# D4.5

# Innovation Management Plan

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## Document information

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## Disclaimer:

**Versioning and Contribution History**

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| v.02 | 14/07/2020 | Arrigo Calzolari | Review |
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[1] Acronyms are marked in purple in the text and defined at the end of the document.

## Executive Summary

The present document "Innovation Management Plan" (Deliverable 4.5) is prepared under the task T4.4. "Innovation Management" (IM) of Work Package (WP) 4 – Exploitation, dissemination & communication of the INTERSECT project.

INTERSECT aims at driving the uptake of materials modelling software in industry, bridging the gap between academic innovation and industrial novel production, with the goal of accelerating the process of materials selection and device design and deployment. The Innovation Management task is explicitly conceived to monitor the market needs and the technical evolutions throughout the project lifetime, and to plan an exploitation strategy after its end. One main purpose of Innovation Management is to constantly refine the project work plan so as to meet the market and partner institutions' (including academic, R&D institutes, EU infrastructures) needs with state-of-the-art technological solutions. This deliverable includes the initial IM strategy and a detailed Innovation Management Plan of action. IM activities are managed by AMAT, in close collaboration with the Project Coordinator (CNR), the WP leaders, and the Advisory and Exploitation Board (AEB). Since innovation is not restricted to scientific invention, but embraces all the development and exploitation aspects of the project (such as commercialization, dissemination, licensing, IP management, etc.) this document is tightly connected and complementary to First Data Management Plan (Deliverable D4.2), First Business Plan (Deliverable D4.3), First report on dissemination and communication activity (Deliverable D4.4), Risk assessment and risk mitigation reports (Deliverable D5.2) and the consortium agreement that regulate specific actions and rules in the projects and within the participant groups.

In the initial part of the project (M1-18) the focus activity was on the design and the implementation of software (WP1-2) and the setup of the pilot cases (WP3). Thus, so far the application of this plan was premature. The exploitation activity planning is going to be predominant in the second part of the project, when outcomes and results will be achieved. Nonetheless, we have already set up the innovation tools described below, and we analyzed the qualifying aspects of the projects (e.g., deliverables and governance) along the lines of the present innovation plan (see Sec. 3.4.5). This constitutes the initial step for the actual implementation of the innovation plan.

The rest of the document is organized as follows:

- Section 1 – Introduction: it briefly presents INTERSECT and describes the purpose of the document and its intended audience
- Section 2 – Innovation Strategy: it describes the IM approach
- Section 3 – Innovation Management: it describes the application of the general Innovation strategy to INTERSECT and the specific framework for assessment, as a result of the Mapping phase
- Section 4 – Conclusion: it summarizes the main outcomes of this deliverable.

# 1. Introduction

## 1.1. Concept and approach

INTERSECT is an interdisciplinary and collaborative project for the realization of an advanced industry-driven simulation box (IM2D) for emerging disruptive electronics. IM2D is an interoperable platform that allows the exploration of the materials using a device-oriented approach that is urgently needed by industry. By adopting INTERSECT IM2D into their R&D design processes, European and worldwide semiconductor companies would achieve competitive advantage over their rivals improving:

- **time to market:** shortened design, continuous integration, and validation cycles enabled by the IM2D platform
- **cost saving:** reduced number of experiments
- **R&D strategy & efficiency**: more efficient use of R&D resources, and prioritization of the most important programs
- **development process:** IM2D contributes by increasing the productivity, empowering faster cycles of learning generated from the design databases
- **decision making**: translators can gain greater insight into risk and delays, enabling proactive decision making to manage resources and customer commitments.

## 1.2. Purpose of the deliverable

The purpose of this document is to describe the IM approach and the tools to be adopted during the INTERSECT project development. To this aim, we provide an integrated document that starts from the concepts of innovation and IM, to further describe the main IM tools and their application to INTERSECT. The INTERSECT Innovation Management Plan is dynamic and will be adapted during the project according both to the timeline and the achieved results.

## 1.3. Intended audience

This deliverable is addressed to the members of the project consortium and to any interested parties outside the project. The dissemination level of D4.5 is public (PU) and not limited to members of the Consortium. This document is, first of all, a guide to the project participants to understand all aspects and actions of the innovation process. In addition, it may serve as an informative report for the external parties interested in the innovation potential of the project and its development.

## 2. Innovation Strategy

In the spirit of preparing an IM plan within a collaborative project like INTERSECT that joins together different profiles (academic and industrial partners) with different expertise (materials science, physics, electrical and computational engineering) and different ambitions (scientific research, infrastructure development, commercialization), it is necessary to provide a shared definition of the **innovation concept**.

A ubiquitous definition of innovation does not exist and many possible interpretations can be found. In particular, innovation is often abused for marketing purposes to present an **invention**. This oversimplifies the scope and complications of what the innovation-process entails. More properly we adopted the definition of innovation as: "*any successful generation, development and implementation of new and novel ideas, which introduce new products, processes and/or strategies to a company or enhance current products, processes and/or strategies leading to commercial success and possible market leadership and creating value for stakeholders, driving economic growth and improving standards of living*." [1] Along these lines, the European Commission (1995) defined innovation as the "*successful production, assimilation and exploitation of novelty in the economic and social spheres*". From this perspective, invention is only a limited aspect of innovation, which entails all aspects of a project activity, ranging from vision to business, intellectual property (IP) and communications. In its wider definition, innovation offers new solutions to problems and responds to the needs of both the individual and society.

The innovation processes share some common basic activities that support the generation of ideas for new product and process development and the management of the entire innovation process. These fundamental activities are:

- generation of ideas which potentially could become new products or processes after implementation
- acquisition of knowledge on the generated ideas
- implementation and market monitoring to verify customer satisfaction and after sales.

In order to support its innovation activities (DOA sec. 3.2.1.2), INTERSECT established a strategic structure coordinated by the Innovation Manager Valerio Lunardelli (AMAT), who reports to the Advisory and Exploitation Board (AEB). Within the project, the Innovation Manager is committed to:

- work with partners and stakeholders to keep track of state-of-the-art products, solutions, and services available in the market (competition)

- work with partners to ensure that the planned work adapts and follows the evolving needs of market and society.

## 2.1 Innovation management approach

The models following the IM approach do not focus on the development of invention itself, but rather on the evolution of company's strategies under different social, economic and political circumstances. Among a variety of IM strategies, the approach chosen for the INTERSECT project is commonly known as **Open Innovation** [2].

### 2.1.1 Open Innovation

This approach supports the idea that innovation occurs as a result of interactions between different actors, rather than being the result of an isolated genius [3]. This innovation concept is supported by the European Commission (2016) and its Horizon 2020 program, and is the basis of the present project [4]. Collaborative approaches to research and innovation processes have shown to deliver a positive effect on the results of innovation activities and business profitability.

Open Innovation is a strategy to leverage internal and external sources of ideas and take them to market through multiple paths; collaboration is the key to achieve high innovation rates and efficient product development. The cooperation capacity of organizations through agreements lets ideas flow across organizational boundaries [5]. The concept of Open Innovation is opposed to **Closed Innovation** [6], where the overall innovation process, from ideas to marketing, happens within the organization and profit is generated by pioneering innovation in the market (Figure 1). At odd, in the Open Innovation model both the internal and the external organization environments are involved in the process.

