INCONET-GCC 2

شبكة التعاون الدولية للعلوم التكنولوجيا (الاتحاد الأوروبي - دول مجلس التعاون الخليجي)
EU-GCC Science & Technology International Cooperation Network

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Organisation Name	Short Name	Country
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EUROCONSULTANTS S.A.	ECSA	Greece
AGENZIA PER LA PROMOZIONE DELLA RICERCA EUROPEA	APRE	Italy
TURKIYE BILIMSEL VE TEKNOLOJIK ARASTIRMA KURUMU	TUBITAK	Turkey
FORENINGEN IKED	IKED	Sweden
PANEPISTIMIO THESSALIAS (UNIVERSITY OF THESSALY)	UTH	Greece
ITEMS International	ITEMS	France
THE BRITISH COUNCIL	BC	United Kingdom
The Public Establishment for Industrial Estates	PEIE	Oman
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HIGHER COLLEGES OF TECHNOLOGY	CERT	United Arab Emirates
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Executive summary

The present report sets out the Whitepaper and the Roadmap for INCONET-GCC2, which represents the main common platform for the EU and the GCC countries in the Middle East to work out a collaborative agenda in research and innovation. Tangible success, however, will require overcoming a number of hurdles, such as the lack of an orderly framework for research and innovation collaboration within the GCC itself, limited experience and a critical mass in these countries, and a range of inherent barriers to the establishment of a culture for research and innovation. At the same time, the EU is faced with its own challenges in research and innovation, and to link effectively with other regions. INCONET-GCC2 aims to identify mutual benefits for collaboration between the two regions. It presents concrete recommendations for how to advance in regard to such opportunities in the years ahead.

The document comprises the following sections:

Section 1. Introduction and Methodology

It presents the general introduction to the project and the methodological approach used by the present project to address the issues under discussion

Section 2. Challenges and Vision

It presents the vision of GCC-EU research and innovation collaboration including a general discussion of the optimum approach to such collaboration.

Section 3. Substantive Focus

It provides the focus of the project and GCC-EU research collaboration and the chosen research priorities, Health innovation (especially diabetes) and Smart Cities.

Section 4. Institutional Conditions – GCC as a Partner of the EU

It provides an overview of the Science-Technology-Innovation systems in the GCC. It is important to take into account the nature of the institutions. Conditions for R&D and innovation are shaped in a landscape, an ecosystem.

Section 5. GCC-EU Cooperation on Research and Innovation: State of Play

It provides the background for GCC-EU collaboration to be understood in a broader context of ongoing activities.

Section 6. SWOT analysis

Building on the SWOT analysis and drawing lessons, with a view to the specific conditions of the GCC and the EU, for the direction of influences between them under various scenarios.

Section 7. Roadmap

Way forward, to lay the ground for fruitful GCC-EU collaboration - Priorities for the future in GCC-EU cooperation on research and innovation and specifically: (1) What are the strategic benefits? (2) New research areas; (3) Ways forward for enacting participation by GCC stakeholders in Horizon 2020; (4) Towards a joint EU-GCC research agenda; (5) Summary of recommendations and guidelines for the future.

Section 8. Conclusions

Overview of conclusions.

Table of Contents

1. Introduction

1.1 Introduction to INCONET-GCC2

Increased cross-border cooperation in science, technology and innovation is becoming an important instrument for countries around the world to develop a better mutual understanding and approach to dealing with the key outstanding problems of our time, many of which know no borders and affect more or less all countries, although in different ways. Examples include climate change, our ability to use resources more effectively, develop new sources of energy, ensure sustainable food chains and water supplies and deal with various environmental challenges, achieve quality education, economic growth, new jobs, a safer and more secure society, and so forth. Other issues are inherently local, or regional, but solutions can still benefit from sharing of experience and joint learning with researchers and practitioners in other locations.

Such cooperation may be particularly valuable when engaging countries that display stark differences in economic structure, institutional setups, and also with regard to the social and cultural outlook. The EU research and innovation programmes have taken important steps in recent years to become more open to collaboration with research institutions in other parts of the world. In addition, the EU has special programmes for working with other regions, notably the so-called INCONET programmes on research and innovation. In particular, these programmes embrace international research cooperation through targeted areas where mutually-beneficial conditions can be defined, e.g. because:

a. Identified areas of cooperation address pressing needs that are common for the EU and a collaborating region;
b. Existing areas of expertise and resources complement each other;
c. Both parties will benefit equally from the cooperation and in respect of their mutual independences.

The members of the Gulf Cooperation Council (GCC) form one of the regions that displayed the highest levels of economic growth in recent decades. At the same time, this country grouping is located at the centre of the Middle East, which has been subjected to the most severe political and security problems of any regions in the past decades. Further, thus far the GCC countries have been heavily dependent on natural resource rents, notably oil and gas, for their economic and societal progress. A vast academic literature brought, decades ago, a strong message that commodity dependence is a liability for growth and entails huge risks for development (Corden, 1984; Sala-i-Martin and Subramanian 2003). Although the general validity of such a “natural resource curse” has been refuted (Herb, 2005; Alexeev and Conrad, 2009), a number of studies have pointed to a tendency for weak productivity growth in the rest of the economy, which was recently verified for the GCC countries up to the present time (Warner, 2016).

Economic diversification thus stands out as a key policy objective for these countries, with research and innovation of high importance for enabling the build-up of new competencies, along with the rise of new competitive industries, well-paying jobs and more prosperous societies. Despite multiple initiatives in this respect, however, all the GCC countries are struggling to make progress in devising an effective research and innovation strategy. Their difficulties reflect, for instance, sectoral, institutional, and cultural factors. There has been a heavy reliance on foreign capital and imported cheap labour. Inherent fragmentation in their policy approaches, at the regional level as well as within countries, has further added to the difficulties. Ample evidence, from academic literature as well as by way of practical examples from around the world, demonstrates that progress in research and innovation does not happen in isolation, but is much dependent on a wider context. The relations

between multiple actors and driving forces matter greatly, as is now commonly associated with the notion of innovation systems (Friedman, 1987; Lundvall, 1991).

Against this backdrop, research and innovation collaboration emerges as one of the key elements of any successful strategy on the part of the GCC countries to move away from dependency on oil and gas. As the oil price has fallen dramatically over the past years, renewed calls are being made for the need of economic diversification in the GCC, that is, to grow new industries and sources of well-being. On the other hand, due to the increasing shortage of public funding including for public support of R&D, given the high dependency on oil and gas revenue, the continuation of some reforms that have been undertaken is now in doubt.

Due to the historical linkages between the regions, complementarity and the offerings of European research and innovation frameworks, collaboration between the EU and the GCC around science and technology could support building a sustainable platform for long-term capacity, as well as demonstrating short-term results of importance for maintaining practical and political support. This is as success in these respects requires a delicate balance between institutional leadership and room for bottom-up initiative. Europe has gained considerable experience in how to build appropriate governance structures for these purposes, including through the engagement of relevant stakeholders, although each region and country must ultimately shape its own institutional response. Naturally, cooperation between EU and GCC will depend on the degree to which the respective institutional frameworks of the two regions will be able to carve out a common interest, along with a practically attainable avenue to work together. The fragmentation of the GCC approaches just referred to, as well as other factors, including on the EU side, present challenges that need to be overcome if this opportunity is to be captured.

The present report builds on the above activities. It reviews lessons learned, and builds on them for the purpose of presenting integrated solutions and set out directions for future initiatives and follow-up work. In particular, it presents a Whitepaper section, which ventures into so-called SWOT analysis and takes stock of policy aspects, and a Roadmap section, which sets out directions for the agenda ahead. As a follow-up to the present report, a contingency study will outline the precise steps to be taken next by the key relevant actors.

1.2 Methodological approach used by the present project to address the issues under discussion

In terms of methodology, the report undertakes analysis to define joint scenarios for EU-GCC cooperation such as joint call for proposals, participation of GCC stakeholders in H2020 and participation of European stakeholders in GCC research activities.

The White paper has been prepared with a view to the selected thematic priorities, i.e. it reviews the fundamental rationale for collaboration between the EU and the GCC, including to what extent there are synergies or complementarities, strengths or weaknesses, risks or opportunities, and in which way research and innovation collaboration between the EU and the GCC can help generate better outcomes. In this it incorporates a specification of a SWOT analysis from which a number of conclusions are drawn.

The roadmap, which takes into account and integrates the outcomes of the various proceedings, thematic events, and high level policy meetings, operates at two main levels:

- Thematic level: (1) The thematic roadmap on EU-GCC on Personalised Healthcare for chronic non-communicable diseases (NCDs), including Diabetes, and; (2) The thematic roadmap on EU-GCC on Smart Cities;
- Horizontal level: (1) Based on the above thematic roadmaps extrapolation will facilitate the horizontal roadmap preparation.

Following this report, a continuity plan will be based as above on the selected thematic priorities. The continuity plan draws on the combined interests and visions of the countries involved, along with the analysis and conclusions of the present report, to set out proposals for cooperation in arranging with joint calls (between EU and local funding agencies), as well as other initiatives to incentivize and facilitate actors in the two regions to engage in joint research and innovation activities.

2. Challenges and Vision

2.1 A challenged and rapidly changing world, with a number of dramatic developments

The issues at the centre of INCONET-GCC2, and the prospects for deepened research and innovation collaboration between the EU and GCC in the years ahead, reflect the ongoing changes taking shape in the common wider landscape of economic, social and environmental issues. While bearing the diversity of both regions in mind, some of the outstanding challenges confront both regions as a whole, while others are highly relevant notably for individual countries in the two regions respectively. Some of these changes and challenges may be summed up as follows:

- A knowledge-based economy is taking shape, with the ability to develop and make use of technology and skills that are becoming increasingly critical for competitiveness and the ability to generate value across more or less all industries and areas of economic activity. Europe encounters strengths, e.g. in R&D and established institutions but face challenges with breeding new companies, industries and jobs. The GCC countries have a proud history at the centre of knowledge-creation but presently they are newcomers, relatively speaking, in building vital education, research and innovation frameworks.
- Globalisation continues to roll ahead with cross-border integration of markets for investments, goods and services. While growth and modernization are diffused to more countries around the world, there is also a sense of increasing vulnerability, insecurity and fear of losing certain values. The migrant crisis in Europe has had a major impact on public opinion and on policy. The Middle East has encountered even more far-reaching processes of societal change, uprooting traditions and bringing old and new into contention, as is partly associated with the “Arab Spring” of 2011 and political turmoil in the years since then.
- Financial and structural economic challenges go together and are interwoven with the social and political. Financial sector turbulence, high levels of public indebtedness and unmet public investment needs have many European countries over the last decade, making it hard to handle rapid economic restructuring and channelling the work force from declining sectors to new jobs. Backed by their natural resource rents the GCC countries were able to maintain strong macroeconomic policy positions until the last two years, when their external balances have suffered and public investment is now under pressure.
- The world at large continues to be plagued by rapid population growth although Europe is faced with a rapidly ageing population, approaching a 1:2 ratio of retired to working age population. The Middle East has very young population, with the average age in the GCC varying between 21 and 25 years old. Demographic patterns are very different but some of the underlying issues are common, such as the challenge of how to communicate between generations and accommodate societal change.
- The global environment, including land, resources and the living ecosystems, is under increasing pressure, as seen from climate change, disturbances to food systems and water supplies, deforestation, desertification, and the destruction of bio-diversity at a pace and dimension the world has not seen for more than 60 million years. Economic growth brings increased awareness and concern for the environment, and may thus enable uncoupling between growth and environmental destruction, as it has been observed only for individual issues, such as sulphur emissions and acidification. Broadly speaking, the European populace has become widely aware of and concerned with environmental issues. The GCC countries populate a delicate natural environment marked by desertification, water scarcity, low energy efficiency and high CO_2-emissions. While policy responses are under way, their general populace demonstrates low awareness. With the outcome of the climate negotiations in Paris in November 2015, new

instruments have been introduced to support international collaboration in enabling strengthened environmental protection worldwide.

- The need to tackle the *Grand Challenges* is now playing out at the local level as well. Cities and communities have started to organise new kinds of responses, not least with the help of modern information and communications technology, to spur a shift from fossil to renewable sources of energy, to promote energy conservation, to manage waste and improve waste management, to put in place efficient and sustainable transport and logistics systems, to halt lifestyle related Non-Communicable Diseases (NCDs) including diabetes, which are set on a path of rapid diffusion more or less worldwide, and with the highest levels seen anywhere in the GCC countries. Social cohesion, stability and prosperity are all related and now subjected to new forms of pressure.
- Among these, many countries are witnessing rapidly growing income differences, a shortage of jobs notably for the young resulting in high levels of youth unemployment and frustration especially among the well-educated who do not attain jobs matching their skills, and also the continued high levels of conflict and insecurity that we associate with global and regional terrorism. Conditions and concerns in these respects have had political repercussions in many countries, including in both the Middle East and Europe.

Reflecting the above, the two regions meet with common challenges as well as interests to realize better outcomes on a range of aspects. These include Economic growth; National security; Rational Public Finance; Job creation for future generations; Sustainable lifestyles, urban development and more sustainable energy systems including use of energy.

2.2 The GCC countries and Europe

Within this context, the oil-rich GCC countries have behind them several decades of remarkably strong macro-economic performances and a lift in Gross Domestic Product. All the GCC countries are now beyond the middle-income economy status. Saudi Arabia, Oman, Qatar and the UAE occupy, for instance, places 4-7 respectively in the 2013/14 World Competitiveness Report's ranking of macroeconomic stability. On policy variables such as "Government Procurement of Advanced Technology", they rank 6, 12, 1 and 3 worldwide. From having been without much modern infrastructure just a few decades ago, these countries thus now rank among the most stable, richest and also, in some respects, most sophisticated economies in the world.

These performances would have been impossible had it not been for the oil and gas earnings of these countries. Their rise during the past years has, in fact, been pointed to as "evidence" against the general validity of the so-called "resource curse" (Fasano, 2002). Research in INCONET-GCC indeed found the GCC countries to have invested more in information technology, education, health, research and innovation than their peers in the Middle East, which have been lacking natural resource wealth on such a scale (Andersson and Djeflat, 2012).

The notion that countries perform less well if endowed by rich natural resources than they would have done in the absence of such distractions, and instead focused on their human skill and governance set-up, still retains some tracking. In particular, a number of studies observed low productivity growth outside the dominating commodity sectors (Brahmbhatt et al., 2012; Ismail et al., 2011; Warren, 2015). Meanwhile, in several areas, including research and innovation, the GCC country initiatives appear to have yielded weak results thus far, to which we return below (see Box 1 for a brief review of the natural resource curse literature and its relevance in the present context).

To the extent that a combination of rent-seeking and complacency have been at stake in the GCC, the recent dramatic decline in oil prices brings powerful impetus for change. Some regional leaders speak

of “a blessing in disguise”, indicating that some reforms that were previously not possible, are now coming through. An example is the lifting of subsidies on utilities such as energy and water that have made consumption very cheap, and therefore prevented investment in new technologies and solutions.

Having said that, the pace of change ahead is far from clear. The natural resource-based economy may fuel conditions that are slow in changing, in part because they become embedded in culture, and with people. Further, the loss of resources for the state may put pressure on precisely those investments that are needed to generate research and innovation. Finally, the outcome may blend with the result of other developments. In the last few years, conditions in the Middle East have been much influenced by the legacy of the “Arab Spring”, see Box 2., which importantly must be taken into account when judging the scope for and orientation of reforms and development efforts ahead.

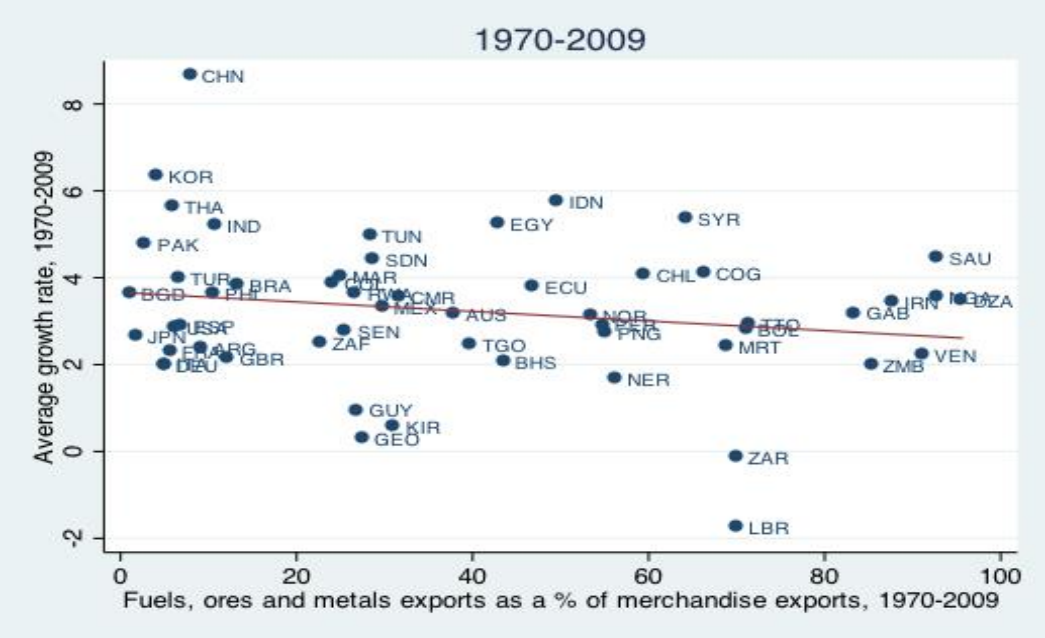
Within less than a year of its inception, the moment that is associated with the Arab Spring brought down five heads of state across the MENA region. The political upheavals that followed have sent much of the wider region into both political and economic turmoil, with tourism revenue and investment severely suppressed in many countries to this day, and millions of businesses and jobs lost along the way. In the oil-rich Gulf, Bahrain suffered a damaging internal conflict related to its delicate Sunni-Shia division, from which the country is still trying to heal. It will take time to claw back its position in key sectors, such as financial services, which require high levels of trust. In Saudi Arabia and Oman, which have the largest domestic populations in the GCC, the Arab Spring fuelled extensive reforms. These initially included higher minimum wages and an expansion of public sector employment. The focus has gradually shifted towards trying to create jobs through training, support for entrepreneurship and SME development.

Box 1: Natural resource curse versus blessing

The so-called “natural resource curse” argument held that richness in natural resource wealth is a liability and source of distraction, hindering rather than helping a country’s economic growth (Auty, 1993; Sachs and Warner, 1995). Figure 1 illustrates the notion that natural resource wealth appears to have made countries fare worse, not better. Resources typically found to be prone to the phenomenon of resource curse include oil, minerals, plantation crops, and coffee and cocoa (Sala-I-Martin and Subramanian, 2003; Isham, et al, 2005). The GCC thus clearly belongs to those that could be expected susceptible to a negative impact.

The curse argument has been advanced over the years with reference to a number of factors. Among them were the appreciation of the exchange rate, resulting in crowding out of other industries and a shortage of employment opportunities due to the ensuing squeeze of labour-intensive industries (Corden, 1984). Other aspects include the presence of intensive conflict, internal and external, for controlling and reaping the gains, and high returns to capital accruing mainly to the public sector, leading to its inflated size (Devarajan et al., 2009). On the other hand, the curse was never believed to be inevitable. A number of today’s developed and diversified economies were for instance clearly helped by rich natural resources at the outset of their industrialisation process. The GCC countries would have performed less well without them. Still, the question is whether the reform efforts of these countries have seen successful in laying the basis for sustainable diversification, and where these countries are heading next.

Figure 1: Negative correlation observed between mineral exports and growth



***Source**:* World Bank

When contrasting to the situation in North Africa, the resource-rich GCC countries were able to make use of their rich resource base to undertake reforms in support of stability and thus to defend the basis for long term prosperity. The repercussions remain at hand, however. In both Saudi Arabia and Oman, salary reforms and other benefits have been costly for the economy. In Oman, the economic reforms have been accompanied by greater freedom for the press and a stronger mandate for the democratically elected Majlis Shura, in effect an Advisory Council awarded real powers. In Saudi Arabia, some increased opening has taken place for women in politics, although in other respects developments have rather gone the other way. Press freedom for instance has been reduced significantly across much of the region.

The European Union, meanwhile, has been fighting a recurrent financial and debt crisis since 2008, which has brought economic stagnation and high unemployment, especially youth unemployment, in many countries. Southern Europe in particular finds itself in a vicious circle of savings, reduced investment, "brain drain" especially of well-educated younger people, an ageing society, and reduced confidence in the future. But many countries in Northern Europe have lost momentum as well, including the Netherlands, Denmark, Finland and the United Kingdom. Political divisions have increased.

