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ISGAN
INTERNATIONAL SMART GRID ACTION NETWORK

Smart Grid Case Studies

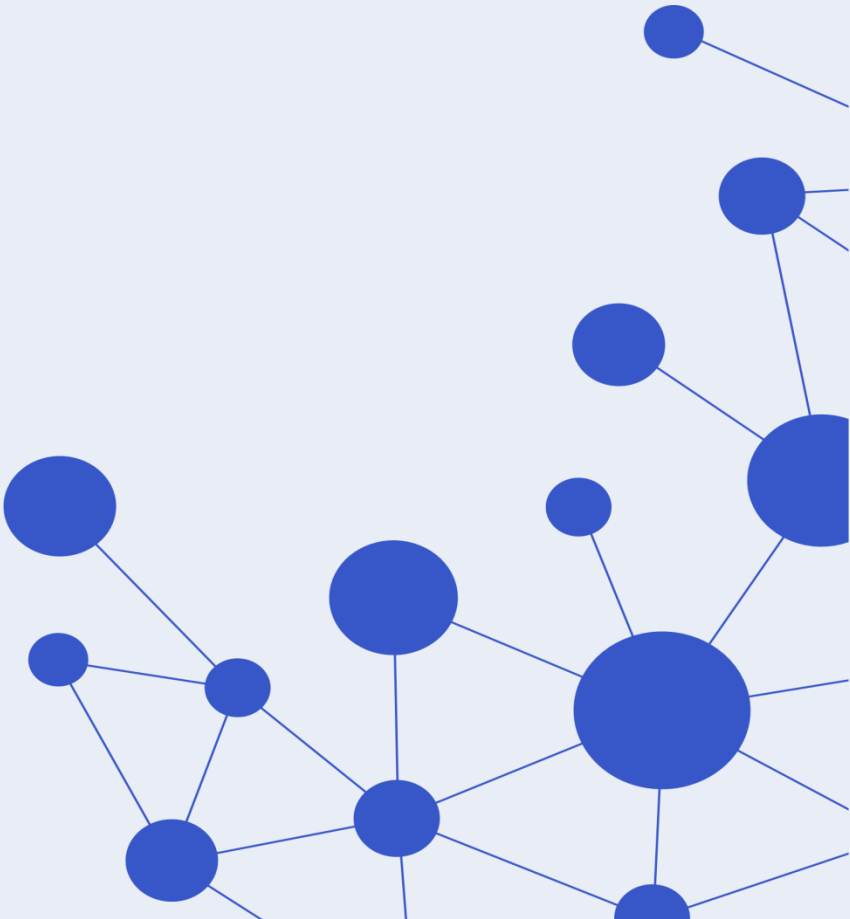
Innovative Regulatory Approaches with Focus on Experimental Sandboxes

Casebook

Australia, Austria, Germany, Italy, the Netherlands, the United Kingdom and the United States

ISGAN Annex 2 Smart Grid Case Studies

May 2019



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About ISGAN Casebooks

ISGAN casebooks are meant as compendium documents to the global trends and discussion about smart grids. Each is factful information by the author(s) regarding a topic of international interest. They reflect works in progress in the development of smart grids in the different regions of the world. Their aim is not to communicate a final outcome or to advise decision-makers, but rather to lay the ground work for further research and analysis.

Disclaimer

Acknowledgments

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[1] The ISGAN Knowledge Transfer Project (KTP) constitutes a deep-dive approach for international collaboration on key topics of relevance for the development and deployment of smart grids. Placing focus on individual learning and collective co-creation by interdisciplinary groups of participants with complementary competencies, the KTP concept involves interactive workshops preceded by considerable participant preparation and results in material (e.g. policy messages for ministers or project reports) enabling continued efforts on the topics in focus and a wider dissemination to relevant stakeholders in ISGAN countries and beyond. For more information see: www.iea-isgan.org/knowledge-transfer-project/

Preface

The idea for the focus of this casebook on experimental (regulatory) sandbox Initiatives was generated during the CEM9/Nordic Clean Energy Week, as a result of the workshop *Intelligent Market Design – Boosting Global Smart Grid Deployment*[2] (23 May 2018) and the following Annex and inter-annex meetings. In these discussions, market regulation was repeatedly identified as a key topic for further collaboration in research and innovation. To enable a deeper international dialogue on this topic, ISGAN thus launched a new workstream for the purpose of sharing experiences and lessons learned from sandbox projects from around the world related to the development of smart grid solutions. It builds upon ongoing annex strategies, including engagement of ISGAN Annex 7 with the European Strategic Energy Technology Plan (SET Plan) Action4 that involves an evaluation of current projects in regulatory innovation zones and similar initiatives.

Although, at this early stage, we are still developing a common understanding of how sandboxes can be of relevance to all ISGAN member countries, we share the understanding that experimental space is needed, in which innovators are allowed to trial new products, services and business models in a real-world environment without some of the usual rules and regulations applying. Such sandbox trials are expected to provide evidence to help understand whether regulation should change permanently, as exemptions will in most cases be project-related and limited in time.

Matching the needs of industry and policy makers' options as well as consumer interests goes beyond the established set of research, technology and innovation policy instruments (e.g. pilot- and demonstration projects in the frame of current regulation). Regulatory sandbox programs will thus have to address several policy and legislative fields simultaneously and have to be framed as an orchestrated set of complementary policy actions combining R&I-instruments (e.g. public funding of replication projects) with legislative measure (e.g. experimental clauses), coupled with innovation-oriented regulatory bodies and other instruments of energy policy.

Regulatory experiments such as regulatory sandboxes[3] would provide an arena for product, process and service innovations and business models, based on interventions in regulatory frameworks (e.g. energy laws, exemptions, derogations, tariffs, building regulations, zoning rules, etc.) and/or other framework conditions (e.g. creating an atmosphere of active participation), thus requiring legislators, public administration as well as other stakeholders to be involved.

As this is a new kind of mixed policy intervention with complex governance issues between public, semi-public and private actors, efforts have to be made and resources provided to develop an adequate mix of innovation-oriented legislative or regulatory measures, as well as project-related support mechanisms and funding instruments.

[2] For workshop summary and policy brief see: http://www.iea-isgan.org/isgan-side-event-at-cem9-policy-brief-and-workshop-summary/

[3] In some countries, the basic ideas are taken from the FinTech sector's currently developed Regulatory Sandbox instrument.

This casebook provides detailed information on planned or implemented Sandbox Programs for Australia, Austria, Germany, Italy and The Netherlands. An overview of the previously well documented program in the UK is provided as well.

Hawaii is included as an example of another form of regulatory experimentation. In this case, one US state is experimenting with a performance-based method for tariffs which, if successful, can be rolled out as a regulatory innovation to other US states or other countries. The main focus of the casebook however is laid on experimenting to achieve the above mentioned innovation goals by means of sandbox projects.

Special acknowledgements: In the international knowledge exchange (KTP) workshop on experimental sandboxes on 1 April 2019 in Stockholm, ISGAN partnered with the International Confederation of Energy Regulators (ICER). The Swedish Energy Agency and the Swedish Smart Grid Forum also provided considerable support, especially in regard to the ISGAN Public Workshop taking place the following day.

Executive Summary

The urgency of transition of the energy system requires speeding up the innovation processes that will shape its future technological, economic and regulatory components. The challenge for innovators is to tackle the uncertainties of the required changing institutional frameworks (including energy law, regulation of monopolistic grid operators, market structures, infrastructure investment mechanisms, etc.).

All energy systems, whether vertically integrated or deregulated, have some sort of regulatory or market oversight. Some of these regulations have been long established and originate from stem out of initial structures created around the turn of the 20th century. However, as the electricity grid transitions towards a more decentralized structure, with deepened engagement of end-users (including consumers) and involvement of a wider variety of other stakeholders and service providers, there is a need to enable testing of new regulatory structures that can better support integration of advanced smart grid technologies and business models

Given that innovators lack opportunities to develop and replicate new solutions in real-world contexts, experimental space is needed to trial new goods, services and business models in a real-world environment without some of the usual rules and regulations applying. Such sandbox trials are expected to provide evidence to help understand whether regulation should change permanently, as exemptions will in most cases be project-related and limited in time. However, in granting exemptions, it is important to consider that regulators and policy actors should avoid the risk of discriminating among market players and to jeopardize customers' welfare

Regulatory sandbox programs require an orchestrated set of complementary policy actions combining:

- research and innovation instruments (e.g. public funding of replication projects), with
- legislative measures (e.g. experimental clauses), coupled with innovation-oriented regulatory bodies, and
- instruments of energy policy (Ministries).

Experiments, such as in regulatory sandboxes, can provide an arena for goods, process and service innovations and business models, based on interventions in regulatory frameworks (e.g. energy law, exemptions, derogations, tariffs, building regulations, zoning rules, etc.) and/or other framework conditions (e.g. creating an atmosphere of active participation), thus requiring legislators, public administration as well as other stakeholders to be involved in addition to regulatory bodies.

The need for regulatory sandboxes is often related to solutions which were not thought of or were not necessary before, but which are related to new challenges for the energy system. Hence, the scope of experimenting mentioned and applied for most often are related to:

- development of flexibility services for grid stability,
- reduction in environmental impacts,
- sector coupling,
- energy storage integration in the power sector, and
- management of local energy communities.

The main innovation goals, which are considerd as feasibly addressed with a sandbox program are:

- new products (e.g. for energy management),
- new services (e.g. peer to peer exchange of energy and flexibility services),
- platform solutions (e.g. distributed ledgers with blockchains) ,
- new tariff-models (e.g. grid tariffs for battery storage) and
- new business models (e.g. local energy community).

For different stakeholders learning is as important as the experimenting in sandbox projects:

- **For innovators perceiving regulatory barriers**, a review of a project proposal by experts from regulatory bodies is highly valuable whether a regulatory exemption is necessary or not.
- **Learning among innovators can be intensified** if trustful knowledge exchange can be organized through formats such as Community of Practice, which provide opportunities for not having to make the same mistakes others already have paid for.
- **For regulatory bodies and legislators,** trials in regulatory sandboxes provide valuable evidence to help understand whether regulation should change permanently.

Status on regulatory sandbox programs and calls for energy related projects

Among the 20+ countries that participated in the Stockholm workshop on regulatory sandbox on 1 April 2019, it was identified that 13 countries have put sandbox programs in place or are making preparations for designing and planning sandboxes, while others have not yet considered implementing such an instrument. Examples:

- Countries that already have implemented sandbox programs: Germany, Italy, South Korea, the Netherlands, Singapore and the United Kingdom,
- Countries that have been discussing a sandbox program: Australia, Denmark, Ireland, and Spain,
- Countries that are in the stage of designing and proposing a sandbox program for implementation: Austria, France, Norway and Sweden.

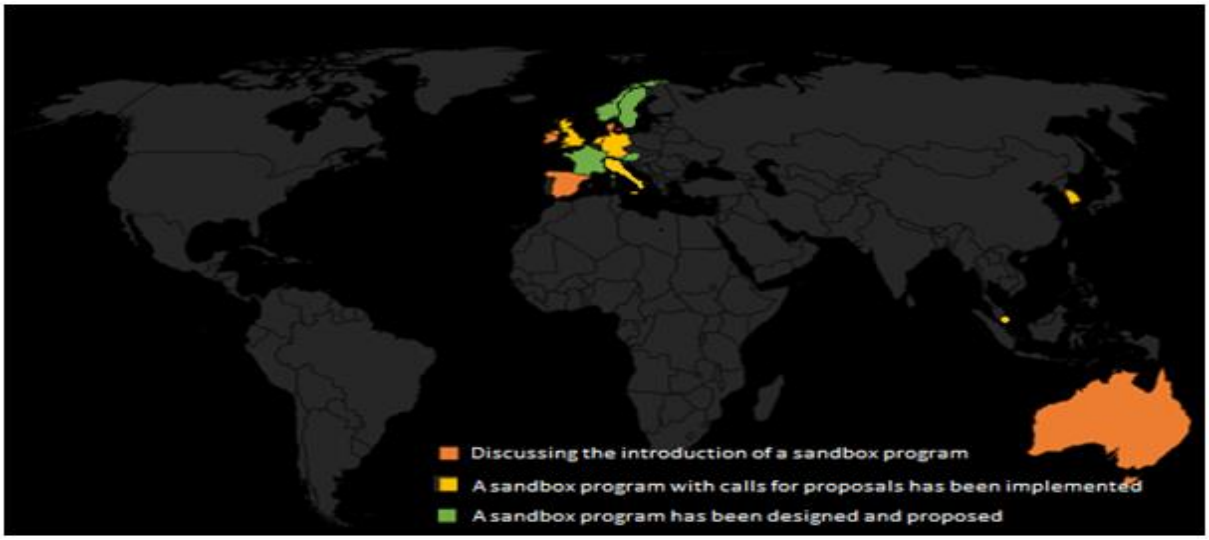

Figure 1. Map of countries indicating to have implemented a sandbox program

In recent years, two countries, Germany and The Netherlands, have already adapted the rule set for regulatory bodies to allow more room for experimenting. Regulatory bodies in Italy (ARERA) and UK (OFGEM) are already in the position to foster innovation and have sufficient room for maneuver for experimenting. In Norway, the regulatory body (NVE) considers current legislation to provide sufficient room for experimenting as well. France has already designed and proposed changes and is expecting its implementation soon. Countries like Australia, Austria, Brazil, Denmark, India, Ireland, Jordan and Singapore are discussing changes in the regulators' rules for experimenting.

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1. Why do we need regulatory sandboxes?

The urgency of transition of the energy system requires speeding up the innovation processes that will shape its future technological, economic and regulatory components. In the current phase of reconfiguring the energy system, experts conclude that timely deployment of solutions and business models, which can already build on tested technologies, depend on real-world experimenting. Tackling the uncertainties of the required changing institutional frameworks (including energy law, regulation of monopolistic grid operators, market structures, infrastructure investment mechanism and so forth) is a challenge for innovators. They lack opportunities to develop and replicate new solutions in real-world contexts, as future regulatory, institutional conditions do not yet exist.

All energy systems whether vertically integrated or deregulated have some sort of regulatory or market oversight. Some of these regulations have been long established and stem out of initial structures created around the turn of the 20th century. However, as the electricity grid transitions towards a more decentralized structure, with deepened engagement of consumers and involvement of a wider variety of stakeholders and service suppliers, there is a need to enable testing of new regulatory structures that can better support integration of advanced smart grid technologies and business models. But there remains limited experience in enabling more flexible regulations that can allow for testing market applications of new technologies, programs, and services. Thus, countries lack examples on how to support the creativity and innovativeness of business, grid operators and other actors in the innovation eco-system for the future energy system, while also ensuring a reliable, stable and cost-effective grid.

The main scopes of experimenting with smart grids, for which sandboxes are considered as possible instruments, are the development of flexibility services for grid stability, reduction in environemental impacts, sector coupling and energy storage integration in the power sector and management of local energy communities. All five scopes require adaptations or clarification of rules and regulations, as the related use cases have not been part of the ordinary way of running the energy regime. Only in a few cases, countries seem to focus on smart electricity grids only, or solutions “behind the meter”. Increasingly, experimenting with local energy communities, producing and sharing electricity locally, are also raising regulatory questions that sometimes require special permits or waivers.

As a unique case, Hawaii is taken as an example of another form of regulatory experimenting. In this case, one US-State is experimenting with a performance-based method for tariffs, which in case of success can be rolled out as a regulatory innovation to other US-States or other countries. This allows the experimentation with regulatory innovations in a form which is legally binding and unlimited with respect to time or other restrictions, which is another way of real-world experimenting and learning.

The main innovation goals, which are considered as feasibly addressed within a sandbox program are:

- new products (e.g. for energy management);
- new services (e.g. peer to peer exchange of energy and flexibility services);
- platform solutions (e.g. distributed ledgers with blockchains);
- new tariff models (e.g. grid tariffs for battery storage); and,
- new business models (e.g. local energy community).

2. Case studies by country

2.1 (Australia) Regulatory sandbox arrangements to support proof-of-concept trials in the Australian national electricity market

Title of Program or Activity	Regulatory sandbox arrangements to support proof-of-concept trials in the Australian national electricity market	
Location	Australia	
Main scope of experiment	• Smart electricity grid • Integrated approach/sector coupling • Energy Storage • New business models • Flexibility services for grid stability • Behind the meter • Others: Scope of proposed trials determined by trial proponents. Potentially all of the above could be proposed to feature in trials.	
Main innovation goal	• New technological solution, product, service • New tariff-model • New business model • New regulation • Others: Objective is to encourage innovation which has the potential to contribute to the long-term interests of consumers. Potentially all of the above could be proposed to feature in trials.	
Regulatory body	Australian Energy Market Commission	
Implementation Time Period	Some elements could be implemented in 2019, others pending decision of Energy Ministers.	
Funding Amount (direct and in kind)	Public	None directly. ARENA has funded trials separately to this process.
	Private	Determined by trial proponents
Lead Organization	Australian Energy Market Commission	
Additional Key Stakeholders/ Organizations	Australian Energy Regulator (AER), Australian Energy Market Operator (AEMO), Energy Consumers Australia (ECA) and Australian Renewable Energy Agency (ARENA).	
Link to Program's Website/News	https://www.aemc.gov.au/market-reviews-advice/electricity-network-economic-regulatory-framework-review-2019	
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Background and Overview

The Australian Energy Market Commission (AEMC or Commission) is currently developing the design of regulatory sandbox arrangements for the national electricity market (NEM).

On 7 March 2019 the AEMC published interim advice to Australian governments that recommended the introduction of formal regulatory sandbox arrangements in the NEM to make it easier for businesses to develop and trial innovative energy technologies and business models.[4]

The AEMC's interim advice is that current arrangements for facilitating proof-of-concept trials can be improved and that trials can be better facilitated and coordinated through the introduction of regulatory sandbox arrangements in the NEM. This is based on consultation with stakeholders and analysis of sandbox arrangements in Australia and overseas.

■ Existing arrangements in Australia

The NEM is comprised of five physically connected regions on the east coast of Australia.[5] It is comprised of a number of competitive wholesale markets and regulated monopoly networks. Consumers have the ability to choose their electricity retailer.

