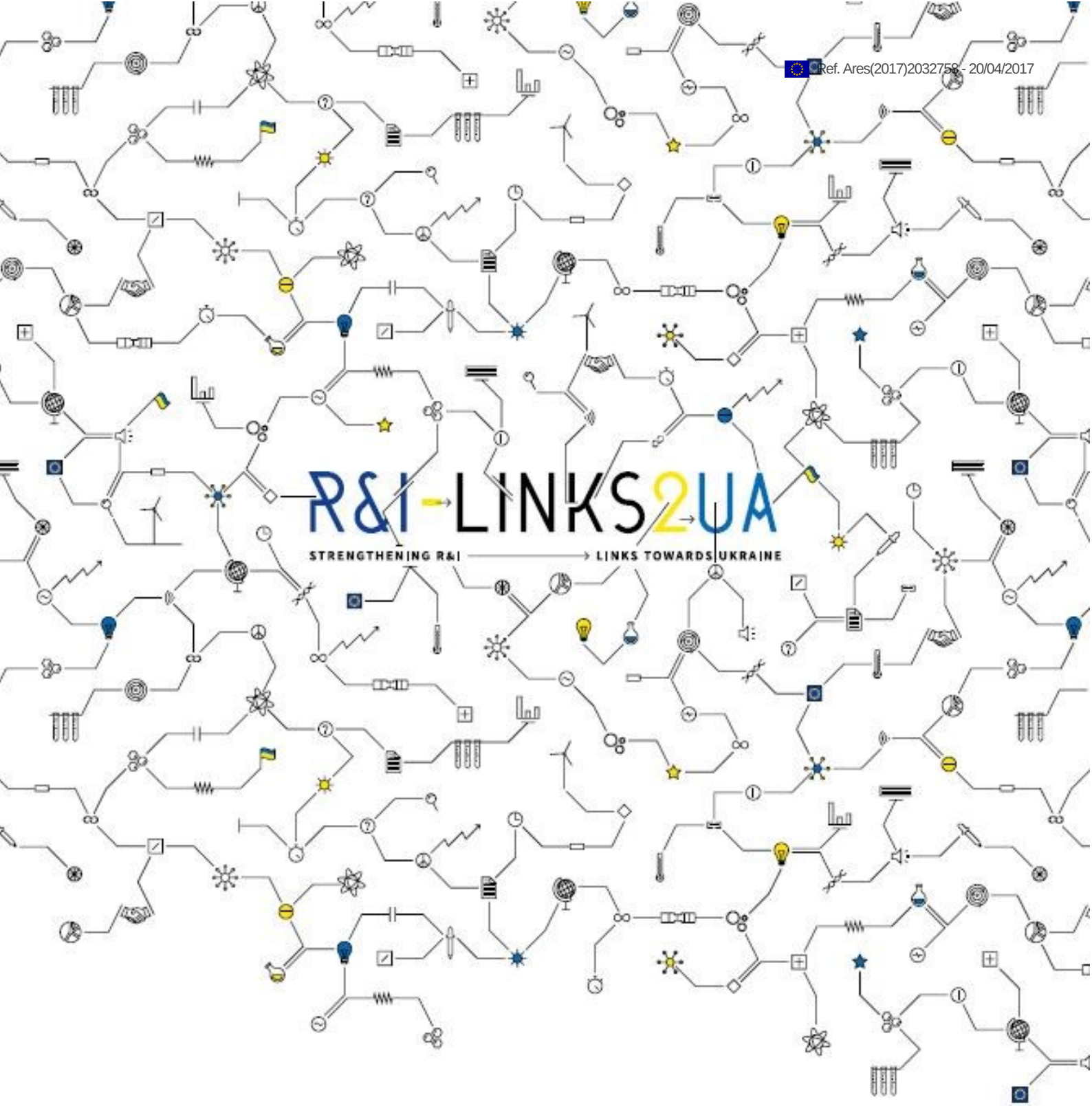

Input Paper

PPP Initiative “Resource materials” EU-UA high-tech cooperation and potential for Smart Specialization for Ukraine

This report constitutes a formal deliverable, **namely D1.5 Input paper for the International workshop on exploring the possibilities to straighten the cooperation between EU MS and Ukraine in field of New materials"** of Work Package 1 "International Knowledge exchange to support the integration of Ukraine into ERA" of **the RI-LINKS2UA project "Strengthening Research and Innovation Links towards Ukraine"**

Project Consortium:

RI-LINKS2UAisfundedbytheHorizon 2020 – Framework Programme for Research and Innovation under the grant agreement no. 692476.

