islander
ACCELERATING THE DECARBONIZATION OF ISLANDS' ENERGY SYSTEMS

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DELIVERABLE 2.1:

SET OF APPLICABLE LOCAL AND NATIONAL REGULATIONS

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Abbreviations

- AVBFernwärmeV: Verordnung über Allgemeine Bedingungen für die Versorgung mit Fernwärme
  (Ordinance on General Terms and Conditions for the Supply of District Heating)
- AMI: Advanced Metering Infrastructure
- ANM: Active Network Management scheme
- CENELEC: Comité Européen de Normalisation Electrotechnique
- CHP: Combined Heat and Power
- CIM: Common Information Model
- CfD: The Contract for Difference
- CROPEX: Hrvatska burza električne energije d.o.o. (Croatian Power Exchange Ltd)
- DAM: Day Ahead Market
- DER: Distributed Energy Resources
- DMS:Distribution Management System
- DNO: Power distribturo in Scotland
- DSO: Distribution System Operator
- EC: Energy Communities
- EEG: Erneuerbare-Energien-Gesetz (German Renewable Energy Sources Act)
- EEX: European Energy Exchange (energy market)
- EnEX: Hellenic Energy Exchange
- EPEX: Energy Market for the EU
- ESQCR: Electricity Supply Quality and Continuity Regs
- EU: European Union
- FCH: Fuel Cells and Hydrogen
- FFR: Firm Frequency Response
- HEP ODS: Croatian DSO
- HERA: Hrvatska energetska regulatorna agencija (Croatian Energy Regulatory Agency)
- HOPS: Hrvatski operator prijenosnog sustava (Croatian Transmission System Operator)
- HROTE: Hrvatski operator tržišta energije (Croatian Energy Market Operator)
- IDM: Intra Day Market
- IEC: International Electrotechnical Commission
- IPTO: Independent Power Transmission Operator
- IT: Information and Technology
- LAP: Legal and Administrative Processes
- OMS: Outage Management System);
- PV: Photovoltaic Installation
- RAE: Energy Regulatory Authority
- SGAM: Smart Grid Architecture Model
- TSO: Transmission System Operator
- UK: United Kingdom

1 Executive summary

"D2.1 Set of applicable local and national regulations" presents the regulations that need to be taken into account to implement the ISLANDER project following the current legislation framework. An analysis has been carried out in the context of low voltage installations, medium voltage installations, district heating and hydrogen installations. Furthermore, an energy market has been included in section 5 that is particularised to each of the five islands participating in the project.

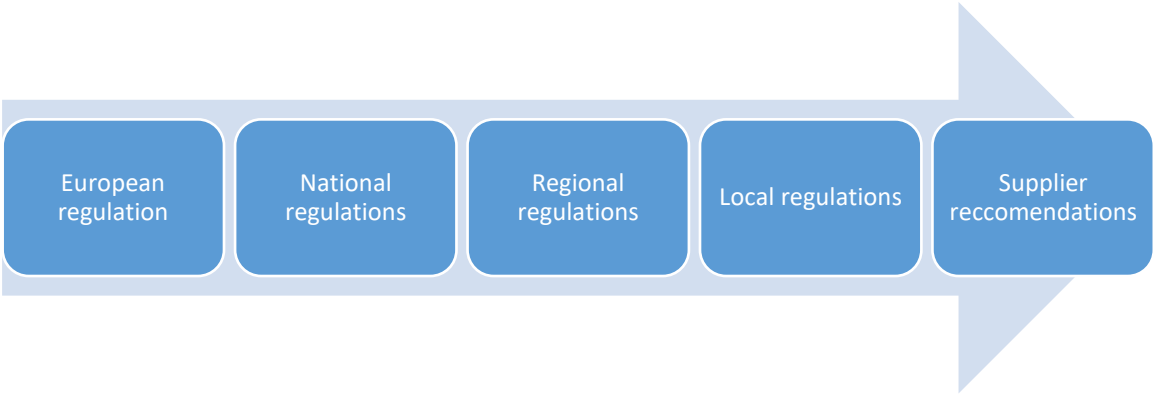
Due to the ISLANDER project strategy to ease the replication of results, this deliverable is not only providing the German legislation analysis, but also presenting the methodology, steps and key relevant topics to take into account to help other follower islands address an analogue study.

2 Introduction

This deliverable is intended to establish the guidelines for an effective deployment while fulfilling all the national and local regulations which apply in the case of Borkum. Nevertheless, the approach to this deliverable has been wider with two main objectives: serve as a guideline for the rest of the follower islands or external readers interested to apply this knowledge into their national or local framework, and also, make a first study about the energy market in the different islands.
Even if Borkum is the showcase of ISLANDER project, where all assets will be deployed and tested, the perspective of WP8 related to replication strategy made us focus this deliverable with a wider scope in order to structure the content in a way that the study of the regulatory framework in Borkum Island is not the only single result, but also gathering in this deliverable the methodology and key points considered to help on the replication of this regulatory study.

3 Methodology followed for regulations analysis

This section gathers the procedure developed in this deliverable in order to find and analyse the existing regulations. Main objective of this section is to let any reader be able to use these guidelines to replicate a similar analysis in other countries.
Workflow to take into account when analysing any applicable regulation is:



The planning of a plant for the generation of energy is subject to several framework conditions, most of which are generally valid on a national level.
However, it is necessary to check whether there are deviating regulations at regional level for each framework condition.
In particular, the following regulations must be examined in relation to:

- Existing building codes that can be different according to the location: size of building, type of building, specification on the roof to let PV fit with the environment etc
- Possible protection of historical monuments: not only the monument but also the surroundings must be following certain conditions

- Electrical installation regulations
- Energy feed-in regulations
- Grid connection ordinance (low voltage or medium voltage)
- Ordinance on the supply of district heating
- Energy market

4 Legal and policy frameworks analysis

This section will define the regulations applicable at a national level in Germany. There are no local regulations different in the region of Niedersachsen (Lower Saxony), so the detailed study is going to be framed in the German regulations.
Only with regard to building law are there regional differences or more detailed regulations. For example, the "Baugesetzbuch" (Building Code) [10] (Source: https://www.gesetze-im-internet.de/bbaug/) applies at the federal level, the "Niedersächsische Bauordnung" [11] (Lower Saxony Building Code) (Source: http://www.nds-voris.de/jportal/?quelle=jlink&query=BauO+ND&psml=bsvorisprod.psml&max=true&aiz=true) at the state level, and the "Bebauungsplan" (Development Plan) applies in the municipal building area.
In Germany, building law is a matter for the federal states. While the "Baugesetzbuch" regulates urban land-use planning, the respective "Landesbauordnung" (building code) of a federal state defines practical concerns of building on a plot of land. These include, among other things, stability, fire protection and the form and scope of the building application. The Land building codes also regulate who the building supervisory authorities are and how administrative procedures are carried out. In addition, they contain regulations on administrative offences, legal ordinances and regulations. The regulations differ in detail from federal state to federal state.
In Germany, ordinances and laws governing the construction and operation of facilities for the generation, transport and feeding in of energy are generally applicable and do not vary from region to region.
As a general methodology followed in the assessment of the regulation, next key relevant points were considered along this section 4 to provide the presented analysis

- Name of the current regulation.
- Scope of the regulation: main objective and targeted audience.
- Name of the institution in charge of regulating mentioned topics.
- Name of the auditing agencies in charge of each system.
- Related policy frameworks involved in the regulated topic.
- Access to the regulation: Link or way to access
- Analysis of regulation

All VDE and DIN regulations mentioned in this document [12] aren't accessible to the public audience and have to be bought or a membership is necessary. This is due to their organisation policy.
Their websites are for DIN: https://www.din.de/en
And for VDE [13] its: https://www.vde.com/en
The further mentioned federal laws are accessible to the public audience on the internet with the following link: https://www.gesetze-im-internet.de/

Laws and regulations regarding state (Niedersachsen) laws are also accessible to the public audience with the following link:
http://www.voris.niedersachsen.de/jportal/portal/page/bsvorisprod.psml

Moreover, other references taken into account in the description of this deliverable are refered [8] Bundesministerium der Justiz und für Verbraucherschutz and [9] Niedersächsisches Vorschirfteninformation system (NI-VORIS)

Once we have explained the general approach in the methodology followed, within the next sections, we can proceed to go through the detailed analysis of this regulation in the Borkum community.

4.1 Low-voltage installations

Existing Building codes
Building permit
In general, no building permits are required for photovoltaic systems. However, this statement only applies to photovoltaic systems mounted on roofs or facades. Other conditions apply to ground-mounted systems. Only the design of roofs and facades can be regulated in the development plan.

Possible protection of historical monuments
The "protection of historical monuments" is also a matter for the Länder. In Lower Saxony, for example, the "Niedersächsisches Denkmalschutzgesetz" (Lower Saxony Monument Protection Act) [14] (Source: http://www.voris.niedersachsen.de/jportal/?quelle=jlink&query=DSchG+ND&psml=bsvorisprod.psml&max=true&aiz=true) regulates the protection of historic buildings. This applies in particular to the building on which a PV system is to be erected and to adjacent buildings.

Electrical installation regulations
The following electrical standards apply to the installation of PV systems:

- DIN VDE 0100-712:Oktober 2016 Installation of low-voltage systems - Part 7-712 Requirements for special category premises and equipment - Photovoltaic (PV) power supply systems.
- DIN EN 62446-1:Dez 2016 (VDE 0126-23) Grid-connected photovoltaic systems - Minimum requirements for system documentation, commissioning testing and periodic testing.
- DIN EN 62305-3 Beiblatt 5:Feb 2014 Lightning protection Part 3: Protection of structures and persons; Supplement 5: Lightning and surge protection for PV power supply systems.
- VDI Richtlinie VDI 6012 Renewable and decentralised energy systems for buildings. Basics, mounting solar modules and collectors on buildings.
- VDE AR-E 2100-712 Measurements for the DC area of a photovoltaic system to maintain electrical safety in the event of firefighting or technical assistance

VDE regulation is not public for the general audience, they need to be bought and they are expensive. Nevertheless, electricians have access to these regulations to gain the knowledge necessary to out their work.

