A.SPIRE Webinar
“The Essence of Processes4Planet”

31st March 2021
09:00  Welcome - Mr Pierre Joris, A.SPIRE President

09:05  Opening keynote: “Processes4Planet: EU Industrial partnerships contributing to recovery”
Mr. Jean-Eric Paquet, Director General Research and Innovation, European Commission

09:25  A.SPIRE community – time for impact
Mr. Pierre Joris (Domo Chemicals), A.SPIRE President

09:40  Processes4Planet SRIA and the first HEU Work Programme
Mr. Ludo Diels (VITO), Chair of IRIAG

10:00  Success story: FUDIPO
Prof. Erik Dahlquist, Senior Professor in Energy Technology, Mälardalen University.

10:15  SPIRE-SAIS: Skills Alliance for Industrial Symbiosis
Antonius Schröder, TU Dortmund University
Opening keynote:

“Processes4Planet: EU Industrial partnerships contributing to recovery”

Mr. Jean-Eric Paquet,
Director General Research and Innovation,
European Commission
A.SPIRE community: time for Impact

Mr. Pierre Joris
(Domo Chemicals),
A.SPIRE President
Unique cross-sectoral community +
Formal cooperation
• Clean Steel
• Clean Hydrogen
• Others …

Roadmap Design
• Builds on SPIRE learnings
• Priority to higher TRL
• Skills
• Competitive gap analysis,
  Framework/Standards

Partnership
• Feedback Panel
• Impact Panel

Industrial implementation
• First-of-a-kind plants
  Hubs for Circularity

• First-of-a-kind plants
"Processes4Planet SRIA and the first HEU Work Programme"

Mr. Ludo Diels (VITO), Chair of IRIAG
Strategic Research & Innovation Agenda

Three Ambitions, 14 Innovation Actions

Innovation area

- Renewable energy integration
- Heat reuse
- Electrification of thermal processes
- Electrically-driven processes
- Hydrogen integration
- CO₂ capture for utilisation
- CO₂ utilisation in minerals
- CO₂ & CO₂ utilisation in chemicals and fuels
- Energy and resource efficiency
- Circularity of materials
- Industrial-Urban symbiosis
- Circular regions
- Digitalisation
- Non-technological aspects

Progress up until milestone year

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<thead>
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<th>Year</th>
<th>2024</th>
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1 Progress is depicted here as % of total TRL9 projects programmed in each area, and for circular regions, digitalisation, and non-technological aspects % of total investment needs until 2050.
10 HEU calls aligned with Processes4Planet

Industrial – Urban Symbiosis

Digital
Non-technological
Basic assumptions for H4C

Potential for resource efficiency and reductions in waste, emissions, pollution lies in synergies when connecting processes across company borders. The implementation needs:

- Technology development
- Overcoming non-technological barriers to implementation
- Engaging all stakeholders to get support and co-financing for infrastructure

Facilitation between companies and stakeholders in regions is key

H4C are self-sustaining economic industrial ecosystems for full-scale Industrial-Urban Symbiosis and Circular Economy, closing energy, resource and data loops and bringing together all relevant stakeholders, technologies, infrastructures, tools and instruments necessary for their incubation, implementation, evolution and management.
TWIN-TRANSITION-01-14: Deploying industrial-urban symbiosis solutions for the utilization of energy, water, industrial waste and by-products at regional scale

RIA; 8 – 12 M€; 27,5 M€; TRL 4 ➔ TRL 6

- Real-scale pilot for energy flows, industrial waste and water - 50% improvement
- Sustainable new value chains and business models;
- Actions to overcome non-technological barriers for exploitation;
- Relevant indicators and metrics;
- Connect to European Community of Practice (ECoP);
- A broad cross-sectorial symbiosis in regions;
- Outcomes from previous SPIRE IS-projects;
- Assessment methodologies and KPIs;
- Social aspects of the community - cooperation with other regions
HORIZON-CL4-2022-TWIN-TRANSITION-01-10: Circular flows for solid waste in urban environment
IA, 12 – 18 M€; 42 M€, TRL 5 ➔ TRL7

- Real scale demonstrator for the circular flow of solid waste (process, manufacturing, construction industries)
- Reduce 80% solid waste generated
- Implement a social innovation spin-off action with local stakeholders
- Connect to the EU Community of Practice (ECoP)
- Manage and process waste streams to be valorised/used as feedstock for process industries
- New approach to end-of-life materials removing the usual barriers;
- Technologies: Digital tools for classification and sorting; Recycling
- Assessment methodologies and KPIs;
- Create societal awareness;
- Social aspects of the community (location of demonstration) and its improvement through I-US.
HORIZON-CL4-2021-TWIN-TRANSITION-01-16: Hub for European Circularity Community of Practice (ECoP) platform

