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UNLOCKING RESEARCH POTENTIALS AND REGIONAL IMPLICATIONS OF DEVELOPMENT

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Abstract

The overall plan and the strategies carried out in the framework of the EU project STAR*AgroEnergy (FP7-REGPOT-2011) are presented as a reference case study on "capacity building".

A main am of this project was to significantly improve the research capacity of the University of Foggia (UFG) and its ability to act as a "hub" for the promotion of bioenergy and bioeconomy, which implied strengthening UFG's research power, bolstering the links with stakeholders and fostering capacity building activities.

Three parallel pathways of investment in research capital were applied: *a)* improving the research activities through an interdisciplinary approach ("bonding" by research integration inside university); *b)* consolidating a critical mass of researchers ("bridging" by recruitment outside university); *c)* expanding the research network through large and qualified scientific and non-scientific collaborations ("linking" through two-way secondment-based collaborations and institutional partnerships).

A major strength of this approach has been the high level of integration achieved between the two major drivers of scientific and technological innovation, i.e., "research community" and "local stakeholders". According to this view, research and technological development is conceived as a source of innovation opportunities for the region, by supporting regional economic trends, in-tune with its social needs.

The STAR Research Unit has followed an integrated approach to renewable energy generation, derived from agriculture and agro-food industries, and to knowledge based bio-economy, according to sustainability criteria. The target was to build up a methodology reconciling bio-based production with nature and landscape conservation, maintenance of ecological resources, and protection of cultural heritage of the most relevant rural areas of Southern Europe, through models of viable, dispersed bioenergy generation and biorefinering, together with proximal energy consumption.

Key words: capacity building, regional development, research capacity, bioeconomy, bioenergy & biomaterials, smart specialization, key enabling technologies, social capital, triple helix model.

1. Introduction & Background

Capacity building

The 2014 edition of the International Conference on Technology Policy and Innovation (ICTPI) was devoted to opportunities, challenges, and policies related to capacity building in emerging technology regions (ICTPI, 2014). The concept of *capacity building* (CB) finds its scope to support the practical needs of development with respect to countries, communities and organizations. The United Nations Development Programme (UNDP), one of the first organizations to deal with CB, provided a useful starting definition: CB is defined as a "long-term, continual process of

development that involves all stakeholders, including ministries, local authorities, non-governmental organizations, professionals, community members, academics and more" (UNDP, 1997; 1998). The goal of CB is "to tackle problems related to methods and tools of development, while considering potentialities, limits and requirements associated to the concerned entity (country, community or organization)". According to the same UNPD definition, CB is the process by which individuals, groups, organizations, institutions and/or societies increase their ability "to perform core functions, solve problems, define and achieve objectives effectively, efficiently and sustainably". The CB scope is to understand and deal with the particular development needs in a broad context and under a contrasting set of circumstances. UNDP also outlines that CB takes place on a three-level hierarchy: individual, institutional and societal. This three dimensional approach to increase and reinforce capacity will be detailed hereinafter.
The concept of CB should be considered closely linked to that of a "learning" organization that constantly changes and adaptively experiments by using the feedback of its results in order to change its form and processes in ways that make it more successful (van Geene, 2003). CB can also be seen as a process (rather than a product) inducing a multi-level change in individuals, groups, organizations and systems. Ideally, CB seeks to strengthen the self-adaptive capabilities of people and organizations, in order that they can respond to a changing environment on a dynamic basis. Thus, CB is a planning approach that turns ideas into action; a continuous process of adjusting people's attitudes, values and organizational practices, while generating appropriate knowledge and skills among the various stakeholders in a partnership.

Research capacity

Improving the capability to do and use research is of the topmost importance and should be thought as a key dimension of CB. *Research capacity* (RC), therefore, is a fundamental pillar of the development process, characterizing emerging technology regions. RC could be defined as the collective abilities of individuals, organizations and systems to undertake and disseminate high quality research efficiently and effectively. Enhancing RC is a CB process itself. This means improving researchers' skills, as well as their access to research information and resources; supporting researchers in playing a more regular and effective role in policy-making; paying special attention to skills gaps (when present) in science and technology (Thomas and Wilson, 2010). Strengthening RC is one of the most powerful, cost-effective, and sustainable means of advancing knowledge, technology, innovation and development (CHRD, 1990). Building RC is similar to building other kinds of organizational capacity (White, 2002). In management terms, building such a capacity reflects a commitment to "quality improvement" and characterizes what we have defined already as a "learning" organization (Senge, 1990). RC is, therefore, aimed primarily at research managers, research team leaders and individual researchers who need to familiarize themselves with the concepts and practices of capacity building and organizational development (Thomas and Wilson, 2010). Therefore, it is directly relevant to those running research consortia involving a range of partners. However, its principles are relevant to a much wider audience, since society at large should be involved in building its capacity, from the ground up, within each given context.

Sustainable development

To complete this introductory section, which provides elements able useful to define properly the key concepts on which this paper is focused, it remains to clarify the term "development". Since CB is aimed to promote development, is there a common understanding of what "development" really means? What is it supposed to achieve, and what should its pre-eminent qualifications or attributes be? There is no doubt that countries with similar average per-capita incomes can differ substantially when people's *quality of life* is accounted for; access to education and health care, life expectancy, employment opportunities, democratic participation, availability of clean air and safe drinking water, are all possible indicators, and many others could be also selected to create a panel. It is true that *economic growth* can also enhance the potential for reducing poverty and solving other social problems. However, history offers a number of examples where economic growth was not followed by similar progress in human development. Instead, growth was achieved at the cost of greater inequality, higher unemployment, weakened democracy, loss of cultural identity, or over-consumption of natural resources needed by future generations (Soubbotina, 2004). On this respect, "sustainable development" is a term widely used by politicians and civil society; a huge *corpus* of definitions and interpretations is available in the literature, but it is not the scope of this paper to address this complex issue. "Sustainable" development could probably be otherwise called "equitable and balanced", meaning that, in order for development to continue indefinitely, we should balance the interests of different groups of people, within the same generation and among generations, and do so simultaneously in three, strongly interrelated areas: economic, social, and environmental, respectively.

