Action Plan

SRIP MATPRO

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ACTION PLAN: SRIP – MATERIALS AS END PRODUCTS

OPERATION ABBREVIATION: SRIP MATPRO

APPLICANT: ECONOMIC CHAMBER OF SLOVENIA

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SUMMARY

Key orientations of SRIP MATerials as end PROducts (SRIP MATPRO)

1.) The key objectives

The key objective of SRIP MATPRO is to create value chains with a focus on the production of materials for use in complex products with high added value and a strong potential for positioning in global value chains. Connectivity will be based on promoting and enhancing the development of ambition and quality as well as on strengthening the strategic alliances and the establishment of horizontal networks, thereby achieving a critical mass of competences and capacities, complementing various technologies in terms of the development of new materials, products and services, the integrity of covering the whole cycle from development to marketing, and addressing technological and non-technological innovations, promoting entrepreneurship as well as providing other common services. The joint development of the R&D initiatives will be carried out in two basic directions i.e., through a common pre-competitive development between companies from related branches, where it is to solve the fundamental challenges, and to joint development within the established value chains between companies from different branches. MATPRO members will be provided with an appropriate research environment, which is especially important for medium and small enterprises. In doing so, we will contribute to reducing the risks of investing in high-tech equipment, achieving a critical mass of competencies, capacity and investment potential, increasing the utilization of equipment and contributing to establishing long-lasting business relationships.

<u>The main objectives of the operation:</u>

- To strengthen the cooperation of producers of materials that already achieve high added value and play a significant role in international value chains, among themselves and with knowledge institutions.
- Identification of the value chains (SLO): 2017 - 2023: 5 chains, 2019 - establishing at least 2 chains; 2023 - establishment of at least 3 (additional) chains, of which identification of the value chains (international): 2017 - 2023: 3 chains, 2019 - establishment of 1 chain, 2023 - establishment of 2 chains. All of these goals represent the lowest values that we expect to be exceeded.

<u>Objectives by 2023</u>

- Increase in added value per employee for companies active in the production of alloys and metals (participating in established and appropriately supported value chains) by 25% by 2023.
- Increase in export and added value per employee in the area of smart coatings (participating in established and appropriately supported value chains) by 20%.
- Increased investments in development by 15%, added value by 5% and exports in the field of smart multicomponent materials by 10%.
- Increased intensity and quality of representation of Slovenian interests within international organizations, partnerships and consortia (6).
- Number of commonly developed services (10).
- Number of relevant initiatives in terms of development policy e.g., iInitiatives for the implementation of innovative public procurement (8).

2.) Key global indicators

The performance indicators presented in the tables are designed to monitor the performance of all the value chains included in SRIP MATPRO. The purpose is to verify and monitor the business results of the different forms of established cooperation. In the case that the value chain during a given 3-year period (first or second) does not reach the planned growth at in least four out of seven (all indicators are given in the text of the Action Plan) of the performance indicators, it is considered not to be economically viable. The exceptions are predetermined risks, which particularly affect all companies in certain activities, but in this case the value chain must also achieve better business results than a comparable activity (a smaller drop in added value).

SRIP MATPRO		till 2018	till 2022	Activities: C20, C22, C23 in C24
Added value/ Employee	Productivity of labour. The higher the value added per employee, the higher the potential gross salary of the employee.	2,3% Per year	2,8% Per year	Higher value added rise is expected than the number of employees due to larger investments in automation and optimization of production.
Exports (turnover on foreign markets)	Higher exports, on average, mean higher competitiveness of the company or a general increase in demand abroad.	1,8% Per year	2,3% Per year	Net sales in the non-domestic market
Investments in R&D	Higher R & D investment is expected to be reflected in a higher value added, but there is an expectation of a lag between investments and a positive impact on the financial statements	2,0% Per year	2,0% Per year	This includes both expenditures and R & D investments. Companies are not required to report these values, so the comparison between companies is limited to a statistically significant sample (companies that together account for at least 25% of sales).
EBITDA	EBITDA is a cash-flow from operations before depreciation. The higher the EBITDA, the more profitable business is.	2,3% Per year	2,8% Per year	
Net profit	Net profit represents the final result of the business. Attachment "net" means that a particular SRIP company can have a loss, but the aggregate result is still positive.	2,3% Per year	2,8% Per year	Net profit is calculated "cleared", excluding impairment of financial assets (fixed and current assets) and revaluations (Financial investments)

In 2013	Metallurgy and metallic materials (activities 23 and 24)	Chemical industry and industry of multicomponent materials (activities 20 in 22)
Share in total sales	3,03%	4,12%
Share in total sales of manufacturing branch	9,96%	13,53%
Export orientation (% of sales)	67%	71%
Employees in R&D (FTE / 100,000)	1.220	5.771
Researchers in R&D (FTE / 100,000)	558	2.693
Investments in RR	23 mio €	29 mio €
% GNP	0,06 %	0,08%
Added Value / Employee	38.200 €	43.000 €

3.) SRIP Strategy

SRIP MATPRO is focused on materials and, preferably, on materials production. The materials are divided into metallic materials, which include metallurgy, foundry and technologies of production, and processing, as well as multicomponent materials, whose main characteristic is that they are not homogeneous but include different materials/components, combined in very different ways (from coatings, nanocomposites, Multi-layered films, glued structures, to classic composites). The main objective of SRIP MATPRO's work is to create value chains and networks for joint developments in the field of materials; therefore, in addition to the production of materials, suppliers of basic components and raw materials, materials processing as well as final product manufacturers are included in the cooperation. SRIP MATPRO gives strong emphasis to both materials and technologies.

The field of materials as final products has a particularly high priority in Europe, which directly and completely follows the principles of smart specialization, and supports the regional advantages of Slovenia. The analysis of the field of materials, world markets and trends, industrial needs and R&D challenges, competence advantages, R&D capacities, and above all, the potential of Slovenian companies demonstrated that the comparative advantages of the main players in Slovenia stand out in the following areas: (i) high specialization and high degree of flexibility, (ii) high technological intensity and strong focus on innovations, (iii) relatively good organization, (iv) responsible attitude, effective use of resources and a high recycling rate, (v) close cooperation between companies and knowledge institutions in the use of public R&D funds, (vi) integration into global chains, (vii) niche mode of operation for medium and small enterprises, (viii) good market knowledge and (ix) the exploitation of local providers. On the basis of the conducted analysis, a set of focal areas was identified that meet the criteria for the development of breakthrough initiatives. The key competences, critical mass and the potential of integration into chains that would allow the development of breakthrough solutions were the most important criteria.

Composition of SRIP MATPRO:

- Slovenian Chamber of Commerce (as a notifier) with 2 industrial associations and its members (86 micro enterprises, 47 small enterprises, 61 medium-sized enterprises and 37 large companies, of which about half are located in the eastern Slovenian region and another half in the western one), represent the immediate supporting environment.
- Direct members of SRIP MATPRO (20 companies and 4 knowledge institutions), where scientific research institutes and knowledge institutions form a broader support environment
- Cooperation talks run with many subjects, both with companies and with knowledge institutes, including two of the largest Slovenian universities.

SRIP membership provides a critical mass of competencies and capacities. The field of human-resources development is one of the key elements of the long-term achievement of the set goals, so SRIP MATPRO pays special attention to it. The work will include the prediction of competence needs, the identification of gaps in current and required competences, and development of appropriate programs for acquiring the necessary competences. SRIP MATPRO supports the internationalization of activities, which has three key orientations: 1) Integration into European initiatives (S3 thematic platforms including pilot projects (e.g., Vanguard Initiative), entry into European development projects (e.g., H2020), 2) Connecting with foreign partners within the framework of the development of value chains. The starting point represents the existing relationships between Slovenian and foreign companies, 3) Promotion of Slovenian industry abroad through the organisation of events or visits.

4.) Focus areas with identification of the activities of joint development

Identified focal areas on which SRIP MATPRO will promote joint research and development tasks are:

a) The area of steels and special alloys.

i) In order to achieve high standards of quality, reliability and safety, the purity of steel and alloys, or the control of non-metallic inclusions, errors and irregularities in the microstructure is important. On the other hand, the requirements of the automotive industry by reducing consumption and environmental impact dictate the use of advanced high-strength steels, and lightweight metallic materials which, in addition to extreme mechanical properties, also provide 100% recyclability. The development of new advanced metallic materials for the most demanding applications and working conditions will enable a significant improvement in the processes of obtaining and storing energy, protecting the environment and improving the quality of life.

ii) Areas of joint development, where Slovenia has a potential and critical mass:

1. The concept of ultra-pure steel and alloys - inclusions lower the strength, but above all the dynamic properties of the material, which means lower reliability. The production of ultra-pure steel involves R&D initiatives in the whole field of steel-making technologies, from the development and understanding of secondary metallurgy to thermodynamic calculations, understanding and modelling processes of the motion of inclusions in the melt, in-situ observation of non-metallic inclusions in the melt (formation, elimination, dissolution and interaction between inclusions), the influence of slag, new methods for the characterization and analysis of inclusions, re-metallurgy, vacuum treatment of steel melt and special metallurgical processes.
2. High-strength steels for lightweight constructions and their transformation - with the transition to high-strength steels and steels enabling the construction of products having minimal weight, which above all combine high strength and elastic properties, besides the development itself, we also encounter difficulties in transforming, machining and joining these materials. Potential and competences are in the field of complex thermo-mechanical processing, the development of high-strength martensitic steels and their heat treatment, the third generation of high-strength steels and nano-structured and nano-bainite steels, low density steels, new multi-layered steels, the production of suitable tool steels, the protection of tool surfaces, the preparation and protection of high-strength steels, steel transformation, production and functionalization of the surfaces of products.
3. Advanced metal materials for demanding applications – the Slovenian metallurgical industry has the significant advantage of rapid adjustment to niche production compared to mass producers. With this, it has the potential to develop advanced metallic materials, which includes the production of new steel grades, for example, maraging steels, nickel super alloys, special steels for high-temperature applications, thermos-electrical alloys and sensors, new electro steels with super low power losses, new magnetic materials, and biocompatible metallic materials, supported by simulations and optimization of the entire process path. Recently at the development of new materials, an important role is given to the imitation and transfer of solutions found in nature, and their application to a wide range of technological areas (biomimetics).

b) The Aluminium:

c) In addition to the automotive and aerospace industries, Al alloys also have enormous potential in a wide range of other fields, such as medicine, pharmaceuticals, military industries, interiors, etc. The development of new high-strength and corrosion-resistant aluminium alloys is expected to combine 100% recyclability, low weight, high carrying capacity and maximum energy absorption.

d) Areas of joint development, where Slovenia has a potential and critical mass:

1. New high-strength and ultra-pure Al alloys – The properties of standard aluminium alloys, including high-quality ones, do not meet the stringent requirements of high-tech applications, which require a tensile strength of more than 600 MPa.Therefore, R&D initiatives are aimed at the development

of new high-strength and ultra-pure Al alloys with better mechanical properties and corrosion resistance, which include the introduction of new alloying procedures, melt refinement, treatment with trapping and modifying agents and an appropriate curing process and thermo-mechanical processing. Al foams represent a significant segment of kinetic energy absorptive materials. New segment is being formed on the field of joining of newly developed Al alloys.

2. Alternative manufacturing methods and maximum recycling of Al - Al alloys are divided into quality classes with special properties and with very narrowly defined alloying elements, which limits their production by using only secondary raw materials. In order to achieve a higher recyclability, the development focuses on new recycle- friendly alloys based on a basic understanding of the complex impact of a large number of trace elements on the properties of Al alloys, the replacement of existing standards based on the purity of primary aluminium, the standards of purity of waste and the introduction of appropriate procedures in the sorting of waste and introducing new melt purification technologies. On the other hand, the production of alloys with the highest quality requirements (for the aerospace industry) still requires the use of a certain portion of the primary Al, which requires further development in order to achieve cheaper and faster production of primary Al.

3. Die cast Al alloys - Trends are aimed at the production of new high-strength, temperature-stable and corrosion-resistant moulded Al alloys for production of complex Al castings for aerospace, and automotive industries. With a large network of foundries and aluminium alloy production, Slovenia has a considerable potential, which requires the acquisition of new technologies for special casting processes and rapid clamping, the development of new alloys, and the investigation of the modification of foundry Al alloys, as well as the determination of the influence of chemical composition, conditions of solidification and cooling, and heat treatment.

e) Technology.

i) The field of classic manufacturing technologies is developing into the optimization and improvement of machining processes, the development of new tools and manufacturing technologies, with the recycling of both basic as well as auxiliary materials and by-products becoming an increasingly important segment of the production process of metallic and non-metallic materials. The greatest advancement and change in the field of technology comes from the additive 3D printing technology.

ii) Areas of joint development, where Slovenia has a potential and critical mass:

1. Rapid Prototyping and additive Technologies – R&D potential and emphasis will be on the development of new metal materials ready for 3D printing, mastering the microstructure and the influence of the direction of construction and density, the introduction of combination of different additive technologies, the production of printed products of large dimensions, printed composites and nanocomposites, greater precision of the printing and surface quality and gradient phase structure with continuous gradient of properties.

2. Recycling - (Metallic materials, rare earths, composites, auxiliary materials, by-products) – successful recycling begins with the development of material, component design and planning of the production process, which also includes the recycling of auxiliary materials, secondary products and waste materials. The potential and competence of maximum recycling capacity exist in the production of raw materials and auxiliary materials, the production of steel and aluminium, foundry, metal products and permanent magnets, the production of composites, elastomers, and auxiliary decomposition, handling and the use of secondary products. A special segment represents the transport, storage and utilization of CO_2 generated in the production of materials, as well as the reduction of energy consumption, the utilization of generated waste heat, and the use of bio-metallurgical processes in the recycling of alloying elements.

3. Advanced casting technology – With the development of materials and above all with the increase in the complexity and dimensional accuracy of castings, the trends in casting techniques and technologies change significantly, which applies both to casting in both single and permanent forms. The main focus is the ability of the melt to fill a thin wall, modification, development and complementation of casting technologies, integration of heat treatment with temperature controlled casting engineering, the development of ecologically acceptable sand mixtures, and the introduction of an integrated simulation product optimization and production.

4. Modern technologies for processing polymers and hybrid materials - In the production of products, it aims to install lightweight, but in mechanical properties comparable materials to classically-used metals, and look for cheaper and more energy-efficient solutions to manufacturing processes that make complex components possible. In the segment of modern processing technologies, there is a strong potential in the field of multi-component polymer spraying, functional integration of structural components into injected products, pressing polyurethane plates with long fibre spraying and hybrid manufacturing.

5. Modelling of materials manufacturing processes - modern development of materials and technologies cannot be imagined without modelling of the processes that take place during material production. Modelling can be done by combining already developed models or by developing new models that cover several phenomena under one framework. The biggest challenges in this field are mainly related to the problem of transitions or clustering of models between different spatial and time scales. The design of the microstructure, which defines the final properties of the material, is in the field of production of materials carried out on all four main spatial scales, i.e. on electron, atomic, mesoscopic, and macroscopic scale, respectively.

f) Multicomponent smart materials.

g) smart integration of the various components into a single material exceeds the existing properties frame and opens the way to completely new materials with so far inaccessible properties.

h) Areas of joint development, where Slovenia has a potential and critical mass:

1. Multi-component smart fibres and textiles - a new generation of multi-component fibers and textiles with built-in functions (environmental responsive components, sensors) that passively or actively contribute to safety (antibacterial action, discharge), provide information (UV sensors) or provide comfort (passive or active conservation Optimal temperatures). At the same time, basic material functions such as strength, stability, etc. are increased or maintained. The technology reforms to use the renewable or recycled materials, aiming for increased durability.

2. Composites - conquering and exceeding state-of-the-art composition, production, processing and re-use of key components in most high-tech sectors (e.g., aviation, automotive, energy, leisure / sports, construction). Automation and shortening of production cycles, new raw materials (thermoplastic resins), combination with additive technologies. The maintenance and especially decomposition and successful recycling of composites is for the time being an untapped potential.

i) Functional coatings and advanced binders (for metals).

j) The key role and scope of the application of coatings and binders to protect products and joining multicomponent structures are increasing, but coatings/binders must meet ever-increasing requirements, which requires a new generation of materials.

k) Areas of joint development, where Slovenia has a potential and critical mass:

1. Functional coatings – next-generation coatings will combine environmental acceptability (no volatile organic solvents, renewable components), functionality (functional nanoparticles, wear and damage indicators) and durability (self-renewing coatings).

2. Resins and binders - new generations will have smaller discharges (solvent abandoning/replacement), modified composition with improved functionality and wider application, as well as quick application (suitable for rapid production of composites or glued structures). Emphasis will also be placed on introducing renewable components.

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ABBREVIATIONS

3D	3 Dimensional
6R	Recover, Recycle, Redesign, Reduce, Remanufacture, Reuse
ADI	Austempered Ductile Iron
AHSS	Advanced High Strength Steel
AM	Additive Manufacturing
AMITIE	Additive Manufacturing Initiative for Transnational Innovation
AOD	Argon Oxygen Decarburization
API	Application Programming Interface
ASCENAM	Adding Simulation to the Corporate Environment for Additive Manufacturing
B2B	Business to Business
B2C	Business to Consumer
BAT	Beat Available Technologies
BAT	Best Available Techniques
BEPS	Base Erosion and Profit Shifting – OECD
BILAT-UKRAINA	EU – Ukraine Project
BIOCORIN	Biocoating for Corrosion Inhibition in Metal Surfaces
BREF	Best Available Technique Reference Notes
CAE	Computer Aided Engineering
CAEF	European Foundry Association
CAUTI	Catheter-Associated Urinary Tract Infections
CC	Centrifugal Casting
CCIS	Chamber of Commerce and Industry of Republic Slovenia
CEDEFOP	European Centre for the Development of Vocational Training
CEEMET	Council of European Employers of the Metal, Engineering and Technology-based industries
CEFIC	The European Chemical Industry Council
CEPE	European Council of the Paint, Printing Ink and Artists' Colours Industry
CGI	Compacted Graphite Iron
CLEPA	European Association of Automotive Suppliers
CM	Competence Model
CPI	Vocational Education Centre (Center poklicnega izobraževanja)
CSR	Corporate Social Responsibility
DED	Direct Energy Deposition
DEMETER	European Training Network for the Design and Recycling of Rare-Earth Permanent Magnet Motors and Generators in Hybrid and Full Electric Vehicles (DEMETER)
DevOps	Development and Operations
DREAM	Driving up Reliability and Efficiency of Additive Manufacturing
EBITDA	Earnings Before Interest, Taxes, Depreciation and Amortization
EBM	Electron Beam Melting
EFFRA	European Factories of the Future Research Association
EMAS	Eco-Management and Audit Scheme
ESR	Electro-slag Remelting
ESS	Employment Service of Slovenia
ETRMA	European Tyre & Rubber Manufacturers' Association
EU	European Union
Fab Lab	Fabrication Laboratory
FEICA	Association of the European Adhesive and Sealant Industry
FEPA	Federation of European Producers of Abrasives

FET	Future Emerging Technologies
FGI	Flake Graphite Iron
FP7	Framework Programme 7
FTE	Full Time Equivalent
GDP	Gross Domestic Product
HDG	Hot-Dip Galvanization
HPC	High Performance Computing
HPDC	High Pressure Die Casting
ICP	Individual Career Plan
ICT	Information Communication Technology
IoS	Internet of Services
IoT	Internet of Things
KET	Key Enabling Technologies
KoC	Centre of Competence
LCA	Life Cycle Assessment
L-IP	Lightweight Steels with Induced Plasticity
LLP	Lifelong Learning Programmes
LM	Laser Melting
LMD	Laser Metal Deposition
LPDC	Low Pressure Die Casting
LS	Laser Sintering
MAESTRO	Modular Laser Based Additive Manufacturing Platform for Large Scale Industrial Applications
MAG-DRIVE	Magnetic Superconductor Cryogenic Non-Contact Harmonic Drive
MATPRO	MATerias for end PROducts
MEDT	Ministry of Economic Development and Technology
OPZG	Indicative program for the transition to a green economy
ORGALIME	European Engineering Industries Association
PM	Powder Metallurgy
QaS	Quality of Service
R & D	Research and Development
REBIOSTENT	Reinforced Bioresorbable Biomaterials for Therapeutic Drug Eluting Stents
REProMag	Manufacturing & Processing Method for Rare-Earth Magnets
RFCS	Research Fund for Coal and Steel
RI-LINKS2UA	EU Project - Strengthening Research and Innovation Links towards Ukraine
ROE	Return On Equity
ROMEO	Replacement and Original Magnet Engineering Options
SaaS	Software as a Service, Storage as a Service
SGI	Spheroidal Graphite Iron
SGS	Système de Gestion de la Sécurité
SKD	Standard Classification of Activities (Standardna klasifikacija dejavnosti)
SLA	Service Level Agreement
SLM	Selective Laser Melting
SME	Small and Medium Enterprises
SME	Small and Medium Enterprises
SRIP	Strategic Development Innovation Partnership
TRL	Technology Readiness Level
TSP	Thematic Strategic Partnerships
TWIP	Twinning Induced Plasticity
UHS	Ultra High Solids
UNTPAM	Ukrainian National Technology Platform on Advanced Materials
USP	Unique Selling Proposition

UTI	Urinary Tract Infections
UV	Ultraviolet
VAR	Vacuum Arc Remelting
VAR	Vacuum Arc Degassing
VD	Vacuum Degassing
VIM	Vacuum Induction Melting
VOC	Volatile Organic Compound
VOD	Vacuum Oxygen Decarburization
WBCSD	World Business Council For Sustainable Development
XaaS	Anything-as-a-Service

TABLE OF CONTENTS

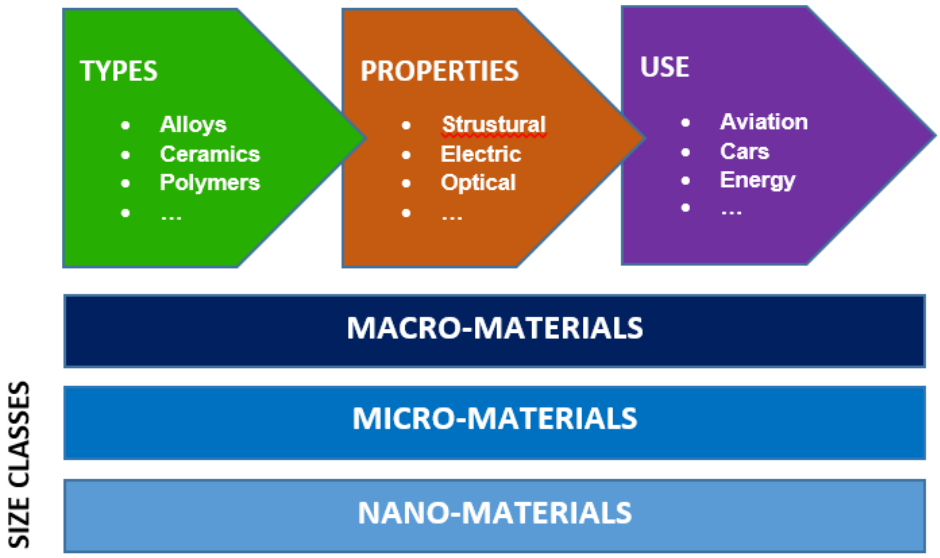
1 Strategy of development for SRIP MATPRO

1.1 Positioning in global trends, chains and markets by defining upcoming technologies

Definition of the field for materials

The field of advanced materials can be defined in many different ways. According to Featherston and O'Sullivan[1], various studies and strategies that dealt with the topic of advanced materials concluded with different definitions: "There is a considerable diversity in terminology, categories and topics addressed by different strategies." Materials can thus be defined by different criteria:

- Conventionally, they can be divided into traditional categories (e.g., metallic materials, ceramics, polymers, alloys).
- By properties (e.g., optical, electrical, magnetic).
- After use (e.g., materials for lowering energy consumption, for aero-space materials).
- According to engineering structure (size classes, e.g., nano-materials, micro-materials).



[1] C. Featherston, E. O'Sullivan, A review of international public sector strategies and roadmaps: A case study in advanced materials, Centre for Science Technology and Innovation, Institute for Manufacturing, University of Cambridge, UK, 2014
http://strategiprocessen.stratresearch.se/Documents/Strategiprocessen/Featherston__OSullivan_2014_-_A_review_of_international_public_sector_roadmaps-_advanced_materials_full_report.pdf

These categories are not mutually exclusive, so materials can simultaneously meet several definitions. Additionally, with advanced materials, categories such as high-added-value materials, modern materials, smart materials and future materials are emerging.

The fact that the scope of materials is extremely wide is confirmed by the fact that one of the world's leading publishing houses for scientific literature, Wiley, publishes 68 scientific journals in the field of material science[2].

In most studies and classifications, the distribution is divided into only a few groups. The working document of the work group for technologies for advanced materials[3] defines advanced materials as:

- advanced metals,
- advanced synthetic polymers,
- advanced ceramics,
- new composites,
- advanced bio-based materials.

A Flemish project describing the Key Enabling Technologies (KET) in 2014[4] provides a detailed analysis and strategy in the field of advanced materials. In the document, advanced materials are divided into 6 groups:

- metals and alloys,
- polymers,
- ceramics,
- composites,
- biomaterials,
- nanomaterials.

It is significant that two chapters for incentive technologies that are not directly related to specific materials were added:

- recycling and sustainability,
- advanced research methodologies.

A broader aspect for materials

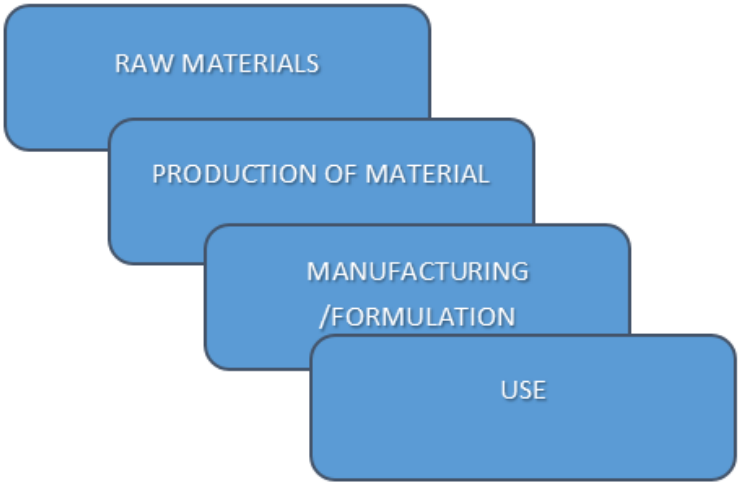
In the context of materials it is also necessary to include the chemical industry, which produces raw materials and components that are incorporated into materials as end-products. This is an extremely wide set of chemicals that are difficult to define clearly,

[2] http://eu.wiley.com/WileyCDA/Section/id-350617.html?&view=JournalSpotlight

[3] Working document Working Group on Advanced Materials Technologies http://www.google.si/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&cad=rja&uact=8&ved=0ahUKEwju8tjp_LzRAhWGYJoKHQCEDvMQFgg4MAM&url=http%3A%2F%2Fec.europa.eu%2FDocsRoom%2Fdocuments%2F11283%2Fattachments%2F3%2Ftranslations%2Fen%2Frenditions%2Fnative&usg=AFQjCNERZSJ1BjV7KDiPKAxjzgbgLf_irA

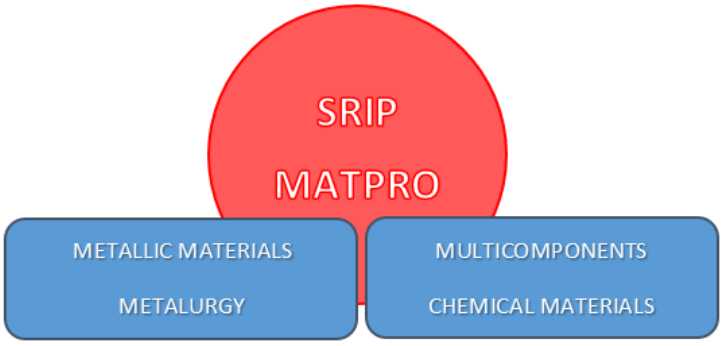
[4] KET-roadmap Geavanceerde Materialen in Vlaanderen Advanced Materials in Flanders, http://www.sim-flanders.be/sites/default/files/ket_rm_am_final.pdf

although they have great importance for materials as end-products, especially from the perspective of value chains.



Focus of SRIP MATPRO

In SRIP MATPRO, according to the approved application, materials are divided into **metallic materials,** which includes metallurgy, foundry and related technologies, and **multicomponent materials,** whose main characteristic is that they are not homogeneous, but incorporate various materials/components, grouped in very different ways (from coatings, nanocomposites, multilayer films, glued structures, to classic composites).



The goal of the SRIP is to develop value chains and networks; therefore, the main components, raw materials, materials processing, as well as finished products, are included in the process.

International trends in materials

In line with the importance of advanced materials to achieve goals in diverse areas such as health, energy, nutrition, safety, mobility, recreation, sustainability, economic growth, the fight against poverty, etc., materials are inextricably integrated in almost all strategic and developmental thinking.

Challenges in the development of the metallurgy and chemical industry

Nanotechnologies, advanced materials, advanced production technologies, biotechnologies (also covered by EU Framework for Research and Innovation Horizon 2020) are key areas that will enable European industry to maintain its global competitiveness and exploit new markets. With them, the metallurgy and chemical industries are inextricably linked and form part of the identified key enabling technologies and enabling technologies of the future, which are recognized and supported by the EU's industrial policy. Research, development and innovation play a very important role. The European Chemical Industry Council CEFIC[5] states that innovation in the chemical industry also leads to the development of advanced materials (such as hybrid and light materials, tissue engineering, self-cleaning surfaces, energy recovery and energy storage) and advanced process technologies that enable more flexible production, more efficient use of energy products, raw materials and water. At the same time, they contribute to improving recycling and increasing the use of renewable raw materials, with which the chemical industry directly influences the enforcement of the principles of a circular economy. The same applies to metallurgy.

On the other hand, the chemical industry is also essential for a sustainable bio-economy[6], promoted by the European Commission in the strategy "Innovation for sustainable growth: the bio-economy for Europe", as chemistry and biotechnology enable the entire value chain from fertilizers, plant-protection products to biomass refining into biomaterials that can be used for food, forage, plastics, coatings, adhesives, fuels and energy, lubricants, cosmetics, pharmaceuticals and many others.

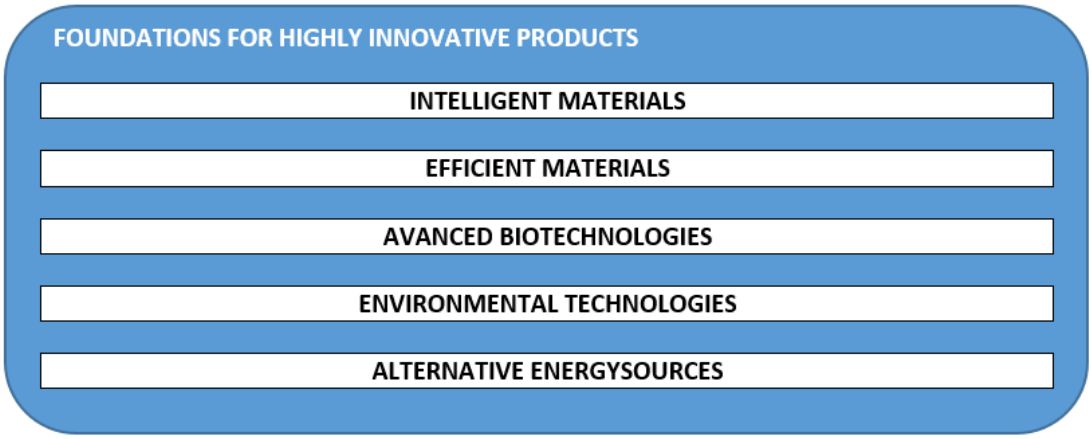
The document, Chemical Industry Vision 2030: A European Perspective (AT Kearney, 2012)[7], illustrates the following examples of future foundations for highly innovative products related to global mega trends:

- Intelligent multifunctional materials (nanomaterials, functional textiles, etc.).
- Efficiency (materials with low weight, insulation materials).
- Health and nutrition (advanced biotechnology, food-chain efficiency).
- Environmental technologies (waste management - a circular economy, "urban mining", clean water and air).
- Alternative energy sources (bio and renewable raw materials).

[5] http://www.cefic.org/Policy-Centre/Innovation/

[6] The European chemical industry and its role in Europe's bioeconomy. CEFIC Position Paper, October 2016.

[7]ttps://www.atkearney.de/documents/856314/1214628/BIP_Chemical_Industry_Vision_2030.pdf/554a744e-4897-452c-a25c-66fc12f00b24



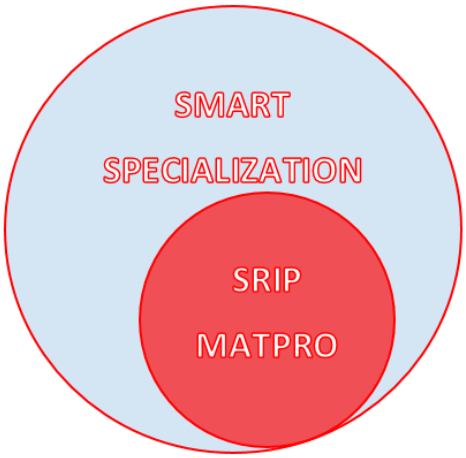
These areas are the foundations on which the metallurgy and chemical industries are strongly influenced by their activities (including high-strength metal materials with nano-modified microstructure, production of man-made fibres, production of food and plant-protection products, production of coatings and smart coatings, innovative polymer composites, the new generation pharmaceutical products, etc.).

Upcoming Technologies: Among the first 10 emerging technologies, the World Economic Forum[8] also lists two-dimensional materials (materials consisting of one layer of atoms, e.g., graphene), metabolic system engineering (chemical micro-organisms), the next generation of batteries (enabling the storage of large amounts of energy), autonomous vehicles (which are largely related to materials produced by the metal and chemical industries).

Positioning of SRIP MATPRO within the concept of smart specialization

The rapid economic changes are the result of long-term and structural trends (exceptional development of ICT, exceptional dynamics in the development of new materials, increasing supply of knowledge-based assets, globalization of production systems, as well as R & D, the rise of services and new global players such as China and India). Due to the intensive development of ICT, the development time becomes shorter. The development of new metallic materials and technologies means the entry of new, so far unknown, options to the market. The dimensions of the impact of the discovery and introduction of new materials are very comparable to the impact of ICT, and often the development of the two is in close co-dependency, as ICT development would be slowed down if it were not supported by the development of new materials, which in fact enabled the technological foundation for ICT. Similarly, ICT with the exceptional capabilities of new systems enables the creation of new materials using modelling methods and measurement–instrumentation–automation equipment, which was not available until now.

[8] Top 10 Emerging Technologies of 2016. World Economic Forum, June 2016



The concept of smart specialization offers a response to the rapid changes in the economic environment. It represents an industrial innovation framework for the development of a regional economy operating in a global environment. The central rule of smart specialization is to focus investments in activities (and not in the sectors themselves), where the region (or state) already has a comparative advantage (specialization) or in emerging areas where new activities can be developed. The principles of smart specialization are a key element of the strategy Europe 2020. European regions must therefore identify key areas, activities or technology areas where they have a competitive edge and focus their regional policies on promoting innovation in these areas.

A very good and operational example of smart specialization is the Vanguard Initiative, which focuses on finding advances in producing and obtaining energy and related applications in extreme environments. It sets an example of good practice for the launch of new economic growth through interregional cooperation, where ultimately all the participants have benefits. Since the goals of the Vanguard Initiative are set to extremely demanding operating conditions, the initiative is vitally dependent on advanced metal and composite materials. SRIP MATPRO can be fully integrated into the Vanguard Initiative.

Due to the regional specifics of smart specialization it is difficult to directly compare Slovenia with other EU regions. Each region has its own specific development path, which is locally conditioned. In general, however, we find that the presence of materials and within them metal and multicomponent materials are very common and strongly emphasized in the documents on regional specializations. In their extremely comprehensive study, the United Kingdom[9] lists the following priority areas called the "Eight Great Technologies":

- "Big data" and energy-efficient computers.
- Robotics and autonomous systems.
- Satellites and commercial applications in space.
- "Life Sciences", genomics and synthetic biology.
- Regenerative medicine.

[9] Department of Business innovation and skills, Smart Specialization in England, Submision to the European Commision, April 2015

- Agro-science.
- **Advanced materials and nano-technologies**.
- Energy technologies.

The focus on materials and related technologies is also found in the smart specializations of Lithuania (new processes, materials and technologies for industry), Latvia[10] (smart materials, technologies and systems), Finland - the Helsinki-Uusimaa region[11] (materials) and the region of Northern Karelia[12] (technologies and materials, (ii) materials knowledge, (iv) metal, plastic and composite materials), Sweden - Östergötland region[13] (advanced materials), and Slovakia[14] (materials and technologies; (i) Building materials and technologies, (ii) Materials and technologies for extreme situations, (iii) Materials and diagnostics for energy, (iv) Materials and technologies for electrotechnics, (v) Nano materials and nano-technologies). Among the few regions where the priority areas of smart specialization are not directly referring to materials are the Spanish region of Galicia[15] and Luxemburg[16].

The necessity of the rebirth of European industry is also reflected in the Vanguard Initiative[17], which currently connects 28 European regions, with the aim of influencing European innovation and industrial policy. The goal of the Vanguard Initiative is strategic cooperation, co-creation and co-financing of research at the highest level with the aim of developing European value chains and priority areas. The Vanguard Initiative, as one of the most important focal areas, has also recognized advanced production methods and related applications that will allow for the launch of economic growth. At the same time, the development of materials, where metal and multicomponent materials are predominant, as well as the technologies of production and processing are key to the realization of the set goals.

[10] Modrite Pelse, Maira Lescevica, Proceedings of the 2016 International Conference "ECONOMIC SCIENCE FOR RURAL DEVELOPMENT" No 42 Jelgava, LLU ESAF, 21-22 April 2016, pp. 126-131

[11] SMART SPECIALISATION IN THE HELSINKI-UUSIMAA REGION, Research and Innovation Strategy for Regional Development 2014–2020, Publication of Helsinki-Uusimaa Regional Council B 51 – 2015.

[12] North Karelia´s Smart Specialization Strategy, Regional Council of North Karelia, Finland

[13] Peter Larsson, CleanSky2, Smart Specialisation Strategies, In September 2014 Region Östergötland took a decision about the continued development of strategic investments and priorities for strengthening innovation in the region. 2015-08-21.

[14] Eva Majkova, Smart Specialisation strategy in Slovak Academy of Sciences.

[15] Smart Specialisation Strategy of Galicia – www. ris3galicia.es

[16] http://www.horizon2020.lu/Other-opportunities/Smart-Specialisation-Strategy

[17] http://www.s3vanguardinitiative.eu/

The design of SRIP MATPRO, with its activities focused on materials as final products, clearly emphasizes priority areas in Europe. It directly follows the principles of smart specialization, and supports the Slovenia's distinct regional advantage.

The importance of metallurgy and metallic materials

Due to the presence of metals in practically all areas, it is no surprise that the metal industry and associated areas are one of the most powerful technical and technological sectors, both in the EU and globally. Metals and alloys are found in a very wide range of high-tech products, which is almost impossible to comprehensively describe. They form an essential element of buildings, aircraft, vehicles, trains, ships, satellites, propulsion systems, nuclear reactors, turbines, batteries, fuel cells, catalytic reactors, wind turbines, magnets, electric guides, pipelines, robots, medical devices and implants, mobile phones and many other products. Just as metals in the past determined the state of the development of civilization (copper, bronze, and iron ages), today's world and the future without metallic materials is unimaginable, and further development is indispensable. Metallic materials are also ideal from the point of view of recycling and environmental protection. They are suitable for reuse; all waste has the potential of re-processing and re-usability, whereby metals are non-toxic, environmentally friendly materials. They fully comply with the principles of circular, sustainable production, since they enable the production of products that use and provide processes with minimal environmental impact, energy saving, safety for employees and are economically sensible and have the capability of reuse (6-R concept: Recover, Recycle, Redesign, Reduce, Remanufacture, Reuse).

Investments in development

The combination of primary metal production, alloying, processing and technologies including the manufacturing of versatile metal-included products and their recycling in the EU represents as much as 46% of all produced value and 11% of total GDP. The turnover of metal products and the metal-processing industry in the EU at the EU level thus amounted to approximately €470 billion, with companies in the EU investing 0.3% of GDP in 2008 (from 2008–2013: 0.27 %), and 0.35% in the Euro area (2008–2013: 0.32%). In

the field of employment, we are talking about the largest sector of the European industry, as the industry employs more than 3.6 million people. The Scandinavian countries are in leading position in production and in R & D with approximately 350 FTE equivalents per 100,000 inhabitants, 6000 FTE per 100,000 employees and 250 FTE researchers per 100,000 inhabitants; 4.300 FTE per 100,000 employees (for all economic activities, there are 300 FTE per 100,000 inhabitants and 165 FTE researchers per 100,000 employees in the EU in R & D). Added value per employee varies from €22.000 to €80.000.

