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The Internationalisation of Research and Technology Organisations

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Title The internationalisation of Research and Technology Organisations.

Abstract

The aim of this policy brief is to come to a guiding document for RTOs to engage in the process of internationalisation and thus facilitate mutual learning between RTOs. The information in report builds on a joint workshop organised by the JRC and EARTO on 21st June 2016.

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Executive summary

In the last decades, Research & Innovation (R&I) have increasingly expanded beyond national borders to become fully internationalised. The creation, accumulation of knowledge and their innovative outputs are nurtured by international networks of academic and technological cooperation. Research and Technology Organisations (RTOs) are no exception to this evolution and have progressively extended the scope of their activities outside their country of origin to fulfil their core mission of producing high impact R&I. The internationalisation of RTOs is also acknowledged as a crucial feature for fostering their contribution to solving societal challenges, supporting industry's R&I needs and boosting competitiveness. RTOs are key actors to promote jobs and growth, and supporting their internationalisation process can further enhance their positive social and economic impact in Europe. In line with Europe's ambition to be "Open to the World", supporting RTOs' internationalisation can contribute to leveraging Europe's R&I potential and strengthen the construction of a European Research Area.

Internationalisation processes have provided continuous opportunities for RTOs to acquire additional resources through the access to new knowledge, the intensification of networks and the use of innovative technologies. At the same time, the expansion of activities to countries both within and outside the European Union involves a number of risks and challenges including legal and institutional barriers, the relatively high costs of internationalisation and higher level of competition. This policy brief aims to identify and analyse a set of motivations and drivers behind the will to internationalise, the different barriers that need to be faced by RTOs in their international activities and the strategies they adopt to make the best of the opportunities and costs linked to internationalisation processes.

Section 2 provides a definition of the main concepts used in the paper, namely RTOs and internationalisation. This clarification aims to set the scene for the main issues tackled in the report, as motivations, barriers and strategies to internationalise vary between different types of RTOs. RTOs are applied research organisations dedicated to the development and transfer of science and technology to firms and society at large. They are non-profit and reinvest their revenues into further development of new knowledge and innovation. RTOs are hybrid organisations in between the public and private spheres. The internationalisation of RTOs is conceived as "a process of increasing involvement in international (non-nationally based) operations and actions by the [RTO], its sub-units or its employees and an increasing openness of the [RTOs] to 'non-national' influences, with the effect of transforming the attributes of the organisation and of modifying its resource dependence features (for example, funding composition)" (Cruz-Castro et al., 2015). Europeanisation is a specific subset of internationalisation referring to the extension of an organisation activities to the European Research Area. While this type of internationalisation has had the strongest effect on European RTOs over the past decades, this report will especially focus on the internationalisation of RTOs to third countries.

Section 3 examines the motivations underlying RTOs' decision to engage in internationalisation. Growth, maintaining, renewing, improving, or expanding operations are among the core drivers for most organisational activity and the internationalisation of RTOs is not an exception. For most RTOs, internationalisation is a means to fulfil their core mission in today's globalised and digitalised world: produce excellent and high impact R&I while solving societal challenges and boosting industry's competitiveness. Remaining relevant and competitive in the R&I fields indeed requires RTOs to take a global stance and to enter partnerships with international actors. Independently of their level of internationalisation, RTOs involved in cross-border cooperation refer to it as a mean to improve their research capabilities and to expand their activities. The access to new knowledge, markets, clients, and funding are the motivations most frequently put forward.

Section 4 analyses the barriers to the internationalisation of RTOs, differentiating between internal and external barriers. Internal barriers relate to the capacity of the RTO itself to internationalise. This may refer to the nature of the RTO, the tension between serving the needs of domestic and foreign clients, the lack of sufficient resources or the capabilities, skills, and knowledge to make optimal use of the opportunities that internationalisation offers. Apart from constraints internal to the RTO, several external barriers can also limit their potential to engage in strategic internationalisation. An example of a policy level constraint can be the lack of an appropriate collaboration framework between countries and/or regions. Others could include problems to operate within the institutional framework in the country of choice and corruption.

Section 5 focuses on the main strategies RTOs adopt to internationalise their activities. The integration of an internationalisation dimension in organisational strategies or even the development of an internationalisation strategy is one of the necessary criteria for a fruitful adaptation to the international environment. Through this, RTOs intend to identify different steps allowing them to expand the range of their activities while safeguarding their interests. Three phases are underlined: risk assessment, market discovery and market consolidation. In the latter phase, different complementary strategies can be identified, including a network approach, a specialisation approach, or a more geographical approach. To support and strengthen the internationalisation of RTOs, different recommendations for both RTOs and policy makers have been identified during the report and are summarised hereafter.

Key Findings & Recommendations

For Policy makers in the Context of a European Continent “Open to the World”

- While being seen by some local/regional governments as diverting some of the attention of RTOs away from their domestic innovation systems and clients, internationalisation can bring benefits in terms of access to excellent knowledge, support to the internationalisation of domestic firms or attraction of Foreign Direct Investments. The public mission of RTOs often includes contributing to solving global societal challenges, which requires a close collaboration with the most relevant partners at international level. National and regional governments, in the context of the European Research Area (ERA), should therefore carefully consider to support rather than hinder this process.
- Building strong transnational networks is essential for successful internationalisation. This can contribute to build up the European Research Area and the innovative potential of regions aided by a process of smart specialisation, through which the European innovation potential can be leveraged. Maintaining and developing favourable framework conditions, exploring the potential to develop programmes that facilitate staff exchange and supporting the exploration of new markets would be a strong asset for the development of transnational networks.
- Internationalisation requires a large amount of funding. Too little discretionary core funding and other support from national governments can limit RTOs in their internationalisation strategies. RTOs call for "proper funding dedicated to the internationalisation of RTOs." They consider this to be "essential to reach the EU target to lead & influence world-wide R&I. Such support is even further required today, at a time of low public and private investment expenditures in Europe. Moreover, sustainability and predictability of funding is essential to plan long-term strategies with no immediate results such as internationalisation, as well as to inspire trust and long lasting relationships with foreign partners."
- Support for direct joint programming between RTOs at international level, exchange and training programmes of business experts and light-weight feasibility studies can facilitate RTOs to jointly engage in sustainable forms of internationalisation. One of the barriers to the internationalisation of RTOs is a capacity problem, often linked to the limited number of internationally experienced scientists and business development profiles among RTO staff. Programmes supporting RTOs to join forces would considerably lower this capacity problem.

For RTOs looking at Further Enhancing their Internationalisation Activities

- RTOs can approach internationalisation by strengthening their knowledge base and their role in innovation hubs linking their national or regional innovation system with international innovation chains. In doing so, RTOs' internationalisation in turn will support internationalisation of their local and regional (academic & industrial) partners as well as creating new links with new knowledge and/or industrial value chains.
- Building critical mass and networks is essential to be a competitive and attractive partner at the international level. RTOs are encouraged to seize the opportunity to grow their networks and cooperate with other RTOs, research actors and companies at transnational level. This can be done by taking part in EU-level collaborative projects for instance, or taking an active role in EU-level networks or associations, participating in international conferences, fairs or events, etc.
- RTOs may search international expansion to reduce their dependency on domestic funders and clients. Internationalisation enables RTOs to access new markets and clients, thus diversifying their resources. Limiting their dependency on a limited pool of national clients by accessing market-leading stakeholders can result in an expansion of economic income and their resilience to adverse future situations. This has especially been crucial in the context of the recent economic crisis in which national innovation markets were sometimes drastically reduced.
- RTOs which depend significantly on client firms that either export or consider engaging in foreign direct investment may consider it their role to facilitate this process by expanding themselves to these countries as well. In doing so, they can facilitate the entry of these firms into foreign markets by offering services that are tailored to both their client and the market itself.
- Each RTO needs to assess its own capabilities, the risks, the costs and potential benefits of internationalisation on its activities. Internationalisation is a costly and risky process requiring long-term strategies and investments, while returns are not immediate. Unrealistic or ill-planned internationalisation strategies can damage RTOs operations and result in unviable activities.

The use of representative offices as listening posts to scope new technological developments may be especially fruitful in technologically advanced economies. There is increasing potential for useful knowledge development in emerging economies as well. RTOs setting up R&D facilities abroad should therefore not be restricted to the most advanced nations.

1. Introduction

Research and Innovation is a fast-evolving sector, heavily influenced by trends such as the globalisation of the economy or the digitalisation of industry. R&I is increasingly globalised, complex and expensive, and international cooperation has become a strategic priority today to access the latest knowledge and the best talents worldwide. It also allows European R&I actors to face global societal challenges more effectively and to boost industrial competitiveness creating new opportunities in different markets.

To respond to such trends and have access to the knowledge they need to produce excellent and high impact R&I, many Research and Technology Organisations (RTOs) entered into an internationalisation process, developing their activities beyond their national borders. This policy brief explores the drivers, strategies and barriers to the internationalisation of RTOs. It provides key recommendations to strengthen the internationalisation of RTOs already in the process, and to support those wanting to internationalise their activities.

RTOs are applied research organisations mainly dedicated to the development and transfer of science and technology to firms and society at large. Most EU member states have developed some form of publicly promoted or supported industrially oriented and applied research organisations which have become important elements in their national and regional innovation system. Increasingly, RTOs look beyond their national borders. Most have become involved in international RTD collaboration activities, some export knowledge and products to foreign markets, or even invest resources and open facilities abroad. The internationalisation of RTOs can contribute to leveraging Europe's R&I potential and help it remain a global R&I leader, showing the way to develop global research partnerships to address societal challenges while remaining relevant and competitive.

