a

Figure 3.4. DCMS 5GTT Environment



In total, DCMS will spend £200 million across all 5GTT projects between 2017 and 2022. The government is making available an additional £35 million to enhance 5G connectivity on rail networks, in conjunction with the Local Full Fibre Networks Programme. This investment had been ring-fenced and is protected from being used for other purposes. This prevents the funds from being reallocated if government priorities shift.

^a See https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/752128/Productivity_web.pdf for more information.

Participants and Eligibility Criteria

DCMS required applicants to demonstrate the business case for the sector or technology, how the project will be delivered, and a defined budget describing the added value to be created. DCMS did not dictate the verticals that they were looking to support but did understand which areas of the market could support a testbed.

To receive funding, all recipients must be UK-registered organizations, create the testbed in the United Kingdom, and work in a collaboration with other partners. International partners are welcome, but a minimum of two grant-receiving UK organizations must participate. For larger grants, such as the Urban Connected Communities Project, there were additional requirements, such as a contiguous urban area including a population of at least 500,000 (or multiple urban areas which have a combined population of 500,000), and a single lead public sector partner.

Support Offered

Each testbed is unique, and there was no established financing structure across beneficiaries. Projects received between £2 and £25 million to establish testbeds. DCMS supported local authorities to develop forward-thinking digital strategies and plans for 5G infrastructure. Many political decisions in the United Kingdom are devolved, that is, taken at the lowest governmental level possible. In practice, this means that rules covering the installation of 5G infrastructure are taken at the local level. The primary activity of 5GTT is funding to develop the 5G infrastructure in the thematic testbeds. The goal is to provide an environment where UK businesses will be able to test, develop, and commercialize 5G applications, services, and products. The 5GTT allowed the testbeds to operate in testing frequencies. Testbeds that are operating in specific verticals also needed clearance of the vertical regulators as well. There were no specific waivers for testbed users.

Examples of Projects

- AutoAir: Installation of 5G infrastructure at Millbrook Proving Ground in support of a testbed for automotive and rail connectivity
- 5G RuralFirst: Intended to increase the potential for new applications of 5G technology in rural areas that have been traditionally underserved by wireless connectivity
- Worcestershire 5G Consortium: Working to enhance cybersecurity, with a focus on protecting the industrial IoT

Case Study 6: Interconnection of Photovoltaic Systems to the Electricity Grid in Urban Environments —Argentina

The Initiative

The purpose of IRESUD is to contribute to the diversification of the energy mix in Argentina by introducing technologies associated with the interconnection of distributed PV solar systems to the electricity network, in urban and peri-urban areas, considering technical, economic, legal and regulatory issues in the country.

In Argentina, the electricity market was liberalized in the early 1990s. Before IRESUD, Argentina's experience in designing, installing, operating, and monitoring distributed energy systems was very limited. Solar technologies were at an incipient stage, and regulatory frameworks were practically non-existent.

Governance

Initially, IRESUD was governed by a Board of Directors formed by members of public bodies (the National Atomic Energy Commission and the National University of San Martin). The Board oversaw two groups:

- The Research, Development and Technical Implementation Group: in charge of the design and Installation of Pilot Systems, the Evaluation and Monitoring Pilot Sites, and the Development and manufacture of inverters.
- The Elaboration of Regulations, Legislation and Management Group: in charge of preparing proposals and drafting regulation for the interconnection of distributed systems to the network, and to survey the typology of systems and tariff conditions.

Initially, a consensus from founding members was required to admit new participants, but this was found to be too burdensome. Members such as the University of San Martin (project leader) started signing bilateral agreements with other public and private institutions, and the partnership grew to a total of 34 institutions.

Participants and Eligibility Criteria

In 2010, the Argentine Sectoral Fund (Fondo Argentino Sectorial, or FONARSEC) issued a call for public-private consortia (FITS 2010) to promote technological capabilities in renewable energy in Argentina. The IRESUD project won that bid and was finally implemented as a public-private partnership agreement between the National Atomic Energy Commission, the National University of San Martin, and five private companies (Aldar, Edenor, Eurotec, Q-Max, and Tyco).

