Regulations and Clean Technology

A Review of Best Practices in Select Jurisdictions

DISCLAIMER

This report was commissioned by Innovation, Science and Economic Development Canada and prepared by Horizon Advisors. It does not reflect the views of the Government of Canada. Neither the Government of Canada nor its employees make any warranty, express or implied, or assume any legal liability or responsibility for the accuracy or completeness of any information contained in this report, or process described herein, and assume no responsibility for anyone's use of the information. The Government of Canada is not responsible for errors or omissions in this report and makes no representations as to the accuracy or completeness of the information.

ACKNOWLEDGEMENTS

This report was prepared by Amin Asadollahi. Research support was provided by Trevor Rous, Dr. Robert Batarseh, Farhan Rahman, and Ashley Racine. Joanna Kyriazis of Zizzo Strategy led the drafting of material related to the role of standards in clean technology innovation. We would also like to acknowledge and thank staff at France's Ministry of Economy and Finance [Ministère de l'Économie et des Finances] and Israel Water Authority [רשות המים] for sharing their insight and perspective.

Table of Contents

Text Boxes

Figures

EXECUTIVE SUMMARY

Regulations that support transformational change and accelerate the commercialization of innovative solutions will be critical in addressing pressing environmental challenges and positioning Canada on track towards realizing its mid-century decarbonization goals. Although existing Canadian regulatory models have specific functions, they are not necessarily designed to drive innovation or to result in transformative change. To this end, Canada has an opportunity to establish a new regulatory body that is tasked to act as a change agent and one that is specifically mandated to drive innovation and clean growth.

In what follows, we examine two different regulatory models that provide similar evidence of how the coordination and tailoring of more, rather than less, stringent regulatory requirements can support environmental policy goals, innovation and economic growth. First, the Dutch Energy Transition and the France Expérimentation program are characterized as regulatory sandboxes that have enabled innovators to test ideas within protected spaces as well as for regulators to establish requirements through experimentation. Second, the example of the Israel Water Authority is provided as a semi-autonomous regulatory model, overseeing all aspects of the country's water sector requirements, and is noted to have successfully set stringent and evolving requirements based on real-world conditions. These examples were selected among a list of regulatory models that were identified by Horizon Advisors for their novel approach in addressing regulatory barriers, enabling innovation and supporting transformational change. Finally, analyses of the three examples provide lessons in the design of an effective regulatory model, including: the regulator's mandate, stakeholder involvement, and the stringency of requirements.

The Dutch Energy Transition is noted to have created protected spaces for innovators and commercial frontrunners with high-potential but high-risk projects to conduct technological, social and governance-related experiments. Its central defining features include the correlation of short-term experiments with longer-term objectives, multiplicity of solution pathways, and a multi-stakeholder governance model. The role of the private sector in the Dutch energy transition is one of its key strengths as well as its weaknesses. On the one hand, the private sector is better positioned to identify key opportunities and barriers to innovation. On the other hand, dominant economic sectors are noted to have a vested interest in maintaining the status quo, which can prevent transformational change that is often necessary to achieving environmental objectives.

In our second case study, the France Expérimentation program provides another example of a regulatory sandbox where the government can identify outdated and inefficient regulations that impede economic growth as well as transformational solutions, including those that are disruptive or otherwise-contentious. The program allows for experiments within a protected regulatory space to test new rules and approaches, which if proven successful, the government could apply beyond the project. Most recently, France expanded the scope of the program to include legislative changes and has indicated its intent to integrate the approach across government ministries. The France Expérimentation program is one of the most innovative regulatory models that has enabled the government to "learn by doing", with a strong program uptake by small and medium-sized enterprises. However, the program's heavy bureaucratic governance model and politicized decision-making process could limit its ability to identify optimal projects and undermine its longevity.

Finally, the Israel Water Authority is provided as an example of a semi-autonomous regulator, overseeing all aspects of Israel's water sector requirements and one that is insulated from political interference. This has allowed the regulator to set stringent requirements that are evidence-driven and to modify them based on real-life conditions. The Israel Water Authority is governed by a board of senior officials from key government ministries and representatives of the public, and their decisions are primarily informed by the analysis provided by the staff at the regulatory body. The regulator's independence allows it to set requirements that may not be politically palatable but are necessary in achieving predetermined policy objectives. As a result, the country has become a world leader in efficient water use, production and recycling technologies.

A detailed analysis of the case studies provides evidence of the strengths and weaknesses of each approach. Accordingly, three key elements are found as essential in the design of an effective regulatory model that supports innovation, transformational change and economic growth:

- The regulator should have a clearly defined vision and objectives;
- It should be government arm's length and have a multistakeholder governance body; and,
- Requirements should be science-informed and have inbuilt dimensions of flexibility.

Vision and Objectives: At the point of its inception, the regulatory body should be provided with a clear vision of the transformational change that it is to achieve. The overarching policy objective should be incorporated in the regulator's *modus operandi* and guide its decisions. Canada's mid-century decarbonization objectives can provide the necessary policy vision for a new regulator focused on innovation and transformational change.

Governance and Oversight: The independence of the regulatory body is central to its ability to determine stringent and flexible requirements that are aligned with its vision and objectives, even if they are not politically palatable. Drawing from the case studies below, a regulator that is mandated as a change agent across economic sectors is best positioned to be independent and at arm's length from the government, and it could report to parliament through the Minister of Finance. A board composed of senior members of the bureaucracy and industry representatives, with a preference for disruptive technology providers, could provide the regulator with leadership and oversight.

Stringency and Flexibility: Strong regulatory signals on the desired policy direction are necessary to enable investment and to orient economic activity towards achieving socio-environmental priorities. Bold regulatory requirements can play an essential role in breaking away from activities that contribute to environmental degradation and impede transformational change. At the same time, requirements should also have the inbuilt dimension of flexibility and are best designed through experimentation in contained settings. Regulatory sandboxes are ideal spaces where gated exemptions and the development of requirements through close industry-government experimentation can support innovation and ensure an appropriate level of regulatory oversight.

It is the conclusion of this report that an independent regulatory body that acts as an agent of change, guided by a clear mandate and governed by a multistakeholder body, is best positioned to determine requirements necessary to drive innovation and support transformational change that can protect the environment and result in economic growth. To achieve longer-term socio-environmental objectives, these requirements should be ambitious and allow for experimentation in contained regulatory sandboxes.

INTRODUCTION

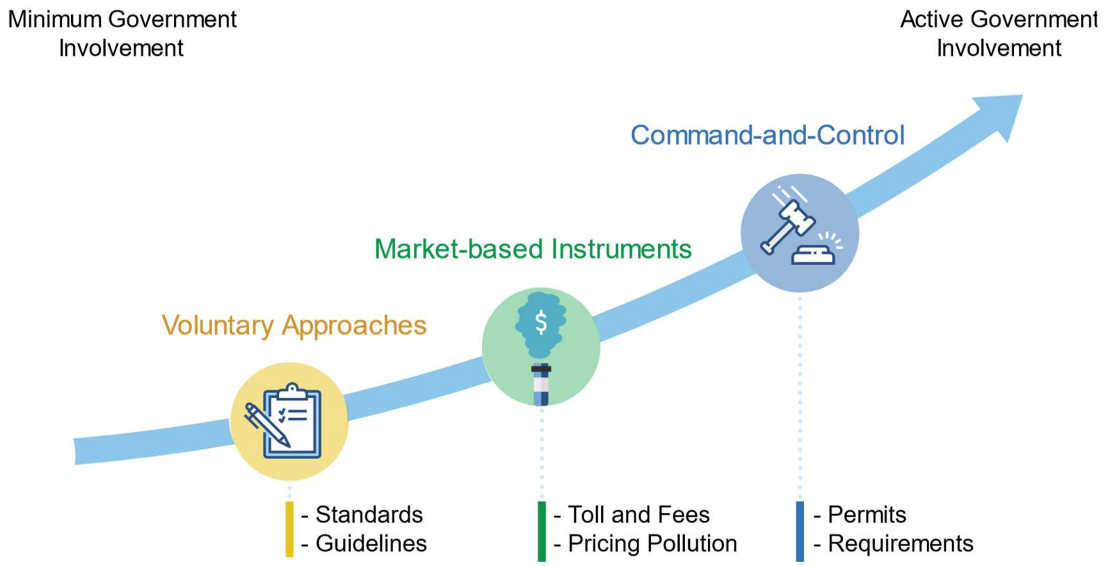
Rising emissions and pollution are impacting the ecological health of the planet, and climate induced environmental norms are expected to result in significant economic losses. However, governments that support clean technology development and commercialization can capitalize on the market opportunities made possible by the demand for innovative environmental solutions. Furthermore, jurisdictions that accelerate decarbonization efforts and clean growth will be better positioned to operate within ecological limits while remaining competitive in a world that is becoming increasingly carbon-constrained.

There is an array of tools at the disposal of governments to support clean growth and innovation. These include policy signals that provide guidance on long term objectives, outreach and education activities that change behaviour, directed investment to create new dimensions of supply-push, and demand-side measures that encourage clean technology uptake.