There are a number of bodies that are responsible for energy in Australia.[6] The AEMC is the expert energy policy adviser to Australian governments. We make and revise the energy rules[7] and provide advice.[8] The AEMC reports to the Council of Australian Governments (COAG) Energy Council, which has responsibility for monitoring and reforming national energy markets.

While the AEMC does not have a formal role in facilitating trials, it can consider innovative rule changes that facilitate new business models where they are in the long-term interests of consumers. For example, the AEMC is currently considering several wholesale demand response rule change requests.[9]

In providing advice on regulatory sandboxes the AEMC was asked to engage closely with the Australian Energy Regulator (AER), Australian Energy Market Operator (AEMO), Energy

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[4] AEMC, *Regulatory sandbox arrangements, Interim Advice,* 7 March 2019. Available at: https://www.aemc.gov.au/sites/default/files/2019-03/Interim%20Advice%20-%20REGULATORY%20SANDBOXES%20-%20for%20publication.pdf

[5] For more information and a map see here: https://www.aemc.gov.au/energy-system/electricity/electricity-system/national-electricity-market

[6] Under the governance structure created by the Council of Australian Governments (COAG) the three market bodies, the AEMC, Australian Energy Regulator (AER) and Australian Energy Market Operator (AEMO), oversee the nation's energy market and report to the COAG Energy Council. The COAG Energy Council is a Ministerial forum made up of representatives of the Commonwealth, State, Territory and New Zealand governments. For more information see: https://www.aemc.gov.au/regulation and http://www.coagenergycouncil.gov.au/australias-energy-markets/governance

[7] Under the National Electricity Law, National Gas Law and National Energy Retail Law, the AEMC makes and amends the National Electricity Rules, National Gas Rules and National Energy Retail Rules that underpin the NEM. These rules: govern the operation of the NEM; govern how market participants can operate in gas and retail sectors; govern the economic regulation of the services provided by monopoly transmission and distribution networks and gas pipelines; and facilitate the provision of services to retail customers and provide specific rights for consumers to whom energy is sold or supplied. For more information see: https://www.aemc.gov.au/about-us

[8] All of the AEMC's work is guided by the three legislated National Energy Objectives. The National Electricity Objective as stated in the National Electricity Law is: "to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to: price, quality, safety and reliability and security of supply of electricity; and the reliability, safety and security of the national electricity system."

[9] For more information see: https://www.aemc.gov.au/rule-changes/wholesale-demand-response-mechanism

Consumers Australia (ECA) and Australian Renewable Energy Agency (ARENA), who each have important roles in relation to innovation and trials in the NEM. The role of these organizations in facilitating trails is as following:

- The AER regulates wholesale and retail energy markets, and energy networks, under national energy legislation and rules. Under the current regulatory framework, the AER has the ability to provide a range of exemptions and waivers for specific purposes and has a range of compliance tools and discretion in deciding whether to take enforcement action. Trials and other forms of innovation can be facilitated by the AER exercising its enforcement discretion, including its powers to issue "no action letters". However, the AER and stakeholders generally considered these were not appropriate mechanisms for facilitating proof-of-concept trials.
- As the independent market and system operator AEMO is involved in several trials in a range of capacities, including trials of new energy technologies and systems.
- ECA is an independent organization set up by the COAG Energy Council in 2015 and seeks to promote the long-term interest of consumers with respect to price, quality, safety, reliability and security of supply of energy services.
- ARENA was established in 2011 with the objective of improving the competitiveness of renewable energy technologies and increasing the supply of renewable energy in Australia.[10] ARENA provides funding to researchers, developers and businesses that have demonstrated the feasibility and potential commercialization of their project. ARENA also builds and supports networks, and shares the knowledge, insights and data from funded projects.

Feedback collected from stakeholders for the interim advice suggested there were barriers to conducting proof-of-concept trials under the current regulatory framework, with stakeholders raising concerns including a lack of flexibility in the regulatory framework, the absence of a defined and well understood regulatory process for conducting trials and the complexity of the framework.

■ Background to regulatory sandbox advice

The *Independent Review into the Future Security of the National Electricity Market (Finkel review)*[11] noted that innovative technologies can help reduce the costs of providing secure and reliable electricity supply and also contribute to reducing emissions. The Finkel Review recommended that the AEMC review and update the regulatory framework to facilitate proof-of-concept testing of innovative approaches and technologies, and this recommendation was accepted by the COAG Energy Council.

As part of the *2019 Electricity network economic regulatory framework review,*[12] the COAG Energy Council Senior Committee of Officials (SCO) requested the AEMC to examine regulatory sandbox arrangements and how to best facilitate coordination of proof-of-concept trials.[13]

[10] Australian Renewable Energy Agency Act 2011, s.3.

[11] Dr Alan Finkel et al., *Independent Review into the Future Security of the National Electricity Market*, June 2017, p.66.

[12] See project page on the AEMC website: https://www.aemc.gov.au/market-reviews-advice/electricity-network-economic-regulatory-framework-review-2019

[13] The request is available on the AEMC website here: https://www.aemc.gov.au/sites/default/files/2019-01/Letter%20from%20the%20Senior%20Committee%20of%20Officials.pdf

The Commission published a consultation paper in December 2018 and received 28 written submissions in response, with most stakeholders supporting the establishment of regulatory sandbox arrangements.[14,15]

- **Commission proposal**

The Commission's interim advice noted that emergence of innovative technologies and business models in the NEM can bring significant benefits to consumers.

The Commission considers that a regulatory sandbox initiative could provide for a regulatory framework that is better equipped to respond to the rapid change in the electricity sector and deliver customer benefits though innovation.

The objective of the regulatory sandbox arrangements should be to encourage innovation which has the potential to contribute to the long-term interests of consumers, rather than simply to facilitate an increased number of trials. Innovations that are in consumer's interests can also be encouraged by establishing a clearer process for proponents of proof-of-concept trials to approach energy market regulatory bodies for feedback and guidance on regulatory issues and regulatory options to avoid unnecessary delays and costs for eligible trials. This can help reduce the barriers to the introduction of more efficient approaches to the delivery of electricity services.

To access regulatory sandbox arrangements, proof-of-concept trials would need to be time-limited and meet appropriate eligibility criteria, and appropriate consumer safeguards must remain in place. Design principles for regulatory sandbox arrangements outlined in the interim advice included that trials should:

- benefit consumers, or at least not make them worse off
- support competitive outcomes
- have a time limit
- have a plan in the event the trial is unsuccessful, such as an ability to revert to pre-existing arrangements
- share knowledge gained to inform regulators and the market, with appropriate limits to protect intellectual property
- be prioritized by the relevant market bodies, to the extent that only a limited number of trials can be facilitated.

The Commission proposes a regulatory sandbox initiative that could make use of a variety of existing and new tools that could be applied according to their suitability to a proposed trial.

Policy Instruments, Actors, and Programs

The regulatory sandbox initiative is best thought of as a toolkit of various regulatory options that can be applied to the specific circumstances of proposed proof-of-concept trials. These

[14] The consultation paper and stakeholder submissions are available on the AEMC website: https://www.aemc.gov.au/market-reviews-advice/electricity-network-economic-regulatory-framework-review-2019

[15] The AEMC's interim advice also builds on the findings of our 2018 *Electricity network economic regulatory framework review* and previous work done by state, territory and commonwealth officials to consider the case for introducing regulatory sandbox arrangements (see attachment to request from SCO).

tools are discussed in more detail below. The table below sets out some examples where these tools may be used.

Table 1: Regulatory tools and examples of how they may be used

Regulatory tool	Examples of how it may be used
Advice on energy regulations	Proponents at an early stage of developing a trial who need guidance on elements of the energy framework that may be relevant. OR Proponents with a specific question on the application of the law or rules where it is appropriate for the AER to provide guidance.
A new AER waiver or exemptions power	Proponents with a specific regulatory barrier that they are seeking an exemption from for a time and size limited trial. E.g. trial of a new technology that doesn't meet current requirements.
A new AEMC expedited trial rule making process	Trials that involve significant deviation from existing regulatory arrangements and/or require alterations to rules to apply on a temporary basis e.g. in-market trials of demand response, trials proposed by market bodies.
AER existing waiver and exemption powers	Limited cases that fall into existing powers, e.g. trials involving DNSP ring-fencing waivers.

- **Coordinated feedback and guidance on regulatory issues**

The feedback from the majority of stakeholders was that the provision of advice was an important element of facilitating innovation and proof-of-concept trials.

Market bodies should develop a new, coordinated approach to providing feedback and guidance to proponents of trials. This would involve one market body being a clear first point of contact for proof-of-concept trials that is able to provide "fast, frank feedback" on a range of issues, whilst referring to the other market bodies where appropriate.

A number of submissions called for a "one stop shop" for guidance and feedback to enable a straightforward process for trial proponents however the Commission sees a number of challenges with this approach. In the national energy framework different market bodies have different responsibilities and it is not appropriate for one body to provide advice on behalf of another.

All guidance and feedback would be subject to a disclaimer that it is not legal advice. It is not appropriate for market bodies that are responsible for developing and applying the rules to provide binding legal advice on their interpretation. Innovators would likely need to obtain their own legal advice separately.

- **New AER waiver or exemptions power**

A new waiver or exemptions power for the AER could provide time-limited regulatory relief from the rules to eligible trials. It could be used if an eligible trial required an exemption from

a specific rule (or rules). As suggested by the AER, this could involve a broad power for the AER to grant specific exemptions and waivers to facilitate the conduct of proof-of-concept trials, subject to a "sandbox guideline" the AER develops in consultation with the market bodies and relevant stakeholders. The exercise of this power by the AER would be subject to eligibility criteria being met.

This would involve changes to the law and rules and may require expansion of AER's existing functions and powers.

- **New AEMC expedited rule process for conduct of trials**

Some in-market trials would not be able go ahead relying solely on regulatory relief and would require temporary alternate regulatory arrangements as noted by some stakeholder submissions.

If a proof-of-concept trial requires more substantial changes to market arrangements, such as new rules or the alteration of existing rules, the Commission is of the view that this is likely better progressed through the rule making process than through an exemption or waiver. A rule making process offers a more appropriate regulatory process in these circumstances, including stakeholder consultation.

The current rule making process is likely too lengthy or represents too high a barrier for the purposes of a limited trial rule.

A new AEMC expedited rule process could be used if an eligible trial required more substantial changes to market arrangements, such as new rules or the alteration of existing rules (e.g. eligible in-market trials). It is envisaged that these rule changes would be time limited, to facilitate the conduct of the trial. If the trial was successful, a permanent rule change could be initiated. The trial rule change process could be similar to the current expedited rule making process in the National Electricity Law (NEL), though likely involving a modified application of the National Electricity Objective (NEO) to allow evidence to be gathered through trials on the impact of innovation on the long-term interests of consumers.

This process would develop an individual regulatory sandbox for a trial that would be a set of rules operating on a time limited basis and possibly limited to a certain geography or certain market participants or customers.

- **Existing regulatory tools**

The Commission also proposes that the regulatory sandbox initiative would facilitate access to existing regulatory tools that may be applicable to proof-of-concept trials such as existing waiver and exemption powers. The first point of contact for guidance would refer trial proponents to these processes where appropriate.

Outcomes and Highlights

There are no current or recent sandbox projects in Australia as the regulatory sandbox arrangements are not yet in place.

Under existing regulatory arrangements (which do not include formal regulatory sandbox arrangements), a range of propositions have gone under trial across the Australian energy sector. These vary in terms of size of the trial, the duration, proponents of trials, the matter being tested and potential impacts of the trial. Some recently completed or launched trials are listed below.

Whilst a number of trials have been able to proceed without formal regulatory sandbox arrangements, many stakeholders considered trials were being limited due to the current regulatory framework. As noted above, the AEMC considers current arrangements for facilitating proof-of-concept trials can be improved through the introduction of regulatory sandbox arrangements.

Some of the trials recently conducted and currently underway (without a regulatory sandbox) are as following:

Project #1 **- Hornsdale wind farm frequency control ancillary services trial**

The Hornsdale Wind Farm 2 (HWF2) trial is the first in-market technical demonstration of a wind or solar farm providing frequency control ancillary services (FCAS) in the NEM. It was undertaken by AEMO and ARENA in conjunction with NEOEN (wind farm owner and operator) and Siemens-Gamesa Australia (equipment provider for the Hornsdale group of wind farms). As a result of the trial, HWF2 is the first Australian wind farm to be registered and offering FCAS in the NEM. The trial ran from August 2017 until February 2018. The trial was underpinned by a MOU signed between ARENA and AEMO in May 2017.[16]

Project #2 **- CONSORT Bruny Island Battery Trial**

The trial aims to explore how the residential batteries can be used by households to manage their energy while simultaneously assisting network operators with ongoing network issues by providing improved network visibility, improved reliability and up-time, and managing voltage levels and load flows across the network and by doing so deferring or avoiding costly network upgrades. The trial involves 40 battery systems and smart controllers installed in homes on Bruny Island in Tasmania's south-east. The trial received funding from ARENA, and it involves several parties.[17]

Project #3 **- New Reg process trial by Ausnet**

The AER, Energy Networks Australia and ECA have launched a project to aimed at improving engagement on network revenue proposals, and to identify opportunities for regulatory innovation.[18] The organizations proposed a draft process aimed at enabling consumer processes to be better reflected in regulatory proposals in advance of lodging those proposals for the AER's assessment called New Reg.[19] Under the draft New Reg process a Customer Forum negotiates aspects of the regulatory proposal in advance of lodgment with the AER. AusNet Services is conducting the trial of the New Reg Process in the development of its regulatory proposal for the 2021-25 period.[20]

Project #4 **- AGL Virtual Power Plant (VPP)**

[16] AEMO, *Hornsdale Wind Farm 2FCAS trial: Knowledge Sharing Paper,* July 2018, pp.1-4.

[17] Australian National University, Reposit Power, The University of Sydney, University of Tasmania and Tasnetworks.

[18] AER, ECA, Energy Networks Australia, *New Reg - towards consumer centric energy network regulation, Directions Paper, March 2018, p.3.*

[19] AER, viewed 30 November 2018, https://www.aer.gov.au/networks-pipelines/new-reg

[20] AER, viewed 30 November 2018, https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/consultation-on-the-new-reg-process

The project by AGL aims to create a prototype VPP by installing and connecting a large number of solar battery storage systems across residential and business premises in Adelaide, South Australia. When complete, the 5 MW VPP will consist of 1,000 distributed energy storage systems capable of dispatching more than 9 MWh of stored energy. The VPP can potentially provide a cost-effective solution in the medium term to smoothing out intermittent renewable energy generation and avoiding expensive upgrades to network infrastructure to meet peak demand.[21] The project seeks to demonstrate the role of distributed smart energy storage in enabling higher penetrations of renewable energy generators in the grid.[22]

***Project #5* - AEMO-ARENA joint Demand Response Trial**

ARENA and AEMO have partnered to trial demand response services using the Reliability and Emergency Reserve Trader (RERT) arrangements. The trial serves several objectives including to:

- evaluate the performance of various demand response resources in electricity supply contingency events
- provide a benchmark for the cost of procuring demand response in the NEM
- improve the commercial and technical readiness of innovative approaches such as en gagement with mass market customers, or behavioral demand response
- provide an evidence base to inform the design of a new market, or other mechanisms, for provision of demand response to assist with grid reliability and security.

Ten demand response proposals representing a broad range of technical and commercial solutions have been funded through the trial. The program has delivered 141 MW in year one and will deliver 190 MW in year two and 202 MW in year three, across New South Wales, Victoria, and South Australia.[23]

Lessons Learned and Next Steps

To progress the development of regulatory sandbox arrangements the Commission proposes two work streams: development of improved guidance and feedback and development of possible law and rule changes.

- **Coordinated regulatory guidance and feedback**

The provision of guidance and feedback to innovative businesses and proponents of trials is likely within the existing functions and powers of the market bodies. As proposed by ECA, the Commission believes the AEMC, AER, AEMO, ARENA and ECA can work together to develop a clearer process for this provision of information. This should include stakeholder consultation. This could proceed in advance of the development of law and rule changes that

[21] ARENA, viewed 30 November 2018, https://arena.gov.au/projects/agl-virtual-power-plant/

[22] AGL, *Virtual power plant in South Australia: Stage 1 milestone report*, July 2017, p.2.

[23] ARENA/AEMO, Joint response to AEMC Directions Paper Section 5: Wholesale Demand Response, May 2018, p.5.

may be needed for other tools in the regulatory sandbox initiative. This work could commence in the first half of 2019.

- **Possible law and rule changes to facilitate trials**

A new AER regulatory waiver power and new AEMC trial rule making power would require further assessment and development.

The Commission proposes to work with the AER, AEMO, ARENA and ECA and consult with other stakeholders in the first half of 2019 and develop recommendations for a package of possible law and rule changes to the COAG Energy Council in the second half of 2019. This work would be conducted under the 2019 *Electricity networks economic regulatory framework review* where possible.

This process could also consider any necessary law and rule changes to facilitate the provision of more detailed regulatory advice by market bodies if identified as appropriate in the first work stream.

Issues for consultation include the appropriate eligibility criteria and whether regulatory sandbox arrangements should be extended to the regulatory framework for gas.

2.2 (Austria) Energie.Frei.Raum (Energy.Free.Room)

Title of Program or Activity	Energie.Frei.Raum (Energy.Free.Room) – preparation for experimental areas / sandboxes for system implementation of new realization concepts and business models. It is a promotion program that is planned to be established as a preparatory phase for a possible introduction of an "experimentation clause" in order to give companies the possibility to test the systemic implementation of new technologies and market models for system integration of renewable energy sources, storage and energy efficiency technologies.	
Location	Austria	
Main scope of experiment	• Smart electricity grid only • Behind the meter • Integrated and flexible energy systems; system integration of RES	
Main innovation goal	Overall, it is aimed to ensure that research and pilot project results can be feasibly implemented	
Regulatory body	E-Control (Austrian Energy-regulator)	
Implementation Time Period	2019-2025	
Funding Amount (direct and in kind)	Public	5 mio. EUR planned
	Private	n/a
Lead Organization	Federal Ministry for Sustainability and Tourism	
Additional Key Stakeholders/ Organizations	Federal Ministry for Transport, Innovation and Technology, Austrian Research Promotion Agency (FFG), Joint Programming Platform ERA-Net Smart Energy Systems (ERA-Net SES), European Technology and Innovation Platforms Smart Networks for the Energy Transition (ETIP SNET), Companies, research institutions, other non-commercial organizations	
Link to Program's Website/News	**https://mission2030.info/**	
Contact Information	Name	Isabella Plimon, Federal Ministry for Sustainability and Tourism
	Email	isabella.plimon@bmnt.gv.at

Background and Overview

There are no regulatory sandboxes in Austria at the moment. However, within the framework the Austrian Climate and Energy Strategy (#mission2030) a number of flagship projects, including “Energy Research Initiative” have been established. The Strategy was drafted in connection with Austria´s engagement in the global initiative Mission Innovation.