Energy feed-in regulations

The "Erneuerbare-Energien-Gesetz (EEG2021)" (German Renewable Energy Sources Act) [15] (Source: https://www.gesetze-im-internet.de/eeg_2014/)regulates the preferential feed-in of electricity from renewable sources into the electricity grid and guarantees their producers fixed feed-in tariffs

Grid connection ordinance (low voltage or medium voltage)

The VDE application rule VDE-AR-N 4105 applies to the planning, construction, operation and modification of, among other things, solar power systems that are connected to the low-voltage grid of a grid operator and operated in parallel with the low-voltage grid.
They are obligatory technical functions of solar power systems, such as power control, unbalanced load, NA protection and provision of reactive power.
It is to be applied to generation systems and energy storage systems that are newly connected to the low-voltage grid, as well as to the expansion or modification of existing systems with a total effective power (Σ PAmax) of up to 135 kW.

Provider's recommendations

Each of the provider supplying the assets to be installed such as inverters, batteries and ultracapacitors should provide a guidance on installation and a set of recommendations for the proper use of the connection and use of the system. These guidance need to be in compliance with local and national regulation abovementioned.
In ISLANDER particular case, partners Cegasa and Zigor will provide a set of technical and end user documentation in WP2 deliverables to describe the systems. Cegasa will focus on Li-ion batteries and Zigor will describe Ultracaps solution for Utility Scale ESS solutions and the Power and control electronics for building solutions. Inverters for household will be selected from a commercial provider out of the consortium, who will be requested to provide specific data.

4.2 Medium-voltage installations

Existing building codes

In general, no building permits are required for photovoltaic systems. However, this statement only applies to photovoltaic systems mounted on roofs or facades. Other conditions apply to ground-mounted systems. Only the design of roofs and facades can be regulated in the development plan.

Possible protection of historical monuments

The "protection of historical monuments" is also a matter for the Länder. In Lower Saxony, for example, the " Niedersächsisches Denkmalschutzgesetz" (Lower Saxony Monument Protection Act) regulates the protection of historic buildings. This applies in particular to the building on which a PV system is to be erected and to adjacent buildings.

Electrical installation regulations

The following electrical standards apply to the installation of PV systems:

- DIN VDE 0100-712:Oktober 2016 Installation of low-voltage systems - Part 7-712 Requirements for special category premises and equipment - Photovoltaic (PV) power supply systems
- DIN EN 62446-1:Dez 2016 (VDE 0126-23) Grid-connected photovoltaic systems - Minimum requirements for system documentation, commissioning testing and periodic testing
- DIN EN 62305-3 Beiblatt 5:Feb 2014 Lightning protection Part 3: Protection of structures and persons; Supplement 5: Lightning and surge protection for PV power supply systems
- VDI Richtlinie VDI 6012 Renewable and decentralised energy systems for buildings. Basics, mounting solar modules and collectors on buildings
- VDE AR-E 2100-712 Measurements for the DC area of a photovoltaic system to maintain electrical safety in the event of firefighting or technical assistance

Energy feed-in regulations

The "Erneuerbare-Energien-Gesetz (EEG2021)" (German Renewable Energy Sources Act) regulates the preferential feed-in of electricity from renewable sources into the electricity grid and guarantees their producers fixed feed-in tariffs.

Grid connection ordinance (low voltage or medium voltage)

The VDE application rule VDE-AR-N 4110 applies to the planning, construction, operation and modification of, among other things, solar power systems that are connected to the mid-voltage grid of a grid operator and operated in parallel with the mid-voltage grid.
They are obligatory technical functions of solar power systems, such as power control, unbalanced load, NA protection and provision of reactive power.
It is to be applied to generation systems and energy storage systems that are newly connected to the mid-voltage grid, as well as to the expansion or modification of existing systems with a total effective power (Σ PAmax) of more than 135 kW.

Providers recommendations

Each of the provider supplying the assets to be installed such as inverters, batteries and ultracapacitors should provide a guidance on installation and a set of recommendations for the proper use of the connection and use of the system. This guidance needs to be in compliance with local and national regulation abovementioned.

4.3 District heating installations

Existing Building codes

In the case of district heating supply, the local development plan must be observed, depending on the design of the necessary buildings. The type of use and size ratios are important here.

Possible protection of historical monuments

The "protection of historical monuments" is also a matter for the Länder. In Lower Saxony, for example, the " Niedersächsisches Denkmalschutzgesetz" (Lower Saxony Monument Protection Act) regulates the protection of historic buildings. This applies in particular to the building on which a PV system is to be erected and to adjacent buildings.

Regulations regarding the usage of seawater

It has to be guaranteed that none of the seawater is polluted by the heating system. According to the German Criminal Code [16] (Strafgesetzbuch (StGB)) §324 (Source: https://www.gesetze-im-internet.de/stgb/) it is a criminal offence to "unauthorizedly pollute a body of water or otherwise adversely change its characteristics"

Ordinance on the supply of district heating

The „Verordnung über Allgemeine Bedingungen für die Versorgung mit Fernwärme (AVBFernwärmeV)" [17] (Ordinance on General Terms and Conditions for the Supply of District Heating) (Source: https://www.gesetze-im-internet.de/avbfernw_rmev/) regulates supply conditions between the district heating supply company and the consumer.
The regulation covers the whole process from conclusion of the contract, installing, technical aspects of the system such as the connection to the distribution network. The distributing company is also permitted to instruct other technical requirements if it is necessary to ensure a secure and stable supply especially regarding the distribution network. Also regulated are liability and billing.

Other important regulations regarding district heating are:

- DIN 12828 European Norm for heating systems: This standard specifies the requirements for hot water heating systems with an operational temperature of max. 105°C. It covers heat generation systems, heat distribution systems and control systems of heating systems. Some parts of this standard are more strictly regulated in German standards e.g. concerning energy efficiency measures.

- DIN 18380 Heating Systems and Central Water Heating Systems: This standard covers technical requirements regarding materials, installation and billing in the process of building a water heating system.

4.4 Hydrogen installations

When talking about regulation of hydrogen installation, the ISLANDER consortium found a project that is very interesting to be included as a source to easily access information in this field - this is HyLaw project. In this section, further details about this project and the information there gathered will be detailed in order to be used as a reference for the rest of the Follower islands. Furthermore, a general structure about the regulation applicable to the implementation of hydrogen in the context of ISLANDER, framed in the German island of Borkum will be also detailed.

4.4.1 HyLaw project: legal framework for hydrogen systems

HyLaw project stands for Hydrogen Law and concerns the removal of legal barriers to the deployment of fuel cells and hydrogen applications. The project is aimed at boosting the market uptake of hydrogen and fuel cell technologies, providing market developers with a clear view of the applicable regulations.
The project brings together 23 partners from different countries: Austria, Belgium, Bulgaria, Denmark, Finland, France, Germany, Hungary, Italy, Latvia, Norway, Poland, Romania, Spain, Sweden, Portugal, the Netherlands and the United Kingdom.
The HyLaw partners first identify the legislation and regulations relevant to fuel cell and hydrogen applications and legal barriers to their commercialisation. They will then provide public authorities with country specific benchmarks and recommendations on how to remove these barriers.
On the project website, it is possible to find the applicable legal and administrative processes in all the countries covered, including Germany. Main information available there is:

- National policy papers of Germany, in German and English language
- EU policy paper
- Some public deliverables inside the project, such as "List of legal barriers" or "EU regulations and directives which impact the deployment of FCH technologies", among others
- Database -this is the most prominent point. It is structured in nine categories, as seen in the following screenshot.

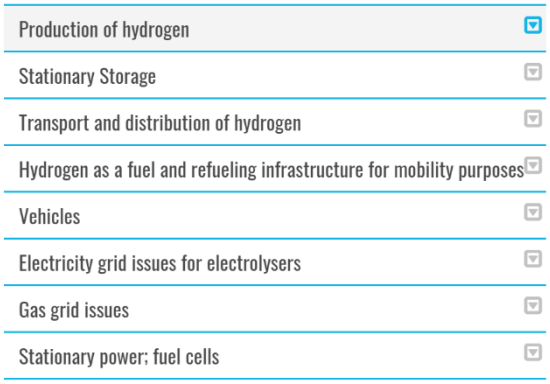


Figure 1 Web-based Database

Within each category, a number of relevant hydrogen applications and different legal and administrative processes (LAP's) are covered. Once selecting the category, application, legal and administrative process (LAP) and the country you are interested in, you will be directed to a page displaying the data collected in the project's course.
Additionally, the website has an interactive map that indicates restrictions in each country (if there are any). The next screenshot shows an example, where it is possible to see that no barrier exists in Germany. Green colour indicates no barrier, yellow colour low barrier, orange colour medium barrier, while the red colour indicates that high risk and barriers are present within the selected country.

