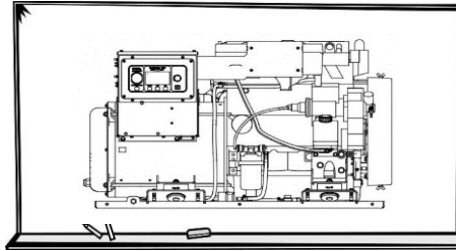




## Training needs regarding Gensets for isolated areas



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Co-funded by the  
Erasmus+ Programme  
of the European Union



## Summary Data of the project

- Mastering Energy Supply focusing on Isolated Areas (MESfIA)
- Within Erasmus+
- Europe-Asia co-operation
- Cooperation for Innovation and the exchange of good practices –KA2-  
**Capacity Building in the field of Higher Education**
- **Budget: 951,297€**
- **Duration 3 years**
- 5 Phases: Preparation, Development, Quality Plan, Dissemination, Management structured in 7 Work Packages...

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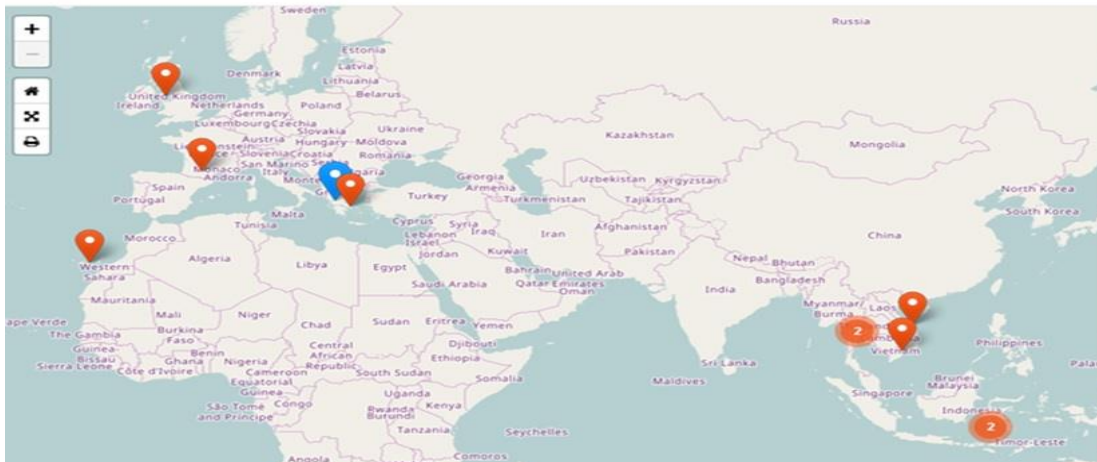
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## Partners of the project

PROJECT COORDINATOR AND PARTNERS MAP



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## Partners of the project

Partner	Name		Country
1	Hellenic Mediterranean University	HMU	Greece
2	Paul Sabatier - Universite Toulouse III	UPS	France
3	Eurotraining Educational Organisation	EUROT	Greece
4	Canary Wharf	CWC	UK
5	Canary Islands Institute of Technology	ITC	Spain
6	Asian Institute of Technology	AIT	Thailand
7	Naresuan University, Engineering department	NU	Thailand
8	NONG LAM UNIVERSITY HOCHIMINH CITY	NLU	Vietnam
9	University of Technology and Education-UNIVERSITY OF DANANG	UD	Vietnam
10	Institute of Technology of Bandung	ITB	Indonesia
11	Universitas Gadjah-Mada	UGM	Indonesia

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## Objectives and Target Groups

Provide high quality **postgraduate** education on energy supply systems for engineers and graduates from science departments, aiming to have activity or to be employed in projects in countries with many **isolated** areas and **insular** systems

### Target groups

- Engineers/scientists at Post-Graduate level residing in countries with island or low electrification rate.
- Higher Education Institutions willing to undertake similar actions



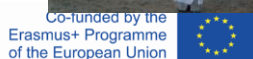
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## Typology of Power systems addressed

- Physical islands
  - Large Island Power Networks
  - Medium Power Systems
  - Small Power Systems
  - Very Small Island Power Systems
- Isolated Areas (not only Physical Islands)
- Resilient Power Systems-Temporarily Isolated areas



ICUE 2020-Section B

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## Potential Uses of Gensets in such systems

1. **Only to charge batteries** when RES generation has been low for rather long time.
2. **To provide power to additional occasional loads in an otherwise Solar Home System (SHS).**
3. To provide **support to a RES based Hybrid Power Stations**, meeting part of the demand at real time.
4. **As the major generating unit**, assisted by the rest type of units on the island to decrease fuel consumption. Such operation is typical in many island power systems. Only in Greece the installed Gen-sets capability is 1000MW
5. As a means to help **in providing Guaranteed Power** of a RES & Storage Hybrid power station in energy markets.
6. **As a back-up unit**, just as in the bulk power systems, however with increased operation hours and start-ups due to inherently lower reliability of the upstream isolated grid.