As part of the Austrian Energy Research Initiative, a funding program Energie.Frei.Raum (Energy.Free.Room) to prepare for a subsequent regulatory sandbox is planned to be launched in 2019 by the Federal Ministry for Sustainability and Tourism.

One of the specific objectives of the program is to reduce barriers for the implementation of market models stirring further system integration of RES, storage and energy efficiency technologies.

An adjustment of the regulatory framework to enable the introduction of regulatory innovation zones/sandboxes through an “experimentation clause” in the Austrian legal framework is considered as one of the options. Findings from projects funded in the program Energie.Frei.Raum will help to define the scope of such an experimentation clause. The projects within the program will address new approaches to integrated and flexible energy systems; system integration of RES and storage, new innovative products and technologies and energy efficiency.

■ Innovation goals

The overarching goal consists in developing and identifying best practices for smart, secure, affordable energy and transport systems. Further goals include:

- New technological solutions, products, services;
- New business models;

Possibly upscale from demonstration to large-scale implementation.

■ General program objectives

Austrian research and innovation are focused on the development of key technologies, sector coupling, digital and smart energy and marketable and comprehensive solutions and technology-based services. The Energie.Frei.Raum program’s approach is meant to assist coordination between innovation efforts and development of the regulatory framework.

One of the main added values of the program is - next to the availability of public funding – the use of a methodology, which establishes a concrete process to determine the potential need for and, if deemed necessary, the scope of a regulatory sandbox. For this, it involves all relevant stakeholders, including the Austrian regulator, E-Control throughout the runtime of the program.

■ Main objectives of the program

Evaluate the necessity to establish temporary regulatory innovation zones to allow operators to test new technologies, processes and business models in an innovative legal and regulatory environment ,

Provide subsequent financing and implementation funding schemes for the development of projects through to TRL 9,

- Enable both local innovators and the public to transform current problems into solutions and to help research and innovation unlock their potential by involving future technology customers and users in the development process as test users,
- Eliminate potential barriers to the testing and implementation of innovative approaches in the energy industry and energy and grid technologies,
- Determine whether an regulatory sandbox and/or an experimentation clause in the Austrian legal framework will be needed to enable the above.

■ Operational goals

- Proposals for optimized framework conditions for the flexibilization of the energy system
- Testing of new integration and market models for the integration of renewables, storage and energy efficiency technologies
- Two-step process:
  - Survey of the needs and potential for regulatory sandboxes with the involvement of all relevant stakeholders,
  - Support and implementation of concrete project ideas.

■ Legal basis for experimentation

Funding will be provided with the framework of a yet to be finalized national directive.

(International) SE-Plan Action 4 and its Implementation Plan. Austria adheres to the implementation of Innovation Activity “A4-IA0-4 Regulatory Innovation Zones” of the SET-Plan WG A4 Innovation Plan.

So far, there are not special legal arrangements for pilot projects and showcase regions. An adjustment of the legal framework might be possible in order to include a so-called “experimentation clause” allowing to facilitate the testing of different instruments akin to the SINTEG clause in the German legislation.

■ Key stakeholders and respective roles per the program

- Federal Ministry for Sustainability and Tourism - funding
- FFG (Austrian Research Promotion Agency) – implementation
- Federal Ministry for Transport, Innovation – policy support
- E-Control– energy regulatory oversight
- Research centers, enterprises and various customer groups – project implementation
- European Technology and Innovation Platforms Smart Networks for the Energy Transition (ETIP SNET)
- Joint Programming Platform ERA-Net Smart Energy Systems (ERA-Net SES)

■ **Intended takeaways or expected results**

- Developed methodological approach for determining the need for a regulatory sandbox that can be re-applied on technological innovation progresses
- Outcome-based policy making
- Anticipate future challenges, esp. from technologies and solutions that have not yet been sufficiently studied, tested
- Building trust and ensuring regulatory stability (as a prerequisite for investment incentives)
- Subsequent impact assessment

Policy Instruments, Actors, and Programs

The setting up of a regulatory sandbox in practice requires a multifold approach that considers the current status of innovation and regulation, funding opportunities and potential cooperation on the national and international levels.

More specifically, it is envisaged to:

- build upon the existing innovation programs based on Austrian Energy Showcase Regions and ERA-NET Smart Energy Systems through the Climate and Energy Fund (KLI.EN) and the Austrian Ministry for Transport and Innovation and the Austrian Research Promotion Agency,
- set up a funding program, “Energie.Frei.Raum” in preparation for the experimentation clause as an regulatory sandbox for firms to test systemic implementation of new integration and market models to integrate renewable energy technologies and storage and energy efficiency technologies into the system,
- only then, decide whether a legal framework for regulatory innovation zones needs to be laid down,
- participate in European and international cooperation initiatives such as Mission Innovation, SET Plan,
- use green finance instruments for research and innovation, foster investment into environmental and climate protection (#mission2030, Flagship Project 8),
- apply for funds under European funding and financing schemes (e.g. EU Structural and Innovation Fund (ESIF), EU Innovation Fund) by including projects in corresponding EU programs for the next planning period.

In a strict sense, in Austria, it would be a *techno-regulatory innovation zone* as technological change is “co-optimized” with regulatory change to identity successful solutions and business models but also approaches to stakeholders’ responsibilities, rules and regulation. That said, both types of innovation are given equal priority.

■ **Rationale for regulatory sandboxes & anticipated benefits**

Regulatory sandboxes are expected to:

- Allow to create a framework for and a structured approach to regulatory innovation,
- Collect first experience from different approaches in practice and not only in theory or through simulation,
- Enable both local and regional innovators and the public to transform current problems into solutions and to help research and innovation unlock their potential by involving future technology customers and users in the development process as test users,
- Eliminate potential barriers to the testing and systemic implementation of innovative approaches and market models in the energy industry and energy and grid technologies.
- Better align innovative technological and grid / energy system solutions with innovative regulatory approaches and test the latter dynamically (as opposed to theory first, consequences later).

■ **Challenges/barriers in policy making**

Some of the challenges related to facilitating innovation through regulatory sandboxes are:

- The differences between European, national and sometimes regional requirements, regulatory frameworks and an overall lack of an overarching framework for regulatory sandboxes in the EU.
- A potential implementation of a regulatory sandbox may require an adjustment of the division of tasks between the Federal Government and regional and local authorities to avoid heterogeneity of legal requirements, simplify structures and foster transparent processes.

The process of setting up of regulatory sandboxes is associated with a number of risks that should be accounted for as part of the risk management procedure:

- Risk to create a permissive environment or a regulatory vacuum if an exemption from the current regulation is granted but no feasible alternative is considered.
- Risk of not defining the scope or the temporal limitation of a sandbox from the start: a sandbox is always a preparation phase and not the final goal.
- The best approach could not be identified within the allotted timeframe (e.g. due to insufficient resources to accomplish the activities).
- Technology-neutrality principle: the regulatory approach may disproportionately benefit one stakeholder group or technology over another even if they are not economically viable. As a result, the identified models may not improve economic viability and business models or cannot be transferred to a broader context or to other stakeholder groups.
- The approach might still be localized i.e. not entirely suitable for replicability/fits the local context rather than the European or global one. Should be relevant from the whole system perspective, the whole country Roles and responsibilities of actors involved have not been sufficiently defined.
- The proposed instrument from a regulatory sandbox may conflict with another existing instrument or policy,

- The next steps for the actual implementation of the outcome of a sandbox have not been formalized before the project start or the evaluation criteria/monitoring procedure were not stipulated.

■ Reason for why existing policy instruments fail to achieve what is expected from Regulatory Sandboxes

Existing regulation is a result of historical developments, which creates path dependencies and changes may be very hard and time-consuming to implement. A regulatory sandbox, in contrast, would allow to test regulatory approaches more flexibly and gather evidence of the added value of a proposed adaptation or a new instrument. The existing regulation may also overlook some of the incentives that might be created among energy system stakeholders. There may be barriers, which can be temporarily lifted in a sandbox to analyze the extent to which changes in regulation would, for example, improve the alignment of stakeholders' incentives with energy policy goals. Similarly, new incentive structures can be tested in practice and the consequences preempted before a general adoption or market introduction.

Last but not least, regulatory innovation is particularly valid when dealing with new emerging technologies (e.g. Blockchain) where their effect on system stakeholders and the energy value chain are not well-known or sufficiently tested. In this case, techno-regulatory innovation can help anticipate the need for regulation and design appropriate mechanisms.

■ Targeted benefits for different actor groups

A regulatory sandbox approach could help:

Regulators and policymakers:

- Knowledge exchange between the regulator and project-responsible parties
- test innovative rules and approaches, governance, institutional change, regulation
- test different rules and/or identify and remove specific barriers to observe changes, effects on incentives in a "controlled environment" of a sandbox and to come up with an optimal regulatory mix that then could be expanded further beyond a sandbox once the effect has been tried and tested.
- bridge the gap between business and investment model development on the one hand and policy support in form of regulation, market structures and infrastructure on the other; allow to test different approaches before going into a legislative process and collect relevant evidence from real-life implementation;
- foster investment into innovative technologies and solutions and their implementation;

Consumers: develop new schemes, tariffs, contracts for consumers (new approaches to taxation) and their active participation (e.g. within local energy communities);

Enterprises: improved public and private investment;

Technology providers: Concepts for consumer and producer flexibility and complex stakeholder interactions (consumers, suppliers, system operators) (e.g. uses of

Blockchain) under innovative regulatory conditions; actively participate in the process of testing and shaping regulatory approaches.

Customer groups (Cities, communities, etc.): can be involved at an early stage into the design of future market models and hence are more likely to actively apply innovation RES technologies.

- **How should policy instruments be designed?**

  - (Stakeholder involvement) A regulatory sandbox approach should ideally take profit of an opportunity to actively involve all stakeholder groups, including the regulator, relevant associations, funding agencies, consumer group representatives, technology providers, etc. to obtain a global buy-in.
  - (Funding) sufficient resources through public and private funding needs to be secured beforehand.
  - (EU-level coordination) Cooperation with other countries e.g. on the EU level within the framework of the joint programming platform ERA-NET Smart Energy System, further helps to secure funding and share best practices and, ideally, streamline regulation on the EU level.
  - (KPIs and monitoring) a monitoring procedure needs to be in place before the launch of a regulatory sandbox along with KPIs that the success of an approach or an instrument can be evaluated against.
  - Before setting up a regulatory sandbox it is crucial to assess whether any barriers in current regulation at all exist that would prevent the implementation of a specific solution, technology or model.

References

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https://mission2030.info/wp-content/uploads/2018/10/Klima-Energiestrategie_en.pdf

Mission Innovation Austria, presentation:

https://nachhaltigwirtschaften.at/resources/nw_pdf/mission-innovation-austria-praesentationen-web.pd (in German)

Strategic Energy Technology Plan. Implementation Plan. Temporary Working Group 4 “Increase resilience and security of the energy system (January 2018):

https://nachhaltigwirtschaften.at/en/news/2018/implementation-plan-of-set-plan-action-4.php

2.3 (Germany) Smart Energy Showcases - Digital Agenda for the Energy Transition

Title of Program or Activity	Funding programme "Smart Energy Showcases - Digital Agenda for the Energy Transition" (SINTEG) SINTEG Ordinance	
Location	Germany	
Main scope of experiment	• Smart electricity grid only • Integrated approach/sector coupling, • Energy Storage • Flexibility services for grid stability	
Main innovation goal	• New technological solution, product, service • New business model	
Regulatory body	German Federal Networks Agency	
Implementation Time Period	2017-2020	
Funding Amount (direct and in kind)	Public	The Federal Ministry for Economic Affairs and Energy is providing up to 230 million Euros to the five model regions selected over a time period of four years.
	Private	In total, some 600 million euros is to be invested in the digitalization of the energy sector as part of the funding programme (Federal Government + private sector). How much of this goes to activities under the SINTEG Ordinance is unclear, but it can be expected that this is only a small part.
Lead Organization	German Federal Ministry for Economic Affairs and Energy	
Additional Key Stakeholders/ Organizations	Federal Networks Agency, Project Partners or subcontractors of the 5 SINTEG projects, Organizations that enter into a contractual agreement with the project partners concerning the project activities	
Link to Program's Website/News	**https://www.bmwi.de/Redaktion/EN/Artikel/Energy/sinteg-funding-programme.html**	
Contact Information	Name	Dierk Bauknecht (Öko-Institut)
	Email	D.Bauknecht@oeko.de

Background and Overview

“In order to make it possible for the participants of the SINTEG programme to test new technologies, procedures and business models in practice without facing financial disadvantages, the Federal Ministry for Economic Affairs and Energy has developed a fixed-term ordinance, which provides these participants with room for conducting experiments.

The rules set out under the SINTEG ordinance are not intended to prejudge any future regulation, but rather make it possible to learn from practical tests so that the existing legal framework can be updated.”

Source: https://www.bmwi.de/Redaktion/EN/Artikel/Energy/sinteg-funding-programme.html

The focus is not on solutions that are legally not allowed, but on solutions that are economically not viable, and the objective is to avoid financial disadvantages. Therefore, participants can apply for a retrospective reimbursement and need to be project partners or need to have a contract with project partners

For which situation does the retrospective reimbursement apply:

When?

- In situations when the network operator needs to take measures to manage network constraints and maintain network security
- In situations when the spot market price becomes zero or negative

For which activities?

- End consumers that provide flexibility that result in higher network charges
- Storage and sector coupling: Compensation for fees and levies
- Compensation for renewables that reduce feed-in with additional consumption

Lessons Learned and Next Steps

The SINTEG Ordinance has been applied across the SINTEG projects. The Ordinance is limited to SINTEG participants, and it has been difficult to get new actors on board.

The relevant time periods (negative prices, network constraints) are quite restrictive. It has therefore been difficult to test solutions today for a future system. One important impact has been the learning about how to set up regulatory experiments.

In the meantime, government has broader interest in regulatory sandboxes in the context of the digital agenda, including regulatory experiments (regulatory innovation zones).

One question is how to set up regulatory experiment as a research project in itself, incl. evaluation and generalization of results? This would include testing of new regulation instead of retrospective reimbursement.

2.4 (Italy) Regulatory experiments to promote innovation in the power system in Italy

Title of Program or Activity	Regulatory experiments to promote innovation in the power system in Italy	
Location	Italy	
Main scope of experiments	*First phase: regulatory experiments at zone level* • Smart electricity grids (series of experiments about Smart functionalities for MV networks) • Electric Mobility (series of experiments about different business models for EV recharge) • Energy Storage at Utility-scale and Dynamic Thermal Rating to cope with HV lines congestions due to excess of wind generation *Second phase: regulatory experiments at system level* • Open protocol for interoperable In-Home Devices connected to new smart meters • Flexibility services and Demand	
Main innovation goals	• New functionalities for networks • New incentive regulation for fostering innovation roll-out • New actors in electricity markets	
Regulatory body	ARERA (the Italian National Regulatory Authority for electricity, gas, water and waste management; formerly AEEGSI)	
Implementation Time Period	2010 – 2019, a wide programme through different initiatives	
Funding Amount (direct and in kind)	Public	Regulatory experiments have been mostly funded through network tariffs and the outcomes of the projects have been made fully public, to enable external evaluation and dissemination of best practices
	Private	Market players make their own investments and are partly remunerated limited to some regulatory experiments (Electro-Mobility, DR)
Lead Organization	Italian Energy Regulator	
Additional Key Stakeholders/ Organizations	Network operators (i.e., DSOs and the Italian TSO Terna) and network users (RES/DG producers, residential consumers, EV Charging Point Operators) and third parties, like aggregators and providers of IHDs (In-Home Devices connected beyond the meter)	
Link to Program's Website/News	**www.arera.it/it/operatori/smartgrid.htm** **www.arera.it/it/elettricita/veicoli_ele.htm** **www.terna.it/SistemaElettrico/ProgettiPilotadiaccumulo.aspx** **www.arera.it/it/operatori/smartmetering.htm** **www.terna.it/SistemaElettrico/MercatoElettrico/ProgettiPilotaexdel300201 7REEL/ProgettoPilotaUVAM.aspx**	
Contact Information	Name	Iva Gianinoni (RSE)
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Background and Overview

Following the dramatic increase in renewable-sourced intermittent generation, led by the European-wide objectives on energy efficiency, emission of greenhouse gas and renewable power production, the Italian power system has been hugely impacted.[24] Coping with secure integration of RES and DG, through innovation in network design and management, as well as promoting demand response and aggregation of DER have been among the most urgent areas of concern for the Italian Regulatory Authority (formerly AEEGSI, now ARERA).[25]

The Italian Regulator has a long experience of incentive regulation, for "traditional areas" like quality of service and productive efficiency. The most recent measures in these fields, which were introduced in 2016 and 2018, respectively, are related to a new remuneration scheme with a capital incentive scheme for the metering activity, which in Italy is operated by DSOs, and a new "output-based" scheme for resilience (against extreme events) of the distribution system and for increase of transfer capacity of transmission networks.

Coming to innovation, the Italian Regulator is very active in promoting innovation in the power system and since 2010 has been launching several regulatory experiments for testing in field new technologies, new services and new business models, in the European framework of full electricity market liberalization. The complete overview of the different regulatory experiments fostered by ARERA is sketched in Figure 2.

