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Deliverable D1.1

Techno-economical and social barriers affecting the deployment of the building-integrated RES V1.1

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Executive summary

For the countries involved in the project this document is bringing upfront the now-days issues and concerns about implementing RET (Renewable Energy Technology) on buildings from a holistic point of view.

There is high bureaucracy procedures in obtaining authorisations, certifications and licensing which are slowly obtained (maybe unnecessarily) or disproportional discouraging investments, even more on a small scale such as houses. Laborious documentation is required and has to be achieved from different administrations.

The still increased investment cost for the RES to be integrated is a prohibitive factor in the implementation, along with unknown issues related to the local impact in the reduction of the energy use from the grid, as a key element in supporting the investment decisions.

In the District Heating Systems (DHS) the RES should be incorporated if an opportunity and feasible, and the definition of **nearby RES** related to the nZEB, could thus incorporate the RES delivered from the DHS.

The centralised system of electricity and the difficult connection to the grid, for now, make the investments in green energy for buildings inefficient due to the high bureaucracy.

Concerning tertiary buildings, there is a big change from public to private sector. The public sector is then mainly influence by regional policies than national policies. Hence, the situation is quite inhomogeneous and hard to summarize.

In many cases c*onsumer acceptance towards new technologies and innovative renovation solutions* is an important social barrier that makes building owners and users choose the old, known, tested, “safe” and widespread used technologies .This is mainly due to the lack of knowledge about technologies and issues, the perception, the feeling, fear, worry and inconvenience that people feel regarding to new technologies.

On the other hand, through initiative to promote the prosumers, different EU Member State Government launched financing scheme for the residential individual energy users to install a PV systems, with State support.

The *lack of educations and confidence in construction professionals* plays a big role when it comes to making a decision to renovate or not. Building owners and users do not know how and where to find reliable experts and professionals to ask for advice and expertise either because in some areas there are limited number of offers or, contrary, there are too many offers to choose from. For many individual homeowners and users, renovation is the second big decision – after buying their home - that could influence all their lives and, as a consequence, they demand for some guarantees that the work would be appropriately done because they are looking for long-lasting solutions that would be both economically, long-lasting and practically viable.

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1. Introduction

This document is made to meet the requirements of deliverable D1.1 "Techno-economical and social barriers affecting the deployment of the building-integrated RES "of the Re-Cognition project (Renewable cogeneration and storage technologies integration for energy autonomous buildings), a Horizon 2020's research and innovation programme.

1.1. Context

In the existing or in the novel buildings development there are several R&D barriers and user-acceptance-related challenges that hinder the smooth integration and proliferation of multiple Renewable Energy Technologies (RETs).
The residential sector is responsible for almost half of the total energy consumption on the world wide scale.

The renewable energy sources that can fit on any building such as PV panels, Solar thermal panels, small wind turbines and clusters of EV Chargers which are zero emissions and zero polluting residues or small scale CHP are considered sustainable regarding the current and future social need can be a key factor in achieving the nZEB (nearly Zero Energy Building).

1.2. Notations, abbreviations and acronyms

Table 1 Acronyms list

BoB	Blocks of Buildings
CO	Confidential
D	Deliverable
DHS	District Heating System
DR	Demand Response
DEC	Other kind of deliverable
DEM	Demonstrator
DSO	Distributor System Operatory
GA	Grant Agreement
M	Milestone
O	Other
ORDP	Open Research Data Pilot
P	Product
PU	Public
R	Report

RES	Renewable Energy Sources
RTO	Research Institute
SME	Small Medium Enterprise
T	Task
UNI	University
WP	Work Package

1.3. Purpose of this deliverable

Challenges specifically regarding plus-energy building are identified and a respective analysis is done as well. On the business front a review of the existing legislation in the countries represented in the consortium will reveal potential restrictions over the installation of building's RES, energy storage, conversion and management systems as well as cross-country differences.

Restriction in self-consumption scheme, lack of standardized communications for the intra-building systems coupling and energy metering as well as government incentives (or lack of them) greatly affect the economic viability of building RES and energy storage deployment and dictate the operational mode (self-sufficiency or energy market transactions) of future building level nano and micro grids. This Deliverable identifies the main regulatory issues and proposes measures to best implement the specific EU directives by Member State.

1.4. Contribution of Partners

Following consortium partners identified the existing barriers and challenges specifically to their region: SVT, POLITO, CERTH, E@W, INTRACOM, ZH, CSEM, WINDCITY, HELPE, TUCN, EC and ETREL.

2. Regulatory, Techno-Economical and social barriers against the renewable energy sources implementation in the residential and tertiary buildings

Currently, self-consumption schemes (of self-produced electricity) are limited by the actual regulatory scheme. This is quite clear for instance in Italy, where besides a limited number of remote areas and industrial sites, self-consumption is restricted to the so-called 'one-to-one' configuration, which foresees a single RES-plant owner self-consuming the available electricity at its own Point-of-Delivery (POD). Owing to this restriction, residential dwellings such as multi-family buildings (condominiums) cannot use the rooftop for community PV projects. Similar restrictions would apply to any power-producing machine, the production of which could be only self-consumed by the POD of building' common loads (e.g., elevator, hall/hallways lighting etc.).

The limitations set by 'one-to-one' configuration are expected to be soon overcome by the new directive included in the Clean Energy Package. The concept of 'energy communities' should allow multi-family building to install common (community) power producing devices and the production of which should be shared by the users.
Indeed, on November 21st 2018 the European Parliament set the new objectives for RES penetration, published the RED II Directive. In this document, there are the actual definitions of (Art. 2):

Renewable Energy Self-Consumers [RESC]: Group of at least two people in the same building (residential or not) who produce and consume (and possibly sell) electricity using RES. If a member is not a family, this activity cannot be his main commercial employment.

Renewable Energy Community [REC]: Legal entity formed by voluntary members who own and live near the production energy systems; members can be physical person, local authorities or SMEs (Small and Medium Enterprises). Its main purpose must be to provide social and economical benefits to its members and/or to the area in which it operates, rather than financial profits.

As well, in the District Heating Systems (DHS) the RES should be incorporated if an opportunity and feasible, and the definition of nearby RES related to the nZEB, could thus incorporate the RES delivered from the DHS.

The articles 21 and 22 describe the benefits of these two entities:

Art 21: Each Member State (MS) undertakes to authorize RESC to produce, store and sell energy without applying any discriminatory charge. Energy exchanged among internal members (in the same building) may be subjected to network and accessory charges. RESC can receive incentives for the energy they feed into the grid, considering its social and environmental benefit. Governments can apply additional charges on the self-consumed energy if: there are already support schemes for the self-consumed renewable energy; the total quota of plants in self-consumption exceeds 8% of the total installed electric power (from 1st December 2026) or the total installed electric capacity is bigger than 30 kW.

Art 22: Likewise the RESCs, the RECs can produce, store, sell and use the self-produced energy. In addition, members can exchange energy each other, provide energy or aggregation services or other commercial energy services and participate in the free electricity market jointly or alone. Also in this case, governments agree to not apply discriminatory fees on the self-consumed electricity. Finally, it is possible that countries decide in favour of cross-border participation.

Even if this is a good starting point for ECs, it is easy to understand that operative rules are still missing. As a matter of fact, no limits have yet been set, for instance, on ancillary charges that ECs may pay. Waiting therefore for more precise regulations, this thesis will investigate to which extent they can affect ECs chances to succeed.

A further step forward by the EU has been done with the Directive 2019/944, whose Art. 2 introduces the word \'Citizens' to highlight the involvement of local people. Citizens Energy Communities (CEC) are a legal entity based on voluntary and open participation and effectively controlled by members or partners. It has the main purpose of offering environmental, economic or social benefits to its members or associates at community level, rather than generating financial profits. Finally, it can participate in the energy generation (from RES or not), distribution, supply, consumption, aggregation and storage, as well as to energy efficiency services, charging services for electric vehicles, or provide other energy services to its members or associates.

Both these directives are awaiting for the transposition by the Member States, in terms of current supporting schemes in Italy, the net-metering scheme is available for residential prosumers (always standing the above-described restrictions). At national level, in relation to the buildings sector, the main energy efficiency policy packages could be grouped into 3 main families:
• Minimum energy performance standards for buildings (Regulatory Standards);
• Tax deductions for improving energy efficiency in buildings;
• Economic incentives for the promotion of energy efficiency / RES technology in private and public buildings.

Concerning tertiary buildings, much change from public to private sector. The public sector is then mainly influence by regional policies than national policies. Hence, the situation is quite inhomogeneous and hard to summarize.

2.1. Legislation barriers

UK

Electrical systems for RES will need to comply with the following regulations:

- BS 7671 (IET Wiring Regulations)
- Electricity at Work Regulation 1989
- Electrical Safety, Quality and Continuity Regulations 2002
- Electrical Equipment (Safety) Regulations 2016
- Electromagnetic Compatibility Regulations 2016
- Control of Electromagnetic Fields at Work Regulations 2016
- ENA Engineering Recommendations G100, G98 or G99 (as appropriate).

Wiring

BS 7671 (IET Wiring Regulations) is an attempt to harmonise UK wiring standards with those in use through much of the European Union as outlined in the CENELEC Electrical Installations for Buildings (IEC 60364).

A new update to the regulations was published in 2018 and came into effect from 1st January 2019.

The regulations are non-statutory so deviation is permissible (normally with a signed departure providing explicit reasons why particular requirements were not followed) however, compliance with the regulations can be used as evidence to demonstrate compliance with statutory requirements.

The selection and specification of wiring for any electrical system is a fundamental element of the overall system design. Incorrect sizing can result in resistive losses, component failure or excessive capital costs. Electrical wiring and cabling should be rated for the maximum voltage and current-carrying capacity for the circuit as per BS 7671 and specified to ensure safety, reliability and to minimise voltage drop and energy losses.

Metering
The DNO may stipulate that a separate Measuring Instrument Directive (MID) compliant import/export meter be required in addition to the sites existing metering arrangement.
A MID approved generation and/or export meter may be required to claim financial incentives such as the Smart Export Guarantee (SEG). The SEG is a mechanism to pay people who generate small amounts of renewable energy for the electricity they export to the grid.

Earthing
Earthing arrangements for RES must satisfy the DNOs requirements set out in the Distribution Licence. DNOs may stipulate a minimum distance between RES earthing systems and DNO equipment. These distances can be quite significant (up to 10 meters) but for a well-balanced three phase system they may be reduced (e.g. 3.6 meters).
Earthing and bonding of the AC side of the system should be completed in accordance with BS 7671 and conform with BS 7430 'Code of Practice for protective earthing of electrical installations and BS EN 50522 Earthing of Power Installations Exceeding 1kV AC'.
For systems capable of operating in 'island' mode additional independent earthing may need to be provided (as required by BS 7671 and BS 7430) to ensure earthing is maintained if the system is disconnected from the distribution network. Further reference can be found in the IET Code of Practice for Electrical Energy Storage Systems

Lightning and surge protection
RES will need to consider the possible effects of a direct or indirect lightning strike. A lightning and surge protection risk assessment should be carried out according to BS EN 62305.
This may indicate the need for lightning and surge protection to be installed at specific lightning protection zones (LPZ) as detailed in BS EN 62305. This will typically mean the installation of Type 1 (discharges very high levels of lightning current) and/ or Type 2 (diverts lightning induced surges to specific components or parts of the system) surge protection devices (SPDs).

Ingress protection from liquids and solids
All components if the RES should have a suitable Ingress Protection (IP) rating for their installation location, as detailed in BS EN 60529. This should include consideration of where

the components are to be located (e.g. flood zones) and the activities that take place at or adjacent to that location.

Battery storage

Battery technology is rapidly evolving, enabling a range of functions such as the storage of solar energy during peak generation, providing peak demand shaving and reducing the need for extra capacity on a system scale.

The choice of battery will depend on many factors, such as the desired power rating (kW), energy storage nominal or effective capacity (kWh), charge/ discharge efficiency, round trip efficiency, expected duty cycle or battery life, loading or size restrictions.

Standards for overall battery system planning and performance are being developed. The 'IET Code of Practice for Electrical Energy Storage Systems' presents the safe, effective and competent application of low voltage electrical energy storage systems and provides information on design, installation and safety considerations.

