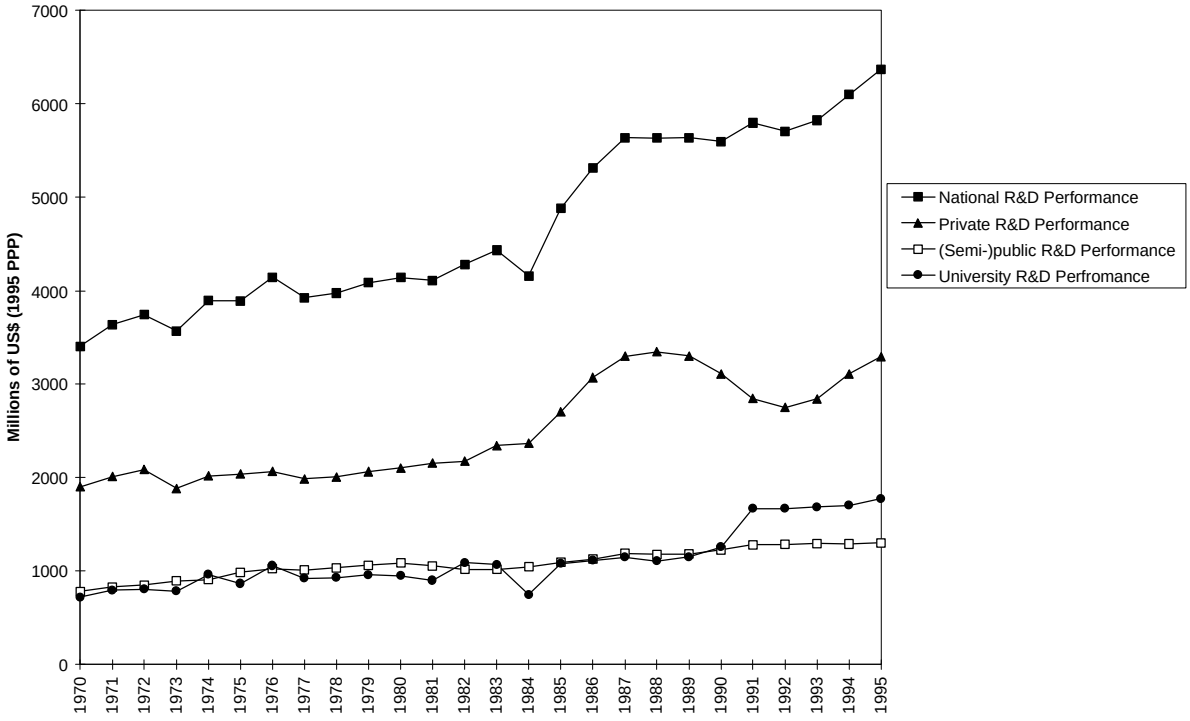
NATIONAL SCIENCE AND TECHNOLOGY EFFORT

In 1995, the Dutch national R&D effort reached $6,371 million (Fl 13,352 million). Private sector firms and private for-profit laboratories performed $3,296 million in R&D in 1995 (Fl 6,855 million). Semi-public[1] research performers accounted for an additional $1,301 million of the R&D performed that year (Fl 2,707 million), while universities accounted for $1,774 million of R&D performance (Fl 3,689 million) (CBS, September 1997).

Figure 1 shows trends in the performance of R&D in the Netherlands R&D over the past 25 years. Growth in national R&D expenditures slowed significantly at the start of the 1990s. When corrected for inflation, the growth in R&D expenditures was 1.5% per year from 1990 to 1995. From 1985 to 1990, growth was 2.71% per year (Tijssen et al., 1998). Over the past decade, the contribution of the different sub-sectors (private R&D, university R&D, and semi-public R&D) to national R&D performance has remained relatively stable (52%, 29%, and 19% respectively) (see also Figure 2).