While noting the importance of these policy tools, the Final Report of the Canadian Government's Working Group on Clean Technology, Innovation and Jobs (2016) in broad terms highlighted the essential role of domestic demand in the development, commercialization and export of innovative clean technology solutions. More specifically, it emphasized that "... policy measures to spur demand for clean technologies would send a broad signal to all actors to increase activity along the entire innovation continuum" (Ibid.: 64).

Regulatory practices that drive demand for clean technology deployment range from voluntary to command-and-control measures (see Figure 1). This report draws lessons from what are judged to be among the best available regulatory practices through an analysis of two different models – a regulatory sandbox and regulatory autonomy – which in different ways drive the demand for technological innovation while supporting clean growth.

FIGURE 1: EXAMPLES OF DEMAND-SIDE MEASURES



Command-and-control measures (e.g., prescriptive requirements) and market-based instruments (e.g., carbon tax) are two of the most effective policy tools in driving desired environmental outcomes. However, they must also be designed appropriately to support competitiveness, innovation and sustainable development. Voluntary initiatives (e.g., technical standards and guidelines) can also support clean growth by proving, scaling and coordinating clean technology innovation. A more detailed perspective on the role of standards in clean technology is provided below (see Box 1).

The market-derived pricing of environmental externalities provides flexibility in the determination of technology and compliance pathways, rewarding better performers while incentivizing behavioural change for entities with higher levels of pollution and therefore costs. However, in order to achieve desired socio-environmental outcomes, externalities must be priced at appropriate levels and increase incrementally as part of the longer-term trend in environmental policy design.

Finally, command-and-control measures allow governments to directly pursue specified policy objectives by means of prescriptive requirements. Taken together they comprise a common regulatory approach that has contributed to positive health and environmental outcomes, from permittable levels of toxins to requirements for product safety and quality. Command-and-control measures can accelerate changes in regulatory oversight while supporting economic growth and creating a demand for innovative solutions. Opponents of command-and-control measures have critiqued their tendency to undercut the basic principles of *laissez-faire* economics, a perceived increase in administrative red tape, and their associated compliance costs for regulated parties. Against these arguments, empirical evidence supports the position that well-informed regulatory frameworks can drive growth, support innovation and result in positive economic and environmental outcomes.

Over 20 years ago, Michael E. Porter and Claas van der Linde (1995) challenged the conventional belief that there is a necessary trade-off between stringent environmental regulation and business competitiveness. Their influential 'Porter Hypothesis' suggested that comprehensive models of environmental regulation can both stimulate innovation and support the conditions necessary for competitive enterprise. This, because "... efforts to reduce pollution and maximize profits share the same basic principles, including the efficient use of inputs, substitution of less expensive materials and the minimization of unneeded activities" (Porter & Linde, 1995: 106). From this perspective, pollution is a symptom of economic waste and points to the inefficient use of resources. Despite the compelling rationale for investment in clean technological innovation, however, commercial actors may be constrained by organizational inertia, risk-averse practices and incomplete information.

Stringent environmental regulations, if inbuilt with appropriate dimensions of flexibility, have tended to support innovation. They can result in partial to full offsetting of their associated regulatory compliance costs (Porter and van der Linde, 1995: 98), improved environmental performance, and in some instances improved business competitiveness (Ambec et al, 2011). Porter and van der Linde suggested that they be complemented with an admixture of market-based approaches (e.g., tradable permits that create incentives for innovation), and encouraged the kinds of product and process changes that lead to a more efficient use of resources while avoiding contributing to pollution (Porter & Linde, 1995: 111). Recent empirical studies support the hypothesis that stricter regulation can stimulate both innovation and business performance (Ambec et al, 2011: 10-16).

BOX 1: STANDARDS AND CLEAN TECHNOLOGY INNOVATION

Standards can be powerful tools for advancing clean technology innovation, removing barriers to commercialization and supporting large-scale deployment by proving, scaling and coordinating. Historically, standardization has been viewed as being limited to mature products, restrictive and stifling of creativity. However, industry is rapidly changing and standardization is increasingly driving innovation (*c.f.,* Zoo et al, 2017; Shin et al, 2015; Allen & Sriram, 2000). Experts in the field are now being called upon to participate in earlier stages of technological development, including in R&D for emerging technologies (e.g., biomaterials and autonomous vehicles).

PROVING | Standards prove that new technologies are credible and well-performing. Emerging technologies can face market barriers due to a lack of successful track record. The application of standards at early stages of technological development can improve adoption and market acceptance. They can provide a framework for deploying advanced technologies through best practices and are supported by consensus of experts. Indeed, standards are backed by deep technical insight and collaboration among government, industry leaders, academia and consumers. Innovators that work with standards have been found to produce higher quality results and have better prospects of their outputs being accepted by the scientific and industrial communities (Stroyan & Brown, 2013). A good example of how standards can enhance confidence in clean technologies is ISO 14034 Environmental management – Environmental technology verification (*c.f.,* Standards Council of Canada, 2016). ISO 14034 has supported new technologies by demonstrating proof of performance, offering methodologies for third party verification of quality and environmental performance, and providing decision makers and stakeholders trustworthy information regarding impacts of environmental technologies.

SCALING | Standards enhance trade and broaden market access for the clean tech sector. They help facilitate international trade and allow companies to expand into new markets. They harmonize processes and expectations across international boundaries, making international trade easier and allowing businesses to set up shop and sell products in other countries. Participating in standard setting can also be a means to leverage one's own technology. By playing a leadership role in international standards-setting processes for new clean technologies, Canada can help shape future international standards and markets in ways that align with its clean technology strengths.

COORDINATING | Standards provide interoperability between new and existing products, services and processes. They help to ensure product components supplied by different companies are compatible with each other and can operate safely and effectively within existing systems. Better interoperability translates into faster market access, increased reassurance for consumers and improved design. For example, the widespread adoption of electrical vehicle (EVs) is, in part, dependent on safe and easy access to EV charging infrastructure. However, industry has nevertheless created several different charging systems and plug in components. A potential EV driver may be reluctant to purchase a vehicle that can only be charged at certain locations. A business that wishes to set up national EV charging networks may be forced to decide between various charging options, or provide all available different charging options, which can increase infrastructure costs. The standardization of plugs, receptacles, and connectors can increase customer acceptance, market confidence and large-scale adoption. (Green, Hartman, & Glowacki, 2018)

By their design, standards not only drive innovation through proving, scaling and coordinating, but they also facilitate closer collaboration among regulators, innovators and adopters, to ensure that regulations keep pace with technology advancement.

Finally, there is an imperative for consistency across government ministries on the interpretation of new requirements. Within the regulatory process, the sharing of information, the uptake of innovative approaches and the dissemination of best practices are of the utmost importance. The coordination of environmental regulation between industry, different levels of government and international partners can contribute to the creation of an investment environment conducive to innovation while reducing some of the obscurities that may persist around rules and requirements.

This paper builds on the above-cited premises by examining some of the existing best practices in the design and application of stringent environmental regulations. What interests us are regulatory models that have resulted in desired environmental outcomes while supporting innovation and economic growth more broadly. The review of case studies also assesses the applicability of these practices in the Canadian context and in relation to the Government's clean growth agenda.

CASE 1: REGULATORY SANDBOXES

Regulatory sandboxes are controlled spaces where businesses are permitted to test innovative ideas without being subject to normal regulatory requirements. They support innovation and allow governments to achieve specific policy objectives by accelerating the shift of technology products toward commercial deployment. In most instances, jurisdictional regulators will work closely with commercial partners to guide the uptake of the technology in question while mitigating potential project risks, whether economic, social or environmental. In return, commercial partners gain hands-on knowledge of the rules and processes required for comparable, evolving technologies. Regulators, on the other hand, "learn by doing" and gain knowledge of best approaches to regulating a product moving forward.

There is a growing body of experience with the use of regulatory sandboxes in financial markets. In February of 2017, the Canadian Securities Administrators, the umbrella organization of Canada's subnational capital market regulators, launched a regulatory sandbox initiative to facilitate the development of innovative financial products for testing across selected financial markets. In 2016, the United Kingdom launched a regulatory sandbox within the boundaries of its own financial market, and since February 2018, it has been advocating for the creation of a global sandbox with partner regulators in other jurisdictions. Lessons learned from financial market sandboxes may be instructive for the clean tech sector.

BOX 2: FINTECH REGULATORY SANDBOX (UNITED KINGDOM)

In 2015 the Financial Conduct Authority (FCA) in the United Kingdom (UK) established a Regulatory Sandbox aimed at the financial technology sector, also known as FinTech. Among the programs objectives are reducing regulatory uncertainty for participating firms as well as the time and cost of getting innovative ideas to market (FCA, October 2017). FCA regulatory oversight provides learning opportunities while improving the credibility of start-up firms seeking finance from investors who might otherwise be weary of investing in them. Participating firms are assigned a dedicated case officer who provides guidance and are temporarily exempt from regulations. FCA works with the firms to ensure that safeguards are in place to mitigate potential harm to customers during testing. Upon completion of the test period the firms must produce a final report that summarizes their findings and planned next steps (FCA, October 2017). The Regulatory Sandbox has been most popular with start-up firms, many of which lack authorization under the FCA. As such, the most frequently used tool in the Regulatory Sandbox is the granting of restricted authorization, which limits activities to the testing of ideas versus their full commercial deployment.

