PRINCIPLES OF ENERGY STORAGE

24th - 28th October 2016
Madrid (Spain)

COURSE

- **Overview of Energy Storage Technologies**
- **Environmental and Safety Aspects**
- **Storage in Hydrogen and Hydrides**
- **Electrochemical Storage (batteries)**
- **Thermal Storage**
- **Compressed Air Energy Storage (CAES)**
- **Hydro Pumped Storage**
- **Kinetic Energy Storage (Flywheels)**
- **Superconducting Magnet Energy Storage (SMES)**
- **Energy Storage with Supercapacitors**
- **Grid integration of Energy Storage Technologies**

Complete Course Duration: 30 hours
(25% of the course will take place in CIEMAT Laboratories)

VENUE & SCHEDULE

CIEMAT. Av. Complutense 40, Madrid (Spain)
Mon-Tue: From 9:00h to 18:00h; Fri: From 9:00h to 15:00h
(The course will be in English language)

INSCRIPTION & ADDITIONAL INFORMATION

Training in Energy and Environment: Mª Carmen Muñoz Ray: Er.ma.bt@ciemat.es (www.ciemat.es)
Phone: +913466748/6295 ;Fax: 913466297

PRICES

General Topics + MODULE 1 + MODULE 2 (30h):	**1000 €**
General Topics + MODULE 1 (16h):	**500 €**
General Topics + MODULE 2 (16h):	**500 €**

Monday 24th	Tuesday 25th	Wednesday 26th	Thursday 27th	Friday 28th
GEN. TOPICS (I)	MODULE 1	GEN.TOPICS (I) / GEN. TOPICS(II)	MODULE 2	GEN. TOPICS (II)
MODULE 1	MODULE 1	MODULE 2	MODULE 2	

Reduction of 50% will be provided for residents in Latinamerica and unemployed people (prove required)

DIRECTION & COORDINATION

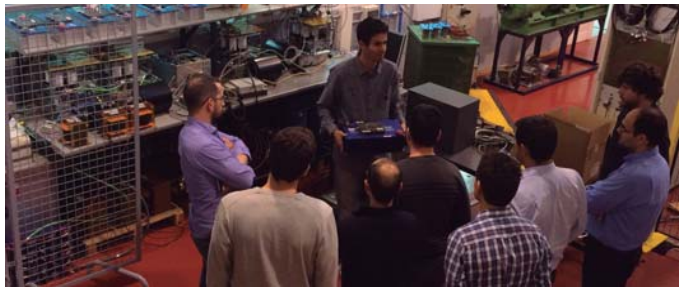
Direction: Dr. Marcos Lafoz . Division of Electric Engineering
Coordination: Mirian Bravo Taranilla. CIEMAT Training Unit

DOCUMENTATION & CERTIFICATION

Technical documentation will be provided to the attendants as well as a Certificate of Assistance

COURSE AIMED AT

Professionals in the energy sector who want to learn about energy storage technologies, their applications and their present status.
The course may also be of interest for people working in institutions related to teaching or researching in this area.



METHODOLOGY

The course will review the fundamentals, technologies and applications of the different systems and also an introduction to power converters and grid connection alternatives for different storage solutions.
It will also be complemented with an introduction to environmental and safety issues. Main factors, which affect their development and implementation such as regulatory, market and environmental aspects, will also be considered.
Theoretical aspects will be complemented with laboratory demonstrations and simulations for different storage systems.
The course is structured in a modular form. Participants can choose three options for attending the course (see Prices).

Teachers

L. García-Tabarés (CIEMAT)
L. Arribas (CIEMAT)
Y. de Benito (CIEMAT)
F. J. Saiz (CNH2)
F. Leardini (UAM)
A. Quejido (CIEMAT)
T. González (CIEMAT)
N. Vela (CIEMAT)
E. García (IMDEA Energía)
J.M. Amarilla (CSIC)
J. Cuenca (CIEMAT)
E. Mejuto (CIEMAT)
E. Rojas (CIEMAT)
J.I. Pérez (UPM)
M. Lafoz (CIEMAT)
P. Moreno-Torres (CIEMAT)
G. Navarro (CIEMAT)
M. Blanco (CIEMAT)

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Energy Storage is becoming a powerful tool for energy management, since it allows decoupling generation from consumption, performing both under the best conditions of efficiency and cost.

On the other hand, it is applicable to different power scales, ranging from small domestic systems to big distribution grids.

Energy storage is based on different technologies, some competitors, some complementary, which are at different stage of development, aiming at becoming massive solutions that modify the energy production/consumption scenario.

In this situation, the goal of this course is to provide a review of the different existing technologies, their present situation and their particular applications, either from a theoretical and a practical approach with demonstrations at the laboratory for a better understanding of their fundamentals, operation and applications.

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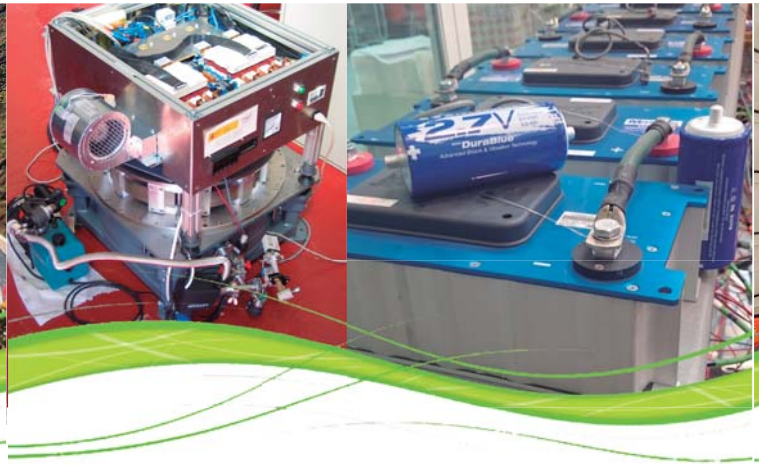

The course will review the following technologies:

Chemical storage in Hydrogen: Gas, liquid and solid states as well as components with a high content of hydrogen (ammonia, methane, methanol or methanoic acid) will be considered as suitable system for hydrogen storage in moving or stationary sources.

Chemical accumulators (batteries): They storage energy in chemical form and presently they are the most widely used systems in most industrial, transportation or renewable energy generation sectors.

Thermal storage: Its high capacity allows considering some renewable energies and particularly concentration solar energy, as manageable within the present energy production scheme.

Compressed Air and Hydro Pumping: They represent massive storage systems that have been used for many years, although there is still space for new developments aimed at increasing their present efficiency.

Fast Energy Storage Systems: With applications where a fast response is critical by themselves or in combination with other technologies. They include storage in Superconducting Magnets, Flywheels and Supercapacitors.

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