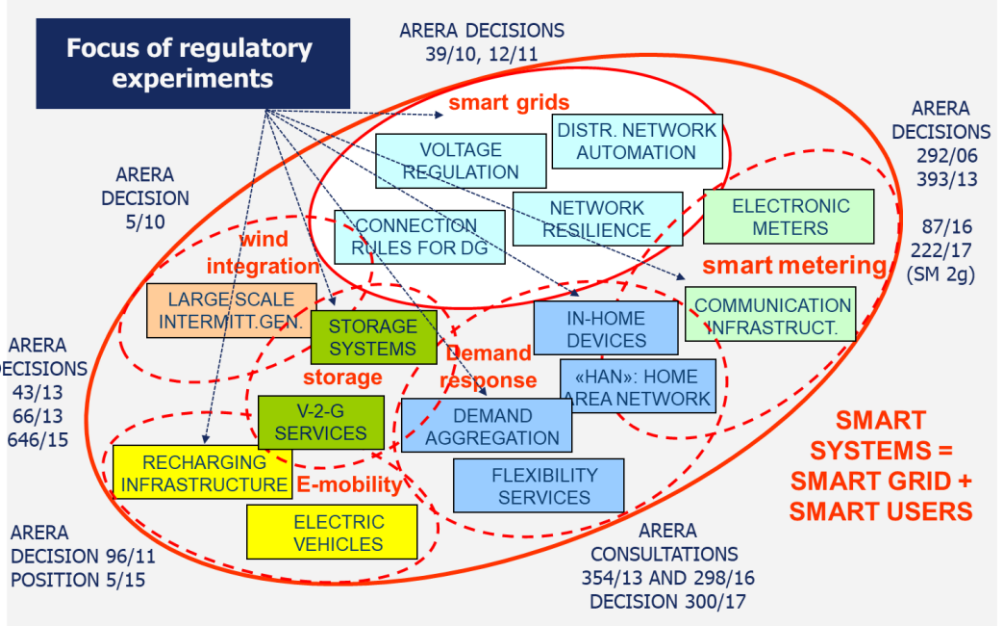

Figure 2: ARERA overall framework for innovation in the power system

The main ideas of the Italian Regulator on innovation in the power system are twofold: first, it must go beyond lab experiments and must be demonstrated in field, in real operating

[24] Just to give a rough idea, the demand peak of the Italian power system is around 60 GW, but in daylight hours of Sundays and holidays demand is about 30 GW. The installed capacity of wind and solar generation units has now reached 30 GW (it was 4 GW only ten yars ago).

[25] ARERA is an independent regulatory authority created under Italian Law No. 481 of 14 November 1995 for the purposes of protecting consumer interests and promoting the competition, efficiency and diffusion of public services with adequate levels of quality as well as cost-reflective and transparent tariffs. Initially limited to electricity and natural gas, the Authority's scope of action has been extended by means of most recent laws to regulation and control of water services, specific functions as regards District Heating and Cooling as well as regulatory and control functions over the waste management cycle, including sorted, urban and related waste (www.arera.it/it/inglese/index.htm)

conditions; second, “smart grids” are not enough, being the crucial point the interaction between networks and system users.

■ General program objectives

All the initiatives taken by ARERA in the current decade are part of a comprehensive programme, whose general objectives are rooted in the recommendations[26] of CEER (the Council of European Energy Regulators), since the Italian NRA is convinced that innovation in regulation is also crucial in order to enable the innovative solutions that are required as a consequence of the new challenges of the power system to meet the goal of sustainability in a cost efficient manner.

Innovative solutions will lead to a more efficient planning and operation of the grid, by means of improved automation and control of network components and end-users’ participation (smart grids). Similarly, demand response requires intelligent systems located at the customer’s site and connected to end-users’ appliances (smart meters). The system needs to offer possibilities for innovative uses of electricity, as in the case of electric mobility. Energy Storage Systems are possible tools to improve the flexibility of the power system. Finally, changes are needed in the Italian electricity market (and in particular in the Dispatching Services Market) taking into account also small and dispersed resources.

■ Scope/dimension and goals of regulatory experiments

The different regulatory experiments cover different scopes / dimensions and different innovation goals and can be grouped in five initiatives:

1. Smart (electricity) grids: advanced solutions and functionalities: new technological solutions, specifically improved automation and control of network components, have been tested in real MVnetworks and in real operational conditions;
2. Utility-scale Energy Storage Systems (ESSs) and Dynamic Thermal Rating for transmission lines: their capacity as new technological solutions to absorb excess power and avoid wind curtailment in off-peak hours should be tested.
3. Electric mobility: integrated approaches/sector coupling applications, such as e-mobility, are emerging, which require innovative services and innovative business models for this new activity.
4. “Chain 2” open protocol for In-Home Devices connected to new smart meters: the direct communication in real time between the smart meter (2nd generation) and interoperable In-Home Devices (IHD) is an innovative solution “behind the meter” to use intelligent systems located at the customer’s site for improving customer awareness and enabling home automation.
5. Flexibility and Demand response: opening the Ancillary Services Market to the participation of both RES and demand units, thanks to aggregation through virtual dispatchable units, is an important innovation step in order to exploit the potential of dispersed resources to the balancing needs of the “new” power system.

■ Key stakeholders and respective roles per the program

The key actor of the whole programme is the Italian Regulatory Authority, which can autonomously proceed to set up regulatory experiments, following the due public procedures.

[26] CEER Position paper on Smart Grids: an ERGEG Conclusions paper. Ref. E10-EQS-38-05, 10 June 2010: https://www.ceer.eu/1279

At the end of the experiments, it is the Authority itself that directly issues the provisions for the regulatory measures to put in place (see below for legal issues). In the different initiatives, responsibility for innovation is with main stakeholders: DSOs, TSO, EV Charging Point Operators (CPOs), market players (RES generation, suppliers and final customers with active demand), aggregators and IHD providers.

- **Project implementation time period**

Initiatives cover the whole decade from 2010 to 2019 and have different timelines:

1. Smart grid: call for demonstration projects launched in 2010; awarded projects selected in 2011, installed and operated 2012-2015; dissemination and lesson learnt in 2014-2015, new incentives rules for large scale roll-out enforced from 2016
2. Storage and DTR: call for demonstration projects launched in 2012, selected in 2013, installed 2014-2015, operated 2016-17, dissemination 2017 to present
3. EV recharge: call for demonstration projects launched in 2010, selected in 2011, installed and operated 2012-2015, dissemination 2016-17
4. Chain 2/IHDs: launched at system level in 2017, operated in 2018, dissemination in 2019
5. Flexibility and DR: call at system level for aggregated units launched in 2017 and renewed in 2018, operated in 2018 to present

- **Legal basis for experimenting and regulatory exemptions**

The whole programme of regulatory experiments has been legally grounded upon regulatory decisions. All regulatory powers are under law n. 481/1995 (institution of the Regulatory Authority for Electricity and Gas). All provisions described here in order to carry out regulatory experiments aim at fostering innovation in the power system and have been set out by ARERA autonomously, always after wide consultation of all stakeholders. In each initiative, a specific regulatory exemption /derogation has been allowed to participants. Details are given in the following section "*Policy Instruments, Actors, and Programs*".

- **Intended takeaways or expected results**

Regulatory experiments are carried out in the interest of consumers and are always based on public calls and consultations. Project outcomes are made fully public, to enable external evaluation and dissemination of best practices. During the application phase respondent projects may be required to present a cost/benefit analysis of the proposed implementation. Details on main results and regulatory outcomes are given in the following section "*Outcomes and Highlights*".

Policy Instruments, Actors, and Programs

As for "smart network" regulation, the Italian experience has been divided in three steps: research, demonstration and deployment of involved smart network technologies/services.

As for research, in Italy a general-interest research program for the energy system is funded through levies on the electricity bills (*Ricerca di Sistema, RdS*) and is carried out by RSE

Ricerca sul Sistema Energetico, ENEA, CNR and other research bodies, including private companies and academics.

When addressing a regulatory issue, at first the Italian regulator commissions a research project to RdS and/or to a University or a research center, which, possibly based on real-field samples of data, identifies the most important characteristics and problems as well as the most important critical parameters and indicators to be asked for in the different initiatives.

Then the demonstration phase is designed around a competitive process, so that only selected demonstration projects would benefit from incentives.

After the positive conclusion of the demonstration, the regulator derives his own thoughts on the matter; “lessons learnt” are outlined in public consultation documents. Then the regulator considers all comments and translates the final shared conclusions into provisions of new regulatory schemes/regimes/incentives (output-based, whenever possible), in order to enable large-scale roll-out of the innovative solutions tested in the demonstration projects.

- **Targeted benefits for different actor groups**

The motivations that guided the different interventions by ARERA through the reported regulatory experiments were described in general in the previous section. More in detail:

1. The main benefit expected from the development and regulation of new Smart Grid functionalities is to increase the “hosting capacity” of the distribution network, thus promoting the integration of RES and DG into the power system. This is mainly beneficial for network operators and RES/DG producers.
2. The exploitation of Energy Storage Systems at utility scale and Dynamic Thermal Rating for transmission lines is expected to reduce wind curtailment and to be beneficial in managing network flows in presence of intermittent sources, thus encouraging to invest both entrepreneurs, such as RES/DG producers, and network operators.
3. In pilot projects about Electric mobility the anticipated benefits were to develop competition of EV charging as much as possible, to kick-start its deployment by both defining roles of actors and business models and suitable electricity network tariffs as well as to integrate e-mobility into the wider transformation of the power system. Main targeted beneficiary is society as a whole, through accelerating decarbonisation of the transport sector, but also providers of EV charging services as well as network operators (that can adopt “smart charging” strategies) will take advantage of this initiative. Policy makers will be able to count on more solid technological bases and a developed marketplace to support EVs rollout.
4. Initiative on smart metering and related innovative functionalities is expected to support suppliers and third parties in identifying new services that can be offered to customers, thanks to the integration between interoperable IHDs and the second generation of smart meters (SM-2G). Over this new communication link (named “Chain 2”) an open communication protocol has been developed for interoperable IHD, and the initiative proved how reliable is communication over this new channel. Further, SM-2G is anticipated that more customized schemes of “Time of Use” prices are enabled (an overall ToU scheme is already in place in Italy and covers around 20 million customers). In parallel, however, also stakeholders of the telecom sector (regulators as well as industrial players) will benefit of the experience gained through this initiative.
5. Opening of the Ancillary Services Market is anticipated to make new distributed resources more and more involved in system balancing, with the possibility of

revenues if their offers are more competitive than ordinary large-scale resources for balancing. Further, the initiative allows to develop a new business actor, i.e. the aggregator of DER (called also “Balancing Service Provider or BSP, that can be a different person from BRP, Balancing Responsible Party).

- **Challenges & barriers in policy making**

Regulation should not only follow, but also encourage innovation; certain regulatory schemes risk to be either too restrictive and discourage investments - and therefore innovation (e.g. price cap) - or too generous, and therefore not favoring the search for targeted "smart" solutions that really provide saving at total cost level (over the whole lifecycle).

In experiments mostly devoted to the user side, one challenge is to identify good regulatory instruments that can support “prosumers” and DG owners to become more active network users.

- **Length of regulatory experiments, exemptions & criteria for selection process**

The length of each regulatory experiment (and therefore of the temporary regulatory measures) is variable according to the complexity of each initiative; it is usually limited to a few years (2 to 4). The different proposals are assessed using several parameters, including qualitative indicators or technical scores attributed by the experts based on the specific requirements of the call, the cost of the project, and one/more indicator specifically designed to capture the benefits of the project, according to a B/C type criterium (i.e., based on the ratio benefits/costs).

The main exemptions/derogations to the ordinary regulation that have been allowed for regulatory experiments are the following:

1. As for Smart (electricity) grids demonstration projects, DSOs were allowed to gain an extra-remuneration on their capital investment for the higher risk embedded in the experiment. On the reverse side, DSOs had to propose demonstration projects with given requirements, among which the most important was that the demo project should be developed in a critical MV network zone, identified through the indicator of Reverse Power-flow Time (RPT[27]), the limit being at least RPT>1% of the year. Only open communication protocols with network users had to be used (i.e. standard EN 61850 was used).
2. As for Energy Storage and Dynamic Thermal Rating initiative, a derogation to the unbundling rules was conceded to the TSO in order to own and operate ESSs, within the size limits of the demonstration projects (210 MWh / 35 MW for energy-intensive storage located in Southern regions with extremely hind wind penetration; 15 MW power-intensive storage in the two major islands for system security issues). On the reverse side, the TSO was mandated to install also DTR applications in the same critical HV network zone where energy-intensive ESSs were built – in order to test the most effective solution to wind congestions. Further, an extra-remuneration on capital investments was envisaged only for storage units able to reach a target level of wind curtailment avoided.[28]
3. As for Electro-mobility demonstration projects, as a derogation from the ordinary

[27] The “Reverse Power-flow Time – RPT” is an indicator of network ‘‘activeness’’, which represents the percentage of time in a year during which power flows from medium to high voltage

[28] With a recent decision, after 2 years of operations, ARERA awarded one out of three storage demonstration projects for extra-remuneration; DTR played a major role in respect of ESS as for actual wind curtailment avoided.

tariff system, a special network tariff structure has been introduced, without fixed costs, applicable only to network points of delivery dedicated to EV recharge in public places. Further, a tariff-funded contribute was awarded to selected demonstration projects, in a non-discriminatory manner between DSOs and independent service providers. On the reverse side, DSOs participating with their own projects should keep separate accounting of recharging assets from distribution assets and should test in field the "multivendor requirement".[29]

4. As for "Chain 2 – interoperable IHDs" initiatives, no derogation was requested, but only a manual anticipation of the future automated procedure for the initial hand-shaking between electricity (LV) smart meters of 2nd generation and interoperable IHDs. The installation of SM-2G is currently ongoing over the whole country by DSOs.
5. As for the most recent initiative on flexibility and Demand Response, important derogations to ordinary regulation of dispatching have been introduced: the minimum threshold for participating in the Ancillary Service Market was relaxed from 10 MVA to 1 MW; renewable-sourced generation units and demand units, so far excluded from the Ancillary Service Market, were allowed, even for sizes smaller than 1 MW, provided that the "virtual" aggregated unit reaches this threshold as a whole; technical requirements were reviewed in order to avoid any barrier, in a fully technology-neutral approach to dispatching products. Market parties can exploit these derogations and participate in the Ancillary Service Market according to ordinary market rules, at their risk.

Outcomes and Highlights

In this section we provide synthetic details on main results and regulatory exemptions for each of the 5 initiatives of regulatory experiments, leaving more room to depict the last initiative, which is still ongoing.

Links to internet URL used for dissemination are also indicated; because these links point to webpages written in Italian, we also add a reference in English for each initiative.

Initiative #1 - Smart (electricity) grids: advanced solutions and functionalities

- **Objective of initiative: To test in real field advanced Smart Grid solutions and functionalities for the management of "active" electricity distribution networks**

Table 2: Details on ARERA Initiative #1

- **Number and year of call:** Regulatory Decision ARG/elt 39/10 (2010)
- **Applications submitted:** 8 DSOs applied proposing 9 pilot projects (Regulatory Decision ARG/elt 12/11 (2010)
- **Number of projects funded:** 8 projects (from 7 DSOs) passed the selection phase, but 1 was aborted during the early stage, so 7 projects completed the demonstration phase
- **Types of smart functionalities:** 6 main innovative functionalities have been trialed (among all demonstration projects): 1) observability of active resources connected to MV networks; 2) advanced voltage regulation; 3) active power modulation; 4) anti-islanding; 5) fast fault isolation in MV networks; 6) electricity storage at MV level.

[29] It is important to remind that EV-recharge initiative was launched before the European Directive 2014/94/UE was published. After the transposition of the EU directive in the Italian law in 2016, DSOs are no longer allowed to invest and operate recharging points; this activity can be carried out only by independent service providers, within a competition frame (see recitals 29-30 of the Directive 2014/94/UE).

- **Types of key actors/organizations:** DSOs
- **Funding volume:** DSOs investment around 15.5 Million euro (recovered through network tariff)
- **Derogations:** extra remuneration of capital cost (a +2% in addition to the ordinary return rate) for a period of 12 years
- **Obligations for grid operators:** demonstration projects had to be realized in critical MV network zone, with RPT >1% on a yearly basis; only open communication protocols could be used for communication between DSOs and network users
- **Main results:** a relevant increase in hosting capacity has been demonstrated, even at the first level of complexity tested (i.e., only through automatic regulation of MV setpoint at PS busbars, without direct communication with DG: see Figure 3).
- **Dissemination:** www.arera.it/it/operatori/smartgrid.htm
- **Outcomes:** Two out of the six smart functionalities trialed (observability of distribution systems, i.e., power flows and state of distributed resources, and ability to regulate the voltage profile of MV networks) were identified after consultation as the most promising in the short term and worth of specific "output based" regulatory incentives for roll-out on a large scale[30]
- **References:** M. Delfanti, V. Olivieri, S. Larzeni and L. Lo Schiavo: "*Regulatory Incentive Mechanisms for Promoting Investments in Smart Distribution System in Italy*" – CIRED Workshop, Helsinki (Finland), 14-15 June 2016, paper n. 0473

	Caso Base		Programma P3			Programma P3 + IRE		
Linea	Limite termico [MW]	Limite tensione [MW]	Limite termico [MW]	Limite tensione [MW]	Aumento rispetto caso base (%)	Limite tensione [MW]	Limite termico [MW]	Aumento rispetto caso base (%)
Carpinone	7.402	-	7.402	-	0%	-	-	0%
Sessano	7.647	-	7.647	-	0%	-	-	0%
Colle Breccione	11.594	-	11.594	-	0%	-	-	0%
Pesche	-	7.258	8.658	8.658	19%	8.658	8.658	19%
Pescolanciano	-	7.624	8.233	8.233	8%	8.233	8.233	8%
Fontecurelli	-	3.296	-	4.406	34%	4.623	4.623	40%
Polverone	-	4.519	-	5.365	19%	5.431	5.431	20%
Pescorvara	4.386	-	4.386	-	0%	-	-	0%
S. Domenico	-	4.164	-	5.023	21%	5.512	5.512	32%
Santa Maria	-	5.049	-	5.232	4%	5.532	5.532	10%
TOTALE [MW]	-	31.91	-	36.91	16%	37.989	-	19%

«**Caso Base**»: without any smart functionality

«**Programma P3**»: first level of complexity (*no communication* with DG)

«**Programma P3+IRE**»: highest level of complexity (*with communication* with DG)

A relevant benefit can be extracted even at less complex levels

Figure 3: Results of Smart Grid pilot projects: hosting capacity increase

Initiative #2 - Utility-scale Energy Storage Systems (ESSs) and Dynamic Thermal Rating for transmission lines

- **Objective of initiative: Operation of utility-scale Battery Energy Storage Systems by the Italian TSO for mitigating curtailment of wind-sourced generation units**

[30] "Output-based" incentives are the regulatory mechanisms more suitable for large-scale roll-out, differently from "input-based" incentives, which had been used for the demonstration phase in the absence of consolidated metrics. In this case output based incentives are granted on the basis of "smartened MW" in areas where the selectivity requirement is fulfilled, and are therefore related to the output of DSO activity; indeed, input incentives used for the demonstration phase were simply an addition to the WACC for the investment done in each selected project, i.e. related to an input (capital) and not to the actual results of DSO activity.