Part of the success of the Regulatory Sandbox is that it allows smaller start-up firms to work with more established ones, which in turn provides access to a larger customer-base, more resources, knowledge, and experience. The FCA selects firms that show the potential to deliver ground-breaking innovation to the UK market that would benefit customers. Selected firms must demonstrate the need for testing in the Sandbox and show that they are ready to test the innovation in 'live' markets (FCA, June 2017). Although not required, many of the firms selected for the program meet the genuine innovative criteria by proposing the use of technology to enhance existing products and services that lower operating costs. From the perspective of the FCA, the program has been a success as close to 90% of firms that completed testing in the first cohort are continuing toward a wider market launch following their test (FCA, October 2017).

THE DUTCH ENERGY TRANSITION

In the early 2000s, its Ministry of Economic Affairs created its Project Implementation Transition, a multi-stakeholder environment for project experimentation wherein the majority of the stakeholders "... would be willing to invest (time and money) and commit themselves to such a process under the condition that the transition management approach would be made more concrete and the government would support it both financially as well as process-wise" (Kemp & Loorbach, 2003: 22). This initial effort laid the foundation for the development of an energy transition policy and demarcated the process for achieving longer-term, sustainable energy objectives.

The net effect of the Dutch energy transition has been a protected sandbox for innovators and commercial frontrunners with projects that have high potential but high risks to conduct technological, social and governance-related experiments. It demonstrates how the forces of 'technology-push' and 'market-pull' can be brought together by a regulatory model that works as a kind of 'socio-technical alignment mechanism' (Laes, Gorissen, & Nevens, 2014: 1140), incorporating the private sector and other non-state actors in a shared bottom-up solution space.

Three defining features of the Dutch energy transition model have emerged from studies of its workings and outcomes (*c.f.*, Foxon, 2011; Kemp, Rotmans and Loorbach, 2007): (1) the capacity to correlate short-term experiments with longer-term policy objectives; (2) its generation of a multiplicity of potential solutions and pathways pursued; and (3) its multi-stakeholder governance model.

In the first dimension, the Dutch energy transition model attempts to catalyze short-term experiments that are guided by a long-term policy vision. It can accelerate project development while allowing the government to learn by doing, as well as concretize a regulatory environment that encourages innovation. It makes possible the pursuit of multiple policy objectives (e.g., reductions in carbon pollution, energy reliability and security, improved affordability) tied to specific targets (e.g., energy efficiency implements, per centage-based emission reduction, renewable energy targets).

In the second dimension, its diversity of transition pathways allows a multiplicity of policy options and solutions to compete against the backdrop of an evolving portfolio. Alongside experiments in technology innovation, the inclusion of policy tools (e.g., market-based instruments, information sharing) can here expand the scope of the sandbox to include the kind of supporting policy approaches that can enable technology deployment. In addition, by incorporating adaptive course correction and learning through experimentation, the Dutch model can address uncertainties related to the success of a project and its contribution to policy objectives. It is important to note, however, that there are risks associated with the possible narrowing of options further along the innovation funnel and that the vested interests of different decision makers can also impact project selection. In terms of the latter, for example, and despite its longer-term sustainable energy goals, the Dutch energy transition includes fossil fuel pathways in its transitional platforms and therefore exposes the economy to lock-in risks.

In its third dimension, the Dutch model has from its inception sought to incorporate newly-created central bodies to coordinate policy and stakeholder participation. In the early 2000s these were strategically placed within the Ministry of Economic Affairs, with participation of public servants from key ministries. The institutionalization of policy as well as the distribution of decision-making across government departments helped to strengthen the Dutch energy transition.

Governance and Administrative Process

At the level of administrative organization, the energy transition was initially coordinated through an Interdepartmental Project directorate Energy transition (IPE) and the Energy Transition Board (ETB). IPE was placed in the Ministry of Economic Affairs and supported the government's transitional efforts as well as policy coordination across government departments. The ETB, for its part, enrolled the private sector in the decision-making process, provided advice to the government, and oversaw the transition platforms (thematic priority areas). The two oversight bodies encouraged coalition-building between frontrunning projects within common priority areas and facilitated synergies across sectors to find system solutions (Veilleux, 2010: 8). The government of the Netherlands later enacted into law an energy transition organization ('Regieorgaan Energietransitie Nederland), composed of the chairs of the transitional platforms along with independent members (Government of the Netherlands, 2008).

The energy transition platforms included seven overarching thematic priority areas - green feedstocks, renewable sourcing of natural gas, sustainable electricity and infrastructure, sustainable transportation, chain efficiency, the built environment, and renewable energy. These thematic areas are extended along a total of 35 transition pathways that can be recursively linked-back to predefined policy goals and the overarching, longer-term vision. The energy pathways traceable from each platform have been designed to encourage innovation in the market, inform the government of appropriate framework conditions, and serve as eligibility criteria for public funding.

Platform members select leading projects for placement within the sandbox. The government's role, on the other hand, was not limited to one of selecting policy options, but rather to organize its policies around a cluster of transition paths, "... to give directions to the market, whilst giving market players the opportunity to develop their own products based on their own market analysis, ambitions and entrepreneurship" (Foxon, 2011: 88). In this key respect, the government acted essentially as a process manager, dealing with issues of collective orientation, facilitating learning and interdepartmental coordination, while encouraging its industry collaborators to drive process outcomes.

Results and Outcomes

Over the course of the Dutch energy transition, hundreds of experiments have been conducted. Although these experiments, combined with policy and program measures, have contributed to innovation and resulted in the expedited deployment of clean technology solutions, overall indications are that the energy policy objectives of the Dutch transition program have yet to be fully-realized.

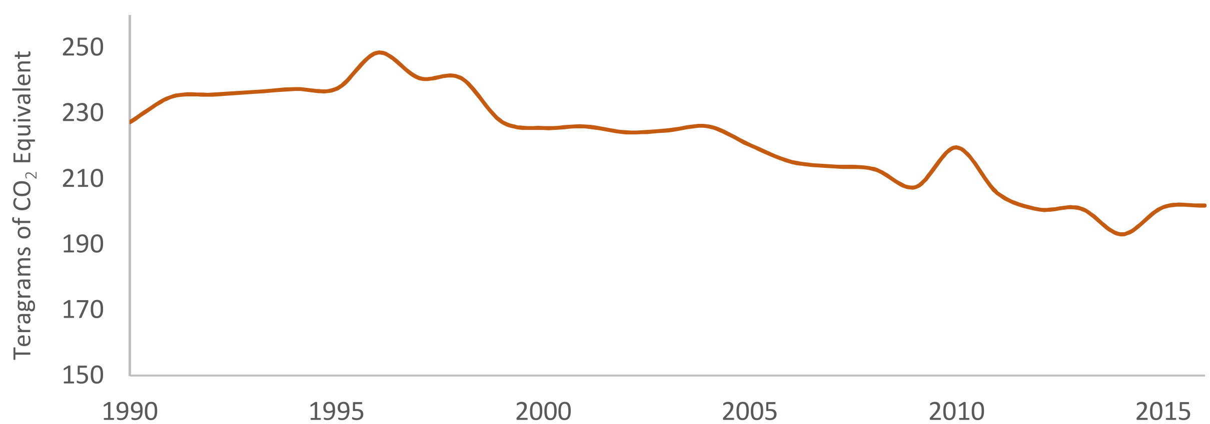
In 2015, the country's overall environmental sector contributed to an economic output (value of goods produced) of over €35 billion and employed 140,000 people (Statistics Netherlands). Much of this growth can be attributed to the rise of renewables. Based on an analysis of Statistics Netherlands data from 2001 to 2015, the largest growth in the environmental sector has been the renewable energy production, with 20 times growth in economic output and threefold increase in employment over this period (Statistics Netherlands). The country is ranked ninth on the Renewable Energy Country Attractiveness Index and its unsubsidized, offshore wind production is noteworthy (Ernst & Young, 2018). However, most analyses suggest that the government has not fully capitalized on its renewable energy potential, and despite experiments under the Dutch energy transition, transformational change in the sector has lagged behind expectations.

According to the Global Cleantech Innovation Index, the Netherlands is ranked 15th and above the global average on overall clean-tech innovation and 5th in general conditions conducive to entrepreneurial activity and innovation (Sworder, 2017). Importantly, however, its performance on eco-innovation has dropped, with the result that it ranks below the EU average (Saes & Veerle Bastiaanssen, 2018). Thus, although the Dutch clean tech sector has grown rapidly, with €5 billion in added value (though this represents only one per cent of its GNP) and accounting for 61,000 jobs as of 2013, the country is not a global clean-tech leader (Blom, Korteland, & Nelissen, 2013).

The Netherlands demonstrates mostly locked-in fossil fuel consumption, and its economy remains heavily invested in oil and gas operations. Although overall emissions have decreased by just over 10 per cent since the launch of the energy transition program, emissions traceable to fossil fuel consumption actually increased by about 4 per cent from 1990 to 2016, according to the latest national inventory submissions (Government of the Netherlands, 2018). This is primarily because of the rise in coal consumption, coupled with the expanded use of liquid and gaseous fuels. In May 2018, the Government of the Netherlands announced that it will shutdown two of its coal plants by 2024 and the remaining three by 2030.