The EU policy

Europe 2020 (EU-COM, 2010) is a 10-year frame strategy proposed by the European Commission for advancement of the economy in the European Union. It follows the *Lisbon strategy* of the previous period (2000-2010) and aims at "smart, sustainable, inclusive growth". On this respect, Europe 2020 puts forward three mutually reinforcing priorities:

– Smart growth: developing an economy based on knowledge and innovation.
– Sustainable growth: promoting a more resource efficient, greener and more competitive economy.
– Inclusive growth: fostering a high-employment economy, delivering social and territorial cohesion.

Considering the EU research policy, we have just entered in the new programming period 2014-2020 and the *Horizon 2020* Programme is now running as the successor of the *Seventh Framework Programme* (*FP7*). In the previous programming period, a specific action to promote R&D was launched and carried on in the years 2007-2013. The name of this action was "Research Potential" (REGPOT) and it was intended to strengthen research potential as well as to forge synergies between regional development and innovation strategies. Considering the 2007-2013 period, the FP7 Research Potential programme supported 169 projects with € 340 million (EU, 2014). Under *Horizon 2020* the "Research Potential" programme have been transferred to the EU's "Cohesion" policy, so that the new EU Members States will be now reshaping the scene inside the "enlarged" Union.

Scope of this work

All this considered, and benefiting from the closed FP7 programming period, this could be the appropriate moment to look back at the previous programme, identify some key findings, and draw lessons for the future.

The particular object of this paper is to focus its analysis on a specific and real case, namely a three-year European REGPOT project, and carry out an investigation according to a "bottom-up" approach. This work is not intended to attempt a comprehensive evaluation of the EU policy on "Research potential"; no results or statistics about funding and achievements at large will be presented here. On the contrary, the true aim of this paper is a sort of "narrative" about the direct experiences faced by a research team that benefited from a REGPOT funding. It is considered worthwhile to reconstruct, since the beginning, the vision, the applied strategy and the progress plan, the awareness developed, the changing in mindset and the attitudes with respect to the internal and external environment of the team, in order to gain significant improvements in research, reinforce research capacity, and achieve a better integration withn the European Research Area (ERA). Overall, this could be considered a successful story, although still a long path has to be followed.

Emphasis is also placed on how (i.e., with what methodologies and actions) such initiatives have established a virtuous-cycle combination with regional development needs, thus grafting into the regional cohesion policy.

The project we will discuss in this paper is named STAR*AgroEnergy (Coordination and Support Action - FP7-REGPOT-2011-1). The acronym STAR stands for *Scientific & Technological Advancement in Research on Agro-Energy*; the sub-title being "an Integrated Approach to Renewable Energy Generation According to Sustainability Criteria."

The STAR project could be considered as a "case study" in research capacity building. What was learned from this experience? What are the points of success and, conversely, of failure that are worth to be mentioned for future applications? As shown below, a wide spectrum of different activities has resulted from this project. Each activity should be considered as part of a comprehensive strategy to boost research, reinforce human resources, strengthen management as well as improve experimental and technical equipment.

2. EU strategy to unlock the research potential

The objective of the EU "Research Potential" programme is to enhance the regional research potential by unlocking and developing existing or emerging excellence in the EU's convergence (and outermost) regions, as well as by helping to strengthen the potential of their researchers to successfully participate in research activities at the EU level. Research and innovation are considered as key drivers of competitiveness, job creation, sustainable growth and social progress.

Many research actors located in the EU convergence regions have difficulties to become active players in ERA as these areas face problems such as brain drain, lack of infrastructure and appropriate access to finance, and low innovation performance. This calls for a clear need to fully integrate them in the ERA.

A well-defined "action plan" is to be implemented progressively during the realization of a "Research Potential" project by the application of the following coherent measures:

– *Exchange of know-how* and experience through trans-national two-way secondments of permanent research staff between the applicant and other, experienced "partnering organisations". Additionally, partners from the applicant's country and, when appropriate, stakeholders like enterprises, SMEs, etc. can be involved.
– *Recruitment of experienced researchers*. In this context, the return of nationals having left the country is encouraged. Experienced engineers, scientists or technicians employed to run the newly acquired equipment are also eligible.
– *Upgrade, development or acquisition of research equipment*. This measure should not account for more than 30% of the total project budget.
– *Organization of workshops and conferences* to promote knowledge exchanges at EU and international level, targeting the research excellence reputation and the visibility of the research team. Active participation of research staff at international conferences, for knowledge sharing, network building, and exposure to an international environment are also relevant.
– *Dissemination and promotional activities* for knowledge sharing, networking and better visibility at national and European level.
– *Elaboration of a strategic Intellectual Property (IP) development plan* for IP management and protection, and innovation capacity building. The plan will provide a framework for improved management of IP issues and protection of know-how.

In order to ensure the long-term sustainability of the research activities, synergies between the measures proposed in the "action plan" and those supported through the "cohesion policy" programmes should be implemented, aiming at clearly achieving added value. The expected impacts resulting from the realization of these activities should concern the following:

– Unlocking and developing the research capacity for an effective contribution to regional economic and social development thanks to a well developed innovation dimension.

- Improving human resources and research management.
- Exploiting innovation potential, particularly in the less advanced regions that are remotely situated from the European core of research and industrial development.
- Promoting a strategy of inclusiveness to benefit both the research community and the industry.
- Fostering better integration into the ERA through long-lasting partnership with excellent research groups and relevant stakeholders. This includes stimulating stronger participation in EU research calls for proposals.
- Upgrading RTD capacity and capabilities of human potential (number of new researchers and training of research staff) and material potential (modern scientific equipment); as well as the quality of research carried out by the research entities.

