AGENCE NATIONALE DE LA RECHERCHE

Presentation of the funded projects in 2011 for the « Stockage Innovant de l'Energie » Programme

AFAQ ISO 9001

« Stockage Innovant de l'Energie » programme

YEAR 2010

Project title	CAP: Pneumatically assisted truck
Abstract	The air hybrid engine absorbs the vehicle kinetic energy during braking, stores it in an air tank in the form of compressed air, and reuses it to propel a vehicle during cruising and acceleration. Capturing, storing and reusing this braking energy to give additional power can therefore improve fuel economy to a range of 4% - 18%. The idea is not new, many previous investigations propose to work on a VVA or HVA engine to make use of the flexibility of such systems in controlling the air flow. Another category of investigations brings adapted engine designs with compressed air dedicated valve added to the engine cylinder head. The technology might be more successfully used in hybridizations and auxiliary power devices, just as electric hybrids. The main differences between energy storage in batteries and in compressed air is that compressed air tanks are cheaper, environmentally-friendlier, easily disposable, have a much higher life cycle and do not drain in time, if a proper sealing is guaranteed. They can also benefit from the high temperature exhaust from the internal combustion engine in hybrids, and can generate high transient torques, as opposed to limitations of high-current demands in batteries. This is also important in regenerative braking, where a great amount of kinetic energy must be almost instantaneously absorbed. The disadvantages are the greater complexity and size of the engine and auxiliary systems (such as heating fluid, etc). This project aims at the conception and evaluation of the pneumatic hybrid functionality with minor modifications on the engine itself. The target application is a long haul truck (4O tonnes). For this kind of application the standard electric hybrid system is too expensive and the recoverd energy is too low, mainly because of the few stop and start phases.
Partners	1. Renault Trucks SAS 2. LMFA – Laboratoire de Mécanique des Fluides et Acoustique - ECOLE CENTRALE DE LYON 3. Laboratoire Ampère – CNRS - INSA de Lyon
Coordinator	Iyad Balloul – Renault Truck SAS.

	iyad.balloul@volvo.com
ANR funding	613 k€
Starting date and duration	January 2011 - 24 months
Reference	ANR-10-STKE-04
Cluster label	Lyon Urban Truck&Bus 2015

« Stockage Innovant de l'Energie » programme

YEAR 2010

Project title	CARBOLEAD 2010 : Carbon honeycomb current collectors for light-weight lead-acid batteries
Abstract	The aim of the project is the increase of the energy density of the lead-acid battery replacing the conventional lead alloy current collectors with conductive carbon honeycomb composite ones. In the beginning of the project the conductive carbon composite material will be developed, optimizing its cost in terms of time and energy consumption. Further the developed material will be electroplated with lead-tin alloy layer with proper thickness, optimal corrosion and mechanic resistance. After the optimization of the electroplating processes, all the obtained experience will be focused on the development of the prototype AGM valve-regulated lead-acid batteries (VRLAB) with honeycomb grids. The aimed energy density of 80Wh/kg and 150Wh/l will be achieved by both increase of the active material utilisation up to 70-80% due to the honeycomb grid structure and due to the low density of the carbon current collectors. One part of the prototypes will be tested under the electric vehicle and hybrid electric vehicle protocols, and another will be used for demonstration in commercially available electric scooter, replacing its original lead-acid batteries. A special study will be carried out on the structure of the interface between the carbon and the lead coating and its evolution during the battery ageing. The corrosion processes will be optimised. The management of the prototypes will be improved using integrated "low cost / long life) reference electrodes ($Ag/Ag_2SO_4/H_2SO_4$). The reference electrodes will be manufactured industrially using a new technology patented by CEA in 2007. They will work as electrochemical sensors inside the battery cells, allowing improving the duration and the security of the charge process keeping lower positive grid corrosion rates, and estimating State of Charge by innovative approaches. The preliminary economic analysis of the new technology showed that it is capable to deliver a battery at same or lower cost per kWh as the actual AGM-VRLAB or tubular batteries.
Partners	1. CEA – LITEN 2. Institut Jean Lamour – CNRS

	3. STECO Power 4. Material Mates
Coordinator	Angel Kirchev – CEA - LITEN angel.kirchev@cea.fr
ANR funding	397 k€
Starting date and duration	January 2011 - 36 months
Reference	ANR-10-STKE-02
Cluster label	TENERRDIS

