NiChe Cluster
POLICY BRIEF

Roadmap to achieve 2050 sustainable goals by using non-conventional energy sources for feedstock material processing

The NiChe Cluster is formed by four EU-funded projects which aim to enable the transition towards a more sustainable chemical and building materials sector using non-conventional energy sources for feedstock material processing. The Cluster is working on solutions that will contribute to technology development to reduce the environmental impact of the chemical and building materials industry.

In this document, three of the NiChe projects share their recommendations to make the use of non-conventional energy sources from NiChe to mainstream.

Context

The European chemical and building materials industry is responsible for a relevant share of the EU's greenhouse gas emissions. Moreover, the latest global developments have eroded the European market share in the sector and its competitiveness.

A change is needed to reach the objective of climate neutrality while boosting the industry's competitiveness.

The NiChe Cluster aims to enable the transition towards a more sustainable chemical and building materials sector using non-conventional energy sources for feedstock material processing.

Key points

- Improvement in energy efficiency: it can be based on methodology developed by Tanaka (Energy Policy 2008, 36, 2887) and Giacone & Mancò (Energy, 2012, 38, 331) for energy efficiency performance in industry. It can be based on the analysis of input and output energy and exergy flows, with estimation of the energy equivalent content of raw materials based on LCA (Life Cycle Assessment).

- Improvement in resource efficiency: it can follow a methodology for energy efficiency (referring to resources rather than energy), but assessing the resource needs (based on LCA) to make the different inputs (materials and energy) for plant operations and the expected project performances.

- Decrease in CO_2 emissions. It can derive from the energy efficiency assessment and the losses of energy in the process (without considering the electricity generation and at steady state), but including in the analysis the decrease in CO_2 equivalents (based on LCA) deriving from raw materials substitutions and avoiding the use of co-reactants (oxidants and reducing agents, etc.).

- Decreased OPEX (Operational EXpenditures) and CAPEX (CAPital EXpenditures). This metric can be based on techno-economic assessment based on engineering process simulation.

- Electrification of the chemical process industry – and in particular the specialty chemicals industries – by moving from batch to continuous production with flexibility being ensured by the application of alternative energy forms.

- Advancement in the technology readiness level (TRL) of flow technology for multiphase streams involving suspensions or viscous products from TRL4 (technology validation in lab) to TRL6 (industrial demonstration), thus pushing the transition from chemical reactions with poor resource – both material and energy – efficiency and variable product quality to processes with high resource efficiency and excellent, uniform product properties.

- Introduction of a “first-of-a-kind” high temperature microwave processing system at industrial level offering a variety of vital benefits to energy intensive sectors: reduced energy consumption, lower lifetime operating costs and enhanced sustainability profile.

- The influence of the new heating technologies solutions in terms of stability, process efficiency and characteristics of raw materials, intermediate/sub/final products will be investigated to improve performance of the industrial processes within 3 industrial sectors (Cement, Ceramics and Steel).

The NiChe Cluster

PowerPlatform: Establishment of platform infrastructure for highly selective electrochemical conversions

The PERFORM project is targeting two global trends: electrification and a shift towards bio-based feedstocks.

The project is applying a multi-level approach including a combined integration between electrification, reduction of process complexity, avoiding the use of co-reactants through system integration, innovation in processes and bio-based use of feedstocks, as well as the development of a flexible PowerPlatform pilot plant platform. The project will result in the development, design and construction of the flexible integrated PowerPlatform pilot plant (TRL 6), demonstrating the use of electrochemistry and advanced technologies for efficient and selective conversions of biomass molecules to building blocks for high performance applications (e.g. polymers / coatings / adhesives). The project will allow fast scale-up to commercial implementation.

PERFORM is expected to contribute to technology development to reduce the environmental impact of the chemical industry and to reduce CO_2 emissions from the production of chemicals. As we continue to develop towards a bio-based economy over the coming decades, the biorefinery will take on an increasingly important role. It will enable Europe to convert biomass into the marketable products needed to meet the demands of European society in the areas of food, chemicals, materials, and pharmaceuticals. The challenge of these developments, amongst others, are changes in raw material and expansion of the product range, requiring the need of new process concepts. The future of sustainable society and economy is largely based on realizing technologies which use local resources (including renewable energy) and allow to shift from large centralized productions to distributed models (at regional level). There are many benefits for society in this new model of production, from a better integration at territory level with positive impact on jobs, to lower costs, risks and environmental impact of transporting chemicals, creation of symbiosis models, reduction of the impact of large production plants, etc.

Sonication and Microwave Processing of Material Feedstock

SIMPLIFY responds to the EU Horizon 2020 call SPIRE-02-2018. It is an innovation action in which leading European industries and university groups in process intensification, ultrasound, microwave, multiphase processes, polymerization and crystallization, team up to address the domain of electrification of chemical industry.

In four years, a consortium of 11 European organizations, led by KU Leuven, will focus on intensified processes, where alternative energy sources enable flexible continuous technologies to achieve localized ultrasound and microwave actuation of multiphase, flow reactors powered by electricity from renewable sources for the purpose of high-value product synthesis.

The DESTINY project aims to realize a functional, green and energy saving, scalable and replicable solution, employing microwave energy for continuous material processing in energy intensive industries. The target is to develop and demonstrate a new concept of firing for granular feedstock to realize material transformation using full microwave heating as alternative energy source and complement to the existing conventional production.

