D2.1 Review of Normative and Legislation

WP2, T2.1

Date of document: 19th April 2021

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HAPPENING – H2020-LC-SC3-EE-2020-1

GRANT AGREEMENT No. 957007

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957007

Technical references

Project Acronym	**HAPPENING**
Project Title	**H**e**A**t **P**um**P**s in existing multi-family buildings for achieving union's **EN**ergy and envIro**N**mental **G**oals
Project Coordinator	Irantzu Urkola Tecnalia irantzu.urcola@tecnalia.com
Project Duration	1st October 2020 – 31st March 2024 (42 months)

Deliverable number	**D2.1 Review of Normative and Legislation**
Dissemination Level	PU
Work Package	WP2
Task (s)	T2.1
Lead beneficiary	EURAC
Contributing beneficiary(ies)	TECNOZENITH, TECNALIA, AEE-Intec
Due date of deliverable	31st March 2021
Actual submission date	19th April 2021

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Versions

No.	Name SURNAME	Partner	Contribution	Date
0.1	Roberto FEDRIZZI	EURAC	TOC delivered	2021/02/02
0.2	Roberto FEDRIZZI	EURAC	Structure and chapters 1 and 2	2021/03/05
0.3	Samuel KNABL	AEE	Chapters 3.3, 4.3, 5.3, and 6.3	2021/03/12
0.4	Lorenzo CIVALLERI	TECNOZENITH	Chapters 3.2, 4.2, 5.2, and 6.2	2021/03/12
0.5	Jon ITURRALDE	TECNALIA	Chapters 3.1, 4.1, 5.1, and 6.1	2021/03/15
0.6	Roberto FEDRIZZI	EURAC	Review and consolidate the document	2021/03/29
0.7	Iñigo URRA Irantzu URKOLA	TECNALIA	Review	2021/03/30
0.8	Lorenzo CIVALLERI Samuel KNABL	TECNOZENITH AEE	Review of respective chapters	2021/04/16
0.9	Roberto FEDRIZZI	EURAC	Final review prior submission	2021/04/19
1.0	Irantzu URKOLA	TECNALIA	FINAL VERSION for SUBMISSION	2021/04/19

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Abbreviations and acronyms

Acronym	Description
CA	Consortium Agreement
CEN	European Committee for Standardization
COP	Coefficient of performance
DHW	Domestic hot water
DMP	Data Management Plan
DPO	Data Protection Officer
EC	European Commission
ECP	Eurovent Certified Performance
EER	Energy Efficiency Ratio
EHPA	European Heat Pump Association (EHPA)
ESCO	Energy Services COmpany
GDPR	General Data Protection Regulation
GHG	GreenHouse effect Gases
GWP	global warming potential
H&C	Heating and cooling
HFC gases	Hidrofluorocarbon gases
HP	Heat Pump
kW	Kilo Watt (capacity unit)
kWh	Kilo Watt hour (energy unit)
NZEB	Nearly zero energy buildings
PE	Primary Energy
PV	Photovoltaics
RES	Renewable energy sources
SEER	Seasonal Energy Efficiency Ratio
WP	Work-package

Abstract of the HAPPENING project

Currently, **buildings are responsible for 40 % of the energy demand and 36% of the CO_2 emissions in Europe**. Decarbonisation of existing buildings plays a key role in order to reach the overall climate protection targets. However, current renovation rates lie in the order of 1%.

Heat pumps are a key technology in bringing renewable shares into heat supply of buildings; especially their combination with onsite renewable electricity production e.g. by PV allows to bring high renewable shares. Their current installation in existing multi-apartment buildings is however still marginal.

The proposed technological solution is based on decentralized heat pumps, in such a way that it results an easy-to-install solution for installers, low-intrusive for the occupants and easily adaptable to a large number of different building situations. This is flanked by developing near-zero planning, implementation and operation processes, in order to facilitate the work during the planning phase, ensure a high-quality installation and effective operation, and reduce the efforts and costs within the whole retrofitting project. The challenge of cost-competitiveness is addressed by developing new financial and business models. Bringing new players (such as financial experts) and financing models to the renovation market is expected to bring the needed paradigm change and boost investments in the residential retrofitting sector. Dissemination of measured performance and system characteristics from HAPPENING will be one of the key results of the project.

Through **3 demonstration sites (Spain, Italy and Austria)**, the project will demonstrate a highly versatile, scalable and replicable solution package for buildings energy system retrofitting allowing 70-75% of renewable energy fraction, 30-50% of PE and GHG savings, reduction of planning time by 50% and installation/operation time by 30% and payback time for ESCOs and investors of less than 8 years, compared to best available solution existing today.

1. Introduction

1.1 Objectives of the deliverable D2.1

This **deliverable D2.1** is related to the task T2.1 and is aimed at analysing the normative and legal boundary conditions in the countries where the demonstration buildings are located and in the reference markets, to guarantee that the technical drivers to the development will be in line with regulations at the demonstration buildings, and that the unit can smoothly reach its deemed markets at project end.

In this context, this report initially drafts what are the main regulations and directives framing and influencing the heat pumps market in Europe. It then focuses on the national norms and regulations that can affect the design and management of a heat pump system integrated with a PV field; the three Member States are under the spotlight, where the demonstration sites are located. In this way, we gathered and summarised what we will need to pay attention to when designing our heat pump systems and tried providing some practical hints to interested professional readers.

1.2 Deliverable description

The deliverable D2.1 is structured in several chapters:

- European regulations overview
- National and local regulations on integration of RES in heating and cooling systems
- National regulations on heating and cooling systems design
- National regulations on electric plants design
- National regulations on monitoring and metering heating, cooling and electricity uses

1.3 Contribution of partners

The subtask "*T 2.1.1 Analysis of the normative and legislation in reference markets*" in WP2 is led by EURAC. As the analysis of the normative and legislation must be done for the 3 countries of the demo sites, the demo team leaders and partners contributed to the elaboration of this deliverable, mainly, TECNALIA for the Isparter demo, TECNOZENITH for the Italian demo case and AEE-Intec for the Austrian demo.

1.4 Relation with other activities in the project

This deliverable is mainly related to the activities in the "WP2 Industrialisation of HAPPENING technologies", "WP3 Monitoring for performance evaluation and smart controls" and "WP4 Demo implementations", in order to make sure that the HAPPENING solution complies with the normative and legislation in the countries of the 3 demo sites.

2. European regulations overview

Over the past decade, the European legislator has tested the technological development and innovation capacity of the heat pump industry, setting increasingly ambitious energy efficiency targets, with the aim of reducing primary energy consumption and climate gas emissions from products placed on the European market. In fact, there are several legislative measures that continue to affect heat pumps, both because of their wide scope for technological improvement – in the name of minimal energy consumption and environmental impact – and due to their still enormous potential for growth in the construction market.

For heat pump systems, actually, very challenging and decisive development and diffusion scenarios are expected to achieve the decarbonization objectives, especially in the residential and tertiary sectors, where the greatest energy consumption of buildings is concentrated. The energy consumption of residential buildings accounts for 28% of total heating and cooling consumption. The main items of energy consumption in residential buildings are:

- heating and cooling consumption, which accounts for 3/4 of total consumption in the residential sector
- consumption to produce domestic hot water (DHW) which accounts for 10% of residential consumption.

Still European legislation on system regulations, renewable sources and greenhouse gas emissions, and its adoption in Member States is far from being unitised. These regulatory uncertainties slow down a broader and more decisive development of the heat pumps sector. A less uncertain and broader legislative and regulatory framework, aimed at simplifying the design, placing on the market and installation of heat pumps, can allow the industry and the supply chain to make the necessary investments with more decision, effectively responding to the needs of a constantly growing market, for the benefit of end users and in line with European policies for decarbonisation.