CSA; 2 M€

- EU CoP to connect Hubs4Circularity and stakeholders (networks);
- Support to H4C with knowledge, tools, training materials and providing them to circular practitioners;
- Analyse available collaboration models, tools, technologies, solutions - from previously funded projects;
- Define a set of methodologies, KPIs and gaps for the quantification of circularity and symbiosis;
- Provide a state-of-art analysis of regions best suited for the first implementation of advanced H4C + roadmap ➔ first demonstrator in 2026 (lifting up & expanding existing Hubs);
- Foster business-to-territory;
- Involve scenarios and infrastructures that are already in place (SRL);
- Provide a solid plan for self-financing the ECoP in the long term from once funding has ended.
HORIZON-CL4-2021-TWIN-TRANSITION-01-17: Plastic waste as a circular carbon feedstock for industry

IA; 12 – 18 M€; 38 M€

- Valorise a wide variety of unsorted polymer waste in large amounts, to avoid landfill;
  - Includes plastic, packaging, non-sorted polymers, textiles, PPE
  - Provide support for secure supply of targeted waste and feasible business case

- Produce material streams of high industrial interest, replacing the ones currently produced from fossil feedstocks
  - Olefins, hydrogen, syngas, etc.
  - Targeting electrified cracker technologies

- Attention to variability & contaminants;
- Decreased environmental impact of products and processes (60 % reduction GHG)
HORIZON-CL4-2022-TWIN-TRANSITION-01-11: Valorisation of CO/CO\textsubscript{2} streams into added-value products of market interest (IA)

IA; 12 – 18 M€; 40 M€; TRL 5 ➔ TRL 7

- CO/CO\textsubscript{2} streams to produce added value products and/or intermediates (polymers, resins, chemicals, food/feed ingredients, minerals, etc.) excluding fuels and/or energy carriers;
- Economically viable and sustainable alternatives to existing products;
- Concepts enabling 100% utilisation of RES, coping with potential fluctuations in the energy supply;
- At least 60% GHG emissions mitigation, improved environment footprint (safe);
- Mature technologies for separation/purification of CO/CO\textsubscript{2} containing waste streams;
- Demonstrate the proposed concepts in an industrially relevant environment and appropriate scale (replicability & scalability);
- Co-design of learning resources.
HORIZON-CL4-2021-TWIN-TRANSITION-01-21: Design and optimisation of energy flexible industrial processes

IA; 12 – 18 M€; 40 M€; TRL 5 ➔ TRL7

- In existing process, identification of potential flexibility and redesign and modify to more flexibility and its response rate;
- Development or redesign of digital process control systems & connection to energy grid platforms;
- Evaluation of the potential use of on site energy storage and conversion;
- Optimisation of the new process design at pilot scale;
- Overall increased energy efficiency of the industrial process within the energy system;
- Cost reduction of the overall process through valorisation of excess energy streams.

RIA; 8 – 12 M€; 28 M€; TRL 3-4 ➔ TRL 5-6

- Electrification of the industrial production process by electrochemistry (control of electrons);
- CO₂ cannot be the input; H₂ cannot be the output;
- Production of products from both the oxidation and reduction half-reactions is recommended;
- Open to all types of electrochemical processes/liquids;
- All aspects of the electrochemical process need to be addressed (new electrochemical conversion routes; improved electrodes/electrocatalysts; reactor design, optimization and control of mass and charge transfer; separation of the products);
- Energy savings, material savings, CO₂ emission savings compared to classical production.
HORIZON-CL4-2022-TWIN-TRANSITION-01-17: Integration of hydrogen for replacing fossil fuels in industrial applications

IA; 12 – 18 M€; 42 M€; TRL 5 ➔ TRL 7

- Utilisation of hydrogen as feedstock and energy carrier;
- Integration of hydrogen into new production routes;
- Replacement of fossil fuels by hydrogen to generate high temperature heat (modification of heating equipment, off-gas systems, measures for NOx-reduction);
- Development of oxygen(-enriched) combustion processes;
- Detection and regulation of fuel gas characteristics;
- Proven economic viability;
- Significant reduction of CO2 emissions of industrial process;
- Improved energy efficiency of the industrial process;
- Significant reduction of hydrogen fuel needs of the developed process.
HORIZON-CL4-2021-RESILIENCE-01-01: Ensuring circularity of composite materials

