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Italy-Turkey Dialogue on Technological Innovation

Report sponsored by UniCredit and edited by Istituto Affari Internazionali (IAI) and Global Relations Forum (GRF)

Abstract

This project aims to identify ways and means to increase technological cooperation between institutions and companies of two large developed countries and important economies, Italy and Turkey. After a short introductory review on the two national research and technology systems the report describes the situation, programs, capabilities and opportunities in two particular sectors - distributed energy generation and renewable sources (DG) and the internet of the future (IF) - that will probably have an important impact on the future of the two countries' economies and societies. The report, supported by background papers written by high-level specialists, illustrates and assesses status, development policies, efforts and resources devoted to these sectors. Highlights of the longer-term prospects are also included. Some remarks, focusing mostly on the potential bilateral and multilateral cooperation, conclude the report, that was presented at the VII Italian-Turkish Forum of Dialogue.

Keywords: *Italy / Turkey / Bilateral relations / R&D / Renewable energy / Distributed Generation (DG) / Information and communication technologies (ITC)*

Italy-Turkey Dialogue on Technological Innovation

Edited by Istituto Affari Internazionali (IAI) and Global Relations Forum (GRF)*

Introduction

Technological innovation is a specific aspect of innovation that includes other activities such as organization, sales distribution, finance. There are many examples of non-technological innovation that drive the success of leading companies.

Technological innovation has, nevertheless, some special characteristics that distinguish it from traditional innovation. First of all, it provides a bridge between research and the economy. It is, therefore, an essential component of every industrial policy. Moreover, it has a strong horizontal character, involving many sectors of human activity. Finally, if successful, it stimulates imitation and adoption and has, therefore, a strong and widespread impact.

The subject of innovation can be examined from a methodological viewpoint, focusing analysis on the various approaches and tools, regardless of the specific application areas; many international meetings follow this line.

In this project, the main objective is to explore the relationship between two large developed countries and two important economies with the aim of identifying ways and means to increase technological cooperation between their institutions and companies. To do so, the organizing team has chosen another approach: after a short introductory review on the two national research and technology systems, it has been decided to describe the situation, programs, capabilities and opportunities in two particular sectors: distributed energy generation and renewable sources (DG) and the internet of the future (IF).

Both areas have similar interesting characteristics: development based on existing technologies accompanied by strong research programs, very high “pervasiveness”, big growth expectations based on new potential applications. Both will probably have an important impact on the future of our economies and societies.

Document sponsored by UniCredit and prepared by the Istituto Affari Internazionali (IAI) and Global Relations Forum (GRF) in the framework of the VII Italian-Turkish Forum of Dialogue, Rome, Palazzo Barberini, 8-9 November 2010. The Forum has been organized by UniCredit and the Center for Strategic Research of the Turkish Ministry of Foreign Affairs in cooperation with IAI, GRF and the review East.

* Authors: Angelo Airaghi, Eren Camlikaya, Claudio Casale, Memduh Karakullukçu, Paolo Traverso. Global Relations Forum (GRF) is an independent, non-profit membership association committed to being a platform for engaging, informing and stimulating its members and all interested individuals in all matters related to international affairs and global issues (http://www.gif.org.tr).

More specifically:

- the DG represents an alternative to - or better, an integration of - the existing centralized electricity generation systems. It includes many of the new generation technologies especially the renewable sector (minihydro, solar, wind, waste-to-energy, fuel cells, etc) together with new ways of storing and distributing electricity (smart grid). This systemic approach is, also, suitable to increase, in parallel, the social involvement of the local communities in the energy policies and choices. Most countries include the DG in their energy perspectives and, worldwide, there are a number of big demonstration projects ready to start;

- the “internet revolution” requires no comment. But what is important is that we are at the beginning of this revolution. The tumultuous growth of demand is putting the existing infrastructure under stress and is complicating the “administration” of the grid. At a time when whether or not a person has access to a high-speed connection makes an economic and social difference (the internet democracy), many countries are trying to solve the contradictions between the need to serve everybody in the same way and the level of investment needed. Moreover, a clear and fast improvement in ICT infrastructures can also give way to new applications: just to provide a few examples, the developments related to webTV, interactive TV, the search for information, development of new services, eGovernment applications, simultaneous automatic translations, etc.

In the meantime both sectors are crucial for the development of small, dispersed communities, like islands or isolated villages typical of both countries.

Of course there is a long list of other sectors (like aerospace and defense, automotive, textile, shipbuilding etc.) where scientific and industrial ties are in place that can potentially benefit from an improvement of the bilateral cooperation.

This report, supported by background papers written by high-level specialists, illustrates and assesses the status, the development policies, the efforts and the resources devoted to these sectors. Some highlights of the longer-term prospects are also included.

Some remarks, focusing mostly on the potential bilateral and multilateral cooperation, conclude the report.

I. Research and Technological Development in Italy

1. Key players

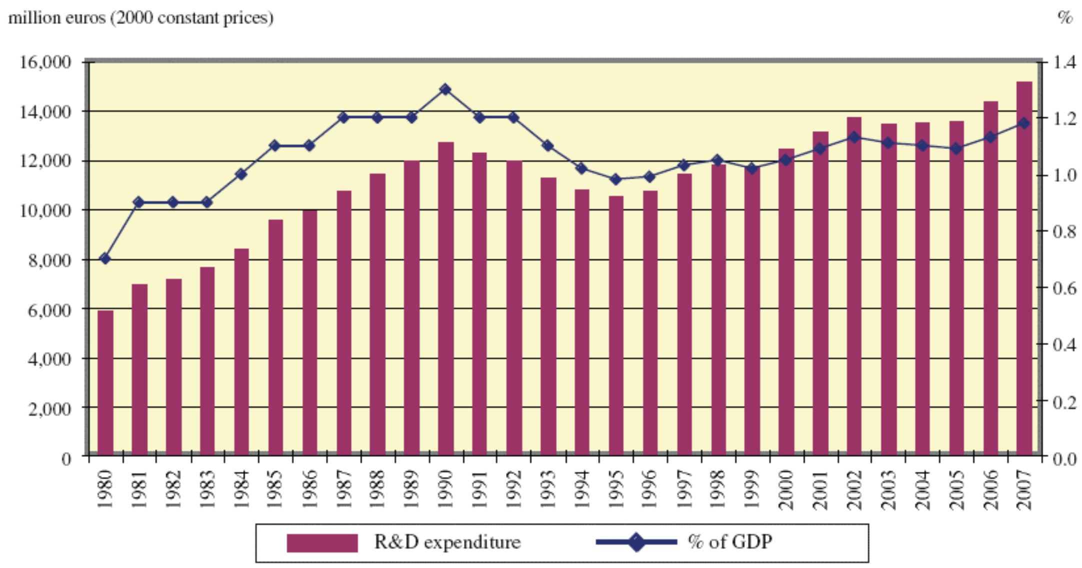
As is common, the Italian RTD system is articulated in three main classes of actors: universities, research centers (mostly, but not exclusively, public) and companies. In summary, RTD activity is carried out by 50 universities (it is estimated that 1/3 of the time of 65,000 university professors and researchers is devoted to research activities).
In addition, there is a network of public research institutions (the so-called EPR - Enti Pubblici di Ricerca): the largest is the National Research Council (CNR) with 6,000 researchers and 110 research institutes; other bodies are ENEA (energy and environment), ISS (health), Cira (aerospace), INGV (geophysics and volcanology), INFN (nuclear physics), INAF (astronomy and astrophysics), etc.

Basic research is done mostly by the universities, but public research institutions are also active in this field in parallel to their engagement in applied research and service to the industrial world. The industrial system has its own research structure.

2. RTD expenditures and policies

The total expenditures have reached 19,000 ml euros, or 1,2% of the Italian GNP, with a moderate increase in both absolute and relative terms in recent years.

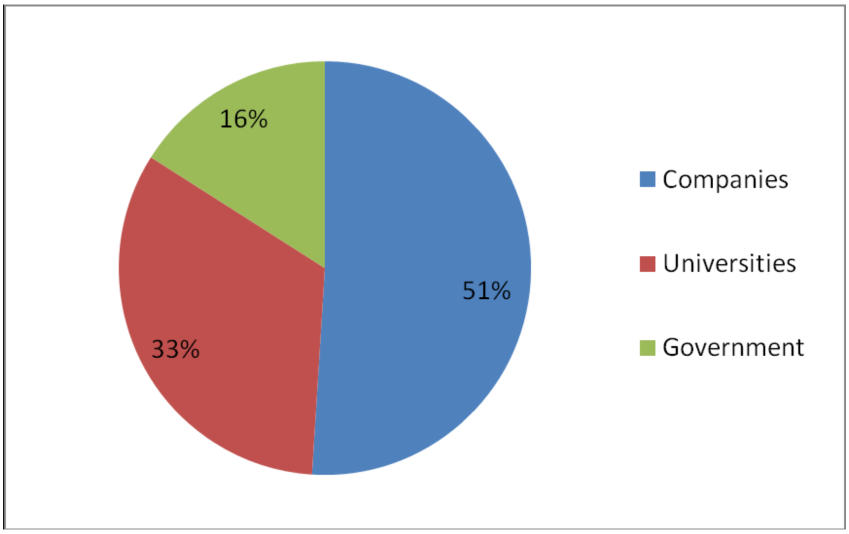
Fig. 1 – *R&D expenditure over GDP in Italy, 1980-2007*



Note: Since 1995 only intramural R&D expenditure is considered.
Source: CERIS-CNR elaboration on ISTAT data.

The industrial sector accounts for about half of the expenditures, universities for about 1/3 and the government (agencies, public research centers and subsidies) for the remaining part.

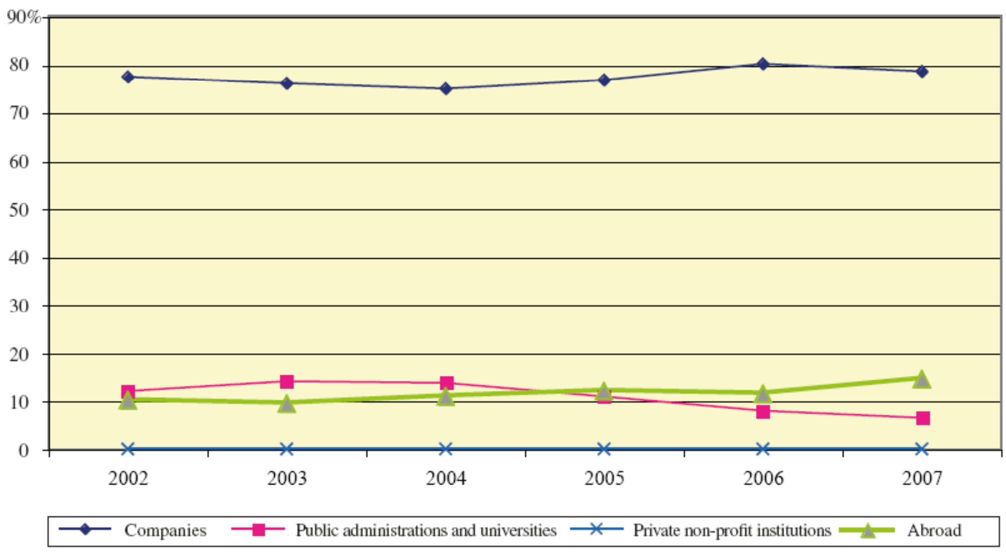
Fig. 2 - *Main investors in RDT (2007)*



Source: CERIS-CNR elaboration on ISTAT data.

Companies invest mostly their own money; the average support received by public (national and international) bodies is in the range of 20% and has remained stable in the last few years.

Fig. 3 – *Financing sources for company R&D in Italy, 2002-2007*

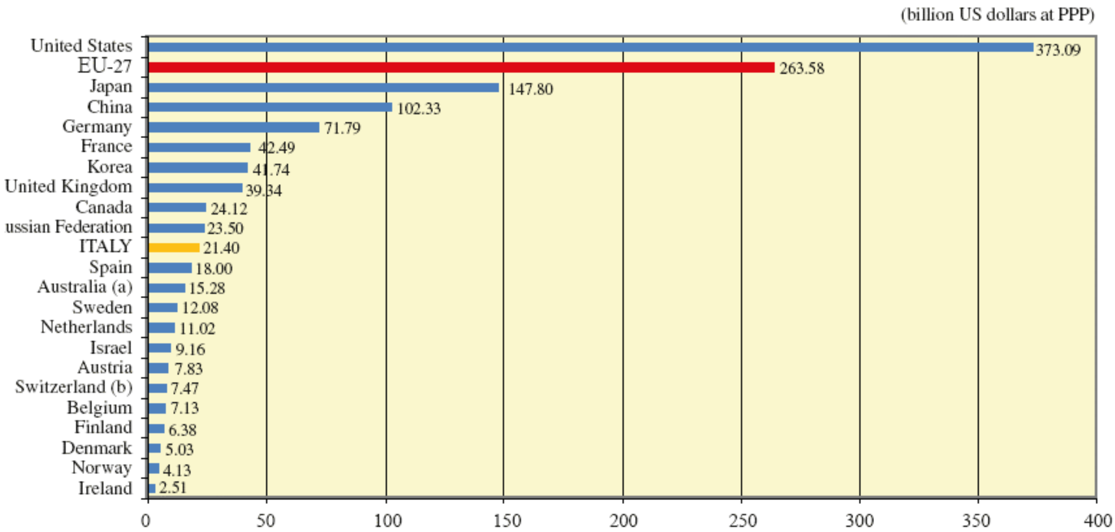


Source: ISTAT.

RTD employs 120.000 people, of which 50% in the public sector and 50% in the private one.

Italy's overall RTD expenditure places it among the 10 largest investors in the world (see fig.4). This is consistent with its economic performance: it ranks among the 10 largest economies and 10 largest exporters globally.