IRESUD also had the support of ENRE and the National Ministry of Energy. From its inception, the University of Buenos Aires and the National University of the Northeast, Lujan National University, National University of la Plata, and the National Technological University were also involved.

Throughout the life of the IRESUD initiative, other organizations and sites for installation of solar PV pilot plans were selected by the project's core founders. There were no strict eligibility criteria for new organizations to join. Members were asked to show commitment to develop the activities of the project, including installing and maintaining pilot sites, developing research, and reporting to the IRESUD consortium. Sites were selected based on bilateral agreements with universities, public institutions, provincial organizations, and co-ops.

Support Offered

IRESUD was partially subsidized with \$3.8 million from FONARSEC through the National Agency for the Promotion of Science and Technology (MinCyT). During the 2012-16 period, total project funding was \$6 million. IRESUD offered technical assistance to its participants in the design and installation of solar PV pilot plants and the development of instruments (promotion, subsidies, legal, and technical regulations) to promote the installation of grid-connected distributed PV systems in the country.

Examples of Outputs

During the project, 55 pilot low-voltage PV systems were installed in 16 provinces around the country, with a total PV potential of 129 kWp. Moreover, IRESUD

had a direct contribution in terms of regulation in the sector. Some of its key outputs were:

- Standard AEA 90364-Sec. 712 "Photovoltaic energy supply systems" of the GT10 working group of the Argentine Electrotechnical Association.
- Provincial Law 7824/14 of the Salta Province, to enable distributed electricity generation from renewable sources.
- Draft bills for the self-consumption of electrical energy with a net balance system, establishment and regulation of the federal generator system using the system of injection of renewable energies, and a National Promotion Scheme for the generation of energy distributed from renewable sources.

4. Stimulating the Uptake of Regulatory Innovation and Implementing Innovative Models Using Existing Regulatory Frameworks

When it comes to regulatory innovation, regulators often regard sandboxes as the ultimate and strongest measure to inform about the regulatory needs of a sector or industry and to accommodate innovators through regulatory derogation. However, often existing regulatory frameworks can accommodate innovators without exemptions from licenses or any kind of derogation from existing regulation. This might be because instruments already exist, or innovators simply need advice on how to fit their business model into existing regulation.

Two core challenges to innovation in regulatory frameworks can be identified. These derive from diversity in regulatory approaches and regulators, which act in many cases as individual authorities and not in a direct hierarchy under the government.

The first issue is that the authority of different regulators often overlaps. Therefore, not only does regulatory derogation in the context of sandboxes need cross-regulator coordination, but any regulatory changes, both on the level of the regulator and the legislative

level, need to reflect on this coordination problem and any regulatory issues regarding their level of authority. Moreover, regulators differ in their institutional propensity to implement more forward-looking approaches. They also must work on different budgets, which can require external funding to stimulate innovation seeking activities.

4.1. Bespoke Advice to Innovative Businesses on Regulatory Compliance

Experience from Ofgem’s Innovation Link program highlights how regulatory advice and feedback can support the uptake of regulatory innovation by using existing regulatory frameworks. The box below presents the service.

Mini Case Study 2: Ofgem’s Fast-Frank-Feedback Service

The Innovation Link was created to support organizations looking to introduce innovative propositions to the energy sector. It offers two parallel services: (i) a “fast frank feedback” service, which provides advice on how an organization’s innovative product, service, or business model can fit into relevant regulation^a and (ii) regulatory sandboxes, which are not necessarily only derogations or exemptions from certain regulatory requirements, but also include guidance and commitments regarding existing regulation and its enforcement to increase the confidence of innovators regarding their product, service, or business model.^b

The fast-frank-feedback mechanism is primarily guidance on existing regulations and support. Moreover, applicants for a regulatory sandbox are automatically offered the feedback service if their project is deemed to fit into existing regulation. This can contribute to the facilitation of the completion of these business ideas by providing guidance on how exactly they can work without an exemption from existing regulations. Regulatory sandboxes, however, were introduced with the intention that innovators trial innovative business products, services, and business models that cannot currently operate under the existing regulations, even in situations where additional support such as bespoke advice was provided.^c The feedback service hereby enabled applications for sandboxes to be filtered and helped the innovator identify regulatory barriers to their business model.

^a OFGEM (2018).