All power conditioning equipment must comply with BS EN 50160 'Voltage characteristics of electricity supplied by public electricity networks.' In addition, consideration should be given to the general safety requirements of the installation as detailed within the BS EN 50272 series.

Short circuit currents on batteries can be large, it is therefore important to consider the risks associated with arc flashes.

Energy storage systems should be designed and installed in line with BS EN 61427-2:2015 'Secondary cells and batteries for renewable energy storage. General requirements and methods of test. On-grid applications.

If the RES is required to provide power to emergency lighting during when mains supply is not available, then the system must be designed and installed in line with BS EN 50171 'Central Power Supply Systems.

Batteries present chemical hazards (due to the incorporation of corrosive, caustic or toxic chemicals) and charging hazards (due to potential gas generation and/or thermal considerations). RES that include energy storage may need to be compliant with health and safety regulations referring to dangerous substances.

Consideration should also be given to minimising the risk of fire or other damage, both accidental or deliberate. An energy storage system of less than 1MWh is unlikely to face environmental restrictions under the COSHH57 or COMAH58 regulations. Suitably ventilated and corrosion resistant enclosures should be used and installed in a way that will avoid any contamination of ground water and the environment.

Standards for overall battery system planning and performance are being developed.

IEC TS 62933-3-1 Electrical Energy Storage (EES) systems - Part 3-1: Planning and performance assessment of electrical energy storage systems - General specifications

The 'IET Code of Practice for Electrical Energy Storage Systems' presents the safe, effective and competent application of low voltage electrical energy storage systems and provides information on design, installation and safety considerations.

Code of Practice for Electrical Energy Storage Systems (IET, 2017)

Energy storage systems should be designed and installed in line with BS EN 61427-2:2015 'Secondary cells and batteries for renewable energy storage. General requirements and methods of test. On-grid applications.'

BS EN 61427-2:2015 Secondary cells and batteries for renewable energy storage. General requirements and methods of test. On-grid applications (BSI, 2015)

All power conditioning equipment must comply with BS EN 50160 'Voltage characteristics of electricity supplied by public electricity networks.' In addition, consideration should be given to the general safety requirements of the installation as detailed within the BS EN 50272 series.

Short circuit currents on batteries can be large, it is therefore important to consider the risks associated with arc flashes.

European Council Directive 89/391/EEC (EU Workplace Health and Safety Directive)
A battery installation will need to comply with standards specific to its battery type (such as lead acid, lithium ion, flow batteries etc.), as well as compliance with electrical installation standards

BS 7671:2008+A3:2015 Requirements for Electrical Installations. IET Wiring Regulations (IET/BSI, 2015)

Batteries present chemical hazards (due to the incorporation of corrosive, caustic or toxic chemicals) and charging hazards (due to potential gas generation and/or thermal considerations). Workplaces that have energy storage may need to be compliant with health and safety regulations referring to dangerous substances.

The Dangerous Substances (Notification and Marking of Sites) Regulations 1990 and The Dangerous Substances and Explosive Atmospheres Regulations 2002.

Solar PV
The IET Solar PV manual sets out industry accepted good practice for the electrical design of solar PV systems and is aligned with international standards. The manual covers electrical design, network connection, battery systems, system commissioning and system installation and maintenance.

Any PV module selected should be certificated & CE marked. Crystalline modules should be certified to IEC 61215 & IEC 61730 and thin-film modules should be certified to IEC 61646 & IEC 61730. Systems installed within coastal areas may also be certified for resistance to salt mist corrosion (IEC 61701).
Solar PV modules can also be certificated under the Microgeneration Certification Scheme (MCS) product standard MCS 005 which is a nationally recognised quality assurance scheme, supported by the Department for Business, Energy & Industrial Strategy.
Certification of a pitched solar mounting system can be achieved under MCS product standard, MCS 012, demonstrating resistance to wind uplift, weather tightness and external fire spread.
PV module casings and pre-fitted connector cables should be double insulated (safety class II) as recommended by BS 7671 for systems where the string voltage exceeds 120Vdc. Double insulated components minimise the risk of fire and electric shock.
DC solar connectors provide a quick and safe way of connecting components within the PV system and should be class II rated and certified in accordance with BS EN 50521 'Connectors for photovoltaic systems – safety requirements and tests'.
PV cables must comply with BS EN 50618 'Electric cables for photovoltaic systems.' The selected cables should ensure suitable resistance to environmental factors such as

moisture, sunlight, heat, chemicals and abrasion. AC and DC cables should be separated and clearly identified.
Switch-disconnectors provide both load-break-switching and isolations function. DC switch-disconnectors must comply with BS EN 60947, they must not be polarity sensitive and must isolate all live conductors.

Solar inverters
Solar inverters should be selected with respect to the distribution network connection capacity available. Common practice is to undersize solar inverters to optimise power output and overall inverter efficiency if the amount of sunlight will be lower than may be expected because of location, weather or orientation of panels.
Occasional loss of production at peak generation is balanced against improved solar inverter efficiencies at times of lower generation, however, the solar inverter output may need to be regulated at times of high PV generation to ensure the inverter's maximum power rating is not exceeded.
Solar inverters may also be undersized to maximise on generation throughout the day on systems with a restricted distribution network connection (i.e. export limit)
All inverters should be CE marked, comply with BS EN 62109 Series. 'Safety of power converters for use in photovoltaic power systems' and BS EN 62116 'Utility-interconnected photovoltaic inverters' and must be either type tested to the relevant Engineering Recommendation (G83/ G59/ G98/ G99) or have an additional G59 relay which has been witness tested by the DNO.
Type testing provides evidence that the inverter will provide protection to the distribution network in the event of under-voltage, over-voltage, under-frequency, over-frequency and loss of mains power.

Battery inverters
Battery inverters can provide a wide range of functions including; monitoring of battery conditions (i.e. state of charge, cell voltages, temperature etc.), battery management, internet/ GPRS/ WLAN communication, remote control and back-up power supply/ island operation.
As well as being capable of operating in 'island' mode, the inverter must be rated to supply the power required by the load, including any inrush current. Critical loads will be generally separated from other loads and connected to the energy storage system via a dedicated distribution board which automatically disconnects mains supply and connects the energy storage system to these loads.
Additional consideration should be given to the operation of protective devices and the provision of continuous earthing when operating in island mode. Residual current devices (RCDs) for the critical loads will need to be capable of operating under both supply conditions and not trip as a result of the transition.

Wind Turbines
For turbines with a swept area up to 200m^2, (notionally up to 50kW) the Microgeneration Certification Scheme (MCS) MCS 006 (issue 2.1) identifies the assessment criteria required to meet IEC 61400-1 Wind Turbines – Design Requirements and selected requirements of the RenewableUK Small Wind Turbine Standard (15 January 2014).

The MCS (and RenewableUK) standards can be found at:
http://www.microgenerationcertification.org/mcs-standards/product-standards/small-and-micro-wind-turbines

Small Wind Turbines that have been certified in accordance with the MCS Standard and following their processes are registered on their website:
http://www.microgenerationcertification.org/consumers/product-search?product_type_id=6776
For medium sized wind turbines with a swept area from $200m^2$ to $1,000m^2$, (notionally 50 – 500kW) UK guidelines sit with the MCS to aid their development of Medium Wind Turbines within the Certification Scheme (and contribution to the revision of the international wind turbine IEC61400-1 standard to include content on medium wind turbines).

Romania

In Romania the national law is coherent in terms of support schemes but not in terms of RES implementation. The centralised system of electricity and the difficult connection to the grid, for now, make the investments in green energy for buildings inefficient due to the high bureaucracy. Also the priority that EU gives to RES is not always reflected at the national level where the absence of clear strategies of implementation, the lack of flexibility from the competent authorities and the lack of a clear law discourages people to make a step towards RES.

The instability and unpredictability of the promotion systems and a lack of information towards the energy providers and clients prevent using a technology that has a good cost-benefit ratio.

On the other hand, through a recent initiative to promote the prosumers, the Government launched a financing scheme for the residential individual energy users to install a minimum of 3 kW of PV systems, with a State support of maximum 20.000 lei (approx. 4.000 Euro/system). There is an associated Guide on how to become a prosumer, how to install the PV system and an official list of approved installers, by the Ministry of Environment.
In the first week of the launch, after the first day the online system for the Beneficiaries registration has been closed due to fraud suspicion (September 2019) and since then no updates.

Greece

Net-metering:
The offsetting of generated - consumed energy (also known as net-metering) is one of the tools for promoting self-production and self-consumption with RES, applicable within the Greek region. Net-metering allows the consumer to cover a significant portion of self-consumption while allowing it to use the network as an indirect storage of green energy. The term "net" derives from the fact that consumer debit / credit refers to the difference between the energy consumed and the energy produced over a given period of time.
The development of photovoltaic plants by self-producers has been established (Government Gazette 3583B / 31.12.2014) and subsequently replaced by the Ministerial Decision YPEN/ DAPEK/ 15084/ 382 (Government Gazette 759B/ 6.3.2019) and concerns the installation of photovoltaic stations to meet the same needs of electricity consumers, through net-metering.
With L.4414/ 2016 (Government Gazette 149A/ 9.8.2016) the self-generation through net-metering was extended upon other technologies, in particular small wind turbines, biomass/ biogas/ bioliquids stations, small hydropower plants and stations of electricity - heat co-

generation (CHP), whereas by L. 4513/ 2018, Government Gazette 9A / 23/1/2018 (concerning Energy Communities) and Ministerial Decision YPEN /DAPEK /15084/ 382, (GG 759B/ 6.3.2019) It is now possible to install storage units in combination with self-production systems.

In more detail, the following are noted (GG 759B/ 6.3.2019):

- Installation of one or more generating stations in commonly owned or shared real estate is permitted as a general condition. The written agreement of the co-owners is required on the basis of the Civil Code clauses.
- Only in the case of stations that are connected to the Medium Voltage (MT) network (installation> 135 kVA), it is permissible to combine two of the above-mentioned RE technologies from the prosumer[1] or energy community;
- Maximum installed capacity per installed technology should reach up to 50% of the agreed consumption capacity and not exceed 20 kW (for Low Voltage installation);
- In the case of two power sources, one of which is a wind turbine, the upper installed limit can be 60 kW;
- Connecting plants under the net-metering scheme may, upon request from the relevant grid operator, be allowed to install a fixed battery storage system for electricity storage. The storage system is part of the internal electrical installation of the generator and its installation must comply with national and international standards and regulations. The storage system should be connected and operated in parallel with the distribution network;
- If a battery pack is installed, this should not exchange energy with the grid, therefore battery should charge from the RES-generated energy only. The stored energy should explicitly be used for feeding the prosumer' loads;
- The rated power of the battery inverter may not exceed 30 kVA. Maximum amperage should not exceed the maximum charging capacity of the prosumer supply;

<u>The Licensing and Installation Process in Steps is:</u>
1. Submission of HEDNO Connection Application
2. HEDNO Engineers' Autopsy
3. Sending and Accepting Connection Offer
4. Drafting and Signing of Connection Agreement
5. Drafting and Signing of a Netting Contract with the Electricity Provider where applicable
6. Meter Certification at REDF Certification Center in HEDNO premises
7. Installation of the RE System
8. Network Connection and Activation

<u>Comments:</u>

Slow-adoption of net-metering theme in Greece:
It is almost four years since the net-metering program was launched and the results are rather disappointing -about 4 MW of PV systems have been installed during this time-; such integration rates can compromise national objectives' regarding future RES development and emissions' targets. Also, with the current market prices (among the lowest internationally) and the existing legislations, depreciation time of a small residential PV-based self-production system would be about 10 years. Therefore, the following

[1] The 'self-producer' term is used in Greek legislation

improvements has been proposed from the Hellenic Association of Photovoltaic Companies, for improving the net-metering regime in Greece[2].

Today, self-producers are burdened with Services of General Interest (SGIs)' charges, evaluated at the **total sum** of their energy consumption, even on the energy that they themselves produce and consume locally before infused on the network. This is extremely unproductive, and unfair. Regarding the rest regulated charges (network and system usage charges), the self-producer is charged only for the energy absorbed by the grid and not for the whole energy consumption. The overwhelming percentage of SGIs relate to indirect subsidy for diesel-based electricity production on the islands. If SGIs were to be calculated on the actual energy consumed and not the total energy consumed, reduces the depreciation time for a home system PV system would be reduced by up to one year.