However, while the internationalisation of firm R&D (among many others: Dachs et al, 2008; Edler, 2008; Reddy, 2000; Kuemmerle, 2001; Thursby & Thursby, 2006; Von Zedtwitz & Gassmann 2002), universities (e.g. Beerkens & Derwende, 2007; Kehm and Teichler, 2007) as well as the international collaboration of individual researchers (e.g. Jonkers & Cruz-Castro, 2013; Jonkers & Tijssen, 2008; Katz & Martin 1997; Wagner, 2005; Wagner and Leydesdorff, 2005) have received ample attention in the scholarly literature, there are only few studies analysing the internationalisation process of public research organisations (Cruz Castro, Jonkers & Sanz-Menendez, 2015; Ebersberger & Edler, 2009; Jonkers & Cruz-Castro 2011; Loikkanen et al., 2010).

The number of studies is even lower with respect to Research and Technology Organisations specifically, despite their emergence as major international players over the past decades (see e.g. Berger and Hofer, 2011; Loikkanen et al., 2010; Preissl, 2000). EARTO highlighted previously that research into RTOs is made more difficult by the lack of a systematic consolidation of RTOs in official international statistical data collections of among others R&D expenditures (EARTO, 2015). Some countries, such as Germany, define their RTOs (such as the Fraunhofer Gesellschaft) as belonging to the government sector arguing that a significant share of their resources comes from the public sector. Other countries, such as Spain for the Basque RTOs, classify them as belonging to the business sector. For the analysis of RTOs, a consistent functional labelling of the organisation in the national innovation system is considered more important than its legal status (EARTO, 2015). EURAB argues that RTOs have emerged as central actors in the European Research Area, e.g. in terms of their participation in the EC Framework Programmes. Their growing interest to be involved in cross-border cooperation is also reflected at the organisational level, with the development of designated offices in charge of facilitating internationalisation, of representative offices and international (joint) laboratories in different countries (Jonkers & Cruz Castro, 2010).

The aim of this policy brief is to come to a guiding document for RTOs to engage in the process of internationalisation and thus facilitate mutual learning between RTOs. A secondary audience consists of policy makers in the European Commission and the European Member States dealing with the governance and funding of RTOs. The information this brief report provides builds both on insights from the academic literature as well as from practical experiences of RTOs. Among the main theoretical inputs is a recent book chapter by two of the authors of this report (Cruz-Castro et al, 2015). The main empirical input for this report stems from a joint workshop organised by the JRC and EARTO on 21st June 2016. In preparation to this event a survey was circulated to EARTO members. 22 European RTOs provided detailed responses to its open-ended questions. The results obtained were complemented by presentations and roundtable discussions in a workshop at which representatives from the 22 organisations participated together with EARTO representatives, commission officials and academics. Throughout this report, "quotation marks" are used to indicate that statements or claims are directly based on either the survey responses or the workshop minutes. A certain sampling bias may have arisen from the self-selection of survey respondents and workshop participants: i.e. it is possible that especially organisations with an interest in internationalisation have chosen to participate and that their responses do not fully cover e.g. the barriers faced by RTOs who do not consider internationalisation as an interesting/feasible option. The different inputs received do highlight a strong heterogeneity regarding RTO internationalisation processes and the need for a comprehensive assessment of the incentives and limitations linked to these dynamics. Different types of RTOs could follow different approaches to internationalisation, face different types of barriers and have different motivations. The paper will therefore explore: 1) what RTO features and external factors (conditions in home systems) incentivise or hinder the internationalisation of their activities; and 2) what different strategic approaches RTOs have taken to internationalise.

The report is organised as follows:

- Section 2 provides an overview of the different types of RTOs. The motivation for including this short section is that the motivations, strategies and barriers to internationalise vary between different types of RTOs. The section will also explain in more detail what we refer to by internationalisation.
- Section 3 examines the motivations underlying RTOs' decision to engage in internationalisation. The increase of revenue and impact and the maximisation of technology transfer activities appear as the most recurrent justifications.
- Section 4 analyses the barriers to the internationalisation of RTOs, differentiating between internal and external barriers.
- Finally, before concluding, section 5 focuses on the main strategies RTOs adopt to internationalise. Three phases are underlined: risk assessment, market discovery and market consolidation. In the latter phases different RTO strategies can be identified.

2. RTOs and Internationalisation: conceptual framework

Non-university Public Research Organisations (PRO) have been objects of interest among academics and policy makers. According to Sanz-Menendez et al (2011), "the term public research organisation (PRO) is used to refer to a heterogeneous group of research performing centres and institutes with varying degrees of "publicness". This is understood in broad terms as the level of governmental influence on their research activities and funding, rather than just mere ownership".

Cruz-Castro et al (2015) and Sanz-Menendez et al (2011) identified two attributes of research organisations that were likely to condition R&D activities: a) the degree of external autonomy and resource dependence of the organisation –in terms of funding, human resources, access to external knowledge, for instance– and the associated degree of autonomy and discretion over resources; b) the type of internal authority structure that characterises the functioning of the organisation, more precisely the relationship between the research professionals and the management of the centre.

Based on that features, they distinguish four ideal types of PROs: Mission-oriented centres (MOCs) which are owned and sometimes run by government departments or ministries at the national or sub-national levels and whose role is to provide knowledge and technological capabilities to support policy-making; Public research centres and councils (PRCs) which are overarching institutions performing, and in some cases funding, basic and applied research in several fields; Independent Research Institutes (IRIs) which are publicly supported institutes of diverse sizes performing both basic and applied research focused on "issues" or "problems" rather than just fields; and Research and Technology Organisations (RTOs) (Sanz-Menendez et al, 2011).

PRO Management		Internal authority	
		+	-
External autonomy	+	<i>RTO</i>	<i>IRI</i>
	-	<i>MOC</i>	<i>PRC</i>

Source: Authors

Source: Cruz Castro et al., 2015

Other empirical research trying to account for the non-university public research organisations has been in general more descriptive. In this literature it has become traditional to identify three empirical categories of research organisations, despite the historical identification of eight different types of research laboratories (van Rooij 2011): government laboratories, academic, and research and technology organisations (e.g. Arnold et al. 2010; OECD 2011). The rationale of this classification/taxonomy is mainly related with the relevance of the empirical groups and self-identification, and combines elements of history, evolution and current attributes.

RTOs, as one of the existing empirical groups of research organisations, are mainly dedicated to the development and transfer of science and technology to the private sector and society. RTOs are often in the semi-public sphere: neither totally public nor private, they have a public mission and work at the boundary between the public and private spheres. RTOs are mostly non-profit: they reinvest their revenues into the development of new knowledge and innovation.

In the present report, the organisations analysed insisted on a functional rather than theoretical definition to classify themselves as RTOs, assuming that there is sometimes a discrepancy between the label used in theoretical models and the way the RTO label is used by many organisations to refer to themselves. The functional definition is based around a set of core attributes (e.g. applied R&D activities, mission related to firm technology service provision, non-profit orientation, etc) mainly focused on the mission of RTOs and assuming a wide variety of legal forms and government dependence.

The concept of RTO refers to a broad and heterogeneous category of organisations with a variety of legal forms and governance models. However, despite their heterogeneity, RTOs share functional specificities, as they aim to bridge the gap between basic science and market solutions. They are distinct from universities and enterprises but have close links with them, as well as with local, regional and national governments. A defining characteristic of RTOs is that they receive a substantial share of their funding from both private and public sources. Their funding may come in the form of institutional block funding from national or regional governments, from bidding for competitive project funding, from competitive contract research for firms or governments, or from bilateral collaborative research with industry (EARTO, 2015; Hales, 2001; Leijten, 2007). Many RTOs also receive part of their resources from licensing their IPR or through participation in spin-off firms (Leijten, 2007). Table 1 below shows the different sizes and shares of public, private and EU funding of some of the RTOs involved in the elaboration of this report.

Table 1. Funding structure of some European RTOs involved in the elaboration of this policy brief - data 2015

	Country	Size (Annual turnover) M.Euros	Relative size to Biggest (FhG) = 100)	Total Public Funding (Block grant, Program funding or competitive funding) %	Total Private Funding (contract research for industry, sales, and fees) %	Share of the EU FP funding in the total
ACR	AT	60	3%	20%	80%	3%
ATIGA	ES	49	2%	24%	76%	6%
CETMA	IT	8.5	0.4%	82%	18%	4%
CIRCE	ES	7	0,5%	67%	33%	47%
CSEM	CH	73	3.5%	67%	33%	12%
Digital Catapult	UK	14	0.7%	99%	1%	1%
DTI	DK	137	6%	34%	66%	3%
EURAC	IT	25	1%	95%	5%	10%
EURECAT	ES	28	1%	66%	34%	24%
Fraunhofer	DE	2.115	100%	71%	29%	5%
Imec	BE	415	20%	20%	80%	6%
LEITAT	ES	16.5	1%	30%	70%	20%
NOFIMA	NO	64	3%	15%	70%	30%
SINTEF	NO	353	17%	50%	50%	8%
SP	SE	170	8%	42%	58%	7%
TECNALIA	ES	103	5%	50%	50%	23%
TNO	NL	418	20%	68%	32%	7%
TWI	UK	75	4%	20%	80%	17%
VTT	FI	251	12%	78%	22%	12%
FEDIT ¹	ES	243	11%	33%	66%	9%

As suggested by the table, public funding can be allocated in different ways and there are important differences in this respect between RTOs. Despite these variations the RTO

¹ FEDIT is not an RTO but an association or network of Spanish RTOs. It does not conduct itself any R&D activity, but includes in its figures the aggregated activities of their members.

concept remains analytically useful as an ideal type to distinguish it from other types of Public Research Organisations (Sanz-Menendez et al, 2011; Leijten, 2007; Hales, 2001). In comparison to universities and public research centres such as the CNRS, CSIC, CNR, MPG and academies of sciences in Eastern European countries (Sanz-Menendez et al, 2011), RTOs are more focused on applied research with high(er) technological readiness levels. They are involved in the later steps of technological development and innovation, but they are not market actors and they therefore leave the commercialisation phase to private firms.

