Finanziato dall'Unione europea NextGenerationEU | Ministero dell'Università e della Ricerca | Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA | ecosister

INTERSPOKE INTEGRATION

Methodology

In order to answer the question about interspoke integration, the monitoring team developed, after a lengthy discussion, an interspoke matrix (Table 1) which showed the level of interactions between two spokes at task level (first level). In addition, the monitoring team read through the deliverables of each of the tasks that were found to contain interactions to further flesh out synergy and overlapping opportunities (second level). This was done by identifying the results described in each piece of research and integrating them with results in other spokes to develop a coherent, real-world application strategy. Finally, interaction between more than two spokes has not yet been explored in depth, however, there are almost certainly multi-spoke opportunities since the team has seen evidence of this when assessing the work done in the current document.

	Spoke 1	Spoke 2	Spoke 3	Spoke 4	Spoke 5	Spoke 6
	Materials for sustainability and ecological transition	**Clean energy production, storage and saving**	**Green manufacturing for a sustainable economy**	**Smart mobility, housing and energy solutions for a carbon neutral society**	**Circular Economy and Blue Economy**	**Ecological Transition based on HPC and Data technology**
Spoke 1	/	7	10	4	5	5
Spoke 2	7	/	8	4	2	3
Spoke 3	10	8	/	1	8	3
Spoke 4	4	4	1	/	2	1
Spoke 5	5	2	8	2	/	3
Spoke 6	5	3	3	1	3	/

Table 1: Interspoke Matrix: Synergy Count

	1 Materials for sustainability and ecological transition	2 Clean energy production, storage and saving	3 Green manufacturing for a sustainable economy	4 Smart mobility, housing and energy solutions for a carbon neutral society	5 Circular economy and blue economy	6 Ecological transition based on HPC and Data Technology
1 Materials for sustainability and ecological transition		• Mobility • Industry • Building	• Industry 5.0		• Building And Construction Wastewater Treatment	• Mobility & Aerospace Health Industry & Diagnostics
2 Clean energy production, storage and saving >>			• Clean Energy Production • Carbon Capture • Simulation & Digital Twins	• Energy Transition & Social Acceptance Smart Mobility	• Circular Economy • Blue Economy • Soil Conservation	• HPC For Fluid Dynamics • Nano-Particles For Energy Storage
3 Green manufacturing for a sustainable economy					• Circular Manufacturing Agrifood Resource Management • Open Innovation	
4 Smart mobility, housing and energy solutions for a carbon neutral society					• Tourism And Cultural Industries • Healthy Urban Planning: Recycled Or Reused Materials For Urban Planning	• Sensors For Smart Mobility And Energy Efficiency • Modeling Indoor Air
5 Circular economy and blue economy						• New Technology To Increase Material Circularity • HPC For Natural Resource Management
6 Ecological transition based on HPC and Data Technology						

Table 2: Interspoke Matrix: Synergy Themes

Results

The monitoring team lists below the proposed synergy and overlapping opportunities categorized by spoke and work package based on the matrix that was described in the methodology section. Below, one can see the interaction between two spokes, the opportunities for synergies and examples of best case scenarios that the monitoring team identified. This analysis is ongoing and will be updated as deliverables are completed and the interspoke interactions become more evident through the description of prototypes, pilot programs and/or demonstrators.

Spoke 1 ⇔ Spoke 2

Work Package Interactions: S1W1⇔S2W2; S1W3⇔S2W2; S1W5⇔S2W1, S2W2, S3W3

1) Mobility: the transition presents industrial development opportunities to certain segments of the value chains that are missing today in the region and, more generally, at national and european level:

- Fuel cell development of H2 conversion in electricity for H2 powered vehicles to complete ER value chain which is still very small

2) Industry: the availability of hydrogen opens up interesting opportunities in the decarbonization effort:

- Electrification: industrial facilities development for
  i) re-use of automotive batteries or
  ii) recycling raw materials extracted from depleted batteries (lithium, cobalt, nickel) for the factories that develop Li-ion batteries electrodes
- Energy-consuming industries: H2 burners which are crucial for exploiting the H2 thermal capabilities

3) Building: the ecological transition requires renewable energy sources and energy storage systems, to achieve this there is a fundamental need for the development of new materials:

- Development of domestically produced energy storage systems

Spoke 1 ⇔ Spoke 3

Work Package Interactions:S1W1⇔S3W1, S3W3, S3W4; S1W2⇔S3W2,S3W3; S1W3⇔S3W3

Industry 5.0: integration and optimization of materials through the use of AI and simulations

1) on board diagnostics with smart components
2) self-configurable production lines
3) materials with a small carbon footprint
4) energy and materials decarbonization:

- Development of manufacturing systems with low emissions and small carbon footprint through the use of LCA
- Development of an industrial supply chain which integrates reuse and recycle of materials and components

- Production lines designed through the use of a digital twin
- Industrial systems with ZEV (zero-emission vehicles) with an eye for storage and balanced (carbon neutral) consumption of the production line
- Regional IP protection and the development of proprietary software for automated systems in order to promote an independent production of KH (potassium hydride)

Spoke 1 ⇔ Spoke 5

Work Package Interactions:S1W3⇔S5W2

1) Building and Construction: The availability of materials sourced from waste. The production of structural (cementitious) and non-structural (insulation) materials should focus on sourcing industrial waste for reuse. The industrial sector should promote a certified supply chain to this end:

- The development of a supply chain which integrates certified raw materials without any Contaminants of Emerging Concern (CECs)
- The production of industrial cement which contain fibers composed of biological recycled materials (plastics)
- Insulation that contains plant-based fibers

2) Wastewater treatment: prototypes that can be adapted to treat different type of waste and wastewater:

- Ultrafiltration devices with geopolymers membranes

Spoke 1 ⇔ Spoke 6

Work Package Interactions:S1W1⇔S6W1; S1W4⇔S6W1; S1W5⇔S6W2

1) Mobility & Aerospace: the transition presents opportunities in industrial development based on simulations (digital twins) of products and/or production lines, specifically, interactions between components and surrounding conditions that can enable the optimization of functionalities tied to consumption parameters and maneuverability obtainable only with HPC capabilities:

- In the battery & energy storage sectors, the development of efficient cooling and heating systems
- Alternative battery chemistry for better performance
- In the aerospace sector, the simulation of performance and the development of complex, innovative materials

2) Health Industry & Diagnostics: new materials for next level health devices & machines for diagnostics and implants (bioneural applications):

- Polycrystalline silicon for thin film transistors used in digital radiography and organic electrodes as electrochemical energy storage devices in neural implants

Spoke 2 ⇔ Spoke 3

Work Package Interactions:S2W1⇔S3W1, S3W2, S3W3; S2W2⇔S3W4, S3W5; S2W3⇔S3W5; S2W4⇔S3W1, S3W3

1) Clean Energy Production: biomass produced as a result of agrifood and textile industry can be converted into biofuels:

- Agricultural secondary residues can be converted through pyrolysis into bio-oil, syngas and biochar to reduce reliance on fossil fuels
- Installation and local production of energy & energy storage for energy hungry industries with medium to low thermal needs
- Implementation and support of H2 supply chain for thermal use

2) Carbon Capture: biomass in primary industries can be converted into biochar to sequestrate carbon

- Biochar can be produced to reduce waste and for its potential in carbon sequestration

3) Simulation & Digital Twins: optimization and efficiency of production processes through digital twins and LCA analysis

- Digital twins for production lines
- Energy accumulation in the industrial sector through AI management of energy consumption to exploit the fluctuation of energy costs throughout the workday

Spoke 2 ⇔ Spoke 4

Work Package Interactions:S2W1⇔S4W2, S4W4; S2W2⇔S4W4; S2W4⇔S4W4

1) Energy Transition & Social Acceptance: the implementation of RES needs public engagement to be fully embraced and overcome public skepticism:

- The energy sector's transition towards RES ecompasses both techno-economic as well as social aspects. To be a successful endeavor it needs to account for public opinion and include the societal impact the transition has on communities that face disenfranchisement.

2) Smart Mobility: Dedicated infrastructure for smart mobility with special reference to batteries

- Ecosister's infrastructure for smart mobility is a crucial element for transitioning to RES. It proposes to pursue the objectives to optimize the mobility systems and evaluating its reliability

3) Urban Decarbonization: CO2, O3 and black carbon capture through nature based solution:

- Green roofs and CO2 sensors are useful for the reduction of air pollutants in and around buildings in cities
- CO2 capture in open, public places reduces the heat island effect of cities
- In order to effectively capture and sequester carbon in RER it is also crucial to map the main sources of pollution and develop a systems of hubs and clusters in CCTS projects.

Spoke 2 ⇔ Spoke 5

Work Package Interactions: S2W1⇔S5W2, S5W3; S2W4⇔S5W5,

1) Circular economy: urban mining to reuse materials for energy production and storage:

- Waste from Electrical and Electronic Equipment (WEEE) can be sourced for secondary raw materials utilized in the design of solar panels, wind turbines and electric vehicles.
- Lignin and keratin based electrospun fibers used in the design of supercapacitors, electrodes and batteries.

