STRATEGIES AND IMPACTS OF FINANCING TECHNOLOGY TRANSFER ENTITIES: A MULTIFACETED APPROACH

https://doi.org/10.47743/jopafl-2024-31-3

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Abstract: The article investigates the impact of various funding sources on Technology Transfer Entities (TTEs), including government support, private sector investments, grants, and European funds. It emphasizes the crucial role these financial mechanisms play in enabling TTEs to bridge the gap between academic research and commercial application. By analyzing the influence of government funding, the significance of licensing and patent revenues, and the benefits of private and European investments, the article demonstrates how these resources assist TTEs in achieving financial stability, fostering innovation commercialization, and navigating the market. It also highlights the importance of aligning TTEs' goals with broader societal and economic objectives. Through case studies, the research illustrates the essential need for a diverse funding strategy and effective management for TTEs to optimize their contribution to the technological innovation ecosystem, economic growth, and societal well-being.
Keywords: financing, innovation, commercialization, patents, investments

Introduction

Technology Transfer Entities (TTEs) are funded from various sources. These may include government funding, funds from research institutions (state, private or mixed forms of public-private partnership), licensing and patent revenues, private sector investment and grants from non-profit organizations or foundations. European funds (public funds) play an extremely important role. Even if they are not always available, they direct research towards the priorities of the European Union (green transition, sustainable development, circular economy, clean energy sources, etc.), and investment funds (private funds) support the research priorities of the private economy (see the huge investments made by private companies in the development of artificial intelligence or anti-covid vaccines). Regardless of funding sources, ETTs need to have a diversified funding strategy to ensure stability and manage financial risks. ETTs can be funded from different sources, which may vary according to their specific financial model, institutional structure and regional or national context. The most common sources of funding for ETTs are: government funding, funding from research institutions (state, private or mixed forms of public-private partnership), licensing and patent revenues, private investment funds, grants, European funds.

Income from government grants

Government funding plays a vital role in supporting technology transfer entities because these organizations often operate at the intersection of academic research and commercial applications, where funding gaps exist. Funding provided to ETTs can take the form of core operating funds or dedicated grants for specific projects, designed to support a variety of costs including salaries, infrastructure and other operational expenses (Nugent et al.,

2021). The impact of government investment in R&D on stimulating technology transfer in universities has been highlighted by initiatives such as China's programs to promote university-business collaboration (Rao & Piccaluga, 2012). It has also examined how funded academic research influences patent renewal decisions, noting that legislation such as the Stevenson-Wydler Technology Act has had a significant impact on technology transfer in the US and other nations (Tahmooresnejad & Beaudry, 2018). In South Korea, the passage of the Technology Transfer Promotion Act highlights proactive efforts by governments to encourage technology transfer from national research projects (Kim et al., 2015). Some governments in the European Union, particularly in the northern EU countries, provide direct funding to ETTs, either as core operating funds or in the form of grants for specific projects. These funds can cover staff, infrastructure and other operational costs. The importance of EU funding has been highlighted in several recent studies which have analyzed its impact on different sectors. A notable example is research in the renewable energy sector, which has explored how the EU is managing the challenges of technology transfer, with a focus on current trends and intellectual property rights in the industry (Kulkarni et al., 2022).

EU investment in research and development, as well as the implementation of demand-driven measures in critical areas such as health, was highlighted as substantial. These initiatives aim to promote innovative projects, combat diseases and encourage healthy living through EU research project funding (García-Holgado et al., 2019). The importance of setting up technology transfer offices as mechanisms to encourage innovation and economic growth was also examined. Karanikić (Karanikić, 2022) highlights the vital role played by the establishment of a National Technology Transfer Office in Montenegro, which is seen as an essential organizational structure for advancing technology transfer initiatives in the country. The analysis of Croatia's development in the context of technology transfer policies highlights the challenges and progress made by lower-technology EU countries (Švarc & Dabić, 2019). The study highlights how EU assistance contributes to improving technological capabilities in economies in transition.