Most RTOs have a public mandate and some are still owned by governments, even though they may operate as companies. This implies a regulatory/institutional framework which defines their freedom to operate. Governments regulate, steer or even control RTOs in various ways, e.g. through public ownership, direct control, service agreements, charters, formal roles in management (e.g. as board members) as well as the integration of the organisation in the civil service (Berger and Hofer, 2011; Hales, 2001). Even in cases where there is less formal control of regional or national governments on the RTO, their role as important funder gives them a more or less implicit influence on important strategic organisational choices.

As noted above RTOs come in a diversity of forms, size and governance, and hence can be classified on a number of dimensions which helps to explain their varied approaches to internationalisation. Leijten (2007) argues that one of the defining characteristics of RTOs is that they are managerially independent. According to Sanz-Menendez et al (2011) they have comparatively high levels of autonomy in comparison to other ideal-types of PROs such as Public Research Centres (PRC) or Mission Oriented Centres (MOC). "In general, the administrative links of RTOs with governments tend to be looser than for the three other PRO ideal types" (Sanz-Menendez et al, 2011). However, this does not mean that the level of autonomy of all RTOs is equal.

The **internationalisation of RTOs** is conceived as "a process of increasing involvement in international (non-nationally based) operations and actions by the [RTO], its sub-units or its employees and an increasing openness of the [RTOs] to 'non-national' influences, with the effect of transforming the attributes of the organisation and of modifying its resource dependence features (for example, funding composition)" (Cruz-Castro et al., 2015). Different elements of the internationalisation process can include: 1) increased communication and cooperation with foreign peers; 2) the mobility of personnel; 3) joint R&D projects; 4) "exporting knowledge" or (technological) products and services; 5) "Foreign Direct Investment" either in the form of 5a) investing in representative offices abroad and 5b) investing in R&D facilities abroad. Among RTOs themselves the understanding of internationalisation tends to vary depending on the nature of the organisation. While for small organisations any transnational (and at times even trans-regional) activity or cooperation is considered as internationalisation, larger RTOs differentiate between Europeanisation and internationalisation/globalisation. The former refers to interactions of RTOs with other R&D actors located in other EU Member States, whereas the latter would only refer to interactions with actors located in Third Countries. An operationalisation of the concept of internationalisation which would be required for the unambiguous classification of more and less internationalised RTOs, would include a measure of the share of resources invested abroad and received from foreign sources. Table 1 provided an estimate of the share of FP funding in the budget of European RTOs, which is one share of internationalisation. A number of these RTOs, such as IMEC, Tecnalia and Fraunhofer are also very active outside the European Union. IMEC, for example, estimates that more of 50% of its total revenue is from foreign sources. In the absence of comparable data for the RTOs in the table, revenues from international sources in general could not be included.

RTOs do differ in their degree of internationalisation. The factors which influence the degree of internationalisation include size, mission, degree of autonomy and related to this sources and nature of funding. Size as proxy of the level of resources and the potential organisational slack (free resources) is probably the main factor to account for

internationalisation; however this factor is “mediated” by the other variables including the level of autonomy. Fraunhofer, one of the largest European RTOs, is not only among the largest participants in the European Framework Programmes but it has also established representative offices in a number of Asian countries and R&D units in North America. It serves European clients operating in foreign markets, but also actively searches for project funding and contract research in the markets in which it operates. TNO has, partially due to national public funding cuts, become more selective in its internationalisation strategies. Nonetheless, as one of Europe's largest RTOs, it maintains representative offices in a number of countries outside Europe in addition to being an important actor at the European level. Tecnalia has followed its domestic firms abroad and established a presence especially in Latin America in which it successfully exploits mature technologies developed over the years. The Welding Institute (TWI) which operates much like a firm and has a high level of autonomy is one of the most global EARTO members, which also reflects its technological specialisation as it serves especially the highly globalised oil industry. IMEC is another global player: over 50% of its turnover comes from foreign sources. It has established subsidiaries in various European and third countries, through which it leverages the knowledge developed in its main site in Flanders, Belgium.

Both Cruz Castro et al (2015) as well as Charles and Ciampi Stancova (2015) argue that the tendency of an RTO to engage in internationalisation is heavily influenced by their level of autonomy, which is tied to its governance and the sources of its funding. RTOs that are heavily reliant on support by national or regional governments tend to cater mainly for the needs of public and private clients at the national or regional level. Charles and Ciampi Stancova (2015) hypothesized that the more RTOs are asked to seek private sector funding the more likely they are to explore international markets with a greater reliance on large multinational companies as a core client base. This is especially evident for independent RTOs without much core government funding such as IMEC. Other RTOs which have seen the share of core government funding decrease - a result from the economic crisis affecting many EU member states - have increasingly been looking for opportunities abroad. However, not all have the resources or capabilities to do so. As will be discussed in several of the following sections, the potential of RTOs to do this partially depends on the degree of autonomy (and support) they get from national or regional public authorities.

In comparison to Public Research Centres (PRCs) such as the Max Planck Gesellschaft, CNRS and CSIC, RTOs also have relatively high levels of internal authority. This refers to the control of RTO management over the activities of its staff. These higher levels of internal control can to some extent limit the type of spontaneous, bottom up, interactions that characterise international collaboration in the academic world (Wagner, 2006; Katz & Martin, 1997). On the other hand these high levels of internal control gives the organisation greater power to devote resources and manpower to the strategic aim of internationalisation if it so chooses. The combination of external autonomy and internal authority promotes the potential “actorhood” of RTOs (Cruz Castro et al, 2015).

3. Drivers & Motivations - Why do RTOs engage in internationalisation?

This section aims to understand the drivers influencing RTOs' choice to internationalise. Growth, maintaining, renewing, improving or expanding operations are among the core drivers for most organisational activity and the internationalisation of RTOs is not an exception (Cruz-Castro et al, 2015). For most RTOs, internationalisation is a "means to fulfil their core mission: produce high impact R&I while contributing to the solving of societal challenges and boosting industry's competitiveness. Carrying out relevant state-of-the-art R&I and remaining competitive requires RTOs to take a global stance and enter into partnerships with the best players at international level". Independently of their level of internationalisation, RTOs involved in cross-border cooperation refer to it as a mean to improve their research capabilities and to expand their activities. Cruz-Castro et al. (2015) identified a set of internal motivations and external factors fostering the internationalisation of RTOs (Table 2).

Table 2. Internal motivations and external factors influencing internationalisation

Internal motivations	External factors
Access to foreign knowledge based / collaborative partners	Changes in the research field (including globalisation)
Access to markets / clients	Changing relationship with national/regional government (less institutional funding / more autonomy)
Following domestic clients	Increasing potential: ICT and international mobility
Partnering to attain critical mass / influence / access to resources	Changing mission and changed demands from government
Access to foreign, including EU, funding sources	Changes in the funding landscape (emergence of new EU funders)
Paving the way for clients / new business models	Increase R&D demand in emerging countries (associated with their societal changes)
Facilitating FDI	

Source: adapted from Cruz-Castro et al (2015) supplemented with empirical data collected for this project.

The external factors of this classification point out elements linked to the institutional environment, to modifications of the funding landscape and to the globalisation of research as incentives for internationalisation of RTOs (Cruz-Castro et al, 2015; Loikkanen et al., 2010). The current report focuses on the scope for organisational level strategic behaviour by RTOs, which can include but is certainly not restricted to promoting bottom up interactions by their researchers. Regarding the institutional environment, RTOs generally have, in comparison to public research centres or mission-oriented centres, a higher degree of autonomy from their national and regional governments to determine employment conditions, resource allocation and their own organisational structure. This autonomy allows them to look for alternative sources of funding that may be located abroad and provides RTOs with the possibility to give an international orientation to their activities (Cruz-Castro et al, 2015). The emergence and development of research funders at European level is a second factor fostering internationalisation. Linked to the already relatively high degree of autonomy of RTOs, it gives these organisations the opportunity to reduce their dependency on national governments further, while exploiting the others advantages which these types of

projects bring (Cruz-Castro et al., 2015). Thirdly companies increasingly source their R&D internationally. A recent analysis of the Danish companies' R&D investments shows that more and more R&D services are bought abroad (i.e. outside Denmark) (REF missing). This points towards a global market for R&D services with a rapidly increasing international division of labour and increasing specialisation among knowledge providers and R&D environments and clusters. Finally, the globalisation of research and the higher mobility of researchers is a fourth external factor incentivising internationalisation of RTOs. A number of different initiatives both at global and European level have increased internationalisation of research activities over the last decade (Nedeva and Wedlin, 2015). Through this bottom up "research collaboration" aspect of internationalisation, all European RTOs, including late comers and smaller RTOs can and do acquire new knowledge and competencies. However, it is the organisational level strategic internationalisation actions through which RTOs change their material resource (funding and investment) distribution which are of greatest concern in this report.

These different incentives from the environment of RTOs have resulted in a framework which fosters the development of international research cooperation and activities. These external factors are complemented by internal motivations stemming from RTOs to internationalise. These internal motivations were one of the main topics for discussion during the workshop and echoed to a great extent the findings of Cruz-Castro et al. (2015). Four main aspects were highlighted: access to new markets and clients, access to a foreign knowledge base and collaborative partners, strengthening the consumer-base at local level and access to foreign public sources.