On the other hand, while output increased by a quarter from 1990 to 2014, industrial emissions have decreased by about a third and indicate an improvement that is significantly higher than that of the rest of the economy (Roelofsen et al., 2017: 13). Much of this improvement preceded the Dutch energy transition described in this report, suggesting that the decrease in industrial emissions is only loosely correlated with the real or perceived success of the program.

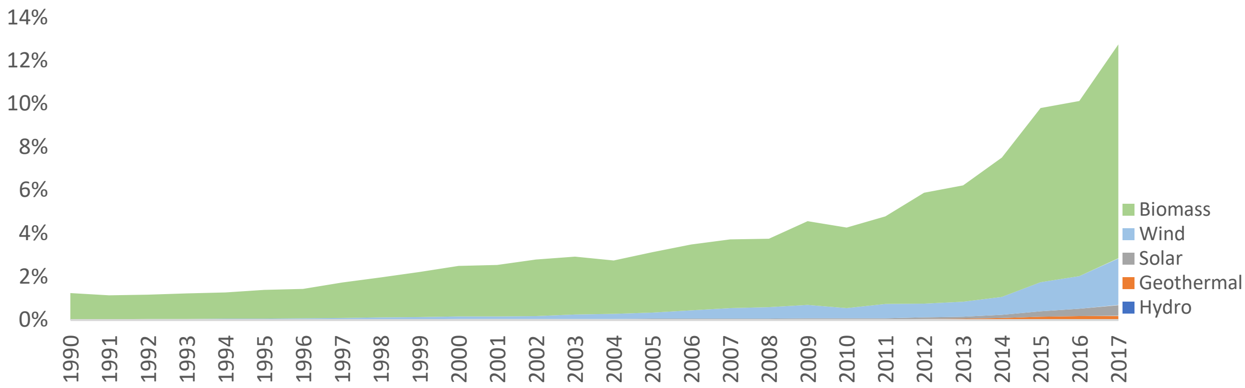
FIGURE 2: HISTORICAL EMISSIONS (NETHERLANDS)



Data source: National Inventory Reporting 1990-2016 (Government of the Netherlands, 2018)

Among other targets, the Dutch energy transition initially aimed for a 40 per cent renewable target in the electricity market by 2020 and 2 per cent annual energy efficiency improvement (Kemp, 2010). The country later adopted an overall target of 14 per cent sustainable energy by 2020 while maintaining its commitment to 80-95 per cent emission reduction by the middle of the century (Government of the Netherlands, 2016). Although the Netherlands has high renewable energy potential, the total share of indigenous production increased from just over 1 per cent in 1990 to about 13 per cent in 2017 (see Figure 3). Other policies, such as the approval of new coal-fired electricity facilities, may have hindered the advancement of clean technology solutions in the electricity market. Energy efficiency improvements are also performing below targets, with the National Energy Outlook estimating improvements over the period of 2013-2020 at 1.7 [1.6-1.8] per cent per year (ECN, 2017).

FIGURE 3: RENEWABLES AS A SHARE OF INDIGENOUS ENERGY PRODUCTION (NETHERLANDS)



Data source: Statistics Netherlands (CBS)

Innovation within a sandbox does not necessarily result in transformational change outside of it. Moreover, direct causal correlations would need to assume a static political, social and economic environment. Despite the above-noted shortfalls, the Dutch energy transition and the success of its experiments have provided policy directions that were incorporated into subsequent energy and innovation policies. Beyond its role as a sandbox for experiments, the program also helped to direct government funding support and contributed to the prioritization of investment in areas that most directly aligned with longer-term policy objectives. The Dutch energy transition successfully acted as a catalyst for new technology and policy experiments, which in turn contributed to broader public conversations on the need for innovation and on the Dutch advantage in emerging solutions.

The fundamental weakness of the Dutch energy transition was the active role of the private sector in the transitional platforms, which in turn exposed the Dutch energy transition to the risks associated with dominant economic sectors directing the research agenda (Kemp, Rotmans, & Loorbach, 2007: 327, and Laes, Gorissen, & Nevens, 2014: 1140). Nevertheless, the government provided policy direction and acted as a process manager, which in turn enabled a degree of technology neutrality and the pursuit of a decidedly diverse set of experiments. Most indications are that more stringent regulatory measures would have enabled the Dutch government to set more ambitious decarbonization objectives and more clearly articulate its plan for achieving sustainable development goals.

THE FRANCE EXPÉRIMENTATION

In the French experience, the use of a regulatory sandbox to support innovation is the culmination of the efforts of three successive governments and with varying degree of support across the political spectrum. Beginning during the 2007-2012 Presidency of Nicolas Sarkozy, France began issuing time-bound exemptions from select regulatory requirements for entities developing new technologies. Towards the end of President François Hollande's term in office, the process was formalized through the launch of the France Expérimentation program in 2016. In 2018, President Emmanuel Macron – who as the Minister of Economy, Industry and Digital Affairs under the previous administration oversaw the France Expérimentation program – made the reduction of regulatory requirements that unnecessarily impede industrial growth and overburden the bureaucracy, a cornerstone of the mission of his government's ministries (Government of France, 2018: 3). At the First Inter-Ministerial Committee for Public Transformation in February 2018, France confirmed its commitment to government reform, improved efficiency and quality service. This is part of France's Action Publique 2022, a five-year program to modernize public institutions and government policy (Government of France, 2017).

The France Expérimentation program's principle aim is to support and accelerate the commercialization of innovative products and services, by identifying outdated and/or inefficient regulations that impede potentially transformational innovations, especially when they are disruptive or otherwise-contentious technologies. It allows for the controlled testing and evaluation of a new technology prior to the revision of the regulation(s) that might impede its application, as well as for the creation of new regulations to accommodate the given technology.

Governance and Administrative Process

The France Expérimentation program was initially led by the business branch [Direction Général des Entreprises (DGE)] of the French Ministry of Economy and Finance. The DGE was entrusted with receiving and performing the initial screening of projects. Following the DGE's initial review, potential bids for support would be shared with other government departments for input, including the Prime Minister's Office. As part of a new system since May of 2018, the DGE and Interministerial Directorate for Public Transformation [Direction Interministerial de al Transformation Publique (DITP)] have formed a joint-secretariat to oversee the activities of the France Expérimentation program. DITP is a government entity that acts as an inter-ministerial body advising the Prime Minister's Office and reports to the Minister of Public Action and Accounts [le ministère de l'Action et des Comptes publics] (formerly part of the Ministry of Finance). Further support at the levels of governance and administration is now provided by the Directorate General of the Treasury [direction générale du Trésor (DG Trésor)] and the French bureau that oversees regional business competition and employment affairs [directions régionales des entreprises, de la concurrence, de la consommation, du travail et de l'emploi (DIRECCTE)].

The joint DGE-DITP secretariat receives proposals under the France Expérimentation program and then returns evaluations and approvals after consultation with other relevant government departments. Within each department, applications are examined by sectoral teams comprised mainly of scientific and engineering experts. If there is consensus on a given project, it is then referred to the Prime Minister's Office for final approval. Conversely wherever there is dissent as to which projects should be approved, the Prime Minister's Office serves as the arbitrator. As a rule, the secretariat aims to build consensus on projects across government departments.

Importantly, the Expérimentation program is not designed to circumvent existing restrictions and regulatory measures addressed to new technology uptake and dissemination. Its administrators attempt to ensure that no proponent of an innovative product receives unnecessary beneficial treatment, and it does this by restricting the assessment of projects to traditional sites of departmental purview. Under its initial governance model, projects that were not accepted into the program would be redirected elsewhere for potential assimilation alongside existing programs. The criteria for rejection of a proposal under the rules of the program can include:

- ❖ Requests for support that already exists under other policies or other program measures;
- ❖ Proposals that are not feasible or acceptable under current legislation;
- ❖ Attempts to access comparable support under the program in addition to that which has already been received from other departments (double-dipping).

Eligible projects under the France Expérimentation program must result in societal benefits by leading to 'innovation' in products and technologies that are real (i.e., quantifiable and measurable) and have economic benefits (e.g., business growth and employment). The government must also have the required administrative resources, knowledge and technical capacity to accept new types of projects. Finally, projects must stand up to recurrent evaluation practices over time to receive continued support.

The onus is on the proponent to identify the regulatory exemptions they wish to seek, while making a business case for why such regulations prohibit the advancement of their innovative product or service. What is more, applicants must demonstrate a commitment to time-bound solutions that respect French and European Union law, an approach to mitigating risks, and a methodology for evaluating the socio-economic benefits of the regulatory exemption. If approved, the experiments are drawn into the regulatory sandbox as a means of confirming and then exempting projects from the otherwise-applicable regulatory barriers to innovation.

The French Constitution authorizes regulatory bodies to implement experimental exemptions under the conditions, among others, that the experiments have defined objectives, are time-bound, and that the exemptions are limited to the experiments being conducted. If experiments carried out within the sandbox result in positive outcomes, policy support is built for the suspension of identified regulatory obstructions over an extended period before its permanent removal is considered. Perhaps the most important change to the France Expérimentation program under the current government is the expansion of its scope, to include not only regulatory exemptions within the sandbox but also proposals that aim to direct legislative changes. Over time, successes and lessons learned from the France Expérimentation program will be incorporated into new government bills, potentially resulting in deeper-running changes to existing laws and regulations.