EU	
primary metals, alloys, metal processing, recycling - share of all produced value.	**46%**
share of GDP	**11%**
turnover of "metal products" in 2015	**€ 470 billion**
investments in R & D as a share of GDP - 2013	**0,3 %**
investments in R & D as a share of GDP – 2008 - 2013	**0,27%**
number of employees in the industry	**3,6 million**
in all industrial areas together - employees in R & D	**300 FTE/100.000 inhabitants**
in all industrial areas together - researchers in R & D	**165 FTE/100.000 employees**
added value per employee	**22.000 – 80.000€**
Euro-zone	
investments in R & D as a share of GDP - 2013	**0,35%**
investments in R & D as a share of GDP – 2008 -2013	**0,32%**
Scandinavia	
R & D sector metallic materials	**350 FTE/100.000 inhabitants**
R & D sector metallic materials	**6000 FTE/100.000 employees**
researchers in R & D - metallic materials	**250 FTE/100.000 inhabitants**
researchers in R & D - metallic materials	**4300 FTE/100.000 employees**

In Slovenia (economic activity in metal production) there are 83 companies with 7415 employees, with net sales revenue up to €1.49 billion, added value per employee amounted to €38,710, while the share of sales in foreign markets was 71.0%. Furthermore, in the economic activity of the foundry, there are 65 companies with 4078 employees, the net turnover is €448 million, the added value per employee is €34,500 and the share of sales on foreign markets is 70.1%. In the metal-processing industry, as a user and material producer, there are a total of 2865 companies with 52,603 employees, with a net turnover of €6.93 billion, added value per employee is €38,200, while the share of sales on foreign markets 66%, which amounts to almost €5 billion. In total, all of these companies generated €8861 billion of net revenues in 2013 and employed 64,096 people, with 1220 FTE employees in RR per 100,000 employees, and 558 FTE researchers per 100,000 employees.

Slovenia

metal production	number of companies	**83**
	employees	**7.415**
	net income	**€ 1,49 billion**
foundry	number of companies	**65**
	employees	**4.078**
	net income	**€ 448 million**
	share of sales on foreign markets	**70,1%**
metal proc. Ind.	number of companies	**2.856**
	employees	**52.603**
	net income	**€ 6,93 billion**
	share of sales on foreign markets	**66%**

share in total sales of companies	**3,03%**
share in total sales of manufacturing	**9,96%**
export orientation (% of sales)	**67%**
employees	**64.096**
employees in R & D (FTE/100.000)	**1.220**
researchers in R & D (FTE/100.000)	**558**
investments in R & D	**€ 23 million**
v % BDP	**0,06 %**
added value/employee	**38.200 €**

With this, Slovenia ranks in 8–9th place in the EU according to the number of employees in R & D and employed researchers (the leader Sweden in 2013 had 5100 FTE employees in RR per 100,000 employees and 3600 FTE researchers per 100,000 employees). The picture is very similar in the area of total production, where Slovenia in the EU ranks in 9–10th place. Companies in the metal industry (SKD 25, 28, 29) invested €92 million in R & D in 2013. 0.26% of GDP (2008–2013: 0.23%); companies in metal industry (SKD 23) €9 million, which represent 0.06% of GDP (2008–2013: 0.02%), which in the EU places Slovenia in the third place in terms of investments, where investments in R & D in 2013 were at the level of 0.01% of GDP.

Slovenia – EU rating - 2013

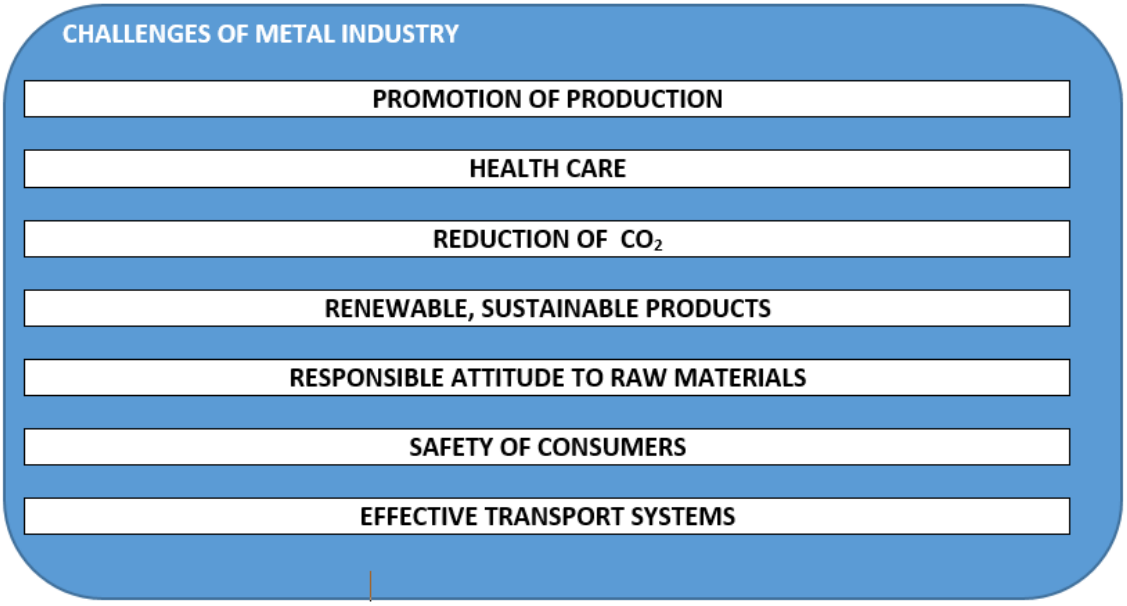
metals – employees in R & D	**8. – 9. place**
total production - employees in R & D	**9. – 10. place**
companies met.mat. - investments in R & D	**3. place**

Challenges of the metal industry

With an exceptional economic value and social potential (many high value-added jobs), the metallurgy and metal-processing industry also carries the potential for essential technological, environmental and social changes in the future, which include:

- Careful use, maintenance, and recycling of primary materials.
- Developing technologies for reducing CO_2 footprint and using renewable energy sources.
- Modernization and higher energetic efficiency of transport systems.
- Promotion of consumer safety and security.

- Developing proven products to protect the health of the aging population.
- Promotion of the manufacturing sector in the EU.
- Development of renewable products and products with an extended lifetime and thus improving the resource efficiency (6-R: **R**ecover, **R**ecycle, **R**edesign, **R**educe, **R**emanufacture, **R**euse concept).



Europe and Slovenia share a common industrial tradition. For Europe as well as for Slovenia, since the industrial revolution, it has continued to be a driving force in the field of metallurgy and metal processing industry – not only in research, patents and innovations, but also in the production of industrial alloys, further technological processing, applications for end-users and recycling. In order to maintain and further develop the technological advantage it is essential to invest in the next generation of metal materials with specific properties. In this way, we will continue to be able to cope with rapidly growing competition, changes in society related to energy resources and resources as such, reuse of materials, reduction of climate change, health care, and safe employment. For this reason, the metal industry and, in particular, metallurgy in Europe, are again strategically placed in the very top of the requirements for basic and applied research. It is worth pointing out that the highest EU institutions in the development of Europe's development and competitiveness policies have also put the emphasis on the need for a revival of industry (the third industrial revolution) and thus the development of new materials, both metal and multicomponent. Due to the high added value it is necessary to comprehensively address the entire value chain in the field of materials: from materials acquisition, alloy design, technological production, optimization, creation of new value, to education and training. This requires a large concentration of knowledge, adequate investment, as well as new innovative transdisciplinary approaches.

In neighbouring Austria, which has the fourth-highest intensity of R & D investment in the EU, investments as a consequence of the awareness of the importance of industry and production and the need to master the concept of Industry 4.0 and digitization are increasing. Investments in research and development in Austria increased by 2.8% in 2015

and accounted for 3% of GDP, of which 62% are entrepreneurial capital and 32% are state resources. In the future, Austria sees potential in robotics, interactions between people and machines, the energy sector, new production technologies and, in particular, the development of new materials, of which metal materials for the most demanding applications already represent an important and traditional segment of Austrian development policy. Austria is known for being a leader in the development of high-quality steels, Ni-alloys, titanium and Ti-alloys, and is succeeding in setting up a metallurgical pool in the state of Styria with one of the strongest value chains in Europe in this field. It connects world-renowned knowledge institutes, research institutions and major companies in the field of steel production and processing.

Ukraine (not a member of the EU) is recognized as one of the most potentially important Eastern EU countries. Ukraine is extremely strong in R & D in the field of materials. In the FP7 and Horizon 2020 programs, several projects have been carried out to help Ukraine promote development, research and innovation, and to strengthen cooperation between Ukraine and the members of the European Union, among others in the field of super-hard metal materials, superalloys, alloys, advanced characterization techniques and nano materials.

Orientation of the Slovenian metal industry

In global markets the Slovenian metal industry, with relatively low human and capital potential, has no real chance to successfully compete in mass production. But it has a tradition, knowledge and experience, as well as a significant market share and integration in the value chains in individual niche areas. It is demonstrated by its flexibility and competitiveness, including in the field of high-tech products and technologies based on its own knowledge. In 2015 this role was also recognized by the leading companies in the field, and, in order to integrate joint research and development potentials, the Center of Competence for Innovative Metal Materials (KC IKM) was founded with the initiating companies being SIJ, Acroni, Elektrode Jesenice, Ravne Systems, Jesenice Development Center, the Institute of Metals and Technology and the Faculty of Natural Sciences and Engineering at the University of Ljubljana.

The Slovenian metal-processing industry is one of the leading industries in Slovenia, both in terms of revenue and exports. Metal industries thus account for 29% of revenue (generating € 7.3 billion), 30% of exports (€ 5.1 billion), it employs 34% of employees, and produces € 2.1 billion of added value, which is 32 % of the total added value of all manufacturing activities in Slovenia. It is highly export-oriented; by direct export it generates 2/3 of its revenue or 20% of Slovenian exports, operating in virtually all world markets.

Manufacturing in Slovenia - Metal industry sectors	
share of revenue	29%
	€ 7,3 billion
share in exports	30%
	€ 5,1 billion
share of exports in revenue	67%
share in Slovenian exports	20%
employees	34%
added value	€ 2,1 billion

Its key markets are Germany, Austria, Italy, France, etc. Given the global trends, it is clear that Slovenia needs a stable and strong metal industry, which is and will remain mainly export oriented. Such orientation requires further strategic strengthening of development, together with a sustainable and long-term vision. At the same time, own production of steel and aluminium is an important competitive advantage and the basis for successful implementation of the development and growth strategy in the whole metal-processing value chain. Of course, a further breakthrough requires the creation of appropriate value chains and networks in various segments of industry and commerce, both nationally and internationally, for which Slovenia has all the conditions. The industry development strategy itself must follow the below strategic documents:

- Horizon 2020[18],
- Slovenian strategy for smart specialization S4[19],
- Metallurgy Europe 2012-2022[20],
- Strategy for the Development of Metallurgy in Slovenia 2015-2025[21],
- Principles of sustainable production[22].

Priority areas of development

In order to move from predominantly traditional to green or sustainable production with higher added value and at the same time causing smaller environmental impact, the so-called 3R-6R principles of sustainable (circular) production should be ensured. This, of course, represents new challenges in various fields of metal materials and technologies, which are therefore becoming increasingly complex. The field of classic manufacturing technologies is developing with optimization and improvement of machining processes, as well as with the development of new tools and manufacturing technologies. An essential novelty is the introduction of laser technologies into tool manufacturing processes. Both in the field of laser cutting and welding. The biggest progress is recorded for the so-called "additive" technologies. Additive technologies are already in service for the production in

[18] https://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/H2020_SL_KI0213413SLN.pdf
[19] http://www.svrk.gov.si/fileadmin/svrk.gov.si/pageuploads/Dokumenti_za_objavo_na_vstopni_strani/S4_ dokument_potrjeno_na_VRS_150920.pdf
[20] http://www.esf.org/fileadmin/Public_documents/Publications/metallurgy_europe.pdf
[21] https://www.ntf.uni-lj.si/omm/wp-content/uploads/sites/5/2015/11/Strategija-razvoja-metalurgije-v-Sloveniji-2015-2025.pdf
[22] I.S. Jawahir: Sustainable Manufacturing: The Driving Force for Innovative Products, Processes and Systems for Next Generation Manufacturing, College of Engineering, University of Kentucky, Lexington, KY, 2010.

the field of polymeric materials (the recent opening of the production line for the new running shoes – Adidas, and the combined production of the carrier and the filament lamps - Philips). In the near future the field of metal materials will represent a significant share of rapid prototyping technologies. Of particular interest is so-called small series production, such as the development of models and prototypes, products of pilot production for medicine, the automotive and aviation industry, and smaller batches. Additive technologies are a very promising solution in the cases where the production of classic tools for pressure casting and injection moulding is too high for the parts requiring exceptional geometric complexity and precision. The challenge lies also in the complex geometry of products that could not have been manufactured by any of the so far known methods. The introduction of new materials into finished products is also a challenge from the point of view of the management of upcoming technologies. The challenge is represented by the technology of the hot and cold production of products from high-strength materials, new light metal materials, the combinations of non-metallic materials such as, polymers, graffiti, graphene, and as the separate field, the development of biocompatible metallic materials. The business model is constantly changing, as buyers are looking for partners who are able to provide production capacities in the long run and respond quickly to requirements and changes.

Chemical industry and the industry of multicomponent materials

The second key topic of SRIP MATPRO deals with multicomponent materials and the chemical industry. The chemical industry is one of the most important industry branches, which provides end-products such as multifunctional materials, as well as basic and advanced input materials. As such, the chemical industry is an enabling industry and is vital for the entire economy, since it supplies the input raw materials, semi-finished products and products intended for installation, further processing or further use in production processes. It is the provider for practically all other industries, as well as for non-industrial sectors (e.g., agriculture), and for final consumers. It is a highly innovative and technologically advanced industry that offers sustainable solutions to the various pressing problems of the modern world. It consists of three main segments: the narrower chemical industry, the pharmaceutical industry and the rubber and plastics industry.

Investments in development

In the EU, the chemical industry is one of the key strategic industries, based on knowledge, high competences and the skills of personnel, has exceptional potential for growth and development (materials, technology, etc.), and in many respects achieves a globally important role, as it significantly contributes to exports in the EU. In 2013, EU companies in the chemical industry (SKD 20 and 22) invested 0.07% of GDP in R & D, while the Euro-area companies accounted for 0.09% of GDP. In Slovenia, the chemical industry is also one of the most important manufacturing industries with a long tradition. It represents 22% of revenues, 24% of sales revenues abroad and 39% of net profits of all the manufacturing industries. It employs 16% of all employees in manufacturing, of which there are 5771 FTE in R & D per 100,000 employees and 2693 FTE researchers per 100,000 employees, which puts Slovenia in the EU at 7th and in some cases even in 4th place (the leader in 2013 was Denmark ~ 12,200 FTE in R & D per 100,000 employees and 6600 FTE researchers per 100,000 employees). On the other hand, investments in chemical companies in R & D in 2013 amounted to € 29 million, representing 0.08% of GDP (2008–

2013: 0.07%). The products are on average those with higher added value, with the added value per employee in the chemical industry of € 43,000 this exceeds the Slovenian average in manufacturing industry by almost a half.

Chemical industry 2013	
EU	
investments in R & D as a share of GDP - 2013	**0,07%**
Euro-zone	
investments in R & D as a share of GDP - 2013	**0,09 %**
Slovenia	
revenue	**22%**
export revenue	**24%**
share of net profit in manufacturing	**39%**
share of employees in manufacturing	**16%**
investments in R & D as a share of GDP - 2008 -2013	**0,07%**
share in total sales of companies	**4,12%**
share in total sales of manufacturing	**13,53%**
export orientation	**71%**
employees in R & D	**5.771 FTE/100.000 employees**
researchers in R & D	**2.693 FTE/100.000 employees**
investments of chemical companies in R & D	**€ 29 million**
investments in chemical companies in R & D, a share of BDP	**0,08%**
added value/employee	**43.000 €**

The chemical industry In Slovenia has a strong tradition. Over time, its scope increased; both in terms of the number of companies and their development and innovation capacities, as well as in terms of generated revenues, added value, number of employees, etc. It represents a very important share in the Slovenian economy. Considering its very strong export orientation, its share in the most vital, internationally active business, and thus its role in the internationally most competitive part of the economy, it has a very strong influence on the economic growth of the country. The Slovenian chemical industry realizes over 80% of its sales revenues on foreign markets, which reflects its export competitiveness, the ability to compete with foreign competitors, and thus a strong inclusion in international business trends, chains and markets.

In today's world, markets are increasingly focusing on meeting health, safety, sustainable development and comfort needs. Here, too, the chemical industry appears as a supplier of materials, products and technologies used in many steps towards meeting these needs. At the same time, it should be emphasized that the highest EU institutions have put the emphasis on a rebirth of industry at the forefront of shaping Europe's development and competitiveness policies. The chemical industry is again essential, with the production of materials and with its technologies.

Polymer industry

Among non-metallic materials, polymer materials represent a very important group of materials. Materials are produced by the polymerization of low-molecular chemicals, mostly from non-renewable fossil resources. Polymer materials are the most typical new-age materials created by man. Their global production has grown extensively from early discoveries in the 1930s. The production of polymer materials in 1950 amounted to about

1.5 M tonnes. In 2014 it reached 311 M tonnes. European production in 2014 employed 1.45 M people in 62,000 enterprises, most of which were small or medium-sized enterprises with a turnover of over € 350 billion. It is estimated that the production of polymers in the state economy has a multiplicative effect with a factor of 2.4 in GDP and a factor of 3 for employees. European polymers production is therefore an extremely important branch of manufacturing of materials. It is technologically demanding and globally competitive. [23]

In the production of polymers a very large number of basic ingredients are being combined. The range of composition and functional properties of polymer materials is extremely wide. They range from simple and cheap consumer goods (e.g., polyethylene) to high-quality materials with high performance (kevlar). The production of most of the polymer materials is closely related to petrochemistry and today it runs in extremely large quantities, ensuring competitiveness through the economy of volume. In Slovenia there is no such production, there is only the production of relatively small quantities of specialized polymers. Among these are polyamide (nylon), polyester and alkyd resins, polyurethanes, melamine resins, and phenolformaldehyde resins. In these areas Slovenia possesses competitive knowledge. In addition to the production of selected basic materials, the production of multicomponent mixtures and composites is highly developed. The key problems involved lay in the formulations to achieve the desired properties (e.g., silicone masses, adhesives). In these areas, the range of materials and business strategies is very diverse and spans from suppliers to manufacturers of end products. Furthermore, the area is populated by an extremely large number of companies that process and re-process plastic materials into end-products. They work on a very different level of expertise, they are of different sizes where each of them is uniquely positioned in the value chains in which they participate. Finally, there are companies also included in different value chains, that integrate semi-products (materials) into demanding end-products. We have a wide range of companies which are specialized niche manufacturers as well as large-scale producers. The development-intensive companies have relatively strong positions in highly specialized niche segments. As a rule, successful companies supply international markets and for them the Slovenian market represents a smaller share.

The segmentation of participants on the non-metallic materials side differs significantly from the field of metallic materials, in particular due to the much greater diversity of the used materials and the consequent participation of companies in a larger number of value chains. Material producers are usually suppliers to end-users and therefore have limited market reach, which is largely marked by their development strategies. Slovenian companies and research organizations are prominently involved in the European Research and Development Area in the field of non-metallic multicomponent materials. The inclusion is not evenly distributed, but there are significant differences: we have a smaller number of development-intensive, open-ended companies that regularly participate in international projects. Most of the research and academic institutions are also involved, while the majority of companies do not participate in such activities at all.

[23] Plastics - the facts 2015, Plastics Europe, Brussels 2015, http://www.corepla.it/documenti/5f2fa32a-7081-416f-8bac-2efff3ff2fbd/Plastics+TheFacts+2015.pdf

We can highlight the activity of some companies: Polycom, NGMOLDING, EPS, DBS, Eurostars! A++SILENCER, Pro4Plast, NG EPS, PolySocket, NaturTruck, H2020 PolyHalter, RNT-O; Tuba Lajovic: Wheypol, Wheypol 2; Guideline: BIOPUR, IPDS, H2020 GELCLAD, BBI AgriMax; AquafilSLO: Healthy Seas, DeFishGear, Plast: PLASTIC. Research institutes or academic organizations in the field of polymers: (Chemical Institute: Faculty of Technology Polymers, TECOS, University of Maribor) regularly participate in international projects.

1.2 Comparative advantages of participants in Slovenia - the definition of investment ability

As announced in the application for the tender, the SRIP MATPRO working group carried out an overview of the field in order to provide an assessment of the situation, competence advantages, critical mass and, above all, the potential shown by Slovenian companies in the field of materials.

First, we prepared the criteria and steps by which we later captured the situation. In doing so, we had the goal of identifying companies with an ambitious and successful development model that has the potential of success on a global scale. We have been trying to capture the content diversity in the field as well as small and medium-sized enterprises.

We carried out an analytical overview based on economic business data. As the key criteria, we used the size of the company (turnover, employees, exports) and growth figures. The analysis was carried out in three size classes of companies (large, medium, small). The successful companies in the field were identified. At the same time, we reviewed the companies that in recent years received awards (Chamber of Commerce of the Republic of Slovenia and the Gazelle awards). Among the large companies, there are manufacturers of metals (metallurgy), which are followed by companies working in the field of coatings and lastly companies that deal with polymer materials and composites. Among the very successful companies are also toolmakers as well as final product manufacturers who actively use advanced materials.

Interviews

In the next step we proceeded to individual interviews in companies (on the basis of the priorities written in S4 and the carried out analyses). With the contacted companies, we received very good responses and conversations were usually attended by management representatives and employees with key development responsibilities. The talks were very revealing, substantive and comprehensive.

General considerations

On the basis of the interviews we can draw some important conclusions (which are generalized and apply only to a wider field of materials):

- Successful companies are strongly linked to export, which represents the majority of their sales. In the field of materials, business-to-business sales are predominant, meaning that companies are in the middle of the value chain and do not have direct access to the final customer. Due to large exports, companies are extremely tied to foreign partners and are strongly integrated into international chains. Consequently, they are very well informed about the latest economic trends, strategic orientations and market needs. The fact that a significant part of Slovenian companies are linked to larger international groups at the same time restricts their position in the international space, while in other aspects it also strengthens it.

- The development in companies is organized in many different ways and it comprises a whole range of options: from strong development with many employees and highly educated personnel to almost zero development. Here, the difference is most evident in larger companies, where the organization and extent of development are the matter of the company's tradition and management's decision. A successful development policy with good results can be managed in different ways. Larger companies, which maintain flexibility, are quick in decision making and are decisive in implementing and financing R & D. As a rule they can successfully lead the development even with a very slim R & D department structure. Successful small businesses generally have very small, but in comparison to the large companies, a relatively large proportion of employees devoted to development. Their people in charge for development do not solve fundamental scientific questions but are extremely application oriented and their response must be quick. In the absence of traditional development, it can also be based on productive excellence and innovation.

- As a rule, larger companies work more closely with Slovenian research institutions (RI). They have registered research groups and with RI participate in the registration of projects and in the continuous provision of various services. Small companies cooperate poorly with RI, but we discovered a small company that successfully cooperates with a specialized institute in Russia and integrates its products into the world's best insulation materials.

- Companies do not have a strong interest in scientific publications. More important is the protection of intellectual property, which is currently very limited. Larger companies use patent protection, although they can act in a marketing role or simply by preventing the closure of opportunities by competition. As a rule, smaller companies do not protect their intellectual property with patents, but concentrate on their speed and comparative advantage as the key elements of their protection.

- For companies, top-level scientific literature is not an important source of information and they do not follow the scientific literature. They use it rarely and solely to solve the immediate issue. More information is obtained through professional literature. In this area, there is a huge gap between RI, which are oriented towards scientific excellence, and the performance of companies of which part they are. Companies in more traditional areas (chemistry) that do not scientifically represent interesting and modern topics can also work without RI.

- With small exceptions, companies generally do not actively participate in the European Research Area. The number of applications for international projects is low, and expectations are also low. The same applies equally to large and small companies. The companies expressed dissatisfaction with the time frame of the process (application-selection-implementation) and the bureaucratic burdens that arise from cooperation. The additional bureaucratic load significantly burdens the employees and actually represents an obstacle in their development work. A small number of companies, which participate well in international projects, have good experience and are constantly applying successfully.

- In companies the development ideas are mostly obtained from their customers who are at the end or near the end of the value chain. Most of them are the expression of immediate need, for which they develop a solution with their own developers and in cooperation with suppliers. The source may also be a variety of publicly available data from which, with careful analysis and sufficient pre-knowledge, it is possible to determine the purposes of competition. Companies have the ambition to provide unique products, but their goal is usually not to open new paradigms and define trends. As a rule, small businesses are more focused on extremely ambitious solutions to overtake international competition.

Companies in the processes of strategy-planning and policy-making do not participate at the European level. The reason is that the largest Slovenian companies are still relatively small when compared to EU companies. Therefore, their impact is very low.

We conclude that the comparative advantages of partners in Slovenia in the field of metallic and multicomponent materials stand out in the following areas (illustrated examples are given):

- High specialization and high degree of flexibility, which ensures the delivery of highly demanding and complex orders tailored to the wishes of customers. There are, for example, steel plants in Slovenia that maintain separate and very specialized niche production programs (Acroni – stainless-steel sheets and thick sheet metal from high-strength, wear-resistant steels; Metal Ravne - special tool steel and steel for energy plants; Štore Steel - high-strength spring and structural steels) in which they rank at the very top of the manufacturers. The narrow specialization enables them to respond immediately to market demands. The same advantages are exploited by Gomline, which produces silicone mixtures, and Duol, a globally important manufacturer in covered structures.

- High technological intensity and orientation to innovation. These are key to achieving the competitive advantage of products. Due to strong competition companies are focused on innovation and the continuous development of products and production processes, which results in high productivity and high-quality of products. Aluminium companies (Impol, Talum) are constantly investing in the development and innovation of not only high-strength aluminium alloys, but also the production, recycling and processing technologies. The approach is also characteristic for AquafilSLO and Helios TBLUS, which are constantly investing in innovative production. AquafilSLO has thus managed to develop the globally unique collection and recycling of nylon

fishing nets. On this basis, the developed material is marketed under the trade name ECONYL®. Extremely active and successful is also the field of composites, where there is a high concentration of knowledge and production.

- Relatively good organization and resistance to market stress. With the production of specialized products of smaller batches, Slovenian companies are capable of rapid changes and adjustments to market fluctuations. On the other hand, the orientation of the Slovenian industry to the broader industrial sectors, such as the automotive industry, transport, consumer goods (household appliances), and interconnection (Acroni - Hidria, Unior - Štore Steel, Talum - LTH Casting etc.) allows for more stable long-term planning with lower market stress. It plays the role of linking to different markets and strategic relationships with the most reliable partners.

- Responsible behaviour. In general, companies maintain a high degree of safety, careful protection of health and the environment, and are consistent or even go beyond the standards defined in health and safety legislation. Most companies in this segment have already achieved quality, management and environmental management standards such as ISO 9001, ISO / TS 16949 and ISO 14001.

- Effective use of resources and high recycling rates, reflected in efficient production processes, efficient use of secondary raw materials, in particular in the production of steel and aluminium and lower production costs. The recycling of waste carpets and fishing nets is an important project in AquafilSLO, and Helios TBLUS plans to use raw materials from renewable sources for its upcoming products. The introduction of unused waste materials into production was also identified in the companies Atotech and Cinkarna Celje.

- Close cooperation with the institutions of knowledge in the use of public R & D funds (which by all criteria take up a much too small share in terms of the impact of the industry) and access to the results of publicly supported research, thus facilitating research and development.

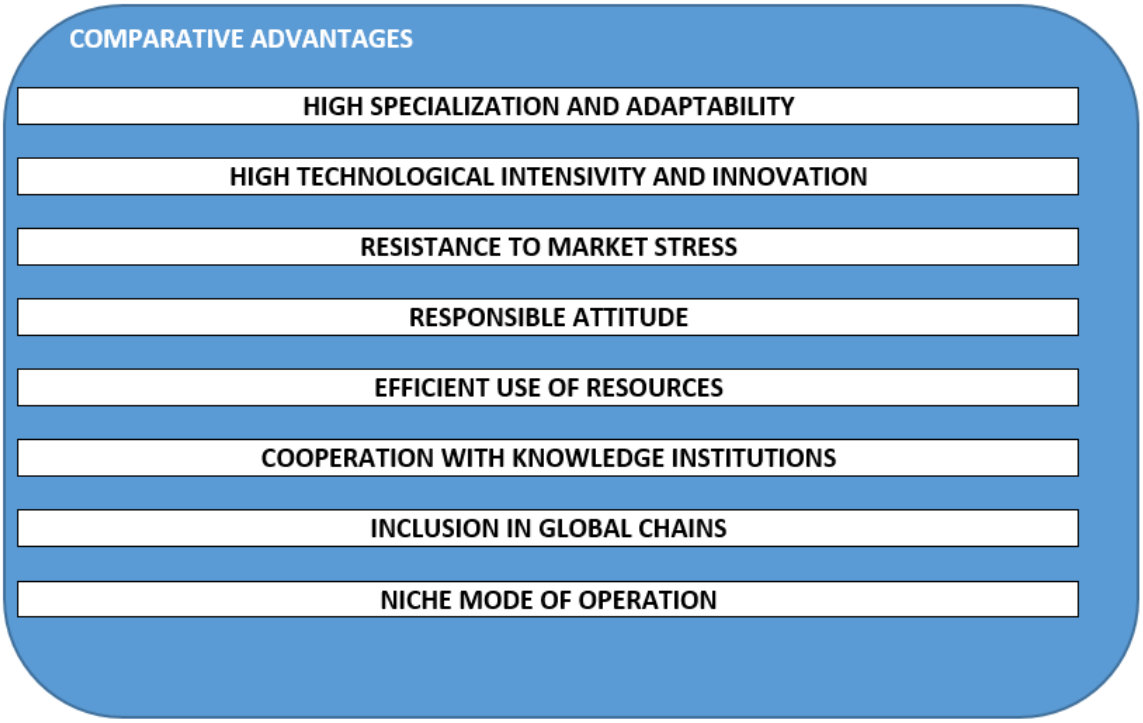
- Qualified personnel. Companies invest significantly and systematically in the lifelong education of employees, which is reflected in a highly skilled workforce. A great advantage for Slovenian companies is also the high level of foreign language competences, which also stems from the geographical location of Slovenia (proximity to Austria and Italy as important export markets) and offers great advantages in establishing business contacts and cooperation with foreign markets.

- Integration into global chains; Slovenian companies already have a long tradition of business cooperation in international value chains, especially in the automotive industry, involving companies from the material producers (aluminium, steel), materials processing (casting, forging, extrusion) and manufacturers of end-products (assemblies, devices , etc.) lightweight materials, coatings, etc.

- A niche mode of operation of middle and small companies enables flexibility and fast responses.

- Good understanding of the market, especially in the field of automotive, transport and household products and major customers.

- Companies benefit from local providers who can offer quality services and posses complementary knowledge. This in practice confirms the multiplicative effect that successful export-oriented companies have on the local environment. An example is the successful participation of Mikrocaps microcomputer, which specializes in microencapsulation and cooperates with several important companies in the development of new products.



S4 states that in the field of metal production (C24) and the production of metal products (C25), Slovenia has not only significant comparative advantages, but is also comparable to the leading European countries (from the point of view of technological intensity). It is oriented towards the development of advanced metal materials for demanding applications, following the trends of transition to the circular economy. Another area where Slovenia has great potential is smart multicomponent materials and coatings. The activity "Manufacture of man-made fibres (C20.6)" has significant comparative advantages and the dynamic growth in value added per employee and exports. Slovenia possesses excellent competences and capacities in the production of basic chemicals, fertilizers and nitrogen compounds, plastics (C20.1), and Slovenian companies are also well developed in the field of coatings, where extreme growth in the world market for smart coatings is expected. Likewise, "Production of paints, varnishes and similar coatings (C20.3)" shows comparative advantages. The listed activities are part of the metal and chemical industries. However, it should be emphasized that, from the point of view of substances, formulations, materials, and the related products and technologies, all segments of the chemical and

metal processing industry are important (the activities of SKD 20, 21, 22, 24, 25 and 28 in its entirety). Therefore, SRIP MATPRO includes the metal and chemical industries in the broader sense. These activities represent additional assistance based on capturing the necessary information on the intentions of companies and partners, their research and market initiatives, and possible investment plans. Due to the exceptional complexity of metallurgy and multicomponent materials, SRIP activities will primarily focus on areas identified by companies and participants (and those interested in joining the creation of new or upgraded, market chains or networks – projects and related realization of the set goals) as those with the highest potential. In the framework of SRIP MATPRO, comprehensive support will be provided (as well as in-depth mentoring assistance, if needed) through a multi-level support environment.

Presentation of partners

Clustering support environment (within the Chamber of Commerce and Industry of Slovenia - CCIS): Teams CCIS-Association of Metals and Non-metals, CCIS-Metal Industry Association and Chamber of Commerce and Industry of Slovenia. The chemical industry associations will be the basic coordinators and catalysts of the MATPRO operation within each industry, which will promote synergies between companies and relevant partners (the advantages: because of the nature of their operations, they possess a wide knowledge of the industry, companies and most of the key actors within them, production activities and products, they gather and process regular economic and statistical data on industry, etc.). When working in SRIP, it will also explore the potential of the industry and international development trends, as they have many international industrial and strategic links; directors of associations have exceptional and long-term experience in the design, setting up and running of projects, including in the field of government inter-departmental project centres, government departments and competence centres.

CCIS with 170 years of tradition as the largest economic association in Slovenia and the representative of companies in dialogue with the Government of the Republic of Slovenia will cooperate with its professional services, of which the most important parts for SRIP are: (1) Environmental Protection Service, which provides assistance in implementing complex legislation, and also covers aspects of sustainable development, since all new products must meet the various criteria in this regard; (2) The Center for International Business – internationalization. This provides detailed knowledge of the requirements and conditions on foreign markets, regularly organizes the incoming and outgoing business delegations and business networks in Slovenia. It advises members daily, conducts a number of training courses in support of strengthening the international operations of Slovenian companies; 3) The Human Resources Department, which has highly developed know-how regarding the legislation and practice of human resources development. Together with its partners, it has developed a methodology for determining the future competence needs (Career platform); (4) Legal Services; (5) Macroeconomic Developments, Indicators and Statistics; (6) other organizational units within the CCIS, both regional and sectorial, will need to find additional synergies between companies operating in different industries.

CCIS - The Association of Metallic and Non-metallic Materials is the largest branch association of the companies in the metal and non-metal industry. It is an autonomous, non-political and professional organization that links companies with the main registered activity of the production and processing of metallic and non-metallic martials. It is an autonomous member of the CCIS. Its purpose is to form (in the interests of members) and communicate the views and demands on legislative and governmental bodies, social partners and other domestic and international organizations. The association of metallic and non-metallic materials joins 58 companies. In the association, the members of the association exercise their interests regarding the conditions of management, professional development, progress of work and business, thereby improving their competitiveness on the domestic and foreign market by forming positions and policy towards social partners, legislative and governmental institutions and other domestic and international associations. It provides members with expert assistance in the form of information, advice, training, representation and proposal submission, and establishes links with international associations such as CEEMET (European Employers Association of Metal Industries), FEPA (Association of European Manufacturers of Abrasive Materials) and CAEF (European Foundry Association).

In fulfilling the objectives of the Association of Metallic and Non-metallic Materials, it performs activities and tasks, in particular in the following areas:

- Exercising the interests of members with majority support in the bodies of the association.
- Addressing regulatory proposals and providing opinions and comments with the aim of promoting the interests of members.
- Providing information on the activities in the field of metal production and its relative position with the regard to the entire economy.
- Participation in standardization, metrology and other state institutions regarding the standardization and technical regulations, as well as in the issues in the field of testing and certification.
- Cooperation and influence on the design of Slovenian technical regulations in the process of implementing EU legislation.
- Representation of members' interests in R & D and technology.
- Promotion of members at home and abroad through the dissemination of business and professional information.
- Implementation of public authorizations in professional education.
- Participation in the design of educational programs in the field of vocational and higher professional education.
- Participation and implementation of negotiation activities in the formulation and enforcement of collective agreement.
- Representing members' interests in the field of social policy.

CCIS - Association of Metal Industries is an industry association within the CCIS and the largest voluntary association of companies in the “metal” industry. Its purpose is to form (in the interests of members) and communicate the views and demands on legislative and governmental bodies, social partners and other domestic and international organizations. The metal industry association has approx. 180 members, employing nearly 20,000 people. It carries out activities for raising the competitiveness and financial effectiveness of its members by organizing joint promotional activities, promoting development and advisory projects, participating in the upgrading of the vocational education system and performing public authorizations related to the protection of domestic industrial production. It participates in the harmonization and implementation of technical regulations, as well as in performing the tasks of representation, counselling and providing information for the needs of its members.

The Association is a place for meeting and connecting business, a centre providing quality business information and a place to combine the knowledge and experience of experts. The objectives and tasks of the Metal Industry Association are:

- Creation of a competitive environment for the development of the members of the Association of Metal Industry.
- Promoting R & D activities; technology-driven custom-made membership through cooperation between industry, R & D institutions, and other members.
- Strengthening technological and managerial skills for companies operating in value chains involving the metal processing industry.
- Cooperation in the creation of industry-specific legislation, conditions for employment and training of employees.
- Supporting companies in their activities on the global market.
- Effective help through services and organization of projects.
- Tasks and program orientations for achieving the set goals.
- Legal representation of members in the field of metal processing and in the development of sectorial legislation.
- Monitoring the situation in the field and proposing measures for the development of the profession and vocational and professional education.
- Providing business information and consulting from the field of operation – dissemination of good practices.
- Cooperation in foreign trade promotion in the areas of its operation.
- Membership in international business and employers' associations in the field of metal processing.
- Providing help at other members' needs.

The Association of Metal Industries is also a social partner to the collective agreement for the metal industry at national and international levels. At the international level, it is also a full member of the ORGALIME (European Association of Mechanical Engineering Associations, Electrical and Electronic Industries and Metal Processing), CEEMET (European Association of Employers of the Metal Industry), and is also linked to the

Association of Engineers, Mechanical Journal, Strategic Council Slovenia 5.0, CLEPA (European Association for Automotive Suppliers) and EFFRA (Association of European Factories of the Future).

Wider support environment. Scientific research institutions and universities: As an example, it is worth noting the Institute of Metals and Technology, which has been industry's key partner since 1947. It operates in the field of metallurgy, metal-processing and tooling, mostly in the development and evaluation of metallic materials and products with demonstrated international scientific excellence. In the field of chemical industry the National Institute of Chemistry has been for decades one of the key partners of the chemical industry in the development of new materials and products. With internationally accredited scientific excellence of its researchers is in many areas among the leading research institutions in the world. In the field of rapid prototyping and processing technologies, combining both metal and plastic processing industry, TECOS Slovenian Tool and Die Development Centre, should be mentioned. TECOS, as the only competence centre in Slovenia, has a wide range of basic and applied knowledge, to perform the development of integrated products as well as the advanced and modern prototyping technologies in the field of processing of metal, polymer and composite materials. All the institutions have modern laboratory equipment and cooperate with most of the renowned foreign research institutions. In addition to the scientific research institutions, and as a very important part of the wider support environment, there is the Faculty of Natural Sciences and Engineering, University of Ljubljana. In the field of materials it is strongly linked to Slovenian industry. We anticipate that SRIP MATPRO will contribute to the strengthening of the already existing cooperation with Slovenian companies. The cooperation will be stimulated through funds dedicated to specific projects (including education and training). On the other hand, the focus in the work of research institutions will be shifted from basic research to solving the applied industrial problems needed by Slovenian industry. The tighter cooperation will facilitate the increase of MATPRO member's global competitiveness.

Institute of Metals and Technologies - IMT is a public research institution, with the primary research and educational work focused on the field of metallic materials and technologies. The primary task of the Institute is to create new knowledge in the fields of metallurgy, steel, aluminium, metallic materials, tooling, composites, nanosciences and nanotechnologies, eco-technologies, vacuum optoelectronics, pressure metrology, engineering materials, biocompatible materials and environmental protection. Its secondary task is to transfer the generated knowledge to industry. The aim of work is also to improve the quality of life and to contribute to the sustainable development of society. Especially in the field of metallurgy, it can be compared (in terms of expertise and achievements) with a number of major European institutes, such as Max-Planck, Fraunhofer and IWT-Bremen, which are well equipped and operate with budgets of € 2–3 billion.