« Stockage Innovant de l'Energie » programme

YEAR 2010

Project title	CONIFER : Innovative concept and tools for smart grid applied to railway transportation
Abstract	It is expected to have a growth of the rail traffic in the coming years which would face a growing energy consumption connected to: the big socio-economical development expected indicates the increasing fourfold of the travellers' demand on the horizon of 2030. Also, as far as the goods transportation is concerned, the main lines established by the "Grenelle de l'environnement" law, foresee a development of all rail freeway with less than 500 000 truck per year carried by rail. This context forces all rail freeway and energy actors to search for technical solutions in order to give an answer to this future transport demand in mastering energy consumption and billing. For this reason, a scientific and technological breakthrough within electrical rail system is essential. It becomes possible through the incorporation of innovative devices for storing energy, new means of renewable and relocated production, and an energetic optimization of the network architecture. Thus, research, just like CONIFER project, must be made all enquiries in the development of smart grid theme. Such a transformation of the rail network needs the preliminary developing of designing and analysis tools in order to permit modeling future smart grid. Also, the industrial research project CONIFER (Innovative concept and tools for smart grid applied to railway transportation), proposes to anticipate the production evolution and the distribution of electrical energy in the rail field working on tools at two stages. The first stage of study is about the proposal of dimensioning space for the setting up of permanent electric rail traction – IFTE (fixing of locations, electric bases and catenaries by the road). The future hybrid IFTE will fit delocalized productive sources and the storing system into the complementary characteristics which will allow the highly valued of the breakthrough within rail energy recovery. CONIFER will also suggest to use a tool of optimal results for the future hybrid IFTE taking into account not only all constraints linked to the sub-station and its employment but also constraints linked to reliability and good complementary of all elements considered. In a word, the future hybrid IFTE combined with an intelligent management of energy, will allow having a

new element at disposal for the creation of future electric rail networks more efficient in terms of energy. The second stage of study, the CONIFER project concerns the dimensioning of future intelligent electric rail network in an overall approach. In order to simplify, the given network will be a reduced one able to form up a railway. In order to suggest an overall optimal solution, the approach will lean on a systemic vision of the network taken into account. This future alimentation electric railway network system needs the conversion elements between the electric transportation network and the railway alimentation network, the hybrid IFTE previously dimensioned, the catenaries and trains running on the railway. The smart characteristic of the network will be translated into a new architecture and a new management strategy of the production and the storing sources elaborated by the hybrid IFTE. The setting-up and the using of these tools, the CONIFER project includes an applied research combining the creating and modeling part with an experimental work through some architectural platforms and a restraint layout.

Partners	1. SNCF 2. L2EP – Hautes Etudes d'Ingénieurs 3. L2EI – ENSAM Lille 4. L2EP - Ecole Centrale de Lille 5. SERMA Ingénierie 6. G2ELAB – Université Joseph Fourier
Coordinator	Jean Chabas – SNCF jean.chabas@sncf.com
ANR funding	907 k€
Starting date and duration	January 2011 – 42 months
Reference	ANR-10-STKE-05
Cluster label	

Project title	LIO2 : Development of a rechargeable lithium-air battery with very high energy density
Abstract	The development of Lithium-air batteries represents an important breakthrough in batteries because for the first time an all electric vehicle with a range comparable to the traditional petrol driven ICE (> 500 km) car can be envisaged without recharging. A preliminary project of short duration (ANR funded project "LIO") demonstrated the feasibility of the aqueous lithium-air concept in which the product of the reaction is stored in the aqueous electrolyte as a precipitate and not in the porosity of the air electrode as is done in the anhydrous Li-air concept. The objective of the project LiO2 is to remove the barriers which have been identified in the LIO project, to enable the Li-air technology to reach a new phase towards the development of a high range electric car. In order to do so, LiO2 aims to increase the current density to 50 mA/cm², to increase the number of cycles to more than 100 initially and to increase the capacity to 200 mA/cm² of electrode. Finally, the demonstration of the progress achieved will be demonstrated in a 5 cell battery using ambient untreated air and with the following performance : –2 Ah, 15V, 30 Wh –200 mAh/cm², 10 cm² –C/10 –100 cycles To reach these goals, the LiO2 project will develop new Li+ conducting ceramics which are stable in contact with Li metal. New ceramic membranes will be produced in order to have a barrier to air and water which is sufficiently thin to not enable high current densities. These thin electrolytes will be reinforced with a mechanical support. Several ceramic processing techniques to produce these membranes will be compared such as Spark Plasma Sintering, Tape Casting or Slip Casting. New anionic polymer membranes will be developed which are more stable by using interpenetrating networks of polymers. These membranes will be used to protect the air electrode from CO2 and LiOH precipitation inside the electrode. A novel reversible air electrode will be developed which will be stable to oxygen evolution Finally, the growth of lithium metal on an ironically conducting solid ceramic surface will be studied by using in-situ techniques. These studies will be important to understand the cyclability of lithium metal on solid material with a transport number = 1. The results of these studies will be used to