In recent years, the wave of immigrants from the Middle East has caused havoc and a closing of borders within Europe, and a further worsening of the political divide between those who stand for an open Europe and those who wish to close the border. Through all this, however, thus far the EU has pushed ahead with an ambitious strengthening of its research and innovation framework, currently under the label "Horizon 2020", the continued strength of which is seen as instrumental to retaining the economic dynamism and future unity of the continent.

Box 2: The "Arab Spring" in the GCC

The Arab Spring was widely seen as the dawn of bottom-up initiative and constructive engagement by enlightened new generations in the politics of the Arab world. In retrospect, the dominating impact in many Arab countries has been that of turmoil, a loss of investment and tourism revenue, and a backlash, perhaps under the influence of conservatives, the military or other incumbent vested interest, depending on context. Compared to other Arab countries, the oil-rich GCC countries were able to undertake countervailing reforms, however, and thus the impact on these countries appeared more subtle.

To some, the Arab Spring "fell from the sky"; an absurd consequence of the insult at the hands of a female police officer experienced by a greengrocer who set himself ablaze in Sidi Bouzid, a medium-sized Tunisian town, in December 2010. In reality, there had been signs, and examples of similar rage, for years, even decades (Andersson and Djeflat, 2012). The difference this time had to do with the momentum, the remarkably forceful, apparently unstoppable, human energy that the incident unleashed. Within less than a year, the Arab Spring claimed the downfall of four heads of state (Tunisia, Egypt, Libya and Yemen), all of whom had held power for many years and appeared firmly in control when it all began. Following far-reaching unrest, it toppled innumerable cabinet ministers and high-ranking public officials in a range of countries and impacted on policy agendas across basically all the 22 countries of the Arab League of Nations.

Underlying the Arab Spring was, in part, the rise of more all-encompassing education, of rapid change in technology, and of demography, all of which interacted with institutions and culture that are strongly embedded at the local level and take different shapes across the Arab world.

In particular, the arrival and diffusion of ICT, in a situation of generally underperforming media coverage and education systems, typically coincided with;

- Demographic change in the shape of rapidly growing young generations and an average age of only 21 to 25 across the various countries of the region;
- Until the present, a deficit of other channels than outright unrest for making the popular voice heard, e.g., undeveloped civil society, relatively inactive press, etc.
- Weak economic opportunity for the vast numbers of young and increasingly educated citizens although overall resources may appear abundant, with enormous and visible wealth accumulated by a small number of privileged individuals;
- The inability of initiatives in R&D and innovation to engage and inspire the broader population and create a sense of shared interest among the masses in knowledge sharing in regard to new technologies and associated ways of resolving economic, societal, and environmental challenges.

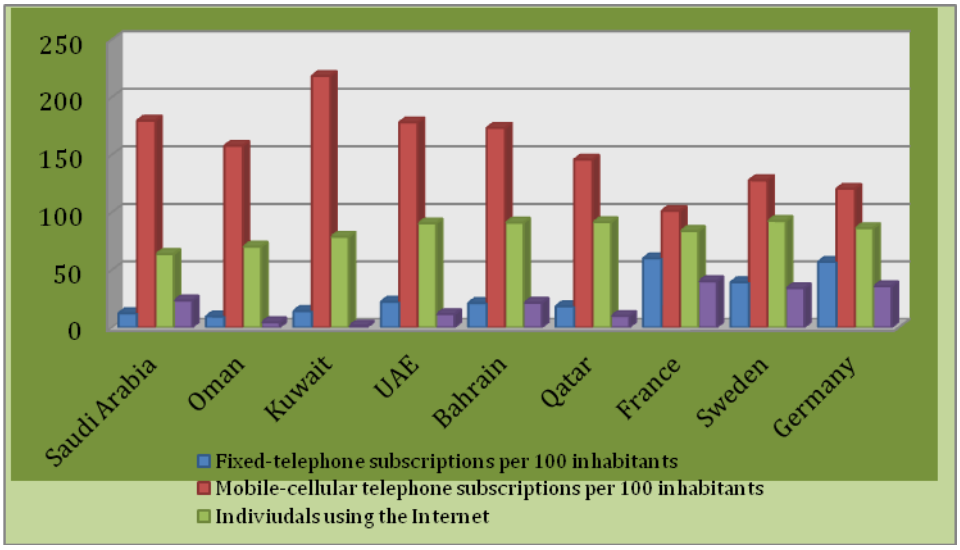
2.3 R&I: current situation in GCC countries and Europe

Over the last decade, the GCC countries have embarked on multiple development efforts and reforms with the objective of strengthening their frameworks for education, research, innovation, entrepreneurship and industrial renewal, as a key to their ability to diversify their economies away from oil and gas dependency.

In the area of Information and Communications (ICT) technology, Figure 2 demonstrates their strong standing in the new generations of communication, notably mobiles but also the Internet. Likewise, there has been an explosion in usage of social networks. That these countries lag in fixed networks merely shows that they leapfrogged past generations of infrastructure that are now less relevant. Having said that, the degree of success varies between the GCC countries, e.g. with the degree to which

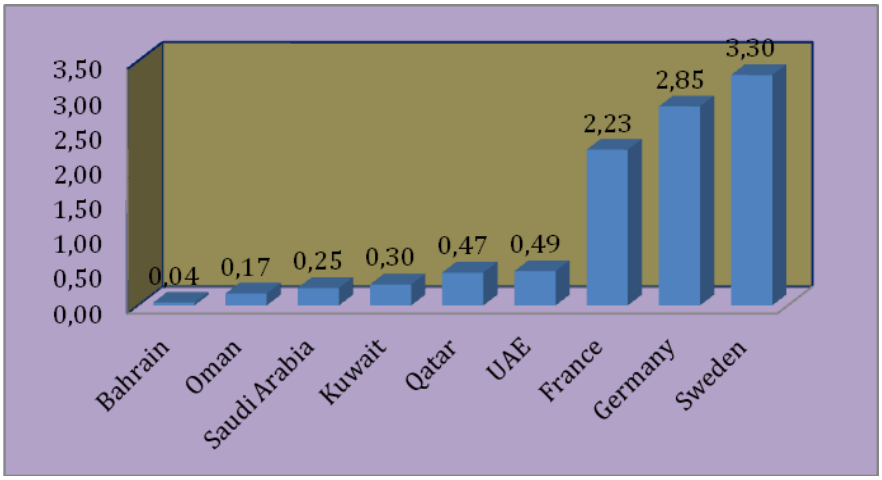
there have been comprehensive reforms allowing for genuine competition. The network development has not been entirely effective, with each country going for their own connection to the wider international networks, and with an overlapping and surplus cost of parallel networks instead of co-usage within countries as well. In the case of Oman, new services are often blocked, in effect to protect the state-owned provider, Omantel, resulting in higher prices and less performance for users. Although e-government services have developed rapidly in all countries, and "smart cards" have been developed for broad-based usage, there is a tendency for ICT to be "routinized" within existing structures. Few domestic innovations have been introduced and new locally rooted services of the kind seen elsewhere in the development of smart cities appear less present in the GCC, and surely not to an extent that is on par with their advance of mobile communication and social networks. Partly associated with this, there is also a lack of extensive content developed in Arabic language, and hence also a low presence of effort to address specific local issues.

Figure 2: Penetration of selected ICTs, 2014 or latest year (per 100 people)



Source: ITU (2016)

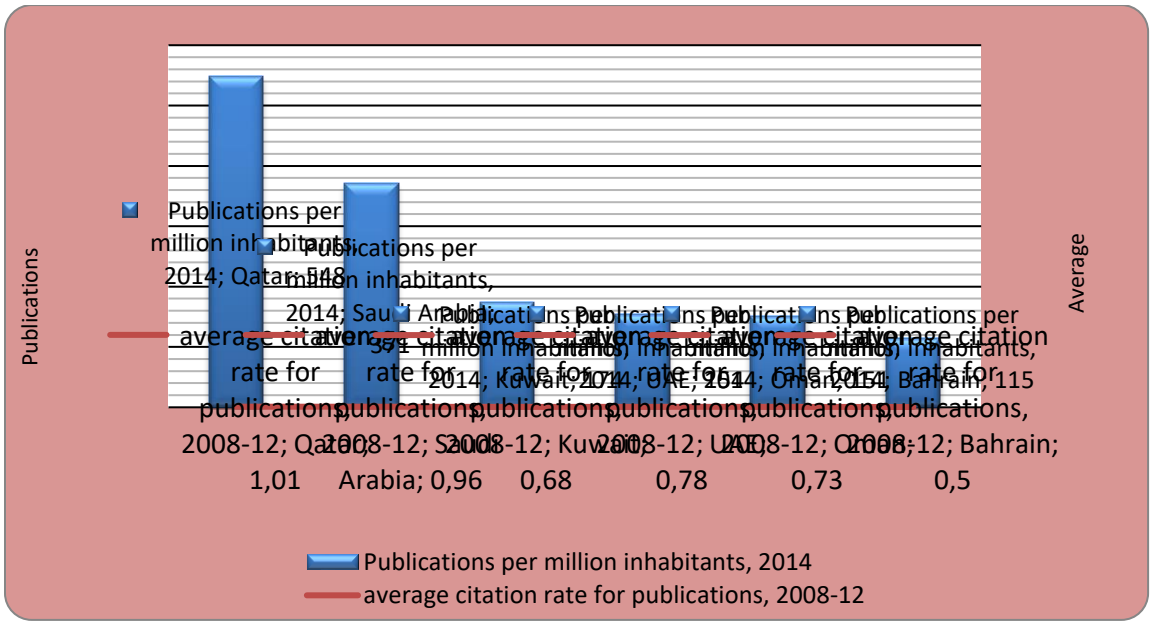
Figure 3: R&D Expenditures, as per cent of GDP*



Source: The World Bank (2016)* (data from 2011 or latest available)

Various studies from across the world suggest that the value of ICT will critically depend on other factors, including research and education (OECD, 2014). The weak presence of research and innovation hampers the ability of the GCC countries to make creative use of their strengths in ICT, as well as value-creation more broadly. Figure 3 shows that the share of GDP invested in R&D remains at a low level in the GCC countries. In a way, this may be seen as a consequence of their high GDP per capita, coupled with only a small role for R&D in their economies, and mostly low efficiency of investment in R&D. Most R&D is undertaken by universities, which is subjected to robust driving forces, both external and internal, to generate respectable academic output including scientific publications. In the Arab World, the strongest growth in such output has taken place in Egypt and Saudi Arabia, while Qatar and Saudi Arabia show the strongest citation levels. Figure 4 shows the standing of each of the GCC countries in both average number of publications 2014, and the average citation level for 2008 - 2012.

Figure 4: Publications per 000' inhabitants, 2014, and average level of citations 2008-2012, GCC countries



Source: UNESCO (2016)

Table 1: Most important foreign countries in scientific co-publications, GCC countries

	1st collaborator	2nd collaborator	3rd collaborator	4th collaborator	5th collaborator
Bahrain	Saudi Arabia (137)	Egypt (101)	UK (93)	USA (89)	Tunisia (75)
Kuwait	USA (566)	Egypt (332)	UK (271)	Canada (198)	Saudi Arabia (185
Oman	USA (333)	UK (326)	India (309)	Germany (212)	Malaysia (200)
Qatar	USA (1168)	UK (586)	China (457)	France (397)	Germany (373)

Saudi Arabia	Egypt (7803)	USA (5794)	UK (2568)	China (2469)	India (2455)
UAE	USA (1505)	UK (697)	Canada (641)	Germany (389)	Egypt (370)

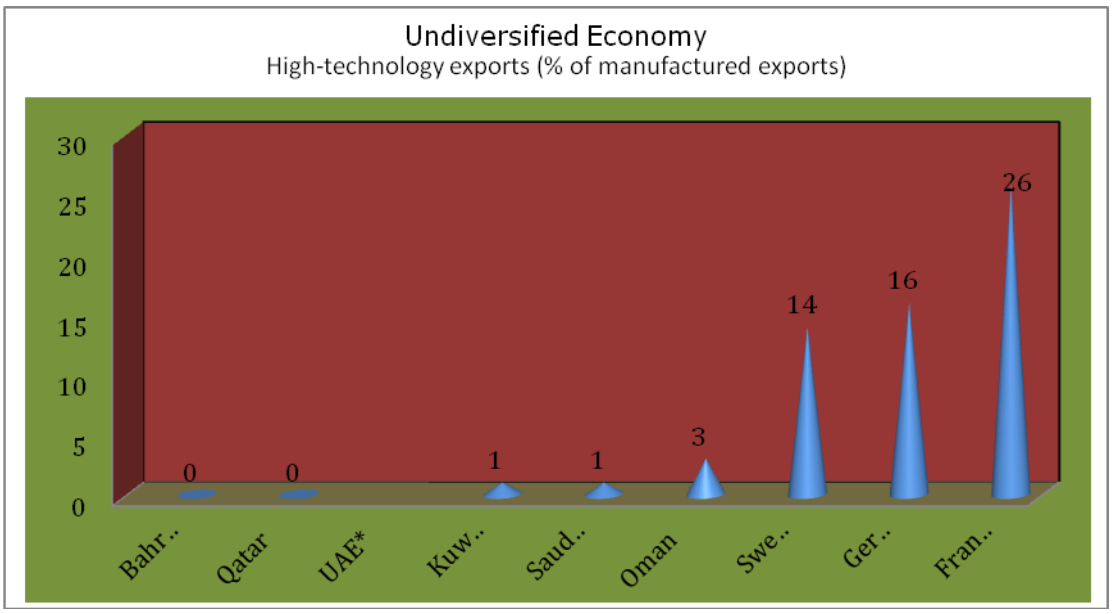
Source: UNESCO (2016)

Co-authorship with international partners are greatly important in most of the Arab world, where it accounted for two-thirds of all scientific publications 2008-2014 on average (UNESCO, 2015). As shown by Prat and Ytsma (2012), reported in a mapping that was undertaken in INCONET-GCC, both the United States and European countries represent major partners in scientific publications for all the GCC countries. In recent years, co-publications with Chinese researchers have grown particularly fast, especially in Qatar and Saudi Arabia where, as can be seen from Table 1. China now attains 3rd and 4th place respectively among foreign countries with most co-publications (Thomson Reuters Web of Science, 2015). Still, the US and also the UK remain more important in each single country. Germany and France are other European countries with a high prevalence of co-publications with the GCC.

While there is also high demand for patents as output, results are weak in this regard. More broadly, policy frameworks in the GCC call for an emphasis on applied R&D, although the share of industry in R&D funding as well as execution is very low. These observations consequently suggest the presence of serious mismatches in the innovation systems of the GCC countries.

It may thus come as no surprise, as indicated by Figure 5, that the level of economic diversification in the GCC countries, as measured by their share of high-tech products in overall exports, is even lower than their R&D intensity. Among the Arab countries, the strongest performer in high-tech exports is Tunisia. The GCC countries display a rapid increase in some specific categories, such as electronics for Saudi Arabia and space technology for the UAE, but the share of such products in the overall exports of the GCC countries remains low. Studies of productivity growth outside the oil and gas sector in the GCC countries likewise point to mostly meagre, or even negative, outcomes in recent decades (Warner, 2015).

Figure 5: Level of economic diversification, based on share of high-tech exports in overall exports



Source: The World Bank (2016)

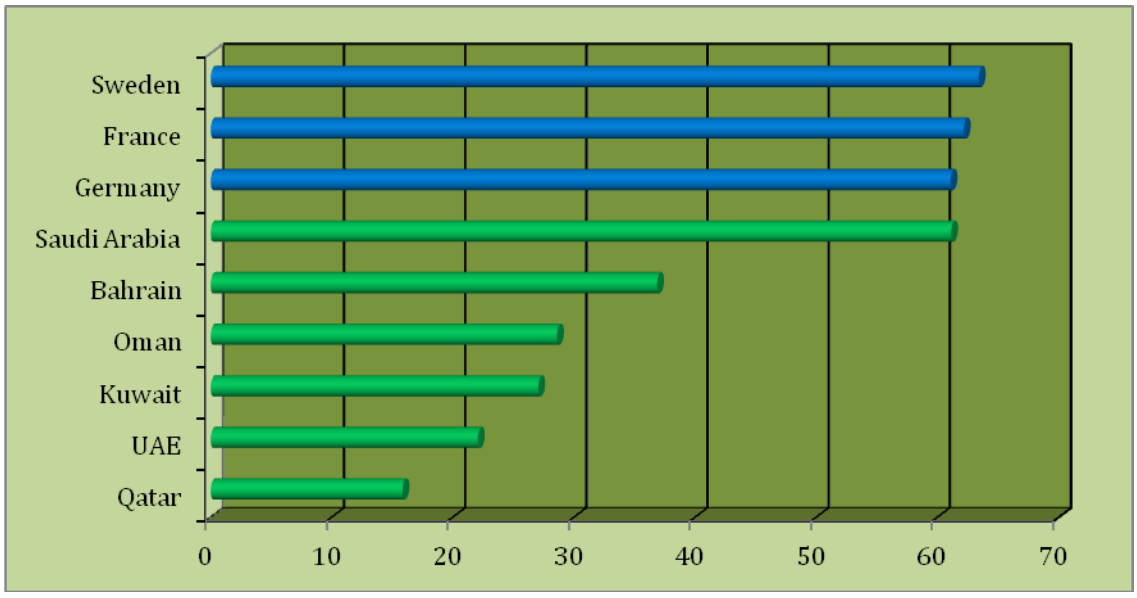
With regards to education, we already noted that the GCC countries have demonstrated a greater increase in investment than other countries across the MENA region, which have been lacking corresponding financial means. All the GCC countries have achieved a level of enrolment in secondary education that is on par with Europe or other developed regions.

Having said that, it appears that the increase in investment has been disproportionately large in tertiary education, and with a more meagre increase growth in resources invested per student especially in primary education. As seen from Figure 6, Saudi Arabia demonstrates as high enrolment in higher education, as do leading European countries. On the other hand, the expansion in terms of volume has not been paralleled by commensurate improvements in quality. Performance measures such as OECD (2014) point to significant weaknesses in the GCC at all levels of education. Table 2 highlights the presence of several severe challenges, based on the ranking of the World Economic Forum (the ranking is shown for each of the individual GCC countries out of a total of 140 which participated in the study at global level) on various indicators.

Lingering quality problems appear in the Arab Gulf, not only in educational outcomes. The World Economic Forum (2015/2016) points to work-force skills and work ethics as critical areas, contributing to the high dependence on cheap immigrant workers across the GCC countries. The issues at hand are structural as well as institutional and cultural.

A limited supply of skilled professionals blends with the strong presence of a traditionalist trading culture, and the role played by natural resource rents in the modern state of these economies. The set-up has been referred to as a *rentier culture* that is prone to a cautious, marginalist and short-term approach to commercial deals with outsiders, tight control of financial resources and high reliance on tangible investment (Bizri, 2012). This has strong implications for research and innovation collaboration as well. Human resources tend to be scattered across fragmented organisations that display limited exchanges between them and form isolated islands.

Figure 6: Human Capital (Gross Tertiary Enrolment, per cent of adult population)



Source: UNESCO, 2016. Data from 2011 or latest available

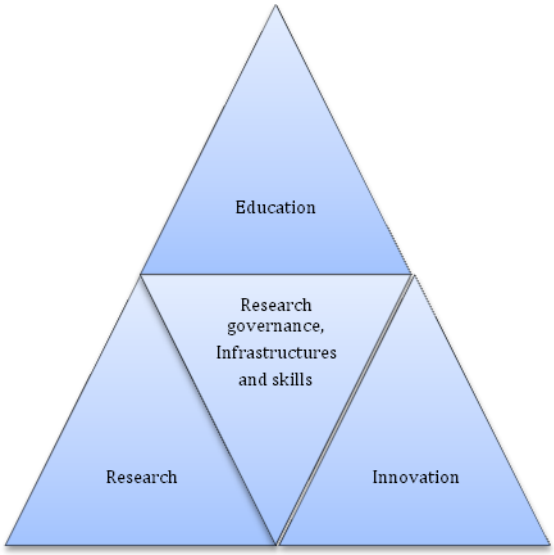
Table 2: WEF rankings in the area of Education

	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
Overall Ranking (GCI)	39	34	62	14	25	17
Primary education enrolment	48	81	73	78	35	94
Secondary education enrolment	53	32	62	10	7	67
Tertiary education enrolment	73	80	82	103	44	99
Quality of education system	26	88	106	2	47	12
Quality of management schools	43	86	128	7	62	20
Internet access in schools	34	81	84	18	63	9

Source: World Economic Forum, 2016

The University landscape meets with issues in this context, which are partly of a general nature and relevant to all countries, but which manifest themselves differently in the GCC compared to Europe or OECD countries more generally. Figure 7 presents the stylized notion of the "Knowledge Triangle", an illustration of the key task for universities to integrate all the three main realms of knowledge generation – education, research and innovation – for the task of generating high powered output in all. GCC policy frameworks tend to draw on a functional approach, with institutions created to serve a limited (isolate) purpose that may be more or less ad hoc, with high expectations for quick deliverables. That can be a challenge for long term performances in a rapidly changing environment, and for international cooperation. As elaborated e.g. by Hazelkorn (2005), universities commonly meet with complex organizational challenges as well as external and internal constraints, in ways that have a bearing on realizing potent synergies between the different parts of the triangle. In the GCC, universities tend to be strongly focused on the first of these three pillars, based on a traditional approach to education. There is a lack of tradition as well as resources to support R&D, and thus far limited attention has been paid to innovation.