Storage-related issues:
Conditions regarding small-scale energy storage should be in line with the spirit of EC Guidelines as well as upcoming technological developments (e.g. EV charging infrastructure). EC Directive 2018/844[3] states that "…buildings can be leveraged for the development of the infrastructure necessary for the smart charging of electric vehicles and also provide a basis for Member States, if they choose to, to use car batteries as a source of power". Also, "smart charging" should include the ability to perform time-controlled charges. The arrangements promoted to date through the Greek Legislation do not allow power exchanges between the storage system and the network and therefore do not align well with such directives. The ability of grid charging should be available for other reasons as well, such as UPS readiness in case of frequent black-outs.

Other issues:

- A clear distinction in the Greek law between connected and non-connected prosumer with the grid does not seem to exist
- The limitations of capacity (kW) and number of different technologies installed can decrease the potential and viability in certain cases of prosumers

Italy

In Italy, for thermal technologies, the so-called 'Conto Termico' is active. This scheme encourages interventions to increase energy efficiency and the production of thermal energy from renewable sources for small plants. The beneficiaries are mainly the public administrations, but also businesses and individuals, who will be able to access funds for 900 million euros per year, of which 200 are destined for public administrations.

Thanks to the Conto Termico, it is possible to redevelop one's own buildings to improve their energy performance, thereby reducing consumption costs and quickly recovering part of the expense incurred. Recently, the Thermal Account has been renewed with respect to the one introduced by the Ministerial Decree 28/12/2012.

However, the actual scheme does not include the installation of micro-cogeneration units, which have therefore been excluded from a mechanism that has proved particularly effective in promoting small interventions to increase energy efficiency, carried out both from families and small businesses and from public administrations. It is proposed that micro-cogeneration be included in the list of interventions that can be incentivized by this mechanism if it

2 https://helapco.gr/wp-content/uploads/HELAPCO_Authorisation_proposals_25Feb2019_com.pdf
3 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2018.156.01.0075.01.ENG

guarantees a primary energy saving (PES) of at least 20 percent. It would also be advisable to provide for the promotion of hybrid systems consisting of the combination of a micro-cogeneration with an electric heat pump, a particularly efficient solution in cases of significant heat consumption.
On the permitting level, significant barriers to entry for micro-cogeneration remain, determined by the complexity of the bureaucratic process necessary to install and operate this type of plant. Even the recently approved legal provisions, with regard to authorization simplification, are not applied.

In terms of tax treatment, the formalities required for a micro-cogeneration plant are similar to those required for a large-scale plant, as there has been no legal reference to the concept of "FER assimilability", thereby creating burdens and obligations hardly sustainable for micro-sized plants. It is therefore proposed to eliminate the electrical workshop complaint for high-efficiency micro-cogeneration plants or, alternatively, to harmonize the simplifications envisaged for high-efficiency cogeneration plants with the provisions of the tax simplification rules governing the payment of excise duties on fuels, including natural gas.

On the PV side along with several improvements during the last 10 years, a barrier in Italy is still represented by the complex administrative regulations at the regional level and development-inhibiting bureaucracy. However, starting from 2015 a simplified permitting procedure has been introduced for PV systems to be installed on buildings with a size below 20 kW_p; this way, all the required authorizations to install the system, to connect it to the grid and to allow the net-metering can be obtained with a unified and simplified procedure. Another current minor barrier was caused by the rapid and frequent changes in the rules and subsidizing mechanisms from 2007 to 2014, which caused phases of exasperated and chaotic growth of the market, followed by periods of almost total stagnation; this phenomenon created a general mistrust in the technology and, especially, influenced negatively all business activities related to the PV sector. In addition, several limitations are still present when PV panels must be installed on historical buildings or simply within historical centres of towns, as they are subjected to specific building regulation[4].
BIPV market suffered for the inability to consolidate even if it has “the potential to become an industry-leading, reliable, renewable and cost-effective energy source”. Many BIPV-oriented companies failed, and many innovative and excellent products have disappeared because of the price pressure of Building Applied Photovoltaic (BAPV) systems[5].

Barriers to BIPV diffusion are also related to difficulties that investors, planners, architects and builders encounters in practical implementation of this technologies, mainly due to lack of awareness and a persistent resistance among stakeholders. A questionnaire among 82 stakeholders showed that the lack of expertise and training courses is a crucial factor which reduce the diffusion of such technology [18]. Other major barriers to BIPV diffusion are the perceived aesthetics lack and the absence of adequate software and tools to facilitate the designing[6].

[4] L. Mazzarella, Energy retrofit of historic and existing buildings. the legislative and regulatory point of view, Energy Build. 95 (2015) 23–31. doi:10.1016/j.enbuild.2014.10.073
[5] P. Heinstein, C. Ballif, L.E. Perret-Aebi, Building integrated photovoltaics (BIPV): Review, potentials, barriers and myths, Green. 3 (2013) 125–156. doi:10.1515/green-2013-0020
[6] M. Tabakovic, H. Fechner, W. Van Sark, A. Louwen, G. Georghiou, G. Makrides, E. Loucaidou, M. Ioannidou, I. Weiss, S. Arancon, S. Betz, Status and Outlook for Building Integrated Photovoltaics (BIPV) in Relation to Educational needs in the BIPV Sector, Energy Procedia. 111 (2017) 993–999. doi:10.1016/j.egypro.2017.03.262

Slovenia

In Slovenia the final customers' production is regulated by the Decree on the self-supply of electricity from renewable energy sources (March 2019). The decree transposes into national legislation some principles from the Directive 2018/2001 on the promotion of the use of energy from renewable sources, especially on the field of self-production and renewable energy communities. The main principles of the decree are:

- The 11 kVA limit of rated capacity of production units connected to the same grid connection point, which was valid till the adoption of the new decree, is replaced by the limit of 80% of grid connection point's rated power;
- If the produced energy exceeds the building's internal consumption the building's energy supplier is obliged to take over the surplus;
- Single-tariff net-metering remains valid for determination of energy quantities, grid fees and taxes;
- Battery systems are considered as a part of self-supply system.

Legislation barriers:

- Construction permission isn't required for units classified as simple energy production units (PV units <1 MW; CHP, wind, fuel cell units <50 kW). For larger units a construction permission must be obtained by the investor. In some cases, the response times of the competent agency are very long;
- The limit of production unit's rated capacity (80% of grid connection point's rated capacity) is introduced to prevent from excessive impact (above all feeding the grid) of local production on the operation of the distribution grid (dependent on the actual situation of the local grid, this limit can also be reduced by the DSO). This requirement doesn't enable installation of larger units at customers with high share of continuous consumption, where feeding the grid occurs only occasionally and in minor extent;
- The main barrier for installation of RES relates to the multi-apartment buildings owned by different owners. The relevant act (Rules on management of multiple dwellings) requires a consent of 75% of the owners for installation of production units classified as simple energy production units, and of 100% of the owners for larger units (whose installation requires an obtainment of construction permission). In practice, it is extremely difficult to acquire the consent from the required share of building owners (especially for larger units where a 100% consent is required).

Barrier common to all manufacturers of EV charging equipment (charging stations and charging infrastructure management systems):

- Some countries have introduced specific legislative requirements related to treatment of charging session's data (meter data of energy delivered to EV's battery, customers' identification data, billing data), mostly in connection with data security and privacy. Development of specific solutions for different countries results in additional development costs, which is reflected in higher price of equipment and ICT solutions.

2.1.1. Product certification and qualification

As regards the EV chargers there are no special barriers related to product certification. The requirements for material in composition, safety and quality standards are the same as valid for electrical appliances and enclosures.

Safety standards to be compline with criteria

Italy

The safety standards to comply with for SWT concern:

- wind technology;
- electromagnetic compatibility;
- electrical security;
- grid code;

In particular, those applying for Windcity' SWT are:

- IEC 61400-2:2013 Wind turbines - Part 2: Small wind turbines;
- Electromagnetic compatibility EMC requirements from Comité International Spécial des Perturbations Radioélectriques (CISPR; English: International Special Committee on Radio Interference), CISPR 11. Wind turbines and their electrical components and systems shall be designed concerning EMC as to: reach a specific level of operational safety of the wind turbine during energy production or the event of faults, keep the wind turbines' emission to the environment within tolerable levels, avoid that disturbing sources are interfering with other sub-systems or components of the wind turbine leading to malfunction of single components or loss of control;
- Electrical security for power converters requirements as per IEC 62477;
- and Grid Code and System Integration, including the EN 50438 to EN 50549 regulation transition and discussion about national codes across EU towards a common code;
- Concerning the building, and therefore the building response to vibrations from the SWT, and evaluation of their effects on structures, the ISO 4866 applies to this project.

Quality standards (materials, efficiency etc.) criteria:

Switzerland

Special provisions should be observed when testing and commissioning of a grid-connected PV systems as listed in **EN 62446**. This standard is also in force in Switzerland. Low voltage electrical installations conditions specified in **IEC 60364-7-712** (SN 411000-7.12 in Switzerland) must also be met.

EN 62446 requires standardized documentation for PV installations to provide customers, operators, controllers and service engineers with the main data of the system. The system documentation consists of a series of documents that must be kept in a precise and logical order: basic data of the system, wiring diagram, data sheets, operation and maintenance documentation.

The norm also addresses the question of testing a PV installation from the point of view of compliance with the standards in force, both during commissioning and during mandatory periodic inspections. The correct execution of these tests and these measurements makes it possible to guarantee the conformity of the installation at the level of the standards and at the technical level. The main verifications concern the AC components, visual control of DC components, conductivity of the protective and potential compensation conductor, open circuit voltage and polarity, short-circuit current and service current, measurement of insulation, functional tests. On this occasion, the manufacturer and the operator of the installation also collect important information for the mandatory documentation of the system

Several laws, ordinances and recommendations are in force regarding protection against electrical risks of PV system. With different accents, they aim to ensure the protection of people and property as well as the exploitation of compliant installations, equipment and appliances. Material goods must first and foremost be protected against overvoltage, overloads and short circuits. Such events can trigger fires and must therefore be avoided with the appropriate technical means.
The lightning protection obligation, as well as the protection class of a building, are not influenced by the installation of a photovoltaic system. To effectively protect a building and its equipment against the consequences of an overvoltage, it is required to perform a risk analysis according to **EN 62305-10** (in force also Switzerland).

In Switzerland norms and directives of the AEA/VKFI[7] are the most important in the field of fire protection. The Fire Protection Directive 14-15 "Use of construction materials" lays down the requirements which building materials must meet with regard to their reaction to fire. Solar panel have to meet the same requirements to fire reaction as multilayer construction roofs and walls (requirements to be met by the upper layer, thermal insulation layer, under-roofing, etc) In particular, installations for producing solar energy on the outer walls must not contravene to the requirements of section 3.1.1 para. 2 of the fire protection directive mentioned. Photovoltaic modules with a glass-glass or glass-membrane structure that are used as part of a roof are considered a fireproof superior layer in the sense of fire protection requirements if the weather-exposed layer consists of RF1 incombustible building materials and that the total thickness of the membrane layer is 1.5 mm maximum.
With regard to the risk of fire, the inverters must be considered as equipment assemblies with regard to their arrangement and assembly. With their control systems, they must be installed in places always easily accessible.

2.1.2. Product installation

UK

Microgeneration is often classed as permitted development and may not require an application for planning permission.

Content taken from https://www.planningportal.co.uk/info/200130/common_projects

The installation of solar panels on non-domestic buildings and land may be 'permitted development' with no need to apply to the Local Planning Authority for planning permission however certain conditions will need to be met.

Non domestic buildings and land for the purposes of these permitted development rights includes businesses and community buildings.

[7] Association des établissements cantonaux d'assurance incendie/ Vereinigung Kantonaler Feuerversicherungen

Planning Permission: Solar panels mounted on a non-domestic building

All the following conditions must be observed:

- Equipment should be sited, so far as is practicable, to minimize the effect on the external appearance of the building and the amenity of the area.
- When no longer needed the equipment should be removed as soon as reasonably practicable.