In addition, Szpringer explore the European system of financial supervision and its impact on regulatory assessment, including the influence of stress tests on stock prices (Szpringer & Szpringer, 2017). This work provides a broad perspective on financial structures in the EU and their implications for technology transfer and economic stability, highlighting the crucial role of finance in supporting technology transfer and innovation within the European Union.

Governments in Eastern Europe often fund research and development through ETTs in the form of grants or contracts. These funds can support the development of new technologies, patenting and licensing, and facilitate collaboration between researchers and industry. The French term "Incitative Fiscale" refers to tax incentives offered by governments in Europe to support technology transfer. According to Bloom, R&D tax credits have been shown to be effective based on evidence from a group of countries, providing insights into the impact of tax incentives on technology transfer (Bloom et al., 2002) a study of nine OECD countries (Australia, Canada, France, Germany, Italy, Japan, Spain, UK and USA) between 1979 - 1997. The UK's R&D tax credits scheme allows companies to deduct a proportion of their R&D expenditure from their corporation tax. There are two schemes, one for small and medium-sized enterprises (SMEs) and one for larger companies.

France has one of the most generous tax incentive schemes for technology transfer in Europe, known as the Crédit d'Impôt Recherche (CIR), which allows companies to deduct a significant proportion of their R&D expenditure (Bozio et al., 2014). Ireland offers a technology transfer tax credit scheme which allows companies to claim a 25% tax credit for R&D expenditure. This is in addition to the normal deduction of technology transfer expenditure from corporation tax, meaning that companies can effectively benefit from a double deduction for R&D expenditure. The Netherlands has a tax incentive scheme known as WBSO (Wet Bevordering Speur- en Ontwikkelingswerk), which offers tax rebates on the salaries of employees working on projects within ETTs. Belgium offers a number of tax incentives for technology transfer, including a corporate tax deduction for R&D expenditure and a tax exemption on researchers' salaries.

Governments can also provide funding through venture capital programs, which can help "scale up" technologies developed by ETTs. A number of European governments have introduced funding programs through venture capital funds to support innovation and the development of new technologies. These are often designed to stimulate private investment and help start-ups and other innovative businesses to grow and expand. In the UK, the British Business Bank is owned by the UK government and invests in venture capital funds that support growing businesses. It operates a number of programs including Enterprise Capital Funds and Angel CoFund. Bpifrance (France) is France's public investment bank offering a wide range of financing instruments for innovative businesses, including venture capital investments. In Germany there is KfW, based in Frankfurt, which is Germany's development bank operating a range of venture capital investment programs for start-ups and innovative businesses. Since 2014, this bank is considered the largest national investment bank. Finnish Industry Investment Ltd (Tesi), Finland, is a state-owned investment company that invests in venture capital funds and supports Finnish Technology Transfer Entities. In Ireland, the Irish Strategic Investment Fund (ISIF) of the Irish Central Bank has invested in several venture capital funds to support the development of new technologies and innovation in Ireland.

These venture capital funding programs help fill the "funding gap" that may exist for technology transfer entities seeking to develop and commercialize their technologies. In addition, government involvement can help attract other investors because it reduces the perceived financial risk in the capital markets associated with investing in innovative companies and emerging technologies. The specific analysis of government funding of ETTs depends very much on the geographical and institutional context, as government policies vary significantly from country to country. However, it is clear that government funding is an essential tool to ensure that research results can be efficiently transferred to the private sector and bring wider economic and social benefits.

In conclusion, it is important to note that the success of an ETT depends not only on funding. Effective management, innovation culture, collaboration with industry, and the existence of a diversified funding strategy that is conducive to technology transfer are also essential elements. Universities need to ensure that their technology transfer policy is aligned with their academic mission and the interests of the community they serve.