Figure 7: Knowledge Triangle



Finally, it should be noted that the GCC countries provide active support to the best and brightest of its graduates to join leading universities abroad for higher education studies, including at master and PhD level. However, there is a stark dominance of US universities with a lot fewer heading for Europe. While this appears to students from many other parts of the world, students from some of the GCC countries are particularly concentrated on the US, with the situation becoming even more tilted over time. Overall, the MENA region displayed a 20 per cent increase in students going to the US in 2013-2014 compared to the previous year. The biggest jump of any country was for Kuwait, which displayed a 42.5 per cent increase, while Saudi Arabia was in third place with a 10 percent increase. As a consequence, these two countries accounted for 1 respective 6 per cent of all foreign students in the US at that time, while the number going to Europe is on the increase but at a much lower level. The flow of foreign students from these countries is largely funded, and influenced, by government provided scholarships (Eurostat, 2016).

Table 3: Youth versus overall Unemployment (latest year available)

	Country	Youth (15-24) unemployment (%)	Overall unemployment (%)
GCC	Bahrain	20.1 (2001)	15.0 (2005)
	Oman	N/A	15.0 (2004)
	Kuwait	11.3 (2005)	2.0 (2005)
	Qatar	1.6 (2007)	0.4 (2011)
	Saudi Arabia	28.2 (2009)	10.9 (2011)
	United Arab Emirates	12.1 (2008)	4.0 (2008)
Other MENA Countries	Algeria	24.3 (2006)	9.7 (2011)
	Egypt	24.8 (2007)	12.2 (2011)
	Iran	26.8 (2012)	15.3 (2011)
	Iraq	30.0 (2012)	15.0 (2010)
	Jordan	27.0 (2009)	12.3 (2011)
	Lebanon	22.1 (2007)	9.0 (2007)
	Libya	22.0 (2010)	30.0 (2004)
	Mauritania	N/A	30.0 (2008)
	Morocco	21.9 (2009)	9.2 (2011)
	Syria	19.1 (2007)	8.1 (2011)
	Tunisia	30.7 (2005)	16.0 (2011)
	West Bank/Gaza	46.9 (2009)	23.5/40 (2010/2011)

Source: World Bank data, CIA World Factbook and UNCT Iraq

The difficulties to advance on research and innovation reflect, first, the availability of resources, as tuition fees, or compensation from the Government for education in the case of state-owned universities is commonplace in the GCC, while there is much less support for research and innovation. Second, success in research and innovation often hinges on achieving a certain "scale", a critical mass of resources, which is lacking except for a few prioritized agendas, such as renewable energy at MASDAR in the UAE. Third, there is a tendency for strong reliance on top-down governance approaches, which leaves limited room for cross-horizontal linkages. Associated with this factor, there tends to be a strong drive for centrally determined "specialisation", with the individual institutions enjoying limited autonomy, and thus lacking the flexibility to attract or invest in particular assets or individuals beyond their given focus areas. This has implications for their ability to adjust to local conditions or what is relevant for specific actors in their particular university environment, as well as

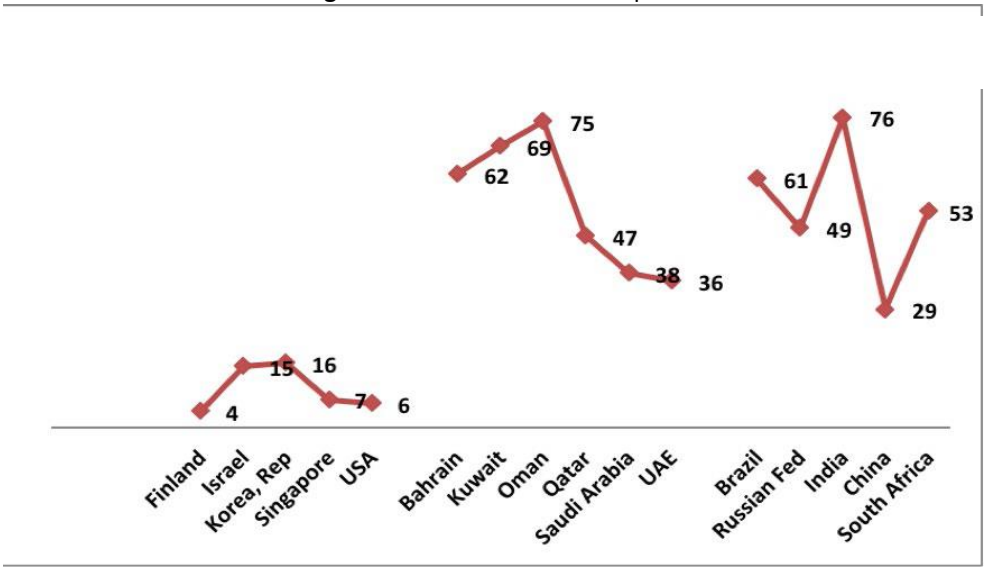
to evolve in the context of international partnerships. Fifth, research and innovation cannot be achieved in isolation, but success in either is severely dependent on engaged and creative actors, whether in the form or experienced researchers, or partner institutions in society which themselves engage in research or invite universities to work with them in addressing the issues that confront them. The GCC sees very little of such initiative, although there are some exceptions, e.g. in oil and gas. Sixth, low risk-appreciation and a short-term perspective makes policy makers and university management press for "safe bets" and swift results, countering the very nature of research as a drive to discover the "unknown", and thus push for *applied* rather than *basic research*, although there is a lack of experienced researchers as well as of an engaged industrial sector and also wider "user side", accounting for a state of severe mismatch in the innovation system.

Meanwhile, weak links between universities and working life/industry generate a "gap" with respect to the employability of graduates, contributing to the high levels of unemployment in most countries in the region (Table 3). Compared to most other regions of the world, the Middle East more broadly displays high levels of youth unemployment relative to unemployment overall, which is reflected in parts of the GCC as well, notably in Saudi Arabia and Oman. Established value systems, such as "*wasta*", induce employers to hire through contacts while downplaying the relevance of skills. Merit-based promotion is commonly seen as a challenge, applying throughout the GCC. In this context, Tlaiss and Kauser (2011) note the importance of building new models for career counselling, mentoring and networking around universities in the Middle East. Sultana and Watts (2008) presented six recommendations to each Mediterranean and Arab country to improve tailored awareness creation and career guidance to students.

Others stress the importance of refraining from short-term gains by way of higher employability at the expense of lower development-potential and lower employment or productivity over time, as technology progresses and the work-place is set to keep evolving (Hanushek, 2012). Professional organizations need to collaborate with educational institutions in both the public and the private sphere to work out ways of combining the vitality of the knowledge triangle as a whole with a strengthening of the employability of graduates today. There is wide agreement on the need of improved collaboration between key stakeholders to advance this agenda at several levels, including with appropriate measures directed at students themselves.

Drawing on all the elements discussed above, and additional ones, the concept of the innovation ecosystem as a dynamic and interdependent process has taken shape. Researchers, entrepreneurs collaborate along with other actors, while competences interact to promote idea generation, innovation and commercial experimentation around new technologies as well as other sources of knowledge and inspiration. As one attempt to measure and compare the associated processes and outcomes across countries, Cornell University, the international business school INSEAD, and the World Intellectual Property Organization (WIPO) have developed a Global Innovation Index (GII). The theme of the GII 2014, which covers 143 countries, is "The Human Factor in Innovation." Figure 8 below shows GII 2014 for selected countries including GCC and BRICS countries.

Figure 8: Global Innovation Impact



Today, R&D and innovation stand out as core elements of any effective response to address many of the most important outstanding societal issues, and also as key to more constructive and effective collaboration between Europe and the GCC more generally. This is as economic diversification at the income and cost levels seen in the GCC requires success in building research capacity and innovation. At the same time, despite major efforts by each of the GCC countries in isolation to build such capacity, they have failed in collaborating and doing so together. Further, they have all relied on extensive cheap immigration notably from South Asia, and many of their flagship investments in foreign collaboration have basically failed, although there are exceptions such as Masdar in Abu Dhabi and the Education City in Qatar. On the whole, there was little progress across the GCC in having members of their large young generations take inspiration from the opportunities that are at hand in science and technology, in becoming an innovator, or an entrepreneur.

Europe, meanwhile, has the world's most developed research and innovation system, under the auspices of Horizon 2020. Since many years, the EU has built the experience of how a grouping of diverse countries can grow significant cross-border linkages and enhancement of national capacity. Moreover, in recent years, the EU has become more inclusive in relation to outside countries, as seen from the operational features of Horizon 2020. In many areas, researchers from the GCC countries can join European research consortia in various bids, opening for research funding as well as for strengthening linkages and mutual learning with their colleagues and peers in the EU and elsewhere as well.

3. Substantive Focus

Based on the analysis of needs that took place in the first phase of the INCONET GCC and the consultation that followed in the start of the second phase with the EC, the following two areas of GCC-EU cooperation were highlighted:

- Health Innovation research, with focus on Personalised Healthcare for chronic non-communicable diseases, and;
- Smart Cities.

The criteria for the selection of the two areas relate to existing societal challenges and the potential impact from GCC-EU research cooperation in tackling those challenges.

3.1 Health research with focus on Personalised Healthcare for chronic non-communicable diseases

Countries of the Gulf Cooperation Council (GCC) – Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, the United Arab Emirates and Yemen– are facing unparalleled and unprecedented demands for health services. These demands will increase during the next decades due to an increase of the population as well as due to social, economic, and demographic changes that are taking place in the region. Meeting such demands will pose great challenges for the healthcare systems of GCC countries. Planning, organizing, and financing healthcare systems are complicated tasks that require crucial decisions regarding better healthcare policies. This is further complicated by the fact that GCC countries are witnessing high population growth, sedentary lifestyles, increases in chronic diseases, unstable economies, shortages of qualified manpower, etc. All these demands and challenges will require the development of healthcare policies that lead to efficient and effective healthcare delivery to all populations.

It is estimated that total healthcare spending in the region will reach $60 billion by 2025. No other region in the world faces such rapid growth in demand with the simultaneous need to realign its healthcare systems to be able to treat the disorders of affluence. Although there has been major investment in the healthcare system in the GCC, many residents remain unsatisfied with the availability and quality of care at government-run hospitals and clinics. While the healthcare systems, are mainly run by the governments, government agencies mostly lack strategies and policies as well as the managerial skills needed to run healthcare facilities. Therefore, government-run healthcare centres (hospitals and clinics) are ill-prepared for a rapidly growing and aging population, nor are they prepared for the rise in chronic diseases such as diabetes, whose prevalence has grown as countries have developed.

The recent paradigm shift in lifestyle and rising per capita incomes has led to the consumption of unbalanced diets and a more sedentary lifestyle in the GCC, thereby aggravating the prevalence of lifestyle ailments such as diabetes and cardiovascular diseases.

The GCC countries' economic progress and epidemiologic transition over the past 50 years have outpaced development of their healthcare systems. The health of the populations is being influenced simultaneously by their greater reliance on food of poor nutritional value, low physical activity, growing wealth, and migration from rural to urban living. The result is a large and expanding burden of chronic disease — especially diabetes — and disability, even as mortality due to acute illness wanes. To handle the new challenge, the GCC countries' health systems must undergo a transformation.

Their current delivery systems are handicapped by underinvestment, a severe workforce shortage

(especially of nurses), a hospital bed shortage and lack of robust, interoperable IT. A large, well-integrated primary care delivery system is also lacking. At the same time, the GCC countries have the unique opportunity to leapfrog other countries: Their relative freedom from legacy infrastructure and entrenched interests mean they can adopt an innovative model for health care delivery that is purposefully designed for the 21st century, rather than emulating models elsewhere.

Visionary leaders who embark on this ambitious agenda will be remembered for three accomplishments: first, for implementing a high-performing health care system that is centred on the needs of citizens and offers continuous support, thereby promoting civic contentment; second, for promoting economic diversification into knowledge industries; and third, for providing inspiration to the Ummah and the rest of the world and for restoring the leadership role of Arab medicine.

GCC countries have some of the highest rates of Type 2 diabetes in the world; five of the IDF's "top 10" countries for diabetes prevalence in 2010 and (forecast for) 2030 are from this region. Currently, the IDF estimates suggest that in 2010 the ranking of countries by highest prevalence of diabetes started as follows:

- United Arab Emirates (UAE; prevalence 18.7 per cent),
- Kingdom of Saudi Arabia (KSA; prevalence 16.8 per cent),
- Bahrain (15.4 per cent),
- Kuwait (14.6 per cent),
- Oman (13.4 per cent).

Higher incidence of lifestyle diseases translates into higher per capital healthcare cost, as the average treatment cost in the case of lifestyle-related ailments is higher than other hospitalized cases.

Moreover, the rising population coupled with ageing demographic pattern is expected to drive healthcare demand in the GCC. The GCC population growth has averaged 3 percent per annum over the past five years, among the highest growth rates in the world. Moreover, the average life expectancy across the region has risen from 60 years in the late 1970s to 75 years primarily due to various health reforms. The sharp population growth is set to be accompanied by a shift in the demographic structure of the region over the next 20 years, as the young population ages. The current average age in the Gulf is low; however, the proportion of population above 60 years of age will increase as Gulf baby boomers born during the region's first oil price boom become pensioners. This will generate significant healthcare demand; according to health experts, four-fifths of a person's healthcare needs typically occur during the post retirement age.

Another emerging issue in the GCC is healthcare insurance. Most GCC countries are framing legislative policies to mandate employers to provide basic healthcare services, including insurance, to their expatriate employees. The expatriate workforce forms about 40–80 percent of the total population of the GCC countries. With Saudi Arabia being the first GCC country to mandate medical insurance for expatriates in 2006, the health insurance industry is predicted to grow to include GCC citizens boosted by the lack of healthcare quality.

3.2 Smart Cities

To cope with increasing urbanization GCC city leaders need to find new ways to manage complexity, increase efficiency, reduce expenses and improve quality of life. To address key challenges in water and energy supply, transport and mobility, sustainable development and citizen engagement governments are exploring and utilizing technology and intelligent urban policy.

Deployment of Information Communication Technologies (ICTs) is crafting smart cities in the Gulf

Cooperation Council region including Saudi Arabia, Kuwait, United Arab Emirates, Qatar, Oman and Bahrain. Increasing economic dynamism in the GCC region has led development authorities, infrastructure companies, governmental and corporate entities to be more cognizant of deploying ICT solutions for various infrastructural platforms such as intelligent transportation, telecommunications, airports, sustainable environments, public safety, energy efficient buildings, residential and utilities projects. These projects not only stretch the limits of creativity, but also inform us about the neoliberal trajectories pursued by "globalizing" cities and their excessive focus on sustaining competitiveness.

The Smart City concept entails common characteristics that are key indicators of smartness in a city: a smart economy (sustainable economic growth), smart mobility, smart environment (wise management of natural resources), smart people, smart living (a high quality of life), and smart governance (participatory governance). In the literature, there are widely accepted measures of what a smart city constitutes. For instance, the smartness of a city should be measured by its participatory governance, its smart economy, its smart urban mobility, its smart environmental strategy and management of natural resources, and the presence of its self-decisive, independent, and aware citizens leading a high-quality urban life.

Three necessary conditions are defined to create a spatially enabled society: first, citizens have to be "spatially literate"; second, "a conducive environment" for sharing spatial data is needed; third, globally unified geospatial standards are needed. The practical application of this view refers to individuals' ability to use geospatial information and location technology as a means to improve the way they interact with the space and other individuals on/in/through space.

The six countries in the Gulf region share several common features, such as the high per capita GDP, monarchical rule and central authority, and abundant financial wealth generated from their dependence on oil and gas. The abundant wealth has contributed to the "introduction of comprehensive administration reform and the need to provide more public services". The public policies have been formulated and implemented in different sectors. The Smart Cities in the region are "important sources of innovation and economic growth, as well as vehicles for globalization". There is a diffusion of Smart Cities phenomena occurring in the Gulf region. Indeed, governments are not different from individuals or organizations when comes to innovation. There are many, such as Education City in Qatar, Healthcare City in Dubai and Masdar City in Abu Dhabi. The free zone concept is crucial to the understanding of smart city. "A free zone is one with multiple economic incentives, opportunities and benefits". The majority of Smart Cities in the Gulf are free zones. However, those without population are mostly called enterprises, while others are called cities only for marketing purposes. Some Smart Cities built for political, economic, religious, ethnic or education reasons. The use of terms such as bay and park is common. Nevertheless, some aspects are lagging behind, notably relative to Europe where the smart city agenda is now firmly disused among cities with more than half a million participants (European Parliament, 2013).

Various factors influence to what extent a smart city agenda is embraced, and whether it is organised so as to fuel innovation. An important aspect has to do with the degree to which citizens and users are genuinely engaged in interactive communication with the ability to influence outcomes so as to meet with their real needs (Cohen, 2012). Many of rulers in this region are policy entrepreneurs with great latitude to spur change but other stakeholders tend to assume a more lax attitude. As the need for economic diversification increases, however, there is more scope for innovation. Overcoming social inertia and dependence on immigrant workers and the ability to link smart city agendas to be matched by reforms in, e.g., education and heath, are also greatly important for eventual outcomes.

The diffusion of initiatives is partly a result also of geographical proximity. When neighbouring states and cities adopt innovative practices, important spill-over effects generally account for new inspiration

to follow suit and use similar tools to meet with economic and social challenges. The degree of communication between governmental officials as well as businesses and ordinary people matters as well in this context. Thus far, the GCC countries were mostly hesitant to learn from each other, although they engaged in often intensive competition and were thus sometimes provoked by each other's successes in advancing related initiatives. The very high level of ICT diffusion, notably in regard to mobile telephony, Internet access and social media in the GCC, is set to underpin a fertile environment for future progress in these domains.

4. Institutional Conditions – GCC as a Partner of the EU

4.1 Introduction

Various indicators are used to monitor and measure Science and Technology Innovation (STI). These indicators include:

- R&D Expenditures as Percentage of GDP;
- Number of Researchers in R&D per Million People;
- R&D Expenditures per Researcher;
- High-Technology Exports as Percentage of Manufactured Exports;
- Number of Scientific and Technical Journal Articles; and
- Number of Patent Applications Filed by Residents and Non-Residents.

In addition to these indicators, the Science Citation Index (SCI) is commonly used to measure scientific output. The following paragraph will focus on reviewing and analyzing the R&D Expenditures as Percentage of GDP.

In some countries R&D expenditures include a very large portion (about 85 to 90 per cent) for salaries of researchers and technicians, which leaves very little funding for research equipment, material, training, and capacity building. While higher spending on R&D is important, increasing expenditures on knowledge-based intangibles such as ICT skills and competencies are essential to prepare "knowledge workers" to support knowledge-based development.

The main sources of R&D financing are public or government funding of national research institutions and research projects in universities and the private sector, including large corporations and SMEs. The world average of R&D expenditures as percentage of GDP was 2.13 per cent in 2011. Korea had the highest R&D expenditures as percentage of GDP, at 4.04 per cent in 2012, which was followed by Israel at 3.93, Finland at 3.55, and Japan at 3.39 per cent. To emphasize the importance of STI, in 2008 Korea established a Ministry for Knowledge Economy. The United States is planning to increase R&D expenditures as percentage of GDP from the current level of 2.79 to 3.0 per cent by 2020. In 2012 China scored 1.98 per cent, which was the highest among the BRIC countries while India, which scored the lowest at 0.76 per cent, vowed to increase its level of expenditures. Realizing the value of STI, China has more than doubled its R&D expenditures from 0.9 per cent in 2000 to 1.98 per cent in 2012.