^b OFGEM (2017).

^c The Association for Decentralised Energy. Available at: <https://www.theade.co.uk/news/policy-and-regulation/ofgem-regulatory-sandbox-now-open>.

The experience from Ofgem has shown that innovators are often unaware of existing regulations and often do not even need sandboxes. This can also mean that rules and interpretation might not be clear enough and easy enough to find. Another finding was that start-up participants usually need reassurance that their model will work in the current regulatory regime to make it attractive to investors; hence, they do not need a sandbox, just advice.

It is therefore important to ensure that innovators are aware of existing regulations and to offer support on how complex innovation projects fit into existing regulations. Therefore, in some cases advice in combination with commitments by the regulator regarding enforcement and interpretation of regulation are sufficient to allow an innovative business model to run.

Nevertheless, there may also be some caveats when a regulator is providing too much advice to businesses. The private sector usually provides legal and regulatory advice. For example, the large amount of applications for the Innovation Link sandboxes that could be realized under the current regulations suggests that they may not have sought legal and regulatory advice before applying. Providing this kind of advice could be quite costly for the regulator in the long term, and it may only be helpful to offer it if a potential project has a demonstrable benefit to consumers or if the declarations of the regulator regarding enforcement and interpretation of the regulation are essential for the realization of the project.

4.2. Targeted Innovation Funding for Regulators

There is a high degree of heterogeneity among regulators in many countries, especially if they are independent and not part of a government department. This leads to differences in terms of their propensity to innovate. Moreover, one regulator might be willing than another to provide more funding for innovation projects. Targeted government funding thus can facilitate existing ideas and stimulate the use of innovative instruments such as sandboxes. The British Regulators' Pioneer Fund is a good example of how a government can use funding as a push factor to realize projects on regulatory innovation by the regulators.

Case Study 7: UK Regulators' Pioneer Fund

In July 2018, the Department for Business, Energy and Industrial Strategy (BEIS) launched the first call for proposals for a novel innovation-support scheme that would invest up to £10 million over the next two years in regulator-led projects. The Regulators' Pioneer Fund (RPF)—a competitive grant fund for UK regulatory agencies—provides regulators with development funding of sufficient scale (up to £1 million) to test and implement new regulatory approaches that have the potential to improve their performance while (critically) supporting innovators to bring new products and services to market. The RPF was created to provide financial support to regulators for realizing projects to:

- 1) implement a possible regulatory change;
- 2) explore a possible regulatory change; or
- 3) explore other possible solutions to a regulatory issue faced by innovative businesses.

The aim of the competition is to promote regulatory practices that support and encourage market innovation. It hopes to show that the United Kingdom has a flexible regulatory environment that can keep pace with technological developments. It does this by providing regulators with the instruments to help businesses bring innovative products and services to market, by making specific improvements to regulation across the four priority areas identified in the UK Government's Industrial Strategy.^a

The following are the types of projects that have been invited to take part in the competition for funding:^b

- Immediate implementation of a regulatory change where a regulator has evidence of demand by innovative businesses (projects up to 18 months)
- Short research and development (R&D) projects (about 6 months) that explore either:
 - ▶ solutions for a regulatory issue faced by innovative businesses, or
 - ▶ proactive measures to support innovative businesses

^a See <https://www.technology-law-blog.co.uk/2018/10/the-regulators-pioneer-fund-laying-the-ground-rules-for-robotlawyers-and-flying-cars.html> for more information.

^b See <https://apply-for-innovation-funding.service.gov.uk/competition/199/overview#summary> for more information.

- A short trial or pilot study (about 6 months) of an initiative to change a regulatory approach that can enhance support for innovative businesses
- Two-part projects (up to 18 months) that start with a short R&D project, trial, or pilot study (about 6 months), followed by review and implementation of a regulatory change that supports innovative businesses

The main objective BEIS hopes to achieve by funding the RPF is to encourage innovation in regulation to facilitate the market uptake of innovative services and products. This has meant that regulators have used most of the RPF's funding to set up initiatives working directly with businesses within their sector. Nevertheless, other regulators have also used RPF funding to establish instruments that would encourage collaboration between regulators, such as an exploratory study on a cross-sectoral sandbox.