All the following limits must be met:

- Solar panels installed on a wall or a pitched roof should project no more than 200mm from the wall surface or roof slope.
- Where panels are installed on a flat roof the highest part of the equipment should not be more than one meter above the highest part of the roof (excluding the chimney).
- Equipment mounted on a roof must not be within one meter of the external edge of that roof.
- Equipment mounted on a wall must not be within one meter of a junction of that wall with another wall or with the roof of the building.
- The panels must not be installed on a listed building or on a building that is within the grounds of a listed building, or on a site designated as a scheduled monument.
- If the building is on Article 2(3) designated land* the equipment must not be installed on a wall or a roof slope which fronts a highway.
- If the equipment is on the roof of the building the capacity for generation of electricity across the whole of the site cannot exceed 1 megawatt.
- Other than microgeneration solar thermal equipment or microgeneration solar PV equipment, if there is to be any other solar PV equipment installed on the roof of a building then the Prior Approval (56 days) of the Local Planning Authority is required. This will assess the design and external appearance of the development, particularly in respect of the impact of glare on occupiers of neighboring land.

Note - If you are a leaseholder you may need to get permission from your landlord, freeholder or management company.

Installation of solar panels on the roof of a building will usually be subject to building regulations. The ability of the existing roof to carry the load (weight) of the panel will need to be checked and proven. Some strengthening work may be needed. Building regulations also apply to other aspects of the work such as fire protection and weather proofing. It is advisable to contact an installer who can provide the necessary advice.

Planning Permission: Building mounted wind turbines

The installation, alteration or replacement of a building mounted wind turbine can be considered to be permitted development, not needing an application for planning permission, provided ALL the limits and conditions listed below are met:

Limits to be met:

- Permitted development rights for building mounted wind turbines apply only to installations on detached houses (not blocks of flats) and other detached buildings within the boundaries of a house or block of flats. A block of flats must consist wholly of flats (e.g. should not also contain commercial premises).
- Development is permitted only if the building mounted wind turbine installation complies with the Microgeneration Certification Scheme Planning Standards (MCS 020) or equivalent standards. Read more about the scheme.
- The installation must not be sited on safeguarded land.

- Only the first installation of any wind turbine would be permitted development, and only if there is no existing air source heat pump at the property. Additional wind turbines or air source heat pumps at the same property requires an application for planning permission.
- No part (including blades) of the building mounted wind turbine should protrude more than three metres above the highest part of the roof (excluding the chimney) or exceed an overall height (including building, hub and blade) of 15 metres, whichever is the lesser.
- The distance between ground level and the lowest part of any wind turbine blade must not be less than five metres.
- No part of the building mounted wind turbine (including blades) must be within five metres of any boundary.
- The swept area of any building mounted wind turbine blade must be no more than 3.8 square metres.
- In Conservation Areas, an installation is not permitted if the building mounted wind turbine would be on a wall or roof slope which fronts a highway.
- Permitted development rights do not apply to a turbine within the curtilage of a Listed Building or within a site designated as a Scheduled Monument or on designated land* other than Conservation Areas.

In addition, the following conditions must also be met. The wind turbine must:

- use non-reflective materials on blades.
- be removed as soon as reasonably practicable when no longer needed for microgeneration.
- be sited, so far as practicable, to minimise its effect on the external appearance of the building and its effect on the amenity of the area.

** Designated land includes national parks and the Broads, Areas of Outstanding Natural Beauty, and World Heritage Sites.*

You may wish to discuss with the Local Planning Authority for your area whether all of these limits and conditions will be met.

Planning Permission: Standalone wind turbines

The installation, alteration or replacement of a standalone (not building mounted) wind turbine within the boundaries of a house or block of flats can be considered to be permitted development, not needing an application for planning permission, provided ALL the limits and conditions listed below are met.

A block of flats must consist wholly of flats (e.g. should not also contain commercial premises).

Limits to be met:

- Development is permitted only if the stand alone wind turbine installation complies with the Microgeneration Certification Scheme Planning Standard (MCS 020) or equivalent standards. Read more about the scheme.
- The installation must not be sited on safeguarded land.
- Only the first installation of any wind turbine would be permitted development, and only if there is no existing air source heat pump at the property. Additional wind turbines or air source heat pumps at the same property requires an application for planning permission.
- The highest part of the stand-alone wind turbine must not exceed 11.1 metres.
- The distance between ground level and the lowest part of any wind turbine blade must not be less than five metres.
- An installation is not permitted if any part of the stand-alone wind turbine (including blades) would be in a position which is less than a distance equivalent to the overall

height of the turbine (including blades) plus 10 per cent of its height when measured from any point along the property boundary.

- The swept area of any stand-alone wind turbine blade must be no more than 3.8 square metres.
- In Conservation Areas, development would not be permitted if the stand alone wind turbine would be installed so that it is nearer to any highway which bounds the curtilage (garden or grounds) of the house or block of flats than the part of the house or block of flats which is nearest to that highway.
- Permitted development rights do not apply to a turbine within the curtilage of a Listed Building or within a site designated as a Scheduled Monument or on designated land* other than Conservation Areas.

In addition, the following conditions must also be met. The wind turbine must:

- use non-reflective materials on blades.
- be removed as soon as reasonably practicable when no longer needed for microgeneration.
- be sited, so far as is practicable, to minimise its effect on the external appearance of the building and its effect on the amenity of the area.

** Designated land includes national parks and the Broads, Areas of Outstanding Natural Beauty, and World Heritage Sites.*

Installation of a wind turbine attached to a building will normally be subject to building regulations. Size, weight and force exerted on fixed points would be considerable.

Building regulations also apply to other aspects of the work such as electrical installation. It is advisable to contact an installer who can provide the necessary advice. An installer registered with the relevant competent person scheme (as listed in Row 17 of Schedule 3 of the Building Regulations) may be authorized to self-certify the work to comply with this aspect of the building regulations without involving local authority building control.

If the wind turbine is not attached to your house, then only the electrical installation and connection will be captured by the requirements of the building regulations.

If the electrical work is of the type listed in Row 12 of Schedule 3 of the Building Regulations and your installer is a member of a competent person scheme listed against that row, then the installer may be authorized to self-certify the work to comply with this aspect of the building regulations without involving local authority building control.

If planning permission is required:

It is advisable to seek pre-planning advice early during the project, for confirmation of fees and required documents. This is done via a Preliminary Planning Application and it has the benefit of notifying the developer of any complications. The planning application process usually take 8-12 weeks.

The information likely to be required includes:

- Location plan
- Site/ block plan
- Elevation drawings
- Design and access statement (a document which outlines the design principles and concepts that have been applied to the proposed development and shows how issues relating to access to the development have been dealt with).
- Specification of the proposed key components (e.g. PV modules, inverters, energy storage system, EV charge-points, substation etc.).
- Structural and foundation details (where applicable).
- Fencing specification and details (where applicable).

- Distribution network connection details.
- Details of any ancillary works, buildings proposed, or advertising space.
- Ecological assessment (where applicable).
- Landscape/ visual assessment (if the application site lies within, or would impact upon, an Area of Outstanding Natural Beauty; National Park or World Heritage Site).
- Historic environment statement (where applicable).
- Glint and glare impacting the surrounding environment (where local sensitivities are identified).
- Details of construction and decommissioning (including construction traffic management plans and compounds for material storage and contractor parking).
- Application fee where required.

The Renewable Energy Consumer Code (RECC) was set up by the Renewable Energy Association to ensure the quality of the product and installation and provides a dispute resolution service if there is an issue with an installer.
https://www.recc.org.uk/

The Microgeneration Certification Scheme (MCS) is a nationally recognised quality assurance scheme, supported by the Department for Business, Energy & Industrial Strategy. MCS certifies microgeneration technologies used to produce electricity and heat from renewable sources and is an eligibility requirement for the UK Government's financial incentives, which include the Renewable Heat Incentive.
Permitted development rights for wind turbines and air source heat pumps will only be accorded for equipment installed by an installer who has been certificated through the scheme using a certificated product. The installer is therefore responsible for ensuring that the installation meets permitted development noise standards at the time of installation.
The MCS website provides a list of accredited installers familiar with commissioning microgeneration systems.

https://www.microgenerationcertification.org/

Greece

According to paragraph 9 of article 27A of Law 3734/2009: 'For the placement of photovoltaic systems and small wind turbines in buildings and other construction establishments, instead of issuing approval for small-scale construction work, simple notification to the designated competent body may be provided following the decision of the Ministry. "Regarding the grid connection, the responsible Network Operator makes use of the known load-feeding supply, when technically possible, otherwise the prosumer will incur an expense for the appropriate increase in supply. The prosumer is required to ensure that the required metering gauge for monitoring the absorbed-injected energy, can be placed at the existing supply, as well as regarding the installation of the meters that will form part of his internal electrical installation.

Regarding technical requirements for small wind-turbines installation the following rules may apply (order under Ministry of Environment and Energy 2019[8]:

[8] http://www.entec.gr/consultants/gr/news/261-2018-12-11-09-52-59

- Minimum distance from the ground, floor or other horizontal surface at least 3 m to the ground, floor orbit of rotation;
- Minimum distance from wind turbine of the same station at least equal to 2.5 times the diameter of the impeller (2.5 x d);
- Minimum distance from another wind farm at least equal to the maximum height of the wind turbine, defined as the height of the structure from the ground or floor to the highest point of the impeller track (with the impeller flap at the top);
- For overhead distribution networks, fixed barriers (buildings, posts, etc.), road axes, road networks and railway stations and networks, a minimum distance of at least equal to the maximum wind turbine height of not more than 10% height and minimum horizontal distance of the line (or voltage element) from buildings provided for in the Regulation on the Installation and Maintenance of Electricity Outdoor Power Lines;
- The dimensions and location of the small wind turbine should not allow a shadow flicker to be created in an individual legally existing home, for longer than 30 hours per year and 30 minutes daily;
- Ensuring a minimum noise level of less than 45 db (A) at the station closest to the legally existing residence. The noise level is documented by the distance-noise diagram included in the type certificates of the specific small wind turbine;

Distinction between very small (2-3kW) and small (<60kW) wind turbines and related requirements is still not clear under current Greek legislation. Nor specific rules that apply for small wind turbines mounted on buildings.

2.1.3. Establishing the production capacity, standards and certifications

PVs: PV systems are designed and implemented in accordance with applicable European standards, EN 62446: 2009 & IEC 62305 governing PV projects.

WTs: Regarding small wind turbines (<60kW), the ones which are certified according to IEC 61400-2 or 61400-1 of the International Electrotechnical Commission, or any other national standard, may be installed (ground installation). In addition, certified noise and power quality measurements shall be required in accordance with IEC 61400-11 and IEC 61400-21 respectively. The above is substantiated by the issuance of a relative Certificate from the Center for Renewable Energy Sources[9].

EVs: Ministry of Infrastructure and Transport has defined the conditions and regulations which apply to the installation of electric charging devices for EVs in relevant infrastructure (such as gas stations, parking lots etc.)[10]. Based on these regulations, the accepted sockets-outlets are defined by IEC 62196-2 'Plugs Sockets-outlets, Vehicle Couplers and Vehicle Inlets – Conductive Charging of Electric Vehicles'. In more detail, for interoperability issues, the socket for AC Charging mode (IEC 61851-1 – Mode 3) is defined by IEC 62196-2 'Type 2' (VDE-AR-E-2623-2-2) standard and for DC Charging (Mode-4) it is defined by IEC 62196-2 'Type 3' (DC Compo 2).

[9] http://www.cres.gr/cres/index.html

[10] https://www.heliev.gr/wp-content/uploads/2017/11/%CE%9A%CE%A5%CE%91%CE%B3%CE%B9%CE%B1%CF%86%CE%BF%CF%81%CF%84%CE%B9%CF%83%CF%84%CE%AD%CF%82.pdf

Legislation about system mounting area criteria

Greece

Mounting support systems for PV panels secure the PV system from extreme weather conditions such as wind, snowfall, earthquake and temperature changes. Such extreme conditions as well as their corresponding safety coefficients are specified in Eurocodes. For the static adequacy of the support system itself, a corresponding certificate may be requested from the supplier.

Italy

The installation of a SWT concerns regulatory measures about **local authorities' permission**: these are country dependent or even region/province dependent. The SWT in the project is a "micro" wind turbine with geometrical dimensions (1,5 x 1,5 m) sufficiently small to accomplish with the great majority of regional authorization rules: e.g. at the project Proposal stage it has been checked that local Corby, UK provisions for SWT are satisfied and similar to the Italian Architectural Heritage Preservation code.