Edler and Ebersberger (2009) argue on the basis of survey data that for PROs focusing on basic science, the search for scientific excellence² and reputation are the most important motivations. For RTOs as organisations which are more involved in applied research and less in basic science, they consider economic and external factors (such as improving the ability to contribute to solving societal challenges or answering industry's R&I needs) to be at least as prominent as improving the quality of scientific research capabilities.

3.1 Access to foreign knowledge base, collaborative partners and lead clients

Accessing foreign complementary knowledge and creating synergies with foreign partners in order to carry out relevant state-of-the-art R&I with high impact is one of the main objectives of the internationalisation of RTOs. The globalisation of scientific fields and of knowledge creation has involved a high increase of researchers' mobility and collaboration over the past decades. Researchers are frequently working with different universities, firms, RTOs and other research organisations and move increasingly abroad to conduct research. This increase in mobility and international collaboration has had positive effects on the quality of research (OECD, 2015).

The internationalisation of researchers is accompanied by a simultaneous internationalisation of RTOs, which both follow their own researchers abroad, hire foreign staff and collaborate at the operational level (bottom-up processes) in addition to collaborating with foreign RTOs at the organisational level to exchange knowledge and foster synergies among researchers (top-down process). "RTOs need access to regions outside [their] own country; specifically when excellent knowledge is available but no comparable activities are developed in the home country". The development of cooperation with key international partners is considered to be an essential feature for increasing the creation of impactful research and for building successful innovation ecosystems.³ Through partnering with different research stakeholders, RTOs can increase

² Scientific excellence as understood in the research evaluation literature as referring to high levels of scientific impact as measured e.g. through highly cited publications.

³ For example Eurecat, a Spanish RTO explicitly includes this motivation in its internationalisation plans.

their access to research infrastructures and participate in dynamic clusters of research. The UK's Offshore Renewable Energy RTO Catapult and the Spanish RTO Tecnalia have thus recently committed to work together to take forward offshore renewable energy research and development⁴. This type of partnership is meant to increase the quality of the research and to anticipate changes in the field, to identify new trends and technologies and to come to a greater understanding of societal challenges in a global context. Through the development of synergies with collaborative partners, RTOs aim to attain a critical mass allowing them to be both resource efficient by bundling forces, more flexible and able to act in global markets and environments by becoming a more credible partner for foreign governments and Multi-National Corporations.

Market expansion can also lead to increasing competences due to the access to market-leading clients that may not be present in the national territory and require an internationalisation of activities. Fraunhofer thus highlighted that most electronic suppliers are located outside Europe and that a common cooperation necessarily implies a degree of internationalisation. Similarly, the Spanish RTO CIRCE⁵ started in 2012 an on-going collaboration with the International Energy Agency in order to develop joint activities with the main stakeholders involved in the development of electric vehicles (among others Japan, USA, China). The collaboration between the Spanish RTO LEITAT, the mining industry and renewable energy firms in Chile is another example of international synergies. The development of international activities also allows for expanding scientific and technological human capital through recruitment as well as the training and gains in experience which international experiences confer on existing staff (Bozeman et al., 2001). This could in turn foster the development of new 'know how', spin-offs and other new activities and thus generate future income.

3.2 Access to new markets, clients and funding

As for private companies, the possibility of accessing new markets and clients is a key driver for the internationalisation of RTOs. The development of cross-border activities allows for the diversification of resources. Limiting their dependency on a limited pool of national clients by accessing market-leading stakeholders can result in an expansion of economic income and increasing their resilience to adverse future situations. This has especially been crucial in the context of the recent economic crisis in which national innovation markets were sometimes drastically reduced.

As was discussed in the previous section, the reduction of (core) public funding since the turn of the century has been an important driver for the internationalisation of many other RTOs. However, it is not only public funding that is being reduced. In some countries, e.g. Finland, the market for contract research is no longer growing but decreasing nationally. For an RTO like VTT, this was a powerful incentive to go international, following the logic that organisations aim to maintain or expand their operations (Cruz Castro et al, 2015). Fraunhofer considers the size of the German market limited in comparison to the opportunities that internationalisation brings for expansion. Tecnalia and Eurecat (Spanish RTOs) indicate that internationalisation offers them an opportunity to exploit/sell mature technologies abroad. Finally, for internationally prominent RTOs, internationalisation is as much driven by the will to preserve and maintain existing market positions as by the will to expand further. This is especially the case for the more specialised RTOs, who hold a strong position in a global niche market. For instance, the Danish RTO DHI is one of the leading research organisations within water-related technologies in the world, and 82% of its total turnover is generated outside Denmark. The Belgian IMEC, with offices in Belgium, the Netherlands, Taiwan,

⁴ <http://www.tecnalia.com/en/energy-and-environment/press-releases/ore-catapult-and-tecnalia-to-collaborate-on-offshore-renewable-energy-research-and-development.htm>

⁵ Research Centre on Energy Resources and Consumption (*Centro de Investigación de Recursos y Consumos Energéticos*), <http://www.fcirce.es/>

USA, China, India and Japan, realises more than 50% of its turnover (about 415 million euro) at international level⁶. This makes internationalisation and access to foreign markets more a pre-condition for further activities than a project for future development as is the case for smaller or less internationalised RTOs. In addition to increasing financial resources and expansion, the access to international markets and clients are also driven by the expectation to increase RTOs' international reputation (Cruz-Castro et al., 2015). This can increase the competitiveness of the RTO in the domestic and EU market.

3.3 Strengthening the domestic consumer base

In complement to fostering research capabilities and the diversification of resources, the access of RTOs to new markets, to new knowledge and to collaborative partnerships is meant to provide economic and knowledge return at local and national level. Gaining access to new knowledge acquired abroad and disseminated domestically, local innovation systems stand as direct beneficiaries from the internationalisation of RTOs. This knowledge dissemination function of RTOs to the local ecosystem can be a core driver of internationalisation and has in several cases been recommended by national governments.

This is the case for the Norwegian NOFIMA⁷, for which the internationalisation process came from an explicit demand of the Ministry of Education and Research to be at the forefront of research and to benefit the regional and national innovative stakeholders. It considers that its multitude of international activities in the aquaculture field brings back insights that it can exploit also in the Norwegian context. Similarly, the Dutch TNO requires knowledge-based returns as one of two alternative mandatory preconditions to any internationalisation process (the other being economic returns). Governments often consider innovative firms to be a national asset, encouraging them to export knowledge (provided it results in appropriate financial rewards to the country). As their close partners, RTOs are also used as an official mechanism for encouraging inward investment from commercial enterprises. The result is either international customers for the RTO, or the RTO developing activities abroad. A recent trend is the linking of RD&I to the provision of aid to third world countries – again encouraging RTOs' internationalisation by the home government. This transfer of knowledge is often used to pave the way for clients with new business models to be introduced abroad. The knowledge and networks acquired through cross-border activities thus serves to anticipate potential needs of domestic clients in emerging markets.

In addition, RTOs can support local businesses in their own internationalisation activities. Some RTOs participate in the elaboration of joint commercial and distribution plans with client companies interested in expanding abroad. An example of this type of support is given by the Spanish RTO Tecnalía, which seconded the national energy company Iberdrola in a project of recycling wind turbines in Scotland⁸. Similar activities are developed by most big RTOs such as Fraunhofer with local businesses. A representative from the Danish Technological Institutes, with a turnover of 26% from international customers, indicated that the degree of internationalisation of RTO activities therefore depends to a large extent on the nature of the clients served and their needs. RTOs with clients in sectors where a lot of business occurs outside the home country therefore also have a large degree of internationalisation. The international aquaculture consulting and research services of NOFIMA can also be seen in this light.

⁶ http://www2.imec.be/be_en/about-imec.html

⁷ NOFIMA is specialised in specialised in food science, aquaculture and fisheries
<http://nofima.no/en/>

⁸ <http://www.deia.com/2015/07/05/economia/iberdrola-tecnalia-y-gaiker-lideran-el-reciclaje-de-las-palas-de-aerogeneradores>

3.4 Access to European, international public funding and national support programmes

The economic crisis faced by most European countries since 2008 has in some cases drastically reduced local and national public funding for RTOs. At the same time private funding remained flat or decreased as well. This has resulted in the need to diversify sources of funding and to look for alternative opportunities both at European and international level either in order to sustain operations, or as a way to grow and expand. RTOs may seek foreign funding also to increase their autonomy and reduce risks associated to the dependence on their domestic governments and client base.

Complementarily to European projects (Framework Programme funding, EUREKA network project), several RTOs also have access to other international sources of funding. The Swiss organisation CSEM (Swiss Centre for Electronics and Microtechnology), with 80 CHF million turnover, benefits for example of "direct business relations with several partners worldwide. [Its] local operation in Brazil (CSEM do Brazil) benefits from local funding instruments. These cooperation[s] are extremely valuable for [Swiss] SMEs which enter international value chains, otherwise inaccessible to them (e.g. Brazil, Korea)". National level "cooperation development agencies" are playing an important role in supporting the internationalisation of RTOs. For example, the Swedish SIDA or the international S&T organisation CYTED based in Spain through specific programmes like IBEROEKA (managed by the Spanish innovation agency CDTI focuses in Latin America) actively support their local RTOs to exploit their knowledge in recipient countries to contribute to development aims.

4. Barriers against internationalisation

Now that the preceding section has discussed the drivers and motivations of RTOs to engage in internationalisation, the current section asks what the main barriers against internationalisation are. To this end table 3 complements some of the barriers identified in the literature with information collected through the survey and the workshop. Realising that these barriers differ in nature, we identify a set of barriers which are internal and external to RTOs.