A few remarkable advantages in developing Open Innovation strategies are the possibility of exploring new markets and the increased flexibility. Furthermore, they facilitate access to those new markets and new knowledge, allow to share both risks and resources in the process, support innovation, and foster the creation of new value, the confrontation of ideas and practices, and the creation of synergies.

When following an Open Innovation strategy, particular attention must be dedicated to overcome critical issues, such as the dependence on the underlying value system, the identification of the "added value" contributed by each partner, the distribution of income and liabilities, and the change in valuable aspects from tangible to intangible.

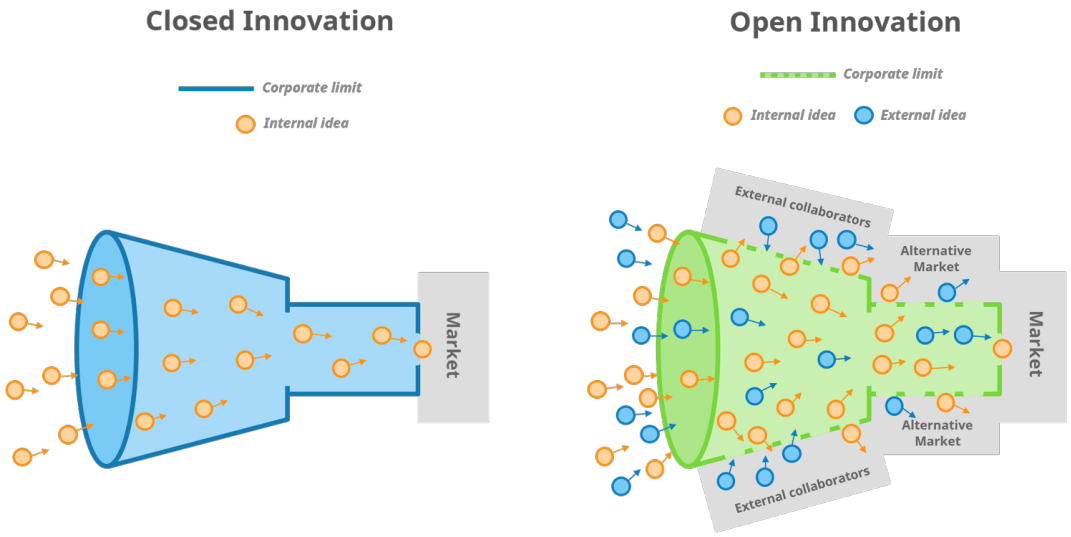


*Figure 1. Closed vs Open Innovations. Picture adapted from Ref. [5]*

In the development of an Open Innovation model, several processes can be followed:

- **Outside-in Process:** organizations invest in cooperation with other agents and integrate external knowledge
- **Inside-out Process:** to outsource internal knowledge and technology. This allows organizations to reduce fixed costs of the R&D activities, to set them as a reference in the market and their products/services as a standard, and to provide benefits from licenses and patents
- **Coupled Process:** cooperation with other participants through strategic networks for an extended period. Greater benefits can be obtained and success depends on the choice of the right partners, and on the integration of the external knowledge and skills [7].

Within the Open Innovation model, the **Coupled Process** naturally fits with the characteristics and the multiple-purposes of a collaborative experience, like INTERSECT.

Depending on the strategies, organizations need to develop specific core capabilities [8]. In the case of the outside-in process, organizations must rely on their absorption capacity to integrate sophisticated and costly technology. Moreover, they must recognize the value of new external information, assimilate that information, and apply it to the market, taking advantage of efficient generation and integration processes. In the case of the inside-out process, organizations must rely on their multiplicative capacity to transfer internal knowledge to their parties. Organizations must select the most appropriate partners and

must be able to code and share their knowledge. Finally, for coupled processes, organizations need to develop an effective connection capacity to build and maintain relationships with partners, particularly with complementary entities and competitors.

Table 1 summarizes the main Open Innovation Activities for each process:

| Inside-out | Outside-In | Coupled |
|---|---|---|
| Licensing out | Licensing in | Co-development |
| Corporate venture capitalist | Merger & Acquisition | Collaboration |
| Staff Exchange | Innovation contests | Co-marketing |
| | Acquisition of right | Commercialization |
| | Outsourcing R&D | Co-promotion |
| | Technology scouting | Cross-distribution |
| | | Cross-license |

*Table 1. Open Innovation activities*

### 2.1.2 Open Innovation in INTERSECT

INTERSECT adopts a project-tailored Open Innovation approach, whose main principles are summarized in Table 2, in comparison with both Closed and Open Innovation models. In particular, INTERSECT follows a specific coupled process called Collaborative Product Development (CPD), in which a network of multi-disciplinary partners and suppliers works together to achieve common goals for competitive products. Indeed, INTERSECT relies on a multidisciplinary team of scientists, researchers, developers, engineers who cover a wide range of scientific areas including material science, nanotechnology, electronic engineering, and informatics and work together on the development of a common IM2D platform. IM2D integrates open-source materials modelling codes (Quantum ESPRESSO [9] and SIESTA [10]) with physical models and codes for emerging devices (Ginestra™ [11]). The code interconnection and management of data exchange and storage is controlled by an *interoperability hub,* based on ontology, lying on the AiiDA [12] and SymPhoNy [13] infrastructures (see D4.2).

| Closed Innovation Principles | Open Innovation Principles | INTERSECT approach |
|---|---|---|
| Smartest people in the field work | Not all most talented people | The INTERSECT consortium encompassed a unique interdisciplinary group of highly skilled scientists |

| | | |
|---|---|---|
| for us. | work for us. | and engineers working from academic, industrial (SMEs), and R&D Institutions. INTERSECT AEB provides an outlook from outside of the consortium to find and leverage ideas that can be used to improve INTERSECT innovation results. |
| To profit from R&D we must discover, develop and ship it ourselves. | A combination of internal and external R&D can generate tremendous value. | Internally, INTERSECT relies on a consortium that is a core of world-renowned academic research teams in the development of codes/infrastructures supporting materials science field and nanoelectronics, such as CNR (IT), ICN2 (ES), EPFL (CH), FRA (DE), together with an industrial-driven software company, AMAT (IT), and two world-wide R&D teams, IMEC (BE) and FMC (DE), expert in advanced simulation of materials and devices for synaptic electronics and neuromorphic computing. Externally, INTERSECT partners and activities are actively linked with other EU research initiatives. such as Materials MARKETPLACE, MaX Centre of Excellence, Optimade, etc. In addition, INTERSECT AEB allows connections with industrial and academic stakeholders to generate, evaluate and validate INTERSECT value from a market and research perspective. |
| If we discover it ourselves, we will get it to market first. | We don't have to originate the research to profit from it. | INTERSECT main objective is to re-use existing stand-alone models and related academic European codes relevant to disruptive electronics, realizing the IM2D box and maximize their exploitation for a medium-long term through different business models. |
| If we create the most and the best ideas in the industry we will win. | If we make the best use of internal and external ideas, we will win. | INTERSECT is about making the best use of internal and external ideas to collaborate on IM2D development. Scientists, developers and R&D engineers are working together to build up a unique infrastructure to link the different existing codes. |
| If we are the | Building a better | Use case identification and exploitation, market |

| | | |
|---|---|---|
| first to commercialize an innovation, we will succeed. | business model is better than getting to market first. | analysis and business planning are key actions to drive INTERSECT innovation process to select and validate the most promising ideas and generate new business pathways (see also business plan D4.3). |
| We should control our IP so that our competitors don't profit from our ideas. | We should profit from others' use of our IP and we should buy IP whenever it advances our own business model. | INTERSECT has a consortium agreement which regulates the access rights to background and results, to regulate IP ownership and exploitation, and to prevent any conflict with IP rights (IPR) (see also Data Management Plan D4.2). |