Areas under monument protection criteria

Greece

Any installations within declared monuments/ areas of the World Cultural Heritage are strictly forbidden.

Italy

At the project Proposal stage it has been checked that SWT dimensions satisfy the Italian Cultural Heritage Preservation Code A.7 provision for simplified authorization procedure.

Romania

In order to install PV systems, by law there is required to obtain an official permit from the DSO, so as to state that the end user will become a prosumer and another official permit from the local authority, so as to state that the building will sustain the PV system, with no threat to the building roof or other part. For this last issue, a Structural Expertise is required and the costs may be prohibitive for the Beneficiaries.

Certifications for company that mounts for each of the RES criteria

Italy

To operate at height with moving & suspended loads, which is in agreement in all countries with the legal requirements related to the workers operation at height, safety and security.

Solar thermal systems

In the Italian legislation, solar thermal systems for civil use are considered as an integral part of the sanitary system. For this reason, no special authorizations are required except those required by the local municipalities. If the building is part of an area subject to restrictions, the necessary authorizations must be requested from the competent offices.
The certification of the works and the testing must be carried out according to the provisions of law 46/90[11] and related implementation decrees and the subsequent ministerial decree 37/08[12].

Photovoltaic Solar Energy Systems

Photovoltaic Solar Energy Systems for civil use (up to 20 kW of power), as long as they are not located in protected natural areas, do not require special authorizations, other than those requested by the local municipalities, normally consisting of request of authorization following the procedures provided for by the P.A.S. (Simplified Authorization Procedure).
For all other photovoltaic solar energy systems, however, it is necessary to obtain preventively the authorization pursuant to Legislative Decree No. 387/2003[13] and subsequent amendments.
It should also be considered that the plants located in protected areas, regardless of their power, and the industrial plants (power ≥ 20 kW) are always subject preventively to the preliminary screening assessment.
Industrial plants that are integrated or partially integrated into buildings, unless they are located in protected areas, are not subject to a preliminary screening assessment but must be subjected to a single authorization pursuant to Legislative Decree No. 387/2003 and subsequent amendments.
The placement of photovoltaic systems is also permitted in agricultural areas.
The unique authorization procedure takes place pursuant to art. 12 of Legislative Decree No. 387/2003 and subsequent amendments.
Recently, The legislative decree 115/2008[14] was approved which, implementing European Directive 2006/32/EC[15] (energy end-use efficiency and energy services), simplifies and defines the improvement measures in terms of energy efficiency, giving the possibility to present a simple communication to the local municipality instead of DIA, in the case of adherent photovoltaic systems or integrated in the roofs of buildings, thus facilitating the spread of BIPV technologies.

Small Scale Wind Turbine

In Italy, the installation of single wind turbine with a total height not exceeding 1.5 meters and a diameter not exceeding 1 meter is subject only to the obligation of communication to the local municipality but does not expect the necessity of any type of authorization.
Outside the previous category, appropriate authorizations are required. In particular, for wind power plants up to 60 KW, Italian legislation provides the start of PAS (Simplified Qualifying Procedure). In essence, an architectural and electrical project must be presented to the municipality and await its approval (which occurs within thirty days). For installations over 60 KW, however, it will be necessary to transmit a Single Authorization application to the relevant province.
Another permission to ask, before beginning the works, is the seismic authorization, provided by the superintendents of public works who will carry out a whole series of technical surveys on the area. In this case, the reference legislation changes according to the Region.

[11] https://it.wikipedia.org/wiki/Legge_5_marzo_1990,_n._46
[12] https://it.wikipedia.org/wiki/Dichiarazione_di_conformit%C3%A0
[13] http://efficienzaenergetica.acs.enea.it/doc/dlgs_387-03.pdf
[14] http://efficienzaenergetica.acs.enea.it/doc/dlgs_115-08_coordinato.pdf
[15] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32006L0032

Micro-CHP

The authorization procedures for the installation of micro-CHP systems follow a simplified procedure defined by law 239 of 2004[16] which among other things defines the promotional measures for the development of high-efficiency cogeneration plants by defining the technical characteristics that these plants must comply.

Switzerland

In 2014, the general building permit requirement for BIPV installations was deleted in Switzerland and replaced by an announcement procedure. This applies to projects that meet the following conditions: the installation must be 'sufficiently adapted to the roof of the building, the building must not be under protection or be in a protected area and it must be in a building zone or an agricultural zone.

BIPV installations are considered sufficiently adapted to roofs if:

a) they do not exceed the sides of the roof perpendicularly by more than 20 cm;
b) they do not protrude from the roof, seen from the front and from above;
c) they are not very reflective according to the state of the technical knowledge;
d) they constitute an integral surface.

Once the planned BIPV installation meets the criteria mentioned above, an advertisement made in the context of the announcement procedure set at the cantonal level is sufficient. It is not necessary to obtain an authorization. If no objection from the competent authority is received within a specified period, the installation may be constructed.

In new constructions, the free spaces for solar installations are more extensive, as they are mostly included in the architectural design of the building. The optimal roof adaptation is when the solar installation completely covers the surface of a roof pan. Facade installation can determine the colour or surface of a house.

BIPV installations can also be mounted on buildings classified as monuments or on buildings forming part of a protected site or landscape. In this case, an authorization is still required and the installation must comply with the integration cantonal or municipality guidelines. The law requires authorization only for cultural property of cantonal or national importance, which are defined in the Planning Ordinance (Article 32b, OAT[17]). Solar installations on protected site of communal importance do not require any authorization according to the OAT. The cantons have the right, under certain conditions, to extend the obligation authorization to build to other categories of buildings. The cantons and the municipalities may also require a building permit for other buildings or unprotected areas, if these constructions have an impact on a property to be protected.

Whether the BIPV installation is subject to announcement or permission to build, the others construction provisions and standards apply, concerning protection fire, product declarations, safety at work, accident prevention, standards SIA[18], especially regarding wind and snow loads, etc. As the electrical installation constitutes the essential of a photovoltaic installation, such works require authorization to install by ESTI[19], which is delivered only to competent professionals who have received the necessary training.

[16] https://www.senato.it/documenti/repository/eventi/dicembre2004/fscommand/Elenco%20leggi/239.pdf

[17] Ordinance on Territorial Planning

[18] Swiss Society of Engineers and Architects

[19] Federal Inspectorate for Heavy Current Installations

Slovenia

As regards the EV chargers there are no special requirements for installation. No specific certification is required for the companies that install the EV charging equipment in Slovenia. On the other hand, in different countries it may be required to obtain a legal permit from the local authority, especially if the EV charging will be installed on public spaces.

2.2. Technological barriers

Greece

A High-efficiency co-generation unit is defined as a co-generation unit that, in the 24-hour characteristic condition, ensures primary energy savings of at least 10% over the thermal and electric energy produced in discrete processes.

Small-scale cogeneration, to be sustainable for residential applications, is necessary to be compatible with the other operating parameters of the host heating such as water flow levels and temperatures so as to avoid installing, for example, large storage tanks for thermal absorption. It is also important to keep in mind that the small cogeneration does not respond well to fast opening-closing cycles and that machines are usually designed to cover 60% of peak load. This normally leads to a high amount of annual needs covered by the system. However, some form of additional heat source may be required very cold winter days or when the house is uninhabited for some time and it needs quick heating.

The Greek legislation has not yet imposed any minimum permissible operating criteria for the CHP units e.g. minimum efficiency, maximum emission limits which could help into the better integration of such technologies in small-scale applications.

Indicative supporting measures for micro-CHP integration[20]:

- Exemption of small self-producers from VAT
- Reduction, on behalf of HEDNO, of costs related to metering equipment

Simple rules for grid connection with the Low Voltage network should be established (e.g. following the requirements of prEN50438 “Requirements for the connection of micro-generators in parallel with public low voltage distribution networks’).

2.2.1. Product certificates

UK

Battery storage

Energy storage is subject to many different regulatory frameworks across EU Member States. As such there is no consistency amongst the Member States on the way storage is treated in the energy system. For example, in some Member States battery storage facilities pay both consumer and producer grid fees but in others only producer fees are paid.

[20] Greek Energy 2019

https://ec.europa.eu/energy/sites/ener/files/documents/swd2017_61_document_travail_service_part1_v6.pdf

The lack of a clear definition for energy storage in European regulatory framework has resulted in a lack of coherence in the classification of storage facilities across Member States. The new electricity Directive and Regulation, which replaces the Electricity Directive (2009/72/EC) and the Electricity Regulation (EC/714/2009), is part of the EU's Clean Energy for All Europeans legislative package. It formally recognizes the role that energy storage plays in EU power markets and Member States will be expected to implement the directive into national law within the next two years.

https://europa.eu/rapid/press-release_IP-19-1836_en.htm

Currently most Member Sates classify energy storage systems as a form of generation.

https://www.store-project.eu/documents/results/en_GB/european-regulatory-and-market-framework-for-electricity-storage-infrastructure

Connection of generating equipment to the distribution system

Connection of new generating equipment (i.e. RES, battery storage) to a European distribution system will need to comply with the requirements from the European Connection Code: Requirements for Generators (RfG).

In general, within each European country local Distribution Network Operators (DNO) or Distribution System Operators (DSO) are responsible for the local distribution network supplying electricity homes and businesses. In order to manage the networks safely and efficiently, battery installations must meet engineering standards.

In the UK, DNOs categorise battery storage as non-intermittent generation as set out in Appendix 1 of the DNO distribution charging statements and as such, will be required to comply with one of two Engineering Recommendations (ERECs) G98 and G99.

http://www.energynetworks.org/electricity/engineering/energy-storage/energy-storage-overview.html

EREC G98 relates to the connection of microgeneration i.e. type tested small-scale embedded generators (up to 16 a per phase) in parallel with public low-voltage distribution networks (3.68 kilowatts (kW) on a single-phase supply and 11.04 kW on a three-phase supply.

EREC G99 relates to the connection of generating plant to the distribution systems of licensed distribution network operators where generation is above 3.68kW and/or >230v.

Type testing certification applies to generation devices (e.g. batteries) rated to ≤50 kW which have been tested to ensure that the design meets relevant technical and compliance requirements for the Engineering Recommendations and that the manufacturer declares that all 'like' generation units produced will be built to the same standards and perform in the same way.

The advantage of type testing and the use of fully type tested generation devices in installs is that it tends to simplify the connection process and reduce commissioning test requirements. As a result, interactions with the DNO should be made simpler and cheaper.

Greece

Greek legislation specifically regarding microgrids is not yet defined. Some initial efforts for techno-economic feasibility analysis of microgrid systems in Greek Islands have been established[21].

Romania

There are numerous legitimate technological barriers to the widespread development of RETs, including the limited integration in existing infrastructure, inefficient knowledge of operating and maintenance, insufficient research and development initiatives and technical complexities like unavailability of standards, energy storage, conversion and integration in the existing grid.
Giving the increasing demand of energy, one of the technological barriers of RETs is the low energy output which makes increase their size and weight. The existing buildings have limited space and structural integration is amongst the biggest problems affecting the development of renewable energy projects. In Romania many of the existing buildings would need a new structural analysis to make sure they can support the extra weight and, in some cases, vibrations that the RETs bring.

Since the RET is a relatively new and not optimally developed, *the lack of operating and maintenance culture* is another impediment in implementing it. A good efficiency cannot be achieved if the plant is not optimally operated and if maintenance is not carried out regularly. Lack of availability of equipment, components and spare parts will require a substantial increase in the production costs, as these items need to be imported from other countries, therefore being procured at high prices and so increasing the overall cost.

Investment in *research and development is insufficient* to make renewable energies commercially competitive with fossil fuel. Both governments and energy firms shy away from spending on research and development as renewable energy is in its development stage and risks related to this technology are high.

The existing standards, procedures and guidelines in RETs are insufficient in terms of reliability, durability and performance. A major technical issue which renewable energy is facing today is the storage, conversion and integration of energy in the existing grid. The supply of sun or wind is not continuous despite their infinite abundance and electricity grids cannot operate unless they are able to balance supply and demand. To resolve these issue, large batteries need to be developed or integrate with the existing grid which can compensate for the times when a renewable resource is not available. For the integration in the existing grids of the building the energy needs to be converted in the standardised form which brings a energy loss through conversion.