RIA; 8 – 9 M€; 25 M€; TRL 3 ➔ TRL 6

- Innovative dismantling and sorting systems (functional recycling of complex composites);
- Safe, environmentally friendly (landfill reduction) and commercially attractive solutions, for a wide range of composites;
- Pilot level feasibility of reuse and/or recycling solutions of composites and its secondary raw materials;
- Tools development to demonstrate circularity and environmental benefits of tested solutions;
- Learning resources outcome development with local and regional educational organisations;
- New value streams, new business opportunities and revenue; flows for recycling companies, benefiting particularly SMEs;
- Increased uptake of novel composites in applications that are today limited.
HORIZON-CL4-2022-RESILIENCE-01-01: Circular and low emission value chains through digitalisation

RIA; 6 – 8 M€; 24 M€

- New solutions for improved use of secondary raw materials;
- Digital tracing and certification of secondary raw materials;
- Real-time access to information on material compositions and material quality (e.g. bar code, product passport, …);
- “open source” software, open hardware design, and easy access to data;
- Means and tools to indicate the composition and origin of recycled materials (bar code etc.);
- If possible: contribution to standardization;
- Demonstrate an increase in the waste reduction by application of digital technologies & optimisation of use of secondary raw materials in the value chains.
Buildings and Industrial Facilities in Energy Transition, cluster 5

HORIZON-CL5-2021-D4-01-04: Full demonstration of heat upgrade technologies with supply temperature in the range 90-160°C
IA; 8 M€; TRL 7 – 8 end of project

HORIZON-CL5-2021-D4-01-05: Industrial excess (waste) Heat-to-Power conversion based on organic Rankine cycles
IA; 10- 14 M€; TRL 7 – 8 end of project

HORIZON-CL5-2022-D4-01-05: Development of high temperature thermal storage for industrial applications
RIA; 3 – 4 M€; TRL 4 – 5 end of project

HORIZON-CL5-2022-D4-01-04: Development & pilot demonstration of heat upgrade technologies with supply temperature in the range 150-250°C
RIA; 3 - 5 M€; TRL 5 end of project
Success story: FUDIPO

Prof. Erik Dahlquist,
Senior Professor in Energy Technology,
Mälardalen University
FUDIPO project - demonstration of AI and learning systems in process industries

Erik Dahlquist, coordinator FUDIPO project, Malardalen University, Sweden
Västerås 31 March 2021
Open platform – Node-Red base; don’t need pay license fees for functions

Python- Numpy (Numerical Python, like Matlab), Panda (statistics and DB storage); Scikit-Learn (library tools); Github (library of functions with codes); Open Modelica
Different ”AI-tools”

- Gaussian Probability Regression Model in Matlab
- PLS, partial least square regression
- PCA, principal component analysis
- ANN, artificial neural nets (deep learning)
- SVM, Support vector machines
- Grey box models
- Physical models, MPC – model predictive control
- BN, Bayesian nets
- Gaussian Mixture Model (GMM)
- Gaussian Process Regression
- Reinforcement Learning
- Google algorithm – search engines
FUDIPO Partner distribution
**FUDIPO structure**

- Order plan
- Optimization
- Production plan
- Modified Production plan
- Risk of failure
- Machine learning
- Data preprocessing
- Statistical models
- Physical Models
- Decision support
- Fault diagnostics
- Soft sensors
- Model adaptation
- Model based control
- Sales - income
- Costs - expenses

**Processes**

Future Directions of Production Planning and Optimized Energy – and Process Industries
1. Demonstrator Background: Mälarenergi AB, Block 6

High temp corrosion sensor
Results BN at CFB boiler 5

Diagnostics and decision support
Learning system in a fiberline – updating models semi on-line

Dissolution rate of lignin in time:
\[ \frac{dL}{dt} = C_1 \cdot [OH]^a \cdot [HS]^b \cdot e^{A \cdot \frac{t}{B}} \]

Model-based control:
- NIR measurement of lignin content
- Multivariate statistical model
- Feedstock material
- Chemicals

Optimization:
- Optimal minimum value of residual lignin on pulp
- Diagnostics + Retrofit

Fiber line

Billerud-Korsnäs
BN for RCA of Screen clogging in Lower Cooking Circulation
Oil refinery at Tupras - Connection of the Physical Models

Determine feed comp by NIR

Optimize use of feed
Overall scheme of the WWTP at Mälarenergi (Sweden)

BN and MPC

Minimize electricity
Reduce: NO3, NH4, BOD, PO4
Maximize biogas prod
**Micro gas turbines, mCHP**

- Fleet management of mGT plants
- Decision support
- Physical and statistical models
- Maintenance on demand
- Diagnostics
- Data pretreatment
- Measurements
RF Sensor

Detect concrete and metal balks, MC, salts....

Constant frequency, move sensor

Frequency scan, bulk measurement
Let’s write the future – together!