*Table 2. Open Innovation in INTERSECT*

## 3. INTERSECT Innovation Management

Innovation Management within European projects is a process that requires an understanding of market, legal, social, and technical issues, with the goal of successfully implementing appropriate creative ideas. The basic elements of the INTERSECT IM plan were already included in the original DoA with the establishment of the governing bodies and the definitions of ambitious deliverables in each WP. These constitute the starting point of this plan (Sec. 3.4). The innovation plan presented below describes the actions and/or steps to undertake within the INTERSECT consortium in order to realize the open innovation strategy of Section 2. This Innovation Management Plan tends to explore and scout new potential opportunities, and to internally validate them through market research and industrial/institutional stakeholder feedback. After their positive validation, these opportunities will be integrated in both Business and Communication plans.

### 3.1 General plan and tool description

The implementation of the open innovation model within INTERSECT is based on a multi-step plan, constituted of four phases: **mapping, scouting, assessment,** and **exploitation**, as shown in Figure 2.

1. In order to identify, classify and organize the INTERSECT deliverable from an innovation standpoint the first step is the **mapping phase**. The Innovation Manager will lead this process in cooperation with the Project Coordinator. The classification of the INTERSECT deliverables in terms of their innovation potential will follow later in this section.

Innovation has been evaluated following the *Technology Readiness Level* (TRL) and *Market Readiness Level* (MRL) criteria. The innovation risk for each deliverable has been evaluated through a *risk matrix* (see Annex-1 for further details). The mapping process allows us to create an **INTERSECT *innovation roadmap*,** adopting the *Stage Gate Model* (SGM) approach (Annex-1), which is an industry validated protocol to monitor the Innovation evolution of the project. The results of the mapping phase are presented in Section 3.4 of this Deliverable.

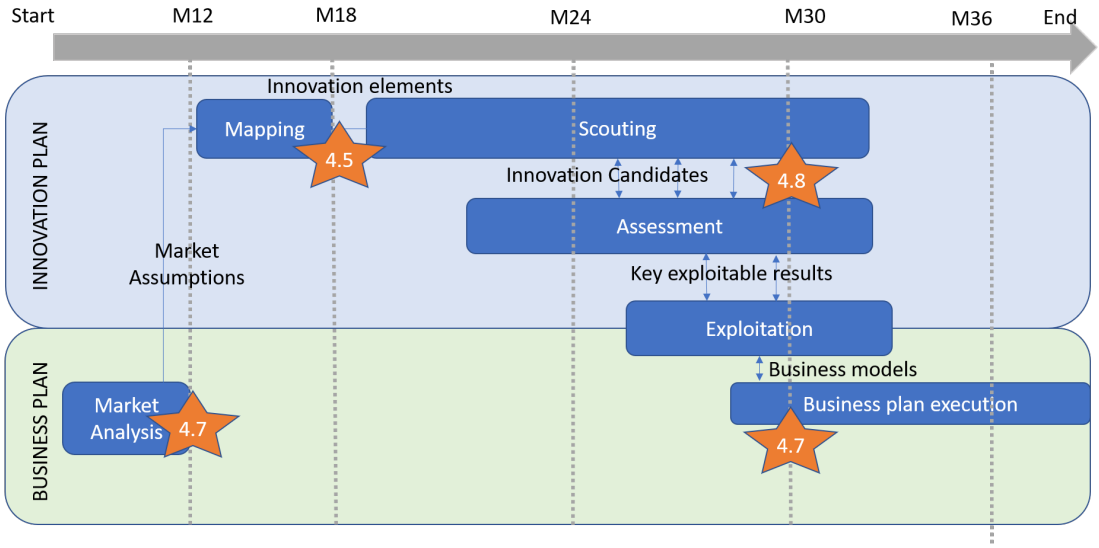


*Figure 2. Innovation plan. Stars indicate the number and time of the main deliverables.*

2. The following step is the **scouting process**, a rolling activity driven by an innovation roadmap and led by the Project Coordinator in cooperation with the WP leaders and the Innovation Manager. The Project Coordinator collects the project results, focusing on IP during the project execution. According to the innovation roadmap, WP leaders, in collaboration with the other Innovation actors, will analyze every result, selecting the ones with high innovation potential.

3. The selection and analysis of the innovation potential of results/actions will be done by using the so called *Innovation Radar Survey* [14] method and its questionnaire (see Annex 1)**,** which will allow the Innovation Manager and the AEB to draw an Innovation assessment in agreement also with the EU evaluation rules (see Annex-1 for further details). The **assessment process** will be performed by a set of indicators, namely the *Innovation Readiness Indicator* (IRI), *Innovation Management Indicator* (IMI), and *Market Potential Indicator* (MPI) and then evaluating the *Innovation Potential Indicator* (IPI) conceived to measure the *Real-Win-Worth It* (R-W-W) *screening* criteria [15] for the business impact of the innovation.

4. The description of single indicators and of the R-W-W screening is reported in ANNEX-1. The assessment process is the basis for the **exploitation phase**, during which the Innovation Manager and the AEB will analyze and select the **business model** that can maximize the impact of the innovation among the market segment. The Exploitation phase will use the Market analysis, assumptions and trends reported on the first Business Plan (Deliverable 4.3 "First business plan", M13) and will be the starting point for the "Business Plan revision" (D4.7, due M31). We remark that, as stated in DoA, we consider as outcomes/results of the project not only the implementation of the IM2D simulation box, but also the scientific data on materials and devices, the population of materials databases (e.g. OptiMaDe [16]) and the integration/development of EU cloud hubs, such as the Materials Marketplace [17]. Therefore, the assessment of the business strategy in its general sense also involves the definition of the communication plan, the data management plan and of the IP regulation.

According to the INTERSECT project timeline (see stars in Figure 2):

- The "Innovation Management Plan" (D4.5) is presented at M19 showing the innovation framework and the mapping process results
- Starting from the M19 the scouting process will regularly capture the INTERSECT innovation candidates and update the Innovation plan
- The Innovation Manager, flanked by the AEB, will evaluate and revise the present plan and define the "Innovation management assessment and revision" (D4.8) at M31 accordingly. The Exploitation process main outcomes will be published in the "Business Plan revision" (D4.7, M31), that will describe the INTERSECT business opportunities for exploitation, basing the analysis also on the progress made in the innovation field by the consortium.

