

Practical necessity and legal options for introducing energy regulatory sandboxes in Austria

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ABSTRACT

As the legal framework is designed for an established energy regime, innovative solutions for the energy transition often encounter barriers. Since rapid changes in the legal framework may involve uncertainties, testing solutions in the exceptional framework of regulatory sandboxes can be a constructive instrument of innovation policy. Until June 2021, Austrian energy law contains neither an explicit authorisation to grant such exemptions nor custom-made regulatory sandboxes. This paper is the first to investigate the practical need for regulatory sandboxes in Austria (specific fields of experimentation were identified) and elaborate necessary changes for energy law eligibility, taking European law into account.

1. Introduction

Digitalisation and decarbonisation of the energy system promote the development of new energy business models and technologies. They support energy efficiency, renewable energy, energy security, and the efficient use of existing and new infrastructure. In doing so, innovators often encounter regulatory barriers, as the current legal framework is not adequate to the new challenges (Schiavo et al., 2013), as it has co-evolved with long-established technological systems (e.g. distribution grids) and business models. Rapid adaptation of the regulatory framework is often not possible or associated with legal uncertainty. Nevertheless, the urgency of the energy transition requires supportive framework conditions for the innovation ecosystem.

Regulatory sandboxes are currently considered to have the potential to become effective tools in this respect. As seen from recent policy documents (European Council 2020, European Union, 2018), the debate about regulatory sandboxes and innovation zones has reached the European level.

A sandbox can be understood as a tool with which a new solution can be tested in a practical manner. Regulatory sandboxes are exceptional experimental spaces for innovative projects. From an innovation policy perspective, the regulatory sandbox intends to develop innovative solutions in an experimental environment. Regulatory sandboxes can thus

be viewed in connection with research funding, as they may be necessary in some cases to create the legal basis for experiments. Moreover, and equally important from a policymaking perspective, it helps gather experiences and use the knowledge gained for changes in the legal and regulatory framework (cf. Schittekatte et al., 2020). Thus, they are increasingly used as policy instruments to create experimental spaces to accelerate innovation processes under complex and interactive technological, institutional and legislative conditions and developments. From a legal perspective, this is often not trivial, as regulatory sandboxes require an exemption from otherwise binding legal requirements. In most cases, new laws or regulations must create conditions that allow exemptions.

The instrument attracted public attention when a growing number of countries implemented sandbox programmes in the FinTech sector, to which most practice-oriented literature in the energy sectors refers (e.g. Zetzsche et al., 2017). Other areas of application, for example, in transport and mobility regulation (e.g. autonomous or assisted driving), are also known (Lachmayer et al., 2019). However, as regulatory sandboxes are a relatively young policy instrument, good practice examples are still scarce, and evidence-based ex-post evaluations are not known to the authors. This situation is particularly true for the energy sector with a growing number of regulatory sandbox initiatives (IEA ISGAN, 2019).

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Austria runs various innovation funding programmes. These award specific amounts of funding for projects that are judged to be innovative. However, even in these projects, the testing of specific measures and technologies is subject to the generally applicable laws and regulations. It is not possible to circumvent the requirements simply by having the status as a research project. So far, there have been no exemptions granted for sandboxes by the Austrian regulatory body; in fact, there is not even an explicit authorisation for granting exemptions from legal or regulatory requirements. As the legal framework must be fully complied with, room for granting exemptions requires action from the legislator. Thus, Austria aims to be one of the first countries to implement a sandbox programme in the energy sector and is preparing legal requirements (which are currently being finalised) for sandbox experiments to be granted (status June 2021). The sandbox programme shall supplement existing innovation funding, i.e. it is intended to enable testing within the limited framework of research projects but in actual environments.

This paper analyses the (i) legal requirements that must be considered when introducing regulatory sandboxes into the Austrian legal framework. It also investigates the (ii) actual need for regulatory sandboxes in the energy sector. By merging the actual demand for sandboxes and the legal provisions, we clarify (iii) which topics can benefit from regulatory experiments. To support decision-making, (iv) we prioritised the eligible topics (by determining the leverage effect and under consideration of further criteria).

2. Regulatory sandboxes in the energy sector: concept and international comparison

In the following, we will present the conceptual considerations for designing regulatory sandbox initiatives in the energy sector based on first international experiences.

