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WP1 – FC Gensets Specifications
D1.1 – Test Site Description and requirements for EVERYWH2ERE gensets specification

Due date of deliverable
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1.0

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Dissemination Level		
CO	Confidential	
PU	Public	**X**

Executive Summary

EVERYWH2ERE "D1.1 Test Site Description and requirements for EVERYWH2ERE gensets specification" has the aim to describe the identified type of demosites (with a specific focus on the demosites currently recommended by ENVI, D1, ACC, FHA) and what are their technical (energy demand profile) and non-technical (hazardous and installation permitting aspects) requirements towards the definition of the most proper EVERYWH2ERE gensets specification.

The deliverable has been redacted thanks to the precious support of the Demonstration and Steering Committee and it acts as a useful document for gensets' manufacturers towards the design and engineering of the generators (T1.4, WP2, and WP3).

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Abbreviations and acronyms

FC	Fuel Cell
LCOE	Levelised Cost of Electricity
KOM	Kick Off Meeting
A/R	Return trip
FCA	Full Cost Analysis
DSO	Distribution System Operator

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1. Introduction

The scope of D1.1 "Test Site Description and requirements for EVERYWH2ERE gensets specification" is to have a preliminary overview of the demosites where the EVERYWH2ERE gensets will be tested. Starting from the outcomes of the workshop held in Genova during the second day of the EVERYWH2ERE Kick Off Meeting (7th February 2018), the deliverable introduces a review of the technical and non-technical issues that the consortium will have to take into account for the definition of Gensets specification and Balance of Plant.
EVERYWH2ERE demonstration campaign will be held in construction sites (ACC), music festivals (D1), temporary events in Italy (ENVI) and Spain (FHA). In this deliverable, each of this category is presented, providing guidelines about the requirements of each specific sector of application and a focus on the current identified project demosites.
This overview has to be considered preliminary because demonstration campaign will start at M30 and agreement and technical details between the consortium and demo responsible are currently under discussion. Nevertheless, this deliverable is more than helpful to provide indication to technology manufacturers and gensets' integrator (PCS, SHSA, GENP, LINDE, MAHY)

More in details:

- In Chapter 2, technical and non-technical parameters to be taken into account in the gensets design and specifics definition are described.
- Chapter 3 presents a description of the application of gensets in construction sector, with a dedicated paragraph presenting the two construction sites where EVERYWH2ERE gensets will be tested under ACC supervision.
- Similarly, Chapter 4 and 5 are devoted to the description of demonstration in music festivals and public temporary events in Italian and Spanish cities.

Relevant inputs for the present deliverable have been collected both via direct interaction with demosite responsibles and from KOM discussions where a dedicated parallel work session during Day 2 took place. Two parallel session have indeed been specifically organized (one dedicated to gensets and BoP components specification and one dedicated to demonstration activities and preparation) in order to maximize partners' interaction and stimulate project work since the beginning. Indeed, these sessions, being based on a participatory approach, helped in the process of building a common understanding of project's technical activities to be performed in demosites, common challenges and facilitate the development of agreed strategies and formulation of specific solutions to solve technical issues.

The outcomes of each session have been collected into KOM Minutes: RINA-C in quality of project coordinator shared them with all project partners to collect possible integrative information or comments. Then, on the basis of all those inputs, it has been possible to include in the present document consolidated and agreed information.

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2. Towards FC based temporary gensets specification: what to be taken into account?

Diesel-powered generator sets, thanks to their simplicity, low cost and speedy installation remain the main source of electrical power for many consumers throughout the world as construction sites, festivals and other temporary events.
Portable power generators are an essential part of the construction industry. Construction contractors often find themselves at job sites where the lack of electrical service or regular power outages occur. That is why they require portable units. Portable generators allow contractors to continue working without disruption and meet deadlines. Whether a construction site is off in some far-off, remote location, or in the middle of a busy metropolitan area, having a generator and engine for temporary or prime power can be irreplaceable. What's more, having continuous power on a job site is essential to day-to-day operations and the overall completion of a project. For temporary power purposes, having a diesel generator can mean the difference between downtime on the job, and a fully functioning construction site. On the other hand, for prime power needs, a diesel generator can be just as effective as any sort of continuous power supply. Not to mention, backup power options like a diesel generator or engine, provide the opportunity to bring portable power to any construction site, anywhere.
The drawback is that in recent years the costs associated with diesel generation have increased substantially, with fuel prices up by 50 per cent in many locations.
At the same time, environmental concerns are driving operators of diesel generator sites to consider how they might be able to reduce their CO_2 emissions.
The most established technologies in the current framework are, as mentioned, diesel-powered generators and gas fuelled generators. Gas fuelled generators can cut emissions by up to 40%, compared to diesel and have the potential to be much more cost effective, depending on the market rates of natural gas. Whilst piping gas from a mains supply could reduce their financial viability (especially if the connection is new or a distance away), gas generators could still be a cost effective power source for large, long-term projects.

Nevertheless, pollutant emissions from combustion engines installed in NonRoad Mobile Machinery NRMM (e.g. diesel or gasoline fuelled engines) as temporary gensets are, significantly contribute to air pollution by emitting carbon oxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), and particulate matter.
European emission standards for engines used in new non-road mobile machinery (NRMM) have been structured as gradually more stringent tiers known as Stage I...V standards. Stage I...IV regulations for diesel engines were specified by Directive 97/68/EC and five amending Directives adopted from 2002 to 2012. One of the amending Directives also introduced emission standards for small, spark-ignited non-road engines. From Stage V, Regulation 2016/1628 specifies emission requirements for all categories of compression ignition (diesel) and positive ignition mobile non-road engines, replacing Directive 97/68/EC and its amendments.

Category	Ign.	Net Power	Date	CO	HC	NOx	PM	PN
		kW		g/kWh				1/kWh
NRE-v/c-1	CI	P < 8	2019	8.00	7.50[a,c]		0.40[b]	-
NRE-v/c-2	CI	8 ≤ P < 19	2019	6.60	7.50[a,c]		0.40	-
NRE-v/c-3	CI	19 ≤ P < 37	2019	5.00	4.70[a,c]		0.015	1×10^{12}
NRE-v/c-4	CI	37 ≤ P < 56	2019	5.00	4.70[a,c]		0.015	1×10^{12}
NRE-v/c-5	All	56 ≤ P < 130	2020	5.00	0.19[c]	0.40	0.015	1×10^{12}
NRE-v/c-6	All	130 ≤ P ≤ 560	2019	3.50	0.19[c]	0.40	0.015	1×10^{12}
NRE-v/c-7	All	P > 560	2019	3.50	0.19[d]	3.50	0.045	-

[a] HC+NOx
[b] 0.60 for hand-startable, air-cooled direct injection engines
[c] A = 1.10 for gas engines
[d] A = 6.00 for gas engines

Fig. 1 - Stage V emission standards for Non Road engines (NRE)

The regulation about stage V was proposed in 2014 and finalized on September 14, 2016 (detailed technical requirements will be defined in the implementing legislation expected in 2017). The standards

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are effective from 2019 for engines below 56 kW and above 130 kW, and from 2020 for engines of 56-130 kW.
Stage V emission limits for engines in non-road mobile machinery (category NRE) are shown in Table 4. These standards are applicable to diesel (CI) engines from 0 to 56 kW and to all types of engines above 56 kW.

In the latest years, a new technology appeared on the market: hybrid systems which couple an internal combustion engine with a battery. Hybrid power solutions are being used increasingly on sites to operate in tandem with a generator. Whilst the generator meets larger peak-time power requirements and charges the hybrid's battery, the hybrid then takes over during periods of lower demand, reducing the need for the generator to operate at an inefficient, low load.
In order to find the most suitable and beneficial gensets technology, to design EVERYWH2ERE hydrogen fuelled gensets and to benchmark their technical and non technical performances with on the market alternatives, different aspects have to be taken into account.

2.1 Technical aspects

The main issue approaching temporary power generation process is to get a generator that can handle all the needed power generation needs, this is one of the most critical aspects of the engineering sizing/design/choosing decision. A wrong estimation can indeed bring unexpected problems because it can put undue stress on the unit and even damage some of the devices connected to it. Unfortunately, determining exactly what size of generator to get is often very difficult and involves a number of factors and considerations. While there is no substitute for having a certified electrician perform an inspection and calculate everything on the local loads, the guidelines below could offer some starting points.

i) Investigate Your Requirements:

Proper sizing of the generator (or the customised design/engineering of a genset) is crucial to the success of any installation and requires a good working knowledge of electricity and its characteristics, as well as the varying requirements of the electrical equipment comprising the load. When analysing the electrical load, it is important to be aware of the major appliance or piece of equipment present on the sites to determine its starting and running requirements in terms of watts, amps, and voltage.
When choosing the generator output for commercial or industrial applications, it is usually suggested to select a rating that is approximately 20 to 25% higher than the peak load (for example, if the load is about 40 kilowatts, select a 50 kW genset). A higher rated generator will operate comfortably at approximately 80% of its full capacity and will provide a margin of flexibility if the load increases in the future.
It is crucial to keep in mind that at startup, many electrical devices need more current to start their electric motors. This initial surge may only last for a few seconds, but it must be part of your calculations when sizing a generator.

Here in the following a short list of aspects to be considered:

- Make a list of the items that need to be powered by the generator
- Make a note of the starting and running wattage of the respective items
- Calculate the total power requirements in kVA or kW following the following guidelines

a) Have a good estimation of starting and running Wattage: take a look at the identification plate or the owner's manual in the buyer's kit of each respective device, tool, appliance, or other electrical equipment.

b) Ampere - Watt Conversion: power requirements of tools are often stated in amperes. In order to convert the power requirement of a tool from ampere to watts, follow the following proposed calculation algorithms.

For resistive load: Wattage = amperes x volts
For reactive load: Wattage = (amperes x volts) x load factor

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c) Depending upon the type and number of devices, and the way the generator is scheduled to be used, there are a few different ways of calculating power requirements (Single motor running, Multiple motors running simultaneously, No electric motors etc.)

