

RENESENG

The Renewable Systems Engineering grant (RENESENG) is a new FP7 Marie Curie project that researches and trains a new breed of engineers with project experience in biorefineries and emphasis on advanced process design, synthesis, model-based screening and analysis and process integration. RENESENG continues and builds on a series of successful EU and national projects and will be training future scientists and engineers in biorefinery related topics.

The award is worth approx. 4,2 million EUROS to a European Consortium of major universities and biofuel companies. The project duration is 4 years starting on 1st of November 2013.

RENESENG aims to prepare a new generation of highly-qualified researchers in Biorefinery and bio based Chemical Systems Engineering Sciences in Europe. The programme is expected to bear high impact in the design of newly establishing industrial complexes in biorefining and more generally in eco-industries. RENESENG brings together interdisciplinary academic and industrial teams of high-quality expertise, embracing disciplines in agricultural sciences, chemistry and chemical engineering, biology and biotechnology, computer science, process engineering, logistics and business economics, as well as social sciences with an emphasis on life cycle analysis skills.

The project brings state-of-the-art systems technologies mobilizing a critical mass in Europe that is already particularly active in this area but needs to coordinate the efforts and reduce fragmentation of knowledge. The principal scientific challenge of the network will be to foster inter-disciplinary research from expert groups with dedicated interests in bio-renewables using a model-assisted systems approach as an integrating aspect, further capitalizing on its potential and role to address complex and large problems. The aim is to develop and validate modelling, synthesis, integration and optimization technology addressing:

- 1) Lignin-based and cellulosic processes
- 2) Water-based paths to biomass production
- 3) Waste treatment paths
- 4) Hybrids of bio-renewables with other forms of renewables.

In parallel RENESENG will develop a program of training activities including, development of communication, business, and social skills, visits and social events allowing to prepare a new profile of researchers able to transmit their knowledge in to the wide stakeholder base associated with the bioeconomy. RENESENG ensures high quality careers prospects for all, through the active participation of 6 industrials, the creation of spin-offs and the sustainable implementation of a multicenter PhD training program.

Participants

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Scientific Objectives

Major scientific aims of the RENESENG project are to:

- Build **synthesis capabilities** in PSE tools addressing challenges to important problems in bio renewables including process design, supply chain analysis, valorization of paths and industrial chemistries, and process integration ;
- Develop families of **models** to function at different level of analysis (**multi-scale applications**) and compatible with each other;
- Consolidate **bio renewables modelling and systems engineering knowledge** into sharable environments, repositories and software prototypes with capabilities to support engineering tasks (flowsheeting, scale-up, costing, screening) and decisions further offering the opportunity to build dedicated communities of expertise.

To build such capabilities, RENESENG should advance conventional modelling and systems engineering technology, namely:

- Produce **modelling templates and flowsheeting technology** dedicated to key processes, intermediates and products;
- Build synthesis functions to produce **benchmark technology** to target efficiencies;
- Build synthesis functions to **systematize process integration**, as well as the integration of parallel paths and chemistries;
- Produce dedicated methods for **costing, scale-up technology** that is currently missing;
- Produce dedicated thermodynamic models and methods to **model new chemicals and feedstocks**;
- Advance systems methods to infuse **LCA** across all the different levels of analysis and process development;
- Develop **prototypes of enabling software** to support the efficient development of solutions;
- Develop **repositories of data and knowledge** to share with the community, and build communities (wikis) to exchange and disseminate.

RENESENG will develop and validate modelling, synthesis, integration and optimization technology addressing:

- lignin-based and cellulosic processes (lignocellulosic biorefinery) ;
- water-based paths to biomass production (water biorefinery);
- waste treatment paths and utilization of resulting biomass (residue and MSW biorefinery);
- plant based oil processing and conversion, optimization of the value creation from co-products (oil-based biorefinery).