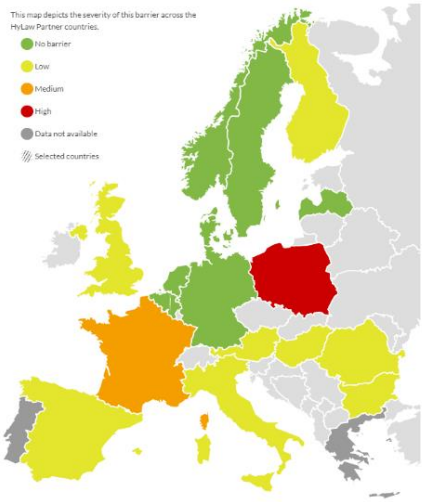


Figure 2 Hydrogen country severity barrier

4.4.2 Methodology followed to approach the hydrogen regulation

In order to track the regulation framework, the reference points to consider are:

1. EU legislation: can be found in this portal
2. National legislation
3. Regional / Local regulation

By accessing the HyLaw project, a table containing legislative data can be found: https://www.hylaw.eu/database/legislation?laps%5b%5d=9
The mentioned information provided is:

- Country: Select from the list all the European countries available in this study
- Category: Different hydrogen applications can be found such as production of hydrogen, stationary storage or electricity grid issues for electrolyzers among others. The full list can be seen here:

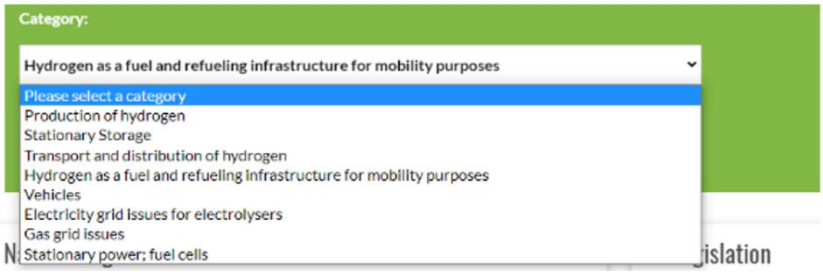


Figure 3 Category list

- Application: a scroll down list can be found as depicted in the next image, which is related to the category selected. For example, by selecting the category "Hydrogen as fuel and refuelling infrastructure for mobility purposes" The next images details the various application options: Fuel Origin, Fuel Quality, Measurement and finally, HRS and Hydrogen delivered to stations

Figure 4 Application list

- Under the Legal and administrative processes (LAPs) list, you can see the specific topics related to the category and applications selected above.

Once the four main entry points are selected, the HyLaw website provides two lists: one of them framed in the national legislation in the selected country, and a second one related to EU legislation.
Regarding the national / local rules to be applied to the hydrogen, each organisation should look for further information internally in the local energy agencies, or energy departments in the national / regional governments in order to have the whole overview of the regulation that applies to the installation.

4.4.3 Study of the hydrogen regulation in the context of ISLANDER and the German island of Borkum

Taking into account the provided information before for HyLaw, and landing to the specific case to Borkum, the following table shows a compilation of the rules and basic regulation that must be considered from the point of view of the production, storage design and operation of hydrogen systems.

NORMATIVE AND REGULATION IN THE DESIGN OF A HYDROGEN SYSTEM		
NATIONAL LEGISLATION	EU LEGISLATION	LOCAL LEGISLATION
National Policy Paper-Germany	Directive 2014/23/EU (ATEX Directive)	Municipal Building Code (Kommunaler Bebauungsplan)
Building code (Baugesetzbuch, BauGB)	Directive 9992/EC (ATEX Directive)	
Federal Land Utilization Ordinance	Directive SEVESO 2012/18/EU (control accident involving dangerous substances)	
Federal State Building Regulations	Industrial emissions Directive 2010/75/EU	
Law to the ADR European Agreement	Directive 2014/18/EU (Control accident hazards)	

Ordinance for Transportable Pressure Equipment (Ortsbewegliche-Druckgeräte-Verordnung)	Directive 2014/34/EU (ATEX Directive, covering equipment and protective systems)	
Renewable Energy Act (Erneuerbare-Energien-Gesetz)	Directive 2011/92/EU (Effects on environment, EIA Directive)	
Electricity Grid Access Ordinance (Verordnung Uber den Zugang zu Elektrizitatsersorgungsnetzen)	Directive 2014/52/EC (Assessment of the effects of projects on the environment)	
Low Voltage Connection Ordinance (Niederspannungsanschlussverordnung, NAV)	Directive 2001/42/EC (Assessment of plans and programmes on the environment)	
Energy Tax Act (Energiesteuergesetz, EnergieStG)	Directive 2004/35/CE (Prevention and remedying of environmental damage)	
Electricity Tax Act (Stromsteuergesetz, StromStG)	Directive 2009/104/EC (Health and safety of workers at explosive atmospheres)	
Renewable Energy Act (Erneuerbare Energien Gesetz, EEG)	Directive 1999/92/EC (Health and safety of workers)	
German Immission Control Act (Bundes-Immissionsschutzgesetz, BImSchG)	Directive 2014/68/EU (Harmonization of laws of pressure equipment)	
German Energy Industry Act (Energiewirtschaftsgesetz, EnWG)	Directive 92/43/EEC (Conservation of natural habitats and of wild fauna and flora)	

Ordinance on Industrial Safety and Health (Betriebssicherheitsverordnung, BetrSichV)	Directive 2009/147/EC (Conservation of wild birds)	
Ordinance on Installations Requiring Permit (Verordnung über genehmigungsbedürftige Anlagen,4. BimSchV)	Directive 2014/94/EU (Deployment of alternative fuels infrastructure)	
Environmental Impact Assessment Act (Gesetz über die Umweltverträglichkeitsprüfung, UVPG)	Directive 2009/28/EC (Promotion of use of energy from renewable sources)	
Ordinance for the protection of hazardous substances (Verordnung zum Schutz vor Gefahrstoffen)	Directive 2009/72/EC (Common rules for the internal market in electricity)	
Biofuel Sustainability Ordinance (Biokraftstoff–Nachhaltigkeitsverordnung, Biokraft–NachV)	Commission Regulation EU 2016/1388 (Network Code on Demand Connection)	
	Directive 2012/27/EU (Energy efficiency)	

4.5 IT infrastructure

IT systems deployed in the island of Borkum are in the context of driving energy assets into a smart management system and so it is worth mentioning standard ISO/IEC 27019:2017 [4] which concerns information technology, security techniques and information security management that provides guidelines based on ISO/IEC 27002 for process control systems specific to the energy utility industry.
According to the public ISO definition of this standard, ISO/IEC 27019:2017 is based on ISO/IEC 27002:2013 applied to process control systems used by the energy utility industry for controlling and monitoring the production or generation, transmission, storage and distribution of electric power, gas, oil and heat, and for the control of associated supporting processes. The relevant particular information that this standard is defining includes next key points:

- "Energy management systems, e.g. of Distributed Energy Resources (DER), electric charging infrastructures, in private households, residential buildings or industrial customer installations;"
- "Distributed components of smart grid environments, e.g. in energy grids, in private households, residential buildings or industrial customer installations;"

- "All software, firmware and applications installed on above-mentioned systems, e.g. DMS (Distribution Management System) applications or OMS (Outage Management System);"
- "Remote maintenance systems for above-mentioned systems."
- "Central and distributed process control, monitoring and automation technology as well as information systems used for their operation, such as programming and parameterization devices;"
- "All further supporting information systems used in the process control domain, e.g. for supplementary data visualization tasks and for controlling, monitoring, data archiving, historian logging, reporting and documentation purposes;"
- "Communication technology used in the process control domain, e.g. networks, telemetry, telecontrol applications and remote control technology;"
- "Advanced Metering Infrastructure (AMI) components, e.g. smart meters;"
- "Measurement devices, e.g. for emission values;"
- "Digital protection and safety systems, e.g. protection relays, safety PLCs, emergency governor mechanisms."

This standard is not accessible to the general public for free, and further information can be found here: https://www.iso.org/standard/68091.html. This standard is the most recent work for gathering previous standards and aims at different levels of the architecture domains, mainly in terms of service, distribution and operation.

Even if the abovementioned ISO is very complete and convenient to consider in the project, due to the restriction of access, a different approach should be also considered in the the ISLANDER project in case it is finally impossible to have access to the whole payed standard, so that other relevant IT open protocols also related to the scope of ISLANDER, that are open and accessible to the general public are listed in next table:

Protocol	Scope
SGAM [6]	IT documentation
IEC 61968, CIM [7]	Definition and exchange information with the DSO
FIWARE [8]	Open microservice platformatization, IoT and IIoT integration
OpenADR [9]	Energy interoperability for Demand response services

5 Energy market study

This section aims at providing a general study about the energy markets in all the islands participating in the project, both as case study likewise Borkum, or as Follower islands as Orkney, Cres, Skopelos and Lefkada.
The consortium compiled a study about the more relevant points to be included in this study, so the structure of information here depicted is also a valuable output, furthermore than just the information collected for each particular case.
Thanks to the work done in the next section, the project replication will be eased thanks to the consideration of several transversal aspects that will be taken into account and used as a comparative analysis among the islands throughout the project

lifespan. The main structure of the document is presented in the next table, which is to be filled in by each of the particular cases:

First considerations		
Is the island interconnected to the mainland?		
Is there a monopoly on the island? (only one TSO/DSO that operates on the island?)		
Types of energy market.		
Type	Description about how it works (minimum energy to include, organisation to sell the energy, price to sell, taxes, fines for not reaching compromised target, type of company/end-user who can access to this market....	Brief description about key points to consider when participating
Day Ahead		
Intra day		
Ancillary services		
Feed-in tariff		
….. include other		
Energy market in island and in mainland: main differences		
Type of difference (economical type of access, regulation....)	Definition	Advantage and/or disadvantage
National applicable Regulation to access energy market		
Name of organisation	Name of the regulation	Key points covered in the regulation: (such as minimum price, installation certification, minimum volume of energy to access the market, kind of end-user, kind of installations...
Organisation 1: xxxxx		
Organisation 2: xxxxx		
Obstacles to ease the energy production (this chapter is addressed to include spotted problems of		
Type of obstacle (regulation/ social/ economical...)	Definition of obstacle	Is there a tentative proposal so solve this obstacle? Who should be involved to solve it?
Obstacle 1: Regulation		