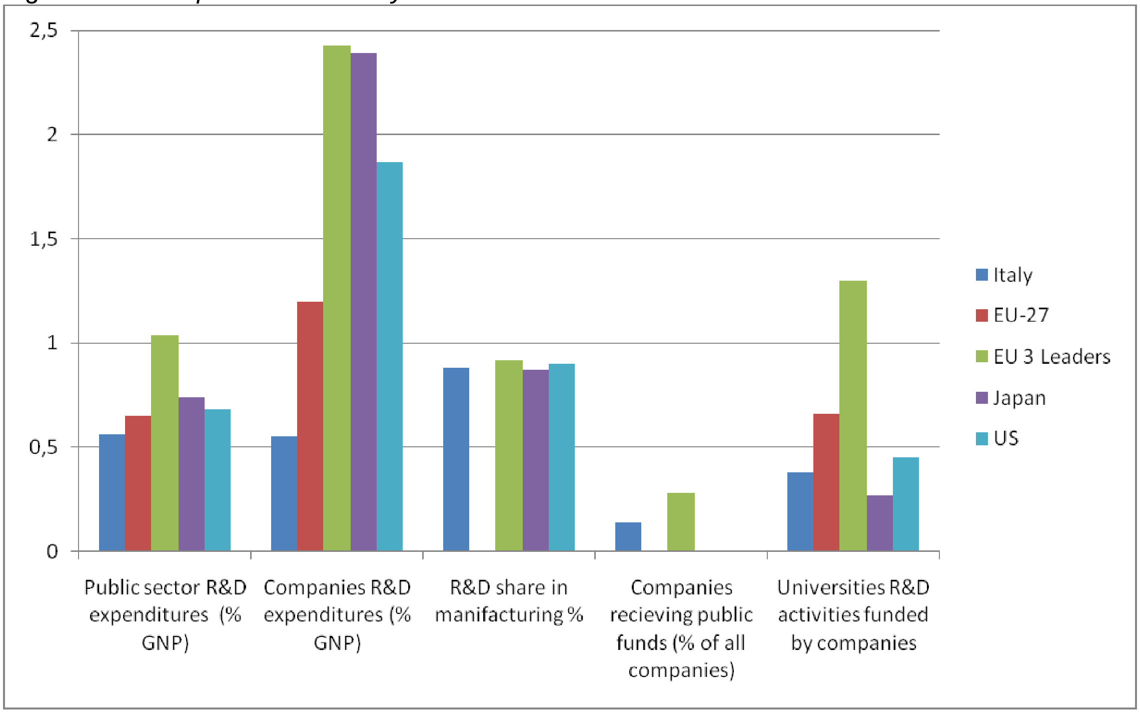
Fig. 4. – *R&D expenditure in some OECD and non-OECD countries, 2007*



Notes: (a) 2006; (b) 2004.
Source: OECD, *Main Science and Technology Indicators*, 2009-2.

If we move from the absolute to the relative terms, the picture changes. In general, Italy is placed around the European average but well below the leading countries. In particular, as mentioned above, public RTD expenditures are in line with the rest of Europe (0.55% versus 0.65% of GNP), while private expenditures are much lower (0.55% versus 1.2% of GNP).

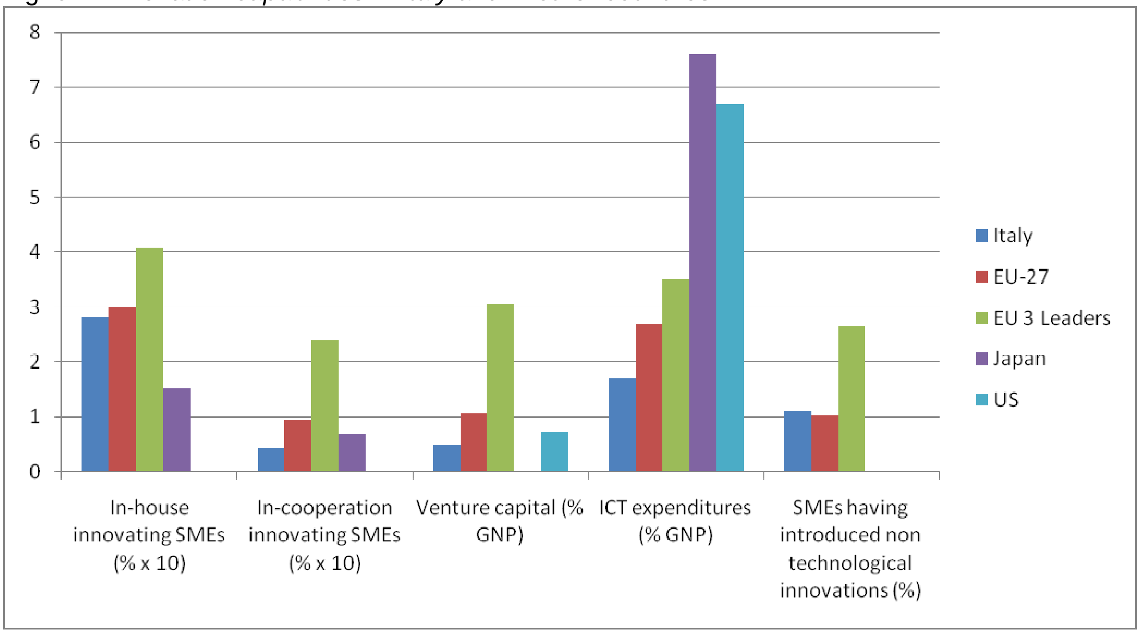
Fig. 5. – *R&D expenditures in Italy and other countries*



Source: European Innovation Scoreboard.

The following data related to the innovation aspects gives a clearer picture.

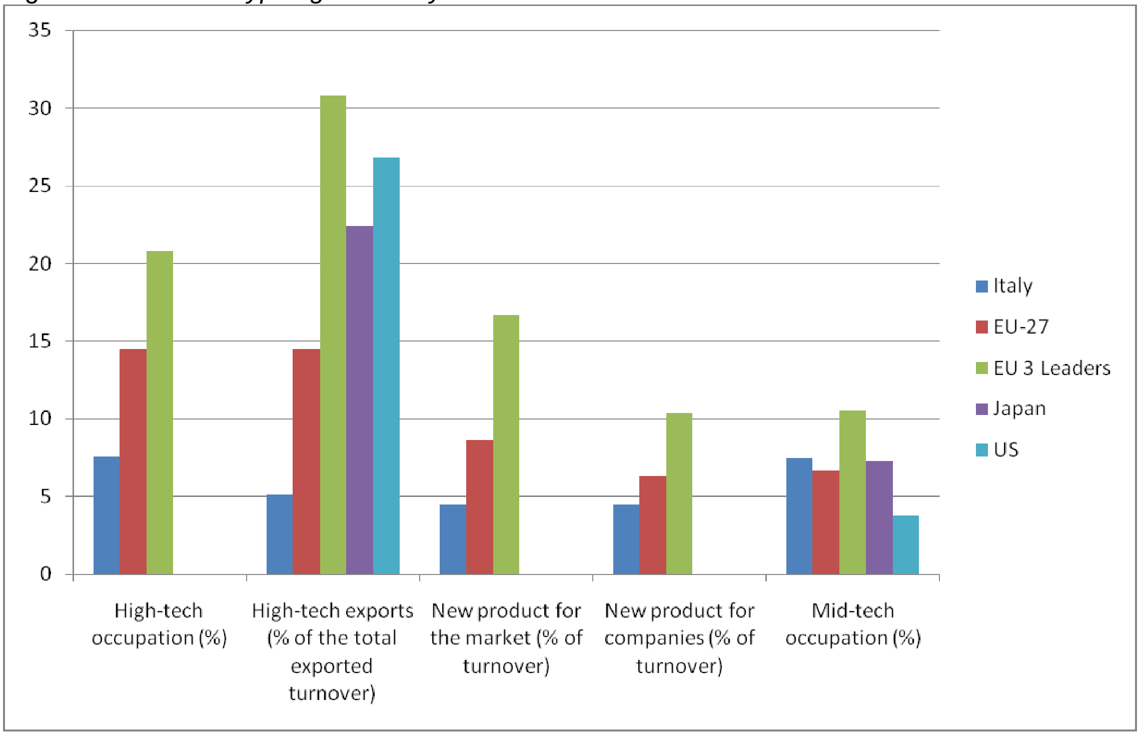
Fig. 6. – *Innovation capabilities in Italy and in other countries*



Source: European Innovation Scoreboard.

Finally, the number of high-tech SMEs is much below the European average.

Fig. 7. – *Production typologies in Italy and in other countries*



Source: European Innovation Scoreboard.

These indicators, all from official sources, shall be interpreted to understand the real situation:

- The peculiar structure of Italian industry (few large companies and a very large number of SMEs mainly engaged in medium-low tech sectors). All the figures stress the relatively low percentage of high tech SMEs. This means that Italian industry, due to its specialization and structure, can achieve an excellent economic performance while investing less in R&D (but probably more in innovation);
- The diffusion of the well-known model of “industrial districts”, whereby there is a concentration of companies, research centers and service activities operating along the same value chain in a specific geographical area, making RTD efforts highly efficient and effective;
- The difficulty of the statistical system to collect the “real” data for RTD expenditures from companies (typically low tech SMEs) that are not organized in way of providing reliable data on their RTD effort.

3. Governance and support policies

Over the years, Italy has adopted an articulate system of direct incentives for RTD, especially addressed to the less developed regions (the South and the big islands); another important source of funds for RTD is the European Framework Program.

The introduction, in 2007, of a tax credit for companies investing in RTD has been a great success (much above expectations): a deductible of 10% of yearly expenditures and 40% of the value of contracts that private companies give to universities and public research centers. This was introduced in an attempt to overcome one of the weak points of the Italian RTD system: poor interaction between public and industrial research.

Nevertheless, Italy's position as revealed by the international comparisons is unsatisfactory and must be improved. There seems to be broad convergence, at both Government and Parliament level, on this. The Italian response to the 2008-2010 international economic crisis has been focused largely on the containment of public expenditures and public expenditures on RTD have suffered more than other activities. Both Government and all political parties agree that this situation has to be corrected as soon as possible. In principle, everybody agrees on the so-called "Lisbon objectives" (to reach an RTD expenditure of 3% of GNP by 2020), but this implies a huge financial, organizational and professional effort for the coming decade. The National Research Plan (PNR), soon to be finalized, has precisely this objective.

One of the consequences of the government's financial constraints has been the rapid growth of alternative funding sources: the first, related to a more articulated view of public administrations is, increasingly, the regional administrations and this will probably grow even stronger in the near future. The second new source is private non-profit institutions and, more broadly, the general public: there are now fiscal incentives for making grants and donations to research. Both these lines are consistent with the best international practices (see Fig. 3).

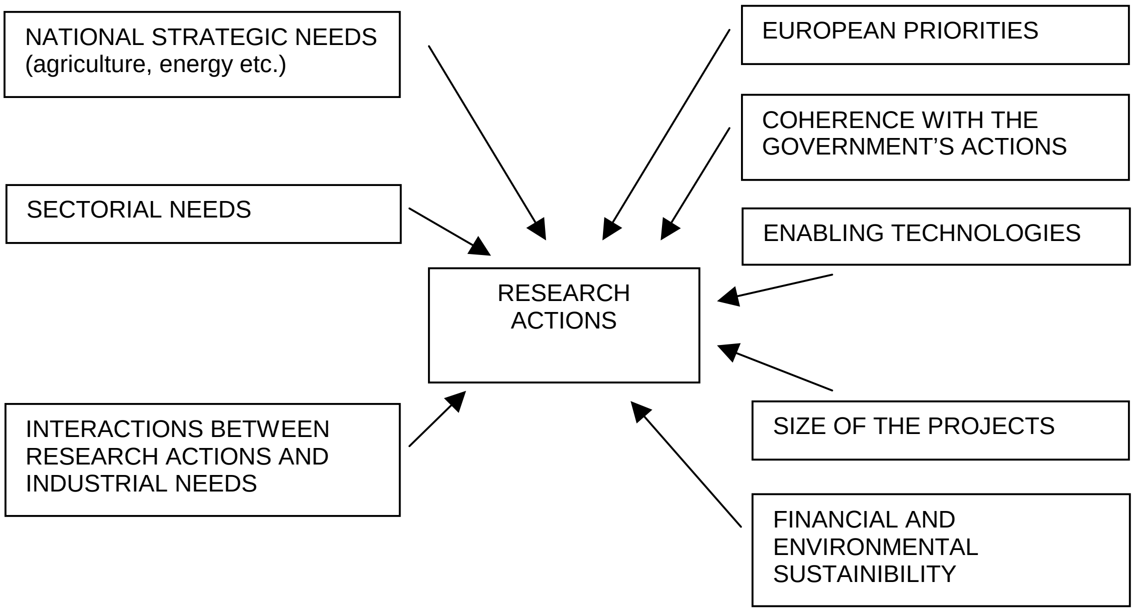
One positive fallout at this time of financial difficulty is that research structures have been forced to become more and more efficient and selective; the benefits of these efforts will become evident in the coming years.

The PNR stresses the need to concentrate public efforts along four main lines:

- undertake a nationwide effort (research and industry) to promote the so-called enabling technologies (energy, mobility, cultural goods, Made-in-Italy, life sciences) under the guidance of the industrial system;
- reinforce the existing network of excellence centers;
- improve the national research evaluation system as a prerequisite for enhanced selectivity in the allocation of funds;
- increase the interaction between research and industry.

As a result, the evaluation grid to select the future proposals to fund or support can be summarized as follows:

Priority Definition Proposal Evaluations Criteria



In the meantime, the PNR envisages greater coordination among the various players and a more active promotional role on the part of Government at both the national and European level. The PNR, finally, should (but real figures are not yet available) indicate a strong increase in public expenditures in the coming years.