## 3.2 Innovation Phases

Each phase described above is a structured set of activities, with clearly defined responsibilities. These activities have specific objectives, starting inputs, involved actors and final outputs.

For each process, we define:

- **Objective**: scope of the activity
- **Inputs**: inputs to the activity, and the persons/boards who provide them
- **Actors**: responsibility assignment matrix RACI to identify the roles in completing the process activities:
    - Responsible: Main executor of the process

- Accountable: The person who is accountable for the correct and thorough completion of the process
- Consulted: The people who provide information for the process
- Informed: The people kept informed of progress of the process

- **Activities**: list of the activities
- **Outputs**: description of outputs of this activity.

A description of the implementation of each phase to the specific needs and characteristics of INTERSECT is illustrated in the following.

### 3.2.1 Mapping

Starting from the Market analysis of D4.7, the Innovation manager organizes the INTERSECT outcomes identifying the ones with innovation potential, collecting the IP background statements and creating an innovation framework, and following an industrial-validated model.

| **Objective:** | Mapping INTERSECT deliverables with innovation potential | | | |
|---|---|---|---|---|
| **Input** | INTERSECT project | | | |
| **Actors** | Responsible | Accountable | Consulted | Informed |
| | Innovation Manager | Project coordinator | AEB | WP leaders |
| **Actions** | - Identification of INTERSECT deliverables with innovation potential<br>- Classification of the deliverables using the following criteria<br>  ○ TRL – Technology Readiness Level<br>  ○ MRL – Market Readiness Level<br>- Define the innovation path framework using the SGM approach<br>- Define the risk level with the Risk Matrix<br>- Create an IP register | | | |
| **Outputs** | Innovation framework<br><br>List of key innovation elements<br><br>IP Register | | | |

### 3.2.2 Scouting

Following the innovation framework, the WP Leaders, coordinated by the Project Coordinator, collect all the innovation-relevant information using the European Union

**Innovation Radar Questionnaire** [14] during the project execution (see Annex 1). During the Innovation profile action, the Project Coordinator collects and organizes the information about the results with innovation potential. At this stage the results are called **innovation candidates** and are ready to be evaluated by the Innovation Manager and the AEB during the assessment phase.

| | | | | |
|---|---|---|---|---|
| **Objective:** | Capturing information and innovation profiling related to INTERSECT results | | | |
| **Input:** | INTERSECT key innovation element | | | |
| **Actors** | Responsible | Accountable | Consulted | Informed |
| | Project coordinator | Innovation Manager | WP leaders | AEB |
| **Actions** | - Collection of data and information INTERSECT project key results<br>- IP information collection<br>  ○ Identifying background IPs<br>  ○ Identifying foreground IPs<br>- Innovation profiling<br>  ○ Applying the Innovation Radar Survey to capture innovation data/components and information | | | |
| **Outputs** | List of innovation candidates<br>Updated IP register | | | |

A template document with the innovation radar questionnaire (16 questions) has been prepared and shared among all partners in the reserved area of the INTERSECT web site (www.intersect-project.eu), under a dedicated section named “Innovation”. The document includes also the evaluation score (from 1 to 10) to each question of the survey. This will provide a quantitative starting evaluation of the proposed “candidates”. A six-month schedule from M19 to M37 has been drawn by Innovation Manager for collecting, updating and analyzing the innovation questionnaires that will be discussed in the assessment phase (see below). The reserved “Innovation” section also includes a **Stakeholder Register** (see also Deliverable D4.4) with the list of the main stakeholder profiles interested in the INTERSECT activity, and the **IP Register** of all the involved parties (see Sec. 3.4.6).

### 3.2.3 Assessment

The list of *innovation candidates* will be evaluated and ranked by the Innovation Manager and the AEB following the EU Innovation Radar guidelines [14]. The innovation candidates

with a high rank of innovation potential will be qualified as key exploitable results and moved to the next level, the Exploitation Phase.

| **Objective:** | Analyse and rank the INTERSECT innovations to select the key exploitable results | | | |
|---|---|---|---|---|
| **Input:** | List of potential innovation results and framework | | | |
| **Actors** | Responsible | Accountable | Consulted | Informed |
| | Innovation Manager | AEB | Project coordinator | WP leaders |
| **Actions** | Assessment analysis and focus sessions to rank and evaluate framework to rank innovation potential from the standpoint:<br>- Innovation readiness<br>- Innovation management<br>- Market potential<br>- Select the key exploitable results | | | |
| **Outputs** | List of key exploitable results | | | |

### 3.2.4 Exploitation

The Innovation Manager supported by the AEB will analyze each key exploitable result to identify the best business model that can be adopted to maximize the business growth of the results. As a result of this activity, a canvas model will be developed for each key exploitable result. This activity will be directly connected with the business plan activity. Starting from the business model canvas, market segmentation, competitive landscape and marketing activities will be analyzed on the D4.8.

| **Objective:** | Identify the business model for developing the Business Plan | | | |
|---|---|---|---|---|
| **Input:** | List of key exploitable results | | | |
| **Actors** | Responsible | Accountable | Consulted | Informed |
| | Innovation Manager | AEB | Project coordinator | WP leaders |
| **Actions** | - Brainstorm for innovation Business Models focused on formulating value propositions, branding and market segmentation<br>- Identify the best Business Models which can exploit the innovation result<br>- Identifying the “go to market” needs of high potential innovations<br>- Align and validate new Business Models with industrial relevant partners | | | |
| **Outputs** | Business model definition | | | |

## 3.3 Governance

Table 3 summarizes the key roles and responsibilities in the INTERSECT Innovation Management.

| Role | Responsibilities |
|---|---|
| **Project Coordinator**<br>Arrigo Calzolari (CNR) | • To support the innovation manager in the mapping phase.<br>• To lead the scouting activity collecting by the WP Leaders the information regarding INTERSECT results<br>• To collect data and information on the INTERSECT project key results.<br>• To collect and catalogue the IP information.<br>• To check that the Innovation Radar Survey is filled by the WP Leaders for innovation results candidates.<br>• To ensure that all the pieces of information related to the project results are complete and updated.<br>• To support the Assessment and the Exploitation phase. |
| **WP leaders**<br>WP1 Adham Ashibon (FRA)<br>WP2 Nicola Marzari (EPFL)<br>WP3 Andrea Padovani (AMAT)<br>WP4 Arrigo Calzolari (CNR)<br>WP5 Arrigo Calzolari (CNR) | • To provide the information about the INTERSECT results and their IP to the Project Coordinator.<br>• To collaborate on the selection of the innovation candidates.<br>• To fill the Innovation Radar Survey for the innovation results candidates.<br>• To ensure that information is always complete and updated. |
| **Innovation Manager**<br>Valerio Lunardelli (AMAT) | • To lead the mapping activity and set the innovation framework.<br>• To validate the list of key results.<br>• To support the Project Coordinator collecting information about key results, IP, and innovation profiling.<br>• To drive the selection of the innovation candidates.<br>• To lead the Assessment and Exploitation phase.<br>• To advise on the best business and IP strategy approach. |
| **Advisory Exploitation Board**<br>Valerio Lunardelli (AMAT)<br>Tibor Grasser, Institute for Microelectronics, Wien (AU)<br>Teodoro Laino, IBM Zurich Research | • To periodically review the list of innovation candidates.<br>• To support the Innovation Manager during the Assessment and Exploitation phase by validating the innovation opportunities and advising which is the best business model to adopt.<br>• To review the exploitation plan and support exploitation plan execution. |

| | |
|---|---|
| Lab, Zurich (CH)<br><br>Alexandr Fonari, Schrödinger software, New York (USA)<br><br>Jennifer Rupp, Massachusetts Institute of Technology, Boston (USA)<br><br>Markus Ganser, Robert Bosch GmbH | |