Obstacle 2: xxxx		
Obstacle 3: xxxxx		
Other key factors to study in the energy market for islands		
Key factor nº	Definition	Actor involved (national laws, DSO, end-user …)
Access to market		
Which electricity markets / system services / capacity markets / etc. is available in your island?		
How can we reach these flexibility markets within the framework of the ISLANDER project? (Can everybody enter the market or is it restricted to some actors only)?		
Which market/service would you consider for ISLANDER purposes? Can it be replicated to other islands?		
Regarding all abovementioned questions : do you expect significant changes in the near future ? (evolution of the distribution, production, markets…)		
Any other relevant information regarding access to market?		
Off-grid assets		
Off-grid assets in the islands: regulatory aspects.		
Off-grid Microgrid (not connected to the main grid) owned by energy communities (not connected to the network like a low populated village)		

Any other relevant info regarding off-grid assets	

5.1 Island of Borkum (Germany)

In Europe, with the exception of Great Britain and Germany, there is only one transmission system operator per state. In Germany, on the other hand, for historical reasons, the four transmission system operators (TSO) - Amprion, 50Hertz Transmission, TenneT and TransnetBW - work primarily in their geographically defined control areas.
In the geographical area for Borkum, TenneT is responsible and operates the 380kV and 220kV electricity grid. For the further distribution of electricity in the downstream areas of Weser-Ems and Weser-Elbe, there is the grid operator EWE Netz GmbH, which supplies the region with 110kV and 20kV. EWE Netz GmbH is also the operator of the submarine 20kV cable to Borkum.
These cables provide the island with a power supply of 10 MegaWatt. On the island, this power is received by the Nordseeheilbad Borkum GmbH and distributed to the citizens.
As in the rest of Germany, the electricity supply itself is divided into the physical connection by the grid operator (DSO) and the sale of the electricity by a distribution company. This means that the electricity customer has the option of buying his electricity from any electricity provider in Germany and the grid operator has to ensure that the customer is always supplied with electricity.
Nordseeheilbad Borkum GmbH is both the grid operator and an electricity provider on the island. If a customer has not chosen an electricity provider or if a contract with an electricity provider has been terminated or has expired, Nordseeheilbad Borkum GmbH, as the responsible basic supplier, must ensure that the customer is supplied with electricity.
If a customer wishes to connect a power generation system to the grid of a grid operator, he must first register it with the responsible grid operator. Depending on the size of the system and the expansion of the grid, the operator then decides where the system may be connected and which voltage form is to be used (e.g. medium voltage or low voltage). The feed-in of the generated energy into the DSO grid is regulated according to the Energy Industry Act (Energiewirtschaftsgesetz - EnWG) and the Renewable Energy Act (Erneuerbaren-Energien-Gesetz - EEG).
As the island of Borkum is almost completely equipped with an electricity grid, there are no off-grid-systems or off-grid-microgrids. However, if an electricity connection is needed in a remote area of the island but it is not possible to provide this connection for technical or economic reasons, there are no requirements to be met by the grid operators or electricity markets if an object supplies itself with electricity.

Electricity price composition Germany:

- Grid usage fees: 24.9%
- § Section 19 NEV levy: 1.5%
- Offshore levy: 1.4%
- KWKG levy: 0.9%
- Concession fee: 5.7%
- EEG levy: 22.1%

- Electricity tax: 7.0%
- Value added tax: 16
- Procurement/margin: 20.6%

Conclusion: Only about 21% of the average electricity costs (2021) are accounted for by the distribution of an energy company. The grid accounts for 25% and the remaining 54% are taxes, levies and surcharges.

The next table shows a summary with key relevant points presented in an homogeneous way in all Follower islands:

First considerations		
Is the island interconnected to the mainland?	Yes, it´s connected to the mainland via submarine cables	
Is there a monopoly on the island? (only one TSO/DSO that operates on the island?)	EWE Netz GmbH is responsible for the submarine connection cables from the mainland to the island. From the connection point on the island, only the Nordsseheilbad Borkum GmbH is responsible.	
Types of energy market.		
Type	Description about how it works (minimum energy to include, organisation to sell the energy, price to sell, taxes, fines for not reaching compromised target, type of company/end-user who can access to this market....	Brief description about key points to consider when participating
Day Ahead	Overall, there are two main energy markets for the Day Ahead Market. One is direct exchange access via the EEX (European Energy Exchange) and the other is OTC (also called direct trading between two market participants). A fixed amount of energy is bought at a fixed time for a fixed delivery period. The energy can be bought on the EEX up to 5 years in advance and is called a speculative transaction because nobody knows	In order to gain direct access to EEX, you have to be a registered energy trader. This is achieved through certificate courses. Afterwards, one can get direct access via EEX and participate in the daily market activities. Another possibility is that someone else buys there on behalf of the company. Here, however, the energy then effectively becomes more expensive because the intermediary trader adds his commission.

	how the energy prices will develop.	
Intra day	On the one hand, there is the so-called spot market and the balancing energy market. The spot market is also traded on the EEX (European Energy Exchange). Quantities required at short notice are purchased here and must be held in reserve by the producers under contract. The control energy market is traded on the EPEX (Energy Market for the EU).	In order to be able to participate in the spot business, the trader must be a certified energy trader and have corresponding access to EEX. The corresponding free capacities can then be traded here. It is possible to participate in the balancing energy market in 3 levels, which in turn are clustered in 2 essential differences. 1. minute/secondary reserve - here the system operator must provide a total of 5 MW of capacity 24/7 and must also be able to make this available at any time. 2. primary reserve - here the operator must provide 1MW and also be able to completely shut down and start up again within 15 minutes. CHANCE: High economic revenues RISK: High contractual penalties or compensation payments in the event of non-compliance.
Ancillary services	Imbalances are settled directly by the transmission system operators or the upstream grid operators.	n/a
Feed-in tariff	The Renewable Energy Sources Act (Erneuerbare	Access is actually very simple. The prerequisite is

	Energien Gesetz / EEG) regulates the legal basis for the payment and market access of renewable generation plants. This describes, for example, what payment a plant receives or how long the term of the payment is.	that it is an EEG installation that generates renewable electricity and consumes it itself or feeds it into the local grid. The system operator also has other obligations, such as the documentation obligation to register his system in a market master data register (Marktstammdatenregister). Other annual reports are the amount of electricity generated directly to the Federal Network Agency (Bundesnetzagentur).
Energy market in island and in mainland: main differences		
Type of difference (economical, type of access, regulation....)	Definition	Advantage and/or disadvantage
Type of access, regulation	The island of Borkum is connected to the mainland grid via submarine cables and is subject to the same applicable regulations.	There are neither advantages nor disadvantages compared to a mainland location.
National applicable Regulation to access energy market		
Name of organisation	Name of the regulation	Key points covered in the regulation: (such as minimum price, installation certification, minimum volume of energy to access the market, kind of end-user, kind of installations...
Organisation 1: Bundesnetzagentur (BnetzA) (Federal Network Agency)	German Energy Industry Act (EnWG) Renewable Energy Sources Act (EEG)	The EnWG is used to ensure a secure, affordable, consumer-friendly and environmentally compatible supply of Energy. Also targets an efficient, unaltered competition and reliable operation of energy supply networks.

		The EEG is focused on renewable energy sources.
Organisation 2: European Energy Exchange (EEX)	Applicable regulations regarding Spot Markets	To gain access to the EEX Spot market it is mandatory to be member of the energy exchange. It is also necessary to have admission for clearing at the European Commodity Clearing AG (ECC) There are Day-Ahead and also Intraday markets available.
Organisation 3: EPEX SPOT SE (European Power Exchange)	Applicable regulations regarding Spot Markets	As EEX is merged with EPEX SPOT SE it is also necessary to be a member as well as having the admission for clearing at the ECC. Works as Day-Ahead as well as Intraday Market.
Obstacles to ease the energy production (this chapter is addressed to include spotted problems of		
Type of obstacle (regulation/ social/ economical...)	Definition of obstacle	Is there a tentative proposal so solve this obstacle? Who should be involved to solve it?
Obstacle 1: Regulation	As stated in the EEG smaller producers like household photovoltaic systems have to limit their output to 70% of their maximum generator power. This is used as a motivation for self-consumption of their own production.	n/a
Obstacle 2: Regulation	To distribute energy on open markets it is necessary to have a minimal output of 1 MW.	n/a
Obstacle 3: Social	Especially Wind Turbines are not always accepted by some locals even if their construction matches the applicable	n/a

	laws regarding distance to residential areas. (e.g. resistance among the locals when wind park Riffgat was constructed)	
Obstacle 4: Ecological	For every largescale energy source that is planned to be constructed an assessment about environmental impact has to be made because of the location inside the national park Wadden Sea. (IUCN protected area)	n/a
Obstacle 5: Regulation	Because of the "Redispatch 2.0" regulation every energy source (renewable as well as non-renewable) >100 kW needs to be connected to a grid control system to prevent possible overload.	n/a
Other key factors to study in the energy market for islands		
Key factor nº	Definition	Actor involved (national laws, DSO, end-user …)
n/a	n/a	n/a
Access to market		
Which electricity markets / system services / capacity markets / etc is available in your island?	As described above, markets are the same as on the mainland.	
How can we reach these flexibility markets within the framework of the ISLANDER project? (Can everybody enter the market or is it restricted to some actors only)?	Basically, only a legal representative is necessary to enter the market under the Renewable Energy Sources Act (EEG). This can be either a company but also a person who has e.g. a household photovoltaic system installed and declared themself as a legal representative. For producers with larger power output, it is possible to access EEX/EPEX under the conditions specified above.	
Which market/service would you consider for ISLANDER purposes? Can it be replicated to other islands?	It would be considered using the market under the Renewable Energy Sources Act (EEG). It can only be replicated to other islands in the archipelago of the East Frisian Islands but not outside Germany.	