develop new interface layers with lithium.

Partners	1. EDF R&D 2. ENSCBP-Institut Polytechnique de Bordeaux 3. LPPI – Université Cergy Pontoise 4. LRCS – Université de Picardie 5. CIRIMAT – Toulouse 6. Solvay France 7. Renault 8. CTI
Coordinator	Philippe Stevens – EDF R&D Philippe.stevens@edf.fr
ANR funding	989 k€
Starting date and duration	January 2011 – 36 months
Reference	ANR-10-STKE-001
Cluster label	

AFAQ ISO 9001

« Stockage Innovant de l’Energie » programme

YEAR 2010

Project title	MAGCOOL : New giant magnetocaloric materials round room temperature and applications to magnetic refrigeration
Abstract	Needs of cooling and refrigeration systems absorb more than 15% of the total worldwide electric production, as requested and used in many fields such as food and pharmacy industries, buildings, transports.. Almost all fridge machine use the classical principle of compression/depression of gases, but this technique gives rise to huge amounts of CO2 (electrical energy) and generates leaks of the very detrimental fluids to ozone layer that are HCFC and CFC. Both aspects markedly contribute to the green house gas effect. New frigorigen fluids are less effective and more difficult to control. From a technological breakthrough, magnetic refrigeration principle leads to easy design compact, silent and energy efficient machines. The principle is based on a giant magnetocaloric effect (MCE) exhibited close to RT by specific magnetic materials, Magnetization/demagnetization of these MCE bodies in the close vicinity of ordering temperature leads to develop heat/cold within the material related to the adiabatic principle of magnetization. Successive cycle magnetization = heat-demagnetization = cool down allow describe a Carnot type cycle, is quite original comparison made with the today technology. Questions with this new principle can be addressed to four major points that are considered for in the present proposal. 1 Search for new and performing MCE materials based on cheap as possible elements (less RE metals) 2 Develop small scale productions via processes that can be up-scaled in industry 3 Design magnetocaloric bodies (from powders) to form elements of moving or rotating machines, besides allowing efficient thermal exchange with specific fluids 4 Optimise electromagnetic efficiency of systems built of strong permanent magnets, soft magnetic circuits and MCE bodies. This new deal of promising refrigeration system arising ~ 10 years ago implies a wide panel of multidisciplinary activities and knowledge’s. The proposers are all actively involved at least in one of the many fields required to develop all aspects of the field. Most of them are still involved in collaborating activities devoted to the most promising series, with Gd based materials and more

especially the FeSiLa type compounds. There are AMSNA - McPhy Energy - INSTITUT NEEL/CRETA – G2ELab – Cooltech Applications aiming design functional fridge MCE machines, mass production of powder being handled by ERASTEEL and AMSNA. Small scale production was made effective, which efficiency is at least as good as the reference but expensive Gd, but far from the expected max. performance The present project is based first from experience, but fundamental and theoretical approaches are considered for a better understanding, not only in terms of materials and their physical properties, but as well for the design of efficient (magnetic couplings, heat transfers, COP). For this doing the project gather the recognized competence of solid state material scientists from INSTITUT NEEL/CRETA, ICMCB, CRISMAT, and engineer "frigorists" from Cooltech, G2Elab, LGeCo, the consortium being linked by industrial specialist for high tech metallurgy and processes from McPhy, ERASTEEL and AMSNA. France owns the fair and unique advantage to own the whole panel of specialists in the many required fields of academic knowledge and industrial know-how, with the many important and high level characterization instruments, just effective in chemistry, metallurgy, fine product synthesis, functional techniques on one side and calculation, numerical simulation, heat transfer engineering.. on the other side. So the present project aims to federate forces in a operating consortium, to succeed in the new, clean and effective refrigeration technology, gaining the position of worldwide leader in the field, benefits made for economy and society.