The PNR also stresses that tools conceived to improve the interaction between public and private investors must be set up. Taking into account the very positive tradition of "industrial districts", the national and regional Authorities have launched a number of initiatives such as science parks, excellence centers, technological or meta districts, thematic business innovation centers, etc. Some of them will be mentioned in the following parts of this document.
Finally, Italian RTD policy considers international cooperation as one of the main drivers to be pursued with even greater intensity in the coming years.

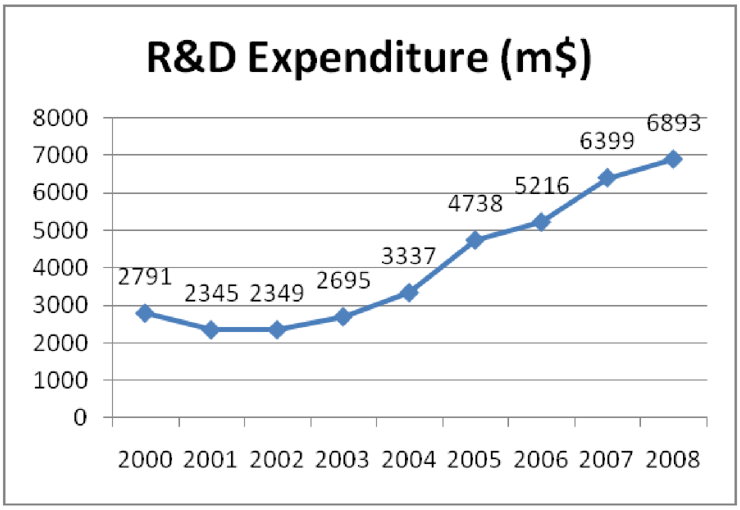
II. Research and Technological Development in Turkey

1. Technology Policy and Planning Key Players

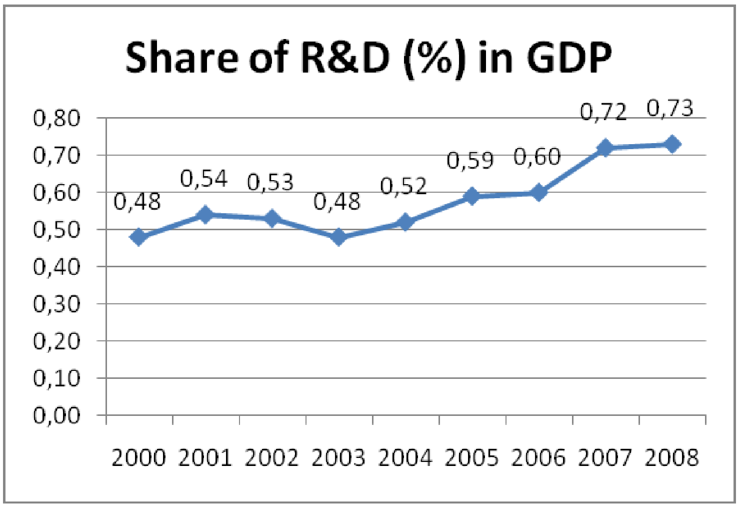
The seeds of Turkish science and technology policy can be traced to the establishment of the State Planning Organization. SPO was established in 1960 to prepare five year development plans covering all aspects of economic development. In response to the need to develop science and technology policies, the Scientific and Technological Research Council of Turkey (TUBITAK) was founded in 1963. TUBITAK was also given the mandate to support and to conduct basic and applied research in natural sciences.

In 1980, SPO and TUBITAK prepared the first comprehensive policy document, titled “Turkish Science Policy: 1983-2003”. This document also proposed the establishment of a new institution, the Supreme Council for Science and Technology (BTYK), chaired by the Prime Minister, to design, coordinate and implement science and technology policies in Turkey. Together with SPO, BTYK has been working on policies for the establishment of a complete national system of innovation with necessary institutions and initiatives working in coordination with TUBITAK as its secretariat.

In the last decade, national strategies shaped mainly by these three institutions, concentrated on increasing total R&D expenditure while boosting the share of private sector’s contribution. Therefore, current targets as indicated in the *National Innovation Strategy 2008* document adopted by the government for the 2013 include increasing R&D expenditure to 2% of GDP from 0.73%, the share of privately financed R&D to 55% from 47.3% and the number of researchers to 80,000 from 67,244[1] [2].



[1] Scientific and Technological Research Council of Turkey (TÜBİTAK), *STI Policy - Turkish Research Area*, http://www.tubitak.gov.tr/sid/1004/pid/547/index.htm.
[2] Turkish Statistical Institute (TURKSTAT), *Research And Development Statistics* (2008 values), http://www.turkstat.gov.tr/VeriBilgi.do?tb_id=8&ust_id=2.



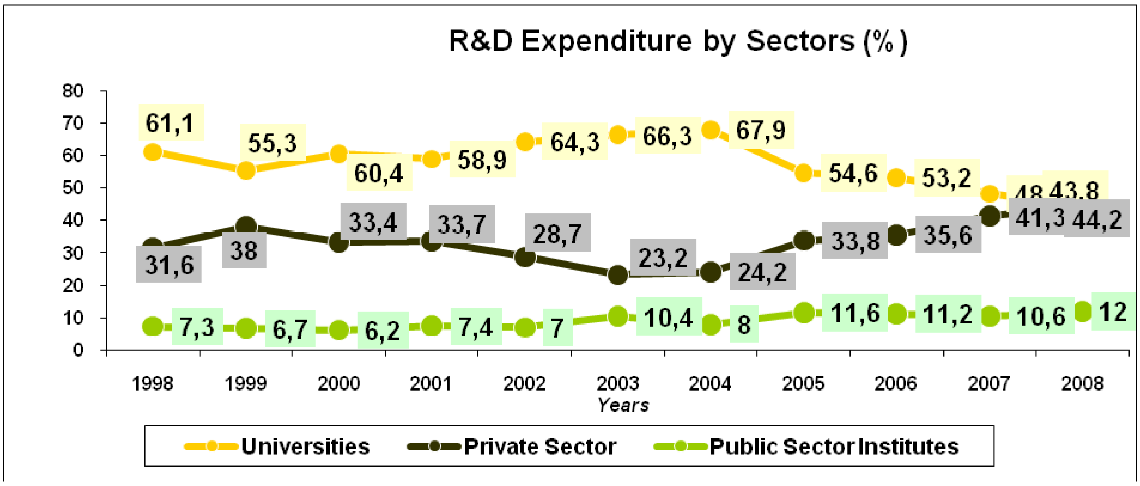
2. R&D Activity: Key Players

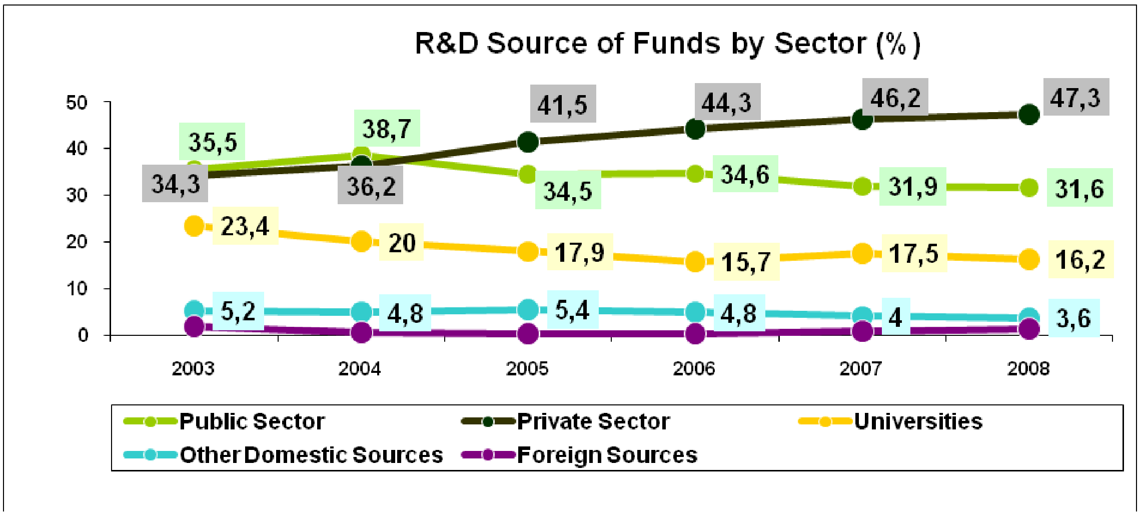
In Turkey, TUBITAK, universities and private companies are the key contributors to research and development. Public R&D is concentrated around TUBITAK and academic institutions whereas private R&D is conducted by companies.

Total R&D expenditure in Turkey was 5.38bn USD (6.893bn TL) in 2008 which corresponded to 0.73% of GDP. The PPP adjusted value of the R&D expenditure was 7.03bn USD. Universities and private companies accounted for 43.8% and 44.2% of this R&D expenditure respectively. The remaining 12% was used by public research institutes predominantly by TUBITAK. Even though there are many other public research institutes such as Turkish Atomic Energy Authority and National Boron Research Institute, they have limited R&D budgets in comparison to TUBITAK[3].

Universities, private companies and public sources funded 16.2%, 47.3% and 31.6 of this total R&D budget respectively. The remaining 4.9% of the R&D expenditure was financed by other domestic and foreign sources. (Please see Figures below)

[3] Turkish Statistical Institute (TURKSTAT).





a. TUBITAK

TUBITAK is a key player in the national science and technology scene with a total budget of 1.4 billion TRL (approx. 1 billion USD) in 2009.

TUBITAK has 4 primary roles: to conduct in-house research, to conduct the selection process of public grants, to fund researchers and to contribute to the development and implementation of national science and technology policies.

TUBITAK conducts in-house research and development activities in 15 institutes employing 2,354 R&D personnel. Nearly a third of TUBITAK budget was allocated in 2009 to the in-house research activities. Its role in selecting among R&D grant-applications from academia, public institutes and private companies makes TUBITAK a key player in the national R&D arena. In 2009, TUBITAK allocated 140m TRL (approx. 100m USD) to academic projects and 412m TRL (approx. 295m USD) to industrial projects. Other than conducting in-house research and providing R&D grants, TUBITAK spent 60m TRL (approx. 43m USD) on researcher funding by supporting 15,000 graduate students in 2009. TUBITAK also continues to function as the secretariat of BTYK and supports science and technology policy programs such as "Vision 2023" published in 2003.

b. Universities

In Turkey, universities function as both higher education and research institutes. Since academics both teach and conduct research, universities are critical to the development of human capital and the R&D volume generated. As of 2008, universities accounted for almost half of total R&D in terms of expenditure (43.8%) and R&D personnel (44.5%). In 2008, universities spent 2.36bn USD on research and development with nearly 30,000 R&D personnel. As the universities in Turkey are predominantly public institutions, a very high ratio of university R&D is publicly funded. Currently there are around 51,000 graduate students enrolled in 139 universities studying for a degree in science and engineering programs as potential researchers. As a result of policies to promote science and technology education such as TUBITAK's aforementioned researcher funding program, Turkey witnessed a sharp increase in R&D personnel from 28,000 to 67,244 during the 2002-2008 period.

c. Private Sector

Private companies conducted 44.2% and funded 47.3% of total research and development activities in Turkey in 2008[4]. For 2013, share of private sector is targeted to be 55% in total source of funds and to be 60% in the total R&D expenditure according to BTYK.

The breakdown of private sector R&D expenditure by corporation size has not been reported in the recent years; however, since 1995, the share of SMEs in TUBITAK funded projects rose from 22% to 81% (by number of projects) indicating a growing interest of small and medium sized companies in doing research and development. These projects accounted for 47.5% of the total TUBITAK industrial grants in 2009.

3. Implementing Technology Strategy: Institutions and Policies

Over the years, Turkish policy-makers designed and launched institutions and instruments to advance technology and innovation investment among Turkish corporations. The main institutions to serve this purpose are KOSGEB targeted at the SMEs, Technology Development Zones (TDZ) targeted at university-industry cooperation and Technology Development Foundation of Turkey (TTGV) targeted at the provision of alternative sources of R&D funding.

a. KOSGEB - SME Support Policies

A major objective of Turkish innovation policy has been the promotion of R&D activity within the SMEs. With that vision, The Small and Medium-sized Industry Development Organization (KOSGEB) was established in 1990 as an affiliate organization of the Ministry of Industry and Trade. It provides grants to SMEs for R&D and operates incubation centers located at university campuses. During the 2003-2007 period, KOSGEB allocated a total of 688m TRL (approx. 550m USD) to SMEs for both R&D

[4] Turkish Statistical Institute (TURKSTAT), *Research and Development Activities Survey 2008*, http://www.turkstat.gov.tr/PreHaberBultenleri.do?id=4143.

related and non-R&D projects. KOSGEB's incubators played a critical role especially for micro-firms and start-ups[5].

b. Technology Development Zones - University-Industry Partnership Policies

The strategy to increase the share of private R&D has brought to the fore industry-university partnerships that can mobilize the human and infrastructure resources of the universities. Technology Development Zones (TDZ), also known as science parks, play a pivotal role in promoting private R&D collaborations between private entities and universities/research centers. Empowered by the Technology Development Law (no:4691), TDZs are run by private management companies which can have local administrators, financial associations, foreign private entities and universities as their shareholders. Other than proximity to qualified R&D personnel and technology transfer services, science parks provide considerable tax incentives to companies conducting research and development. Incentives provided by the TDZ law include full corporate tax exemptions for the local and foreign technology companies as well as income tax exemption for their R&D personnel.

Similar tax incentives are offered to large technology companies outside the TDZs provided that they have substantial R&D operations, measured by the number of R&D personnel, as specified under the recent legislation (no: 5746).