Input Paper

PPP Initiative “Resource materials” EU-UA high-tech cooperation and potential for Smart Specialization for Ukraine

Internationalisation of the Ukrainian Platform on Advance Materials

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Kiev, January 2017

Foreword

Ukrainian Technology Platform on Advanced Materials (UTPAM) had been launched in Ukraine within the FP7 funded project BILAT-UKR*AINA as one of the Pilot activities (2013-2015). Among its tasks the follows ones were stipulated:

- to provide the fruitful and effective cooperation between the representatives of industry and other important stakeholders in formulating the demands for new materials and technologies of their production for establishing of R&D priorities in advanced materials and technologies and revealing the new areas of applications for the known groups of materials;
- to attract the attention of government and public organizations and investors to new materials and new technologies by presentation the detailed information about advanced materials research investigations;
- to ensure the contacts with representatives of European Technology Platforms

During the time of its activity the permanent links has been established and realised under special Agreements between National Academy of Sciences of Ukraine and State Enterprise Antonov as well as between NASU and Yuzhnoye (Pivdenne) State Design Office deal with research in the field of advanced materials. Sustainable interaction with EUMAT also brings the essential input in activity of UTPAM.

At the same time the Ukrainian status as associated to the Horizon 2020 country entered in force since 2015 and new challenges defined both in EU and in Ukraine requires widening the existing frames of cooperation. Particularly the necessity of UTPAM internationalisation and its participation in forming the demands of stakeholders became possible as the key element of all ETPs. This approach allows us move from separate actions and steps to PPP initiatives.

Under support of Ministry of Economy and Trade and Ministry of Education and Science of Ukraine National academy of sciences of Ukraine proposes the Cross-cutting Programme Initiative "Advanced long lasting resource materials for transport, energy, medicine and environment protection – "RESOURCE MATERIALS"" considered a PPP initiative of the HORIZON 2020 programme of the European Union in the period 2018-2020.

Background Information

Global Challenges to be responded through the Programme

European Council adopted the European Strategy 2020 - strategy for smart, sustainable and inclusive growth. 70th UN General Assembly approved the concept of sustainable human development until 2030. The Goal 9 has been formulated as follows: "Build resilient infrastructure, promote sustainable industrialization and foster innovation". *90 trillion may be invested into infrastructure worldwide for 15 years* that is $ 6.7 trillion annually in accordance to the report "Driving Sustainable Development Through Better Infrastructure: Key Elements of a Transformation Programme" (Global Economy & Development, Working paper 91, July 2015 under Edition of Lord Stern). The activity largely linked people with the sphere of material production, in particular, the production and processing of natural resources and manufacturing of materials, constructions for sustainably operating infrastructure in the transport, energy, industrial production and environmental protection. This activity will help to meet the global challenges, which are:

- Population is growing in the World and the increase in demand and consumption, mining and processing of material resources is likely to double over the next 40 years. Human impacts on the environment in terms of production /consumption irreversibly worsen in case of further exploitation of obsolete production technologies, industry, services and infrastructure [1-3]. Thus, people need more effectively using materials and energy, longer operating infrastructure and other facilities easily recyclable.
- Mineral resources are limited, thus ... Mankind is looking for materials that meet the scientific and technical requirements of continuous operation for a long life, long duration determined by reducing their technical, and economic parameters to a critical level, and pollution below acceptable standards, and so on.
- European Safe Life Concept is in the deep contradiction with real aging infrastructure across Europe (including Ukraine). Recently in FP7 Safe Life X project «Extension management of aged infrastructure networks and industrial plants» it has been stated:
  "Safe use and the subsequent development of European transport, industrial and energy infrastructure faces considerable difficulties due to their age". The first conclusion concerns: "One of the biggest problems of safety is the degradation of materials. A good knowledge of the degradation mechanism is crucial to be able to warn and evaluate properly the resilience of the system"[4]. Nevertheless, there is no EU R&D programme focused exactly on this problem. To our best knowledge, it must be overcome using modern materials specifically oriented on the long-term operation.