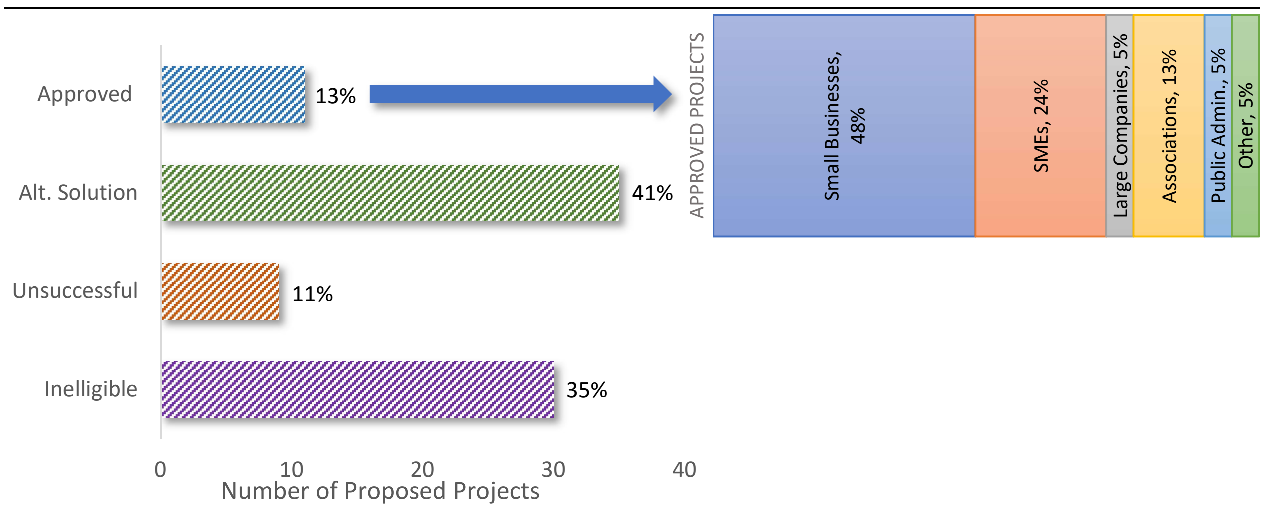
Results and Outcomes

It is not possible to appropriately assess the success of the France Expérimentation program because the program is in its infancy; accordingly, there is a marked absence of detailed program indicators, and insufficient information on the extent of stakeholder engagement to provide insight on the program's limited uptake.

However, there are other indicators to assess on whether France is on the right trajectory in accelerating innovation and supporting environmental solutions. In 2017, France's eco-innovation ranking was just above that of the Netherlands, ranking 13th in the European Eco-Innovation Composite Index (Choe, 2018). However, as noted by the study, there is information missing on the country's eco-innovation activities, affecting its overall score. That said, the Global Cleantech Innovation Index has found similar results, ranking France 13th in overall clean-tech innovation, owing to its strong position in emerging clean-tech innovations and early-stage investment, but low renewable energy consumption (Sworder, 2017). The Renewable Energy Country Attractiveness Index, on the other hand, ranks France 6th (Ernst & Young, 2018), and the country is home to major renewable energy companies such as Neoen, with the largest European photovoltaic facility in 2015, as well as the state-owned Électricité de France (EDF) with significant domestic and international renewable energy projects. Nevertheless, these rankings are likely to have been significantly influenced by activities that predated and were not directly affected by the France Expérimentation program. Examining the limited information available on program results will yield more appropriate indicators with which to assess its success.

The France Expérimentation's first requests for proposals took place over a period of six months, ending in December of 2016, and resulted in 85 applications. Submissions came from across France's economic sectors, with the largest number of applications from the environment (24%), followed by the energy (13%) sector. The program has also been successful in attracting proposals from very small businesses, as well as small and medium-sized enterprises (see Figure 4).

FIGURE 4: PROPOSALS SUBMITTED IN 2016 TO THE FRANCE EXPÉRIMENTATION PROGRAM



Data source: Direction général des entreprises (DGE)

The government was able to find alternative solutions for about 40 per cent of proposals submitted in the 2016 process, and the ability of the program to redirect and find alternative solutions remains one of its key strengths. The majority of unsuccessful projects are noted to have been addressed to the removal of legislative barriers (not within scope of the first round of the program) or else required changes at the EU-level.

Successful projects, on the other hand, have resulted in the implementation of five regulatory exemptions in regions where projects have been authorized, and in addition, six other exemptions are currently under consideration. The successful regulatory experiments being implemented include:

- Wastewater treatment fluorimetric quality measurement;
- Treated wastewater reuse for irrigation
- Insect meal production for aquaculture,
- Raising microcredit ceiling (in Mayotte);
- Electronic wallet for patient reimbursement in clinical trials.

The second request for proposals was launched in May 2018, with an open deadline for projects requesting regulatory changes and a May 31, 2018 deadline for projects of a legislative nature. The results of the first round of applications are not yet available. However, selected projects that require legislative changes will be included in an omnibus Government Bill in the national legislature that aims to support growth and business transformation (plan d'action pour la croissance et la transformation des entreprises [PACTE]). Details on PACTE were released in June of 2018, and it focuses on the importance of innovation and the promotion of experimentation across a number of industrial sectors. The relevant section of the Bill will be expanded by the end of August and will include amendments authorizing a number of new experiments under the France Expérimentation program.

One of the key successes of the program is its capacity to directly drive regulatory changes, with about half of the successful experiments resulting in exemptions and exit from the sandbox within two years after its launch. Given the complexity of processes necessary for regulatory changes, this is a significant achievement. Moreover, regulatory amendments in this variation on the sandbox model are the result of real-world experiments identified as necessary for the advancement of innovation and judged to contribute positively to the French society. The program's ability to attract small-sized technology proponents is also noteworthy. Perhaps the most important indicators of the program's success are its relatively uncontested political uptake, as well as the move on the part of the current government to embed the France Expérimentation program's approach to governance across the bureaucracy.

CASE 2: AUTONOMOUS REGULATORY AUTHORITY

Regulatory models that place governments at arm's length and provide oversight of all aspects of an economic sector are more efficient, responsive to changing circumstances, and have the capacity to advance more stringent requirements. This is because the types of authority structure that usually feature in these models have considerable power with respect to administration of policies, including the design and enforcement of requirements. Regulators that fall within this category often have oversight of well defined areas, and therefore, significant knowledge and expertise over the area within their purview. Finally, their independence can allow them to advance policies that are science-based and evidence-driven while being shielded from political interference in the day-to-day management of responsibilities. Such regulatory models often have organizational bottom-up inputs, engage in stakeholder consultations, and are ultimately accountable to the people, reporting either directly to the parliament or through a government ministry.

In Canada, the Alberta Energy Regulator is a case example of an independent agency that receives policy guidance from the provincial government, and it is ultimately responsible for developing and enforcing requirements over the province's energy sector. The roles and responsibilities of the Impact Assessment Agency of Canada and the Natural Resources Canada's Major Project Management Office are different than that discussed in this report. The former assesses a project's adverse effects against the backdrop of public interest. The latter acts as a single-window for major project applications. In this report, our focus is rather tailored to the effectiveness of an arm's length regulator that oversees the design and enforcement of requirements for an economic sector. One of the most successful examples in this area is that of the Israel Water Authority.

THE ISRAEL WATER AUTHORITY

Israel's experience with a single regulator overseeing its water sector began in 1959, when the passage of its Water Law integrated all of the country's water resources into a centrally planned system under the purview of a Water Commission. For more than three decades the Commission's policies were dominated by the concerns of the Ministry of Agriculture, mainly as a consequence of the far-reaching influence of a considerably powerful agribusiness lobby. By the late 1990s this arrangement was the subject of significant reform efforts, and a special Parliamentary Investigation Committee was formed in 2002. The main findings of this group were, in the first place, that too many interests were involved in the management of the water supply chain, leading to a division of responsibilities that was unclear. Relatedly, from within the water sector there were concerns about the perceived over-politicization of the Water Commission's allocation and tariff policies. Accordingly, a series of reforms to the Water Law would lead to the founding of the Governmental Authority of Water and Sewerage (the Israel Water Authority, or IWA) by 2007.

Nominally the former role of the water commissioner was transferred to the Director of the IWA, who would be appointed by the Cabinet for a five-year term. The renamed Ministry of Energy and Water retained its responsibility for the formulation of Israel's national water policy and external water relations.

Taken together, these measures would establish the IWA as a semi-autonomous regulatory agency operating at arm's length from the Israeli polity, effectively drawing a line between the level of policy and the professional level of management in the water industry (World Bank, 2017). It acts as the principle conduit for and management of the whole of Israel's water sector, including the potable water supply, wastewater and irrigation services. It also oversees the activities of Mekorot, the public sector water utility founded in 1937 and designed to operate as a regulated commercial entity, as well as Israel's regional and municipal water utilities.

Governance and Administrative Process

It is perhaps unsurprising that Israel's water sector has since the 1960s been characterized by one or another model of integrated management, owing to how its founding principles centralized decision-making authority over a valued economic resource for the creation of a new nation-state. Large-scale, rain-fed agriculture was intended to serve as the cornerstone of a centrally-planned national water system, and heavy-handed regulations were required to make water accessible to the growing numbers of Israeli citizens in remote or otherwise water-scarce regions.