Thanks!
SPIRE-SAIS:
Skills Alliance for Industrial Symbiosis

Prof. Antonius Schröder
TU Dortmund University
SPIRE General Assembly
31.03.2021

Skills Alliance for Industrial Symbiosis
SPIRE-SAIS

Antonius Schröder
TU Dortmund University
European Blueprint Framework

(1) Technological and Economic Demands and Skills Requirements

- Technological and Economic Development Demands
- Skills Needs

(2) Skills Adjustment

- Skills Classifications
- Job Profile Assessment
- VET Support

(3) Strategies / Measures

- Foresight Observatory
- Training Offers
- Learning Arrangements
- Division of Responsibilities
- Pilot Measures/Tests
- Incentives: Awards, Online Fora
- Image/Recruitment/Talent Management

(4) Alliances and Leadership

- EU Level: SPIRE, Sector Associations
- Joint Processes: Associations, Companies, Training Providers
- National/Regional: national sector associations, training providers

(5) Implementation and Rollout

- Hubs for Circularity (Regions)
- EU Open Coordination
- National sector associations
- National VET Systems (in cooperation with other industry blueprints)
Current Situation

- The current level of implementation and skills is higher for EE rather than for IS.
- Beneath internal and industrial actors: public actors are also main actors of IS (41%) and EE (48%).
- The main barriers for EE/IS:
  - cost of investments
  - regulatory issues
  - outdated plants, infrastructure and equipment
  - cooperation challenges, integration of regional stakeholders, working across different sectors
  - skills gaps.
- Mainly no specific training programs (57% EE, 74% IS) current training measures are primarily non-formal/unstructured.
- Low/middle level of skills needs to be updated:
  - Specific job-related technical / professional skills
  - Transversal skills (esp. digital, green and personal skills)
  - Management skills
**Skills Level (Management / Operation)**

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<th>Skills Classifications</th>
<th>Job Profile Assessment</th>
<th>VET Support</th>
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**VET Skills:**

(a) **Professional / technical:**
- Understanding IS and EE
- Energy and waste reduction
- Resource, re-use and reduction
- System optimisation
-...

(b) **Transversal (soft skills):**
- Multidisciplinary thinking and acting
- Environmental awareness
- Team working
- Strategic thinking
-...

**Management Skills:**
- Managing IS and EE
- Legislative knowledge
- Financial management
- Development of business and cooperation models
-...

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**Cross-sectoral Management Level**

**Sector / Company 1 – 4, ...**

(Industrial Symbiosis)

**Facilitator**

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**Sector/Company 1**
- Company internal SI/EE Management

**Sector/Company 2**
- Company internal SI/EE Management

**Sector/Company 3**
- Company internal SI/EE Management

**Sector/Company 4**
- Company internal SI/EE Management

**Sector/Company ...**
- Company internal SI/EE Management

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**Sector/Company 1**
- Operational Production / Maintenance Level (Energy / Resource Efficiency)

**Sector/Company 2**
- Operational Production / Maintenance Level (Energy / Resource Efficiency)

**Sector/Company 3**
- Operational Production / Maintenance Level (Energy / Resource Efficiency)

**Sector/Company 4**
- Operational Production / Maintenance Level (Energy / Resource Efficiency)

**Sector/Company ...**
- Operational Production / Maintenance Level (Energy / Resource Efficiency)
VET Situation

IS and EE relevant skills in VET systems:

- IS and EE do have **no comprehensive attention** in the programmes of VET institutions.
- Relevant courses are integrated in some **general programmes**, or only some lectures are integrated in the courses.
- There are **very little VET programmes focusing on IS and EE** in particular. In contrast to that it seems that **training of IS and EE specialists** (not focusing on particular sector) is a growing trend in the USA
- The best examples of IS or EE related skills provision come from projects and **non-formal/informal company level trainings** rather than formal VET programmes.
- Most of relevant projects focus on only one of SPIRE sectors (**lack of inter-sectoral collaboration**) 
- VET systems are moving towards “**dual approaches**” combining work based with school learning
European Blueprint: Next Components

### (3) Strategies / Measures

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<th>Training Offers</th>
<th>Learning Arrangements</th>
<th>Cross-sectoral Division of Responsibilities</th>
<th>Pilot Measures/Tests</th>
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#### Roadmap

### (4) Alliances and Leadership

- **EU Level:** SPIRE, Sector Associations
- **Joint Processes:** Associations, Companies, Training Providers
- **National/Regional:** National sector associations, training providers

#### Integration in existing sectoral structures

### (5) Implementation and Rollout

- **Hubs for Circularity** (Regions)
- **EU Open Coordination**
- **(National) Sector Associations** (in cooperation with other industry blueprints)

#### Cross-sectoral and cluster collaboration
END OF THE WEBINAR - VIRTUAL COFFEE BREAK
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