



Economic footprint indicators for DTI

February 2018

Prepared for:

DTI, Denmark

Authors of the report:

Valentijn Bilsen
Miriam Van Hoed

IDEA Consult SA
Rue Joseph II 40
B - 1000 Brussels

T: +32 2 282 17 10
F: +32 2 282 17 15
info@ideaconsult.be

www.ideaconsult.be



TABLE OF CONTENTS

| | | |
|-----|---|---|
| 1/ | INTRODUCTION | 3 |
| 1.1 | Context | 3 |
| 1.2 | Scope | 4 |
| 1.3 | Methodology | 4 |
| 2/ | SUMMARY | 5 |
| 3/ | ECONOMIC FOOTPRINT INDICATORS FOR DTI | 6 |
| 3.1 | Overview of indicators | 6 |
| 3.2 | DTI core activities | 8 |
| 3.3 | Knowledge transformation and transfer through (outflow of) research staff | 8 |
| 3.4 | Knowledge transformation and transfer through contract research | 8 |
| 3.5 | Knowledge transformation and transfer through spin-off activities | 9 |
| 3.6 | Total multiplier effects | 9 |
| 3.7 | DTI infrastructure: Combined technology infrastructure projects | 9 |



1/ INTRODUCTION

1.1 Context

RTOs are considered important technology transfer agents in the national innovation systems. In 2005, the EURAB concluded¹ that *"Research and Technology Organizations (RTOs) are distinctive, mission-oriented R&D organisations which perform key functions in European innovation systems and which exhibit characteristic strengths."* EARTO defines the RTOs as organisations with the *"core mission to harness science and technology in the service of innovation, to improve quality of life and build economic competitiveness."*² They thus distinguish themselves from universities whose predominant activity is education, and from enterprises, whose predominant activity is the production and sales of goods and services.

The RTOs have a distinctive role in research collaboration with industry, and in particular with small and medium enterprises³. Also in regional research and innovation, and in smart specialisation, RTOs are driving and/or steering actors. They *"occupy nodal positions within innovation eco-systems, bringing together key players across the whole innovation chain [...]"*⁴ In this sense, their contribution to the realisation of the ERA is acknowledged⁵.

In 2017, IDEA Consult calculated the economic footprint of 9 European RTOs for the European Association of RTOs (EARTO). DTI was one of the 9 participating RTOs for this study. Underlying document reports on the specific indicators for DTI, based on the calculations in the EARTO study⁶.

The Danish Technological Institute, founded in 1906, is a self-owned and not-for-profit institution. They develop, apply and disseminate research- and technologically-based knowledge for the Danish and International business sectors.

The Institute participates in development projects, which are of use to society in close collaboration with leading research and educational institutions both in Denmark and abroad. On top of this, the Institute carries out consultancy and standardisation services, which contribute to a dynamic and harmonious development of society.

Their most important task is to ensure that new knowledge and technology quickly can be converted into value for customers in the form of new or improved products, materials, processes, methods and organisational structures. DTI works together with new and existing companies, either individually or in groups, on ways to enhance technological and management restructuring and efficiency, across a broad range of industries as well as in leading edge sectors.

Therefore, they focus on innovation and competitiveness, management and training, sustainable exploitation of resources and cost-effectiveness in company and society.

¹ European Research Advisory Board (EURAB) Final Report, Research and Technology Organisations (RTOs) and ERA: https://ec.europa.eu/research/eurab/pdf/eurab_05_037_wg4fr_dec2005_en.pdf

² Website EARTO: <http://www.earto.eu/about-rtos.html>

³ See for example Albers-Garrigós J., Rincon-Diaz C. A. & Igartua-Lopez J.I. (2014). Research technology organisations as leaders of R&D collaboration with SMEs: role, barriers and facilitators, *Technology Analysis & Strategic Management*, 26(1), 37-53.