Income from licensing and patents

When Technology Transfer Entities license technology to companies or other organizations, they may receive revenue from these agreements. In the operational context

of Technology Transfer Entities, the process of licensing technology to corporate or institutional entities is the most common method used to monetize innovations. This approach allows ETTs to earn revenues through contractual agreements, which may stipulate different forms of financial compensation. Essentially, revenues can be structured in the form of upfront licensing fees, royalties calculated as a percentage of revenues from sales of the final product based on the licensed technology, or other agreed payment mechanisms. Licensing fees have the advantage of providing an immediate source of capital for ETTs, while royalties provide a long-term revenue stream. In the latter case, the revenue earned is linked to the commercial success of the technology or product the ETT makes. This monetization strategy aligns with the objectives of leveraging R&D, facilitating the transfer of knowledge and technology from academia or research to industry, thus contributing to innovation and the dynamization of the knowledge-based economy.

Grant income from non-profit organizations, foundations and private sector investments

Many foundations and other non-profit organizations offer grants for technology transfer, especially for projects that have the potential to have a significant social or economic impact. Private investment in ETTs and related start-ups can take the form of venture capital, angel investors or other types of equity financing. These capital injections are essential to support the early commercialization and development phases of innovative technologies, which are often associated with significant risks and capital-intensive needs. In return for funding, investors may receive equity stakes in start-ups or other forms of financial compensation, negotiated on the basis of an assessment of growth potential and anticipated revenues.

Venture capital is recognized for its role in the development of high-impact, high-growth firms, and both the advantages of the model and its limitations in fostering major technological innovations are appreciated. Key concerns include the strict selectivity of innovation projects attracting funding, the concentration of resources in the hands of a small number of investors with major influence over the direction of technology, and a recent low attention to corporate governance by these firms (Lerner and Nanda, 2020).

Working with private investors gives ETTs access to additional financial resources, but also to investor expertise and networks, which can be crucial to navigating the market and accelerating growth. This synergy between private capital and technology transfer entities stimulates innovation, supports the development of new businesses and contributes to the economic exploitation of scientific research results. Collaboration with private investors is therefore a vital strategy for ETTs, enabling them not only to finance their technology transfer operations and projects, but also to actively participate in the creation and sustainability of a robust innovation ecosystem that fosters the transformation of knowledge and technology into commercial success and positive social impact.

Private sector investment is the oldest source of funding for ETTs and can take various forms. Of these, venture capital investment can play a significant role in supporting the growth and development of technology transfer entities. Venture capital is funding provided by investors to start-ups and young companies with growth potential in exchange for an equity stake. In the context of ETTs, venture capital can support the commercialization of innovative technologies.

1. Seed stage: In this early stage, ETTs may need funding to identify the technology they want to develop, for a preliminary assessment of technical and commercial feasibility, and to initiate procedures to protect intellectual property. Venture capitalists can provide the necessary funds for research and development as well as market exploration.
2. Early-stage development phase: After concept validation, ETTs may need additional investment to build working prototypes, a minimum viable product or to conduct pilot studies. Verifying working hypotheses at market level, collecting feedback from consumers or users and potential partners requires funding that can be provided by venture capital.
3. Growth stage: In this phase, ETTs may seek to expand their operations, bring products to market or expand into new markets. The market validation phase is achieved by measuring the actual demand for the product by an increased number of customers or partnerships. In the second stage of this phase, investments need to be made to expand production or service capabilities to serve a wider market. This stage is called scaling up. This is followed by geographical expansion (the geographical conquest of new markets) and, finally, product or service diversification to broaden the product or service offering. Venture capital can provide funding to support this growth.
4. Maturity and exit stage: In this phase, ETTs prepare the initial public offering (IPO) or look for a buyer. Venture capitalists play an important role in this phase as they recoup their investment and earn profits.
Studies show that venture capital funds work most effectively in the most innovative EU economies (Wierzbicka, K., 2019). Venture capital can also be an important tool to attract talent and build credibility with business partners and other financiers. At the same time, venture capital comes with certain disadvantages, such as dilution of ownership and pressure to grow quickly and exit from financial risk at a time of growth. In Europe, there are several venture capital funds focusing on technology and innovation, such as Northzone, Atomico, Balderton Capital and others. EU-wide initiatives, such as the InvestEU programme, also aim to mobilize private investment, including venture capital, in research and innovation.