Currently there are 18 science parks hosting 927 companies (885 domestic, 42 foreign) with 8,055 R&D personnel as of 2008. This number corresponds to nearly 30% of all researchers in the private sector. During 2004-2008 period, tax exemptions in the TDZs totaled 923m TRL (approx. 700m USD). The total exports of companies' science park branches are reported to be 208m TRL in 2007. Software projects constituted 61% of all projects conducted in science parks followed by defense (11.6%) and electronics (7.2%) in 2008. Moreover, sectoral breakdown of the remaining TDZ activity span a wide spectrum including material science, aerospace, energy and automotive[6].

c. TTGV – Diversifying Funding Sources

TTGV serves a critical role in diversifying both the sources and the instruments of funding for technology companies throughout their evolution from pre-incubation to commercialization. As one of the key financial institutions, Technology Development Foundation of Turkey (TTGV) was established in 1991 to support policies developed by TUBITAK and BTYK. Initially sponsored by the World Bank, TTGV currently functions as a self-supporting intermediary of public funds for R&D allocated by the Undersecretariat of Foreign Trade and international funds in collaboration with the World Bank and European Investment Fund (EIF).

TTGV has invested in 2 private venture capital firms. It has also collaborated with EIF, KOSGEB and Development Bank of Turkey in establishing the Istanbul Venture Capital Initiative (iVCi) which is a fund of funds program. By committing 40m USD to iVCi, TTGV has aimed to strengthen the young venture capital industry which included only

[5] Small and Medium Sized Industry Development Organization (KOSGEB), 2009 yılı Faaliyet Raporu (2009 annual report), http://www.kosgeb.gov.tr/Pages/UI/Baskanligimiz.aspx?ref=23.
[6] Presidency of the Republic of Turkey, *Auditing report*.

3 companies with a collective fund volume of around 400m USD and annual investments approaching 100m USD in 2009[7].

4. Looking forward: Driving forces of R&D

Within the last 20 years, most of Turkey's science and technology policies developed by BTYK were intended to promote R&D supply. Institutional structures like KOSGEB, TTGV and TDZs as well as grants and tax exemptions served that objective and lead to an increase in national R&D expenditure. The near tripling of R&D expenditures between 2002 and 2008 surpassed the respective growth achieved by the EU countries. Nevertheless, total R&D expenditure of 5.38bn USD is still low in comparison to most European nations.

a. Public Funding Support

The R&D grants given by TUBITAK and KOSGEB and loans by TTGV can be considered as one of the major driving forces behind the rapid increase in total R&D expenditure in recent years. TUBITAK's support programs include industrial grants for large enterprises and SMEs. Total amount of these industrial grants increased to 412m TRL (approx. 295m USD) in 2009 from 3.9m TRL in 1996 while the share SME's shifted from 22% to 81% in terms of the number of projects indicating a significant change in the composition of private R&D players. On the other hand, KOSGEB's grants for SMEs reached 193m TRL (approx. 150m USD) in 2007 up from 11.2m TRL in 2002 in order to supplement TUBITAK's efforts. In addition to these, Turkish partners received 62.3m € from 7th FP, nearly doubling the amount of 38.4m € from 6th FP. Through all these funding programs TUBITAK, KOSGEB and TTGV continue to contribute considerably to the implementation of Turkey's ambitious R&D targets.

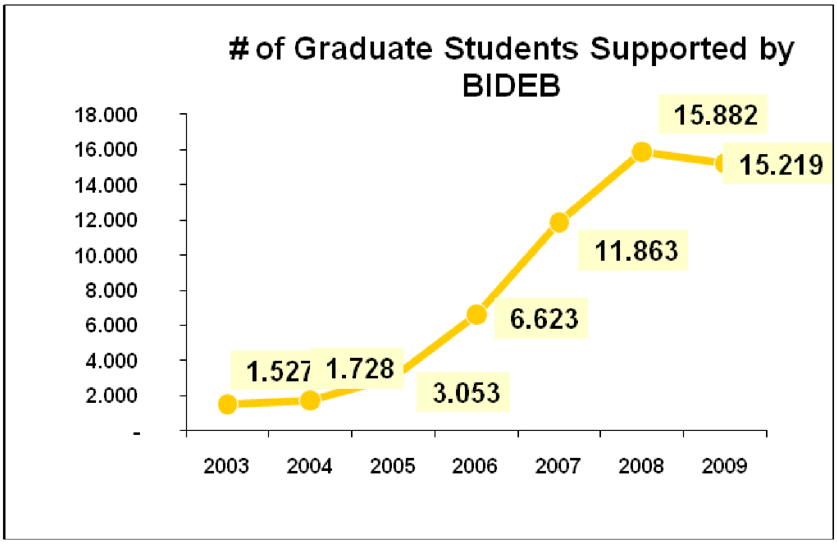
Second largest supply side initiative to increase innovation other than direct R&D grants and loans is the financial support provided by the establishment of science parks. After formation of 18 science parks, total amount of tax exemptions reached nearly 1bn TRL (approx. 700m USD) in total for the years 2004-2008. Motivated by the generous tax exemptions, science parks are transformed into huge clusters of R&D both by local and foreign firms, thus developing informal bonds among university and corporate researchers. Consequently, science parks in Turkey are currently hosting nearly a third of all R&D personnel from the private sector and still have more room to grow with newly established zones and enlargement projects of existing TDZ's.

Turkey has set ambitious targets for her R&D supply. The authorities have provided the funds to achieve those objectives and gradually developed a range of instruments and policies for effective use of such funds. Given the policy commitment displayed in the recent years, a steady increase in public funding, better-functioning institutions and new policy instruments should be expected to move forward Turkey's R&D generation capability in the coming years.

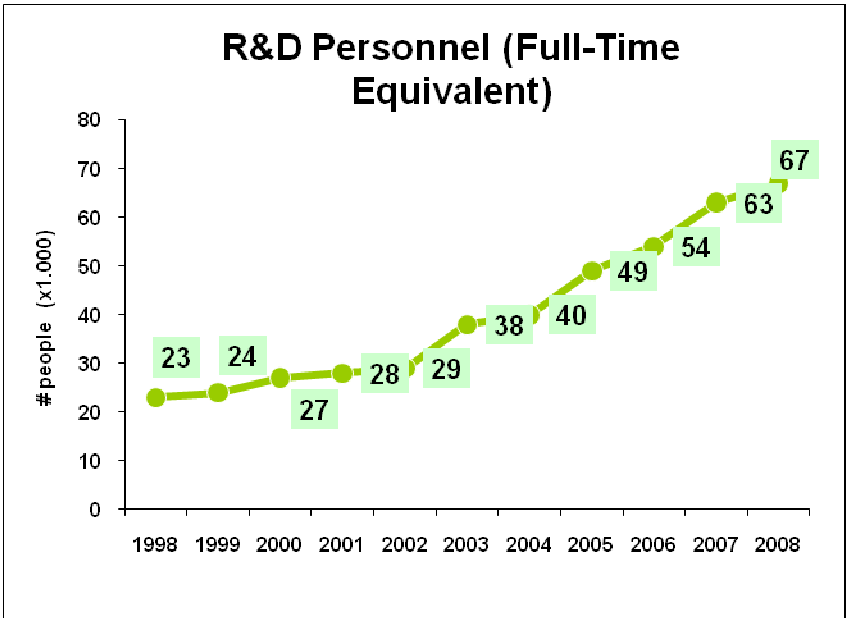
[7] Technology Development Foundation of Turkey (TTGV), *Models for National Technology and Innovation Capacity Development in Turkey*, 2009, http://www.ttgv.org.tr/content/docs/final-report_turkey-ksp.pdf.

b. Human Capital

For successful implementation of a complete national system of innovation, human capital is the critical component. Together with public efforts on institutionalizing and funding R&D, high quality human capital of Turkey has had a significant role in the progress up this point. In line with long term strategies of higher education, 41 public and 22 private new universities have been established since 2002 and total number of higher education institutions reached 139. 28% of all graduate students (51,000) and 24.5% of professors (11,500) were in science and engineering departments as of 2009[8]. Moreover, 11,222 graduate students are currently enrolled in medical schools. Number of R&D personnel nearly tripled in a decade and reached 67,244 in 2008. The generous subsidies and strategic support programs to fund researchers such as TUBITAK's scholarships of graduate students (65.4m TRL in 2009) and "Industrial Thesis" (SAN-TEZ) project of Ministry of Industry and Trade have been instrumental in this rapid progress. International technology companies that decide to develop an R&D presence in Turkey increasingly benefit from this ambitious broadening of the high caliber human capital supply in the Turkish economy.



[8] OSYM (Student Selection and Placement Center for higher education), http://www.osym.gov.tr.



c. Manufacturing Industry

Apart from the generous incentives and top-notch human capital, the flexible and competent manufacturing industry has been critical in driving the R&D system. Comprising 25.3% of the GDP, manufacturing industry in Turkey accounts for 18.8% of total employment. As the backbone of the manufacturing industry with 69.7% of employment within the sector, SMEs have become more eager to pursue R&D activities in recent years due to successful implementation of various policy initiatives. Consequently, the share of high and medium-high technology production has increased from 28% in 2000 to 43% in 2006 with automotive, chemical, petroleum, consumer electronics and composites as leading sectors. These figures indicate the success of rapid transformation and flexibility of Turkish manufacturing industry to address the immediate needs of the economy during a shift from low and medium-low technology products to high and medium-high technology products. Parallel with the production, export share of high and medium-high technology products increased to 40% from 28% in 2000. This trend will play a critical role in enhancing Turkey's global competitiveness in high-tech businesses[9].

d. Large Engineering Firms

Throughout the years, large Turkish companies have excelled in large-scale engineering projects like dams, factories or power plants. As the pioneer sector in exports, construction companies operate in 80 different countries as of today. Total budget of the projects managed by Turkish engineering companies exceed 170bn USD and is expected to increase with the growing demand from emerging markets[10].

Expertise in large-scale engineering projects like power plants and airports in diverse geographies is critical for Turkey's long term success in implementing complex engineering projects. Managerial know-how in the realization of such engineering

[9] Turkish Industrialists' and Businessmen's Association (TÜSİAD), http://www.tusiad.org.
[10] Turkish Contractors Association (TCA), http://www.tmb.org.tr.

projects may be leveraged to help Turkey become a global player in new engineering projects including new technologies.

5. Room for Improvement

The ambitious range of strategic priorities makes it a true challenge for Turkey to realize the entirety of its objectives. There has been a massive increase in financial support for R&D in the last 10 years; however, these funds have been allocated across many domains. The policy makers are aware of the need to concentrate supply side incentives as indicated in the Vision 2023 document and are likely to shift to a more focused strategy in the coming years.

Another issue regarding national innovation policy is the asymmetry of support mechanisms. Financial support programs, researcher training efforts, incubators and other institutions are all examples of supply-side initiatives to promote research and development and increase total research output. In order to have a complete system of R&D generation, complementary demand side policies need to be developed to absorb risks that are inherent in the early stages of the R&D process. If a critical volume of production is not reached with iterated cycles of product development, commercialization of the technology is put at risk. Demand side policies to remedy such structural challenges should include public procurement initiatives with well specified standards and requirements to guide the development of new technologies. Only by absorbing the inherent risks in the R&D activity, public authorities can lead an increase in Turkey's global share of high technology industries.

Despite the efforts of institutions like TUBITAK, KOSGEB and TTGV, commercialization is still an important issue specifically for SMEs. Although the number of applications increase with time for the R&D grants and loans, perceived risk of the potential obstacles on the way to achieve commercial products alienate companies from completing the cycle of R&D –driven innovation. Strengthening the technology transfer activities in TDZs would help implement a more effective mechanism for commercializing the research conducted in science parks. Moreover, despite the abundance of financial support programs, scarcity of institutions like venture capital firms to share the risk of the innovation process limits the total space of technology production.

III. Renewable Energy and Distributed Generation

1. Concepts and Prospects

1.1. Concepts

Distributed Generation (DG) is a new approach in the electricity industry, one which has begun to supplement conventional generation based on large power plants. DG consists of much smaller, dispersed power plants directly connected to distribution networks or even sited on customers' premises (houses, factories, stores, dwellings etc.).

The current literature, laws and regulations worldwide do not use a consistent definition of distributed generation. In many countries, however, generating plants below 10 MW (or 10 MVA) are given special treatment – for instance, exemption from dispatching orders by the national TSO (Transmission System Operator).

In principle, several benefits can ensue from the diffusion of DG plants. They can help avoid, or defer, the need for investment to enhance distribution networks (and, consequently, some transmission facilities also). They can reduce distribution costs and energy losses on networks. They can improve the reliability, continuity and quality of electricity supply, possibly with the support of storage systems. They can enable a distribution system, or a part of it, to go on operating temporarily, like an island, in the event of a fault in the main grid.

Renewable energy sources (RES) such as hydropower, wind and solar energy are typically employed in the distributed generation solely of electricity (RES-E). DG technologies based on fossil fuels, on the other hand, look particularly cost-effective in cogeneration, that is, combined heat and power production (CHP), thanks to the much higher overall conversion efficiency of this application. Biomass-fired plants (including those burning waste) come somewhere in-between, as cheap and locally available feed-stocks could make them economically advantageous even when producing only electricity.

Distribution networks have so far been designed to convey energy in one direction, from substations to customers. The presence of distributed generating plants would turn them into "active" networks, where power can flow in either direction and voltage evolve very differently from the original design. Managing such a system could be challenging, all the more so because it may also require some management of customers' loads, as well as support in the form of energy storage. This would include battery charging for electric vehicles and the use of a combination of sources with complementary features (e.g. hydropower and wind). That is why the innovative concept of creating so-called "smart grids" (capable of intelligently integrating and managing the actions of all connected operators) looks particularly attractive for implementation in distribution systems with DG.

