



## Summary report of the

### COOPERATION WORKSHOP of the SET-Plan Action 6

#### on "Continuing efforts to make EU industry less energy intensive and more competitive"

27-28 June 2018, La Tricoterie, 158, Theodore Verhaegen straat, B-1060 Saint-Gilles (Brussels)

### Executive summary

#### Objectives

The Implementation Plan<sup>1</sup> of the Strategic Energy Technology (SET) Plan Action 6 on "Continuing efforts to make EU industry less energy intensive and more competitive" was endorsed by the SET Plan Steering Group on 29 September 2017. It describes the future activities that will contribute to reaching the targets defined by the Temporary Working Group, which includes the SET Plan Countries representatives and the stakeholders.

**This Cooperation Workshop aimed to contribute to the realisation of the Implementation Plan: enhancing cooperation between National programmes and further developing the activities into actual projects.**

#### Attendance statistics

Out of a total of more than 180 registrations, 140 did actually participate: 70 industry, 26 research, 17 academia (i.e. 113 stakeholders), 17 EU institutions, 9 national government and 1 regional government representatives. All groups were well represented, except for the Countries: 8 Countries (AT, CH, DE, ES, FI, IT, SE and TR) were represented, some Countries could not send delegates despite active participation in the Working Group.

#### Proceedings of the workshop

The workshop started earlier for the **Countries** and Commission representatives who held a closed session sharing concrete experience on **bi-multi lateral cooperation**.

The workshop was then formally **opened by the chair** of the Working Group, Timo Ritonummi (representative for Finland) to include the stakeholders from industry, research and academia. Haitze Siemers, Head of Unit, DG Energy, highlighted the critical **contribution expected from industry** to meet the European energy and climate targets and to create jobs and acknowledged the remarkable **progress achieved so far** by the SET Plan Working Group on energy efficiency in industry, towards concrete implementation through this workshop.

The Country Representatives shared the results of their closed session: they presented possible **cross-country cooperation models**: the so-called 'Berlin Model', by which each partner is funded by 'his' country and the EUREKA network project model. Four Countries representatives

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<sup>1</sup> [https://setis.ec.europa.eu/system/files/set\\_plan\\_ee\\_in\\_industry\\_implementation\\_plan.pdf](https://setis.ec.europa.eu/system/files/set_plan_ee_in_industry_implementation_plan.pdf)

presented their **National R&I funding programmes** with a focus on energy efficiency and emissions reductions in industry, and cross-country cooperation.

The **European Energy and Climate Policies** were presented with a focus on industry, including future funding opportunities: the R&I framework programme 'Horizon Europe' (2021-2027) and the 'Innovation Fund' in support breakthrough low-carbon technologies in industry. The **Anti-trust and State-Aid rules** were also presented with a focus on R&I and large scale demonstrations of innovative technologies in industry.

The core of the workshop then started with the **parallel sessions addressing the four priorities** of the Implementation Plan: Steel, Chemical, Heat & Cold and Systems.

The **Steel sessions** addressed the possibilities of the EU steel industry to improve its resource efficiency and drastically reduce its CO<sub>2</sub> emissions, in particular for the primary steel making. The seven projects presented have already started to address the first feasibility or pilot phase(s). But the next phases - pilot or industrial scale demonstrations – are yet to be launched. The challenges and opportunities of the various innovative solutions were discussed, as well as the prerequisites to make them a success: regulatory framework, funding support and cooperation between stakeholders.

The other **sessions Chemical, Heat & Cold, Systems** were organised differently. Rather than projects that have already started, 'Project Ideas' were collected and shared before the workshop. Each session began with very short presentations of the project ideas. Where complementary, the ideas were then clustered and discussed in several roundtables to initiate the building of potential collaborative projects.

In the **Chemical and System sessions**, most of the project ideas were related to a specific product, technology or programme, so they were discussed individually. These focussed discussion groups contributed to confront the ideas to outsiders, develop them and identify interested partners.

In the **Heat & Cold sessions**, the Project Ideas were more complementary and could be clustered. In the roundtables, the participants brainstormed on potential way to optimise the ideas presented and to integrate the different technologies with the final aim to increase the energy efficiency in industry. This raised not only the interest of research institutes but also of industrial stakeholders (users and manufacturers) who expressed their interest to be involved in future projects.

The workshop finished with the **final session**, including reports from the parallel sessions to all participants and the concluding statement by the Chair.

### Outcomes

From the presentations and discussions on **cooperation between Countries**, the Countries have expressed their readiness to open bi-multi-lateral cooperation using the Berlin or EUREKA models, whereby coordinated calls are opened on specified areas in two or more Countries and each Country funds 'its own' beneficiaries. Two conditions apply: (i) the area is in line with National priorities; (ii) there is in each Country a critical mass of interested beneficiaries in the specified area, so that calls for proposals would be open and competitive.

The **sessions on Steel** enabled the steel makers and other stakeholders to have an open discussion on the various technologies and to identify specific areas where on-going innovative projects could cooperate. This first contact was facilitated by the presence of the Commission in a sector where compliance with Anti-trust rules is a sensitive issue. The needs to cooperate with energy

suppliers and to blend funding sources were also identified for large scale demonstration and future deployment.

The **sessions on Chemicals** allowed stakeholders to exchange on generic topics such as process intensification, electrification. The sessions also enabled discussion on specific project ideas and identification of interested partners.

The **sessions on Heat & Cold** allowed the stakeholders to develop the Project Ideas and in several cases to cluster similar ideas. This group of candidate projects showcases a wide interest for this area, with a potential for bi-multi-lateral Countries cooperation.

The **sessions on Systems**, allowed the stakeholders to confront the ideas to outsiders, develop them and identify interested partners. In the particular area related to 'Digitisation' in the Systems priority, some project ideas developed into candidate projects that could be submitted under the relevant Horizon 2020 'SPIRE' call for proposals.

Globally for all four priorities, the Workshop discussions confirmed a wide interest from the attendees in several areas defined by clusters of Project Ideas (see Table 1 below) but there is not yet a sufficient critical mass of stakeholders in a group of Countries that could justify launching bi-multi-lateral cooperation in these areas.

#### Next steps:

- Upload all workshop materials on a Website accessible to all participants and members  
(done: <https://webgate.ec.europa.eu/fpfis/wikis/display/SETA6EFFIND> )
- Support the development of Activities/Project ideas into projects
- Facilitate cross-border cooperation towards joint calls between countries, by mapping the interest in Areas (or clusters of Project Ideas) from stakeholders through an open consultation, to identify Countries with a critical mass of potential beneficiaries;
- Facilitate cross-border cooperation between relevant Countries, namely through dedicated workshop sessions
- Take into consideration the identified Project Idea clusters / Areas, when defining the future EU R&I funding programmes
- Continue to organise regularly networking events similar to this workshop
- Provide support to all these actions by means of a service contract

**Table 1: mapping of number of interested partners per Area/Activity** (i.e. summing the partners interested in the Project Ideas relevant to the Activity/Area as defined in the Implementation Plan).

Priority	Activity No	Activity name	Contributing ideas	Countries															
				AT	BE	CH	DE	ES	FI	FR	GR	IT	NL	NO	PT	SE	TR	UK	US
1A-Steel	ST1A.1	CO2 emission avoidance through direct reduction	25, 34, 41,43	2			3			1						3			
1A-Steel	ST1A.2	Hisarna smelting reduction process	30	1			2			1			1						
1A-Steel	ST1A.3	Top Gas Recycling – Blast Furnace	33, 46		1					3					1				
1B-CHEM	CH1B.1	Process intensification	5, 6,44		1	2	2	2							1				
1B-CHEM	CH1B.3	Power-to-X & unconventional energy	10, 11, 13, 20, 45				2	2					2	1	2		1		
3-Heat & Cold	HE3.2	Heat upgrade	29		4				1			1	1	1				2	
3-Heat & Cold	HE3.3	Heat-to-Power (electrical) recovery	3, 14, 15, 16, 18, 36		3		1		1			4		2				2	
3-Heat & Cold	HE3.4	Poly-generation	7,9, 13, 29,35		2	1	3	3	1	1	1	6	2	3				3	1
5-SYST	SY5.1	Symbiosis and non-conventional energy	17, 38, 39, 40	1	2	1	5	1	1	3			2					2	
5-SYST	SY5.2	Digitisation	1, 21, 26, 37					1		1		2		2					
5-SYST	SY5.3	Knowledge exchange, training and capacity	12, 42, 47									1		1				1	
				Colour code:			Nb of partners within:			1-2	3-4	5-6							