Table 3 barriers to internationalisation

Internal	External
Strategic orientation, mission and autonomy of the RTO (Cruz-Castro et al, 2015)	Lack of collaboration framework at international level (likewise the existence of such frameworks can be considered "facilitators")
Effective internationalisation investment as well as the efforts and adjustments needed for running a multinational RTO (especially for smaller RTOs)	Higher levels of competition at the international level
Resource constraints, funding arrangements	Funding dependence from national/regional governments and the tension between the funding/governance-relationship and serving the needs of foreign clients
Capacity problems: lack of competences, capabilities, experience, local skilled workers, intercultural knowledge and contacts	Legal aspects, IPR, tax aspects, fiscal barriers
High Costs of internationalisation, also in terms of administrative support	Diversity of international markets: different interests in different regions
Strategic barriers: 'know how' drain; inappropriate research topics for the domestic market; inappropriately large benefits to foreign firms (Edler, 2007)	Need/size of domestic market

Source: Berger and Hofer (2011); Cruz-Castro et al (2015); Edler (2007) and empirical material collected for this project.

Internal barriers are those that are related to the capacity of the RTO itself to internationalise. This may refer, for example, to the nature of the RTO, the aforementioned tension between serving the needs of domestic and foreign clients, the lack of sufficient resources or the capabilities, skills and (cultural) knowledge to make optimal use of the opportunities that internationalisation offers. Apart from constraints internal to the RTO, a number of external barriers can also limit their potential to engage in strategic internationalisation. These constraints may exist at the policy level as in the case where an appropriate collaboration framework is lacking between countries and/or regions. They may also have to do with the legal or fiscal framework in the market of choice. Finally competition and the size of the domestic market can pose constraints on the ability of an RTO to internationalise. The sets of barriers related to "strategies and markets" identified in the table are so closely tied to strategy development that they will be discussed in more depth in the next section.

4.1 Funding dependence, mission and control from regional/national governments

As discussed in Section 2, the management of RTOs has a relatively large degree of freedom to develop its own strategies. Nonetheless, many remain reliant on national or regional government for a substantial share of their resources and these governments have various levels of control over the extent to which the RTO can serve the needs of foreign clients. For CSEM, for example, "the main orientation is national industry, which relays internationalisation nominally to a second priority. However the bridge that this internationalisation creates for CSEM also benefits national firms". Tied to the issue of autonomy and the relationship between governments and RTOs are the tensions that can exist between a government's desire to increase the competitiveness and access to foreign knowledge of an RTO and its concerns over the optimal use of public funds to foster domestic interests (Charles and Ciampi Stancova, 2015; Cruz-Castro et al, 2015). Some governments fear that internationalisation can cause the ineffective use of domestic public investments, the "expatriation of RTOs' R&I results" (Charles and Ciampi Stancova, 2015), a drain of "know how" from the domestic system and inappropriately large benefits to foreign firms vis a vis local competitors (Edler, 2007). This tension can also occur with some national customer firms who see "their" RTOs carrying out research for foreign clients as a way of collaborating with their competitors. As a response, governments may tie their funding to provisions which limit their use outside the regional or national context, or constrain an RTO's desire to internationalise in other ways. RTOs with lower levels of autonomy thus depend on the extent to which their government favour internationalisation, whereas organisations with higher levels of autonomy can make these strategic decisions themselves.

4.2 Sufficient access to financial resources

As highlighted by Cruz-Castro et al (2015) RTOs are more likely to have the capability to strategically engage in internationalisation if they have some "organisational slack", i.e. have sufficient "free" resources to do so⁹. The high initial investments, e.g. opening of representative offices or detailed evaluations of potential markets, but also the costs of travelling to meetings and the recruitment or training of specialised personnel, requires strong financial muscle which can be difficult to muster especially for smaller RTOs. Setting up joint units abroad and running them in a sustainable and continuous way (rather than project-based) is financially challenging and is therefore beyond the reach of many RTOs.

This relates in part to the availability of funding from public or private sources and can constrain some of the organisations with low levels of funding to engage in internationalisation even at times in which resources from traditional national sources are being reduced: i.e. when RTOs' need for additional foreign income would be highest. SINTEF for example indicates that "due to lower levels of institutional funding (only 6-7%) it does not have [sufficient] resources to engage in internationalisation". For many RTOs, "business development resources do not stretch to overseas activities, and the main priority remains on supporting national industries."

The way in which project funding is provided is also tied to the relative degree of free resources an RTO has. Whether project funding is provided in a full costing mode or a direct costing mode can have a considerable influence on the relative ability of an organisation to save up resources to use for strategic ends. "[Considering] the large up front investments [required for internationalisation] the current funding schemes are [deemed] insufficient" by some responding RTOs. This can also be due to the high coordination costs related to the "bad administration/research ratio [for international

⁹ "Free" resources referring to resources over which the management of the organisation has a relatively great degree of discretionary control, because they are tied up to for example salary commitments.

projects], [as this implies] higher costs which are not always accounted for by the funder".

This ties into the preceding section on the RTOs' relation to its government. A high share of core funding provided by a national/regional government can facilitate internationalisation because it provides the organisation with the "organisational slack" (free resources) to engage strategically in this process. At the same time, it can use these resources only if the government either gives it high levels of autonomy or, as in the case of NOFIMA for instance, actively requires and supports the RTO to internationalise. A high dependence on project funding may on the one hand reduce the organisation's financial flexibility, but on the other hand it may condition the internationalisation process as it spurs RTOs to search for foreign project funding to reduce their reliance on domestic funding and expand their operations. In order to exploit the opportunities offered by e.g. European project funding, RTOs do require a certain critical mass in resources and capabilities to assuage associated risks. The relatively low success rates in Horizon 2020 in comparison to national funding programmes was mentioned by some RTOs as an impediment to applying for European funding.

RTOs that operate in small innovation systems may not have accumulated sufficient financial resources to engage in internationalisation. In the latter case the lack of larger, internationally active companies in the domestic innovation system, may also reduce the potential of an RTO to engage in internationalisation. Collaboration with other RTOs, firms and universities can offer one channel for RTOs to increase their critical mass and exploit complementary expertise.

4.3 Organisational structure of RTOs

The way an RTO is organised can affect its potential for strategic internationalisation. Some of the more distributed RTOs lack a central, focused, organisation at head quarter level which has the mandate to develop internationalisation activities for the organisation as a whole. This does not hold for all distributed organisations. Some institutes do have a relatively large degree of autonomy, but these institutes are either of sufficient scale to develop their own internationalisation strategy or have a central organisation which has the ability to coordinate and support these activities. In general RTOs of smaller size are less likely to internationalise, while larger sized RTOs are more likely to do so. However increasing size in interaction with the autonomy of the component units can change the direction of these size effects.

4.4 Organisational capabilities: lack of knowledge and skills to effectively internationalise

Effective internationalisation requires changes in the management and administration of an RTO. Apart from the set-up of institutional structures, this involves the development of competencies to deal with the legal, fiscal and logistical/managerial issues which operating in a different country entails. The associated costs can be substantial and may therefore be difficult to bear, especially for smaller RTOs.

Lack of access to foreign markets is a more general barrier to internationalisation. Internationalisation implies the need to invest in market research, marketing and partner searches. The latter can take time due to "the lack of confidence that domestic players usually demonstrate to foreign newcomers". Most of the time, "RTOs need to work (or just to be present) for years before achieving new contracts with national players". Another issue cited by an RTO representative in this respect is that it "can take a lot of effort and time to build up the necessary expertise on e.g. foreign funding systems". Apart from building relations to potential clients this extends to forming fruitful collaborations with foreign research collaborators.

Related to this issue is that RTO staff may also have insufficient competencies, capabilities and country specific knowledge about barriers and opportunities as well as the linguistic, cultural, business, political, and administrative knowledge to exploit these.

Communication issues may also arise due to a "lack of common understanding on business behaviour". In addition to knowledge, "the lack of professional networks" in other countries can be a constraint. Most RTOs, including some of the largest ones have "capacity problems in terms of the number of internationally experienced scientists and business development staff". Not only is the number of employees with the right skill set or motivation limited, there are also "constraints for many of [the] RTOs' experienced staff members to engage in international careers due to e.g. family commitments." Human capital and the level of interest is thus frequently a bottleneck which also makes it difficult to expand the international experience and focus beyond the core team of an international activity to the organisation as a whole. Some RTOs like Fraunhofer have found it "easier to motivate their staff to engage in projects for foreign clients from their home office, rather than carrying out projects abroad". Some RTOs also report difficulties in recruiting foreign staff, an issue that is explored in more depth in the section on strategies.

4.5 Legal, administrative and fiscal barriers

RTOs can face legal, fiscal or administrative barriers in the foreign countries in which they want to operate. These constraints may exist at the policy level when appropriate collaboration frameworks are lacking between countries and/or regions. When there are no cooperation platforms with sufficient support from public administration, it can be difficult to build up a long-term relationship with partners in those countries.

Legal barriers may be due to a weak enforcement of Intellectual Property Rights (IPR) issues in some countries, formal/informal barriers to bidding for government contracts, administrative barriers in setting up units, unfavourable tax regimes, acquiring the appropriate licenses to operate in the foreign market but also e.g. issues related to corruption which may result in "ethical losses"¹⁰. The negotiation of contracts in foreign countries tends to require greater efforts, on e.g. the use of intellectual property, the applicable law and the place of jurisdiction. In some regions, industries and public authorities have no tradition of working with organisations like RTOs. In such cases, a large effort is needed to introduce the concept, establish (procurement) procedures, etc. Tighter import and export regulations can involve a tremendous effort. Local taxes can also form a barrier. For example, longer secondments abroad can lead to permanent and taxable establishments. Social security of staff members can be subject to complicated rules when researchers work in two or more countries. Certain (including European) countries have registration requirements, which raises bureaucratic costs.