2.1 Main directives and regulations in the heat pumps sector

Some of the main measures and Directives that, in recent years have affected and influenced the design of heat pump systems, placing them at the centre of the EU energy strategies as the best technologies for air conditioning available on the market, are listed here:

- Ecodesign and Energy Labelling on eco-design and energy labelling of energy-consuming products
- RE-Directive on the promotion of renewable energy sources
- EPB-Directive on energy performance in buildings
- REACH for the registration, evaluation, authorization and restriction of chemicals
- RoHS on restrictions on the use of certain hazardous substances in the construction of various types of electrical and electronic equipment
- WEEE on the management of waste electrical and electronic equipment.
- F-Gas on fluorinated greenhouse gases

Thanks to the eco-design of increasingly sophisticated and efficient machines, the use and reuse of raw materials and components with a low content of heavy metals and hazardous substances, the gradual introduction of refrigerant gases with low global warming potential (GWP) and the financing of the management of the end of life of their products for their correct disposal or recycling, the heat pump manufacturers are now moving towards increasingly "circular" production and economic models.

For the heat pump industry, keeping up with the technical-regulatory evolution is still not a simple matter but constitutes an important challenge for the future, an opportunity for the entire sector to go beyond the obligations imposed by European legislation, contributing to the ongoing change of the economy towards a Green Economy.

2.2 Voluntary certification programs for energy performance declaration

In Europe there are several independent and voluntary certification systems that aim at increasing consumer confidence in the performance declared by the manufacturer, giving products greater competitiveness on the market. At European level, the most widespread certifications used by heat pump manufacturers are Eurovent Certified Performance (ECP) and Heat Pump Keymark.

2.2.1 Eurovent Certified Performance

Since 1996, the Eurovent Certified Performance (ECP) mark certifies the performance of air conditioning and refrigeration products according to European and international reference standards.

The certification activity was initiated and promoted in the 90s by the European Eurovent association. The activities are now managed independently by Eurovent Certita Certification and are accredited according to the ISO 17065 standard for certification.

When manufacturers participate in this certification program, they must submit their model list or model ranges, together with the performance data of the machines to the certification body. The files are evaluated by Eurovent Certification and, subsequently, a predefined number of units is selected for the performance test carried out by independent laboratories. The test is generally performed on a product and on the basis of this the family to which it belongs can be certified.

The Eurovent Certified Performance mark guarantees customers, installers and end users that products are subject to independent checks and that their performance is carefully evaluated. If the results comply with the standards, the data of the relevant models or ranges are published on the Eurovent online portal of certified products. The models are also subject to regular random tests to verify compliance with the data declared in the catalogue.

The ECP mark is affixed to around 1200 heat pump ranges, representing 70 brands and more than 20.000 models (2017 data). It is a widely used brand in the commercial and industrial sector but increasingly used also in the residential sector.

2.2.2 Heat Pump Keymark

The HP Keymark certification, whose scheme is owned by the European Committee for Standardization (CEN), is a voluntary certification process for heat pumps in force since 2015, promoted by the European Heat Pump Association (EHPA), which aims at responding to growing regulatory needs faced by heat pump manufacturers, certifying the validity of the energy consumption and noise emissions data declared by the energy label for heat pumps.

The Council decision of 18 June 1992 invited the European standardization bodies to continue discussions on a possible harmonized expression of compliance with European standards. This led to CEN / CENELEC entering the field of voluntary certification. Over time this has developed into the "Keymark" schemes, first for solar products in 2003 and then for heat pumps in 2016.

Heat Pump Keymark is a voluntary, independent and European certification mark (ISO Type 5162 Certification) applicable to all heat pumps subject to Ecodesign regulations. This certification is based on independent and third-party testing and is open to all certification bodies operating in Europe once accredited. In 2017, 19 brands achieved the HP Keymark certification with 312 certificates issued.

3. National and local regulations on integration of RES in heating and cooling systems

3.1 Spain

DHW/H&C targets set by the RES in Buildings directives

The Technical Building Code (*Código Técnico de la Edificación* - CTE) is the regulatory framework that establishes the requirements to be met by buildings in relation to the basic requirements of safety and habitability. One of the basic requirements of the CTE is energy saving and its objective is to achieve a rational use of the energy necessary for the use of the buildings, reducing consumption and achieving that the origin of part of the same is from renewable sources of energy.

This technical regulation has evolved over the last years by including measures towards higher sustainability, energy efficiency and renewable energy use. When it was introduced, in 2006, its Basic Document on Energy Savings (“*Documento Básico de Ahorro de Energía”, DB-HE*) introduced requirements for the thermal envelop quality, maximum energy demand of buildings, minimum energy efficiency of thermal and illumination systems and minimum use of renewable energy sources. In 2013, a major review of *DB-HE* took place and a new section was introduced (*HE0)*, which explicitly limits the use of non-renewable primary energy use in buildings. Then, in the 2019 update (the version in force at the time of writing this document), previously mentioned measures were updated, elaborating on points such as minimum renewable energy fraction and increasing the requirements for energy efficiency and sustainability.

First, *Section HE0 – Energy consumption limitation* limits the energy usage of a building, based on two indicators: total primary energy consumption and non-renewable primary energy consumption. The energy consumption considered for the limits corresponds to heating, cooling, DHW and humidity control services. The maximum non-renewable primary energy limit varies depending on the climatic zone, as shown here:

		Winter climatic zones					
		α	*A*	*B*	*C*	*D*	*E*
Non-renewable primary energy consumption for heating, cooling, DHW and humidity control (kWh/m^{2}year)	*New buildings and expansions*	20	25	28	32	38	43
	Retrofitting	40	50	55	65	70	80

Table 3.1: Non-renewable primary energy consumption limits in residential buildings (private use) according the CTE – HE0 (Spanish Government, 2019)

As it can be observed, these requirements apply generally to new buildings and then to existing buildings in the following cases:

- Building expansion (increase above 50 m^2 of useful area)
- Change of use (useful area > 50 m^2)
- Retrofitting implying both thermal envelope (>25%) and thermal equipment.

Then, in the *Section HE4 – Minimum contribution of renewable energy to supply Domestic Hot Water (DHW) demand*, it is stated that the minimum contribution of renewable energy will supply at least the 70% of the annual energy demand for DHW and swimming pool climatization. This share can be reduced to 60% in case of DHW demand is lower than 5.000 l/d. This is mandatory for (a) new buildings with DHW demand greater than 100l/d, (b) integral refurbishment of buildings or thermal installation with DHW demand greater than 100l/d, (c) interventions in existing buildings with DHW demand greater than 5.000l/d and involving a demand increase higher than 50% of initial demand, and (d) new or refurbished indoor swimming pools. In the case of interventions in existing buildings, the minimum contribution is established over the increase of DHW demand. The renewable energy sources can be integrated in the building thermal generation system or be accessible through a connection to a district heating system. The heat pumps for DHW and swimming pool climatization must present a Seasonal Energy Efficiency Ratio (SEER) higher than 2,5 (when electrically activated and higher tan 1,15 when thermally activated) to be considered as renewable contribution. The SEER value will be determined for the preparation temperature of DHW, that must be higher than 45ºC. Finally, the minimum renewable contribution can be partially or completely replaced by residual energy coming from refrigeration systems, dehumidifiers, and heat pumps thermally activated out of the building thermal installation. This is especially relevant for the HAPPENING system, in which such heat recovery can take within the system under certain operating conditions.

Finally, *Section HE5 - Minimum photovoltaics contribution of electrical energy* of the Spanish CTE requires that a certain percentage of energy consumption comes from renewable energy sources, particularly photovoltaic solar energy. For this reason, it states that it is necessary to install systems for solar energy collection and transformation into electrical energy by means of photovoltaic processes for personal use or for the electricity grid. This is obligatory for new buildings and integral refurbishments when their use is different from private residential and their surface area is greater than 3.000 m^2. The required installed capacity must be between 30kWp and 100kWp depending on surface area.