Table 3: Details on ARERA Initiative #2

- **Year of launch:** Regulatory decision 288/2012 (2012)
- **Number of Applications submitted and of projects funded:** 3 “energy-intensive” storage sites (each with 2 twin units) in critical HV network zones (Regulatory decision n.66/2013); moreover, 2 “power-intensive” storage sites in major islands (Regulatory decision n.43/2013)
- **Types of projects:** Energy intensive storage units, corresponding to installed power of 35 MW / 210 MWh (charge/discharge duration: 7 hours), all using the same storage technology, i.e. NaS batteries. Power intensive storage units: several technologies, charge/discharge duration up to 1 hours
- **Types of key actors/organizations:** TERNA (Italian TSO). Manufacturers of Battery Energy Storage Systems
- **Funding volume:** TSO investment around 160 Million euro (recovered through network tariff)
- **Derogations:** The TSO was exceptionally allowed to own and operate storage units; extra remuneration of capital cost (a +2% in addition to the ordinary return rate) is foreseen for a period of 12 years, under condition that a given target of wind curtailment is avoided
- **Obligations** for the TSO: demonstration projects had to be carried out in critical HV network zones, with wind curtailment in action. Installation of Dynamic Thermal Rating in the same HV network zone was mandatory, in order to test the most effective solution to cope with HV line congestion
- **Main results**: Although storage units have several capabilities, the operation of TSO-owned storage was aimed for a specific network service (i.e. avoiding curtailment of wind-sourced generation units). Considering only time-shift effects the benefit/cost ratio was very low (see Figure 4a). For other services, storage units should be operated by market players, in a competitive framework
- **Dissemination**: www.terna.it/SistemaElettrico/ProgettiPilotadiaccumulo.aspx
- **Outcomes**: The TSO is no longer allowed to own and istall storage units. DTR proved to be much more effective for the purpose of reducing wind curtailment than storage (see figure 4b with data of first year of full operation – 2016)
- **References**: L. Lo Schiavo and M. Benini, *Pilot projects on Battery Energy Storage Systems in the Transmission grid: regulatory framework and first results*, AEIT International Conference, Bari 2018, Proceedings ISBN 978-8-8872-3740-5T

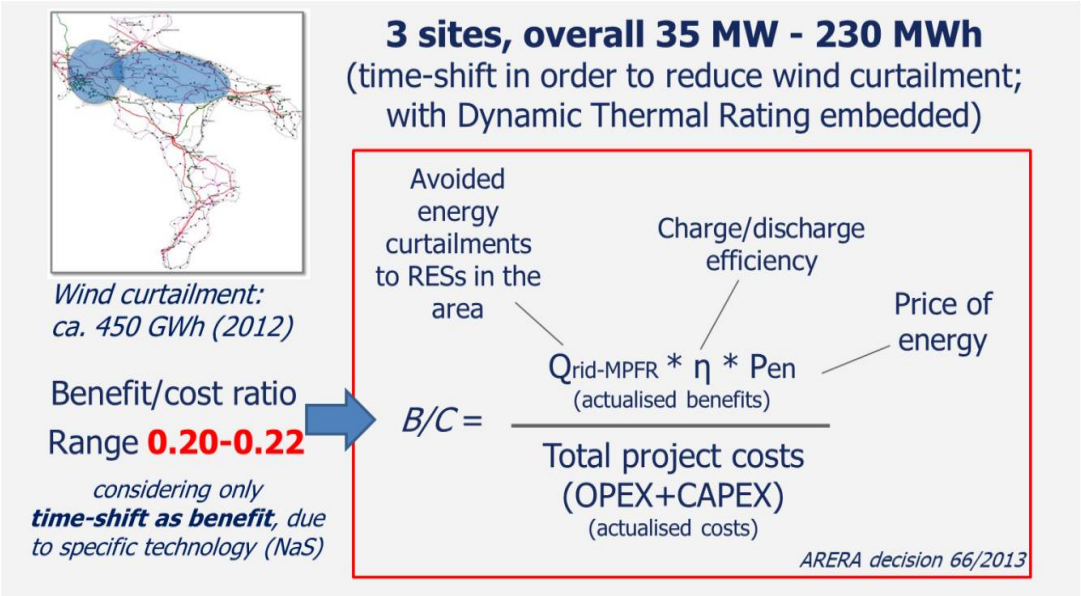

Figure 4a: CBA for pilot projects of energy storage system

Results of first year of full operations (2016)

Parameter	Value
Technology most suited for time-shift	**NaS** (*)
Capacity [MW] / [MWh]	35 MW / 230 MWh
Investment	≈160 M€ (**)
Wind curtailment avoided	66.8 GWh/y
- due to Storage	17.7 GWh/y
- due to DynamicThermal Rating	49.1 GWh/y
Average availability (including tests)	81.5%
Overall energy efficiency (avg 1 year)	50.7%

(*) operating range of temperature: 305-350 °C (**) DTR investment costs: <1 M€

Full report publicly available (in Italian) for dissemination
https://www.terna.it/it-it/sistemaelettrico/progettipilotadiaccumulo.aspx

Figure 4b: Results of pilot projects of energy storage system (1st year of operation)

Initiative #3 - EV recharge pilot projects

- **Objective of initiative: To test and evaluate different business models for charging of Electric Vehicles in public places**

Table 4: Details on ARERA Initiative #3

- **Year of launch:** Regulatory decision ARG/elt 242/10 (2010)
- **Number of application received:** 10 proposals were submitted and evaluated (Regulatory decision ARG/elt 96/11).
- **Number of projects funded:** 5 projects were selected and 4 were carried out.
- **Types of projects:** Main aim of the demonstration projects was the in-field test of different business models for EV charging activity: 1 project was based on the business model of DSO, 2 on the model of Charging Service Provider (CSP) in competition, 1 on the model of competitive CSP
- **Types of key actors/organizations:** Charging Service Providers (CSPs); DSOs
- **Funding volume:** Investment in charging stations amount to around 2 Million euro, covered through a special grant. Typically, mono-technology AC 3 kW and 22 kW charging stations, with a single socket or two sockets (and two standards) were installed, while no high-power dual technology (AC or DC) station was installed
- **Derogations:** A special network tariff, with no fixed part, has been introduced for points of delivery dedicated to EV recharge in public places
- **Obligations:** DSOs participated to this initiative under an unbundling constraint and with a "multi-vendor" requirement
- **Main results:** The multivendor requirement proved to be too complex. Localization of charging points confirmed to be most crucial decision (see Figure 5)
- **Dissemination:** www.arera.it/it/elettricita/veicoli_ele.htm
- **Outcomes:** The DSO-based business model is no longer available. The special tariff for points of delivery dedicated to EV recharge in public places is still enforced in order to favur the kick-off of electro-mobility
- **References:** L. Lo Schiavo, Bonafede D., Celaschi S., Colzi F., "*Regulatory issues in the development of electro-mobility services: lessons learned from the Italian experience*" 1st e-mobility Power System Integration Symposium, Berlin 23 Oct. 2017

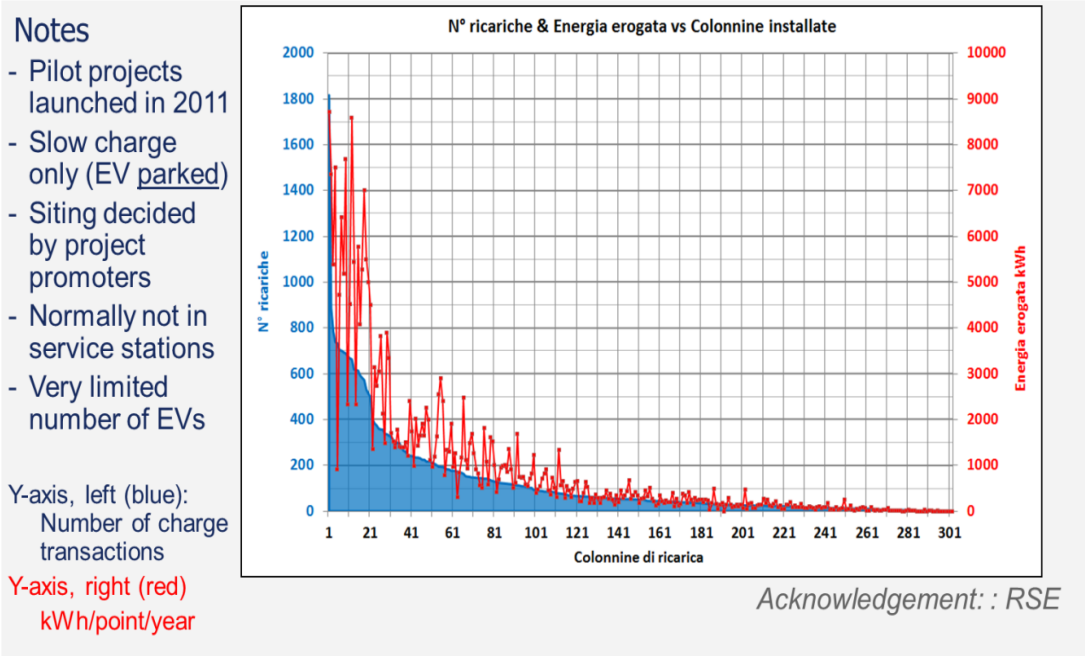

Figure 5: Results of EV recharge pilot projects: relevance of localization of charging points

Initiative #4 - "Chain 2" performance in 2nd generation of Smart metering

- **Objective of call:** ***Tests of "Chain 2" Communication performance between 2nd generation Smart Meters and interoperable In-Home Devices***

Table 5: Details on ARERA Initiative #4

- **Year of launch:** Decision 222/2017/R/eel (2017)
- **Project:** 1 nation-wide trial, open to several providers of IHDs and associated services
- **Types of projects:** Monitoring of the performance of "Chain 2" communication in second generation (2G) Smart Meters
- **Types of key actors/organizations:** DSOs and IHD manufacturers
- **Funding volume:** No funding has been necessary; each party covered its own costs without any extrafunding. No extra funding was required on top of ordinary tariff for DSOs nor payment towards IHDs manufacturers
- **Types of key actors/organizations:** DSOs and IHDs providers (or IHD-based service providers)
- **Derogations:** No derogation was requested, but only a manual anticipation of the future automated procedure for initial hand-shaking between electricity (LV) smart meters of 2nd generation and interoperable IHDs
- **Obligations:** Each market party participating in the survey had to collect automatically data on messages received by IHds from smart meters; DSOs had to collect data on messages sent by each smart meter coupled with IHD; a platform has been implemented and managed by RSE as independent party to assess actual performance level of Chain 2
- **Main results:** The communication has been implemented through Power Line Carrier (PLC, band C Cenelec) and extremely satisfying results have been achieved[31] (first results have been published in the ARERA consultation paper n. 245/2018)
- **Dissemination:** www.e-distribuzione.it/it/open-meter/chain-2.html
- **Outcomes:** The initiative has allowed to confirm the effectiveness of the open communication

[31] As for real-time messages (latency: 1 second), the average success rate for communication from smart meter to IHD (end-to-end, through PLC) was 98.7% and 95% of cases had a success rate better than 97.2% (i.e., 2,8% of messages were lost).

protocol, which can be used by market parties to enrich their offers. Therefore, since 2019 the innovation has been released to all customers equipped with 2G electricity meters (roll-out is ongoing)

- **References:** *(forthcoming)* A. Pitì *et alii,* Smart Metering 2.0 Enhancing A New Customer Experience,CIRED 2019, Madrid, paper n. 1775

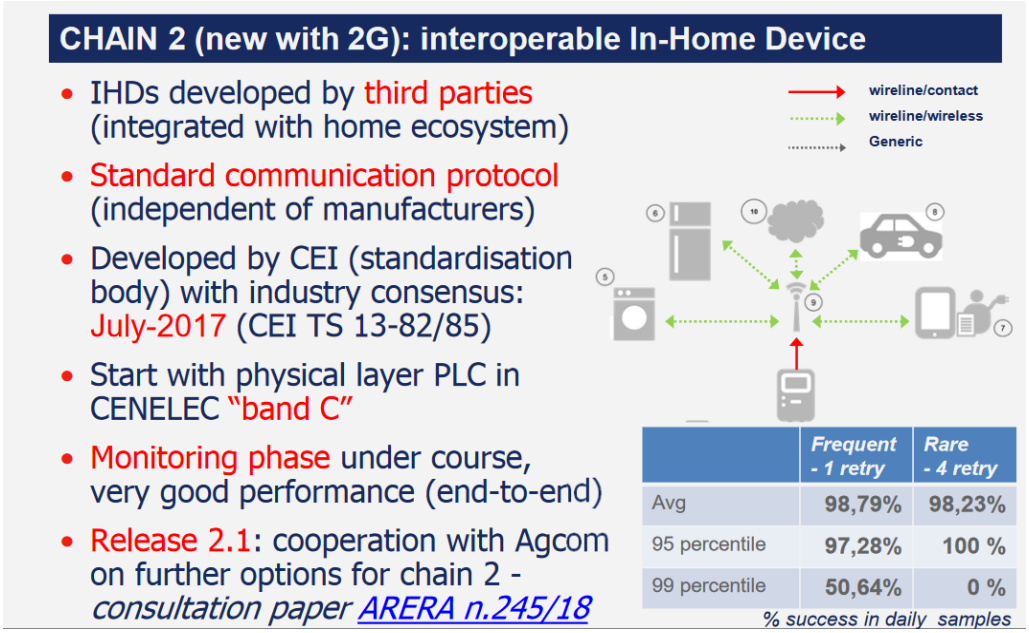

Figure 6: Specifications and results of pilot projects on "Chain 2" Communication in 2G SM

Initiative #5: Flexibility and Demand Response through aggregation

- **Objective of call: Opening of the Ancillary Services Market (MSD) to new resources through aggregation of renewables and distributed generation units as well as active demand units**

The standard regulatory framework for the Italian electricity market was designed more than 10 years ago, when renewable production was negligible (but traditional hydro plants), storage devices (other than hydro pumping storage plants) were only a theoretical issue and Demand Response was at its beginning. During the last decade, considering the new needs of the electricity market, some improvements in regulation have been implemented, including more intraday markets sessions, provisions concerning real time curtailment of renewable production - in particular also a specific compensation for wind production - and new regulation for storage devices, considering them equivalent to production units.

In the meanwhile, ARERA started evaluating the possibility of a complete review of the regulation of dispatching market, in order to exploit the flexibility resources provided by the development in control technology for renewable production and by the continuous improvement in Demand Response performance. In 2013 the integration of renewables within the Ancillary Service Market (MSD: *Mercato dei servizi di dispacciamento*) for downward regulation was suggested for the first time, but no implementation effectively followed; moreover, the possibility to insert consumption units in the balancing market have been studied for years. Different stakeholders aiming at developing Demand Response services have been heard too. Finally, in 2017 a decision was issued by ARERA, addressing

a regulatory experiment initiative that was split in several calls, each aimed at testing the performance of new aggregation of resources within the dispatching market.

Key concept of the new environment is the "Virtual Dispatchable Unit" (UVA, *Unità Virtuale Abilitata*), i.e. an aggregation of "not relevant"[32] production and consumption units matching some requirements, concerning: the minimum regulating power; the location of the units in the same geographical perimeter; the real time information to be provided to the Italian Transmission System Operator (Terna) by the BSP - Balancing Service Party responsible for the aggregate; the possibility that the BSP is a different entity than the BRP (Balancing Responsible Party, i.e., the market participant); the binding programs of the concerned BRPs. Not relevant units can be offered in aggregates referred to each bidding zone. Derogating from the standard regulatory framework, in the experiments DER aggregation is enabled, the minimum threshold for flexibility AS markets is lowered, the settlement of the UVA is based on the remuneration of the effectively delivered resource.

"Virtual Dispatchable Units for Consumption" (UVACs), "Virtual Dispatchable Units for Production" (UVAPs) as well as "Mixed Virtual Dispatchable Units" (UVAMs), as described in Table 5, have been considered in the experiments.

ARERA decision also foresees demo projects related to "relevant" units, and in particular the possibility for them to take part in MSD to provide specific resources.

- **Overall objectives of projects**

In all projects Terna is trying to test different solutions in terms of settlement of the activated resources, fees in case of not delivery and settlement of imbalances.

- **Outcomes and impacts of projects**

Projects have been running for about one and a half year: the experience is not wide, nonetheless some interesting elements have been collected.

Most UVACs are composed by loads associated to local generation, which simply provide upward regulation. Therefore, for the future the distinction between UVAC and UVAP will be cancelled in order to allow only UVAM ("Mixed Virtual Dispatchable Units"): in fact, if also in the UVAC most regulation is managed by activating local generation, it is useless to distinguish between different virtual units.

As for UVACs, in Summer 2017 TERNA expected a scarcity of upward resources due to both high temperatures and low hydro levels (as a consequence of a dry winter season with reduced snowfall): the upward resources provided by UVACs were therefore really welcome. In order to incentivize their development, a specific capacity remuneration was granted to each UVAC, against the obligation to submit upward bids in the most critical hours (usually afternoon and early evening to cope with the summer peak load); the same mechanism was repeated also in 2018 winter and summer months. The granted capacity remuneration got its scope: up to July 2018 UVACs for about 420 MW were activated. For UVAPs no specific capacity remuneration was provided: the development of such technology therefore resulted to be slower than the UVAC and up to July 2018 about 94 MW were activated.