Workshop structure (Detailed agenda in Annex)

Day1	duration	Room "Mezzanine" UPSTAIRS		
08:30	0:15	Welcome - registration (Countries representatives & Commission only)		
08:45	1:40	<b>A - Possible bi-multi lateral cooperation models (Countries representatives &amp; Commission only)</b> - Summary presentation of possible bi-multi-lateral Cooperation models - <i>Piotr Swiatek - Germany</i> - Eureka Network Platform for International R&D&I Cooperation - <i>Maria del Pilar Gonzalez-Gotor - Spain</i> - Nordic cooperation - how to make regional cooperation work - <i>Susanna Widstrand - Sweden</i> - Discussion on cooperation models to identify the most appropriate models		
10:25	0:20	Welcome - Registration - Coffee - room "Foyer" - Ground floor (All)		
		Room "Arches" - Ground Floor		
10:45	2:05	<b>B – Possible cooperation models - National and EU programmes</b> <i>Moderator: Ian Andersen, DG Interpretation</i> - <b>Welcome</b> - <i>Timo Ritonummi - Chair of the SET Plan Working Group on Energy Efficiency in Industry</i> - <b>Opening speech</b> - <i>Haitze Siemers, Head of Unit New energy technologies &amp; Innovation, DG Energy</i> - <b>Presentation of the outcome of session A and Q&amp;A with stakeholders</b> - <i>Countries representatives</i> - <b>National R&amp;I programmes in Energy Efficiency in Industry</b> - <i>Countries representatives</i> - <b>EU Energy/Climate policy and funding opportunities in Energy Efficiency in Industry</b> - <i>Eric Lecomte</i> - <b>Introduction to Parallel sessions</b> - <i>Eric Lecomte, DG Energy</i>		
12:50	1:10	Lunch break - room "Foyer" - Ground floor		
		<b>1 - Steel</b>	<b>2 - Chemical</b>	<b>3 - Heat&amp;Cold (H&amp;C)</b>
		Room "Mezzanine" UPSTAIRS	Room "Arches" Ground floor	Room "Salon" DOWSTAIRS
14:00	0:30	1a-2a - Regulatory context: <i>(together with "Chemical" in room "Arches")</i>	1a-2a - Regulatory context: - Information on Anti-trust regulation - Information on State Aid rules	3a - Implementation Plan for H&C - EU & National programmes in H&C
14:30	1:45	1b - Activity 1A.1 Direct Carbon Avoidance	2b - Activities 1B.1– Process intensification & 1B.2-Separation	3b - Activity 3.2 – H&C upgrade & 3.4 - Polygeneration
16:15	0:30	Coffee break - room "Foyer" - Ground floor		
16:45	1:45	1c - Activity 1A.2&3 - Smart Carbon Usage thru Process Integration	2c - Activity 1B.3 – Electrification (Power-to-X, unconventional sources)	3c - Activity 3.3 – Heat-to-power
18:30	1:30	<b>Networking cocktail</b> - room "Foyer" - Ground floor		
20:00		End of Day1		
Day2	duration	Room "Arches" - Ground Floor		
08:15	0:15	Welcome		
		<b>4 - Systems</b>		
08:30	1:30	4a - Activity 5.3- Knowledge exchange, training and capacity building		
10:00	0:30	Coffee break - room "Foyer" - Ground floor		
10:30	1:30	4b - Activity 5.1a - Symbiosis & 5.1b-Non-conventional energy sources		
12:00	0:15	Short break - room "Arches" - Ground Floor		
12:15	1:30	4c - Activity 5.2 Digitisation		
13:45	0:50	Lunch break - room "Foyer" - Ground floor		
14:35	1:55	<b>C - Outcome of parallel sessions:</b> - presentation of emerging projects resulting from discussions and - first feedback from Countries representatives <b>- Conclusions</b>		
16:30		End of Day2		

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## *Detailed report on the Workshop sessions*

### **PLENARY SESSION-A – CLOSED SESSION FOR COUNTRIES REPRESENTATIVES**

The workshop started earlier for the Countries and Commission representatives who held a closed session sharing concrete experience on bi-tri-multi lateral cooperation. The various cooperation models were discussed to select the models that would be relevant for the types of projects of Action6 and presented to the full audience in the following session.

### **PLENARY SESSION-B: OPENING, COOPERATION MODELS, NATIONAL AND EUROPEAN R&I PROGRAMMES**

The workshop then formally opened to the complete attendance including also the stakeholders from industry, research and academia. The chair of the Working Group, Timo Ritonummi (representative for Finland) welcomed the participants and recalled the objectives of the workshop.

Haitze Siemers, Head of Unit New energy technologies & Innovation, DG Energy, gave the opening speech. He highlighted the critical contribution expected from industry to meet the European energy and climate targets and to maintain its competitiveness: this is a necessary condition, not only for creating jobs in Europe, but also to show the rest of the world this is a sustainable and prosperous way to go. He recalled the policy context of the SET Plan and acknowledged the remarkable progress achieved so far by the Working Group on energy efficiency in industry to co-define a strategy: priorities, targets and implementation plan, and most importantly to progress on their realisation through this workshop.

Four Country Representatives shared the results of their closed session, presenting their National R&I funding programmes with a focus on energy efficiency and emissions reductions in industry, and possible cross-country cooperation models. The representative for Germany, Piotr Swiatek, presented the so-called 'Berlin Model', by which each partner has to be funded by 'his' country. This model was used for bilateral cooperation of Germany with Finland, Greece and multilateral with Austria and Switzerland. In particular it was used to launch a call for cooperation projects between Finland and Germany on Energy Efficiency in Industry (and other topics) in 2012. The 'Berlin Model' can of course be used by other Countries without German participation; its principles are used in the Nordic Energy Platform for cooperative research between Denmark, Finland, Iceland, Norway and Sweden. The representative for Spain, Pilar Gonzalez-Gotor, presented the EUREKA network project model, with participants in at least two Eureka countries and national evaluation procedures and funding. Since 1985, 6500+ projects for a total budget of €42 billion have been launched in 40 Eureka countries. Susanna Widstrand (Sweden) and Elvira Lutter (Austria) also presented their countries' R&I programmes and proposals. The Swedish authorities see the Berlin model as an efficient option, but the ERA-NET Co-fund is also good.

One key aspect is that Sweden may agree to fund project partners that are not Swedish if the project leader/coordinator is from Sweden and these partners have unique competences and/or research infrastructures that serve the purpose of the project.

Eric Lecomte, Policy Officer, DG Energy, presented European Energy and Climate Policies with a focus on industry targets, challenges and opportunities linked to the transition to low carbon emissions and the switch to new energy sources and vectors. The next R&I framework programme 'Horizon Europe' (2021-2027) was also presented, in particular the clusters 'Digital and Industry' and 'Climate, Energy and Mobility' relevant to industry.

On behalf of DG Climate colleagues, Eric Lecomte also presented the revised Emissions Trading Scheme (ETS) directive: the strengthening of the ETS through steeper reduction of emissions allowances is balanced with free allocations for sectors exposed to global competition (risk of 'carbon leakage') as well as the low carbon 'Innovation Fund' and 'Modernisation Fund'. Especially the Innovation Fund aims to support renewables and carbon capture and storage (CCS) as well as, large scale first-of-a-kind demonstration of breakthrough low-carbon technologies in industry.

## **PARALLEL SESSIONS: STEEL, CHEMICAL, HEAT & COLD, SYSTEMS**

In a joint session including Steel and Chemical stakeholders, Andrei Murarasu, Case Handler, DG Competition, presented the **Anti-trust rules and compliance** with a focus on R&I and Katarzyna Piechucka-Thom, DG Competition, presented the **State-Aid rules** with a focus large scale demonstrations of innovative technologies in industry.