The Institute is a multidisciplinary public research institution well connected to the higher education organizations. It performs the research programs (as a public service), where

the results are expected to remain practically useful for at least one decade. It is important that there is a long-term public demand in researching this field. The Institute performs basic and applied research and takes care of the development and operation of the infrastructure (nuclear power plant, other power plants, etc.) within the framework of the Research and Innovation Strategy of Slovenia. The Institute is involved in domestic and international scientific research activities and is connected to the related organizations in Slovenia and abroad.

The Institute provides comprehensive accessibility and the use of knowledge in society and the economy, transfer of research achievements into practice, popularization of science, dissemination of scientific culture and information to the public. Within the framework of its activities, the Institute places special emphasis on the scientific basis for the protection of the environment and the monitoring of processes in it, and the development of new and clean technologies.

The Institute consists of organizational units, namely: scientific-research, infrastructural, and administrative units. The bodies of the Institute are: the Steering Committee, the Scientific Council and the Director. The Management Board has five members, of which: two members are appointed by the founder, one member upon proposal of the ministry responsible for research activity, and one member upon proposal of the ministry responsible for the economy; two members are appointed by the Scientific Council of the users of the Institute who have a long-term interest in connecting to the research activities of the Institute or to the interested public. The last member is an elected employee of the Institute.

National Institute of Chemistry - KI is one of the leading scientific research institutions in the country. It covers all areas of chemistry, among which materials is one of the main activities. KI supports excellence in science and the use of scientific achievements in practical use. The challenges of competitiveness, sustainable development, education of personnel and circular economy are priority issues for KI. Through the Department of Chemistry and Technology of Polymers (D07), KI has a long history of high-quality research and development in the field of polymers and plastics, with a strong application component that involves cooperation with industry. KI has excellent experience and confirmed ability to participate in international project work as a partner or coordinator (EU Framework Programs, Horizon 2020, Interreg Programs, etc.) as well as in key national projects. The department D07 was a key partner in the formation of the Centre of Excellence for Polymer Materials and Technologies. Through SRIP MATPRO, KI will primarily support research and development in the field of multicomponent materials in which polymer materials play a leading role. Participation in SRIP MATPRO is part of the mission of the KI, which will continue its work in this field.

Faculty of Natural Sciences and Engineering, University of Ljubljana, was formed in 1994 with the transformation of Faculty of Science and Technology. At the University of Ljubljana the courses in metallurgy started already in early 1939. The main activity of the Faculty is providing a university level education, namely at all undergraduate and postgraduate levels of study. The Faculty has five program groups financed by the Ministry of Education, Science and Sport. Fundamental and applied research is carried out within national projects or directly in the cooperation with industry, as well as in the context of various European programs. The results of the research work are presented at top-level conferences and in recognized international journals.

The Department of Materials and Metallurgy educates through four study programs at all university and higher professional education levels. The department's education programs have a long tradition and have been practiced since the establishment of the University of Ljubljana until now. The new study programs are designed in a modern way in accordance with all the standards of university education and scientific research excellence. Considering the fact that Slovenian companies in the field of chemical, metallurgical and metal-processing industries are among the most important exporters in Slovenia, there are many opportunities for employment. The study process and scientific research work are carried out within six chairs. The Department of Scientific Research works in the fields of development of new materials and technologies within several international and domestic projects and in close cooperation with industry.

Slovenian Tool and Die Development Centre - TECOS is a technology centre established in 1994 on the initiative of Slovenian toolmakers as an institution of private law. It was established by the Government of the Republic of Slovenia, the Municipality of Celje and the Chamber of Commerce and Industry of Slovenia. With its rich and long-standing tradition in the development of new products, tools and technologies, it is a development partner to many manufacturing companies in metal processing and other industries in Slovenia and the wider EU region. TECOS is integrated into all branches of the manufacturing industry, specializing in the design, optimization and development of parts, processes, materials and entire production systems, as well as its individual assemblies. In addition to good references in the field of processing polymer materials (thermal or duroplastic systems), metal materials, automation of industrial plants, development of environmentally friendly products and the use of modern CAE technologies, TECOS also owns the laboratory where it develops, tests, and introduces new technologies for processing and manufacturing polymers, composites, hybrid and metallic materials and other system solutions. The work also includes energy and cost-optimized production systems. TECOS enters the SRIP MATPRO as a research and

development centre to support the industry operators for faster deployment, upgrade, and optimization of various prototype technologies.

Slovenian National Building and Civil Engineering Institute is the leading institute in the field of construction in Slovenia. The scientific and research activity is the main focus of ZAG's mission. The work is intended to support the economically very important field of construction.

ZAG Research and Testing Division is organized into four departments: Department of Materials, Department of Construction Physics, Construction Department and Department of Geotechnics and Roads. The departments include various laboratories and sections. In the past 10 years, ZAG has participated in more than 50 European projects (4th - 7th FP).

With its multidisciplinary activity in various fields of construction, and by linking basic and applied research with solving real problems, ZAG has become recognizable in Slovenia and wider. ZAG is one of the most active members of the European Network of Building Research Institutes (ENBRI) and FEHRL (Forum of European National Highway Research Centers). ZAG often acts as a link between domestic industry and international research and thus enables direct contact between our companies and the most advanced technologies in individual fields of construction. The international activity reflects in memberships in technology platforms such as: ECTP (Europan Construction Technology Platform), ERTRAC (European Road Transport Research Council), and E2BA (Energy Efficient Buildings).

Companies. A large number of companies are involved in the SRIP MATPRO application. Companies contribute with their specific proposals and also wider with the intentions to develop new value chains and to increase the competitiveness of existing ones.

Carrier companies. Carrier companies are also signatories to the Consortium Agreement and participate in already developed partnerships (value chains) and development initiatives. These companies, representing different fields, are:

- Steel: SIJ (Acroni d.o.o. , Metal Ravne d.o.o., Elektrode d.o.o., etc.), Štore Steel d.o.o.
- Aluminium: Impol d.o.o., Talum d.d.

- Non-ferrous metallurgy: Zlatarna Celje d.d.
- Advanced functional and integral composites: Magneti d.d.
- Coatings, adhesives, resins: Helios d.o.o.
- Filaments and granulates: AquafilSLO d.o.o.
- Atotech d.d. in Cinkarna Celje d.d.

A wide group of companies. The professional trade associations of the CCIS cover the vast majority of companies in the field of materials from the east and west Slovenian development regions. These companies will be involved in SRIP MATPRO's activities and will develop new chains of value corresponding to their development needs within SRIP.

All three Associations join 116 micro enterprises, 60 small enterprises, 78 medium-sized enterprises and 66 large companies, 161 of them come from eastern Slovenian region and 163 are from the western region.

Government of the Republic of Slovenia, local governments and other partners at the national and international levels. Given that the success of SRIP MATPRO is in the interest of the entire country, it is expected that the Government will also be very engaged in the process, that it will listen carefully to the companies' needs, and that it will help for the common benefit and implement the necessary improvements proposed to better the business environment in a timely and coherent manner.

In addition to the stated and logical partners, the international research subjects with highly specialized knowledge in strategic areas that complement the existing chains and significantly increase their innovative and socio-economic potential, are also included in the proposed value chains. In this regard, the most interesting subjects for cooperation are those which lack the implementation environment and partners for the application of their specific knowledge, This is an untapped potential, which, in a rapidly evolving technological world, is usually very time-limited.

A good example in the field of materials are the Ukrainian R & D institutions, of which the leading role is played by the institutes of the Ukrainian Academy of Sciences (e.g., Frantsevich Institute for Problems in Materials Science[24], Institute of Macromolecular

[24] http://www.materials.kiev.ua

Chemistry[25], Nekras Institute of Iron and Steel and other specialized institutes[26]). Through the years these institutions have gathered a substantial fundamental knowledge on materials. It is important that Ukraine has a strong, technologically advanced industry, such as the aerospace industry. The Ukrainian government strongly supports the acceleration of innovation and the transfer of technologies into practice. The Governmental Resolution from 2012 also places the "Promotion of new technologies for materials, their processing and integration, the creation of the nanomaterial industry and nanotechnologies"[27] among the priority areas of development. At the EU level the potential of Ukrainian institutions was recognized and the basic mechanisms for cooperation have already been developed within the project BILAT-UKRAINE[28] in the 7th Framework Program, under which the Ukrainian National Technology Platform for Advanced Materials (UNTPAM) was established. The framework for cooperation is being deepened in the context of the ongoing RI-LINKS2UA[29] project, which is mainly dedicated to the preparation of project proposals for calls under Horizon 2020. An agreement on cooperation in the R & D area has already been concluded between the Republic of Slovenia and Ukraine, which could serve as a basis for new cooperations.

Competences - staffing

An important comparative advantage of the metal and chemical industry in Slovenia is the high-quality personnel with good knowledge and competences. Both the metal and chemical industries are strongly dependant on quality of personnel; therefore, there are relatively high investments in human resources. Education and training are very complex and demanding processes, therefore there is a high demand on a common systematic approach. Due to the constantly changing technologies, as well as the changing of the generations of employees combined with the fluctuation in the number of entries in the respective educational courses provided by the schooling system, occasionally there is a lack of employees with specific competences. The situation can produce a pressing or even critical conditions for certain companies that are being limited in their progress by the lack of personnel. Since 2009, the CCIS - Association of Chemical Industry has been systematically and intensively assisting companies in acquiring appropriate staff and upgrading their employees' competencies. In 2011, the Association set up the Competence Center for Human Resources (KoCKE), which provides the entire chemical industry with custom-tailored training courses. In just 18 months of operation the KoCKE project provided more than 400 training courses lasting on average of more than 11 teaching hours per course and servicing over 3,500 students. From mid-2013 to 2016, the KoCKE centre has trained over 3,500 employees in the chemical industry.

Examples of areas with high potential for development

Some examples that carry a high potential for development are stated. In the field of metallic materials, the very promising topics include the advanced metallic materials

[25] http://www1.nas.gov.ua/en/Structure/dc/ihvs/Pages/default.aspx
[26] http://www1.nas.gov.ua/en/Structure/dptpms/isi/Pages/default.aspx
[27] United Nations Economic Commission for Europe, Innovation Performance Review Of Ukraine, United Nations New York and Geneva, 2013, https://ri-links2ua.eu/page/7/attach/icp7.pdf
[28] http://www.bilat-ukraina.eu
[29] https://ri-links2ua.eu

needed for a new applications (including the advanced high-strength metallic materials, which, in addition to the development of aluminium, steel and various alloys, also include the development of suitable tool steels and tools, and technologies for the transformation of materials, for machining and bonding, and furthermore there are the concepts of multi-material systems). There is a substantial growth of additive technologies (3D printing) developed for the production of complex metallic products, and rapidly solidified aluminium alloys with improved mechanical properties intended for the automotive industry. Another interesting area is the joining or plating of various steel plates and combinations of steel and aluminium in order to achieve affordable and corrosion-resistant products for extreme operating conditions. In the field of multicomponent materials, there is the development of intelligent synthetic materials for smart clothing, UV and fireproof clothing, coating, bedding, for uniforms, for health-promotion clothing, for the next generation of fishing nets, etc. The technologies of partners with a comparative advantage over competitors at the global level (patents or laboratory-developed processes) include steel and aluminium alloying, multicomponent spinning technology, ECONYL® recycling technology, microcapsules installation technology, and the production of nano titanium dioxide dispersion (nano TiO_2).

1.3 SRIP MATPRO performance targets and indicators, taking into account the global and specific objectives of S4

The main objectives of the operation are:

- Strengthening of the cooperation of producers of materials that achieve high added value and act in international value chains and with knowledge institutions.

- Identification of the value chains (SLO): 2017–2023: 5 chains, 2018 – establishment of at least 2 chains; 2023 - establishment of at least 3 (additional) chains. Internationally it is initially planned to identify the value chains: 2017–2023: 3 chains, 2018 - establishment of 1 chain, 2023 - establishment of 2 chains. All these figures represent the lowest boundary, which is expected to be exceeded.

Value chains - Slovenia		
2017 - 2023		**5 chains**
till 2018		**2 chains**
till 2023 – the establishment of additional value chains		**3 chains**
International		
2017 - 2023		**3 chains**
till 2018		**1 chain**
till 2023		**2 chains**

Goals by 2023

- Increase in added value per employee in companies in the production of alloys and metals (participating in established and appropriately supported value chains) for 25% by 2023.

- Increased exports and added value per employee in smart coatings (participating in established and adequately supported value chains) by 20%.

- Increased investment in development by 15%, added value by 5% and exports in the field of smart multicomponent materials by 10%.

- Intensity and quality of representation of Slovenian interests within international organizations, partnerships and consortia (6).

- Number of developed common services (10).

- Number of relevant initiatives in terms of development policy, e.g., Initiatives for the implementation of innovative public procurement (8).

- The dynamics of the SRIP MATPRO membership in the direction of linking relevant partners in Slovenia.

Definition of performance indicators for SRIP MATPRO

Performance indicators are designed to monitor the performance of all value chains that are included in SRIP MATPRO. The purpose is to verify that this form of cooperation gives tangible business results. In the case that the value chain during a 3-year period (first or second) does not reach the planned growth in at least four of the seven performance indicators, it is regarded as being economically non-viable. The exceptions are the predetermined risks, which particularly affect all companies in certain activities. However, in this case, the value chain must also achieve better business results than a comparable activity (for example a lower drop in added value).

Basic guidelines for determining performance indicators

Performance indicators are determined as the average of annual growth rates at the aggregate level (except for ROE or profitability of capital), for metallic materials and multicomponent materials separately. Target values are calculated as the sum of a particular category for the entire value chain (sum of added values for all companies included in a particular SRIP MATPRO value chain). Target changes for indicators are calculated as the weighted sum (sum of the indicator changes for all companies included in SRIP MATPRO operating in a certain category divided by the sum of the entire category).

It should be noted that the calculations are based on unconsolidated and unaudited financial statements that are available every May and are valid for the previous year. These

financial statements must be submitted by all companies by March 31st for the previous year. As the annual fluctuations in performance indicators are usually high (falls or growth), it is reasonable to determine the performance after the end of the longer period, i.e., in 2020 for the period 2017–2018. In the second period (2020–2022), on average higher/improved performance indicators are expected, since certain activities can affect business results only over a longer period of time. Targeted investments into a new field (for example, 3D printing) means higher investments in equipment, personnel and research and development expenditure, which has a positive impact on the company's business success, only in a few years' time. The performance indicators were also defined for SRIP MATPRO as a whole, and it should be taken into account that additional value chains will be created in the second period, which will have an impact on the performance of SRIP MATPRO as a whole. The realization of the envisaged objectives can also be accelerated with the increased co-investment of the state.

			till 2018	till 2022	Remarks
Indicator label	**Metallic materials**	**Meaning of the indicator**	per year	per year	**Comparable aggregates: C20 and C22**
A1	Added value	Added value is a fundamental performance indicator, since it measures the difference between sales and costs of goods, materials and services. The higher the greater the surplus, the company may then pay for employees, amortization, financing costs, profit tax and profit.	1.5%	2.0%	It is expected that in the second period the growth will be higher due to the inclusion in SRIP MATPRO.
A2	Added value/ Employee	Productivity of labour. The higher the value added per employee, the higher the potential gross salary of the employee.	2.0%	2.5 %	Productivity of labour. The higher the value added per employee, the higher the potential gross salary of the employee.
A3	Exports (turnover on foreign markets)	Higher exports, on average, mean higher competitiveness of the company or a general increase in demand abroad.	1.5%	2.0%	Net sales in the non-domestic market.
A4	Investments in R&D [30]	Higher R & D investment is expected to be reflected in a higher value added, but there is an expectation of a lag between investments and a positive impact on the financial statements	2.0%	2.0%	This includes both expenditures and R & D investments. Companies are not required to report these values, so the comparison between companies is limited to a statistically significant sample (companies that together account for at least 25% of sales).
A5	EBITDA	EBITDA is a cash-flow from operations before depreciation. The higher the EBITDA, the more profitable business is.	2.0%	2.5%	
A6	Net profit	Net profit represents the final result of the business. Attachment "net" means that a particular SRIP company can have a loss, but the aggregate result is still positive.	2.0%	2.5%	Net profit is calculated "cleared", excluding impairment of financial assets (fixed and current assets) and revaluations (Financial investments).
A7	ROE	Profitability of capital reflects the ratio between net profit and average equity. The value below 8% reflects insufficient profitability	0.1%	0.1%	ROE is calculated excluding impairment of financial assets (fixed and current assets) and revaluations (financial investments).

[30] The implementation of this objective also depends heavily on tax legislation changes.

	Multi-components		till 2018	till 2022	Comparable aggregates: C23 and C24
B1	Added value	Added value is a fundamental performance indicator, since it measures the difference between sales and costs of goods, materials and services. The higher the greater the surplus, the company may then pay for employees, amortization, financing costs, profit tax and profit.	2.0%	2.5%	It is expected that in the second period the growth will be higher due to the inclusion in SRIP MATPRO.
B2	Added value/ Employee	Productivity of labour. The higher the value added per employee, the higher the potential gross salary of the employee.	2.5%	3.0%	Productivity of labour. The higher the value added per employee, the higher the potential gross salary of the employee.
B3	Exports (turnover on foreign markets)	Higher exports, on average, mean higher competitiveness of the company or a general increase in demand abroad.	2.0%	2.5%	Net sales in the non-domestic market.
B4	Investments in R&D [31]	Higher R & D investment is expected to be reflected in a higher value added, but there is an expectation of a lag between investments and a positive impact on the financial statements	2.0%	2.0%	This includes both expenditures and R & D investments. Companies are not required to report these values, so the comparison between companies is limited to a statistically significant sample (companies that together account for at least 25% of sales).
B5	EBITDA	EBITDA is a cash-flow from operations before depreciation. The higher the EBITDA, the more profitable business is.	2.5%	3.0%	
B6	Net profit	Net profit represents the final result of the business. Attachment "net" means that a particular SRIP company can have a loss, but the aggregate result is still positive.	2.5%	3.0%	Net profit is calculated "cleared", excluding impairment of financial assets (fixed and current assets) and revaluations (Financial investments).
B7	ROE	Profitability of capital reflects the ratio between net profit and average equity. The value below 8% reflects insufficient profitability	0.1%	0.1%	ROE is calculated excluding impairment of financial assets (fixed and current assets) and revaluations (financial investments).

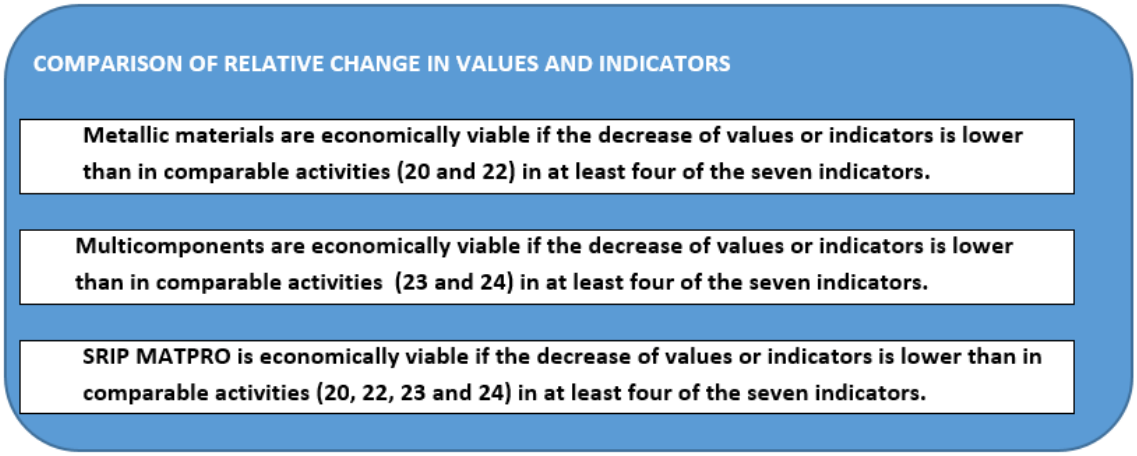
[31] The implementation of this objective also depends heavily on tax legislation changes.

	SRIP MATPRO		till 2018	till 2022	
MATPRO1	Added value	Added value is a fundamental performance indicator, since it measures the difference between sales and costs of goods, materials and services. The higher the greater the surplus, the company may then pay for employees, amortization, financing costs, profit tax and profit.	1.8%	2.3%	It is expected that in the second period the growth will be higher due to the inclusion in SRIP MATPRO.
MATPRO2	Added value/ Employee	Productivity of labour. The higher the value added per employee, the higher the potential gross salary of the employee.	2.3%	2.8%	Productivity of labour. The higher the value added per employee, the higher the potential gross salary of the employee.
MATPRO3	Exports (turnover on foreign markets)	Higher exports, on average, mean higher competitiveness of the company or a general increase in demand abroad.	1.8%	2.3%	Net sales in the non-domestic market.
MATPRO4	Investments in R&D [32]	Higher R & D investment is expected to be reflected in a higher value added, but there is an expectation of a lag between investments and a positive impact on the financial statements	2.0%	2.0%	This includes both expenditures and R & D investments. Companies are not required to report these values, so the comparison between companies is limited to a statistically significant sample (companies that together account for at least 25% of sales).
MATPRO5	EBITDA	EBITDA is a cash-flow from operations before depreciation. The higher the EBITDA, the more profitable business is.	2.3%	2.8%	
MATPRO6	Net profit	Net profit represents the final result of the business. Attachment "net" means that a particular SRIP company can have a loss, but the aggregate result is still positive.	2.3%	2.8%	Net profit is calculated "cleared", excluding impairment of financial assets (fixed and current assets) and revaluations (Financial investments).
MATPRO7	ROE	Profitability of capital reflects the ratio between net profit and average equity. The value below 8% reflects insufficient profitability	0.1%	0.1%	ROE is calculated excluding impairment of financial assets (fixed and current assets) and revaluations (financial investments).

[32] The implementation of this objective also depends heavily on tax legislation changes.

Definition of risks for the realization of the goals: alternative performance indicators

The estimate is based on the latest macroeconomic forecasts of 27 March 2017. According to the EU Commission estimates, Slovenia's economic growth is estimated at 3% (EU Commission winter forecast). The forecast after 2018 is less reliable. Estimates of long-term economic growth for Slovenia vary between 1.5 and 2.5%. In addition, a change in the prices of input materials, especially raw materials and petroleum products, is an important risk factor. It is also sensible to define objectives insofar as the economy is shrinking (a fall in GDP according to the Statistical Office of the Republic of Slovenia) and/or in the case of rises in prices of raw materials in one year (World Bank Metals & Minerals and Energy Indexes) by more than 10%. In both cases, it is expected that the added value will be reduced in value chains as well as in the activities of the economy (as determined according to the SKD classification). Meaning that in no SRIP MATPRO value chain as well as in comparable economic activities (SKD 20, 22, and separately 23, 24) estimated growth in indicators will not be achieved. In such cases, it is reasonable to distinguish the performance of the value chain from a comparable activity by comparing the relative fluctuations in indicators.



In addition, non-financial performance indicators for SRIP MATPRO are defined. These indicators are "soft" by nature and are mainly input data, which (with certain delays) also affect the companies' financial data.

Metallic materials	Description	till 2018	till 2022
Number of new partnerships	Partnerships among the SRIP MATPRO members	3	7
Number of new products	Products developed using tools and incentives in SRIP MAPRO	6	8
Number of patents	/	2	6
Number of connections with external partners	Number of provable business links with partners outside SRIP MATPRO	2	3
Number of companies using ICPs	Identified gaps in employees' competencies and prepared training plans	3	6

Multi-components	Description	till 2018	till 2022
Number of new partnerships	Partnerships among the SRIP MATPRO members	3	7
Number of new products	Products developed using tools and incentives in SRIP MAPRO	6	8
Number of patents	/	2	6
Number of connections with external partners	Number of provable business links with partners outside SRIP MATPRO	2	3
Number of companies using ICPs	Identified gaps in employees' competencies and prepared training plans	2	4

SRIP MATPRO	Description	till 2018	till 2022
Number of new partnerships	Partnerships among the SRIP MATPRO members	6	23
Number of new products	Products developed using tools and incentives in SRIP MATPRO	12	34
Number of patents	/	4	18
Number of connections with external partners	Number of provable business links with partners outside SRIP MATPRO	4	9
Number of companies using ICPs	Identified gaps in employees' competencies and prepared training plans	5	10

2 Joint Development Plan

2.1 Focus areas and technologies, and criteria for their determination

The concept of determination of focus areas and technologies was based on:

- Analyses of global markets and trends, taking into account national, European and global strategies and strategies of key technologies (materials, energy, environment, mobility, etc.).
- Estimation of market share, potential, and degree of risk (of each technology).
- Identification of major industrial needs and related R & D challenges.
- Needs for competences and global positioning of research institutes and knowledge institutions.
- Determining the capacity and competences of Slovenian industry and companies and their positioning in the context of global trends on international markets and within international value chains.
- Analysis of already existing and the potential of creating new value chains within Slovenia.
- Degree of development and maturity of each field and technology.

The elementary guidelines used to identify the focus areas and technologies are taken from the EU strategy for development and innovation. The methodology is based on international integration and identification of R & D capacities (investments, human resources, infrastructure, effectiveness), study of access to new markets and contribution to international commitments (e.g., environmental protection), and a Smart Specialization Strategy that clearly defines the priorities and focus areas of S4. Within the priority area Development of materials as final products, the identification of focus technologies was carried out on the basis of an analysis of the critical mass of competences and the capacity of actors, which ensures the representativeness and coverage of the entire area and the orientation towards new breakthrough technologies and directions based on the cooperative actions of several partners.

Competency analysis[33] covered the identification of knowledge and competences both in scientific and research activities as well as in the economy, in the narrower thematic areas, in the areas of metallic materials (advanced third-generation, high-strength steels, high-temperature, steady-state steels for working under extreme conditions, new superalloys with a lower content of critical elements, additive/3D technology for the production of metal products, processing of high-grade steels, multicomponent materials with an expanded set of electrical and magnetic properties, green production and processing of metals, introduction of light alloys into aircraft design and cars of the future), and multicomponent materials (identification of application areas in the economy and the identification of knowledge and competence holders. The areas in which the overall development process the critical mass is achieved were highlighted. The stages from basic knowledge to

[33] The definition of competencies according to CEDEFOP is: demonstrated ability of the individual to master the modes of work and to use skills, qualifications and knowledge in normal and changing circumstances. The concept of competence includes, among other things, knowledge, motivation, behavior, values, attitudes, self-image, skills, etc.

products and services with high added value achieved in global markets (with a strong linkage between knowledge carriers and the proven potential for creating new value in international markets) were evaluated.

The starting point for selecting focus areas

Within the framework of specific material-related strategies, the concept of defining the focus areas and technologies relates primarily to an analysis of the Slovenian Academy of Engineering. In the field of the development of metallurgy in Slovenia, it follows the strategy of the Strategic Council for Metallurgy, which clearly shows the importance of metallurgy as one of the key and priority industries in Slovenia as well as in Europe. The need to establish and support the adequate business environment has been highlighted. The strategy of the Strategic Council for Metallurgy directly relates to the strategy of development of metallurgy in Europe, known as Metallurgy Europe. Within it, the European industry has committed itself to boost the research in the field of metallurgy and thus, in September 2014, the largest research consortium in the world in the field of metalworking and processing and related research was created. The objective of the program is to finance technologies not covered by the H2020 program and aim at promoting the re-industrialization of Europe. The program was created in terms of increasing the technological and competitive advantages of Europe as the response to similar programs in the US, India and China. The content of the program was officially presented on September 10th, 2014. The London Museum of Science (Science Museum) was symbolically chosen for the presentation venue. The program was set up under Eureka as a new research cluster. Initially, it gathered knowledge, innovation and enthusiasm of more than 180 companies and laboratories from 20 countries. Due to the strategic importance of metallic materials, the metallurgy program places the EU's priority development areas on the production of metallic materials and its related areas as one of the EU's most powerful sectors of technology. With exceptional economic and technological value, metallurgy also provides significant changes in the field of life (use, conservation and recycling of materials, reduction of CO_2 emissions, increased energy efficiency of systems, increased safety and reliability, health protection, etc.).

The main areas where the consortium "Metallurgy Europe" expects the creation of new technologies and which also represent the basis of the focus areas of development at SRIP MATPRO are: (1) light metal materials, alloys and metal composites; (2) steels and other alloys for use at high temperatures; (3) new and improved steel; (4) advanced superconductors; (5) thermoelectric alloys; (6) biocompatible metallurgy; (7) metal-based sensors; (8) automated production of metal products based on addition (3D printing); (9) combinatorial development of new alloys; (10) coating and surface protection; (11) powder metallurgy and microstructure design; (12) modelling and simulation of materials and processes and advanced characterization; (13) recycling, disposal and reduction of waste.

New technologies should include:

- Accelerated synthesis and discovery as well as the introduction of new alloys into applications.
- Better specific mechanical properties of lightweight structural alloys.
- Higher temperature and phase stability of materials, especially for materials used in energy production and other applications intended to operate in extreme environments.
- New lightweight and damage-resistant metal structures, especially for transport requirements.
- New permanently durable alloys for pipelines, very demanding CO_2 transport, gas pipelines and geothermal installations.
- Better biocompatibility and/or resorption capability for medical applications.
- Improved understanding and control of the phenomena of degradation, corrosion and radiation.
- Special physical and multifunctional properties.
- Design of alloys with modelling, genetic algorithms, neural networks, inverse modelling.
- Better designed and physically based simulation of properties and technological behaviour of metal products.
- Sensors for insertion, diagnostic capabilities, internal process monitoring, and closed-loop control.
- Improved materials and characterization of defects with microscopy.
- Precise measurement and forecasting of thermophysical, thermomechanical, thermodynamic, thermocapillary, wetting and diffusion properties in multi-component metallic systems.
- New metal manufacturing technologies that improve the production of alloys, metal forming, manufacturing closer to the final form, additional processing, powder metallurgy, heat treatment, surface engineering, corrosion protection, joining techniques, and recycling.
- Sustainability assessment, including the time-dependent development of the microstructure and optimization of performance with a large number of parameters.
- Efficiency of resources and easier accessibility or low-cost materials.
- Better environmental performance, better compliance, recyclability and renewal capability, in line with the ISO long-life cycle.

In assessing the focus areas of multicomponent materials, criteria that were exposed in key sectoral analyses, such as The New Plastics Economy (Ellen McArthur Foundation, World Economic Forum, McKinsey, Jan. 2016), were considered. The study identifies three necessary areas for the transition to a sustainable and circular state: 1) to create effective management of plastics after use, 2) drastically reduce the releases of plastics into nature, and 3) to separate plastics from the use of fossil resources. We also followed the lead in key European documents such as the Roadmap to a Resource Efficient Europe, COM / 2011/0571, and more specifically, in the Closing the Loop - An EU action plan for the Circular Economy COM (2015), where plastics is defined as one of the five priority areas, where development and innovation are recognized as an important element in the way towards the set goals. The public private partnership Biobased Industries in its annual plan for 2016 clearly identifies the production of raw materials and materials as an important part of its operation. On the basis of the analyses, areas with great potential for

the breakthrough of market-relevant high value-added solutions were identified. In the field of multicomponent materials they represent the core focal areas of SRIP MATPRO.

These include:

- Coatings, resins and adhesives with new functional properties, reduced emission levels, the use of renewable and biodegradable raw materials with the possibility of their re-use.

- Innovative textile products with new functionality, and beneficial impact on comfort and health. Use of renewable resources.

- Advanced recycling and use of renewable resources, with the aim of setting up methods for the use of a wider range of materials and mixed materials, separation technologies and depolymerization.

- Complex processing technology for the production of complex multi-material products with more efficient use of materials and energy effective processing.

Criteria for determining focus areas

The definition of focus areas and technologies is, and will continue to be, based on a critical assessment of the facts that justify the importance of the areas, i.e., the existence of knowledge (competences) and the capacity of the economy, taking into account social challenges (trends and markets, including access to raw materials) and key technologies.

The key issues are:

- What are our comparative advantages in terms of knowledge and competences in industry and science?
- What are the challenges of the market and the needs of the business sector in order to be competitive?
- Where are the new or growing markets and where are the opportunities for the development of new industries?
- What environment is needed to successfully respond to market trends?
- Where and what are the obstacles and weaknesses?
- What is the role of the state and the incentive mechanisms?
- In which areas and in what way should we combine R & D activities?

Only focused research can lead to true technological breakthroughs (FET - future emerging technologies). New breakthrough technologies, which are unknown to the market, require extensive investments in the development of products and technologies and market design, which is why they can be placed on global markets through a combination of industrial investments and with the support of the State of Slovenia. On the other hand, through breakthrough scientific achievements, we can attract global

corporations to organize their research and development departments in Slovenia and possibly a part of the production of the products that follows.

- How to overcome inflexibility in the distribution of long-term state research funds and focus them on new important development areas that are consistent with the long-term goals of industry and Metallurgy Europe. Breakthrough basic research, funded in this way, will also be a "ticket" to the largest EU projects and other top international cooperation. In Slovenia there are no such mechanisms.

- How to channel public funds in the long run to complement existing knowledge for implementation needs in Slovenian companies and the formation of new companies. Key enabling technologies (KET) can also lead to technological breakthroughs. Also, in order to finance these kinds of steps, we need appropriate mechanisms that are not yet available in Slovenia.

- What strategies and support environment can be expected from the industry's orientation to new areas such as, for instance, magnesium alloys?

- How to systematically organize state support in the sequence from basic research to new products and market placements?

Three-fold process of narrowing the focus areas

The process of narrowing of focus areas and technologies is thus composed of:

- The first part covers the scientific and technological field, which focuses on the capacities of the scientific and technological development itself, taking into account the scientific basis and findings, including trends, potential applications, key technological challenges, potential obstacles and possible evolution of the technology.

- The second, industrial-business, part includes the analysis of the industrial environment and the potential of technology implementation and its further development in the industrial environment, the possibility of establishing national and international value chains, and identifying potential socio-economic effects.

- The third part focuses on assessments of sustainability (low-carbon objectives, the circular economy), international market assessments and potential end-products, their life cycle, and the identification of the incentive effects and capacities required for the successful implementation of technologies and the establishment of horizontal networks.

Focus areas

Based on an analysis of global markets and trends, reviewing national, European and global strategies and strategies of key technologies (materials, energy, environment, mobility, etc.), assessing the market share, potential, maturity and level of risk of each technology, identification of major needs of European industry and related R & D challenges, a review of companies active in the field of materials, as well as interviews

and workshops carried out, a set of areas that meet the criteria for the development of breakthrough initiatives were identified. The key competencies (on the state-of-the-art level) are the most important element, on which the development of as yet non-existing breakthrough solutions (beyond the state-of-the-art) becomes possible. Another key element is the critical mass and the successful connection into the value chains. Initiatives in individual focus areas are on very different stages of development, from clear ideas without testing of the concept, to fully-formed partnerships with a clear distribution of roles and the timetable and financial implementation plan outlined. A set of initiatives is considered to be a dynamic collection. In such a collection the initiatives can diminish, new ones can arise, and their progress towards fully integrated projects depends primarily on the willingness of partners and participating companies. The process of development and differentiation can be well under way within SRIP MATPRO, which provides a framework, support and also a stimulating competitive environment for the development of the best initiatives. The aim of the process is to make sure to provide the mechanisms to seek and recognise the best initiatives, and to promote the cooperation of companies through chains/networks with competent and comprehensive projects and providing adequate support for the R & D activities. Since the process will be active over several years, it is not necessary that all initiatives are at the same level of development, instead variable degrees and the pace of development must be allowed. The competition between initiatives must be allowed in order to come up with the best ideas, motivated and initiative partners and the highest overall impact.

Identified and revised focus areas that generally cover light, advanced and functional materials, composites, coatings, binders and fibres, production and processing technologies, active sensor integration etc. are:

a) Steels and special alloys:

1. The concept of ultra-pure steels and alloys.
2. High-strength steels and their transformation.
3. Advanced metallic materials for demanding applications.

b) Aluminium:

1. New high-strength and ultra-pure Al alloy.
2. Alternative manufacturing methods and maximum recyclability of Al.
3. Die casting of Al alloys.

c) Technology:

1. Rapid prototyping and complementary technologies.
2. Recycling (metallic materials, rare earths, composites, auxiliary materials, by-products).
3. Advanced casting technologies and casting of products.
4. Modern technologies for processing polymers and hybrid materials.
5. Modelling of materials manufacturing processes.

d) Multicomponent smart materials:

1. Multi-component smart fibres and textiles.
2. Composites.

e) Functional coatings and advanced binders for metals:

1. Functional coatings.
2. Resins and binders.

In Slovenia, there is a potential to establish an extremely strong and internationally integrated value chain i.e. the network of companies, research and knowledge institutions with appropriate capacities, and in particular competences in various areas such as, the production of high-strength, nano-composite, high-entropy and multi-layered materials, the production of tool steels, tool making, protection of tool surfaces, preparation and protection of steels for light constructions, transformation and manufacturing of products, eventual functionalization of surfaces with newly developed surface protection technologies.

a1) The concept of ultra-pure steels and alloys

In order to achieve high standards of quality, reliability and safety of products and structures the purity of steels and alloys - the control of non-metallic inclusions, defects and irregularities in the microstructure is important. Inclusions lower the material's strength, and especially its dynamic properties, which unavoidably leads to the introduction of higher safety factors and consequentially to the oversizing and higher material consumption, environmental pollution, large weight and energy losses. Production of ultra-pure steels and alloys that enable minimalistic design approaches and lighter structures requires R & D initiatives in the entire field of technologies of steel production, mostly of secondary metallurgy (AOD, VOD, VIM, VAR, ESR), which can be combined with modelling and understanding of processes, sophisticated methods of characterization of microstructure, and assessment of the achieved properties on end products. In the field of control of inclusions recent research has focused on thermodynamic calculations and modelling of the processes of movement of the inclusions in the melt, and in-situ observation of the non-metallic inclusions in the melt (the formation, precipitation, the dissolution and interaction between the inclusions), the influence of slag and fire sustainable linings on the type and amount of non-metallic inclusions, new methods of analysis of inclusions, ladle metallurgy, vacuum processing of steel melt (VD, VAD, VOD), special metallurgical processes, and the influence of inclusions on the surface defects and features. Several EU projects are currently active under the RFCS Foundation; "Improvement of steel cleanness by reducing refractory contamination in secondary steelmaking", "In-use properties of super high-strength steels generated by a range of metallurgical strategies", "Dynamic stirring for improvement of energy efficiency in secondary steelmaking". The most important European companies in the development and production of steel are: ArcelorMittal, Böhler, SSAB, ThyssenKrupp, Tata Steel, Voestalpine. Worldwide the most important companies are: Hesteel Group, Novolipetsk Steel, Nippon Steel, Nucor Co., POSCO, Villares Metals, etc.

Slovenia has the potential, and above all, the need to establish value chains in the field of purity of steel and alloys. The field of control of non-metallic inclusions is common to all three Slovenian steelmaking companies, whereby, by deepening our knowledge, we open the possibility for their entering into more demanding markets. Thus, the value chain in the field of purity of steels and alloys will, together with the support of research institutions, link the producers and steel users, thus enabling them to achieve higher standards. For

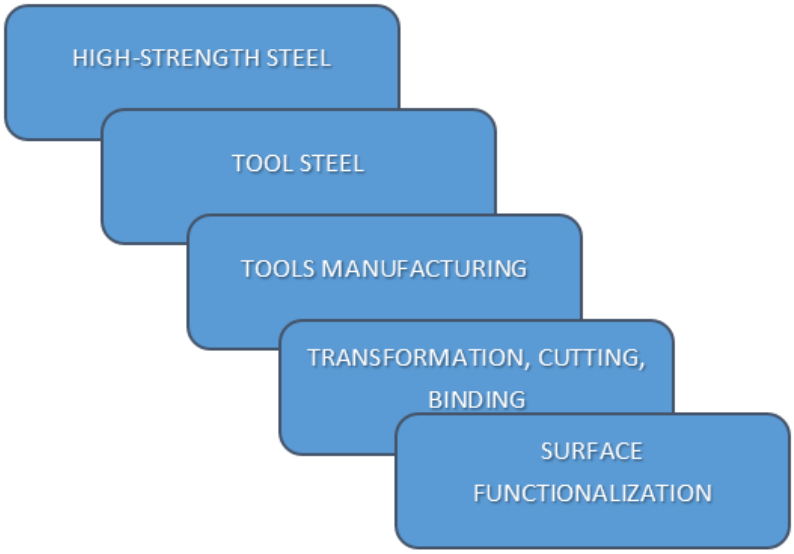
the study of processes, model verification and the transfer of results from experimental laboratory research into production, it is necessary to establish the capacities for the pilot production of steel, intended to cover the wide range of aggregates and manufacture the small quantities of steel (up to 2t). A similar pilot plant can be found in the Austrian metallurgical pool in the federal Austrian state of Styria, which enables Austrian steelmakers to maintain a leading global position in the development of special high-quality steels.

a2) High-strength steels and their transformation

The requirements of the automotive industry have been dictated by the need to lower consumption, CO_2 footprint and environmental impact. They are met by the use of ever-lightening, better, and recyclable materials. Despite the development of advanced composite materials, various steels remain the mostly used material in the production of cars (> 50%). Steel is 100% recyclable. In doing so, the high-strength steels are being introduced, which, for safety reasons, must provide adequate elasticity/toughness. These properties, however, present great problems in the transformation, processing and joining of these materials. Global research is thus focused on the areas of complex thermo-mechanical processes, the development of high-strength martensitic steels and their heat treatment, to the third generation of high-strength steels (L-IP-lightweight steels with induced plasticity, TWIP-twinning induced plasticity) and nano-structured - nano-bainite steels with a high strength and elongation ratio. The recent EU-RFCS projects include "New multiphase AHSS steel grades for hot forming, with improved formability and reduced springback", "New nano-structured bainitic steels for improved durability of wear-resistant components: microstructural optimization through simulative wear and field tests", " In-use properties of Super High-strength steels generated by a range of metallurgical strategies", etc. The main players in the development of the new generation of high-strength steels for the automotive industry are ArcelorMittal, SSAB, TATA Steel, ThyssenKrupp, US Steel Co., VoestAlpine.