2.1. Concept and instrument development

Regulatory sandbox programmes with climate and energy policy objectives are still pioneering instruments of mission-oriented RTI policy. Therefore, it is not yet possible to refer to evaluation reports of the individual programmes in force (see below). As a new instrument of mission-oriented innovation policy, regulatory sandboxes have so far emerged in areas with two kinds of innovation dynamics (Kubeczko and Wang, 2019): These are fields of innovation primarily characterized by:

- Very rapid technological progress with unclear consequences regarding the need for setting new legal provisions. Examples include regulatory sandbox initiatives in connection with digitisation in fields of innovation such as FinTech, eHealth, eGovernment, autonomous driving, blockchain, Internet of Things, or platform economy.
- The need for solutions to major societal challenges. This driver is particularly evident in the goal of decarbonising the energy, mobility, and industrial sectors.

A systematic overview of existing energy sandbox initiatives is rare, with IEA ISGAN (2019) being the most prominent. Formal ex-post evaluations for assessing sandbox programmes are not yet available. The scientific literature on the application of regulatory sandboxes in the energy sector includes a report from Van der Waal et al. (2020) on Dutch experiences, which highlights that “*these experiments do not take place in a vacuum but need to be formulated and implemented in a multi-actor, polycentric decision-making system through collaboration with the regulator but also energy sector incumbents*”. Potential areas of application in the energy sector include technologies and business models that fundamentally change traditional solutions, such as distributed ledger applications of blockchain technology (Ahl et al., 2019), energy communities (Lowitzsch et al., 2020), smart power grids (Bauknecht et al.,

2020), or hydrogen fuels (Stangarone, 2020). However, the entire field of climate and energy technologies is subject to rapid development, and the call for innovation in regulation is widely encountered: This includes the requirement to coordinate transmission grids, distribution grids and markets that have been separated due to liberalisation (e.g. Hadush and Meeus, 2018); to promote the integration of the energy system through sector coupling (Cambini et al., 2020); not to hinder local private actors (e.g. peer-to-peer traders, energy communities), who can and want to promote decarbonisation through local action, potentially enabled by ICT, by regulatory uncertainty or barriers (e.g. Melville et al., 2017; Bastida et al., 2019); and to take a holistic view of decarbonisation holistically and reflect this in regulation (Ford and Hardy, 2020).

2.2. International experiences

In a casebook, IEA ISGAN (2019) surveyed regulatory sandbox initiatives on energy topics and areas of innovation in the context of the IEA’s ISGAN TCP (IEA Technology Collaboration Programme ‘International Smart Grid Action Network’) in more than ten countries for which experimentation is planned or already made possible based on regulatory exemptions. The casebook dealt extensively with Germany, Great Britain, Italy and the Netherlands, all of which have already established regulatory sandbox programmes:

- **Germany – SINTEG experimental clause:** In Germany, the federal government has implemented an experimental clause enabled by the Energy Industry Act. Research projects within the SINTEG funding programme have the option of applying for exemptions.
- **Great Britain – OFGEM Innovation Link:** In Great Britain, the energy regulator OFGEM may grant exemptions to enable regulatory sandboxes. In a two-stage process, this programme first offers the possibility of submitting an expression of interest and receiving advice on regulatory issues (OFGEM, 2020). In the second phase, confirmations about the legality of experiments are prepared, more detailed legal advice is offered, or explicit exemptions are granted.
- **The Netherlands – Decree for experiments:** A decree allows network operators and energy communities to apply for temporary exemptions in the decentralised generation of renewable electricity. Since 2015, 17 projects have been approved under the programme. Eligible projects were large-scale experiments in a distribution network with a maximum of 10,000 end users or energy community projects with up to 500 customers connected to the distribution network via a single connection point. Meanwhile, the Dutch sandbox has expired and has not been renewed.¹
- **Italy – ARERA Exceptions for strategic projects:** The energy regulator ARERA grants specific exemptions for strategic projects in areas relevant to energy policy and provides project financing. In international comparison, the regulatory authority plays a proactive role (selection and grant provision).

IEA ISGAN (2019) also identified regulatory sandbox programmes in South Korea and Singapore. Eight other countries are already discussing or developing a sandbox programme, including the Austrian case described in this paper.