### **1. Steel sessions**

The Steel sessions addressed the possibilities of the EU steel industry to improve its resource efficiency and drastically reduce its CO<sub>2</sub> emissions, in particular for the primary steel making, i.e. the production of crude steel from iron ore. Two pathways are considered: Carbon Direct Avoidance (CDA) replacing coal by hydrogen or electricity, and Smart Carbon Usage (SCU) by process integration with reduced use of carbon or by end-of-pipe carbon capture and use – CCU. The different pathways can be combined with carbon capture and storage (CCS) technologies

The projects presented have already started to address the first phase(s): feasibility or pilot scale demonstration. But the next phases - pilot or industrial scale demonstrations – are yet to be launched. The challenges and opportunities of the various innovative solutions were discussed, as well as the prerequisites to make those solutions a success: regulatory framework, funding support and cooperation between stakeholders.

#### **Key messages on regulatory framework:**

- The EU steel industry needs EU legislation that preserves its competitiveness vs. other regions in the world; an economically healthy EU industry is important allowing for continued investments in R&D and its implementation at industrial scale.
- The legal and societal opportunities and limitations of CCS need to be better addressed.

- Access to sustainable energy vectors (electricity, H<sub>2</sub>) at competitive prices is key for much needed business cases.
- A market for new low-carbon products needs to be created

**Key messages on funding support:**

- Inter-operability and blending of funding sources are needed for funding short term, mid-term as well as long term projects

**Key messages on Cooperation between the stakeholders:**

- Develop a common understanding on challenges and ways forward,
- Promote cooperation on specific research questions
- Identify synergies and promote a cross sectoral approach also between steel sector and energy providers.

**Carbon Direct Avoidance (CDA) - Project presentations**

1. Fossil free steel making using hydrogen produced by electricity from renewable energy sources (HYBRIT) – *Hybrit Development AB*
2. Salzgitter Low CO<sub>2</sub> Steelmaking (SALCOS) – *Salzgitter AG*
3. Technology development and demonstration for using hydrogen in Steelmaking (H2Steel) – *KI-MET GmbH*
4. Electrowinning of iron metal from iron oxides (SIDERWIN) – *ArcelorMittal*

The above three projects address replacing coal by hydrogen to reduce the iron ore. Large scale hydrogen production using water electrolyser is foreseen. The discussions addressed the potential for cooperation between the stakeholders on specific research questions; for example improving the efficiency of electrolysers for hydrogen production is a key research topic which would benefit from cooperation between the 3 projects.

**Smart Carbon Usage through Process Integration - Project presentations**

1. Hisarna smelting reduction process for lowering energy consumption and CO<sub>2</sub> emissions of steel production – *Tata Steel Europe*
2. Reduced energy consumption through process design including flue gas recycling on Submerged Arc Furnace – *SINTEF Industry*
3. Top Gas Recycling-Blast Furnace using plasma torch– *CRM Group*

**2. Chemical sessions**

The two sessions dedicated to the chemical sector were addressing priority areas of:

- process design including for the utilisation of alternative feedstock, process intensification, modular approach, catalyst, separation technologies;
- direct and indirect utilisation of electricity in the chemical production including power-to-X technologies and unconventional energy forms.

Nine presentations were shared during these two sessions. Most of them were related to a specific product and/or technology and therefore were discussed around a dedicated table.

During the first session, based on the additional priorities indicated by the participants, a group discussion was dedicated to process intensification reaction engineering and process design.

Another discussion which started around the systemic approach to energy management improvement in chemical clusters, was broadened to the challenge related to decision making in the chemical industry to address the ambitious climate objectives in a framework of a more diverse mix of energy and feedstock sources including

Project Ideas 23 and 45, both addressing the opportunities and challenges of the direct and indirect use of electricity in the chemical industry were discussed together.

### General discussion roundtables

- 1B.1-Process intensification, Reaction engineering / Process design: identification of areas for improvement (CEFIC, Evonik, BASF, CIEMAT, SINTEF, Solvay):
  - Catalysts: high challenge but difficult to address in collaborative approach,
  - reactor design: new concepts, (catalytic membrane reactors), 3D-printing
  - Modular flexible production units: closer to materials or to customers; how to make smaller cheaper; new business models
- 1B.1 GHG emissions reduction: from systemic approach for higher efficiency in chemical clusters to disruptive changes (derived from Idea 44)
  - optimisation of energy and resource efficiency in chemical clusters is a must
  - key technologies for higher efficiency include heat pumps for low temperature heat recovery and advanced process control
  - the ambitious 2050 climate targets require to go beyond the optimisation of existing processes and will entail major investments in disruptive technologies
  - support to decision making (through appropriate tools) will be key to the competitiveness of the European chemical industry in the context of a wide portfolio of technology options enabling the best utilisation of the a broader mix of feedstock sources and energy supply with their specific (regional) constraints.

### Project Idea roundtables – 1B.1 Process intensification and 1B.2 Separation

- Idea 6 (&5): Hybrid reconfigurable small size plants (Green Waste to Energy SL; CIEMAT)
  - Concept: whole value chain approach: from waste to products; contribution to circular economy; flexibility in feedstock supply
  - The challenges and risks: Economics of small size; Business case; impact of lower electricity prices on power generation economics
- Idea 27: NH<sub>3</sub> separation, Carbon free energy carrier, chemical storage (AEE-INTEC, SINTEF, Fraunhofer)
  - Concept: NH<sub>3</sub> is a safe energy carrier and can be used for long term energy storage. NH<sub>3</sub> can be obtained from waste streams (biogas residues, motorway stations, airports,...), waste water (waste water treatment plants – denitrification) etc. by membrane distillation technology which is running by low-exergy, low temperature excess heat or renewable

energy (eg solar thermal energy). NH<sub>3</sub> is converted in a fuel cell (SOFC) into electricity and heat; with this system low-exergy excess heat (eg from industrial processes,) which drives the membrane distillation to produce the NH<sub>3</sub> can be transformed into high-exergy energy (electricity and high temperature heat)

- Objective: Research is needed to further develop the fuel cell, as well the membrane and membrane module for membrane distillation
- Interested partners: AEE-INTEC, SINTEF, Fraunhofer, Newcastle University, Hayat Kimya San A.Ş., Mälardalen University, EURECAT
- Idea 10: Electrochemical H<sub>2</sub>S splitting into hydrogen and elemental sulfur (TUPRAS)
  - Concept: In the developed method, the electricity consumption is lower compared to the electrolysis of water. Also, deterioration of the electrodes by Sulfur is avoided, therefore the biggest obstacle for commercialization is eliminated
  - Objective: development of efficient, durable and cost-effective processes for the electrochemical splitting of H<sub>2</sub>S is a key challenge for the integration of these processes into the refineries
  - Interested partners: Repsol, Solvay, TUPRAS

### Project Idea roundtables – 1B.3. Power-to-X and unconventional energy sources

- Idea11: Power-to-fuel: CO<sub>2</sub> conversion technologies for chemical energy storage (CIEMAT)
  - Concept: the electro-chemically assisted catalytic conversion is applicable to different energy profiles: power stations (coal, biomass, waste) and other carbon-intensive industries, e.g. cement, steel but also biogas, biomass/waste thermal conversion. Use excess renewable energy (solar, wind) for H<sub>2</sub> production (mainly electrolysis), adjust demand, co-generation, grid balance, flexibility to the grid.
  - Objective: The process Technology is validated technically at TRL 4. Economic assessment and Process Modelling for optimization of design and implementation are needed to progress to TRL 5.
  - Next actions are: Identify partners & build a Consortium to submit a proposal to a suitable Call next year. In the meantime data published by partners will be shared to start working on modelling, techno-economic assessment, business case development.
  - Potential collaboration / partners: KORONA inzeniring, SUMITOMO SHI FW Energia Oy, SINTEF, Energy Center Politecnico Torino, Mälardalen University Future Energy Center, Eurecat, PDC, Hayat, Tüpras
- Idea 13: Plasma based waste gasification using renewable energy sources (CLARIANT)
  - Discussion: different options for use of syngas were jointly assessed/evaluated; partners have different kinds of feedstocks; Exchange with other companies active in the field
  - Interested partners: Sabic, Evonik, Hayat, Avantium, Materiales Renovados
- Idea 20: Production of renewable biofuels through water electrolysis with liquified biomass source and solar energy inputs (ISEL, GSYF, PT; PDC, NL; SINTEF, NO; Avantium, NL; Enrique Parre, ES)

- Objective: to perform the scale-up/construction of electrolyser and catalytic reactor prototype units, capable to produce syngas (TRL 4 to 5/6); Evaluate several kinds of biomass; Techno-economic evaluation
- Interested partners: ISEL, GSYF, PT; PDC, NL; SINTEF, NO; Avantium, NL
- Idea 45 & 23: Optimal direct or indirect use of electricity in chemical processes (BASF & Dow Benelux)
  - Discussions addressed: Role and impact of electricity powered chemical processes vs changing energy system. Which process to be converted to 100% electricity powered? What would be the gains? Re-design of existing processes taking into account grid developments. Material and construction challenges
  - Partners (types of): chemical companies (producers, OEM, EPC); electricity (grid operators, producers, OEM, EPC); research institutes

### 3. Heat and Cold session – Activity 3.2 (Upgrade) & 3.4 (Polygeneration)

In the area (3.2) of Heat upgrade, only one idea (29) was presented. It was discussed, developed by a group of 10 interested partners from 6 countries.