In Slovenia there is a high potential to establish extremely strong and internationally integrated value chains, i.e., networks of companies, research institutes and knowledge institutes with adequate capacities. There are competences at all levels, from the production of high strength steels, the production of suitable tool steels, the production of tools, the protection of the surface of tools, the preparation and protection of high-strength steels, the transformation and manufacture of products, to the eventual functionalization of surfaces with newly developed surface protection techniques.

The integration and development of joint R & D initiatives in the field of high-strength steels will enable the development of complex high-demanding products with the upcoming high-strength requirements of the automotive, aerospace, and military industries.



a3) Advanced metallic materials for demanding applications

In the pursuit of re-industrialization, the EU has recognized metallurgy as one of the key strategic areas. Today metallurgy in the EU represents one of the most powerful sectors of technology with excellent development potential. Metallurgy is also one of the strongest technology sectors in Slovenia with exceptional development and market potential. Potential, which through focused and systematic investments in research and development, will enable the development of new products and thus will lead to a competitive advantage of the Slovenian economy. This is evidenced by data related to the production of metals, the foundry industry and the metal-processing industry in Slovenia. The Slovenian metallurgical industry has an advantage over the mass producers, due to the possible rapid adjustment to niche production, which on the market adds higher value added per unit of production. In the Slovenian metallurgical industry, the development departments traditionally cooperate with research and educational institutions, which enables the development of new metallic materials with better mechanical properties. The development of new advanced metallic materials for the most demanding applications and operating conditions (high-temperature resistant steels and alloys, thermoelectric alloys and sensors, new electro-steels with super-low watt losses, new magnetic materials and biocompatible metallic materials) will enable a significant improvement in the processes of obtaining and storing energy, protecting the environment and improving the quality of life, and will also influence the opening of new jobs for highly educated personnel and the increase of added value in manufactured products.

Slovenia has great potential in the field of advanced metallic materials, especially on the side of technologically well-developed companies with their own development, which involves the production of new steel grades, for example, maraging steels, nickel super alloys, special steels and biocompatible metallic materials, supported by simulations and optimization of the entire process pathway, taking into account recycling and sustainable production. Coordinated R&D initiatives and linking the research capacities of institutions and companies, most of which are already globally recognized, will enable the placement of new products with increased added value on the market.

There is a high development potential in the production of maraging steels. The production of these materials is of strategic importance, therefore and each country is forced to develop its own production capacities. The production of high-temperature radiation resistant steels, and nickel superalloys are very demanding metallurgical process, which require a thorough understanding of metallurgical processes. This reflects in a high added value at products, such as high-temperature-resistant nickel superalloys for turbine blades, new high-temperature and wear resistant steels for thermal and nuclear power plants, etc.

An increasingly important area covers electro-magnetic applications, in particular by introducing EU directives for the complete electrification of vehicles. The research is focused on the modification and development of electrical insulation materials with significantly lower watt losses, which enables the achievement of the required electrical characteristics at a significantly lower weight, and on the other hand, to the development of new magnetic materials. In the field of magnets, due to the monopoly of China over the production of rare earths and their limited and expensive recycling, development focuses on the possibilities of replacing expensive materials with cheaper and more accessible ones. In addition, materials with sensory and diagnostic capabilities, which will enable the direct monitoring of properties and condition of the material, also appear as an important area of development.

On the other hand, there is also an exceptional potential in biocompatible metallic materials. In recent years, the development of modern metallic biomaterials for use in medicine has been recording significant advances with an emphasis on biological and mechanical biocompatibility with respect to the principle of non-invasiveness. Traditionally, in the field of biomedical applications, metallic materials such as stainless steels, Co-Cr alloys and Ti alloys are offered by Arcam EBM, Dentaurum, Iwatani, NeoNickel, and others. In addition, Mg alloys, tantalum and niobium are used, but their proportion is much smaller. In optimizing biological compatibility, research focuses on the use of non-toxic elements, such as titanium, niobium, tantalum, molybdenum and zirconium. According to known allergic reactions of most of the products containing nickel there is the on-going process of its complete withdrawal from all products intended for medical use. Vanadium and aluminium are also being replaced due to proven neurological toxicity. The development of mechanical biocompatibility focuses primarily on the optimization of the modulus of elasticity, the relationship between strength and ductility, refractive toughness and wear resistance. Due to the patient-specific requirements, more and more R & D activities are taking place in the direction of use of additive technologies for the production of implants. Most research in the field of biomedical applications is focused on the development of Ti-alloys. The emphasis is on the development of alloys with a lower modulus of elasticity and with the addition of non-toxic and cheaper elements. In the case of implants that are intended to be removed from the body after a certain period of time, it is important that there is no fouling of the implant, since in this case the removal becomes difficult. For this purpose, materials with the addition of Zirconium, which has the proven ability to inhibit the formation of calcium phosphate, are developed. In the case of memory alloys, research is focused on the development of nickel-free alloys due to the aforementioned allergic reactions. At the very development of materials, one should not neglect the importance of imitation of solutions that are found in nature, and to their implementation to a wide range of technological areas (biomimetics).

Stainless steels have the longest tradition of use for biomedical applications, they are primarily used to strengthen the bones, the spine and in cardiovascular medicine. The strategies for the development of nickel-free stainless steels are focused on the addition of manganese and nitrogen, which are the substitutes for nickel and act as an austenite stabilizer.

Methods for the production of such steels include electro-remelting under slag, electro-blasting under pressurized slag, low-pressure casting, and nitrogenation in the solid state.

Cobalt alloys feature good corrosion properties and excellent wear resistance, and are therefore often used for artificial joints. Recent research on cobalt alloys is predominantly focused on the substitution of nickel with nitrogen. In recent years, biodegradable alloys have also emerged on the market They are particularly suitable for biomedical fracture treatment applications, where after healing, an additional operation is required to remove metallic fastening elements. Suitable mechanical properties and poor corrosion resistance in the biological environment allow the degradation of these materials in the human body after they are no longer needed. To this end, initially magnesium was introduced, but due to too rapid dissolution it was replaced by its alloys, especially Mg-Zn, Mg-Ca and Mg-Zn-Ca. The main weakness of commercially available Mg alloys still remains their poor corrosion resistance, so research is steered towards the development of biocompatible coatings that would prolong the lifetime of Mg alloys. In addition, research also focuses on the development of biodegradable alloys with prolonged lifetime in the human body, i.e., iron and its Fe-Mn and Fe-Mn-Pd alloys.

b1) New high-strength and ultra-pure Al alloys

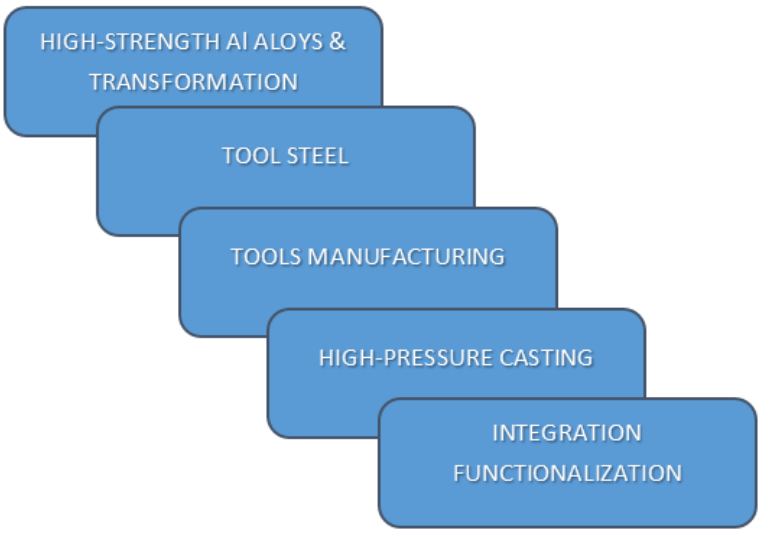
In the case of aluminium, the main drive of development is currently the automotive and aerospace industry, with Al alloys also having a huge potential in a wide range of other fields, such as medicine, pharmaceuticals, military industry, interiors, etc. Particularly in the automotive industry the development is aiming to produce new high-strength and corrosion-resistant aluminium alloys, which should combine 100% recyclability, low weight, high load capacity and thus reduced component volume and increased safety through high energy-absorbing capabilities. A reduction of weight can also be achieved by the appropriate design of components based on a minimalistic approach, meaning higher complexity of products and the introduction of special casting and transformation technologies.

The value chain operating in this area, with exceptional R & D potential for the development of new aluminium alloys and positioning into completely new markets, joins partners in the field of aluminium and aluminium-alloy production, the transformation and casting, the production of special high-thermal-conductivity steels, the production of complex tools with supported by additive technologies and surface protection, manufacturing of products and their re-integration and recycling. Due to the high potential of additive technologies, such as 3D printing, it is necessary to increase the activities in the development of new aluminium materials, metallic powder production technologies, and other supporting products for such technologies. Naturally, the appropriate support from the institutions of knowledge and research institutions is needed.

The properties of standard aluminium alloys, also of high quality, do not meet the stringent requirements of high-tech applications, which require a tensile strength of more than 600 MPa. Therefore, the research and development is focused on providing new light-weight materials together with manufacturing and processing technologies, in particular to new aluminium alloys for the automotive industry using the highest possible proportion of secondary aluminium and aiming for better mechanical properties with corrosion resistance. The phase system Al-Zn-Mg-Cu is the core for the development of the best alloys intended for forging. The average tensile strength for this alloy in the T6 regime is up to 500 MPa. Additional special alloying elements such as Cr, Mn, Mo, Ce, and Zr are added to form new microstructural components and control crystalline grains and pods. The result is a further improvement in mechanical properties (even at elevated temperatures). Important processes that affect the quality of the material occur during curing, which makes development of high-quality and high-strength alloys highly dependable on the quality of manufacturing technologies. At Brunel University, they developed a special MC-DC (Melt Conditioned Direct Chill Casting), which represents the physical treatment of the melt during curing with intense mixing of the melt to achieve fine crystalline grains and the corresponding distribution of the non-metallic inclusions.

New Aluminium alloys for the most demanding applications in the aerospace industry are in addition to standard alloying elements micro-alloyed with combinations of elements Sc, Zr and Er. At present, several new alloys from the 7000 series are being developed, focusing primarily on the improvement of corrosion properties. An important area represents the development of alloys and technologies for the production of "crash" profiles for the automotive industry, where Al foams show a great potential. The technologies of joining the Aluminium parts made of new alloys as well as of conventional Al alloys with other metals or non-metals, is also an important issue.

The introduction of new technologies: alloying procedures, melt refinement, processing with fragmentation and modifying agents, appropriate curing process, and thermo-mechanical processing represent the second step in the production of ultra-pure aluminium alloys with high mechanical properties and good corrosion resistance. Fast-curing technologies, with the proper conduction of extrusion process and the appropriate chemical composition, make it possible to achieve superior corrosion and mechanical properties. An important part of production of alloys is a heat treatment, which is in the case of precipitation of two or more phase particles a very complex problem. In order to achieve the appropriate size of the microstructural constituents of the alloy and therefore to gain the best mechanical properties, it is necessary to optimize the type and proportion of additive components used for fragmentation and modification, as well as the temperature profile and processing time.



b2) Alternative manufacturing methods and maximum Al recycling

The basic characteristic of metallic materials, especially aluminium, is their complete recyclability. The importance of aluminium recycling is also based on the fact that the primary production of aluminium consumes approx. 186 MJ/kg of electrical energy, while the secondary production uses typically 10-20 MJ/kg. The aluminium alloy market is specific, characterized by quality classes in which materials with special characteristics are classified and with very narrowly defined alloying elements. For this reason, the most demanding aluminium alloys are difficult to produce by using secondary raw materials, especially if they are not properly classified. The larger the share of the secondary raw material used, the cheaper the final material becomes. The market for high-strength aluminium alloys is competing with other advanced materials, especially with ultra-high-strength steels (they are lately acting as functionally lighter and cheaper materials as wrought aluminium alloys). This will have a major impact on the future of aluminium alloys, and especially on the future of recycled materials. The long-term competitiveness of aluminium alloys is important, therefore the proportion of recycled secondary raw materials in the production of aluminium alloys should be as high as possible. It is mandatory to find a ways to improve the ratio of properties to cost by reducing production costs. Improving the recycling rate of conventional aluminium alloys (with a maximum quantity of trace elements between 500 ppm to 1500 ppm - separately for each element) depends largely on the ability of global aluminium producers to develop a fast and cost-effective technology for automatic separation of waste Aluminium (municipal waste) and conversion of it into a unified alloy with a well-defined chemical composition. The increase in the proportion of secondary Aluminium is achieved by the appropriate methods of mechanical and electromagnetic sorting procedures by using the appropriate two or multi-compartment furnaces for melt treatment, which involves cleaning of the melt by flotation and filtration.

In parallel with waste separation, digitally supported processes for the classification of secondary aluminium of different qualities, and the control of the corresponding ratio in use of secondary and primary raw materials will have to be developed and implemented. These processes are currently at a very early stage of industrial development, meaning

that their introduction into regular production will take substantial additional time. In addition to conventional recycling methods, Solid State Recycling Techniques (SSRT) are used to compress small parts of secondary aluminium into high-density compressed material. Such raw material is used for extrusion process producing the material having the same mechanical properties as classically produced profiles.

In order to achieve a higher recyclability and as a result of a reduction in production costs, several strategies are being introduced to improve the ratio of properties to cost for aluminium alloys by developing new, recycling friendly alloys. Some strategies attempt to replace existing standards based on the purity of primary aluminium (achieved by electrolysis) with new standards based on the purity of waste that will be achieved by their sorting. The aim of the new standards is also to combine kinetic and cast aluminium alloys into a smaller number of quality classes. Before completing the development of new alloy compositions and prior to the development of standards based on recycled material, a thorough understanding of the complex impact of a large number of trace elements on the properties of wrought aluminium alloys will have to be achieved. The characteristics of wrought aluminium alloys are the result of a complex interaction between the chemical composition and the microstructural characteristics that arise in the process of solidification, heat treatment and transformation. With fixed process parameters, the properties of the material depend mainly on the chemical composition of the alloy. The tolerances for the intervals of the concentrations of the alloying elements depend on the required properties.

The extent of recycling also depends on the ability of production technology to maintain the standard composition and quality of the alloy, despite the high proportion of waste aluminium used. In other words, the difficulties in recycling of wrought aluminium alloys arise from the problem of achieving tolerances of standard alloy constituents, or more generally, the ability of alloys to refine the elements that are usually not present in the composition. This should be the starting point for creating the so-called recycling friendly wrought aluminium alloys. In technological processes for the production of aluminium alloys with a high share of secondary raw materials, new melt refining and cleaning processes should be included, which will enable not only the removal of unwanted chemical elements but also the removal of non-metallic inclusions. The usual metallic melt filtration methods are upgraded with dual filtering and AFS systems with a finer filter porosity and a vibration table.

b3) Die casting of Al alloys

World trends in aluminium casting are aimed at producing high-strength, temperature-stable and corrosion-resistant complex Al alloys and castings for the automotive and aerospace industries. With a large network of foundries and the production of aluminium alloys, Slovenia also has a considerable potential for operating in this field, which requires the acquisition of new technologies and carefully coordinated joint R & D activities. Such production is of strategic importance for the aluminium industry as it represents the development of new niche products and semi-finished products and their positioning in the global industry. So far, there have been few studies in the field of rapidly solidifying alloys and the modifications of such alloys.

The newly developed foundry aluminium alloys depend on the chemical composition, the conditions of solidification and cooling, and the heat treatment. They have excellent mechanical properties, corrosion resistance, as well as a wide range of other beneficial properties, such as appearance, ease of manufacture, excellent strength to weight ratio and good welding ability. Aluminium alloys with Zr, Mo and/or V in an appropriate ratio achieve a 40% better tensile strength in a cast state.

Die casting is a process of casting light non-ferrous alloys, the characteristics of which are a short casting cycle and, consequently, high productivity. In particular, it is intended for more or less large-scale production of moulds having complicated shapes. The development of die casting follows the direction of the implementation of special casting processes to achieve extreme properties. These special procedures are: squeeze casting, thixo casting and rheo casting and local squeezing, which are especially suitable for the production of complex castings. Faults occurring during high-pressure casting can be avoided by casting in a mushy state, thus affecting the melt liquid and changing the dendritic structure to a globular one, leading to an increase in mechanical properties.

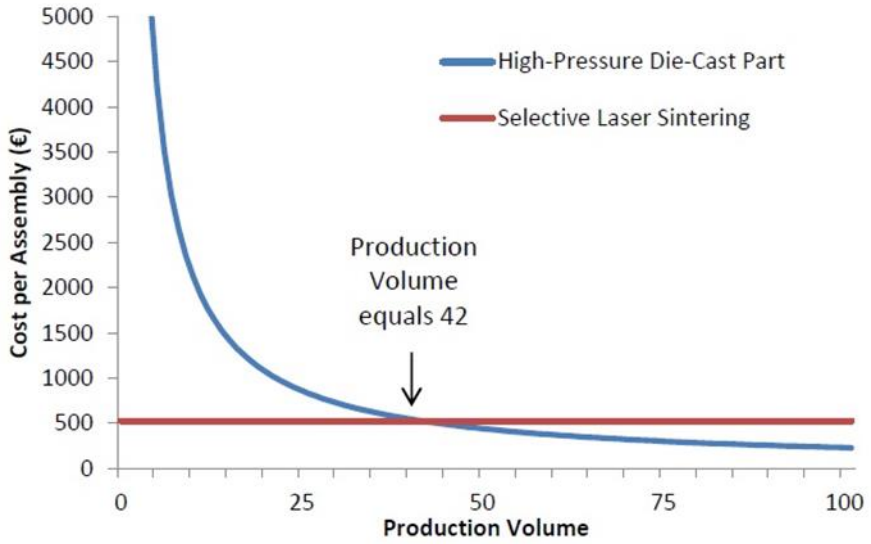
Know-how, which is required for the production of high-quality aluminium alloys, requires a deep understanding of metallurgical processes, which requires investments in human resources, both in research in companies as well as in research institutes. New aggregates and technologies for special metallurgical processes will generate new jobs. An increase in employment of up to 30% is estimated, as well as a substantial increase in added value to products, together with an increase in annual revenue. New high-strength aluminium casting alloys and mastering of the most demanding technologies will enable an increase in sales on global markets and gaining competitive advantage over Asian producers. Such high-end products will not only be useful in the automotive industry, but the market will expand to the aerospace and energy industries.

The goals can be achieved by reaching the stability in production quality, which requires a thorough understanding of the occurrence of errors. The primary tool in such cases is the modelling of processes. The recent progress made in the metallurgy of curing of Aluminium alloys derives from modelling at all levels, from the distribution of atoms in the melt, to the understanding of nucleation, dendritic growth, macrosegregations, etc. The most important goal of modelling is to unify all processes from different levels, thus providing the best possible description of the entire process of die casting.

c1) Rapid prototyping and additive technologies

Rapid Manufacturing has already established itself as an important tool in reducing the time from idea to product marketing, while at the same time reducing the cost of development and increasing the quality of end products. The basic idea of rapid prototyping is to produce the final product based on the CAD model as fast as possible, without using classical processing techniques where the material is being removed. In the case of rapid prototyping of products in comparison with conventional production systems, the production time and costs are reduced by 50% to 90%. Due to the mechanical properties of the used materials from which the prototypes were made, they were initially used only for presentations of finished products, for the visualization of concepts, for design and matching analysis, and to easily perform functional tests. Nowadays, this

technology is becoming more and more interesting in the production of small and prototype series. Now it is possible to get to the end product faster and more cost-effectively than by using conventional manufacturing processes. Of course, the viability of the use of additive technologies depends on the type of product, material and size of the series.



Costs of making similar pieces of Aluminium: AM vs. classic technology (Joseph C. Benedyk, Light metal age, 2018)

Progress in the development of new additive technologies has caused the technology of rapid prototyping processes to be increasingly used for the production of end-products with full functionality. Usually, these are the small-scale productions - from a few tens to 1000 pieces. According to analytical estimates, the value of the market for advanced materials for high-speed prototyping and additive technologies will grow from the current EUR 200 million to EUR 850 million by 2021.

Rapid prototyping technologies for the production of end-products in the automotive industry, aerospace, tool making, construction, architecture and medicine, which are successfully placed in the Slovenian manufacturing sector (both by the primary producers of feed materials as well as by the users - the toolmakers and the processing industry) include:

- 3-Dimensional Printing (3D-P; 3-Dimensional Printing).
- FDM (Fused Deposition Modelling).
- LOM (Laminated Object Manufacturing).
- Stereolithography (SLA).
- Selective Laser Sintering (SLS).
- PolyJet technology.
- Direct Laser Sintering of Metal Powders (DMLS).
- Laser Engineered Net Shaping (LENS).
- Selective laser melting (SLM).
- Manufacture of plastic prototypes by vacuum casting.

3D Printing technologies or additive manufacturing (AM), which relates to metallic materials, are divided into:

- Laser methods.
    - Laser Sintering (LS).
    - Laser Melting(LM).
    - Selective Laser Melting (SLM).
    - Laser Metal Deposition (LMD).
- EBM – 3D printing by means of electron-beam melting.
- DED – 3D printing using an electric spark.
- UAM ultrasonic adding of metal.

One of the most important advantages of 3D printing or additive technologies is the ability to create end products of complex shapes with high efficiency use of materials, without the need for a final mechanical treatment, while at the same time allowing the production of materials with complex chemical compositions. By using 3D printing the hot and cold phases of the processing of materials is avoided (which always represents a critical phase in the manufacturing of products). The quasi-static properties of relatively "new" materials produced by additive technologies are already well known and are well comparable with existing, conventionally derived materials. On the other hand, the dynamic properties and resistance to fatigue of these materials still quite unexplored. In addition to the development of new technologies the focus is also on the implementation of new materials, the development of methods for testing, control of microstructure, effects of the direction of product building, the density of printed material on the mechanical properties, porosity, anisotropy of materials, residual stress and surface conditions. In addition to the development of new technologies, the development in the field of 3D printing of metal materials is increasingly focusing on the development of new materials and the production of powders suitable for additive technologies that enable production of products that are subject to the different thermodynamic conditions “in use" than those produced by classical manufacturing processes. Techniques suitable for the manufacture of powders for additive technologies include electrothermal wire stripping, plasma dewatering in the cloud, gas condensation, DC plasma and RFI plasma (Radio frequency induction plasma), where spherical powders are obtained. In the case of steels, the base materials are stainless and maraging steels, in the case of Aluminium the materials are AlSi and AlSiMg alloys and in the case of non-ferrous alloys they base on inconel 718 and Ti-6Al-4V.

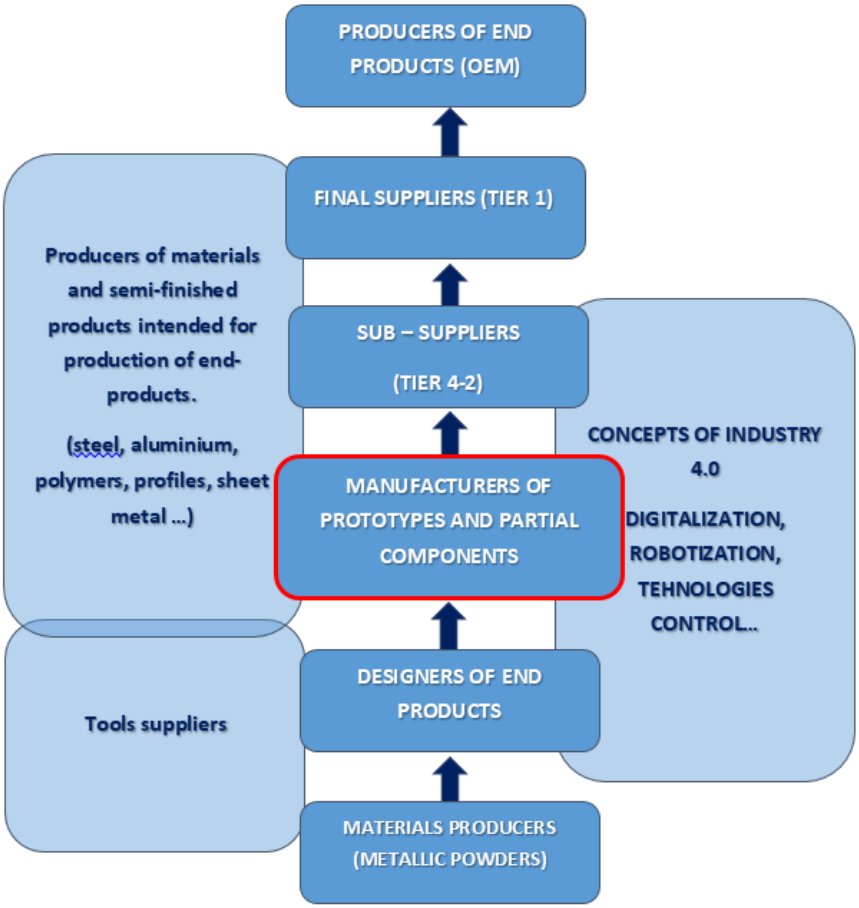
On the other hand, the development of additive metal printing technologies is aimed at combining various 3D printing techniques and conventional technologies to achieve maximum and affordable properties, the development and implementation of new materials, the development of methods for their testing, the control of microstructures with direct influence on the change of properties, achieving higher surface quality and precision of printing, the possibility of eliminating additional mechanical and thermal treatments and product development with gradient composition and gradient-changing properties. The other development course aims to the study of the influence of the direction of construction, the density of the printed material and the process control parameters on the mechanical

properties, porosity, anisotropy of the material, residual stresses, and the condition of the surface.

As can be concluded from the review of European this is one of the most propulsive and active research areas of technologies and materials. The emphasis is on the heat history of the product and the appropriate heat treatment by which the materials' recrystallization can be achieved, residual stresses can be eliminated and mechanical and dynamic properties improved. By improving mechanical properties, the extremely important field of use of additive technologies opens up in medicine. 3D printing enables the use of different combinations of elements with a gradient alteration of the strength and structural properties within the product, and above all an individual's anatomy adapted to the production of implants.

At present in Slovenia, there are no production capabilities in small to medium-sized companies that would produce metallic products (ranging from 10 to 1000 pieces) by additive technologies. The 3D printing technologies using metals is still too expensive and thus unprofitable. In SRIP MATPRO special attention will be given to the development of this segment, in which it will join partners to the development of new services, such as 3D metal printing of plastic inserts for the injection of polymer prototype products, 3D printing sand moulds for metal casting and 3D printing of complex metallic products with high added value, such as combustion engine exhaust gas catalyst. The development focus will be devoted to new metallic materials suitable for 3D printing, the production of printed large sized products, printed composites and nanocomposites, greater precision (resolution) of the printing and surface quality and the gradient phase structure that is achieved through printing. Knowledge of complex metallic products gained through the 3D printing technology will enable the further extension of the 3D printing to other areas of the metal-processing industry, because the transition from one type of production to another when there is a sufficient knowledge is relatively simple, and investments become reasonable even for smaller companies.

The potential value chains within SRIP MATPRO in the field of rapid prototyping technologies, especially in the field of printing of metals, where research institutes play an important role in understanding the influences of process parameters on the obtained properties and their support of industrial partners with findings, together with the pilot centres that actually test the technologies in a small-scale industrial environment, consists of a large group of partners.

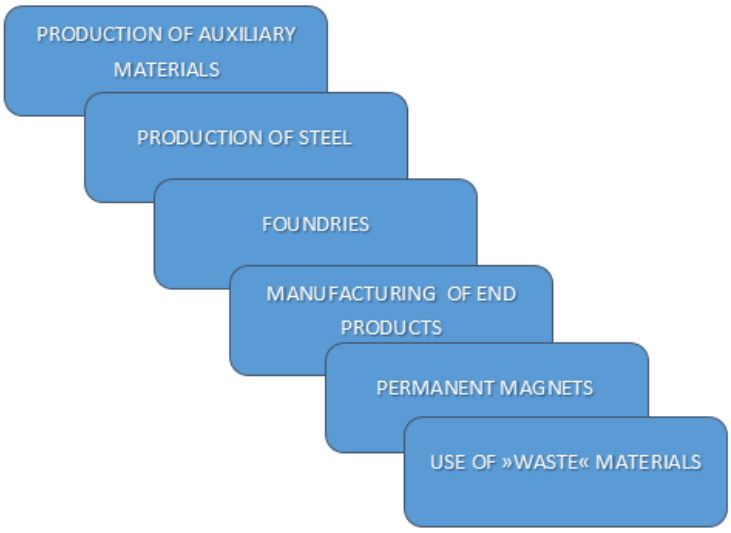


c2) Recycling of metallic materials, rare earths, composites, by-products and other sources

Recycling is becoming an increasingly important segment of the production process for metallic and non-metallic materials. Key aspects of ecology, as well as the reduction of energy and other resources consumption and the preservation of natural resources are crucial. Lately, certain strategic materials have come to the forefront of the role of recycling in order to increase their accessibility. Accessibility is a serious challenge in the production of permanent magnets based on rare earths, where China has a monopoly. In the case of steel, the recyclability rate is very near to 100%, where at the production of high-quality steels, especially of ultra-pure steels, the introduction of new technologies for removal of inclusions is mandatory. For aluminium, especially for high-strength alloys, the goal is to come closer to 100% recyclability and at the same time maintaining the high strength properties for materials made of secondary raw materials. With the pressing demands on weight reduction and improvements in functional properties, the use of composites and combinations of different materials (e.g., mixtures) is increasing remarkably. On the other hand, these materials are very problematic from the point of successful decommissioning and recycling. For successful recycling, it is necessary to keep in mind this problems already at the stage of the development of materials, the construction of components, and the planning of the production processes. It is not to forget about the recycling of secondary products that include both auxiliary materials needed for the production of the materials

and the production of the end-products, as well as waste materials, such as slags or cuttings of composite products. In SRIP MATPRO the value chain, with all competent partners that already operate in Slovenia, covers all the key partner groups: the production of raw and auxiliary materials, the production of steel and aluminium, foundries, the production of metal products and permanent magnets, the production of composites, elastomers, decommissioning, handling and the use of secondary raw materials. There is also the utilization of so far unused sources, such as nylon-6 fishing nets, where in Slovenia we have a unique, market proven and recognized technology, which can be, based on our experience, upgraded to become functional for additional valuable materials.

From the industrial as well as the state point of view, the competitive advantage of the recycling of strategic elements and the re-processing of waste (with a high content of important elements and the proper design of the recycled input materials aiming to independence from international suppliers as well as to the improvements of the properties of final products) is very important. In the area of by-products, however, everything goes primarily about the preservation of the environment and the creation of an appropriate dialogue and the balance between the legislation and the operation of Slovenian companies in harsh international markets.



In the field of recycling, a very specific but strategically important segment is the recycling of rare earths. In the rare-earth-magnets market, Nd-Fe-B magnets dominate, with an approximately 95% market share. They are followed by the Sm-Co magnets, which actually represents a niche market. The Nd-Fe-B market for sintered magnets amounts to about 70,000 tonnes, most of which are made in China and Japan. In recent years the European share of production has shrunk. There are 4-6 companies in EU that actually produce Nd-Fe-B magnets. The annual production of Nd-Fe-B magnets moves about 10,000 tons. In Slovenia, Kolektor Group and Magneti d.d. are active in this field, where Magneti d.d. is actually the second largest European producer of sintered Sm-Co magnets. Currently, in the EU, no systematic recycling of rare earth magnets exists. For many years Magneti d.d. has been carrying out internal recycling of waste magnets, which is a very demanding process. The production of conventional sintered magnets allows only up to

5% of the additives derived from waste material. The tolerance of materials on contamination with different raw materials is extremely low.

An analysis of the quantities of rare earths currently in circulation in Europe (after half a century of importing rare earth materials) shows that it would be sensible to start recycling waste materials. Why continue to import expensive rare earths and be dependent on a single supplier, since residues in landfills throughout Europe are full of such materials? Currently, the import of rare earths, mainly from China, is much cheaper than the recycling of waste. Above all, it is necessary to establish a strategy for the more efficient recycling of waste magnets. It is irresponsible to expect magnet manufacturers such as Magneti d.d. and Kolektor Group to do the job alone. It is necessary to establish harmonized national and international chains or networks to achieve these goals through targeted research aimed at more efficient waste collection, better material analysis, and new techniques for the treatment and processing of waste permanent magnets and rare-earth products. In Europe, Magneti d.d. and Kolektor Group are already actively involved in research in this field (MAG-DRIVE, REPROMAG, ROMEO, DEMETER, etc.).

Recycling is also an open question in the field of multicomponent materials. The first challenge is to improve the efficiency of existing materials that go beyond the technological capabilities for economically efficient recycling. For non-metals, most often plastics, impurities are the biggest impediment to the recycling since they are difficult to remove. The recycling of crosslinked systems (resins, binders) that make up most of the reinforced composites is unresolved. Composites are the largest unresolved recycling challenge of multicomponent materials, as composite applications are increasing, and they also include increasingly expensive components. Such are carbon fibres used in advanced composites that are much more expensive than conventional glass-fibre reinforcement. Multicomponent materials, despite improved properties, represent a greater barrier to recycling than conventional homogeneous materials. It is expected that the trend of their use will be further on the rise. This applies to classical reinforced composites (fibres - cross-matrix), for nanocomposites, filled elastomers, as well as for combined (fused) structures of metallic and non-metallic parts. The study conducted by the Ellen MacArthur Foundation and the World Economic Forum, highlights the recycling of multicomponent, mostly polymeric materials, as one of the most important challenges for achieving the objectives of a circular economy.[34] At present, carbon-fibre composites are already being used for structural elements in the aviation industry (fuselage, carriers, wings)[35] and small-sized automotive production, and it is expected that the use will expand into large-scale automotive production. [36]

[34] The New Plastics Economy Rethinking the future of plastics
http://www3.weforum.org/docs/WEF_The_New_Plastics_Economy.pdf
[35] IATA Technology Roadmap 2013
https://www.iata.org/whatwedo/environment/Documents/technology-roadmap-2013.pdf
[36] Plastics and Polymer Composites for Automotive Markets – Technology Roadmap 2014
https://plastics-car.com/Tomorrows-Automobiles/Plastics-and-Polymer-Composites-Technology-Roadmap/Plastics-and-Polymer-Composites-Technology-Roadmap-for-Automotive-Markets-Full-Report.pdf

This will result in increasing quantities of waste composites from production (cuttings) and from end-of-life products (vehicles) that will need to be recycled. Recycling procedures for composites are mostly in the experimental or developmental phase, depending on the target system. In the field of composites, Slovenia has a strong position with a large group of important manufacturers of complex composite products, which already form part of future recycling chains as they design, construct and manufacture products that will need to be recycled after use. Such companies are Elan (windmills, vessels, skis), Akrapovič (parts for motorcycles and cars), Pipistrel (Albatross aircrafts with fuselages and other aircraft parts), Ultramarine (vessels), Veplas, Rgroup, etc.

Recycling can be improved by using new sensor materials, responsive materials and extending the Internet of Things to the field of materials. All these elements will contribute to improving identification and facilitating the separation of materials, which is a prerequisite for successful recycling. Here, we can expect that multicomponent smart textiles with fibre-integrated functional add-ons will play an important role in the recycling of textiles, which is in comparison with other segments, exceptionally under-developed. In this area, AquafilSLO has important expertise, which is at the same time the largest SRIP MATPRO partner in the fibre and textile sector in Slovenia.

There is also an important opportunity in the field of so far unexploited resources. An excellent example is the recycling of fishing nets from nylon-6, where AquafilSLO has unique and market proven and recognized technology, which on the basis of experience gained, carries the potential to upgrade for the acquisition of additional valuable materials.

Recycling challenges present a number of combined and cross-linked materials on which Slovenian manufacturing companies have built strong competences: multilayer films (Plasta), cross-linked elastomers (e.g., silicones, sealing materials - Gomline, Donite Tesnit), foamed polyurethanes (Plama PUR, KOPUR). Some of these companies deal with both production and recycling (Plasta, Plama PUR, KOPUR).

c3) Advanced casting technologies and casting

The trends in casting techniques and technologies are changing significantly with the development of materials, which applies both to casting in single-use and permanent moulds. The dominant foundry casting technologies in single-use moulds are in the field of castings of materials with higher melting point (grey cast iron, white cast iron, molten cast iron, Ni alloys, Co alloys, partially Cu alloys), which include gravity, centrifugal and vacuum casting. Casting into permanent moulds (mainly Al, Mg and Zn alloys) is carried out by means of gravity, low pressure (LPDC), pressure (HPDC) and centrifugal force (CC). Lately, there has been an increase in the production of parts made by die-casting technology (in particular aluminium alloys). The reason is in the needs of automotive and transport industries which require lighter and functionally more effective components.

In the future grey cast iron will also play an important role due to the fact that in the field of road and sea transport, the main power unit represents the diesel engine, where the engine block is still produced from a group of grey castings. The same trends are true for the vehicle's brakes. Depending on the shape, size and distribution of graphite, the matrix microstructure of a grey cast iron has a whole spectrum of different properties. For

example, the tensile strength of grey cast iron with laminated graphite (FGI) ranges between 120 and 350 MPa, grey castings with vermicular graphite (CGI) between 300 and 450 MPa, and grey cast-iron graphite (SGI) between 400 and 900 MPa. Other features such as good damping of FGI grey cast iron represent a compromise between relatively good mechanical properties and good thermal conductivity of CGI grey cast iron, etc. Recently, isothermally enhanced grey cast iron, i.e., Austempered Ductile Iron (ADI) with a tensile strengths of 900 to 1.600 MPa and a breakdown elongation of 1 to 6%, has become very important. The group of grey cast irons will continue to be the main casting material in the future, with the need for increasingly complex geometry.

From the review of world trends in the development of materials, it is evident that the development of materials is relatively well followed by technological progress, although technologies often lag behind. One of the important constraints is the castability i.e., the ability of the melt to fill a thin wall. The development is in the direction of modifying the existing technologies using optimized and new materials. Thus, new technological approaches are being sought to enable the casting of components for e-cars, which, in addition to low weight, must provide a high degree of dimensional accuracy, sealing and technical purity. It is expected that new casting technologies such as Squeeze Casting, Rheo Casting, Thixo Casting, will prevail. In this way, the manufactured products have up to 30% better mechanical properties together with reduced amount of macro defects, while the material is at the same time fully recyclable within foundries. Achieving proper breakthroughs in foundry technology requires a complete virtual–experimental approach, including a prototype manufacturing process.

In the field of auxiliary materials, such as sand mixtures, the development of new binding systems is completely ecologically acceptable (the use of synthetic and composite based refractory materials).

By 2022, the main goal of the initiative is to develop pilot level KET technologies, processes and products in the field of casting and to upgrade the existing technical and scientific initiatives and projects with the aim of achieving top quality, increasing economic productivity and strengthening of competencies on a global scale.

Advanced technologies will enable testing or providing of efficient pilot production processes that will be able to automatically monitor, analyse, modify, adapt, and learn. The concept of network implementation of KET in the environments where the concept of Industry 4.0 is being implemented, should enable the production of innovative, custom-tailored products with the highest possible quality (0 ppm defects at manufacturer and 0 ppm defects for the customer), and the reconfiguration of production systems, in a way that the performance and functionality respond as quickly as possible to the parameters of casting technologies and adapt to market requirements - Integrated simulation of product and production. For stable production it is necessary to develop a system for monitoring and controlling the quality and traceability of castings. A model of direct linking of advanced casting technologies with business models will be established by which certain business chains will be built up between partners (including SMEs) and customers.