To meet these challenges, the principally new approach to materials development and production is expected to be applied. It has to be grounded on one of the most integrated characteristics of these materials – a resource of their service under given conditions of exploitation. **We define the RESOURCE MATERIALS as materials of new generation, which meet the scientifically and technically sound requirements of pre-assigned resource objects of continuous operation. These materials are considered recyclable to return them in exploitation after giving them new functions.** The resource-providing materials are going to embrace huge segment of market in the next 15-20 years because: i) extension of the service life for existing infrastructure and ii) development of new infrastructure solutions using as-invented materials, mostly composites. Thus, the society should formulate requirements for systematically increasing technical level of resource materials (for all branches of industry) to maintain high level of competition and safe life, reduce energy consumption and materials, significantly reduce pressure on the environment, which is a global strategy of sustainable development.

[1] R. Tomellini Added Value Materials. Cambridge, 2010.
[2] Material efficiency: A white paper by J.M. Allwood, M.F. Ashby, T.G. Gutowski, E. Worrell Department of Engineering, University of Cambridge, Trumpington Street, Cambridge CB2 1PZ, United Kingdom // Resources, Conservation and Recycling 55 (2011) 362–381,
[3] J.M.Allwood, M.F.Ashby Sustainable Materials, 2012 UIT Cambridge Ltd.
[4] Survey «Extension management of aged infrastructure networks and industrial plants» FP7 Grant Agreement 608813, http://www.safelife-x.eu-vri.eu

Challenges specific for Ukraine

- Ukrainian scientists are very skilled in the development of the resource materials but the Country does not use this potential properly.
  Space and Atomic projects of the past century were stimulating the development of exclusive materials, which determined the 70-years progress of Materials Science and the World economy.
  The segment of market for resource materials and strategy of its development has not been formed yet in the World – thus, Ukraine has a chance to start formation it first by means of initiation and implementationof the Cross-cutting Programme Initiative "Advanced long lasting resource materials for transport, energy, medicine and environment protection - «RESOURCE MATERIALS" overcoming several barriers:

- ✓ There are scientists, but scattered…;
- ✓ There are plants and enterprises, but each remains de-focused…;
- ✓ There are IPRs and technologies, but scattered and non-systematic…;
- ✓ There is powerful transit potential, but not used properly…;
- ✓ There is an economically justified need for construction of new infrastructure in the segments of transport, energy, industry of Ukraine as a part of the European infrastructure, but … lacks the support of Government;
- ✓ Transformation requires concentration of resources: power–scientists–industry (Customers–Developers– Manufacturers – End-users) to solve a complex problem - creating the segment of market named "Materials for infrastructure" (resource materials) to meet requirements of the Global market and Global Challenges to receive Smart specialization in the EU market!
- ✓ Transformation of new infrastructure, including transit one, to customer of RESOURCE MATERIALS.

In a number of EU countries and in Ukraine, the structure of the basic sectors of the economy strongly differs by quality (the use of resource materials) both duration and safety of operation. Transition of these industries to a new level of quality and diversification will require substantial investment over several decades. All the above is a prerequisite to establish public-private partnerships and entrepreneur discovery mechanisms, which can be realized within the "Resource Materials" Interdisciplinary Program Initiative.
The PPP "Resource Materials" should be intended to shape, develop and complete new and huge Segment of Market at the level of € 2-3 Trillion for next 10 to 15 years.

Important Market Aspects for PPP "Resource Materials"

Investments in infrastructure – transport, irrigation, energy and information and communication technology – are crucial to achieving sustainable development and empowering communities in many countries. It has long been recognized that growth in productivity and incomes, and improvements in health and education outcomes require investment in infrastructure. Inclusive and sustainable industrial development is the primary source of income generation, allows for rapid and sustained increases in living standards for all people, and provides the technological solutions to environmentally sound re-industrialization. Without technology and innovation, industrialization will not happen, and without industrialization, development will not happen.

- ✓ Obviously, power plants, bridges, railways, supporting structures, and other costly transport, energy, infrastructure facilities, parts of the human musculoskeletal system, robots in fully automated manufacturing, environmental facilities - they should have the resource of reliable operation over 50 years. In this formulation of the problem, there is nothing "subversive": today the aggregates of

hydropower plants started in the second half of the 20th century, working more than 50 years, nuclear reactors over 40 years, bridges - more than half a century, etc.