Furthermore it is also important to have in mind the most relevant technical targets that EVERYWH2ERE gensets manufacturer/designer have to take into account to provide reliable and robust generators that can be competitive with SotA Diesel gensets.
Reliability: No unexpected system failures - No shutdowns due to capacity overload
Lifetime: Increased longevity of the generator - Guaranteed performance
Affordability: Smoother hassle-free maintenance - Assured personal safety

It is essential that the gensets aim to comply with all regulations established by the Occupational Safety & Health Administration (OSHA) and strict adherence to all local, state, and national codes is mandatory.
Before selecting/designing a generator, it's also important to take a look to local/municipal ordinances that may dictate requirements regarding placement of the unit (setback from building and/or lot line), electrical wiring, gas piping, fuel storage (a crucial issues for pressurized hydrogen), sound and exhaust emissions

2.2 Health and Safety Aspects

Guidance given in this section is of a general nature and they are taken from UK legislation and relevant European Community directives. If it is necessary to certify part or all of a fuel cell system using these directives, the full documents should be obtained to assess conformity, unless using a third party for certification.

2.2.1 General Health and Safety Requirements

General health and safety requirements should be addressed with respect to:

- Materials and products,
- External temperatures,
- Errors of fitting,
- Extreme temperatures,
- Noise,
- Vibrations,
- External radiation,
- Emissions of hazardous materials and substances,
- Risk of being trapped in a machine,
- Risk of slipping, tripping or falling,
- Lightning.

2.2.2 Protection against mechanical hazards

The Machinery Directive requires the following aspects to be considered:

- Risk of loss of stability,
- Risk of break-up during operation,
- Risks due to falling or ejected objects,
- Risks due to surfaces, edges or angles,
- Risks related to combined equipment,
- Risks related to variations in operating conditions,
- Risks related to moving parts,
- Choice of protection against risks arising from moving parts,
- Risks of uncontrolled movements.

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2.2.3 Protection against electrical hazards

The electrical equipment, together with its component parts, should be made in such a way as to ensure that it can be safely and properly assembled and connected. The following should be addressed:

- Protection against hazards arising from the electrical equipment,
- Protection against hazards which may be caused by external influences on the electrical equipment,
- Electricity supply,
- Static electricity,
- Electromagnetic compatibility.

Protection against flammable gas appliance hazards

The Gas Appliances (Safety) Regulations require the possibility of unburned gas release to be considered.

2.2.4 Protection against fire and explosion hazards

The manufacturer should safeguard against risk of fire and explosion.
For fuel cell components for use in potentially explosive atmospheres the Equipment and protective Systems for Use in Potentially Explosive Atmospheres (EPS) Regulations 1996 apply.
The ATEX Workplace Directive (99/92/EC), implemented in the UK by the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) 2002, will also apply. Although DSEAR does not specifically require the production of an explosion protection document, as required by the ATEX Workplace Directive, the key requirement of the Regulations is that risks from dangerous substances, e.g. flammable gases, are assessed and controlled.

2.2.5 Protection against pressure release hazards

The Pressure Equipment Regulations (PER) 1999 apply to any equipment that could contain pressures in excess of 0.5 bar. The Regulations require the following aspects to be addressed:

- Strength of equipment,
- Provisions to ensure safe handling and operation,
- Means of examination,
- Means of draining and venting,
- Materials for pressure vessels,
- Wear,
- Assemblies,
- Provisions for filling and discharge,
- Protection against exceeding the allowable limits of pressure equipment,
- Safety accessories,
- Manufacturing procedures,
- Marking and labelling,
- Operating instructions.

At elevated temperatures and pressures, hydrogen attacks mild steels severely, causing decarburisation and embrittlement. This is a serious concern in any situation involving storage or transfer of hydrogen gas under pressure. Proper material selection, e.g. special alloy steels, and technology is required to prevent embrittlement.

2.2.6 Control system requirements

For an appliance equipped with safety and controlling devices, the functioning of the safety devices must not be overruled by the controlling devices (see the BS EN series of standards for control device requirements).
All parts of appliances that are set or adjusted at the stage of manufacture and which should not be manipulated by the user or the installer must be appropriately protected.

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Levers and other controlling and setting devices must be clearly marked and give appropriate instructions to prevent any error in handling. Their design must preclude accidental manipulation.
The surface temperature of knobs and levers of appliances must not present a danger to the user.

2.2.7 Equipment Information, warnings, markings and instructions

The EU Equipment Directives and the UK implementing regulations contain requirements relating to:

- Information and information devices,
- Warning devices,
- Warning of residual risks,
- Marking of equipment,
- Instructions.

Appliances must be correctly installed and regularly serviced in accordance with the manufacturer's instructions.
Where practical, particularly for industrial applications, the fuel cell should be located outdoors. Fuel cells for residential applications should be designed, installed, operated and maintained to be safe in typical indoor locations. For non-residential indoor installations, the fuel cell should be located in a well ventilated area in which combustible materials are minimised. In designing the installation consideration should be given as to whether it is necessary to separate the rooms or spaces that enclose the fuel cell installation from other building areas by fire barriers. Use of appropriate protective devices for openings (i.e. doors, shutters, windows, service entries, etc.) should also be considered. Voids or openings between the room in which the fuel cell is enclosed and adjacent rooms into which combustion products could pass should be avoided. The shared walls should be gas tight. A check should be made that any automatic fire suppression system installed has been correctly specified for the room or space in which the fuel cell and associated components are located. All installations should comply with building and fire regulations.
For outdoor installations weather protection may be required. Hydrogen storage cylinders and vessels located outdoors need to be protected from extreme temperatures (below –20°C and above 50°C). Permanently installed hydrogen vessels must be provided with substantial supports, constructed of non-combustible material securely anchored to firm foundations of non-combustible material and protected from accidental impact, e.g. from a vehicle. Transportable compressed gas cylinders and vessels shall be secured against accidental dislodgement and protected from accidental impact. The area around hydrogen installations should be kept free of dry vegetation and combustible matter. If weed killers are used, chemicals such as sodium chlorate, which are a potential source of fire hazard, should not be selected for this purpose.

2.3 Permitting Aspects

Temporary gensets installation and use in dedicated sites (both construction sites and temporary sites) often have to be compliant to special sites regulatory framework particularly related to permitting and safety to workers aspects. Here in the following some of the most important directive/guidelines that the installation/use of gensets in dedicated sites have to be compliant to are presented.
EVERYWH2ERE gensets have to be compliant to this directive and to be equipped with all the required components. In spite of regulations described in section 2.2, these guidelines are useful for the definition of requirements for the use/installation/operation of the gensets

2.3.1 Health and safety of workers

Health and safety aspects, related to workers, was taken into account by the European Commission in the Framework Directive 89/391/EEC. In addition to the Framework Directive, a series of individual directives and regulations focusing on specific aspects of safety and health at work were adopted.

Mainly, Directive and Regulations that have to be considered are:

- Directive 89/654/EEC - workplace requirements,
- Directive 89/655/EEC – work equipment,

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- Directive 89/656/EEC - use of personal protective equipment,
- Directive 90/269/EEC - manual handling of loads,
- Directive 92/58/EEC - safety and/or health signs,
- Directive 95/16/EC – lifts,
- Directive 2001/45/EC - use of work equipment for working at height activities,
- Directive 2006/95/EC - electrical equipment,
- Directive 2006/42/EC - new machinery directive,
- Regulation (EC) No. 1907/2006 - REACH concerning registration, evaluation, authorisation and restriction of chemicals and establishing a European Chemicals Agency,
- Regulation (EC) No. 1272/2008 (supplementing of Regulation (EC) No. 1907/2006 – REACH),
- Directive 2009/104/EC – use of work equipment,
- Regulation (EU) 2016/425 on personal protective equipment.

These Directives and Regulations are implemented differently in the legislation of each Member State and sometimes Member States legislation can be more restrictive.

2.3.2 Access requirements

The Directive 89/654/EEC concerns the minimum safety and health requirements for the workplace. The Directive gives general information about how to manage with work places to enhance safety. Each Member State than has provided, in its own legislation, the implementation of the minimum requirements.
Related to access requirements we first need to assess:

- Possibility of moving safely about the workplace,
- Possibility of escaping from the workplace in case of fire or other emergency from the site to a safe area,
- Possibility of having safe access to any place or workplace amenity.

Safe access to/egress from the workplace has to be guarantee for the workers, the responsible and all the visitors that potentially could come. This means that passages need to be free of any obstruction, especially to ensure the safe and rapid egress of a person in case of emergency, and adequate with regard to dimensions (width, high).
In case of a work inside a building, it is important to assess first that emergency routes and emergency exits are free and unlocked and also, in order to prevent issues, is important to expose a signals/safety panels of men at work in order to avoid someone locked the doors or encumber emergency routes.
For the same reason and in order to prevent accidents, the access to the work site need also to be signalled both to be recognisable and to be visible.
If workers are at risk of falling from height (in general, from a minimum height of 2 meters) specific measures such as barriers, infill panel, safety harness, etc., have to be undertaken.

The assessment of all these points has to be undertaken previous the commencement of the works on site to guarantee an adequate organization of the work that is an essential step of prevention. Indeed, sometimes, for a secure access it is necessary to consider the use of special equipment as lifting equipment.

The access to the worksite has to be properly controlled to prevent access of unauthorized persons. Adequate warning notices, barriers and security staff have to be put in place to prevent this. The personnel have to held an identifying card duly signed by the authorized representative of the contractor. If required, more restrictive measures can be put in place (for example fingerprint control).

2.3.3 Man/machine interface

Man/machine interface is a key issue on sites. The main hazards associated with man/machine interface are:

- Personnel being struck by plant and vehicles,

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- Personnel being crushed by plant and vehicles,
- Collision between plant and vehicles.