Subsidies

Apart from the net-billing, as main incentive for prosumers (see section 5.1.1), the National Government, in collaboration with Autonomous Communities (regions), has recently announced an initial budget of 200M€ for the promotion of PV self-consumption in industrial, tertiary and public buildings as part of Recovery, Transformation and Resilience Plan to reactivate the economy.

Then, Autonomous Communities have their own money distribution regarding renewable energy measure aids. For example, the Basque Country, the region in which Ispaster is located, approved a 6M€ program for energy renewable installations for electric self-consumption in January 2020.

In August 2020, another program was published, with almost 15M€ for energy retrofitting in existing buildings in the Basque Country. One of the measures defined as eligible for the subsidies are "improvements on energy efficiency and renewable energy use in thermal installations for heating, cooling, ventilation and DHW". More specifically, among the specific retrofitting actions, the following are specified as eligible: "high efficiency hydrothermal and aerothermal [heat pumps] solutions implying the replacement of existing thermal generation equipment, resulting in an energy efficiency increase of HVAC and DHW systems". Apart from the thermal part, subsidies are also offered for retrofitting works involving PV installation. Therefore, the potential replication of the HAPPENING solution is supported as it is are aligned and could apply for such subsidies.

Regarding the heat pump development activities included in HAPPENING, it is worth noting that funding is available also for the transition towards natural refrigerants (as R290, to be used in the project). For instance, "*PIMA Frío*" (Plan of Environmental Sustainability Boost regarding refrigeration) aims at natural refrigerants for the implementation of installations based on alternative technologies to HFC gases (which have high GWP). This program, which was approved through Royal Decree 1114/2018, has a budget of 1,5M€.

3.2 Italy

DHW/H&C targets set by the RES in Buildings directives

In 2015, the *Decreto Requisiti Minimi* introduced some changes to the legislative decree n. 192/2005 implementing the European Union Directive on nearly zero energy buildings (NZEB), introducing new calculation methods and new minimum requirements regarding the energy performance of buildings.

The most important novelty is the introduction of the concept of "reference building", i.e. a building identical to that of the project in terms of geometry, orientation, location, use and surroundings and having thermal characteristics and energy parameters specified by the planner. According to that, it is necessary to perform 2 calculations:

- calculation of the energy performance of the reference building
- calculation of the energy performance of the real building, which is then compared with the relative reference building

The purpose is to identify a reference to calculate a range of limits that the building must respect, depending on whether it will undergo renovation or will be newly built. In this sense, there are not specific limits set; instead the limits are defined based on the local context and design of the building.

For the calculation of the energy performance and the use of renewable sources in buildings, the following technical standards are adopted:

- UNI TS 11300-1, 2, 3 and 4
- UNI EN 15193

The energy performance limits of the building are the annual amounts of primary energy required for heating, cooling, ventilation, for the production of domestic hot water and, in the non-residential sector, for lighting, lifts and escalators. In particular:

- The global annual energy use is calculated as the sum of the primary energy uses related to each energy service, with a monthly calculation interval.

- It is possible to compensate between the energy needs and the energy produced from renewable sources or from cogeneration produced within the border of the system.
- Both total primary energy and non-renewable primary energy are calculated, obtained by applying the relevant conversion factors, total primary energy fP_{tot} and non-renewable primary energy fP_{nren} specified in the decree, to the final energy consumed at the building premises.

Since the same primary energy consumption can be obtained with a very good envelope solution and a poor H&C system installed or vice-versa, the decree also sets minimum limits to be respected regarding each energy related measures possibly implemented during a construction process (once more for both newly built and retrofitted buildings).

In this case, minimum requirements are set for:

- global average transmission coefficient per unit area of external surface in kW/m^2K. The limit is parametrised over the local climate conditions and to the specific construction process undertaken
- area of transparent surfaces exposed to sun during summer per unit of external surface. The limit is parametrised over the building geometrical features
- seasonal average efficiency of the heating system. For heat pumps, the limit on the seasonal COP is set to 3,0
- seasonal average efficiency of the domestic hot water production system. For heat pumps, the limit on the seasonal COP is set to 2,5
- seasonal average efficiency of the summer air conditioning system. For heat pumps, the limit on the seasonal COP is set to 3,0
- percentage of thermal loads covered by means of RES. At the date of this report writing, the minimum RES integration is set to 50% of the DHW demand and 50% of the heating plus cooling demand (as reported in the decree 28/2011). The RES cannot be only electric in nature (i.e. one cannot only use PV to cover the quote). Lower limits can be accepted if it can be demonstrated that RE solutions cannot be installed due to specific technical reasons.

Subsidies

For some years now, heat pumps have benefited from several forms of tax incentives, when used for retrofitting buildings. This means that heat pumps have been recognized as a strategic technology in the context of the energy requalification of buildings:

- Ecobonus: it is a tax deduction calculated as the 65% of the investment incurred for the measures to replace an existing heating system with efficient systems, like the heat pumps driven. For installations in multifamily houses, the tax deduction is increased to 75%, if it involves a communal system.

  The deduction is applicable to personal and companies' taxation; both resident and non-resident taxpayers, who own the property subject to the installation can benefit of the deduction.

  The deduction, which can amount to maximum 30.000 € per house or per dwelling in case of multifamily houses, is split in 10 yearly instalments.

Air source heat pumps installed must respect a minimum COP in heating mode (T=35°C - 7°C) of 3,8, if the rated thermal capacity is lower than 35kW, and 3,5 if the rated thermal capacity is lower than 35kW. The same must respect a minimum EER requirement (T=18°C - 35°C) of 3,5 in cooling mode, if the rated thermal capacity is lower than 35kW, and 3,0, if the rated thermal capacity is lower than 35kW.

Water to water heat pumps have different thresholds set; both the minimum COP (T=35°C - 10°C) and the minimum EER (T=30°C - 18°C) equal 4,2.

- In substitution to the Ecobonus, starting from 1 July 2020, some types of interventions aimed at the energy requalification of buildings, including the installation of a heat pump, can benefit from a Superbonus, a tax deduction calculated as the 110% of the investment costs split over 5 fiscal years. The Superbonus applies to interventions carried out in multifamily and single-family houses; taxpayer can only be private house owners' companies; real estates are excluded.

  Compared to the Ecobonus, accessing the tax deduction requires a systemic intervention on the building that improve the energy efficiency of the building by at least 2 energy classes. The goal must be achieved by means of measures involving the building envelope (insulation and windows) and the replacement of the heating system. Once the goal is achieved, not only measures on envelope and heating system are eligible for the tax deduction, but also other solutions, e.g. the installation of PV panels, electric batteries and car charging stations.

In both cases, the house owner and taxpayer can opt to directly deduct the credit from own taxes or to transfer the credit to specific categories of market players:

- The ESCO who have invested in the requalification process
- Credit institutions and financial intermediaries

3.3 Austria

DHW/H&C targets set by the RES in Buildings directives

In Austria, the integration of renewable as well as the installation of heat generation systems in general is defined in the OIB6 2019 guideline. For new construction and major renovation of buildings, the technical, environmental, economic and legal feasibility of using high-efficiency alternative systems (decentralized energy supply systems based on energy from renewable sources; combined heat and power; district/local heating based on renewable sources or from high-efficiency combined heat and power plants; heat pumps), if available, must be considered, taken into account and documented.