- ✓ It is becoming increasingly evident that the industrial, energy and transport infrastructures in Europe are transnational and increasingly dependent on all EU MS and neighbour countries. The efficiency of industrial production and competitiveness of goods is closely related to the timely delivery of materials and products, and can be implemented only in case of adequate logistics and high-speed transport infrastructure. This must be well developed, by the general standards in all mentioned countries. The role of safe and rapid transit is increasing and serving to increase competitiveness of entire EU economy. For EU and Ukraine it is strategically important to secure one of the key places in the transit corridor "New Silk Road", the Trans-European Transport Network (TEN-T) and other transit projects.
- ✓ EU stimulated research activities (see project SafeLife-X) showed that Europe has problems with aging infrastructure and these problems are increasing dramatically. Years of experience have allowed observations to identify problems of long-term operation, such as corrosion, fatigue, overgrowing, swelling, embrittlement, and many others. At the same time, new materials suitable for a longer work have been developed.
- ✓ The transportation infrastructures such as roads, railways, tunnels and bridges – life artery of Europe – needs in products and commodities. There is a significant contribution to the development of new European standards EN particularly in the Risk-Based Inspection Framework (pwi00319020 CEN TC 319, maintenance) [4].

However, the resource of any infrastructure, constructions, and vehicles is grounded on the stability and reliability of the materials which they are made from. The European analysis does not forecast those specific materials and technologies giving new quality to create long-lasting infrastructure, does not predict of how to change the infrastructure and material consumption in the 21st century. Here the named Programme "Resource Materials" is going to give mankind these answers and therefore, is worth implementing.

- **Specific Markets of Resource Materials**

- ❖ Development of transit infrastructure using in part Ukrainian raw materials: nanoparticle reinforced alloys, steels and weldable cast-irons, cements for a new quality, self-healing high speed rails, carriages, concrete constructions, pipelines etc.
- ❖ Development of self-healing concretes for transit high-ways, sea gas-oil platforms and port terminals, novel systems for protection of environment and recycling/ utilization of secondary raw-materials and wastes;
- ❖ Development of infrastructure monitoring network using built-in nano-sensors and Big data processing system to control "health and aging" of infrastructure.
- ❖ Development of composite materials based on metal, ceramic and polymer matrices for transit corridors in the frame of NEW Silk Road (East-West) and the TEN-T;
- ❖ Development of Energy Infrastructure as a part of transit infrastructure including big and local power plants, hybrid accumulating / feeding systems (commutation materials, electric energy transforming / accumulating, lighting systems), etc.
- ❖ Development of resource materials for the systems of heat and water supply inside the transit infrastructure;
- ❖ Materials for industrial infrastructure;
- ❖ Development of new materials for nuclear power plants, including materials for the fast-neutron reactors, DSS; sensors for radiation monitoring.

- **Existing pre-requisites**

The National Academy of Sciences of Ukraine, where the materials science is a strongest part, is developing the Research programme titled "Extension of life of infrastructure and transport services" for over a dozen. The selection of materials and material' technologies is concentrated on the problem of aging. Particular emphasis is placed on new materials, which are intended for the construction of modern infrastructure, where the function is continuous stable operation already pledged or projected. The Program Horizon 2020, in some contests requires the creation of durable materials and designs of them. For example, new competition NMBP-06-2017 «Improved material durability in buildings and infrastructures, including offshore» is directly about reliable materials with extended service resource. However, the scale of one-two projects is too small; it should be a full scale PPP initiative involving funds from EC and companies in both Europe and Ukraine.

Thus, the materials theme is reflecting the vision of development of the material-intensive businesses as multibillion segments of the market and long-term perspective plan for building the EU and Ukraine's GDP. For Ukraine and EU it is strategically important to secure one of the key places in the transit corridor "New Silk Road" and other transit projects. Obviously, the economic interest of the EU and China in a powerful and low-cost transport connection will be an incentive to invest in the development of EU-Ukraine's infrastructure, built from Ukrainian raw-materials by Ukrainian companies. In this context, Ukraine's contribution to the field of science and technology of new resource materials for infrastructure could be significant.