3. Close to the turning point: a new paradigm begins

Every action starts with a vision, is guided by a concept, is oriented by a mission statement. If reference to research is not present in the mission statement, developing a relevant research capacity is made more difficult. The STAR integrated research Unit developed a clear understanding of the vision underlying the selected research issues and about the motivations that led the team addressing significant research topics related to a new approach to science, technology and industrial innovation. These issues, far from being merely technical, also have a clear social inspiration and suggest a model of society in tune with nature, and founded on true participative principles.

The world energy economy is currently undergoing a critical period of transformation in technology, governance, social and economic values of energy. A new economics of energy is heralded by national and international negotiations and the assumption that economic growth can be supported largely by fossil fuels is fading rapidly.

The current international situation is characterized by a very acute and serious phase. The environmental crisis is rising dramatically, leading our planet towards an imminent depletion of many natural resources (oil, water, soil fertility, etc.). The importance of fossil fuels in the current productive systems (as source of energy and raw material), in domestic use (heating and electricity consumption), in agriculture (fertilizers, pesticides, fuels), in industry (plastics) and transportation, together with the difficulty to rapidly replace these fossils with renewables of equal power and versatility, make this kind of constriction very dramatic.

To face such challenges and exploit new opportunities, it is imperative to develop novel, renewable sources of energy and raw materials, to be selected in relation to social, economic and environmental conditions of the specific regions.

Recently "bio-economy" has been gaining more and more momentum. The term refers to a broad range of activities in different productive sectors whose common goal is the sustainable use of renewable biological resources for the obtainment of a variety of end products (such as food, feed, biofuels, bioenergy and fine-chemicals). Bioenergy (i.e. the utilization of biomass for the production of transport fuel, power generation, heating & cooling) is a key element of a bio-based economy. Complementary to bioenergy, the *biorefinery* concept is now frequently used to address new bio-based value chains in the chemical industry (the so called "platform compounds" molecules).

An ecological conversion of the productive apparatus and new patterns of resource consumption are unavoidable. The transition from an economy exclusively centred on fossil fuels toward a mix of renewable energy sources, eliminating all forms of waste (properly converted into useful resources) and increasing the energy use efficiency has to be encouraged.

Correspondingly, food security from a healthy agriculture, in ecological equilibrium and preserving biodiversity, is the other side of the same conversion process. A decisive factor could be to convert the traditional mono-purpose agriculture (centred on intensive farming systems aimed to maximize crop production) to multi-functional cropping systems. The latter are based on an ample range of

objectives, apart from food production: soil protection and bioremediation, water saving, landscape preservation, valorisation of marginal lands and abandoned agricultural areas, together with bioenergy generation and biomaterials. Biomass feedstock from dedicated energy crops, agricultural residues or agro-industrial waste might be extremely useful to obtain fuels, power and heat, together with added value chemicals and industrial components while, at the same time, reducing CO_2 equivalent emissions, increase soil CO_2 capture, save fossil resources, increase soil fertility and reduce the overall environmental impact of the productive apparatus.
Centred on this general diagnosis, the *vision* the STAR Research Unit has progressively developed is to apply an integrated approach to renewable energy generation derived from agriculture and agro-food industries and to implement technological criteria closely inspired to a knowledge based bio-economy, according to sustainability principles. The target is to build up a methodology to reconcile bio-energy production, as well as several others bio-based end-products obtained from biomass, with nature and landscape conservation and the maintenance of ecological resources, working out models of viable, dispersed bioenergy generation and biorefinering together with proximal energy use. This has to be done avoiding competition with food/feed production. An intelligent decision should be R&D based and experimentally proven.

4. (Anti)methodological approach to strengthen research capacity

A strategic plan (as well as a research agenda), in addition to the "vision" as the first element, incorporates general objectives and specific goals, defines methodologies and approaches, draws up actions and measures, sets a monitoring design, and an evaluation procedures. In turn, a periodic and cyclic revision of goals and objectives should be conceived (White, 2002).
Not deliberately, a sort of "syncretistic" attitude and "eclectic" approach in CB were applied. At the beginning, having no specific methodological awareness, different kind of knowledge, guidelines, and instructions coming from several approaches and disciplines were assembled, hopefully in synergy, and cautiously used. Probably, this could be conceived as a "naïve" behaviour; in fact, it was through "learning by doing" that progressively the research team better focused its targets, consistently improving its standard, visibility and influence. This process of gradual consolidation was initially based on the energy and enthusiasm of a relatively small number of "initiators" (or "pioneers") that had the capacity to transmit this "charge" firstly to the closest colleagues, gradually expanding the range of this positive "contamination" (like an "auto-catalytic" process).
Epistemologically, this kind of empiric approach could be defined, *ex-post*, as "against method" (*sensu* Feyerabend), defending the idea that there are no methodological rules to constrain the process and considering that "rules" generally do not contribute to scientific success. In other words, prescriptive scientific method would limit the activities of researchers, and hence restrict scientific progress. In this view, science would benefit from a (homeopathic) "dose" of theoretical anarchism.

5. The three dimensions of research capacity

As reported already, research capacity can be conceptualized as the combination of three interrelated and integrated levels: the individual, the organizational and the institutional levels.
The *individual level* requires the development of conditions that allow single participants or small groups to build and enhance knowledge and skills; consequently, it involves the development of researchers and of the research team. Not only research training but also how to design and undertake research, how to publish on high impact journals, intercepting research funding, consolidate a critical mass of researchers, are all activities and objectives related to this level.
The *organizational level* is focused in the development of research capacity at Department level, or within Universities and research Institutes. At this level, the focus is mainly on the management of the research system, towards a better quality of research able to better interact with society.

Finally, the last is the *institutional level*. It should support the establishment of a more "interactive" public administration that is responsive and accountable. At this level, we are focusing the "rules of game", that is to say the politically and regulatory context and the long-term strategy. Very pertinent questions at this level are: How are resources allocated? According to what kind of final targets or specific criteria is this allocation performed?