In general, one of the following standards must be met:

- Use of renewable sources outside the "building" system boundary. At least 80% of the required heat demand for space heating and hot water shall be covered by:
  - Decentralized energy supply systems based on energy from renewable sources (biomass, renewable gas)
  - Combined heat and power

   - District/local heating based on renewable sources or from highly efficient combined heat and power plants
   - Heat pumps
- Utilizing renewable sources by generating revenue on site or nearby:
   - At least 20 % of the final energy demand for hot water by solar thermal energy
   - At least 20 % of the final energy demand for household electricity by PV system
   - At least 20 % of the final energy demand for space heating by heat recovery
   - If necessary, combinations of solar thermal or photovoltaic or heat recovery
- Energy from highly efficient alternative systems

Furthermore, in **Styria**, according to the building law *§6 Code Fernwärme-Anschlussordnung*, there is a district heating connection obligation - but numerous exceptions are applicable (e.g. operation of a heat pumps). **Amendment to the Styrian Building Act 2021** (still under review) §80b: New construction of residential buildings: min. 3 m² PV or 1 m² solar thermal per 100 m² conditioned gross floor area.

Subsidies

In Austria there are different subsidies for the installation of renewable energy sources (e.g. photovoltaic, solar thermal, heat pump, etc.) on the city, state and federal level.

PV systems

Federal subsidies: Investment subsidy from the Climate Fund of up to €250/kWp (depending on system size); investment subsidy from OEMAG of €250/kWp.

State/municipal subsidies: Funding levels and criteria vary across regions. For example, in Graz: Investment subsidy of community PV system (tenant electricity) of 500 €/kWp (max. subsidy amount 40,000 €).

Get out of the oil

Use of oil boilers in new buildings is prohibited in Austria. From 2025 on, a replacement of the existing oil boiler with a new oil boiler is not allowed. From 2035, the operation of oil boilers is prohibited. Boiler replacement is subsidized with up to €10,000 in residential buildings (for private individuals up to €5,000).

4. National regulations on heating and cooling systems design

4.1 Spain

4.1.1 Planning and sizing rules

The main norms that define the specifications for the thermal equipment system design in Spain are the following:

- CTE-DB HE2 – Conditions of thermal installations (Spanish Government, 2019)
- RITE - Regulation of Thermal Installations in Buildings (Spanish Government, 2007)

The main requirements defined by those norms are related to the following aspects:

Comfort and hygiene

- Indoor thermal quality:
    - Temperature: 21-25 ºC
    - Humidity: 40-60%
- Indoor air quality. For the case of dwellings, this is defined by the HS3 document of the CTE, which specifies:
    - Enough outdoor air flow must be provided in order to keep a yearly average CO2 concentration below 900 ppm and that the yearly CO_2 aggregate exceeding 1600 ppm must be below 500,000 ppm*h.
    - That outdoor air flow must be sufficient to eliminate pollutants which are not directly related to human presence. To do so, a minimum flow of 1,5 l/s per habitable space is defined for the non-occupancy periods.
- DHW generation conditions:
    - As anti-legionellosis measures: according to the Royal Decree 865/2003, central DHW installations must have a design storage temperature of 60ºC and reach periodically 70ºC. However, this requirement does not apply to residential buildings. Article 2 states: “Installations located in buildings dedicated to housing exclusively are excluded from the scope of this regulation, except those affecting directly the external environment of the buildings”, which is not the case of the HAPPENING system.
- Acoustic ambient requirements, which must be met also by thermal installations, defined by DB-HR:

- The power of equipment generating *stationary noise* (as the one produced by pumps, compressors and other equipment as such) as well as ventilation grills and HVAC terminal units will comply with the limits established by Law 37/2003:
    - Ldn (day-night average sound level) = 45 dBA for regular rooms / 40 dBA for bedrooms
- Further mounting instructions for such equipment:
    - The contact points between machinery and the building will be designed in a way that noise and vibration levels are limited and will not be increased noticeably when compared to the rest of noise sources of the building. This can be done, e.g., by including anti-vibration supports or by inertial mounting.
    - In the case of equipment installed on top of inertial mounting (such as pumps), the mounting will be made of concrete or steel in order to have enough inertial mass and avoid vibration transmission. Anti-vibrating elements must be placed between the mounting and the building structure.
    - Anti-vibrating supports and flexible connectors complying with UNE100153IN are considered valid.
    - Flexible connectors will be installed between equipment inlet and outlets.

Systems should be designed and sized in a way that ensures complying with the afore mentioned conditions.

Energy efficiency

See previous section:

- Efficiency in the heating/cooling equipment as well as fluid transport equipment
- Minimum insulation in distribution piping
- Installation of metering, regulation and distribution systems
- Installation of systems enabling energy recovery
- Installation of renewable energies

In Spain, the energy performance certificate is compulsory for the following buildings:

- New buildings
- Existing buildings or parts of buildings which are sold or rented
- Buildings or part of buildings in which more than 250 m^2 useful floor area are occupied by a public authority and are habitually frequented by public

The certification and labelling procedure are regulated by Royal Decree 235/2013.

Sizing of components and system

In Spain there are not norms to size the thermal systems in general, but the RITE has recognized documents that can be taken as guidelines to do that. Those documents are guides (no norms) to support on the sizing of thermal systems and the most significant are listed below:

- Practical guide on centralized and domestic hot water (DHW) installations in residential buildings (*Guía práctica sobre instalaciones centralizadas de calefacción y agua caliente sanitaria (ACS) en edificios de viviendas*)
- Technical guide for the design of efficient heat plants (*Guía técnica de diseño de centrales de calor eficientes*)
- Technical guide for air conditioning installations with water (*Guía técnica de Instalaciones de climatización por agua*)
- Technical guide for energy saving and recovering in air conditioning installations (*Guía técnica de Ahorro y recuperación de energía en instalaciones de climatización*)
- Technical guide on Project outdoor climatic conditions (*Guía técnica de Condiciones climáticas exteriores de proyecto*)

All of these guides are published by IDAE (*Instituto para la Diversificación y Ahorro de la Energía*). This institute belongs to the Ministry of Industry, Tourism and Commerce.

4.1.2 Safety requirements

Heat pumps (and refrigeration equipment, in general) are currently undergoing important changes. All the regulation and trends toward sustainability are pushing towards phasing out high GWP refrigerants, fostering the use of natural refrigerants with very low GWP. International safety standards (e.g. IEC EN 60335-2-40) often pose the main barrier to the deployment of natural refrigerants (such as hydrocarbons). This has to be considered for the use of R290 as refrigerant in domestic environments, as proposed in HAPPENING, due to flammability issues. At the time of writing, R290, classified as A3 (flammable), is limited to a charge of 150g for devices at dwelling level.

In Spain, heat pumps must comply with European safety regulations (EN378). Some national regulations that apply to heat pumps are the following:

- **Royal decree 552/2019:** defines the safety regulation for refrigeration installations. The main innovation is that the A2L category is created, in which slightly flammable refrigerants are included, such as R32 and HFOs
- **Royal decree 20/2018:** previously introduced modifications for A2L refrigerants for domestic heat pumps and HVAC units
- **Royal decree 115/2017:** establishes that professionals currently qualified with a refrigerant manipulation certificate must take the complementary formation about alternative technologies to replace HFCs

In addition to fire safety, other requirements apply to:

- Minimum conditions for avoiding / reducing the risk of accidents.
- Appropriate maintenance ensuring the continuity of the equipment characteristics and proper functioning.

The **maintenance** of thermal equipment, it is regulated by **RITE** (Regulation of Thermal Installations in Buildings) in its section “**IT3**”:

The specifications defined in the “user and maintenance manuals” are always prioritized, meaning that the actions there defined prevail over the “generic” requirements established by the norm. In the event of absence of such manual, minimum periodicities are established by the norm. As the HAPPENING system is innovative and “complex” (meaning that there a “cascade” combination of components is installed), there is no clear category under which the equipment falls. The ones that are closer to the characteristics or the HAPPENING system components are the following (including the maintenance periodicity for their use in residential buildings):

- HP for DHW with nominal capacity ≤ 12kW: every 4 years
- HP for DHW with nominal capacity between 12 kW-70 kW: every 2 years
- A/C units with nominal capacity ≤ 12kW: every 4 years

In all cases, maintenance operations will be carried out considering the specifications from the manufacturers for all equipment. For installations with nominal capacity below 70 kW and no “user and maintenance value”, maintenance operations will take place according to the professional judgment of the maintenance company.

