RS2E is a leading French research network on batteries and supercapacitors. Co-ordinated by Prof. Jean-Marie Tarascon and Prof. Patrice Simon, 13 industrial partners, 17 French research labs and 3 applied research centers are working together to achieve better research and technology transfer. RS2E is a public initiative of the Ministry of National Education, Higher Education and Research and of the National Center for Scientific Research (CNRS).

The french network on electrochemical energy storage

STORING ENERGY
UNLOCKING IDEAS

www.energie-rs2e.com
DIRECTORS’ MESSAGE

With the foreseen massive use of renewable energies and the aggressive penetration of electromotive transportation, our extensive reliance on battery technology will only become greater with time, leading to a market of staggering proportions.

Energy storage is becoming a strategically important research field for France with numerous economic and social impacts; we rapidly reacted to this new scenario by creating the Network on electrochemical energy storage (or RS2E from Réseau sur le Stockage Electrochimique de l’Énergie), launched conjointly by the French Ministry of Higher Education and Research and the National Centre for Scientific Research (CNRS).

The main objective of RS2E, is to ensure a sound scientific/technology continuum path to rapidly and efficiently bring new ideas/concepts to fruition. Since its inception, RS2E’s partners have contributed to over 200 scientific publications, filed 12 patents, launched numerous task forces on upcoming technologies (Redox-flow and Na-ion), and advanced the development of in-situ characterization techniques while sustaining diversified training programs that will ensure enduring leadership in the field.

Overseeing a group of such enthusiastic and fully devoted scientists is a wonderful and blessed experience.

Jean-Marie Tarascon and Patrice Simon

WHY DO WE NEED BETTER BATTERIES?

2011
FRANCE
• inaugural meeting of RS2E
• 13.1% of produced energy come from renewable resources

2013
WORLD
• only 3 to 4% of produced electricity is stored
• complete automotive Li-ion battery packs for 500-600$/kWh

2017
FRANCE
• Li-ion battery market double at 24 billion $

2020
WORLD
• complete automotive Li-ion battery packs for 160$/kWh

2025
GERMANY
• shutdown of all nuclear power plants

2050
WORLD
• oil barrel reaches 200$ (vs. 82$ in 2010)
• a target of 100 million EV/PHEV sold annually may allow a reduction of 50% of energy-related CO₂ emissions compared to 2005 levels

2100
WORLD
• possible rise of temperatures by 0.3°C to 4.8°C (min/max estimates)

sources: IPCC, Kinsey Global Institute, Cour des Comptes, European Commission, EREC, IEA
PROJECT OVERVIEW AND GOALS

A UNIQUE UNDERTAKING

RS2E is a collaborative effort between national laboratories, government-funded applied research organizations and privately held companies. Our researches are aimed at improving current generations of rechargeable batteries and supercapacitors.

Industrial applications are not overlooked: medium-term transfer of scientific discoveries is the goal. Our results will find applications in multiple commercial products (electric vehicles, electricity storage from renewable sources and portable electronics).

RS2E is an innovative partnership between industrials and public research.

OUR GOALS

→ CREATE A CONTINUUM BETWEEN SCIENTIFIC DISCOVERIES AND COMMERCIAL PRODUCTS
→ BE AN ACTIVE PART OF A LUCRATIVE AND GROWING MARKET
→ PROMOTE AND FUND BREAKTHROUGH RESEARCHES
→ SHARING IDEAS AMONGST A WIDE ARRAY OF PARTNERS FROM DIFFERENT BACKGROUNDS

THREE WORLDS COMING TOGETHER: BUILDING CONTINUITY

BASIC RESEARCH

17 NATIONAL LABORATORIES

APPLIED RESEARCH

3 GOVERNMENT-FUNDED APPLIED RESEARCH CENTERS (CEA, IFPEN, INERIS)

MANUFACTURING

13 INDUSTRIAL PARTNERS

HOW DO WE REACH OUR GOALS?

WIDE SKILL SETS

Thanks to our wide array of partners we cover the whole electrochemical storage field: from electrolytes and electrode materials to industrialization processes.

FLEXIBLE IP MANAGEMENT

We use an original IP management process that allows flexibility and preferential access to our patent portfolio by RS2E’s Industrial Partners (see page 7).

CONTINUOUS INVESTMENT

From postdocs to analysis instruments, RS2E and its institutional partners are investing to make sure we have both human resources and technical means to reach our goals.

ANNUAL REVIEWING

RS2E’s results are reviewed and discussed annually by French Government’s top executives. We also get feedback twice a year from our Industrial Partners through written comments.
Eco-compatible Storage

Towards Greener Batteries

Rechargeable batteries are also used to store energy from sustainable sources. But couldn’t batteries themselves be sustainable? The general, simple answer is yes. Our own answer aims at promoting biomineralization syntheses routes, redox-active organic structures for low-impact solutions, biomimicry, battery recycling and life-cycle assessment.

GROUP COORDINATOR
Dr. Alexandre CHAGNES,
IRCP, Paris

Smart Materials

Tailoring New Battery Architectures

The smart materials team is developing advanced 3D architectures for micro-power sources using microelectronic facilities. They also design bifunctional electrode materials combining ion storage characteristics with optical light harvesting functionality to offer a versatile photonic rechargeable battery solution.