Thus, National academy of sciences of Ukraine comes with a proposal to major scientific and technological initiatives "Advanced Long-lasting resource materials for Transport, Energy, medicine and environmental protection - "RESOURCE MATERIALS."

The concept of "Resource materials" is applicable in various areas, in relation to energy, transport, economics, biology / medicine and ecology, electronics / computer science, human resources and is associated with the concepts of competition and sustainability, thus it is considered in Cross-Cutting format.

• The Objectives of PPP Cross-Cutting initiative "Resource Materials"

The overall objective of the programme is at creating the segment of new materials, critical products and components of products based on them, that have increased life service in infrastructure of energy, transportation, medicine and environmental protection by the implementation of the results of systematic researches and pilot-scale production technologies developed as well as subsequent commercialization through the Public-Private Partnership mechanisms.

The operational objectives of the Project Initiative are:

- Synergy of interaction between scientific, educational and industry sectors, interested in solving the problem of infrastructure renovation in construction industry, transport and energy on a way of Public-Private Partnership;
- Organization of interaction between the Technological Platforms of the EU and Ukraine interested in resource materials as a large segment of market and the subsequent transformation of the infrastructures.
- The definition of the best practical steps for the implementation of technologies in the new infrastructure based on as-developed resource materials;
- Definition Strategic Research Agenda (SRA) and the implementation of the strategy (Roadmap);
- Initiation and development of pre-standards and standards that will be the basis for the effective resolution of the problem of creating new infrastructure.

• Anticipated results of the PPP Cross-Cutting Program Initiative "Resource Materials"

1. The Catalogue of the needs of the various interested parties, stakeholders to be involved in renovation of aging industry, energy and transport infrastructures by building new infrastructures;
2. The materials solutions for expensive infrastructures to replace the old ones in EU countries and Ukraine;
3. The collection of resource materials technologies covering the needs of the next step - the construction of new infrastructure;
4. Rapidly developing Society, High-tech jobs in all EU countries and Ukraine;
5. Reducing the migration tension due to the equalization of living standards;
6. Reducing technological risks in the developing countries of the EU and at the EU borders;
7. Industry Modernization;
8. Development of transport systems: vehicles and equipment (ships, aircraft, electric vehicles, high-speed trains, highways, etc.) competitive for megaprojects like "New Silk Road" andthe Trans-European Transport Network.
9. A new generation of Power supply systems: hybrid storage, electric transportation and energy conversion;
10. The new system of environmental protection and waste management;

Grounding on the expected results of the Program Initiative "Resource Materials", the EU and Ukraine will be able to develop series of projects for new infrastructures for transit corridors, transport, energy and environment protection facilities making future development sustainable.
Terms for implementation of the Programme could be 2018-2022 years. Further renovation steps would be considered for the period 2020-2035 years.