Many DG technologies, particularly those based on RES, are still at a stage where their unit energy-production costs are higher than the selling prices of electricity on the wholesale market. Hence the need for incentives that help producers bridge the remaining gap between revenues and costs, and the need for governments to establish adequate support schemes.

The European Union (EU) has long been active in this field, issuing Directives to Member States for the promotion of RES-E and CHP. The latest is Directive 2009/28/EC, which sets an overall mandatory target of 20% of energy consumption from RES in the EU as a whole, along with separate targets for individual states.

From the foregoing it can be inferred that the conditions are in place for cooperative initiatives to be adopted by Italy and Turkey in the field of Distributed Generation, with special regard to electricity generation and combined heat and power production from renewable sources. Such initiatives could also involve certain aspects of the integration of DG into smart grids.

The Joint Programme on Smart Grids is divided into four sub-programmes, concerning:

– Network Operation, with the aim of developing methods and solutions for the operation of grids with a high DG penetration and controllable loads;
– Energy Management, to manage such systems in an optimal manner from an energy and market perspective;
– Information and Control System Interoperability, for the efficient and reliable exchange of information between smart-grid actors and smart devices;
– Electrical Storage Technologies, to gain a better understanding of the state-of-the-art of energy storage technologies and their performance.

1.2. Prospects

The diffusion of DG could have more than merely technical implications. Such implications start from a simple consideration: electricity generated locally should be consumed locally to avoid transmission costs.

The first implication is philosophical. Today we are accustomed to considering electricity as something that is always available: where and how it is produced is, in general, something we ignore and deem to be irrelevant. The sole condition and consideration is that we should be ready to pay the bill. DG brings the issue closer to us: being directly involved in electricity production, we would all become more careful about our energy and take a more responsible attitude to its consumption (the bill is not, in general, a real deterrent or means of fostering energy-saving attitudes). Moreover, decisions involving local communities and individuals could become an excellent opportunity to grow in awareness and citizenship.

A second implication is organisational. An ideal DG system is based, as previously described, on a number of different devices producing energy in different conditions and at different times of day: solar in the daytime; mini-hydro, depending on the flow of water; wind farms, depending on the wind; and biomass or waste treatment when the plant is activated, etc. Because electricity consumption does not follow the same pattern as production, an intermediate storage system is vital and the distribution grid needs to be able to deliver electricity in two ways (from dispersed production points to storage, and from storage to consumption points).

This configuration implies the existence of an "electronic supervisory system" (SCADA) and, most probably, a local body in charge of running the grid and managing the production, distribution and billing of locally produced electricity. These bodies would also be responsible for exchanges with the national grid, which are necessary to make up for local imbalances or provide backup in the event of temporary local failures. They could belong – or not, as the case may be – to larger, national organisations and have their own billing policies, while at the same time reinforcing, citizens' involvement in energy issues. For example, the electricity utilities tend at present to apply lower prices to electricity consumed during the night (peak demand is late morning and early afternoon). In a community where most electricity is produced through solar devices during the day, this policy would be useless – and probably wrong.

A third implication is related to new applications. One of the most revolutionary is the arrival on the market of electric cars. These consume electricity stored in on-board batteries, with many options as to how the batteries are recharged. One of the simplest is to plug a cable into the grid; this could be done overnight at home. If the electricity is produced locally (e.g. through photovoltaic panels) this could, once more, have major implications for overall energy policy and on the involvement of citizens/consumers at the local level. And there is more: this option could also influence urban planning and house construction models and technologies.

These are just a few examples to show how a supplementary (to centralised generation systems) electricity-generation system could, in the medium-term, have profound implications for society as a whole.

In any case, given the benefits of DG, it is likely to be increasingly adopted by national authorities as part of their energy policy agenda. DG, to a large extent, will build on the nations' renewable electricity generation capacity. Therefore, building competence and capacity in renewables is a key asset on the way to designing a DG strategy. The following national analyses, particularly on Turkey, builds on that premise.

2. DG in ITALY

2.1. The penetration of renewable and distributed generation

In Italy, the statistics produced by the Authority for Electricity and Gas (AEEG) show that the deployment of DG plants (i.e. below 10 MVA) has been growing steadily in the last few years. At the end of 2008, 6,627 MW of DG capacity, with 34,848 units, mostly new solar photovoltaic (PV) plants, were on line, corresponding to 6.5% of the country's total generation capacity.

Energy production by DG plants in 2008 amounted to 21.6 TWh, or 6.8% of national electricity production. Renewable sources accounted for 58.5% of DG production, while the rest came from conventional fuels (in the Italian system as a whole, RES have, in recent years, supplied about 20% of overall domestic production, mostly through large hydropower plants). More specifically, hydropower supplied 42.4% of DG production in 2008, biomass and biogas 11%, wind 3.2%, solar PV 0.9% and geothermal plants (also classed by AEEG as DG) 1%.

The northern, more economically developed, Regions of Italy showed higher DG penetration, with some exceptions for site-dependent sources. For instance, most wind power plants have been set up in the regions of southern Italy and the islands.

2.2. The legislative and regulatory system

The main policy supporting RES-E is an obligation for producers and importers of electricity to feed a given amount of electricity from RES into the power system every year. This is calculated as a percentage of the electricity from non-renewable sources they produced or imported the previous year. Under the current legislation, this percentage is to increase by 0.75% per year in the period 2007-2012 (for example, in 2009 it was 4.55% of non-RES production in 2008).

Tradable Green Certificates (*Certificati Verdi*) are issued by the *Gestore dei servizi elettrici* (GSE) to eligible RES-E producers. These producers can sell their Green Certificates to others who are required to show that they have met their RES-E obligation, thus earning further income in addition to energy sales. Plants that started operating after 1 January 2008 are now granted Green Certificates for the first 15 years, with each Certificate corresponding to 1 MWh of RES-E. Real production is multiplied by a coefficient depending on technology.

As an alternative, plants between 1 kW and 1 MW (200 kW if wind plants) can opt for a comprehensive feed-in tariff. Solar PV plants have been granted a special deal, as they can benefit, for 20 years, from a dedicated feed-in premium scheme (*Conto Energia*), which is added to the income from the sale or direct use of the energy produced. Net-metering exchange schemes are also available for RES-E plants not exceeding 200 kW.

Other measures support RES used for heating and cooling (RES-H&C). Various Italian Regional and local authorities provide funds covering up to 50% of investments through calls for tenders. RES-H&C plants can also qualify for the allocation of White Certificates (*Certificati Bianchi*), which can be traded with subjects who are obliged to meet energy efficiency goals. Support is also provided through tax exemptions for natural gas consumed in district heating and cogeneration (CHP plants).

2.3. The renewable and distributed generation industry

Italian industry holds valuable capabilities and expertise in the technologies used in DG plants, with companies manufacturing components and machinery in all DG sectors.

- Hydraulic machinery. Several Italian and foreign companies have offices and facilities in Italy; mention should be made of Franco Tosi Meccanica, Voith Hydro, Alstom, VA Tech Hydro, Ansaldo, ATB Riva Calzoni, VIBE, and others.

- Wind energy sector. While many companies set up wind farms, fewer factories producing large wind turbines exist in Italy. The main ones are Vestas Italia (part of the Danish Vestas group), Leitwind and Moncada. Several firms supply wind turbine components. A number of firms also make small-sized wind systems.

- Solar PV. Four manufacturers of PV cells are currently in operation: Enipower (ENI group), Helios Technology, Xgroup and Omniasolar. Other companies (Solon, Solarday, Sorgenia Solar etc.) assemble PV modules while others still (Elettronica Santerno, Power One Italy etc.) supply inverters. Very recently, Enel GreenPower, Sharp and STMicroelectronics signed an undertaking to develop a major PV panel factory.

- Concentrating solar plants (CSP). The Archimede project, led by ENEA, has been developing an innovative concept featuring the storage of solar heat in molten salts; a 5-MW prototype is undergoing testing at one of ENEL's thermal power stations.

- Biomass-fired plants. Turboden is a leading manufacturer of Organic Rankine Cycle (ORC) systems.

- CHP plants powered by fossil fuels. Turbec is a well-known player in the micro-turbines market. As for CHP installations driven by internal combustion engines, mention should be made of Fiat Power Train Technologies (Iveco Motors) and Scania. The Finnish Wärtsilä group, which operates through Wärtsilä Italia S.p.A. (formerly Grandi Motori Trieste), and the Italian company Isotta Fraschini, are also well represented in this market. Ansaldo Fuel Cells operates in the Molten Carbonate fuel cells systems.

- Storage devices. The FAAM and FIAMM companies make batteries using various technologies (FAAM is also active in the fuel cell segment), while Arcotronics produces high-tech components and machinery.

2.4. Longer-term outlook

Before looking to likely future developments, it should first be remarked that Italy's overall generation fleet is at present fairly imbalanced towards fossil fuel plants (70% of domestic production came from fossil fuels in 2008). It consequently depends heavily on primary energy imports. Projections of future electricity use show that, as long as no unforeseeable events occur, this trend is set to continue. At the same time, the climate and energy legislative package recently adopted by the EU calls for the promotion of energy efficiency and a greater use of renewable sources.

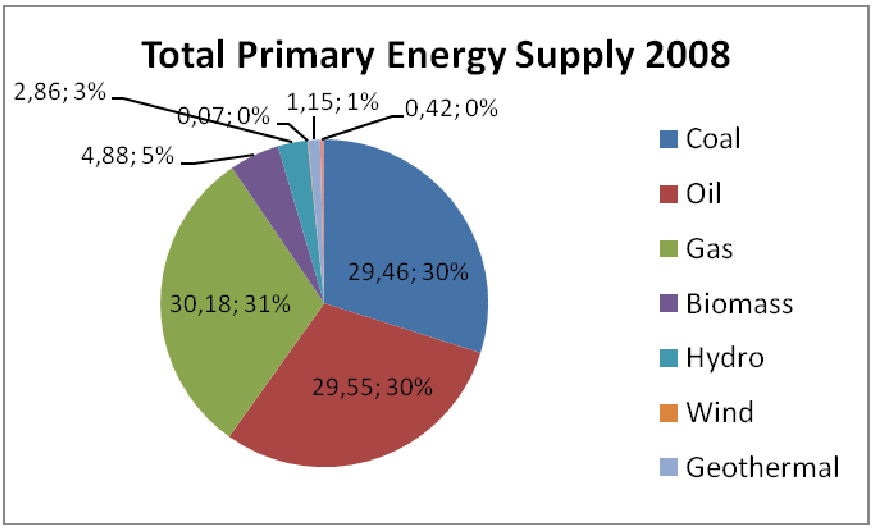
A scenario analysis based on a model of the Italian electricity system and covering a long-term horizon (up to 2050) has been conducted by RSE, focusing on the relevant drivers (economic development, technology advances, availability and costs of primary sources, environmental impact). To assess the impact of DG in particular, four Italian power system scenarios have been developed for the EU's SUSPLAN Project, focusing on two main drivers: technological development and public attitudes. Based on the results of this analysis, the share of electricity produced through DG can be expected to grow further in coming years, roughly in proportion to the share of overall domestic electricity production from renewable sources.

As to overall RES-E production, it is important to recall that the Government has now published Italy's National Action Plan for Renewable Energies of 30th June 2010 in compliance with European Directive 2009/28/EC. This Plan sets a target of 26.39% of overall electricity consumption from RES-E to be achieved by 2020 as a contribution to the overall national target of 17% assigned to Italy by the Directive. The RES-E target is a challenging one, as it is to be attained by gradually increasing RES-E capacity from the 18.8 GW of 2005 to 43.8 GW in 2020, and RES-E production from 56.4 TWh/year in 2005 to 98.9 TWh/year in 2020.

3. DG in TURKEY

Introduction

In the last two decades, Turkey's total primary energy supply (TPES) increased considerably. In 2008, TPES reached 98.6 million tonnes of oil equivalent (Mtoe)[11] with a compound annual growth rate (CAGR) of 4.3% since 1975[12]. Renewable energy sources, predominantly biomass and hydropower, accounted for 10% of TPES in 2008 while fossil fuels (oil, coal and natural gas) provided the remaining 90%.

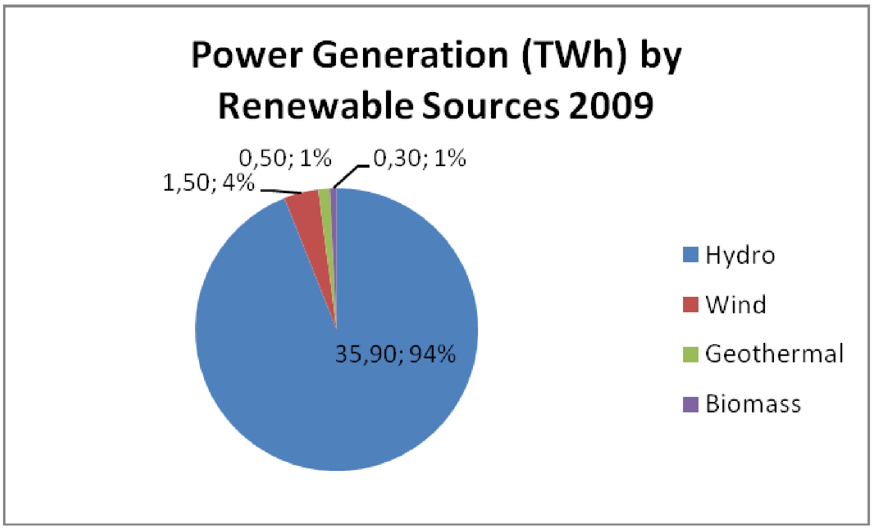


Source: IEA

Parallel with the increase in TPES, total electricity generation soared as well reaching 194.1TWh in 2009 as the consumption grew by CAGR of 7.3% due to the high momentum in urbanization and industrialization during this period. To achieve that, total installed capacity of power generation nearly quadrupled in the last two decades

[11] International Energy Agency (IEA), *Energy Policies of IEA Countries: Turkey - 2009 Review*, 2009.
[12] PriceWaterhouseCoopers, *On the Sunny Side of the Street*, 2009, http://www.boell-meo.org/downloads/Renewable_Energy_Turkey.pdf.

reaching 44,782MW in 2009. With 15,514.6MW of installed capacity, renewable energy sources fuelled 19.6% of the total power generation in 2009 generating 38.1TWh of electricity. Among renewable sources, hydropower has the largest share followed by wind and other sources in terms of production and installed capacity[1].