Figure 1: Total National R&D in the Netherlands: by Performing Sector[2]



[1] Please see footnote 2 for the definition of "semi-public R&D performers."

[2] There have been two major revisions to this data set in recent years. Beginning in 1993 companies with fewer than 50 employees were included in the "private R&D performance" category. This had the effect of slightly increasing the figures for private R&D performance. The second revision concerns the method by which "university R&D performance" was calculated. This revision resulted in a significantly higher estimate (30% or about $350,000 between 1990 and 1991) for university R&D performance. Source: CBS, various yearly reports.

In 1985, 48% of the national R&D expenditure was financed by the government; however, by 1995 the government's share had fallen to 42%. The private sector's share in national R&D financing decreased over this same time period from 49% to 46%.

An important explanation for the decreasing contribution of both government and private companies is the increase in resources coming from abroad. Between 1990 and 1995, R&D performed in the Netherlands that was financed by a foreign source increased almost fivefold. One significant manifestation of this increasing internationalization is the Netherlands' growing participation in R&D programs sponsored by the European Union (Tijssen et al., 1998; CBS, September 1997).

Figure 2 shows R&D as a percent of GDP for the various R&D performing sectors in the Netherlands. After a decrease between 1988 and 1992, national R&D intensity has recovered. The national R&D intensity in 1995 was 2.09% of GDP. Figure 2 clearly shows that changes in private R&D effort are the most important reason for fluctuations in the total R&D effort.

Trends in Private R&D

The significant decrease in private R&D performance that occurred in the late 1980s and early 1990s is mainly explained by the decline in R&D activities of five major Dutch R&D-intensive multinational companies.[3] These reductions in R&D spending were particularly large for the Netherlands's largest R&D spender, Philips, which implemented a series of significant budget cuts when it was confronted with a deteriorating market position in 1987. The relative role of these five large firms in supporting private sector R&D is decreasing. In 1985 these five firms performed 60% of private sector R&D activity; by 1995 their share decreased to 46%.

While these five large firms have decreased their support for R&D in the Dutch economy, smaller firms have increased their relative role in supporting R&D. Between 1990 and 1995, small and medium-sized enterprises (defined as having between 50 and 200 employees) increased their share of private R&D performance from 7.8% to 13.7% (CBS, September 1997). The number of start-up technology-based companies has grown throughout the 1990s (CBS, October 1996). Even though these data demonstrate that the Dutch economy's performance of R&D is becoming less tied to the fortunes of the "big 5 firms," 70% of the total private R&D effort is still performed by companies with more than 1,000 employees.

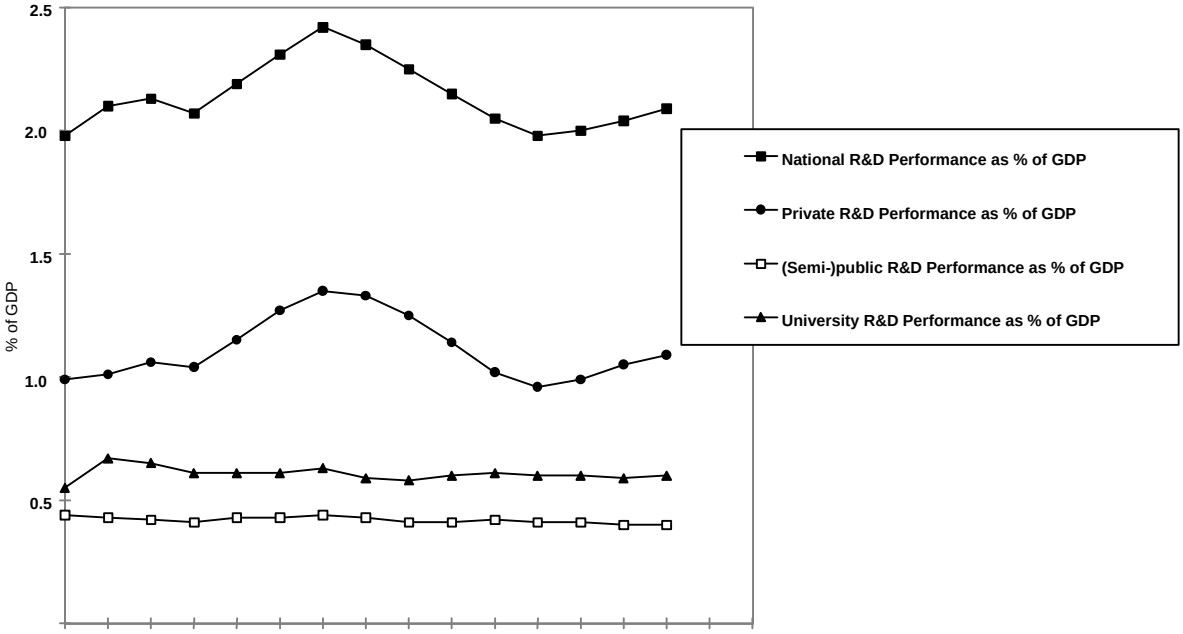
Private R&D performance was 1.09% of GDP in 1995 (private R&D intensity; see Figure 2). The share of private expenditures in the country's R&D intensity is relatively small when compared with other countries. One explanation for the relatively small private contribution to national R&D intensity is the structure of the Dutch economy. Less R&D-intensive sectors such as services, agriculture, and food and beverages account for a significant share of the Dutch economy.