To reduce the risk associated to man/machine interface appropriate measures has to be implemented as:

- Controlling entry into sites by barriers and gates,
- Providing parking spaces clear of work areas,
- Locating main loading and unloading areas,
- Providing pedestrian only areas from which vehicles are completely excluded,
- Excluding personnel from work areas where plant and vehicles are operating,
- Install barriers and signs to warn and prevent personnel entering restricted zones,
- Position workers in safe areas to warn other personnel not to enter into restricted zones,
- Approach plant and vehicles from the front when there is a need speak with a driver. Drivers and operators must stop their plant or vehicle when they see someone in their work zone,
- Verify at all times the functionality of reversing alarms and lights,
- Mobile plant and vehicles are to be fitted with and have operating flashing beacons whilst working.

2.3.4 Health and Safety Signs (Site Hazards, Emergency, Specific behaviour, etc.)

Safety signs are to be displayed where the risks to health and safety cannot be avoided by other means. Safety signs are to be pictorial wherever possible and where lettering is used it must be in English and the native language of the workers on site.
The colours and shapes of safety signs are to be compliant with *Directive 92/58/EEC - safety and/or health signs* and/or with national legislation (if in place).

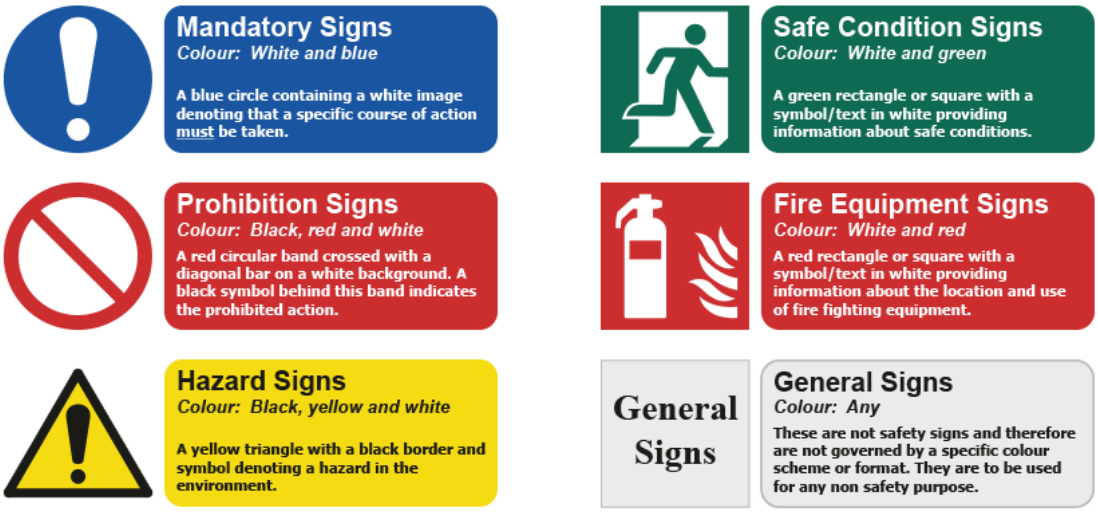

Fig. 2 - Safety signs

Safety signs are to be regularly cleaned and inspected to ensure they have not faded, been damaged or have been removed.

2.3.5 Emergency preparedness

Emergency response should focus on the prevention of ill health and injury, and on the minimization of the adverse safety consequences to persons/workers exposed to an emergency situation. A plan for responding to emergency situations should be developed and should also take into account applicable legal and other requirements. The emergency procedures should be:

- Clear and concise to facilitate their use in emergency situations,
- Readily available for use by emergency services.

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Paper copies of emergency procedures ought to be maintained in readily accessible locations.
Consideration should be given to the existence and/or capability of the following, in developing emergency response procedures:

- Inventory and location of hazardous materials storage,
- Numbers and locations of people,
- Critical systems that can impact on health and safety,
- The provisions of emergency training,
- The detection of emergency control measures,
- Medical equipment, first aid kits etc.,
- Control systems, and any supporting secondary or parallel/multiple control systems,
- Monitoring systems for hazardous materials,
- Fire detection and suppression systems,
- Emergency power sources,
- Availability of local emergency services and details of any emergency response arrangements currently in place,
- Legal and other requirements,
- Previous emergency response experience.

Emergency response procedures should define the roles, responsibilities and authorities of those with emergency response duties, especially those with an assigned duty to provide an immediate response. These personnel should be involved in the development of the emergency procedures to ensure they are fully aware of the type and scope of emergencies that they can be expected to handle, as well as the arrangements needed for coordination. Emergency service personnel should be provided with the information required to facilitate their involvement in response activities. Emergency response personnel has to be properly trained and should remain competent and capable to carry out their assigned activities. The need for retraining or other communications should be determined when modifications with an impact on the emergency response occur. Periodic testing of emergency procedures should be performed to ensure that the organization and external emergency services can appropriately respond to emergency situations and prevent or mitigate associated safety consequences.
Emergency response procedures should give consideration to:

- Identification of potential emergency situations and locations,
- Details of the actions to be taken by personnel during the emergency (including actions to be taken by staff working off-site, by contractors and visitors),
- Evacuation procedures,
- Responsibilities and authorities of personnel with specific response duties and roles during the emergency (e.g. fire-wardens, first-aid staff and spill clean-up specialists),
- Interface and communication with emergency services,
- Communication with employees (both on-site and off-site), regulators and other interested parties (e.g. family, neighbours, local community, media).

Emergency response equipment and material needs to be reviewed periodically. Emergency response equipment should be available in sufficient quantity and stored in locations where it is readily accessible; it should be stored securely and be protected from being damaged. This equipment should be inspected and/or tested at regular intervals to ensure that it will be operational in an emergency situation.
Special attention should be paid to equipment and materials used to protect emergency response personnel. Individuals should be informed of the limitations of personal protective devices and trained in their proper use.
Emergency drills can be used to evaluate the organization's emergency procedures, equipment and training, as well as increase overall awareness of emergency response protocols. Internal parties (e.g. workers) and external parties (e.g. fire department personnel) can be included in the drills to increase awareness and understanding of emergency response procedures.
According to these issues, genset installation should be submitted for the approval of local Fire Department.

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2.3.6 Health & Safety Plans and Risk Assessment

The Health and Safety Plan is the document where has to be defined, for a specific worksite, the foresee activities, the related risks and the measures that are going to be implemented for eliminate/reduce them. The Health and Safety Plan has to cover all the relevant activities focus on the management of health and safety on site including, as a minimum, the following data:

- Project Scope of Work and Key Employees,
- List of major activities (specify planned duration) and perceived major hazards,
- Regulation and Permits H&S requirements
- Fire Fighting Requirements
- Description of main activities,
- Location of activity site(s),
- Number of employees (estimated) and main professional tasks,
- Organization structure chart,
- Chief Project Foreman and lead Health and Safety managers,
- Qualified person(s) to provide first aid, fire-fighting and evacuation on site,
- Emergency reaction system and activation, specifying teams and team leaders,
- Description of the risks affecting the activities (risks assessment),
- Description of the measures adopted to eliminate/reduce risks.

The Health and Safety Plan has to be reviewed and up-dated to reflect changes to work practices, to work activities and to site conditions.
The risk assessment has to:

- Establish the risks arising from the work activity,
- Be appropriate, given the nature of the work, and such that it remains valid for a reasonable period of time,
- Be proportionate to the level of risk and the nature of the work,
- Identify and prioritise the control measures required to protect the health and safety of the employees and others who may be affected,
- Take account of any factors that could change during the course of the job, thereby introducing additional hazards or increasing the level of risk arising from existing hazards.

Risk assessments must be undertaken by competent persons who have knowledge and experience of the activity being assessed and the process must start at the design stage and continue through the construction stage. Documentation arising from the risks assessment shall contain the proposed resolution or mitigation measures necessary to reduce these risks.
Risks assessment has to be reviewed as the Health and Safety Plan to reflect changes to work practices, to work activities and to site conditions. It has also been reviewed when there have been changes in legislation or other guidance relevant for the project.

2.3.7 Other Standards And Best Practices

In addiction to the Regulation Requirements the following list of standard and best practices should be take in account for the evaluation planning and implementation of the topics above mentioned:

- NFPA (National Fire Protection Ass.) 50A: Storage of Hydrogen,
- NFPA (National Fire Protection Ass.) 50B: Storage of Liquid Hydrogen,
- US OSHA 29 CFR Pt. 1910: Occupational safety and health standards.

2.4 Outcomes of the Kick Off Meeting Workshop

During the KOM it has been recognized the difficulty of handle the logistic and the gas refuelling of the hydrogen storage. According to these points some suggestions/guidelines have been identified:

- To start events and music festivals identification already in summer 2018,

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- To identify events and music festivals as much closer each other and close to LINDE or other hydrogen supplier, gas supply point,
- To avoid events and music festivals held on Sunday due to the impossibility to mobilize gensets on trucks due to ADR issues,
- To identify since Y1 the most proper contract to be proposed to events' and music festivals' organizers in order to optimize project logistic and gas budget (WP6 support),
- To properly take care of dust/air filtering at the FC gensets inlet in demonstration in construction works particularly for tunnels construction sites,
- To always operate EVERYWH2ERE gensets in parallel with "plugged-in" electricity or traditional gensets in order to guarantee reliability of power supply at least,
- To consider among "temporary events", festivals and events dedicated to environment and sustainability where a more specific focus on hydrogen/green energy could be conceived and stakeholders could be more interest to test our gensets.

The Demonstration will be properly tracked via a dedicate excel sheet (tracking tool) while gensets will be equipped with data logger able to collect demonstration/monitoring data and store them or on a SD card installed in the gensets or directly transmitting them via GSM protocol to WP4 leader (ENVI), project coordinator (RINA-C) and gensets manufacturer (SHSA-GENP)

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3. Gensets demonstration in construction sites

EVERYWH2ERE demonstration in construction sites is the most easily to be currently foreseen and planned, even at the beginning of the project: more details are indeed here in the following provided if compared to Music Festivals and Temporary Event demonstration, as ACC is strongly committed to host demonstration in two construction sites that are described here in the following.
Considering the time framework of the project and according to the outcomes of the KOM (reduce logistic issues/costs related to Hydrogen delivery), ACC decided to propose two new demosites which are very similar to those ones presented in the grant agreement, but more effective for project demonstration in Portugal and Spain.