- Idea 29 - Thermal upgrade using multistage technologies (Innecs Power systems, NL)
  - Objective: upgrading - lifting very low temperature heat (40-70°C) by 100°C using chemi-sorption/heat pumps), offering large operational flexibility. TRL starting at 4 ending at 6 (Components development, system integration)
  - Interested partners: Aurubis (BE), Solvay (BE), Denercon (BE), Sumitomo SHI FW (FI), Innecs Power System (NL), KU Leuven (BE), University of Newcastle (UK), University of Stavanger (NO), University of Sheffield (UK), University of Genoa (IT)

In the area (3.4a) of poly-generation (heat, cold, power ...) for industrial applications, several ideas (7, 9, 35) were presented. In the roundtables, the participants brainstormed on potential way to optimise the ideas presented and to integrate the three different technologies with the final aim to increase the energy efficiency in industry. This raised not only the interest of research institutes but also of industrial stakeholders (users and manufacturers) who finally decided to be involved in future projects. This group of candidate projects showcases a wide interest for this area, with a potential for bi-multi-lateral Countries cooperation.

- idea 7 (& 9) – Hybrid-fuel poly-generation (heat, cold, power) system for industrial application
  - Description: combination of a solid oxide fuel cell (SOFC) and a micro gas turbine (MGT) hybrid fuel system; the system is flexible and can use natural or biogas and integrate industrial surplus heat - TRL starting at 3 ending at 6 (Components development, system integration)
  - Interested partners: UNIGenoa (IT), SINTEF (NO), BHGE (IT), MTT (NL), RINA (IT), DLR (DE), CERTH (GR), Siemens (DE), HiFLUX (UK), NETL (National Energy Technology Laboratory of the Department of Energy, US)
- idea 9 (7 & CHEM-13) – Multiple industrial waste to energy

- Description: Highly flexible gasifier for industrial waste; Fuel-cell quality syngas conditioning. TRL starting at 2 ending at 5 (Concept and components development)
- Interested partners: ADVENTUM (ES), CIEMAT (ES), IMESAPI (ES), U. Genoa (IT), SINTEF (NO)
- idea 35 (& 7) – Sustainable conversion of CO from Metallurgy industry
  - Description: Water Splitting technologies (using CO from metal industry) for hydrogen & electricity production. TRL starting at 3 ending at 6 (Components development / system integration)
  - Interested partners: SINTEF (NO), Arcelor-Mittal (FR), SUMITOMO (FI), Nordic Blue (NO)
- idea 29 - Low emissions compact CHP for industrial application
  - Description: Downsize high efficiency components for micro-CHP system (<2MWe) - gas/steam turbines – boilers and Heat Recovery Steam Generator; Fuel and operational flexibility; High temperature heat –source >600 °C; system integration using Digital twins
  - Interested partners: Aurubis (BE), Denercon (BE), Inneco Power System (NL), University of Stavanger (NO), University of Sheffield (UK), University of Genoa (IT); KTH (DE); Fincantieri (IT), Ansaldo (IT, CH), ENEA (IT), City University of London (UK)

#### **4. Heat and Cold session – Activity 3.3 (Heat-to-Power)**

In the area of heat-to-power conversion, several ideas focusing on the idea of improved thermal cycles for recovering more waste heat were presented, discussed and developed into several candidate projects with many interested partners from many countries. The two thematic concepts shall be further developed by the mentioned interested parties in a follow-up process after the workshop. This group of candidate projects showcases a wide interest for this area, with a potential for bi-multi-lateral Countries cooperation.

- ideas 3, 15, 18, 36 - Next generation power cycles (especially supercritical CO<sub>2</sub>) for wide temperature ranges
  - Description: Further development and adaptation of next generation power cycles (especially supercritical CO<sub>2</sub>) for achieving higher performance, lower costs, smaller size and wider temperature ranges using an environmental-friendly media. TRL starting at 3, ending at 7 (for components)
  - Interested partners: ENEA (IT), University of Genoa, Ansaldo (IT), BHGE (IT), Stavanger University (NO), SINTEF (NO), Siemens (DE), City University of London (UK), Sheffield University (UK), Newcastle University (UK), Solvay (FR), Aurubis (BE), SUMITOMO (FI)
- ideas 3, 14, 16 - Cost effective Organic Rankine Cycle (ORC) for low-grade heat-to-power
  - Description: Cost effective ORC for the use of low-grade heat for power generation or mechanical drive application.

- Tasks included: Design/selection of suitable working fluids; turbine design; direct/indirect evaporation; heat exchange recuperator/condenser; operability extension and thermal storage integration. Market needs and business models (purchasing/leasing).
- Interested partners: Aurubis (BE), Solvay (BE), Denercon (BE), University of Newcastle (UK), University of Stavanger (NO), University of Sheffield (UK), BHGE (IT), University of Genoa (IT), Siemens (DE)

## **5. System session - Activity 5.1 – Industrial symbiosis and non-conventional energy sources**

It can be noted that the ideas presented below covered a significantly wide array of topics, and varied from the follow-up of existing projects to new initiatives; however, the former made up the majority in this session. This mix is encouraging, as it shows on the one hand that the public (EU, national) and private funding invested so far have borne fruit, and on the other that the private sector is pushing to further develop ideas in order to ensure R&I development followed by market roll-out.

A number of partners from different backgrounds and countries are interested in contributing to these ideas. Since the work done to date is sometimes at an advanced level the discussion also included the concrete results and their deployment in time, thus giving any interested party the benefit of a clear(er) timeline regarding the future developments, the investment needs and the actual results. In terms of funding sources, the participants – both idea promoters and the other stakeholders – mentioned the need for a mix of private and public funding, including the Horizon 2020 and Horizon Europe programmes. A friendlier and more long-term regulatory framework was also seen as a pre-condition for enhanced (private) investments in such R&I activities

- idea 17: Strengthening the business case of Electrification via Power-to-Heat & Demand Response (SYMPOWER)
  - During roundtable discussion, participants could brainstorm and share expertise around electrification of industrial processes which could participate in balancing services: what are the challenges (CAPEX, the involvement of the electric sector stakeholders and especially the TSOs, new business models (decarbonisation), legislation uncertainty) and solutions. The proposal promises two main final achievements that are interconnected: decarbonisation of the process by min. 30%, while opening future perspectives for a complete decarbonisation; a shortened payback time for the investments. Currently the proposal is at TRL 3, the proposed project would result in a TRL5 stage.
  - Participants: European Copper Institute, stakeholders from Belgium, the Netherlands, Finland, etc.
- idea 38: Integration of a high temperature (800-1000°C) 24h/day solar process for energy intensive industries (EURONOVIA)
  - The running H2020 SOLPART project aims to develop and implement, for the first time, at a pilot scale, a high temperature (800-1000°C) 24h/day solar process for reactive particle thermal treatment in energy intensive non-metallic minerals' industries, such as cement, lime, phosphate or clay processing. More specifically, the project has focused on the thermal decomposition of carbonates, hydroxides and organic impurities in minerals with temperatures between from 150° and 900°C. Participants discussed the main

challenges: provide heat in a continuous mode including transport and storage systems; scale-up from multi kW to multi MW; high temperature design, construction, materials. Another subject that they would like to further explore with other stakeholders is the potential application of the project solutions to other applications outside the lime and cement sectors. The project partners have also applied for a patent based on their achievements.