Regarding all abovementioned questions: do you expect significant changes in the near future ? (evolution of the distribution, production, markets...)	There are no significant changes to expect in the near future regarding the earlier mentioned topics.
Any other relevant information regarding access to market?	n/a
Off-grid assets	
Off-grid assets in the islands: regulatory aspects.	There are no off-grid assets located on the island and therefore no regulations.
Off-grid Microgrid (not connected to the main grid) owned by energy communities (not connected to the network like a low populated village)	There are also no Off-grid Microgrids installed on the island.
Any other relevant info regarding off grid assets	n/a

5.2 Islands of Skopelos and Lefkada (Greece)

Greece has one mainland electrical system and 29 autonomous systems in non-interconnected islands. However, both islands of Skopelos and Lefkada are interconnected to the mainland and so the same specificities that apply to the main system also apply in these islands.

In the Greek electricity system there is one TSO, the Independent Power Transmission Operator (IPTO) and one DSO, the Hellenic Electricity Distribution Network Operator (HEDNO). In that perspective there is a monopoly in both islands as well as the entire mainland system.

The electricity markets that are available in the islands are the electricity day ahead and the intraday market. The energy trading process is run by EnEX, the Nominated Electricity Market Operator for the Greek Bidding Zones. Trading in EnEX follows specific sets of rules that can be found here. [18]

Any company engaged in energy-related activity licensed from the Regulatory Authority of Energy, as well as self-suppliers are eligible to become Trading Members at EnEx Energy Markets. Any participant in EnEx Energy Markets shall engage a sufficient number of Certified Energy Traders according to its needs.

Companies need to prove organizational and financial reliability and need to have a minimum equity capital and minimum contribution to the clearing fund. The minimum equity capital for a general clearing member is 3,000,000 €, while the minimum contribution to the clearing fund is 500,000 €. Consistently, the minimum equity

capital for a direct clearing member is 500,000 €, while the minimum contribution to the clearing fund is 30,000 €.
Moreover, any participant in EnEx Energy Markets shall engage at least one Certified Energy Trader according to its needs and maintain suitable technical infrastructure and clearing accounts. These could pose hurdles for small energy producers that want to participate in the energy market. However, a possible way to overcome such barriers could be through participation to an aggregator.
Until 31/12/2022 the participation of RES and CHP who are temporarily unable to be represented either through FOSE (an aggregator organization/ cumulative representation body), or to participate autonomously in the Electricity Market, will be supported by DAPEEP.
RES producers will have incentives to be competitive and undertake the responsibility of production forecast, as RES units with more than 400 kW will face market obligations. For that reason, aggregators are expected to play an important role in the energy market.
The next table shows a summary with key relevant points presented in an homogeneous way in all Follower islands:

First considerations		
Is the island interconnected to the mainland?	Greece has one mainland electrical system and 29 autonomous systems in non-interconnected islands. However, both islands of Skopelos and Lefkada are interconnected to the mainland and so the same specificities that apply to the main system also apply in these islands.	
Is there a monopoly on the island? (only one TSO/DSO that operates on the island?)	In the Greek electricity system there is one TSO, the Independent Power Transmission Operator (IPTO) and one DSO, the Hellenic Electricity Distribution Network Operator (HEDNO). In that perspective there is a monopoly in both islands as well as the entire mainland system.	
Types of energy market.		
Type	Description about how it works (minimum energy to include, organisation to sell the energy, price to sell, taxes, fines for not reaching compromised target, type of company/end-user who can access to this market....	Brief description about key points to consider when participating
Day Ahead	Via EnEx power exchange. Day-Ahead Market (DAM) refers to buy and sell	RES and the aggregators will have the responsibility

	trades of electricity with an obligation of physical delivery for the next Delivery Day, including the registration of energy quantities resulting from the trades carried out within EnEx's Energy Derivatives Market or from Over-the-Counter Energy Financial Instruments. Harmonized Minimum Day-Ahead Market Clearing Price: -500€/MWh Harmonized Maximum Day-Ahead Market Clearing Price: 3,000€/MWh	of production forecast in order to avoid penalties.
Intra day	Via power exchange. Intra-Day Market (IDM) refers to buy and sell trades of electricity with an obligation of physical delivery by submitting respective orders after DAM gate closure time, and includes three (3) Local Intra-Day Auctions (LIDAs) in isolated (non-coupled) mode. Harmonized Minimum Intra-Day Market Clearing Price: -9,999€/MWhHarmonized Maximum Intra-Day Market Clearing Price: 9,999€/MWhLIDAs (-500,3000) €/MWh Complementary Regional Intra-Day Auctions (CRIDAs) (-9999,9999) €/MWh Single Intra-Day Coupling (SIDC) (-9999,9999) €/MWh	Greek spot power exchanges/ day ahead & intraday rulebook: fe91263e-10c1-1905-df0b-a1db925e466f Clearing rulebook: 20191022_DAM_IDM_Clearing+Rulebook_v1.0_EN.pdf

Ancillary services	The Balancing Market, where in real time the demand is balanced with the available supply, differences between the forecasts / results of the previous two markets and the actual production are covered and the electricity generating units are compensated for their availability to contribute to the balancing process. This market is operated by the Independent Electricity Transmission Operator (IPTO).	The providers of balancing services through hydro installations should submit data related to the hydro stocks and water management (on a weekly basis) as well as a forecast on the water use on an annual basis.
Derivatives	Electricity Futures Contract Specifications in the Financial Energy Market (Derivatives Market)	Nothing to declare.
Feed-in tariff	After 31/12/2015 Greece moved from FiTs to Premiums.	Nothing to declare.
Energy market in island and in mainland: main differences		
Type of difference (economical l, type of access, regulation....)	Definition	Advantage and/or disadvantage
Type of access	Skopelos and Lefkada are interconnected to the mainland and so are governed by the same regulations as mainland.	n/a
Type of access	The island complex of Skiathos- Skopelos-Alonnisos is connected to the main grid however the interconnection is at full capacity resulting into electricity power cuts.	That is also a constrain for entering new players in the region however, IPTO has signed a contract for the development of a new cable and a new GIS substation 150/20 kV that will be installed in Skiathos, thus developing the potential of the area from the end of 2021.
National applicable Regulation to access energy market		
Name of organisation	Name of the regulation	Key points covered in the regulation: (such as

		minimum price, installation certification, minimum volume of energy to access the market, kind of end-user, kind of installations...
Energy Regulatory Authority (RAE) & Hellenic Energy Exchange (EnEX)	Regulation of Energy Exchange: Regulation of DAY-ahead and intra-day market	Eligibility criteria, liabilities, trading products, cost of participation
Hellenic Energy Exchange (EnEX)	Decision 8: "Maximum and Minimum order Price for Day-Ahead and Intra-day market"	Maximum and Minimum accepted power price in trading platform
Energy Regulatory Authority (RAE) & Independent Power Transmission Operator (IPTO)	Balancing Market Rulebook (https://www.admie.gr/en/market/regulatory-framework/balancing-market-rule-book)	Designates the participants and the applicable rules and conditions, defines the Balancing Market Settlement procedure, determines the penalties for the Participants in the event of non-compliance with the provisions of this Rulebook
Obstacles to ease the energy production (this chapter is addressed to include spotted problems of		
Type of obstacle (regulation/ social/ economical...)	Definition of obstacle	Is there a tentative proposal so solve this obstacle? Who should be involved to solve it?
Obstacle 1: Regulation	From 2023 Small producers owing a minimum of 400 kW will not be able to participate in the market independently, they have to go through an aggregator	The small producers will be trading their energy through an aggregator
Obstacle 2: Regulation	By law ECs can own a microgrid on an island. However as there is no past experience (no EC owns any microgrid in Greece) and DSO service is a monopoly in Greece difficulties on the implementation might	An improved regulation framework providing more detail on how the (micro)grid ownership can be facilitated.

	occur. This lack of experience might act as a disincentive for new ECs that aim to own and operate power capacity and electricity grid (MV, LV).	
Obstacle 3: Balancing market operation	At the beginning of its operation the balancing market showed very high prices. This was due to the lack of a sufficient number of participants, the limitation of the transport system to the Peloponnese and the large discrepancies between estimates and real demand that led to increased demand for balancing energy volumes. This led RAE to technical interventions in the market by suspending the negative prices in the downward balancing energy offers and a mandatory submission of a single step for the Technically Minimum Production - in both the upward and downward balancing energy bids.	Apart from the power generators, and the large power consumers which are currently the only ones in the country that offer balancing services, another category offering balancing services will be the added. These are the aggregators who will offer demand response services by adjusting appropriately the consumption of the portfolio they manage. Development of demand response mechanism where aggregators will participate and offer balancing services in the system, with the appropriate adjustment of the consumption of the portfolio they manage. A development of a power compensation mechanism that will lead to increasing the chances for new investments, and in production capacity, thus avoiding the risk of shortage and - ultimately - insufficiency of supply. In addition, if the power mechanism is designed as a reliability option, then it is expected to protect consumers from sharp price increases, while

		maintaining the fundamental role of brand promotion through market operation.
Other key factors to study in the energy market for islands		
Key factor nº	Definition	Actor involved (national laws, DSO, end-user …)
Regulations for island energy communities (EC)	Rules and regulations on the development of energy communities on islands (who can participate, how many stakeholders, maximum share per stakeholder, type of entity etc.)	National Laws
Permitted business fields of island ECs. Grid ownership rights	In which kind of business an EC can get involved? (eg. Production of renewable energy, energy storage, energy aggregation, distribution of energy, ownership electricity grid etc).	National Laws
Electricity Regulation Laws, Law for Energy communities	Laws for Electricity market operation, law for establishment-operation of ECs	National Laws
Access to market		
Which electricity markets / system services / capacity markets / etc is available in your island?	The same as on mainland market (mentioned above)	
How can we reach these flexibility markets within the framework of the ISLANDER project? (Can everybody enter the market or is it restricted to some actors only)?	Any company engaged in energy-related activity licensed from the Regulatory Authority of Energy, as well as self-suppliers are eligible to become Trading Members at EnEx Energy Markets. Any participant in EnEx Energy Markets shall engage a sufficient number of Certified Energy Traders according to its needs. Companies need to prove organizational and financial reliability and need to have a minimum equity capital and minimum contribution to the clearing fund. The minimum equity capital for a general clearing member is 3,000,000 €, while the minimum contribution to the clearing fund is 500,000 €. Consistently, the minimum equity capital for a direct clearing member is 500,000 €, while the minimum contribution to the clearing fund is 30,000 €.	