3.1 Alto Tamega Construction Site

- **Project type**: Alto Tamega JV Dam and Hydro-electric PW
- **Country**: Portugal
- **Category**: Dams and Hydraulic Works
- **Budget**: 107.46 Million €
- **Estimated life span**: 54 months
- **Status**: Contract signed, works started

The "Alto Tamega" dam is a double curvature concrete dome with parabolic axis in plant. The maximum height between the coronation and the lowest point of the foundation will be 106.50m. The hydroelectric power plant located on a dam foot, in the central area, will be equipped with two Francis turbines of 100 m^3/s of normal capacity, including their respective hydraulic circuits. The total power installed will be 160 MW.

Earthworks are being carried out currently and concreting works will be started by the next few months. Due to the remote area location, temporary gensets presence is mandatory to provide power to local construction site particularly for energy intensive processes in distant areas.

Fig. 3 - Alto Tamega Construction Site overview

3.2 "Del Tres Ponts" tunnel Construction Site

- **Project type**: "Del Tres Ponts" tunnel (Tunnel of the three bridges) JV
- **Country**: Spain
- **Category**: Ground works and Roads
- **Budget**: 29.25 Million €
- **Estimated life span**: 36 months
- **Status**: Contract signed, works started

The project includes the improvement of the C-14 road between the Organyà exit and the existing tunnel of the Montant de Tost, just before the intersection of the LV-4001 road in Northern Spain. Its objective is to improve the road safety of the section in question by solving the current problem of rockslides, from the road slopes, on the roadway.

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In the first stage, the road comes through a small existing tunnel of 51.5 m in length which section is provided to enlarge, but the main action consists of the new "Dels Tres Ponts" tunnel execution, of 1.300,62m in length, by using explosives.

In the previous and subsequent stages from "Del Tres Ponts" tunnel, the main action will consist of an enlargement of the C-14 current roadway to 10 m wide section. In order to achieve this section, there are planned structures in the river sideways in some points along the road outline.

Fig. 4 - Drilling works of the new South tunnel mouth

DEMOSITE INTERVIEW

Reference to local technical normative for installation and operation of gensets:

Reference to permitting (which local authorities, which allowance etc.) to be asked to use the gensets

Local norms regarding the setup and operations of gensets at festival sites differ not only from country to country, but from region to region. Permitting procedures need to start the earlier the better to guarantee an efficient planning process and roll out of test sites. Permitting needs to take into account normative mentioned in section 2.3 for the use of gensets in working contexts.

Permitting process will need to be planned in close cooperation with responsible of local grid/DSO in case of parallel operation of gensets and direct grid connection supply.

Reference to current contractual arrangements for the installation and operation of gensets in construction sites

Most of the times the construction company has an annual/multi annual contract with an energy company, which is then responsible for powering the site often via both grid connection and genset. The energy company rents different generator for the needs of the different areas of the construction sites. Contracts normally established are often "all inclusive" except for the fuel costs which are a side: rental of the gensets/equipment, transport A/R, installation, testing, on-site assistance of one or more technicians, disassembly, supply of fuel which is paid aside as an additional voice of cost. Construction companies often rent gensets for back-up/emergency power supply, not only for direct power supply, so there is the possibility that the gensets are rented but experience zero or low usage rate.

Reference to current data monitored at construction sites (about environmental, acoustic impact)

Construction sites are usually acoustically monitored in case of presence of close built-up/residential areas, nevertheless it will be important to try to acoustically monitor different equipment/technologies. CO_2 footprint is usually calculated based on fuel consumption, mostly only for internal benchmarking. Nevertheless, environmental impact of construction sites is becoming an area of interest/analysis not only about construction and demolition wastes monitoring.

Reference to current costs for gensets rental, maintenance, fuel

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Compared to total construction industry expenditures, overall spending on power/fuels represents about 2.5% of given costs; specifically, power/fuel spending is approximately 4% of heavy construction, 3.7% of special trade contracting, and 1.2% of building construction costs.
Current fuel costs are between 0,65-1,30 €/l according to different EU countries and markets/contracts (i.e. related to the annual consumption) while rental price are between 15 to 200 €/day considering size and duration of the contract.

If possible, please provide daily/hourly profile of usage of gensets in similar condition
Gensets are used for both emergency power back up or to provide continuously (24/24 – 7/7) power to the construction site.

Current Companies and technologies used for providing power/renting gensets
Generators can be rented easily and cheaply from a very big amount of rental companies all over Europe: normally construction companies are linked to local rental companies that can easily provide maintenance services.

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4. Gensets demonstration in Music Festivals

As an industry with thousands of diverse events in various sub-sectors, and a combined audience and client-base of millions, music festivals industry can have the ability to materially contribute to the decarbonisation of temporary gensets technology and the promotion of hydrogen and fuel cells in this entry market.

A transition to a less carbon intensive power supply in music events is a mission pursued by different EU initiatives (Green Music Initiative, Julie's Bicycle, Powerful thinking etc.) and stakeholder's approach changed from a sceptical interest in new approaches, to an ongoing dialogue about how to practically implement new technology and smarter ways of working to achieve better efficiency.

There are now many success stories of events across Europe that have saved energy, fuel and costs. In the recent Festival Industry Green Survey (Powerful Thinking: 2016), over 50% of respondents stated they are now using LED festoon lighting, and a third of respondents had introduced monitoring of generator energy/fuel consumption in 2016 proving a higher energy and environmental sensibility of such industry.

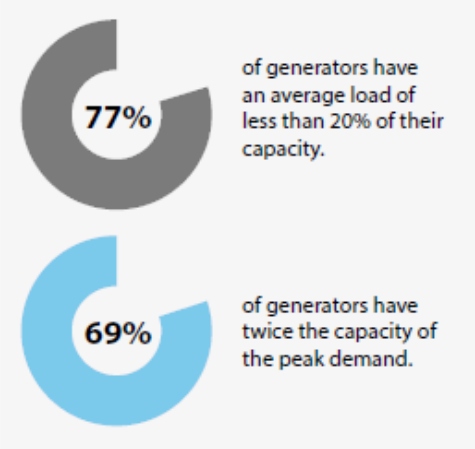

Fig. 5 - Netherlands gensets study about their management and performances

Since the 1980s, when outdoor events were becoming more prevalent, a 'plug and play' model has persisted in the events industry, where event organisers expect power to be cheap, readily available and power companies will supply generators with an estimated significant margin of contingency in their capacity to ensure that they can provide a reliable supply of energy, which is often based on unknown or incorrect power requirements.

The recommended load for generators to be running at to maximize fuel efficiency and minimize potential damage to the engine of a generator is 60- 80%.

The Power Behind Festivals Guide (2012) showed that, of the generators monitored at eight events, every single system had periods of working below a 25% load, and some of them operated entirely below a 25% load. In over half of cases, the generator was more than double the capacity required. At one event, the capacity of the main stage generator was eight times larger than the peak load.

An innovative company in Holland called Watt-Now has been busy collecting energy data at events, whilst working with event organisers to identify energy saving and renewable energy solutions. They have analysed 270,000 data points from outdoor events in the Netherlands over two years (2014–2015) finding that 77% of generators they measured had an average load of less than 20% of their capacity (see Figure above).

Power is typically one of the five largest single production costs for a festival. It is one of the few payments not known pre-event, and it is left to a third party to report on, often without safeguards or proper scrutiny. Power also typically represents up to 65% of an event's 'core' carbon footprint.

Nevertheless, estimating energy consumption in the festival sector as a whole and single festival consumption profile is more difficult as most festivals run from unmetered diesel powered generators so kWh information is very rare. However, diesel consumption data is more readily available. Julie's Bicycle has collected information for 20 large music festivals (approximately one third of the UK large music festival market, with large defined as over 20,000 audience) and has found that they use 0.5 litres diesel per audience member per day. For the UK festival sector, this results in a total annual diesel consumption of approximately 12 million litres (Sussex University and Julie's Bicycle 2011). Extrapolating this UK benchmark to 4,200 European festivals, total annual diesel consumption amounts to 100 million litres. How many kWh are produced using this fuel is currently unknown. Here in the following some example of good practices to reduce energy consumption in Festival industry are presented.

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Festival	Good practice	Savings achieved	Awards
Shambala Festival, UK Over 200 diverse musical acts across 12 live stages	Transition to 95% non-mineral based power through the use of WVO bio-diesel and six micro renewable energy suppliers on site	88% of energy emissions (from 2009 to 2010)	First organization to achieve a 3 star IG certification from Julie's Bicycle
Roskilde Festival, DK Largest North European music festival	Low energy equipment on stages – all stage lighting based on LED technology	40% of power consumption	
Glastonbury Festival, UK; Largest greenfield music and arts festival in the world; 120,000 visitors per year	Plans to expand the use of renewable power sources (particularly solar panels) and power sharing	10% (expected)	1 star Industry Green for the 2010 event
Rock in Rio Lisbon/Madrid 2008	240 PV solar panels for energy during preparation works.	19 MWh generated with 9 tonnes of GHG emissions saved.	
Boom Festival 2008, Portugal	Use of 45000 Litres of waste vegetable oil for generators.	117 tonnes of GHG emissions avoided (fuel switch for generators)	European Festival Award 2010 – Green'n'Clean Festival of the Year – Greener Festival Award 2008 and 2010 (Outstanding Prize)
Splendour in the Grass, Australia	Invested $10,718 in renewable wind energy generation	Offset more than 480 tonnes of emissions from hosting event	Commended Award "for their 2010 event from Greener Festival Awards"
Melt Festival, Germany; Europe's largest indie and electro music festival, attracting 20,000 visitors per year	In 2011 a solar power plant was installed, producing about 170,000 kWh of electricity per year and can supply 50 households with electricity	10% (expected), due to use of LED Lighting systems.	Green 'N' Clean Award 2011 "Efficient Mobility" Award 2010 of the German Energy Agency

DEMOSITE INTERVIEW

Reference to local technical normative for installation and operation of gensets:

Reference to permitting (which local authorities, which allowance etc.) to be asked to use the gensets

Local norms regarding the setup and operations of gensets at festival sites differ not only from country to country, but from region to region. Permitting procedures need to start the earlier the better to guarantee an efficient planning process and roll out of test sites. Permitting needs to take into account local site-specific rules & laws (urban environment, green site, brown site, natural park etc) and they are generally divided in electrical – safety regulation and environmental – fuel leakage, emissions, sound levels etc.