*Table 3. Innovation Management Roles & Responsibilities*

## 3.4 Mapping activity output

### 3.4.1 INTERSECT Innovation pillars

INTERSECT will realize industry-ready integrated, standardized, interoperable software solutions starting from academic software or knowledge results from existing and past projects. IM2D platform will provide industrial stakeholders a yet-unexplored access to the most advanced academic models. INTERSECT also allows a broad, fast, and easy link (both to information and data) between the materials modelling community and semiconductor industry. The implementation of the IM2D software is the capital but not the only expected outcome from the INTERSECT project. Other innovation aspects will deal with, e.g., software components (single or parts of codes, workflows, plugins, modules, Graphic User Interface (GUI)), science&data (new materials, new devices, physical properties), and networking (other projects, collaborations, database population, digitalization infrastructures).

The innovation pillars of the INTERSECT project are:

- **Supporting the interoperable technology development starting from identifying key user stories** (WP1 and D1.1) and using the simulation-enabled material-device codesign for driving efficient R&D processes. IM2D infrastructure is conceived to be as general as possible and agnostic to specific device solutions, i.e. an efficient platform for any new disruptive electronics, not limited to the piloting cases described in WP3.
- **Developing the IM2D multiscale methodology connecting material modelling to electron device simulation.** INTERSECT introduces a holistic concept of memory device modelling, including ab initio material simulations, device models, and compact models for developing emerging electronics devices. IM2D allows stakeholders to simulate electronic devices and their reliability from (i) a Materials-to-device approach, where material properties, including structural and electrical effects of defects initially calculated by using electronic and discrete modelling, are further exploited by the Ginestra™ code to simulate the electrical response of a selected

device; and (ii) Device-to-materials approach, where specific electrical device characteristics (e.g., I-V curve) are coded using Ginestra™ to identify/determine specific material properties (e.g., spatial and energetic distribution of defects), to be investigated by using atomistic approaches.

- **Developing semantic interoperability based on ontology.** INTERSECT develops an high level semantic interoperability based on a material-transport extension of the EMMO ontology [18], that we are developing in collaboration with the EMMO developer team [19] (D1.3). Through the integration of the SimPhoNy infrastructure, we realize an open simulation platform for the seamless integration of various models used in industry as defined in WP1 (D1.2).
- **Enhancing the academy-to-industry technological transfer**, i.e., the acquisition of advanced know-how in the industry workflow. INTERSECT embraces a new paradigm that couples materials and device modelling, semantic interoperability and automation. The result is a high-performing software: an efficient learning solution which aims at accelerating the technological transfer from academia to industry by reducing the learning curve for the users (D1.1).
- **Re-using, upscaling and upgrading materials models and related software**. INTERSECT re-uses and upscales existing materials and device modelling codes developed by academic research institutions (such as Quantum ESPRESSO and SIESTA at TRL4) and SMEs (Ginestra™, TRL4) to realize a platform tailored on the industrial needs acquired by the industrial final users (TRL7). The semantic interoperability layer is implemented by upscaling and integrating the SimPhoNy and AiiDA infrastructures.

### 3.4.2 Key innovation elements

In order to identify the key innovation elements, we analyzed the INTERSECT deliverables listed in the DoA, on the basis of their innovation potential. The deliverables have been classified using the following parameters:

- TRL for the assessment of the maturity of the technology developed in the project (see Sect. 3.4.3)
- MRL for the assessment of the commercial readiness of technology to be launched in the marketplace (see Sect. 3.4.3)
- KPI as identified in D5.1
- SGM approach (see Sect. 3.4.5)

The overall deliverable analysis is summarized in Table 4, while the specific indicator descriptions and their application to INTERSECT are reported in the following Sections (3.4.3-3.4.5).

### 3.4.3 Technology vs Market Readiness Level

According to the recommendations on the enabling of innovation, research and growth in ICT for the Digital Single Market [20], we evaluate the INTERSECT outcomes (codes and data) on the basis of the TRL and MRL cross correlation indicators. MRL inherits its scale from TRL, matching the level of granularity. Similar to technical product development, MRLs feature four business process-oriented phases, from ideation to scaling business, to a sustainable and resilient–commercial operation (for further details see Annex 1 and MRL section at www.cloudwatchhub.eu).

The chart below (Figure 3) represents the TRL vs. MRL evolution of the INTERSECT project deliverables. At the end of the project, starting from the **business models** identified during the **exploitation phase**, the INTERSECT outcomes will be hopefully exploited by engaging the first pioneers (paying customers). This will allow it to penetrate in the market segment and expand the market share.

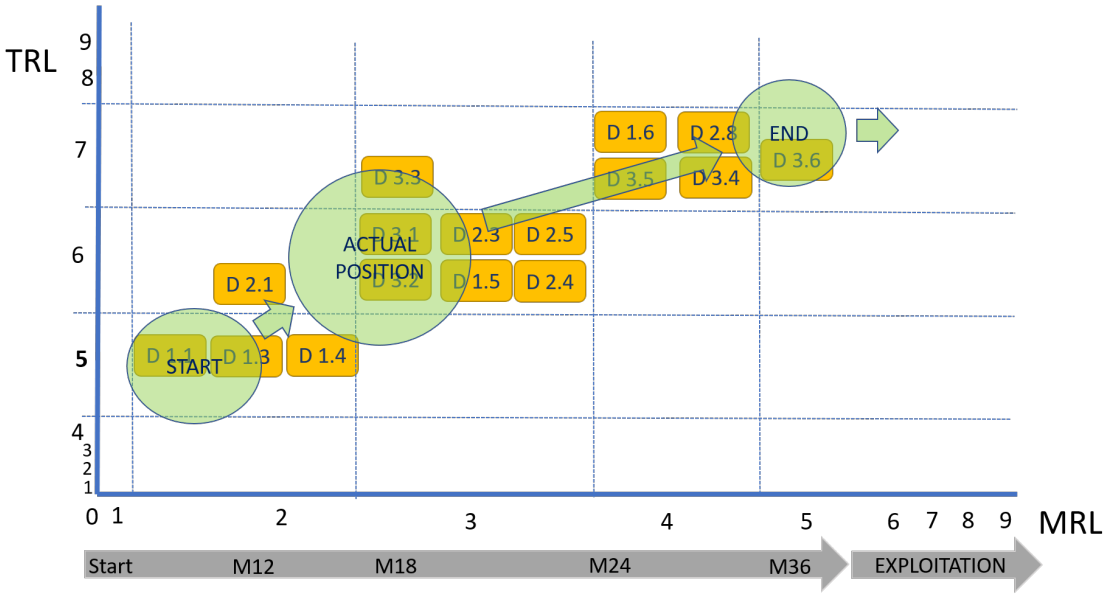


*Figure 3. TRL vs. MRL INTERSECT positioning*

### 3.4.4 Innovation Risk assessment

In order to successfully drive the innovation roadmap, an Innovation Risk Matrix (Annex-1) has been adopted, aiming at identifying the INTERSECT innovation risks during the project execution. The Innovation Manager together with the AEB will conduct the evaluation, with the support of the WP Leaders and the development teams. Team members will rate each activity independently and then justify their rationale. They will discuss different rates to seek consensus. The resulting scores will serve as the project's coordinates on the risk matrix.