4.2 Italy

4.2.1 Planning and sizing rules

The main norms that define the specifications for the thermal equipment system design in Italy are the following:

- (1) Decreto ministeriale Sanità 5 luglio 1975 e s.m.i.
- (2) Legge 9 gennaio 1991, n. 10 e s.m.i.
- (3) Decreto del Presidente della Repubblica 26 agosto 1993, n. 412 e s.m.i.
- (4) Decreto del Presidente del Consiglio dei Ministri 14 novembre 1997 e s.m.i.
- (5) Decreto del Presidente del Consiglio dei Ministri 5 dicembre 1997 e s.m.i.
- (6) Decreto Legislativo 19 agosto 2005, n. 192 e s.m.i.
- (7) Decreto del Presidente della Repubblica 2 aprile 2009, n. 59 e s.m.i.

The main requirements defined by those norms are related to the following aspects:

<u>Comfort and hygiene</u>

- Indoor thermal quality:
    - Temperature: the design temperature must be between 18°C and 20°C for the heating systems (1)

- Indoor air quality:
  - For the calculation of the energy requirements of the building it is mandatory to use the UNI TS 11300 that imposes specific air change rates depending on the designated use of the rooms (7).
  - In order to guarantee a minimum air quality in residential dwellings the openable windows surface shall not be less than 1/8 of the floor surface (1).
- DHW generation conditions:
  - Anti-legionellosis measures: The "Guidelines for the prevention and control of Legionellosis" published on the 13th of May 2015 by the Italian Ministry of Health aims to merge, update and integrate all the specifications above national guidelines and regulations regarding the Legionella disease (Italian Ministry of Health, 2015). With respect to centralized DHW distribution systems, it states that the temperature of water in the accumulation tanks must be maintained at 60º degrees at least, while the distribution water temperature must be at 50º degrees at least. No prescriptions are given for single-apartment system.
    In general, the guideline suggests that low temperature water (between 20°C and 50°C) should never stagnate in dead- or poorly used branches of the DHW distribution system.
- Acoustic requirements:
  - For external sources, noise emissions shall be limited to values indicated in the annex of (4) depending on the urban classification of the location.
  - For Internal sources, noise emissions shall be limited to values indicated in the annex of (5) and for residential building is 35 dB (A) for non-continuous noise sources and 25 dB(A) for continuous noise sources.

Energy efficiency

- Efficiency in the heating/cooling equipment as well as fluid transport equipment: the energy performance limits are exposed in section 3.
- Minimum insulation in distribution piping: the minimum insulation is presented in the annex of (2), it requires different thickness depending on the pipe size, the conductivity of the insulation and the place where the pipe is placed. In general, for pipes installed inside the thermal envelope, the insulation must equal the pipe dimeter at least. For outdoor installations, the insulation must equal at least twice the pipe diameter.
- Installation of metering, regulation and distribution systems: according to (3) the heating systems dedicated to multiple users shall have a temperature control unit and a metering system in every housing unit.
- Installation of renewable energies: there is a minimum share of renewable energies, section 3

In Italy the energy performance certificate is compulsory for the following buildings:

- New buildings.
- Existing buildings or parts of buildings which are sold or rented

- For the retrofit to be eligible for the Superbonus (see section 3) the performance certificate must prove the improvement of the energy performance of the building by at least two classes or the achievement of the best class.

The certification and labelling procedure are regulated by Decreto Legislativo 63 del giugno 2013.

Sizing of components and system

- Heating systems, newly installed or subject to a refurbishment, shall be sized according to the UNI-TS 11300 and the UNI EN 12831 that define the calculation of the energy requirements of the buildings and the calculations of heat pumps performances.
- DHW systems including the storage, newly installed or subject to a refurbishment that are intended to serve a communal system, shall be sized according to the UNI 9182.

4.2.2 Safety requirements

Heating systems are subject to the Decreto Ministeriale 1 dicembre 1975 which states the need for a correctly deigned expansion vessel, a supply of the heat transfer fluid, a safety thermometer and a pressure gauge.

Heating systems and DHW systems are subject to the Decreto legislativo 15 febbraio 2016, n. 26 which is the transposition of the directive 2014/68/UE that shall apply to the design, manufacture and conformity assessment of pressure equipment and assemblies.

Heat pumps are subject to the UNI EN 378 covering safety and environmental requirements. This standard specifies the requirements for the safety of people and property, provides guidance for environmental protection and establishes procedures for the operation, maintenance and repair of refrigeration systems and the recovery of refrigerants. In particular, the first part describes the criteria for the classification and selection of this systems, the second part considers the design, the construction and the installation of the systems, the third part describes the requirements of the installation site from a safety point of view, while the fourth part is about safety of people and goods. The standard gives also attention to environmental issues.

The refrigerants that are used in the heat pumps are subject to the Decreto del Presidente della Repubblica 16 novembre 2018, n. 146 about F-gas with global warming effects.

4.3 Austria

4.3.1 Planning and sizing rules

Thermal comfort

In Austria, indoor air temperatures must be matched according to the type of usage of the rooms. The minimum indoor air temperatures required by ÖNorm H 7500-1:2015 are shown in the table below. However, in general a higher indoor temperature of 22°C is usually agreed with tenants since higher are considered as more comfortable and wanted. Regarding humidity, a value of 30 to 45% relative humidity should be aimed for.

Room type	Standard indoor temperature in °C
Living rooms and bedrooms	20+
Kitchen	20+
Bathrooms	24+
Toilets	15+
Lobby, hallway, etc.	15+
Stairwells	15+

Table 4.1: Standard room temperatures ÖNORM H7500-1: 2005

Acoustic comfort

For permanently installed heat pumps or retrofitted systems, the sound emissions of 45 dB(A) for residential areas and 50 dB(A) in mixed areas must be maintained between 21:00 to 07:00 o'clock. The requirements for noise protection of rooms used by people (e.g. living rooms, bedrooms, offices) have higher requirements of 30 dB(A) and 25 dB(A), between 22:00 and 06:00. The requirements stated above are minimum noise emission standards for heat pumps. These may differ depending on the zoning plan and the prevailing ambient noise situation and can be found in ÖAL Guideline 6/18 or ÖNORM S 5021.

Outdoors, directly in front of a residential area, there are no legal limits for noise pollution/noise emissions. As a general rule, however, the noise of a technical system must not stand out from the local background noise during quiet hours. A guideline value that applies in many rural residential areas during the night hours from 10:00 p.m. to 6:00 a.m. is 30 dB(A) sound pressure level at the neighbours' property line.

Energy efficiency

In Austria, an energy performance certificate must be issued for buildings that are newly constructed or renovated. An energy certificate is also required if you want to sell or rent a building, this is regulated in the federal law EAVG 2012. The energy certificate contains various key figures that are determined using certified or standardized procedures. Among other things, the energy demand for heating, indoor air, cooling, etc. is calculated. The process of determining these key figures is explained in ÖNORMEN H 5056 to H 5059.

The energy certificate describes the energetic condition of the building and enables a comparison of buildings with each other regarding their overall energy efficiency. The reference building is defined by the Austrian Institute for Building Technology.