3. Methods

This paper aims to elaborate on the following aspects:

- Analyse the legal framework for introducing energy regulatory sandboxes in Europe and Austria: What are the requirements for implementing energy regulatory sandboxes? Where are legal

¹ We thank an unknown reviewer for this comment.

adoptions to European law or national law needed so that regulators or authorities can permit regulatory testing?

- Investigate the actual cases that need regulatory sandboxes in the energy sector: Which specific cases do the energy market stakeholders and energy research propose to be tested in a regulatory sandbox framework?
- Merge these points and thus clarify which cases are legally eligible: Which specific cases that need energy regulatory sandboxes can be enabled by national changes in law and which sandboxes require adoptions in European legislation?
- Prioritise eligible cases for decision makers: When necessary legal adoptions are manifold and heterogeneous, policy makers want to know which cases to focus on first.

These multiple objectives require the application of various methods (see Fig. 1).

Therefore, in a first step, energy research projects were screened (see 3.1) and a stakeholder workshop was carried out in order to identify possible topics for regulatory sandboxes (see 3.3). This was followed by a compilation of the identified issues and their legal analysis (see 3.2). In selected cases, expert interviews with policy makers were also conducted for legal validation purposes (see 3.4). A second stakeholder workshop then took place with the aim to prioritise and assess their leverage effects on climate and energy policy objectives (see 3.3 and 3.5). The identified topics are listed in the evaluation in 4.2 in the form of questions. The specific Austrian or European legal matters that require a regulatory sandbox are not discussed in detail. The detailed listing of the respective provisions would go beyond the scope of this paper; they can be found in Kubeczko et al. (2020).

The methods used are described in detail below.

3.1. Analysis of research reports

As a basis for identifying the (legal) barriers to innovative technologies and in line with the actual needs for regulatory sandboxes, reports from about 40 Austrian and international R&D projects were examined and documented for indications of regulatory barriers. Solutions, such as energy-related technologies and services hampered by legal barriers, have been included in the list of areas with potential needs.

3.2. Legal analysis

After the respective barriers were identified, the need for a regulatory sandbox was assessed based on the research analysis and workshop input (see below). In some cases, the demand for a regulatory sandbox was not confirmed, i.e. if a technology was not economical due to the usual network charges. After that, the relevant hampering Austrian and European legal provisions were analysed. Since the electricity and gas sectors, in particular, are heavily regulated in Europe, the focus was on these energy carriers.

Subsequently, the legal provisions connected with the impeding provision, particularly the superior legal provisions, were examined to determine whether they enable or prevent the establishment of regulatory sandboxes. This assessment was carried out in a holistic analysis of

Austrian law as well as the European legal provisions (in particular the new requirements of the legislative package *clean energy for all Europeans* (cf. European Commission, 2020)), which have primacy in application and thus are binding for Austrian legislature. Wherever the establishment of a regulatory sandbox is possible, it was suggested which possible solutions in terms of energy economics and energy technology could be tested in a sandbox and which provisions of energy law should be adapted accordingly.

The analysis also included an assessment of the European and Austrian legal provisions that should generally be considered when implementing regulatory sandboxes in Austria.

3.3. Comprehensive stakeholder engagement

Two national workshops (2019-12-04 and 2020-01-20, Vienna) formed the centre of the participatory stakeholder engagement. These built on each other, but both were specifically held to gather the views of many stakeholders on the topic of regulatory sandboxes in energy law. A total of around 80 participants were involved. In addition to the Austrian energy regulatory authority and the responsible ministry, the participants included industrial companies, technology developers, energy suppliers as well as energy community service providers and scientific institutions. In this way, a very comprehensive picture of the existing challenges could be obtained. The first workshop focused on identifying the challenges stakeholders face when implementing innovative technologies, services, processes and other solutions. The focus of the first workshop was on discussing, validating, and supplementing existing regulatory challenges or research questions from existing research projects and discussing the need for regulatory sandboxes, advisory and clarification processes. Building on this, the second workshop focused on potential areas and research questions for regulatory sandboxes and their design. The objectives were to prioritise and then assess the potential of the identified topics. For prioritised topics, the potential contributions to climate and energy policy objectives and leverage effects were discussed. Furthermore, factors for the programme's design were examined from the perspective of the stakeholders' needs.

3.4. Expert interviews

Interviews were carried out with representatives responsible for green electricity and tariffs from the Austrian energy regulatory authority and with legal experts from the responsible ministry to deepen and thoroughly examine specific legal issues and increase the robustness of the identified topics and related approaches to solutions.