Revenue from European and international funds

Technology transfer entities can also obtain funding through various European or international programs, such as Horizon or the EU's Framework Programme for Research and Innovation. European funds are an important source of funding for technology transfer entities. These funds can be accessed through various European Union (EU) programs dedicated to innovation and research, such as Horizon 2020 (which ended in 2020), followed by Horizon Europe (2021-2027). Horizon 2020 was the EU's largest research and innovation program, with a budget of around €80 billion available over seven years (2014-2020). It included various funding instruments, such as research grants, Marie-Curie actions for researcher mobility and the SME Instrument for developing and scaling innovation in small and medium-sized enterprises.
Horizon Europe is the successor to Horizon 2020 and will run from 2021-2027 with a budget of around €95.5 billion. It has three main pillars: Excellent Science, Global Challenges, European Industrial Competitiveness and Innovative Europe. EU funds can be used by Technology Transfer Entities for a variety of activities, such as research and technological development, cooperation with industrial and academic partners, technology

transfer and commercialization of research results. The application process for EU funds is competitive and requires rigorous planning and preparation.

In terms of the effectiveness of these funds, this depends on the capacity of the ETT to manage the funds, the quality of the projects and the extent to which the results can be commercialized or lead to other forms of social or economic impact. ETTs can contribute significantly to innovation and technology transfer, but it is essential that they are well managed and have adequate access to funding. In conclusion, we emphasize that technology transfer entities are diverse and play key roles in promoting innovation and technology commercialization. They can vary according to their specific field of activity, organizational structure and institutional affiliation. Sources of funding can vary significantly, reflecting the diversity of business models and objectives specific to each entity. Below we present, in summary, a list of the most popular ETTs and possible sources of funding for each of them:

Technology Transfer Offices (TTOs): Often located within universities or research institutes, these entities facilitate the transfer of technology developed within the institution to industry, managing patents and technology licensing. Funding for TTOs often comes from budgets allocated by host institutions (universities, research institutes), government funds dedicated to innovation and technology transfer, revenue generated from technology licensing and, in some cases, from partnerships with the private sector.

Science and Technology Parks (STPs): These areas are designed to promote collaboration between universities, research institutes and companies, providing space and resources for start-ups and innovative technology companies. TSPs can be funded through government grants, investment from local or regional authorities, public-private partnerships, as well as by renting office and laboratory space to companies and start-ups.

Business Incubators (AI): Focuses on supporting the development of early-stage start-ups by providing access to office space, mentoring, technical resources and support in obtaining funding. Funding for AI can come from a variety of sources, including government funding, financial support from universities or research organizations, private investment and participation fees paid by incubated start-ups.

Business Accelerators (BAs): Similar to incubators, accelerators offer intensive mentoring and development programs to accelerate the growth of start-ups to a later stage. AAs can often be funded through private investment, venture capital funds, corporate sponsorships, and by taking a portion of the participating start-ups' capital in exchange for services.

Technology Investment Funds (TIFs): These funds provide capital needed to develop and scale innovative technologies, focusing specifically on start-ups and technology companies. FITs are predominantly funded by capital committed by private investors, pension funds, financial institutions, venture capital funds and sometimes public-private partnerships.

Technology Transfer Companies (TTCs): These are private companies that specialize in evaluating, protecting and commercializing innovative technologies, often working in partnership with universities and research institutes to facilitate technology transfer. TTCs can obtain funding from a variety of sources, including revenues from licensing and consultancy services, private investment, venture capital funds and government grants dedicated to supporting innovation and technology transfer.

Research and Development Consortia (RDCs): These groups, which can include universities, companies and governments, collaborate to share resources and expertise in

research projects with the aim of developing new technologies that can then be commercialized. Funding for CCDs often comes from contributions from participating members (both public and private sector), research grants, government funding programs for collaborative research, and sometimes from revenue generated by licensing the technologies developed.

