The European Cluster on Catalysis

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European Cluster on Catalysis

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Catalysis - A key technology for sustainable development

In an age of dwindling global energy supplies, catalysis has moved to the front lines of the struggle to obtain *new, sustainable technologies for the future*.

Catalytic technology is intimately intertwined with the new and emerging solutions for our current and future energy sources.

A clean and sustainable future involves discoveries from the field of catalysis, either to improve energy efficiency, enhance and open up new pathways for energy storage, or even mitigate the environmental impact which is all but inevitable in times of technological and industrial progress.

Courtesy Prof. G. Centi

Catalysis - A key technology for sustainable development

- Catalysis and catalytic processes account (directly, indirectly) for about 20-30 % of GDP
  - manufacture catalysts in Europe: about 3-4 B€ (*global market for catalysts*: US$ 16.3 billion in 2012, chemical processing accounting ~ 75%, petroleum refining ~ 25%)
- Of the 50 greatest volume chemicals currently produced, 30 are produced via catalytic routes.
- These 50 highest volume processes account for more than 20 billion tons of carbon dioxide emitted to the atmosphere each year; catalysis is crucial to reducing this *environmental burden*.

Courtesy Prof. G. Centi

Grand challenges in the field of catalysis

1. Catalysis to address the evolving energy and chemical scenario

- new raw materials (from natural gas to biomass and CO_2, including non-conventional fossil fuels); use of renewable energy in integration with catalysis; energy-saving processes through catalysis; process intensification by catalysis and integration of catalysis with other technologies as membrane to reduce the number of process steps; new catalytic technologies for energy storage and conversion (including fuel cells, H_2 production and storage); catalysis for novel polymers and intermediates;

2. Catalysis for a cleaner and sustainable future

- catalysis for eco-technologies (from air to water and waste; stationary and mobile; including photocatalysis); towards 100% selectivity; catalysts in novel process design for resource and energy efficiency; cleaner fuels in refining ; novel catalytic processes to reduce eco-impact of fine and specialty chemicals production (including asymmetric catalysis, organocatalysis and enzymatic process, tandem process); eco-conception (LCA) of catalysts and processes

3. Addressing catalysis complexity

- catalyst design for multistep reactions, for bulky molecules; catalysis for materials with specific properties (electronic, photonic, magnetic); synthesis of advanced and hybrid catalytic systems with tailored reactivity: functional nanoarchitectures in catalysts, novel preparation methods, integrating homo-, hetero- an bio-catalysis, novel nanoparticles, organometallic complexes, organocatalysts, biomimetic catalysts and enzymes, catalysis with immobilized or single site complexes;

4. Understanding and design catalyst from molecular to material scale

- from deductive to predictive catalysis; theory and modelling of catalysis; new approaches in catalysts and reaction mechanism understanding (including in-situ and operando methods); model systems (including surface science approach); bridging molecular to reactor engineering aspects in design new processes; kinetics and reaction engineering;

5. Expanding catalysis concepts

-catalysis with electrons, photons and other energy sources than heat; design catalysts to operate under non-conventional or extreme conditions; use of non-conventional solvents in catalytic processes; novel catalytic materials

Courtesy of Prof. Gabriele Centi, ERIC, University of Messina

Examples of practical challenges for the applications of catalysis

- replacement of critical raw materials
- efficient conversion/valorisation of CO_2 and biomasses
- more enantioselective catalysts and realization of multistep reactions in life science applications
- stability of catalysts in aqueous phase and catalysis in unconventional media

Industrial sectors involved

- Food products and nutrition, animal feed
- Fertilizers
- Health and pharmaceuticals
- Automotive and transportation
- Environment protection & depollution
- Production of monomers and polymers
- Functional materials
- Fine chemicals
- Commodities production
- Fuels, natural gas, energy production and storage
- Renewable raw materials
- ……

Cluster on catalysis scope: context

European Commission

Challenges require:

- scientific excellence, frontier research
- interdisciplinarity, integration and coordination of efforts
- synergically integrated efforts at regional/national level with EU programmes/platforms
- tight interaction among academia and industry
- stimulate unconventional approaches to catalytic materials, reactions and processes
- to avoid jeopardising/overlapping of efforts
- to strenghten EU position towards competitors (China, US, Japan, India, BRIC countries)

integrated approach at EU level: particularly important for areas of crosscutting activity linking key enabling technologies to their application in addressing societal challenges (e.g. ***Competitive low-carbon energy)***

Relevance of catalysis in EU and outside

- Catalysis: most interdisciplinary and overarching technology in the chemical industry
- 85% of chemical products involve catalytic processes
- Catalysis underpins several industrial strategic sectors

Features of catalysis science & technology

- Highly interdisciplinary field: interactions/synergies needed
- High added value products
- Crosscutting and interdisciplinary issues

key technology for European economy, industry and growth

What EU is doing (H2020): EU vision

- Energy Roadmap 2050
- Low-carbon economy: SET-Plan towards a Low Carbon future
- Materials Roadmap Enabling Low-Carbon Energy Technologies
- Roadmap to a Resource Efficient Europe
- SPIRE initiative

Societal challenges (in red topics involving catalysis)

- Health, demographic change and wellbeing;
- Food security, sustainable agriculture and forestry, water research, and the *bioeconomy;*
- Secure, *clean and efficient energy;*
- Smart, *green and integrated transport;*
- Climate action, *environment, resource efficiency and raw materials;*
- Europe in a changing world - inclusive, innovative and reflective societies;
- Secure societies - protecting freedom and security of Europe and its citizens.

What EU has already done (FP7 NMP)