Source: IEA

3.1. Renewable Sources: Current State

a. Hydro

Hydropower accounted for 94.38% of the total electricity generation within the renewable energy sources in 2009. Total installed capacity for hydropower is 14.5 GW whereas Turkey's potential hydroelectricity capacity is 37.1 GW[13]. Although the installed capacity is currently 39% of the potential, an additional 48% of that potential is at various stages of planning and development. The majority of the HPPs are operated by the state but many of them will be privatized in near future. With that vision, 67% of the energy generation licenses granted to the private sector were for the construction of the new hydropower plants in 2008[14].

b. Wind

Wind power is another critical renewable energy source not only for Turkey but also for the region due to a unique combination of climate and topography. Estimated physical capacity exceeds 48GW (wind speed> 7.5m/s) with 803MW of installed capacity as of 2009[15]. This capacity generated 1.5TWh of electricity in 2009[16].

The turning point for the investments on wind power has been the enactment of "Law on the Utilization of Renewable Energy Resources for the Purpose of Generating

[13] International Energy Agency (IEA), *Energy Policies …*, cit.
[14] PriceWaterhouseCoopers, *On the Sunny Side of the Street*, cit.
[15] Republic of Turkey Ministry of Energy and Natural Resources, *Energy*, http://www.enerji.gov.tr/index.php?dil=en&sf=webpages&b=enerji_EN&bn=215&hn=&nm=40717.
[16] International Energy Agency (IEA), *Energy Policies …*, cit.

Electricity" in 2005 before which, the total installed capacity was less than 20MW. In order to promote generation of electricity with renewable sources, government set the target of 20GW for the installed wind power capacity by 2023 in its "2009 Electricity Market and Security of Supply Strategy". Given this target, current transmission system operator will be investing in grid performance in terms of grid connections and transmission to accommodate 15GW of wind power due to its variable nature[17].

c. Geothermal and Biomass

Geothermal and biomass accounted for 2% of the total power generation among renewable sources with 1.2% and 0.8% respectively. Total installed capacity is 158.2MW.

Geothermal and biomass are also used for heating. 5Mtoe of firewood was used for heating in rural areas whereas 0.9Mtoes of geothermal heat fueled district heating systems in 17 municipalities to serve residences, spas and greenhouses in 2008[18].

d. Solar

Similar to geothermal and biomass, main use of solar energy in Turkey is heating. Thermal solar collectors are widely used in houses and industrial sites utilizing more than 1% of Turkey's technical potential of solar energy estimated at 32.6Mtoe by the government.

3.2. Setting Policy Targets: 2023 Objectives

Due to her young and urbanizing population and comparatively low energy use, growth in energy demand in Turkey is expected to be high in the following decades. Therefore, securing the energy supply is among the top priorities in energy strategy along with market reform and environmental issues. In order to secure energy supply, Turkey aims to increase power generation through renewable sources while actively engaging with neighboring countries to diversify natural gas and oil sources.

The overall target for renewable sources is to provide at least 30% of electricity generation by 2023. This is a considerable increase as the total power generation is estimated to double by the same year. Given that vision, the authorities target harnessing the hydropower potential of 140TWh, geothermal power capacity of 600MW, and increase the wind power capacity to 20GW over the next 13 years[19].

3.3. Institutional and Legislative Framework

The Ministry of Energy and Natural Resources (MENR) is the main body responsible for the preparation and implementation of energy policies. Within MENR, the General Directorate of Energy Affairs (EIGM) conducts studies and develops policies on renewable energy where the Electrical Power Resources Survey and Development Administration (EIE) is responsible for surveys and research on renewable energy sources. The Energy Market Regulatory Authority (EMRA) was established by the Electricity Market Law (EML) in February 2001 as the independent regulatory authority

[17] International Energy Agency (IEA), *Energy Policies …*, cit.
[18] Idem.
[19] Republic of Turkey Ministry of Energy and Natural Resources, *Energy*, cit.

to supervise market, implement a licensing regime and monitor the progress in the renewable energy segment.

Following EML in 2001, the amendment to the Electricity Market Licensing Regulation (EMLR) in 2003 marked the first legislative step towards electricity generation from renewable resources.

Meanwhile, market reforms were slowly transforming the power sector by moving to cost-reflective tariffs and privatizing distribution companies and generation assets. Building on EML and EMLR, "The Law on the Utilisation of Renewable Energy Resources for the Purpose of Generating Electricity" was enacted in 2005 and its subsequent amendments constitute a critical milestone for power generation from renewable sources in Turkey.

Under this law, feed-in tariffs, purchase obligations, connection priority, reduced licence fee and exemption from licence obligations for small scale generators (up to 500KW) were critical support mechanisms to promote renewable sources. In addition to EML, EMLR and Renewables Law, "Environment Law" enacted in 2006 and "Energy Efficiency Law" enacted in 2007 form the basis of the current legal framework on generating electricity from renewable sources.

Recent regulatory documents on renewable sources include the "Public Support for Investments 2009 (TEBLIG 2009/1)" by the Undersecretariat of the Treasury and "Regulations on the Program for Supporting R&D Projects in the Energy Sector (ENAR), 2010" by MENR. ENAR document focuses on the scope of R&D support for renewable energy technologies and TEBLIG 2009/1 document covers public support mechanisms for all kinds of investments without including clean energy. In June 2010, the government also proposed an amendment to the Renewables Law revising the incentive scheme. The new scheme, which is still pending, suggests higher tariffs for renewable energy licensees and even higher tariffs for licensees who procure equipment from domestic suppliers.

3.4. Looking Forward: Key Assets

With quite ambitious medium to long term targets in renewable energy, Turkey has an active agenda to implement its strategies. Key contributors to the successful realization of this agenda are:
- R&D policies and incentives,
- human capital,
- medium to high-tech manufacturing industry,
- corporate expertise in large scale engineering projects.

These key assets will need to be mobilized within a transparent and reliable policy and incentive framework to ensure foreseeability. Only by bringing together these components in a coherent, steady policy framework, Turkey can fully mobilize the requisite financial, organizational and human resources to secure renewable energy sources.

3.4.1 R&D Policies and Incentives

State Planning Organization (SPO) and the Supreme Council for Science and Technology (BTYK) have been working on policies for the establishment of a complete national system of innovation with necessary institutions and initiatives in coordination with the Scientific and Technological Research Council of Turkey (TUBITAK) since 1990s. Initiated by TUBITAK, National Research and Technology Foresight Program (Vision 2023 Program) offers some guidance to Turkey's long-term R&D policies.
Together with the Vision 2023 Program, Energy Efficiency Law enacted in 2007 urges TUBITAK to fund R&D projects on topics like renewable energy, energy efficiency and storage systems. Substantial advances in these areas will play a major role in increasing the total energy supply through renewable sources as indicated in the national energy strategy.

Envisioned by the aforementioned policies, Turkey has several support mechanisms to promote R&D, including research grants for private sector and academia, loans for technology start-ups, tax exemptions to technology companies and development programs to increase total workforce in science and technology.

As an integral part of extensive efforts aimed at increasing the overall R&D activity, energy research has been attracting serious attention in the last years.

Apart from providing funds to energy R&D under its industrial grants program TUBITAK has invested heavily in energy R&D as part of its in-house research activities. As one of the main players in energy research, Energy Institute of TUBITAK has more than 130 full time researchers operating in Marmara Research Center with a budget of 75.3m TRL for its multi-year projects in 2009.

It has four strategic business units: Advanced Energy Technologies, Fuel Technologies, Vehicle Technologies and Power Electronics Technologies. Some of the current research projects include liquid fuel production from biomass, coal gasification and hybrid motor vehicles.

Apart from TUBITAK, the Ministry of Energy and Natural Resources (MENR) also provides funding for both academic and private R&D projects specifically in the domain of energy under its ENAR (Energy Research) program with a total budget of 50m TRL in 2010.

The Technology Development Foundation of Turkey (TTGV) provides soft loans up to 1m USD for projects on renewable energies, energy efficiency and environmental technologies. TTGV has also established the "Local Energy Technologies R&D Platform" in 2010 together with MENR, EUAS (Electricity Generation Co. Inc owned by the state) and OSTIM (Organized Industrial Zone) to define roadmaps to increase domestic energy supply through development of relevant technologies.
Since 2000, Technology Development Zones (TDZ) play a pivotal role in promoting private R&D collaborations between private entities and universities/research centers. In addition to proximity to qualified R&D personnel and technology transfer services, science parks provide considerable tax incentives to companies conducting research and development. Although TDZs successfully clustered nearly 30% of private R&D

personnel in Turkey, the volume of energy related research is still relatively low, comprising only 0.7% of all projects among science parks.

3.4.2 Human Capital

Since human capital is a critical component in implementing long term energy policies, the volume of teaching staff and graduate students is a significant parameter.
As of 2008, universities accounted for almost half of total R&D in Turkey in terms of expenditure (43.8%) and R&D personnel (44.5%). In 2008, universities spent 2.36bn USD on research and development with nearly 30,000 R&D personnel.

Currently, 7,385 faculty members are working with 36,432 graduate students in all branches of engineering in Turkish universities. Nearly 50% of the faculty members and the graduate students conduct research in fields that support directly or indirectly energy R&D&D efforts like mechanical, electrical and chemical engineering as well as material and nuclear science.

Furthermore, there are graduate energy institutes which currently house 185 faculty members and 620 graduate students.

3.4.3 Medium to High Technology Manufacturing Industry

A critical contributor to Turkey's energy R&D&D will be the competence of medium to high technology manufacturing firms. After acquiring the necessary know-how either through national R&D efforts or through technology transfer, the next step in developing renewable energy capability is the manufacturing of high quality sub-components.

In order to ensure affordable renewable based electricity in the long-run and to increase total supply at the same time, Turkey needs to invest in its local power plant manufacturing capabilities and decrease its dependence on imports. Furthermore, the emergence of such competence will allow Turkish firms to become, over time, active global players in the rapidly growing renewable sector. Medium and high-tech manufacturing firms that have become integrated with global value chains and that function seamlessly within such structures can leverage their technical expertise, and business knowhow to take part in this transformation.

a. Hydro

Of the new electricity generation licenses, 67% have been granted to HPP projects in 2008. Turkey's corporate expertise in large construction projects has been a critical domestic asset in dam construction; however, the limited production capacity of the state owned HPP turbine manufacturer[20] encourages investors and engineering project integrators to import power generation equipment.
As the capacity of the hydro power plants increase, resistance from the local communities to large dams or resistance due to other environmental concerns results in diminishing marginal returns for the HPP investments.

[20] Temsan is the state owned HPP turbine manufacturer.

b. Wind

Although there aren't any domestic manufacturers of wind power plant equipment for projects with capacities larger than 1 MW, wind turbine production is gaining interest among small manufacturers. Smaller turbines are easier to manufacture but are limited in capacity. This type of use is widespread in remote residences and highways to generate electricity on small scales. There are also plans and attempts by domestic manufacturers to build mid-high capacity wind power plants in Turkey.

Despite the efforts to manufacture mid-size wind power plant equipment, the sector needs to overcome certain problems to reach feasible production. Continuing cost advantage of imported equipment; complexity of the certification process; limited focus of academic research on the subject and scarcity of funding mechanisms for large scale projects are examples of such problems.

Due to the aforementioned factors, current installed capacity for wind power to generate electricity consists of plants assembled by foreign system integrators with components manufactured in different countries. Instead of building an entire wind turbine, domestic manufacturers can concentrate their efforts on manufacturing individual components like the tower, nacelle, or the wings[21] to increase their competence.

c. Solar

Despite solar's estimated potential of 32.6 Mtoe, widespread use of this renewable source in Turkey is in heating with thermal collectors. A small share of households utilizes thermal collectors for water heating. In response to this demand, domestic companies invested in manufacturing equipment like glass layer, selective surface and isolation layers as integral components of thermal collectors[22]. Mature industries like metallurgy and chemicals can be incentivized to invest in selective surface manufacturing.

Apart from thermal collectors for heating, parabolic collectors are used to generate electricity for industrial use. These solar collectors consist of parabolic cases, heat conducting liquid, vacuumed glass and metal tubes and steam generator. Turkey's glass and metal industries are potential entrants to the manufacturing of parabolic collectors. Although vacuumed glass pipes are not manufactured by local companies at the moment, successful prototypes of local parabolic collectors will enter the market in near future to generate electricity and feed the grid with the excess amount.

Photovoltaic (PV) based systems are used to generate electricity directly from solar power without an intermediary like water or any conducting liquid. Use of PV panels which consist of silicon based PV cells is limited to locations like remote residences, university campuses and telecommunication towers in Turkey. Due to the lack of necessary know-how to manufacture PV cells, local firms in Turkey have started

[21] Çimtaş is a company constructing towers for wind turbine; several other firms exist who are competent in steel production. Composite boat producers like Yonca-Onuk are potential candidates for wing manufacturing. For the nacelle, successful companies like İşbir, Emsa and Aksa can contribute to production of electromechanical parts and several others for standard mechanical components.