When comparing investments in R&D (an input measure) and patent activity of the Netherlands (an output measure), the Netherlands score relatively high when compared with other countries. The main areas of patenting activity are farming equipment, agricultural and food technology, audio-visual technologies, basic chemistry, biotechnology, and electro-technologies (CBS, October 1996). The paradox of modest R&D intensity and relatively high patent output can be explained partly by the patent activity of large Dutch multinational companies, which also

[3] Akzo Nobel (chemical; healthcare products, coatings, chemicals and fibers), DSM (activities in life science products, performance materials, polymers and industrial (fine) chemicals), Philips (consumer electronics), Royal Dutch/Shell (oil and natural gas firm), and Unilever (food / consumer products).

perform R&D in other countries but file the resulting patents in the Netherlands. These large firms account for 30-35% of the patents in the Netherlands (CBS, September 1997).

Figure 2: Netherlands R&D Performance as Percent of GDP (Tijssen et al., 1998)



Trends in Public R&D

Total public sector support for all forms of R&D in 1995 was $2,772 million dollars (Fl 5,766 million) (CBS, September 1997). From 1985-1996, public sector support for R&D has increased by 2.8% percent in real terms. However, the Dutch economy grew at faster pace (4.1%) over that period, and therefore government-supported R&D funding as a percentage of GDP has been steadily eroding. In 1985, government R&D accounted for 0.92% of GDP, but it had decreased to 0.77% by 1997 (Tijssen et al., 1998; Ministry of Education, various yearly reports).

The government's contribution to privately performed R&D has been on the decline for more than a decade. In 1985, the government financed 13% of the research performed in the private sector, while in 1995 it supported only about 7% of the private sector's total effort (Tijssen et al., 1998).

Because of the decreasing role of the government in financing R&D, both universities and the semi-public research institutes have been forced to acquire research funding from other sources. For the semi-public research institutes, the majority of whose efforts are in applied research, this reduction in funds from the national government has resulted in heightened efforts to attract funds from the private sector (CBS, September 1997 and Tijssen et al., 1998). Semi-public research institutes received 16% of their funding from private companies in 1995, up from only 12% in 1990 (CBS, September 1997).

In 1995, the Ministry of Education, Culture, and Sciences contributed 62% of the governmental budget available for financing R&D, while the Ministry of Economic Affairs accounted for the second largest share of 16%. The dominant role of the Ministry of Education, Culture, and Sciences stems from its mission to finance universities directly. Its support constitutes the "primary flow" of funds to universities, accounting for about 42% of the government's R&D budget. This Ministry also funds the Netherlands Organization for Scientific Research (NWO),[4] which channels resources to its own research institutes, to Dutch universities, and to the semi-public research institutes.