[32] A unit is deemed "relevant" when its injection or withdrawal has a significant impact on electricity system operation, both in terms of balancing and congestion purposes.

The experiments showed that, in order to activate a virtual unit, a BSP incurs in significant investment costs associated to the IT infrastructure and the control room to provide communication with each unit as well as with TERNA centralized dispatching and monitoring center. The introduction of a capacity remuneration for all UVAMs (including the already activated UVACs and UVAPs that evolve towards the UVAM approach) for a limited period seems to be the most suitable solution, since it does not imply a permanent balancing capacity remuneration. For this reason, ARERA decided to introduce a capacity remuneration for all UVAMs for a limited period of two years.

ARERA is carefully monitoring the situation since an active participation of large loads also in wholesale market in the future is of utmost importance. The participation of Demand Response to the future capacity market may constitute a significant step forward, but a revision of criteria for participating in wholesale market might be considered too.

Table 6: Details on ARERA Initiative #5

- **Year of launch:** Decision 300/2017 (2017)
- **Number of calls:** The Italian TSO Terna has already launched different calls, after approval of regulatory exemptions and obligations for each call
- **Sequence of calls:**
  - The first call was launched by Terna in Summer 2017 and concerned “Virtual Dispatchable Units for Consumption” (UVACs). UVACs are aggregated composed only by consumption units and may include also local production units, when coupled with the industrial process or used for self-production.
  - The second call was launched by Terna in Autumn 2017 and concerned “Virtual Dispatchable Units for Production” (UVAPs) involving all the “not relevant” production units, either programmable or not programmable.
  - The third call was launched by Terna in Spring 2018 about “Relevant units powered by renewables sources”: the goal is to allow large wind and run of river generation units to take part in the Ancillary Service Market, providing some specific services, above all balancing resources.
  - The fourth call was launched by Terna in October 2018 and concerned “Mixed Virtual Dispatchable Units” (UVAMs), involving both generation (including RES) and consumption units, representing the natural evolution of UVACs and UVAPs. Also, storage units and V2G units can be part of UVAMs. A fifth call is expected during 2019 for storage units for extremely fast response service (this product is not yet requested in the Ancillary Service Market).
- **Types of key actors/organizations:** TERNA (Italian TSO), Balancing Services Parties BSPs, Balancing Responsible Parties BRPs.
- **Funding volume:** UVACs and UVAMs have been allowed for a specific capacity remuneration (30 k€/MW), in addition to remunerating the effectively delivered resource; these costs are under evaluation and are covered through the final dispatching tariff (uplift).
- **Derogations:** The most important derogations allowed by the Regulator are the following:
  - the minimum threshold for participating in the Ancillary Service Market was relaxed from 10 MVA to 1 MW;
  - renewable-sourced generation units and demand units, so far excluded from Ancillary Service markets, were allowed, even for size smaller than 1 MW, provided that the “virtual” aggregated unit reaches this threshold as a whole;
  - some technical requirements were reviewed in order to avoid any barrier, in a fully technology-neutral approach to dispatching products;
  - a capacity remuneration mechanism has been introduced (this is not allowed to “ordinary” dispatchable units, i.e., large generation plants with size > 10 MVA that are not renewable sourced);
  - the possibility that the BSP is a different entity than the BRP is foreseen.
- **Obligations:** Aggregators have the same obligations of real time monitoring as ordinary

dispatchable units on the whole aggregate

- **Main results:** Under evaluation; so far the reliability of aggregated resources is around 80%
- **Outcomes:** The expected outcome of the whole initiative is to review the whole regulatory framework for dispatching, enlarging the participation of DERs to Ancillary Service Market, after regulatory experiments.
- **References:** A. Galliani, M. Pasquadibisceglie, *"A new concept for Italian dispatching market: regulatory decision 300/2017"* AEIT International Conference, Bari 2018, Proceedings ISBN 978-8-8872-3740-5

Lessons Learned and Next Steps

Fostering innovation in the power system has been one of the most important activity of the Italian Regulator, in order to cope with the huge impact of renewable-sourced generation, with wind and solar installed capacity grown from 4 GW to 30 GW in less than a decade.

In a first phase, the regulatory focus was on the selection of pilot projects in given critical spots of the network, which were selected for their criticality, and an approach focused on critical zones was adopted, in order to experiment in real field conditions Smart grids, large-size Storage units and EV charging stations. In this first phase the Regulator launched several initiatives and for each initiative selected a few demonstration projects among the proposals (presented by DSOs, TSO and CPOs, respectively), identifying the most promising ones according to an assessment of benefits and costs. For each initiative, a special remuneration was granted to selected projects (as a derogation of ordinary WACC for DSO and TSO, and via a direct grant for CPOs) and in turn public dissemination of results was mandatory. In the case of Smart grids projects, lesson learnt have been extracted by the Regulator and discussed in a public consultation (consultation paper 255/2015), which summarized the results of the pilot projects in six innovative functionalities, which had been the object of experimentation. After public consultation, the Regulator consolidated the results of the experiments with "output-based incentives" for the roll-out on wide scale at system level: two of these functionalities were identified as most promising in the short term, and worth of specific incentives, because they were not yet promoted by existing incentive regulatory mechanisms, for instance for quality of service.

In a second phase, the Regulator moved towards innovation at system level. This approach proved to be necessary for involving market parties, in a fully non-discriminatory manner. The two most recent cases of "initiatives at system innovation level" are about: (i) the introduction of interoperable In-Home Devices (IHDs) that can dialogue with smart meters thanks to a fully open communication protocol, developed by the Italian standardization body (CEI) with industry consensus; and (ii) the introduction of aggregation of dispersed resources, including renewables and active demand, for enhancing flexibility services within the Ancillary Service Market. It is important to note that in both cases a major role has been played by relevant grid operators (i.e. DSOs for interoperable IHDs and TSO for flexibility services), in order to ensure a single regulatory framework, and that a fully open market procedure has been followed, in order to avoid any discrimination. Regulatory exemptions have resulted to be crucial especially for flexibility services, since the current regulatory framework limits the participation to the Ancillary Service Market only to "Relevant Units" and only above a rather high capacity threshold: both these constraints have been released for

the experiments of aggregation of small-size resources previously not admitted to ASM, like renewables and Demand Response

The following table provides an overall view of both first and second phases.

Table 7: Summary of ARERA's initiatives for innovation in the power system

	Activity	Who	Timeline	Pilots or calls	Size (total)	Cost (*)
INITIATIVES AT CRITICAL ZONES LEVEL	Distribution	DSOs	2011-15	7 projects for smart grids	8 primary substations	Around 15 M€
	Electric vehicle recharge	CPOs	2011-15	4 projects in different business models	Around 500 charging points	Around 2 M€
	Storage	TSO	2014-17	6 storage units	35 MW, 210 MWh	Around 155 M€
INITIATIVES AT SYSTEM INNOVATION LEVEL	Metering	IHD-providers; DSO	2017-18	7 IHD's providers	Around 100 final customers	No public investment
	Dispatching (flexibility services and aggregation)	AD, DG, BSP; TSO	2017- now	Several calls for BSPs	170 MW (AD) 66 MW (DG)	Under evaluation

(*) Note: only impact on tariffs is indicated in costs (private investments are not assessed)

Legend:

- *DSOs: Distribution System Operators*
- *CPOs: Charging point operators*
- *TSO: Transmission System Operator*
- *IHDs: In-Home Devices*
- *BSPs: Balancing Service Providers (aggregators)*
- *AD: active demand*
- *DG: distributed generation*

■ Results, positive/qualitative/factual impacts

As already mentioned, some experiments have been effective in identifying regulatory mechanisms that are suitable for large-scale roll-out of the tested innovative functionalities. In other cases, such as storage, field experiments were useful to publicly show effective performance of storage units (in a context of extremely high wind-sourced generation) and proved that actual energy efficiency in real conditions is much lower than nominal efficiency (due to wind unpredictable variations and storage size as well as State of Charge constraints).

In addition, the innovation programme of the Energy Regulatory Authority has been the occasion to launch a new and rather original cooperation among regulatory authorities, especially with the Telecom Regulatory Authority (AGCOM), which is exploring the benefits of Internet of Things and Machine-to-Machine communication services.

- **Did the sandbox programme practically help close the gap, speeding-up market uptake as well as technology implementation?**

In general, after the ten-year experience in regulatory experiments, it can be concluded that the approach of the Italian Regulator has been successful until now in promoting innovation in the power system. In some of the most mature initiatives it has been also possible to adapt regulation to the new challenges and requirements of the power system (from the technological point of view in the case of SG functionalities, also in business models in the case of EV charging). The most recent initiatives "at system innovation level" (such as IHD related business and Flexibility/Demand response for Ancillary Services) are more directly concerned with markets and, in addition to yielding results that are guiding innovation in several fields, are also preparing the ground for subsequent regulatory schemes and decisions as well as for opportunities for new market parties.

The "sandbox" approach could be useful for smaller experiments, in order to test proofs-of-concept especially in the areas of innovations on the retail market side (self-consumption schemes, peer-to-peer platforms, new "citizen energy communities" and so forth). The recent consultation on the strategic plan of ARERA (consultation paper n. 139/2019) foresees the implementation of sandboxes as a new tool for fostering innovation on the market side; however, the implementation path shall be consistent with the regulatory policy of both non-discrimination among market players and neutrality towards different technologies.

The most recent initiative for enhancing flexibility and DR services can be considered to be designed as a sandbox programme, in the sense that a central party (TSO) plays an important role, defining exemptions to current dispatching rules that must be approved by the Regulator and selecting market parties interested in experimenting innovation. It is important to highlight that (like in all previous initiatives) a fully open market procedure is being followed by ARERA, in order to avoid any discrimination. The experiments intend to test in field the real "firmness" of dispersed resources in providing flexibility services.

- **Pros and cons with different initiatives and calls**

In the frame of the whole period 2010-19, several initiatives and calls have been launched, as described in the previous sections. In some cases, network operators have been requested to submit proposals for pilot projects (smart grids, storage, EV recharge business models). Market players have been directly involved in other cases more recently (SM 2G Chain-2 and DR/Flexibility Resources in Ancillary Service Market), in which network operators act as neutral facilitators only (e.g. DSOs for IHDs communication with smart meters; TSO for DR and flexibility in ASM) .

The two kinds of experiments are different and require to be treated with different tools. For instance, incentives can be used only for network operators, who are in turn obliged to fully disseminate results, while for market players a non-distortive approach implies that exemptions cannot be granted only to a few parties but have to be ensured to all interested market parties.

- **How might it be replicated or what would be needed to change?**

Some features are absolutely important in all initiatives and calls, for instance the requirement to use only fully open communication standards between network operators and

market players for real-time communication as well as to disseminate results. However, each initiative/call has its own peculiarities and therefore must be conceived and managed taking into consideration specificities accurately.

- **What is the best time frame for the regulatory exceptions? Are there any risks that the time is too long or too short?**

The whole process from experimentation to final regulation requires anyway quite a lot of time, in order to identify sound shared solutions. Moreover, pilot projects test a prototypal solution and often over a period of 2-3 years technological solutions change, so that at the end of the pilot new opportunities are available. In general, the Italian Regulatory Authority suggests not to exceed 3 years for each trial, although in a few cases shorter time frames are admissible.

2.5 (The Netherlands) Experimental projects in the Dutch energy legislation

Title of Program or Activity	Experimental projects in the Dutch energy legislation (Experimenten Elektriciteitswet/ experiments Electricity Act))	
Location	The Netherlands	
Main scope of experiment	The projects can ask for exemption of specific articles within the electricity legislation for: Electricity supply, Production and distribution in local communities, The Smart electricity grid only, Integrated approach/sector coupling, Energy Storage, New Flexibility services for grid stability in a house or a residential area. (Prerequisite) It must be local, renewable or CHP	
Main innovation goal	The main goal is to see with the experiments if the Electricity Act 1998 has to be made fit for future solutions for the energy transition in the Netherlands. This can be found in solutions like new technological solutions, new products or services or a new tariff-model and matching supply and demand. After 4 years, the government will evaluate the outcome and lessons learned from the projects to see whether a legislation change is needed for a wider range of users. The project can continue as they where they were set up	
Regulatory body	The Ministry of Economic Affairs and Climate change makes the legislation on energy. RVO is executing the experiments scheme. The Electricity Act 1998 provides the legal basis for experiments. Further rules are laid down in a general administrative regulation	
Implementation Time Period	This programme was open from 2015-2018 and resulted in 17 approvals for experiments. In 2019 a new legislation for a new programme is expected to be launched that will be open to all market players (e.g. suppliers, system operators, new players like aggregators, energy communities) and not only for electricity but also for natural gas. The ministry is now working on a new approved version that will start later in 2019.	
Funding Amount (direct and in kind)	Public	No funding is involved. Only extra space/ exemptions within the legislation (electricity law) for a specific project and a specific time. No exemptions on energy taxes.
	Private	If innovation is necessary technical funding is possible from other innovation programmes.
Lead Organization	Ministry of EZK and RVO.nl	
Additional Key Stakeholders/ Organizations	The 17 experiments now in progress. DSO's, regulatory body ACM	
Link to Program's Website/News	**https://www.rvo.nl/subsidies-regelingen/experimenten-elektriciteitswet (in Dutch only).**	
Contact Information	Name	Erik Ten Elshof en Jan Luuk de Ridder (EZK) Nicole Kerkhof, Johannes van Steenis and Wido van Heemstra (RVO.nl)
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Background and Overview

In the Netherlands there are innovation programmes on smart grids (SG) and smart energy systems (SES) since the beginning of 2000. These projects are working on new innovations. The regulation is based on central supply and decentral use. With SG and SES this changes and ask for new solutions also in the regulatory field.

In 2015 started the programme with experiments with exemptions in the legislation. The programme is now closed and 17 projects are approved. The programme was set up as follows:

Two types of projects are eligible for exemption:

1. **'Large' Experiment:** the waiver holder (a cooperative association – who gets the dispensation) - in consultation with a regional grid operator (DSO) - carries out the 'large' experiment in the DSO-grid with a maximum of 10,000 customers - mainly consumers – who use the electricity. In this 'large' experiment the waiver holder can combine renewable electricity production/ CHP, supply to the consumers and set their own tariffs. By matching supply and demand they can try to reduce the necessary grid capacity. The regional grid operator will continue to fulfill the other independent statutory tasks relating to grid management in 'large' experiments.
2. **Project Network:** a joint network of up to 500 customers with only one connection to the grid of a network operator (DSO). In a project network, the waver holder may combine production, supply and management of the local electricity grid. (compared to a big experiment they can also operate a local electricity grid).

Duration of exemption: An exemption from a number of provisions in that law makes it possible to deviate from the Electricity Act. This exemption has generally a duration of 10 years.

Goal: This regulation must make clear to what extent the experiments actually lead to more sustainable electricity at local level and electricity from CHP cogeneration at local level, more efficient use of the available energy infrastructure and more involvement of electricity users in their energy supply. Also it must make clear which changes in the Electricity Act are necessary for a successful energy transition.

Policy Instruments, Actors, and Programs

- **Setting up a Regulatory Sandbox in practice**

Legislation: EZK incorporates possibilities within the legal framework of the Electricity ACT 1998 and a general administrative regulation.

Execution by RVO: Information meetings, community of practices, DSO meetings, eligibility checks of applications, progress control, meetings with candidate projects; control by the regulator of the method of tariff calculation.

- **Rationale for regulatory sandboxes & anticipated benefits**

Experience with local production and use of electricity and knowledge of necessary adaptations of Electricity Act. Benefits: more efficient use of the grid due to local tariff incentives, more involvement of consumers, lower costs to society.

- **Challenges/barriers in policy making to allow for more innovation in Smart Grids through Regulatory Sandboxes**

Sharing electricity, supply and demand, within local communities is not allowed. Regulatory sandboxes can help in a changing world with new insights from practical situations that can be translated into new policies if necessary.

- **Targeted benefits for different actor groups**

By having experiments, the knowledge is built on real-time situations and can help in the upscaling to other areas. New businesses are possible and more chances for sustainable local communities.

- **Key actors and involved Stakeholders / Organizations**

Involved (energy) communities and representative organization “Hier Opgewekt” (a Dutch organization to help and spread knowledge to energy communities – www.hieropgewekt.nl), (housing) project developers and housing corporations, Ministry of Economic Affairs and Climate change, RVO, regulatory body ACM, DSO’s, (Energy Tax authorities), supporting service providers (administration/ access to energy markets/ consultants and business developers.

- **How should such policy instruments be designed?**

The Ministry of Economic Affairs and Climate held a public consultation via the Internet and spoke to all relevant stakeholders.

- **Examples and good practices of designing and implementing existing sandbox**

Two examples of experiments in the Netherlands and one specific study outcome on this topic are:

Example #1 - (Zwijssen in Veghe) An operational project network

Project plan Decentralized sustainable electricity generation Collegepark Zwijsen Veghel. Collegepark Zwijsen realizes approximately 115 apartments in a former school complex in Veghel whose buildings date from 1954 to 1977. Energy-saving and sustainable generation of electricity are central to the new apartments.

For the sustainable generation of electricity, all roof surfaces oriented on the southeast and south-west are equipped with solar panels. The total installed peak power will be approximately 200 kW. With this, the solar panels provide at least 50% of the electricity requirement.

The complex is provided with an energy management system. Residents indicate whether they have electricity users switched on based on solar power. Tariff differentiation for electricity is applied so that users can attune their behavior accordingly. To limit the peak load of the complex, the peak load is investigated with a CHP heat coupling of 20 kW electrical and 80 kW thermal capacity. The cogeneration produces electricity as far as there is heat consumption.[33]

Example #2 - ((Schoonschip) An operational project network

A sustainable floating water houses complex

The VvE Schoonschip has received an exemption for the Experimental Electricity Law Experiment. At the Johan van Hasselt canal in Amsterdam-Noord, 46 water houses will be realized. These homes are as self-sufficient as possible in the field of energy. This involves using a very advanced smart grid.