These three levels might overlap substantially and there are no sharp or clear boundaries among them. There is no doubt that we can easily identify these three levels when we focus our attention on the research system. The real question is: How can these three levels interact each other or how they are linked? According to a "hierarchical" concept, only contiguous levels can affect each other (*Fig. 1*). Differently, according to a "membership" model, links and bridges can be activated among every levels of organization, to affect, influence, modify, and produce adaptations or changes with respect to every other organization levels, no matter the closeness among them (*Fig. 1*). This latter model is similar (or analogous) to the game tactics of the so-called "total football" (very popular in the 70s of the XX century and originally conceived by the national football team of the Netherlends); according to these game tactics, there are no fixed roles by players but great adaptability to play different roles according to the prevailing conditions of the match. When considering a *Research & Innovation* system, a very good analogy is to think at the system as an "ecological pattern", or an "ecosystem mosaic", with several patches or "tesserae", all interconnected. The "fractal" dimensions showed by this pattern means that the same organizational rules are acting or functioning at every hierarchical level and a "self-similarity" is the emerging rule or the ordinating factor. A second analogy (or similarity), when considering a *Research & Innovation* system is to think at a neural tissue, made of billions of neural cells, connected one another without any kind of hierarchical structure. This refuse of hierarchy is another interesting feature that leads the model we assumed to that conceived by Feyerabend (2010).

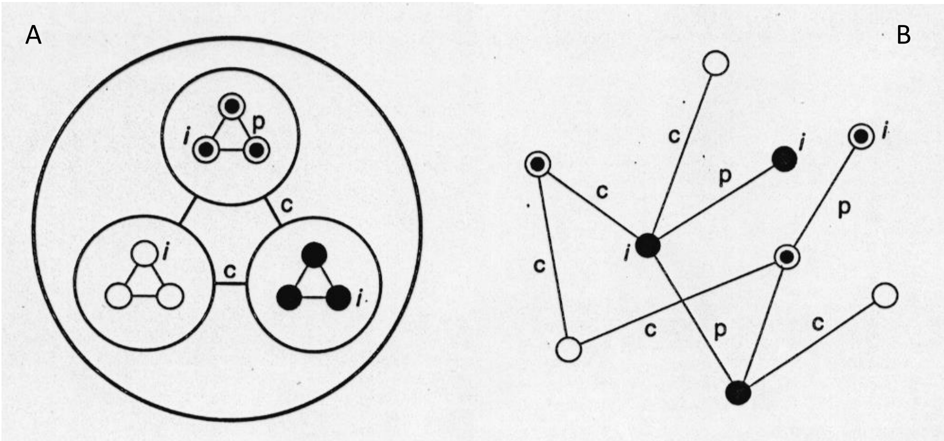

Figure 1*. Schematic comparison of the two contrasting model related to the research & innovation system, the "hierarchical" (A) and the "membership" models, respectively. More details in the text.*

6. Soliciting "social capital"

Three parallel and interconnected strategic pathways in unlocking and developing research potentials have been identified and consequently applied. This strategy is based on the concept of "*social capital*", i.e. the expected collective benefits derived from the cooperation between individuals and groups, considering the core idea that "social networks have value". Social capital is a concept that describes the extent and nature of relationships people have with others, with their communities, institutions and systems. Social capital theory distinguishes between 'bonding',

'bridging' and 'linking' forms of social capital (Narayan 1999; Woolcock 1998). As in the previous section, we can see that a similar conceptual triad highlights the milestones along the CB process.
The first path is “*bonding social capital*” and it refers to trust-based, co-operative relations among members (researchers and administrative staff) inside the same organization. This means to gain stronger ties in multidisciplinary collaborations within the team and the research unit in order to get a better organization and innovative approaches, thus reaching a higher research capacity. Improve and qualify management activities also pertains to “bonding”, targeting a better organization of the management staff.
The second path is “*bridging social capital*” and it comprises to establish mutual relations between researchers from different European Countries and research Institutions. This kind of connections within a multifarious “research milieu” is specifically related to “mobility” and the aim is to push ahead the research team by means of international collaborations.
Finally, the third path is “*linking social capital*” that comprises relationships among people who are interacting across explicit, formal or institutionalized authority in society. In other terms, this means connections with public and private institutions, organizations, enterprises, in order to generate a proper impact of research.
These three parallel paths are similar to the concentric waves formed when a small stone is thrown into a pond (*Fig. 2*). While the *first ring* represents the gain of internal consolidation within the team, the *second ring* signifies the strengthening of the research activity by recruiting experienced researchers from outside. Parallel to recruitment, another opportunity to improve significantly the CB impact is offered by the two-way secondment (incoming and outgoing researchers and people from the administration). Finally, the *third ring* denotes the need to link research in our own Institute, Department or University with other European institutional partners and to establish collaborations with stakeholders.

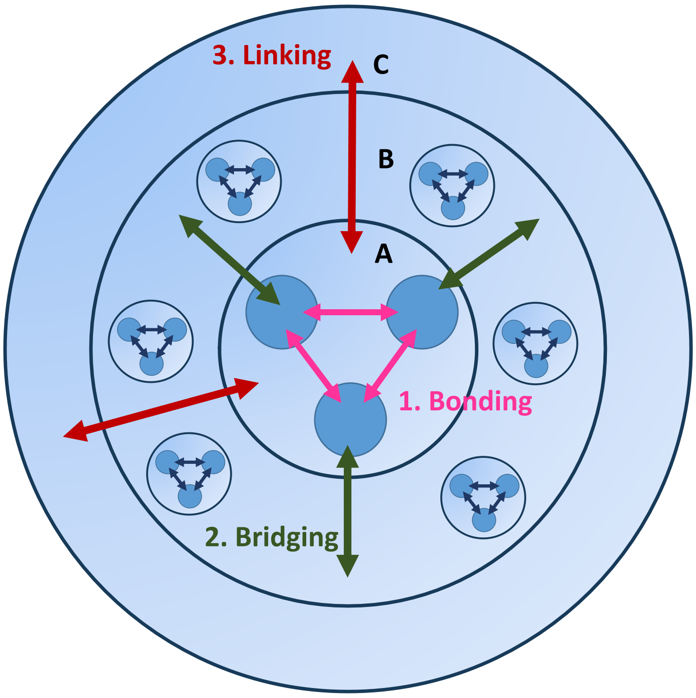

Figure 2. *Strategic approach to unlock research capacity based on the concept of “social capital”. A) integrated research Unit; B) allied research Institutions; C) society and economic world. More details in the text.*