Through the RPF, BEIS also hopes to understand the challenges regulators are currently facing. BEIS also uses the program as an “information tool” on current regulatory challenges that feeds into its policy planning. The fact that the government is using the RPF as a window to press regulatory challenges demonstrates its long-term willingness to adopt an anticipatory regulatory approach.

These examples show that while targeted funding for regulatory innovation allows regulators to bring forward their own ideas and act on the needs of businesses, the funder can still maintain control about prioritizing sectors without compromising on the microlevel the innovation process.

Regulatory innovation should ideally be driven by the needs of regulators and businesses. Administering funding through a competition prevents any uninformed, narrow pre-selection of instruments and initiatives by the funder. Moreover, using a mission-based approach with broad themes and mostly a high-level sector focus allows a middle ground between an overly strong intervention in the innovation process and aligning the regulatory needs of businesses with policies, especially in the areas of energy security, competition, and industrial strategy.

5. Success Factors and Lessons for the Latin American and Caribbean Region

The cases studies on innovation testbeds and regulatory sandboxes reveal a number of features and lessons that could be of use to the LAC region. The following are seven main takeaways.

1. An agile and experimental approach to regulation should be considered as part of the innovation policy mix in LAC.

Innovation testbeds and regulatory sandboxes are examples of this experimental approach, albeit they represent a relatively small fraction of the overall innovation policy mix. Implementing these types of programs would help to minimize the pacing problem, increase knowledge and trust between innovators and regulators, effectively and rapidly address knowledge gaps about the law that could be preventing certain innovations from taking off, and build evidence for the need to update regulatory frameworks. There are other associated regulatory challenges, such as the transboundary nature and global reach of some technologies/companies and liability and regulatory enforcement.

2. Testbeds may be more feasible to implement than sandboxes.

The rigidities imposed by the LAC legal system, which follows the civil law tradition and emphasizes the systematic codification of the general law, mean, in some cases, having to seek parliamentary approval to be able to offer regulatory wavers. Those approvals may be easier to obtain if the sandboxes promote innovations that may have substantial socioeconomic impacts and that are in line with national policy priorities (e.g., green innovations).

Taking the issue of legal rigidities into account, Argentina and Uruguay are discussing the possibility of drafting ‘blanket regulations’ to enable the creation of sectoral sandboxes. Other countries should consider revising their regulatory frameworks to facilitate the implementation of experimental schemes.

3. The international examples show that both approaches are implemented, in practice, in variety of ways and include a series of complementary supports.

They act as one-stop shops for information and advice on existing regulation, provide temporary exemptions, offer funding for (collaborative) research and innovation projects, provide access to testing facilities, and promote networking and knowledge sharing.

4. The multisectoral nature of some innovations requires coordinated action by actors and regulators.

This may call for a multisectoral governance mechanisms and/or the leadership of an organization with a supra-national mandate. Regardless, it is essential to establish feedback mechanisms within these instruments to collect evidence and information on regulatory barriers and decide how to address them.

5. Regulators should remain neutral, at arms’ length from the private sector.

This can be addressed in many ways. Regulatory sandboxes could, for example, work with licensing companies only (as in the Ofgem program), or with approved technologies that need further adaptation and enhancement to operate in real settings (as in the NHS program). Setting up competitive funds open to any innovator also promotes competition and guarantees neutrality. Competitive R&D grants provide an opportunity to foster collaboration between academia, industry, and key stakeholders.

6. Innovation agencies can play a fundamental role in implementing those type of initiatives.

They are key players in the innovation ecosystem, with good knowledge of innovators and innovation processes, which tend to be perceived as neutral agents (with an independent role). Furthermore, they have the infrastructure and knowledge to implement competitive research, development, and innovation calls and projects.

7. A dedicated program to encourage innovation within regulatory agencies should be considered.

The UK's Regulators' Pioneer Fund is case in point. It provides financial support to implement or explore regulatory change and explore other possible solutions to regulatory problems faced by innovative companies. Such a fund, which could also be implemented via the innovation agencies, could help relax financial constraints that prevent regulators from responding to changing demands given competing priorities, and may also provide a first entry point before the implementation of a full-blown testbed or regulatory sandbox.

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