Permitting process will need to be planned in close cooperation with responsible on-site energy provider and/or festival producer.

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Reference to current contractual arrangements for the installation and operation of gensets in construction sites

Most of the times the festival has a contract with an energy company, which is then responsible for powering the event. The energy company rents different generator for the needs of the different stages, camp sites, back stages, catering areas, commercial areas or production facilities. Contracts normally established are often "all inclusive" except for the fuel costs which are aside: rental of the gensets/equipment, transport A/R, installation, testing, on-site assistance of one or more technicians, disassembly, supply of fuel which is paid

Reference to current data monitored at construction sites (about environmental, acoustic impact)

Due to nature of the sector as of now no data monitored and / or disclosed on environmental or acoustic impact yet. CO2 footprint usually calculated based on fuel consumption, mostly only for internal benchmarking and very seldom disclosed. Acoustic impact of generators only on festival campsites and small stage environment (f.e. acoustic, classical music, spoken word) and in residential areas (urban festivals) of relevance.

Reference to current costs for gensets rental, maintenance, fuel

Power is typically one of the five largest single production costs for a festival. It is one of the few payments not known pre-event, and it is left to a third party to report on, often even not disclosed transparently. i.e. only invoiced by the energy company as a flat amount, not giving the festival producer the chance to differentiate properly between rental and fuel costs. At best festival promoter gets a two-part invoice from the generator rental company: rent of gensets (including transport, staff and distribution) + fuel costs. Rental costs differ from event to event from Euro 150 per day (100 kVA / 80 kW) to Euro 850 (1.000 kVA / 800 kW) excluding fuel costs, transport, distribution gear and maintenance. This wide range exists due to festivals tacking place on sites either easy to operate or complicated, which leads then to alternating rental costs. The production duration and number of genset rented are another factor for the varying rental costs per unit. Transport often is charged by km, so that varies a lot, too!

Festivals itself differ very much in rental costs and consumption patterns due to their size, stage setups and production. Some have grid connection, some are produced 100% off grid with generators.
EE MUSIC (http://ee-music.eu/) collected data (2013 – 2015) to create a pan European dataset:

- *Big Event; Concert / 1.000 – 3.000 visitors per day: 2.000 – 8.000 kWh per day,*
- *Small Festival / 3.000 -15.000 visitors: 8.000 – 15.000 kWh per day,*
- *Medium Festival / 15.000 – 35.000 visitors: 15.000 – 30.000 kWh per day,*
- *Big festival / 35.000 – 150.000 (and more) visitors per day: 30.000 – 100.000 kWh per day.*

Some examples are presented here below with an energy consumption estimation:

Name	Visitors per day	Energy	Duration	Remarks
Shamballa / UK	10.000	62.000 kWh	3 days	100% Renewables
Melt / DE	20.000	156.000 kWh	3 days	Grid & generators
Wacken / DE	75.000	130.000 kWh	3 days	Grid & generators
Sziget / HU	80.000	300.000kWh	8 days	Grid & generators
Roskilde / DK	160.000	400.000 kWh	8 days	Grid & generators
Glastonbury / UK	160.000	1.000.000 kWh	3 days	Only Generators

In a full cost analysis (FCA) Festival promoters today have to pay around 1 €/kWh (which is higher than off-grid hydrogen based LCOE) coming from generators (ZAP Concepts / Green Events Netherlands 2017). The FCA includes:

- *Rent,*
- *Transport,*
- *Distribution of Energy (cables etc.),*

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- *Staff,*
- *Fuel Costs.*

This very high price per kWh is based on some sector specific facts:

- *Generator Sets are rented as 'Twin Sets' to cover for possible blackouts / failure with two Gensets running parallel all the time,*
- *Peak Load is estimated far too high in 85% of the cases (Powerful Thinking 2016) making genset run on a too small load / very inefficient (ideal would be 60 -80%, please have a look at graph below),*
- *they use way too much diesel for the needed peak load (litres per kWh).*

If possible, please provide daily/hourly profile of usage of gensets in similar condition

Load profiles for gensets at festivals alter between very high peak loads and very low baseloads. Studies from the European Commission funded EE MUSIC project have shown, that the very high peak loads based on the showtimes on the mainstage led to far too big generator sets to guarantee these capacities.

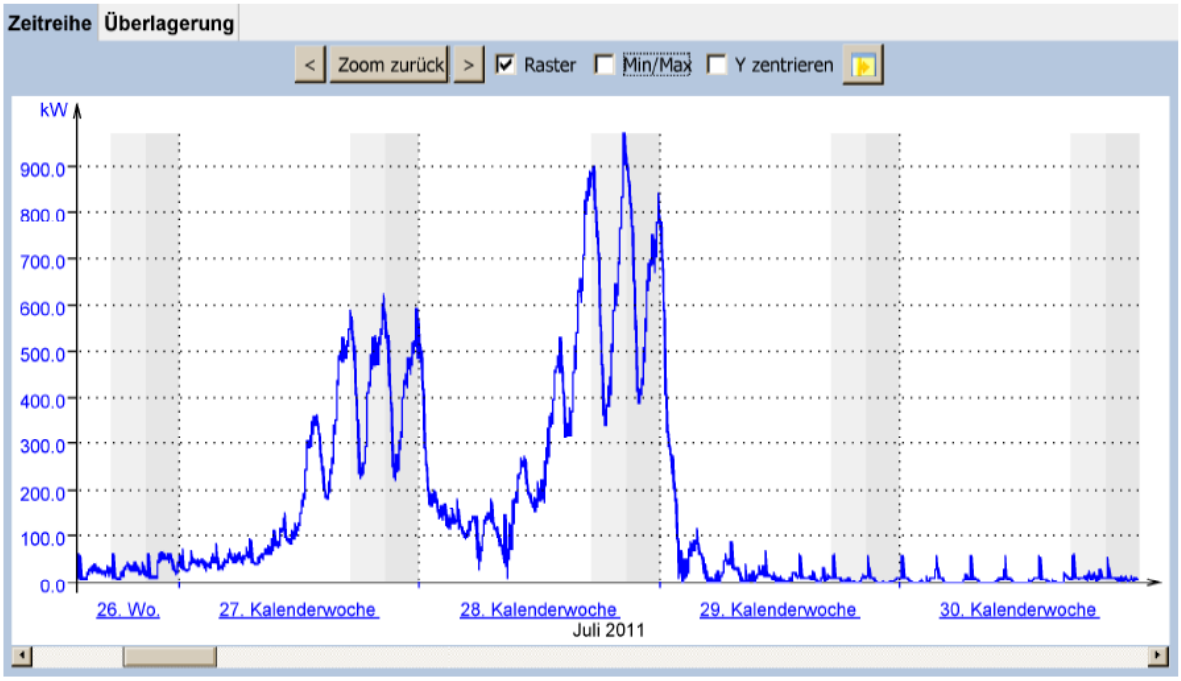

Fig. 6 - Weekly Load Profile of Melt Festival / DE. shows high peaks on production days (Friday / Saturday / Sunday at night) and low base load the other days.

Peak Load was estimated far too high in 85% of the examined cases (Powerful Thinking 2016) making genset run on a too small load / very inefficient the rest of the time (ideal would be 60 -80%, please have a look at graph below). Powerful Thinking study has shown that this makes a case for hybrid gensets (efficient generator for base load / battery for peak load).

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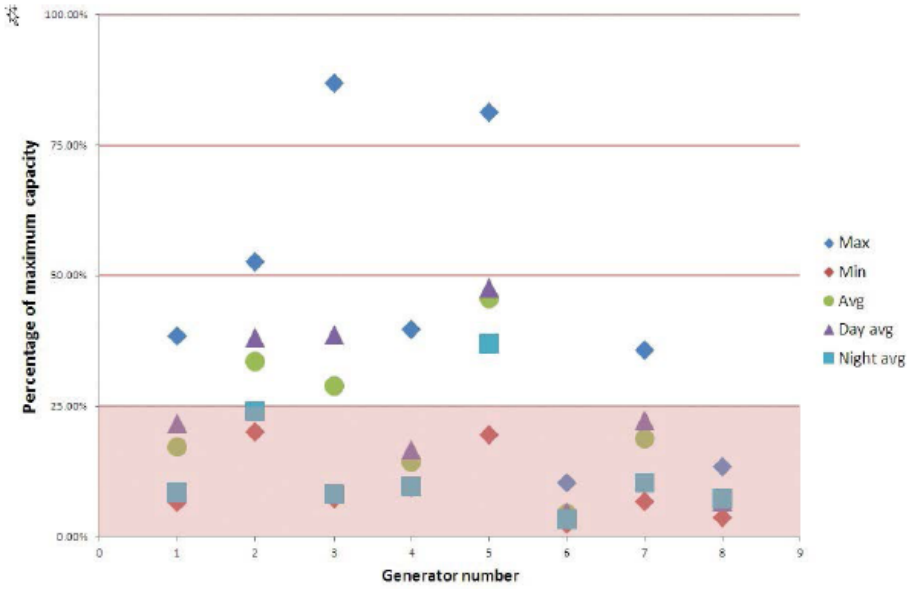

Fig. 7 - Off design of gensets in music festivals

Current Companies and technologies used for providing power/renting gensets

Generators can be rented easily and cheaply from a very big amount of rental companies all over Europe. Nevertheless, there are some rental companies, energy providing companies and service providers, with a strong background in the festival sector. With some of these a strategic partnership could make sense to ensure access, setup and operation of the festival test sites.