The introduction of new advanced casting technologies and the production of products will enable an upgrade from TRL 3-5 by the development projects or by carrying out industrial

research (sensors, simulations, modelling, prototyping, complementary technologies, characterization, advanced non-destructive investigations). The joint development of new products, internationalization, human resources development, and above all, integration between developers and users of advanced foundry casting technologies, on the one hand, and the global market for foundry products on the other, are activities that will be carried out during the pilot implementation of advanced foundry casting technologies and manufacturing.

c4) Modern technologies for the processing of polymers and hybrid materials

In recent years trends in the global polymer industry have intensified and dictate to manufacturers of components the search for new innovative products and cost-effective solutions. Manufacturers primarily aim to use light-weight, but by mechanical properties, comparable materials to classic metals, and are looking for cheaper and more energy-efficient solutions to manufacturing processes that make it possible to produce much more complex components, which ultimately reduces the number of component parts.

Polymer composite materials have exceptional potential and represent important technological advances, both based on structural components as well as in the component parts of motors, interior and chassis, as they offer a unique combination of exceptional strength, low weight, corrosion resistance and electrical insulation.

Building on the industry's need for cost reduction and weight, in recent years, it has become a constant practice to replace the medium and low-loaded metal parts with composites. In most cases, these parts are reinforced with short glass fibres and made by the technique of injection of polymers.

Managing effective processing of these materials and also knowing the mechanical properties is a paradigm that opens up completely new R & D areas and allows us to penetrate into developing niches that will in the future have an edge over competitors and open up entry into other eco-efficient markets and electric vehicles.

New components made of composite materials will allow a combination of minimum noise levels, maximum weight savings and maximum possible price reductions due to cheaper and more efficient production compared to steel or aluminium. The products will be multifunctional and will reduce the number of parts, logistics problems, energy consumption and, ultimately, the possible number of errors in the supply chain and in operation.

However, in spite of the relative price accessibility of basic materials, these products are not yet widespread due to a lack of knowledge about these technologies (non-existent reliability-assessment methodologies for lifetime determination and predicting product failure).

The production of complex carrier components made of polymer materials (thermoplastic composites) is extremely complex. In development terms, Slovenia is lagging behind EU

and wider, where the needs increase on a daily basis. In the production of new models of cars the growth figures for such elements is remarkable.

In the horizontal value chain the modern polymer processing technology will address this lack of knowledge and, through its operation in all value chains, will help manufacturing companies to introduce the latest technologies into their production, thereby significantly enhancing the added value of their products.

The main challenges in the value chain are:

- Knowledge of the latest polymer-processing technologies.
- Knowledge of the mechanical properties of the latest polymer composites.
- Life-expectancy studies under operating conditions.
- Processing technologies.
- Management of the synthesis technologies that include state-of-the-art CAE (computer aided engineering) and virtual optimization methods.
- New production models, realization of production processes and cost planning.

In this way, a specialized system will be developed in the value chain to solve the above-mentioned problems. New methods developed in the project and included in the system will enable companies to obtain appropriate solutions that will enable the immediate introduction of technology and will be based on the design of products, the choice of appropriate material and technology, and the determination of processing parameters for the selected material. Thus, the competitiveness of Slovenian companies in the global market will increase significantly, and above all, they will consolidate their position against companies from countries with low-cost labour outside Europe. These are very complex products and must be designed with a verified life expectancy for use in long-term, high-level dynamic loads applications.

The main benefits for Slovenian companies are:

- Increasing competitiveness of Slovenian companies in competing with the challenges of low-cost workforce countries.
- Increase of the added value up to 25% by introducing the production of more demanding products at lower production costs and a much larger input of R & D knowledge.
- Enabling Slovenian companies to quickly adapt to the production of highly complex components of special polymer composites with lower costs in order to maintain their position as suppliers to the major European automobile manufacturers.
- To enable an increase in production of demanding multifunctional structures by 20% by replacing metallic materials with thermoplastic composites or hybrid components.
- Significant reduction of energy consumption and environmental impact in the production of such components.
- Reducing the price of the products by 30% by replacing metals with composite and multicomponent materials, and thus following OEM targets for their products.

New multifunctional polymer components. As part of the research, a feasibility study for a variety of industrial cases will be prepared, which will enable the end user to respond in a quick and clear way to the question of whether a particular component can be replaced with a multicomponent product, or whether there is a possibility to produce the same product with other technologies. For individual cases, the replacement technology and the most appropriate material will be determined according to the required characteristics and functionality of the product.

Processing technologies:

- **Polymer injection:** the ability to produce very complex components in large batches; all of the above listed materials can be used for injection technologies, the problem is that metal processors (for injection tools) mostly do not know the specifics of the design of plastic products and that a great deal of knowledge is needed to properly construct the product and anticipate the appropriate load capacity. Without the use of modern CAE it is impossible to master such design.

- **Multicomponent (xK) polymer spraying:** the technology involves spraying of the core or critical parts made of high-strength material, follows the spraying of parts that are not mechanically or thermally critical. Technology enables the production of complex components at a relatively low price (if the series is large enough). All the materials listed above can be used for spraying, there is a problem of joining and simulating the joints.

- **Functional integration of structural components into injected products:** the plate made of knitted endless carbon fibres is preheated and then thermoformed in the tool, and finally a thermoplastic polymer is obtained. The product is characterized by high strength, no finishing is needed. Good knowledge of the bonding properties and a demanding simulation of mechanical properties is required.

- **Compression of polyurethane plates with long fibre spraying:** glass fibres are cut down and sprayed onto a tool coated with thin film or paint. The PU mixture is added, followed by compression and hardening of the plates. Instead of fibres, a pre-prepared structural sandwich panel (honeycomb) can be used.

- **Hybrid products:** Combinations of stamping and spraying technologies show their advantages in products where thermoplastic material is riveted, soldered or injected on metal. All these operations take place on a conveyor (high structural strength, time savings and costs, high cost of investment)

During the introduction of new technologies, companies are hampered by not knowing the ultimate mechanical properties of the products, because they lack reliable analysis methods, by which they would be able to anticipate the behaviour of the product in the real world. Special attention will be devoted to the production and optimization of design methodologies and the optimization of manufacturing technologies, covering the latest

CAE (computer aided engineering) and virtual optimization methods that comprise numerical simulations of processes and products.

The results will have a strong financial impact on companies that will use the new methodologies. Only with the replacement of metals by composites, can a cost reduction of up to 30% be expected. In addition, the costs will be reduced due to a greater degree of automation and the integration of several functions into one production phase. The use of simulation tools in the development phase will further reduce development costs by early detection of the potential errors and risks. In addition, the rapid pre-evaluation of the manufacturing process and structural features means a significant reduction in the time of the product to reach the market. All of this will lead to greater competitiveness of Slovenian companies in the global market, and above all, they will consolidate their position in favour of companies from countries with low-cost labour outside the EU.

c5) Modelling of materials manufacturing processes

Modern development of materials and technologies cannot be imagined without modelling of processes that take place during the manufacture of the material. Modelling can be done by combining already developed models or by developing new models that cover several phenomena in the basic model. Thus, in recent years, Computational Materials Science & Engineering has become increasingly intensified at all levels of development and optimization of engineering materials and technologies for their production. With the rapid development of industry and the transition to Industry 4.0, it is expected that this trend will further strengthen.

Due to the intensive development in various modelling and simulation of materials and end-products related areas, and the rapid growth of available computer capabilities and capacities, there lays a great opportunity for Slovenian companies but, on the other hand, there is also a great danger to stay behind. Lagging behind in modelling can have extremely negative effects on the competitiveness of companies in the long run. From the review of literature, it is evident that the biggest challenges in this area are to a large extent related to the problem of the transition (or the coupling of models) between different spatial and time scales. The design of the microstructure, which defines the properties of the material, is carried out in the field of the production of engineering materials in all four main spatial scales, i.e. in electron, atomic, mesoscopic, and macroscopic level, respectively. Two main directions for resolving the problem of coupling the models across different scales are being implemented: the first is the ICME (Integrated Computational Materials Engineering) approach, where hierarchical linking of the material models on different scales using relevant parameters, that are exchanged between the models, simulating the development of the microstructure during the thermomechanical processing of materials. Lately this approach is being intensively used in the development of materials and end-products, and is being increasingly transferred from research laboratories to industrial practice. In the ICME approaches the transition between the scales is discrete, which can lead to the effects without any physical justification, therefore many problems will still have to be addressed in the future. The very good side of ICME approaches is that, in comparison with alternative approaches, which represent the second direction of development and are based on the theory of the renormalization group and the adaptive

network thickening (a typical example are the methods of the phase field of the crystal), the calculation is significantly less intense.

The main challenges and guidelines in the field of modelling and simulation of engineering materials are:

- Simulations throughout the complete process chain, from the design, manufacturing and use of engineering materials.
- Modelling as an independent contribution to applied research that is conducted at the experiment equivalent level (calculation experiments) and the connection of modelling with experimental results.
- Reverse engineering - transferring the products development needs to the process of materials production.
- Development and integration of models that are robust and fast enough to be used on-line to control the materials manufacturing processes.
- Development of models and simulation tools for virtual testing.
- Development of methods for validation of models and simulation tools.
- Development of plug and play tools and platforms for their direct integration into the ICME concept.

d1) Multi-component smart fibres and textiles

The Slovenian strategy of smart specialization among non-metallic materials particularly highlights the production of fibres and textiles. In Slovenia the results of the sector are: EUR 280 million of annual sales, 1300 employees, EUR 53 million of added value, EUR 22 million EBITDA, EUR 7 million of net profit. In the textile sector, in 2016[37] the European platform for fibres, textiles and clothing prepared a survey of the sector future trends where four future challenges are highlighted:

- Smart high-performance materials:
  - High-performance fibres and textile materials for technical applications.
  - New 1, 2 or 3 dimensional fibre-based structures for technical applications.
  - Multifunctional textile surfaces and associated processing technologies.
  - e-textiles for smart structures, functional interiors and smart clothing systems.
- Advanced digital production, value chains and business models.
- Circular economy and efficient use of resources.
- High-value-added solutions for growing markets.

High priorities are given to interlinked innovation promoters: knowledge and education, regional excellence and the European dimension. The development is therefore focused on fibre and textiles with increased functionality, which improves the properties or adds new features, thereby improving the usability and user experience. The second key focus

[37] Towards a 4th Industrial Revolution of Textiles and Clothing - A Strategic Innovation and Research Agenda for the European Textile and Clothing Industry (2016) http://euratex.eu/fileadmin/user_upload/documents/Library/R_D/TextileETP_SIRA_public_version.pdf

is towards greater durability in terms of reducing the burden during production and increasing recycling i.e., developing materials that are more suitable for recycling (easier identification, suitable composition, etc.). The third branch of development includes aspects of digitization for the production of tailor-made products and the integration of active sensory elements including the integration of ICT in the sense of the "Internet of Things" that will allow a radical leap into the new product quality.

The field focuses on the development of new-generation intelligent synthetic materials and its wide applicability in various industries. The most illustrative is the use in the textile industry, where the development of synthetic materials in terms of improving the functionality of materials is most evident in various products, which are used practically every day. As such, it has an extremely large and direct impact on economic effects. The partners' initiative goes a step further in terms of developing materials and processes that will represent a new generation of products in global markets. In addition to the textile industry, the range of the new generation of products is also in the automotive, aerospace and construction industries, which uses technical fibres and textiles. "Multicomponent spinning" will replace the previous classic mono-component process based on the development and production of traditional filaments with limited functionality, so that the final products could have at most one functional feature.

The essence of multicomponent spinning is that on the basis of the development of additional dosing and melting units for nano, submicron and micro-components in any physical state, a new technology is created that enables modular programming of the finished product and the production of any number of materials. Completely different materials are being created i.e., fibres that incorporate nano particles, sensors, etc., and significantly improve the existing functionalities of both basic material (fibres) and mainly, of end-products.

Companies operating in the field of smart fibres and fabrics have competitive advantages that enable them to effectively develop into a group of companies that define future trends and have a leading role in the markets.

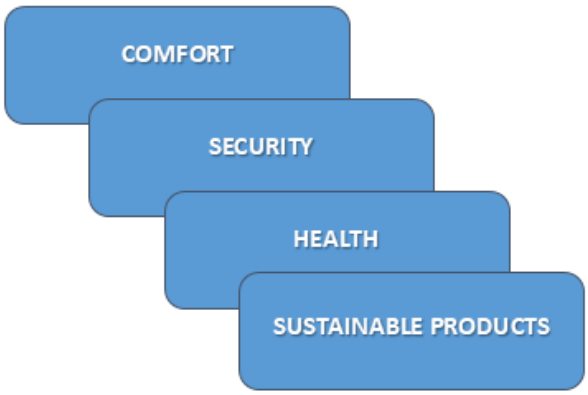
The organization of the initiative in the field of multi-component smart fibres and textiles is expected to change the relationships in value chains and establish direct links between participants. The initiative in this field includes four product lines:

i. Comfort
New generation of smart clothing that compensates for the loss of body heat by activating fibres with an electrically conductive core (conductive knit). (TRL 3-4)

ii. Security
a) Textiles with built-in photochemical additives that detect and indicate UV radiation. (TRL 4-6)
b) Fire-resistant clothing: the additive modifies the polymer’s degradation mechanism during combustion in a way that prevents air access and thus ensures fire safety. (TRL 2-3)

iii. Health
Thermally active fibrous knit fabric with microencapsulated phase-changeable material, which compensates for thermal changes and offers stable temperatures to the user.

iv. Sustainable products
a) The next-generation fishing nets based on ECONYL® 100% recycled material with integrated innovative anti-pollution biocide.
b) Upgrading ECONYL® technology for the extraction of copper. (TRL 5-6)



A review of developments in the textile industry at the European level and active contacts with Slovene textile companies is a confirmation of the assumptions set out in the Action Plan, and at the same time it highlights the major development challenges of the area. It is primarily a challenge to the development of fibres and fabrics with a wide range of additional functions that can be passive by nature (e.g. improved thermal properties based on phase-changeable materials) or active (sensors and information elements including the "Internet of Things" (IOT)). A radical leap in the sector will most likely define technological leaders in the next period.

Contacts with companies have shown a great interest in cooperation and ambitious plans that fall within the scope of the work of SRIP MATPRO and offer important opportunities for achieving the set quantitative indicators. In this area, it is therefore necessary to speed up the activities that lead to integration into international value chains (e.g. cooperation with EUROTEX) and the preparation and implementation of concrete multi-partner projects.

d2) Composites

Composite materials are one of the areas with the largest on-going development activities of materials and with drastic increase in use. Composites are suitable for the production of structural elements of complex shapes, have high mechanical performance in terms of weight, and therefore allow the weight reduction of products while maintaining or improving properties. At the same time they are relatively easy to manufacture and are cheaper than comparable substitutes. With the development of new types of composites, their applicability is rapidly increasing. For instance, there are carbon fibre composites that are used today in the aviation industry for the production of fuselages and other structural

elements[38]. Composites are also used in the most demanding sporting products, racing vehicles and vessels, etc., which demonstrate their excellent properties and versatility.

The group of composite materials consists of fibre-reinforced cross-linked polymer systems (for example: glass fibres - polyester resin, carbon fibres - epoxy resin, UHMWPE - polyolefins, etc.), as well as of all other functionally mixed systems, including nanocomposites. The latter are the topic of an exceptional number of development and research projects. Although the development of these materials has a great economic potential they are still in its very early stage of development. Graphene is a nanoscale filler material, which is currently being widely studied and represents one of the most active areas in scientific literature in the field of advanced materials. A set of nanoparticle fillers that promise functional improvements of basic materials is large. Among them are, for example, zinc oxides for UV absorption, titanium dioxide, molybdenum sulphide for tribological enhancements. They may also be bio-based, such as, nano-fibres and nanocrystals of cellulose. Among the composites we can also find filled systems where fillers serve to modify properties, such as, viscosity, thermal conductivity, electrical conductivity, etc. This way, the range of applications of classic basic materials is expanding, which is an extremely attractive and above all cost-effective way of development.

Composites are the subject of rapid development, but some important challenges remain unresolved. For the development of the use of reinforced composites in mass production (for example, the automotive industry), their production is too demanding and too slow. Their preparation include robotised manual work, but the production cycles are far too long for the large-scale production. Solutions are being searched for using shorter fibres along with the use of thermoplastic binders. An example is the H2020 Walid project where thermoplastic composite wind turbines are being developed. The production of such materials enable easier production and easier recycling. With faster and more automated production of composite products, products of larger dimensions are also a challenge. They can be fabricated in one piece (no merging of parts is needed) and have superior mechanical properties, but the issue of the production of such pieces has not yet been resolved, especially not for the large-scale production. Among the possible solutions, additive technologies are also being considered.

Another challenge in the field of composites is their more efficient production without the need for post-processing. In the current production, the composite products need to be trimmed and cut out where a lot of waste is generated, and in the case of more expensive raw materials, this represents a significant cost. After de-moulding the composite product must be post-treated and painted, so that the manufacture of the composite product in the mould itself in many cases represents only half of the manufacture cycle. It is considered that for large-scale use, a combination of faster manufacturing, less waste and more complete moulding is essential.

In the field of nanocomposites, the limiting factor is the ratio between the achieved improvements in properties and the increased costs due to nano-fillers and more

[38] IATA Technology Roadmap 2013
https://www.iata.org/whatwedo/environment/Documents/technology-roadmap-2013.pdf

demanding production. The fundamental challenge is the nanoparticle dispersion and their compatibility with the matrix. In the dispersion process into the polymer matrix nanoparticles can easily aggregate, which leads to less compatibility between the nanoparticles and the matrix, which in many cases requires the nanoparticles surface functionalization.

The challenge in the field of composites, which does not relate solely to them, is their joining with other, especially metallic elements. When replacing heavy-metal components with composites, it is necessary to ensure optimum joining of the composite with other parts of the structure, otherwise the improvement in mechanical properties at the level of the finished product is largely unused. Merging can be achieved mechanically (screws, riveting, etc.), and for more demanding applications adhesives produce better results. An analysis of the development of the use of polymer elements in the automotive industry highlights this area as one of the main obstacles to the wider use of composites[39].

In Slovenia, the production of composites is well developed and several successful companies have been established (Elan, Akrapovič, Albatross Fly, Ultramarine, Seaway, Veplas, Rgroup, Seascape, etc.), so the environment for connecting and joint development is good. Production for demanding products stands out (wind power plants, motorcycles, automotive, aircraft, vessels). Companies have excellent competencies to further improve their market position. The possibilities and willingness to connect are also significant. The possibility of including Slovenian resin or polymer systems producers in networking processes should also be mentioned.

Intensive contacts with companies and the continuation of the analysis of the situation in the Slovenian industry has highlighted the production of composites as one of the most propulsive sectors. It includes a large number of companies, which are larger than small and medium-sized enterprises. Production consists of different types of composites from classic polyester / glass fibre to high performance carbon based fibres and specialized as, for example, acrylic/aluminium hydroxide. The worldwide use of composites is increasing, with Slovenian producers ideally segmented to quickly capture niches in which they can become leading players. Experience shows that complex products that upgrade the composite base can capture certain market segments and become established with their own brand and products with high added value. Examples of such approaches are available in aviation, nautics and bathroom equipment.

The Slovenian composite industry has a long tradition that comes from early investments in R&D dating back to the 1970s. Today, the situation is fundamentally changed and the composite industry, in spite of its importance, does not have an adequate academic backbone or an organized, larger research unit. The survey shows that a common development centre is possible and even necessary, as manufacturers do not directly compete with each other, they are in different markets or market segments and use different technologies. The size of the composite industry, the demonstrated growth, a

[39] Plastics and Polymer Composites for Automotive Markets – Technology Roadmap 2014 https://plastics-car.com/Tomorrows-Automobiles/Plastics-and-Polymer-Composites-Technology-Roadmap/Plastics-and-Polymer-Composites-Technology-Roadmap-for-Automotive-Markets-Full-Report.pdf

large number of companies, willingness to cooperate with each other and insufficient academic and research support highlight this sector as one of the most interesting to support joint development investments. For a competitive breakthrough in this field, however, adequate development support is needed, which should include the following elements:

- Integration of composites (technology, design) into school programs at secondary, higher and university level.
- Establishment of a joint research and development pilot center providing support to the whole sector.
- Continuing and accelerating the creation of new value chains and ambitious projects.

e1) Functional coatings

The products, structures and components have contact with the environment over their surfaces, which are usually being coated with coatings. A thin layer of coating (thickness of a few microns to less than a millimetre) gives a look to the product, protects it from external influences, and in the case of advanced materials, provides advanced functionality. In the latter case, we are talking about functional coatings. The development of functional coatings is the most effective way for the coating industry to open up new markets and to increase added value.

The second course in the development of the coating industry provides sustainability, i.e., the development of coatings based on raw materials from renewable sources. Recycling of applied coatings is due to a negligible mass and volume compared to the substrates to which they are applied, technically problematic and economically unacceptable. Consequently, sustainability in the coating industry can only be achieved by using raw materials from renewable sources.

In its review of trends for 2016[40], the American Coatings Association highlighted the development of low-volatile organic compounds (VOCs) of paints and coatings as a key development task. Changes in the regulations also require innovations in the field of biocides. There is also a wide scope for the development of coatings with additional functionalities such as, conductivity, thermal insulation, acoustic absorption, nanostructured coatings. Development goes in the direction of the use of special additives such as nanoparticles, dendrimeres, nanotubes, which is evident from a very rich set of patents, but these are fillers that are too expensive for most applications. Development continues in the field of water-based coatings (thermoset emulsions, colloidal dispersion, water soluble systems), coatings with a high content of solids, two-component systems, powder coatings and radiation-curing coatings[41].

[40] Trends in coatings industry
http://www.paint.org/article/important-market-trends-impact-the-industry-in-2016/
[41] Market analysis of the coatins industry
https://www.ihs.com/products/paint-and-coatings-industry-chemical-economics-handbook.html

The world market of coatings is big and is still growing. For the entire global coating market, the projected growth is from EUR 130 billion in 2013 to EUR 165 billion in 2020 (Global Paints and Coatings Market Will Reach $ 176.5 billion in 2020, Persistance Market Research, 2014).

Coatings for industrial use account for 57% and a volume of 45% of the global market of coatings (Global Market Analysis for the Paint & Coatings Industry, International Paint & Printing Ink Council, 2015). After the crisis, their market in 2008 reached an average of 5.5% annual growth in value and 5.1% per volume. The future growth of the market is strongly influenced by the overall growth of the economy, since the vast majority of everything that is being produced must also be painted in one way or another. Nevertheless, the growth forecasts of the coatings industry follow the growth in the last decade, which is about 5% annually.

Smart or functional coatings represent (summarized by market segments) by volume, small, but by value already a significant share of the global coatings market. Their market is projected to grow from EUR 540 million in 2015 to EUR 5200 million in 2020 (Smart Coatings Market Set to Reach $ 5.8 billion by 2020, PCI Magazine, 2015). As such the smart coatings are by far the fastest growing segment of coatings. At the same time, they are materials by far the highest added value in the coatings industry.

Since 2000, the coating industry has been characterized by the transition from low or medium-dry solvent coatings to water-soluble and dissolving coatings with high dry-matter content. This transition was conditioned by two directives, Directive 1999/13/CE and Directive 2004/42/CE. These directives and derived national legislation have put the EU at the forefront of reducing emissions of volatile organic matters (VOCs). Additional restrictions on the emissions of organic solvents at the EU level are not expected.

Major changes in the whole European chemical industry have been made by the REACH Directive 2006/1907/EC, which regulates the registration, evaluation, authorization and restriction of chemicals in the EU. As a consequence, in the on-going process, the use of a number of substances that have already been established in the industry has been limited for health and environmental reasons. Much of the development is thus focused on finding new, healthier and more environmentally friendly solutions. These activities, which are characteristic of the entire industry, do not in themselves contribute to growth and an increase in market share, but are necessary for its preservation. A large portion of the development potential of the coating industry is intended to replace components that are recognized as health or environmentally hazardous. In some cases, just a simple replacement is needed, and in other cases the entire already established technologies must be changed.

The recycling of coatings is extremely difficult due to their application as thin layers on large surfaces. A better solution for improving sustainable aspects is the use of materials based on raw materials from renewable sources. In the coating industry the concept of carbon footprint and LCA analysis has not yet been widely implemented. At the EU level there are no such legislative requirements. Market trends lead to a lowering of the carbon footprint of the entire painting process, in addition to the coating, it also covers its application for purely economic reasons. Coatings that allow simpler, faster and above all

cheaper application (usually at the expense of the energy needed for painting and hardening), the market recognizes higher added value. Consequently, the development of such coatings is becoming a trend in the global coatings industry.

The Slovenian coatings industry produces following results: EUR 290 million of annual sales, 1200 employees, EUR 70 million of added value, EUR 30 million EBITDA, EUR 17 million of net profit. Main companies: Helios, Jub, Exoterm, Belinka-Belles, Chemocolor, Rgroup, Silco, etc. The leading company represents about 2/3 of the sector. With new ownership, Helios enters a new development cycle, in which it intends to intensify its development work and establish a centre that will operate at the level of a multinational group. This represents a qualitative leap and an exceptional opportunity in the field.

Among the coatings intended for industrial use (according to their market potential in the markets where the Slovenian coating industry operates) several segments can be highlighted:

- Coatings for commercial transport, designed to protect all types of vehicles and mobile machinery, with the exception of passenger cars. In this segment, global growth after the crisis in 2008 was on average 11.6% per year in value and 12.4% per volume; The segment is reaching the average of the coatings industry (EUR 3.2 billion to EUR 5.2 billion per year).

- Coil coating for the coating of sheet metal coils, mostly for final use in construction (75% in 2013), and the use in the vehicle industry, household appliances and elsewhere is expanding. This segment is characterized by large volumes of individual products and economies of large scale, although average figures are lower than in the previous segment (average for 2013 is EUR 3.6 billion per year).

- General industrial coatings covering a wide variety of applications in industry, with the market share of 10% of the global market represents the largest segment among industrial coatings.

In the above-mentioned segments of industrial coatings, the greatest potential for growth is due to the high added value in coatings for commercial transport, and due to the large scale of production in coil-coatings, as well as in the combination of both.

The Slovenian coating industry is already an important player in the European coating market, with the Helios Group among the ten largest coatings producers in Europe. In spite of its size, the Helios Group is just not large enough to be a general "trendsetter" in EU. Helios is able to achieve such a position in individual niche areas, elsewhere trends can only be co-created or followed. With the recent change of ownership of Helios (bought by the Japanese company Kansai Paint, one of the ten largest world manufacturers of coatings), the position of Helios is changing. The plan is to become a Kansai paints EU development centre, and thus the opportunity to set trends in individual segments of the

EU coatings market is gained. With the takeover of Helios, Kansai Paint has set itself the goal of becoming the world's fourth largest paint manufacturer, doubling sales in three years, and aiming to sell more than EUR 15 billion annually in the next decade and hence winning the first place in the global market. In order to achieve these goals, the European market is the key market in which Kansai Paints is present through the Helios Group. This means significant growth potential for Helios, but also the need to expand R & D activities, production capacity and investments in human resources.

In the field of coatings for industry, it is pointless to talk about the development of new products, since they have to be adapted to each customer or even to each production line of the same customer. Strategically It is so logical to talk about the development of new coating technologies, which are inextricably linked to the development of polymer binders for them. The opportunity for Slovenia in the field of coatings is in three key technologies:

- **Water-dilutable coatings** are, according to their design, health and environment friendly, contain significantly less volatile organic substances (solvents) than traditional coatings, and in the medium-term perspective, it is possible to imagine practically usable water-soluble coatings completely without emissions of volatile organic materials. The development of water-based coatings is significantly faster than the development of other parts of the coatings industry, new generations follow in a few years intervals, and consequently, constant and negligible investments in R & D are necessary. For Helios, it is crucial not only to develop coatings, but also their own binders and production processes for their manufacture. For the industrialization of the developed solutions, investments in the amount of several million euros are planned. Water-dilutable coatings, which are intended for almost all market segments, despite their advantages, also have weaknesses such as: the complexity of the application, less possibility of reducing the number of deposited layers and the higher energy requirement of their drying and hardening.

- **Dilutable coatings,** with a high and very high dry-matter percentage, achieve a very low emission of solvents per unit of painted surface, and are in certain cases, even better than water-dilutable coatings. Thus they represent future trends at some industrial coating segments, with particular emphasis on coatings for commercial transport and partly at general industrial coatings. Compared to water-dilutable coatings, this technology makes it possible to produce materials requiring less energy and time, which does not only reduce the carbon footprint but also lowers costs.

- **The third key technology represents binders based on raw materials from renewable, usually biological sources**. Research in this field has been going on for a long time, also within the FP7 project NEXT1KOAT. Binders from renewable sources are not conceived as a separate technology, the use of such raw materials is gradually being designed in water-dilutable as well as in coatings with high and very high dry-matter percentages.

Functional coatings, as a rule arising from at least one of the key technologies, are essential for increasing the added value in the coatings industry. The three key technologies that go beyond the boundaries of individual coating segments are not the only development orientations in the field of coating. Due to the great market potential, we highlight the coil-coating segment where the goal is to improve productivity and reduce the carbon footprint of production. The aim is to minimize the coatings hardening time in conventional convection as well as (N) IR furnaces. The speed of production lines reaches some 100 m/min (painted sheet metal), while the hardening times are measured in seconds. To achieve these goals, the development of new binders is essential. Helios sees one of the possibilities for binders of the future and is developing hybrid inorganic-organic modifiers. We anticipate that in the future, new anti-corrosion protection technologies will be developed, which will be used in all segments in which the metal surfaces are being painted in one way or another.

e2) Resins and binders

The Slovenian chemical industry includes several successful companies in the production and use of resins and binders. These include polyester resins, melamine resins, phenol formaldehyde resins and elastomers, silicones, adhesives, putties and sealing materials. Current challenges in the development of resins and binders are reducing the content of volatile organic compounds, the introduction of bio-based raw materials, and formulations to achieve specific properties. The challenges are partly caused by new or emerging legal requirements.

Resins and binders are important for the products in which they are used as constituent elements (composites or homogeneous materials that they modify or bind, e.g., insulating materials). The multiplicative effect of resins and binders is high. Resin and binder manufacturers are heavily involved in value chains in various sectors.

The area is well connected with the concepts of the SRIP Circular Economy, where the development of bio-based building blocks suitable for the production of resins and binders will take place.

2.2 Integrating and developing common R & D initiatives for the marketing of demanding, comprehensive and integral products and services

For progress in development, it is crucial to connect to the most active and demanding international value chains. The goal of SRIP MATPRO is to establish chains of production of materials with the leading role of Slovenian companies and to include significant potential of Slovenian partners for the production of more complex products with higher added value and greater potential for placement in global value chains where these products have greater visibility and a corresponding role and value. In order to search for key international partners and the possible integration of Slovenian companies into the leading international chains, SRIP MATPRO will also provide for proper dissemination, which will include the presentation and promotion of SRIP's activities, partners and effects at international trade fairs, workshops, scientific congresses, conferences and meetings, connecting events such as the S3 platform and Vanguard Initiative, the organization and implementation of interviews, etc.

Successful Slovenian companies in the field of materials export most of their production and have excellent connections with international partners and are already deeply integrated into international value chains. Within SRIP MATPRO, we contacted the trans-regional thematic platforms in S3[42]. Although materials represent the synergy with all three platforms (Energy, Industrial Modernization and Agro-Food), we consider that connections are the strongest within the framework of the Industrial Modernization Platform. In the future, the development of links and the integration of SRIP MATPRO into the S3 thematic platform will give additional attention, especially in terms of useful links for strengthening the national program and faster integration into international value networks.

The concept of integration will be based on promoting and increasing the developmental ambition and quality, and the depth of strategic integration and the establishment of horizontal networks, thus achieving a critical mass of competences and capacities, complementing different technologies in terms of developing new products and services, integrating the entire cycle from development to marketing, and addressing technological and non-technological innovations, promoting entrepreneurship and providing other common services. An example of successful implementation of the concept of open integration is the competence centre of innovative metal materials KC IKM, which has been operating since autumn 2015. It is an operational ecosystem deriving from the field of steel, it includes transforming tools and technologies and has the ambition to expand and connect with other metallic and non-metallic materials, technologies and sustainable processes. The key objectives of KC IKM are the preparation and implementation of joint business-technological projects and the introduction of practical measures of the concept of Industry 4.0, and special emphasis is also given to promoting the development of the personnel. It is an example of good open link practice in order to achieve greater dynamics of the development of participating partners and the transition to the development of suppliers, a higher added value achieved on the market by new joint products, and the

[42] http://s3platform.jrc.ec.europa.eu

emergence of new markets and customers based on joint performance and a comprehensive offer.

In order to ensure the integration and development of joint research and development and innovation initiatives in the field of materials, we will follow the integration of various materials in terms of industrial symbiosis and the search for common grounds with strategic partnerships in other areas. We will take care of promoting sectoral and cross-sectoral cooperation, involving partners from the technical, economic, social and marketing fields already at the level of research and development, as well as by promoting multidisciplinary and transdisciplinary research and the active inclusion of supportive technologies. The first step will be to strengthen the R & D integration of otherwise independent partners (economy, research organizations, knowledge institutions and other relevant development partners), through the condition of cooperation, the deployment of activities and systematic integration into international value chains.

On the other hand, the strategic development innovation partnership will promote the investment of companies in joint research and innovation through active networking and the establishment of links and synergies between companies, R & D centres and knowledge institutes (in the value chain and between value chains - horizontal networks). In particular, investments will be made in the development of more complex comprehensive products and services that require a multidisciplinary approach, the transfer of technologies to different technology areas and between different sectors, social and eco-innovation, which ensure the quality of life and support for the creation of new value chains.

Basically, the joint development of R & D initiatives will take two directions:

Through joint pre-competitive development between companies from related industries. In this segment we will organize the principles and framework for solving common development challenges of the companies active in the same or similar segments (e.g., production of steel, aluminium, advanced metallic materials, coatings, resins, adhesives and polymers). These are mainly fundamental challenges that are pre-competitive and common (TRL 3-5) and will be addressed by linking fundamental research to research institutions, supported by numerical simulations and the modelling of microstructure and its impact on the mechanical and dynamic properties, with development-oriented application-based research of influential parameters common to various applications. The development of specific applications (TRL 6-9) will take place independently or within individual development chains. In such projects, research institutes will have a common, central position, mainly due to equipment and the possibility of in-depth theoretical studies. Topics and orientations will be defined by companies, while research institutes and knowledge institutions will play a role in the research program itself. The purpose of this cooperation is to strengthen the joint development capacity with the aim of achieving a critical mass, the better utilization of R & D equipment and establishing links for the transfer of knowledge and experience. Pre-competitive cooperation will strengthen the cooperation among stakeholders in the innovation system and will provide broad sectoral innovation support for companies to develop new breakthrough products and services. We anticipate that on this basis, cooperation through joint projects between companies that have not yet cooperated will be established. Based on the development of

common sectoral development themes, proposals for tenderers in the field of pre-competitive development projects within S4 will also be prepared.

By joint development within the established value chains. Within this segment, we will organize joint development within value chains between companies operating in different sectors. The joint development in the chain will go beyond the classic cooperation between the direct supplier and the user and will cover the entire chain, from numerical simulations, the implementation of laboratory research to the transfer to the real environment, first on the pilot and ultimately to the real industrial level. The entire development process will be facilitated and accelerated, mainly due to the faster transfer of information and the synergies of the direct cooperation of the various development groups. We anticipate that such integration will enable the faster preparation of final solutions ready to enter the market and will support the development of more complex, integrated products and services that go beyond the developmental capacity of an independent entity.

Horizontal integration. In addition to direct work on materials, we will also integrate horizontal links with related SRIPs and activities in areas that are common to different value chains in the development of common R & D initiatives.

- Competence development and staff training (in conjunction with competence centres).
- Entrepreneurship.
- Market analysis and marketing.
- Investment planning.
- Preparing proposals for improving the support environment.
- Economic and environmental analyses.

2.3 Focusing of research capacities and establishment of joint capacities

The concentration of research capacities will be based on the analysis and assessment of research competences, relevance and applicability of research in the world and in Slovenia, scientific excellence and the equipment of research institutions, research and development departments of companies, competence centres and independent research institutions. The aim is to identify the most competent researchers and institutes from individual fields, which would be the bearers of a particular area responsible for networking and upgrading capabilities into a single, accessible, integrated, inter-regional capacity-building area, efficient investment in research equipment (complementarity and not duplication) according to competencies and sector/technology needs, with the emphasis on cross-sectoral and international integration and deepening cooperation, identification potential and the exploitation of existing research capacities.

Through the establishment of joint capabilities, we will ensure an appropriate research environment for members, especially for medium- and small-sized companies, to reduce the risks of investing in high-tech equipment, to achieve a critical mass of competences, capacity and investment potential, increase equipment utilization and contribute to the establishment of lasting business relationships, based on trust. In this regard, special emphasis will be placed on the development of conceptual designs for future pilot projects,

and the links between individual SRIPs. The SRIP MATPRO is expected to develop and provide new materials, which will be applied in other SRIPs. To put scientific knowledge into practice, the implementation of pilot projects is necessary, which applies to all the focus areas of SRIP MATPRO. As an example we can provide the proposal of the pilot research centre in the field of aluminium.

National industrial pilot research centre for advanced aluminium alloys and development of technologies.

AlPilot. Impol and Talum, as the sixth and eighth largest Slovenian exporters, play a significant role in international markets. Both companies together employ about 3000 people, which makes the development and performance of both companies for the Slovenian region Podravje extremely important. Both companies are engaged in the production and processing of aluminium, which records constant growth in demand. In the last 30 years the consumption of aluminium products has been increasing with a 5-7% growth rate. A new breakthrough in the field of aluminium brings the focus of the automotive industry to reducing the weight of cars due to the reduction of emissions and fuel consumption, which gives aluminium a competitive edge. In spite of the excellent mechanical properties of aluminium, it competes with other metals and materials, with the competitive advantage also being created through the development of advanced alloys with better mechanical and transformation properties.

The main constraints on the development of advanced alloys and technologies are due to inadequately developed infrastructure, since it is very difficult to transfer laboratory findings from the level of laboratory tests to the industrial level. We encounter the scale-up problem (scaling: the transfer of results from laboratory samples weighing a few 100 g to the industrial level of the level of 10 kg). In principle, this entails high costs due to excessive inputs of raw materials, while researchers are faced with time constraints, as most production facilities operate continuously, and the transfer of technology requires many repetitions, mainly to solve problems that cannot be detected and solved in the laboratory due to the small sample size. The solution to accelerate the research phase is to establish pilot testing devices that will allow the development of new alloys, technologies and products in real conditions and dimensions, but without time constraints and with significantly reduced costs of raw-material consumption. Pilot devices will link researchers at universities and industrial researchers and will accelerate the transfer of knowledge between the two spheres. The research centre will also be an excellent learning ground for students.

Concept of operation. The national industrial pilot research centre for the development of advanced aluminium alloys and technologies (**AlPilot**) should be placed in a real production environment, where the necessary research infrastructure is available, along with the required qualified operation and engineering personnel.

Regional needs. The proposed location of the development centre is in the Municipality of Slovenska Bistrica and the Municipality of Kidričevo, which are located in the Podravska region. The National Industrial Pilot Center would be located at the locations of both Impol and Talum, in accordance with the infrastructure, strategic orientations and development focus of each company (Impol rolling, extruding profiles, Talum alloy development, mould

casting, toolmaking). The National Industrial Pilot Research Center is planned to be an open type organization. Research capacities would be at the disposal of research institutions and universities to transfer research from the laboratory to the industrial environment.

Purpose and objectives of the research centre. Purpose of the project: To establish a research centre for the development of advanced aluminium alloys and technologies, which will include an industrial laboratory with pilot devices in order to promote industrial development and the development of competences and strategic development partnerships at home and abroad.