7. A new and open research mindset

The strategy to unlock research capacity in terms of *social capital* was previously explained. Another feature or trait of this overall strategy should be related to the mental attitude of researchers and research team. It demands *a completely new mindset* in the way to approach research, as well as establish relationships inside and outside the research team. A certain number of empirical guiding principles, gained from experience, were developed within the STAR research Unit. We would like to report just few sentences that do not need to be explained further and that easily describe a new attitude of the research team:

- Be a “seed” of change in your own research community (and in the larger community of your community).
- There are no limits or boundaries but “frontiers” (the frontiers are ideal lines where people is “in front”, or “face to face”, keen to exchange ideas and proposals).
- “Surfing” is on the crest of the waves. Hang out at the “edges”. Nothing happens in calm waters.
- “Growth” is worked from within but “vision” is developed looking outside and far away.
- A strong hierarchy is never relevant, especially in research. Be a protagonist (with no frenzy to be a star).
- Be “connected” and establish a dense and effective collaboration network. Create and expand your co-operation “rhizome”.
- “Work as a hub”, boost your research capacity by intensifying knowledge exchanges in both directions (from science to society and the opposite).
- Be “tuned” and address your research activities considering the most urgent, needed and felt topics in your research field.
- Approach research “systemically”, think globally, recognize the general pattern of every question, go beyond specialization, understand the context and the framework. Be careful to the implication of your work.
- Be “adaptive” and “responsive”; be able to reorient dynamically the development strategy according to external inputs and a changing context.

This set of guidance, considered as a whole, is useful to identify a sort of research “style” or, is also possible to say, our inner “beliefs” and research attitude. The STAR research Unit considers this lines as the “core” trait of the interdisciplinary viewpoint that characterizes our research approach.

8. From inter- to trans-disciplinarity. Still a long journey to travel.

The surplus value gained by an interdisciplinary research unit is the ability to cope with scientific problems according to a system-approach vision, driving attention on interactions and overlapping rather than single or narrow problems.

The boundaries between interdisciplinarity and transdisciplinarity are fuzzy, since a transdisciplinary research is currently distinguished from interdisciplinary research simply based on a higher degree of knowledge integration. We will see, in a while, that a further effect of integration is the “expansion” of the research space and the rise of unexpected questions. According to the US National Academy of Sciences interdisciplinary is a research approach that “integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice” (NAS, 2005).

Research carried out within the boundary of a single academic discipline limits the potential variety of scientific and local knowledge that can contribute to the understanding of the issues at hand and the generation of new knowledge (Miller et al., 2008). A step further is the *multidisciplinary* approach, where several academic disciplines are jointly involved and the exchange of knowledge is a prerequisite to progress in understanding the scientific issues put forward. There are bridges across the disciplinary borders, so that disciplines improve and evolve but just in parallel, without any kind of integration. This integration of knowledge from different backgrounds fails because is not perceived as the added value of a new methodological approach, although researchers are working on a common issue (Tress et al., 2006). Differently, researchers involved in an *interdisciplinary* approach are required to look beyond their own discipline, and work with the other relevant disciplines to find areas of overlap that are likely to yield new understanding and a different quality of knowledge (Bammer, 2005). Therefore, interdisciplinary research incorporates a greater degree of integration with respect to a unified research problem, firstly considering a shared formulation of the research issues and common methods of evaluation, perhaps even the creation of new questions (Eigenbrode et al., 2007). Finally, *transdisciplinarity* connotes a research strategy that crosses many disciplinary boundaries to create a holistic approach. The integration of diverse forms of research is now the shared goal of the knowledge process, specifically planned to reach the unity of knowledge beyond disciplines. This approach generally includes specific methods to relate knowledge with problem-solving. This strategy is particularly useful when the nature of a problem is under dispute, and can help to determine the most relevant problems and research questions involved (Funtowicz, and Ravetz, 1993). When knowledge about the problem "is uncertain, when the concrete nature of problems is disputed, and when there is a great deal at stake for those concerned by problems and involved in dealing with them" (Pohl and Hirsch Hadorn, 2008), then this approach should be considered the best to fit. It requires to adequately addressing the complexity of the problems in place and the diversity these problems are perceived from a wide range of stakeholders. The approach needs to be participative, and inclusive. Using specific technique (such as "focus group", to make just one example) experts interact in an open discussion and dialogue. This approach requires grasping the overwhelming amount of information involved, and getting over the specialized languages in each field of expertise. Under these conditions, "researchers need not only in-depth knowledge and know-how of the disciplines involved, but skills in moderation, mediation, association and transfer" (Wikipedia). All participants provide a different perspective, complementing each other and resulting in a more complete description of knowledge than any single person could do alone. In addition, this kind of research enables members from the community to share a set of values that influences and enables the production of knowledge (Miller et al. 2008).

Transdisciplinary research has a number of advantages compared to disciplinary, multidisciplinary, and interdisciplinary research approaches. Some of the advantages are summarized here (Habermann et al., 2013):

- It creates new knowledge by crossing disciplinary boundaries.
- It supports the analysis of complex problems from different perspectives and a detailed understanding of the issues at hand.
- It enables the participants to deal with complexity, uncertainty, change and imperfection.
- It encourages system thinking and guides the participants to look at the whole and its relationship to the parts of an issue.
- It involves researchers and the public in the whole research process. Consequently, it enables the integration of multiple knowledge, overcoming the epistemological barriers between academia and non-academia.
- It enlarges the view and perspective of participants to incorporate issues outside disciplinary boundaries.
- It enables participants to jointly learn about (and understand) complex problems and to facilitate knowledge exchange.
- It targets societal issues or needs and expectations of the society. As a result, it bridges the gap between research and practice.