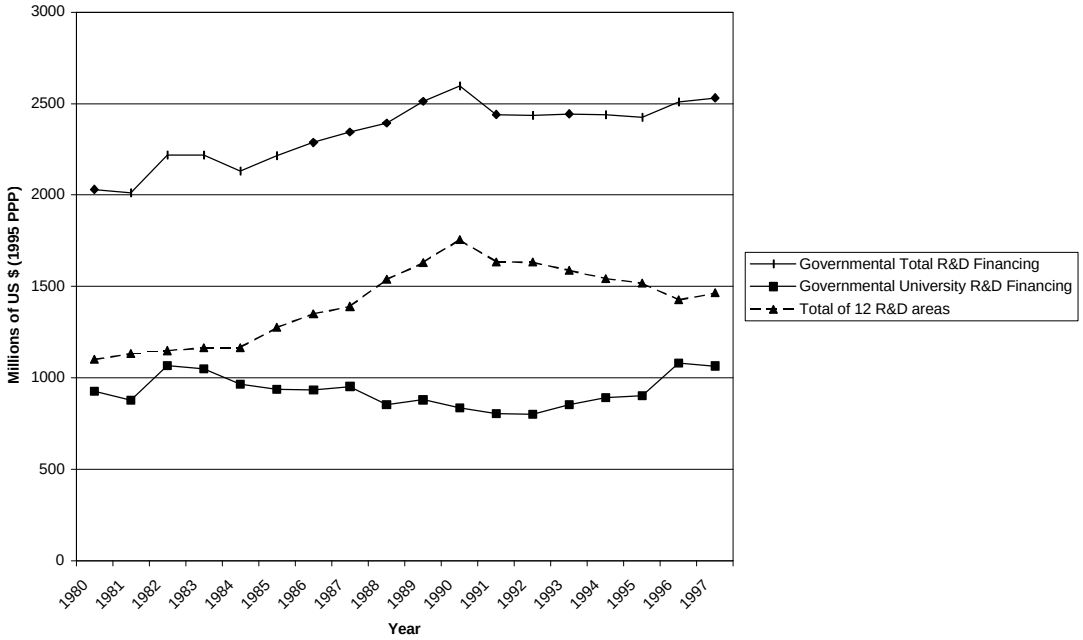
The remainder of the Netherlands's governmental budget to finance R&D comes from the Ministry of Agriculture, Nature Management and Fisheries (7%); the Ministry of Transport, Public Works and Water Management (4%); the Ministry of Housing, Spatial Planning and Environment (3%); and the Ministry of Defence (3%) (Ministry of Education, Culture, and Sciences, various yearly reports).

Priority changes in governmental R&D support are reflected in data from the science budgets of the Ministry of Education, Culture and Sciences (see Figure 3, 4, and 5). Besides university R&D financing, 12 categories of R&D areas are distinguished (see Figure 3). Energy R&D is one of them.

Figure 3: The Netherlands' Government Support for R&D Financing[5]

[4] NWO (The Hague) is an agency of the ministry of Education, Culture and Sciences. NWO stimulates, initiates and coordinates top-level scientific research, which is mainly carried out in Dutch universities and national research institutes. NWO manages resources from the government ($300 million in 1997; "second flow" of resources to universities). It is an intermediary organisation. Assessment and evaluation of research proposals by independent experts, a so-called peer-review system, is the basic mechanism through which NWO allocates its resources and tries to ensure the quality of research. Over two-thirds of NWO expenditures benefit academic research. NWO is responsible for about 17% of national academic research capacity.