Slovenia

As equipment technical specifications or certification procedures required, in general, for EV charging systems (charging stations and charging infrastructure management systems) no

[21] http://www.cres.gr/services/istos.chtm?prnbr=24864&locale=el

special certification is required. Some EV manufacturers (e.g. Renault) require additional features of EV charging equipment and a special certification to prove that the stations comply with their requirements. Introduction of specific solutions adapted to requirements of individual EV manufacturers results in additional development and material costs, which is reflected in higher price of charging equipment.

A specific technological barrier relates to incorporation of EV charging into various demand response schemes (building energy management systems, flexibility markets, …) that require an accurate charging load management. At the moment, the charging station and EV communicate via the pilot wire according to standard IEC 61851. This communication enables only basic exchange of information, such as the state of EV battery charger (i.e. "EV not/ready for charging) and the charging load control using the PWM signal. For charging load management, a wider scope of data is needed to enable estimation of flexibility potential of individual charging session:

- energy required by EV user to be delivered to EV battery,
- departure time (i.e. the time till when the required energy must be delivered, and
- maximum power of EV's on-board charger.

The IEC 61851 standard doesn't enable the acquisition of data listed above directly from the EV. Therefore, the needed data are determined indirectly:

- EV user inserts data via a smart phone application, or
- using statistical methods applied on historical data of user's charging sessions for estimation of charging duration and required energy, or
- using metering data from the meter in charging station (for determination of EV charger's maximum power).

These methods are quite inaccurate and doesn't assure an optimum determination and exploitation of charging flexibility potential. A standard that uses digital communication between the EV and the station is already adopted (ISO 15118). This standard enables direct acquisition of data listed above from the EV; however, it is not yet widely implemented in EVs.

Italy

Related to existing or lack of nano and micro grids availability, Windcity came across some cases of privates who are willing to embed our turbine in an existing photovoltaic system. These systems are meant to comply with basic needs and therefore are only for self-consumption; they usually comprise of an inverter, a battery and a solar charge controller, therefore they can be identified as the most simple case of microgrid. Our goal is to adapt the existing system in order to add our turbine minimizing the costs.

2.2.2. Grid concerns

Decentralized renewable sources facing problems with grid issues (access and transport, grid codes, interconnection, difficulties in cooperation with DSO)

Greece

The significant penetration of RES can cause violations of network limits. Indicatively in 2017 for the town of Trikala in Central Greece, the short circuit level in MV had reached the max. designed limit[22]. For this purpose, the Greek DSO (HEDNO) has devised and posted on-line a plan for exploring the possibility of connecting RES stations to the existing Network infrastructure per Regional Prefecture[23].

Switzerland

A BIPV module has to comply both with electro-technical requirements as stated in the low voltage directive 2006/95/IEC or CENELEC standards related to the module itself and with the building products standards provided by the European Construction Product Regulation CPR 305/2011. To harmonize these standards, CLC/TC 82 has published in 2016 the norm EN 50583-1 that applies to photovoltaic modules used as construction products. According to this norm, BIPV modules must comply to the same norm as a standard PV module: EN 61215 for the design qualification and type approval and EN 61730 for safety qualification. The objective of EN 61215 norm is to determine the electrical and thermal characteristics of the modules and to show, as far as is possible within reasonable constraints of cost and time, that the modules are capable of withstanding in open-air climates. The objective of EN 61730 is instead to provide safe electrical and mechanical operation of the modules during their expected lifetime. As construction products, BIPV modules have also to be designed to comply with the wind, snow and mechanical loads as well as other requirements set out in the Eurocodes EN 1990, EN 1991, EN 1993 and EN 1999. For Switzerland the norm SIA 261 has also to be met.

EN 50583-1 distinguishes between BIPV module that contain at least one pane of glass and those that do not. In addition to naming the general requirements, it classifies BIPV modules containing glass into five different categories depending on the intended mounting type:

A. Sloped, roof-integrated, not accessible from within the building
B. Sloped, roof-integrated, accessible from within the building
C. Non-sloped (vertically) mounted not accessible from the building
D. Non-sloped (vertically) mounted accessible from within the building
E. Externally integrated, accessible or not accessible from the building

BIPV modules which contain one or more glass panes shall comply with the respective product standards for glass in buildings: EN 14449 if the photovoltaic cells are laminated to a glass pane with an interlayer; EN 1279-5 if they are mounted directly in the cavity of a multiple glazing unit. Additional clauses from EN 13022-1 apply to BIPV modules that are used in structural sealing glazing.
For BIPV modules not containing glass panes, the following building product standard are instead applicable: EN 13956 if they contain polymer waterproofing sheet; EN 14782 and EN 14783 if they include a metal sheet as the back cover.

The data sheet information for BIPV modules shall conform to EN 50380. In addition to it the data sheet information for BIPV modules shall include the information as required for CE marking according to product standards that comply with the CPR.

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22 https://www.deddie.gr/Documents2/DIAVOULEYSEIS%202018/DD%20ANAPTIXI%20DIKTYOY/%CE%A3%CE%91%CE%94%202019-2023.pdf

23 https://www.deddie.gr/el/themata-stathmon-ape-sithia/sundeseis-stathmwn-ananewsimwn-pigwn-energeias-ape/dunatotites-aporrofisis-isxuos-stathmwn-ape-apo-to-diktuo/dunatotites-sundesis-stathmwn-ape-ana-perifereia/

Switzerland's electricity system is in the midst of the greatest upheaval in its successful history. The energy reform is changing the entire electricity economy. The modernization of the transmission grid has slowed down in the past few decades. Only a third of Swiss grid's entire 6,700-kilometre transmission grid dates from the period after 1980, even though the demands on the grid have shifted dramatically in recent years. On the one hand, new energy sources and power plants have been connected to the grid, and on the other, electricity consumption has risen. This constantly rising demand is already leading to structural bottlenecks in the transmission grid, and this congestion will only increase further in the future. Modernizing the transmission grid is therefore key to ensuring a sustainable energy future. Switzerland can have the upgraded grid it needs by 2025.

Hydropower and other sources currently supply some 70% of Swiss electricity, which leaves around 30% of Swiss production to be shifted from nuclear to renewables. It was found that Switzerland can phase out nuclear (as planned by the Energy Strategy 2050) and switch to renewables without risk of grid intermittency, if it does not rely solely on PV. This is because Swiss hydropower can compensate for limited intermittency, though less so in winter when PV output is low and Swiss rivers get limited water. Since its entry into force on January 1, 2018, the new Swiss energy law has created communities of self-consumption. Under certain conditions, landowners are now allowed to sell electricity generated on their land to their tenants or neighbors, but also to group together in production micro-grids.

Italy

We can identify as a grid issue the power conversion stage needed to inject power to the grid because of the compliance with grid code and MPPT control strategy.
Due to the relatively small size of the turbine and its variable speed control there are few suitable power converters on the market. We have two possibilities: back-to-back power converters or diode rectifier + boost. Both the active front end rectifier and the DC/DC boost converter are commonly designed for different sizes: the first one is mainly for rated power of ten/hundreds of kilowatts, while the second is available either for very limited power rating (mW to ten/hundred W) or for industrial applications (hundred of kW).
Moreover, none of them is specifically developed for variable speed operation. What's more, there is a lack of research on variable speed operation for low rated power (500-5000 W) turbines.
Finally, the plurality of grid codes country by country, and the certification issue for inverter producers, can act as a barrier or an obstacle even for the RES manufacturer in the design for system integration.

2.3. Economical barriers

Economical aspects are among the biggest concerns when it comes to implementing renewable energy technologies. Payback and upfront costs are crucial in this context.

Romania

Time taken for the initial investment to be recouped is one of the major barriers because users and building owners are less likely to invest in projects that take more than 3-7 years to pay for themselves. Therefore, if the long-term benefits from maintenance cost and energy savings are not self-evident, due to the fact that the initial cost can be high, users and building owners are less likely to invest in such projects.

The instability of founding schemes and/or the inability to secure finance on acceptable terms is another economical barrier that influences consumer decision. This applies to all levels of ownership (from the level of the individual householder to the small landlords, to the case of fragmented ownership in condominiums and, finally, in the renting market).
High operation and maintenance cost are also an important economical barrier because of the lack of technically skilled personnel.

Lack of competitiveness in the RETs comparative to conventional energy technologies in current market scenario is an important barrier because it increases the price of installation, maintenance and operation.

2.3.1. Economical concerns

***Existing or lack of market transparency and market prices not including the external costs of energy criteria*:**

Italy

The energy tariff is comprehensive of many commercial inputs, which are difficult to identify as single entries.
Taking into account the variation of electricity price within regions, e.g. in isolated/island villages and communities, compared to the average could be an important enabler to foster decentralized generation by RES as those in the project.

BIPV market, in particular, suffered for the inability to consolidate even if it has “the potential to become an industry-leading, reliable, renewable and cost-effective energy source”. Many BIPV-oriented companies failed, and many innovative and excellent products have disappeared because of the price pressure of Building Applied Photovoltaic (BAPV) systems.[24]

Barriers to BIPV diffusion are also related to difficulties that investors, planners, architects and builders encounters in practical implementation of this technologies, mainly due to lack of awareness and a persistent resistance among stakeholders. The lack of expertise and training courses, as well, is another crucial factor which reduce the diffusion of such technology. A questionnaire among 82 stakeholders showed that major barriers to BIPV diffusion are: need of training course, lack aesthetics, lack of software and tools to facilitate designing.[25]

In Italy, different types of incentives have been granted cyclically to facilitate and stimulate RES introduction, valid also for residential building.
There are several schemes followed for the granting of these incentives, which can be summarized as follows:

[24] Heinstein, Patrick, Christophe Ballif, and Laure-Emmanuelle Perret-Aebi. "Building integrated photovoltaics (BIPV): review, potentials, barriers and myths." *Green* 3.2 (2013): 125-156
[25] Tabakovic, Momir, et al. "Status and outlook for building integrated photovoltaics (BIPV) in relation to educational needs in the BIPV sector." Energy Procedia 111 (2017): 993-999

- **Premium tariff** ("Ritiro Dedicato") for renewable energy installations, that are promoted through a simplified purchase from GSE26 at a guaranteed minimum price. Renewable Energy producers can decide between selling the produced energy on the free market themselves or sell it to the GSE, who then sells the energy on the free market on their behalf. Thus, GSE can be considered a mediator between producers and the market. Producers can decide whether they want to receive a guaranteed minimum price or the market price. In case the market price is higher than the guaranteed minimum price, the producer receives an annual adjustment.
- **Net-metering** ("scambio sul posto") a form of auto-comsumption that allows prosumers to offset the electricity produced and fed into the network at a certain moment with the energy taken from the grid and used. Therefore, the electricity system is used as a tool for the virtual storage of electricity produced but not self-consumed at the moment in which it is produced.
- **Tax regulation mechanisms**: Since 1993, photovoltaic and wind energy plants are eligible for a reduced VAT of 10% (instead of 20%) for both companies and private individuals. Since 2008, the municipalities have the opportunity to grant a reduction in real estate tax (IMU) to buildings equipped with renewable energy installations. Also, tax deductions and direct contributions are now a reality for over a decade for the installation of renewable energy plants and for the production of energy through these plants.

Energy efficiency certificates ("Titoli di efficienza energetica") that provide for the recognition of an economic contribution, in relation to energy savings resulting from the implementation of specific efficiency measures

Knowledge dissemination of e.g. support schemes, pilot or demonstration projects (e.g. tar removal for biomass gasification, direct-drive for wind turbines) criteria:

UK

Whilst UK Government incentives to install RES are still potentially available, accessing them is becoming increasingly challenging, as a result developer are increasingly looking to see if economics allow their project to be built subsidy free.

As the cost of RES is tending to fall and energy prices rise, incentives may no longer the main stimulus to deployment. It is therefore advisable to consider the business case on the basis of unsubsidised generation, with the potential for an additional income should an incentive prove to be available.

https://www.independent.co.uk/environment/renewable-energy-projects-uk-government-funding-feed-in-tariffs-a8331276.html
Investment in independent renewable energy projects has dropped by 20% since 2016 and is down more than 45% from the peak of £418m invested in 2014.

The decline follows the government's decision to close incentives such as the feed-in tariff, Renewable Obligation Scheme to new RES projects.