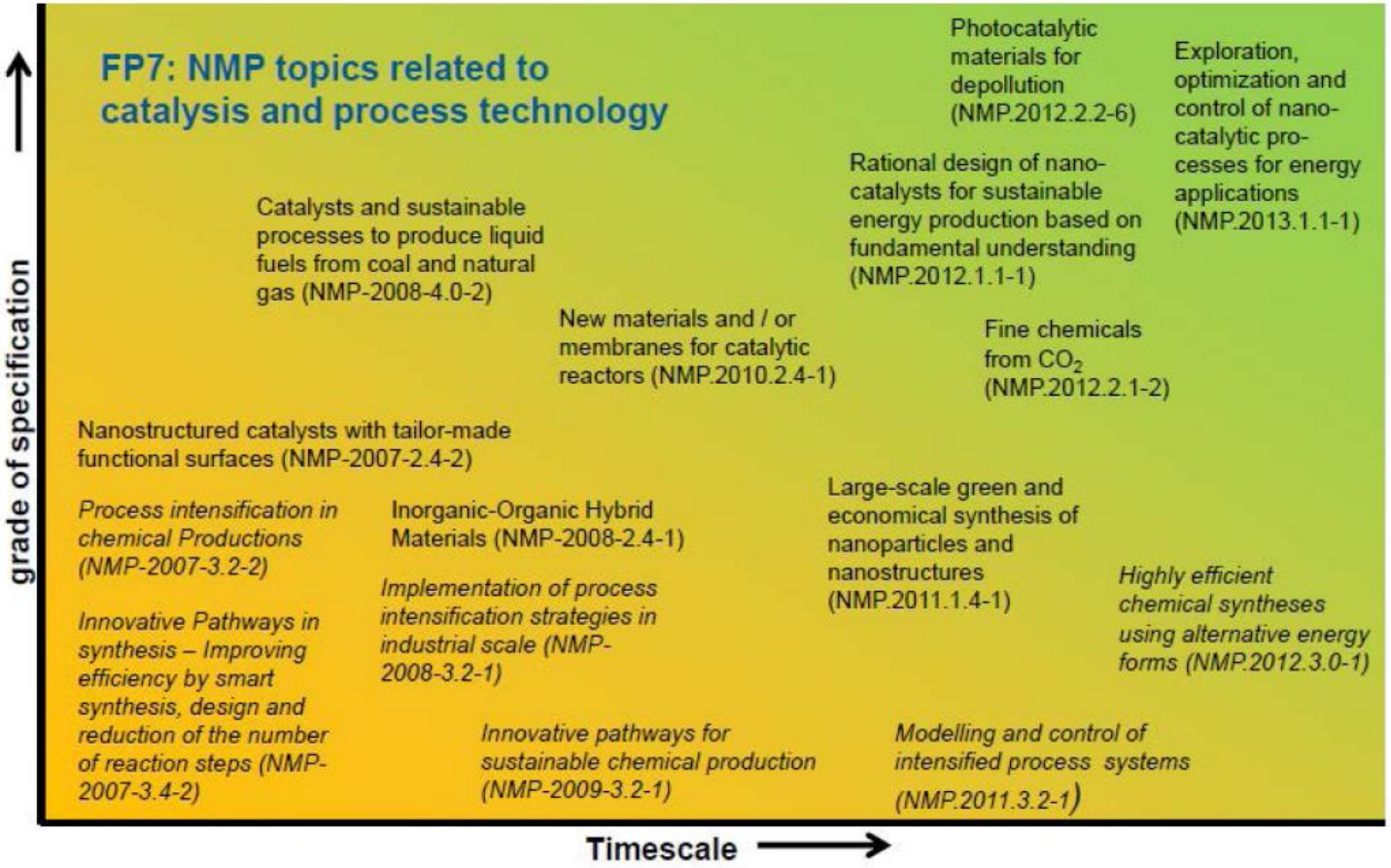


Figure 1: NMP topics related to catalysis and process technology, released within FP7

Cluster on catalysis scope: context

but….

however, weaknesses at European level:

- segmented/fragmented and jeopardized research and technology efforts
- lack of a common vision and of coordination at EU level
- weak interaction/gap among national roadmap and energy policies and H2020 vision
- often try-and-error approach to problem solving, not focussed research
- EU programs: only partial coverage of all technical/industrial issues related to catalysis
- strong competition from China, Russia, US

Europe risks to frustrate its intellectual/scientific advantage

Why a cluster?

to ensure leading position of EU and fill the gap

Synergy, coordination, focus, knowledge-based approach and joint efforts needed

- **Focus** human and economic resources
- **Coordinated, effective and rational approach** to the Grand Challenges in catalysis
- Foster **synergy** among stakeholders, research, academia, industry, initiatives at EU level