- Potential partners: stakeholders from the engineering, materials and applications domains were interested in the projects and its future developments.
- Funding for follow-on of the running project: the project partners would like to continue the development of the results through another EU-funded project from an upcoming H2020 call. They are also aiming at obtaining the financial support of industrial companies from the relevant domains, in order to ensure faster market roll-out.
- idea 39: Re-use of carbon of steelmaking by fermentation of the steel mill gases into fuels and chemicals (Steelanol). (ARCELORMITTAL)
  - The partners presented some of the developments and market aspects of the work from the on-going Steelanol project. The focus here is to use carbon from the steel processes to produce fuels and chemicals, a solution that is (also) a CCU solution.
  - Carbon Capture and Use (CCU) had been identified early on as a solution to climate change mitigation, but many stakeholders had preferred other technologies. The CCU is now seen as a strong solution for some sectors, including steel. However, a number of measures need to be implemented in order to support its development and uptake. Participants identified the main needs for legal framework for CCU products: stable RED II directive and a good LCA methodology.
  - Funding from both public and private sources needed to demonstrate viability and roll-out, including in other technological sectors
- idea 40: Re-use of carbon of steelmaking by fermentation of the steel mill gases into fuels and chemicals – Carbon2Chem project. (Thyssen-Krupp)
  - The Carbon2Chem (C2C) project is a 10-years research projects funded from both public (German) and private (led by Thyssen-Krupp) sources.
  - Participants addressed the follow-up of running C2C project, which should ideally start in 2020, based on the promising results achieved so far. The potential topics to be addressed in the future project are: H<sub>2</sub> production from iron processing, using carbon for the production of chemicals (CO<sub>2</sub>-to-CO), improving systems' performance and efficiency, etc. Discussants also identified the need for additional regulatory support for the development and market roll-out of these solutions.
  - Potential partners that had expressed their interest during the meeting for various topics and applications within the future project: SINTEF (NO), CIEMAT (ES), Fundacio EURECAT (ES), HAYAT (TR)

## 6. System session - Activity 5.2 - Digitalisation

The ideas and project proposals presented show that there is a growing interest and work on the (further) digitization of the process industries in the EU. This digitization trend regards both the ‘classical’ digitization – e.g. the replacement of manual work or legacy technologies with digital ones – but also the new IT exploits, such as Big Data, IoT or AI. These ideas aim in generally at obtaining high TRLs (including a TRL 9) at the end of their projects. Many of these results would generally be applicable in both brown- and green-fields.

Throughout the discussions, it was noted that different types of stakeholders – companies, universities, research organizations, etc. – were interested in the ideas presented, and were discussing avenues for cooperation in the (near) future. Most of the companies were from the EU, Member States and Associated States (Norwegian or Turkish entities). The existence of possible funding opportunities under the H2020 calls was also seen as an opportunity for quick developments. Finally, the cross-sectorial/cross-cutting nature of digitization makes it easier for different types of stakeholders to cooperate on the proposed ideas and projects.

Though some project ideas (21, 26, 37) presented in this session have some similarities, they were discussed separately in 3 roundtables, to have reasonable group sizes and give more time for each project. Collectively, this group of candidate projects showcases a wide interest for this area, with a potential for bi-multi-lateral Countries cooperation but also for submitting proposals under the forthcoming H2020 call DT-SPIRE-06-2019<sup>2</sup>: *Digital technologies for improved performance in cognitive production plants* (IA, opening: 16/10/2018, deadline: 21/02/2019).

- idea 01: Cognitive energy optimization in design and operations / Digital twins (U. Oslo)
  - Objective: Implementation and demonstration of a maintainable, standards-based digital twin for energy and carbon minimization in 2-3 European process facilities with high energy and carbon footprints: e.g. Petroleum, Metallurgy, Base Chemicals, etc.
  - The project idea was well-received at a previous SPIRE brokerage event, and was met with interest in the SET-PLAN discussions as well. The discussion addressed the relevance/challenges of this project (modularity, standards, missing data, governance, ex-post controls). Another topic discussed was the potential structure of the project, and which topic can be addressed under which work-package.
  - Potential partners have been identified during the discussion (in addition to others identified during SPIRE brokerage event earlier)
  - Funding: the interest is in both EU and national and/or private funding opportunities. One possibility is the forthcoming call DT-SPIRE-06-2019 for which several potential partners had expressed a direct interest
  
- idea 21: Process Smartness using Digital Twins, Big Data Analytics and Smart Sensors (SINTEF)
  - Objective: to optimize the process by: adaptive intelligent operation (self-correction), Minimize environmental footprint; increasing manufacturing flexibility; error prevention instead of condition monitoring; develop model frameworks and data-based models.

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<sup>2</sup> <http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/dt-spire-06-2019.html>

- The aim is to advance the project ideas from a TRL5 level to a TRL9. The targeted primary energy savings potential are of 25%, while the GHG emissions savings potential is of 40%
  - Potential partners from the following categories: industry, vendors, R&D and academia, with an emphasis on IoT, robotics, big data, AI.
  - Funding: public and private funding sources are sought; one possible funding opportunity is the forthcoming H2020 call DT-SPIRE-06-2019
- idea 26: Real-time sustainable decision-making tool for monitoring and optimization in manufacturing processes (TECNALIA)
    - Objective of the project: Detect changes in the production process and make the system respond to these dynamic fluctuations. Increase production performance, reduce energy and resource consumption, waste or by-products production by more than 20%.
    - Method: the optimization proposes three work streams under data capture, process/plant model and machine learning. The plant model and machine learning are based on interactive and self-learning process control integrated with management tools, definition and implementation of KPIs, standardised algorithms and interfaces, and the provision of optimization tools for real-time decision making in industrial processes. Numerous sensors need to be installed in order to capture and store data safely in order to enable the other two aspects.
    - Project targets: the aim is to advance the project ideas up to TRL7 level.
    - Looking for partners in data acquisition, communication, automation, analytics, modelling, prediction and standardisation of relevant data interfaces. Two use-cases had been proposed in the discussions, for the steel and chemical industries.
    - Funding: public and private funding sources are sought; one possible funding opportunity is the forthcoming H2020 call DT-SPIRE-06-2019
- idea 37: Hybrid mathematical/machine-learning modelling of a manufacturing plant archetype (Politecnico di Torino)
    - Main objectives of the proposed project are: global optimisation of the plants; hybrid modelling of a manufacturing process; data-driven machine-learning and mathematical modelling; decision support systems, etc. In addition, the proposed solutions aim at achieving energy savings and a reduction in CO2 emissions. The development of manufacturing plant archetypes can be applied to both brown and green-fields, depending on the existing situation and the available investments.
    - The idea was explored with different types of partners throughout the discussions.
    - Funding: public and private funding sources are sought; one possible funding opportunity is the forthcoming H2020 call DT-SPIRE-06-2019

## 7. System session - Activity 5.3

### Key messages

1- Having standard tools and methodologies for evaluating sustainability (incl. environmental impact, taking into account social, economic indicators) and for data formatting is essential for sharing data in order to optimize ecosystems, e.g. by normalization, black box use, co-simulation. Data are to be considered as resources and they should be controlled and kept by the owner.

2- Training on new methodologies at the university level, closer interfaces between industry and university and life-long learning in industry are essential. It includes solving complex problems (for example: optimisation with respect to multiple objectives having each local optimum), helping people to produce more (and innovative) ideas, providing interdisciplinary education, more generally educating people to make decisions in a blurred context.

3- Energy efficiency and sustainability can be improved by extending the scope beyond the sub-systems/plant border and so to exchange material and energy flows between various stakeholders: other industries, cities, local bodies. Large scale simulation tools are required (with multi-objective analysis) as well as training of policy and decision makers to foster dialog with experts.