4.6 High(er) level of competition

The other side of the coin is that the level of competition in foreign markets may be higher than in the domestic market. Not only will the RTO lack the knowledge and historically grown network of relations that characterise its operations in its own national context, it may also need to compete with domestic knowledge providers in the foreign country of choice as well as with counterparts from other countries that choose to operate in the foreign market. Japan and the US, for example, are very complex environments for European RTOs to operate in due to their well-developed industries and research organisations, which means that they must bring something of high added value to be recognised as a potentially interesting partner.

Besides, operating in a foreign country often brings additional costs as was highlighted in several of the preceding sections. These costs may be due to the additional administrative costs - the ratio between administrative and research costs tend to be less favourable for international activities - logistics or e.g. the additional investments required to overcome regulatory barriers. As a consequence the prices that the European RTO has to charge may be higher than that of domestic or other foreign counterparts. In developing countries they will often be too high for potential customers to bear.

¹⁰ <https://www.scu.edu/ethics/focus-areas/business-ethics/resources/only-the-ethical-survive/>

5. Strategies – How do RTOs internationalise?

As discussed in section 3, the core motivations of RTOs to internationalise are to fulfil their core mission in today's globalised and digitalised world: produce high impact R&I while solving societal challenges and boosting industry's competitiveness. Through the internationalisation process, RTOs reach further knowledge and expand their resource base to ensure survival, maintain their operations and grow. RTOs also aim to access new markets and expand their activities, to apply for additional European or international public funding, to find new partners to attain a critical mass that allows them to increase their visibility at the national and international level. While these different motivations, pave the way for setting up cross-border activities, they are by no means a sufficient precondition for a successful internationalisation process. In addition, the integration of an internationalisation dimension in organisational strategies or even the development of an internationalisation strategy is one of the necessary, criteria for a fruitful adaptation to the international environment. Through this, RTOs intend to identify different steps allowing them to expand the range of their activities while safeguarding their interests. This section characterises the distinctive phases of successful internationalisation strategies.

Before going into more detail, it is important to stress once again the heterogeneity of RTOs. Given their variations in organisation, governance, size and the domestic context in which they operate, it will be clear that one size does not fit all. Internationalisation is not necessarily an objective for all RTOs, nor does it always have positive impacts for all. Before deciding on whether to engage in internationalisation, RTOs need to assess their objectives and weight the potential costs and benefits. Not only do the drivers, motivations and barriers RTOs face vary depending on their characteristics and national environment, but the strategies they adopt in the internationalisation process need to be different as well. Nonetheless, this section aims to highlight some common elements in the strategies followed by RTOs to come to successful internationalisation.

The main strategies followed by RTOs to engage in internationalisation include for instance a network approach to build critical mass at a transnational level, a specialisation approach to become one of the world leaders in a specific niche market, or a more geographical approach with a strategic choice of countries where RTOs decide to internationalise their activities. The availability of funding mechanisms has also a strong influence on RTOs' internationalisation strategy.

RTOs do not normally start with internationalising to third countries¹¹, though for example the EARTO member TWI did start to expand to third countries very early on. It has been more common for RTOs to expand first to "similar markets". The availability of external funding is also a key aspect. European Framework funds and the single market provided a spur to Europeanisation. RTOs do not necessarily approach Europeanisation and internationalisation to third countries in the same way. "Tecnalia, for example, "separates the corporate functions of European Framework Programmes and [the development [of] international market activities both in Europe and in third countries." The experiences, competencies, skills and organisational structures supporting Europeanisation are nonetheless likely to be conducive to internationalisation to third countries as well. In some cases historical or cultural ties have shaped the direction of internationalisation, e.g. in the case of Spanish RTOs operating in Latin America. The expansion to third countries is also often related to the expansion of domestic firms to emerging countries and the prospects that fast moving or advanced economies offer. Finally, as argued by e.g. Eurecat and LEITAT in the case of Latin America, the existence of government support programmes stimulating expansion to specific foreign countries/regions can influence the selection of countries.

In their strategies towards internationalisation, RTOs are expected to combine features of both academic research (joint research, co-authorship, mobility) and enterprises (R&D

¹¹ i.e. Countries situated outside the European Union.

related FDI) (Berger and Hofer, 2011). Cruz Castro et al. (2015) differentiated between several types of internationalisation strategies. The first is to promote individual researchers in the RTOs to engage in bottom up international collaboration activities with foreign counterparts. This research driven internationalisation is similar to the international collaboration activities in the academic world and does not necessarily rely on a top down institutional strategy. The management of an RTO can promote this behaviour at the operational level, which may also involve international mobility of personnel, by offering support and incentives. RTO management can also actively promote the search for project funding or research contracts from international sources. In Europe this type of internationalisation is frequently tied to the participation of RTOs in the Framework Programme or other European initiatives. This strategy implies the development of contractual activities with foreign clients, bidding for European or international public research projects as well as the development of collaboration with (researchers from) different RTOs, and other research actors. The recruitment of foreigners can facilitate international collaboration. It can also strengthen the RTO's knowledge and skill base. This does not need to be restricted to content related knowledge but can extend to knowledge of foreign markets and may thus facilitate the export and exploitation of knowledge abroad. A further step consists of the elaboration of an organisational strategy that can involve joint organisational activities with foreign RTOs or establishing a physical presence outside the country of origin either in the form of representative offices or R&D facilities abroad (Jonkers and Cruz-Castro, 2011). Table 6 summarises the characteristics of each of these two approaches.

The answers provided by European RTOs present at the joint EARTO – DG JRC workshop largely confirmed these findings and complemented them with further practical insights. Workshop participants insisted in particular on the identification of RTOs' capabilities as an important precondition to any type of internationalisation. Second, a phase of market discovery in which RTOs explore potential sources of funding, business opportunities with possible clients and collaborations with foreign partners was mentioned. Finally, a phase of "market consolidation" which can include both the acquisition of project funding as well as (potentially) organisational level actions was highlighted. As argued by Berger and Hofer on the basis of the literature on the internationalisation of firm R&D (Kuemmerle, 1999 in Berger and Hofer, 2011), the market exploration/consolidation strategies differ in nature depending on their level of development. RTOs can focus in their internationalisation strategy on the transfer and/or exploitation of the knowledge and expertise they have developed in their home system. This strategy tends to be characterised by the bidding for project funding and at the maximum level the establishment of representative offices. A final stage in the internationalisation strategy is the R&D augmenting step in which knowledge is being acquired or developed in a third country which is exploited also in the home system. To this end RTOs can develop "listening posts" in third countries, establish partnerships with foreign counterparts or establish their own R&D facilities in third countries. Often this last phase is oriented to technologically advanced third countries, but it is not unlikely that some of the largest RTOs will follow the emerging trend among transnational companies and establish R&D facilities in emerging economies to exploit the knowledge developed there for the host and home system.

Table 4. Strategies for RTO internationalisation

Phases	Strategic actions
Risk/capability assessment	<ul style="list-style-type: none"> - Assessment capabilities - Assessment needs and risks
Market exploration	<ul style="list-style-type: none"> - Market research - Network approach: partnering with foreign counterparts in R&D projects to build critical mass - Specialisation approach: being dominant in a global niche market - Geographical approach: country selection - Recruitment and mobility - Developing capabilities and contacts
Market consolidation	<ul style="list-style-type: none"> - Inclusion of internationalisation in a strategic innovation and research agenda at business development level - Organisational level collaboration with foreign RTOs - Bidding for public projects and contract research from foreign client - Offering support to European firms aiming to enter the foreign market - Establishing a physical presence abroad: <ul style="list-style-type: none"> - Establishment of representative offices and listening posts - Establishment of R&D units abroad

5.1 Phase 1: Identifying RTOs' capabilities

While for the leading RTOs such as Fraunhofer (operating in 4 continents) internationalisation has long been part of their day-to-day activities, smaller national or regional RTOs often have to tackle a number of internal issues prior to engaging resources into internationalisation processes. Among them, the identification of their own risk-taking capabilities appears as a key determinant of an RTO's capacity to develop successful cross-border activities. These capabilities are to a great extent determined by the integration of internationalisation into an RTO's organisational structure and human resources.

When internationalisation is not a central element of an RTO's strategic innovation and research agenda, resource commitment is often limited. Internationalisation strategies tend to require efforts from diverse service lines in order to leverage benefits from one another. Effective internationalisation thus requires sustained investments and efforts as well as administrative adjustments necessary for running a multinational RTO. Key Performance Indicators on internationalisation are lacking in many RTOs, whereas they can be a way to come to a coordinated approach towards internationalisation throughout the organisation.

All types of RTOs have to align their internationalisation objectives with the required investments as well as with the business models required for implementing the strategy: "how much is required as initial investment, what is the timing and volume of the expected returns, etc.?" RTOs often lack a long-term budget for international actions while they are costly and the result is not immediate (there is a longer time to innovation and time to market). For example, applying for European public calls for funding, identifying possible clients or partners, or defining transnational research and innovation projects require setting up or mobilising a team in charge of developing these activities. This involves both financial costs and a prioritisation of tasks that the smallest RTOs may not be able to afford. While internationalisation is often presented as a way to diversify activities, it requires from RTOs a prior capacity to develop additional projects on the side of their daily issues. Underestimating this aspect may lead to a dispersion of tasks that could weaken the overall sustainability of the RTO. Sub-optimal internationalisation efforts frequently result in non-efficient, non-coordinated or single, unsustainable international activities.