**In cases 1 and 2 the gen-set may be transportable or even rented**



## Items of Training

- Prime Moving Machines (Mechanical Engineering)
- Generator And Electrical Parts.
- Auxiliary Circuits
- Communication And Automation Systems
- Various Economic And Regulatory Issues
- Co-operation With RES
- Weather And Conditions Precautions (for refuelling and understanding efficiency issues)





## PRIME MOVING MACHINE

Potential training issues:

- What is the expected mechanical power to provide the outputs we wish?
- Dimension of the installation room and heat dissipation
- Precautions related to the dust, fume exhaust
- Potential ways of using heat power otherwise lost to the atmosphere
- Torque-velocity output especially at specific rotation speed known as the synchronous speed.
- Maintenance:
  - Safety precautions
  - Typical maintenance schedule
  - spare parts to be readily available for the maintenance of this prime mover



## PRIME MOVING MACHINE -Fuel

- Genset autonomy (size of fuel tank, fuel consumption, fuel transport in the area where the genset has been installed)
- Typical Operational pre-cautions, especially in terms of technical minimum as the low operating point increase the sulphur deposits on the metals of the interior of the engine.
- Understanding the technical manual of the gen-sets and identifying the potential fuel consumption at various loading points
- Difficulties relevant to long duration storage of the fuel and the high share of bio-diesel in the fuel blend in terms of the engine maintenance





## GENERATOR AND ELECTRICAL PARTS

- Smooth operation of a generator depends on its earthing, the protection circuits as well as the interconnection equipment.
- *Very frequently typical education on synchronous generators, such as modeling of the electrical part, P-Q curves, the excitation role can clearly serve diesel generators as well, However,*
  - ✓ *Large diesel gen-sets may be of lower rotation speed leading to the selection of salient-pole rotor machines.*
  - ✓ *In much smaller power systems injecting power to very few houses, even single-phase synchronous or even asynchronous generators may be used.*
  - ✓ *In some cases even DC generators may be used.*
  - ✓ *Unlike bulk power systems, where DC generators use is limited, in small systems their use is expected to be much wider requiring more emphasis in the curricula*



## Generator and Electrical Parts

- More training focus on energy storage items may be required (excitation system may be supplied via batteries).
- It has been noted that a diesel back-up generator cannot even start up under a relatively low capacitive load factor. So, more emphasis should be given in reactive power operation of diesel gensets.



## Grounding

- Safety for personnel and operational Grounding
- Commonly Used Methods Of Grounding should be known to the students
- Generators may be commonly grounded through external impedance in order to limit the electrical and mechanical stresses during faults.
- The grounding of generator assists the protection of machine through the detection of ground faults.
- More detailed information is provided in international standards of IEEE, namely IEEE Std C62.92.2 , IEEE Std C37.101 and IEEE Std C37.102.
- In the IEEE Std 665, the grounding practices accepted by electric utility industry are described considering the personnel safety and the protection of the equipment.
  - Neutral ground for using as voltage reference of the electrical system,
  - Safety ground for protecting the personnel and
  - Equipment ground for protecting the equipment during current faults

## Grounding

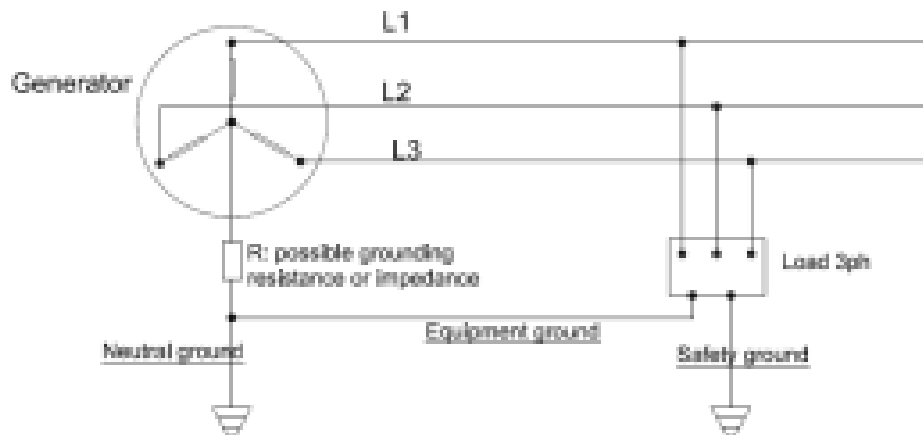


Fig. 1. Definition of neutral grounding, safety grounding and equipment grounding