### Project Idea roundtables

- Idea 12: Simplified Sustainability Screening and Evaluation Toolkit to support Decision Making in the Process Industries (Britest Ltd)
  - This project aims at further developing to TRL8 the toolkit framework developed (to TRL4) in the European project STYLE & building on recommendations from other related projects, e.g. SAMT, MEASURE, SCREEN
  - Development of an open access simplified sustainability evaluation toolkit, incorporating upfront materiality check to customise the tool for the specific user and scenario, qualitative screening for identification of hotspots, and semi-quantitative analysis features to allow early-stage evaluation of Societal, Economic and Environmental factors. The toolkit should particularly focus on the needs of SMEs and organisations lacking sustainability and provide them with training.
  - Scope is being developed as part of 2020 round of H2020 calls as “Integration of harmonized sustainability evaluations into decision making in the EU materials manufacturing and process industries” – output likely to be of value broader than SPIRE/ NMBP – potential for common action.
  - Interest was shown from SIDENOR, Newcastle University, University of Oslo. Potential partners should include representatives from key process sectors. Cooperation is also needed with social sciences regarding the phrasing and design of tool questions to ensure consistent responses and results interpretation
- Idea 42: Multicriteria optimization of industrial energy ecosystems (U. of Oslo)
  - Develop a numerical model of total site energy integration by making several simulators working together combined with an optimization algorithm. Further validation and demonstration on a real industrial site is also required.
  - New education forms for engineers and doctors and generally more interdisciplinary, jointly by academia and industry and associated to large scale demonstration experiments.

- Idea47: Master program on Innovation for Energy Efficiency and Sustainability in Industry and Services (Politecnico di Torino)
  - International program (indicative: 1 year, 15 students), taught in English, with a modular structure so that it can accommodate the demands / expectations of a broad variety of potential users, aimed at a “Totally Integrated European Energy Market”
  - Put great attention on the communication skills, which could represent a “social output” of the program, broadening its impact
  - The target should not be limited to manufacturing industry, but other sectors (including the media enterprises) should be involved
  - Some of the topics could be handled by MOOCS or blended-learning schemes: this would be mostly used for topics that are more general. More specific topics should however be handled locally, taking into account country/regional specific aspects (e.g. national or regional regulations, market or technical constraints, competing teaching & learning offering from universities and training agencies, etc.)
  - A topic which is considered critical is the assessment by Auditors of Sustainability Reports addressing diverse aspects such as: energy, resources, materials, waste ...
  - Potential partners of the project include: Universities, Professional Associations/Societies, Regulators, ESCOs, Consultancies

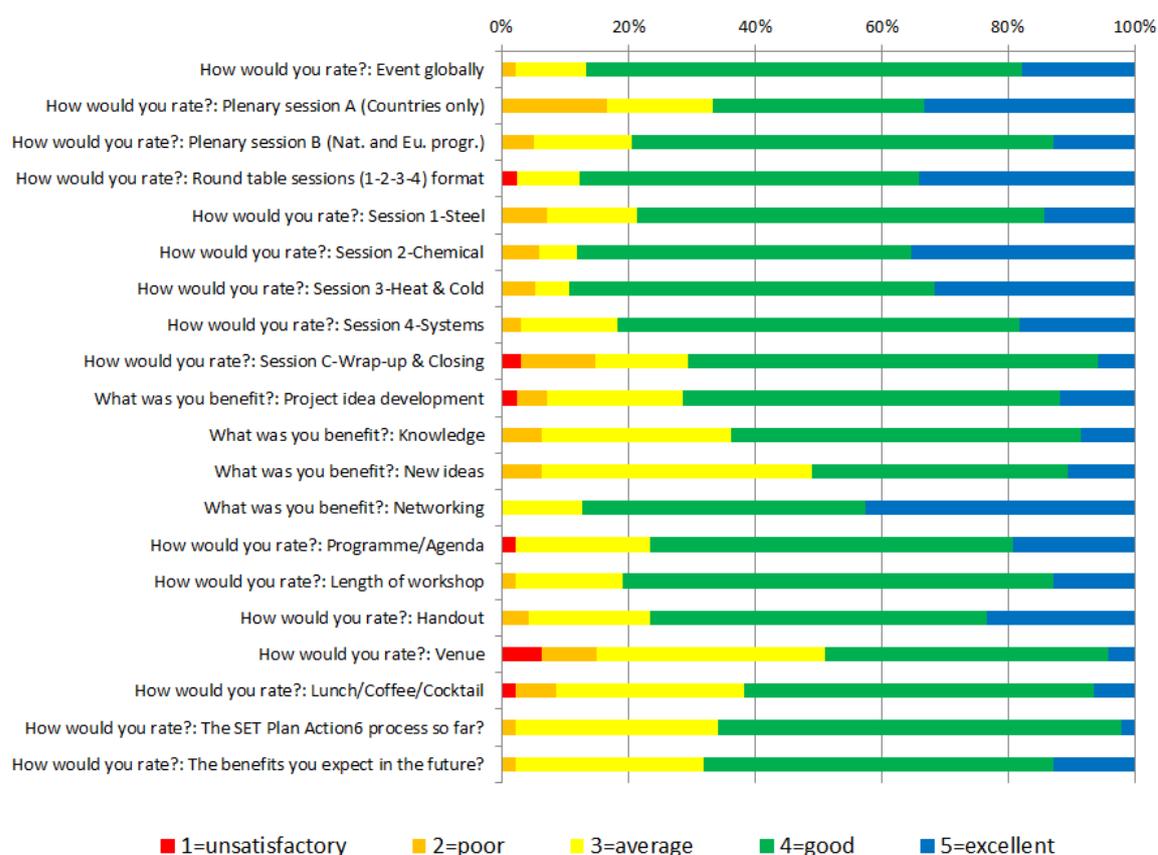
## ANNEXES

### 1. Workshop feedback survey: results

Just after the workshop, the participants were invited to fill in a feedback survey. 47 responded (=33% of 140), 3 Country representatives, 3 session moderators, 3 Commission, 17 Idea sponsors, 21 other participants.

For the assessments, the scale used was: 1-unsatisfactory, 2-poor, 3-average, 4-good, 5-excellent. Summing '4-good' and '5-excellent' answers, the '*positive assessments*' rate was calculated.

For the **event globally and for each session**, the 'positive assessments' rate amounted to a large majority: between 79 and 89%, except for Session-C-closing: 71%.



In terms of **benefits**, the 'positive assessments' rate was the largest for networking (87%), followed by idea development (71%), knowledge (64%), new ideas (51%).

The Workshop **materials** (programme/agenda, length, hand-out) were positively assessed by 77% to 81%.

The opinion on the **venue** was mixed: 4% excellent, 45% good, 36% average, 8% poor, 6% unsatisfactory. Refer to free text comments below ('What participants liked', 'What needs improvement')

The **SET Plan Action6 progress** 'so far' and 'in the future' are rated positively by 66% and 68% respectively.

From the open text questions:

*Note: the answers to the open questions are shared openly without approval/disapproval assessment by the Commission.*

**What participants liked:**

- roundtables format, open discussion, positive spirit, exchanges, opportunity to create networking and cooperation;
- balance between plenary, roundtables and networking; organisation and time-keeping;
- presence of relevant actors (member states, stakeholders, industry, EC...); bringing together project ideas, possible project partners and financial support from EU and MS;
- Venue: nice, versatile, informal, good for networking.

**What needs improvement:**

- Roundtable group size not to exceed 6-7p; more time to develop project ideas; more coordination of presentations beforehand; method to capture & communicate findings & workshop outcome; one moderator was sometimes discourteous, which was not fostering interactivity.
- More specific information regarding public funding (especially at MS level) and more clarity on practical ways of cross-border cooperation;
- Sharing clear objectives upfront & giving visibility on next steps at the end of the event (roadmap, outlook)
- Venue: chairs (lack of) comfort, air conditioning, security (no balustrades around stage), electric plug-ins, speakers' audibility, cross-noise during roundtables
- More time for discussions between countries

**Suggestion on the organisation of such workshop:**

- The workshop format is really good. More similar or shorter (1-1,5 days) workshops, not longer
- Identify topic / idea leads beforehand and provide them with necessary tools & info to capture, summarize and feedback results of the sessions; avoid discussions of two ideas from the same sponsor in two roundtables at the same time
- Finalise the preparation work, from 2016 to now: matching project ideas / roadmap with funding opportunities for research, possibly with just a few countries;
- MS representatives that indicate interest in the topic should be present at the event, and should provide more information on concrete budgets/funding schemes and funding synergies with other MS

**What do you expect from the SET Plan Action6 process?**

- Identify relevant priority areas, roadmap and process for the transformation of our industry to lower CO2 emissions and more efficient use of energy using advanced technologies;

- Keep track of emerging / innovative / economic technologies, finding partners for project setup and consortium building;
- Provide concrete funding opportunities for R&I: SET PLAN could define a "cloud" of R&I ideas, where institutions from only 2-3 countries pick up those consistent with their National plans and funding schemes, align their R&I programmes, launch calls and develop them jointly.