[5] The Science Budgets give an indication of the (estimated) governmental budget available to finance R&D (see Ministry of Education, Culture and Sciences, various yearly reports). Unfortunately, these budgets are not reported each year in the same format. Consequently, data for some years are missing. The most reliable historical data available are used in these figures. In 1996, the method used in calculating university R&D changed inducing an increase in this category. All data used in Figures 6 and 7 are taken from (Ministry of Education, Culture, and Sciences, various yearly reports).

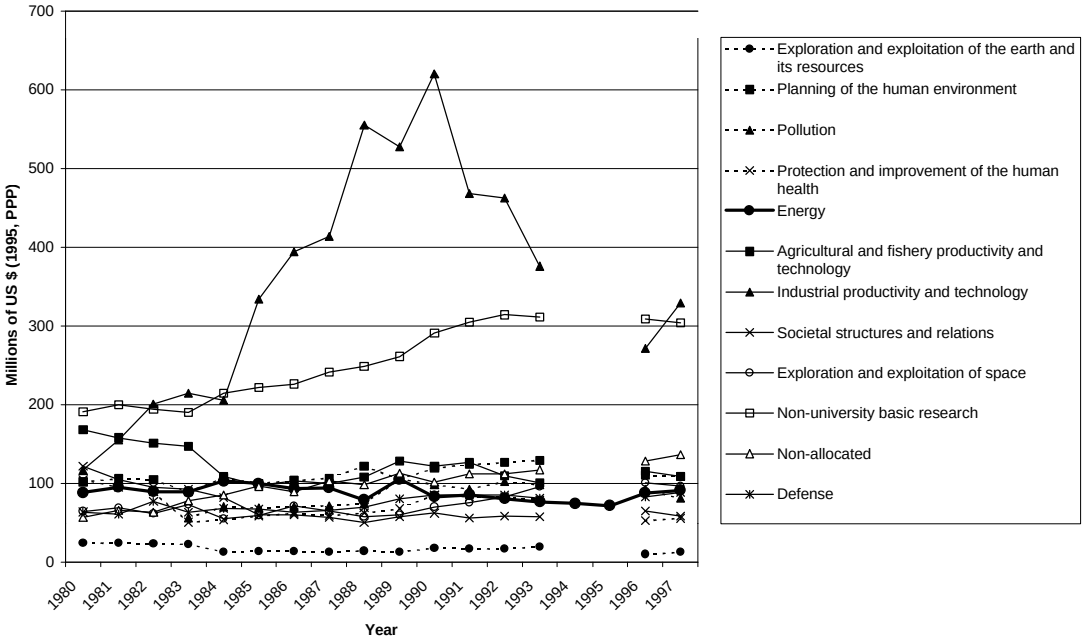


Growth in R&D for the 12 major socioeconomic areas was about 30% from 1980 to 1996/97. Among the 12 R&D areas funded by the federal government, the largest increases over the past decade have occurred in the areas of industrial productivity and technology and non-university basic research (see Figures 4 and 5). The non-allocated R&D area grew also considerably (from $60 million to $125 million). Non-university basic research has also grown considerably over this time period. Funding in this area increased from roughly $190 million in 1980 to $300 million in 1996/7, a real increase of 30%. The increases in funding for NWO and the Royal Netherlands Academy of Arts and Sciences (KNAW)[6] indicate the growing importance of non-university performers of basic research (Ministry of Education, Culture, and Sciences, 1997).

Large fluctuations occurred in industrial productivity and technology R&D. In the mid-1980s, the government began a broad initiative to stimulate industrial competitiveness and innovation (e.g., the INSTIR instrument, Innovation Oriented Research Programmes). Funding grew from $150 million in 1980 to around $500 million in 1989/90. Most of this industrial productivity and technology R&D is supported by the Ministry of Economic Affairs (Ministry of Education, Culture, and Sciences, 1988). However, industrial productivity and technology R&D spending declined rapidly after 1990 to around $300 million per year currently.