3.5. Evaluation of the sandboxes' leverage effects

Those topics that require or are deemed to require the testing of possible solutions in regulatory sandboxes were prioritised. The prioritisation was carried out according to the following four criteria:

- Overall effectiveness for CO₂-neutrality: the direct and indirect relevance of a successful regulatory sandbox for achieving energy

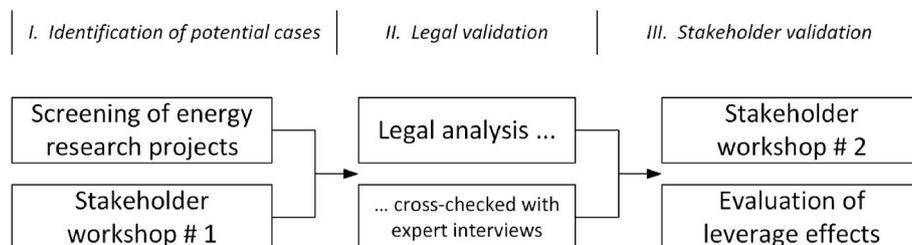


Fig. 1. Methodology of the process to identify needs for energy regulatory sandboxes (source: Energieinstitut an der JKU Linz).

and climate policy goals was evaluated, especially regarding climate neutrality in the upcoming decades.

- **Complexity of implementation:** it was evaluated with what effort or complexity a legal implementation based on a regulatory sandbox can be carried out and the relation between this complexity and the possible effects.
- **Potential for social transformation:** it was assessed what social added value could arise through active participation and acceptance of the population in implementing the analysed measures (i.e. inspiration and information, cf. [Pons-Seres de Brauwer and Cohen, 2020](#)).
- **Defining legal parameters:** it was evaluated to what extent the establishment of a regulatory sandbox is considered as a learning and evaluation process for changing current legal parameters, i.e. whether legal issues are analysed in the context or as a goal of a regulatory sandbox, whether evidence-based, faster legal implementation is possible.

Experts from different institutions and with different areas of expertise (law, economics, socio-economics, technology) conducted a Likert scale grading for each category for each measure. The individual valuations were summed up and put into unweighted relation. A final cross-check of the results by the experts lead to the consensus that the ranking is adequate. The subsequent presentations of the result to stakeholders also did not lead to any criticism.

4. Results and discussion

The results are split into legal results (section 4.1) and outcomes from the literature review and the stakeholder engagement (section 4.2).

4.1. Legal framework for regulatory sandboxes

European law is superior to national law and restricts the possibilities of the Member States. Therefore, a distinction must be made between restrictions that arise from the overarching European legal framework and those that exist at the national level. Changes would be necessary at the corresponding level for the respective regulatory sandbox cases, as described in 4.2.

4.1.1. European legal framework

International, European, and national climate and energy policy goals require a comprehensive transformation of the energy system toward deep decarbonisation. This transformation process relies on a wide range of technological, institutional and social innovations, i.e. it goes hand in hand with new technological demands on the energy system and is based on changed roles and behaviour of many actors (e.g. 'prosumers'). At the same time, the energy transition is embedded in a relatively dense regulatory framework, set up for centralised and non-volatile generation units and the corresponding transmission and distribution networks. Regulatory sandboxes are intended to accelerate the transition to an appropriate legal framework without giving up previous achievements such as security of supply or competition.

Some countries grant regulatory exemptions directly on a legal basis in the form of a national law (e.g. the Netherlands) or in the form of an ordinance, which is a general legal norm issued on a legal basis by an administrative authority (e.g. Germany). The possibility of exemptions from legal requirements is not fundamentally alien to the Austrian legal system. Appropriate regulatory mechanisms (status June 2021) can be found in traffic law (exemptions on specific equipment requirements or safety standards and prohibition regulations, cf. [Lachmayer et al., 2019](#)) or the law governing industrial installations (approval of a trial operation, which suspends the preventive prohibition of the operation of industrial plants before permission).