European Cluster on Catalysis

European Cluster on Catalysis

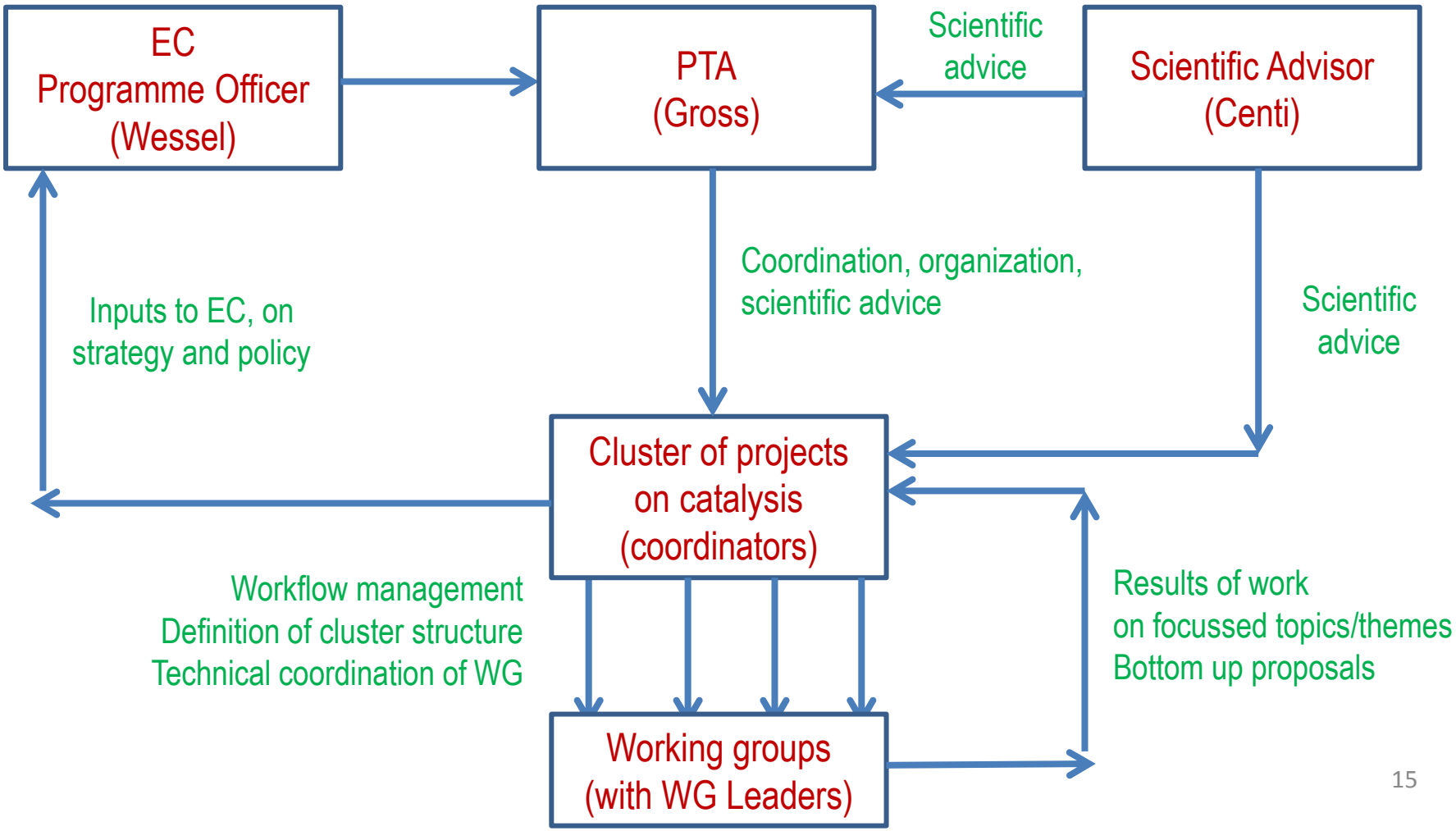
joint meeting/coordination point for stakeholders in the field of catalysis

First Cluster Meeting: 13.1.2015

- to be set-up and developed in the **timeframe of H2020**, but ideally continuing afterwards
- **gathering together and coordinating** all EU projects related to catalysis
- directly promoted by EC, coordinated by a **dedicated PTA**
- strong involvment, though on a volountary basis, of **project coordinators**
- structured in different **working groups** addressing different sub-topic/tasks
- bottom-up approach
- no confidentiality issues involved (inter-project coordination, not content of project involved)
- 1-2 joint one-day meetings/year (always at European Commission in Brussels)

Cluster on catalysis scope: cluster concept

Cluster structure and roles



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Cluster on catalysis scope: joint activities

- coordinate, link together and integrate activities of EU founded projects on catalysis
- create networking and synergies among the existing networks
- edit new or update existing roadmaps for catalysis in Europe
- stimulate open-minded, interdisciplinary workshops and discussion forum on frontiers activities fostering new ideas, visions and directions in catalysis
- regulations/standardisation activity (e.g. test in photocatalysis)
- define policy for H2020 and themes/topics for future calls
- discuss and plan new joint proposals
- define coordinated and common actions to sensitize public and popularize the role and benefits of catalysis for the society
- *further*….

Activities of the Cluster (to be delivered by Mid 2016)

- Edit a **Compendium** collecting aims, coverage and main results of founded projects
- Identify possible **synergies and integration** activities
- SWOT analysis of EU in the field of catalysis
- **Project matrix**: gaps and overlaps identification
- **Project matrix**: coverage at EU level of all relevant aspects/problems/issues related to catalysis?
- Organize joint **workshops** also involving further industrial stakeholders
- Organize joint **dissemination activity**
- Mapping regional/national activities vs EU projects on catalysis
- Organize joint **advanced training activity** and skill enhancment at both academic and industrial level
- Database on materials for catalysis