Scientific Research Methodology

The central philosophy of the project follows the systems hierarchy in reviewing carbon-based industrial systems, offering different levels for modelling and decision making. More specifically: **At the fundamental level (Level 1)**, mathematical modelling of equipment and equipment compartments offer building blocks customizable into different model granularities supporting model-based optimal designs of individual biorenewable systems at scales appropriate to the application; **At Level 2**, based on the physical-chemical-biological characterization of (bio)chemical conversions and transport phenomena in individual units, process intensification (Level 2a) and process integration (Level 2b) build efficiencies; **At level 3**, the scope of research is extended to value chain networks, which should be designed taking into account both processing and logistic subsystems as well as biomass supply/ products scenarios. A **holistic approach** embraces all of the above layers alongside LCA methods and analysis for sustainable development.

The following tasks and works will be executed within the project:

1. Mathematical modelling and multi-scale application
2. Equipment and process integration of biorefinery concepts
3. Bio renewables value chain network modelling and optimization
4. Life cycle assessment, sustainability and economics feasibility
5. Validation, Evaluation and on-site training
6. Systems tools and software

Training Objectives

In parallel with research activities, major training aims of the RENESENG project will be to:

- Develop systems tools to promote **innovation and creative thinking**;
- **Create a new generation of multi-disciplinary researchers** in Biorefinery Systems Engineering sciences that will be able to transmit their knowledge in the next networking teams;
- **Train the needed workforce** to develop sustainable, economic and technical feasible processing technologies to replace the old chemical based production route, to help competitiveness and creation of green jobs;
- **Develop a multi-program of training activities**: scientific high level training, transferable skills courses (exchanges, development of communication, business, IPR, social skills, etc.), industrial training (industrial sites visits, best practices in spin-off creation, etc.) and social events ;
- **Create new spin-offs** based on project results with participation of fellows;
- **Guaranty a high quality career perspective** for the whole network through the active participation of industries with a high interest to this new engineer profile;
- Ensure a durable exploitation of the RENESENG training experience by the **creation of a multicenter PhD training program and long term collaborations.**

Impact

The highly focused training program of RENESENG aims also to ensure continuation of their own professional development once the RENESENG Project is over. The presence of the industrial teams will ensure that the intersectorial training will remove the classical barriers to mobility by equipping the researchers with a much wider set of skills that any single institution could deliver.

The fellows will learn all the different aspects of developing a research project, from problem solving, prioritizing tasks, to human resources management, financial management and communication skills, that will enable them progress in their chosen career and will help them to prepare new projects.

Fellows will be called to present the activities and the importance of research in biorefinery and bio-chemicals systems engineering during info days to University students as well as open science days to the public or presentation in schools to attract young people in engineering sciences. Participation of women in the PSE field remains very low. Priority should be given to assure a 30% of women in research fellows.

Working within RENESENG will provide each researcher with a unique opportunity to build their own network of contacts in both academia and industry.

RENESENG objective is to prepare all the fellows for a real interesting career and create attractive opportunities for them. The consortium will provide an academic-industrial environment which will allow the fellows to experience the different working environment, different approach to problem solving, different priorities and also to learn different skills. Collaboration with industrial partners will also promote a more entrepreneurial mindset, encouraging academics to seek applications for their science and providing researchers within valuable skills in process system development and management.

The ultimate long-term objectives of RENESENG is to initiate and encourage agreements between European universities that will lead to join, a multicenter PhD program in order to strengthen European research and structure the research in the new field of design of biorefinery, biofuel and (bio)chemical process systems of the future, their exploitation and career opportunities for young scientists. The network program will have a significant impact for the partners involved that goes beyond training and research programs. Integration and exchange will mutually increase the partners' workforce and effectiveness, not to the least via collaboration with external researchers with specific know-how and experience in the relevant fields. This will contribute to diversify the scientific and technological expertise of the partners and reduce knowledge fragmentation, and will also lead to new long term collaborations. In addition the presence of international researchers at the host institutes will improve the communication skills of local researchers and students with respect to foreign languages and will certainly enhance the readiness for international mobility, thus improving knowledge transfer to other European countries.

RENESENG aims to foster a new generation of highly-qualified researchers in Biorefinery and biobased chemicals Systems Engineering Sciences in Europe, essentially preparing future communities of systems engineers that are expected to bear high impact in the operation and design of newly establishing industrial complexes in biorefining and more generally in eco-industries. The effort requires to bring together academic and industrial teams, with particularly interdisciplinary and high-quality expertise.