**How can the SET Plan Action6 best help? Any other suggestion?**

- Identify yearly the research priorities
- Track & communicate progress of key enabling technologies for the future energy transition
- Organise such (yearly) workshops and brokerage events; with regard to regulatory frameworks: discuss needs and convey them into the EC.
- Lead to a joint commitment of all stakeholders incl. MS - not only loose indications, to make it concrete now after spending quite some time and efforts.
- Publish funding call, coordinated with National budgets;
- More coordination and synergies with other EU programmes

## 2. Detailed agenda

Day1	duration	Room "Mezzanine" UPSTAIRS		
08:30	0:15	Welcome - registration (Countries representatives & Commission only)		
08:45	1:40	<b>A - Possible bi-multi lateral cooperation models (Countries representatives &amp; Commission only)</b> - Summary presentation of possible bi-multi-lateral Cooperation models - <i>Piotr Swiatek - Germany</i> - Eureka Network Platform for International R&D&I Cooperation - <i>Maria del Pilar Gonzalez-Gotor - Spain</i> - Nordic cooperation - how to make regional cooperation work - <i>Susanna Widstrand - Sweden</i> - Discussion on cooperation models to identify the most appropriate models		
10:25	0:20	Welcome - Registration - Coffee - room "Foyer" - Ground floor (All)		
		Room "Arches" - Ground Floor		
10:45	2:05	<b>B – Possible cooperation models - National and EU programmes</b> <i>Moderator: Ian Andersen, DG Interpretation</i> - <b>Welcome</b> - <i>Timo Ritoumami - Chair of the SET Plan Working Group on Energy Efficiency in Industry</i> - <b>Opening speech</b> - <i>Haitze Siemers, Head of Unit New energy technologies &amp; Innovation, DG Energy</i> - <b>Presentation of the outcome of session A and Q&amp;A with stakeholders</b> - <i>Countries representatives</i> - <b>National R&amp;I programmes in Energy Efficiency in Industry</b> - <i>Countries representatives</i> - <b>EU Energy/Climate policy and funding opportunities in Energy Efficiency in Industry</b> - <i>Eric Lecomte</i> - <b>Introduction to Parallel sessions</b> - <i>Eric Lecomte, DG Energy</i>		
12:50	1:10	Lunch break - room "Foyer" - Ground floor		
		<b>1 - Steel</b>	<b>2 - Chemical</b>	<b>3 - Heat&amp;Cold (H&amp;C)</b>
		Room "Mezzanine" UPSTAIRS	Room "Arches" Ground floor	Room "Salon" DOWSTAIRS
14:00	0:30	1a-2a - Regulatory context: <i>(together with "Chemical" in room "Arches")</i>	1a-2a - Regulatory context: - Information on Anti-trust regulation - Information on State Aid rules	3a - Implementation Plan for H&C - EU & National programmes in H&C
14:30	1:45	1b - Activity 1A.1 Direct Carbon Avoidance	2b - Activities 1B.1– Process intensification & 1B.2-Separation	3b - Activity 3.2 – H&C upgrade & 3.4 - Polygeneration
16:15	0:30	Coffee break - room "Foyer" - Ground floor		
16:45	1:45	1c - Activity 1A.2&3 - Smart Carbon Usage thru Process Integration	2c - Activity 1B.3 – Electrification (Power-to-X, unconventional sources)	3c - Activity 3.3 – Heat-to-power
18:30	1:30	Networking cocktail - room "Foyer" - Ground floor		
20:00		End of Day1		
Day2	duration	Room "Arches" - Ground Floor		
08:15	0:15	Welcome		
		<b>4 - Systems</b>		
08:30	1:30	4a - Activity 5.3- Knowledge exchange, training and capacity building		
10:00	0:30	Coffee break - room "Foyer" - Ground floor		
10:30	1:30	4b - Activity 5.1a - Symbiosis & 5.1b-Non-conventional energy sources		
12:00	0:15	Short break - room "Arches" - Ground Floor		
12:15	1:30	4c - Activity 5.2 Digitisation		
13:45	0:50	Lunch break - room "Foyer" - Ground floor		
14:35	1:55	<b>C - Outcome of parallel sessions:</b> - presentation of emerging projects resulting from discussions and - first feedback from Countries representatives <b>- Conclusions</b>		
16:30		End of Day2		

Day1	duration	Room "Mezzanine" - UPSTAIRS
		<b>1 - Steel</b>
14:00	0:30	<b>1a-2a - Regulatory context</b> (this joint session 1a-2a is taking place in the room of Session-2 Chemical) - Information on Anti-trust - <i>Andrei Murarasu - European Commission, DG Competition Unit E2</i> - Information on State aid - <i>Katarzyna Piechucka-Thom - European Commission, DG Competition Unit H2</i>
14:30	1:45	<b>1b - Activity 1A.1 - Carbon Direct Avoidance (CDA)</b> - <i>Jean-Theo Ghenda, Eurofer</i> - Introduction - <i>Jean-Theo Ghenda, Eurofer</i> - Project Idea presentations
		<b>Fossil free steel making using hydrogen produced by electricity from renewable energy sources (HYBRIT)</b> <i>Mårten Görnerup, HYBRIT Development AB (25)</i>
		<b>Salzgitter Low CO2 Steelmaking (SALCOS)</b> <i>Volker Hille, Salzgitter AG (41)</i>
		<b>Technology development and demonstration for using hydrogen in Steelmaking - (H2Steel)</b> <i>Thomas Buergler, K1-MET GmbH (43)</i>
		<b>Electrowinning of iron metal from iron oxides (SIDERWIN)</b> <i>Hervé Lavelaine, ArcelorMittal Maizières (34)</i>
		- Discussion on cooperation, on how to make it happen
16:15	0:30	Coffee break
16:45	1:45	<b>1c - Activity 1A.2&amp;3 - Smart Carbon Usage thru Process Integration</b> - Introduction - <i>Jean-Theo Ghenda, Eurofer</i> - Project Idea presentations
		<b>Hisarna smelting reduction process for lowering energy consumption and CO2 emissions of steel production</b> <i>Koen Meijer, Tata Steel Europe (30)</i>
		<b>Reduced energy consumption through process design including flue gas recycling on Submerged Arc furnaces</b> <i>Bernd Wittgens, Casper v.d. Eijk, SINTEF Industry (33)</i>
		<b>Top Gas Recycling – Blast Furnace using plasma torch</b> <i>Jean Borlee, CRM Group (46)</i>
		- Discussion on cooperation, on how to make it happen
18:30		End of Session