Partners

1. G2ELAB – Université Joseph Fourier
2. CRETA – Institut Louis Neel
3. ICMCB
4. CRISMAT
5. ERASTEEL
6. Aperam Alloys Imphy
7. McPhy Energy SA
8. LGeCo
9. Cooltech Applications

Coordinator

Afef Lebouc – G2ELAB
afef.lebouc@g2elab.grenoble-inp.fr

ANR funding

1142 k€

Starting date and duration

January 2011 – 42 months

Reference

ANR-10-STKE-008

Cluster label

TENERRDIS

« Stockage Innovant de l'Energie » programme

YEAR 2010

Project title	MICMCP : Use of Identification Methods to characterize Phase Changes Materials
Abstract	The buildings account for today approximately 42% of the final total energy consumed in France and 23% of the CO2 emissions. "Le Grenelle de l'Environnement" took the measurement of this effect, and laid down very ambitious objectives for the energy renovation: reduction of energy consumption of 20% in the tertiary buildings and 12% in the residential buildings in 5 years; on the horizon 2020, the objective is to have renewed 30 % of the residential park. Besides the energy aspects, it is also necessary to take into account and to improve the comfort of the occupants. Indeed, thermal comfort is mainly related to the thermal inertia of the building, especially in summer. However, the renovation of buildings by the inside cause a reduction of their thermal inertia which could be filled by Phase Change Materials. The other asset of these materials relates to the storage of energy resulting from the direct solar contributions during the interseason or winter days and their restitution in the night. The use of the MCP is an interesting solution because they present a strong density of energy storage in a reduced volume, thanks to the latent heat of transformation. The modeling of the energy and thermal behaviour of the buildings integrating PCMs require a fine knowledge of the phase transition processes. The commercial computer codes used by the professionals of the building often use apparent characteristics which are badly evaluated by current practices. It is however essential to precisely determine some thermophysical characteristics (apparent specific heats including the latent heat in particular…) so that the modeling is representative of the physical phenomena. As it is explained that the methods currently employed, calorimetry in particular, are not sufficiently exact; this is why, within the framework of project MICMCP, we propose to work on the characterization of Phase Change Materials by the mean of identification techniques which will give results in conformity with the physics of the phase change. The characterization will be made both in the heating for the fusion and in the cooling in the crystallization of supercooled liquids. The objective is to determine the apparent thermal characteristics, generally used with the commercial software. We

suggest identifying them by experiments on samples of increasing sizes and complexity: small homogeneous samples studied mainly by calorimetry, macroscopic samples (fraction of liter) studied with finely instrumented measurement cells or on models allowing to study the PCM in their commercial configuration (for example 1mx1m). Finally, it will be evaluated the influence of a more accurate determination of the thermodynamical properties for applying in commercial codes for buildings. The methods of identifications are completed by the determination of the errors due to the imperfect knowledge of certain parameters of the experiments or the measurement errors. The project is thus to develop numerical methods of analysis of experimental results. It will be a question of establishing, at first by direct models, the physics of the thermal phenomena, either in the calorimetric cells, or for the experiments on macroscopic samples, or on models. Then the main work will be to implement identification methods in these three cases and to deduct the associated precisions. The sensitivity analysis will be used to the design and then development of the experimental devices. Finally, these studies will allow defining a protocol of experiments allowing a procedure of technical evaluation of the industrial PCM.