Government Agencies and Non-Profit Technology Transfer Organizations: Some government agencies or organizations are dedicated to facilitating technology transfer between the public research sector and industry, providing support in terms of regulation, funding and networking. These entities rely largely on government funding, grants, donations from foundations and other non-profit organizations, and in some cases partnerships with the private sector for specific projects.

As can easily be seen from the above summary the sources of funding for technology transfer entities are varied and reflect a combination of public and private support, highlighting the importance of collaboration between different actors in the innovation ecosystem to facilitate technology transfer and commercialization of innovations.

Next, I will present a study that explored the mechanisms and impact of investments made by technology transfer entities (TTEs), using a methodological approach anchored in the analysis of public data and financial reports. The aim of this analysis was to identify, through case studies, the ways in which invested capital, partnership structure and subsequent financial outcomes contributed to optimizing the technology transfer process.

The investigation is based on a mixed methodology, integrating quantitative analysis of financial data and qualitative analysis of partnership structures, in the context of three specific case studies: the investment in BioTechX, a technology transfer entity; the commercial partnership with TechSolutions, a technology transfer entity; and the financing of the technology transfer entity start-up GreenEnergy. Data was extracted from internal financial documents provided by the three technology transfer entities.

Analysis of the "Innovatech" investment in BioTechX: ROI assessment and impact on Innovation in Biotechnology

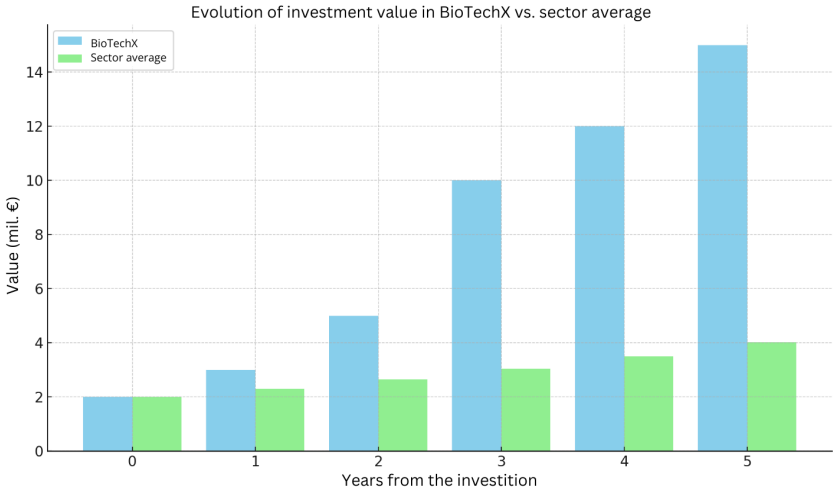
"Innovatech" has chosen to invest €2 million in the technology transfer entity BioTechX for a 20% stake. This structure suggests an initial valuation of BioTechX of €10 million. Venture capital (VC) investment in this context indicates a financial commitment to supporting early stage innovation and technology development, recognising the potential of BioTechX to generate value through its innovative solutions. By calculating the ROI (Return on Investment) based on the financial data provided, we were able to assess the financial effectiveness of the investment. With annual revenues of €50 million five years post-investment and a stake of Innovatech valued at €15 million, the ROI can be estimated by comparing the increase in the value of the stake with the initial investment.

$$\text{ROI} = \frac{\text{Final Value of the Investment} - \text{Initial Value of the Investment}}{\text{Initial Value of the Investment}} \times 100$$

The author's study found a positive correlation between significant venture capital investment and rapid revenue growth in biotechnology. This reflects the general trend in the biotech sector, where adequate funding is crucial for research and development (R&D), clinical testing and bringing innovations to market. The success of BioTechX in developing

and commercializing a new treatment for diabetes illustrates the positive impact of this type of investment on innovation and economic growth in the field. With an ROI of 650%, Innovatech's investment in BioTechX far exceeded the industry average for biotech investments. According to an internal audit financial report, the average return on venture capital investment in biotech and healthcare ranged from 10% to 20% per year. This indicates an exceptional performance of BioTechX, highlighting the effectiveness of Innovatech's investment strategy and the innovation potential of the start-up.