Today the IWA supports the government's broader, short- and longer-term policy objectives related to water management and security, while maintaining its independent authority. While it works closely with government departments, its insulation from political interference is possibly one of its key strengths. IWA decisions are coordinated at the level of the Water Authority Council, which serves as the IWA board of directors and is made up of senior representatives of the Israeli Ministries of (1) Finance, (2) Energy and Water Resources, (3) Environmental Protection, and (4) the Interior, as well as two members of the public as a means of facilitating stakeholder dialogue. The IWA Director reports to the Minister of Energy and Water.

As a decision-making body, the Council serves a bridge linking to the government departments. In practice, however, the board of directors rely on IWA staff recommendations and elected officials cannot interfere in its decisions. At the managerial level, the IWA's structure is comprised of a series of committees that oversee the respective areas of investment planning, the allocation and supervision of water rights, the regulation of tariffs on water earmarked for agricultural, domestic and industrial use, and the performance of service providers including local water utilities. The exercise of issue-specific decision-making powers can require consultation with any of the Ministries with stakes in the national water sector - Energy (concerned with sewage and wastewater, runoff and drainage), Agriculture (who set the criteria for the pricing and balance of water allocation between crops and other ecological regions), Environmental Protection (water quality and issues of contamination and effluent discharge monitoring), Health (drinking water quality and reuse standards), Finance (tariffs, budgets and the promotion of the water industry), and the Interior (urban water supply and quality). This is because Israel's overarching and longer-term policy vision regarding water sufficiency and security, has provided guidance on the infrastructure investments required to meet the country's variable water demands.

While IWA does not make, authorize or subsidize infrastructure investments directly, it quantifies and enforces the costs passed down to consumers resulting from infrastructure construction and maintenance. It therefore provides the government with independent advice on the true cost implications of water infrastructure projects. It also makes the decisions on water withdrawal and allocation that can directly impact water infrastructure projects.

In many respects, the IWA regulatory approach is the culmination of Israel's 50 plus year experience with the Integrated Water Resources Management approach (see Durham et al., 2002). IWRM has been championed globally as the most sustainable of possible responses to water stress ever since the first UNESCO International Conference on Water, which took place in 1977 at Mar del Plata, Argentina (Jeffrey and Gearey, 2006: 1-2). In-line with this overall philosophical commitment to sustainability, the IWA adopted the following objective for its 'Master Plan for the National Water Sector' (IWA, 2012) as projected towards the year 2050: "... to ensure the supply of water, the provision of sewage services and reuse of treated wastewater and the management of drainage and runoff water - with appropriate quality, quantity and reliability, and in an economically viable manner, for the sustainable benefit of all consumers."

As a model, IWRM entails integration at all of the (1) physical, (2) sectoral-managerial, and (3) organizational levels. The national water system in Israel demonstrates integration, we'd contend, at each of these levels:

[1] Physical integration, as Fischhendler and Heikkila (2010) describe it, implies practices of conjunctive management and coordination at the 'ground level' of reservoirs, basins, lakes and aquifers, and "... aims to integrate the management and use of all the elements of the natural hydrologic system, including surface water, groundwater, riparian lands, and floodplains or wetlands." In Israel integration of this type was set in motion as early as the 1950s.

The major physical infrastructure investments associated with the 1959 Water Law were intended to promote the national agenda of settlement, sufficiency and security; most prominently, this included the establishment of the National Water Carrier in 1964 by Mekorot. This integrated supply scheme first relied on the storage capacity of the Sea of Galilee, and began the north-to-south transfer of water across the country in 1965 through a network of pumping stations, piplelines and installations. By the 1970s Mekorot was making major infrastructure investments in connecting the western Coastal Aquifer and the Mountain Aquifer in the east for bulk water conveyance. Today Mekorot transports 95 per cent of Israel’s potable water resources (surface water, groundwater, and desalinated water) to regional providers.

[2] Sectoral-managerial integration, on the other hand, Fischhendler and Heikkila (2010) suggest is achieved with the coordination of specific management choices (like reservoir releases, regulatory decisions on water quality, infrastructure planning, watershed protection, and water pricing) across and between different managerial groups, like those concerned with energy and waste, municipal supply, agriculture, or ecology.

The IWA provides a venue or locus for those coordination efforts, helping to facilitate physical and sectoral integration by bringing together the government units, agencies, utilities and private organizations that have responsibilities for managing different sectoral users or aspects of the physical infrastructure.

[3] Integration at the organizational level, especially between potential collaborators.

Here, the IWA Director and Council have assumed leadership roles in the promotion of public-private partnerships and other collaborative investments in in the water sector. As a country, Israel has made a special effort to promote innovation by fostering the conditions for a unique 'industry-utility-university ecosystem' in which the emerging water technologies that germinate among academics and entrepreneurs, can be subsequently tested and optimized in real-time and at real-scale by regional and municipal utilities before going to market (World Bank, 2017: 31).

All of this is to say, that in the Israeli case the uptake of IWRM has meant a regulatory emphasis on the management of demand through price changes, amended licensing structures and technology improvement. These initiatives are identically aimed at securing the sustainability of the national water system and have met with several quantifiable measures of success.

Results and Outcomes

Israel's commitment to controlling the costs associated with its nationally integrated system, is demonstrated above all else by the IWA's adoption of strong demand management as the cornerstone of its approach, accomplished in the first place by (1) pricing practices aimed at a reduction in per capita potable water consumption; and by (2) increasing water productivity (especially through technological innovation and the use of nonconventional waters).

With respect to its pricing initiatives, the IWA sets performance targets for improved efficiencies at the various levels and subsectors of the water service chain. Since 2009, it has helped to secure the long-term financing of the water sector based on the principle of full cost recovery through the increased tariffs levied on all water and sanitation services. Increased tariffs have helped to reduce per capita urban water consumption, owing to the success of public education campaigns and the installation of water saving devices in homes and businesses. Such decidedly stringent regulations have contributed importantly to the financial viability of the water sector, and marked a shift whereby it "... started operating within the constraints of a budget that reflected its real costs, moved towards efficiency at the service provider level, achieved financial sustainability, and was gradually decoupled from the national budget altogether" (ibid: 34).

Beginning in 2014, the IWA moved to equalize the subsidies on offer to residential users who live close to water sources and those who require pumping services over longer distances. The result has been a uniform tariff structure for consumers, with all potable water and sanitation service users paying the same price. Rollbacks for residential and commercial users have been made possible with the realization of efficiency improvements at the local level.

In 2017, new legislation was introduced to equalize the prices for water earmarked for agribusiness across the country, meant the end of the wide variations in transport prices between different regions and supply sources. Since all Israeli farmers now pay the same tariff for irrigation water, this will result in wider ranging cross-subsidies between regions and water supply sources overall (World Bank, 2017: 15).

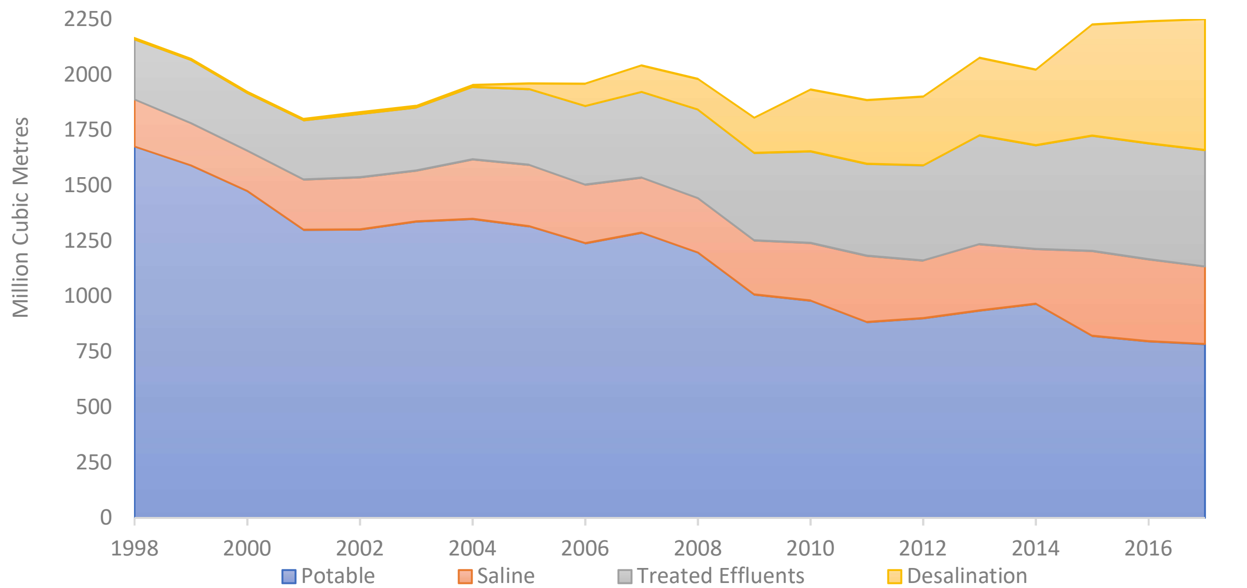
Fundamentally, these measures have taken the form of innovations in nonconventional water production and storage, and include several examples.