Cluster on catalysis structure

European Commission

WG1

WG topic and subtopics	WG Leader and WG subtopic leaders	Participants
Scientific and technical issues (WG1)	**E. Hensen (Novacam)**	
Catalysis fields (e.g. homogeneous, heterogeneous, photocatalysis etc.) and integration thereof (WG1a)	G. Centi (NEXT-GTL, ERIC)	L. Curri (Limpid, photocatalysis), B. Etzold (SusFuelCats), E. Klemm and A. Sepulveda (ENMIX, porous materials, membranes), S. Perathoner (INCAS, INSTM), R. Beranek and W. Macyk (4G-Photocat), E. Hensen (Novacam), F. Katsaros (NEXT-GEN CAT), P. Davies (PCTADES)
Advanced analytical approaches in catalysis, in situ and in operando studies (WG1b)	B. Etzold (SusFuelCats)	M. Rønning (Freecats), E. Hensen (Novacam), P. Davies (PCTADES)
Modeling, design and development of novel catalysts (WG1c)	G. Gianbastiani (CNR, Freecats)	G. Gianbastiani (Freecats), E. Hensen (Novacam), G. Marin (OCMOL), E. Klemm and A. Sepulveda (ENMIX, porous materials, membranes), G. Granozzi (Decore), D. Serrano (CASCATBEL), D. Akporiaye (Fastcard, modeling), R. Berankek (4G-Photocat), P. Davies (PCATADES), E. Schols (CyclicCO2R), R. Navarro (DEMCAMER),
Transition from critical raw materials to abundant elements based catalysts (→ coordination with EU Cluster on Raw Materials (WG1d)	M. Rønning (Freecats)	R. Berankek (4G-Photocat), P. Cool (NEXT-GEN CAT)
Processes and scale-up, industrialization (WG1e)	G. Saracco (Eco2CO2)	G. Marin (OCMOL), E. Klemm (ENMIX), G. Centi (NextGTL, ERIC), F. Katsaros (NEXT-GEN CAT), E. Schols (CyclicCO2R), I. Bedel (CEOPS), Paul Collier(JM), B. Etzold (SusFuelCats), J. Komornicki (CEFIC-Suschem), N. Kos (Capita)

Expected deliverables

European Commission

WG1

Sub-WG	Expected deliverable	Delivery date
Catalysis fields (e.g. homogeneous, heterogeneousetc.) and integration thereof (WG1a)	Short report	June 2016
	Inputs for Roadmap (WG3a)	January 2016
	Suggestions for calls	January 2016
Advanced analytical approaches in catalysis, in situ and in operando studies (WG1b)	Short report	June 2016
	Inputs for Roadmap (WG3a)	January 2016
	Suggestions for calls	January 2016
Modeling, design and development of novel catalysts (WG1c)	Short report	June 2016
	Inputs for Roadmap (WG3a)	January 2016
	Suggestions for calls	January 2016
Transition from critical raw materials to abundant elements based catalysts (→ coordination with EU Cluster on Raw Materials (WG1d)	Short report	June 2016
	Inputs for Roadmap (WG3a)	January 2016
	Suggestions for calls	January 2016
Processes and scale-up, industrialization (WG1e)	Short report	June 2016
	Inputs for Roadmap (WG3a)	January 2016
	Suggestions for calls	January 2016

Expected deliverables

WG2

WG topic and subtopics	WG Leader and WG subtopic leaders	Participants
Networking, synergies and international cooperation (WG2)	**E. Klemm (ENMIX)**	
Networking among the projects, synergies/integration with EU bodies and initiatives (ERIC, SusChem, EMIRI, Eurokin, DeChema , SPIRE, etc.) (WG2a)	D. Serrano (CASCATBEL)	P. Cool (NextGenCat), S. Perathoner (INCAS, INSTM), J. L. Viviente (DEMCAMER), D. Serrano (CASCATBEL), N. Kos (CAPITA), G. Marin (OCMOL)
International cooperation (WG2b)	G. Centi (NextGTL, ERIC)	L. Curri (Limpid, Asean countries), Zinfer Ismagilov (DEMCAMER, Russia),
Market survey, interactions/involvement/networking of industry stakeholders and end-users (WG2c)	D. Akporiaye (Fastcard)	J. L. Viviente (DEMCAMER), Paul Collier (JM) J. Komornicki (CEFIC-Suschem), N. Kos (Capita)