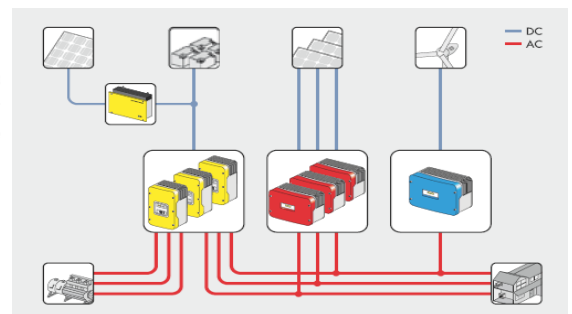
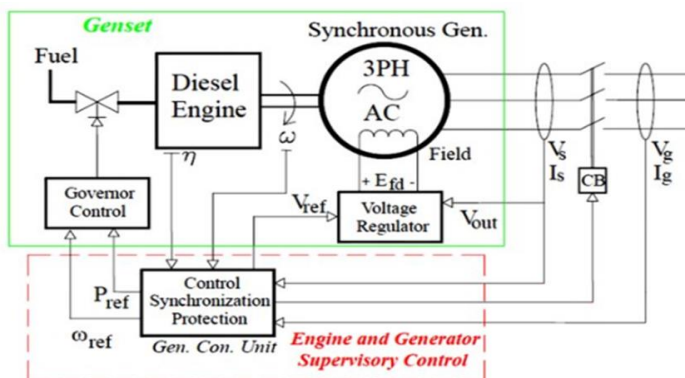
## INTERCONNECTION WITH THE GRID

The gen-sets may even create the grid and the frequency for the rest units of the small power system and the consumption devices. Therefore understanding items relevant to the grid-connection of the gen-sets are an integral part of building mini-grids.

- Students should be able to:
  - understand how to electrically isolate the gen-sets from the upstream network. This will help the maintenance of the rest of the network under safety.
  - identify and understand the equipment used for synchronization.
  - understand the use of any sensors or measuring quantities required by the utilities.

## Interconnection with the grid

Indicative Diagram of the subsystems in Interconnected operation



Generator Creating the Grid



# MESFIA Auxiliary circuits and Communications

- Understand the role of Droop and Voltage Regulation circuits for the stable operation of weak power system.
- Understand the typical responsibilities of a typical Governor of a gen-set
- Understanding DC Circuits (Chargers/batteries) role as they:
  - Start up the engine
  - Unlike large generators (where it is coupled) provide power to Excitation Circuit.
  - Are extremely important for the efficient operation of various Protection schemes
- Communication and metering
  - Tele-communication capabilities
  - Monitoring capabilities
  - Metering infrastructure
  - Switchboard signaling
  - Communication with Distribution network Operator



## CO-OPERATION WITH RES

- Presentation of some [successful examples](#) of isolated power systems with increased RES penetration preferably from areas with similar weather or other conditions.
- Presentation of the [characteristics of Controllers](#) that interconnect diesel gen-sets and RES components along with their capabilities and limitations
- Limitations on the [technical minimum of the units](#), as these are linked with the capability of the grid to absorb RES. Ways to reduce RES output
- Items like [start-up time and ramp-up and ramp down](#) times of the generators. the students should be able to understand these time-limitations so that the scheduling of diesel gen-sets takes place timely
- When designing a Diesel-RES system, the [number of the diesel gen-sets](#) that should be installed is a matter of optimization. Small number of units may have adverse effect on the co-operation with RES and at the same time increase the complexity
- Use of [software that can combine RES and diesel systems](#) can be of significant interest to be taught so that the students can build their own examples.





## As A Synopsis...

- There is market for Diesel Gen-sets to operate as Prime and not as Back-up units, as in most of the markets, in many cases being the primary source for meeting the demand of a small power system such as in islands
- They are a form of Distributed generation even though not environmentally friendly one
- Their efficient operation is of significant importance to meet resiliency requirements in isolated areas
- Thus, for Training of Engineers at Post Graduate Level so that they can cope with the peculiarities and become ready for applying intelligent solutions to energy supply of isolated areas, as the ones sought for in MESfIA definitely some of the aforementioned items of training should be involved.



## Common Problems-Require common actions



CRETE



Kamojan, West Java





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Thank you!

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