The result of the application of the Innovation Risk Matrix to the INTERSECT plan is shown in Figure 4, in which yellow labels (DX.Y) indicate the project deliverables. This analysis complements the general risk assessment related to the overall realization of the project ("Risk assessment and risk-mitigation reports", D5.2, M19).

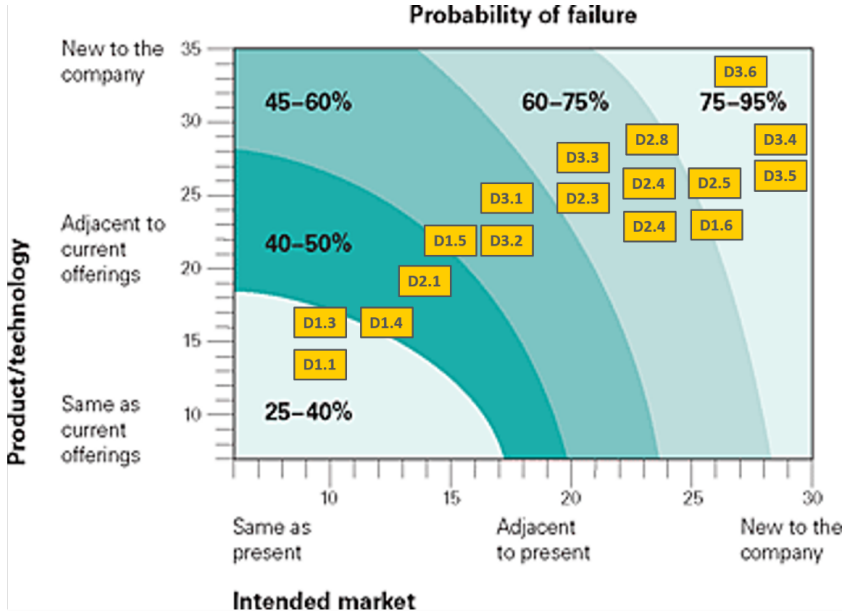


*Figure 4. INTERSECT Innovation risk matrix. DX.Y labels identify the project deliverables. Picture adapted from Ref. [15]*

### 3.4.5 Innovation framework

The final output of the Mapping phase is the Innovation framework. INTERSECT innovation framework follows the SGM approach, an industrial model applied to new product development projects with the purpose to create more value. Its strength lies in genuinely improving an organization's ability to convert innovative ideas into practical applications and new products, using a roadmap comprising various deliverables called **stages** (ANNEX-1). Following Stage-Gate models the Innovation manager organized the deliverables with innovation potential in the different stages: Scoping, Building Business Cases, Development, Test and Validation, Launch. The results of the SGM analysis applied to the project deliverables are summarized in Table 4 along with evaluation of the present TRL and MRL indexes.

| N° | Deliverable name | Delivery Month | TRL | MRL | Key Metrics | Stage-Gate |
|---|---|---|---|---|---|---|
| D1.1 | Report on use cases and system requirements | 6 | 5 | 2 | Dissemination activities impact | Stage1 – Scoping |
| D1.3 | Report on INTERSECT developed ontologies and MODA | 12 | 5 | 2 | Dissemination activities impact | Stage 3 – Development |
| D2.1 | Plugins for code interoperability | 12 | 6 | 2 | Prototype impact | Stage 3 – Development |
| D1.4 | Report on high-level requirements, interoperability interfaces for coupling and linking | 18 | 5 | 2 | Dissemination activities impact | Stage 2 – Build Business Case |
| D1.5 | GUI design and setup | 18 | 6 | 3 | Prototype impact | Stage 3 – development |
| D3.1 | Atomic defect properties extracted from the electrical measurements on FE-$HfO_2$-device | 18 | 6 | 3 | New IP agreements | Stage 2 – Build Business Case |
| D3.2 | Atomic defect properties extracted from the electrical measurements on OTS selectors. | 18 | 6 | 3 | New IP agreements | Stage 2 – Build Business Case |
| D3.3 | First report on IM2D box evaluation through user feedback based on the FOMs | 18 | 7 | 3 | Measure of the interaction with users, designers and engineers Investment on innovation and project management | Stage 4 – Testing and Validation |
| D2.3 | QE and SIESTA workflows for advanced materials parameters (Tasks 2.1.3-5): Part I. | 24 | 6 | 3 | Prototype impact | Stage 3 – development |
| D2.4 | Materials-to-device and device-to-materials syntactic interconnections | 24 | 6 | 3 | Prototype impact | Stage 3 – development |
| D2.5 | Semantic | 24 | 6 | 3 | Prototype impact | Stage 3 – |

| | | | | | | |
|---|---|---|---|---|---|---|
| | interoperability of the automated workflows through SymPhoNy. | | | | | development |
| D1.6 | GUI deployment- | 36 | 7 | 4 | Prototype impact | Stage 3 – development |
| D2.8 | Realization of Ginestra™ data section on Material Cloud | 36 | 7 | 4 | Prototype impact | Stage 3 – development |
| D3.4 | Impact of stable defect configurations on performances and scaling of $HfO_2$-based FE-devices | 36 | 7 | 4 | More efficient and targeted exploration Industrial demonstrator impact New IP agreements | Stage 4 – Testing and Validation |
| D3.5 | Impact of stable defect configurations on the electrical performances of OTS selectors | 36 | 7 | 4 | Industrial demonstrator impact More efficient and targeted exploration Costs saving | Stage 4 – Testing and Validation |
| D3.6 | Second report on IM2D box evaluation | 36 | 7 | 5 | Industrial demonstrator impact Return on Investment. Costs saving Measure of market penetration Investment on innovation and project management Jobs created | Stage 5 – Launch |

*Table 4. Key Innovation elements in INTERSECT deliverables.*

In the SGM approach, **Gates** are intermediate meetings to set out the project advancements. Within INTERSECT, the Gates decisions will be part of the INTERSECT Governing Board responsibility and discussed during their periodic meetings. A GANTT chart for INTERSECT stages is shown in Figure 5. At present (M18), we are at the end of the screening activity (Stage 1-2), while other exploitation activities (Stage 3-5) have only recently started.