Figure 4: Government Support for 12 R&D Socioeconomic Objectives

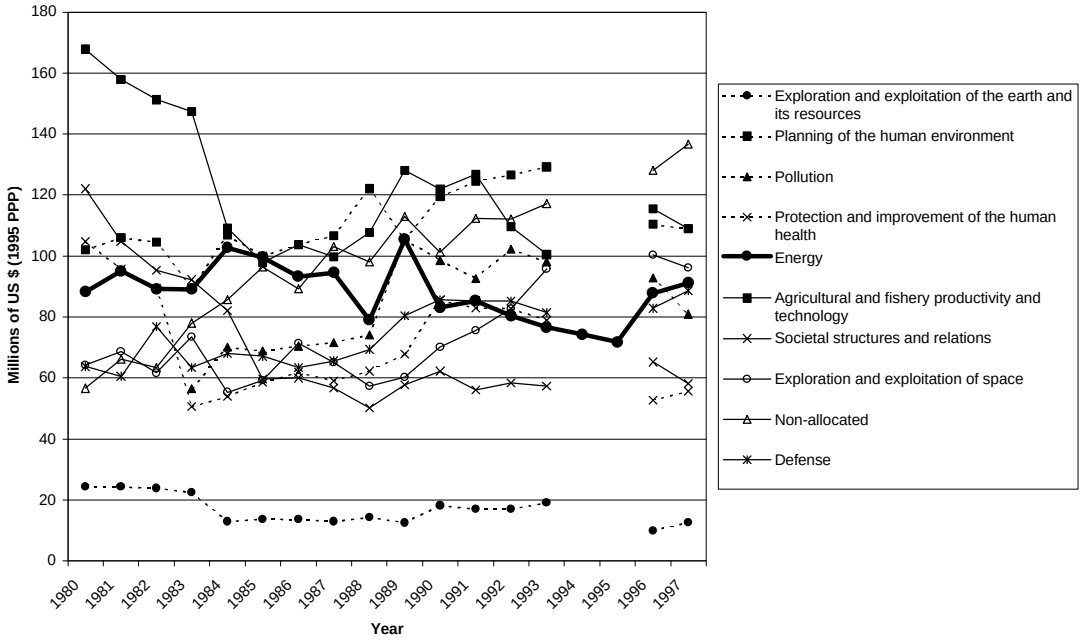
[6] The KNAW (Amsterdam) is an umbrella organisation for basic scientific research institutions and information dissemination agencies. The main tasks of the Academy are advising the government on science, stimulating (international) co-operation between scientific researchers, implementing government programmes and projects), and peer review.



Funding devoted to Defense and Exploration of Space grew also (from $60 million each in the early 1980s to respectively $85 and $100 million now). Investments in pollution R&D increased significantly from 1985 to the early 1990s (from $60 to $100 million), apparently stagnating (currently around $90 million).

The largest decreases in support occurred in the area of societal structures and relations R&D; from 1980 to 1985 funding decreased $50 million per year. Since then it has fluctuated around $60 million. Other decreases have occurred in R&D investments in exploration of the earth, human health, and agricultural productivity and technology.

Figure 5: Government Support for 10 (of 12) R&D Socioeconomic Objectives



Energy R&D has fluctuated between a high of $100 million in 1985 and a low of $75 million in 1995. This area has recovered recently, with budgets of approximately $90 million in 1996 and 1997. Some of the fluctuation in the energy R&D budget can be attributed to changes in the composition of government-supported energy R&D. For example, with the waning importance and public acceptance of nuclear energy in the Netherlands,[7] the government budget for nuclear research has decreased in the last few years (currently about 25% of energy budget, down from 35% in 1990). The budget for renewable energy R&D, on the other hand, has increased steadily in recent years, from about 3% in 1990 to its current level of 7% (Ministry of Education, Culture, and Sciences, yearly report).