9. Concept map of research, research topics and their interactions

In order to consolidate a critical mass of researchers and plan the research activities within a suitable time frame, it is very useful to arrange a strategic set of research topics the Unit or Department is interested to. With respect to these topics, the research work will be actively oriented and progressively focused, to reach (as soon as possible) a high scientific profile and a good reputation. For this reason, the research unit should be able to arrange a “concept map” of the research topics and to organize the research interactions among these topics, thus generating information flows and feedback to reinforce these topics and gain an in-depth understanding of the research strategy. This kind of “concept map” could be the starting point in order to establish dedicated research teams within the overall interdisciplinary research unit, each exploring a specific research *niche* and able to exploit better the advantages of scientific specialization, without ever losing sight of the useful connections among the teams.

Concept maps help to create a research strategy; they include the key concepts associated with every topic, and the relationships between the various features of the same topic. A concept map allows brainstorming, identifying what is already known about the topic and what are the knowledge gaps. A concept map is useful to graphically represent and organize ideas, to show how these ideas are related to each other, to reveal new knowledge patterns among concepts, to generate questions research should be focused, to check if all the relevant pieces fit together or anything is missing.

The research *topic* is the general domain in which the research is focused. Research *problems* are drawn from the general domain described by the topic. A research study *goal* “is the major intent or objective of the study used to address the problem” (Creswell, 2005). Research goals essentially detail what the research study intends to do in order to address the problem. Finally, the research goals are operationalized by one or more research *questions*. Research questions “narrow the purpose (or goal) into specific enquiries that the researcher would like answered or addressed in the study” (Creswell, 2005). By attaining answers to those research questions, the study goals are met and a contribution towards solving the problem is made (Leedy and Ormrod, 2005).

According to Kerlinger and Lee (2000), “adequate statement of the research problem is one of the most important parts of research”. A clear, precise, and well-structured problem statement leads to a quality research (Jacobs, 1997). The “heart of every research project is the problem. It is paramount to the success of the research effort” (Leedy and Ormrod, 2005). Furthermore, “to see the problem with unwavering clarity and to state it in precise and unmistakable terms is the first requirement in the research process” (Leedy and Ormrod, 2005).

10. Promote the “circulation” of knowledge

To act as a “hub” of knowledge means to promote knowledge exchange. Generally, we use to talk about “knowledge transfer” but, in this case, there is a risk in using this kind of expression. The term “transfer” would mean as if the flow of knowledge is occurring only in one way, namely in the top-down direction, where the *top* is the research institution producing knowledge (the source) and the *down* is the technical organization receiving knowledge and implementing it (the sink), such as enterprises, stakeholders, or society as a whole.

Differently, we should talk about “knowledge exchange” or “knowledge circulation”. We need to put in action what the term “*encyclopedias*” originally meant; from the ancient Greek “*enkyklios paideia*”, literally “training in a circle” (from *enkyklios* “circular” and *paideia* “education”), knowledge should be put into circulation in the most virtuous way, in order to obtain waves of innovation.

As was specified already, there are several kinds of knowledge that should be identified and understood in the larger transdisciplinary domain. To act as a “hub” will produce a twin benefit: from one hand, it generates an enabling environment for research; from another hand, the collaboration with stakeholders will anchor research to operative applications, thus securing an immediate acceptance. This creates the best conditions to promote social and economic development. To act as a “hub”, moreover, also means to activate “bridging” and “linking” initiatives within the scientific community and becoming a promoter of new research perspectives, different approaches, to carry on a vision and new proposals that could generate consensus and become a reference in the research community.

11. Research needs for development

One of the major strength in promoting capacity building in research should be the high level of integration between the two main drivers of scientific and technological innovation, that is to say i) research community and ii) stakeholders, respectively. Linking interactions with the European research community, from one hand, and linking relationships with stakeholders, from the other, are complementary actions, both essential to strength innovation and socio-economic development. Collaborations with leading European research institutions promotes a better integration within the ERA. Apart from knowledge, to implement innovation there is also the need for technology demonstration and testing facilities. Stakeholders, for their part, are absolutely relevant and their involvement in the strategic choices related to research and innovation is a must. The establishment of a formal or informal "stakeholders' network" is very advisable in order to generate agreement and support, triggering and stimulating synergies among productive sectors, to reach a solid economic impact of research, provide advices and orientations, check the interest in promoting regional development.

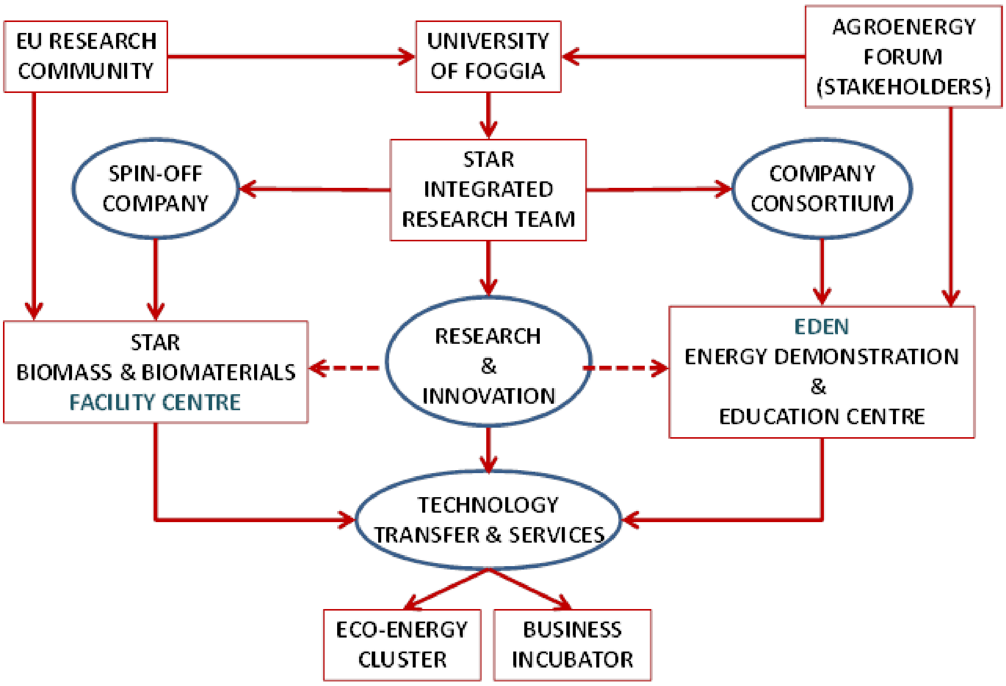

Figure 3. *Capacity building in research should sustain long-lasting structures to support technology transfer and the implementation of know-how into business. A university spin-off (STAR Biomass and Biomaterial Facility Centre) and an Energy Demonstration and Education Network (EDEN Consortium) are two complementary realizations of the STAR project.*