For this purpose, the Austrian Institute for Building Technology published guideline 6. This guideline is updated on a continuing basis. Due to the "guideline-character", it is up to the federal states how they implement the guideline in their state law. The directive was drawn up based on the building directive specified by the EU (Directive 2002/91/EC) and has been replaced by EU Directive 2010/31/EU. In Austria, ÖNORM H 5055 was created for this purpose, which specifies and describes the content and structure of an energy certificate. ÖNORM B 8110-5 and 6 are also relevant for the preparation of the energy certificate, as they define the different climate models of Austria and the usage profiles of different building types, which are to be applied for the preparation of the energy certificate. Figure 3.1 shows an excerpt from the rating scale as an example.

After the Energy Performance Certificate for the building has been issued and all other agency approvals have been positive, the building's heating and cooling loads are calculated. These loads are considered the basis for the design of the heat source and represent the highest heat demand for space heating in the winter months and the highest cooling energy demand in the summer months, respectively.

The heat load is calculated via ÖNORM EN 12831-1 and the national supplement ÖNORM H 7500- 1 and 2. These standards describe and illustrate the calculation principles for the heating load calculation. Furthermore, the indoor temperatures that should be used are given for the different room types. For the heating load calculation, the site-related standard outdoor temperature is also included and determined by the Austrian Institute for Building Technology and published in Guideline 6.

The energy demand, which is needed for hot water preparation, is determined with ÖNORM H 5151-1. Furthermore, in the guideline, the dimensioning of the piping, the safety valves, the hot water quantity, the hot water storage tank, etc. are described and calculated.

Known the energy requirements of the space heating and hot water preparation, the requirement for the heat source (boiler, HP, etc) can be calculated based on the yearly peak load (coldest day in Austria with the highest space heating load plus. hot water preparation). If a HP is used, the heat source is selected and designed via ÖNORM EN 15450.

For the calculation of the cooling load, ÖNORM EN ISO 13791 and ÖNORM EN 15255 are applied. As a national supplement, ÖNORM H 6040 was created. In ÖNORM EN ISO 13791, ÖNORM EN 15255 and ÖNORM H 6040, the calculation steps, how the cooling load must be calculated, and which site-related reference values are to be assumed, are described and presented in more detail.

Sizing of components and system

ÖNORM EN 15450:2008 describes how to calculate the heat pump capacity based on the heating load and hot water demand. This includes several different reduction factors that take into account the type of heat pump system. In order to reduce the number of starts to a minimum, it must be ensured that the heat output delivered by the heat pump is fully transferred to the heating system. A buffer tank which is connected in parallel to the heat pump can support this and also functions as an aid to hydraulic de-coupling. A guideline for dimensioning the buffer tank volume is 12 l to 35 l per kW of maximum heat pump capacity.

4.3.1 Safety requirements

ÖNORM B 5019 - also known as the "Legionella standard" - regulates the hygiene-related planning, execution, monitoring, renovation and operation of central drinking water heating systems.

The specifications in this ÖNORM are valid under the condition that drinking water is heated centrally, in particular for hospitals and health resorts, care facilities, bathing facilities, accommodation facilities, community facilities as well as public buildings and residential complexes (terraced houses, apartment buildings) with branched distribution networks.

Drinking water heating systems which supply only one dwelling (decentralized solutions or also via dwelling stations), one or two-family houses or facilities in which a growth of Legionella can arise, but which are not to be classified as central drinking water heating systems, are not part of this standard.

Summary of the norm:

- The heated drinking water must have a temperature of at least 60°C when entering the distribution system during proper operation. This temperature must be ensured throughout the year.
- Technical measures must be taken to ensure that a minimum temperature of 55 °C is maintained at every point of the water heater (except cold water supply line) during periods when water is not being drawn (at all times).
- Preheating stages must not fall below 55 °C - except for 4 hours charging time of hot water storage tanks.
- The distance from the node of the circulation line to the furthest consumer must not exceed 6 m.
- Thermal disinfection of the entire hot water system with at least 70 °C must be possible.
- Temperature measuring nipples or taps for water sampling must be available at defined points.

Decentralized solutions and 2-pipe systems using an apartment station are not subject to the standard and can therefore also be operated at lower temperatures. In 2-pipe systems, the required temperature of the heating flow depends on the heating system and heat transfer as well as the required output of the home station.

Further standards which must be considered in case of DHW-systems:

- DIN 1988-300: May 2012: Technical rules for drinking water installations - Part 300: Determination of pipe diameters; Technical rule of DVGW
- DVGW Worksheet W 553 1998-12 Dimensioning of circulation systems in central drinking water heating systems
- ÖNORM EN 806-…
    - -1 Issue: 2001-03-01 Technical rules for drinking water installations Part 1: General
    - -1/A1 Edition: 2002-03-01 Technical rules for drinking water installations Part 1: General (Amendment)
    - -2 Issue: 2005-07-01 Technical rules for drinking water installations Part 2: Planning
    - -3 Issue: 2013-08-01 Technical rules for drinking water installations Part 3: Calculation of internal pipe diameters - Simplified method
    - -4 Issue: 2010-07-15 Technical rules for drinking water installations Part 4: Installation

  - -5 Issue: 2012-03-15 Technical rules for drinking water installations Part 5: Operation and maintenance

- ÖNORM H 5142 Issue: 1990-08-01 Domestic installations; hydraulic circuits for heating systems
- ÖNORM H 5151-1 Issue: 2010-12-15 Design of central hot water heating systems with or without domestic hot water production Part 1: Buildings with a specific transmission conductance > 0.5 W/(K - m2) and ÖNORM H 5155 Issue: 2013-09-01 Thermal insulation of piping and components of building services installations.

ÖNORMEN EN 378-1 to 4 describe and illustrate the safety requirements of refrigeration systems and heat pumps in more detail. In the first part of this ÖNORM, the basic requirements, classifications and selection criteria are described and defined, containing the

- classification of refrigerants
- classification of locations of refrigeration systems
- classification of refrigeration systems (including description of different refrigeration systems)
- maximum permissible refrigerant charge

The second part of this ÖNORM deals in more detail with the design, testing, marking and documentation of refrigeration systems and heat pumps, such as the,

- list of possible hazards (mechanical, electrical, thermal, due to materials and operating environment)
- safety requirements (general, for components and piping)
- requirements for the installed components.

The third part of this ÖNORM describes and defines the requirements for the installation site and the protection of persons when a refrigeration system or heat pump system installed:

- requirement for the refrigeration components for installation outdoors/ in a machine room/ in a people accommodation area).
- requirement for the machine room (installation room of the heat pump) in terms of its access, ventilation, open flames, emergency lighting, doors, etc.
- the required air flow for the mechanical emergency ventilation.

The fourth and last part of this ÖNORM describes and specifies the requirements to be met for operation, maintenance, repair and recovery.

- requirements for user's manual and documentation.
- requirements for maintenance and repair.
- requirements for recycling and disposal of the installed components.

The power supply for a heat pump must be electrically installed in such a way that it can be switched off independently of the power supply for other electrical equipment, in particular for lighting systems, ventilation systems, alarm and other safety equipment. The power connection of the refrigeration system shall comply with the requirements in EN 60204-1:2006, sections 4 and 5.

5. National regulations on electric plants design

5.1 Spain

5.1.1 Planning and sizing rules

In Spain, the self-consumption of electrical energy for facilities that are connected to the electrical distribution network in their area is regulated by Royal Decree 244/2019, of April 5, which regulates the administrative, technical and economic conditions of self-consumption of electric energy, and Royal Decree-Law 15/2018, of October 5, on urgent measures for the energy transition and consumer protection, which repeals many points of the previous regulations, established by Royal Decree-Law 900/2015.