[26] Italian joint-stock company, wholly owned by the Ministry of Economy and Finance, that deals with the management of energy services, https://www.gse.it/

The feed-in tariff meant homeowners, small businesses or communities considering building a renewable energy source such as a solar array, wind turbine, or hydro technology, could expect payments for electricity generation from energy companies.

In 2017 the government also closed the Renewable Obligation Scheme to new projects – the scheme encourages renewable energy generation by forcing energy suppliers to source a proportion of their electricity from renewable sources.

The UK government has proposed a 'Smart Export Guarantee' (SEG) system which will come into force from 1 January 2020. It is designed as a partial replacement for Feed-In Tariffs. Under this smart export guarantee, energy suppliers will be required to offer a payment for the electricity households with solar PV panels, and other small-scale renewable electricity generators, export to the grid.

Energy Storage
https://publications.parliament.uk/pa/cm201617/cmselect/cmenergy/705/705.pdf
costs still have to fall for storage to reach its full economic potential, these are coming down rapidly with deployment.

Despite the potential for storage to contribute to a balanced grid, offset the need for carbon intensive baseload, and to provide cost savings for consumers a number of challenges to its deployment remain

• Lack of clarity on the legal and commercial status of storage
• Insufficient incentives for investors as a result of complex revenue sources

The lack of a formal definition for storage was problematic. The European Parliament has adopted a motion that would see a new asset class for storage which will provide flexibility around who can own and operate" storage assets. A separate asset class for electricity storage "would allow different entities in the system, including suppliers as well as distribution network operators, to use storage".

When storage exceeded 50 MWh it is regulated differently and is charged twice. Storage facilities are charged once for consuming the electricity they store, and then for supplying it back to the grid. One business told us this cost them £11m in one year. We were told a number of schemes which could be larger are specifically designed to be 49.9 MWh to sit below this line.

Storage also lacks a clear route to market in the UK because the main public mechanism that aims to support storage, the Capacity Market, is not fit for this purpose with recent auctions failing to deliver significant energy storage.

Switzerland

In respect to standard PV, the BIPV market has fewer projects, smaller module volumes, more customized elements, and longer project durations. This implies higher modules costs. Global cost is further increased (up to a factor of 2–3 for a BIPV roof, compared to PV panels added on top of tiles) by costs not directly linked to PV (for example ridges or scaffolds) and by the margins of the various stakeholders (e.g. company coordinating the PV part takes a profit on all components). The realization of BIPV projects when financial considerations are a key point is therefore penalized. Cost decreases will eventually be driven by higher module production volumes and a larger number of projects.

Today the cost of BIPV modules is very high in the range of 250-300€/m2 in respect to those of standard silicone modules that are at 60-90€/m^2. In the future, by increasing the production volume, customisation of colour and sizing should not increase the costs of a PV module more than 20–100 €/m^2, depending on the techniques applied, the size of the elements and the level of manufacturing automation. The cost of BIPV module could drop therefore, below those of many faced materials and come close to those of high quality roofing tiles (about 50€/m^2).

As BIPV project are more individual and localised compared to the general and delocalized traditional PV project, they are less standardized and therefore more expensive. Some generic rules may be anyway defined to optimize the project management and reducing the extra costs. Rules may include the early integration of PV in the design process with clear information to all stakeholders (shorter design and engineering time), the introduction of more automation in the project acquisition and design phase (an increase in successful offers), the efficient coordination of the various teams working on a building site (e.g. the PV part can benefit from scaffolds already in place). This approach would lead to manage multiple similar project with teams operating faster and faster.

2.3.2. Energy production versus prosumer need

Building renewable energy harvesting destination criteria:

Italy

Windcity turbine is suitable both for stand-alone and grid-tie operation. We address mainly to private who are willing to achieve a certain independency from the grid and whose demand for electrical power does not exceed few kW, or more considering modular installations of many 1-1,5 kW devices. They can be simple citizens, shops, small hotels. etc in town or in isolated areas

Energy trading availability criteria:

Italy

Italian regulations allow to sell energy to the DSO or exchange it. Following is a simple schematic of the regulations.
The Simple Production and Consumption Systems (SSPC) are electrical systems connected to the public network, characterized by the presence of at least one electricity production plant and a consumption unit (consisting of one or more real estate units) directly connected to each other, in which the transport of electricity does not take the form of transmission and / or distribution activities, but rather as an energy self-supply activity.
This is thanks to the presence of a single end customer and a single producer, in the case represented by corporate groups or by cooperatives or consortia or "historical". The SSPCs are divided into two groups: historical Consortia and Cooperatives with their own networks and Other Simple Production and Consumption Systems (ASSPC).

The ASSPCs, in turn, are divided into the following categories:

SSP-A, -B: type A or B on-site exchange systems;
SEU: Efficient User Systems;

SEESEU-A, -B, -C and -D: Existing Systems Equivalent to Efficient User Systems of type A, B, C or D;
ASAP: Other Auto Production Systems;
ASE: Other Existing Systems.

The existing or lack of technology to prognose the renewable energy production and consumption criteria:

Italy

Due to the lack of suitable components, i.e. boost converter, we might be facing additional R&D costs to design an appropriate device. Very little is available in literature about the operation of small size variable speed wind turbines.

UK

Energy storage can also generate revenue through supporting national network balancing. The commercial arrangements. Behind the meter battery storage provide an opportunity to avoid network charges (e.g. DUoS, TNUoS) and participate in 'demand side response' (DSR) services for National Grid for financial reward.

DSR services would require battery operators to schedule battery charging and discharging to align with an external signal such as a change in price or from the TSO or DSO.

RES can be managed as stand-alone units or as local clusters, depending on the needs of a specific service or value stream. Distributed RES may also be aggregated to allow them to be managed and operated as groups for non-geographically sensitive energy services such as frequency response.

Battery storage can therefore be used to provide a range of services at different levels in the energy system through demand shifting, exporting (discharging) or a combination of the two. These can be broken down into the following areas:

Behind the meter activities: This term refers to a range of activities that minimize the costs associated with using the electricity network or purchasing energy.
Time-shifting: Generated electricity can be consumed onsite or stored and used when onsite consumption exceeds solar generation or to avoid DUoS or TRIAD charges.
Arbitrage: Electricity can be stored for export when time of use (ToU) tariffs are more favourable.
Export limiting: For systems that have a restricted distribution network connection – surplus electricity can be stored for export when there is capacity to do so.
Peak lopping: Energy storage can provide additional supply capacity when onsite consumption exceeds the agreed supply capacity

Transmission System Services: These are services (e.g. capacity markets and balancing services) which can be contracted through the TSO. TSO procure these services to balance the demand and supply in the transmission system to ensure the security and quality of the national electricity supply. Services are broken down into:
Frequency response: Used to manage fluctuations in system frequency in the near term (up to 30 min post fault)

Reactive power: Used to manage voltage within the required range
Reserve: Used to manage unforeseen demand increases or generation unavailability in the mid-to-long term (15 min+ post fault)
Contingency: For restarting the network following a total loss of power.

Distribution System Services: Similar to TSO services, these are contracted through the DSO for provision of services at the distribution network level. Unlike TSO services, the provision of these services from Demand Side Response (DSR) assets is in its infancy in most countries, although some small-scale services are in commercial operation, most notably in Sweden. These services in future are expected to provide network stability, security and resilience by providing capacity power quality services at the distributed level.

Wholesale Energy Market: Energy is traded ahead of time, meaning traders must predict the demand and generation requirement for any time period. Within this period, the trader must control their assets/contracts to manage any variance or 'imbalance'. Traders gain financially through trades but are financially penalised for any imbalance. DSR gives traders increased flexibility in their portfolio, which enables these imbalance costs to be reduced. Wholesale energy trading is limited to energy suppliers in many countries, although some utilise 'Balance Responsible Partners' (BRPs) which enables non-energy suppliers, such as aggregators, to manage an energy portfolio.

Peer-to-Peer Services: This is a relatively new concept. Where customers have a direct connection or sit under a single network node such as in a micro-grid, it may be possible to 'trade' energy locally at a better rate than could be achieved externally or to enable a non-financial benefit such as reduced dependence on the grid.

The services described would typically require contractual relations with third parties in order to access them. These include:
Aggregators – An organisation which acts as a middle-man between the demand source and the service operator (e.g. National Grid). Demand and generation sources are aggregated to create larger 'units' which can be operated and traded to provide services which could not be accessed by individual assets. Aggregators earn money by retaining a share of the income from these services. The actual percentage depends on the contract; however, it typically ranges from 5-30%.
Energy Suppliers – Services such as the Balancing Market (BM) and Imbalance can currently only be accessed by energy suppliers. To tackle this, some aggregators such as Limejump have also become energy suppliers, with varying success.

National Grid aims to introduce a new suite of balancing services that work more effectively together and will be taking a gradual and phased approach in implementing them.
Frequency response, and in particular Firm Frequency Response (FFR) was the first product to undergo rationalisation and simplification, starting at the end of 2017 and resulting in proposals for new services and changes to the existing services. Simplification of reserve services also began mid-2018.

At a European level, the European Electricity Balancing Guideline (EB GL) seeks to establish a pan-European balancing market. This would require the alignment of the balancing markets and products across all European states. This is being implemented through two projects; Trans-European Replacement Reserve Exchange (TERRE) and Manually Activated Reserves Initiative (MARI).

National Grid is currently proposing three new dynamic frequency response services and a revised static response service. The new frequency products are currently mid review and so little clarity is available on the final requirements or format.

For the new DSR services, National Grid would like to move to 'per second' monitoring of the assets. The hope is that increased monitoring will reduce the need for upfront testing, making the process of registering new assets more efficient and reducing entry barriers for new participants. It is likely that half-hourly settlement would also be required, although this is yet to be confirmed.

As with current frequency response services there are no geographic or connection voltage level limitations. Assets would be automatically dispatched based on frequency measurement. It is not currently clear whether the frequency would be required to be measured locally as with existing frequency services, or if central measurement would be introduced.

The new frequency services cover both dynamic and static dispatch profiles. Dynamic dispatch requires assets responses to be proportional to the frequency deviation, providing a smaller response when the deviation is low and a larger response when the deviation is high. Static dispatch by comparison provides a set response shape once frequency exceeds a given range, and this response is sustained in full for the agreed duration, regardless of later fluctuations in frequency.

The loads of small and medium size buildings for the 2020s and 2030s are uncertain and as such the total renewable generation and mix of generation required to meet this load is uncertain. Key factors will be the conversion of heating to electricity and adoption of electric vehicles

Switzerland

Broadening the BIPV market does not only require cost decreases, but better marketing and communication of its multiple benefits. PV façades should be presented as a multifunctional building element rather than as a semiconductor product for which only performance matters. In this sense, the efficiency losses of coloured modules in respect to standard modules become irrelevant. In addition to being the building skin, the BIPV module can produce 70–140 kWh/m^2 per year, a significant amount in respect to zero energy produced by passive building element.

BIPV market provides more opportunities for local companies to develop unique products. BIPV market could therefore be an opportunity for the building sector, employing local workforce, rather than for the traditional PV industry. Building a PV façade is more about architecture and building engineering than about minimizing the levelized cost of electricity, as is the case for utility-scale PV deployment.

2.4. Social Barriers

Greece

Status in Greece: Nearly 6 in 10 people believe that wind turbines and photovoltaics do not destroy buildings aesthetics or the natural environment, while one in three are in favor of renewable energy sources for Greece's independence from other countries and foreign companies[27]. The president of the Hellenic Scientific Association of Wind Energy estimated that the energy targets for 2020 are impossible to achieve as well as for that to happen we need to add 4,000 MW of renewable energy the next two years, which is impossible[28]. Economic recession of recent years has worsened these prospects.

In addition to photovoltaic and thermal solar systems, the use of others RE technologies are low and have not been systematically recorded. This is partly due to the lack of consumers' awareness regarding the benefit such technologies can bring into the energy mix and considering energy bills' reductions.

Italy

Currently, social barriers in Italy mostly concern large wind installations (aesthetic and noise issues, disturbance with local fauna) and some biogas plants, which use dedicate energy crops as the digester feed that competing with other land uses.