Capacity building in research should sustain long-lasting structures to support technology transfer and the implementation of know-how into business. Two different but complementary initiatives have been fulfilled by the STAR project (*Fig. 3*):

- The creation of a university spin-off, to share and transmit scientific know-how in close contact with allied research institutions and the ERA. We have established a "STAR Biomass and Biomaterial Facility Centre", i.e. a specialized laboratory on biomass and biomaterial characterization and an experimental station to operate with pilot plants on energy conversion processes.

- The second initiative is a company consortium named EDEN (the acronym stands for “Energy Demonstration and Education Network”) well fit to promote and facilitate technological implementation among the associated firms and to work as a “business incubator” with respect to the local district where the University of Foggia operates.

According to this overall picture, the “Facility Centre”, in the form of a university “spin-off”, is aimed mainly to opearte “technology transfer”, considering the closer relationship with the European research community via the good position and credibility reached by the STAR interdisciplinary research Unit. On the other side, but in a very complementary fashion, the EDEN Consortium is promoting business with the involvement of the university. This structure is suitable especially to stimulate directly the economic growth, to favour new job placements, to enlarge the possibility to intercept public funding and generate opportunity of sustainable development.

12. Manifesto of the European Mezzogiorno

Starting from the question about what should be the contribution of science and research in the construction of social wellbeing and development, the proposal of a “Manifesto of the European Mezzogiorno” was launched (Koukios and Monteleone, 2014a). In order to target a sustainable bio-economy as a new development strategy for the Southern European regions, a Manifesto is proposed to policy- and decision-makers for an immediate action to revitalize the economies of those regions and countries that are currently experiencing a deep and complex systemic crisis. This Manifesto advocates the adoption of a new development model to get the economies and societies of the Southern European Countries (from Portugal, on the West, to Cyprus, on the East) out of the crisis, targeting a sustainable bio-economy. This work, which has taken the form of a Manifesto, is co-authored by scientists and engineers from the five Southern EU countries that are all presently experiencing a deep and complex systemic crisis: Portugal, Spain, Italy, Greece and Cyprus. It advocates the adoption of a new development model, focusing on the target of sustainable bioeconomy, around which other themes and topics will crystallize. Implementing this model will act as a locomotive to get the economies and societies of these countries efficiently out of their crises, and smoothly into greener post-crisis “pastures”. The proposal is articulated in ten critical steps or theses for immediate action by the policy- and decision-makers, as well as other key actors within this troubled area of the European Mezzogiorno.

These are the Ten Commandments of the Manifesto:

I. Recognize research and innovation as key development drivers.
II. Give priority to product innovation for sustainable development.
III. Generate innovation power from three “tsunamis”: info, bio, nano.
IV. Couple technical innovation with required “soft” research actions.
V. Focus national innovation strategies on green bioeconomy targets.
VI. Consider critical points for deployment of Southern European bioeconomies.
VII. Pursue new forms and modes of research in bioeconomy.
VIII. Generate new professional skills by new education and training missions.
IX. Learn to navigate within a complex policy landscape.
X. Plan for international cooperation on green bioeconomy themes.

13. The regional enabling technologies

Innovation plays an important role at regional level, as regions indeed are important engines of economic development. A positive loop promoting social development at regional level can be triggered by strengthening the research capacity applied to the several productive sectors that are related to the bio-based economy (*Fig. 4*). Promoting a synergy between regional research and innovation policy is perfectly in line with the so-called “*triple helix*” model (Leydesdorff, 2012). This model emphasizes various features related to the university “third mission” (apart from education and research), closely related to the academic involvement in socio-economic development of the region, through university technology transfer and entrepreneurship training, in alliance with government policies aimed to strengthen university-industry links. The "triple helix" operates according to an interactive rather than a linear model of innovation: as firms raise their technological level, they engage in higher levels of training and knowledge sharing (Stanford University, 2014). This kind of dynamic triggers a co-evolving sub-set of social systems that interact each other, recursively, thus reshaping their institutional arrangements (Stanford University, 2014).

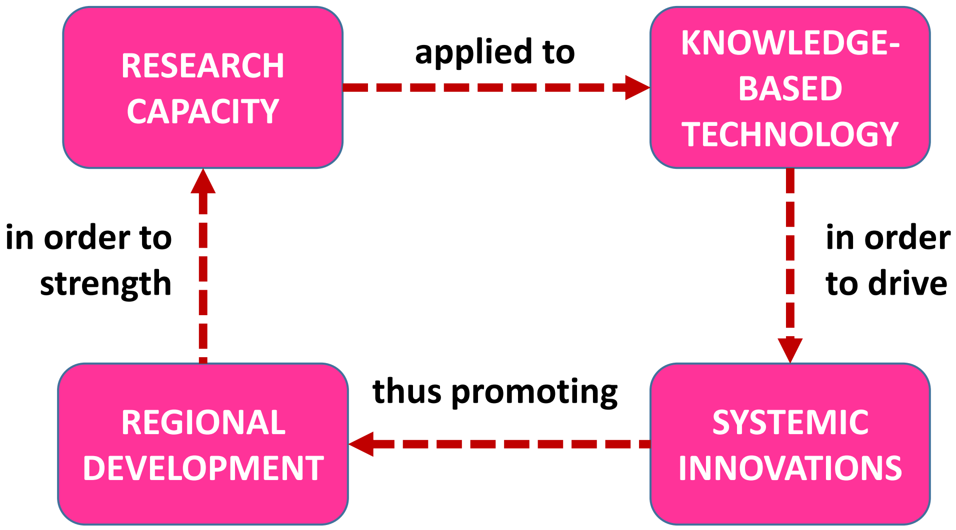

Figure 4. *A positive loop promoting social development at regional level can be triggered by strengthening the research capacity applied to the several productive sectors that are related to the bio-based economy.*