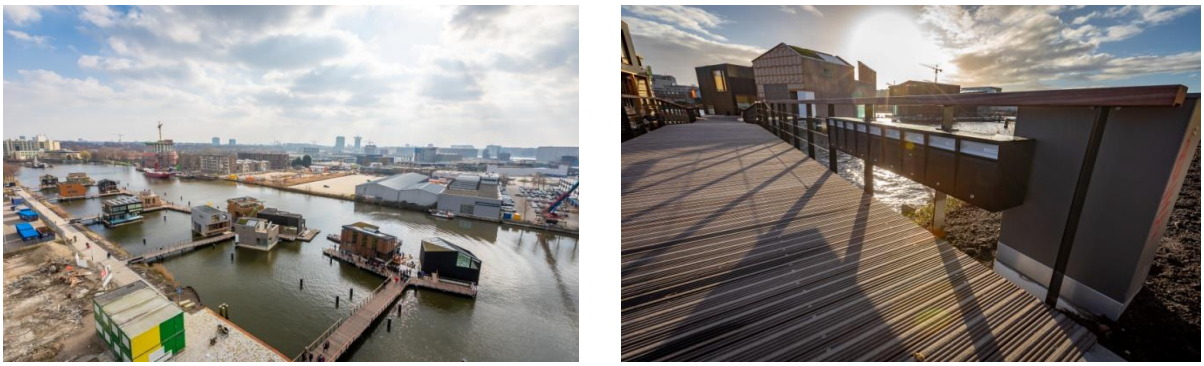

Figure 7: Schoonschip in Amsterdam

Source**:** www.isabelnabuurs.nl

A private electricity grid will be installed behind the meter of the local grid operator (Liander) realized, with 30 connections. Every home is provided with a battery for decentralized energy storage. Dutch supplier Greenchoice takes the balance responsibility.

One of the technologically interesting aspects in the experiment is the smart grid software that will control the individual battery systems, but also the aggregated form (i.e. all individual batteries as one community system). In addition to the battery systems, smart heat pumps, the heat storage tank and smart household appliances are also integrated into the smart grid.

GridFriends (the name of the consortium, consisting of Schoonschip, CWI, Fraunhofer, Metabolic and Spectral Utilities) started a three-year project to further develop the software and algorithms for the best possible smart grid for local communities. They are using blockchain technology.[34]

A study that is conducted in the Netherlands on regulatory sandboxes is FUSE

FUSE, Flexibility Unleashing Sustainable Energy, is a thinktank consisting of leading energy experts in the Netherlands. FUSE studied a number of local energy initiatives to map existing institutional barriers. One reoccurring element in the different initiatives is the Experiment Degree on local sustainable electricity generation.

[33] http://collegeparkzwijsen.nl/

[34] http://schoonschipamsterdam.org/

Many of the initiative that wanted to get a derogation under this degree did not qualify due to strict conditions. The following requirements were experienced as stringent:

- A minimum of 80 % of the participants needs to be household consumers: Initiatives voiced that a higher percentage of companies would improve the business case.
- Production units with a maximum capacity of over 5 MW could not participate: This condition excluded solar and wind parks
- All participants need to be connected to the same low or middle voltage net: The requirement blocks upscaling possibilities outside the region
- Only small consumers (kleinverbruikers) can participate, not large consumers: Large consumers, companies, can be of added value because they often have a different consumption pattern than household consumers and this can support locally balancing demand and supply.
- The derogation is given for 10 years. The Degree is unclear about who will own the network after the end of the experiment, and this is experienced as a (financial) risk.

The Ministry of Economic Affairs and Climate change is currently working on an improved Degree, which will also address/tackle the above-mentioned barriers.

- **How are the policy instruments operationalized?**

The legal basis is created in the Electricity Act 1998 and further elaborated in the general administrative regulation. Important to know that exemptions are not allowed for European rules, like the freedom of choice and the principle of non-discrimination.

- **Length of regulatory exemptions,**

It depends on the experiment how long an exemption is approved; the maximum is 10 years.

- **Criteria for selection process,**

Parties who want to start a project (seek for an approval to operate with exemptions of the law) have to comply with certain criteria. E.g. (the list is somehow longer than this):

- participation must be open and voluntary
- members must be allowed to leave the experiment
- members of a cooperation shall not lose their rights and obligations as household customers
- cooperation's are financially responsible for the imbalances they cause in the electricity system, or have delegated this responsibility to a balance responsible party
- it must be safe
- dispensation isn't necessary to fulfill the experiment (things are already allowed)
- the consumer protection must be ok, and in line with European requirements (like freedom of choice)
- financial, technical and organization expertise is required
- a minimum of 80% of the participants must be consumer
- the production capacity must be limited to the final use of the participants
- there is an obligation that there are sufficient arrangements in the case the party goes bankrupt and consumers must be certain of the supply of electricity by another supplier

- **Information required from applicants for sandbox projects**

All the information necessary that they comply to the criteria set in the general administrative regulation.

- **Which type of actors is involved in the reviewing process**

Government, regulator and parliament.

Outcomes and Highlights

During the first 4 years (2015 – 2018), 15 applications have been granted: 7 “Project networks” and 10 “large experiments”. 4 Project networks are operational January 2019 and none of the “large experiments”. The project networks are initiated mostly by project developers. One is an initiative from the local community. The large experiments are initiated by local energy communities (5), project developers (4) and housing corporations (1).

All projects include a considerable amount of solar-PV installations (sometimes up to 100% of the electricity consumption involved). In some project networks the connection to the DSO grid has a considerably lower capacity than normal due to matching supply and demand (e.g. heat pumps) and usage of storage (batteries).

In some cases, the consumers are really involved, especially when the initiative came from the local (energy) community. In other cases, the project developer unburdens the consumers and local community.

Lessons Learned and Next Steps

- It takes time before an experiment is operational. In the case of a project network it has to be incorporated in an early stage of development of the project.
- Especially with big experiments it is difficult to develop a good business case. Also due to the limited scale of the projects. A lot of issues have to be solved by the corporative association/ waiver holder like contracts with the DSO’s and all (administrative) requirements to act as an energy supplier, electricity producer and local grid operator. And how to match demand and supply and to motivate the consumers. Most issues are new to the waiver holder/ cooperative associations/ energy communities. Sometimes the experiment issues are also new to the Dutch energy world. Benefits on the more efficient use of the electricity grid are difficult to cash with the regulated DSO. This can make it difficult to keep enthusiasm in the project and energy communities. With experiments there are a lot of uncertainties for the investors and it is a rather complex and new process to implement.
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- It is difficult to find many projects suitable for an experiment. Most developers and communities want to spend their limited time in the development of the (new) buildings and the energy supply is often a minor issue. Most experiments are on a limited scale.
- Increase of the scale and exemption possibilities of the scheme can increase the impact and attract new stakeholders like system operators, energy companies, local governments and partnerships.

2.6 (UK) OFGEM's Innovation Link

Title of Program or Activity	Innovation Link, Ofgem's Innovation Link is a 'one stop shop' offering support on energy regulation to businesses looking to launch new products, services or business models. It offers fast, frank feedback on regulatory issues and grants regulatory sandbox support on a case by case basis in instances where current regulation prevents the launch of a product or service that could benefit consumers.	
Location	United Kingdom	
Main scope of experiment	• Smart electricity grid only • Integrated approach/sector coupling, • Energy Storage • Flexibility services for grid stability • Behind the meter • Others: Scope of proposed trials determined on a case by case basis. Trial plan are often jointly developed by applicants and OFGEM to help them understand what is possible. Potentially all of the above could be proposed to feature in trials.	
Main innovation goal	• New technological solution, product, service • New tariff-model • New business model	
Regulatory body	OFGEM – Office of Gas and Electricity Markets	
Implementation Time Period	Launch: December 2016 1st call: February 2017 2nd call: October 2017	
Funding Amount (direct and in kind)	Public	The Innovation Link does not offer funding for trials, however, applicants may apply for public funding from other schemes
	Private	Yes
Lead Organization	OFGEM – Office of Gas and Electricity Markets	
Additional Key Stakeholders/ Organizations	N/A	
Link to Program's Website/News	• **https://www.ofgem.gov.uk/about-us/how-we-engage/innovation-link** • Insights from running the regulatory sandbox in 2017 and 2018: **https://www.ofgem.gov.uk/system/files/docs/2018/10/insights_from_running_the_regulatory_sandbox.pdf** • More information on 'fast, frank feedback': **https://www.ofgem.gov.uk/system/files/docs/2018/10/fast_frank_feedback_can_and_cant.pdf** • More information on what a regulatory sandbox offers: **https://www.ofgem.gov.uk/system/files/docs/2018/09/what_is_a_regulatory_sandbox.pdf** • Outcome of sandbox window 1: **https://www.ofgem.gov.uk/system/files/docs/2018/09/outcome_of_sandbox_window_1.pdf**	
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2.7 (US) Hawaii's development of performance-based regulation to support distributed generation and innovative product offerings

Title of Program or Activity	Hawaii Public Utilities Commission's Investigation of Performance-Based Regulation	
Location	Hawaii, United States	
Main scope of experiment	This is an integrated regulatory approach that will support the deployment of energy storage, behind-the-meter renewable energy, and innovative solutions to support grid transformation.	
Main innovation goal	New business model	
Regulatory body	Hawaii Public Utilities Commission	
Implementation Time Period	The regulatory proceeding began in April 2018 and final rules need to be in place by January 1, 2020.	
Funding Amount (direct and in kind)	Public	N/A
	Private	-
Lead Organization	Hawaii Public Utilities Commission	
Additional Key Stakeholders/ Organizations	Hawaiian Electric Companies (utility); Division of Consumer Advocacy (state consumer advocate); City and County of Honolulu, County of Hawaii, County of Maui (state and local governments); Hawaii Coalition, Hawaii Solar Energy Association, Distributed Energy Resources Council of Hawaii (distributed generation industry); Blue Planet Foundation, Life of the Land (nonprofit environmental groups); Ulupono Initiative (impact investing firm)	
Link to Program's Website/News	http://puc.hawaii.gov/energy/pbr/	
Contact Information	Name	Jenny Heeter (NREL)
	Email	Jenny.Heeter@nrel.gov

Background and Overview

Hawaii's electricity market has been changing rapidly, transitioning away from fossil fuels towards renewable energy and storage. In 2015, Hawaii adopted the country's first 100% renewable portfolio standard (RPS). Utilities must meet 100% of sales with renewable electricity by 2045, with interim goals to facilitate the ramping process (Hawaii State Energy Office 2018) At 27.6% renewable sales during 2017, utilities are on track to meet their 2020 target of 30% (Hawaii Public Utilities Commission 2018a). Hawaii relies predominantly on imported petroleum for electricity generation—an arrangement that results in the highest national retail prices (EIA 2018) but provides for opportunities to shift generation to renewable resources, as those costs decline. Most recently, Hawaiian Electric Company (HECO) requested regulatory approval for paired solar and storage power purchase agreements ranging from $0.08-$0.10/kWh, compared to their fossil fuel prices of about $0.15/kWh (Greentech Media 2019). Developers are also negotiating a lease for a pumped storage hydropower facility capable of powering more than 20% of the island's electrical needs (Hawaii State Energy Office 2018). Lastly, the state's net-metering policy limits exports of excess to the grid and thereby incentivizing consumers with PV panels to consider installing batteries (Mykleseth 2015).

In recognition of this transformation, and the resulting changing role of electric utilities, Hawaii is in the process of investigating performance-based regulation (PBR). PBR creates a new business model for utility companies. Most investor-owned utilities are regulated using a cost of service (COS) approach. Within the COS regulatory framework, utilities earn money from returns on capital investments. They also have an incentive to increase sales in order to generate more revenue. Public policies may encourage new technologies such as smart meters and distributed generation, but COS by itself will not provide an incentive to utilities to accelerate their adoption. Transitioning to PBR allows regulators to provide utilities with added financial incentives for achieving public policy goals.

Each element of PBR, when disaggregated, can supplement and exist within other regulatory approaches. In essence, PBR shifts utility ethos from "did we pay the correct amount for what we got" to "did we get what we wanted" (Lehr, 2013). PBR can be used to incentivize any number of objectives, including customer satisfaction and cost containment. While some jurisdictions have developed components of PBR, not many examples exist of full PBR implementation

Hawaii has been examining PBR for a number of years. The Hawaii Public Utilities Commission (PUC) issued a whitepaper in 2014 that offered its perspective on aligning utility business models with public policy goals (Hawaii Public Utilities Commission 2014). The PUC had previously ordered HECO companies to develop a sustainable business model but noted that almost one year after their order, the HECO companies had not complied. The PUC's whitepaper highlighted several problems with the current utility business model gave guidance to HECO companies when developing a future business strategy. The guidance focused on creating an electric system that could integrate increasing penetrations of renewable energy, both utility-scale and behind-the-meter, create modern transmission and distribution grids, and be responsive to the state's public policy goals for a clean energy future.

Building on the PUC whitepaper concepts, in April 2018, Hawaii Governor Ige signed the Hawaii Ratepayer Protection Act (Senate Bill 2939). The Act directs the state PUC to develop a utility new business model that separates utility revenues from capital expenditures35. The PUC was directed to complete the redesign by January 1, 2020. Legislators included items that the PUC must consider when developing its rules, including several items related to renewable energy and energy efficiency:

- Integration of renewable energy resources, including customer-sited resources
- Timely execution of third-party interconnection
- Access to utility system information. (Hawaii Senate 2018)

The PUC is also able to consider additional items, as it sees fit.

To develop a PBR mechanism, the PUC established a two-phase process that has included multiple technical workshops and stakeholder comment periods. The process generally has involved PUC staff developing a whitepaper, hosting a technical workshop, and stakeholders providing feedback after the workshop. The process allowed stakeholders to provide comments and feedback during technical workshops as well as through the formal regulatory docket. PUC staff synthesized stakeholder comments and provided guidance along the way.

The Phase I process is outlined in Figure 8.

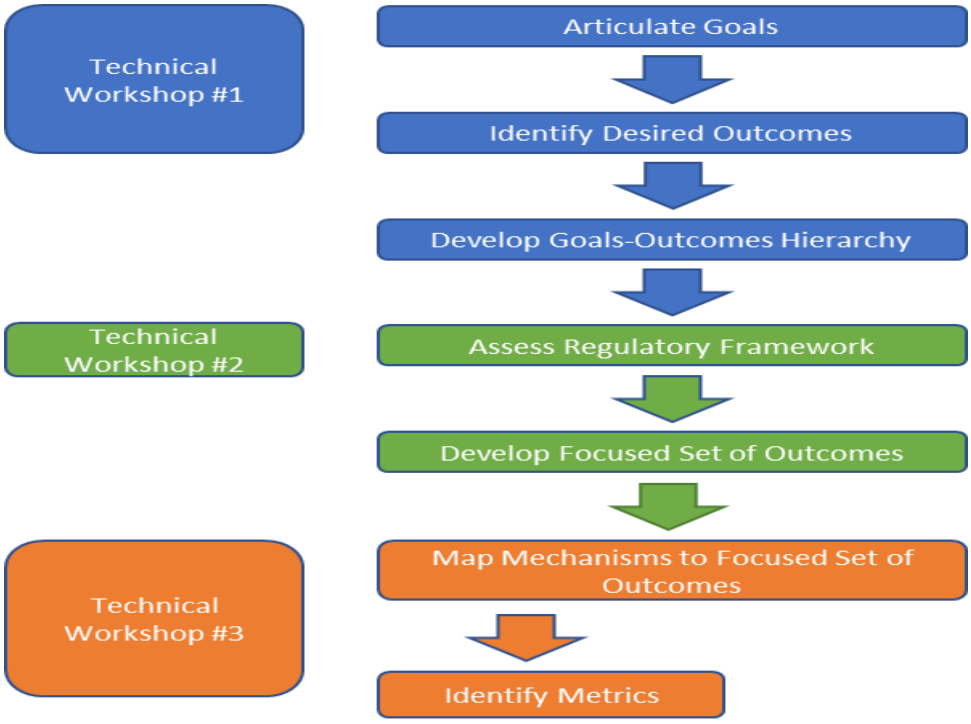

Figure 8: PUC regulatory process for Phase I

Adapted from: Hawaii Public Utilities Commission Staff (2018).

Hawaii's PBR investigation is occurring in 2018 and 2019, and final regulations are due by January 1, 2020, according to the Ratepayer Protection Act (Hawaii Senate 2018). Many

35 The Act only applies to the state's investor owned utilities: Hawaiian Electric, Maui Electric, and Hawaii Electric Light, which are operating companies owned by HECO.

stakeholders have been involved with the investigation. The Hawaii PBR docket has included regulators and staff, utilities, non-governmental organizations (NGOs), and renewable energy groups. The technical workshops also saw participation by experts in PBR, and were facilitated by an independent group, Rocky Mountain Institute. Table 8 provides a list of key stakeholders.

Table 8: Key Stakeholders Involved with Hawaii's PBR Process

Stakeholder Group	Specific Organizations
Utility Regulator	Hawaii Public Utilities Commission
Consumer Advocate	Division of Consumer Advocacy (State)
Regulated Utility	Hawaiian Electric Companies (HECO)
State and Local Government	City and County of Honolulu, County of Hawaii, County of Maui
Impact Investing Firm	Ulupono Initiative
Nonprofit Environmental Groups	Blue Planet Foundation, Life of the Land
Distributed Generation Industry	Hawaii Coalition, Hawaii Solar Energy Association, Distributed Energy Resources Council of Hawaii
Technical Experts	Regulatory Assistance Project, Strategen Consulting, Pacific Economics Group, Synapse Energy Economics, Arizona State University, Public Policy Consulting, The Brattle Group, Rabago Energy LLC

Policy Instruments, Actors, and Programs

Stakeholders and the legislature have noted the failures of the existing regulatory regime and the need to create new frameworks in order to support Hawaii's energy goals. A majority of the parties in the PUCs PBR investigation proceeding found that the current regulatory model encourages utilities to make capital investments to ensure their financial integrity, even at the expense of public policy goals. Some stakeholders noted that there had been incremental changes to the regulatory framework, but those did not fully remediate the fundamental flaws of the regulatory framework. (Hawaii Public Utilities Commission Staff 2018) Rather than prioritize specific programs or system inputs, PBR focuses on the well-being of the system as a whole. Earnings, under this scheme, are a function of a utility's compliance with a series of pre-defined output-oriented standards. (Bowman & McKay 2001).