⁴ Website EARTO: <http://www.earto.eu/about-rtos.html>

⁵ European Research Advisory Board (EURAB) Final Report, Research and Technology Organisations (RTOs) and ERA: https://ec.europa.eu/research/eurab/pdf/eurab_05_037_wg4fr_dec2005_en.pdf

⁶ In which European-level parameters, averages of sector rates and Input-Output tables were applied.



1.2 Scope

As any RTO, DTI primarily aims to generate a scientific and/or technological impact in society. However, its activities also leave a so-called 'economic footprint' in society – an impact that is much less known and documented. The focus of the EARTO study, and thus of the indicators for DTI, is to specifically highlight the economic footprint of RTOs' activities. In this analysis, we focus on two types of activities that are expected to generate a strong economic impact:

- ▶ the economic leverage of the RTOs' core activities through spending and employment;
- ▶ the economic leverage of the knowledge transfer through contract research and spin-off creation.

Although we are well aware of the fact that the total economic footprint of an RTO goes beyond the above mentioned effects, we have consciously chosen for a conservative estimation of the economic footprint, to avoid double-counting (and thus overestimations). The analysis results in objective and robust observations on the economic effect of RTOs on the European economy.

1.3 Methodology

The methodology in the economic footprint is based on the classic input-output approach, combined with micro-data input from the RTO. The advantage is that direct economic effects are exact and that the quantification of the indirect effects is based on the RTO-specific data rather than on sector averages. Both elements benefit the accuracy of our results.

In addition to the direct and indirect economic effect, also induced impact (the effect of additional direct and indirect employment leading to extra consumption in the local economy) and fiscal return (the return for the governments via fiscal flows originating from direct, indirect and induced impacts) are calculated.

Particularly interesting are the leverage effects we see arising from the economic footprint results: what is the additional employment in the European economy that can be related to one person employed at an RTO? If grants are received, how many euros flow back to the national government for each euro it invests in the (daily operation of) RTO?

In the overall EARTO study, we further complement this economic footprint assessment with a number of indicators on downstream effects: the scientific and technological activities of the RTO. We focus on forms of knowledge transfer and knowledge conversion that typically have a strong economic impact as well, in particular on outflow of research staff, contract research and spin-off creation. Additional to the 2013-2014 economic footprint assessment, we now complement the assessment of the economic impact of contract research through application of a technology multiplier effect (as in the 2013-2014 study) with an additional input-output approach measuring the (monetary) downward effects. The latter is a lower boundary and benchmark to the first. For the spin-offs we have additionally added an analysis of their survival rate compared to the average start-up company in Europe.

The quantification of these economic effects is an important value added in the demonstration of the RTOs' value for the economy and society in Europe.

In underlying report, we present the indicators of the economic footprint for DTI as one of the 9 RTOs in the original EARTO study. This means that we apply the parameters from the EARTO study⁷ to DTI-specific data on purchases and contracts to obtain the figures for DTI and thus its share in the EARTO total. As DTI does not have spin-offs, no DTI-specific analysis on this type of knowledge transfer is included in this note. We first present a summary of the key indicators and multipliers, and subsequently present the individual indicators in more detail. For more information on the conceptual and methodological framework of this study, we refer to the EARTO report⁸.

⁷ In general the EU averages of sector indicators or taxes, and EU-level Input-Output tables, but also EARTO rates for HC/FTE and indirect/direct effects or induced/direct+indirect effects in the calculation of the economic effects of spin-offs and contract research.

⁸ http://www.earto.eu/fileadmin/content/03_Publications/2018/EARTO_Economic_Footprint_Study_-_Impact_of_9_RTOs_in_2015-2016_-_Final_Report.pdf



2/ SUMMARY

A total of 6,818 jobs (in head counts (HC), equivalent to 6,154 full-time equivalents (FTE)) are created in the European economy that can be linked to the activities of DTI.

The total effect corresponds to a total turnover of 0.853 billion euro and a total value added of 0.335 billion euro.