(1) *Recharge, capture and leak prevention.* Israel has found an innovative solution to recharge aquifers with nonconventional waters (e.g., treated wastewater during months of low agricultural demand) and through the capture of occasional flash flood. In the field of leak prevention, the IWA has sought to mitigate the risk of water lost or wasted from deteriorating infrastructure by guiding investment in new technologies for leak detection and repair. Regional and municipal utility companies also have a strong regulatory incentive to detect leaks within their network of pipelines, and those that offer Automatic Metering Reading (AMR) are required to inform costumers of potential leaks beyond the meter.

(2) W*astewater for reuse in agriculture.* In the 1960s, only around 10 per cent of 130 million cubic meters of collected wastewater was recycled. As a basis for comparison, Israel is now the undisputed world leader in the use of treated wastewater for irrigation, reusing 87 per cent of its wastewater overall and representing 50 per cent of its irrigation waters nationally. The World Bank (2017: 19) reports that there are 67 operative wastewater treatment plants on Israeli soil, most of which have upgraded their technological capabilities to provide tertiary treatment after the enactment of new wastewater reuse treatment standards in 2010 - the goal being to allow treated wastewater to be used for all types of agricultural uses, without restrictions (ibid).

(3) *Desalination and brackish water use.* According to IWA, 85 per cent of Israel's domestic urban water is now supplied by its 5 major seawater reverse osmosis desalination plants operating along the Mediterranean Coast, a volume representing 40 per cent of the country's total water consumption (World Bank, 2017: 21-2).

FIGURE 5: WATER PRODUCTION (ISRAEL)



Data source: Israel Water Authority

According to the Global Cleantech Innovation Index, Israel is ranked 6th on overall clean-tech innovation and 2nd in emerging cleantech innovation (Sworder, 2017). The process of uptake and dissemination of new water technologies in Israel, has been lauded as instructive for other countries where conditions of water scarcity are imminent. What is more, Israel is exporting expertise in the fields of water management and water technology at a value of approximately 2 billion USD per year (Israel Ministry of Foreign Affairs, 2018).

In June of 2015, for example, Israel signed a cooperation agreement with the World Bank for the penetration of privately-owned Israeli water technology into countries with inadequate water system infrastructure. Large scale water infrastructure projects are now being undertaken by Israeli firms in Ghana, Serbia and China. Elsewhere, Israeli firms are active in the markets for water recycling services, especially in the fields of water purification, where new filtration technologies can provide for improvements in potable water quality, and in wastewater treatment and reuse, where the chemical, biological or physical treatment of municipal and industrial wastewater makes the reclamation of water for agriculture possible.

At present there are more than 600 Israeli companies that can be defined as specialized in clean technology; of these firms, approximately 200 are active in the water sector (Israel Ministry of Foreign Affairs, 2018). The fields of activity these companies are involved in, can be represented schematically as technologies used in the following subsectors: (1) water resource transport; (2) water purification [including the use of bio-filters to reclaim runoff water] and wastewater reuse; (3) the irrigation industry, including water conservation techniques in agriculture like low-volume, drip irrigation; and (4) water control and leak monitoring systems.

Although Israel's global leadership in water sector predates IWA's formation, the new regulator's approach established an environment conducive to innovation and further accelerated new technology deployment in the sector. IWA's oversight of all of Israel's water sector, its insulation from political interference and its ability to set science-based regulations allowed it to advance most effective requirements that ensured environmental integrity while meeting Israeli society's water needs.

CONCLUSION

Regulations are an essential policy tool for achieving socio-environmental objectives, and more specifically, for realizing mid-century decarbonization goals that will require accelerated technology innovation and commercialization of transformative solutions. Traditional regulatory models can advance short-term policy objectives but are not necessarily designed to drive innovation or to result in transformative change.

Well-designed and stringent regulations are necessary to correct market failures as well as to drive innovation, support economic growth and orient investment towards societal priorities. The case studies presented in this paper provide evidence on common design elements of regulatory models that have directly or indirectly supported clean technology innovation. Accordingly, three overarching components central to a well-designed regulatory model are noteworthy:

- Clearly defined vision and longer-term policy objective(s);
- Regulatory autonomy and multistakeholder governance; and,
- Stringent requirements with inbuilt dimensions of flexibility.

VISION AND OBJECTIVES

A regulatory model is most successful when it is guided by an ambitious and a clearly defined overarching, longer-term policy vision on the transformational change that the regulator is to achieve. To improve uptake, such vision should be informed by a process of inclusive and meaningful citizen engagement. To further strengthen the permanence of the desired change, the vision should be entrenched in a jurisdiction's legal framework.

The overarching policy objective should be incorporated in the regulator's *modus operandi* and guide its decisions. The policy vision should be high-level but sufficiently prescriptive to provide the level of guidance necessary for the design and enforcement of appropriate requirements. The regulator could also be provided with predetermined objectives and milestones, which it would report against on a regular basis.

Lessons for Canada

Canada's mid-century decarbonization goals is an ideal foundational principle that can guide a regulatory model that supports clean growth over the longer-term. Although several potential decarbonization pathways are included in Canada's mid-century strategy, the Government of Canada has not made a commitment to a given pathway or introduced policies beyond 2030. This, in turn, affords a regulatory agency the level of flexibility needed to design appropriate measures to achieving decarbonization goals, the objectives of which are sufficiently high-level to have applicability across most economic sectors. Milestones could also be included to assess incremental progress.

GOVERNANCE AND OVERSIGHT

The most effective regulatory model is one that ensures the independence of the regulator and positions it at government arm's length. Its oversight and decision making can be delegated to a multistakeholder board of directors that is advised by the staff at the regulatory body.

The private sector should be included in the multistakeholder board, for they are often better placed in valuating technology solutions that face regulatory barriers and/or innovation that could be advanced through regulatory changes. Although incumbents should be included in the multistakeholder board, preference should be given to SMEs and disruptive technology providers. In addition, senior members of the bureaucracy (e.g., deputy ministers) from key departments as well as notable academics and/or thought leaders should also be included in the governance body.

Consistent policy signals across government departments and the continuity of regulatory direction are essential in accelerating clean technology innovation and commercialization. To this end, the new regulator could also take on the role of interdepartmental coordination of regulatory policy that supports innovation.

A regulator that is tasked to support innovation and transformational change is likely best placed to maintain its autonomy by reporting to directly to the Parliament or through the Minister of Finance, because of its impact across economic sectors.

Finally, case studies reviewed in this paper demonstrate the need for more active public engagement beyond regulatory consultation requirements. To achieve broader support and ensure continuity of desired transformational change, a parallel body with a diverse representation from public could be tasked to provide guidance and engage the broader public on policy direction and the regulator's mandated vision.

Lessons for Canada

Canada could create a new regulatory body that is arm's length from the government and specifically tasked to support innovation. The new regulator could also coordinate requirements with provincial, territorial and Indigenous governments. Ideally, it would be governed by senior representatives from appropriate federal departments as well as industry, with preference to disruptive technology providers. A parallel group could provide advice on policy direction, with membership drawn from the public, thought leaders, state elders, and Indigenous leaders. The new regulatory body could be internally organized around economic (sub)sectors or separate entities could be formed for each sector. The regulator could report to the Minister of Finance.

STRINGENCY AND FLEXIBILITY

To accelerate innovation and clean growth, regulations must be bold and ambitious while having inbuilt dimensions of flexibility that allow requirements to adapt to real world conditions. The stringency of regulations should be science-based and optimize the use of market-based instruments. The regulator should first identify policy barriers and/or enabling requirements, then test solutions in contained spaces, and in the final stage, implement new requirements based on lesson from such experiments. Regulations should also always have inbuilt processes of review and adjustment.

To accelerate transformational change necessary to achieving socio-environmental objectives and to catalyze investment, regulatory requirements must send a strong policy signal towards the desired direction of growth. Stringent regulations are essential in enabling innovation, supporting disruptive technology solutions and driving clean growth. To achieve the latter objective, requirements should specifically avoid fossil fuel investment lock-in, increase product life and (re)use to the extent possible (particularly, by optimizing opportunities in circular economy), and include lifecycle ecological considerations. It is important for governments to provide directional guidance (e.g., decarbonization) that are backed by regulations, without determining technology winners and losers.

Three key elements can provide flexibility in an effective regulatory model. First, multiple compliance pathways should be enabled through an evolving portfolio that is guided by longer-term policy objectives. Second, requirements should be developed by doing, testing and through experimentation. The sandbox model described above provides an ideal approach where regulators work with industry to devise appropriate solutions for new technologies through gated exemptions. Finally, regulations should be responsive to changing condition and allow for adaptive course correction.

In the context of this paper, to support clean growth and innovation, the regulator should act as an agent of change, optimizing the use of available policy levers and coordinating its efforts with other levels of government. Although the regulator may be limited to work within areas where it has clear constitutional authority, transition pathways determined by the regulator could also act as a government funding precondition.

Finally, close collaboration with other levels of government and alignment with international partners can improve the success of regulations, and this can be achieved either through formal arrangements or through ad hoc information sharing.