Partners

1. LATEP – Université de Pau
2. LEMTI - Université d'Artois
3. CETHIL – INSA de Lyon

Coordinator

Jean Pierre Dumas – LATEP
jean-pierre.dumas@univ-pau.fr

ANR funding

685 k€

Starting date and duration

January 2011 – 36 months

Reference

ANR-10-STKE-003

Cluster label

Project title	SACRE : Compressed Air energy storage for the electrical grid
A stract	Though the Huntorf compressed air storage was a success, CAES did not experience the rapid development expected in the 80's. However, when their power range is considered, they appear as the only credible alternative to pumped hydroelectricity plants. Recent changes in the technical and economical context can drastically modify this situation. On one hand, « adiabatic » concept, in which the heat generated in the compression system is stored, should increase the energy efficiency to 70%, especially when improvements are searched for systematically (compressor train, expander, heat storage materials, design of the heat exchanger) and when underground voids are available in the vicinity of the electric grid. On the other hand, electric energy storage makes intermittent sources of energy, e.g. windmills, more attractive, and environmental concerns lead to a more complete assessment of storage benefits, including carbon balance and optimal management or dimensioning of the electric grid. The first part of the SACRE project includes a static modeling of the French electric grid, which will allow optimal implementation of storages. A typical day will be modeled, allowing for a more precise dimensioning of storage main characteristics. Benefits will first be assessed through a marginal approach; however a more sophisticated method will also be used in which two equilibrium models, with and without CAES, will be compared; possible gains will include smaller investments for peak consumption and reduction of CO2 emissions. The second part of SACRE deals with air storage techniques in salt caverns, aquifer layers, mined caverns or above-ground tanks. A map of available voids or suitable geological formations will be drawn, together with an assessment of the range of costs of a stored KWh. A detailed conception study will be performed: well architecture, large casing diameter, corrosion by salty air, and environment protection concerns (cavern abandonment). Experience drawn from the Huntorf storage proves that severe although tolerable rock spalling must be expected. Numerical computations will allow extrapolation of this result to different depths, cavern shapes and features of the P-T cycle; a rock-mechanics testing program will be inferred from these

computations. Operating an adiabatic CAES also means storing heat in severe conditions – 650°C, 70 bars, salt particles in the air. For heat storage material, ceramics originating from waste treatment will be considered. This innovation might be a breakthrough. Exchanger architecture will be optimized and materials will be fully characterized. This effort will provide data for the design of a 1 m3 prototype. Extrapolation to scale 1 will be discussed together with possible advantages of a multi-storied storage system and with selection of the storage material container. Assembling of the various technical parts of the system will be made through the study of the behaviour of air during pressure build up and decompression. During the first year of the project, a preliminary design of an advanced adiabatic system will be made; it will be used as a backbone for the following of the project; it will allow assessment of the results obtained in the course of the project and it will be continuously updated as the project proceeds.

Partners	1. LMS – Ecole Polytechnique 2. Laboratoire PROMES – Perpignan 3. EDF R&D 4. GEOSTOCK 5. L2EP – HEI Lille
Coordinator	Pierre Berest - LMS Berest@lms.polytechnique.fr
ANR funding	666 k€
Starting date and duration	January 2011 – 36 months
Reference	ANR-10-STKE-006
Cluster label	DERBI

« Stockage Innovant de l'Energie » programme

YEAR 2010

Project title	SOLIBAT : All solid state batteries manufactured by Spark Plasma Sintering
Abstract	Since the 90', rechargeable Li-ion batteries are the most widely used for energy storage in portable devices. However, today's most performing cells have almost reached their intrinsic limits while the demand in terms of performances and safety is still increasing. Commercially available batteries may not be able to answer the needs of new emerging applications (electric and hybrid vehicles, storage of sustainable energy...), or even more specific applications with strong added value. In this context, it is necessary to develop advanced battery technologies with characteristics such as high energy densities, long life, low production cost, little or no maintenance and a high degree of safety. "All solid state" Li-ion batteries may withstand such requirements and offer additional interests if we consider the possibility to work at high temperature or to design specific cell geometry. Up to now the development of such technology has faced assembly problems. Recent results obtained in the context of the project CeraLion (Stock-E-07-04) show the feasibility of developing bulk-type all solid state batteries by Spark Plasma Sintering. The objectives of this new project are then to valorize our previous results and the associated pending patent by bringing the use of all solid state technology closed to the applications. This project requires remaining relatively fundamental by considering the optimization of existing materials to fit the applications requirements in the aim to improve our prototypes performances. This will only be achieved by optimizing in parallel the formulation/mixture of solid compounds (active materials, electrolyte, electronic additive) in the composite electrodes. These lasts must have an optimized microstructure insuring ionic and electronic percolation within the ceramic volume without penalizing the energy density. The all solid state batteries will be obtained by adjusting parameters of the sintering technique from which the study of the influence on the electrochemical behavior of cells will allow to isolate the optimal conditions. These parameters will be used to prepare cells, some of which will have a peculiar geometry. These cells will then be characterized using standards defined by our industrial partner, which will validate the all solid state technology.