2) Blue economy: marine renewable energy sources and seas as carbon sinks:

- Blue economy ecompasses areas which are ideal for offshore wind-farming, biomass from fisheries and algae for the production of biofuels and also optimizing the health of the seas to enhance their ability to act as carbon sinks

3) Soil conservation: Conservation of soils promotes carbon sequestration

- The proper conservation of soils, for example grassland soils, but also the production of biochar, enhances their ability to sequester carbon

Spoke 2 ⇔ Spoke 6

Work Package Interactions:S2W1⇔S6W1, S6W2; S2W2⇔S6W1

1) HPC for Fluid Dynamics: the production of more accurate models to better understand the dynamics of wind and wave motion

- High Performance Computing (HPC) can be used to produce high-fidelity simulations of wind/wave motions to better understand atmosphere/ocean interactions and achieve more accurate weather forecasts
- HPC fluid dynamic tools to design the next generation wind turbine

2) Nano-particles for Energy Storage: the study of atomistic characteristics of materials for increased energy storage:

- Investigating the atomistic characteristics of new materials for electrodes and electrolytes that are easier to recycle to maximize the capacity and operation voltage of Li-ion batteries.
- Multi-scale modeling approach for the description of the structural-property relationships at nano-scale of the organic conjugated redox systems (OCRS) for electrochemical energy storage devices

Spoke 3 ⇔ Spoke 5

Work Package Interactions: S3W3⇔S5W1, S5W2; S3W4⇔S5W1

1) Circular Manufacturing: Reusing waste materials and adopting LARG supply chains from other industries for a more sustainable building and construction sector:

- Urban waste and recycling mineral residues for ceramic production which is used in the construction business. Shellfish waste to use in the production of cementitious materials for construction.
- Lean, agile, resilient and green (LARG) supply chain model adapted to strategic industries in E-R
- Pilot scale biorefinery system based on insect larvae

2) Agrifood Resource Management: LCA modeling for a better management of resources in the agrifood industry:
- LCA assessment of waste and wastewater to ensure an environmentally sustainable circular economy
- LCA analysis for the enhancement of biomass from agricultural waste and better resource management in the agrifood industry

3) Open Innovation: OI and multi-stakeholder collaboration for sustainable transition:
- Application of living labs as a key field emphasizing open innovation and meaningful relationships essential for a sustainable transition

Spoke 4 ⇔ Spoke 6

Work Package Interactions: S6W2⇔S4W1, S4W4

1) Sensors for Smart Mobility and Energy Efficiency: More energy efficient sensors for vehicles
- Edge systems are computational systems that require less power. One example of these is HMI (Human-Machine Interaction) which is being used more and more in the automotive field. Integrating these sensors inside vehicles has the potential two-fold effect of improving road safety and reducing power needed for computations, rendering mobility smarter and vehicle technology more energy efficient

2) Modeling Indoor Air: fluid dynamics models can be useful in understanding indoor air movement
- A better understanding of turbulence dynamics and fluid modeling is a tool to study indoor quality issues and improve well-being

Spoke 5 ⇔ Spoke 4

Work Package Interactions:S4W2⇔S5W4; S4W3⇔S5W1, S5W4;

1) Tourism and Cultural Industries: transition of tourism and cultural industries towards a circular economy:
- Tourism, cultural and non, can be rendered more sustainable through a combination of regulation and persuasion

2) Healthy Urban Planning: The design of cities, access to healthy food, safe places to exercise and air quality have an impact on the well-being of the population
- Urban planning should keep in mind the needs of the population in order to pursue a healthy lifestyle. Air quality, indoor and outdoor, is paramount to a healthy population. Further, sidewalks, bike lanes and access to nutritious and affordable food are key to improve the population's well-being as well as to reduce the strain that an unhealthy population places on public administrations

3) Recycled or Reused materials for Urban Planning: the potential of recycled and reused materials to create new ones in urban development and planning:

- Waste material, such as plastics, can be used in bituminous mixtures for pavements and roads to reduce the consumption of raw materials and energy.

Spoke 5 ⇔ 6

Work Package Interactions:S5W2⇔S6W1; S5W5⇔S6W3

1) New Technology to Increase Material Circularity: new technology is necessary to target climate change mitigation and pollution prevention by analyzing microscopic interactions in materials:

- X-ray diffraction technique to identify crystalline phases of CFAs (Coal Fly Ash) and develop CFA-based absorbents to capture some contaminants

2) HPC Technology for Natural Resource Management: HPC technology can be used to develop new approaches to ensure more sustainable land and water management and prevent contamination migration:

- HPC and AI driven models enable precision farming that can optimize resource management and reduce waste
- Contamination migration and reaction diffusion models can be instrumental in better understanding and reducing aquifer contamination