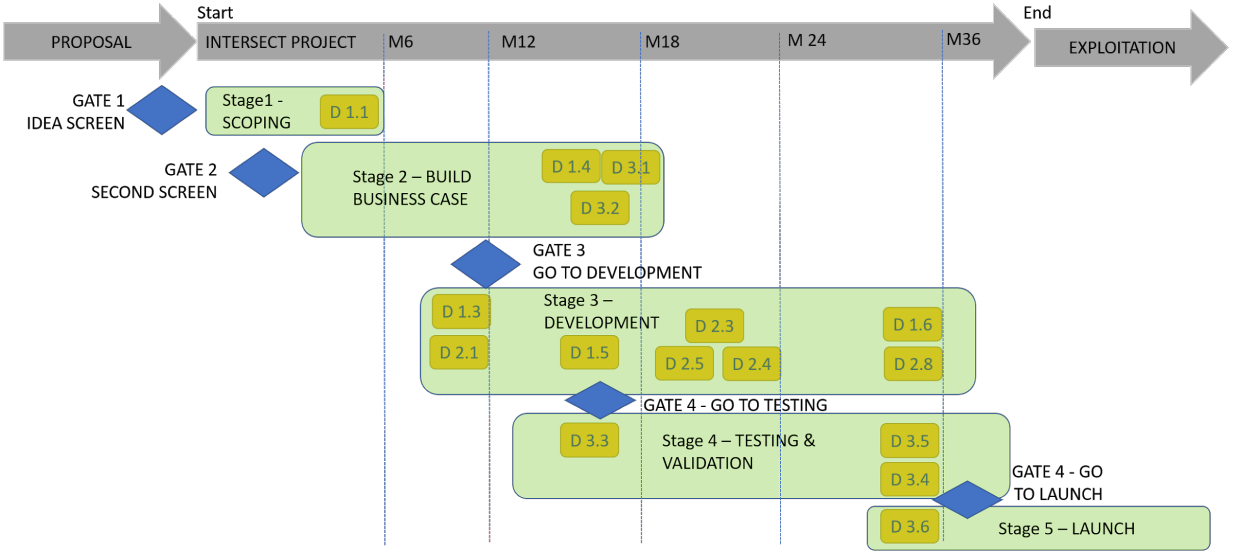


*Figure 5. INTERSECT innovation framework. DX.Y labels identify the project deliverables within the GSM model.*

### 3.4.6 IP Register

INTERSECT actively monitors the creation of Intellectual Property during the lifetime of the project. As part of this process, results which are both jointly and individually owned will be identified and documented in an IP Register. The template of the IP register has been prepared and it is described in the next paragraph. The management of the **IP Foreground** and **IP Background** is regulated under the Grant Agreements and Consortium Agreement.

**IP register template**

1. ***IP Background.*** It includes a list of all IP components **related to the results** brought by the partners into the project. Results might be reports, software code, data, etc. There may be several IP components for each result. IP background includes also the reference to know-how, which may be delivered as training or consultancy to support use. A template ofIP background is shown in Table 5.

| Name | Short description | IP Owner | Type of protection or licensing action used | Protection or licensing actions used | Under what terms is the IP needed for exploitation? |
|---|---|---|---|---|---|
| Party X | | | | | |
| Party Y | | | | | |

*Table 5. Template of IP background*

2. ***IP Foreground.*** It collects the list of all IPs **created during** the project. This includes all the IPs related to all components of this result. A template of IP foreground is shown in Table 6.

| Name | Short description | Owner & Beneficiaries | Contributions | IP managers | Confidential [YES/NO] | Protection and licensing | Revenues and costs sharing |
|---|---|---|---|---|---|---|---|
| Party X | (Please provide a short description of IP asset) | (List all partners involved and the IP owner during the project) | (List all contributions to the IP of each partner to the result) | (List all partners involved and the IP owner after the end of the project) | (Indicate whether the result is confidential) | (Provide details on the protections used) | (Indicate foreseen costs and revenues associated to this IP) |
| | | | | | | | |
| | | | | | | | |

*Table 6. Template of IP foreground*

## 4. Conclusions

INTERSECT project has the ambition to lead a significant impact in innovative, previously unfeasible modelling support for the co-design and the optimization of disruptive electronics, bridging the gap between materials and devices, both from a technical and a business perspective. To this aim, an Innovation Management Plan has been defined from the early beginning of the project. The Mapping process results represent the baseline for the future INTERSECT innovation steps. This deliverable will also serve as a guidance for the consortium members and will be updated throughout the development of the project, in order to adjust to the innovation activity requirements. The Innovation Management Plan is considered as an adaptive living document and it will be further updated according to the different project phases.

## ACRONYMS

AEB - Advisory and Exploitation Board

CPD - Collaborative Product Development

EMMO - European Materials Modelling Ontology

GUI - Graphic User Interface

IM - Innovation Management

IMI - Innovation Management Indicator

IM2D - Interoperable Materials-to-Device

IP - Intellectual Property

IPI - Innovation Potential Indicator

IPR - Intellectual Property Rights

IRI - Innovation Readiness Indicator

KPI - Key Performance Indicator

MPI - Market Potential Indicator

MRL - Market Readiness Level

R-W-W - Real-Win-Worth It

SGM - Stage Gate Model

SME - Small and Medium Enterprises

TRL -Technology Readiness Level

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## ANNEX 1 - Innovation Toolkit

In this ANNEX we summarize the main aspects of the tools and models introduced above. The Innovation Manager and AEB will be held responsible for these tools and procedures, to be implemented by all Consortium members.

### Stage Gate Model

The "Stage Gate" model [21] is the industry standard for managing new product innovation excellence. It integrates numerous performance-driving practices into easy-to-understand steps for success. Its design engages users of all decision-levels and functions, enabling quality execution, timely decisions, alignment and speed. This process allows products to reach markets faster and organizations to generate better profits.

The innovation process is divided into five major phases (or stages) , each being preceded by a gate, making five gates in total. These gates are intermediate management ratification steps, waypoints which must be passed to either start the following stage or kill the project.

The process starts from a preliminary gate decision, the Gate 1 "Idea Screen" where the staff brainstorm new ideas and select the most promising ones.

The Stage-Gate technique breaks new product development projects into five phases:

1. **Scoping**, where the relevance of the idea is assessed, its scope and feasibility are clarified and evaluated, and the market and competition evaluated
2. **Business case creation**, entailing more in-depth investigation so as to build a business simulation, including identifying customer and end-user requirements, determining product positioning, defining product specifications, and project scheduling
3. **Development**, focused on new product design with preliminary tests with potential customers, and preparation of a production plan and a launch plan
4. **Testing and validation**, during which tests are conducted (in a lab, in the factory, with customers, etc.) and product launch scenarios are ratified
5. **Launch phase**, when the product enters the market, with monitoring of production and quality.

In between each of the phases, the gates serve as "quality control", entailing intermediate meetings to clearly set out the project's situation by assessing costs, current and future timescales, potential risks, quality control and staff involvement. This is a discovery or ideation stage when members of staff consider market opportunities and brainstorm new ideas.