The level of risk-taking capabilities increases with the degree of involvement into international activities. Thus, while bidding for cross-border activities requires additional human resources, setting up joint units or representative offices abroad involves supplementary financial costs that most RTOs cannot absorb. In order to reduce potential adverse consequences, the opportunity costs of internationalisation, i.e. the ratio between resources involved and expected outcomes, needs to be thoroughly evaluated prior (and possible re-evaluated during) any expansion of activities.

The choice of many European RTOs to first expand their activities within Europe should be seen in this light. Not only are the risks, costs and requirements for making this step in general lower than for expansion to third countries, the predictability of benefits in e.g. access to European funding are also likely to be higher. Increasing activities in a European context brings benefits to RTOs in terms of access to resources as well as knowledge, network and reputation. Nonetheless it is a more competitive context which does require substantial investment in resources and smaller RTOs who want to explore this route need to assess the capability requirements and risks involved.

5.2 Phase 2: Discovering new markets

After the first phase of assessing RTOs' capacities to develop in an international environment, the identification of a potential market to settle in is a second fundamental aspect to be taken into account for a successful and long-lasting internationalisation process. This involves several issues that need to be jointly addressed i.e. rather than a linear set of sequential steps, these approaches can be alternatives to each other or be developed in interaction with each other.

Reaching critical mass and building strong transnational networks are essential for successful internationalisation: national funding and national networks are often not enough to be an attractive and competitive partner at the international level. Strong transnational networks give access to excellent knowledge and create the critical mass necessary to provide the best solutions and to remain competitive internationally. This approach is relevant for RTOs of all sizes, and especially so for the smaller ones that have more to do to reach critical mass. Creating strong partnerships with other RTOs, industry and other research actors both from the EU and third countries e.g. through the EU Framework Programmes are important ways to build such networks. Favourable framework conditions and programmes that facilitate staff exchange and support the exploration of new markets and potential alliances with sufficient time, funding and skilled staff are also essential for the internationalisation of RTOs. Illustrative examples of what already exists in the EU:

- ELAN Network, a DG DEVCO project coordinated by TECNALIA, whose aim is to create a Network of European and Latin-American Research & Innovation actors to

facilitate the generation of Technology-based business opportunities among EU and LAC.

- AERTOs, an FP7 ERANET project whose rationale was to foster greater RTO cooperation within Europe with the aim to achieve important efficiency gains by exploiting synergies and avoiding duplication of effort by identifying challenges and tackling them jointly through common programs and initiatives.
- ROBOT-NET, a shared infrastructure network aimed at sustainably optimising robot technology transfer throughout Europe.
- the Joint Institute for Innovation Policy is a joint undertaking of four major European RTOs to come to joint activities in the field of Innovation Policy support at the European level.
- the European Joint Programming initiatives aim to bring together research organisations around common themes, partially based on national research funding programmes. For example the European Energy Research Alliance (EERA) brings together researchers from over 170 Public Research Organisations and Universities across Europe. Platforms such as EERA can and do play a role in coordinating activities outside the EU as well.

Such initiatives support RTOs to work together towards internationalisation, joining efforts to approach international partners, and sharing the risks of going abroad. RTOs also "benefit from this networking effect by participating in international cooperation projects in the European Framework programmes", which some workshop participants argued "could be improved by further taking into account the specificities of internationalisation projects (requiring upfront investment, less risk-averse mechanisms, etc.) and better exploiting the potential of RTOs." "Moreover, the possibility for partners from third countries to take part in collaborative projects in EU R&I Framework Programme is also key to create strong international networks. One of the approaches to foster their participation could include developing work programmes and projects addressing the specific R&I needs of these countries."

The existence of possible public sources of funding to finance European or other international projects deserves special attention as they can represent a significant input. At European level, the Framework Programmes (Horizon 2020) stand out as the most important opportunity for funding. A number of other international programmes aim to foster the creation of top level groups of high level partners in order to strengthen the development of international innovation ecosystems. Prior to managing "knowledge export" (marketing, selling or exporting knowledge, products and services abroad) and to attract funding from foreign sources, RTOs in many countries can benefit from internationalisation support programmes as well as the aforementioned development aid programmes in which RTOs are active participants. The British RTO Transport System Catapult benefits for example from funding provided by the Newton Fund, aimed at strengthening science and innovation capacities at international level and from the FCO Prosperity Fund, dedicated to support innovation projects overseas.

Specialisation is also a very efficient internationalisation strategy. The more specialised RTOs, which have become strong players in a global niche market, can be more competitive and attractive for partners at the international level. For instance, the Danish RTO DHI is one of the leading research organisations within water-related technologies in the world, and 82% of its total turnover is generated outside Denmark. The main goal of these very specialised RTOs at the international level is to strengthen their offer towards customers by working together with the key players in their research area.

On top of these approaches based on network and funding opportunities as well as specialisation, a more geographical approach can also be used by RTOs to strategically select the countries where to internationalise their activities. The needs of clients for the services an RTO can offer in one system can differ radically from those desired in a different system. This requires the RTO to make strategic choices regarding the countries to which it chooses to expand its activities and tailor the offer of its services to the potential clients operating there. Due to the higher levels of competition at the

international level there is also an increased need for differentiation, competitive pricing and scalability of services. RTOs are very often partners but also competitors among themselves. Once they internationalise their activities they must differentiate themselves from the local RTOs and other foreign competitors. Because there is a need for added value, they should offer something that is not available locally.

In this regard, a strategic focus may be targeted at countries or regions in which fast transitions are taking place or those with the potential for economic growth in specific sectors. VITO, a Belgian RTO specialised in clean technologies and sustainable development, focuses for example on a limited number of regions chosen on the basis of market analysis. Before its expansion to China, Qatar or India, a thorough analysis of the match between market demand and VITO's products was carried out in order to select the most suitable approach for each market.

Some further aspects, such as cultural proximity, may in addition be taken into account. The Spanish CIRCE, Tecnalia, LEITAT and Eurecat are for example particularly active in South American countries. A common approach to identify the potentialities of a country or a region and the possibilities of economic support to cover part of the costs generated by the internationalisation process is to establish contact with the domestic and local (foreign) public authorities. The Spanish RTO LEITAT, for example, obtained funding support from a local governmental organisation in Chile, CORFO, by responding to a call to attract international Centres of Excellence.

Chambers of commerce, enterprise organisations and national/regional innovation agencies can often provide useful information regarding local characteristics of the economy. Following the development of bilateral relations between the RTO's country or region of origin and other countries/regions, as well as participating in international congresses and exhibitions can complement these aspects. National/regional governments in Europe also offer support to establish contacts through international missions but it remains extremely challenging to set up a fruitful cooperation agreement on the basis of a single visit – so follow up investments in relationship building are required from the side of RTOs.

In the preceding section on barriers we highlighted that RTOs frequently lack knowledge of the countries in which they want to operate. Insufficient knowledge and a lack of understanding of foreign markets and conditions can impair strategic planning: "for example, the expectation of easy, quick returns from international activities, can lead to frustration. This makes it more difficult to maintain the continuity of international activities." Recruitment, also of foreign staff, is an often deliberate approach, which RTOs have taken to address this capacity problem. For example, IMEC, one of the most internationalised RTOs with over 50% of its revenue coming from foreign clients, has "74 different nationalities among its staff". The recruitment of foreign staff can be understood as "domestic internationalisation" which, apart from other benefits such as the capturing of knowledge that is not locally available, can contribute to the preparation of effective internationalisation by facilitating "knowledge export" and access to networks, project acquisition or direct foreign investments in facilities through their knowledge of foreign markets.

Furthermore, the cooperation between European RTOs and companies is essential. To transfer their R&I services and technology at international level, RTOs either follow their national clients or look for foreign ones able to contract new research lines or to adapt their existing technologies to the specific national needs where these technologies have to be deployed. Indeed, even though industry and market/commercial organisations are often more visible than RTOs at the global level, when collaboration is already established at European level, European firms will often not look for local partners when going abroad.

Building on projects funded by national or European sources, potentially followed by project with local partners in the foreign market, a next step can involve the export of products, knowledge and services and the bidding for projects and contracts from local

(i.e. foreign) sources – this phase is discussed in the following paragraphs. It is also in this phase (though it can be put in place earlier) that internationalisation starts taking a central place in RTO's strategic innovation and research agenda at business development level.

5.3 Phase 3: Market consolidation

After 1) a thorough assessment of risks, needs and capabilities, followed by 2) an exploration of the foreign market, country specific capability building, the development of an internationalisation strategy and the acquisition of the first projects abroad, the RTO may 3) attempt to consolidate its position in the foreign market. As was highlighted in the preceding sections a number of European RTOs are not only very successful in the acquisition of European project funding and research contracts, but have also internationalised to third countries. For example IMEC, TNO, Fraunhofer and TWI all have a significant presence in a number of third countries. The consolidation of their presence in foreign markets can follow two -potentially sequential - strategic approaches. The first approach is to attempt to exploit technological 'know how' developed in the home country by marketing it to foreign clients. This can involve the establishment of representative offices in foreign countries such as the offices set up by TNO in Japan, Saudi Arabia and Canada. Fraunhofer and IMEC for instance also have such offices in third countries. A second approach consists in using the foreign presence to build up country specific knowledge through market research, partnering with foreign partners and by being active in the foreign market. Indeed, part of Tecnalía's strategy to become a global player is to establish R&D units abroad, close to experts in a specific technology in order to accelerate the development of know-how in an open innovation model. This in turn makes the RTO an increasingly relevant partner for domestic European firms (including SMEs) who want to expand to this market itself but lack the 'know how' and resources to do so.