Name	URL
Aggreko	https://www.aggreko.com
Bredenoord	https://www.bredenoord.com/en/
Firefly	http://www.fireflyhybridpower.com/
Tangent	https://tangent.energy/
Powerline	https://www.thepowerline.co.uk/
The Powershop	http://thepowershop.eu/
ZAP	http://www.zapconcepts.com/en/
Boels	https://www.boels.de/

Other recommendations from Music Festival industry

As of today hydrogen and FC gensets are more expensive for festival promoters to rent & run due to the fact that diesel gensets are really cheap to rent basically everywhere in Europe. This does not even take into account the price and limited disposability of hydrogen. Within the existing market situation / pricing of diesel gensets the switch to hydrogen and FC gensets seems not feasible from a business point of view. This would change in case of a clear regulatory framework regarding CO_2 emissions of events or a subsidized market change. Furthermore, the use of not yet certified equipment could be a potential non-technological barrier in the use of EVERYWH2ERE gensets as well as in their transport according to International Carriage of Dangerous Goods by Road (ADR) also considering that music festivals are often scheduled in weekend when certain goods like hydrogen cannot be transported on highways etc.

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5. Gensets demonstration in Temporary Events in EU Cities

Running a temporary event from a local distribution grid connection can be the cheapest option for some events. Using a grid connection can reduce transportation involved in delivery and collection of equipment. Using a 'green tariff' or arranging with local energy provider a dedicated supply agreement - an electricity contract which delivers energy from renewable sources - can also be the greenest option (even if not so easy to be verified).
However, using a grid connection is often not a practical option unless the site or showground already has a supply – often the case only for city event sites. Otherwise, installing the substations or extensions to the underground cabling required can be prohibitively costly for temporary events. Additionally, a grid connection may not be a suitable solution for the temporary power needed on a complex multi-venue site, where power sources are required at specific points over a large area. Furthermore, in case of big events, a temporary connection of several MW of required power supply, can generate grid stability issues at local level also not encouraging local DSO to provide power in that area.
In all these cases, the use of temporary gensets is the most common option.
Thanks to the support of ICLEI (for what it concerns the understanding of needs and constraints at city level, both technical and non-technical) and of FHA and ENVI (and its linked third party), EVERYWH2ERE will study how to make FC genset the most effective solution for city events thanks to their zero emission and zero noise impact, which is very relevant for EU cities.

5.1 Temporary events in Italy (ENVI supervision)

According to the received Letter of Support, ENVI will potentially involve different temporary events also thanks to IREN and IREN ENERGIA support who often supply power to temporary events both via dedicate "plug-in" connection and rented gensets.
In the following paragraphs, the specific case of "Slow Food" events and of events hosted by Torino Municipality (two of EVERYWH2ERE LoS authors and interested in hosting the demonstration) will be analysed and presented.

Fig. 8 - Slow food events location in Northern Western Italy

5.1.1 Slow Food events

Slow Food is a grassroots organization founded by Carlo Petrini in Italy in 1986 and currently worldwide spread. Promoted as an alternative to fast food culture, it strives to preserve traditional and regional cuisine and encourages farming of plants, seeds, and livestock characteristic of the local ecosystem. It was the first established part of the broader slow movement. Its goals of sustainable foods and promotion of local small businesses are paralleled by a political agenda directed against globalization of agricultural products". Three events have been identified by Slow Food as potential democases for EVERYWH2ERE project. Data dedicated to each event are briefly presented here in the following as well as general guidelines (acting as an operative recap of events' data collection)

DEMOSITE INTERVIEW
Reference to local technical normative for installation and operation of gensets:
Usually Slow Food electric designer takes care of it in agreement with the supplier (rental) of the generators. Safety aspects 81/08; INAIL ex ISPESL on pressurized machines.

The temporary power installations are subject to different restrictions according to Italian law. The main fields regulated are their acoustic emissions, as well as fire hazard and electrical safety.

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Acoustic emissions:
Italian "Direttiva 2000/14/CE" states that for power generation system from 10 to 400kW the maximum acoustic emissions have to remain below $E < 95 + lg(P_{el})$ *where Pel is the net power (expressed in kW).*
Safety Distance:
If the genset is located open air, the minimum distance "D.M. 30/11/1983" dictates is 3,50m from every vertical structure.
Fire hazard:
"D.Lgs 152/06" states that there is no need for authorization but just the necessity to notify the following generator types:

- *Fuelling: LPG or Methane, Nominal power < 3 MW*
- *Fuelling: diesel or petrol or biomass, Nominal power < 1MW*

Reference to permitting (which local authorities, which allowance etc.) to be asked to use the gensets
The only permits Slow Food as organizer asks is the request for the occupation of public land. From the grid point of view, normally the power supplier takes care of all special permits that a "heavy temporary" connection to the local grid can require due to local grid instability.

Reference to current contractual arrangements for the installation and operation of gensets in construction sites
Traditional daily rental of the gensets/equipment (fuel costs are aside): the costs mentioned in the following are inclusive of transport A/R, installation, testing, on-site assistance of one or more technicians, disassembly – No specific electric contracts (in terms of extra-power costs etc.)

Reference to current data monitored at construction sites (about environmental, acoustic impact)
At the moment they do not have a coded system for data monitoring. Acoustic monitoring of the single gensets could be quite difficult in urban areas, while emission monitoring could be performed at exhaust chimney,

Reference to current costs for gensets rental
Salone del Gusto 2016 € 29.000,00 (11 days) – Slow Fish 2017 € 11.200,00 (8 days) – Cheese 2015 € 1.150,00 (5 days)

Reference to current maintenance interventions and costs per year
Included in rental costs

Reference to current fuel costs in the events
Salone del Gusto € 24.700,00 – Slow Fish € 2.800,00 – Cheese € 432,00

If possible daily/hourly profile of usage of gensets in similar condition
Indicatively from 10.00 to 24.00 only during the days of the event (4/5 days)

Current Companies and technologies used for providing power/renting gensets
Aggreko SpA

1) Sample Event: Terra Madre /Salone del Gusto

- Location: Turin
- Frequency: biennal event (next attended in 2018 – potential gensets hosting in 2020)
- Duration: 5 days
- Number expected partecipants: almost 1 million in 2016

Electrical requirements:

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- 1.100 kW provided by 6 diesel gensets
- 3.700 kW provided by electric grid

2) Sample Event: Cheese
- Location: Bra (AT)
- Frequency: biennal event (2017 and 2019 - potential gensets hosting in 2021)
- Duration: 4 days
- Number expected partecipants: almost 270.000 in 2015

Electrical requirements:
- 40 kW provided by 1 diesel genset
- 1.560 kW provided by electric grid

3) Sample Event: Slow Fish
- Location: Genova
- Frequency: biennal event (2017 and 2019)
- Duration: 4 days
- Number expected partecipants: almost 150.000 in 2015

Electrical requirements:
- 720 kW provided by 3 diesel gensets
- 700 kW provided by electric grid

5.1.2 Municipality of Torino events

When temporary events occur in the heart of the city of Torino, power is normally supplied by a direct connection with the electric grid with the establishment of a dedicated contract with local DSO/power provider. As you can see from the requirement of some sample public events, the role of FC gensets is mostly related to back up and emergency power production

1) Previous Event as a sample: 3rd World Forum of Local Economic Development 2015
- Location: Torino
- Frequency: salutary hosting
- Duration: 5 days

Electrical Supply
- 250 kW provided by 1 diesel genset
- 1 Static UPS 60 kW/60 kWh
- 700 kW provided by electric grid

In the following table, municipality of Torino presents a recap of their current rental agreement for gensets.

Event duration	Energy source (Fuel=F, Gas=G, Other=O)	Nominal Power (kW)	Renting fee €	Energy price (€/liter or €/kWh)	Fuel included in rental price	Average running hours per day
1 -6 days	F	25 kW	400	1.30	N	8
1 -6 days	F	40 kW	450	1.3	N	8
1 -6 days	F	240 kW*3	1800	1.30	N	8

5.2 Temporary events in Spain (FHA supervision)

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement 779606. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme, Hydrogen Europe and Hydrogen Europe research

FHA, as fully responsible of 25kW and partial responsible of 100kW EVERYWH2ERE FC gensets systems, has identified and arrange the commitment of different music festivals, temporary events and exhibition venues. The plants will be tested and analysed at several loads, power ramps, storage needs and schedule and climate conditions with the aim of characterizing the whole operational envelop and understanding the FC genset limits.
The promotion and dissemination of the use of hydrogen in local and regional events that FHA has carried out during the last decade, has a strong liaison with the project goals and the sustainable development of these urban events demosites.
First of all, and as one of its main supporters, the Government of Aragón fully supports the consortium with valuable and experienced insights and to contribute to empower the future replicability of the demonstrated Fuel Cell gensets providing useful legislative, technical and economic data to enable the assessment of the replication potential in our context. As the project idea is well in line with the internal priorities of Government of Aragón of sustainability, energy framework and business model, etc. several Councils of the surroundings have also expressed their support to the project. Some of them are the most important in the Aragonese region. Cities as Huesca and Zaragoza host dairy events where the plants can be tested, achieving a strong dissemination between different target groups, especially the general public that assist to these events. In addition, worldwide well-known events such as Moto GP hold in Motorland circuit can be addressed due to the close link with the Government of Aragón.
On the side of the private sector, the response has been quite positive. It has to be understood that including this innovative system as a demonstration site in your own business is not an easy idea. Nevertheless, open-minded discussions with the organization of music festivals, venue's responsible or private event promoters have addressed them the conviction of letting us collaborate with them. To name some of them:

- Demanda Folk. This summer music festival lasts 2 days but it is developed in a beautiful natural landscape of the Sierra de la Demanda, Burgos, Spain. That leads the organization to hold very strict rules to achieve the highest sustainability at the event. One problem that could not have been addressed yet is the production of energy by diesel gensets, so they are willing to participate and switch them for the EverywH2ere FC gensets systems.
- Fundación Festival Cine de Huesca. This Foundation host several urban events such as film projections in the city park or tours through the city, where portable energy generation is required.
- El Señor Wom & Asesores S.L. and Zaragoza & Eventos S.L. are event promoters that basically develop music festivals of 1-4 days of duration where energy production systems must be implemented as support service for the grid or sometimes, as direct energy production for the event.
- Walqa Technological Park. This venue, where FHA facilities are located, host dairy events – some of them are organized by FHA - where energy production systems must be implemented as support service for the grid or as off-grid service.