[22] Baymak, Ezinç and Feniş are large companies able to manufacture all components of thermal collectors.

manufacturing PV panels using imported cells. Although there are initiatives with that vision, costs are still high in comparison with imported panels and lack of public incentives prevents development activities to decrease production costs.

d. Corporate Expertise in Large-Scale Engineering Projects

Together with technical know-how, human capital and production capability, system integration and project management are critical dimensions in energy investments. Therefore, the fourth key contributor to the successful realization of long term energy investments will be the accumulated managerial expertise of large Turkish companies.

As the pioneer sector in exports, Turkish engineering/construction companies implemented projects worth of 23.6bn USD globally in 2008. Construction project exports reached this amount in 8 years from 750m USD in 2000. In order to meet this demand, Turkish steel and cement production also grew rapidly. Today, Turkish companies manage construction projects worth 170bn USD in 80 different countries. Although Russia, Turkmenistan and UAE account for almost half of the investments in 2008, African countries have become attractive investment targets recently. Turkish companies are operating large-scale projects in diverse geographies with success, coming third after United States and China in construction[23].

Through the expertise of large construction companies like GAMA and ENKA, Turkey has the potential to lead large-scale energy projects both locally and within the region. Based on their expertise in building power plants for years, these companies are candidates for integrating wind turbines, biomass facilities and industrial solar power plants as well. Considering the growing energy demand in the Middle-east, Caucasus and northern Africa, management competence in these geographies distinguishes Turkey as a potential system integrator of energy projects.

4. Potential for Bilateral Collaboration

Bilateral cooperation in a technical domain should be predicated on shared aspirations and complementary competences.

The first question is whether Turkey and Italy share an interest in developing their renewable energy sectors. Renewable energy may implicate a distributed energy system with a preference for extensive local production. That is not an issue addressed or prioritized in the Turkish policy planning. Whether the focus on renewable energy as a distributed system and hence on local production is a cause for strategic divergence between the two sides needs to be carefully considered and discussed.

Provided that the introduction of renewable energy and development of the renewable sector is a shared aspiration between Italy and Turkey, the next issue is to address is possible complementarities.

[23] Turkish Contractors Association (TCA).

Complementarities may appear in different forms. Some examples are:
- Complementarities across sub-segments of the renewables sector
- Complementarities within the sub-segments of the renewables sector (i.e. within wind industry, or the solar industry)
- Complementarities in terms of target markets (Italy with easy access to EU markets, Turkey easy access to Middle Eastern markets)
- Complementarities between R&D capabilities
- Complementarities between manufacturing capabilities

Once useful and meaningful complementarities are specified, the two sides can then formulate a comprehensive strategy of collaboration to leverage their strengths. The strategy for collaboration should be far-reaching and should advance institutions and mechanisms for cooperation in:
- Joint public funding schemes for R&D
- Joint funding, incentives or mechanisms for human capital
- Joint procurement policies
- Joint schemes for provision of VC funding for renewable energy
- Joint schemes to facilitate and incentivize corporate cooperation

Aligning national objectives, identifying complementarities and developing comprehensive schemes for bilateral collaboration is not an easy task and would demand careful effort and determination on both sides.

Moreover the two countries can join their capabilities in multilateral collaboration. For example, in the research and development (R&D) area, ENEA and RSE (an Italian research institute formerly called ERSE) from Italy and TÜBİTAK from Turkey have recently started co-operating within the framework of the Joint Programme on Smart Grids launched by EERA, the European Energy Research Alliance. This Joint Programme, which is co-ordinated by RSE, brings together many of the major European research centres in the fields of DG, RES, distributed energy resources (DER) and, in general, smart energy networks.

IV. Internet of the future (IF)

1. Concepts and Prospects

1.1. Development of ICT in Europe

As a result of the technological developments of the last decade, Information and Communication Technologies (ICT) have become pervasive and now influence many and various aspects of life and the economy. But their success is now their limit.

1.2. Prospects for next generation Internet

Although it was not planned, the Internet of today has become a critical element of the economy in almost all economically developed countries. Its physical infrastructure, software and content are now an integral part of all our lives lives. The Internet has shown remarkable flexibility in the face of continuously increasing numbers of users, data volumes, and changing usage patterns, but now faces growing challenges in meeting the needs of the knowledge society. Technological progress in various area is starting to show the limits of today's Internet. Current networks are an evolution of the first network designed in the 1970s and are no longer able to meet the growing demands of users. Some of the current limitations of the Internet are: mobility management, number of devices, network types supported, bandwidth limits, available memory and computing power, flexibility, reconfigurability, security and privacy, and so on. The time is right, therefore, to start designing the Future Internet. In this context, various debates are being conducted as to when and how the Internet should evolve in the future.

1.2.1 The European Initiative

The European ICT Research and Development strategy is based on a number of different tools. The first is the Framework Research and Technological Development (RTD) Programme 2007-2013. Within this programme, ICT is by far the largest beneficiary area. ICT research projects are expected to receive more than 9,000 million euros in grants, with RTD investments envisaged thus far totalling more than 20,000 million euros over seven years.

But this accounts for only 5-10% of the Europe-wide investments in ICT RTD. To help the 27 Member States converge around major common objectives, the Commission recently proposed an i2020 Strategy for the Information Society which contains a list of objectives to be met by every Member State by 2020. Internet of the Future is central both to the RTD Framework Programme and to the i2020 Strategy.

This huge amount of funds will have to be spent on both infrastructure (the so-called Next Generation Network, with much higher speed and transmission capacity) and applications. The priority areas are government and the civil service, health, mobility, energy, the economy, trade and so on.

1.2.2 A longer-term vision

Ten years ago, the European Commission developed a vision for the Information society called “ambient intelligence”. Based on that vision, everybody, and every organisation, should eventually have the opportunity to be connected with the Net anytime and anywhere, in natural language, in order to receive all kinds of services and applications. The real novelty of this vision was the stress placed on the natural language (not only words but also gestures, pauses etc). This way, the “digital divide” (today more than 2/3 of the world’s population is excluded from the Information Society) could have been reduced by 80% by 2020.

But this vision also included a number of aspects which have now become much more evident, such as the social implications of the new communication devices (see, for example, the spread of SMS on mobile phones and its consequences on communication and social behaviour patterns, especially among teenagers); or the diffusion and social-political implications of the “social networks” (Facebook, Twitter etc.).

Typing and handwriting could become obsolete technologies replaced by dictating; the study of foreign languages for travel or business could become less important than today, replaced by simultaneous automatic translations; office work could be transformed, both in terms of roles (secretarial activity would eventually disappear) and of ways of doing things; distance working and virtual meetings could become much more frequent than today.

The learning process, too, is under discussion: the fact that the information needed will be available when and where desired could reduce the importance of memorising or mentally storing facts, telephone numbers, stories, poems etc. Intellectual processes, including reasoning capabilities, could be affected in an unpredictable way.

This is not science fiction: all the technological building blocks already exist and the first experiments are under way. And the timescale is relatively short: large-scale demos could be in place in five years time and commercial applications could become a reality in less than a decade.

Other areas to be profoundly affected are the media industry: the new and improved e-books on offer (with the double option of reading and hearing) seem to be meeting with the approval of a new generation of consumers and the sharply increasing demand for electronic newspapers is moving in the same direction.

The driverless car is under study in many labs and prototypes are soon to be presented to the general public.

The option (or temptation) of direct democracy experiments is already available in small environments but could become an opportunity (or a fear) for larger ones.

And the list could go on.

Alongside these new kinds of application, some very delicate questions need to be considered. First of all, the need to close, or at least narrow, the digital divide: too many people still today have difficulty using computers and interacting with the net. Second, the need to give everybody the same connection possibilities: differences (between cities and villages, say) could have grave implications for democracy and citizenship. Third: the need to give greater attention to three main issues: privacy, security and dependability. Future demo projects will have to take care of these issues.

2. IT in ITALY

2.1. The Italian ITC industry

In 2008, the ICT sector (including broadcasting and media) accounted for more than 100,000 companies with a total turnover of 157 bn euros, 66 bn added value and 8.4 bn investments. Of course, the ICT sector is one of the most innovative, investing 6.5% of its turnover in R&D.

A growing part of these investments is and will be devoted to the implementation of the Internet of the Future.

2.2. R&D trends

The Italian trend is in line with the general line of development. After the first Internet infrastructure (Web 1.0), strongly geared to the sharing of data and information, the second generation Internet (Web 2.0) has been more focused on exchanging content and social networking. The Next Generation (Web 3.0) will allow content and information sharing and service application development.

2.3. Content of Internet of the Future projects

Research is now focused along the following lines:

- The Next Generation Network should be able to meet the needs of every user under dynamic conditions and respond immediately to every request. It will include innovative technologies in the fields of fibre optics, wireless communications, sensors and satellites.

- the Internet of Content and Media, where multimedia content can be shared, modified and used by a plurality of users. Human language technologies, knowledge management, multimedia perception and interaction will be important enablers of this line of development.

- the Internet of Services, where a great variety of applications is active and available. The list of services and sectors includes business, public utilities, government, personal services etc.

- the Internet of Things, where objects of everyday life become electronic devices interacting actively with the network. The Internet of Things will be closely connected with embedded systems and the so-called “systems of systems”. At one extreme we will have systems interacting with the physical environment (e.g. industrial plants or automated factories), while at the other they will interact with social environments (smart houses, hospitals, nursing homes, schools etc).

- the Internet for and by people, where individuals or groups of individuals can share ideas and projects, participate in social life, and create and share content. Here, the crucial technologies are related to new kinds of interfaces.

These different Internet environments have many common features. Users (prosumers, clients and citizens, business people, civil servants etc) can access more than one environment.

Another way of structuring the programme is to regroup the applications around three main areas:
- life-centred Future Internet
- the Internet of Public Services
- the Internet of e-business and ecosystems.

Programmes of this nature are being developed by a complex network of institutions and companies (universities, research centres, science parks, technology districts, competence and excellence centres, industrial and service companies). All of these bodies and sectors operate individually but also, and increasingly, through cooperation at the local, national and international levels.

2.4. Support policies

ITC activities are supported by the same kinds of programmes, projects and arrangements as in other fields. Due to their size, they “intercept” a significant part of the public funds devoted to RTD support.

Special mention should be made of the initiatives developed by Italy’s Ministry for Public Administration and Innovation. Its aim is to modernise Italian bureaucracy through a powerful injection of Information Technologies and applications. Its programme (e-Government 2012) is already under way and involves the national, regional and local levels of government. Its main objectives are to facilitate interaction both within the public administration and between it and citizens, reduce its costs and improve its effectiveness. More recently, this programme has been reshaped and extended to bring it more closely into line with the European Innovation Strategy i2020.

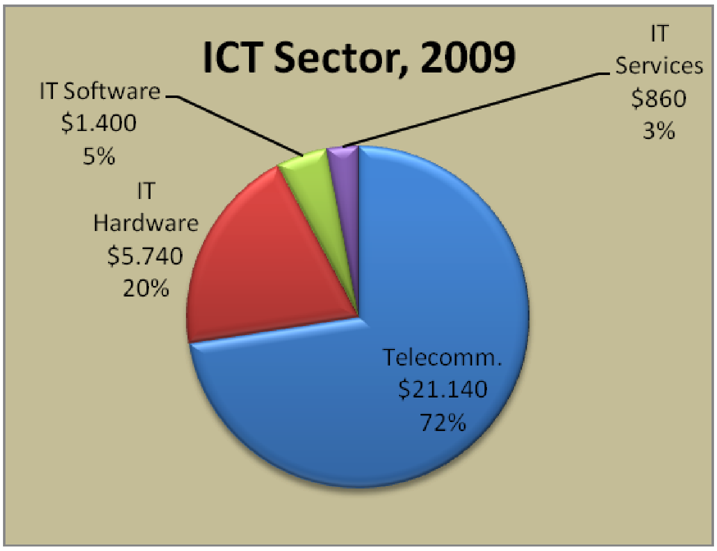
3. IT in Turkey

3.1. ICT in General

Information and communication technologies (ICT) sector is recognized as one of the main driving forces of economic development. In 2009, expenditure in ICT accounted for 4.7% of GDP[24] with 29bn USD[25]. As a key sector in increasing economy-wide productivity and creating new business models, ICT is widely regarded a strategic sector.

Turkish ICT market reached 29bn USD with a compound annual growth rate of 14% over the 2005-2009 period. It is expected to increase significantly in the coming years due to the growing demand in IT services and infrastructure. The Telecommunication Authority of Turkey announced that the ICT sector is estimated to reach 160bn USD by 2023.

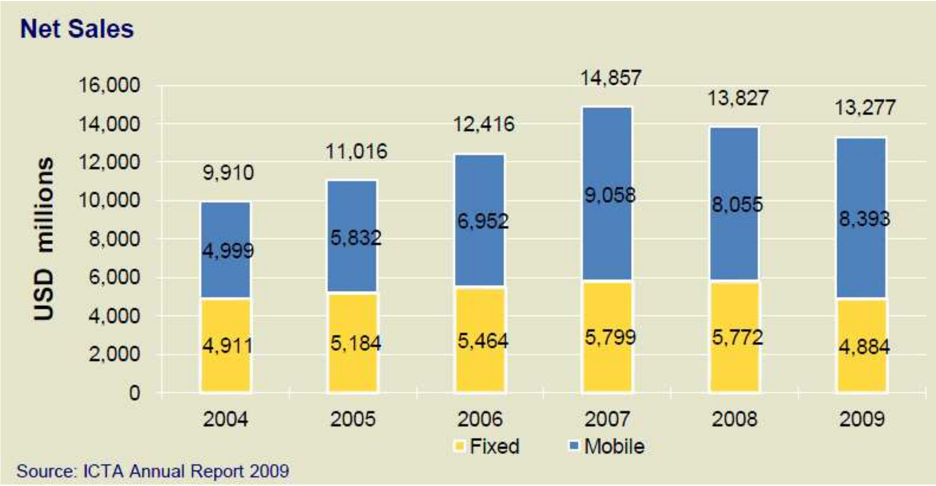
In 2009, the share of telecommunication technologies within ICT was 72% composed predominantly of carrier services while information technologies comprised the remaining 28% with hardware, software and services[26].