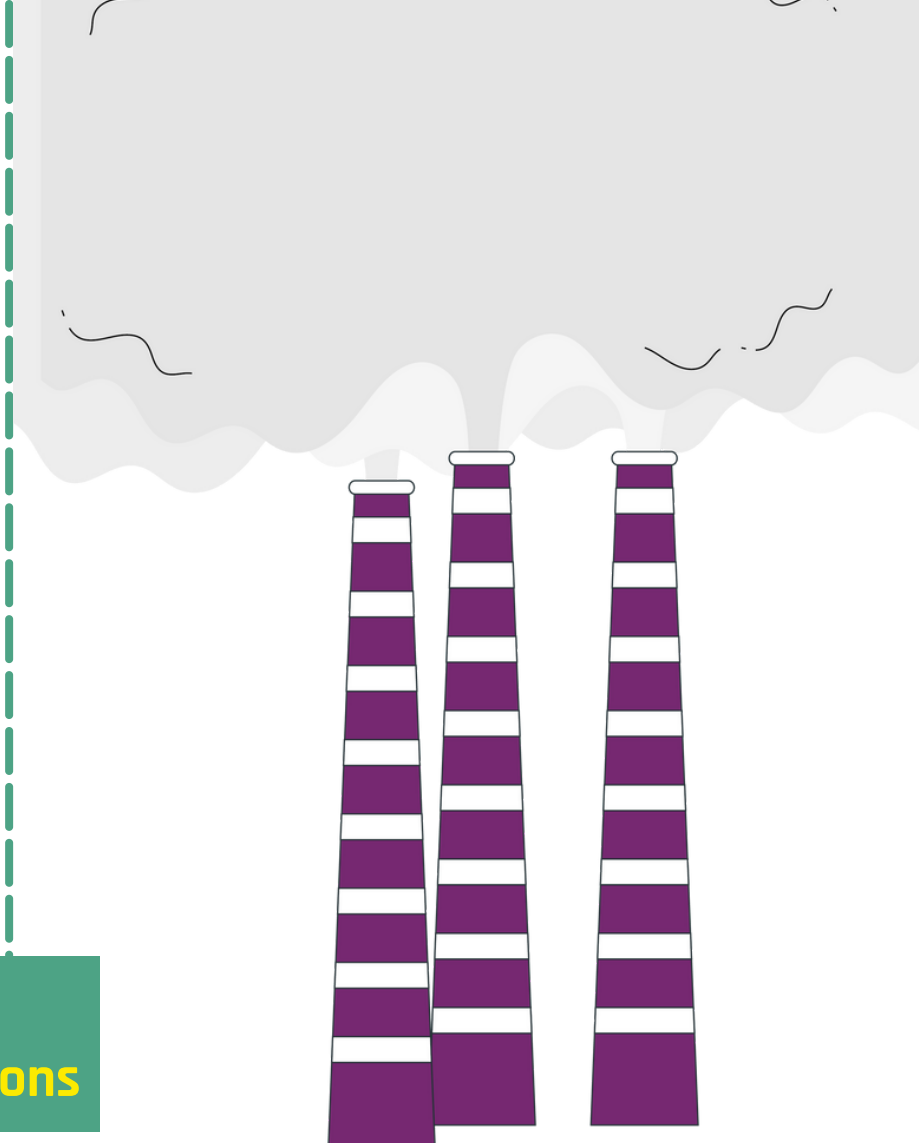
Legislation

Legislative barriers regulations and standards do not appear to be critical for market introduction because valeric and adipic acids and their corresponding esters have already achieved REACH (Registration Evaluation, Authorisation and Restriction of Chemicals). The current benefit from CO_2 certificates is too low to produce an effective impact on the market of low-carbon technologies, but

- there are incentives (for the consumer market) on bio-based chemicals and
- opportunity-cost of less energy intensive products, which can use renewable energy sources.

This is likely to change under the spur of the Paris agreements. This will also depend on the cost of fossil fuels and raw materials, but as indicated renewable energy will be soon cheaper than from fossil fuels. It is thus imperative for competitiveness of the chemical manufacture in Europe to exploit the combination between bio-based sources and renewable energy.

To achieve this it is necessary to create the legislative environment for innovation in this direction. The distributed manufacturing concept addressed in PERFORM will require specific legislations, for example in the use of off-peak renewable energy to produce chemicals. In Germany 80-100% of electricity is expected to be produced from renewable sources by the year 2050, which will require seasonal electricity storage, feasible only with the concept of electrochemical storage in products. However, no legislation is in effect for the remunerability of the grid compensation effect given by this approach.



Conclusions & Policy recommendations

- Reduce renewable energy prices
- Increase CO_2 prices
- Incentivise the use of bio-based raw materials
- Make the EU industry become more environmentally friendly
- Make the EU more globally independent: this will lead to incentives to keep chemical production plants in the EU and give the opportunity to make them more sustainable. If policies require the industry to be more sustainable, without any regulation these will move production outside the EU and continue using fossil feedstocks and energy.
- Increase energy security within the EU
- Increase raw material security within the EU

Bibliography

- The recent 2015 Paris agreements
- The latest eco-design directive (ErP-directive, 2009/125/EC) foresees the establishment of mandatory requirements for energy-related products.
- REACH (Regulation for Registration, Evaluation, Authorisation and Restriction of Chemicals)
- Methodology developed by Tanaka (Energy Policy 2008, 36, 2887) and Giacone & Mancò (Energy, 2012, 38, 331)
- Renewable Energy Directive
- Energy efficiency measurement in industrial processes

Discover our innovation to make the use of

non-conventional energy sources

from NiChe... to mainstream.

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