An Overview of Dutch Science and Technology Policy

Throughout the 1990s the Dutch government has worked to develop a more thoughtful and selective approach to its allocation of R&D resources (both in the national Technology Policy (Ministry of Economic Affairs) and in the Science Policy (Ministry of Education, Culture and Sciences)). This approach is driven, in part, by budgetary considerations and also by the realization that knowledge is increasingly important to the overall health of the economy. One aspect of this more thoughtful and selective approach to funding R&D is the government's desire to fund research in selected strategic research areas (e.g., energy R&D) that can simultaneously meet both businesses' needs and societal needs (Ministry of Education, Culture, and Sciences, 1997). An extensive strategic foresight activity was started in 1992 (see OCV, June 1996).

In 1995, the policy strategy document "Knowledge in Action" was published both by the Ministry of Economic Affairs and by the Ministry of Education. This policy document formalized much of the government's new thinking about science and technology policy. One of its central ideas was the need to increase the "interaction between producers and consumers of new knowledge." That is, the government needed to find new ways to increase cooperation and interaction between private firms and the semi-public research institutes to actually increase the application of knowledge generated. One avenue for increasing this interaction would be to give firms a larger

[7] After the closure of the Dodewaard reactor, Borssele will be the only nuclear power generation facility in the Netherlands. The Borssele facility is to be shut down in 2004.

and more formal role in helping the government set new research priorities (e.g., through Foresight Activities or setting research programs for semi-public research institutes).[8]

Another change in the government's science policy – in line with the mentioned way of thinking – is the previously mentioned changes in the way universities and semi-public research institutes are supported. In particular, the government is attempting to move these institutions' support away from block grants and towards a system that is more based upon merit. For example, the share of direct funding ("first flow" or block grants, which are known in many other countries as General University Funds) decreased from 62.2% to 55.7% between 1986 to 1996 (VSNU, 1997). As a result, universities are becoming more and more dependent on the "second flow" (merit-based or peer-reviewed) grants. In addition, universities have been encouraged to increase their contract research activities with the private sector (the so called "third flow"[9] of resources) (Tijssen et al., 1998).

The semi-public research institutes (e.g., the Netherlands Energy Research Foundation (ECN)[10] and the Netherlands Organization for Applied Scientific Research (TNO)) are being encouraged "to operate in a market-oriented way." To accomplish this, the government is subjecting the direct subsidy it provides to these institutes to an increasing level of input from the "demand side," i.e., the private sector. The government believes that, by directly involving the private sector in setting priorities for the research carried out at universities and semi-public research institutes, the private sector will be more likely to make use of research results.

The private sector is being encouraged to increase its own R&D efforts through an expanded R&D tax credit.[11] The private sector is also being encouraged to increase its partnership activities with other firms, with universities, and with semi-public research institutions. Currently, most government R&D programs[12] require private firms to partner with other R&D providers as a condition for receiving support.

The ultimate goal of these new government initiatives extends beyond the quantitative growth of the R&D enterprise. The new programs are also seeking to stimulate technological innovation in the Netherlands and to ensure the more efficient application, commercial and otherwise, of the knowledge generated by the nation's R&D networks.

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[8] See, for exapmle., OCV, February 1996 and OCV, June 1996.

[9] The "third flow" of resources is defined as funding for reseach that comes directly from third parties such as the European Union and private companies.

[10] The ECN was transformed in the late 1970s from a nuclear energy R&D centre to a laboratory that is predominantly focused on long term energy research. Currently, ECN is financed through three lines: (1) the co-operative financing programme aims at co-operation with companies in developing technologies, which are applicable in the short to near term (cost-sharing). Steering committees (involving representatives from market parties) guide the priorities in research; (2) the second line concerns the long-term "Energy Generation in a Natural Environment" (ENGINE) programme. Representatives form the energy sectors, companies, universities and the government are involved in formulating the programme; (3) the basic subsidy of the Ministry of Economic Affairs is destined for facilitating and conditioning the first two lines.

[11] In 1997, the government increased by 20% (to a total of $300 million) the budget set aside to cover the R&D tax credit. This governmental support is not covered in yearly R&D statistics produced by the CBS.