Some RTOs, e.g. Tecnalía "report to seize the opportunity that internationalisation offers to export their knowledge and maximise their returns on mature technologies which are no longer as relevant in their own markets by marketing them to clients in emerging and developing markets." In parallel, RTOs are "also interested in these markets as well as in more sophisticated ones due to the potential they offer to acquire new knowledge and sell the most advanced technologies." The nature and autonomy of the RTO and the extent to which it receives a high or low share of institutional funding from its national/regional government can influence the way it operates in this respect. TWI and IMEC receive a relatively low share of institutional funding and operate much like companies in their (intensive) approach to internationalisation.

Larger European RTOs, in some cases those with a relatively high level of autonomy, continue their internationalisation process by also establishing R&D units and institutes in other third countries (e.g. Tecnalía, TWI and IMEC have already done so). Unsurprisingly it is the technologically more advanced countries which are the initial prime target for such activities as exemplified by the R&D units set up by Fraunhofer in the USA. At first instance, the R&D units established abroad can play an important role in tailoring the domestically developed knowledge and products to domestic markets and strengthening ties to foreign clients and collaborators. In doing so, they can strengthen the exploitation of domestically produced 'know how'. RTOs can also "engage with local partners in designing national programmes/projects and advising governments from those regions. This enable[s them] to provide access to information, identify research priorities and build trust." The literature on frugal innovation, the increasing availability of highly skilled manpower in emerging countries and the activities of multinational corporations in India and China suggest that RTOs may in the future also benefit from innovations developed in the context of emerging markets which can be exploited in domestic markets (Von Zedtwitz, 2004), thus augmenting the domestic knowledge base.

6. Discussion

In the last decades, Research & Innovation (R&I) have progressively expanded beyond national borders to become fully internationalised. Today, R&I has no geographical boundaries and the creation, accumulation of knowledge and their innovative outputs is nurtured by international networks of academic and technological cooperation. Research and Technology Organisations (RTOs) are no exception in this respect and have progressively extended the scope of their activities outside their country of origin to fulfil their objectives of producing excellent and high impact R&I. Favouring RTOs in their internationalisation process can further enhance their positive social and economic impact. In line with Europe's ambition to be open to the world this can contribute to leveraging Europe's R&I potential and strengthen the construction of a European Research Area.

Under the right conditions, internationalisation of RTOs can be an important growth factor. Organisations which possess sufficient resources, competences and autonomy to strategically engage in internationalisation can exploit the opportunities which cross-border collaboration offer. However, considering the heterogeneity of RTOs in terms of size, ties to their national/regional governments and clients, each organisation needs to assess its own capabilities, the risks, the costs and potential benefits. **Internationalisation is a costly process and RTOs should assess under which conditions the likely benefits are larger than the costs.**

RTOs differ in their motivations to internationalise and the strategies they adopt in doing so. **A crucial step for RTOs is to assess the risks involved in possible offshore activities and the capabilities they have for doing so.** Devoting resources to activities abroad eats into the resources devoted to other business activities. Unrealistic or ill-planned internationalisation strategies can damage RTOs' operations, while resulting in unviable activities. Many RTOs, especially, but not only, the smaller ones, lack crucial competencies, expertise and human resources to successfully enter foreign markets. Developing these capabilities takes time and effort. Recruitment and temporary exchanges of foreign staff with experience of other markets can be part of the solution.

After a careful assessment of risks and capabilities, further steps involve market exploration and once a foothold has been established in a foreign country, market consolidation. A central motivation is to expand to foreign markets in search of new clients and markets to exploit mature or potentially novel domestically produced expertise and technologies. National government and client firms can be worried about the extent to which this is purely beneficial from the perspective of the domestic system fearing it may lead to a sub-optimal use of public resources, a drain of domestic know how, a diversion of RTOs research agenda and undesirable advantages to foreign competitors. RTOs tend to be aware of these risks and take them into consideration in their internationalisation strategies.

Internationalisation enables RTOs to access new knowledge and high level partners. **For them, the internationalisation process is a crucial way of strengthening their role in linking their national or regional innovation system with cross-border knowledge pools.** In doing so, RTOs can enhance their potential benefits to domestic and foreign clients. Internationalised RTOs can also be an important source of support for domestic companies seeking to expand to foreign markets. These motivations are perhaps especially strong for those RTOs with relatively high levels of government control, for whom the contribution to their domestic innovation system is a core element of their mission. Promoting RTOs access to new sources of knowledge and competencies can be an important motivation for national/regional governments to favour and support their RTOs in the internationalisation process.

RTOs which depend significantly on client firms that either export or consider engaging in foreign direct investment, may consider it their role to facilitate this process by expanding themselves to these countries as well. In doing so, during or prior to the internationalisation of their clients, they can facilitate the entry of these

firms into foreign markets by offering services that are tailored to both the client firm and the market itself. In second instance the experience gathered about the foreign market can be exploited by the RTOs also for other clients. Offering support to the internationalisation of domestic firms can be another way for national/regional governments to support RTOs.¹²

The extent to which governments can pose a barrier to the internationalisation of RTOs is related to the institutional arrangements that govern their relationships, but it also depends on the degree of autonomy and of the amount of available resources each RTO has. **Internationalisation is a long-term and risky process which requires sufficient, predictable and sustainable resources.** Too little core funding or high dependence on local markets can impede RTOs (especially the smallest ones) in their internationalisation strategies. For good and successful internationalisation processes RTOs need to **have some degree of flexibility and autonomy to use their available funding.** RTOs may search international expansion to reduce their dependency on domestic funders and clients. This process of diversification can be a way to mitigate the risks associated with dependency on a narrow client base, which have become apparent in times of economic crisis and public funding cuts. However, while internationalisation can be an opportunity for an RTO to spread risks by diversifying its resource base, it can also be risky in terms of the required investments in financial resources and organisational capabilities which are distracted from other activities. **RTOs need to weigh the opportunity-cost ratio.**

Some RTOs made use of available support measures and development aid programmes to internationalise their activities to designated regions. However, RTO representatives participating in the workshop indicated that "these measures should be developed further". The "lack of suitable and flexible funding arrangements required to support the large upfront investments needed for international activities is very often considered as the main bottleneck for RTOs to develop their activities beyond their borders." National/European level export financial support is usually restricted to firms and therefore not accessible to all types of RTOs. To overcome the lack of critical mass to successfully internationalise, **cooperation between European RTOs and companies could be reinforced to look for synergies and together explore other markets.** RTOs suggest that "EU or MS level policy makers could explore the potential to develop programmes that facilitate staff exchange and support the exploration of new markets and potential alliances with sufficient time, funding and skilled staff." The EC funded "ELAN network can form a potential example. This network aims to generate technology based business opportunities between the EU and Latin America. Several RTOs take part and this network may expand in the future". RTOs could in addition develop further networks and programs to benefit from the potential of current R&I funding to support different forms of internationalisation. For example, "Joint activities such as the JIIP or EERA rely for their resources on EU project funding as they do not receive institutional funding. This makes their operation financially challenging." Trust building measures such as joint hubs, frequent workshops, joint visits, exchange and training programmes of business experts and light-weight feasibility studies are all measures that can facilitate RTOs to jointly engage in sustainable forms of internationalisation.

Because of the costs involved and because the needs of clients in different countries varies considerably, RTOs need to be selective in choosing the countries they want to approach. Europeanisation carries limited costs due to the relative similarity of the markets, lower administrative barriers, and increasingly favourable framework conditions in the emerging European Research Area. It also carries large benefits in terms of the access to European funding and the potential to collaborate with leading public research organisations, universities and firms which can increase know how and competitiveness of the RTO in national and international markets.

¹² One example of EC funding that was accessible to RTOs was the "EBDC programme to support the exportation of research to India. However this project was recently ended".

Technologically advanced markets can be important learning sources from leading stakeholders and collaborators. **The use of representative offices as listening posts to scope new technological developments may be especially fruitful in such advanced economies.** If the activities of multinational companies are something to go by, there is potential for useful knowledge development in emerging economies as well. RTOs setting up R&D facilities abroad may therefore not be restricted to the more advanced nations. Apart from adapting domestically produced 'know how' and technologies to foreign markets, such R&D units in both developed and emerging contexts may result in the development of knowledge that can be used to benefit the domestic as well as the foreign system.

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Abbreviations

ACR	Austrian Cooperative Research
ATIGA	Intersectoral Technological Alliance of Galicia
CETMA	Engineering, Design and Materials Technologies Center
CIRCE	Research Centre for Energy Resources and Consumption
CORFO	Production Development Corporation
CSEM	Swiss Center for Electronics and Microtechnology
DEVCO	Directorate-General for International Cooperation and Development
DHI	Institute for Water and Environment
DTI	Danish Technological Institute
EARTO	European Association of Research and Technology Organisations
EERA	European Energy Research Alliance
ELAN	European and Latin American Business Services and Innovation
ERA	European Research Area
EU	European Union
EURAB	European Research Advisory Board
EURAC	European Academy of Bolzano
EURECAT	Technology Centre of Catalonia
EARTO	European Association of Research and Technology Organisations
ERA	European Research Area
NOFIMA	Norwegian Institute of Food, Fisheries and Aquaculture Research
OECD	Organisation for Economic Cooperation and Development
PRO	Public Research Organisation

R&I	Research and Innovation
ROBOTT-NET	ROBOT Technology Transfer Network
RTD	Research and Technological Developments
RTOs	Research and Technology Organisations
TNO	Netherlands Organisation for applied scientific research
TWI	The Welding Institute
VITO	Flemish Institute for Technological Research
VTT	Technical Research Centre of Finland

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