From a legal perspective, however, not all topics that have been identified as 'candidates' for a regulatory sandbox from an energy policy or RTI policy perspective are equally suitable for establishing regulatory

sandboxes. Mandatory secondary legislation (in particular the rules of the EU internal energy market) may hinder the creation of experimental spaces. Specific implementation obligations (e.g. in connection with the clean energy package (cf. [European Commission, 2020](#)) may determine the design of regulatory sandboxes. Wherever experimental space can be created from an energy law perspective, the requirements of European primary legislation must be taken into account (especially state aid legislation) as well as constitutional requirements (especially the principle of legality and the principle of equality) when defining the specific provisions of national law.

With Art 5 of the EU Regulation on the internal market for electricity (hereafter Electricity Regulation) ([European Parliament and Council, 2019b](#)), however, the EU legislator has explicitly given the Member States the option of providing exemptions from balance responsibility in the interest of innovative projects with limited time and content. With Art 16 of the Directive on common rules for the internal market for electricity ([European Parliament and Council, 2019a](#)) and Art 22 of the Directive on the promotion of the use of energy from renewable sources ([European Parliament and Council, 2018](#)), the energy market is opened to new participants by introducing 'Citizen Energy Communities' and 'Renewable Energy Communities'.

The scope for implementing the energy communities provided by the Directives gives the national legislator the option of differentiated implementation regarding organisational types of communities or country-specific infrastructures. Therefore, the Member States have room for manoeuvre, and the concrete design of the energy communities in the individual Member States will depend heavily on the national provisions. Within this scope, various forms, incentives and business models can be tested in regulatory sandboxes (cf. [Lowitzsch et al., 2020](#)).

4.1.2. Austrian legal framework

From the perspective of Austrian constitutional law, the principle of legality and the objectivity requirement of the principle of equality are of great importance for the design of regulatory experimentation in energy law. The legislator must specify sufficiently who is responsible for granting exemptions by ordinance or decision, and the objectives, basic rules, and procedures for granting exemptions for innovative projects must be specified. The degree of predetermination of administrative action in detail is mainly determined by case law and differentiates according to the respective object of regulation and according to the need for legal protection of those who are subject to the law (cf. Austrian constitutional court decisions 13.785/1994 and 11.499/1987). In areas such as environmental or economic law, the judiciary applies a less strict standard of legal determination than, for example, in criminal law. Especially in the regulation of economic matters, the requirements for determination according to the jurisdiction must not be exaggerated. Case law of the constitutional court has clarified this, e.g. in the case of the authorisation to set 'economically justified prices', where rapid access and the consideration of diverse local and temporal differences are necessary for a meaningful and effective regulation. This jurisdiction applies to price-fixing in energy law.

The principle of equality requires (cf. Austrian constitutional court decisions 6410/1971 and 8169/1977) that the legislator can provide objective justification for differentiation between those subject to the law or for a deviation from the legally established system of order. Since regulatory sandboxes are created by granting exemptions, there may be treatment favouring those actors to whom the exemption applies. Consequently, there must be an objective justification for this. An objective justification may lie in the character of the regulatory sandbox as a learning and experimental space for climate and energy policy objectives. A transparent selection process and accompanying monitoring and reporting obligations are also recommended from an innovation policy perspective and contribute to the objective justification. At the same time, however, it must be ensured that there are not too extensive hurdles that would prevent smaller organizations in particular (especially in the area of energy communities) from participating in a

regulatory sandbox programme.

It is found that the energy regulatory authority cannot exempt demonstration projects for experimental purposes due to the lack of legal or regulatory provisions in Austrian energy law. A draft bill (Austrian Ministry for Climate Action, 2020) schedules the possibility of granting exemptions from electricity and gas network charges for research and demonstration projects (status June 2021). As will be shown in Chapter 4.2, the need for regulatory sandboxes may go beyond this.

4.2. Potential regulatory sandboxes

Within the energy sector, topics that show a need for regulatory sandboxes are predominantly in the areas of electricity and gas. These two energy carriers are intensively regulated compared to other energy carriers such as oil and biomass, which are not network-bound. District heating, being another network-bound energy carrier, is also less regulated, probably due to its regional limitations and network-specific peculiarities (cf. Holzleitner et al., 2020). At the same time, these dense and strict national provisions originate from superior (European) legal provisions. Often, these superior (European) provisions are very specific or conclusive and, at the same time, do not contain experimentation clauses (in the sense of regulatory sandboxes) at the European level or rarely authorise the Member States to establish such.

In 4.2.1, we look at the Austrian potential for regulatory sandboxes. Section 4.2.2 examines those regulatory sandboxes that must be addressed at the European level.