	Moreover, any participant in EnEx Energy Markets shall engage at least one Certified Energy Trader according to its needs and maintain suitable technical infrastructure and clearing accounts. These could pose hurdles for small energy producers that want to participate in the energy market. However, a possible way to overcome such barriers could be through participation to an aggregator
Which market/service would you consider for ISLANDER purposes? Can it be replicated to other islands?	Borkum is an interconnected island as Lefkada and Skopelos. Therefore, DAM, intra-day, ancillary services
Regarding all abovementioned questions : do you expect significant changes in the near future ? (evolution of the distribution, production, markets...)	Until 31/12/2022 the participation of RES and CHP who are temporarily unable to be represented either through FOSE (an aggregator organization/ cumulative representation body), or to participate autonomously in the Electricity Market, will be supported by DAPEEP. RES producers will have incentives to be competitive and undertake the responsibility of production forecast, as RES units with more than 400 kW will face market obligations. For that reason, aggregators are expected to play an important role in the energy market
Any other relevant information regarding access to market?	n/a
Off-grid assets	
Off-grid assets in the islands: regulatory aspects.	Island is interconnected, off-grid is possible in distant villages with no access to grid but that means the energy will not be sold in the market
Off-grid Microgrid (not connected to the main grid) owned by energy communities (not connected to the network like a low populated village)	n/a
Any other relevant info regarding off grid assets	n/a

5.3 Island of Orkney (United Kingdom)

Orkney is connected to the UK grid and is governed by the same regulations and codes as the UK mainland. The rules governing electricity trading are extensive and intricate and are a specialist subject in their own right. See the Elexon Beginners Guide for an overview (https://www.elexon.co.uk/guidance-note/beginners-guide/)
The supply of electricity normally requires a license, which carries quite onerous conditions and is extremely costly and time-consuming to obtain and subsequently to operate. Most schemes to sell branded power or for peer-to-peer trading between separate sites use the services of an existing licensed supplier to carry out the inner workings of the trade and to fulfil the licence obligations. See Ofgem guidance at https://www.ofgem.gov.uk/publications-and-updates/selling-electricity-consumers-what-are-your-options . Within the Ofgem guide, "white labelling" describes how an organisation can market their own energy brand and "sleeving" describes a process for peer-to-peer transfer over the distribution or transmission network (e.g. moving power from Eday to a hydrogen facility on the mainland).
The next table shows a summary with key relevant points presented in an homogeneous way in all follower islands:

First considerations		
Is the island interconnected to the mainland?	Yes, connected to the UK grid.	
Is there a monopoly on the island? (only one TSO/DSO that operates on the island?)	The DNO monopoly holder is Scottish Hydro Electric Power Distribution plc, trading under the umbrella name SSEN. The role of the DNO is to operate and maintain the distribution network, including managing new generation and demand connections. Generation connections will hold an Embedded Generation Connection Agreement with the DNO. In the North of Scotland and the Isles, stations with a capacity of 10MW or above will also hold an agreement (Bilateral Embedded Licence Exemptible Large Power Station Agreement) with National Grid ESO. Supply of electricity is a separate function from distribution. Distribution and Supply licenses are mutually exclusive, so the SSEN monopoly on distribution has no influence on the ability to buy or sell power in an open and competitive market	
Types of energy market.		
Type	Description about how it works (minimum energy to include, organisation to sell the energy, price to sell, taxes, fines for not reaching compromised target, type of company/end-user who	Brief description about key points to consider when participating

	can access to this market....	
Day Ahead	Via a power exchange, where generators can sell power to the exchange and consumers can buy power. Generators and consumers must provide or take their contracted volumes or face imbalance charges. Power is traded in half-hourly blocks. Typically used by large generators, large consumers and licensed suppliers to adjust their established profile (established via bilateral contracts, see below) to match day-ahead forecast generation or demand.	Requires full participation in the Balancing Mechanism and other codes.. Exposure to imbalance risk, particularly for small generators or consumers. Small users would normally sell or purchase their power from a licensed supplier (bilateral agreement, see below) and the supplier would then use the power exchange as required to balance the aggregate of all their bilateral contracts.
Intra day	Via power exchange, as above. Large generators/consumers can fine-tune their contracted position to match near-term forecast generation or demand. Trading can continue down to gate closure, 1 hour ahead of delivery.	UK power exchanges: https://www.epexspot.com/en/tradingproducts https://www.nordpoolgroup.com/
Ancillary services	There are several Ancillary services which can be contracted for, to assist balancing of generation and demand and to support system voltage and frequency. Some are mutually exclusive. All require plant to be suitably flexible and controllable. See appendix 1 for a summary.	The connection rules for generators (EREC G99) include some mandatory services for voltage and frequency support (e.g. fast current injection in response to an external transmission system fault and the ability to reduce power output in response to over-frequency).

Feed-in tariff	Closed to new entrants in March 2019. The Contract for Difference (CfD, see below) is now the main system of revenue support for low-carbon generation.	n/a
Bilateral contracts	Most electricity in the UK is traded via bilateral contracts between a generator and a customer. That customer may be a large electricity user or, more often, a licensed retail supplier. For island-size renewable generators, the bilateral contract is usually a Power Purchase Agreement (PPA) with a licensed supplier.	PPA is usually on a must-take basis, which obliges the counterparty to take all generation. The corollary is that the generator is obliged to offer all power to the PPA counterparty. A standard PPA may need to be customised if there is a need to use significant power on site (e.g. for hydrogen). The PPA counterparty carries the imbalance risk (which arises when actual generation does not match forecast generation). To reduce this, a standard PPA may require the generator to forecast output in half-hour blocks on timescales varying from month ahead to hour ahead. Large demand customers may similarly be required to forecast demand. A worthwhile forecast is problematic for experimental systems, so the need for and usefulness of forecasts should be discussed when the PPA is negotiated. PPA price may be either fixed or variable. Variable rates are usually linked to a reputable power

		exchange hourly or half-hourly index price.
Contract for Difference	A system under which a generator is paid the difference between a "strike price", at which the contract is agreed, and a reference price, which for intermittent generators is linked to the day-ahead market price, based on hourly volumes. The generator also sells his energy in the usual way and therefore receives a total price roughly equal to the strike price. A CfD has a 15-year term.	Contracts are bid for on a competitive basis, with rounds held roughly every second year (round 4 is expected to start in 2021). Not all technologies are supported in each round. Round 3 had a "remote island wind" category, to mitigate the additional costs and grid charges associated with island locations. The minimum plant capacity for this category was 5 MW. There are tough eligibility criteria (need to have secured a grid connection and to have relevant consents), a strict timetable for progress to completion, minimal scope to adjust project capacity after contract award and a very detailed bureaucracy for information exchange and other reporting. Invoicing for the difference price is daily.
Energy market in island and in mainland: main differences		
Type of difference (economical l, type of access, regulation....)	Definition	Advantage and/or disadvantage
Type of access	Orkney is connected to the UK mainland grid and is governed by the same codes and standards.	A common regulatory regime simplifies normal power purchase agreements, where off-the-shelf versions can be used. It could be argued the national regime is too heavy and inflexible to facilitate local, small-scale innovative projects.

Capacity	The Orkney distribution network has been at full capacity for a number of years and recent generator connections have had to accept constraints under an active network management scheme (ANM)	The level of constraint for late entrants is high and new connections are unlikely to be financially viable.
National applicable Regulation to access energy market		
Name of organisation	Name of the regulation	Key points covered in the regulation: (such as minimum price, installation certification, minimum volume of energy to access the market, kind of end-user, kind of installations...
Organisation 1: National Grid ESO and Elexon.	Balancing and Settlement Code	Rules and governance for trading (including notification of trades in advance of delivery) and for settlement of imbalance. Administered by Elexon.
Organisation 2: National Grid ESO	Grid Code	Technical requirements for connecting to and using the transmission system. The transmission system does not yet extend to Orkney, although sites with generation capacity of 10MW or more may be captured by some of the requirements. The Distribution Code (below) will be more relevant to most Orkney generators
Organisation 3: Energy Networks Association	Distribution Code and Engineering Recommendation G99	Technical requirements for connecting to and using the distribution system. EREC G99 contains the detailed requirements for generators and (at least until the end of 2020) was

		harmonised with the European ENTSO(E) requirements.
Organisation 3: Ofgem	The regulator for the gas and electricity markets.	Has oversight of the electricity market
Obstacles to ease the energy production		
Type of obstacle (regulation/ social/ economical...)	Definition of obstacle	Is there a tentative proposal so solve this obstacle? Who should be involved to solve it?
Obstacle 1: Distribution network capacity	The existing Orkney distribution network is at capacity	Proposed new generation is being asked to subscribe towards a new transmission connection to the Scottish mainland. This will then provide a separate "generation" network of connections for larger projects, but does not appear to provide reinforcement for the existing distribution network. It will therefore not alleviate existing constraints under the ANM and will not facilitate connection of small projects (e.g. individual wind turbines) to the distribution network. There are also significant issues around the public acceptability of a separate network of overhead lines, in addition to the existing distribution network. The transmission network owner (SSEN) responsible for the design is constrained by licence terms and by Ofgem to provide what is effectively the lowest cost solution.
Obstacle 2:	Transmission use of system charges	These charges are locational and are higher for sites further from main