GROUP COORDINATOR
Dr. Frédéric SAUVAGE,
LRCS, Amiens

Industrial Partners

and government-funded organizations also contribute to the 5 research areas and will, ultimately, develop prototypes. They are the ones breathing life into RS2E’s scientific discoveries.
Supercapacitors, which can be charged or discharged in a matter of seconds, nicely complement batteries. They are used in applications ranging from power delivery (power electronics, start-stop systems) to energy recovery (in tramways, cars, and harbor cranes). Our research projects are focused on extending their autonomy by designing new materials and devices.

GROUP COORDINATORS
Pr. Patrice SIMON, CIRIMAT, Toulouse
Pr. Thierry BROUSSE, IMN, Nantes

**NEW CHEMISTRIES**

**BATTERIES FOR TOMORROW**

Li-ion is a well-known, mass-produced technology but what’s next? This question is at the origin of much turmoil in the scientific community. At RS2E, we decided that the replacements worth investigating are Na-ion batteries with additional research efforts focusing on Li-air, Li-S, redox-flow, and solid-state batteries but deviating from the “me too” approach.

GROUP COORDINATOR
Pr. Jean-Marie TARASCON, Collège de France, Paris

**ADVANCED LI-ION**

**THE CURRENT TECHNOLOGY**

Although an old technology, improvements are still possible. We are investigating materials with better storage properties, cycle life, and safety through the use of better electrode materials, in-depth study of the processes involved upon cycling, and the interfaces between the active material and improvement strategies.

GROUP COORDINATORS
Dr. Laurence CROGUENNEC, ICMCB, Bordeaux
Dr. Laure MONCONDUIT, ICGM, Montpellier

**PRE-TRANSFER PLATFORMS**

are prototyping machines available to our partners and research groups. They can produce small, industrial-grade devices for testing purposes.
Three government-funded organizations joined RS2E in 2011. CEA, INERIS and IFPEN are world-class specialists in applied research and technology transfer.

Their core contribution to RS2E covers prototyping new battery systems (CEA), integrating battery systems in vehicles (IFPEN) and safety assessment of new battery solutions (INERIS). Public organizations’ research labs are also providers of scientific discoveries and innovations.

They take part to collaborative task-forces (e.g. on Na-ion batteries) with national labs to help designing novel battery prototypes as well as supervising students and leading large technological research projects. They are also involved in RS2E’s management and decision making process.

Industrial Partners are critical members of RS2E thanks to their vision of the battery market as a whole and their manufacturing expertise. Our medium-term goal is to give them access to functioning prototypes and scientific breakthroughs developed by partner national laboratories and public organizations. They currently benefit from our growing patent portfolio and white papers and are closely involved in RS2E’s management.

From small-sized companies to top-tier multinational companies, our 13 Industrial Partners are covering all the value chain: materials manufacturers (Aurock, Solvay, Solvionic, Total), battery manufacturers (easyLi, E4V, Freemens, Saft) and battery end-users (Alstom, EADS Astrium, EDF, Renault, Zodiac Aerospace).

Their presence is a constant reminder of what we strive to achieve: efficient technology and knowledge transfer!
WE HAVE A DREAM

GLOBAL WARMING, THE FINITE NATURE OF FOSSIL FUELS, AND POLLUTION HAVE CONSPIRED TO MAKE RENEWABLE ENERGY A EUROPEAN IMPERATIVE. WITHIN THIS CONTEXT, RS2E FACES A GREAT CHALLENGE IN SHAPING NEW WAYS TO STORE ENERGY AT A LARGE SCALE AND LOW COST IN A SUSTAINABLE MANNER.

Thus, our dream is to provoke paradigm shifts in the design of new materials, elaboration of electrodes, assembly of batteries/supercapacitors, and to achieve mastery over interfaces. Then, new technologies could, over the next 10 to 50 years, bring the world to a new horizon.

We hope that 50 years from now, i) cells will be assembled in a single step using 3D-printing technology, ii) better materials will be found using a reliable materials genome, iii) new systems will solely rely on abundant and low cost materials made by low temperature processes, iv) evolution of interfaces will be characterized operando by imaging techniques, v) cells will be repaired via the use of self-healing materials, vi) Li-free technologies will have emerged, and vii) new eco-efficient systems merging storage and conversion functions within the same device will be developed.

To promote these evolutions, researchers must keep their minds open to new possibilities, free of the indoctrination of their respective communities. It is the type of spirit that RS2E strives to cultivate.

PREPARING DISCOVERIES FOR INNOVATION:
OUR PATENT POLICY

RS2E’s goal is to design, develop, market and commercialize innovative technologies. Protection and commercial development of research results are strongly encouraged: a significant patent portfolio is a great way to serve our objectives and help our partners maintain their market lead.

To support this policy, we set up an innovative technology-transfer scheme for patents resulting of research collaborations among national labs (see fig. below). Thus, any patent application following new results is presented immediately to our industrial partners. This is a decisive advantage considering that a patent application is usually made available only 18 months after its priority date. Depending on their current business and development strategies, they can decide whether or not to use the patented technologies in collaboration with the inventors.
THE 17 RESEARCH LABORATORIES INVOLVED

IMN, Nantes
LRCS, Amiens
LG2A
IEMN, Lille
PHENIX
Collège de France
IRCP
LCMCP, Paris
IS2M, Mulhouse
CEMHTI, Orléans
ICMCB, Bordeaux
LEPMI, Grenoble
CIRIMAT, Toulouse
ICG, Montpellier
ICR
MADIREL, Marseille
IPREM, Pau

© RS2E / OCTOBER 2015
WWW.ENERGIE-RS2E.COM