Obviously, innovation is not uniformly distributed across regions and tends to be spatially concentrated. Even regions with similar economic growth pattern may have different innovation capacities. The Apulia region (in the South-East part of Italy), for example, is still among the Italian regions lagging behind in social and economic development as compared to Central and Northern Italy, and also considering the benchmark of the average European GDP. Despite this general condition, according to the Regional innovation Scoreboard, the Apulia region marks a higher score with respect to other Mediterranean regions, being its innovation performance significantly improved in recent years.
The *Key Enabling Technologies* (KETs) are considered to be the preferential pathway for a European region to reach the development of new goods and services and the restructuring of industrial processes needed to modernise EU industry and make the transition to a knowledge-based and low carbon resource-efficient economy. Whilst the EU has very good research and development capacities in some key enabling technology areas, it has not been as successful at translating research results into commercialised manufactured goods and services.
Considering this specific regional dimension in selecting the most promising technologies and the best fitting technological improvements, the STAR integrated research Unit has developed a set of technologies as the outcomes of its research activity. These technologies are the following:
Bioresource assessment: Use of spatial analysis and land planning tools to assess biomass potential and design sustainable bioenergy supply chains; biomass sustainability criteria include soil carbon balances and soil fertility aspects.
Biorefineries: A number of biomass processing pathways are investigated, either separate or in technologically integrated schemes. The focus is on the following:

- Anaerobic digestion, with emphasis on biofeedstock pretreatment to enhance efficiency and enlarge the spectrum of substrates to be digested;

- Microalgae cultivation, combined with waste treatment, and integrated with anaerobic digestion for biofuels and fine chemicals production;
- Thermochemical conversion, i.e., biomass pyrolysis and gasification, focusing on biochar, a semi-carbonised biofuel, and a soil carbon-sequestering agent.

Biobased carbon mitigation: This is a key element of the STAR activities, with specific research on the potential for soil carbon sequestration; modelling the soil carbon balance in bioenergy cropping system; and biochar use as a strategy to sequester carbon and contribute to climate change mitigation.

Biosystems management: Systematic activities in these critical fields:

- Methods, tools and databases to support decision-making process in the domain of agro-energy; also, identification of best practices aimed at favouring sustainability, as well as promoting social acceptance of biomass plants at community level;
- Analysis of key drivers and barriers for local, regional and rural "green" development with respect to bioenergy value chains; the financial system is also considered as a possible driver of bioenergy innovation.

14. The regional strategy for development

An effective and well balanced "regional innovation strategy" should support both innovation demand from companies and empower the innovation offer by research centres. Regional agencies should qualify at the best this kind of matching.

Smart Specialisation Strategy (S3) is the new EU strategic approach to economic development through targeted support to research and innovation. It will be the basis for Structural Fund investments as part of the future Cohesion Policy's contribution to the *Europe 2020* jobs and growth agenda. More generally, smart specialisation involves a process of developing a vision, identifying competitive advantage, setting strategic priorities and making use of smart policies to maximise the knowledge-based development potential of any region, strong or weak, high-tech or low-tech.

There are specific constraints to regional innovation as well as major drivers of it. It is worth to mention just a few of them, specifically the most relevant and frequently observed in less developed regions.

Less developed regions are facing dramatic problems of "brain drain", the best part of younger generations move towards more attractive Countries. To fight this phenomenon is one of the most important action of a wise governance. "Active Principles", "Labs from the Bottom", "Future in Research" are three relevant initiatives launched by the Apulia regional administration specifically addressed to young people. Financing projects designed by young people, promoting their entrepreneurial attitude, strengthening their skills, and fostering the generational turnover within universities are the general objectives of all these instruments.

Regions where people have a favourable attitude and is more positively oriented towards new ideas also has better conditions for both innovation and entrepreneurship. Continuous training and learning, promote the development of new skills, stimulate innovation and encourage the structuring of a participating community. Pre-commercial procurement, incentives and services to create innovative "start-up" are tools that significantly increase the effectiveness to convert good ideas into business.

Finally, a strategic partnership between public and private services, together with a reinforcement of public research infrastructures, and their increasing level of integration into a network of services and facilities, are other relevant targets to enhance research and development and increase the innovation rate at regional level. The regional sponsorship between private companies and public research institutions was carried out through *technology clustering* and the structuring of several *productive districts*. These initiatives facilitated the dialogue between research and technology, academia and companies, increasing the impact of innovation, improving the matching between technology supply and demand.

These are the main initiatives that characterized the policy of the Apulia regional administration and marked a good impact and a relative success with respect to other Italian convergence regions. The new programming period 2014-2020 surely will represents a fundamental test to turn potentials into reality and confirm the regional emerging trend.

15. Concluding remark

"Despite the lip service paid by policy- and other decision-makers in many countries to research and innovation, their role as key drivers of socio-economic development is not only underestimated, but – even worse – it is in practice considered as part of the problem, instead of the solution! So, in their efforts to reduce costs and save resources in order to face the pressing financial aspects of the crises, government and business tend to sacrifice research and innovation funding". At the same time, "R&D activities are not – as it should – re-oriented to adjust to the particular demands of the crisis-situations" (Koukios and Monteleone, 2014a).
In time of crisis, not less, but more emphasis should be paid to research and innovation by government and business. We believe that such a new strategic view is currently growing around Europe, also being catalysed by the just launched Horizon 2020 Programme of the European Union (Koukios and Monteleone, 2014b).

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