As a result, electrical consumers can now install local PV generators for self-consumption to cover part of their electrical needs free of any tax or charge. Furthermore, self-consumers can install storage systems to increase self-consumption rate, charging the battery with PV excess and discharging when consumption is greater than generation. There are different kind of self-consumption depending on the PV excess treatment:

1. Self-consumption without excess. Since PV excess is not injected into the grid to avoid disturbances and simplify grid-connection procedures, a zero-grid injection kit must be installed to ensure PV generation will be regulated or shutdown when it is higher than consumption.
2. Self-consumption with excess and net-billing. The PV excess is injected to the grid and it is remunerated in the monthly electricity bill at the pool price as far as there is consumption to be compensated.
3. Self-consumption with excess and without net-billing. PV excess is sold to the electricity market as any other electrical generator.

In addition to individual self-consumption through internal networks, collective self-consumption is allowed sharing generation systems among different electrical consumers, if all of them belong to the same kind of self-consumption and fulfil one of the following conditions at least:

1. They are located in the same cadastral reference according to their first 14 digits or, where appropriate, according to the provisions of the twentieth additional provision of Royal Decree 413/2014.
2. They are connected in BT and at a distance less than 500 m. To determine this distance, the distance between the measuring equipment will be considered in its orthogonal plan projection.
3. They are connected to the LV network derived from the same transformation centre.
4. They are connected to internal networks or connected by direct lines.

Connection to electric grid

In relation to consumption facilities, both in the self-consumption modalities without excess, and in the self-consumption modalities with excess, consumers must have access and connection permits for their consumption facilities, if applicable.

In relation to generation facilities, those self-consumers without excess are exempt from obtaining access and connection permits. Those self-consumers with PV excess but with an installed capacity equal or lower than 15kW located in urbanized areas are also exempt from obtaining access and connection permits. The rest of self-consumers must obtain access and connection permits from the distribution system operator according to regulation established in the Royal Decree 118/2020.

Operation in island mode

Self-consumption facilities isolated from the network are those in which there is no physical possibility of connection to the network at any time and are outside the scope of the previously described legislation.

Grid servicing by the inverter (DC/AC converter) installation

Article 6 of RD 1699/2011 states: "The cost of the new facilities required from the border point to the point of connection with the existing distribution network, of the repowering of distributor lines of the same voltage level as the connection point, and, if necessary, of the repowering of the affected transformer of the distribution company of the same tension level as the one of the connection point will be realized in charge of the connection requester".

Sizing requirements for the electric loads of HPs

The HAPPENING system involves the installation of HPs at dwelling level. This implies additional power loads to the current electric installation. Therefore, regulations for dwelling electric installations should be considered. In Spain, the norm regulating these aspects is the REBT (*"Reglamento electrotécnico para baja tensión",* Electrotechnical regulation for low voltage). The most relevant points defined there that should be considered for the HAPPENING system are the following:

- **Regular electrical outlets** (power socket) withstand at least up to 16A, which is equivalent to 3450W.
    - 16 A (2p+T, "Schuko type") socket outlets are defined by figure C2a in norm UNE 20315.

- In the **kitchen** there is a separate circuit specially prepared for the requirements of "high" load appliances (such as oven/cooktop…). It has a thicker wire section (6 mm^2 minimum) and the load per electrical outlet is at least up to 5400W.
    - 25 A (2p+T, "Schuko type") socket outlets are defined by figure ESB 25-5A, in norm UNE 20315.

- For **heating**, separate circuit(s) are expected, with a maximum power of 5750W allowed per circuit.

5.1.2 Safety requirements

As previously stated, self-consumers without excess must install a zero-grid injection kit ensuring that no energy is injected to the grid at any time. For this purpose, a device must be monitoring consumption and generation and regulate generation in case this becomes higher than consumption in less than 2s to ensure zero injection to the grid.

Apart from this, PV and storage inverters must comply with all the technical requirements for grid connection:

1. Insulation resistance (IEC 62109:1)
2. Dielectric strength (IEC 62109:1)
3. Voltage impulse (IEC 62109:1)
4. PV array insulation resistance detection (IEC 62109:2)
5. Residual current detection (IEC 62109:2)
6. Maximum and minimum variations in grid voltage and frequency (EN50438)
7. Active and reactive power regulation (EN 50438)
8. Connection and reconnection conditions verification (EN 50438)
9. Maximum THD levels (IEC 61000-3-2)
10. Maximum voltage fluctuations and flicker (IEC 61000-3-3)
11. Maximum direct current injection (EN 50438)
12. Islanding prevention measures (IEC 62116)
13. LVRT measurements (IEC 62910)

Safety requirements for the electric loads of HPs

Safety, as stated in previous section, is regulated also by the REBT norm. It specifies a minimum number of separate electric circuits in each dwelling, prepared for the specific loads of each type of consumption. For the case of HAPPENING, the most relevant circuits are the ones corresponding to heating and A/C. In both, the maximum power allowed per circuit is 5750W.

Then, every circuit must have its corresponding automatic switch as means of protection. In the case of the heating and A/C circuits, it will be set for 25A.

In this sense, a point that could be meaningful for HAPPENING system is that, in the case of the circuit corresponding to appliances using water (washing machine, dishwasher and electric boiler are specified), the automatic switch is set at 20A. However, in this case, no fuse/automatic switch is required if there is a separate circuit for each of the appliances.

In any case, the installation of the new electric system should be carried out by a qualified installer, who must prepare a design technical report observing all the relevant requirements prior to the installation. In residential buildings, a formal project is required only for installed power over 100 kW.

5.2 Italy

5.2.1 Planning and sizing rules

Connection to electric grid

In Italy, PV systems can be connected to the electric grid according to Decree n. 387 of the 29th of December 2003 which corresponds to the transposition of the European Directive 2001/77/CE.

Operation in island mode

The installation of an off-grid PV system is allowed and regulated by the deliberation of 20th November of 2014 (574/2014/R/EEL) and of the 18th of December 2014 (642/2014/R/EEL) published by the Italian Regulatory Authority for Electricity Gas and Water (AEEG) (Autoritá per l'energia electrica il gas e il sistema idrico (AEEGSI), 2014; Gestore Servizi Energetici (GSE), 2014)

Grid servicing by the inverter (DC/AC converter) installation

The technical and economic requirements for connection to electricity grids of electricity generation plants is regulated by the deliberation of the 23rd of July 2008 (ARG/elt 99/08) published by the AEEG (L'autorità per l'energia elettrica e il gas (AEEG), 2008).

Low Voltage Connection Technical Rule

EIA standard 0-21: Technical reference rule for connecting Active and Passive Users to BT Networks of electricity distribution companies. The purpose of the Standard is to define the technical criteria for the connection of users to electricity distribution networks with voltage alternating current up to and including 1 kV. In addition, for Active Users:

- It defines the start-up, operation and disconnection of the production plant
- It prevents production facilities from operating on the island on portions of BT networks of the DSO

The Standard applies to all networks of electricity distribution companies and to the electric systems of the users of distribution networks. The users of the network are the holders of:

- the utilization facilities (Passive users) connected to the BT electricity distribution networks
- the production facilities (Active users) connected to the electricity distribution networks concerning fixed, mobile or transportable installations, which convert every form of useful energy into energy connected in parallel to the BT networks of the Distributor.

Design criteria for an electrical system for civil housing

EEA Rule 64-8 to Art. 21 defines the electrical system for civil housing as the set of all the components responsible for generating, distributing and using electric current by:

- supply circuits of user appliances;
- plug socket supply circuits;

- protective equipment.

All materials and appliances used must comply with EIA standards and EI-UNEL unification tables and must be marked with the IMQ mark when it is provided for. They must be suitable for the environment in which they are installed and must have characteristics that withstand the mechanical, corrosive and thermal actions to which they are subjected.

