Introduction

Supercapacitors (also known as ultracapacitors, electrochemical capacitors or double-layer capacitors) feature exceptional capacitance values (even hundreds or thousands of farads), several orders of magnitude higher than traditional devices.

Energy storage

Until recently, batteries were the only affordable energy storage system in conventional applications. Nowadays, supercapacitors are a sound alternative with high power density, fast recharge and long lifetime (up to 1 million of charge/discharge cycles). On the other hand, since the energy density available in supercapacitors is lower than in batteries, the most common application is in hybrid (batteries/supercapacitors) energy storage systems, for example to sustain the load peaks, to reduce the system weight or to extend its lifetime.

Present scenarios

The supercapacitor technological development and cost reduction (together with the advancements in the supporting electronics) opened new scenarios in electrical and electronic systems, offering extraordinary opportunities for applied research and industry. In fact, the number of manufacturers is constantly growing as the estimated business turnover.

Test and modelling

Supercapacitor modeling and simulation are still open issues. A supercapacitor (module) cannot be functionally reduced to a simple capacitance, even including series and parallel leakage resistances. For example, the equivalent capacitance may strongly decrease with frequency. Also the experimental methods to identify the modeling parameters are under investigation.

Potential applications in nuclear fusion

Supercapacitors were introduced or proposed in several fields, as smart grids or electrical vehicles. However, their benefits are particularly relevant in applications with limited duty cycle, as large experimental plants. The ENEA Research Center in Frascati is the main Italian institution working in the field of nuclear fusion. A nuclear fusion facility (tokamak) can be regarded as a giant electrical machine. Up to the 40% of the costs for the realization of international projects like ITER [http://www.iter.org], JT-60SA [http://www.jt60sa.org] or the new proposal DTT to be built in Frascati [http://utfus-dite.frascati.enea.it/DTT] are related to the electrical and electronic systems (power supplies, converters, electrical delivery, motors, radiofrequency sources, control and automation, diagnostics). The total power of a tokamak as DTT may reach hundreds of megawatts with a variable profile. Such values can be managed only in two ways (often in conjunction): by connecting the plant to a high-voltage grid or by exploiting some form of energy storage (rotating machines and flywheels or, in special cases, superconducting magnets). In absence of an adequate energy storage, the plants can be realized only in locations with extraordinary power capabilities (even the maximum of the entire country), after preventive authorization and under special power delivery contracts. The convenience of supercapacitors is evident considering that in those cases the peak power is relatively short with a sufficient recovery time.

Future prospects

Supercapacitor technologies are relatively new on the market. The achievable performances are expected to be higher and higher at lower and lower costs. A significant contribution is expected by nanotechnology. The process improvement would reduce the component unbalance and the need of compensation devices. At the same time, currents and commutation frequencies would be increased by power electronics developments.

ENEA
Italian National Agency for New Technologies, Energy and Sustainable Economic Development

Ordine degli Ingegneri della Provincia di Roma

OCEM POWER ELECTRONICS

SUPERCAPACITORS AND ENERGY STORAGE

From research through industrial applications up to nuclear fusion plants

Friday 13 May 2016

Aula Brunelli
Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA)
Via Enrico Fermi, 45, Frascati (RM)

Free access – Mandatory registration

Websites for information and registration

http://fusvm4.frascati.enea.it/fusione/index.php/en/

For Italian engineers interested in the CFP credits:

http://www.ording.roma.it/formazione/index.aspx

Per gli ingegneri iscritti all'Ordine (only for Italian engineers)

L'Ordine degli Ingegneri della Provincia di Roma, in collaborazione con il Centro Ricerche ENEA di Frascati, propone ai propri iscritti questo seminario tecnico gratuito sul tema **SUPERCONDENSATORI E ACCUMULO ENERGETICO**.

I supercondensatori presentano valori di capacità eccezionali (anche centinaia o migliaia di farad), diversi ordini di grandezza superiori ai dispositivi tradizionali e offrono una valida alternativa alle batterie con alta densità di potenza, ricarica veloce e vita utile lunghissima (fino a 1 milione di cicli di carica/scarica).

Per consentire la presenza ed il confronto di numerosi esperti internazionali, il workshop sarà tenuto in lingua inglese.

La partecipazione al seminario rilascia n. **6 CFP**, ai fini dell'aggiornamento delle competenze professionali ex DPR 137/2012 e successivo regolamento approvato dal Ministero della Giustizia. I CFP saranno riconosciuti unicamente con la partecipazione all'intera durata dell'evento. L'attestato di partecipazione al seminario, previo controllo delle firme di ingresso e di uscita, potrà essere scaricato dall'area iscritti nei giorni successivi all'evento e dovrà essere custodito dal discente ai sensi dell'art. 10 del Regolamento per l'Aggiornamento delle Competenze Professionali.

Per i dipendenti ENEA iscritti ad un Ordine degli Ingegneri vengono riservati 40 posti previa registrazione sul sito ENEA riportato in alto (sezione Forthcoming Meetings).

Program 13 May 2016

8:30 Registration desk open

9:00 Welcome and introduction
Aldo Pizzuto, ENEA
Carla Cappiello, Ernesto Vocaturo, Ordine degli Ingegneri

9:30 Workshop overview
Alessandro Lampasi, ENEA, Italy

10:00 Technologies and devices available on the market and future trends
Jan Ernst, Maxwell Technologies, Germany

10:45 – 11:00 Break

11:00 Technologies and devices available on the market and future trends
Rait Karri, Skeleton Technologies, Estonia

11:45 Supercapacitors: modelling, testing and quality control
Valeriy Martynyuk, Khmelnitskiy University, Ukraine

12:10 Present and potential applications of supercapacitors
Mario Conte, ENEA, Italy

12:25 RSE experience with supercapacitors for the electrical sector
Luigi Pellegrino, Riccardo Lazzari
Ricerca sul Sistema Energetico (RSE), Italy

12:50 Supercapacitors in compact tokamaks: the new PROTO-SPHERA experiment
Paolo Micozzi, ENEA, Italy

13:00 – 14:00 Lunch break (ENEA canteen available)

Afternoon

14:00 Energy storage in power systems
Maria Carmen Falvo, University of Rome Sapienza, Italy

14:20 The role of high-step up dc-dc converters in integrating energy storage in nanogrids
Paolo Mattavelli, University of Padua, Italy

14:40 A new system for compensation of peak energy consumption
Alexander Shpak, Khmelnitskoblenergo, Ukraine

15:00 Tools for supercapacitor and energy storage simulation in PSIM
Jules Fono, Powersys, France

15:20 Supercapacitors in electrical vehicles
Fabio Giulii Capponi, University of Rome Sapienza, Italy

15:40 – 16:00 Break

16:00 Modular high-current systems based on supercapacitors
Sandro Tenconi, OCEM Power Electronics, Italy

16:20 Effective harvesting of solar energy on flexible supercapacitor basis
Roman Petrus, Lviv Polytechnic University, Ukraine

16:40 Potential evolutions in a large experimental plant
Giuseppe Maffia, ENEA, Italy

17:00 – 17:30 Open discussion