During the proposal preparation, FHA has detected some enterprises – EDMI Internacional S.L., Atlas Copco GESÁN Grupos Electrógenos Europa S.A., etc. - that rent these Automatic Diesel Gensets to venues, events, music festivals in the Aragonese region.
EDMI Internacional S.L. < http://www.edmi.es/> does the testing and commissioning of Automatic Diesel Gensets. They are currently contractors of the vast majority of Aragonese Councils, music festivals in the region and they collaborate with huge and well-known events such as giving support to Champions League football matches TV broadcasting or delivering the required electricity in different locations during the shooting of Game of Thrones.

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Fig. 9 - EDMI Gensets

On the other hand, Atlas Copco GESÁN Grupos Electrógenos Europa S.A. < http://www.gesan.com/en> has the whole value chain. They do the manufacture, erection, testing & commissioning of Automatic Diesel Gensets which can be used for a wide variety of segments such as public & governmental, industrial, construction sites, telecommunications, data centres, utilities, etc.
It is widely well-known that these companies are going to move their fleet to an eco-friendly, zero-emission and completely respectful with the environment fleet due to restricting urban regulations coming soon, regarding both noise and air contaminant emissions. As early adopters, these companies have shown their interest in the project given that EVERYWH2ERE FC gensets systems proposed have been identified by them as a potential and promising niche market.
In addition, these companies are used to apply to public tenders published by the Councils of the cities, as it is mandatory for these kinds of institutions as public bodies/authorities to choose the best techno-economical offer through a public process.
Having the commitment of both parties, tenderers – company – and contractors – Council – it is assured the use and test of EverywH2ere FC gensets systems in the events hosted by the Council, i.e. Huesca, Zaragoza, Jaca, Sabiñánigo, etc.
Regional companies such as Calvera Maquinaria e Instalaciones and Instrumentación y Componentes, S.A. have expressed their support to the project. Calvera develops projects related to compressed gas transport and they are specialised in hydrogen. Inycom is keen on control and communication systems related to hydrogen systems.
To sum up, these are the public authorities, events' promoter, venues and companies that have expressed their interest and are willing to support the project hosting EVERYWH2ERE FC gensets systems under the responsibility of FHA:

Organisation	Type of event
Government of Aragón	Public authority
Council of Huesca	Public authority
Council of Zaragoza	Public authority
Council of Jaca	Public authority
Council of Sabiñánigo	Public authority
Council of El Pobo	Public authority
Walqa Technological Park	Public authority - venue
EDMI Internacional S.L.	Company
Atlas Copco GESÁN Grupos Electrógenos Europa S.A.	Company
Demanda Folk	Music festival
Fundación Festival Cine de Huesca	Event
El Señor Wom & Asesores S.L.	Event promoter
Zaragoza & Eventos S.L.	Event promoter
Festival Poborina Folk	Music festival
Polifonik Sound	Music festival
Torero 2000 S.L.	Event promoter
El Veintiuno	Event promoter

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Calvera Maquinaria e Instalaciones	Company
Instrumentación y Componentes, S.A.	Company

There is the possibility to contact and arrange the commitment of plenty more music festivals, event promoters, companies or public authorities but has not been possible during the proposal preparation. Preliminary results and efforts developed in WP7 - Dissemination, Stakeholders and Public Opinion Engagement, jointly with the friendly first experiences in year 1 of demonstration and monitoring are crucial to engage more events in order to increase the use and test of EverywH2ere FC gensets systems. FHA, as fully responsible of 25kW and partial responsible of 100kW systems, jointly with the 71 companies that make up its Board and in close collaboration with the Government of Aragón, is the best partner in the region to hold the systems and attract more successful events into the project.

Considering that the plethora of potential events is quite wide, FHA analysed potential demosites in Spain/Aragon at a larger glance, providing more generic guidelines here in the following in its interview.

DEMOSITE INTERVIEW

Reference to local technical normative for installation and operation of gensets

Reference to permitting (which local authorities, which allowance etc.) to be asked to use the gensets

FHA gathered the normative, standards and regulations related to H_2 usage in Spain. Due to the length, FHA has elaborated a specific report titled "LEGISLATION APPLICABLE TO H_2 TECHNOLOGIES AT EUROPEAN AND SPANISH LEVEL" that can be found in the annex of this document

Reference to current contractual arrangements for the installation and operation of gensets in construction sites

Traditional daily/weekly rental of the gensets/equipment (fuel costs are aside): the costs mentioned in the following are inclusive of transport A/R, installation, testing, on-site assistance of one or more technicians, disassembly – No specific electric contracts (in terms of extra-power costs etc.)

Reference to current data monitored at construction sites (about environmental, acoustic impact)

Now, they do not have a coded system for data monitoring. Acoustic monitoring of the single gensets could be quite difficult in urban areas, while emission monitoring could be performed at exhaust chimney,

Reference to current costs for gensets rental

FHA contacted local generators rental companies who provided information about rental prices for one and two months (information here in table below)

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APPROXIMATED RENTAL PRIZE					
Rental period	ONE MONTH				
Prize per	CALENDAR DAY				
Working regime / Machine	24 hours/day	8 hours/day	Standby	Extra hour	secure
Genset 40kVAs	76 €	48 €	34 €	3 €	6%
Genset 100kVAs	109 €	69 €	49 €	5 €	6%
Rental period	TWO MONTHS				
Prize per	CALENDAR DAY				
Working regime / Machine	24 hours/day	8 horas/día	Standby	Extra hour	secure
Genset 40kVAs	38 €	76 €	27 €	3 €	6%
Genset 100kVAs	65 €	109 €	45 €	5 €	6%

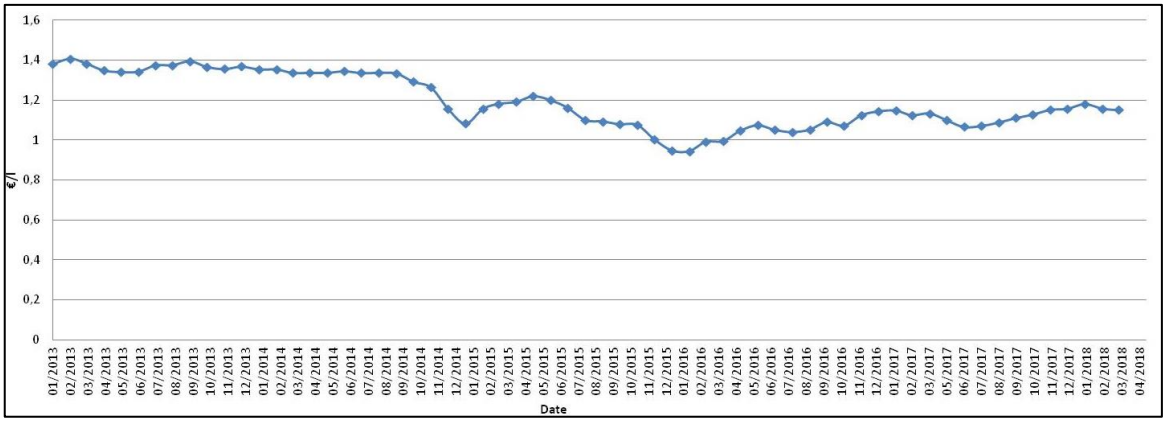
Fig. 10 - Diesel gensets rental prices in EU

Reference to current maintenance interventions and costs per year

Included in rental costs

Reference to current fuel costs per year

Here in the following FHA proposes an overview of last five years diesel prices together with an estimation (realized with local rental companies' support) of State of The Art Gensets performances, in order to potentially evaluate the fuel operation costs of diesel gensets for benchmarking.



About gensets SotA performances, information received so far are::

Atlas Copco

Fuel consumption	8.5 kW	30 kW	100 kW
100% workload	2.6 l/h	7 l/h	21.7 l/h
75% workload	2 l/h	5.2 l/h	16.5 l/h
50% workload	1.5 l/h	3.8 l/h	11.7 l/h

Barloworld Finanzauto

Fuel consume	40 kW		100 kW	
Frequency	50 Hz	60Hz	50Hz	60Hz
100% workload	9.5 l/h	-	24.1 l/h	28 l/h
75% workload	6.3 l/h	-	18.5 l/h	26 l/h

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If possible daily/hourly profile of usage of gensets in similar condition
Indicatively from 12.00 to 2.00 only during the days of the event (4/5 days)

Current Companies and technologies used for providing power/renting gensets
Here in the following, contacts that have been mobilized among local gensets rental companies.

EDMI International Machinery	info@edmi.es;	http://www.edmi.es/index.php	Zaragoza (Spain)
ATLAS COPCO	ac.spain@es.atlascopco.com	https://www.atlascopco.com/es-es	Madrid (Spain)
BARLOWORLD FINANZAUTO (Dealer of Caterpillar Inc)	consultas@finanzauto.es	http://www.finanzauto.es/es/	Madrid (Spain)

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6. Conclusion

In this report, an accurate review of the EVERYWH2ERE potential demosites towards the definition of gensets specification was carried out thanks to the support of each "demonstration category" responsible. Outcomes of this deliverable will be useful for further WP1 (i.e. definition of KPI panel for monitoring and tracking demonstration) activities and particularly for WP2 and WP3 for the design and engineering of 25 kW and 100 kW gensets.