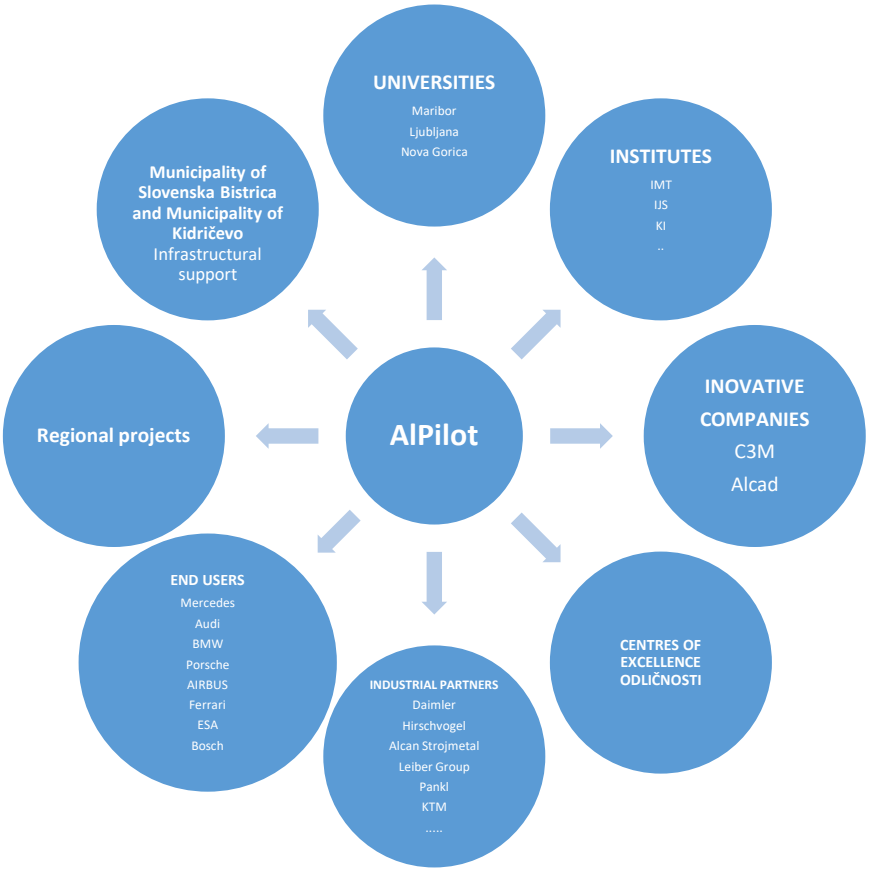
OPERATIVE GOALS

Increasing in use of secondary aluminium in the processes of production of aluminium alloys.
Development of new advanced aluminium alloys.
Improvements of properties of aluminium castings produced by high pressure casting technology.
Development of support services for quality assurance: materials research, analytical chemistry and environmental protection.
Development of technologies for transformation processes.
Development of technology for establishing a smart factory management system.
Development of support infrastructure to ensure the effective operation of the development center, project management, business-university links and the development of researcher competencies.
Development of new technology for the production of nano structured aluminium alloys.

STRATEGIC GOALS

Increase of added value per employee by 25% in Talum and Impol over a period of five years after the establishment of the Center.
In the framework of the implementation of research projects, at least 10 SME aluminium processing companies will be involved in the period of three years from the launch of the research center.
Increase the turnover of export of aluminium products by 25% over the period of five years from start-up.
20 researchers employed in the pilot center after the implementation of phase 3.
To create at least 80 new jobs in the industry, of which at least 70% with level VII. of education (over a period of five years).

Partnership



The development of the centre. Pilot equipment for the operation and development of the centre is prepared according to the economic priorities. In the transition period, until the realization of phases 2 and 3, the partner companies would also devote their own industrial equipment to research.

DEVELOPMENT OF THE CENTER BY PHASES

Location	Slov. Bistrica	Kidričevo	Estimated investment
PHASE 1 (2018-2021)	Installation of pilot devices for casting bars and heat treatment	Installation of pilot plants for pressure casting	**€ 15,1 million**
	Research equipment		
	Infrastructure		**€ 3,5 million**
PHASE 2 (2021-2024)	Installation of pilot devices for extrusion, hot and cold rolling, forging		**€ 6.1 million**
	Infrastructure		**€ 2,5 million**
PHASE 3 (2025-2026)	Placement of pilot plants for quick solidification		**€ 1.2 million**

The framework for the financial plan for the procurement of equipment is prepared in stages. The prices refer to a fully equipped centre with all the planned research and pilot equipment. The equipment is spread into phases, with the first phase of the project being essential for starting the research and development at the given pilot level. For phases 2 and 3, we will negotiate with the state. If the companies want to follow their strategies, pilot devices will be an absolute must, so that R & D support can play its role in the production and strategy.

Plan of projects for the pilot centre for the period 2020–2030. The first part of the development centre project will include the construction of an industrial laboratory with pilot devices that will provide the necessary infrastructure for conducting research to the pre-industrial TRL 6 level and an easy transition of technology transfer to the industrial environment up to TRL 9. The appropriate infrastructure located in the right place will reduce the process of carrying out the research work and thus make it more affordable. Due to the proximity of the two main partners of the project, the implementation of research can be carried out smoothly.

Expected results

EXPECTED IMPACTS OF THE DEVELOPMENT CENTER ON THE ECONOMY

Indicators	Current values	Expected values by 2025
New products and services	€ 7,2 million Impol* + € 15 million Talum * without the price of the raw material	Market potential: € 23,2 million Impol* + € 20 million Talum **Total € 43,2 million** * without the price of the raw material
Added value	€ 1,8 million Impol	€ 5,8 million Impol
Export	Impol 95% - € 442,154 million Talum 80% - € 240,000 million **€ 656,508 million**	Impol 95% - € 474 million Talum 85% - € 260 million **€ 734 million**
New jobs of researchers in industry	68 ARRS	**78 ARRS** (10 new)
New employments in R & D (employees in the center according to its complete equipment delivery)	/	**20**
New jobs in the industry	/	+ 30 Impol + 50 Talum **+ 80**

*** Feasibility is possible with the State funding of the center.**

2.4 Cross-sectoral cooperation and integration with SRIPs (SMART FOOD, CIRCULAR ECONOMY, MOBILITY, FOOD)

Materials, advanced materials, material as end products exposed in S4 are also highlighted in the vast majority of themes of European leading technologies with the largest existing capacities, competitive advantages and the potential for achieving strategic development goals. Examples are to be found in national KET programs, national S3 strategies, and sectoral plans (e.g., specialized associations and technology platforms). Materials are taking a special central role, as advanced materials represent one of the key bases for most other key technologies such as electronics, nanotechnologies, health technologies, energy and sustainable solutions. Due to the specificity, significance and

size of the development and production of materials, despite the strong connections, the materials remain an independent area.

Due to the described role of materials, it is natural that many synergies and connections between SRIP MATPRO and other SRIPs are taking place. Thus, during the development of the Action Plan, we had intensive contacts with other SRIPs, in particular with CIRCULAR ECONOMY, MOBILITY, SMART FACTORIES and HEALTH, with which SRIP MATPRO will connect in its activities, while at the same time it will include ICT support and enabling technologies (Robotics, Plasma Technologies, Nano-technologies).

Other SRIPs

In cooperation with other SRIPs we will help to build value chains and support them to various levels of the development of materials, formulations and products so that in the synergy between individual SRIPs, the desired results are achieved (for example, in the development of new, high-strength lightweight materials for smart cities, smart factories, new transport means, advanced biocompatible materials in medicine, for the development of new environmentally more sustainable plant protection products for the food sector, in the production of secondary raw materials from multicomponent waste, which requires the transition of companies to a new business model. For companies in the plastics processing segment of the chemical industry it is also vital to adjust the consumption of secondary raw materials in their production processes. The challenge is the uneven quality of recyclables and their small available quantities.

The highlighted points of contact between the SRIPs represent a good basis for integration, co-operation and complementarity, which will enable the attainment of goals that would be otherwise be more difficult to achieve. The demarcation between the aspects covered by different SRIPs arises logically and in line with the SRIP programs, and the established communication will prevent the duplication of efforts. In the future we expect that even more common points and synergies with other SRIPs will be identified. From an implementation point of view, the interconnections between the SRIPs represent a great opportunity for involving the partners of different SRIPs into common value chains.

SRIP CIRCULAR ECONOMY

Since the companies of the metal and chemical industries are involved in several roles within the circular economy (as a supplier or user of materials), the associations are interested in offering them assistance in one place. Therefore, SRIP MATPRO will closely connect with the SRIP Circular Economy. In this context, SRIP MATPRO will focus on the recycling technologies and the sustainability aspect of the materials itself, while the activities related to organizational, technical and technological issues of logistics, energy flow and legislation will be carried out within the SRIP Circular Economy.

The contact points of both SRIPs are:

- The use of renewable resources, both in terms of identification, logistics and processing, as renewable raw materials will increasingly be included in the

production of non-metallic and multicomponent materials. The contact points are in the field of new coatings, composites, lightweight materials, etc.

- Refining waste in terms of establishing new circulating material flows. The production of advanced materials and the development of new materials will have a key impact on the need for new recycling routes and technologies, while recycled and rebuilt materials will enter material production. Examples of links are in the field of the use of recycled metal alloys for the production of high-quality metallic (e.g., aluminium) materials, as well as in the fields of composites and composite materials, where new smart and functional materials represent an increase in the range of waste materials, which increases the need for technological solutions for separating increasingly complex mixtures.

- Measuring the effects of materials and technologies on sustainability. Material production leads to the significant use of resources, which has a significant effect on sustainable balance sheets, which are measured using the same methods (e.g., LCA, carbon footprint) that are crucial as a criterion for the development of a circular economy. For a comprehensive assessment of the sustainability of materials, the waste-management phase should be taken into account, which is again the domain of the SRIP Circular Economy.

SRIP SMART FACTORIES

In SRIP Smart Factories, materials are crucial for waste-free production and for the definition of needs for processing technologies and logistic links (suppliers, routes and waste products). In this case, two contact points between the two SRIPs can be pointed out:

- Processing technologies that include tools made of special metallic or composite materials. In the field of materials the production of tool materials is an example of highly specialized niches with high added value.

- Inorganic materials that are heavily integrated into the SRIP Smart Factories are at the same time one of the raw materials for the production of complex multiphase and multifunctional materials. There is also an organizational connection in this field, since the companies are members of the CCIS - Association for the chemical industry, which is one of the core associations within the framework of the SRIP.

Within the cooperation between the frameworks SRIP MATPRO and SRIP Smart Factories, we will directly activate the activities of enabling technologies of robotisation, plasma technologies and nano-technologies.

Robotisation. In the period 2015–2020, 15% annual growth of the global robot market is expected (China 20%, Korea 5%, Japan 5%, Europe 5–15%, North America 5–10%) as well as the breakthrough of collaborative robotics. This area is characterized by strong demand from the automotive industry, followed by the electronics industry. In other industries the intensive robotisation of production is also taking place. It is driven by the increase of energy efficiency and production modernization. Automation and robotics create new jobs (the example of the automotive industry in the US where in the period

2010–2015 80,000 new industrial robots created 230,000 new jobs; in Germany 3% growth in the number of industrial robots per year represents a 2.5% growth in jobs per year). The development potential of robotics is reflected in:

- Advanced robotic systems, such as cognitive robot systems, advanced human-robot interfaces, two- and multi-hand robotic systems, robotic diagnostics, mobile robot platforms, mini-, micro- and nano-robotic systems.

- Advanced robotic control: robotic emergency management, 2D/3D robotic vision for adaptive control and quality control, advanced robotic learning and programming.

- Advanced robotisation and flexible production: collaborative robotics, reconfigurable/modular robot systems, robot service, assembly, welding.

Currently Slovenia is not sufficiently robotized. Some of the perspective industrial areas for Slovenia are completely robot-free. In general, the number of robots used in the Slovenian industry is small, the situation is better in the automotive industry, but significantly worse in other industries.

SRIP MATPRO and industrial robotics are areas that develop collaboratively and in parallel, since robotics constantly needs new metallic and other materials for the development. New materials used in robotics must have improved characteristics, the weight is an important factor that heavily influences the speed of operation, the performance and energy efficiency of robot systems. Another important factor is the durability of the used materials. Conversely, the metallurgical and metal processing industry is the one that badly needs the introduction of robot systems due to the their exceptional potentials for multi-purpose use and complementarity.

In the medium- and long-term perspectives, it is necessary to consolidate the connection between robotics and research organizations, and above all, it is necessary to work together on the development of products and materials. It is necessary to increase the connection of robotics with SMEs in terms of strengthening supply networks and creating development networks. It is also necessary to encourage modernisation and digitization of the production processes and the management of the entire production cycle.

By successfully linking our activities, we expect to boost the digitalization process by automating and robotising the production lines. It is estimated that in the next few years the number of robot systems will increase by at least 50% in relation to the current situation. It is expected that the exports of automated industrial systems and equipment will increase by at least 25% to 2023, particularly in the fields of toolmaking, robotics and smart industrial mechatronic systems. The introduction of robot technologies into the user's production processes increases the competitiveness of domestic enterprises and, consequently, makes it possible to maintain jobs.

An important role of connecting MATPRO and robotics is detected for automated industrial robotic systems and equipment, the use of various robotic cells, robotic welding

applications, robotic laser welding, robotic integration in industry, robotic manipulation, for the introduction of collaborative robotics, etc.

Plasma technologies. Plasma technologies represent a key technological breakthrough in modern industry. The market potential in 2020 is estimated to be EUR 10 billion a year. Worldwide, their use grows at around 15% per year. The driving force is the need for innovative products that cannot be manufactured without the use of plasma, the ecological integrity of the technologies and high added value, since the implementation of plasma technologies requires in-depth knowledge. Plasma technologies were initially established in microelectronics, later in tooling, the chemical and automotive industries, and the current challenges are the use of plasma in medicine and agronomy. The comparative advantage of Slovenian industry is the leading role of partners in global innovation trends in the field of plasma technologies, in the use of such technologies, which are the result of domestic knowledge, in mass production and innovative technological solutions protected by patents. An example of good practice is Kolektor group, which has more than 50% of the world's share in the production of composite commutators, and their plasma process is protected in all relevant countries with the original patent EP1828434 (B1). The goals of using plasma technologies are technological restructuring in terms of replacing obsolete, environmentally unfriendly, wet chemical processes, raising added value per employee, raising the level of digitization with automation, linking knowledge and partner creativity and new market opportunities in the global market. Partners who already use plasma technologies in regular production will upgrade their lines and optimize processes, and use plasma technologies to expand to other segments of production. In addition, partners who do not yet use plasma technologies will obtain the necessary information on the possibilities of using plasma technologies for the processing of specific materials. With the close cooperation of material and plasma technology experts, companies will be able to develop new specialized lines that will be used in regular production and will enable the development of innovative products that bring high added value. The key development will be focused on automated lines with the continuous processing of products and semi-finished products, thereby increasing production and expanding the scope.

Plasma technologies that are important for SRIP MATPRO are: plasma cleaning of metallic and non-metallic components prior to further processes such as merging, spraying, application of specific coatings; plasma nanostructure and functionalization of composite products; plasma processing of protective coatings with optimized speed and application quality; treatment of highly hydrophobic materials with strong UV radiation sources and on-going activation to achieve optimum wettability or stickiness, as well as the treatment of medical devices and implants to achieve the desired biological responses (improvement of osteo-integration, anti-microbiality, etc.). The use of plasma technologies is foreseen in the automotive and aerospace industry, in biomedicine, in aluminium production, in the metal processing industry and in the manufacture of composites.

Nano-technologies are emerging in all sectors of the industry, from the chemical and textile industries, to computer science, informatics, energy, transport and the automotive industry, and above all to pharmaceutical and defence industries. They enable the production of devices (machines) or materials that are lighter, faster, stronger, having completely new or additional specific characteristics. Materials made of tubular nano-structures are distinguished by their low density, which is six times lower than the density

of steel, and by exceptional strength, which can be up to 200 times as much as the strength of steel. Nano-films or nano-surface coatings represent a material with high hydrophilicity, water-repulsion, self-cleaning characteristics, resistance to absorption of dust, and good resistance to various fluids. Special optical effects are also known (photochromic, electrochromic, thermochromic, mechanochromic and chemochrome coatings). The potential of emerging new materials based on nano-technology is extremely high.

In the field of metallic materials, we expected the improvement of properties of materials at which the addition of nano-particles changes the properties of the basic material or its surface. In the technological sense, we are faced with great challenges related to the production of nano materials, their incorporation into metallic materials, recycling and characterization. The problem is that for these materials the limits of detection for analytical devices are reached.

In SRIP MATPRO the following areas of KET nano-technology can be used in the design of new materials and products:

- Development of analytical techniques using focused ion beam microscopy for metallographic research of metallic materials.
- Development of 3D FIB-SEM tomographic method for the quantitative characterization of materials.
- Development of a method for proving the presence of rare earths.
- Characterization of surfaces and the study of defects.
- Development of advanced automatic algorithms for 2D sequencing, which enables high-resolution 3D material analysis.
- Design and development of metal membranes with defined permeability.
- Research of thin-films photovoltaic materials.
- Investigation of the protective layer of Nd-Fe-B magnets.

SRIP MOBILITY

The connection between SRIP MATPRO and SRIP Mobility is extremely strong, as the sector that is covered by SRIP Mobility represents one of the largest buyers of metallic and non-metallic materials (sheet metal, castings, coatings, rubber, plastics, light-weight materials, etc.) and at the same time it sets out key requirements for new materials (strengths, new composites, functional coatings, reduction of sustainable loads from production). Cooperation has been identified in two main areas:

- Obtaining information on special needs for new materials i.e., on the use of materials (processing, joining) that must be taken into account in the production phase of materials.

- Participation in the value chain as a key user of materials in the global sector with high technological complexity and high added value.

SRIP HEALTH

It is estimated that in 2060, twice as many Europeans as today are going to be 65 years of age or older (152,6 million in 2060 compared to 87,5 million in 2010)[43]. Due to an aging population and a changed lifestyle, there will be a significant development of disease patterns, with patients with chronic diseases or multiple diseases such as cancer, diabetes, cardiovascular problems, respiratory diseases, urological problems, strokes, wear and joint damages, dementia and depression. It is estimated that in 2010 more than one-third of the European population had at least one chronic illness.

Solving these problems is ensured by best quality medical devices, and it is necessary to provide appropriate conditions for the development of new materials and technologies that will produce safe, effective and innovative devices tailored to the patient. Such an approach is extremely important both from the point of view of universal public health (faster and better treatment), as well as from the aspect of important influence on the national economy (through increased working capacity of the population, less sick leave, disability retirement and lower costs for the healthcare fund) and, consequently, on economic growth.

The medical sector covers more than 500,000 products and refers to each instrument, apparatus, device, software, implant, reagent, material or other object used for medical purposes - as a central or only supportive element in diagnosing, preventing, monitoring and treatment of the disease. The medical device is therefore an element of support to other methods of treatment. In-vitro devices with appropriate diagnostics represent the essence and basis of all therapies, including pharmaceuticals and surgery, for the treatment or prevention of diseases. Consumer goods are also considered as medical devices. Also included are self-adhesive patches, contact lenses, toothpicks, X-ray devices, pacemakers, etc., as well as patient-adapted products such as breast implants, catheters, veins, hip dentures, etc., which provide support for the regeneration of damaged tissues and organs, or represent artificial organs[44].

An important part of the advanced technological solutions of medical devices comes from the use of special materials with unique properties. Most of the products are made of synthetic polymeric materials such as: polystyrene, polypropylene, polyvinyl chloride, silicone, styrene, thermoplastic elastomers, polycarbonates, polyamides, etc. Some medical devices (orthopaedic implants, tympanic tubes) are based on inorganic materials such as steel, ceramics, titanium, aluminium, silver, and gold alloys. Natural polymer materials are most commonly used for medical textiles and medical supplies. All these materials are becoming more and more revolutionary in terms of safety and adaptation to the individual patient, which requires adequate diagnostics. The materials of the new generation must therefore have improved mechanical properties, biodegradability, specific bio-functionality (anti-microbiality, proliferativity, osteo-integration, etc.), with a particular

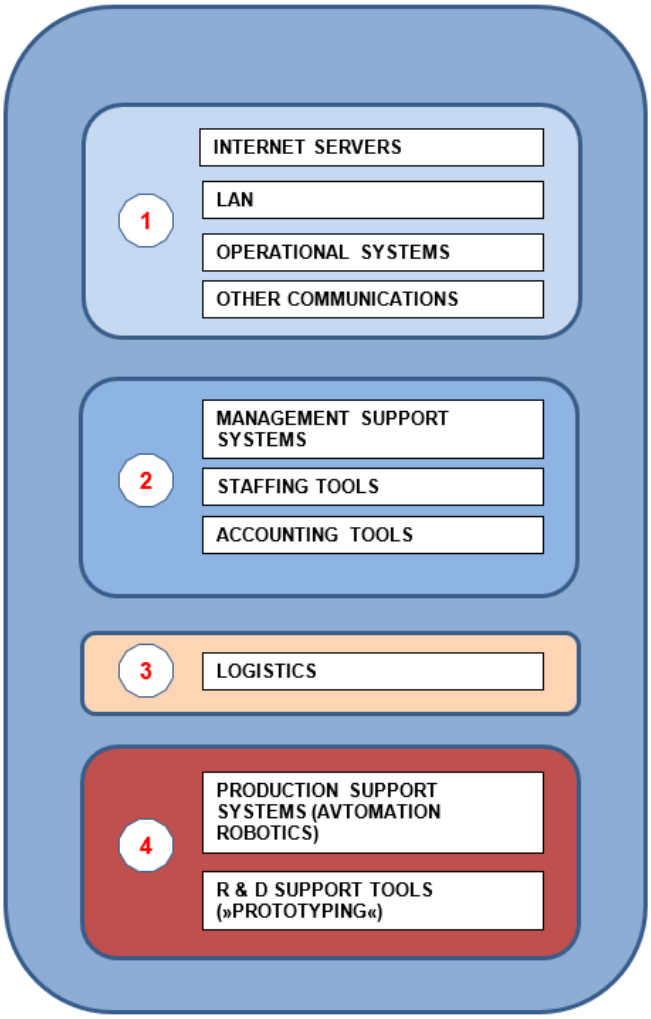
[43]Bijak, Jakub and others (2007). Population and labour force projections for 27 European countries, 2002-2052: impact of international migration on population ageing. European Jorunal of Population, vol.23, No.1, pp.1-31.

[44] http://www.who.int/medical_devices/systematic_Review_needs.pdf
http://eur-lex.europa.eu/legal-content/SL/TXT/?uri=CELEX:52012DC0540

group being porous materials. The direct connection between the two SRIPs is the development, testing and use of advanced medical materials.

Horizontal SRIP Smart cities and communities - PMiS

The use of ICT tools in value chains and SRIP MATPRO can be divided into four levels of integration, as shown in the figure below.



The first level (1) covers the general areas of ICT, where the cooperation of partners with external providers gets relatively easy. Companies need consulting, implementing installation and maintenance of systems, and above all as far as possible the smooth transition to new, upcoming technologies. The second level (2) of ICT integration already requires intensive and coordinated cooperation with external, and the implementation requires considerable time. At this level, the main focus is the establishment of the computerization of business support for small businesses. The third (3) level - logistics (in all forms) is an area that requires complex adaptation of the provider of ICT services separately for the characteristics of each company. At this level, the establishment of contacts and communication with external providers are complex and confidential. The training of users is necessary. As the last strategic level (4) it represents support to the production process (automation, robotics, etc.) and the development of research tools.

This is a fundamental support for the implementation of new ideas, innovations, and experiments, which makes connecting with external ICT providers very limited and the establishment of cooperation is a very lengthy process.

Horizontal digital transformation focuses on the co-creation of digital SRIP solutions in the areas of various value chains, so they get a greater chance: to better address the true needs of digital users, to form digital business models, to provide in business laboratory tested, certified solutions before they come to the market, to support the preparation and implementation of the entire project. It helps to establish digital platforms for the more successful promotion and implementation of the SRIP in the global market. We assume that SRIP MATPRO will need the following support from Horizontal digital transformation:

- Workshops to find synergies between content of value chains and digital abilities in favour of end users (digital).
- Workshops for transferring the model of linking the needs of end users with the capabilities of digital technologies in the SRIP MATPRO areas.
- Educational workshops in the field of understanding the capabilities of digital technologies in the renewal of business models, processes and products, as well as in the field of learning about trends, the concepts of the digital economy and digital business models, and the development of digital competences and digital culture.
- Trainings for increasing digital competencies.
- Innovation and renewal of strategies - linking business and digital strategy of the company or value chain; Transfer strategies into business.
- Creating new products / solutions and business models based on the capabilities of modern technologies.
- Establishment of digital platforms (partnerships, business cooperation rules, digital concepts and technology).
- Pilot projects on establishing business experimental environments / Living Labs.
- Analysis and upgrade of business processes and cooperation in designing processes that will support new business models.
- Creating a modern (digital) user experience for new digital products / solutions.
- Creation of modern marketing processes and the use of tools for marketing automation when entering the market and internationalization.
- Design of ICT infrastructure and application architecture to support new business models and process organization.
- Project management for the digitization, transformation, design of specifications and requirements.
- Big-data analytics and services. With big data analytics, real-time data becomes manageable in real time and provides real results without any other investment.
- HPC infrastructure - HPC cloud service for a safe and efficient environment that replaces own software capabilities.

Horizontal IoS (Services on the Internet, platforms) offers support for the development of modern digital application solutions based on cloud-native microsites, API, mobile and modern web-based clients and other third-party concepts. Horizontal IoS offers comprehensive support for technologies, platforms and horizontal services for the development of modern, digital solutions through the following content sets:

Technologies for the development of modern digital services.

- Design of modern digital solutions.
- Establishment of a cloud-native architecture.
- Microservices and an environment for the development and implementation of microservices.
- New XaaS cloud applications and new cloud-based models.
- New methods for ensuring scalability and resistance to failures.
- Managing of APIs, API Gateways to marketplaces.
- Integration and orchestration of services.
- Containers, virtualization and environments for container delivery.
- Management of microservices, SaaS containers and applications.
- Security aspects of IoS applications.
- Providing QoS and SLA.
- Open data and open APIs.
- DevOps development procedures.
- Automation of service infrastructure and installation and control procedures.

Horizontal services for the development of digital solutions.

- Customer management and customer relationship management solutions within the meaning of the "Customer-Engagement" concept.
- Solutions to detect customer needs and desires.
- Individualized communication models with customers via digital channels.
- Solutions for omni-channel operations.
- API management and API management solutions.
- Marketplace solutions and digital platforms.
- Solutions for developing innovative user experiences, especially for mobile digital solutions.
- Solutions for the integration of services, applications, back-office systems, data and other resources (integration platforms).
- Secure decentralized data management services based on Blockchain 2.0 concepts for specific domains, in line with vertical requirements.
- Services to provide regulatory aspects of the use of IoS in terms of providing audit trail, certificates, electronic signatures, identity and other advanced aspects of authentication, authorization, etc.
- Services for storing and managing of documents in digital form, archives, delivery, service, traceability, etc.
- Services to support digital business processes, workflows, process models and business processes, and assess the sustainability of business models of business entities.
- Solutions for the integration of services in the field of reduction of logistics routes.
- Business Intelligence Solutions (Business Intelligence).
- Solutions for monitoring and analysing global media.
- Payment services and APIs.

- Electronic messaging services.
- Solutions for secure storage and assigning access to sensor data based on chain sequencing and smart contracts.
- Services for synthesis and recognition of Slovene speech.

IoT solutions. Today, success in supply chains and breakthroughs in the market are very much connected with the management of the so-called Internet of Things. Adding sensors to work processes, collecting and processing huge amounts of data, customizing business models. This is the essence of digital transformation. The leading Slovenian companies and research institutions have joined forces in the field of ICT and IoT within SRIP Smart Cities and Communities. The following areas are interesting for SRIP MATPRO:

- IoT devices, sensors, platform integration.
- Education, e-learning, human resources.
- IoT solutions for different domains.
- IoT business models.
- Communication solutions for IoT.
- Prototype, Fab Lab creative laboratories.

In the horizontal SRIP PMiS ICT will build systems and sensors for Internet of Things (IoT) that require advanced materials as final products. One of SRIP MATPRO's goals is the development of high-tech materials for space technologies and applications, which include IoT sensors on satellites and communications systems for data capture.

Within the SRIP PMiS ICT, the VESOLJE-SI Center of Excellence will determine the target properties of materials for satellite components and provide laboratory infrastructure (nano-indenter, thermal-vacuum chamber) for testing new SRIP MATPRO materials in a simulated space environment.

For the development of IoT communication systems for capturing large amounts of data from satellites, the development of new composites for parabolic mirrors and light-weight materials for the Earth stations will be required.

Cyber security. We are increasingly aware of the importance of security and privacy in a modern digitized environments. We know that in the era of IoT we will have to invest significantly more knowledge, time and efforts than we ever have in the safety of information services, in their design, construction and management. Providing security and privacy is difficult and requires specialized knowledge, products and solutions. In SRIP MATPRO these challenges will be addressed through the Cyber Security in the Horizontal ICT Network within SRIP Smart Cities and Communities.

Cyber security solutions will address:

- Security of products and services to ensure the security and privacy of information services and thus to increase competitive advantage.

- Cyber security throughout the life cycle to address security challenges globally, from the very first steps in service planning, to their use and recovery. The approach will ensure the adaptation of products and services to specific challenges and specificities of users, technologies, processes, and personnel.

- To train professionals, technicians and planners through education, training and awareness-raising. To provide much needed new staff through regular education, as well as to raise the security awareness of management personnel, end-users and young people, future users of e-services.

- A competence centre for cyber security, which will help to cope with the risks of services by providing a concentration of knowledge about security threats and incidents, and advise on their prevention, mitigation, and elimination.

Other potential technologies

Vacuum technologies. New materials require new processing and preparation techniques, including vacuum technologies. The introduction of new materials therefore inevitably requires R & D activities, which offer the use of customized vacuum technologies.

Analytical methods. All analytical techniques for qualitative and quantitative analysis of surfaces (SEM, TEM, Auger, FIB ...) can only be operated under ultra-high vacuum conditions. Without the analytical methods there is no development of new materials.

Vacuum metallurgy is the field of material technology that deals with the production, shaping or treatment of metals in a controlled atmosphere, at pressures substantially lower than normal atmospheric pressure. The purpose of using a vacuum is to prevent the contamination or reaction of metallic workpieces with gases in the atmosphere. In some procedures, the reactive gases are introduced, thus influencing the properties of the material. Examples of vacuum metallurgy are:

- Vacuum arc remelting.
- Vacuum inductive remelting.
- Vacuum casting.
- Vacuum deposition.
- Vacuum soldering.
- Plasma surface treatment.

Some techniques performed in a vacuum:

- Vacuum distillation.
- Vacuum drying - lyophilization.
- Vacuum packing.

Pressure metrology is an important element in ensuring the traceability and accuracy of pressure measurements, on which all technology performed in vacuum conditions relies. Different technologies are carried out in various vacuum areas, from the most demanding,

which are carried out at a pressure of 10^{-8} Pa or even less (analytical methods) up to 10 kPa (vacuum packing). This means that the range of low pressures to be measured in industry and other branches of the economy extends over 12 size classes. Different technologies also need different degrees of measurement uncertainty. For the most demanding, such as the lyophilization of pharmaceutical agents, the required uncertainty is only a few tens of percent. Different requirements regarding the measurement range and measurement uncertainty are dictated by the development of measurement techniques and the development of customized measurement and calibration procedures intended for different technologies.

3 Internationalization

Internationalization within the framework of SRIP MATPRO will take into account the bases and guidelines presented in the strategic documents, such as the Program for the Promotion of Internationalization 2015-2020 (2015)[45], which represents the general approach to internationalization, and annual documents such as the International Challenges 2017-2018 (Ministry of Economic Development and Technology - MEDT 2016)[46], Which highlights concrete, short-term opportunities for internationalization. SRIP MATPRO will primarily contribute to the goal of integrating Slovenian companies into international value chains and to the implementation of the slogan: Slovenia: Green, Creative, Smart. An important challenge for SRIP MATPRO is the establishment of Slovenia as an innovative international research and development hub.

Because CCIS organizes a large number of international contacts for the Slovenian economy, SRIP MATPRO will be naturally engaged in appropriate activities wherever the potential is identified. With its membership, which includes development-oriented companies and research institutions, SRIP MATPRO is in a position to concretize the principles of Slovenian internationalization in specific projects and collaborations. This will primarily help to establish contacts at the international level, as well as to involve foreign partners in the value chains. Through its work, SRIP MATPRO will encourage contacts that can lead to direct foreign investments, although they are not within the immediate agenda of the SRIP MATPRO objectives.

SRIP MATPRO will join the EU's Thematic Strategic Partnership (TSP), S3, which operates under the Joint Research Commission EU (JRC). With the defined priority areas (within the SRIP MATPRO), we will actively search for European links for value chains on the platform.

We are very interested in involving Slovenian companies in pilots in the field of: Advanced Manufacturing for Energy Applications, High Performance Production through 3D Printing, Efficient and Sustainable Manufacturing; Smart Regional Investments and Textile Innovation.

SRIP MATPRO also aims to join to the Vanguard Initiative. With the entry of Slovenia into Vanguard membership, we will join the initiative of advanced, well-organized, EU regions that believe that they can compete with the largest world markets.

As part of the national smart specialization program, we are linking with the thematic S3 platforms. We have identified the most appropriate thematic platform for Industrial Modernization (http://s3platform.jrc.ec.europa.eu/industrial-modernisation), and within it the area of Innovation in Textiles (http://s3platform.jrc.ec. Europa.eu/textile-innovation), the thematic area Efficient and sustainable production (http://s3platform.jrc.ec.europa.eu/efficient-and-sustainable-manufacturing), where a pilot

[45] http://www.izvoznookno.si/Dokumenti/Analize/Program%20INTER%202015-2020_končna.pdf
[46] SLOVENIJA Zelena. Ustvarjalna. Pametna. MEDNARODNI IZZIVI 2017 – 2018, Ministrstvo RS za gospodarski razvoj in tehnologijo, December 2016

project on Production of Advanced Components and Materials is already running. Opportunities for cooperation have also been discovered in the field of Advanced Production for Energy Applications for demanding environments (http://s3platform.jrc.ec.europa.eu/adma-energy) as an already operational pilot project of the Vanguard Initiative. The goal is to provide to all the emerging value chains their international partners.

The goal of the Vanguard Initiative is strategic cooperation, co-creation and co-financing of research at the highest level, with the aim of developing European value chains and priority areas. The Vanguard Initiative, as one of the most important areas, also recognizes advanced methods of production and related applications that will allow the launch of new economic growth. At the same time, the development of materials, where metallic and multicomponent materials are predominant, as well as the technologies of production and processing, are key to the realization of the set goals. Promising opportunities are also in direct links with active national programs (S3 or other), where common themes can be found. The actions will not be confined to EU countries alone, opportunities can also be found in other countries where there is a potential for knowledge, resources and the market (e.g., Ukraine).

In the field of internationalization of SRIP MATPRO, partners expect that the state institutions of the Republic of Slovenia together with CCIS will work strongly and within coordinated actions to overcome the EU's unfavourable perception of Slovenia. International cooperation between companies and research institutions is greatly hampered by the prevailing view (in the EU) that Slovenia, as a Balkan state, is an unreliable partner.

3.1 Target markets

The choice must be made systematically, as the primarily chosen market is not always necessarily the best one to achieve the goals. A gradual process of selection enables companies to systematically exclude markets that are not relevant, and ultimately formulate a list of priorities. First of all, it is necessary to identify (in principle) interesting target markets. In the next step, they are evaluated according to previously defined criteria. Specific information about the market and industries is crucial to the process of decision making regarding the choice of the target market.

First, it is necessary to identify theoretically interesting target markets. In the next step, they are evaluated according to previously defined criteria. Specific information about the market and industries is crucial in the process of detailed harmonization regarding the choice of the target market.

Review of the procedure

- First, it is necessary to exclude markets that are not suitable for co-operation. We define unacceptable areas (exclusion criteria) and define the conditions that the market must fulfil (mandatory criteria).

- In the second step, the remaining target markets from the economic, demographic, legal and political points of view (the basic set and the choice of target markets) need to be compared. The result of the comparison is a list of potentially attractive markets.

- Finally, using a detailed selection of target markets, we use industry-specific information, and we make a final decision about choosing the most attractive target market. In the case that several markets are marked as interesting, a priority list for entry into the market is compiled.

It should be noted that when choosing a market, it is not always the market of a particular country as a whole. In many cases, due to resource constraints and the specificities of individual regions within the country, it makes more sense to choose individual regions as the potential target markets.

Target markets, which in principle come into final selection, need to be compared with each other according to economic criteria, criteria specific to the target group, and political and legal criteria. This allows us to better assess market potential and market risks. In the end, the selected areas need to be evaluated separately (for each country) and to obtain a priority list of suitable markets.

Prior to the final selection of the target market, it is necessary to obtain information specific to the particular industry, data on competition, customers and potential sales partners. The most important information about potential clients is the size of the segment of the potential target group, segment growth and profitability.

Once the precise selection is completed, the company receives a profiled analysis that includes a comparison of different markets according to certain criteria, and a priority list of the most suitable entry markets. In the next phase, an appropriate strategy for entering this market is chosen.

3.2 Entering the market

There is no general recipe for selecting a form of entry into the market, since the choice of the appropriate entry method depends on many factors. We can roughly distinguish between factors related to the company, products and the market. A combination that is specific to each situation and the characteristics of these criteria determine which strategy to enter the market is best suited for a specific internationalization plan.

OVERVIEW OF STRATGIES OF ENTRING TO THE MARKET

EXPORT STRATEGIES		DIRECT INVESTMENTS			CONTRACTING STRATEGIES OF ENTRY TO THE MARKET	
Direct export	Indirect export	Acquisition abroad	Greenfield investments	Joint venture	Licencing	Franchising

There are direct exports to the business partner on the foreign target market and indirect exports:

- For direct exports, the company has direct contact with customers or importers. This is an advantage, as the company only needs additional expertise. On the other hand, there are additional costs (for example, market research and operational implementation of activities).

- Indirect exports are made through trading partners. Indirect exporters have thus limited control over how, when, where and to whom their products are sold. This strategy does not bring any upgrading of export or market expertise.

If there is enough demand in the target country, there is a potential for a long-term business relationship. There are several options available for direct investments[47]:

- Acquisition of an existing company abroad - this method allows relatively quick access to qualified staff, customers, suppliers and the existing distribution network.

- A subsidiary abroad (a greenfield investment - in this case, the structure and all contacts must be redesigned, for which a considerable amount of time is needed.

- Establishment of an international joint venture - with a strategic partner from the country of destination, the costs, risk and control over a branch abroad (management costs are therefore higher) is shared.

Licensing and franchising are among the contractual forms of entry to the market in which companies are not active themselves in export or direct investment. This strategy makes it possible to cover the market, especially in the cases where activities are difficult (trade or investment barriers).

- When licensing, the licensor grants a foreign licensee the right to use intangible property (against payment of royalties). There is also the danger that the license holder becomes a competitor.

[47] Considering the interest, capacity and ambitions of the participating companies in SRIP MATPRO, also to check the possibilities and implementation of reverse-flow processes - attracting a foreign investor, a joint venture partner, joint development, creating a hub.

- In contrast to franchise licensing, the company makes available the right to use the entire business model (against payment of fees) - the right to use the trademark, copyright, business model, marketing concept, knowledge, etc.

3.3 Support for entry into the market

On the basis of interviews already conducted with some of the members of SRIP MATPRO, the following interests of the members have been formulated for the desired support in the field of internationalization (ranked from the most desirable):

- Acquiring the contacts in foreign markets that are applicable according to the business interest of SRIP MATPRO members.
- Exchange of experiences among members of SRIP MATPRO in relation to foreign markets.
- Joint operations abroad.
- Participation at fairs abroad.
- Foreign trade education.
- Direct foreign investments (in both directions).
- Good R & D practices abroad.

Considering that the first two activities are the most important and are in the interest of all, they will be the primary focus. However, if such an interest in SRIP MATPRO continues, other aspects will not be neglected.

Making contacts in a foreign market is a tailor-made CEMP service, which is carried out individually. It is a process that contains at least the following steps:

- An introductory meeting between CEMP and the selected company, where both present the relevant points of interest, while the CEMP page presents the set of activities that the company is carrying out and the ways of their implementation. A cross-section of these two categories on both sides represents an entry point into the next step.
- An agreement on goals.
- Setting up markets, promotional tools, and timetables.

On the basis of interviews with the members of SRIP MATPRO, the most important markets are: the German-speaking region, north Italy, the Middle East headed by Dubai and Doha, USA and Russia. In these markets, CEMP has appropriate channels that can be activated for each SRIP MATPRO member.

The exchange of experiences between members of SRIP MATPRO according to individual workshops and/or the markets they cover will take place in a group of up to 20 individuals, where after the initial presentation of the market/markets, the emphasis will be on the exchange of experience in practice, followed by informal networking.

The number of such events is not limited, and depends on the actual interest. The first event in a series is usually organized at the premises of CCIS (as the main platform for connecting the business community in Slovenia) due to the neutrality of the organizer. All following events can be organized directly at the interested members of SRIP MATPRO .

An essential prerequisite for the success of all these activities is the active participation of the participating companies, two-way communication and proactivity.

3.4 Marketing and sales channels

Following the choice of the market and the entry strategy for it, the marketing concept for the processing of the foreign market should be developed. First, a check is needed as to whether and to what extent the transfer of concepts from the home market is possible. Questions are divided into a strategic and operational part.

In the strategic part, it is necessary to clarify which groups of clients are being addressed on the foreign market (segmentation and targeting) and how to position products in relation to the competition (positioning and USP - Unique Selling Proposition). The decision on the possible introduction of the company's own brand must be met and to what extent can the marketing web (product, price, sales, communication) be transferred or adapted.

- Segmentation = Defining benefits for customers/partners.
- Targeting = our advantages compared to the competition.
- Positioning = defining properties that connect the customer/partner to our company.

In the operational part, it is necessary to clarify what are the possibilities for product standardization, the technical and regulatory framework for the adjustment of the product/service, certification, determine the communication measures for the foreign market, define prices and payment terms, find suitable sales channels.