Table 1. Evolution of investment value in BioTechX vs. sector average



Source: public data collected by the author

The updated graph illustrates the comparison between the evolution of the value of the investment in BioTechX and the estimated growth of an average investment in the biotech sector, given an average annual return of 15%. It is clear that the investment in BioTechX has performed significantly better than the sector average, with an impressive increase from €2 million to €15 million in just 5 years, reflecting an ROI of 650%. In comparison, an average investment in the sector, adjusted for a 15% annual return, shows a much more modest growth, highlighting the exceptional performance of BioTechX and the investment strategy adopted by "Innovatech".

Financial Evaluation of the TechSolutions Partnership: Initial Investment, Revenue Generation and Financial Performance

In order to perform a detailed financial analysis of the partnership with TechSolutions, we considered the following key aspects: the initial investment, the generation of royalty income and the assessment of the financial performance of the investment by calculating the return on investment (ROI) and other relevant financial indicators.

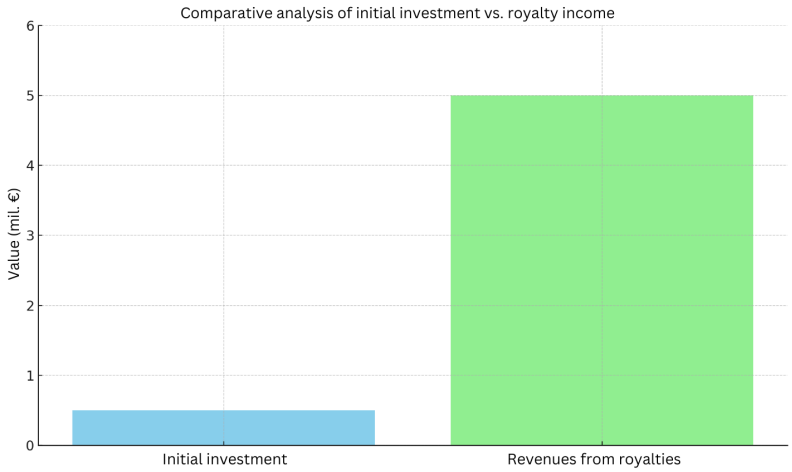
Initial Investment and Partnership Structure. TechBridge invested €500,000 in the development of a software platform with TechSolutions, obtaining exclusive licensing rights. This partnership structure involved close collaboration, with TechBridge contributing financially to the technology development and in return receiving exclusive rights to commercialise the platform.

Generation of Revenue through Royalties. Since its launch, the TechSolutions platform has been adopted by over 1,000 companies, generating €5 million in royalty revenue over three years. This indicates a rapid adoption rate and an efficient business model that has enabled the initial investment to be recouped and multiplied. For the Return on Investment (ROI) calculation to assess the financial efficiency of the investment in TechSolutions we used the following formula:

$$\text{ROI} = \frac{\text{Final Value of the Investment} - \text{Initial Value of the Investment}}{\text{Initial Value of the Investment}} \times 100$$

Financial Performance Analysis. In addition to ROI, we can also consider other indicators to assess financial performance, such as payback period and Net Present Value (NPV), which require a discount rate to discount future cash flows. The return on investment (ROI) for the TechSolutions partnership is 900%. This result indicates exceptional financial performance, highlighting the effectiveness of the strategic partnership model and exclusive licensing structure in generating significant royalty income. Generating €5 million in revenue from an initial investment of €500,000 demonstrates the high potential for monetizing innovations in the technology sector, as well as the added value through widespread adoption of the platform developed in partnership.
This analysis highlights the importance of careful selection of partnerships and investment projects, particularly in the area of technology transfer entities, where exclusive licensing rights and the ability to expand rapidly into the market can have a significant impact on financial success.