		centres of national demand. These high charges are a barrier to the larger projects referred to above. The charging methodology is set by Ofgem.
Other key factors to study in the energy market for islands		
Key factor nº	Definition	Actor involved (national laws, DSO, end-user …)
n/a	n/a	n/a
Access to market		
Which electricity markets / system services / capacity markets / etc is available in your island?	See previous response ("types of energy market.") for general electricity trading and ancillary services. The UK capacity market may also be available for generation and for demand side response, but probably only for parties with a firm rather than constrained grid connection (i.e. not viable for ANM connected generators because the ANM constraints may prevent the capacity being available when called on). The minimum capacity is 2MW, although this may be aggregated. Capacity which receives revenue support (e.g. feed-in-tariff, renewables obligation or contract for difference) is generally excluded. Capacity market auctions take place for one year ahead and four years ahead.	
How can we reach these flexibility markets within the framework of the ISLANDER project? (Can everybody enter the market or is it restricted to some actors only)?	The supply of electricity normally requires a license, which carries quite onerous conditions and is extremely costly and time-consuming to obtain and subsequently to operate. Most schemes to sell branded power or for peer-to-peer trading between separate sites use the services of an existing licensed supplier to carry out the inner workings of the trade and to fulfil the licence obligations	
Which market/service would you consider for ISLANDER purposes? Can it be replicated to other islands?	i) Making use of the distributed battery storage in EVs. The ReFLEX project has presumably already carried out an in-depth review of commercial options. ii) Electrolysers may be able to offer demand side response (upward or downward) as an ancillary service (but note that effective participation in ancillary services requires high plant availability and so may not be suitable for prototype or demonstration plant).iii) Given that hydrogen production may not be on the same site as generation (e.g. windfarm in the outer isles feeding an electrolyser station on the mainland), the "sleeving" services of a supplier may be needed to convey electricity from the generator and to cover any necessary balancing. iv) A community energy scheme	

	("white labelling", via a supplier) is likely to be well received.
Regarding all abovementioned questions: do you expect significant changes in the near future? (evolution of the distribution, production, markets...)	Proposed new generation is being asked to subscribe towards a new transmission connection to the Scottish mainland. This will then provide a separate "generation" network of connections for larger projects, but does not appear to provide reinforcement for the existing distribution network. It will therefore not alleviate existing constraints under the ANM and will not facilitate connection of small projects (e.g. individual wind turbines) to the distribution network.
Any other relevant information regarding access to market?	The UK regulator, Ofgem, has an innovation scheme intended to assist development of new services and business models. This can provide detailed guidance to proposed start-ups and includes a "regulatory sandbox" which in certain circumstances allows time-limited derogation of specific rules, see https://www.ofgem.gov.uk/about-us/how-we-engage/innovation-link Again, the ReFLEX project may have experience of this.
Off-grid assets	
Off-grid assets in the islands: regulatory aspects.	Not governed by the grid code or distribution code if there is no grid connection. Systems which are capable of running in "island" mode but also have a grid connection remain bound by the usual network codes. Safety aspects (including privately owned overhead lines, underground cables) are governed by the Electricity Supply Quality and Continuity Regs 2002 (ESQCR)
Off-grid Microgrid (not connected to the main grid) owned by energy communities (not connected to the network like a low populated village)	i) This would qualify as electricity supply and so probably still require some form of supply licence. Although the licence obligations in respect of the (national) grid would clearly not apply, the obligations in respect of customers would remain. There are examples in Fair Isle, Foula and Eigg. (See https://www.gov.scot/news/powering-fair-isle/) ii) The distributors' obligations which would normally fall to the DNO now fall to the community energy company. These are set out in the ESQC Regs and include the permitted range of voltage and frequency (which by agreement may be wider than normal grid limits), the obligation to maintain continuity of supply and the circumstances in which the distributor may interrupt supply or refuse connection
Any other relevant info regarding off grid assets	i) Maintaining continuity of supply without a grid connection will require considerable reserves of

	dependable backup power. Although this can be mitigated to an extent by maximising diversity of generation types, the reserve capacity is by nature likely to be under-utilised and therefore a cost burden. ii) Maintaining power quality (voltage stability, frequency stability, transient disturbances) as generation and demand changes is technically challenging without a grid connection, particularly for small systems. The importance of these issues depends on what loads the off-grid system is supplying, but in general terms if the supply needs to have a similar dependability and quality as a normal grid supply (e.g. for domestic customers) and a grid supply is available nearby, the grid is likely to be most cost-effective option.

Apart from this general information, it is also relevant to declare certain extra information on UK Ancillary Services:

i. Balancing services which may be contracted for are summarised below. This is a rapidly changing field as the balance of UK generation shifts from large, centralised, dispatchable plant with high inertia, towards distributed, intermittent, low-inertia renewable generation. Power flows are becoming more variable and less predictable and the reduced system inertia results in faster rates of change of frequency in response to sudden changes in generation or demand. New services for fast frequency response are being developed and will gradually replace some of the existing services.
ii. See National Grid ESO balancing services web page https://www.nationalgrideso.com/industry-information/balancing-services [19] for details. That page also contains a link to a Balancing Services Guidance document, which gives details of how the services are procured. Methods include tender and auction, in order to procure adequate capacity at the best price. Some services allow particular time-windows to be bid for, so that the plant is free for other commercial use at other times. There will generally be a pre-qualification process to ensure technical and commercial capability. Some services may require specialised and dedicated communications and metering equipment.
iii. Contracts are with National Grid ESO, not the local distribution network operator (which for Orkney is Scottish and Southern Electricity Networks, SSEN). Expect payment for providing the service and penalty for failing to provide.
iv. Most non-mandatory services require a minimum capacity (which varies between services) for eligibility. However, some are open to "aggregator" organisations, who aggregate the capacity of a number of small generators or consumers. This allows small users to participate without the full cost and complexity of direct participation. The National Grid ESO web page linked above contains a list of aggregators.
v. There is overlap between the scope of some of the balancing services (they all require generation or demand to be adjusted up or down, but over different

timescales, for different durations and in response to different signals). There are corresponding rules to govern "revenue stacking" and prevent double payment for one action.

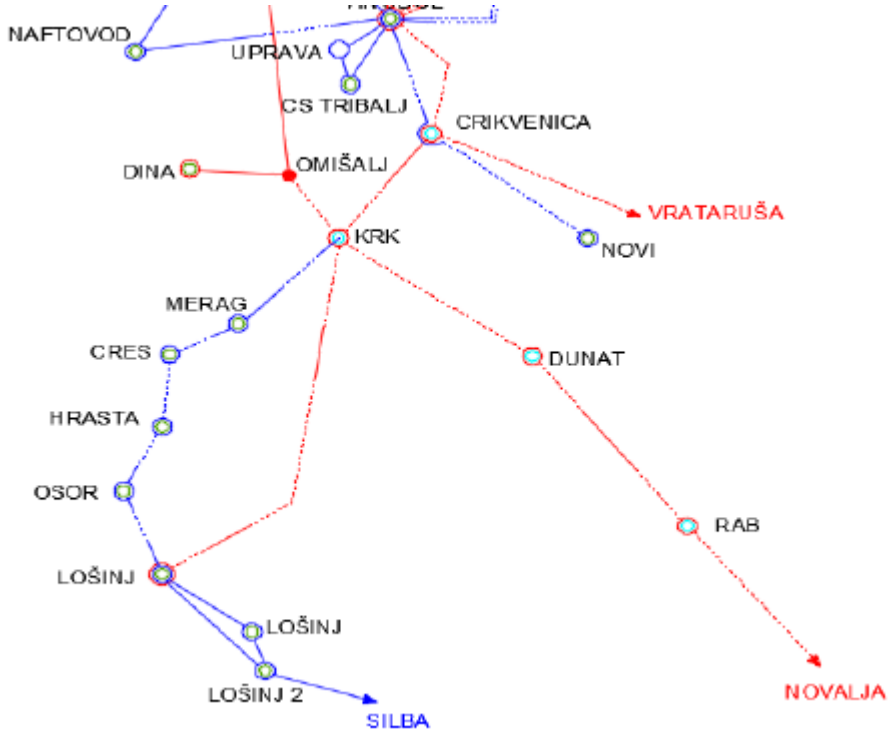
vi. Most of these services require generators to be able to increase output. This implies running at reduced output whenever the plant is required to be available for the service, so may not be cost effective for renewable generators such as wind. Storage technologies may be better able to participate, but the operational strategy for maintaining the state of charge and rate of charge/discharge in order to provide the service would need careful planning, and may not be compatible with other uses, such as buffering tidal energy output to stay within site export limits. However, some services are required only in certain time windows, so leaving the plant free for other use outside these defined times.