4.2.1. Austrian (national) potential

For 15 topics, it was found that (i) a regulatory sandbox is required and (ii) that fitting regulatory sandboxes can be installed by adopting Austrian law. Table 1 provides an overview of the identified topics and their ranking calculated based on the methods described in section 3.5 and an allocation to a cluster. Clusters derived from the 15 topics are:

- Gas regulation cluster (Gas): Gases such as hydrogen, synthetic methane or biogas will play a more prominent role in a future energy system. The fluctuating (electricity) generation makes (long-term) storage a requirement. One advantage of these gases is that they can rely on the existing natural gas infrastructure. However, there are still challenges related to that. Two topics are therefore allocated to this cluster.
- Electricity network regulation cluster (EL-Net): In general, the power grid is subject to rapid changes in circumstances: an ever-increasing proportion of decentralised feed-in, fluctuating feed-in, new technologies (batteries and other storage systems) and new ICT-based market roles (e.g., aggregator) result in high pressure to adapt the electricity network regulation. There are two sub-clusters: The first sub-cluster, “network tariffs and new services”, with five topics, analyses the efficient integration of market players, the approval of new services and the network charges. The second sub-cluster, “optimised network cost recovery”, with two topics, investigates the specifications and the common practice of cost recovery by the regulated distribution network operators.
- Technology preference cluster (Tech): Given the constant efforts to combat climate change and use local resources, future electricity market technologies will include (fluctuating) renewables and the storage systems necessary to integrate them into the energy system. For both technology areas, it should be checked whether a better positioning in the regulation is appropriate, i.e. give preference for system-friendly technologies. In this cluster, two topics are included.
- Energy communities cluster (EC): Energy communities are a relatively new topic in energy sector regulation. The European legislator has given the Member States great freedom in implementation, probably also to meet the diverse initial situations of the Member States. Energy communities still raise many questions about the

Table 1

An overview and ranking of potential topics for regulatory sandbox application.

Topics for regulatory sandboxes (overview)	CLUSTER	RANK
1. Proximity criteria for energy communities: what shall be the parameters with which proximity is legally defined?	EC	1
2. Gas network limits: what adjustment of standards can be made to increase the allowed proportion of hydrogen or biogas while maintaining network safety and energy quality?	Gas	1
3. Dynamic electricity network tariffs: what kind of dynamic tariffs (instead of static kWh- or kW-dependent ones) may enable supportive customer behaviour in smart grids?	El.-Net	3
4. Gas network feed-in: to what extent can the standards be adapted to allow for the direct feed of hydrogen or biogas into the gas grid?	Gas	3
5. Compliance with being a supplier: how can standards be adapted to facilitate the market entry of new-type energy market players (e.g. aggregators, energy communities)?	EC	3
6. Non-profit orientation of energy communities: should profit-oriented service providers be eligible to operate and manage (not: legally control) energy communities?	EC	3
7. ICT for distribution network control: should there be a harmonisation/standardisation among distribution system operators as different technologies may hamper the introduction of smart services?	El.-Net	7
8. Central platforms for power grid data: how can the provision of actual and near-time data (smart meter, transformers, power flows) be organised to enable smart services?	El.-Net	7
9. Exemptions from electricity network tariffs: should distribution system operators be able, based on a sound method, to decrease a customer's charges in case of network-supporting behaviour?	El.-Net	7
10. Network tariff exemptions for system-relevant technologies: which technologies' (future) system relevance justifies exemption? (E.g. batteries, power-to-gas/heat, pumped storage.)	El.-Net	7
11. Eligibility of smart technologies as network costs: how can the regulatory acceptance of using smart technologies instead of standard network extension be mainstreamed?	El.-Net	11
12. External relations of energy communities: how should energy communities interact with the rest of the electricity system (control power, balancing, market participation)?	EC	11
13. Network operator benchmarking: what should be the parameters to assess the efficiency and innovation of network operators?	Tech	13
14. Real-time electricity network status ('traffic light system'): what are the parameters that define the status of the grid, and what restriction of market actions should be associated?	El.-Net	14
15. Control energy market participation: should there be more specific requirements to enable smart technologies and renewables to participate?	Tech	15

community's position, especially within the regulated electricity sector. These questions are only gradually determined, and considerations as to whether better alternatives for detailed interpretations are justified and worth examining.