It is also necessary to consider:

- Trademark management - use, adaptation, international protection.
- Adaptation of the marketing web (product, price, sales channels, communication): differentiation strategy vs. standardization strategy, differentiation, USP, regulatory framework / requirements, economic differences, intercultural differences.
- Adjustment of communication tools (B2B vs. B2C, i.e., consumer vs. investment goods, text, slogans and titles, promise of usability, images, colours).
- Price policy: reference prices of competitors, lower and upper price limits (cost, competitive or demand model), targeting (the point of precedence over competition).
- International sales:
    - Preferred Intensity / Coverage.

- Direct vs. indirect sales.
- Comparison and evaluation of sales / development partners.
- Distribution rate (intensive, exclusive, selective).
- Choice of sales channels (direct / indirect sales, legal and cost aspect, intercultural aspect).
- Choice of actual sales / development partners (criteria).

3.5 Joint appearance on the market

Based on the results of interviews (Section 3.3), the SRIP's primary interest in internationalization is to acquire the appropriate contacts, finding new customers in foreign markets, and in exchanging experiences between SRIP MATPRO members. At present, the joint appearances on the markets remains only the starting idea, which will be later on complemented through the development of the processes. It can contain at least the following activities:

- Organization of a business delegation in a selected foreign market or on a group of markets.
- Networking within the companies between retailers and sales people for foreign markets, on the one hand, and developers on the other.
- Organization and realization of an appearance at a selected foreign fair.

An essential prerequisite for the successful recovery of all these activities is the active participation of the participating companies, two-way communication and pro-activity.

Due to the specific nature and focus of SRIP MATPRO, the choice of "targets" that may not yet be covered by the MEDT strategic and operational documents.

4 A plan of activities for human-resources development based on a career platform for employees

Under the term "human resources" various personnel processes necessary for the efficient management of employees can be combined. These are different processes through which the knowledge, capabilities, skills and personality traits of employees, both for the benefit of the company and individuals, can be best dealt with. Various human-resource processes enable the integration of individual and company goals. The development of human resources is one of the most important elements for the successful management of people, as well as for raising the competitiveness of working conditions and processes in the company, which enable the maintenance of key employees through the continuous assurance of growth and the development of employees in accordance with their potentials. For performance and good business results, it is not enough to invest in technology alone; it is also necessary to invest in human resources in particular.

For the developmental breakthrough in the focus areas of SRIP MATPRO, it is crucial that, in accordance with the development of products, services and technologies, the long-term provision of the necessary competences of the employees needed for the realization of the goals is approached. Competences demonstrate the ability of an individual to master the modes of work and employ skills, qualifications and knowledge in a normal and changing environment. Competences under this action plan include knowledge, motivation of an individual, behaviour, values, attitudes, self-image, and skills. The competences needed to achieve the goals of SRIP MATPRO and its members will therefore be a combination of knowledge, skills and behaviour for the useful purpose of improving the achievements of individuals. Human-resources development for SRIP MATPRO represents the development of competences and investments in human resources in the economy as well as in research and education institutions. Since SRIP covers important areas of the economy with a large number of employees, an effective link between educational institutions (which will provide graduates with appropriate competences in order to get involved in the working environment as soon as possible) and the economy is also important for the developmental breakthrough.

The target groups for which MATPRO will work with its activities in the field of human resources development will be: already employed by members of the SRIP MATPRO, job seekers in the labour market and young people (at all levels of education).

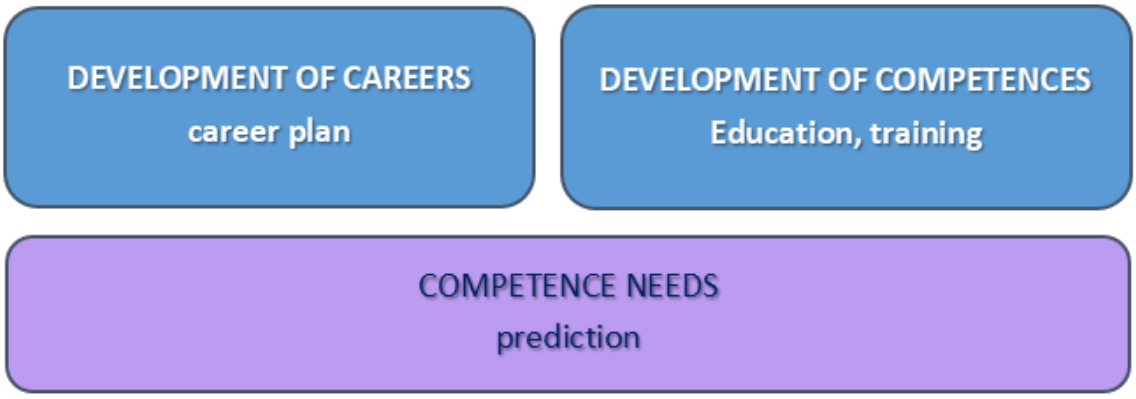
4.1 Model of development for competence based on a career platform for employees

The model of development for competences, which is included in the SRIP MATPRO Action Plan, will be based on the Career Platform for human resources in research and in the economy.

Career platform includes:

- Forecast of the long-term needs for competences.

- Identifying gaps in competencies.
- Development of professional careers.
- Filling the educational and training gaps of staff working in existing programs, i.e., timely preparation of "tailor-made" programs, which ensures the development of specific competencies.



4.2 Prediction of competences and staffing needs

The prediction of competency and staffing needs is based on a career platform and identifying focus areas and technologies (Chapter 2 of the Action Plan).

Focus areas are based on forecasts of global trends, international connectivity, identification of R & D capacities, market-share assessment, potential and degree of risk for each technology, identification of major industrial needs and related R & D challenges, and determining the capacity and competences of the companies involved and their position in global trends, on international markets and within international value chains.

Sustainable aspects and international commitments were also taken into account (such as environmental protection, the potential of new and existing value chains and the maturity level for the individual fields of technology).

An analysis of the capacity and potential of competences of SRIP MATPRO members, which can provide a breakthrough in development, played an important role.

Focus areas of joint development through SRIP MATPRO enables the identification of the necessary competences in the following areas:

f) Steels and special alloys:

1. The concept of ultra-pure steels and alloys.
2. High-strength steels and their transformation.
3. Advanced metallic materials for demanding applications.

g) Aluminium:

1. New high-strength and ultra-pure alloy Al.
2. Alternative manufacturing methods and maximum recyclability of Al.
3. Die casting of Al alloys.

h) Technology:

1. Rapid prototyping and complementary technologies.
2. Recycling (metallic materials, rare earths, composites, auxiliary materials, by-products).
3. Advanced casting technologies and casting of products.
4. Modern technologies for the processing of polymers and hybrid materials.

i) Multicomponent smart materials.

1. Multi-component smart fibres and textiles.
2. Composites.

j) Functional coatings and advanced binders for metals.

1. Functional coatings
2. Resins and binders

The identification of the required competences will be carried out on the basis of the above-mentioned focus areas, value chains, ICT support and SRIP MATPRO as a whole. To this end, we will create professional teams, consisting of developers, representatives of knowledge and education institutions, employees in companies, experts from individual focus areas and other experts who can contribute to predicting the competencies.

The competency prediction process will take place in the interaction between predictions of future competencies from existing databases (O'Net, relevant European database) and the contribution of the profession, based on narrowing the selection of competences, preparing a set of relevant competences and assessing the current and future relevance of competences for a particular area or profile. Predictions of competences for a particular field will be in line with the developmental timing in value chains, in focus areas and will run parallel to the individual TRL phase.

Competence prediction will be supported by the E-platform for long-term predictions of competency needs, which will be placed in the ICT horizontal network with the beneficiary of the CCIS. The E-platform will contain all the necessary data and algorithms needed for long-term predictions of competency needs at the level of all SRIPs for all SRIPs. Each SRIP will have an entry point through which the two-way data flow between each SRIP e-platform will be enabled.

4.3 Development of professional careers

The development of professional careers is based on the preparation of Individual Career Plans (ICPs) for key personnel to achieve developmental breakthroughs in the focus areas of a particular value chain. It includes both the development of competences in companies

as well as in knowledge institutions. ICP is an instrument for planning the development of the individual's potential in the professional and personal field. The individual career plan is the result of a structured process, supported by various tools for the coordination of human resources and personal career goals for an individual with the objectives of SRIP MATPRO. The ultimate result of planning the career is the career development of an individual and well-planned activities to achieve competencies in harmony with SRIP MATPRO, which will be reflected in the plans for the education and training of employees in companies, and in a joint educational platform, where the need for training and education programs will be gathered as needed competences.

For the uniform steering of the process, several workshops training sessions will be conducted for the preparation of ICPs in enterprises and knowledge institutions.

4.4 Linking human resources at all levels

Linking the economy and education at all levels allows the faster adaptation of personnel to the changes required by globalization, digitization and unpredictable changes. At the same time, the predictions for the necessary competences will co-create: the development of appropriate content of study programs and programs at lower levels of education, career orientations, work-based training, and the demands for scholarships.

In the field of employees' training, several companies have created and established educational centres that operate independently or as an organizational unit within the company or group of companies. Due to the abolition of some educational programs in the field of metallurgy, the companies developed and implemented their own training programs. Three training centres in the field of metallurgy were formed (SIJ, Štore, Talum), the Helios Education Center, KOC-KE (Competence Center in Chemistry). There are various training programs conducted by public or private organizations.

Intergenerational cooperation of employees is also important for the development of employees' competences in key breakthrough areas. Young people entering the work process have well-developed competences in the digital field, but less so in areas related to the workplace, while usually employees older than 45 years have a lack of digital competences. Therefore, SRIP MATPRO will encourage measures to promote the implementation of mentoring schemes, apprenticeships and other programs that enable the development of new competences through the intergenerational cooperation of employees.

Cooperation between the economy and educational institutions is already in place, as educational programs in the fields of metallurgy are carried out in secondary schools or in the inter-business training centres, also with the participation of experts from companies.

Cooperation is also taking place between the economy and universities that implement programs in the fields of metallurgy, chemistry, metal processing and other materials, as universities are also closely linked to companies.

Particularly important will be the connection with career centres in universities with the goal of associating students with the economy as soon as possible (involving students in corporate projects, seminar works for companies, participation of students at conferences and other events of SRIP MATPRO and other SRIPs).

In the framework of the educational platforms, international programs of training and competences for the development of competences that are not provided in Slovenia will also be presented.

The promotion of professions and education programs within SRIP MATPRO will cover all verticals: from kindergartens and elementary schools, where the promotion of professions from the fields of metallurgy and chemistry will be carried out in an innovative, children-friendly and comprehensible way. With its proposals, MATPRO will also encourage the upgrading of existing and the development of new programs of education in secondary and higher professional education.

The e-platform for education and training in SRIP MATPRO will include presentations of capacities and offers in the field of training and education: training centers and training programs in companies, educational programs at all levels and international programs. The demands of SRIP MATPRO members for trainings and education for the development of competences in breakthrough areas and tailor-made training programs will be met.

At the level of SRIP MATPRO initiatives for new educational programs or amendments to existing ones will be coordinated and proposed to the competent state institutions (together with representatives of the educational institutions - CPI, Universities) in order to confirm and introduce the proposed contents as soon as possible.

In all areas where appropriate, SRIP MATPRO will support and encourage the early introduction of apprenticeships and other forms of practical training in companies. Support will be given to new forms of training and education, such as the virtual environment and OpenLab, and switching from virtual to digitized real-world environments.

An important activity of SRIP MATPRO will be the promotion of occupations related to the focus areas (metallurgy and chemistry) among young people and their parents (in local environments and throughout Slovenia).

Connectivity will also take place at the SRIP - KoC level, where models for predicting of the competences in KoC - KE 2 will be included in terms of relevance, and vice versa, the models developed under the SRIP MATPRO will be included in the KoC. In the model of predicting competences the competence models developed in KoC-2 will be included in SRIP MATPRO. We will systematically eliminate the overlapping competencies and, if necessary, upgrade them according to the career platform. In the same way, we will integrate and, if necessary, upgrade individual career plans, filling the gaps in competences and contents of training.

Due to the need to develop and manufacture breakthrough products and market solutions, we anticipate that companies in the SRIP MATPRO partnership will require support in

upgrading competences at higher levels of difficulty, as well as in content-specific and technologically very specific areas. Thus, the task of SRIP MATPRO will be, according to KPZ, to prepare the necessary training to upgrade competences to the entire partnership, adapted to particular needs and dynamics in the development of value chains and products. As mentioned above, SRIP MATPRO will methodically rely on the Career Platform and in implementation on the Call for Competence Centers for Personnel Development (KoC2).

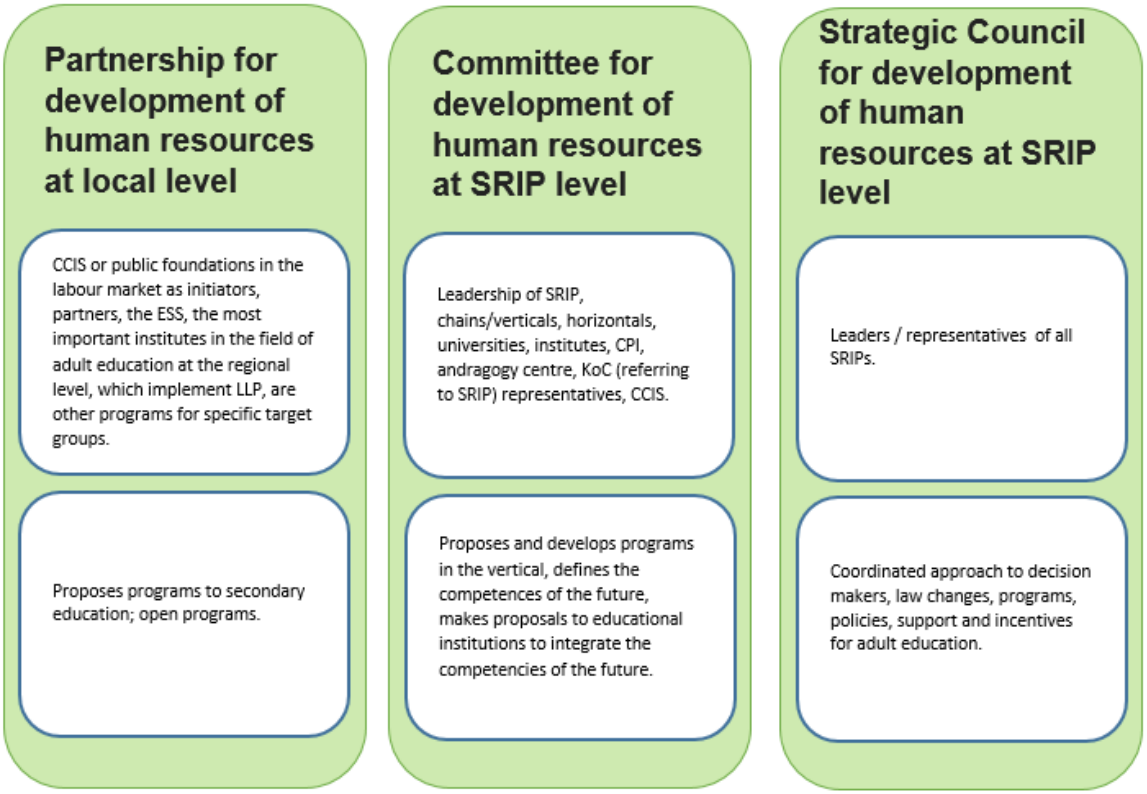
Considering the content distribution of domains within the SRIPs, it is estimated that only one part of metallurgical companies will be connected to SRIP MATPRO, and the same is true for the chemical industry. Other SRIPs are expected to link individual companies or groups of companies from both sectors, and some of the companies will probably remain outside the SRIPs. For this reason, it is essential to interconnect SRIPs; therefore, we propose the establishment of the Strategic Council in the field of human resources and development.

Demands and offers of training and education for the development of competences in breakthrough areas and tailor-made training programs will be supported by the e-learning and training platform that will be implemented with the beneficiary of the CCIS. The e-platform will contain all the data on the capacities and offers of educational centers, training programs in companies, staff in the field, education programs at all levels, and international programs at the level of all SRIPs for all SRIPs. Each SRIP will have an entry point, through which the two-way data flow between each SRIP e-platform will be enabled

4.5 Support to the implementation of the Action Plan

In order to implement an action plan in the field of human-resources development, a Human Resources Development Committee will be set up within SRIP MATPRO, consisting of representatives of companies, institutes, universities, CPI, educational institutions, experts and management of SRIPs, which will be at the SRIP level - coordinated activities, contents, proposals for new programs, and prepared and forwarded initiatives to ministries and other institutions related to the development of human resources.

At the regional level, "human resource development partnerships" will be established, composed of representatives of companies, regional chambers of commerce, labour market foundations, representatives of the Employment Office at the regional level, educational institutions in the region responsible for education and other institutions In the region working in the field of human resources development. The partnerships will prepare priority orientations in the field of competence development and influence educational programs (20% of the open curriculum, content of programs) and propose training programs that are in the interest of the economy for the development of the competences of their employees. IN accordance with the rules, regional level CCIS will lead the Partnerships for the Development of Human Resources.



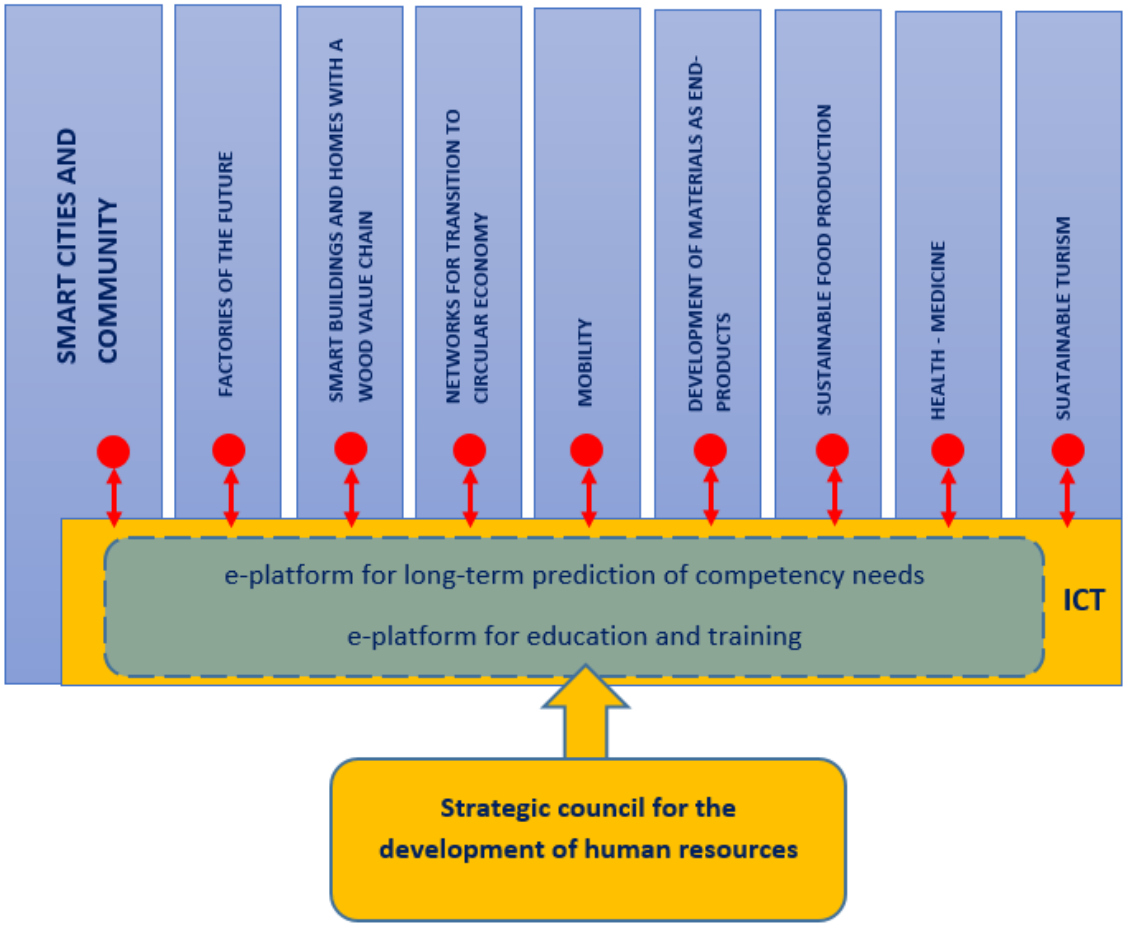
Source: CCIS, 2017

The Strategic Council for Human Resources Development (HRD) will be formulated nationally at the level of all SRIPs and will include representatives of all SRIPs, educational institutions and other representatives of the economy. The Strategic Council will coordinate initiatives for proposals involving new educational programs and supplement existing ones, create common content for educational programs, calls for proposals, proposals for amending laws and other initiatives to the Economic and Social Council and other decision makers in Slovenia as well as international organizations. Thus, resources for education and training will be targeted towards programs / contents for the development of competences that the economy needs in order to achieve developmental breakthroughs.

As the horizontal ICT network through both platforms enters all SRIPs, all SRIPs can, through the access points, access the e-platform database where relevant data can be acquired. Data will serve to plan and implement action plans in the field of human-resources development and the functioning of HRD committees in SRIPs, the operation of partnerships for the development of human resources at the regional level and the functioning of the strategic council at the level of all SRIPs.

The Strategic Council for the HRD at the level of all SRIPs will be guided and coordinated by CCIS.

The development of human resources will be supported by various methods, such as: workshops, staff training, focus groups, events at national, regional and business level, promotion.



Links with other SRIPs in the field of human-resources development in SRIP MATPRO

Since same partners act as members in various SRIPs, it makes sense that the positive experience of carrying out the activity is also transmitted between individual SRIPs. This is especially true for the field of human-resources development, based on an open staffing platform in all SRIPs, adapted to the content and specifications of each SRIP.

The strongest connection in the area of human-resources development in SRIP MATPRO will be achieved with the SRIP Smart Cities and Communities, which is the domicile SRIP for the horizontal network of Information and Communication Technology. In conjunction with that network we will:

- Identify the necessary digital competencies.
- Develop digital competencies and a digital culture.
- Perform knowledge transfer in digital platforms, cloud-native architectures, big-data, micro-services, API development, development of user interfaces and experiences, integration, computer clouds.
- Conduct education and training in the field of understanding the capabilities of digital technologies in the renewal of business models, processes and products, and in the

field of learning about trends, concepts of the digital economy and digital business models.

Also, the area of human resources development in SRIP MATPRO will be linked to SRIPs: Future Factories, Circular Economy, Sustainable Food Production, Smart Buildings and the Home with a Wood Chain, Mobility and Medicine. In all of these SRIPs, the development of human resources will be based on the Career Platform for Employees or in close connection with it.

4.6 Activities

In the area of human-resources development, the Action Plan includes the following activities:

Main activities:

- Training of human resources professionals and others responsible for long-term predictions of competence needs.
- Preparation of relevant competences and profiles in cooperation with KoCs.
- Training for career-guidance providers.
- Assessment of current and future importance of competencies for the set of profiles.
- Identification of gaps in competences and preparation of individual career plans for professional career development of personnel.
- Implement training and education for staff to fill the gaps.
- Creation of new programs for the creation of a system of acquisition and/or development of competences at the workplace.
- Analysis of existing education and training programs in order to identify gaps in competences and providers of these programs.
- Creation of new education/training programs that will take place in educational institutions.
- Promoting professions and education programs in the field of metallurgy and chemistry at all levels.
- Establishment of an entry point for the e-platform with respect to the long-term predictions of competence needs.
- Establishing an entry point for the e-platform for education and training.

Support activities:

- Cooperation with career centres within higher-education institutions and the promotion of career guidance at lower levels of education.
- Promoting new innovative forms of linking the economy with education in line with the objectives and functioning of SRIP MATPRO.
- Encouraging the transition of personnel and their involvement in the pedagogical

and work process.
- Support of apprenticeships and other forms of practical training in companies.
- Supporting new forms of training and education, such as a virtual environment and OpenLab, and switching from a virtual to a digitized real-world environment.
- Coordination of the scholarship policy of the state and enterprises in the priority area of the SRIP.

In the model for predicting competencies we will include the competence models developed in KoC-2 in terms of relevance in relation to SRIPs. We will systematically eliminate the overlapping of competencies and, if necessary, upgrade them according to the career platforms. In the same way, we will integrate and, if necessary, upgrade individual career plans, complement any gaps in competences and the content of training to fill the gaps.

4.7 Objectives and indicators of personnel development

Objective: To build a stepwise sustainable model for providing and managing the necessary human resources for SRIP MATPRO, which will be responsive and adaptive to unexpected changes that include:

- Identification and filling the gap between the current situation and the required skills of employees at all levels of work complexity for companies and institutions within SRIP MATPRO for the purpose of partnership, cooperation and integration.

- Achieve a critical mass of highly qualified employees at all levels of work complexity for companies and institutions - partners of SRIP MATPRO for development breakthroughs in focus areas and long-term implementation of all SRIP MATPRO tasks.

Performance indicators for the development of human resources at SRIP MATPRO.

	Baseline	2018	2022	sum
Strategic Council for Human Resources at the level of all SRIPs - cooperation in the establishment and operation.	0	1		1
Human Resources Committee at the level of SRIP MATPRO.	0	1		1
An entry point in the e-platform for long-term prediction of competency needs	0	1		1
Number of companies that will develop individual career plans for determining the deficit in competences *	0	4	6	10
SRIP Training and Education Plan	0	1	1	2
Number of trainings for mentors/intergenerational knowledge transfer	0	1	4	5
Number of initiatives for the preparation of new and / or supplementing existing occupational standards	0	1	3	4
Number of initiatives for educational programs	0	1	3	4
Number of initiatives for National Vocational Qualifications (NVQ)	0		1	1
Number of initiatives for Additional Qualifications	0		1	1
Number of promotional activities for the promotion of vocations for SRIP	0	2	6	8
Entry point to the e-platform for education and training	0		1	1

* In the period till 2022 at least one company in the vertical value chain.

5 Development of common services

5.1 Development of common services in the field of sustainability (Economic aspect, environmental aspect, social aspect)

Sustainable development

The SRIP MATPRO Action Plan is based on sustainability concepts from the Agenda 2030 for Sustainable Development (Agenda 2030), strategic and legislative documents in the field of the environment, as well as the descriptions of the social and economic aspects that are provided below.

The Agenda 2030, adopted at the United Nations Summit on Sustainable Development on 25 September 2015, represents the international community's historic agreement to eradicate poverty, reduce inequality, ensure progress, and protect the environment for present and future generations. At the forefront of the new development agenda is also respect for human rights and gender equality, and ensuring the prosperity, peace and security for all people and communities. The Agenda 2030 connects in a balanced way the three dimensions of sustainable development - economic, social and environmental - and interweaves them through 17 sustainable development goals that need to be realized by 2030.

GOALS IMPORTANT FOR SRIP MATPRO

Goal 1	**Provide healthy living and promote general well-being throughout all life.**
Goal 2	**Provide to everyone access to water and sanitation and provide sustainable water resources management.**
Goal 3	**Provide to everyone access to affordable, reliable, sustainable and modern energy sources.**
Goal 4	**Promote sustainable, inclusive and sustainable economic growth, full and productive employment, and decent work for all.**
Goal 5	**Build robust infrastructure, promote inclusive and sustainable industrialization, and foster innovation.**
Goal 6	**Ensure sustainable production and consumption patterns.**
Goal 7	**Take urgent action to prevent further climate change and its consequences.**

An action plan from the aspect of sustainability. The main objective in terms of sustainability is to encourage companies to connect between different departments or among persons responsible for the environment, energy, maintenance, development, marketing, human resources and finance, in order to establish or upgrade a systematic approach to environmental management, to provide incentives for the development and implementation of socially responsible policies and reporting on activities carried out, for linking environmental, social and economic aspects relevant to the particular company, and monitoring the indicators of individual sustainability elements.

The methods of work to achieve the set goals will include:

- **Information of partners** will be aimed at informing different target groups about the principles of sustainable business and reporting, the purpose and priority of the introduction of sustainable policies in companies, sectoral innovations (legislation, guidelines, trends), current activities and intermediate performance results and achievements of SRIP MATPRO. It will also aim at adopting timely and optimal decisions for introducing good practices and sustainable policies in companies. Activities will be implemented through various communication channels (web pages, e-news, publications, direct interaction).

- **Motivational actions:** Based on informative communication activities, results and awareness-raising, we will, through direct motivation actions, seek to attract the partners of the involved value chains and other partners to the development of sustainable business models and to implement the activities for achieving the set goals from various areas of sustainable business into company strategies.

- **Individual introductory interviews:** Interviews are intended for a deeper interaction between the SRIP MATPRO project management and the value chain carriers. The aim is to obtain a substantive basis for orienting the value chain in the area of sustainable business. Through the interviews, we will analyse the gaps between the current and the desired situation, define the priority areas, and provide support in developing a sustainable strategy for achieving short-term and long-term results over the selected time period. The results of the interviews will serve as a working basis for orientation in the interaction with other members of SRIP.

- **Focus groups of partners** will be assigned to the carriers of the value chains, which will meet with the purpose of exchanging good practices, opinions, experience in the area of implementing sustainable activities and sustainable reporting and networking. The information will serve as a basis for directing the included value chains. Focus groups will involve, where appropriate, competent experts in the subject areas that will provide in-depth content support.

- **Value-chain workshops** will be intended to meet members who form an individual value chain in order to find common synergies and strategic starting points for the development of targeted, sustainable policies and actions. Workshops will be an opportunity to identify common points, to develop joint activities and to exchange good practices. The workshops will involve, if necessary, competent experts in the subject areas that will provide in-depth content support.

- **Problem conferences** will aim at familiarization with exposed areas of sustainable business and related topics. They will target all the members of SRIP MATPRO as well as external partners (competent ministries and other organizations) who may not be members of the SRIP MATPRO, as they will be able to contribute to determining clearer directions for the future.

- **Individual counselling:** The purpose of this form of information transfer is to provide individual counselling support to interested members or a group of SRIP MATPRO members for the development of sustainable policy actions and strategies or in other priority areas according to their individual needs.

- **Occasional professional meetings:** meetings can be open or closed, and will be aimed at highlighting more complex content challenges that will face a certain value chain or the entire SRIP MATPRO in the area of the development and implementation of sustainable policies.

- **Study visits:** visits to companies and other organizations will be aimed at directly examining the implemented sustainable practices and acquiring new and deepening existing knowledge for further dissemination and providing enriched content support to SRIP MATPRO members.

Economic aspects

Definition of economic sustainability. Sustainable development does not focus solely on environmental issues. The debate on sustainable development is based on the assumption that the company must manage three types of capital (economic, social and natural), which may also be irreplaceable, and their consumption is irreversible. Natural capital cannot always be offset by economic capital. Although we know ways to replace some natural resources, it is very unlikely that an appropriate substitute for ecosystem functions can ever be found, such as, for example, the protection of the earth's surface from UV radiation provided by the ozone layer and the climate stabilization provided by the Amazon rainforest. Indeed, natural, social and economic capitals are often complementary. An additional obstacle to their cross-substitutability is also the multi-functionality of many natural resources. The problem associated with the decay of natural and social capitals is also their partial irreversibility. In addition, the consequences of the depletion of natural and social capitals may also be markedly non-linear. Meaning that the consumption of these capitals has almost no noticeable consequences until a certain threshold is exceeded. With such important consequences of consumption of natural and social capitals, the question arises as to why systematic measures are not taken to prevent and mitigate these consequences. The reasons for this may be in four different market disadvantages (Cohen, Winn, 2007). Firstly, the benefits of natural and social capitals are usually attributable to the owner of the source, but on the contrary, the price paid for the elimination of harmful effects is paid by society as a whole. Secondly, the society often underestimates the real values of natural capital because we cannot objectively assess the actual costs caused by its depletion. The third reason is the asymmetry of available information - often the connection between causes and consequences is blurred, so it is difficult to make rational decisions.

Cohen and Winn conclude their discussion with the recognition that, unlike economic theory, many companies are not capable of complete optimization. Therefore, they often do not optimize the availability of resources, as they are caught in an already-established business model. The most commonly accepted criteria for the corporate sustainability of a company is the effective use of safe equity. Ecological efficiency is usually calculated as

the economic added value of the company, given its aggregate ecological consequences. This idea has been popularized by the World Economic Council for Sustainable Development (WBCSD) with the following assertions: "Ecological efficiency is achieved by the competitive prices of goods and services that meet human needs and improve the quality of life, while gradually reducing the environmental impact for the entire life cycle at a level consistent with the capacity of the Earth."

Below are some of the most common examples of the description of economic sustainability that will help to define performance indicators in the Action Plan.

Beyond the business case for corporate sustainability (Dyllick, Hockerts, 2002). Economic (corporate) sustainability can be defined as meeting the needs of all indirect and direct partners (shareholders, employees, clients, communities) without compromising the needs of future partners. It differs from classic management theory since the economic sustainability is not a sufficient condition for the overall sustainability of society. Economic sustainability means the management of different types of capitals: financial (debt, equity), tangible (machines, land, inventories) and intangible (reputation, innovation, know-how, organization). Economic sustainability provides the company with continuous liquidity, while achieving above-average returns for partners.

Sustainable Production (US Department of Commerce). The economic aspect of sustainable technologies comprises the areas defined by the US Sustainable Manufacturing (US Department of Commerce, 2011). Thus, the US Department of the Economy summarizes it as a "production process that minimizes negative impacts on the environment and natural resources, is safe for employees, communities and consumers and is economically reasonable". There is, of course, ambiguity within this statement, since the production process can be neutral to the environment, but economically devastating and vice versa. For this reason, the component of the economic aspect within sustainable technologies is the most important, because only profitable business means the growth of the cash flow that the company can devote to future development. In any case, this does not only mean compliance with legal bases, but also good practices, demands from customers and end consumers who are willing to pay more for products that respect environmental guidelines in production.

The American Initiative sets out the following aspects of economic sustainability:

- Only large enough investments in infrastructure (production, transport, etc.) can enable successful production and sales, and enable a fast flow of incoming raw materials, semi-products and sales products.
- Creating jobs. Only new jobs create new consumers, buyers of products. Private consumption represents 60% of GDP in developed countries.
- Fighting corruption. At the company level, this means creating the necessary documents and commitments as well as conducting workshops to effectively combat corruption. The disclosure of corruptive scams can significantly jeopardize the reputation of the company as well as of other business partners. This is especially important if the company does not have a strong market position.

- Responsible tax payments. The current BEPS program (OECD) is designed to combat tax optimization strategies when multinationals register a large part of their profits through transfer pricing and other mechanisms in low-income countries.
- Sales and profit growth. Only an increase in sales and profits allows the company to stabilize or grow its market share and allow for the creation of sufficient surpluses for new investments.
- Promoting innovation. Promoting internal innovation or within the value chain brings competitive advantage over competitors in the form of the first provider in the market.
- Contribution to the development of the local economy. A developed local economy means stability in all interactions of the company with the environment and it covers a wide spectrum such as the education system, supply chains, and so forth.

The American initiative transposes the recommendations from a country-wide (macroeconomic) perspective on the operational competences of businesses (microeconomic view). It is not sensible to consider them separately, for example, creating jobs without the growth of sales and profit does not lead to a sustainable business model, and the absence of any of these aspects does not necessarily imply a violation of the principle of economic sustainability.

Economic sustainability in the manufacturing industry (Found et al.). Economic sustainability in the manufacturing industry by the study of Found et al. (A Theoretical Framework for Economic Sustainability of Manufacturing, Cardiff University's Innovative Manufacturing Research Center) comprises business models that have been developed to increase productivity and economic longevity (resilience, sustainability). Some of these models are: Total Quality Management, Business Process Engineering, Just in Time and Lean Thinking, to mention only the most important ones. Despite the fact that these solutions bring economic benefits, these strategies are not implemented in practice and the processes are abandoned.

Lean Thinking is a set of management principles and techniques designed to reduce waste in the production processes and to increase the speed of activity that add value to the final product from the customer's perspective (Womack, Jones, 1996). It is difficult to maintain the sustainability of the lean system as there are limits to achieving productivity. Economic sustainability can be achieved only by a simultaneous view through five lenses: people, technology, processes, leadership and strategy. For people, the company's culture is important, which is also related to motivation and training. In technology, greater automation and sharing of knowledge are important. Processes must follow changes in technology. It is hard to make changes in managerial practice. Leadership needs to be supported by change. The strategy is ready to set new strategic initiatives.

The main factors that are expected to affect sustainability in manufacturing are as follows:

- International Standards and Protocols (UN Global Sustainability Protocol).
- Environmental legislation.

- Society expectations about the impact of production on energy consumption and ecosystems; consumers will increasingly support environmentally friendly products and production.
- Risks and liabilities related to investments. Financial analysts are increasingly taking into account the company's environmental commitments.
- Costs related to regulatory barriers. The scope of environmental legislation will continue to increase.
- Market-friendly, environment-friendly technologies.

Economic sustainability, SGS. The SGS advisory company lists economic sustainability as an aspect that covers everything from the business continuity of management to anti-corruption measures. Systems for education, internal audit and governance need to be coordinated in order to ensure economic sustainability.

Action Plan - an economic aspect

Economic sustainability indicators. For the Action Plan, indicators of economic sustainability were formed, primarily summarizing the definition of the US Department of Commerce. The indicators by which companies measure economic sustainability by sector are the following:

- **Investments in infrastructure**. Share of investments in sales and investments in EBITDA, which stay at the long-term and at the branch level (domestic and foreign competitors) average. The company is autonomous in determining competitors, but taking into account that changes in the selection of comparable competitors must be well-founded and not too frequent (every 3 years). The median values of these indicators are computed among competitors (both domestic and foreign), since the average can be much deceiving due to the extreme values of the indicators in certain years. Namely, this is well anticipated as companies have investment cycles that fluctuate significantly over the years.

- **Creating jobs.** Due to the increasing automation of production, especially for the jobs dangerous for employees, it is not expected that a large number of jobs will be created. Therefore, the most appropriate point of comparison is the relative change in the number of jobs compared to competitors. Relative because the absolute changes in the number of jobs in larger companies are usually higher than for medium or small ones. As a comparable parameter, the median of changes in the number of jobs in competitors is taken into account.

- **Fighting corruption / business fraud.** Indicators in measuring the internal fight against corruption are difficult to form, since the number of reported cases does not necessarily reflect the success of the fight. Likewise, a comparison with competitors is difficult, as this is not a required part of public annual reports or disclosures. It is worthwhile to join the international commitment to fight corruption. Kaufmann (1997) believes that corruption data can be obtained primarily through interviews of sales or purchasing managers or persons who are responsible for concluding purchasing or selling deals. The good empirical practice thus

determines that managers must have the right initiative to fairly report their experiences of corruption.

- **Responsible tax payments**. The current BEPS program (OECD) is designed to combat tax-optimization strategies when multinationals register a large part of their profits through transfer pricing and other mechanisms in low-income countries. Companies can show this responsibility by stating that they do not do business in tax havens. This orientation is much more relevant for companies that have the final consumer buyers (B2C), but it is also expected that trends will be dictated by business customers by the value of the chain (B2B).

- **Sales and profit growth.** The median of the relative sales growth and profit of competitors is calculated, and the result is compared with the result of the company. It is appropriate to compare the average growth of these two categories for a period of at least 5 years. A growing company has easier and cheaper access to various sources of financing (both equity and debt). With the growth of the company, social benefits also increase through the various forms of taxes and social duties.

- **Promoting innovation.** Innovation expenditure is not an accounting item, but only a few companies report the extent of these expenditures in annual reports, as they are often considered as business secrets. Companies can also consider this as part of current expenditure or investments. It is thus important for the company to determine the target value of innovation in relative terms to sales, as innovation should promote sales growth. If this is not the case, the company must identify why sales are declining in spite of the growth in innovation spending.

- **Contribution to the development of the local economy.** This orientation is very important, since only well-developed local environments can contribute to a sufficiently trained and productive workforce. Likewise, the local supply chain reduces the likelihood of supply instability due to shorter delivery routes, but this benefits must nevertheless be weighed along with the economic aspects (the prices of goods of the remote suppliers). Criteria that the company can pursue include, for example, the proportion of purchases that it realizes in its region or the proportion of employees with a certain level of education. Large companies abroad also actively cooperate with the education system (secondary vocational schools) and actively influence the design of programs that enable young people to compete in the labour market after completing their studies.

The indicators of economic sustainability provide guidelines, which should be critically assessed by each company in the value chain and in SRIP MATPRO. The short-term costs associated with it should be weighed. The main parameters must be sales and profit growth, the promotion of internal innovation and investment in productive infrastructure. The created jobs are usually the consequence of a business success, the fight against corruption and the contribution to the development to the local economy. They are upgrades that the company can afford when priorities are met. In the cases where the

company is working for the known customer, or the conditions are requested by the buyer in the supply chain, the fulfilment of the last two criteria becomes even more meaningful.