The data on R&D available for the GCC states is of uneven quality, and not fully comparable to the rest of the world. According to the available statistics, Qatar has the highest level of expenditures, with a target of reaching 2.8 per cent of government revenues since some time. Among the other GCC states, the UAE comes next with a ratio of R&D expenditures at 0.49 per cent of GDP, followed by Qatar at 0.47, Saudi Arabia at 0.25, Kuwait 0.30 and Oman at 0.17 per cent.

Recognizing the importance of R&D, some of the GCC countries have set up targets to increase their expenditures on R&D as percentage of GDP. Kuwait's Four Year Development plan (2010-11 to 2013-14) proposed to increase R&D expenditures to one per cent of GDP. The UAE Vision 2021aims at increasing R&D expenditures to 1.5 per cent. Thus far, however, R&D has remained heavily concentrated in the public sector, and has an emphasis on academic credentials with very little investment being undertaken by private enterprises. Yet, the objectives are for R&D to be applied rather than basic and generate fast results. This situation accounts for a mismatch that leads to considerable tensions. With the recent decline in oil prices, investments in R&D have come under pressure and declined markedly throughout the GCC countries, although the precise degree of the cut-back is unclear. In the years ahead, it is critically important for the GCC states to increase the efficiency

of R&D investment, including its composition and orientation.

To compete in the 21st century, and to diversify their economies and create skilled jobs for their nationals, the GCC states are building up human capital and moving towards knowledge-based economic development. Some GCC states have articulated their visions on knowledge and innovation-based economy; others are implementing policies and programmes to propel their economies toward that goal. The vision statements and development plans of the GCC states make specific references to knowledge and innovation-based economic development.

The GCC states are at various stages of diversifying their economies, with the UAE considered the most diversified economy. These diversification efforts, however, have not remedied the region's labour market and human capital distortions. Some of the challenges and opportunities facing the GCC states include:

- Reforming the education sector and ensuring that education outputs cater for the skills and competencies required by the market. The education system should be geared toward producing "knowledge workers";
- Providing the enabling environment for scientists, entrepreneurs, and innovators to scale up their proven research output and innovative ideas by creating clusters;
- Ensuring the availability of finance, including seed, angel, venture capital and crowd financing to encourage entrepreneurs and investors to commercialize their products, processes, and services;
- Increasing interaction between research centres/universities and industries;
- Increasing the role of the GCC states as "producers" and not only "consumers" of knowledge;
- Building on the success of ICT to ensure the participation of larger segments of the population in the information society;
- Investing more in R&D by meeting existing targets and setting up realistic targets to increase expenditures of R&D as a percentage of GDP;
- Increasing high-technology exports as percentage of total manufacturing exports;
- Targeting regional markets for knowledge products, services, and processes;
- Encouraging and providing incentives to the private sector to invest more in R&D and build the human capital of GCC nationals;
- Increasing the benefits from FDI by ensuring the transfer of technology and skills to local markets and GCC nationals, and;
- Improving the rankings of GCC countries in the various indices, including the Networked Readiness Index, the Global Innovation Index, the Global Competitiveness Index, and the Doing Business rankings.

4.2 Overview of the STI systems in the GCC countries

4.2.1 Qatar

Qatar has embraced a process of intensive **modernization**. At the centre of the process stands the ruling family, a relatively cohesive society, and a consistent steady investment of income generated from abundant gas and oil reserves. Given its limited size, Qatar is particularly strongly endowed with gas, which enjoys a more stable price than oil and which, in principle, could last for 300 years. A major challenge for Qatar will be to modernize society while maintaining a Qatari identity. A number of ambitious projects are under way. Among them, Qatar will host the World Cup in 2022. It is also bidding to host the Olympic Games in 2024. Over the next ten years, Qatar plans to invest up to £147 billion in

new infrastructure including sports stadia, a metro system, new roads, and new utilities (electricity, water, ICT).

Qatar also plans to invest 2.8 per cent of its expanding government revenues on research. It wants to diversify away from its oil and gas industry base and sees investment in science and technology as key to the development of a knowledge economy. The biggest challenge remains the size of Qatar's human capital. Tertiary education uptakes are low and those pursuing science-based degrees outside engineering are a minority. Qatari women tend to dominate research, but often have cultural restriction on travelling and studying overseas. The domestic science base will always be small, but is conveniently concentrated around Doha, which presents an opportunity to develop a streamlined science, technology and innovation sector.

The research environment is divided between a traditional centre based at the segregated Qatar University and a modern centre based around the co-educational international branch campuses at Education City, which is home to the Qatar Foundation (QF). Qatar University has expanded research into: environmental studies (ESC), gas processing (GPC) and advanced materials (CAM). Education City hosts international branch campuses from UCL, HEC Paris, Georgetown, Carnegie Mellon, Weill Cornell Medical, North-Western, Texas A&M, and Virginia Commonwealth. These focus on undergraduate training (except UCL), but are keen to develop postgraduate courses to support research. Education City hosts a number of research centres focusing on: environment and energy (QEERI), ICT (QCRI), biotechnology (QBRI) and cardiovascular medicine (QCRC). It hosts the Qatar Science and Technology Park (QSTP) and will be the home of the new SIDRA Research and Medical Centre.

Qatar has been the leading country in the region when it comes to allocating substantial resources as well as undertaking institutional reform to underpinning a genuine spurt in science, technology and innovation. The strategy has been led by unusually long-term objectives, leading some to question their short-tern relevance. With the decline in incomes from hydro-carbon Qatar has come under pressure to reduce its investments in this area and to seek was of producing faster results.

National vision and commitment

Qatar's National Vision 2030 outlines five major challenges on the path of transforming Qatar into an advanced country by 2030, "capable of sustaining its own development and providing for a high standard of living for all of its people for generations to come": (1) modernization and preservation of traditions, (2) the needs of this generation and the future generations, (3) managed growth and uncontrolled expansion, (4) the size and the quality of the expatriate labour force and the selected path of development and (5) economic growth, social development and environmental management[1]. In addition to Qatar's National Vision, Qatar's National Research Strategy addresses priority areas for research. These can be found in detail under http://www.qfrd.org/About/Qatar-National-Research-Strategy-QNRS. 76 research objectives identified in 2012, lead in 2013 to 12, 6 and finally 3 grand challenges. The grand challenges as they stand to this date are: **cyber security, energy security and water security.**

Education and Research landscape - Higher Education institutions: As mentioned previously, Qatar's higher education environment consists of two players: (1) Qatar University and (2) the Education City, an initiative of Qatar Foundation for Education, Science and Development hosting six American, one British and one French university. Qatar Foundation for Education, Science and Community Development is a semi-private chartered, non-profit organization founded in 1995 by decree of His Highness Sheikh Hamad Bin Khalifa Al Thani, the father of the current Emir. In addition, to branch campuses Qatar Foundation also hosts research centres: (1) Qatar Computing Research Institute, (2)

[1] http://www.qu.edu.qa/pharmacy/components/upcoming_events_material/Qatar_National_Vision_2030.pdf.

Qatar Biotechnology Research Institute, (3) Qatar Environment & Energy Institute, (4) Qatar Cardiovascular Research Centre, (5) SIDRA Research and Medical Research Centre and (6) Qatar Science and Technology Park. Since 2015, QEERI, QCRI and QBRI have been gathered under Hamad Bin Khalifa University (HKBU), which is aimed to become a research university in Qatar managing in particular PhD programs.

The leading research institutions include:

- **Qatar University:** With about 8000 students Qatar's only national University offers PhD programmes in engineering and environmental studies. QU has strong links to the UK (see Table 2) with specific focus on **environmental studies**, **gas processing** and **advanced materials**. In addition to international collaborations, QU provides strong support for its students by fully funding overseas graduate studies (including support for their families as well), on the condition of returning and "transferring knowledge" to QU students via the method of "teaching". In some departments, the private sector determines the direction of research. For example, the energy department is guided by a consortium of 15 business representatives who prioritize research subjects. In comparison, the centre of advanced materials is led academically but collaborates across the sectors. (1) Industrial research collaboration with the QSTP and QF institutes, (2) service provision to businesses and (3) public outreach activities. QU clearly does not lack financial means for collaborative projects since it manages £169 Mio/year (mostly QNRF and QSTP) but in some cases researchers lack the access to high-tech facilities.
- **UCL Doha:** UCL opened in 2011 and offers postgraduate qualifications in museums studies, conservation, and archaeology in partnership with the Qatar Museum authorities. Currently it hosts 100 students. For more information the reader is advised to go to http://www.ucl.ac.uk/qatar
- **Georgetown University's School of Foreign Service** in Qatar was set up in 2005 and hosts about 250 students (30% Qataris) and 32 staff. It has published hugely impressive local and regional studies conducted and cited globally. For more information the reader is advised to go to: http://qatar.sfs.georgetown.edu
- **Weill Cornell Medicine-Qatar** was set up in 2002 offering a two-year pre-medical and a four-year medical programme. Currently WC hosts 200 students. Focus areas of research are diabetes, biobank, Arab genetic order. In Doha, WC has strong links with HMC, SIDRA and H. H. Sheikh Hamad Bin Khalifa. For more information the reader is advised to go to: https://qatar-weill.cornell.edu
- **Texas A&M at Qatar** was set up in 2003 and focuses on chemical, electrical, mechanical and petroleum engineering. Texas A&M currently hosts 400 students (50% expats, 39% of the total are female). Engineering is divided amongst three players in Doha: (1) QU (38% of its students are engineers), (2) Texas A&M and (3) Qatar's Engineering and Environment Institute. Links to the private sector are inevitable in a sector such as energy. Consequently, most Texas A&M graduates work for Qatar Petroleum. For more information the reader is advised to go to: http://www.qatar.tamu.edu

Science and Research Institutions

- Qatar National Research Fund (QNRF). In addition to the research institutions QF established in 2006 QNRF to be the main funding agency in Qatar. QNRF supports mainly R&D and capacity building programs based on competitive funding.

- **Qatar Science & Technology Park (QTSP)** is a home for international technology companies in Qatar, and an incubator of start-up technology businesses. Established in 2004 as a part of the Qatar Foundation, the purpose of the science park is to spur development of Qatar's knowledge

economy. QSTP was inaugurated in March 2009 and currently hosts 32 companies, which focus on engineering, petrochemicals and IT. QSTP functions by provision of office and lab space to tenant companies, and provision of professional services and support programs to those companies. In September 2005 the Government of Qatar passed a law making the science park a "free zone", allowing foreign companies to set up a 100 per cent owned entity free from tax and duties. A feature of QSTP is that it is co-located at Qatar Foundation's Education City with international universities. The science park helps its tenant companies to collaborate with the universities, and aims to act as an incubator for spin-off ventures from the universities (and other sources). Staffed with 1000, QSTP aims to grow Qatar's knowledge economy by encouraging companies and institutes from around the world to develop and commercialize their technology in these sectors in Qatar. Amongst innovation players, QSTP is considered a "failed venture", as it does not fulfil its tasks of "incubating" ideas and processes but hosts companies which have yet to dare to "innovate". Over the past 12 months, parallel initiatives have been funded and set up by the Qatar National Research Fund. The innovation landscape is shaping up.

Qatar Research Institutions:

- **Qatar Energy and Environment Institute** focuses on applied sciences with an emphasis on technology, such as: (1) solar-desalinization and (2) air quality management systems. With its motto "from carbon to creativity" the biggest problem QEERI currently faces is the lack of research culture. For further information the reader is encouraged to go to http://www.qeeri.org.qa/about
- **Qatar Computing Research Institute** is the most active research institute in Qatar, publishing 150 papers and recording 60 patents in 2012. QCRI's vision is to be a global leader of computing research in identified areas that will bring positive impact to the lives of citizens and society. Research areas at QCRI include: (1) content development, (2) Arabic language programme, (3) social computing, (4) scientific computing and (5) social innovation. For further information, the reader is encouraged to go to http://www.qcri.com
- **ICT Qatar:** Established in 2004 as Qatar's ICT policy and regulatory body, the Supreme Council of Information and Communication Technology (ictQATAR) supports Qatar´s ambitious vision to achieve social and political change while advancing global competitiveness. As an independent regulator, ictQATAR protects consumers and businesses from unfair practices as Qatar transitions to a competitive telecoms market. Main area that ICT Qatar investigates is the social impact of technology. Highest ICT services in Qatar are: (1) traffic violations and (2) exit visa. For further information the reader is encouraged to go to http://www.ictqatar.qa/en
- **Qatar Bio-bank Research Institute** is a national centre of excellence in biomedical research and is engaged in basic and applied biomedical research that strongly supports the translation of novel scientific discoveries into new efficient therapies. QBRI aims to establish multi-disciplinary research teams focused in genomic medicine, biomedical engineering, stem cell and gene-based therapies with primary focus in diabetes, cancer, and neurological diseases. For further information the reader is encouraged to go to http://www.qatarbiobank.org.qa/home
- **ASPIRE:** Aspire Academy is a globally recognized national sports academy for the development of Qatar's athletically talented boys. The internationally renowned sports programmes and facilities are a symbol of Qatar's sporting ambitions and pride. Aspire Academy provides integrated sports development, sports science and academic learning for scholarship boys from Grade 7 (12 - 13 years) to Grade 12 (17 - 18 years). The disciplines currently operating within Sports Science are: (1) Talent Identification, (2) Biomechanics & Performance Analysis, (3) Biochemistry, (4) Physiology, (5) Sports Psychology, (6) Strength and Conditioning and (7) Health & Medical Sciences[2].

[2] http://www.aspire.qa/Pages/AspireHome.aspx

- **SIDRA MEDICAL RESEARCH CENTER:** Has been announced in 2004 and will be an academic medical centre which will set new standards in patient care for women and children in Qatar, the Gulf region and internationally. Sidra will work closely with its academic partner Weill Cornell Medical College in Qatar (WCMC-Q) and Hamad Medical Corporation. Located in Doha on Qatar Foundation's 2,500-acre Education City campus, Sidra Medical and Research Center will initially have around 400 beds with infrastructure to enable expansion to 550 beds in a subsequent phase. Main research focus areas within SIDRA are: (1) Genetics and (2) biomedical research. For further information the reader is encouraged to go to http://sidra.org

4.2.2 UAE

The United Arab Emirate's vision 2021 mentions: "in a strong and safe union, **knowledgeable and innovative Emiratis** will confidently build a competitive and resilient economy. They will thrive as a cohesive society bonded to its identity, and enjoy the highest standards of living within a nurturing and sustainable environment". The vision is built on four pillars: (1) responsibility, (2) destiny, (3) knowledge and (4) prosperity[3]. For the purposes of this report we will focus on the third pillar.

In addition to building and harnessing national human capital this pillar also focuses on encouraging entrepreneurial and innovative environments. In the first instance it encourages more Emiratis to enter Higher Education and in the second instance it spurs Universities to work more closely with the private sector and thereby adapt curricula accordingly.

International collaboration is seen as greatly important: "For those industries where Emiratis can learn most from global expertise, the UAE will continue to call upon the best talent from around the world. Our nation will attract and retain the finest and most productive workers and entrepreneurs by offering them fulfilling employment and an attractive place to live".

Diversification of the UAE's economy is a major priority within the vision: "Balanced growth must be fuelled by a sustainable range of energy sources, within which the UAE will ensure an important role for alternative and renewable options such as nuclear power".

Commitment to invest in science and research & development is expressed: "We want the UAE to transform its economy into a model where growth is driven by **knowledge and innovation**. Productivity and competitiveness will come to rival the best in the world, as a result of investment in **science, technology, research and development** throughout the fabric of the UAE economy.

Innovation, research, science and technology aim to form the pillars of a knowledge-based, highly productive and competitive economy, driven by entrepreneurs in a business-friendly environment where public and private sectors form effective partnerships".

The Higher Education landscape in the United Arab Emirates is dominated by two institutions: (1) the National Research Foundation and (2) the Abu Dhabi Education Council.

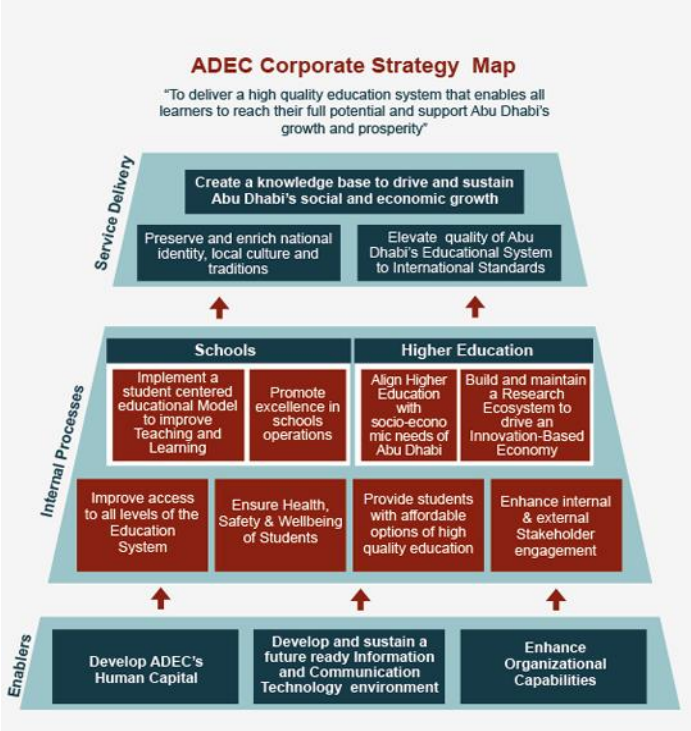
The National Research Foundation belongs to the Ministry of Higher Education and Science and Technology. It was set up in 2008 and is modelled on a foreign system (a mix of Canadian and Irish). The role of the NRF is to promote research at accredited universities. According to the NRF research priorities are: (1) Health, (2) Genetics, (3) Water, (4) Energy and (5) Nanotechnologies.

Abu Dhabi Education Council (ADEC) was established in 2005, issued by His Highness Sheikh Khalifa Bin Zayed Al-Nahyan, the UAE President. The Council seeks to develop education and educational

[3] http://www.vision2021.ae/home-page.html

institutions in the Emirate of Abu Dhabi, implement innovative educational policies, plans and programmes that aim to improve education, and support educational institutions and staff to achieve the objectives of national development in accordance with the highest international standards. ADEC is responsible for managing, guiding, adopting and implementing various educational development strategies and initiatives in Abu Dhabi. Figure 9 provides an overview of ADEC's strategy.

Figure 9: ADEC Corporate Strategy Map



UAE's strategy has achieved a number of important results, with some of the best academic records in the region as measured by scientific publications and citation indices, as well as by fostering new innovative industries. Yet, there are challenges in shaping synergy between research and innovation policies and broader policy agendas, as seen in the energy field, or in rooting some of the successes within domestic society.

Education and Research landscape: The higher education landscape in the United Arab Emirates provides a very complicated picture. Currently there are 3 federal universities (36.6% of the student population) and 71 other accredited (31 universities in free zones) institutions providing higher education. In total the UAE has 120000 students with most of the research being conducted in Abu Dhabi, which is reflected in the £660 million commitment to be spent by 2019.