As presented in the document, one of the most relevant issue for a correct sizing and design of a customized generator is the required power. Nevertheless, gensets power capacity has been already defined by project Grant Agreement.

Most of the technical indications come from previous experiences where diesel gensets have been used in similar indication: this is the main benchmarking technology from the performance, economic and regulatory point of view.

Similarly pressurized hydrogen storage capacity has to take into account demosites indication to reduce at the maximum the number of gas refilling trips, nevertheless as the objective of the project is to realize containerized solutions, also space/volume constraints have to be taken into account.

The importance of taking into account all local regulation and permitting safety measures have been highlighted for an effective realization of the product. At this purpose, the use of non-certification products is at the current stage a bottleneck for future replication and oriented design/engineering of the gensets.

Even if at this early stage of the project, some details about demosites are still under discussion under the guidance of demonstration responsible (ACC, ENVI, FHA, D1), this preliminary overview presented in this deliverable could be useful not only for gensets manufacturers, but also to promote EVERYWH2ERE project among potential new demosites to be engaged (WP7) as well as for business model analysis (WP6).

Further discussion towards a final agreement about demosites involvement will be conducted in the next months, towards a final demonstration strategy definition.

The identification of current market players in the field of rental gensets is also a relevant input to the creation of EVERYWH2ERE Stakeholders group (WP7) and development of a technology to market roadmap.

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7. References

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- Festival Fuel Tool, Powerful Thinking: www.powerful-thinking.org/fuel-tool

- "THE POWERFUL THINKING GUIDE 2017, Smart Energy for Festivals and Events", Powerful Thinking publication, 2017

- "THE POWER BEHIND FESTIVALS, A guide to sustainable power at outdoor events", Powerful Thinking publication, 2016

- "The Show Must Go On Report", Powerful Thinking publication, 2015.

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A. Annex

A1: LEGISLATION APPLICABLE TO H_2 TECHNOLOGIES AT EUROPEAN AND SPANISH LEVEL

FUNDACIÓN PARA EL DESARROLLO DE LAS NUEVAS TECNOLOGÍAS DEL HIDRÓGENO EN ARAGÓN

LEGISLATION APPLICABLE TO H2 TECHNOLOGIES AT EUROPEAN AND SPANISH LEVEL

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INTRODUCTION

This document aims to collect European directives and regulations to be of application within EVERYWH2ERE project at different levels, including Spanish legislation. They are related to general aspects like Pressure Directive and Health and Safety issues, and also specifically to the use of hydrogen. Standards, as codes of good practices, serve as guides to parties concerned. Whilst standards are developed by Standardization Organizations, which include work groups formed by an important number of parties involved, codes can be developed by just one entity or by a few of them. Standards and codes are not legal documents, but they can be used as reference or even become legally binding documents. In this case, the standard is harmonized.
Regarding to European legislation, it's possible to distinguish between Regulation and Directive. Regulation implies a legal instrument immediately enforceable. On the other hand, a Directive is a legislative act which force to all Member States to reach a particular result, i.e., compels to a transposition of the Directive to the national legislation.
At Spanish level, two different kind of legislative documents exist, Royal Decrete (R.D.) and Royal Decrete-Law (R.D.-L) or Law. Similar than European legislation, R.D. is a regulation subordinate to a law.

EUROPEAN DIRECTIVES AND REGULATIONS

- **Directive 94/9/CE**: Approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres. This Directive is known as **ATEX 95**. It's transposed in Spain by Real Decreto **(R.D.) 400/1996**. Both Directive and R.D. have been repealed by the **Directive 2014/34/UE** and the **R.D. 144/2016**, respectively.

- **Directive 97/23/CE**: Approximation of the laws of the Member States concerning pressure equipment. In Spain, the **R.D. 2060/2008** has been published, which approves the Regulation of pressure equipment and their complementary technical instructions. This R.D. completes the **R.D. 769/1999**, which has been in turn repealed by the **R.D. 709/2015**.

- **Directive 2014/68**: Harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment. It partially repeals the **Directive 97/23/CE** and it's transposed the **R.D. 709/2015**.

- **Directive 1999/92/CE**: Minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres. It´s an amendment to the **Directive 89/391/CEE**, which defines the introduction of measurements to encourage improvements in the safety and health of workers at work. Both 99/92/CE and 94/9/CE Directives compose the **Directive ATEX**. Directive 1992/92/CE has been repealed by the **R.D. 681/2003**.

- **Directive 2010/35/UE**: Transportable pressure equipments. It takes under consideration the **Directive 2008/68/CE**, and repeals Directives 76/767/CEE, 84/525/CEE, 84/526/CEE, 84/527/CEE y 1999/36/CE. Transposed in Spain by **R.D. 1388/2011.**

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- **Directive 89/391/CEE**: Introduction of measurements to encourage improvements in the safety and health of workers at work. It's amending by the **Directive 2007/30/CE**, and transposed in Spain by the **Law 31/1995** (Ley de Prevención de Riesgos Laborales, PRL), modified by the **Law 54/2003.**

- **Directive 89/654/CEE**: Minimum safety and health requirements for the work place (first individual directive within the meaning of Article 16 (1) of Directive 89/391/CE). Transposed in Spain by the **R.D. 486/1997**. This R.D. is affected by the **R.D 2177/2004**, which modifies the **R.D. 1215/1997**, and establishes minimum safety and health requirements for the use of equipments by the workers, in temporary works at height.

- **Directive 89/655/CEE**: Minimum safety and health requirements for the use of work equipment by workers at work (second individual directive within the meaning of Article 16 (1) of Directive 89/391/CE). Transposed in Spain by the **R.D. 1215/1997**. It affects to the **Orden of 9 March 1971**, which approves the general occupational health and safety legislation. It's also affected by the R.D. 2177/2004.

- **Directive 91/271**: Urban waste-water treatment. It has been transposed in Spain through the **R.D.-l. 11/1995**, which applies standards on waste-water treatment. It's in turn developed by the **R.D. 509/1996.**

- **Directive 96/82/CE**. Control of major-accident hazards involving dangerous substances. It repeals the Directive 82/501/CEE. In Spain, it has been transposed by **Orden PRE/2476/2015; R.D. 989/2015; Orden PRE/1206/2014 and R.D. 840/2015.**

- **Directive 98/37/CE**: Approximation of the laws of the Member States relating to machinery. It was repealed by the **Directive 2006/42/CE**, being the last one transposed by the **R.D. 1644/2008**.

- **Directive 2004/108/CE**: Approximation of the laws of the Member States relating to electromagnetic compatibility. It repeals the **Directive 89/336/CEE**, and it has been transposed in Spain by the **R.D. 1580/2006**.

- **Directive 2006/95**: Harmonisation of the laws of the Member States relating to electrical equipment designed for use within certain voltage limits. It applies to equipments which operate between 50 and 1000 V alternating current or between 75 and 500 V of direct current. It repeals the **Directive 73/23/CEE**, and it's repealed in turn by the **Directive 2014/35/UE**, which appears in the **Regulation 765/2008/CE**.

- **Directive 2014/94/CE**: Deployment of alternative fuel infrastructure. The **R.D. 639/2016** transposes partially this Directive.

NATIONAL REGULATION

- **R.D. 379/2001**: Storage of chemical products and their complementary technical instructions. Within those instructions appears the complementary technical instruction ITC MIE APQ 5 "Storage and use of pressure gas bottles". It's modified by the **R.D. 105/2010.**

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- **R.D. 919/2006**: Technical regulation of the distribution and use of fuel gases. It's framed within the **Ley 34/1998**, and by the **Ley 21/1992.**
- **Orden ITC/3126/2005**. Rules for the Technical Management of the Gas System. They will be applied in every Gas System, as indicated in the **Ley 34/1998** (Article 59).
- **R.D. 2267/2004**: Fire safety regulations in Industrial Establishments. It's complemented with the **R.D. 1942/1993**.
- **R.D. 842/2002**: Low Voltage Electrical Regulation. This regulation fits in the fields laid down by the **Ley 21/1992**.
- **R.D. 614/2001**: Minimum safety and health requirements for workers against electric risk. It's based on the **Ley 31/1995.**
- **R.D. 393/2007**: Basic self-protection Regulation of establishments dedicated to activities which could rise to emergency situations.
- **R.D. 39/1997**: Regulation of Prevention Services. It completes the **Ley 31/1995.**

STANDARDS AND CODES

ISO STANDARDS

- **ISO/TR 15916:2015.** Basic considerations for the safety of hydrogen systems.
- **ISO 22734 – 1:2008.** Hydrogen generators using water electrolysis process. Part 1: Industrial and commercial applications.
- **ISO 14687:2006**: Hydrogen fuel. Product specifications.
- **ISO 16110:2007**: Hydrogen generators using fuel processing technologies.
- **ISO 26142:2010**: Hydrogen detection apparatus. Stationary applications.
- **ISO 11114**: Gas cylinders. Compatibility of cylinder and valve materials with gas contents.

CEN STANDARDS

- **EN 4126-1,2,3,4,5,6,7**: Safety devices for protection against excessive pressure.
- **EN 13160:2016**: Leak detection systems.

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- **EN 1127-1:2011**: Explosive atmospheres. Explosion prevention and protection.
- **EN 1839:2012**: Determination of the explosion limits and the limiting oxygen concentration (LOC) for flammable gases and vapours.
- **EN 13237:2012**: Potentially explosive atmospheres.
- **EN 15967:2011**: Determination of maximum explosion pressure and the maximum rate of pressure rise of gases and vapours.

EUROPEAN INDUSTRIAL GASES ASSOCIATION (EIGA) CODES

- **Code 23/08**: Safety training of employees.
- **IGC 134/12**: Potentially Explosive Atmospheres (EU Directive 1999/92/CE).

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