Cluster on catalysis structure

European Commission

WG2

Sub-WG	Expected deliverable	Delivery date
Networking, synergies and international cooperation (WG2)	**E. Klemm (ENMIX)**	
Networking among the projects, synergies/integration with EU bodies (ERIC, SusChem, DeChema etc.) (WG2a)	Short report Networking activity established Suggestions for calls (e.g. CSA)	June 2016 January 2016 January 2016
International cooperation (WG2b)	Short report Networking activity established	June 2016 January 2016
Market survey, interactions/involvement/networking of industry stakeholders and end-users (WG2c)	Short report Market survey Database of industry stakeholders and end-users	June 2016 March 2016 March 2016

Cluster on catalysis structure

WG3

WG topic and subtopics	WG Leader and WG subtopic leaders	Participants
Policy, roadmapping, regulations, dissemination (WG3)	**S. Perathoner (INCAS, INSTM)**	
European Roadmap on Catalysis (WG3a)	M. Hollestelle (CAPITA)	F. Katsaros (NextgenCat), D. Akporiaye (Fastcard), S. Perathoner (INCAS, INSTM), J. L. Viviente (DEMCAMER), G. Granozzi (Decore), P. Davies (PCATDES)
Training & Education, Dissemination, Popularisation in the field of catalysis (WG3b)	to be defined	N. Majcen (EuChems), J. Viviente (DEMCAMER), F. Katsaros (NextgenCat), E. Klemm (ENMIX, porous materials), G. Saracco (Eco2CO2)
Policy and inputs for next H2020 calls (WG3c)	L. Bedel (CEOPS)	G. Saracco (Eco2CO2), G. Centi (NextGTL, ERIC), D. Serrano (CASCATBEL), Paul Collier (JM)
Standardisation, regulation, safefy issues (WG3d) (→ coordination with ReACh, ECHA, NanoSafetyCluster)	L. Curri (Limpid)	F. Katsaros (NextgenCat)
Webpage of the Cluster on Catalysis (WG3e)	J. Viviente (DEMCAMER)	E. Schols (CyclicCO2R), Gianbastiani (CNR, Freecats)
Compendium of the Cluster	F. Katsaros (NextgenCat)	J. Viviente (DEMCAMER), L. Curri (Limpid), G. Gianbastiani (Freecats, CNR)

Expected deliverables

WG3

Sub-WG	Expected deliverable	Delivery date
Policy, roadmapping, regulations, dissemination (WG3)		
European Roadmap on Catalysis (WG3a)	Survey of existing RM Collection of inputs from WG1 and WG2 Roadmap	June 2015 January 2016 June 2016
Training & Education, Dissemination, Popularisation in the field of catalysis (WG3b)	Training and dissemination activity at EU level planned	October 2015
Policy and inputs for next H2020 calls (WG3c)	Collection of inputs from WG1 and WG2 Collection of policy and suggestions for call	January 2016 June 2016
Standardisation, regulation, safefy issues (WG3d) (→ coordination with ReACh, ECHA, NanoSafetyCluster)	Survey of state of the art Joint document Suggestions for calls	June 2016 January 2016 January 2016
Webpage of the Cluster on Catalysis (WG3e)	First draft of webpage available Completed webpage	March 2016 January 2016
Compendium of the Cluster	Template for Compendium First draft of Compendium Final version	March 2015 June 2015 January 2016