Abu Dhabi:

- **Abu Dhabi University** was established in 2003 and hosts about 4300 students with 30% nationals and 70% non-Emiratis. Abu Dhabi University provides both undergraduate and postgraduate programmes, and hosts the following colleges (1) English Language Institute (ELI), (2) College of Arts & Sciences (CAS), (3) College of Business Administration (COBA) and (4) College of Engineering and Computer Sciences (CECS). While it is difficult to "grasp" the research output at ADU, commercialization is realized through two on-site spin-off companies: **(1) AccuvisBio** a global

biotechnology company with a spin-off in Abu Dhabi[4] and **(2) Norwegian Institute for Air Research**[5]

- **New York University Abu Dhabi** (**NYUAD**) is a degree-granting liberal arts and research university, located in Abu Dhabi. Together with New York University in New York and New York University in Shanghai, the portal campus acts as part of NYU's **Global Network University**. It was opened in September 2010, and is located in the downtown area of Abu Dhabi.
- **Khalifa University** (also known as Khalifa University of Science, Technology & Research, or KUSTAR) is a science-focused university located in Abu Dhabi with a satellite campus in Sharjah. Founded in 2007, the university has a student population of approximately 1300. Originally established in 1989 as the **Etisalat College of Engineering (ECE)**, the school's main campus was built in Sharjah, and aimed to supply the Emirates Telecommunications Corporation Etisalat with technology-trained workers. Research and Development centres are: (1) Aerospace Research and Innovation Centre, (2) UAE Advanced Network for Research and Education, (3) Etisalat-British Telecom Innovation Centre, (4) Khalifa Semiconductor Research Centre.
- **Higher Colleges of Technology** (HTC) was established in 1988,and is **one of the largest institutions of higher learning in the UAE** with over 18000 students. Between 2012 and 2013, 11232 female and 6855 male students enrolled at 17 campuses throughout the country. **More than 55000 UAE nationals are graduates of the institution.** HCT provides post-secondary education in business, education, engineering, technology, computer and information science, applied communications and health sciences. English is used as the medium of instruction, with faculty recruited from around the world. The HCT has formal alliances with a number of international tertiary education and training institutions, and corporate partnerships with local and multinational companies. Some programmes have international accreditation: for example, the HCT's Bachelor of Education degree was developed with, and is certified by the University of Melbourne.
- **Zayed University** established in 1998, is the newest of the three government-sponsored higher education institutions in the UAE. It is named in honour of Zayed bin Sultan Al Nahyan, the country's founder and first president. Currently, Zayed hosts 10000 students from over 19 countries. Strong science programmes at Zayed are: (1) social entrepreneurship, (2) health sciences, (3) environmental sciences and (4) sustainable development. Zayed University collaborated in a major **cybersecurity and cyberforensics project with the Abu Dhabi police force and has been developing this field of expertise since then.**
- **Masdar Institute of Science and Technology** (Masdar Institute) is a graduate level research institute, which focuses on the following areas: (1) renewable energy, (2) sustainability, and (3) environmental studies. It is located in Masdar City in Abu Dhabi. Masdar Institute is an integral part of the non-profit side of the Masdar Initiative and is the first institution to occupy Masdar City. The Technology and Development Program at the Massachusetts Institute of Technology is providing scholarly assessment and advice to Masdar Institute. Masdar Institute was established on February 25, 2007 and commenced with 170 students coming from over 32 countries. (50% of the researchers are Emiratis and 57% of the total are female). Qualified students from around the world are offered full tuition scholarship, monthly stipend, travel reimbursement, personal laptop, textbooks, and accommodation once accepted to any of Masdar Institute's programmes. Current programmes at Masdar Institute are: (1) Chemical Engineering, (2) Mechanical Engineering, (3) Material Science and Engineering, (4) Engineering Systems and Management, (5) Water and Environmental Engineering, (6) Computing & Information Science, (7) Electrical Power Engineering and (8) Microsystems Engineering. Masdar City was set up in 2006 and will be finished in 2025. **It**

[4] http://www.accuvisbio.com/index.php?option=com_content&view=article&id=28&Itemid=205&lang=en
[5] http://www.nilu.no/OmNILU/Avdelinger/NILUUAEAbuDhabi/tabid/91/language/en-GB/Default.aspx

is intended to be a home for 50000 people and 1500 businesses. Masdar has strong international research and also links to the private sector.

- The **Petroleum Institute** (PI) is an engineering university located in Sas Al Nakhl, Abu Dhabi, offering a variety of engineering degrees. PI is financed and governed by a consortium of five major oil companies: ADNOC, Royal Dutch Shell, BP, Total S.A. and Japan Oil Development Company. Research is strongly driven through the needs of on-site companies. Currently, PI hosts 150 faculty/academic staff and 400 undergraduates (13% nationals).

Dubai

- **University of Dubai** is part of the Dubai Chamber of Commerce and hosts three colleges: (1) College of Business Administration, (2) College of Information Technology and (3) Masters of Business Administration. University of Dubai currently hosts 850 students (700 undergraduates). The courses offered at UD are mostly part time and currently no PhD programmes are offered.
- **Al Ghurair University** (AGU) founded in 1999 by Al Ghurair, an industrial group active in: Foods, Commodities, Construction, Properties, Energy, Printing, Retail and Education, is a private university located in Dubai. The university offers bachelor's degrees in Business Administration, Computer Information Systems, Computer Science and Engineering, Electrical and Electronics Engineering, and Interior Design. AGIU hosts 1000 undergraduates and has three colleges: College of business studies, college of computing and school of design. No research is conducted at this university but there are strong links to the private sector. **Al Ghurair is a diversified industrial group based in Dubai with a market reach spanning more than 50 countries globally.**
- **UAE University** was established in 1976 and is the first and oldest of the three government-sponsored institutions of higher learning in the UAE (the other two are the HTC and Zayed University). The university is located in Al Ain. UAEU is an accredited comprehensive research-based institution providing research solutions to support the UAE and, through its global partners, the wider world. The university admits UAE nationals primarily, with about 15% of its student body coming predominantly from other Gulf Cooperation Council countries. In its capacity as a business school, UAEU was placed as the third best business school in Africa and the Middle East in 2010. As a **Research University the UAEU is ranked as number one in the GCC countries**, number two in the Arab World, and ninth in the entire Muslim world. UAEU is a comprehensive university with diverse undergraduate and post-graduate programmes in nine Colleges that offer a full range of degree programmes in the following colleges: (1) Business and Economics, (2) Education, (3) Engineering, (4) Food and Agriculture, (5) Humanities and Social Sciences, (6) Information Technology, (7) Law, (8) Medicine and Health Sciences and (9) Science.

4.2.3 Kuwait

Kuwait has established specialized scientific bodies, which can undertake work in the field of academic research with the ultimate aim of building up a modern Kuwait. The main scientific, technical and industrial research institutes are:

- ***Kuwait Institute for Scientific Research (KISR)***, which aims to promote scientific and applied research, particularly in matters related to industry, natural and food resources and other primary constituents of the national economy. Its main objectives are to: (1) Conduct scientific research and studies concerned with the progress of national industry and which facilitate the preservation of the environment; (2) Explore and study natural resources and the means for exploiting them, energy and water resources, and methods to improve agriculture and develop aquatic resources; (3) Render scientific, technological and research consultation services to the government and to national establishments; (4) Follow up the development of scientific and technological progress,

and adapt it in ways that conform with the local environment; (5)Establish and foster relations, and carry out mutual research with higher education institutes, and the technological and scientific sectors in Kuwait and various parts of the world.

- ***Kuwait Foundation for the Advancement of Sciences (KFAS)***. One of the foremost goals of KFAS is to promote scientific development in the State of Kuwait by supporting scientific projects, the scientific community and the country's scientific infrastructure. The major aims of KFAS are to: (1) promote social, cultural, economic and technological progress in the state by providing support to related programmes, (2) support sustainable development with positives implications on the society, (3) develop resources and skills of Kuwaiti nationals through scholarships, training, workshops, seminars and conferences, (4) facilitate cross-institutional links and collaborative programmes with international institutions for greater scientific development, (5) establish focus on education, health and environment, (6) award grants and prizes to encourage intellectual progress in the state of Kuwait and other Arab countries, (7) The Research Directorate (RD) at KFAS was established to support the advancement of science and research. The three major funding programmes of RD are: the Research Grant Programme, the Assigned Research Programme and the Kuwaiti Shareholding Companies (KSC) Programme.
- **Dasman Diabetes Institute (Research Sector):** Dasman Diabetes Institute's (DDI) **Mission Statement is** "To prevent, control and mitigate the impact of diabetes and other chronic conditions in Kuwait, through effective programs of research, training, education and health promotion and thereby improve the quality of life in the population". The current strategy is driven towards creating a vibrant scientific culture at DDI that nurtures the values of quality, integrity and excellence and leads to distinguished, internationally credible outputs. Embedded in this strategy are the dynamics of DDI mission, geared to advancing institutional potentials, calibre, and capabilities towards excellence, a mission committed to scientific advancement and realization of institutional global aspirations. The research strategy is reinforced by our collaborations with Kuwait University (KU) and Ministry of Health (MOH) that is driving the development of the Health Science Network, which will impact on local, national and international healthcare delivery and improvement. Our activities also include international collaborations with prestigious universities such Harvard Medical School, Buffalo University, University of Dundee, Forsyth institute, World Health Organization (WHO). Our research themes are aligned with our 4 domains; (i) Public Health research; (ii) Biomedical research; (iii) pediatric research and ;(iv) clinical research. Around 20 clinical trials of different phases are conducted at DDI since the year 2010. Which place DDI as one of the research centres involved in partnering with patients to improve care in the world. Currently, there are a total of 61 on-going research projects at DDI, their efforts were fruitful in publishing number of manuscripts an 105 in the past 5 years) in reputable international journals.
- **Kuwait University (Research Sector):** The Research Sector (RS) is an integral component of the Office of Vice President for Research (OVPR). Established in 1979, RS is mandated to promote, support and sustain the development of scientific research, a key pillar of Kuwait University's (KU) vision alongside academics, for advancing institutional research towards global dimensions, through quality, competence and excellence in faculty research. The fundamental basis for developing a system that renders support, facilities and environment for advanced and innovative research is inherent in this overriding purpose, encouraging faculties to pursue high quality basic, applied and humanities research that yields new knowledge and leads to discovery.
- ***Kuwait Science Club*** is a non-profit organization supported by the Ministry of Social Affairs and Labour of Kuwait, aimed at discovering, supporting and honing the talents of the youth and encouraging them to invest their time in productive scientific work. The Club receives monetary donations from KGL Holding, in line with their Corporate Citizenship programme and their commitment to supporting the club's academic endeavour and scientific undertakings especially of young scientists and members.

Kuwait has established three different types of institute that have at their disposal funds to carry out research as follows: (1) Research specialized institutes: such as Kuwait Institute for Scientific Research (KISR), (2) Higher Education institutes that perform research beside their primary tasks such as Kuwait University (KU) and Public Authority for Applied Education and Training (PAAET), (3) Funding Agencies that serve as funding bodies for research and scientific activities such as the Kuwait Foundation for the Advancement of Science (KFAS), Environmental Public Authority (EPA) and Kuwait Petroleum Company (KPC). The policy framework has suffered from internal divisions however which hampered building strategies for effective long-term capacity-building.

4.2.4 Oman

Most research conducted in Oman has been done at the behest of the government. Oman's research vision is to become the regional research hub for water, energy, downstream petrochemicals, and agro/marine biotechnology. As elaborated in the Strategic Research Plan (TRC, 2009), the areas of research are linked to areas of importance for economic and social development in the Sultanate: (1) Energy and Industry, (2) Health and Social sciences, (3) Biology and environmental resources, (4) Education and human resources, Culture, (5) Humanity & Basic science and (6) Information and Communication technologies. In addition, efforts are made to capture network effects and build clusters around areas of existing strengths marked by leading capabilities, as in the case of Enhanced Oil Recovery where the country is a leading centre for applied industrial research as well as training, engaging multinational companies such as Shell and BP while also domestic industry, including the Petroleum Development Oman (PDO) organisation. Another example is the tourism industry, which links to a scheme to improve governance of Oman's rich heritage in cultural and also environmental assets, along with a thriving and highly profitable hotel and experience industry. Most R&D activities are, however, allocated within the public and university sectors, with small contribution from the private sector overall.

It is expected that over the next 10 years R&D policies are set to further evolve to help underpin a policy that is effective in supporting Inventions, Innovation, Entrepreneurship, Commercialization & value added, through Patenting and other intellectual property rights support. ***The Research Council (TRC)*** was established in 2005 to craft a horizontally coordinated strategy in these respects, based on a mandate to adjudicate and fund research proposals in the national interest. TRC operates on the basis of a state-of-the-art strategic plan (TRC, 2009) for the coordination and development of research and innovation for the nation. Since its creation, TRC has funded over 200 projects and in doing so has speeded up the research culture and the way ahead in S&T. TRC focuses on capacity building and made it a crucial part in submitting proposals to have capacity as an essential part of the project to be accepted together with the value-added of the project. TRC bridges with all academic institutes to reduce the missing link and covers the gaps to enable a smooth process. It aims to improve means of collaboration and implementation involving the government, academia and the private sector. A range of programmes has been introduced to increase general awareness and support of S&T. Still, Oman remains plagued by public sector dominance along with a fragmented government sector and an overly academic orientation to research, which accounted for limited involvement by the private sector in research and innovation as well as in job creation thus far. The Omanisation policy aims to rectify these issues but will have to be accompanied by stronger measures to support competence development and increased productivity in the private sector.

None of Oman's universities, including **Sultan Qaboos University (SQU)** which has nine advanced research centres, thus far introduced proper institutional structures for faculty to engage effectively in research and university-industry linkages remain weak as well (UNCTAD, 2014). The sharp reduction in oil prices from 2014 hurts Oman's economy and has let to stronger pressures to enact required reforms, including to support innovation and entrepreneurship.

4.2.5 Bahrain

Considering the orientations of the economy it is not a surprise that research (especially in science and technology) was never considered as a priority nor was intensely supported as such. Bahrain's institutions of higher learning do not possess any considerable research capability and even though the University of Bahrain includes many accomplished doctoral level staff across a variety of disciplines and it maintains a traditional strength in engineering, it is not funded to carry out research. Nevertheless. There are some universities and public bodies which fund S&T.

- **Dr. Ali Bin Abdulla Al-Khalifa Research Fund:** The Late Ali Bin Abdulla Bin Khalid Al-Khalifa Research Fund is an agency for supporting medical research in the Kingdom of Bahrain. The aim is to lead the way towards health research that improves people's health and quality of life. The main research fields concentrate on prevention, diagnosis and treatment of common diseases in Bahrain such as coronary heart diseases, diabetes, hereditary blood diseases and cancer.
- **The Bahrain Medical Bulletin.** The *Bahrain Medical Bulletin* is an international independent peer-reviewed journal published by the Editorial Board of the *Bahrain Medical Bulletin*. It was first published in June 1979 and it is the second medical journal in the Arabian Gulf. The Bulletin is published four times a year and its mission is to encourage, promote and advance biomedical and health sciences and to provide a medium for local and regional high quality work to be disseminated internationally. The *Bahrain Medical Bulletin* provides individual mentoring, training, funding and awards for research and publication. Furthermore, to encourage scientific research the editors of the publication also organize biannual "Research Writing and Editing Workshops".

Bahrain is served by more than 200 primary and secondary schools including 30 private schools that offer curricula from the UK, US, France, Japan, Pakistan and India. There are a vast number of specialist colleges and universities offering courses in subjects such as finance, medicine, and IT including (1) The University of Bahrain, (2) King Abdulaziz University College of Health Sciences, (3) The Arab Gulf University, (4) Ahlia University, (5) University College of Bahrain (6) The Royal University for Women, (7) The University of London. A few prominent institutions are DePaul University, Bentley University, the Ernst & Young Training Institute, NYIT and the Birla Institute of Technology International Centre. In terms of research publications and citation indices, Bahrain performs rather weakly in regional comparison, however. Its strategic edge of a few years ago in building a leading regional hub in financial and business services has been hurt by the political turmoil of recent years and the sharp decline in oil prices are now weakening public finances. This led however to a revival in new initiatives to put in place improved conditions for research and innovation.

4.2.6 Kingdom of Saudi Arabia

The Higher Education landscape in Saudi Arabia is dominated by the **Ministry of Higher Education** but strategic decision-making on priority areas and funding allocation are driven by **King Abdulaziz City for Science and Technology (KACST)**.

Currently there are 25 government and nine private universities and sit in a wider framework with: (1) National Centre for Assessment in Higher Education **(Qiyas)**, (2) National Commission for Academic Accreditation & Assessment (**NCAAA**), (3) Higher Education Statistics Centre, (4) Saudi Centre of Research Excellence (**SCORE**) and (5) Higher Education Research Centre (**CHERS**). See further http://www.mohe.gov.sa/en/default.aspx

KACST is an independent scientific organization administratively reporting to the Prime Minister. KACST is both the Saudi Arabian national science agency and its national laboratories. KACST currently employs 2500 staff and its main responsibilities are: (1) S&T policy making (including implementation strategies), (2) monitoring and data collection, (3) coordination of S&T agencies, (4) funding of research, (5) service provision such as patenting and (6) fostering of international cooperation in S&T.

The **National Science, Technology and Innovation Plan** developed between KACST and the Ministry of Economy and Planning lists 15 strategic technologies. However, **Saudi Arabia's long-term science and technology plan 2001-2020** lead by KACST lists 12 priority areas[6].

Education and Research landscape

As you will see from the list below, the Kingdom of Saudi Arabia provides an extensive offer of Higher Education institutions. Nevertheless, 130000 students study abroad (75% male students) out of which 70000 in the USA, 15000 in the UK, 13000 in Canada, 8000 in Australia, 14000 in New Zealand. Surprisingly, only 1% of these students stay abroad while the rest return to the Kingdom of Saudi Arabia. The question, which arises here, is to what type of higher education system these graduates return? And what they do with the acquired knowledge? Consequently, what type of research exists or is being built in the Kingdom of Saudi Arabia? The following section will provide an overview of the HE system in Saudi Arabia and allow us to understand a little more about the role of research in Saudi Arabia.

- **King Saud University** (**KSU**) is a public university located in Riyadh. It was founded in 1957 by King Saud bin Abdul Aziz as **Riyadh University**, as the first university in the kingdom not dedicated to religious subjects. The university was created to meet the shortage of skilled workers in Saudi Arabia. It was renamed to King Saud University in 1982. The student body of KSU today consists of approximately 38000 students of both sexes. The female students have their own disciplinary panel. Additionally, the university boasts a centre supervising the progress of the female students, either through the **female faculty members** or through the male faculty members via a closed television network. The university offers courses in the natural sciences, the humanities, and professional studies, for which it **charges no tuition**. The medium of instruction in undergraduate programmes is English except for Arabic and Islamic subjects. King Saud University is considered the most important public university which is down to a number of reasons: (1) strong links to the Ministry of Higher Education, (2) highly interlinked with the private sector and (3) strong support programme for its academic staff. This view is shared by students, representatives of other universities as well as representatives of the NCAAA. Noteworthy are its: (1) distinguished scientific programme, (2) Institute for Nanotechnology (KAIN; in collaboration with the Max Planck Society), (3) Deanship Research Programme, (4) KSU Award for Research Excellence, (5) Distinguished scientific fellowship programme, (6) Prince Sultan Research Centre for Environment, Energy and Water. With its on-site techno park Riyadh Techno Valley KSU aims to support and realize commercialization of science and technology ideas. For further details, see: http://ksu.edu.sa/en/
- **Princess Nora Bint Abdul Rahman University** is the biggest female university globally (38500 students). Main subjects taught are: (1) business, (2) medical studies and (3) administration. Even though no real research is conducted at PNU – this institution is noteworthy due to the role it plays in the **wider context of education for women** - PNU hosts 2000 academics (166 PhD holders) in 17 Departments. In addition to providing education to its female students, PNU is currently preparing programmes in order to link up with the job market. For further information the reader is encouraged to go to http://www.pnuproject.com
- **Shaqra University** was founded in 2010 and provides bachelor programmes. Currently it hosts 18000 students (male and female) in 8 colleges. Teaching assistants and lecturers are graduates from American or British Universities. For further information the reader is encouraged to go http://www.su.edu.sa/English/Pages/default.aspx

[6] Building and Construction; Environment; Information Technologies; Water; Medical and Health; ECP; Math and Physics; Nanotechnology; Petrochemicals; Advanced Materials; Biotechnology; Energy; Space and Aeronautics; Oil and Gas