Table 2. Comparative analysis of initial investment vs. royalty income



Source: public data collected by the author

The graph shows a comparison between the initial investment and the royalty income generated for the partnership with TechSolutions. A significant difference between the two figures is evident, with royalty income of €5 million compared to the initial investment of only €0.5 million. This illustrates the financial success of the partnership and the

effectiveness of the well-structured partnership model for monetizing innovations, as analyzed above.

Initial Investment and Financial Impact of GreenEnergy Technology: An Analysis of Profitability and Sustainability

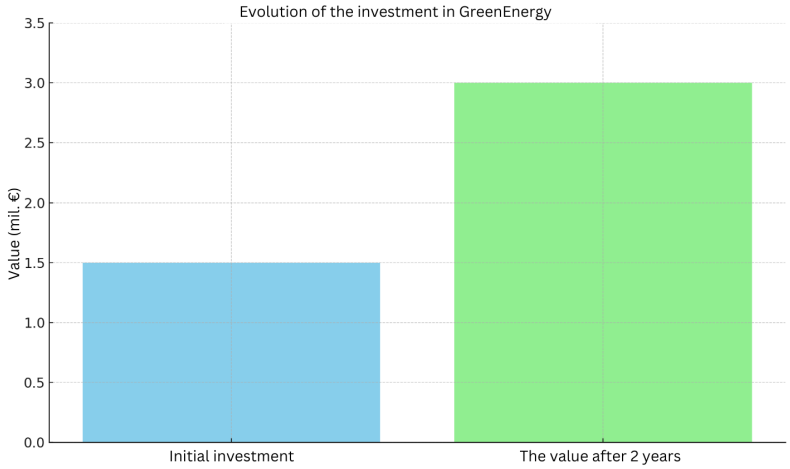
The initial investment of €1.5 million in the GreenEnergy technology transfer entity was directed towards the development of renewable energy technology. This type of early-stage investment is essential for start-ups developing innovative and sustainable solutions, providing the necessary capital for research and development, prototyping and early stages of commercialization. According to the author's study, the implementation of GreenEnergy technology in cities resulted in a doubling of the initial investment in just two years. This indicates not only rapid commercial success, but also market validation for the proposed technology. Doubling the investment in such a short time is an indicator of the start-up's high profitability and growth potential.

Return on investment (ROI) can be calculated to quantify the financial efficiency of the GreenEnergy investment. Given that the initial investment has doubled, we can assume that the value of the investment after two years is €3 million. The formula for calculating the ROI is:

$$\text{ROI} = \frac{\text{Final Value of the Investment} - \text{Initial Value of the Investment}}{\text{Initial Value of the Investment}} \times 100$$

Long Term Impact. Investments in green technology innovation, such as GreenEnergy, not only provide significant financial returns, but also have a profound impact on sustainability and the environment. The commercial success and adoption of the technology in cities indicates the potential to contribute to the energy transition and carbon reduction that are key to achieving sustainable development goals. The return on investment (ROI) for GreenEnergy financing is 100%. This means that the initial investment of €1.5 million has doubled to €3 million in just two years, reflecting an outstanding financial performance. A 100% ROI underlines not only the commercial success of the renewable energy technology developed by GreenEnergy, but also the enormous potential for early investment in sustainable and innovative solutions by technology transfer entities. This financial analysis highlights the strategic importance of supporting green technology start-ups, demonstrating that such investments can generate not only significant financial returns but also positive environmental and social impacts. GreenEnergy's success serves as a compelling example of the potential for growth and sustainable impact through investment in future technologies.

Table 3. Evolution of the investment in GreenEnergy



Source: public data collected by the author

The graph illustrates the evolution of the investment in GreenEnergy, comparing the value of the initial investment of €1.5 million and its value after two years, which increased to €3 million. This visual representation highlights the doubling of the value of the investment in a relatively short period of time, underlining the outstanding financial performance and success of the renewable energy technology developed by GreenEnergy.

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