Partners	1. CEMES – CNRS – Midi Pyrénées 2. LRCS – Université de Picardie 3. Laboratoire Chimie Provence 4. SAFT
Coordinator	Mickael Dollé – CEMES Mickael.dolle@cemes.fr
ANR funding	675 k€
Starting date and duration	January 2011 – 36 months
Reference	ANR-10-STKE-007
Cluster label	AEROSPACE VALLEY

« Stockage Innovant de l'Energie » programme

YEAR 2010

Project title	STAID : Seasonal Thermochemical heAt storage In builDings
Abstract	The aim of the STAID project (Seasonal Thermochemical heAt storage In buildings) is the design and evaluation of a compact seasonal thermochemical heat storage system for building application. The thermal energy storage material is a zeolite/magnesium sulphate composite; one task of the project dealing with the optimization of the material to increase the storage energy density. These materials have been chose because of their low price and low environmental footprint. One key point of the project is the integration of the composite material in the reactor of the thermal energy storage system. Then, the reactor will be design according to the required heating power and energy storage needs. The reactor will be coupled with an air thermal collector. During the sunny days, hot air coming from the collector is passing through the reactor in order to dehydrate the composite material and then to store thermal energy. During the cold days, the moist air coming from the interior of the building is used to release heat in the airflow. The heat is then transferred to the new air from the exterior via a heat exchanger system. The so designed system will allow a long term thermal energy storage without heat losses.
Partners	1. CETHIL – INSA Lyon 2. EDF R&D 3. CETIAT 4. IRCELYON 5. LOCIE
Coordinator	Frédéric Kuznik – CETHIL Frederic.kuznik@insa-lyon.fr
ANR funding	759 k€
Starting date and duration	January 2011 – 36 months
Reference	ANR-10-STKE-009
Cluster label	AXELERA - TENERRDIS

« Stockage Innovant de l'Energie » programme

YEAR 2010

Project title	STOCK-AIR 2 : Thermal storage for the thermodynamic air heating of buildings
Abstract	« Stock-air 2 » project aims at developing and controlling a technical solution where an air-to-air heat pump is coupled to a thermal storage made of Phase Change Material (PCM) in order to erase the electricity demand during the peak hours between 6 p.m. and 8 p.m. This technical option is relevant for refurbishment of domestic heating by electrical resistance of the current installed base of buildings as well as for the future low-energy buildings. Indeed energy storage by solid-liquid phase change stabilizes the condensing temperature of the heat pump and leads to choose the temperature level leading to the maximization of the seasonal heat pump performance. On another hand the phase change allows steady operation of the thermodynamic system and limits drastically energy losses due to short operation cycles associated to low thermal loads. This project aims at developing upstream research on new materials and applied research on heating d systems including energy storage tested in real operating conditions. Developed PCMs will present phase change levels of temperature adapted to air heating systems i.e. 30 to 50℃. Those PCMs will be integrated in energy storage / delivery heat exchangers. Two main technical options will be studied in parallel: - PCM integration in heat pump condenser taking advantage of high heat exchange coefficients - PCM integration in the air circuit associated with enhance heat exchange surface with circulating air Stock – Air2 project is performed under a double approach: a systemic approach based on numerical simulation, and technologic approach for material and system development with an adapted speed for energy storage and delivery of the chosen heating system. One of the .project originalities is based on solving issues related to phase change delay and incomplete phase changes by integration of PCMs in high heat exchange coefficient surfaces (40 to 500 W/m2.K). One of the project work packages addresses PCM container design. The container required qualities are: a very low permeance to the active material, a good resistance to corrosion, sufficient fatigue strength, a good heat exchange performance. The program will lead to test Two physical demonstrators of storage / delivery heat exchangers: one integrated in a heat pump condenser (indoor unit) and the other integrated into

ventilation ducts or plenum. Once those systems are validated by laboratory tests, they will be tested in individual houses.

Partners	1. ARMINES 2. EDF 3. CETHIL 4. RIBO SA 5. AIRWELL INDUSTRIES 6. Laboratoire des Sciences de l'Habitat
Coordinator	Denis Clodic – ARMINES denis.clodic@mines-paristech.fr
ANR funding	626 k€
Starting date and duration	January 2011 – 36 months
Reference	ANR-10-STKE-009
Cluster label	AXELERA - TENERRDIS