- **Majmah University** was founded in 2010, hosts 13 colleges with 9000 female and 6000 male students, and offers education in Engineering, Education and law. There are graduate programmes (masters) in Arabic and religion. For further information the reader is encouraged to go to http://www.mu.edu.sa/en
- **King Abdulaziz University** was founded in 1967in Jeddah, established initially as a private university by a group of businessmen. Its strengths are in: (1) **genetics** (Centre of Excellence in Genomic Medicine research), (2) **nanotechnology** (Centre of Nanotechnology) and (3) **osteoporosis**. The departments' strength is linked to a number of factors, such as (1) highly competitive research, (2) on-site high tech facilities, (3) collaboration with on-site hospital and (4) links to on-site incubator. The eco-system set up for its researchers is hugely impressive. However, the biggest problem KAU currently faces in addition to a lack of sufficient researchers is a lack of trained technical staff for handling high-tech instruments.
- **King Fahd University for Petroleum and Minerals** was set up in 1963 and currently hosts 2000 male students/year. (undergraduates: 5% non-Arabs and graduates: 55% non-Arabs). KFUPM is a public-sector university in Dhahran. Among Saudi universities, it is the highest regarded for excellence in its science and engineering programmes. It offers some programmes that are not offered elsewhere in Saudi Arabia, such as **industrial management.**
- **Dhahran Techno-Valley** aims to gather national and international research centres in one location. The Techno-Valley consists of five entities at the KFUPM Dhahran campus: King Abdullah Bin Abdulaziz Science Park, The Innovation Centre, Consulting Services Centre, Technology Business Incubator, and Liaison Office.
- **Faisal University** currently hosts 2000 students (Female/Male 40/60) and offers masters programmes in Business, Bio-Medical studies and Radiology imaging. Noteworthy is a programme currently being developed for female entrepreneurs.
- **Prince Sultan University** is a private university which is ranked 2nd after KAUST and currently hosts over 2000 students (male & female; graduates & undergraduates).
- **Effat University** founded in 1999 is a female-only university, which currently hosts 1800 students. Areas of strength within Effat are: (1) Biometrics, (2) Architecture, (3) Entrepreneurship, (4) ICT and (5) Islamic finance. Currently, the publication output at Effat is at 30 papers/year. Collaboration levels are currently at 10 per cent, which are aimed to reach 50 per cent.
- **King Abdullah University of Science and Technology (KAUST)** is listed as a publicresearch university located in Thuwal, Saudi Arabia, however, by-passes the decision making process within the structure of the ministry of Higher Education. KAUST was built and operated for the first three years by Saudi Aramco. **It has the second largest endowment of any university in the world,** second only to Harvard. KAUST is often referred as a new "House of Wisdom" or an "Arab MIT" by many people. KAUST was founded in 2009 and focuses **exclusively on graduate education** and research, using English as the official language of instruction. It offers programmes in **Biological and Environmental Sciences and Engineering; Computer, Electrical, and Mathematical Sciences and Engineering; and Physical Sciences and Engineering**. KAUST's core campus, located on the Red Sea at Thuwal, is sited on more than 36 square kilometres (14 square miles), encompassing a marine sanctuary and research facility. KAUST was Saudi Arabia's first LEED certified project and is the world's largest LEED Platinum campus. Designed by the international architecture firm HOK, it was also chosen by the American Institute of Architects (AIA) Committee on the Environment (COTE) as one of the 2010 Top Ten Green Projects. For more detailed information, the reader is advised to go to following link http://www.kaust.edu.sa Current international collaborations are with the US, UK and Germany. KAUST is considered immensely productive with 1000 publications since its opening (2009).
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- KAUST Industry Collaboration Program (KICP) is the industry's gateway to KAUST. It provides the resources to ensure breadth of access to and awareness of all KAUST Research, latest technologies, talent pool, seminars, symposia and other scientific events. KICP is a membership-based programme with the aim of fostering strong and productive partnerships with industry, generating value for both KAUST and KICP partners. **KICP Value Proposition: (1)** Builds, nurtures, and manages industry relationships with KAUST and maximizing the value of industry-KAUST partnerships, (2) Acts as the interface between industry and KAUST and helps align industry partners' R&D needs with the needs and capabilities of KAUST, (3) Serves as a link between industry and Economic Development programmes that include the Technology Transfer and Innovation, Research Park and Innovation Cluster, Seed Fund programme, New Ventures, and the Entrepreneurship Centre, (4) Serves as an interface between industry and KAUST's Research Enterprise including faculty, Research Centres, and KAUST's academic partners, (5) Facilitate partners' sponsored research agreements with the Office of Research Services (ORS), (6) Provides an ideal platform for recruitment of KAUST students and graduates for internships and job placements respectively and (7) Links industry with the KAUST's University Development for donations and sponsorships. KAUST regionally collaborates with Oman, Kuwait, Qatar and Egypt and nationally with KPFUM and King Abdulaziz Jeddah.

Saudi Arabia's ambitious investments in new universities and linking up with leading research institutions in other parts of the world have led to impressive results in terms of scientific research publications, citation indices, etc. At the same time, the country meets with severe challenges in linking research and innovation with broader society. Some investments in attracting foreign researchers failed to produce sustainable results. The country remains excessively dependent on hydrocarbon exports and its public sector is dominating the economy and the labour market. With the collapse in oil prices has left Saudi Arabia financially vulnerable given its particularly low level of economic diversification. This has led to a range of new initiatives in the last years to boost new industries, for which research and innovation are greatly important. Yet, the decline in government revenue has led to reduce expenses in these areas as well, which increases the need for increased efficiency in investment and complementary measures to enhanced productivity.

4.3 Various key issues shaping the rules

As is clear from these country reviews, each of the GCC states has undertaken considerable reforms over the last decade to build a genuine capacity in research and innovation, along wide the expansion of its education sector and in support of building a more diversified economy.

Each of them has demonstrated significant results and these countries now enjoy a massively enhanced standard of living and diverse supply of public services, well beyond what was the situation some years back. Yet, despite the enhanced academic performance, innovation and industry engagement in the innovation system remain weak, with the partial exception of the UAE. Each of these countries meet with lingering key issues and challenges to improve innovation linkages and build more favourable playing rules for competence development and broad stakeholder engagement (UNESCO, 2016). Their innovation systems are marked by serious mismatches, such as a typical bias towards public sector development, extensive education efforts in domains where private sector demand is low, and a mismatch between the skills of graduates and the needs of employers.

Other key areas in need of continued reforms, at the heart of the innovation system, include mechanisms for funding research and innovation, a lack of critical mass in research capacity coupled with an absence of applied research including in industry, limited autonomy which hinders the ability of universities to adapt to local demands. In addition, mechanisms for ensuring institutional

accountability, certification and evaluation are slow in developing. Linked to much of this is a governance framework which is mostly top-down, weak on addressing horizontal linkages and reliant on “own” efforts and overly unilateral linkages with the rest of the world. This means that each of the GCC countries is capable of experimenting and developing policy responses that meet with their specific needs while, on the other hand, they largely forego synergies from collaborating with and learning together with their neighbouring countries in the GCC.

5. GCC-EU Cooperation on Research and Innovation: State of Play

5.1 European RTD activities: H2020

The European Union is a world leader in research and innovation, responsible for 24 per cent of world expenditure on research, 32 per cent of high-impact publications and 32 per cent of patent applications, while representing only 7 per cent of the world population. Over recent decades the world landscape of research and innovation has evolved rapidly, with emerging economies strengthening their research and innovation systems. The number of scientific publications has increased significantly, yet the European Union has maintained its proportional share of the number of scientific publications.

EU leaders believe strongly that research and innovation will create the economic opportunities of tomorrow: research and innovation have been placed at the centre of the EU budget for the programming period between 2014-2020.

H2020, the new framework programme funded by the European Union for research and innovation 2014-2020, is designed to address these societal challenges through funding excellent science, technology and innovation. The Programme is central to the Europe 2020 strategy for smart, sustainable and inclusive growth, the Innovation Union flagship to create a knowledge society, and the goal to complete the European Research Area as a single market for knowledge.

H2020 allows seamless funding (almost 80 billion euros over the seven years) of research and innovation, so that innovative projects can be supported from the laboratory to commercial exploitation. All forms of innovation are funded, including innovation in services and social innovation. H2020 aims to include the best researchers and innovators regardless of where they are located: it is open to participation by researchers from anywhere in the world. H2020 is focused on three pillars: excellent science, industrial leadership and societal challenges - all of which are open for international participation.

This first pillar includes several activities aimed at **individual researchers** of any nationality – offering very interesting opportunities to spend part of their research career in Europe.

- The **European Research Council** offers generous and flexible grants for researchers, from anywhere in the world, to establish research groups in Europe. The grants support investigator driven, "frontier" research in any scientific discipline and there is only one criterion; excellence.
- The **Marie Sklodowska Curie actions** support the career development and training of researchers in all scientific disciplines, through transnational, intersectional and interdisciplinary mobility. Grants for all stages of researchers' careers are available. The MSCA will be the main EU programme for doctoral training, funding 25000 PhDs.

The second pillar includes the so-called **Key enabling technologies** - such as advanced manufacturing, microelectronics, nanotechnology and biotechnology - underpin innovation across many industries and sectors. Innovative companies are at the heart of job creation and growth:

- Strategic investments in key technologies (e.g. advanced manufacturing, micro-electronics) underpin innovation across existing and emerging sectors;
- Like every other world region, Europe wants to attract more private investment in research and innovation;

- Like every other world region, Europe wants more innovative small and medium-sized enterprises (SMEs) to create growth and jobs.

Collaborative research proposals are invited from **consortia** of research organisations, which may also include international partners.

The third pillar is the part of H2020 that also in financial terms, aims to address, major challenges and concerns of citizens and society through collaborative research and innovation. For example, reducing CO_2 emissions depends on new technologies and solutions for energy, transport, agriculture and the management of resources; such challenges are shared by all countries across the globe. The challenges require a broad, multi-disciplinary approach that brings together researchers, industry, public bodies and users to create innovative solutions that will meet peoples' needs. Horizon 2020 will support not only research into new technologies and solutions, but also their piloting, demonstration and market uptake: in this way the full impact of EU funding will be achieved.

A New International Strategy

The European Commission's approach to international cooperation has been set out in a Communication in 2012 entitled "*Enhancing and focusing EU international cooperation in research and innovation: a strategic approach".* The general openness of Horizon 2020 to the participation of researchers from public and private organisations from across the world is part of this approach. International Cooperation is therefore mainstreamed across Horizon 2020 to tackle global challenges, promote mobility of researchers and boost the competitiveness of industries as it brings these benefits to all partners – be they in Europe or elsewhere in the world. In fact, International cooperation is necessary to address effectively many specific objectives defined in Horizon 2020, this is the case in particular for all the societal challenges, which need to be tackled at global level. International cooperation is also essential for frontier and basic research in order to capture the benefits from emerging science and technology opportunities. Promoting the international mobility of researchers and innovators is crucial for enhancing this global cooperation. Activities at the international level are equally important to enhance the competitiveness of industries by promoting the take-up and trade of novel technologies, for instance through the development of worldwide standards and guidelines. All of H2020 is open to international cooperation. Any consortium on any topic mentioned can include an international partner. This is what is called a "General Opening". It is completely bottom up and requires only that project coordinators include international partners when preparing their consortium.

In addition to this general opening, there is the so-called "targeted opening" – on topics, which are pre-identified in the Work Programmes as encouraging or requiring international partners. These topics usually arise out of the dialogues we have with our main international partners. With certain partner countries, coordinated calls for proposals can be jointly agreed and the partners funded separately be each side: the topics for coordinated calls, which bring mutual benefit, are always agreed in the policy dialogues we have with the partner country.

5.2 GCC RTD activities: The Qatar National Research Fund (QNRF) example

Established in 2006, QNRF is a funding agency that aims to foster original, competitively selected research in areas of Qatar's national interest. QNRF enables research and development excellence in Qatar to achieve a knowledge based economy. QNRF supports and promotes advance knowledge and education by providing funding opportunities for original, competitively selected R&D at all levels and cross all disciplines, with emphasis on the four pillars of Qatar National Research Strategy (QNRS).

The strategic objectives of QNRF are:

- To fund research projects of national interest to Qatar
- To build research culture, human capital and infrastructure in Qatar
- To raise Qatar's international profile in research
- To build QNRF's internal management capabilities

QNRF international cooperation objectives are as follows:

- Establishment of a world-class funding organization – adopt and adapt global best practices
- Accelerate opportunities for cooperative international research, education, training
- Stimulate and accelerate R&D through diversification and collaboration
- Raise Qatar's international profile, expand and leverage non-QNRF funding
- Attract top researchers worldwide.

Qatar National Research Fund (QNRF) has developed over the past 10 years into an organization and it has become a change agent for research in Qatar and the MENA region. QNRF's vision is to "…enable research and development excellence in Qatar to achieve a knowledge based economy. It strives to achieve its goals and objectives by supporting original, competitively selected research submitted by scientists at all levels from high school students to well established scientists coming from academic, government and non-government sectors addressing all fields of sciences that align well with the four pillars of Qatar National Research Strategy (QNRS)".

To this end, QNRF has launched many research funding programs and activities and has received more than 8000 proposals of which more than 2000 were funded. Among these funding programs, is QNRF's flagship program the National Priorities Research Program (NPRP) which has been an unequivocal success, attracting researchers of the highest caliber from all around the world to submit proposals in collaborations with researchers in Qatar under some strict conditions that a minimum of 50% of the research efforts should be conducted inside Qatar and not more than 35% of the funds should be expended outside Qatar. Through the NPRP model QNRF gave a good exposure to the Qatari Key Investigators (KIs).

Contrary to what is happing in most of the countries in the MENA region, QNRF has managed to establish a research culture in Qatar and put in place well established policies and procedures. Thus QNRF is posing itself as a good role model for other countries in the region. As a measure of its success, the quality and quantity of publications have witnessed a huge surge, which was one of the main drivers for QU to enter the QS of the 500 top University Ranking. Also TAMUQ was selected as the top ranked university in publications as a result of a study conducted by Elsevier. In addition to the previous KPIs, the number of KIs, post docs, and graduate students are on the rise every year.

In an effort to develop a system to assess the societal and commercial impact of its research, QNRF opted to utilize the concepts of accountability and advocacy to showcase the value of research.

5.3 Inter-institutional collaboration: QNRF – European Commission

Following these recent developments in the Qatari research ecosystem and the outward looking approach that has been adopted, Qatar National Research Fund and the European Commission (DG RTD) have kick started a process to explore the possibility for further cooperation in R&I with specific focus on two key future technologies:

- Carbon capture and storage and carbon reuse
- Concentrated solar technologies

To this end, a dedicated workshop was organised in Doha, February 2016 with the participation of key stakeholders from the policy-making, research, and business communities. The aim of the workshop was to:

- present the current research programmes and large projects both in the EU, through its Framework Programme for Research and Innovation - Horizon 2020, and in the GCC countries
- present current R&D roadmaps and projects in the EU and the GCC
- identify common fields of research between European scientific communities and the GCC
- identify research collaboration models between EU and GCC countries

During the deliberations research topics were identified by the invited experts as of mutual interest for both regions with a potential for further research collaboration. For both key technologies the point of taking advantage of the particularities of the local environmental conditions (e.g. solar heat and PVs) was highlighted.

The participants also had the opportunity to discuss overarching issues that need to be taken into consideration when assessing the level of research cooperation between the EU and GCC, and when exploring ways to enhance and promote it further. The following points were highlighted:

- There is a need for a stronger political will for cooperation between the two regions that could include policy-making, economic, and legislative (including IPR) regulatory measures, as well as the creation of specific incentive mechanisms for further cooperation. To this end, the already existing general EU-GCC cooperation framework could be a good starting point.
- The culmination of such political efforts could be the launching of a dedicated “co-funding” mechanism, starting with the financial support of pilot research initiatives and moving in the long run towards funding of larger scale projects. The already established H2020 funding programme could be used as a starting point for this.
- There is a strong need to promote researcher mobility programmes in order to share knowledge and best practices (at post-grad, PhD, and post-doc levels)
- Capacity building is of paramount importance especially for the GCC region and can be achieved through various events such as training seminars, summer schools, etc.
- There is also a strong need to maintain a bi-regional EU-GCC research collaboration platform that will address the aforementioned issues in a concrete and realistic way. The INCONET initiative has been an example of such a structure, but further political support would be needed in order to deepen its impact.

6. Whitepaper and SWOT Analysis

6.1 Introduction

Based on a SWOT analysis for INCONET-GCC 2 substantive focus (Personalised Healthcare and Smart cities), a white paper for future research activities is to be elaborated. This includes policy recommendations (developed later in the present chapter) to the EC, the GCC and the national regulatory and funding authorities in order to enhance bi-regional cooperation on strategic cooperation domains related to the above mentioned focus. An ensuing roadmap should afterward be proposed to support and coordinate the strategic research and innovation cooperation agenda between the EU and the GCC.

The present SWOT analysis (SWOT standing for Strengths, Weaknesses, Opportunities and Threats) tries to answer the following questions:

Strengths: What is working in the Personalised Healthcare and Smart City Research and Innovation cooperation between the EU and GCC regions? What unique resources can such cooperation draw on? What do its diverse stakeholders see as its strengths? What policy factors are associated with these strengths?

Weaknesses: What could be improved in the Research and Innovation cooperation between the EU and GCC regions? Where does EU cooperation have fewer resources than other regional or international initiatives? What are the sources of these weaknesses? What institutional reorganization is necessary to alleviate weaknesses?

Opportunities: What opportunities are open to the Research and Innovation cooperation between the EU and GCC regions? What trends could it take advantage of? How can we turn EU-GCC cooperation strengths into opportunities? Where or how can both sides realize these opportunities? What institutional reorganization is necessary to better address these opportunities?

Threats: What threats could harm the Research and Innovation cooperation between the EU and GCC regions? What alternatives are offered by cooperating with other regions than the EU? What threats do these weaknesses expose the EU-GCC cooperation to? What policy-related interventions are required to address these threats?

A P. E. S. T. Analysis (P. E. S. T. stands for Political, Economic, Socio-cultural and Technological) has also been applied to describe different PEST factors or changes in Health or Smart cities focus areas, in order to identify concrete cooperation opportunities and carve a sustainable strategic niche in these broad areas.

Furthermore, a Porter's Five Forces Analysis was used as a way of assessing the balance of power (strengths and Threats) in the general context of the Smart City and Healthcare domains (market) of the GCC countries; this helped determine some related threats to the development of EU-GCC cooperation in these topics.

6.2 SWOT Analysis

6.2.1 SWOT Analysis for Smart Cities

Strengths	Weaknesses
○ Knowledge-sharing and cooperation already exist between EU and GCC Cities – Dubai Design District with Barcelona, Madrid and Amsterdam	○ Dominance of ICT corporations - mainly US - over public institutions in R&D initiatives → European multinational ICT companies have little presence compared to US → This affects (lowers) the

– and between EU and GCC companies – Nokia and Zain in Jeddah. ○ EU cooperation offers access to a pool of multiple and diverse case studies (UK, Spain, France, The Netherlands). ○ Multiplicity of successful Smart Cities experiments in different cities in EU: platform development, eservices, transportation (ITS infrastructure), sustainable energy, and foresight studies. ○ European mature eGovernment practices with open platforms and transferable quality standards. ○ European model is built around strong linkages amongst multiple stakeholders – public institutions, universities, private service providers, and general public. ○ Regionally-integrated energy systems and Smart Grid. ○ Mobility and Access to Networks.	number and importance of GCC institutions that (already/would) buy into EU-GCC cooperation. ○ Complexity of stakeholders – e.g. municipalities; service providers; NGOs; ○ Private vs. public partnerships. ○ Roles and responsibilities are unclear. ○ Engagement and consensus is hard to obtain (Business models vs. governmental management). ○ Financing: ○ GCC government now under strict budget control due to low energy prices. ○ R&D Funding within Horizon 2020 is unclear/disadvantageous so no incentive regarding GCC countries. Too difficult to fill ○ Cost-benefit analysis to test and validate the impact of Smart Cities practices are non-existing → Return on Investment is unproven.
Opportunities	**Threats**
○ eGovernment (eservices, applications, platforms) ○ **P-** Policies are being implemented across the GCC – Bahrain, Dubai, Qatar – driven by a high level of conviction and a vast range of expected benefits: ○ **T-** GCC countries have some of the world's largest levels of investments in infrastructures and equipment in connected devices (source: Global competitive index; Global innovation index) → Easy access to services; opportunities for business model innovation based on mobility technologies. ○ Urban development (strategic integration between land use and transportation in GCC cities). ○ **E-** Intelligent Transportation System (communication and security platform) – e.g. cost of congestion and traffic= AED 19.5bn annually for UAE (3.5% of GDP). ○ **S-** Multimodal transportation (metro and light rail). ○ **T-** City planning and design. ○ Sustainable energy (Smart Grid, Smart Buildings) ○ **P-** Policies are being implemented across the GCC. ○ **E-** Energy Efficiency and cost savings. ○ **S-** Growing population in need of water and electricity. ○ Safety and Security: ○ **P-** Cyber security and surveillance.	○ Competitive rivalry: ○ **E-** High competition from Asian and American Smart Cities models. ○ **P and S**- GCC cities compete to attract investors and boost global rankings and reputation. This may lead to low loyalty to cooperating partners. ○ Threat of new entry: ○ **T-** Infrastructure providers own the standards and can block new entrants. ○ Buyer power - Scale and demography in the GCC countries: ○ small number of large-scale cities in the GCC. ○ Limited number of cities that can buy into a large-scale Smart City cooperation – for instance: Riyadh, the most populated city in the GCC is only 45th globally. ○ International mobility of city residents → Changing population → So "**Predictability**" is poor when it comes to impact people life-styles → FOCUS on INFRASTRUCTURE. ○ Threat of substitution: ○ **E-** EU cooperation is challenged by US multinational ICT companies. ○ **T-** Fragmentation of GCC countries power grid → multiple technical challenges. ○ eGovernment and National Security: ○ **P-** Centralized (government) control and ownership of data can conflict with the open-source ethics of Smart Cities. This may trigger GCC governments' resistance to the adoption of certain Smart Cities practices, as they

○ **P-** Centralization and control of data. ○ **S-** Transient population (Dubai airport) and crowd management during mass events (Hajj, Dubai Expo 2020, Qatar World Cup 2022) . ○ **T-** Identity verification. ○ Capabilities and Capacity (adapting solutions to local needs): ○ **E-** Need for future employment opportunities. ○ **S-** Transition to a Digital Economy. ○ **T-** Design Thinking methodology helps translate data into better experiences. ○ **T-** Business model innovation and applied research (this is in harmony with **H2020 key pillars**: Excellent Science and Industrial leadership).	would naturally accelerate social and political reforms (Smart Cities technologies infer open data, distributed intelligence and therefore distributed power). ○ Capabilities and Capacity (adapting solutions to local needs): ○ **S-** Preference for turn-key solutions over building Human Capital. ○ **S-** Overreliance on foreign talents and poor retention. ○ Economic model is uncertain: ○ **E-** How will the benefits of Smart Cities be shared amongst the different partners of the eco-system?