Lessons for Canada

Canada is developing requirements to implement the Pan-Canadian Framework on Clean Growth and Climate Change. These requirements, however, are being advanced within traditional regulatory processes that are not necessarily designed to drive innovation. They are also unlikely to result in transformative change necessary to meeting Canada's longer-term climate objectives. A new regulatory body could work with innovators and disruptive technology providers to identify barriers and enabling policies that can accelerate innovation in protected spaces, and in turn develop bold requirements that are designed to catalyze clean growth and achieve longer-term objectives.

REFERENCES

Allen, R. H., & Sriram, R. D. (2000). The Role of Standards in Innovation. *Technological Forecasting and Social Change, 64*(2-3), 171-181.

Ambec, S., Cohen, M. A., Elgie, S., & Lanoie, P. (2013). The Porter Hypothesis at 20: Can Environmental Regulation Enhance Innovation and Competitiveness? *Review of Environmental Economics and Policy, 7*(1), 2-22.

Blom, M., Korteland, M., & Nelissen, D. (2013). *Clean and green in the Dutch economy: Economic scope and growth potential [Clean en green in de Nederlandse economie: Economische omvang en groeikansen].* CE Delft.

Blom, M., Korteland, M., & Nelissen, D. (2013). *Clean and green in the Dutch economy: Economic scope and growth potential [Clean en green in de Nederlandse economie: Economische omvang en groeikansen].* Delft.

Burtis, P. R. (2004). *Creating the California Cleantech Cluster.* Natural Resources Defense Council and Environmental Entrepreneurs.

Choe, V. (2018). *Eco-Innovation Observatory: Country Profile 2016-2017: The Netherlands.* European Commission Directorate-General for the Environment, Eco-Innovation Observatory.

Durham, B., Rinck-Pfeiffer, S., & Guendert, D. (2003). Integrated Water Resource Management through Reuse and Aquifer Recharge. *Desalination, 152*(1-3), 333-338.

ECN. (2017). *National Energy Outlook 2017.* Petten, Netherlands: ECN.

Ernst & Young. (2018). *Renewable Energy Country Attractiveness Index.* EYGM Limited.

Financial Conduct Authority (FCA). (2017, Jun 16). *Applying to the regulatory sandbox*. Retrieved from https://www.fca.org.uk/firms/regulatory-sandbox/prepare-application

Financial Conduct Authority (FCA). (2018, 02 14). *Global sandbox*. Retrieved from https://www.fca.org.uk/firms/regulatory-sandbox/global-sandbox

Financial Conduct Authority (FCA). (Nov. 2015). *Regulatory Sandbox.*

Financial Conduct Authority (FCA). (Oct. 2017). *Regulatory sandbox lessons learned report.*

Fischhendler, I., & Heikkila, T. (2010). Does integrated water resources management support institutional change? The case of water policy reform in Israel. *Ecology and Society, 15*(10). Retrieved from http://www.ecologyandsociety.org/vol15/iss1/a

Foxon, T. J. (2011). Governing a low carbon energy transition: lessons from UK and Dutch approaches. In I. Galarrage, M. Gonzalez-Eguino, & A. Markandya, *Handbook of Sustainble Energy* (pp. 84-98). Northampton, MA: Edward Elgar.

Government of Canada. (2016). *Working Group on Clean Technology, Innovation and Jobs: Final Report.*

Government of France. (2017). *Lancement d'Action Publique 2022: Dossier de Presse.* Organisation de la direction interministérielle de la transformation publique.

Government of France. (2018). *Appel à projets: Projets relatifs à une dérogation législative.* Ministre de l'économie et des finances & Ministre de l'action et des comptes public.

Government of France. (2018). *Appel à projets: Projets relatifs à une dérogation réglementaire.* Ministre de l'économie et des finances & Ministre de l'action et des comptes public.

Government of France. (2018). *Expérimenter pour Innover.* Paris: Secrétariat de France Expérimentation.

Government of France. (2018, 05 03). *France Expérimentation*. Retrieved from Direction générale des entreprises (DGE): https://www.entreprises.gouv.fr/politique-et-enjeux/france-experimentation

Government of France. (June 2018). *Le Plan d'Action pour la Croissance et la Transformation des Entreprises (PACTE).* Ministère de l'Économie et des Finances.

Government of the Netherlands. (2008). *Energy Innovation Agenda.* Utrecht, Netherlands: EnergieTransitie (Energy Transition Department).

Government of the Netherlands. (2008). *Regieorgaan Energietransitie Nederland*. Retrieved from Ministerie van Binnenlandse Zaken en Koninkrijksrelaties: http://wetten.overheid.nl/BWBR0023534/2008-02-27

Government of the Netherlands. (2016). *Energy Report: Transition to sustainable energy.* The Hague: Ministry of Economic Affairs.

Government of the Netherlands. (2018). *Greenhouse Gas Emissions in the Netherlands 1990-2016: National Inventory Report 2018.* Bilthoven, Netherlands: National Institute for Public Health and the Environment (RIVM).

Green, J., Hartman, B., & Glowacki, P. (2018). *Paving the Road to the Widespread Use of Electric Vehicles.* Retrieved from CSA Group: https://www.csagroup.org/article/paving-road-widespread-use-electric-vehicles/

Greenwald, D. (n.d.). An Israeli Experience: Facing Water Challenges in Scarce Areas. Noumea.

Israel Ministry of Foreign Affairs. (2018). *CleanTech 2018: Conference Primer*. Retrieved from http://mfa.gov.il/MFA/InnovativeIsrael/Conferences/Pages/CleanTech-20181114-5498.aspx

Israel Water Authority. (2012). *Master Plan for the National Water Sector: Summary of Main Points of the Policy Paper*. Retrieved from http://www.water.gov.il/Hebrew/ProfessionalInfoAndData/2012/09-Israel-Water-Sector-Master-Plan-2050.pdf

Jeffrey, P., & Gearey, M. (2006). Integrated water resources management: Lost on the road from ambition to realization? *Water Sciences and Technology, 53*(1), 1-8.

Kemp, R. (2010). The Dutch energy transition approach. *International Economics and Economic Policy, 7*(2-3), 291–316.

Kemp, R., & Loorbach, D. (2003). Governance for Sustainability Through Transition Management. *Paper for EAEPE Conference .* Maastricht, the Netherlands.

Kemp, R., & Rotmans, J. (2004). Managing the Transition to Sustainable Mobility'. In B. Elzen, F. W. Geels, & K. Green, *System Innovation and the Transition to Sustainability: theory, evidence and policy* (pp. 137-165).

Kemp, R., Rotmans, J., & Loorbach, D. (2007). Assessing the Dutch Energy Transition Policy: How Does it Deal with Dilemmas of Managing Transitions? *Journal of Environmental Policy & Planning, 9*(3-4), 315-331.

(1958 [amended July 2008]). *La Constitution française du 4 octobre 1958. art 37, §1.*

Laes, E., Gorissen, L., & Nevens, F. (2014). A Comparison of Energy Transition Governance in Germany, The Netherlands and the United Kingdom. *Sustainability, 6*(3), 1129-1152.

Mekorot. (n.d.). *The National Water Carrier*. Retrieved from http://www.mekorot.co.il/Eng/newsite/Projects/NWC/Pages/TheNationalWaterCarrier.aspx

Porter, M. E., & Linde, C. v. (1995). Toward a New Conception of the Environment-Competitiveness Relationship. *Journal of Economic Perspectives, 9*(4), 97-118.

Roelofsen, O., Pee, A. d., Speelman, S., & Speelman, S. (2017). *Energy transition: mission (im)possible for industry? A Dutch example for decarbonization.* Amsterdam: McKindsey & Company.

Saes, L., & Veerle Bastiaanssen, G. v. (2018). *Eco-Innovation Observatory: Country Profile 2016-2017: The Netherlands.* European Commission Directorate-General for the Environment, Eco-Innovation Observatory.

Shin, D.-H., Kim, H., & Hwang, J. (2015). Standardization revisited: A critical literature review on standards and innovation. *Computer Standards & Interfaces, 38*, 152-157.

Standards Council of Canada. (2016, December 23). *Canada plays instrumental role in the development of new ISO standard on Environmental Technology Verification*. Retrieved from https://www.scc.ca/en/news-events/news/2016/canada-plays-instrumental-role-development-new-iso-standard-environmental-technology-verification

Stroyan, J., & Brown, N. (2013). *Study on the contribution of standardization to innovation in European-funded research projects.* Technopolis Group.

Sworder, S. (2017). *The Global Cleantech Innovation Index 2017.* San Francisco: Cleantech Group.

Veilleux, J.-P. (2010). *Case Study: Energy Transition in the Netherlands.* Government of Canada, Policy Research Initiative.

World Bank . (2017). *Water Management in Israel: Key Innovations and Lessons Learned for Water-Scarce Countries.* Retrieved from http://documents.worldbank.org/curated/en/657531504204943236/pdf/119309-WP-PUBLIC-56p-WcmpeProof.pdf

Zoo, H., Henk, V. J., & Lee, H. (2017). Interplay of innovation and standardization: Exploring the relevance in developing countries. *Technological Forecasting and Social Change, 118*, 334-348.

HORIZON

SOLUTIONS FOR A SUSTAINABLE FUTURE