Cluster on catalysis structure

European Commission

WG1

WG topic and subtopics	WG Leader and WG subtopic leaders	Participants
Scientific and technical issues (WG1)	**E. Hensen (Novacam)**	
Catalysis fields (e.g. homogeneous, heterogeneous, photocatalysis etc.) and integration thereof (WG1a)	G. Centi (NEXT-GTL, ERIC)	L. Curri (Limpid, photocatalysis), B. Etzold (SusFuelCats), E. Klemm and A. Sepulveda (ENMIX, porous materials, membranes), S. Perathoner (INCAS, INSTM), R. Beranek and W. Macyk (4G-Photocat), E. Hensen (Novacam), F. Katsaros (NEXT-GEN CAT), P. Davies (PCTADES)
Advanced analytical approaches in catalysis, in situ and in operando studies (WG1b)	B. Etzold (SusFuelCats)	M. Rønning (Freecats), E. Hensen (Novacam), P. Davies (PCTADES)
Modeling, design and development of novel catalysts (WG1c)	G. Gianbastiani (CNR, Freecats)	G. Gianbastiani (Freecats), E. Hensen (Novacam), G. Marin (OCMOL), E. Klemm and A. Sepulveda (ENMIX, porous materials, membranes), G. Granozzi (Decore), D. Serrano (CASCATBEL), D. Akporiaye (Fastcard, modeling), R. Berankek (4G-Photocat), P. Davies (PCATADES), E. Schols (CyclicCO2R), R. Navarro (DEMCAMER),
Transition from critical raw materials to abundant elements based catalysts (→ coordination with EU Cluster on Raw Materials (WG1d)	M. Rønning (Freecats)	R. Berankek (4G-Photocat), P. Cool (NEXT-GEN CAT)
Processes and scale-up, industrialization (WG1e)	G. Saracco (Eco2CO2)	G. Marin (OCMOL), E. Klemm (ENMIX), G. Centi (NextGTL, ERIC), F. Katsaros (NEXT-GEN CAT), E. Schols (CyclicCO2R), I. Bedel (CEOPS), Paul Collier(JM), B. Etzold (SusFuelCats), J. Komornicki (CEFIC-Suschem), N. Kos (Capita)

Cluster on catalysis structure

European Commission

WG2

Sub-WG	Expected deliverable	Delivery date
Networking, synergies and international cooperation (WG2)	**E. Klemm (ENMIX)**	
Networking among the projects, synergies/integration with EU bodies (ERIC, SusChem, DeChema etc.) (WG2a)	Short report Networking activity established Suggestions for calls (e.g. CSA)	June 2016 January 2016 January 2016
International cooperation (WG2b)	Short report Networking activity established	June 2016 January 2016
Market survey, interactions/involvement/networking of industry stakeholders and end-users (WG2c)	Short report Market survey Database of industry stakeholders and end-users	June 2016 March 2016 March 2016

Cluster on catalysis structure

WG3

WG topic and subtopics	WG Leader and WG subtopic leaders	Participants
Policy, roadmapping, regulations, dissemination (WG3)	**S. Perathoner (INCAS, INSTM)**	
European Roadmap on Catalysis (WG3a)	M. Hollestelle (CAPITA)	F. Katsaros (NextgenCat), D. Akporiaye (Fastcard), S. Perathoner (INCAS, INSTM), J. L. Viviente (DEMCAMER), G. Granozzi (Decore), P. Davies (PCATDES)
Training & Education, Dissemination, Popularisation in the field of catalysis (WG3b)	E-MRS	E-MRS J. Viviente (DEMCAMER), F. Katsaros (NextgenCat), E. Klemm (ENMIX), G. Saracco (Eco2CO2). SCOT Consortium
Policy and inputs for next H2020 calls (WG3c)	L. Bedel (CEOPS)	G. Saracco (Eco2CO2), G. Centi (NextGTL, ERIC), D. Serrano (CASCATBEL), Paul Collier (JM)
Standardisation, regulation, safefy issues (WG3d) (→ coordination with ReACh, ECHA, NanoSafetyCluster)	L. Curri (Limpid)	F. Katsaros (NextgenCat)
Webpage of the Cluster on Catalysis (WG3e)	J. Viviente (DEMCAMER)	E. Schols (CyclicCO2R), Gianbastiani (CNR, Freecats)
Compendium of the Cluster	F. Katsaros (NextgenCat)	J. Viviente (DEMCAMER), L. Curri (Limpid), G. Gianbastiani (Freecats, CNR)

Ongoing Activities of the Cluster

- Website in preparation (www.catalysiscluster.eu) to be completed by end of August 2015
- Compendium in preparation to be completed by end of August 2015

Cluster on catalysis scope

Thank you for your attention

For any information/adhesion to Cluster:

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