6.2.2 SWOT Analysis for Personalised Healthcare

Strengths	Weaknesses
Resourcefulness and adaptability of EU e-Health initiatives and experiences: ○ EU-GCC cooperation offers access to EC instruments that make e-Health a reality, through a pool of multiple and diverse R&D projects (….many…), POLICY measures (…guidelines, regulations, directives…), and Support for deployment initiatives (….CIP, ICT, PSP…); Development of platforms and e-services, etc. ○ **e-Health** initiatives in the EU countries have proven to be valuable tools to **improve** healthcare **services** and also **reduce costs** (e.g.: the EU initiative **e-Prescription Systems epSOS)**. ○ Close collaboration amongst EU stakeholders helped advance **guidelines** which facilitates better rational health treatment based on individual health data. **Importance of e-Health technology - the use of Information and Communication Technologies (ICT) for the health systems:** ○ **P and S-** Possible **public health monitoring** ○ **P -** Improved **adherence to health regulations** (e.g. through monitoring of the overall prescription process ○ **P-** Better **health statistics** and analytical reports at national and regional level ○ **T-** e-Health forms the underpinning **base for Personalised Medicine**, which is a valuable healthcare approach - a paradigm shift from hospital-based to patient-centred healthcare	**Awareness and competitiveness** ○ European commission e-Health research tools are not the only/preferred partnership initiatives that come to mind of the GCC decision makers (e.g. Mubadala Healthcare Networks) → This affects the number and importance of GCC institutions that would embrace into EU-GCC cooperation. **Financing:** ○ R&D Funding within Horizon 2020 is unclear regarding EU-GCC cooperation activities. ○ Personalised Healthcare initiatives are expensive, within restricted government budgets. **Complexity of Stakeholders:** ○ Complex ecosystem of stakeholders: health insurance companies; healthcare providers; governments; educational institutions and general public. ○ Roles and responsibilities are unclear between and within GCC institutions. ○ Engagement and consensus are hard to obtain for multi-stakeholders research processes that are needed to develop Personalised Healthcare plans. ○ Public versus private healthcare providers. **Scientific Barriers:** ○ **P-** Incomplete national and regional health data and statistics across the GCC countries to support research. ○ **S-** Uneven awareness and lack of knowledge on added value of Personalised Healthcare domains and settings.

delivery - to treating and supporting patients with **Non Communicable Diseases** (NCDs).

Personalised Medicine in the EU initiatives

- Personalised Medicine (PM) or Personalised Care (PC) research in the **Research Programmes** of the European Union include: FP7 programme's Enabling Personalized Medicine; The Innovative Medicines Initiative (IMI); Horizon 2020 (2014-2020) Societal Challenges-health and Societal Challenges-food programmes).
- FP7- Health Programme
- Since 2007 the EU has committed over €1 billion of health research funding underpinning the development of personalised medicine (PM).
- Some 100 projects funded under the Health programme and 55 under ICT enabling PM. Main projects relate to Diabetes and cardiovascular diseases (e.g. DEXLIFE: Diet Exercise and Life; REACTION: Remote accessibility to Diabetes Management and therapy in operational healthcare networks.
- The Innovative Medicines Initiative (IMI) programme dedicated to pre-competitive biopharmaceutical research on the safety and efficacy of medicines as well as knowledge management, and education and training: Total budget for IMI 2 is €3,276 billion (2014-2024) → The EU contributes up to €1,638 billion from Horizon 2020.
- The objective of IMI projects is the development of personalised medicine approaches through the use and development of -omics technologies.
- IMI DIABETES PLATFORM IMIDIA: One of the world's leading initiatives in this area, focus on overcoming key bottlenecks for novel therapies and improve disease management.
- Personalised Medicine in H2020 - Societal Challenges - Health Programme is based on the FP7 Health Programme, but includes ICT for Health and focuses on market-driven type projects; the objective being to implement PM in healthcare settings.

EU initiatives on Personalised Medicine (Personalised Healthcare) for Non Communicable Diseases offer good opportunities for cooperation and learning:

- **H2020 Societal Challenges Personalised Medicine** Projects address obesity, type 2 diabetes, or cardio-vascular diseases: e.g. FEEL4DIABETES: Healthy Lifestyle 4 Diabetes prevention;
- **P-** Misaligned research objectives specific to PM may exist between EU and GCC institutions*.
- **T-** Gap of R&D skills and capacity in Life Sciences between EU and GCC institutions.
- Lack of linkages between Research and Industry in the GCC countries.

Personalised Medicine still needs to overcome barriers:

From basic research to **Personalized Medicine** (PM) and treatment (i.e. in translating basic research into patient-centred healthcare delivery) there exist multiple scientific, R&D (clinical relevant information, or more advanced, Clinical Decision Support System), operational, educational, economic, and regulatory (privacy, discrimination, insurance) barriers that still need to be overcome even in the EU countries (Horgan et all 2014).

○ **H2020 Societal Challenges Food Security** Programme addresses obesity Epidemic.	
Opportunities	**Threats**
○ **P-** EU-GCC Cooperation on e-Health is in harmony with the WHO Global NCD Action Plan 2013-2020 on the prevention and control of NCDs; this protocol (convention) unites governments and international partners around a common agenda, namely to reduce the preventable and avoidable burden of morbidity, mortality and disability due to NCDs by means of multi-sectoral collaboration and cooperation at national, regional and global level. ○ **S-** GCC governments **need** to address the NCDs epidemic**:** ○ **P and S**- **Need** to strengthen and orient health systems to prevent and control non-communicable diseases (NCDs) and the underlying social determinants through people-centred primary health care (An action compliant with 2011 UN resolution A/RES/66/2). ○ **T**- **Need** for the surveillance of the NCDs through the monitoring of their prevalence (→ this will help to evaluate progress of **NCDs and assess the impact of policies**. ○ **Strengthening Governance and Leadership: e-government initiatives for Public Health**. ○ **T-** Gather all relevant patient information, health and biomedical data (including genetic profiles), as this is a must-do activity (a required infrastructure/a prerequisite) to later implement **personalized medicine (PM)** and optimize the healthcare delivery system, especially for NCDs → RECO: **Electronic Health Records**. ○ **P and T**- Need for centralized **guidelines** and legislation for data collection, storage and sharing (integration), and to ensure quality, privacy and safety of information. →Opportunity for adapting the EU initiatives on **Patients' Electronic Health Records** to the GCC countries (EU **e-Health Governance Initiatives: epSOS, EXPAND eHGI**). ○ **Widespread Obesity epidemic in the GCC countries:** Obesity is an increasingly widespread ailment that represents a **predisposing (risk) factor to developing chronic NCDs**. ○ **S-** Need to tackle Obesity epidemic in the GCC → Action is required to improve public health	**P and E –Complexity of Governance and Planning:** ○ e-Health is a complex large scale policy programme. ○ Change in healthcare delivery will be hard to realise in the current systems. ○ Technical Challenges: information protection, privacy and security. ○ **Competitive rivalry:** ○ **E-** Existing public-private partnerships with international medical institutions: e.g. Abu Dhabi's Mubadala Healthcare Networks ○ **P-** Complex and fragmented Health policies and institutional stakeholders within each GCC country (especially in the UAE). ○ Fragmented activities, insufficient communication and lack of commonly accepted solutions and standards. So, the implementation of Personalized Medicine is a major challenge in each GCC. ○ **Buyer power:** ○ **E-** Financial benefits of GCC healthcare providers are made of three populations with different economic profiles/lifecycles – nationals, expatriates and tourists – hence require different healthcare settings. ○ Resources and Capital are unevenly available across the GCC countries. ○ **Threat of substitution:** ○ **P, E**- Health systems in the GCC countries are made of competitive private healthcare providers who own and control health data, which is a challenge for the widespread adoption of centralized e-Health systems. ○ **Economic model is uncertain:** ○ **E, T-** The identification of biomarkers is essential for Personalised Medicine, but the research process of discovery, validation and clinical qualification of biomarkers is costly, slow and uncertain. Therefore, there's a risk that Personalised Medicine increases the cost of treatment without increasing positive health outcomes. ○ **E, T**-Insurance companies are reluctant to reimburse biomarker tests and treatment (CDx) because positive health outcomes are unproven. ○ Modifying the reimbursement policies of the health insurance industry will be hard, which questions the funding model for research in Personalised Medicine.

awareness, knowledge and education, to empower population (RECO: e-health application and platforms; Food programmes, mobility, Exercise) ○ **Introducing new modes of healthcare delivery and planning through e-Health:** ○ **PEST - Mobilizing the potential of information technology for the benefit of healthcare systems' efficiency and cost:** [The GCC countries have some of the world's largest levels of investments in infrastructures and equipment in connected devices (source: Global competitive index- Global innovation index)]. ○ **T-Access to ICT networks, equipment and facilities**] (**+) S -Increased mobility** of people (patients) in the GCC (adapting solutions to mobility needs) **(+) S -** Expectations for and affordability for **high quality healthcare in the GCC:** →**T-** e-Health systems can deliver Personalised/Targeted care. →**T-** Possibility for easy access to e-services and e-health platforms. →**T**- Possibility of developing Mobile Health applications. →**E-** ICT applications can create opportunities for business model innovation. ○ **S- Urban development:** →**T, S-** Smart Cities initiative in the GCC. a) City planning and infrastructure that minimize (mitigate) exposure to risk factors, promote/enhance mobility and physical exercise. →**T-** Sensor-based and predictive technologies can help governmental authorities anticipate the public safety – e.g. air quality and chronic respiratory diseases (like asthma). ○ **Promote National Capacity in the GCC countries:** ○ **E and S**- Transition to knowledge economy →New knowledge, expertise and skills for future employment opportunities → Research and Professional training: → T - Patients' data: →**guidelines** on data discovery, interpretation, and quality assurance; → P- Need for guidelines on Information stage, sharing, privacy and safety. ○ **Health Market in the GCC:**	○ **Education and Skills Challenges: execution and requisite skills:** ○ **S-** Preference for turn-key solutions over long term building of Human Capital ○ **S-** Limited Research and Development capacity ○ **S-** Healthcare professionals should be able to implement PM so healthcare could become more individualized, however shortage of healthcare professionals and limited medical education institutions. ○ **S-** Overreliance on foreign talents and poor retention/staff shortage.

○ Business intelligence of international consulting companies has recently increased awareness of the GCC authorities about the e-Health paradigms.	

6.3 INCONET-GCC2 POLICY RECOMMENDATIONS

6.3.1 Methodology

Scoping and Success Criteria

To help translate the SWOT analyses for the two INCONET-GCC2 Substantive Focus areas – Personalised Healthcare for NCDs and Smart Cities – into concrete policy objectives, programmes and solutions for future EU-GCC cooperation in STI, we initially considered the following scopes:

1) Core scope – these are possible STI Cooperation policies and activities of interest that are definitely under the purpose of INCONET-GCC2.
2) In scope – these are possible STI Cooperation policies and activities that deserve interest and may fall under the INCONET-GCC2 purpose.
3) Out of scope – these are possible STI Cooperation policies and activities that may be of general interest, but do not fall under the INCONET-GCC2 purpose (mutual understanding and collaboration on research and innovation).

The map of our scope is defined by a grid made of two dimensions and six variables:

- First dimension is the **type of EU-GCC relationship**: peer-to-peer partnership; transactional relationship; competitive relationship.
- Second dimension is the **type of goals pursued**: EU-only goals; EU-GCC common goals; GCC-only goals.

Scoping Map			
	In the pursuit of EU-only goals	**In the pursuit of common EU-GCC goals**	**In the pursuit of GCC-only goals**
Peer-to-peer partnership	Out of scope (GCC altruism)	Core scope (mutual activities)	Out of scope (EU altruism)
Transactional relationship (buyer-to-seller relationship)	Out of scope (market-based activities)	In scope (win-win activities)	Out of scope (market-based activities)
Competitive relationship	Out of scope (market-based activities)	Out of scope (Competitive activities)	Out of scope (market-based activities)

The "**Core scope**" of INCONET-GCC2 only includes STI Cooperation Policy Recommendations that respect an equal "**Peer-to-peer partnership**" between EU and GCC institutions, and that are "**In pursuit of common EU-GCC goals**".

We also considered "**In scope**" (even though not core) recommendations that are based on a "**Transactional relationship"**, provided that they are "**In pursuit of common EU-GCC goals**".

In addition to these scoping variables, we introduced "**Success Criteria**" to assess the sustainability and scale of our recommendations. In particular, these criteria are "**Building an enabling institutional**

framework" and "**Regional scale**". Hence, our Policy Recommendations for INCONET-GCC2 STI Cooperation were selected based on four **Factors (two scoping variables and two success criteria)**:

- Core Scope (Peer-to-peer relationship in the pursuit of common EU-GCC goals);
- In Scope (Transactional Relationship in the pursuit of common EU-GCC goals);
- Building an enabling institutional framework;
- Regional scale.

Objectives, Programmes and Solutions

Based on the above, the items of the SWOT analyses have been reviewed and sorted in order to produce holistic Policy Recommendations with their Objectives, Programmes, and Solutions - each Policy Objective being supported by different Programmes, each of which supported by specific Solutions.

6.3.2 Policy Recommendations for EU-GCC Cooperation on Smart Cities (SC)

Overall, this Whitepaper recommends four **Policy Recommendations** for future STI Cooperation related to Smart Cities, with the following **Objectives**:

SC - Objectives			
Create now the jobs of the future by embracing the Digital Economy	Leverage Big Data management to improve governance and public decision-making	Use data to protect public safety and security in all circumstances, including during international mass events	Guide urban development to maximize residents' quality of life

In the following tables, we detail the specific **Programmes** and **Solutions** that support the **Objective** of each **Policy Recommendation**.

SC - Policy Recommendation 1				
Objective	**Create now the jobs of the future by embracing the Digital Economy**			
Programmes	Translate Data into User Experiences (apps) using Design Thinking		Build new capabilities and capacities	Accelerate investments and outputs of Applied Research
Solutions	Clarify the economic model for Smart City apps	Educate youth on Business model innovation using mobile technology	Create joint Research and Innovation centres within GCC and EU universities	Leverage EU university branches in GCC to formalize Research and Innovation cooperation aims

SC - Policy Recommendation 2	
Objective	**Leverage Big Data management to improve governance and public decision-making**

Programmes	Build a national/regional platform to house all eGovernment data			Develop and implement data control policies		Develop and implement cyber security policies	
Solutions	Encourage and facilitate eGovern-ment initiatives	Invest in IT infrastructure for future needs	Align standards across all eGovernment initiatives	Review and upgrade data ownership regulations	Review and upgrade data privacy regulation	Review and upgrade data protection regulations	Review and upgrade surveillance regulations

SC - Policy Recommendation 3			
Objective	**Use data to protect public safety and security in all circumstances, including during international mass events**		
Programmes	Develop and implement programmes that support public safety and security at annual Hajj	Develop and implement programmes that support public safety and security at annual Qatar 2022 FIFA World Cup	Develop and implement programmes that support public safety and security at Dubai 2020 World Expo
Solutions	Encourage and facilitate crowd management solutions		
	Encourage and facilitate identity verification solutions		

SC - Policy Recommendation 4					
Objective	**Guide urban development to maximize residents' quality of life**				
Programmes	Support Intelligent Transport Systems	Support Energy efficiencies and Smart Grid	Support Water management	Support Waste management	Support Public safety
Solutions	Encourage and facilitate multimodal public transportation solutions	Analyze behaviours and needs of the national population			
		Analyze behaviours and needs of the transient population			

6.3.3 Policy Recommendations for EU-GCC Cooperation on Personalised Healthcare for Non-communicable Diseases (PHC-NCD)

Overall, this Whitepaper makes two **Policy Recommendations** for future STI Cooperation related to Personalised Healthcare for non-communicable diseases, with the following **Objectives:**

PHC-NCD Objectives	
Promote lifestyles that prevent NCDs	Foster efficient National Health services that improve chronic care of NCD patients

In the following tables, we detail the specific Programmes and Solutions that support each Policy Recommendation:

PHC-NCD Policy Recommendation 1	
Objective	**Promote lifestyles that prevent NCDs**
Programmes	Develop predictive Policies to expand and sustain Public knowledge and awareness regarding NCD risk factors (Obesity, etc.)

Solutions	Design Nutritional and Physical activity policies facilitated and implemented through mobiles	Develop and implement empirical studies on national food consumption	Leverage Smart City technology to build e-Health applications and platforms that mitigate exposure to NCD risk factors (nutrition, mobility and physical activity)

PHC-NCD Policy Recommendation 2					
Objective	**Improve National Healthcare Delivery for NCD patients**				
Programmes	Surveillance of the NCDs through the monitoring of their prevalence and progress				Build the economic case for Personalised Medicine for NCDs - Improve the quality and sustainability of chronic care for NCDs patients
Solutions	e-Health applications that improve patients' adherence/compliance to medication and their quality of life	Electronic health records (automated sources) that allow targeted/precise healthcare services and support performance of Healthcare professionals (Model epSOS)	Develop centralized guidelines and legislation on electronic health records - collection, storage and sharing	Build the economic case for sustained financing for National Electronic Health Records programmes	Develop economically-viable differentiated scenarios for Personalised Health care amongst GCC nationals (local population), expatriates and tourists (transient population)

7. Roadmap

7.1 Introduction: Creating a knowledge-based economy

The main drivers for a knowledge-based economy include investments in: all levels of education; research and development(R&D), including capacity building and collaborative research; entrepreneurship; access to finance, including seed, angel, and venture capital; science parks and business incubators; and commercialization of proven technologies. Important enabling conditions include a sound macroeconomic framework, sound infrastructure, an effective innovation ecosystem, and a business-friendly environment, including transparent regulations. Private sector investments, including Foreign Direct Investment (FDI), need to be undertaken on terms that enable technology transfers and spill-over effects in support of knowledge-based development. Most critical however is the presence of governance, incentive structures and the kind of "mindset" that bring genuine inspiration and motivation to embrace research, innovation and entrepreneurship for business and societal development.

Research and new knowledge need to combine with considerations to meeting with real demands, what consumers and users really need. Success in the introduction and scaling of new products, services, and processes will be possible only if meeting with the needs of the market (local, regional, and international).

Financing R&D, building state-of-the-art science parks, and giving industry tax breaks may be beneficial but are in themselves insufficient for enabling success in innovation and commercialization. Researchers and entrepreneurs operate according to different cultures and institutional logics. Knowledge-based development requires a holistic approach that brings together diverse competencies and abilities within clusters and networks and that are able to evolve in sync with the specific local assets and opportunities. Researchers, practitioners, entrepreneurs, financiers, business angels and professional service providers need to interact in-real-time, through processes that aim at real results. Policymakers need to be attuned to letting go of development processes that cannot be planned and engineered from the top but which require bottom-up initiative and ingenuity.

Knowledge-based development and effective innovation ecosystems thus require the rise and further development of diverse and mutually inter-linked actors, including strong R&D institutions, innovative companies and capable institutions. It also requires a strong physical and cyber infrastructure, and a business-friendly regulatory framework. An Innovation Ecosystem requires the receptiveness of recognizing and removing barriers between organizations and individuals, as well as increasing collaboration across disciplines and sectors. It requires a culture that supports taking risks, tolerating failures, learning from failed experiences and best practices, and celebrating success.