The main advantages of this model are:

- It helps improve the structuring of project progress milestones and the production of a clear schedule
- It often helps eliminate potential risks or errors in the project lifecycle
- It contributes to better decision-making and maximized value creation on the basis of the organization strategic objectives
- Lastly, it improves collaboration both internally (between cross-functional teams) and externally (with partners) and consequently creates equilibrium across all projects.

**Innovation Risk Matrix**

The Innovation risk matrix employs a unique scoring system and calibration of risk to help estimate the probability of success or failure for each project based on how big a stretch is: the less familiar the intended market (x axis) and product or technology (y axis), the higher the risk (Figure A1). A position on the matrix is determined by its score on a range of factors, such as how closely the behavior of targeted customers will match that of current customers, how relevant their brands are to the intended market, and how applicable the technology capabilities are to the new product.

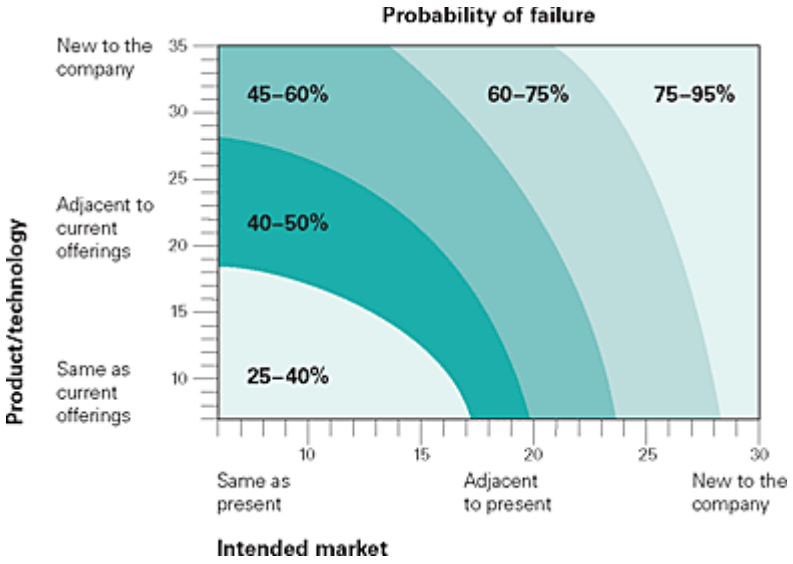


*Figure A1. Risk Matrix for innovations. Picture from Ref. [15]*

**R-W-W Screen**

The Real-Win-Worth It screen, sometimes known as the Schrello screen [15], is a tool built on a series of questions about the innovation concept or product, its potential market, and the consortium's capabilities and competition. It is not an algorithm for making go/no-go decisions, but a disciplined process that can be employed at multiple stages of product

development to expose faulty assumptions, gaps in knowledge, potential sources of risk, and to ensure that every avenue for improvement has been explored.

The R-W-W screen can be used to identify and help fix problems that are miring a project, to contain risk, and to expose problems that might lead to termination of an activity. The R-W-W screen is used to evaluate individual activities, concepts, or ideas by answering questions in three broad topic areas: "Is it real?" explores the nature of the potential market and looks at the feasibility of building the product. "Can we win?" considers whether the innovation and the company can be competitive. "Is it worth doing?" examines the profit potential and whether developing the innovation makes strategic sense (Figure A2).


*Figure A2. R-W-W Questionnaire. Picture from Ref. [15]*

**Innovation Radar**

The Innovation Radar is an initiative of the European Commission focused on the identification of high potential innovations in FP7, CIP and Horizon 2020 projects [14]. It supports innovators by suggesting a range of targeted actions to assist them in fulfilling their potential in the market. This initiative involves: assessing the maturity of innovations developed within the projects and identifying high potential innovators and innovations; providing guidance during the project duration in terms of the most appropriate steps to reach the market; and supporting innovators through entrepreneurship initiatives to cover specific needs concerning networking, access to finance, IPRs, etc.

**Innovation Potential Indicator**

The Innovation Potential Indicator encompasses three indicators that capture essential steps in the innovation development process.

Innovation readiness: Innovation readiness criterion relates to the technical maturity of an evolving innovation. It aims to define the development phase of the innovation, e.g. conceptualization, experimentation or commercialisation. It also takes into account the steps that were taken in order to prepare innovation for commercialisation, e.g. prototyping, demonstration or testing activities or a feasibility study, and to secure the necessary technological resources, e.g. skills, to bring the innovation to the market. In addition, this criterion takes into account the development stage of an innovation and the time to its potential commercialisation.

Innovation management: Innovation Management criterion addresses the issue of the project consortium and its commitment to bring an innovation to the market, an element that is often seen as the most important success indicator of a technology venture. This concept aims to research or confirm the capability of the project's development and/or management team to execute the necessary steps to transforming a novel technology or research results into a marketable product and, finally, to prepare its commercialisation. These steps may include, for example, clarifying the related ownership and IPR issues, preparing a business plan or market study, securing capital investment from public and/or private sources, or engaging an end-user in the project.

Market potential: Market potential criterion relates to the demand and supply side of an innovation. Regarding the demand side, it concerns the prospective size of the market for a product and the chances of its successful commercialisation. Its aim is to assess how the product satisfies a market sector and to indicate that there is potential customer base. With respect to the supply side, it aims to assess whether there are potential barriers, e.g. regulatory frameworks or existing IPR issues, which could weaken the commercial exploitation of an innovation.

Innovation Radar provides a questionnaire (16 questions) that helps to describe and quantify the potential of an innovation within the projects. For more details on Innovation Radar and the Innovation radar questionnaire, we refer to the original links: https://www.innoradar.eu/methodology and https://ec.europa.eu/jrc/sites/jrcsh/files/booklet-a4_innovation_radar.pdf .

**Technology vs. Market Readiness Level**

| Technology Readiness Level- TRL | | Market Readiness Level - MRL | | |
|---|---|---|---|---|
| **Level** | **Technology** | **Level** | **Market** | **Phase** |
| 9 | Actual system proven in operational environment | 9 | Proof of Stability: market stable position. Strategy plan to grow the market share | Scaling |
| 8 | System complete and qualified | 8 | Proof of Scalability: Sales pipeline to reach a stable position | |
| 7 | System prototype demonstration in operational environment | 7 | Proof of satisfaction: positive feedback from the pioneers | Traction |
| 6 | Technology demonstrated in relevant environment | 6 | Proof of Traction: Pioneers, first paying customers | |
| 5 | Technology validated in relevant environment | 5 | Large scale early adopter campaign run a campaign with early adopters | Testing |
| 4 | Technology validated in lab | 4 | Small Scale Stakeholder Campaign Run a campaign | |

| | | | | |
|---|---|---|---|---|
| | | | with stakeholder | |
| 3 | Experimental proof of concept | 3 | Needs Validation | Ideation |
| 2 | Technology concept and/or application formulated | 2 | Needs formulation: user story to articulate needs | |
| 1 | Basic Principles observed and reported. | 1 | Basic Market needs observed. | |

*Table A1. TRL vs. MRL*