3.2. Telecommunications

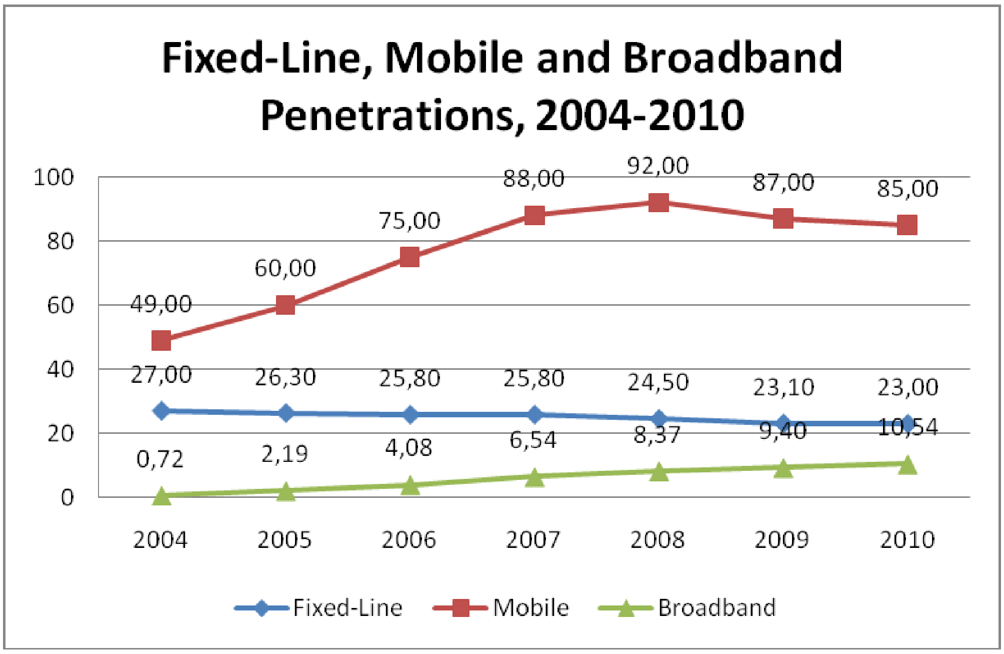
Telecommunication technologies constituted 72% of the entire ICT market in Turkey in 2009. With 85% of mobile penetration and 41.6% of household broadband penetration rate as of 2010-Q2, the market still has room to grow. In 2009, total telecommunications revenue was reported to be 13.3bn USD comprising both mobile and fixed line with 63.2% and 37.8% respectively. For the same year, total investments reached 3.7bn USD with an increase of 46% compared to the previous year[27].

[24] Republic of Turkey Prime Ministry - Under-Secreteriat of Treasury of Turkey, http://www.treasury.gov.tr.
[25] Republic of Turkey Prime Ministry - Investment Support and Promotion Agency of Turkey (ISPAT), http://www.invest.gov.tr/en-US/sectors/Pages/ICT.aspx.
[26] Turkish Informatics Industry Association (TÜBİSAD), http://www.tubisad.org.tr.
[27] Information and Communication Technologies Authority of Turkey (ICTA), http://www.btk.gov.tr.



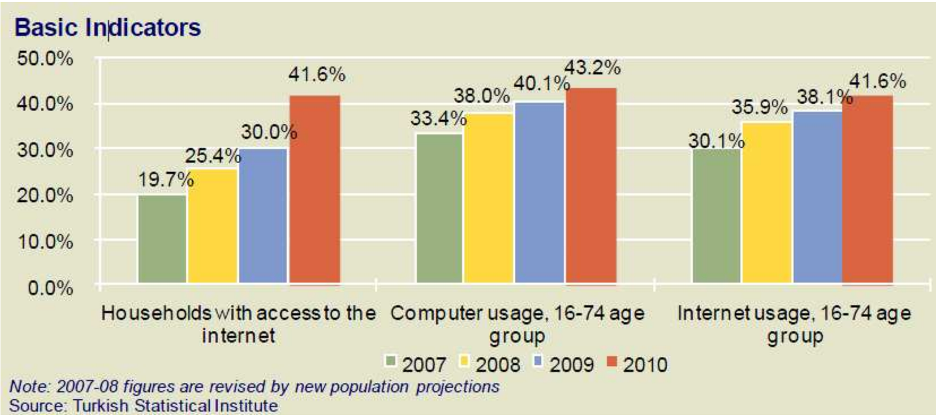
Although mobile services play a major role within the telecommunications sector, 85% of mobile penetration is still below EU average of 125%. GSM operators Turkcell, Vodafone and Avea accounted for 82% of the call traffic in 2009 with 62.8m subscribers. Additionally, with the introduction of 3G services, 2.7m users accessed the internet from their mobile devices. Since the number of GSM subscribers is expected to grow at an annual rate of 5.5% for the following four years, mobile penetration will presumably reach 113% by 2014[28].

Mobile number portability was introduced in Turkey on November 9, 2008 to strengthen free competition in the market.



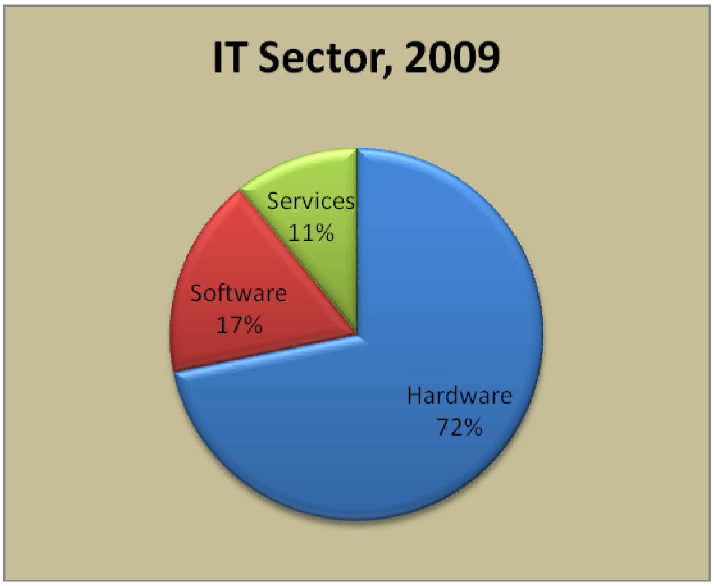
[28] Idem.

Fixed-line penetration in Turkey has been decreasing since 2003 due to the widespread use of mobile technologies. Although the share of call traffic on is low (18%), 83.5% of broadband internet users are ADSL subscribers operating on the fixed-line infrastructure. In 2010-Q2, household broadband penetration rate in Turkey reached 41.6% with 7.62m users (up from 1.6m in 2005) and is expected to increase further in the coming years (12.69m by 2014).[29]



3.3. Information Technologies

Within the information technologies, IT hardware, services and software accounted for 72%, 17% and 11% of total IT revenues in 2009 respectively[30].



[29] Idem.
[30] Turkish Informatics Industry Association (TÜBİSAD), http://www.tubisad.org.tr.

3.3.1 Hardware

IT hardware constituted 72% of the IT market in Turkey with a volume of 5.7bn USD in 2009[31]. Due to the advances in hardware technology and the growing expertise of local manufacturers like Beko, Casper and Escort, PC and notebook sales are on a rising trend. On the other hand, multinational companies like IBM, HP, Dell and Cisco account for a considerable share of the IT hardware market.

As of 2010, household ownership of PCs and notebooks are 33.8% and 16.8% respectively[32]. Total stock of PCs per 100 people was reported to be 25.3 for 2009[33]. When compared with the EU, computer penetration is still low despite the rapid growth in sales. However, this generates an opportunity for market growth in the coming years together with the rising incomes. With faster internet speeds, growing broadband penetration is likely to be the key driver of computer sales.

Strong growth prospects for the Turkish PC market have encouraged PC vendors to increase investment in channels and local production. Market leader HP's new plant is expected to produce 200,000 units a year after operations start in 2010. Meanwhile, Japanese IT giant Fujitsu expects Turkish output to be 70,000-100,000 units in 2010[34].

3.3.2 Software

Software is one of the fastest growing markets with a size of 1.4bn USD in Turkey[35]. The market is composed of both small and larger companies which are progressively being certified for undertaking large-scale projects. While some customers, like the government, require tailor-made software, there are many packaged products on the market as well. On the other hand, rising level of computer and internet penetration offers opportunities for content developers for both computers and smart-phones.

Through the high-caliber human capital from computer engineering departments of universities and self educated enthusiasts, software industry has potential to generate a substantial increase in sales over the next few years. Total of 55 computer engineering departments in various Turkish universities and 727 private computer (design and programming) training institutions train an increasing number of IT professionals to meet the demand of the sector[36].

3.3.3 Services

Services constituted 11% of the IT market with 860m USD in 2009[37]. While support remains the largest services category, other groups including outsourcing on non-core functions and training services are growing particularly fast.

IT services vendors have continued to strengthen infrastructure and service offerings in Turkey, despite the global recession.

[31] Idem.
[32] Turkish Statistical Institute (TURKSTAT).
[33] Republic of Turkey Prime Ministry - Investment Support and Promotion Agency of Turkey (ISPAT).
[34] Market Publishers, *Turkey IT Report Q4 2010*.
[35] Turkish Informatics Industry Association (TÜBİSAD).
[36] Republic of Turkey Prime Ministry - Investment Support and Promotion Agency of Turkey (ISPAT).
[37] Turkish Informatics Industry Association (TÜBİSAD).

3.4. Policies

During the last decade, several governmental policies have been successfully implemented to support the ICT market: a) Enactment of the “Technology Development Zones Law” to promote research and development, b) E-government investments.

In 2001, “Technology Development Zones (TDZ) Law No:4691” was enacted by the government in order to promote university-industry cooperation through the establishment of science parks. As a result of considerable tax incentives and proximity to faculty members and students, science parks have quickly become clusters of technology companies predominantly in the software sector. As of 2009, 61% of the projects were in the ICT sector where nearly half of the R&D personnel were computer engineers or programmers in the science parks. In addition to the TDZ law, “Research and Development Law No:5746” was enacted in 2008 to promote R&D activities conducted by companies outside the science parks.

Investments in the “E-Government” projects aimed at creating a citizen-centric government with online applications are very critical in the national IT agenda. Health, justice and security applications were available in 2009 while the remaining components are planned to be rolled out by the end of 2010. Supported by the International Telecommunication Union, Turkey’s e-health project is a considerable opportunity for local IT vendors since healthcare organizations will demand high-quality services and efficiency improvements.

Concluding remarks

Italian and Turkish authorities have been designing, implementing and funding policies and institutions to achieve ambitious R&D targets. Given the inherently global nature of science and technology, such efforts can easily be supplemented with policies that can leverage international collaboration; and both countries have clear policies on that.

In this paper, we propose a few potential joint policy areas to stimulate discussion. The following ideas are presented in a spirit of intellectual experimentation.

Italy and Turkey are part of the European RTD Framework Program and have some scientific and technological bilateral agreements in place. As far as the European Framework Program is concerned, the rules of the game have already been defined, but bilateral consultation in identifying subjects and organizing the project team could help to improve the two countries' presence and increase the strategic value of the proposals submitted.

At the bilateral level, collaboration could include the following dimensions:

1. Joint public funding: the two nations could allocate resources to support R&D funding for joint efforts in specified areas of mutual interest.

2. Joint human capital investment: most universities already invest in cross-border collaboration. However, if a technology domain is specified as a collaboration area with another nation, the agreement could provide incentives to the universities of the two nations to invest further in training researchers. If appropriate, universities can develop joint programs that can leverage complementary academic competences.

3. Procurement: as discussed above, demand-side support for R&D commercialization is as important as the supply-side R&D incentives. The two countries can coordinate their procurement policies in the jointly determined domain of collaboration to support the efforts by their companies. EU regulations could hinder outright collaboration but innovative policy formulations can be developed.

4. Private Funding / Venture Capital funding: most R&D based corporate initiatives are financially constrained. Moreover, given the risky nature of the R&D effort, securing bank financing may not be easy. VC institutions and practices are not well-developed in many nations. Collaboration between the VC sectors of the two countries or the joint efforts between public or quasi-public institutions (largely represented in both countries) may be crucial in addressing this problem. Authorities may offer financial sweeteners to VC firms for their involvement in projects in their agreed domains of collaboration.

5. Information provision and facilitation of corporate collaboration: although companies that have mutually beneficial complementarities are likely to find each other, SMEs may not always have the time or the resources needed for making that effort successful. Governments could act as a reliable repository of corporate information in the domain of collaboration to facilitate joint efforts.

Effective policy design in any one of these areas would require careful consideration and analysis and could, in the end, not be worth pursuing. On the other hand, there may be other areas of policy initiatives, not included in the above list, that could prove crucial in advancing successful collaboration between the two states.

There are many ways to put in place or improve bilateral cooperation: the scope of this paper is not to select one of them but to open a dialogue on them.

Some joint projects already exist; many Italian and Turkish companies have bilateral technological and industrial agreements; the two scientific systems have a number of joint activities. The first thing to do, then, is to analyze in detail what already exists and to understand the level of satisfaction and the quality of the results obtained. Even the less positive experiences can have great value as lessons to be learned in order to avoid the same mistakes in the future.

Every new approach will, therefore, leverage on this, but should also make an effort to move on with new ideas and initiatives.

The most obvious proposal is to set up a small bilateral team, including representatives from the administrative, scientific and economic environments to collect information on the ongoing activities, review the scientific, technological and industrial priorities and set up a first approach to global collaboration strategy.

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