7.2 An agenda for realizing strategic benefits

As elaborated in this report, the GCC countries meet with a number of challenges in developing an effective and comprehensive knowledge economy, research capacity and innovation ecosystem. The same applies to the EU, as well as to other parts of the world. There is no single optimal "best practice", but the knowledge economy is in steady evolution and handling it requires a never-ending learning and adaptation process. Each country and region needs to find its own solutions but can also benefit from learning from others. As further elaborated in previous sections, the EU and the GCC are complementary and can benefit from collaboration in various respects, encompassing collaboration in specific areas as well as at a more overriding level.

The strategic benefits of EU-GCC research and innovation collaboration are very high. This is in part because of the great untapped potential for engaging in mutually beneficial and more all-encompassing joint initiatives. The GCC countries thus far focused overwhelmingly on national schemes and initiatives that have been fragmented when viewed both from the national and the regional perspective. They are short of experience, programmes and critical mass in their effort to develop effective responses. The EU by contrast has amassed a range of institutions and practical experience on how to devise commonly motivating schemes encompassing both research and innovation. With Horizon 2020, their collaboration has further ventured into devising a host of interlinked schemes that bring a much deeper engagement of multiple stakeholders and which promote social relevance to a much higher degree than was previously the case.

The European Commission's approach to international cooperation was set out in a Communication in 2012 entitled *"Enhancing and focusing EU international cooperation in research and innovation: a strategic approach".* The general openness of Horizon 2020 to the participation of researchers from public and private organisations from across the world is an integral part of the new approach.

Horizon 2020 is thus, in principle, open to the engagement of researchers and other relevant actors outside the EU, including in the GCC. Having said that, thus far the EU and the GCC failed to introduce and develop a set of activities that could be effectively communicated and motivating for collaboration between the two regions.

The present lack of resources in the GCC, due to the declining oil prices, leave these countries with less financial muscles to invest in R&D and infrastructure more broadly. On the other hand, the drive for economic diversification, for which research and innovation are of great importance, has strengthened significantly over the past two years. There is thus, a pressing need for enabling investing in research and innovation in order to be more efficient, and in putting in place conditions that are more enabling, and in removing the hurdles. Managing this agenda is challenging for each country in isolation. An orderly framework for EU-GCC collaboration, that engages them in a bi-regional common agenda for effective action in these respects, could be of significant common interest.

1. It is thus proposed in INCONET-GCC2 Roadmap that the two regions advance to put in place the tools for advancing this agenda. The following measures are recommended as part of this Roadmap:
    - Working out a common advocacy for research and innovation as a key enabling factor for economic diversification, higher productivity, sustainable development, and long term prosperity. This advocacy role is much needed to underpin a better combination of capacities in basic and applied research, with the private sector playing a more important role in sharing and performing the latter.
    - A common task force should be set up, including representatives of the various key actors (policymakers, universities, researchers, businesses, financiers, research councils, entrepreneurs) mandated to realize improved collaboration across sectors and countries, in order to enable common learning processes and improve cross-border synergies.
    - The introduction of instruments for devising common projects, including a resource pool, a scheme for issuing calls, and a framework for actors in the two regions to work out common portfolios of projects and joint innovative projects.
    - Means of strengthening the industrial perspective from both EU and GCC side is important in order to implement the solutions in real cases. Common means to establish business and research relationships, to develop innovative projects, by having local partnerships, to exchange researchers, service designers back and forth
    - Engaging children from early age to be interested in research, innovation and entrepreneurship; acting at the stage of university studies is too late. It is thus important

to develop programs that involve young people and allow them to benefit from broader cross-border collaboration between the GCC and the EU.

- A more systematic collaborative process should be worked out, which is capable of engaging key institutions on both side in concrete joint activities to achieve common goals. Policies and programs need to be developed "from the top" with a view to encouraging more initiative and active collaboration "from below", with the purpose of creating more interlinked and diverse common knowledge pools. There is still a lot to learn in how to do this, and how to use diverse cultural set-ups and experiences in a productive way to support such a process.

2. That priority is placed on advancing joint research and innovation activities in areas of mutual interest and capable of generating new opportunities, including:

Health innovation

- **Challenge of modifying individuals' lifestyles.** Several initiatives have focused on modifying individuals' lifestyles – e.g. if people smoke less and drink less alcohol, they have lower risk of showing long-term conditions such as heart disease or cirrhosis. However, in practice, research has repeatedly shown that **it is very difficult to effectively change individual behaviours and lifestyle**. Most of the individual lifestyle factors are independent from each other and peculiar to each individual, and they depend heavily on the type of the person's everyday routine and her job. Further, there exist strong interactions and correlations between the context of the individual and lifestyle factors. For example, in Ireland, body mass index, cholesterol and blood pressure are persistently higher amongst low-income social classes. Likewise, smoking rates are much higher amongst women aged 18-29 years from poor communities (56%) than among young women from higher social classes (28%)[7]. Thus, to minimize the risks caused by individuals' lifestyle factors one would require a better understanding of wider contextual factors and personal context information. In addition, experience has shown that the general guidelines and health instructions and the way they are presented to the people (e.g. in the form of imperative orders or pressing requirements) oftentimes achieve the opposite effect and hence they are deemed ineffective [citation]. Finally, since only 3% of healthcare expenses in the EU are allocated to disease prevention, there is clearly a case for investing more in the reduction of lifestyle-related diseases.

- **Barriers towards the self-management of health.** Promoting public health and health prevention in the 21st century is a multidisciplinary endeavour, ranging from clinical studies up to provisioning health advice and information to individuals. This evolves at several levels and involves multiple actors, spanning individuals and their activities and lifestyle, the healthcare and social-care providers through their diagnostics and other services and actions, and national and international health agencies through their policies. In state-of-the-art approaches, the individual is far from being the epicentre of the system; it usually participates in the system as a passive recipient of advice and information.

- **The abundance of current mobile health apps.** Currently it is estimated that over 97,000 health and lifestyle related mobile apps currently available on Google Play and Apple App Store with 4 million downloads per day[8]. It is difficult to deny the rising popularity of such industry, which is estimated to $26 billion by 2017. In line with such trend, in 2014, the EC launched a public consultation on green paper on mobile health[9] (mHealth) to help identify the

[7] Health Ireland, http://www.hse.ie/eng/services/publications/corporate/hieng.pdf
[8] Research2Guidance (2013), "The mobile health global market report 2013-2017: the commercialisation of mHealth apps" (Vol. 3).
[9] EC Green Paper on mHealth, 2014. https://ec.europa.eu/digital-agenda/en/news/green-paper-mobile-health-mhealth

advantages and associated risks on the use of mobile technology in the management of health and lifestyle. Despite stating the advantages, the summary report[10] on the green paper on mHealth raised a number of serious concerns in terms of data protection, patient safety and transparency of information. One of the concerns was about the difficulty to prove the efficacy of mobile solutions as it requires long-term studies with health impact assessment. It is acknowledged that most mobile apps available on the market today do not meet the definition of a medical device[11] and regarding apps that provide medical advice and information are needed to make mandatory that such information be checked by a healthcare professional. In fact, such arguments have also been supported in the recent systematic review in the medical domain: It is indicated that most medical apps are currently irrelevant, non-evidence-based or even may be dangerous due to inaccurate content. Thus, without clinician input and validation, mobile health apps can be a liability and such concerns put an important barrier in front of such technology to enable its full potential in terms of delivering better care and medical advice to individuals and enabling the self-management of their health.

- **The need for data-driven services to support evidence-based, personalized recommendations.** Despite the availability of such diverse mobile apps and the acquired data about an individual's everyday life and/or health status, the context and whereabouts of the individual, there still exists a huge gap between the self-management of lifestyle and health and clinical care. In particular, mobile devices and apps, wearable technologies provide a unique opportunity in terms of interacting with individuals, enabling easy-access to the information, collecting lifestyle data and also providing recommendations and advice in a daily life context. However, what is missing is a supporting platform at the backend which provides services to the mobile technology in terms of acquiring the individuals' mobile data, processing it accurately and efficiently, enabling clinicians' intervention for monitoring and tracking the health status and finally turning it into evidence-based, personalized recommendations to be sent back to the individuals. In this respect, clinical domain has intensively studied the effect of lifestyle in various diseases in the randomised clinical trials (RCTs) and reported their results in various predictive models, which are able to calculate long-term risk scores based on lifestyle factors.
- **The need for real-time, context-aware recommendations for enabling lifestyle changes.** The process of providing recommendations for supporting lifestyle changes is complex and should consider many factors in order to result in a significant user acceptance. Indeed, apps can communicate with the user to engage them in behavior change, keep them aware of their progress towards goals, and provide relevant and timely advice and support without generating adverse emotional reactions and threatening adherence. There are many studies dealing with these issues, stating that the proper motivation/need for doing changes in lifestyle and the accuracy (correctness, timely delivery) of the recommendations are among the most important factors from the users' point of view. Moreover, contextual sensing can be an important way of encouraging timely engagement with digital interventions (by knowing that self-monitoring is burdensome and unappealing for users). However, a recent study showed several problems in contextual sensing, like that participants lacked faith in the accuracy with which a smartphone could sense relevant states (e.g. mood, activity levels) and expected that incorrect and irritating suggestions would make them mistrust the app and

[10] EC Summary Report on the Public Consultation on the Green Paper on Mobile Health, 2014. https://ec.europa.eu/digital-agenda/en/news/summary-report-public-consultation-green-paper-mobile-health

[11] Mobile solutions, which have a medical purpose, fall within the scope of the medical devices directives as stated in the Green Paper on mHealth

cease using it. Overall, careful exploration of if and how health behaviour change apps can use context sensing in a way that users perceive as acceptable and useful is now needed.

- **Interoperability issues.** As also addressed in EC Green Paper on mHealth, the slow uptake of international interoperability standards by the mobile health app market is problematic since it is dominated by SMEs and individuals (i.e. app developers). Even a bigger challenge, the envisioned platform to offer data services to the mobile apps to enable evidence-based, personalized recommendation will require interoperability between many mobile platforms delivering health and lifestyle functionalities and the proposed services. If we want such services to be exploited by many mobile applications in the market and extend their capabilities significantly to offer better care and medical advice delivery, interoperability issues should be duly considered and well established standards and mechanisms should be utilized.
- **Privacy and security of the data.** The use of mobile apps and wearable sensors for the collection of large quantities of sensitive personal medical data, as well as the storage and processing of such data in a cloud deployment to offer personalized health recommendations, raises several privacy and security concerns which have to be appropriately addressed. As stated in the EC Green Paper on mHealth, "45% of consumers say they are concerned about the unwanted use of their data when using mobile devices for health-related activities" and a Financial Times investigation reveals that "9 of the top 20 health-related apps have been found to transmit data to one of the dominant companies tracking details about people's mobile phone use." To facilitate the wide adoption of mobile health apps, it is thus mandatory to address the legitimate concerns of individuals on the use of their personal health information. Given the sensitive nature of health data, mHealth solutions should guarantee the privacy-aware collection and use of individuals' health information, as well as take appropriate security safeguards to mitigate security risks. It is important, however, to note that all privacy- and security-related safeguards that should be implemented to protect individuals' sensitive health information, should account for data utility in order to enable the meaningful analysis of the data and their use to facilitate accurate personalized health recommendations for the individuals.

Smart cities

- R&I in the field of Energy/Smart Cities. According to recent studies, the global urban population at 54% in 2014 is projected to rise to 70% by 2050. Cities are engines of economic growth, accounting for 80% of the global GDP. However, they also consume around 75% of global primary energy and are responsible for 70% of the global greenhouse gas (GHG) emissions. It becomes clear that smart city solutions will play a central role in addressing the needs coming from cities in terms of population, resource consumption, safety, security and mobility, among other demands. These solutions include:
  - Smart low carbon energy based services for citizens and business: Smart networks, especially energy, transport and ICT networks are major enablers for delivering services for citizens and business. They need to be managed with innovative and integrated concepts opening up new approaches.
  - Low carbon energies: The optimal use of local and renewable energy sources together with other low emission energy sources is very important. The district level heat, cool and power demand is reduced via energy efficient smart buildings and connection to vehicles.
  - Smart energy management for smart buildings and districts: Holistically operating energy efficient districts have better ability to react to changes. Holistic planning enables cost

savings (multi-functioning systems), increased safety and reliability through better utilization of intelligent, integrated and optimized networks.

- Part of the task is to assess the level of development of each county's infrastructure, institutions and human capital factors that influence the attractiveness of investing in RE projects and play a role in enhancing the reliability of RETs to ensure their sustainable deployment. RE-Readiness Assessment is a rapid estimation of how a country can increase readiness and overcome the main barriers. The identified gaps in GCC are:
  - Key policies (lack of regulatory authorities and energy & climate policies);
  - Power off-take attractiveness due to subsidized electricity tariffs and energy prices;
  - A weak supply chain due to low level of current installed capacity of RETs;
  - Limited awareness of renewable energy resource potential, economic and environmental benefits, and technology learning cost reduction effects;
  - Investment in renewable energy projects is comparatively less;
  - Large fossil fuel reserves reduce the urgency of energy diversification and promotion of renewable energy;
  - Limited organizations for development of human capacity and experts in renewable energy.

The main recommendations for RE deployment are:

- Develop strategic plans to meet sustainable development goals for each of the GCC countries and the region.
- Create collaboration among the GCC energy research institutions and universities as well as international partners.
- Undertake feasibility analysis of long term energy and climate policy (targeted renewable energy production and CO2 emissions reduction) and establish feasible national policies for sustainable energy development.
- Undertake analysis of energy subsidies and incorporate external costs of fossil based power generation technologies.
- Include technology learning effects of innovated clean conversion technologies in long term planning.
- Undertake research on life cycle cost of RETs incorporating their co-benefits.
- Undertake research on methods of financing for evolution of RETs.
- Establish an organization to implement, support and monitor RET projects.
- Use international instruments such as CDM to promote RET development.
- Improve capacity-building and awareness.
- Undertake best practice analysis on renewable energy projects and its application to develop human capital.
- Develop awareness of RET benefits, energy security and global contribution on climate change issues.

Both EU and GCC are facing the aforementioned challenges and have many common interests and possible synergies in designing the next generation of smart cities with efficient energy systems. Good example of this is the EU-GCC Renewable Energy Policy Experts' Workshop and student meetings but also concrete initiatives to build common projects e.g. in developing sustainable urban energy solutions.

3. That collaboration is put in place to address hurdles to an effective innovation system, where individual countries can benefit from the broader bi-regional collaboration, including:
   - Removal of high level of bureaucracy and red tape that prevents effective research, innovation and commercialisation.

- Conditions that account for a fragmented institutional landscape, between as well as within countries since fragmentation on the two levels coincide in frustrating cross-border and cross-sectoral collaboration.

7.3 Recommendations

7.3.1 To the GCC

- To compete in the 21st century, the GCC states should articulate their STI vision and implement strategies and programmes to propel their countries toward diversified and sustained knowledge and innovation-based development.
- The GCC states should maximize their benefits from the large investments they have made in education at all levels, and in ICT and STI, including Research and Development (R&D). This can best be accomplished by creating an enabling environment to invest in knowledge-related sectors. This will require a new emphasis on developing competitive, transparent, productive, and sustainable economies.
- The GCC states should focus the commercialization of research outcomes on areas of strategic importance to them and on providing products, services, and processes, not only to the GCC domestic markets but also to the larger markets of the region and beyond.
- GCC states should coordinate their STI activities and establish Regional Centres of Excellence for issues of strategic importance such as water desalination, environmental issues, and renewable energy. This will avoid duplication of efforts and enhance regional integration.
- GCC states such as Kuwait, Qatar, and the United Arab Emirates that have set targets to increase R&D expenditures as a percentage of gross domestic product (GDP) should make concerted efforts to meet these targets. Other countries should be encouraged to set and meet realistic targets.
- GCC states should encourage the private sector to invest more in training and capacity building as well as R&D and innovation. There should additionally be more collaboration between universities and research centres and the private sector.
- GCC states should make it easier to do business in their countries, so as to encourage private sector investments, including Foreign Direct Investment (FDI). This will result in technology transfers and spill over effects, leading to knowledge and innovation-based economies.
- GCC states should ensure the availability of adequate early-stage funds including seed, angel, venture capital, and crowd financing to encourage entrepreneurs and innovators to scale up and commercialize their research outcomes and innovative ideas.
- GCC states should further encourage GCC research centres and universities to carry out collaborative research with leading research institutions and universities in Organization for Economic Cooperation and Development (OECD) countries.

7.3.2 To the EU

- The European Commission should further encourage and support GCC nationals to collaborate with EU countries through the H2020 and other research programmes, providing incentives and facilitating the way.
- The European Commission should increase collaborative research and the exchange of scientists, researchers, and professors between EU universities and research centres and GCC research institutions. EU professors, scientists, and researchers should be encouraged to spend part of their sabbaticals in GCC universities and research centres, and vice versa. Such cooperation has already begun; however, it should be continued.

- The European Commission should further encourage and intensify collaboration between EU Laboratories and other research infrastructures and GCC countries, as it does through H2020 programmes.
- The EU private sector should support GCC states by transferring relevant technologies and by building up the skills and competencies of GCC nationals in order to increase the human capital of GCC nationals.
- The EU and GCC states should encourage GCC scientists and researchers to register and patent their proven research outcomes and innovative ideas in the EU Patent Office (EPO) Administration and GCC institutions, so as to benefit from lessons learned and best practices.

7.4 Planning and implementation

The recommendations presented in the previous sections aim to serve both as a source of more general inspiration in regard to the direction and processes of policy development in this area, and also to provide practical and concretely useful recommendations for actions to be implemented by a range of key players. These span the European Commission, the European and GCC policy makers and Governmental bodies responsible for the National Research Plans in the different countries, and for the major national and international stakeholders involved in research activities in the GCC region.

In this final section, some adoption strategies are proposed that would allow taking the recommendations and considerations put forward by the INCONET-GCC2 Roadmap into account for future EU-Cooperation research cooperation.

Depending on the level of readiness of the different actors as far as the adoption of each recommendation, complementary and non-exclusive take-up possibilities exist.

Take-up by policy makers and relevant platforms

The INCONET-GCC2 Roadmap is delivered to the EC and to key policy makers from GCC region such as governmental organizations responsible for the implementation of National Research plans and the other initiatives in the region as the GCC General Secretariat. In parallel, the Roadmap will be uploaded at the web site of INCONET-GCC2 in order to keep the relevant stakeholders informed on the operation and to ask for support in getting the message through.

Ideally, the recommendations and proposed actions contained in the Roadmap should be taken into account by the actors in charge of shaping future policy and collaboration strategies, both at bilateral and at multilateral level. It is also hoped that they will inspire broader consultations processes with relevant stakeholders, spanning the policy design and implementation stages, while also applying within countries as well as, where relevant, at the regional and international levels. Hopefully they should serve as inspiration for new forward-looking initiatives.

The INCONET-GCC2 partners are available to provide more information and follow-up recommendations, if required.

8. Conclusions

The deliverable undertakes analysis to define joint scenarios for EU-GCC cooperation such as joint call for proposals, participation of GCC stakeholders in H2020 and participation of European stakeholders in GCC research activities.

The White paper has been prepared with a view to the selected thematic priorities, i.e. it reviews the fundamental rationale for collaboration between the EU and the GCC, including to what extent there are synergies or complementarities, strengths or weaknesses, risks or opportunities, and in which way research and innovation collaboration between the EU and the GCC can help generate better outcomes. In this it incorporates a specification of a SWOT analysis from which a number of conclusions are drawn.

The roadmap, which takes into account and integrates the outcomes of the various proceedings, thematic events, and high level policy meetings, operates at two main levels:

- Thematic level: (1) The thematic roadmap on EU-GCC on Personalised Healthcare for chronic non-communicable diseases (NCDs), including Diabetes, and; (2) The thematic roadmap on EU-GCC on Smart Cities;
- Horizontal level: (1) Based on the above thematic roadmaps extrapolation will facilitate the horizontal roadmap preparation.

The aim of this document is to propose a strategy to improve the level of cooperation between the European Union and the Gulf Region in the field of research and innovation, and to facilitate the level of the RTD collaboration between GCC and the EU. The INCONET-GCC2 Roadmap stems from a number of events and bilateral consultation activities that INCONET-GCC2 has conducted by involving a relevant number of European and GCC research and policy stakeholders. In line with observations of best practice and what works in this policy domain around the world, as one of the key objectives, the recommendations proposed in the present report aim to support a development towards a more inclusive research and innovation policy framework, nationally, regionally and bi-regionally. In principle, the recommendations have been directed towards all the stakeholders involved in research across Europe and the GCC, and specifically to the policy makers both in Europe and in the GCC region.

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