Day1	duration	Room "Arches" - Ground Floor
		<b>2 - Chemical</b>
14:00	0:30	<b>1a-2a - Regulatory context:</b> - Information on Anti-trust - <i>Andrei Murarasu - European Commission, DG Competition Unit E2</i> - Information on State aid - <i>Katarzyna Piechucka-Thom - European Commission, DG Competition Unit H2</i>
14:30	1:45	<b>2b - Activities 1B.1– Process intensification &amp; 1B.2-Separation</b>
		Welcome, scope of SET Plan Activities 1B.1 & 1B.2 and objectives of the session – <i>Sophie Wilmet, CEFIC, SET Plan Chemical Activities Leader; Dominique Horbez, Solvay</i>
		Pitch presentation of Project Ideas
		<b>Systematic approach for energy improvement in chemical clusters</b> <i>Greet Van Eetvelde &amp; Elfie Méchaussie, INEOS Group AG (44)</i>
		<b>Hybrid reconfigurable small size thermochemical plant for power and chemicals production</b> <i>Enrique Montiel, Greene Waste to Energy, S.L. (6)</i>
		<b>Low exergetic ammonium separation for energy conversion in fuel cells</b> <i>Christoph Brunner, AEE INTEC (27)</i>
		Clustering of similar/complementary projects ideas, and other priority topics in the scope of Activities 1B.1 & 1B.2, Splinter discussions
		Sharing of results from each cluster discussion and wrap-up
16:15	0:30	Coffee break
16:45	1:45	<b>2c - Activity 1B.3 – Power-to-X &amp; unconventional energy sources</b>
		Welcome, scope of SET Plan Activity 1B.3 and objectives of the session – <i>Sophie Wilmet, CEFIC, SET Plan Chemical Activities Leader; Dominique Horbez, Solvay</i>
		Pitch presentation of Project Ideas
		<b>Replacement of natural gas-based energy supply for energy-intensive chemical processes by regenerative electric energy</b> <i>Anne Vandermeulen, BASF SE (45)</i>
		<b>electrical Cracking Furnace Technology (e-CRAFT)</b> <i>Cornelis Biesheuvel, Dow Benelux BV (23)</i>
		<b>Plasma based waste gasification using renewable energy sources</b> <i>Stefan Brand, Clariant Produkte GmbH (13)</i>
		<b>Electrochemical H<sub>2</sub>S splitting into hydrogen (H<sub>2</sub>) and elemental sulfur (S)</b> <i>Ersen Ertaş, TÜPRAŞ (10)</i>
		<b>Power to fuels: CO<sub>2</sub> conversion technologies for chemical energy storage</b> <i>Josemaria Sanchez-Hervas, CIEMAT (11)</i>
		<b>Production of renewable biofuels through water electrolysis with liquified biomass source and solar energy inputs</b> <i>Jaime Puna, ISEL - Instituto Superior de Engenharia de Lisboa (20)</i>
		Clustering of similar/complementary projects ideas and other priority topics in the scope of the Activity 1B.3, and Splinter discussions
		Sharing of results from each cluster discussion and wrap-up
18:30		End of Session

Day1	duration	Room "Salon" - DOWNSTAIRS
		<b>3 - Heat&amp;Cold (H&amp;C)</b>
14:00	0:30	<b>3a - Introduction</b> - Sonia Clarena-Baron & Ralf Wezel, EU-Turbines, SET Plan H&C Activity leaders - Implementation Plan for H&C - Sonia Clarena-Baron & Ralf Wezel, EU-Turbines - EU & National programmes in H&C - DG Energy
14:30	1:45	<b>3b - Activity 3.2 – Heat &amp;Cool upgrade &amp; 3.4 - Polygeneration</b>
		Welcome and objectives of the session - Ugo Simeoni - ETN
		Pitch presentation of Project Ideas
		<b>Coupling a high efficiency steam compressor to conventional heat pumps integrates to a high temperature heat pump</b> Gijs Schimmel, Innecs Power Systems B.V. (29)
		<b>novel SOFC-mGT hybrid systems for polygeneration (heat-cool-power-desalinated water) in Island systems</b> Alberto Traverso, University of Genoa (7)
		<b>Energy from waste with zero emissions</b> Pablo Huertas, Materiales Renovados SL (9)
		<b>Small steam boiler with combined cycle gas and steam turbines on multi fuels</b> Reidar Koolen, Innecs Power Systems BV (28)
		<b>Capture energy out of high pressure waste steam in order to prepare the steam for absorption chiller use / Integrated cooling and power plant</b> Kristoff Praet, Innecs Power Systems B.V. (31)
		<b>CO&amp;CO2 free high efficiency metal industry using Chemical and electrochemical water splitting</b> Abdelghafour Zaabout, SINTEF Industry (35)
		Clustering of similar/complementary projects ideas and Splinter discussions
		Sharing of results from each cluster discussion and wrap-up
16:15	0:30	Coffee break
16:45	1:45	<b>3c - Activity 3.3 – Heat-to-power (electrical) recovery</b>
		Welcome and objectives of the session - Sonia Clarena-Baron & Ralf Wezel, EU-Turbines
		Pitch presentation of Project Ideas
		<b>Next generation ORC for Waste heat recovery</b> Mohsen Assadi, University of Stavanger (3)
		<b>Low temperature waste heat recovery using advanced Organic Rankine Cycles (ORC).</b> □ Olaf Bernstrauch, Siemens AG Power and Gas Division (14)
		<b>High temperature waste heat recovery using the sCO2 cycle.</b> Michael, Wechsung, Stefan Glos, Siemens AG Power and Gas Division (15)
		<b>Thermal conversion system from waste heat for cold generation</b> Marco Santini, Baker Hughes, a GE company (16)
		<b>Thermal conversion system for electric power generation (0.5-1MW), to recover waste heat at T &gt; 430°C -</b> Marco Santini, Baker Hughes, a GE company (18)
		<b>Demonstration of Supercritical CO2 Cycles Technology for Waste Heat Recovery Applications</b> Giuseppe Messina, ENEA (36)
		Clustering of similar/complementary projects ideas and Splinter discussions
		Sharing of results from each cluster discussion and wrap-up
18:30		End of Session

Day2	duration	Room "Arches" - Ground Floor
		<b>4 - Systems</b>
08:30	1:30	<b>4a - Activity 5.3- Knowledge exchange, training and capacity building</b> <i>Borana Taraj, EUA, SET Plan Activity 5.3 leader</i>
		Welcome and objectives of the session
		Pitch presentation of Project Ideas
		<b>Simplified Sustainability Screening and Evaluation Toolkit to support Decision Making in the Process Industries</b> - <i>Amy Peace, Britest Ltd (12)</i>
		<b>Optimization of industrial energy ecosystems</b> <i>Gérard Griffay, Arcelor Mittal; Benjamin Remy, University of Lorraine (42)</i>
		<b>Master program on Innovation for Energy Efficiency and Sustainability in Industry and Services</b> <i>Marco Carlo Masoero, Politecnico di Torino (47)</i>
		Clustering of similar/complementary projects ideas, and other topics in the scope of the Activity 5.3, and splinter discussions
		Sharing of results from each cluster discussion and wrap-up
10:00	0:30	Coffee break
10:30	1:30	<b>4b - Activity 5.1a - Symbiosis &amp; 5.1b-Non-conventional energy sources</b> <i>Angels Orduna, Evelina Paunsknyte, Esteban Paragan, A.SPIRE, SET Plan Activities 5.1&amp;5.2 leader</i>
		Welcome and objectives of the session
		Pitch presentation of Project Ideas
		<b>Strengthening the business case of electrification via Power-to-Heat &amp; Demand Response</b> <i>Olivia Sicurani, Sympower B.V. (17)</i>
		<b>Re-use of carbon of steelmaking by fermentation of the steel mill gases into fuels and chemicals (Steelanol)</b> - <i>Wim van der Stricht, ArcelorMittal Belgium NV (39)</i>
		<b>Using metallurgical gases, including the CO<sub>2</sub>, from steel production as a starting material for chemical products (Carbon2Chem®)</b> - <i>Markus Oles, Thyssenkrupp AG (40)</i>
		<b>Integration of a high temperature (800-1000°C) 24h/day solar process for energy intensive industries</b> <i>Jan Baeyens, European Powder &amp; Process Technology (38)</i>
		Clustering of similar/complementary projects ideas and Splinter discussions
		Sharing of results from each cluster discussion and wrap-up
12:00	0:15	Short break
12:15	1:30	<b>4c - Activity 5.2 Digitisation</b> <i>Angels Orduna, Evelina Paunsknyte, Esteban Paragan, A.SPIRE, SET Plan Activities 5.1&amp;5.2 leader</i>
		Welcome and objectives of the session
		Pitch presentation of Project Ideas
		<b>Cognitive energy optimization in design and operations</b> <i>David Cameron, University of Oslo (1)</i>
		<b>A flexible plug and play solution to transform a factory in a simulation laboratory to stimulate innovation and operational excellence</b> - <i>David Sánchez González, University of Vigo (8)</i>
		<b>Process smartness of the future using big data analytics, digital twins and smart sensors</b> <i>Frode Brakstad, SINTEF (21)</i>
		<b>Real time sustainable decision making tool for monitoring and optimization in manufacturing processes</b> <i>Luis Usatorre, TECNALIA R&amp;I (26)</i>
		<b>Hybrid mathematical/machine-learning modelling of a manufacturing plant archetype</b> <i>Francesco Demetrio Minuto, Polytechnic of Turin (37)</i>
		Clustering of similar/complementary projects ideas and Splinter discussions
		Sharing of results from each cluster discussion and wrap-up
13:45		End of Session