5.2.2 Safety requirements

Here below the list of EIA standards applicable to electrical installations is reported:

1. CEI 12-13 Applies to electrical devices connected to the grid for domestic purposes.
2. CEI 17-13/1 Assemblies of protection and control equipment for low voltage (LV switchboards). - Part 1. This Standard applies to low voltage protection and switching equipment which rated voltage does not exceed 1000 V in alternating current with a frequency not exceeding 1000 Hz. It also applies to equipment containing control and / or power equipment, operating with higher frequencies, like inverters.
3. CEI 17-13/3 Assemblies of protection and control equipment for low voltage (LV switchboards). - Part 3 : distribution boards. This norm is a particular requirement for assembled protection and maneuvering equipment intended to be installed in places accessed by untrained personnel;
4. CEI 20-40 guide for using low voltage cables.
5. CEI 23-51 Requirements for the implementation, verification and testing of distribution boards for fixed installations for domestic and similar use.
6. CEI 31-30 Electrical apparatus for explosive gas atmospheres. Classification of hazardous places.
7. CEI 64-8 Electrical installations using a nominal voltage not exceeding 1000V in alternating current and 1500V in direct current.
8. CEI 64-12 Guidance for the execution of the ground system in residential and tertiary buildings.
9. CEI 64-14 Guide to verification of users’ electrical systems.
10. CEI 64-50 Residential and tertiary buildings: Guide for the integration of users electrical systems and for the provision of infrastructure for communications systems and electronic systems in buildings - General criteria.

In the installation of heat pumps as in the case of Project HAPPENING for the Italian case, no additional or particular norms are required, being low voltage three-phase heat pumps and single-phase micro heat pumps. During the design phase attention should be mainly paid to:

- Guarantee that all the new devices will be designed to be connected to the existing grounding grid of the building.
- Foresee in the project the automatic circuit breakers that guarantees safety in case of overcurrent in the circuit. These must be adequately sized according to the underlying electrical loads, with adequate protection curves to cope with the inrush currents of the various devices. Their suitability must be checked with a special calibrated instrument once installed.

- Foresee in the project and to install adequate electric cables to avoid overheating or lower electrical fluxes than required.

5.3 Austria

5.3.1 Planning and sizing rules

The Austrian electrotechnical standard OVE E 8101 contains requirements for the design, construction and testing of low-voltage electrical installations (e.g. heat pumps). The standard is designed to protect persons, livestock, and property from hazards and damage that can occur when low-voltage electrical equipment is used as designed. In addition, the standard promotes the maintenance of proper function. The standard applies to residences and residential buildings, commercial and industrial buildings, office buildings, public buildings, agricultural and horticultural properties, prefabricated buildings, caravans, construction sites, temporary facilities, marinas, outdoor lighting facilities, medical use areas, PV systems, low-voltage power generation facilities, and associated electrical equipment. (OVE, 2019)

The standard is divided into the 7 following sections:

- Part 1 explains the general principles and areas of applicability, the installation of electrical systems with nominal voltages up to AC 1000 V and DC 1500 V
- Part 2 deals with terms and definitions. It explains the technical terms that are necessary to accurately represent places of use or applications.
- Part 3 deals with characteristics, dimensioning and installation of power lines and cables.
- Part 4 deals with protective measures and safety precautions.
- Part 5 contains the assembly and installation of electrical equipment
- Part 6 deals with the testing of electrical equipment
- Part 7 deals with installations of special kind.

The Austrian electrotechnical standard OVE E 8101 is technically equivalent to the European harmonization document IEC 60364 (series) "Erection of low voltage installations" ratified by CENELEC, while retaining the established national protection concept, and currently represents the recognized rule of technology for the installation of electrical systems in Austria. (OVE, 2019) The installation of the heat pump, including lighting, power supply, etc., must therefore comply with national regulations and the IEC 60364 standard. Additional guidance can be found in IEC/TR 61200-52.

Additionally, the “OVE Richtlinie R 15” provides assistance in the design and installation of an EMC, equipotential bonding, grounding, lightning protection and surge protection concept. The guideline applies to the same extent for retrofits/extensions of existing buildings. (OVE, 2019)

5.3.2 Safety requirements

For the installation of heat pumps on the Austrian demo site within the HAPPENING project, no specific standards for the safety of electrical equipment are applicable. The mandatory safety requirements are already included in the standard OVE E 8101, which was described in the section above. In particular, Part 4 of the OVE E 8101 standard deals with protective measures and safety requirements. The main topics covered in part 4 of the standard are:

- Protection against electric shock
- Protection against thermal influences
- Protection against overcurrent
- Protection against interference voltages and electromagnetic disturbances
- Protection against undervoltage
- Disconnecting and interrupting.

6. National regulations on monitoring and metering heating, cooling and electricity uses

6.1 Spain

In Spain, the Regulation of Thermal Installations in Buildings (RITE), via Royal Decree 1027/2007, defines that thermal installations of new buildings must include measuring devices allowing the distribution of costs among the consumers of heating, cooling and DHW. Likewise, those measurements enable the cost distribution according to each consumption.

This norm also specifies requirements for control and regulation: "installations will have regulation and control system as required to keep the design conditions in the conditioned rooms and to adjust the energy consumptions to the variable energy demand". In order to fulfil this requirement, measurement of control parameters is necessary.

Royal Decree 736/2020, which is aligned with EU Directive 2012/27/UE and EU Directive 2018/2002, establishes that it is mandatory for heating and cooling final users to install individual energy meters, as long as it is technically feasible and economically suitable in order to provide them with information about their consumption allowing its optimization.

6.2 Italy

Metering/net billing scheme

The management of the net metering service has been assigned by the AEEG to the Manager of Energy Services (GSE) according to deliberation 570/2012/R/efr. It is foreseen that the electricity generated by a consumer/producer in an eligible on-site plant and injected into the grid can be used to offset the electricity withdrawn from the grid. GSE pays a contribution to the customer based on injections and withdrawals of electricity in a given calendar year and on their respective market values (Autoritá per l'Energia Electrica il Gas e il Sistema Idrico (AEEGSI), 2012).

Heat and water consumption metering/billing requirements

The Legislative Decree n.141, of the 18th July 2016, establishes that for all centralised heating and DHW systems, the installation of individual meters that allow the distribution of consumptions for each user is mandatory (Italian Government, 2016b).

6.3 Austria

Metering/net billing scheme

If a housing subsidy was granted for new buildings and renovations and the property has more than 10 residential units, mandatory energy accounting (regarding heating demand, solar thermal yields, electricity consumption for central ventilation systems and heating systems) must be performed and submitted to the state annually.

Heat and cold meters

In Austria, ÖNORM EN 1434-1 to 6 specifies the requirements, necessary tests, monitoring and maintenance, etc. of heat meters.

The Measuring Instruments Ordinance (BGBl. II No. 31/2016 or CELEX No.: 32014L0032) describes the essential requirements for the initial placing on the market of meters or measuring instruments that are subject to calibration.

In Austria, the accuracy tolerances of meters are regulated by the Federal Law on Weights and Measures (BGBl. No. 152/1950 in the currently valid version). This Federal Law lists, among other things, the basic units with which the heat or cooling meter measures the energy and how the units are to be converted. In Austria, there is a calibration obligation for meters. This is to be understood that the meters must be checked at regular intervals whether the measurement result from the meter is still within the specified measurement tolerance range or not. The periods when the meter must be checked are also specified in this Federal Law Gazette. In the Federal Law Gazette II No. 499/2020, a supplement to this Federal Law Gazette, the requirements of the respective deadlines, for the thermal energy meters, are described in more detail. If the meter measures too inaccurately, it can be replaced or sent to the calibration office for recalibration. However, this only applies to meters that are used for energy billing. Thus meters, which are used in the private sector, are not affected by this law. This Federal Law Gazette also describes in detail which authorities are allowed to perform the verification in Austria and how these authorities must train their employees so that they are certified to do so.