The Action Plan, which will be targeted at the target groups in SRIP MATPRO are defined. These activities are used to define the indicators of economic sustainability that must be defined by enterprises as well as to adequate measures. Individual activities from the aspect of sustainability are specified in the introductory section of the Action Plan.

Code	Activity	Mode of implementation	Target group	Performance Indicators	
				2018 (2 value chains)	2022 (3 value chains)
C1	information	individual consulting of target groups in the field of economic sustainability, informing about the sectoral innovations and activities of SRIP MATPRO	chain carriers, value chains, members of SRIP MATPRO, ZKovI, ZKI, ZKM	5 communication activities	6 communication activities
C2	motivation	motivational actions to promote economic sustainability	chain carriers, value chains, members of SRIP MATPRO, ZKovI, ZKI, ZKM	3 motivational activities	4motivational activities
C3	introductory individual interviews	introductory individual interview s with the chain carrier to determine the current state	carriers of value chains	2 introductory interviews	3 introductory interviews
C4	carriers of focus groups	carriers of focus groups of value chains for the exchange of good practices	carriers of value chains	3 focus groups	3 focus groups
C5	workshops for value chains	workshops of members value chain s for the design of the strategy and the setting of strategic goals	value chains	2 workshops	9 workshops
C6	problem conferences	problem conference for expert discussion of selected areas in economic sustainability	chain carriers, value chains, members of SRIP MATPRO, ZKovI, ZKI, ZKM	2 conferences	3 conferences
C7	individual consulting	providing advisory support to individuals or groups of members of SRIP MATPRO in problem solving	chain carriers, value chains, members of SRIP MATPRO	10 meetings	18 meetings
C8	professional meetings	occasional professional meetings to highlight more complex content challenges in the area of economic sustainability	chain carriers, value chains, members of SRIP MATPRO	5 meetings	6 meetings
C9	study visits	visits to companies and other organizations for examining good practices and deepening knowledge about economic sustainability	chain carriers, value chains, members of SRIP MATPRO, ZKovI, ZKI, ZKM	3 visits	3 visits

Schedule of activities - economic aspect. Activities for informing, motivating and meetings to promote economic sustainability within individual target groups are expected to be carried out in the following timetable:

Activity \ Quarter	2017		2018				2019				2020				2021				2022			
	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.
C1 – information		■	■		■		■			■	■		■		■	■		■		■		
C2 – motivation	■		■			■			■			■		■			■					
C3 – individ. interviews	■					■					■											
C4 – fokus groups		■				■			■			■				■				■		
C5 – workshops of value chain			■		■		■		■		■		■		■		■		■			
C6 – prob. conferences					■					■				■				■				
C7 – counselling	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
C8 – professional meetings	■		■	■			■		■		■	■		■	■		■		■			
C9 – study visits	■			■			■				■				■				■			

The timetable is informative and will be adapted to the current needs.

Environmental aspects, development of common services in the field of environmental protection, education and training

The starting points for the SRIP MATPRO Action Plan, from the environmental point of view, are the following strategic and legislative documents:

Seventh EU Environment Action Program by 2020 [48].With the 7th Environment Action Program, the EU has committed itself to further strengthen its efforts to protect our natural capital, promote low carbon growth through the efficient use of resources and innovation, and safeguard the health and well-being of people while respecting the natural limitations of our planet. A particular focus among the priority objectives is on the transforming of waste into a resources, with greater prevention, reuse and recycling, and the abandonment of wasteful and harmful practices, such as disposal at landfills.

The program has a long-term vision. "In 2050 we live well within the environmental limits of our planet. Our prosperity and healthy environment come from an innovative, circular economy where nothing is discarded and where natural resources are managed sustainably, and biodiversity is protected, valued and restored in a way that strengthens the resilience of our society. Our low-carbon growth has been separated for a long time from the use of resources and has its pace driven by a safe and sustainable global society."

[48] http://ec.europa.eu/environment/pubs/pdf/factsheets/7eap/sl.pdf

Plan for the transition to a competitive low-carbon economy by 2050[49]. The plan contains an analysis of measures by 2050, which would allow the EU to reduce greenhouse-gas emissions from 80 to 95 percent compared to 1990. For the industrial sector, greenhouse-gas emissions can be reduced by 83 to 87 percent by 2050. It notes that the use of more advanced industrial processes and equipment that are more efficient in resources and energy, more recycling and the use of technologies to reduce emissions of other substances other than CO_2 (e.g., nitrogen oxide and methane) can make a significant contribution to these objectives.

Reduction of greenhouse gas emissions compared to 1990	2005	2030	2050
In total - all sectors	-7%	from -40 to -44%	from -79 to -82%
Industry (CO_2)	-20%	from -34 to -40%	from -83 to -87%

Closure of the loop - an EU action plan for the circular economy[50]. With the Action Plan for the Circular Economy, the European Commission is working to develop a sustainable, low-carbon and competitive resource-efficient economy. The plan includes measures with which it intends to influence the production, consumption and management of waste as well as the secondary raw-material market.

The circular economy is focused on the reuse, repair and recycling of existing materials and products. It is based on the use of energy from renewable sources, it abandons the use of hazardous substances, reduces the consumption of raw materials, and through the design of products, enables the circulation of materials and the preservation of added value for as long as possible. Developing product requirements will promote reparability, scalability, durability and the ability to recycle products under the Ecodesign Directive, as well as with the provisions on the extended liability of producers in the framework of legislative proposals on waste.

In the regard of production processes, BREF represents the basic concept. However, given the debate in the European Parliament on the amendments to the Waste Framework Directive (2008/98 / EC), it may be expected that the requirements for industrial waste will be aggravated. An industry-oriented approach using the BREF documents should only be a temporary solution to achieve the goals of a circular economy.

In order to foster innovative industrial processes, linking industries where residues of production (either as waste or by-products) from one industry become input materials for another industry (industrial symbiosis), the plan provides for clarification of the rules for by-products. The Commission notes that at EU level greater harmonization and simplification of rules should be achieved.

Among the priority areas, the European Commission also highlights plastics and critical raw materials, such as rare-earth elements, other precious metals and phosphorus. It pays

[49] COM(2011) 112
[50] COM(2015) 614

particular attention to innovation, investment and other horizontal measures and indicators to monitor the progress made in this area.

The legislative proposal on waste is part of the European Economic Commission's package on the circular economy (December 2015). Discussions on amendments to the directives indicate a tendency towards stricter measures and an even greater focus on the closing of loops of material flows.

Framework program for the transition to the green economy (2015)[51]. The Framework Program for the Transition to the Green Economy (CAP) is based on key areas of transition to the green economy, from sustainable resource management to green practices in agriculture and forestry. The program aims to actively support the process of transition to the green economy as quickly as possible, and to integrate sectoral policy measures and activities. It provides the basis for the establishment of dialogue and partnership of partners in Slovenia, which will jointly upgrade and develop the process of transition to the green economy. On this basis in October 2016, a partnership for the green economy was also established.

Waste Management Program and Waste Prevention Program of the Republic of Slovenia (2016)[52]. The Waste Management Program and the Waste Prevention Program are merged into one document - an operational program. The operational program is an instrument of the Government of the Republic of Slovenia for complying with the prevention of waste generation, ensuring the prescribed waste management and achieving waste management targets for the period to 2020 and 2030 respectively.

In addition to the Waste Management Program, the Waste Prevention Program is a part of the operational program, which also deals with the prevention of waste in enterprises. Objectives related to the prevention of waste in enterprises are:

- Online accessible documents on examples of good practices on waste prevention techniques / technologies.
- Launch programs to identify and implement the potential for waste prevention in companies.
- Raising the performance index from 1.07 (2011) to 1.50 (2020) and establishing 5 new value chains with completed material flows by 2023.
- Additional training for companies responsible for waste in the direction of identifying and using potential for prevention and reuse.
- Support to Environmental Management Systems EMAS and ISO 14001 as a means of preventing waste generation, reuse and resource efficiency.

[51] http://www.mop.gov.si/fileadmin/mop.gov.si/pageuploads/pomembni_dokumenti/opzg_akcijski_nacrt_in_nacrt_aktivnosti.pdf

[52] MOP, 2016, Waste Management Program and Waste Prevention Program, accessible at: http://www.mop.gov.si/fileadmin/mop.gov.si/pageuploads/zakonodaja/varstvo_okolja/operativni_programi/op_odpadki.pdf

National Environmental Protection Program until 2030 (NEAP 2030) - in preparation. The National Environmental Action Program will be prepared with a vision summarized under the 7th EU Environment Action Program:

Legislation - Impact on the environment of production, products, chemicals and waste

The legal framework for the operation of the SRIP MATPRO is provided by the following legislation:

- **Environmental legislation** (Environmental Protection Act and secondary legislation issued in the field of industrial pollution, emissions into air and water, climate change, air quality, water protection, soil protection, waste, noise etc.). :
  - Decree on the type of activities and devices that may cause pollution of large scale (Official Gazette of the Republic of Slovenia, No. 57/15) and best available techniques (BAT) conclusions:
    - for the production of iron and steel.
    - for purification and treatment of waste water and chemicals in the chemical industry.
    - for the non-ferrous metal industry.
  - Decree on the maximum content of volatile organic compounds in paints and varnishes and products for making cars (Official Gazette of the Republic of Slovenia, No. 93/10).
  - Decree on the emission of substances into the air from stationary sources of pollution (Official Gazette of the Republic of Slovenia, No. 31 / 07.70 / 08, 61/09, 50/13).
  - Decree on the emission of substances into the air from a cast-iron foundry, alloys with iron and steel (Official Gazette of the Republic of Slovenia, No. 93/11).
  - Decree on the emission of substances into the air from aluminium production plants by electrolytic procedure (Official Gazette of the Republic of Slovenia, No. 34/07, 81/07, 62/08).
  - Decree on the emission of substances into the air from aluminium and magnesium foundries (Official Gazette of the Republic of Slovenia, No. 34/07).
  - Decree on the emission of substances and heat in discharging wastewater into waters and public sewage (Official Gazette of the Republic of Slovenia, No. 64/12, 64/14, 98/15).
  - Decree on the emission of substances and heat in the discharge of waste water from iron and steel production and treatment facilities (Official Gazette of the Republic of Slovenia, No. 45/07).
  - Decree on the emission of substances and heat in the discharge of waste water from foundries and blacksmiths of cast iron, alloys with iron and steel (Official Gazette of the Republic of Slovenia, No. 45/07).
  - Decree on the emission of substances and heat in the discharge of waste water from non-ferrous metal foundries (Official Gazette of the Republic of Slovenia, No. 45/07).
  - Decree implementing the Regulation (EU) on the auctioning of greenhouse gas emission allowances (Official Gazette of the Republic of Slovenia, No. 14/14).

- Decree on greenhouse gases, activities and installations for which a permit for the release of greenhouse gases must be obtained or the monitoring of greenhouse gas emissions (Official Gazette of the Republic of Slovenia, No. 55/11, 1/13).
- Decree on waste (Official Gazette of the Republic of Slovenia, No. 37/15, 69/15) and
  - 2014/955 / EU: Commission Decision of 18 December 2014 amending Commission Decision 2000/532 / EC on the list of waste in accordance with Directive 2008/98 / EC of the European Parliament and of the Council.
  - Commission Regulation (EU) No. 1357/2014 of 18 December 2014 replacing Annex III to Directive 2008/98 / EC of the European Parliament and of the Council on waste and repealing certain Directives.
- Council Regulation (EU) No. 333/2011 of 31 March 2011 on the criteria for determining when certain types of scrap metal cease to be waste, pursuant to Directive 2008/98 / EC of the European Parliament and of the Council.
- Commission Regulation (EU) No. 715/2013 of 25 July 2013 on the criteria for determining when a waste copper ceases to be waste under Directive 2008/98 / EC of the European Parliament and of the Council.
- Decree on waste electrical and electronic equipment (Official Gazette RS, No. 55/15, 47/16).
- Decree on handling batteries and accumulators and waste batteries and accumulators (Official Gazette RS, No. 3/10, 64/12, 93/12, 103/15).
- The Regulation on End-of-Life Vehicles (Official Gazette of the Republic of Slovenia, No. 32/11, 45/11, 26/12).
- Decree on waste incineration plants and waste co-incineration plants (Official Gazette of the Republic of Slovenia, No. 8/16).
- Decree on landfills of waste (Official Gazette of the Republic of Slovenia, No. 10/14, 54/15, 36/16).
- EU regulations: EMAS and Ecolabel.
- Green public procurement: the Regulation on Green Public Procurement (Official Gazette of the Republic of Slovenia, No. 102/11, 18/12, 24/12, 64/12, 2/13, 89/14 and 91/15 - ZJN-3) and GPP criteria (EU).

- **Legislation in the field of products for construction** (Regulation (EU) No. 305/2011 on construction products and the Construction Products Act, ZGPro-1), which is important in particular for the possible use of residues of production for construction purposes.

- **Chemicals legislation**:
  - Regulation (EC) No. 1907/2006 of the European Parliament and of the Council from 18. December 2006 concerning the registration, evaluation, authorization and restriction of chemicals (REACH).
  - Regulation (EC) No. 1272/2008 of the European Parliament and of the Council from 16. December 2008 on the classification, labelling and packaging of substances and mixtures (CLP Regulation).
  - Directive 2011/65 / EU of the European Parliament and of the Council form 8. June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) and the rules on the restriction of the use of certain

hazardous substances for electrical and electronic equipment (Official Gazette of the RS, No 102/12, 20/14, 57/14, 53/15 and 60/16).

- **Energetic efficiency legislation** – environment friendly design of energy related products (Decree on technical requirements for the ecodesign of energy related products (Official Gazette of the Republic of Slovenia, No. 76/2014).

Customer requirements. The requirements of customers that in particular relate to the establishment and implementation of quality control systems (certification) for environmental management, safety and health at work, and contents of hazardous substances in products.

Action Plan - an environmental aspect. The field of environmental protection is, by its very nature, intersectoral and concerns all, large and medium-sized companies. The CCIS monitors various aspects related to environment, for SRIP MATPRO companies, in particular on the requirements of the legislation and the resulting obligations, on softer approaches and good practices stemming from the contribution of green technologies, eco-design, green procurement as well as systematic approaches to managing environmental requirements and reducing the environmental impact of the economy.

With the transition to a circular economy, the recognition and exchange of information on the flow of materials within the value chain will play an increasingly important role. The CCIS, as a multiplier of activities for the transition to a circular economy, will support the implementation of new environmental trends and principles of industrial on the basis of the Treaty of Slovenia with the Ellen MacArthur Foundation.

Experiences prove that the inter-industry exchange of good practices in the environmental field brings positive shifts for both large and medium-sized companies. These experiences and practices relate to various environmental areas, such as the greening of jobs, green technology and innovation. These experiences are transferred to small enterprises through joint promotional activities supporting the networking of companies and experts working in the field of the environment in the economy as well as in research and state institutions. In the framework of SRIP MATPRO they help for joint development.

The activities within SRIP MATPRO will contribute to strengthening the capacities of companies and the development of competences in the field of environment and circular economy, as well as broader, in terms of sustainability.

Within SRIP MATPRO, we will focus in particular on:

- Requirements arising from environmental, construction, chemical and energy, etc. efficiency legislation (environmental design), which is detailed in the Action Plan - environmental aspect.
- Contents that are important from the point of view of a circular economy: models of a circular economy, examples of good practices, identification of material flows, environmental trends and the application of the principles of industrial symbiosis.

- Contents derived from standards such as ISO 14001, ISO 14040 and ISO 50001, EMAS and sectoral reference documents (where these exist).
- Exchange of business experiences and case studies.

The Action Plan for achieving SRIP MATPRO objectives in the field of environment covers a brief description of the activities and target groups, as well as the quantitative goals defined by the number of events, consultations and other activities carried out. From the aspect of sustainability, activities are specified in the introductory section of the Action Plan

Environmental activities will be aimed primarily at people responsible for the environment, energy, development and innovation in companies - carriers of value chains, members of chains of value and SRIP MATPRO members. Since the field of operation of SRIP MATPRO is directly involved in the implementation of the concept of the circular economy, certain activities will be an opportunity to connect with SRIP Circular Economy.

Code	Activity	Description of the activity and target groups	Number of activities*	
			2018 (2 chains)	2022 (3 chains)
A1	information	Information on novelties of legislation, new trends and business opportunities arising from the environmental aspects of business operations	5	6
A2	motivation	Motivational actions to promote a systematic approach to the management of the environment	3	3
A3	introductory individual interviews	Visit to the companies - introductory interview with the chain carriers to assess the current state of the environment	2	3
A4	carriers of focus groups	Exchange of knowledge and experiences on selected environmental content - linking between carriers	3	3
A5	workshops for value chains	Exchange of knowledge and experiences on selected environmental content relevant to a single value chain - chain linking	5	9
A6	problem conferences	Networking among SRIP members, transfer of good practices and identification of administrative and other obstacles of environmental legislation. Problem conferences will also be an opportunity to connect with SRIP Circular Economy.	2	3
A7	individual consulting	Professional support for SRIP members in solving environmental issues, including, if necessary, visits to companies.	10	18
A8	professional meetings	Occasional expert meetings for dealing with more complex environmental issues and to draft new environmental regulations. Such meetings will also be an opportunity to connect with SRIP Circular Economy.	5	6
A9	study visits	Visits to companies and other organizations to identify good practices, possible interconnections and deficiencies in legislation and / or implement requirements with options for improvement.	3	3

* Note: The number of events, consultations and other activities will be adapted to SRIP MATPRO needs. The scope of activities also depends on the novelty and complexity of the new legislation.

Activity plan - environmental aspect. Environmental activities will be carried out in the following timetable:

Activity \ Quarter	2017		2018				2019				2020				2021				2022			
	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.
A1 – information																						
A2 – motivation																						
A3 – individ. interviews																						
A4 – focus groups																						
A5 – workshops of value chain																						
A6 – prob. conferences																						
A7 – counselling																						
A8 – professional meetings																						
A9 – study visits																						

The timetable for the activities will be adapted to the needs of SRIP MATPRO members and possible public debates on draft environmental regulations.

Identification of administrative and legislative obstacles and the preparation of initiatives for their elimination - cooperation in legislation drafting. In the framework of SRIP MATPRO, the CCIS will monitor changes in environmental legislation and ensure timely notification of SRIP MATPRO members on new EU strategies and policies and their implementation into legislation. On the basis of recognized administrative and legislative obstacles, CCIS will together with SRIP MATPRO members prepare initiatives for their elimination. By organizing discussions where views, comments and suggestions will be gathered, it will actively engage in procedures for adoption of legislation. It will operate professionally, proactively and constructively, with the aim of creating environmental legislation that will be feasible, meaningful, harmonized and economically balanced from the point of view of operating conditions in the common European market.

Social aspect

What is social responsibility? In a developed world, socially responsible behaviour is becoming increasingly important. In the European community, the foundations for the promotion of corporate social responsibility were set in 2001 by the Green Paper on Promoting a European Framework for CSR. It identifies CSR as "... a concept whereby companies voluntarily decide to contribute its share to a better society and a cleaner environment". At present, consumers, partners and financial communities, employees, contract partners, the government, the wider social community, NGOs i.e., different partners require organizations to be responsible for social and environmental impacts and also to report on their behaviour in this field.

The concept of social responsibility relates to the operation of the company as a whole (i.e., its management and employees) both internally and externally, taking into account the interests of various partners who are actively involved in the activities. The core of the

concept lies in the quest for the creation of prosperity or common good and for ethical actions that meet the needs of current generations, without jeopardizing the possibilities of meeting the needs of future generations, and denotes a shift to doing business for the benefit of the whole society, and not just for the owners of companies. In essence, it involves the pursuit of policy implementation, decision-making and advocacy for those activities that are in line with the expectations and values of society. With responsible and sustainable relationships, the satisfaction of employees increases, improves relationships with partners, strengthens the role of the company in the local community, improves anticipation and risk management, and in the long run increases the company's competitive advantage and improves its profitability.

The cornerstone of corporate social responsibility is the economic responsibility that forms the basis for all other levels of corporate social responsibility, which means that the company must be profitable, make strategic decisions, operate efficiently and maintain a competitive advantage. This is followed by legal responsibility, which is an overall law-compliant binding commitment. Already in 2014, the EU adopted the Directive on the disclosure of non-financial information, which Slovenia in 2017 implemented in its legal system. It obliges companies with more than 500 employees to reveal non-financial (social or environmental data) information. The legislation is gradually directed towards promoting sustainable practices among a wide range of economic operators. The amendment to legal liability is ethical responsibility, according to which the company follows an ethical code and business ethics, which is not prescribed by law. At the top of the pyramid of social responsibility, however, philanthropic responsibility, is an indication of the company's efforts to engage in voluntary initiatives and charity.

Many Slovenian companies have always taken good care of their employees, they coexisted well with the community and act responsibly towards the environment and work partners. Social responsibility as an integral concept of the integration of interests of different partners into the company's strategy has only been established recently. Like elsewhere in the world, corporate social responsibility is also more focused on companies with well-established brands, but social responsibility is by no means only the domain of large companies, as medium-sized and small enterprises are increasingly bound to socially responsible business and social sustainability. Two-thirds of Slovenian companies perform various forms of social responsibility, which goes beyond the European average (49%). Nonetheless, many companies lack a systematic approach to the implementation of socially responsible policies, as well as reporting on corporate social responsibility itself.

Benefits of socially responsible business. Numerous examples from history prove that focusing on the financial performance of companies suffices only for short term existence. In order to achieve long-term effects, the strategy of the company must be sustainable, since the interests of partners that actually drive the corporate ecosystem play a significant role in the success of the company and, therefore, their satisfaction is imperative, it is no longer only the matter of choice.

Social responsibility represents a good business strategy of the company and is a good indicator of the long-term success of the company. The advantages of implementing socially responsible policies are numerous for economic operators: socially responsible companies are primarily capable of gaining and retaining better staff, and employees are

more satisfied, committed and motivated to integrate their interests into the operation of the company, which increases productivity, product quality or services and the competitiveness of companies. The introduction of socially responsible policies improves internal communication within the company and promotes common values, which strengthens the company's culture. Social responsibility increases the loyalty of customers, which in this way become the ambassadors of socially responsible brands. The company also increases its competitive position with social responsibility by propitiating itself and separating it from the competition, thus gaining new customers, consolidating its brand and increasing the image, reputation and legitimacy of the company. Supply chains also become stronger. Companies that do not involve social responsibility in their activities risk the suppliers giving priority to socially responsible competitors.

Last but not least, by combining the interests of different partners, the company can find many new synergies and, through cooperation with the local environment, can form a platform for strengthening relations. It is good that companies have a major role to play in the implementation of corporate social responsibility, since companies are the ones that can most effectively determine the needs of a wider society, and also formulate appropriate solutions with social initiatives, innovative solutions to common problems and good relations with the community and authorities.

Developing a socially responsible business model. The social responsibility of the company to all its partners is a key strategy of the company, based on the long-term vision of the company's development. Therefore, it is important for the company to design socially responsible activities and measures in the long run and to introduce them gradually.

The preparation of a social responsibility strategy takes its time. Depending on the complexity and availability of the working team, the preparation of the vision and the strategy lasts for two to three months, and the definition of objectives is continued for another two to three months. First of all, it is important for the company to determine which partners have an impact on the company's operations and what impact they have, since taking into account their interests is crucial for the long-term successful operation of the company. To this end, it must precisely identify the partners of the company, identify their interests and expectations, and on the basis of gap analysis to develop a strategy for the sustainable integration of their interests in the operation and development of the company. In this way, the company will better build positive relationships with different partners, in addition, it will more effectively manage the risks, strengthen the reputation of the company, better understand the market and discover new opportunities for further development.

Partners represent all groups that influence the company and are affected by the company's existence and operation. Social responsibility indicates the coordination of different interests of partners with the goals and strategy of the company. In modern times, where companies' responsibility is increasingly emphasized, the view of partners is broader and covers the supply chain, non-governmental organizations, employees' families, interest associations and the environment in which the company operates, draws resources or removes waste to.

The first step in developing a cooperation strategy is to define a group of partners of the company. They are usually separated into individuals or groups, to those to which the company has legal and financial responsibility influenced by the activities of the company, as well as to individuals and groups that directly affect the company's performance (partners with influence and power of decision making).

For each partner, it is important to know the goals of co-operation and integration and to define how individual partners contribute to achieving the company's strategic goals. It is also necessary to know the priorities that are important to individual partners, what their expectations are and what is the most appropriate and effective partner involved in the pressing issues. Collaboration and integration is a challenging process, but it brings benefits such as, for example, improving the reputation of the company, building confidence, understanding the market, etc.

The basis for sustainability of a company is therefore the responsibility of the company or organization to all partners. They are divided into internal - primary parters and external - secondary partner groups. The primary partner group consists of all employees in the company, owners, customers, suppliers, competitors, sellers and lenders, while the secondary consists of local communities, social activists, media, business interest groups, foreign and domestic governments and other public groups. Successful cooperation coexistence with partners not only helps the company to protect itself and, above all, build its role in an increasingly complex and changing business world, but also contributes to systemic changes that lead to sustainable development.

In parallel with the implementation of the activities, it is vital to keep permanent communication with partners on objectives, priorities and procedures and on the strategy and vision of the implementation of socially responsible activities and measures. In this way, companies build positive relationships with their partners, integrate them into the planning of activities and measures of social responsibility, and communicate their vision and principles of operation, and thus create common values.

The CSR reporting indicators are not precisely defined, so companies are not obliged to report and disclose all indicators. Empirical studies prove that the level of disclosed data is influenced by the size of the company and its activity, which determine the exposure of the company to the public, and thus the likelihood of regulation of environmental policy or the company's response to the company's operations. The indicators of social responsibility are divided into four major groups, in view of the availability of the annual report, the management of the environment, social responsibility and relations with partners.

Reporting on Corporate Responsibility and Reporting Standards. An essential part of the overall strategy for socially responsible development is to inform employees and all other partners about the company's responsibility to the wider social environment, in that way, different partners receive key information about the company's responsible practices and, therefore, key information about its products and services. Thus builds long-term positive relationships with all partners, depending on the success and existence of the entire corporate ecosystem.

Sustainable reporting is a key to ensuring the visibility of a company's operations. Such reporting is a tool for credible communication with all partners of the company, from investors and customers to other partners, and is increasingly being claimed as an expected complement of financial reports on the company's performance. Due to frequent cases of environmental and social irresponsibility of companies and various financial scandals as a result of long-term manipulations with financial statements, mistrust has developed into accounting reports that no longer correspond to the needs and expectations of today's society. Sustainable reporting is therefore a way of transparent and clear disclosure of non-financial information about the company's operations that help build positive relationships with different partners and reveal the overall image of the company as an indicator of its development.

However, the free choice of companies on the method and indicators of reporting also brings fears of the positive bias of such non-financial reports that can selectively reveal only positive aspects of corporate social responsibility, deliberately neglecting poor indicators or those for which the company has fallen in comparison with previous years. Due to the need for comparability and transparency of reports, various sustainability reporting standards have been developed in recent decades, which upgrade existing reporting models on economic and environmental indicators also from a social point of view. Standards vary: from process to presentation standards, from voluntary to standardized forms, from standards that solve individual problems, to those which solve multilateral problems, in short, to highlight the utility of the entire spectrum of areas of social responsibility.

In Slovenia, the most common standards are the ISO 9001 (for quality management systems), ISO 14001 (for the environmental management systems) and OHSAS 18001 (for the occupational health and safety management), and there is increasing interest in reporting standards and guidelines on corporate social responsibility, such as ISO 26000, SA 8000, GRI, IQNET SR 10, AA1000 and UN Global Compact. The increasing efforts of corporate social responsibility companies also encouraged the introduction of new awards, certificates and competitions and indicators for measuring socially responsible activities and measures.

Action Plan - a social aspect. Below is provided a detailed content and timetable plan for the activities of SRIP MATPRO to promote socially responsible policies and information transfer, which will take place in two phases (until 2018 and until 2022). The activities are intended to provide content and professional support to members of SRIP MATPRO and exchange of good practices related to activities in the field of implementing socially responsible policies and focus on four target groups.

Target groups of activities to promote socially responsible policies:

- **VALUE-CHAIN CARRIERS:** The value chain carrier is a core company in a group of partners who form a vertically integrated chain or network, within which there is complementarity in research, development and innovation, the connection of several technologies and product lines. The value chain carriers will be all those companies that will act within the Sustainability Model.

- **VALUE CHAINS:** The members of the value chains are all those partners which participate or are involved in the cooperation with the company, which is the carrier of the selected value chain. The members of the value chain can be all companies working with the chain carrier: suppliers, customers, consumers, subscribers, various educational institutions, research and development centres, education sectors, etc.

- **MEMBERS OF THE SRIP MATPRO**: SRIP members are all companies that have become members of the SRIP with the aim to strengthen the networking of members through cooperation, in such a way that a critical mass of competences and capacity will be achieved to ensure representativeness and coverage of all focus areas.

- **MEMBERS OF Zkovl, ZKI, ZKM:** Members of the parent organizations of SRIP MATPRO (CCIS - Association of metals and non-metals, CCIS - Metal Industry Association and CCIS-Chemical Industry Association) that form a narrower support environment and are the basic coordinators and catalysts of the process of operation SRIP MATPRO within a particular industry are all companies in the metal industry, metal processing industry and chemical industry that carry out one or more production activities and with their membership demonstrate commitment to systematic improvement of the business environment and to strengthening and increasing the competitiveness of the industries through networking with exchange of good practices.

The Action Plan for achieving the goals of SRIP MATPRO in the field of social sustainability includes the definition of qualitative indicators of the planned activities, the definition of the target groups to which individual activities will be focused and the quantitative definition of the implementation of the covered activities. Individual activities from the aspect of sustainability are specified in the introductory section of the Action Plan.

Code	Action	Qualitative indicators	Target groups	Quantitative indicators	
				2018 (2 chains)	2022 (3 chains)
B1	information	individual consulting of target groups in the field of economic sustainability, informing about the sectoral innovations and activities of SRIP MATPRO	chain carriers, value chains, members of SRIP MATPRO, ZKovI, ZKI, ZKM	5	6
B2	motivation	motivational actions to promote economic sustainability	chain carriers, value chains, members of SRIP MATPRO, ZKovI, ZKI, ZKM	3	3
B3	introductory individual interviews	introductory individual interview s with the chain carrier to determine the current state	carriers of value chains	2	3
B4	carriers of focus groups	carriers of focus groups of value chains for the exchange of good practices	carriers of value chains	5	3
B5	workshops for value chains	workshops of members value chain s for the design of the strategy and the setting of strategic goals	value chains	6	9
B6	problem conferences	problem conference for expert discussion of selected areas in economic sustainability	chain carriers, value chains, members of SRIP MATPRO, ZKovI, ZKI, ZKM	2	3
B7	individual consulting	providing advisory support to individuals or groups of members of SRIP MATPRO in problem solving	chain carriers, value chains, members of SRIP MATPRO	10	18
B8	professional meetings	occasional professional meetings to highlight more complex content challenges in the area of economic sustainability	chain carriers, value chains, members of SRIP MATPRO	5	6
B9	study visits	visits to companies and other organizations for examining good practices and deepening knowledge about economic sustainability	chain carriers, value chains, members of SRIP MATPRO, ZKovI, ZKI, ZKM	3	3

Action Plan - Social Aspects. Informing, motivating and meetings for promoting CSR within each target group will be carried out in the following timetable:

Activity \ Quarter	2017		2018				2019				2020				2021				2022			
	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.
B1 – information	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
B2 – motivation	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
B3 – individ. interviews	■										■											
B4 – focus groups		■				■			■			■				■				■		
B5 – workshops of value chain			■				■			■			■				■				■	
B6 – prob. conferences					■					■				■				■				■
B7 – counselling	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
B8 – professional meetings	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
B9 – study visits	■			■				■			■				■				■			

The timetable is informative and will adapt to the current needs of carriers, members of the chain of values and SRIP members of MATPRO.

5.2 Promoting innovation

Every year, the CCIS will organize the competition for the best innovations. It is a continuous process of stimulating innovation among employees, emphasizing the introduction of innovation processes in companies, knowledge institutions and SMEs. The best innovations awarded at the regional level are presented at the National Innovation Day. The call has two stages. At the first stage, the Regional divisions of CCIS will open competitions for the best innovations. Registered innovations will be evaluated according to adopted criteria given in rules that will apply at both regional and national level. The CCIS project has been implemented at the regional level since 1996, and on the national level since 2002. Through the operation of the SRIP MATPRO, the promotion of innovation will be transformed into a new phase of development, as cooperation between the economy, research institutions and knowledge institutions will be emphasized. The cooperation between the listed partners with the goal of joint development of new focus directions that will enable the development of new breakthrough products, services and management models, is becoming extremely important. Due to the structure of SRIP MATPRO, the active participation of all members will be endorsed. The promotion of innovation will be closely linked to the relevant services of the CCIS, and the development of the competences of employees in the transfer of technologies, the conduct of procedures for the protection of intellectual and industrial property, and procedures for filing international patents, trademarks and intellectual property protection.

Innovation activities:

- Slovenia ranks by innovation in the first half (different scales).
- Introduction and promotion of innovation in companies, including SMEs, the introduction of comprehensive incentive systems (motivation, remuneration,

promotion, other financial and non-financial incentives), intellectual property management.
- Implementation of at least one innovation event in connection with the operation of SRIP MATPRO at the regional level.
- Development and provision of the following services within SRIP MATPRO: development of competences of employees in the field of intellectual property, use of intellectual property databases to monitor global development trends - recognizing company opportunities, promoting innovation culture in companies.
- Information.
- Consulting and mentoring (intellectual property, participation in EU programs, innovation systems in companies, etc.).
- Development and introduction of new services: following of global development trends through IP Intelligence databases, the review of »Digital Innovations«.

Promotion of innovations and innovators will be carried out through CCIS and SRIP MATPRO channels. CCIS promotional channels are TV CCIS, events such as awards for best innovations at regional and national level, the use of social networks: Facebook, Twitter, CCIS portal, portal Inovativna Slovenija, CCIS Business Week, Catalogue of Innovative Companies (in Slovene and English), Discover Slovenia (in English). To promote the traditional Slovenian products, we will approach various innovative ways in order to show the quality of products in a new, creative and effective way.

5.3 Encouraging entrepreneurship

With its network of regional chambers and industry associations, the CCIS represents an appropriate support environment for promoting entrepreneurship within the SRIPs.

In doing so, the target group of SMEs involved in the operation of SRIPs will be their value chains and horizontal networks in all development phases. The second target group are the newly emerging SMEs, which will be set up as spin-offs of companies involved in SRIP MATPRO and start-ups, which will have greater growth potential due to their links with the SRIP MATPRO and the opportunities offered by results. In addition, SRIPs will also be encouraged to set up social enterprises. These are companies operating in areas related to sustainable development, especially in the areas of green economy, the circular economy or as social enterprises, which will be part of the development potentials in the circular economy. It is not negligible that such companies employ vulnerable target groups such as older people who, due to different limitations, cannot be included in regular work in parent companies or disabled persons with different physical and psychological limitations.

In the phases of TRL 1-3, highly specialized expert-oriented companies will be involved, which will support the development of basic research and their integration with the economy. Similarly, in the development phases to the TRL 6, specialized SME-related SMEs will be involved in the implementation of support services within SRIPs. In TRL 6-9, SMEs will be involved, as suppliers of major systems in the production processes, in the

fields of introducing production and services and in the field of the introduction of products and services on the market, especially in the international value chains.

The advantage of the development of support measures intended for SMEs arises from the close connection between the large and SMEs within the SRIP MATPRO. The measures will be distributed and implemented separately for potential entrepreneurs, for newly-established SMEs (with special attention to start ups), and companies in growth. The supportive environment will encourage entrepreneurship through various measures.

Measures in the phase of recognizing and developing entrepreneurial ideas in SRIP MATPRO:

- The SRIP's interest in involving SMEs in the development or implementation of a program.
- Information and promotion about the activities of SRIP MATPRO and identification of areas where SMEs would participate.
- Services related to recognizing entrepreneurial opportunities in SRIPs and encouraging the development of business ideas related to the performance and results of the SRIP in all phases of development.
- Linking SRIP with knowledge institutions, career centres at universities and involving students and graduates.
- Training of existing as well as new potential entrepreneurs and help in starting a business.

Services for new Companies:

- Introduction of models of performance and standards in various fields of operation (technological, development, production, environmental ...).
- Networking - a continued form of cooperation between SMEs and larger enterprises involved in SRIP MATPRO (increasing the competitiveness).
- SRIP-a. Training SMEs to ensure the unified quality of products and services within the SRIP.

Services for business growth:

- Promoting innovation in SMEs.
- Financial incentives for growing businesses.
- Joint product development with companies in SRIP MATPRO.
- Intellectual property.
- Acquisition and maintenance of various certifications that demonstrate excellence in business operations and the enforcement of standards that apply within SRIP MATPRO or global value chains.

In the implementation of support services for entrepreneurship, CCIS has established cooperation with other institutions of supportive environment in Slovenia and internationally.

CCIS with all its organizational units operating in all regions and associations will develop and implement joint services for stimulated establishment, operation and development of SMEs in SRIPs. In addition to the supportive environment for entrepreneurship, SMEs will also be able to develop and implement appropriate technological standards, principles of sustainable development and the promotion of innovation in SMEs. At the same time, through the implementation of services in the field of internationalization, competence development and training, and in particular networking between the members of SRIPs, it will enable SMEs to integrate into global value chains, thus achieving greater competitive advantage on the market and faster development .

5.4 Development and implementation of data gathering and monitoring

In establishing a model for capturing and monitoring of results, we will follow general guidelines such as quality, comparability, clarity, up-to-date and objectivity of feedback. We will endeavour not to increase the administrative burden on businesses and to try to obtain data from official registry sources in order to avoid repeated reporting of the same information.

Yearly we will obtain financial data from the official register sources (each time in May for the previous year). The indicators will be calculated using the methodology of the CCIS analytics, based on unconsolidated business data.

Some other data will be obtained yearly from the companies joined in SRIP MATPRO, using an electronic questionnaire, and other (educational programs) by the institutions that keep relevant records. These data are:

- Investments in research and development.
- Number of new partnerships.
- Number of connections with external partners.
- Number of patents.
- Number of renewed and new educational programs.

With the care of a good master, we will randomly check the accuracy of these data (for example, patents in international databases). In this way, we will assess the reliability of data.

5.5 Information, communication, promotion, social dialogue

Communication with the public about novelties (trends, technologies, etc.), activities and results of SRIP MATPRO and promotion:

- Special thematic sets in the magazines »Glas gospodarstva« and Discover Slovenia on key guidelines in connection with the products of companies from

areas covered by SRIP MATPRO, both for the domestic and foreign markets, with the aim of promoting the global value chains (reference material *https://www.gzs.si/o_gzs/discover_slovenia_2016_small_web.pdf).*

- PR and problem articles designed to promote and destigmatize the area of industry ..., published online, newsletters, etc.
- Journal »The« Materials (MATPRO).
- Publication of information through various available CCIS communication channels (web, e-newsletters, ...).
- (an example of the Advanced Adhesive and Sealing Technology Conference for solving of industrial challenges *https://www.gzs.si/mediji/Novice/ArticleId/57945/napredne-tehnologije-lepljenja-in-tesnjenja-za-resevanje-industrijskih-izzivov).*
- Use of social networks to inform the general public *(https://twitter.com/GZSnovice, https://www.facebook.com/GZSsi, https://www.linkedin.com/company-beta/310010/).*
- Organization, preparation and implementation of press conferences and other forms of communication with the media *(https://www.gzs.si/mediji/).*
- TV.GZS - reports, videos, statements *(https://www.youtube.com/user/GZSvideo)*
- Design of advertisements.
- Promoting professions in the field of metallurgy (from kindergarten to University) in an innovative way.

Events - Organizational support / technical organization of key events:

- Organized invitations: editing and distribution of e-invitations.
- Preparation of materials for participants.

Communication support to key events organized by SRIP MATPRO

- Business public:
  - Announcement of events in CCIS calendar and e-bulletin.
  - Online (and through other CCIS communication channels) publishing about the events.
  - Information through social networks.
  - Short video / reportage statements on the event via TV.GZS.
- Media:
  - Invitation of media.
  - Preparing a press release about the event.

Lobbying - Representing SRIP's interests at decision-makers.

- Preparing a lobbying strategy.
- Consulting on lobbying tactics.
- Editing documents for decision makers.
- Organization of meetings with decision makers.
- Placement of topics relevant to decision-makers' in the CCIS and external media.

Dissemination - Finding key partners abroad and promoting members of SRIP MATPRO.

- Conducting interviews and connecting events.
- Presentation of the effects of SRIP MATPRO activities and
- Promotion of SRIP MATPRO members on:
  - international trade fairs and workshops,
  - scientific congresses, conferences and,
  - European Events (S3 Platform, Vanguard Initiative, etc.).