Service	Outline	Remarks
Demand Side Response	Large consumers can increase, decrease or time-shift their demand.	Used for response to both forecast (slow response) and unexpected (fast response) events. Open to large consumers, including aggregators.
Demand Turn Up	Energy users and generators either increase demand or reduce generation at times of high renewable output and low national demand.	Used for response to forecast events - "turn up" generation or demand is scheduled several hours in advance. Entry threshold is relatively low at 1MW, which can be aggregated from sites of 0.1MW or larger.
Dynamic Containment	Very fast acting frequency response to contain system frequency after a system fault.	This service is under development. Battery storage is likely to have the technical capability.
Enhanced Frequency Response	Two possible modes of operation: Static: able to increase output by 1MW or more within 1 second if frequency drops below 49.6 Hz and sustain increase for 30 mins. Dynamic: plant operates in frequency-sensitive mode and varies output in	I think this is a newly introduced variant of Firm Frequency Response, with different requirements for speed and duration of response.

	response to system frequency.	
Firm Frequency Response	Similar to Enhanced Frequency Response, but allows slower response. There are three sub-classes of dynamic response.	FFR is likely to be phased out as new services are introduced.
Fast Reserve	Central dispatch of plant (generation increase or demand reduction) as short-term balancing action.	Min capacity 25MW, to respond within 2 minutes.
Short Term Operating Reserve	Central dispatch of plant (generation increase or demand reduction) as medium-term balancing action.	Must be able to increase generation or reduce demand by at least 3MW.

5.4 Island of Cres (Croatia)

The island of Cres is connected to the mainland with the feeder substation TS Krk at the island of Krk over the 35 kV line according to the figure below:



There is only one DSO on the island – HEP ODS – Elektroprimorje. The ancillary market is very much unavailable as the ancillary services are currently provided by several larger companies in the ownership of the energy utility company. It is possible to participate in the day-ahead electricity market. In the current framework, potential

power plants on the islands can participate in the day-ahead electricity market. Larger facilities can also arrange to provide the ancillary services which are paid with a fixed amount. Development of energy and reserve markets will certainly have to happen in accordance with the current EU directive – however, it is difficult to estimate an accurate timeline. This will also have to be followed by technical development. Off-grid microgrid is not allowed according to the existing grid code. However, if an island operation is a result of an outage then the island operation can happen if there are technical possibilities for such operation.
Once clarified this first annalisis, next table shows a summary with key relevant points presented in an homogeneus way in all follower islands:

First considerations		
Is the island interconnected to the mainland?	YES	
Is there a monopoly on the island? (only one TSO/DSO that operates on the island?)	There is only one DSO on the island – HEP ODS – Elektroprimorje. The ancillary market is very much unavailable as the ancillary services are currently provided by several larger companies in the ownership of the energy utility company.	
Types of energy market.		
Type	Description about how it works (minimum energy to include, organisation to sell the energy, price to sell, taxes, fines for not reaching compromised target, type of company/end-user who can access to this market....	Brief description about key points to consider when participating
Day Ahead	The day-ahead market exists at the national level. Electricity power producers can sell their energy at the power exchange Cropex.	A premium model is used for the renewables.
Intra day	The intraday market exists as well.	https://www.cropex.hr/en/
Ancillary services	Ancillary services are provided by several market players and participation in ancillary service provision is paid with a fixed amount.	The business model for providing ancillary services should be more closely developed.
Feed-in tarif	A feed-in-tariff was used during the past 15 years, but recently a new	A premium model replaced the feed-in-tariff.

	premium model took place in the legislation.	
Energy market in island and in mainland: main differences		
Type of difference (economical, type of access, regulation....)	Definition	Advantage and/or disadvantage
Same energy market as in mainland	n/a	n/a
National applicable Regulation to access energy market		
Name of organisation	Name of the regulation	Key points covered in the regulation: (such as minimum price, installation certification, minimum volume of energy to access the market, kind of end-user, kind of installations...
Organisation 1: HERA Croatian Energy Regulatory Agency (Croatian: Hrvatska energetska regulatorna agencija)	Electricity Market Act (Croatian: Zakon o tržištu električne energije) https://www.zakon.hr/z/377/Zakon-o-tr%C5%BEi%C5%A1tu-elektri%C4%8Dne-energije	This Act defines rules and regulations which enable a safe and reliable production, transfer, distribution, and supply of electric energy. The Act also regulates the trade of electricity and arranges the electricity market as a part of the EU's electricity market. The Act defines the rules which protect the final customers, regulates their rights and obligations, and grants them free open access to the market.
Organisation 2: HROTE Croatian Energy Market Operator (Croatian: Hrvatski operator tržišta energije)	Electricity Market Act (Croatian: Zakon o tržištu električne energije) https://www.zakon.hr/z/377/Zakon-o-tr%C5%BEi%C5%A1tu-elektri%C4%8Dne-energije	This Act defines rules and regulations which enable a safe and reliable production, transfer, distribution, and supply of electric energy. The Act also regulates the trade of electricity and arranges the electricity market as a part of the EU's electricity market. The Act defines the rules which protect the final customers, regulates their rights and

		obligations, and grants them free open access to the market.
Organisation 3: HOPS (TSO) Croatian Transmission System Operator (Croatian: Hrvatski operator prijenosnog sustava)	Transmission Grid Code (Croatian: Mrežna pravila prijenosnog sustava) https://narodne-novine.nn.hr/clanci/sluzbeni/2017_07_67_1585.html	The transmission grid code regulates technical and other conditions for managing, using and connecting to the transmission grid.
Organisation 4: CROPEX Croatian Power Exchange Ltd. (Croatian: Hrvatska burza električne energije d.o.o.)	Electricity Market Act (Croatian: Zakon o tržištu električne energije) https://www.zakon.hr/z/377/Zakon-o-tr%C5%BEi%C5%A1tu-elektri%C4%8Dne-energije	This Act defines rules and regulations which enable a safe and reliable production, transfer, distribution, and supply of electric energy. The Act also regulates the trade of electricity and arranges the electricity market as a part of the EU's electricity market. The Act defines the rules which protect the final customers, regulates their rights and obligations, and grants them free open access to the market.
Obstacles to ease the energy production (this chapter is addressed to include spotted problems of		
Type of obstacle (regulation/ social/ economical...)	Definition of obstacle	Is there a tentative proposal so solve this obstacle? Who should be involved to solve it?
Obstacle 1: Technical	Grid capacity	Technical projects that will improve the situation are undergoing.
Obstacle 2: Regulation	Ban on wind power plants within 1 km from the coast	No
Obstacle 3: Regulation	Environmental concerns	Regulation is changing – not necessarily in favour of renewable installation
Obstacle 4: Regulation/Economical	Markets are still not developed enough for the integration of renewables	Market changes are progressing but too slowly
Other key factors to study in the energy market for islands		
Key factor nº	Definition	Actor involved (national laws, DSO, end-user …)
n/a	n/a	n/a

Access to market	
Which electricity markets / system services / capacity markets / etc is available in your island?	The ancillary market is very much unavailable as the ancillary services are currently provided by several larger companies in the ownership of the energy utility company. It is possible to participate in the day-ahead electricity market. In the current framework, potential power plants on the islands can participate in the day-ahead electricity market. Larger facilities can also arrange to provide the ancillary services which are paid with a fixed amount. Development of energy and reserve markets will certainly have to happen in accordance with the current EU directive – however, it is difficult to estimate an accurate timeline. This will also have to be followed by technical development.
How can we reach these flexibility markets within the framework of the ISLANDER project? (Can everybody enter the market or is it restricted to some actors only)?	A new Electricity Market Act is being developed, and it will rely on the Directive (EU) 2019/944 on common rules for the internal market for electricity. We expect that this new version of the Act will bring significant liberalization to the market: electricity transfer and distribution will remain under state control - however, the production and the distribution of electricity will be commercialized significantly. The new Act will introduce the concept of civic energy, and it will increase the role of renewable energy communities in electricity generation and trade. The role of prosumers on the market will be strengthened as well, and the Act should encourage electricity generation on the consumption site.
Which market/service would you consider for ISLANDER purposes? Can it be replicated to other islands?	The establishment of a renewable energy community was recently initiated on the island of Cres. The intention of this energy community is to engage in the construction of photovoltaic plants on the island, which we'd like to support and present as a successful model for other island communities in our region. The involvement in this new renewable energy community is enabled for both inhabitants of the islands and local island-based companies.
Regarding all abovementioned questions: do you expect significant changes in the near future? (evolution of the distribution, production, markets...)	Given that other private initiatives for the construction of electricity generation plants on the island are already emerging, one of the next tasks will certainly be the management of those systems, i.e. the accumulated smaller plants, which will lead to the development of energy storage technologies, either batteries or hydrogen-based solutions. With that respect, experiences learned from Bornholm will be valuable. Significant market development is expected. The above-mentioned regulation will also go in the

	direction of PPA contracts, of from bigger energy producers towards dislocated consumers.
Any other relevant information regarding access to market?	The particular importance lies in the collection of data about energy consumption and production and in the proper data management, including also the monitoring of meteorological data that will be relevant to forecasts future production plan for the optimal energy management.
Off-grid assets	
Off-grid assets in the islands: regulatory aspects.	Transmission Grid Code (Croatian: Mrežna pravila prijenosnog sustava) https://narodne-novine.nn.hr/clanci/sluzbeni/2017_07_67_1585.html
Off-grid Microgrid (not connected to the main grid) owned by energy communities (not connected to the network like a low populated village)	Off-grid microgrid does not exist since it is not allowed according to the existing grid code.
Any other relevant info regarding off grid assets	n/a

6 Deviations

This deliverable will be submitted without any deviation.

7 Main conclusions

This deliverable gathers the study of the regulation applicable, not only to the ISLANDER project, but also provides the methodology followed in the consortium to follow this study and enable the replication of this study by offering key relevant points and templates to be considered when addressing this study in different locations.
Apart from providing this methodology, since the ISLANDER project is going to be demonstrated in Germany, the deliverable D2.1 also lands on specifying current regulation in the island of Borkum, for which more detailed information about applicable laws and the URL to access them can be found along the document. Even if not all of them are available for the general public and many of them need to be purchased, having their reference will help to understand better the scope of them.

Furthermore, even if it wasn´t in the scope of this deliverable, a nice energy market study has been included, which will be a very relevant output to be transferred to WP4 related to forecasting services.

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