However, it has to be noted that regulatory sandbox programmes should also be open to other ideas and emerging needs for experimentation. Thus, while adhering to the given principles and goals, there should be room for new, as yet unknown issues. The clusters and topics listed here are an analysis of the existing system and existing needs.

Except for three of the 15 identified topics, as expected, all relate to the electricity sector. Thus, it becomes evident that electricity regulation is at the center of the need for innovation.

Regarding these 15 needs, it is possible to implement regulatory sandboxes in Austria through legal adjustments. Solutions for the identified challenges can be tested in these regulatory sandboxes. Since this chapter assesses the introduction of regulatory sandboxes based on what is already possible under the European framework, the assessment can be transferred to other EU Member States with similar problems (e.g. share of hydrogen in the gas network). However, the overarching

European law already leaves room for manoeuvre, which means that the possibility of regulatory sandboxes in other countries also exists, is possibly used, or there is no need for them because regulated markets are designed differently. Summing up, the need for regulatory sandboxes is likely to be similar in the other EU Member States, but this cannot be verified based on the Austrian experience.

The location of the clusters within the ranking shows that the *gas cluster* appears to be the most important, with an average rank of 2. The relevance of hydrogen and renewable gases in a sustainable energy system and the definable parameters to be analysed and controlled in the identified topics are decisive for this position. In second place are *energy communities*, with an average of 4.5. Their high relevance for the social acceptance of the transformation of the energy system and the ease of legal implementation (when sandboxes achieve concrete results) is decisive. The *electricity network cluster* achieved rank 8, on average. Despite the given need for transformation, there are many individual parameters to be optimised, which reduces the effect of a single sandbox (although it is undoubtedly important). The preference for technologies (average rank 14) is very particular and, as a result, is also associated with many influencing factors that need to be optimised.

4.2.2. European potential

In some areas where challenges have been identified, an adjustment at the European level is necessary to allow for the implementation of regulatory sandboxes. Apart from the mentioned authorisation according to Art 5 Electricity Regulation (European Parliament and Council, 2019b), there are no such provisions in European energy law at present. Therefore, if mandatory and conclusive provisions have been enshrined in the European legal framework, Member States cannot deviate from them, not even for experimental purposes. The identification process revealed that there are challenges in which it would be useful and necessary to try out solutions in regulatory sandboxes (see below). Creating more space for experimentation should be considered at the European level to achieve regulatory learning. The following identified topics are exemplary:

- Participation in energy communities: should large companies be allowed to participate?
- Storage and power-to-gas system operation: should distribution system operators be allowed to own, develop, manage, or operate storage and power-to-gas systems?
- Virtual power plant operation: should distribution system operators be allowed to own, develop, manage, or operate so-called virtual power plants?

5. Conclusion and policy implications

Since the legal framework is designed for existing technologies and business models, innovators often face legal barriers. Rapid change to the regulatory framework, especially in innovative areas, often involves legal and other uncertainties. To establish adequate framework conditions for technologies and business models that contribute to achieving the climate and energy policy goals, testing new solutions in so-called regulatory sandboxes should be enabled. These regulatory sandboxes are an approach to accelerate innovation processes within a legal framework that allows innovative solutions to experiment while striving for regulatory learning, namely the adoption of legal provisions to enable and keep pace with the technological developments and solutions needed to tackle the climate crisis.

Given this legal challenge, we approach regulatory sandboxes in two ways: (1) We investigate the legal requirements that must be considered when introducing regulatory sandboxes into the Austrian legal framework. Furthermore, (2) we identify those energy topics that have an actual need for regulatory sandboxes. We thus discuss the legal provisions relevant for building the preconditions for the regulatory body in Austria to grant exemptions, examining it from the perspective of

European Law as well as Austrian energy and constitutional law. Based on the analysis of research reports, legal analysis and extensive stakeholder engagement as described in 3.1 through 3.4, we identified 15 topics that could profit from regulatory sandboxes. We discuss alternatives and provide some considerations regarding a broader basis for sandbox experimenting in European energy legislation.

Some needs for regulatory sandboxes go beyond what can be tested by adoption at the national level. This situation is due to conclusive European provisions that do not allow any deviation, even for limited exemptions for experimentation. By enabling regulatory sandboxes through legislation at the European level, regulatory policy experimentation and improvement would not be limited to the Member States.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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