Specifically, the PUC noted that it was interested in PBRs that result in: "Greater cost control and reduced rate volatility; efficient investment and allocation of resources regardless of classification as capital or operating expense; fair distribution of risks between utilities and customers; and fulfillment of State policy goals (Hawaii Public Utilities Commission 2018b)." These goals serve as a platform for the development of PBRs by stakeholders, and potential adoption by the PUC.

The PUC PBR proceedings are providing a way to gather input on the goals, outcomes, and metrics that should be used when transitioning to PBR. Careful selection of goals, outcomes, and metrics, and the respective incentive mechanisms can direct utility efforts towards enabling the growth of renewable energy, distributed generation, and energy efficiency while maintaining fair rates and fulfilling investor profit margins.

In practice, PBR is a collection of incentives. The components can exist on their own or as part of a more comprehensive package. Common facets of PBR include multi-year rate plans (MRPs), performance incentive mechanisms (PIMs), benchmarking, earnings sharing mechanisms, and price or revenue controls (Table 9). Many similarly named tools also exist (Woolf & Schwartz 2016). Given the disruptive nature of a complete systemic overhaul, partial PBR is becoming more and more prevalent in regulatory jurisdictions across the US. For instance, at least 26 states utilize PIMs to influence the behavior of their electric utilities in some manner (Littel & Kadoch et al. 2017).

Table 9: Key components of performance-based ratemaking

	Definition	Tools	Implication
Multi-Year Rate Plans **MRPs**	Lengthens the time between rate cases. Enables intermediary cost-relief mechanisms.	Rate-case moratorium, attrition relief mechanisms (ARMs), and cost trackers.	Reduces regulatory costs; incentivizes cost-containment and participation in DER, EE, and DSM initiatives.
MRPs are the most common instance of PBR. Longer periods between rate cases (usually 2-5 years) stabilize utility revenue and encourage better cost-management. Having fewer rate cases also reduces regulatory costs. ARMs and trackers mitigate cost pressures by allowing utilities to recover predicted fluctuations between rate cases. ARMs use pre-established forecasts, indexes, staircases, benchmarks, and/or rate-freezes to intermittently adjust rates. Trackers enable cost recovery of actual expenses by tacking them onto the next years' rates. (Lowry & Woolf 2016).			
Revenue Constraints **RCs**	Places controls on rates and/or allowable revenue for utilities.	Price caps & floors, banded rates, revenue caps & floors, decoupling, earnings sharing mechanisms (ESM).	Diminishes or eliminate the link between utility profit and volumetric sales.
RCs may take several forms and serve to re-define the nexus of profit and indicator of utility behavior. Generally speaking, RCs ensure cost recovery regardless of how much electricity a utility sells. Revenue or price requirements are set at the general rate case followed by periodic reconciliation to ensure that actual revenue equates that which was prescribed. In the event that a utility accrues more revenue than allotted by the regulators, ESMs can redistribute excess earnings back to customers (Lowry & Woolf 2016).			
Performance Incentive Mechanisms **PIMs**	Rewards or penalizes utilities based on their compliance with performance-based standards.	Metrics, targets, and financial incentives.	Incentivizes specific, goal-oriented behavior in utilities; aligns customer, investor, and utility priorities.
PIMs are a means of eliciting certain behavior from utilities. PIMs may incorporate with cost-of-service (COS) regulation or be combined within MRPs as the basis of a more comprehensive PBR approach. Traditionally, PIMs have been used to influence reliability, employee safety, public safety, customer satisfaction, plant performance, and costs. More recently, these objectives may include system efficiency, customer empowerment, network support services, and integration of DG, DSM, and grid modernization technologies. Given the subjective nature of performance goals, regulators must adopt quantifiable indicators of success, or metrics, prior to instating a PIM. This process requires data availability, formula creation, transparent reporting, and verification. Performance target and incentive creation follows establishment of the metric. The financial implications and portion of utility revenue dictated by PIMs vary (Lowry & Woolf 2016).			

■ Benefits of PBR for different stakeholders

Implementation of PBR provides many benefits to policy makers, regulators, utilities, and third-parties. While the exact implementation of PBR and PIMs is still to be determined in Hawaii, the PUC staff identified three guiding principles:

1. Customer-centric approach. The staff wants the framework to expand customer choice and participation in utility system functions. The staff also recommends that the framework provide day-one savings for all customers.
2. Administrative efficiency. The staff sees an opportunity to use PBR to simplify the existing regulatory framework, reducing regulatory costs to the utility and its customers.
3. Utility financial integrity. The staff sees two benefits of PBR to the utility's financial integrity. First, it will help reduce regulatory lag, and second, it will provide the utility an opportunity to earn a fair return on their business and investments. (Hawaii Public Utilities Commission Staff 2018b)

The PUC staff guiding principles apply to PBR generally. When looking at PIMs specifically, there are potential benefits to multiple stakeholders. First, policymakers benefit because their objectives are directly tied to financial performance of the utility. For example, Hawaii's objectives to use more renewable energy could be directly tied to a PIM. Second, regulators are provided with tools to help them control electricity costs, by capping the amount of an incentive and pairing PIMs with earnings sharing mechanisms. Third, utilities are allowed to capture financial benefits from new types of products or services. Lastly, third-parties, such as distributed generation and storage providers, are at less of a disadvantage against utilities, as utilities could be financially rewarded for the success of third-parties via a PIM.

■ Challenges of PIMs

Stakeholders identified some challenges with implementation, including "the risk associated with designing new mechanisms including unintended consequences, excessive complexity, information asymmetry, free-ridership, and creating metrics that may be at cross-purposes (Hawaii Public Utilities Commission Staff 2018)."

First, the right metrics must be developed. Metrics ideally should be tied directly to what is in the utility's control. If not, the utility may not be able to meet the target or may be rewarded for meeting the target because of actions taken by others.

Second, there could be challenges getting the right data to support metrics. Ideally metrics should use national or international standards and be fully transparent. If data sources are not available, some jurisdictions have used a "scorecard" approach. Scorecards use available data to track performance, but do not provide a financial incentive. In this way, regulators and the public are provided with transparent information but are not putting utility or ratepayer finances at risk.

Third, setting the baseline for the PIM can be complicated. Stakeholders may have imperfect information about what an appropriate baseline should be. If the baseline is too high, utilities may not be able to achieve target; if it is too low, they may be rewarded for achieving something they would have without the financial incentive.

- **Innovation and New Partnership Pilots**

In addition to PBR, the PUC staff proposed that utilities be able to earn incentives for innovation and new partnerships with third-party service providers. In Hawaii, the transition to renewable energy has brought an influx of third-party providers. Under traditional business models, the utility is not incentivized to support third-party service development, as it results in lost revenue to the utility. The PUC staff proposal proposes one or more of the following to support utility and third-party collaboration and innovation: 1) an expedited innovation pilot process, 2) a web-based innovation platform, and/or 3) an innovation fund (Hawaii Public Utilities Commission Staff 2018b).

Staff provided three examples of how innovation is being supported around the world. The first is via an innovation fund in the U.K., under the RIIO framework. Distribution and transmission network operators are able to submit proposals for about $90 million annually in projects through a Network Innovation Competition (NIC). The NIC is funded thorough a transmission network system charge. Projects have included advanced energy solutions, such as assessing the grid impact of electric vehicles and developing an approach to use distributed energy resources for black start capabilities. Smaller scale innovated projects are funded via a distribution system charge at a level of 0.5-1.0% of base revenue. Finally, the innovation roll-out mechanism (IRM) allows utilities to develop proven projects with environmental or carbon benefits, but that have a longer pay-back period.

The second example that PUC staff highlighted was in Vermont, where the state's distribution utilities are required to provide "transformative energy projects" to reduce fossil-fuel consumption and greenhouse gas emissions. The PUC granted the utilities authority to develop pilots outside of the traditional regulatory process. The PUC does not approve pilots before they are implemented, but the utility is required to notify the PUC of its commencement and progress. After an 18-month pilot program term, the utility can petition the PUC to continue to offer the pilot program and includes the costs in its rates. To date, Green Mountain Power has developed a pilot that provides residential battery storage to customers for either a monthly or one-time fee, with the utility being able to use the battery for its system needs. The second pilot provides customers with an electric water heater that can be controlled by the utility.

The final innovative approach that PUC staff cited was in New York, where utilities connect with third-parties via an online portal, REV Connect. REV Connect provides a platform for third-parties to submit innovative ideas; after that, REV Connect administrators summarize proposals for utilities. Utilities and third-parties can then develop new business models together and get them approve by the regulator. (Hawaii Public Utilities Commission Staff 2018b)

The distributed energy resources companies involved with the PBR investigation raised an additional pathway for innovation. They propose including smart grid demonstration projects and "bring-your-own-device" ("BYOD") projects. BYOD would provide a framework to allow customers to provide grid services with their own device or a third-party device. A BYOD program is in contrast to a utility-owned and sponsored program, for example, if a utility owned residential storage projects like Green Mountain Power's pilot program. (Hawaii PV Coalition et al. 2019).

It is unclear how much support the innovation pilots would have from stakeholders, if implemented, or if the PUC would approve any of these approaches as part of the PBR investigation.

- **Design of Policy Instruments and Implementation**

PBR examples from around the world lend some insight into best design and implementation practices. One of the most widely-cited instances of PBR is that developed by the Office of Gas and Electricity Markets in Great Britain. MRPs have been a part of the British system for more than 25 years, but a regulatory revamp in 2013 placed greater financial weight on performance criteria and innovation. The foundation and namesake of the approach dubbed 'RIIO', pertain to the formula: Revenue = Incentives + Innovation + Outputs. RIIO made three key alterations to the previous price cap system. It extended contract length from 5 to 8 years allowing for even longer-term planning and cost recovery; it linked base revenues to pre-established cost forecasts rather than capital investments; and it used a broad spectrum of PIMs to hone output excellency. Whereas one or two supplementary PIMs are becoming fairly common place, RIIO tracks and incentivizes six distinct performance categories: customer satisfaction, reliability and availability, safe network service, connection terms, environmental impact, and social obligations (Lowry & Woolf, 2016). Upon review, each category incurs a unique financial result for utilities, but all outcomes are publicized and compared to other utilities through a scorecard. A 2017 appraisal indicates all distributors have decreased their carbon footprint, improved their times to quote connections, and reduced the length of outages. All except one were awarded for customer service. (Lowry & Deason et al. 2017).

RIIO is not without challenges. Eight years between rate cases, for instance, is a long time for regulators to forego reviewing utility investments—a potential risk to customers. Furthermore, the use of forecasting to predict and account for intermittent changes in cost is a time and labor-intensive endeavor. As a result, RIIO implementation is considerably more expensive than other regulatory proceedings. North American regulators are known to use cost trackers paired with indexing or hybrid attrition mechanisms to produce viable predictions at a fraction of the research cost, but the trade can occur at the expense of incentives for cost-containment (Lowry & Woolf 2016).

The Ontario Energy Board has worked through several MRPs since first embracing the strategy in the 1990s. Each iteration, though distinct, has included an indexed price cap that utilizes econometric models to determine low-expense benchmarks. At first, there was no means of cost recovery for capital expenditures that exceeded the indexed rate. Only by the third MRP did the Board enable a cost tracker called the Incremental Capital Module to cover additional expenses, though eligibility criteria require a foreseeable excess of at least 10%. Later, the Board added Advanced Capital Modules that had to be requested during rate case proceedings (Lowry & Deason et al. 2017).

In 2010, the release of a report entitled, "A Renewed Regulatory Framework for Electricity" (RRFE) informed the Board's fourth generation plan. The MRP introduced mechanisms for flexible response to distributors, specifically, the design of custom PBR schemes for large distributors and an Annual PBR index for those with low capital expectations. These "menu"

options discern between utilities' potential for cost containment and are known as "incentive compatible." Similar to RIIO, the RRFE instated a scorecard that would report on cost, earnings, customer service quality, reliability, DSM, and safety performance. Though not nearly as comprehensive with PIMs, the system used similar public display of performance mechanisms. According to results from joint research at Lawrence Berkeley National Laboratory and Pacific Economics Group Research, the period between 2003 and 2011 saw incremental growth in distributor productivity by a factor of 0.45% a year. This was significantly higher than that observed in the U.S., at -0.01%. Unfortunately, data pertaining to PIMs' impact on reliability is insufficient to draw conclusions. Major weather events' altered reliability data such that year-to-year comparisons are not necessarily indicative of utility-driven changes and the deployment of outage detection devises changed the accuracy of reporting mid study (Lowry & Deason et al. 2017).

New York Governor Cuomo's 2014 plan for power sector transformation—Reforming Energy Vision (REV)—is another example of an output driven PBR initiative resulting for many years of MRP. The key drivers, in this case, are a collection of incentives called Earnings Adjustment Mechanisms (EAMs), the New York terminology for PIM. The standards tracked by the EAMs are system efficiency, energy efficiency, customer engagement and information access, and interconnection (Lowry & Woolf 2016). After Superstorm Sandy, the governor ordered an investigation on the city's storm preparedness.

The result, the Moreland Commission on Utility Storm Preparation and Response, catalyzed the discussion of regulatory reform. Having already decoupled their utilities' revenue from sales, the state took an extra step and provided a means for utilities to profit from DER used to displace plans for transmission infrastructure (Lowry & Deason et al. 2017). A survey aggregates data on how well utilities process requests and identify potential DER sites and the prescribes positive earnings adjustments to those with favorable results (Littell & Kadoch et al. 2017). DSM is also incentivized with programs such as the Brooklyn Queens Demand Management program from utility ConEd to a similar end—offset large infrastructural expenses. Without the program, system updates would have demanded upwards of one billion dollars in 2017 (Lowry & Deason et al. 2017). The state also supports programs that help EAM success. These include the Clean Energy Standard, the Clean Energy Fund, and an Affordability policy. (Mitchell 2016).

Outcomes and Highlights

Hawaii has some components of PBR already and PUC staff have proposed modification to the multi-year rate plans and the earnings sharing mechanism, and have proposed new PIMs (Table 10, Table 11). These recommendations are not decisions by the PUC; stakeholders will react to the recommendations and then the PUC will issue a final order. PUC staff recommend establishing 3-6 PIMs that in total would increase or decrease utility earnings by 150-200 basis points. Three of the PIMs are related to renewable energy and storage deployment. PUC staff proposed additional PIMs and PIM metrics not included in Table 11.

Table 10: Status of PBR Components in Hawaii

PBR Component	PBR Components Already in Place in Hawaii (Hawaii Public Utilities Commission (2018b)	Hawaii PUC Staff Proposal for PBR Modifications (Hawaii Public Utilities Commission Staff 2018b)
Multi-year Rate Plans (MRPs)	Three-year cycle for general rate cases	Five-year cycle for general rate cases
Revenue Decoupling	PUC approved revenue decoupling in 2010	Continued revenue decoupling
Earnings Sharing Mechanisms	The ESM provides increasing share credit to customers when the utility earns more than the authorized return on equity (ROE). The first 100 basis points over authorized ROE results in 25% share credit to customers; the next 200 basis points over authorized ROE results in 50% share credit to customers; and all ROE exceeding 300 basis points over authorized ROE results in 90% share credit to customers	An updated ESM that provides both upside and downside potential for utilities and customers
Performance Incentive Mechanisms (PIMs)	Service quality PIMs in place since January 1, 2018 (e.g. system reliability and customer service)	PIMs focused on reliability, interconnection experience, customer engagement, and distributed energy resource asset effectiveness; Additional detail is found in Table 3

Table 11: PUC Staff Proposals for Renewable Energy Related PIMs

Outcome	Prospective Metrics for Further Focus
Interconnection Experience	-Time and cost to interconnect to the network -Developer satisfaction survey -Public-facing distributed energy resources interconnection dashboard
Customer Engagement	-Participation and customer adoption of demand response, solar PV, community renewable energy, storage, and time-of-use rates -Accessibility of customer data
Distributed Energy Resources Asset Effectiveness	-Demand response, PV, storage, and non-wires solutions' (NWS) contributions by load/sales, by class -% grid supporting services provided by distributed energy resources vs. traditional resources

Source: Hawaii Public Utilities Commission Staff (2019)

While the PUC staff proposal is not directly tied to smart grid investments, such as metering or infrastructure, many of the outcomes and metrics identified could be enabled by smart grid investments. For example, advanced metering infrastructure (AMI) could be used to support an interconnection dashboard. Similarly, AMI could be used to facilitate participation in

demand response programs and provide increased accessibility of customer data. HECO has proposed efforts to modernize its grid, including deployment of smart meters with integrated communications, a meter data management system, and an improved telecommunications network (Hawaiian Electric 2019).

While PBR and PIMs are not yet fully adopted in Hawaii, the regulatory docket and legislative mandate provide some certainty that changes will be made to the existing regulatory structure. It remains to be seen how many aspects of PBR the PUC will adopt.

Lessons Learned and Next Steps

PBR development in Hawaii is an ongoing process, with final regulations due by January 1, 2020. As such, lessons learned focus on the regulatory process to date.

First, having a legislatively mandated deadline for implementing regulatory changes has resulted in an accelerated regulatory process. Second, as part of the technical workshop process, PUC staff and stakeholders have drawn on technical expertise from across the country. Third, PUC staff issued staff reports before each workshop, summarizing comments by stakeholders and establishing “straw man” proposals. This allowed stakeholders to have a better sense of likely PUC priorities. In other dockets, stakeholders may have little to no direction from Commissioners or Staff, which can delay or prevent approvals, as stakeholders may propose something the PUC rejects.

Going forward, the PUC will issue an order on Phase 1 of the proceeding, which will focus on which areas of utility performance should be improved and the metrics to measure those outcomes. After that, Phase 2 of the proceeding will begin. The PUC expects that Phase 2 could include energy policy PIMs, mechanisms to support cost-effective, service-based solutions, and different authorized rates of return on equity (Hawaii Public Utilities Commission 2018b). Finally, the PUC noted that while substantial changes in the regulatory framework may result from Phase 2, it supports regulatory gradualism, noting that implementation of dramatic changes would be phased in over time.

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