Interests and Stakeholders

The EU interests concern

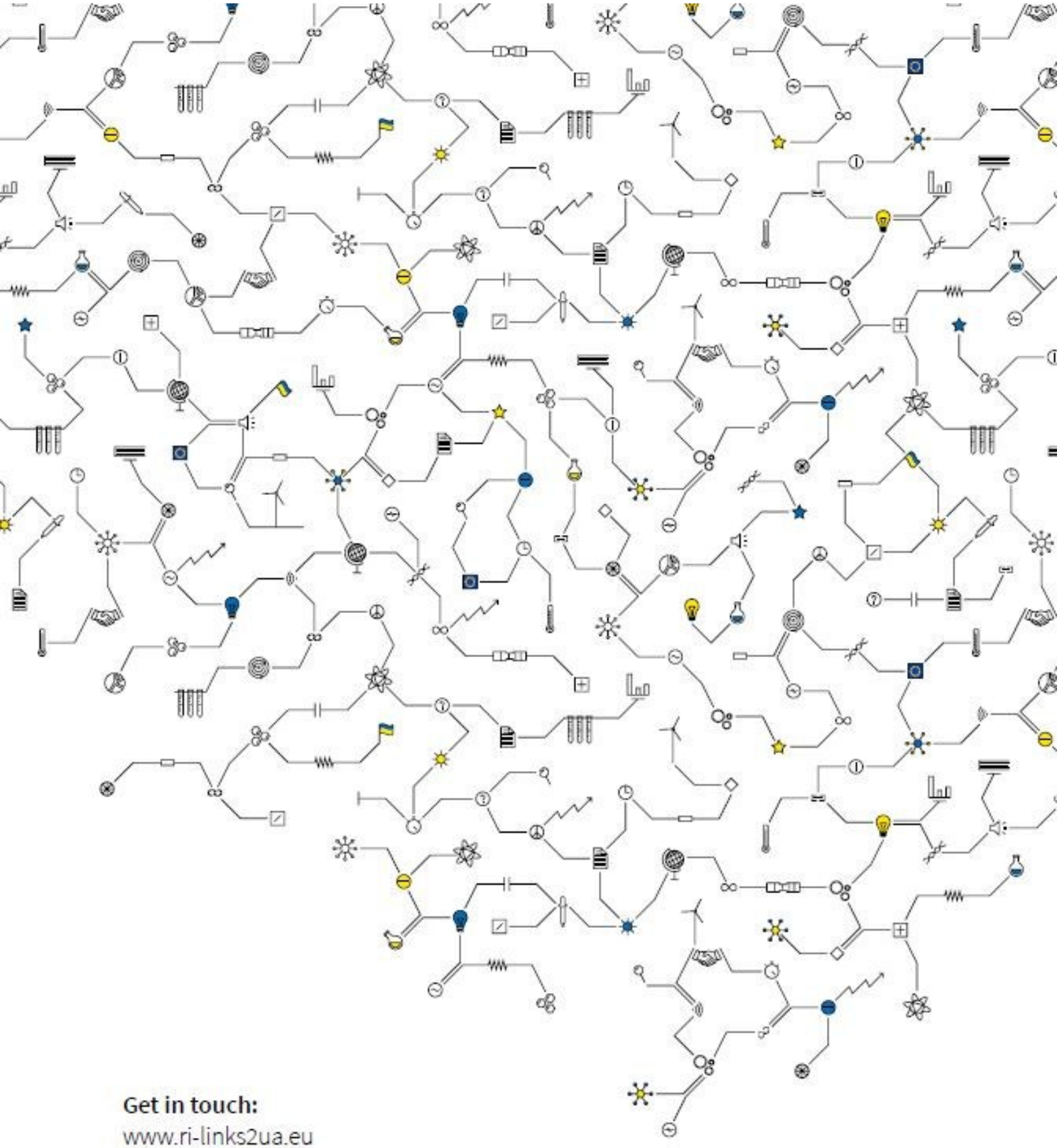
- New segments of materials, technologies and services;
- Developments of the EU transport corridors (the Trans-European Transport Network) as a minimum. As a maximum - New Silk Road with Asia;
- Safe Infrastructure development in EU;
- Low impact on Environment;
- Competitive materials IP and technologies, sales outside the EU;
- Technology and constructions of a new type and safety;
- Highly skilled jobs in the EU;
- New jobs in the EU, developing countries and in Ukraine;
- Reducing the social tensions caused by migration, potential migration from Ukraine;
- Reducing the probability of industrial accidents in the EU, developing countries and on the borders of the EU.

The Ukrainian interests concern:

- RIS3 and S3 in high-tech materials;
- Innovative and integrated Science and Education;
- New industry, transport and, energy infrastructure constructed from materials made in Ukraine;
- Reconstructed industry;
- Changed structure of the industry;

- The new infrastructure of cities, villages, industrial and transport hubs;
- Participation in the Trans-European Transport Network and the transit Megaproject "New Silk Road" between China and the EU;
- New transport infrastructure that meets the high-speed delivery standards of (electric vehicles, high-speed trains, highways, etc.);
- The Energy Strategy coordinated with the EU;
- New energy-generating capacity, energy-accumulating systems, energy-converting systems, improving energy consumption;
- The new system of environmental protection and recycling

Achieving these goals for the European economy and way of life is possible, provided that the whole industry to modernize itself, increasing the efficiency, quality and safety. Security is essential to human well-being and to ensure the efficiency and competitiveness of the industrial and transport systems as a whole. Any breach in the chain of production - transport has negative consequences for the industry and for the transport system, which goes beyond a single country. It is therefore important that in all European countries, there is a consistent approach to security, and that this approach is also supported consistently by different industries and vehicles and technology. This should be a long-term goal that mobilizes the efforts of all parties involved.



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This project is funded by the Horizon 2020 EU FP for R&I under grant agreement no. 692476