There are a number of social/socio-cultural/cultural barriers that keep the RETs from being widespread. Some of the challenges are listed as it follows:

UK

Energy-related projects are highly specialised require specialist knowledge and are vulnerable to economic and policy changes. The volatility of the regulatory changes can add significant risk to existing projects especially if delays to project timelines are incurred.

The National Grid is constrained in some areas because it was not designed for two-way flows of electricity. This requires investment in flexible smart solutions to balance the supply of electricity with increasing local demand.

UK Energy technology, policy, regulations and markets are changing rapidly. The economic and political environment is unstable given Brexit, climate change and an insecure funding environment. However, there is high interest and demand from the business sector for sustainable technologies.

Human factors such as the relationships between people's lifestyles and RES hardware/software present social barriers. A cultural shift is necessary to convert people to conscientious prosumers.

RES requiring user input, decision making or oversight cannot assume that users will homogenously interact with the technology. For example, groups like the elderly, technophobes or disinterested parties may lack the time and energy to ensure proper functioning of RES.

Smart RES interfaces deployed in small buildings or homes may risk of deterring people from using their smart systems, as they lack day to day familiarity with this technology.

The shift from consumer to a 'prosumer' mindset represents a significant potential change in sustainability behaviour and commercial and consumer culture. Prosumers actively participate in the new technological structures for self and social gains – maximising quality of life and energy reduction.

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[27] https://www.ethnos.gr/ellada/38714_safis-strofi-tis-koinis-gnomis-yper-tis-egkatastasis-ape

[28] http://ikee.lib.auth.gr/record/304242/files/GRI-2019-24176.pdf

Distributed ledger technology such as Blockchain may be necessary to effectively manage a microgrid for renewable energy and battery storage and to facilitate peer-to-peer trading between local producers and consumers.

Romania

The *lack of educations and confidence in construction professionals* plays a big role when it comes to making a decision to renovate or not. Building owners and users do not know how and where to find reliable experts and professionals to ask for advice and expertise either because in some areas there are limited number of offers or, contrary, there are too many offers to choose from. For many individual homeowners and users, renovation is the second big decision – after buying their home - that could influence all their lives and, as a consequence, they demand for some guarantees that the work would be appropriately done because they are looking for long-lasting solutions that would be both economically, long-lasting and practically viable.

In many cases c*onsumer acceptance towards new technologies and innovative renovation solutions* is an important social barrier that makes building owners and users choose the old, known, tested, "safe" and widespread used technologies .This is mainly due to the lack of knowledge about technologies and issues, the perception, the feeling, fear, worry and inconvenience that people feel regarding to new technologies.

A significant part of the existing building stock is composed of multi-apartment buildings, often with multiple owners, and decision-making rules on necessary majorities can be complex. This makes *decision-making in condominiums* an important social impediment in any kind of renovation.

The *disruption factor* is also fundamental and needs to be assessed especially in cases of deep renovation. It refers to all the troubles linked to refurbishment work for the occupants that might impact the decision making for the occupants.

In Romania one important socio-cultural barrier comes from the history of communism regime because people were accustomed that the state made all the decisions when it comes to implementing all the technologies.

Switzerland

In Europe, the potential of BIPV is estimated at more than 22% of the expected 2030 electricity demand and all markets, including India, China, and South America, consider it to be an important option for generating electricity. Several recent analyses estimate that the BIPV market could grow by close to 40% per year in the next decade. Up to now, however, due to the lack of custom PV products, BIPV has been limited to rooftop integration of relatively conventional PV modules or to emblematic demonstration project. Due to this, architects and building constructor still see BIPV as a strong technical constraint and/or as a non-aesthetic add-on to buildings, impeding BIPV deployment for the majority of buildings.

Only recently, the mind-sets of various stakeholders along the BIPV value chain have started shifting thanks to a growing societal awareness of energy issues. New opportunities for creative architectural design are being generated by evolutions in technologies and costs and are being pushed forward by policies. A 2015 survey of 500 Swiss homeowners showed that 85% were considering installing PV with a willingness to pay a premium of 22% for a roof with architecturally integrated panels, in comparison to a rack-mounted PV installation. They also showed a preference for coloured (red or black rather than the traditional blue) locally manufactured modules. This suggests a trend towards valuing non-monetized properties rather than a pure return on investment.

Thanks to advanced technologies, BIPV can now be perfectly integrated into building envelopes and fully participate in their architectural expression, with interesting and architecturally coherent variations in proportions, surfaces, colours, and textures. BIPV is becoming a true building material with all the traditional characteristics of construction and expression. This evolution is also occurring in academic research on sustainable design. In PV2050 project (founded by Swiss National Science Foundation), Swiss researchers have developed the Advanced Active Façade (AAF) concept, which combines passive and active energy design strategies while meeting contemporary architectural requirements. This façade design incorporates an opaque BIPV façade-cladding following contemporary façade design trends on a non-loadbearing wood-panel substructure. This approach can share a better awareness of the possibilities offered by solar panels among the many stakeholders involved in a BIPV project.

Despite of the technological progress recently achieved to push BIPV, the lack of building codes and standards or their non-uniformity from country to country, in particular for PV façade elements, remain a barrier to BIPV adoption. This situation increases the perceived risk of using novel technologies in the traditionally conservative construction sector. Recent efforts led to the European norm EN 50583, which partially addresses the lack of harmonized rules by indicating which building codes have to be taken into account, only partially attenuate this risk. The procedure for installation of BIPV system remains subject to local laws

Following the reactor disaster of Fukushima in 2011, the Federal Council and Parliament decided on Switzerland's progressive withdrawal from nuclear energy production. This decision, together with further far-reaching changes in the international energy environment, requires an upgrading of the Swiss energy system. For this purpose the Federal Council has developed the Energy Strategy 2050. This continues and intensifies the strategic thrust of the Energy Strategy 2007 with new objectives. What is basically new is that the existing five nuclear power stations are to be shut down and not replaced. The first set of measures in Energy Strategy 2050 aims at increasing energy efficiency and promoting the development of renewable energies. Thanks to this strategy, electricity production from renewable sources has increased from 2010 on. In 2017, 3653 gigawatt-hours (GWh) were produced; this corresponds to 6.4 percent of the overall net electricity production (excluding consumption by storage pumps). In base year 2010 electricity production from renewables was 1402 GWh. As a consequence, between 2010 and 2020 a net increase in capacity of about 3000 GWh will be striven for. When broken down according to technology, it is apparent that the photovoltaic sector

3. Definition of parameters that describe the 'human comfort' in the buildings

Building Interior microclimate stability and comfort has parameters to be achieved. Renewable sources can contribute to reach specific standards in lighting, air quality, heating and cooling if integrated into BEMS (Building Energy Management System) and contribute to energy management to achieve setpoints.

All energy sources have an impact on our environment. Conventional energy sources based on oil, coal, and natural gas have proven to be highly effective drivers of economic progress. With the rapid increasing of conventional energy sources and energy demand, worldwide primary energy consumption has grown [29], [30]. The recently released report of the International Energy Outlook (IEO2009) projects an increase of 44% in the world energy demand from 2006 to 2030, and 77% rise in the net electricity generation worldwide in the same period. However, the report is that 80% of the total generation in 2030 would be produced from fossil fuels [31]. This global dependence on fossil fuels is dangerous to our environment in terms of their emissions unless specific policies and measures are put in place.

Due to certain environmental issues, many organizations have encouraged intensive research for more efficient and green power plants utilizing advanced technology. Since environmental protection concerns are increasing, both clean fuel technologies and new energies are being intensively investigated [30]. Fossil fuels - coal, oil and natural gas - do far more harm than renewable energy sources, by polluting air and water, damage to public health, wildlife and habitat, water use, land and global warming emissions [32].

All renewable energy technologies are not appropriate to all applications or locations. As with conventional energy production, there are environmental issues to be considered [33]. The exact type and intensity of environmental impacts varies depending on the specific technology used, the geographic location, and a few other factors. By understanding the current and potential environmental issues associated with each renewable energy source, we can make steps to effectively avoid or minimize these impacts as they become a larger portion of our electric supply [32].

Renewable technologies are considered a primary, domestic, clean and inexhaustible source of energy. Optimal use of these resources minimizes environmental impacts, produce minimum secondary wastes and are sustainable based on current and future economic and social needs [34]. Renewable energies are energy sources that are continually replenished by nature and derived directly from the sun (such as thermal, photo-chemical and photo-electric), indirectly from the sun (such as wind, hydropower and photo synthetic energy stored in biomass), or from other natural movements and mechanisms of the environment (such as geothermal). Renewable energy does not include energy resources derived from fossil fuels, waste products from fossil sources or waste products from inorganic sources [35]. Renewable energy technologies turn these natural energy sources into usable forms of energy—electricity, heat and fuels.

Renewable energy sources that meet domestic energy requirements have the potential to provide energy services with zero or almost zero emissions of both air pollutants and greenhouse gases [37]. Renewable energy system development will make it possible to resolve the presently most crucial tasks like improving energy supply reliability and organic fuel economy; solving problems of local energy and water supply; increasing the standard of living and level of employment of the local population; ensuring sustainable development of the remote regions in the desert and mountain zones; implementation of the obligations of the countries with regard to fulfilling the international agreements relating to environmental protection [37]. Development and implementations of renewable energy project in rural areas can create job opportunities and thus minimizing migration towards urban areas [38].

4. Conclusions and key findings

Implementation of RESs may face variety of technical, economic, institutional, sociocultural and environmental barriers. Inappropriateness of technology, unavailability of skilled workers for maintenance, unavailability of spare parts, high cost, lack of access to credit, poor purchasing power and other spending priorities, unfair energy pricing, lack of information or awareness, and lack of operation and maintenance training are the critical barriers impeding the dissemination of DRESs.

The barriers to the dissemination of RESs can be addressed through conducive policy environment, supportive regulatory framework, and appropriate institutional arrangements. Long term conducive policies and appropriate regulatory framework that involve financial incentives (capital subsidies and soft loans) to users, inclusion of externalities in the cost of energy, withdrawal of subsidies to fossil fuels, development of specialized institutions, cooperation with international agencies, and participation of local community in planning and implementation are the frequently prescribed measures for increased Implementation of RESs. In addition, for improved diffusion of RESs, appropriate institutional arrangements are required to facilitate R&D, capacity building, conducive market, credit facilities and awareness generation. Role of RES related policy making and implementation agency, R&D institutions, NGOs and academic institutions would be crucial to overcome barriers to the promotion of RESs.

During last few decades, adequate institutional support to R&D activities and commercialization of solar PV technology and LED lamps has significantly reduced the cost of solar lighting systems and consequently led to their accelerated adoption. For other RESs, similar institutional support is needed to improve their Implementation. As sociocultural barriers are more critical to the Implementation of cooking related RESs, it is necessary to demonstrate their utility to the public at institutions and community centers to overcome socio-cultural barriers associated with them. Also, institutional support to awareness generation, resource assessment and after sales service is crucial for increasing the rate of Implementation of RESs.

As mentioned before renewable energy sources that meet domestic energy requirements have the potential to provide energy services with zero or almost zero emissions of both air pollutants and greenhouse gases. Renewable energy system development will make it possible to resolve the presently most crucial tasks like improving energy supply reliability and organic fuel economy; solving problems of local energy and water supply; increasing the standard of living and level of employment of the local population; ensuring sustainable development of the remote regions in the desert and mountain zones; implementation of the obligations of the countries with regard to fulfilling the international agreements relating to environmental protection.

The number and quality of research studies shows an advanced technological evolution of the solutions applied to achieve the nZEB. Active and passive technologies for space heating and cooling are tested worldwide and their reliability in reducing energy consumption and improving usability conditions is proven, both in controlled environments and in real operating conditions. The use of innovative materials combined with traditional solutions offers a promising approach to face the ZEB problem. Active service systems are applied to guarantee both energy savings and IEQ (indoor environmental quality) levels. Renewable energy sources are fundamental for a nZEB development: solar, geothermal, bioenergy and wind should be exploited to produce the energy to meet the building's needs. The availability of sources, conversion efficiency and related costs are all issues still affecting the RESs. These issues can be partially overcome with an integrated design approach, considering the boundary conditions of the building system and the constrains affecting the building performance, followed by a cautious commissioning phase aimed at verifying the actual state performance. The design of advanced controls gives one more chance to improve the behaviour of each single technical element, the energy and environmental performance of buildings and the interaction with the energy grid.

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