

## Fiche Séminaire de l'ED EEA

Merci de transmettre cette fiche complétée au format Word  
au secrétariat de l'ED EEA : [secretariat.edeea@insa-lyon.fr](mailto:secretariat.edeea@insa-lyon.fr)  
**2 semaines avant la tenue du séminaire**

Rappel :

- Ne sont validés que les séminaires effectués par des personnalités reconnues dans leur domaine et extérieures aux laboratoires associés à l'ED EEA.
- Un séminaire sera validé pour **1 heure** (45 minutes de présentation et 15 minutes de questions)

**Laboratoire organisateur associé à l'ED EEA :**

AMPERE     CITI     CREATIS     INL     LAGEPP     LGEF     LVA

**Intitulé du Séminaire : Can supercapacitor assisted converter and protection techniques change the road map of future DC systems?**

**Date : 21/04/26**  
**de Vinci, 3<sup>ème</sup> étage**

**Heure : 13h**

**Lieu : INSA, Bât L.**

**Nom(s), Prénom(s), Titre(s) de ou des intervenant(s) :**  
KULARATNA, Nihal, Professeur Université de Waikato, NZ

**Nom prénom du permanent du laboratoire en charge de l'émargement :**  
Bruno Allard <bruno.allard@insa-lyon.fr>

**Résumé :**

With the world moving towards renewable energy resources AC versus DC debate comes back. Rapidly developing power electronic systems help us exchange power across DC and AC interfaces. State of the art power converters used to link DC output based renewable systems to grid come with several issues: (i) complexity of the product (ii) limited conversion efficiency (iii) requirement of central energy storage systems (ESS). When these converters keep feeding excess energy back to the grid it brings the potential issue of grid-stability.

Given that solar/wind outputs are DC, industry has chosen to combine SPWM based inverters with MPPT based DC-DC converters and battery banks. Today, lighting, whiteware and infotainment industries develop consumer products where line frequency disappears in the rectifier blocks, where AC line frequency or voltage regulation is not a concern. This case justifies moving into a DC world dominated by DC (micro) grids and DC powered consumer products. In DC systems, rectifier losses are primarily eliminated. Most 'inverter driven" white goods and lighting systems do not require a precise DC rail. By combining these two advantages, together with battery-free distributed energy storage, electrical industry can justify the advantage of DC systems, with (a) increased efficiency (b) less components for reliability (c) less battery storage for environmental friendliness.

After 2000, supercapacitor (SC) industry has grown with over 1200 manufacturers and over 60k employees and a growth rate of 2.83%. Today single cell SCs come in four families with device sizes from fractional farads to over 100,000 F. Given that their equivalent series resistances are one order lower than lithium based rechargeable batteries SCs allow very high charge/discharge currents without overheating.

These high temperature capable SCs combined with ohms order loop resistances they create large time constant circuits. For example, 1 F SC combined with a 1-ohm loop resistance creates a circuit with a time constant ( $\tau$ ) of 1 second. This 3V rated SC comes with a storage capacity of 4.5 joules, compared with a 1  $\mu$ F, 100V capacitor with a storage capacity of only 5 mJ forming a  $\tau$  of 1 $\mu$ s. A common 3 V rated SC of 3000F comes with an energy storage capability of 13.5 kJ or 3.75 Wh. A larger SC of 100,000 F could store over 65 Wh. This practical scenario leads to consider these devices to be used in power converters with built in short/medium term energy storage and transient over voltage and over-current protection systems. These new Supercapacitor Assisted (SCA) converters and protection systems combined with DC powered consumer systems help us eliminate the three main issues (i) to (iii).

Presentation is on the new Supercapacitor Assisted (SCA) design approach for more efficient, less complex and central energy storage free future converter systems and protection techniques for the DC world. SCA techniques presented will include EMC free low speed DC-DC converters, DC LED lighting, DC whiteware, surge protectors and DC circuit breakers, with a brief introduction to an experimental household hybrid inverter system based on distributed SC energy storage.

Nom et Signature du Responsable des séminaires du Laboratoire  
Xavier BOMBOIS <xavier.bombois@ec-lyon.fr>