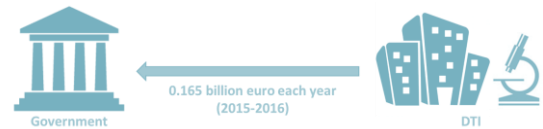
- ▶ In 2016, **1,933 HC jobs** or 1,808 FTE in Europe stem from the **core activities** of DTI, corresponding to a total additional turnover of 0.237 billion euro and a value added of around 0.046 billion euro each year.
- ▶ The **contract research** that DTI engages in within Europe, amounts to 0.069 billion euro. This results in an annual technological value creation of 0.137 billion euro (directly). This value creation results in another **4,886 HC jobs** or 4,345 FTE jobs that can be linked to DTI's activities, as well as a total of 0.616 billion euro of turnover and 0.290 billion euro of value added.






For each job in DTI, another 4.73 jobs are created elsewhere in the European economy (on top of the 1 direct job in DTI), either at the suppliers of DTI or in the

broader economy, thanks to the additional consumption of the employees of both DTI and their suppliers, and thanks to the effects of knowledge transfer through contract research.

The total fiscal return amounts to 0.165 billion euro in 2016. That means that each year, DTI's core activities, contracts and spin-offs generate tax revenues from social security and wage taxes, corporate taxes and value added taxes (VAT) that amount to 0.165 billion euro.



The figure below and table in the next section summarise the key results for the economic footprint of DTI in Europe in 2015-2016.

| |  EMPLOYMENT (HC) |  TURNOVER (B€) |  VALUE ADDED (B€) |
|---|---|---|--|
| Direct | 1,107 | 0.150 | 0.004 |
| Indirect | 616 | 0.067 | 0.032 |
| Induced | 209 | 0.021 | 0.010 |
| Total core | 1,933 | 0.237 | 0.046 |
| Fiscal return core (B€) | 0.031 | 0.003 | 0.006 |
| = 0.040 BILLION EURO FISCAL RETURN CORE ACTIVITIES | | | |
| Contract research | 4,886 | 0.616 | 0.290 |
| Total | 6,818 | 0.853 | 0.335 |
| = 0.165 BILLION EURO FISCAL RETURN TOTAL CORE ACTIVITIES, CONTRACT RESEARCH, AND SPIN-OFF ACTIVITIES | | | |



3/ ECONOMIC FOOTPRINT INDICATORS FOR DTI

3.1 Overview of indicators

| | 2015 | 2016 |
|---|---------------|-------------------------|
| CORE ECONOMIC ACTIVITIES OF RTOs | | |
| Direct impact | | |
| Employment creation (HC / FTE) | 1,035 / 1,004 | 1,107 / 1,074 |
| Turnover creation (billion euro) | 0.136 | 0.150 |
| Value added creation (billion euro) | 0.007 | 0.004 |
| Indirect impact (through RTOs suppliers) | | |
| Employment creation (HC / FTE) | 663 / 592 | 616 / 548 |
| Turnover creation (billion euro) | 0.072 | 0.067 |
| Value added creation (billion euro) | 0.034 | 0.032 |
| Induced impact | | |
| Employment creation (HC / FTE) | 202 / 181 | 209 / 186 |
| Turnover creation (billion euro) | 0.020 | 0.021 |
| Value added creation (billion euro) | 0.010 | 0.010 |
| Fiscal and parafiscal returns | | |
| <i>Through employment (billion euro)</i> | 0.030 | 0.031 |
| <i>Through turnover (billion euro)</i> | 0.003 | 0.003 |
| <i>Through valued added (billion euro)</i> | 0.006 | 0.006 |
| TOTAL impact of core economic activities | | |
| Employment creation (HC / FTE) | 1,900 / 1,777 | 1,933 / 1,808 |
| Turnover creation (billion euro) | 0.228 | 0.237 |
| Value added creation (billion euro) | 0.051 | 0.046 |
| Fiscal and parafiscal return (billion euro) | 0.039 | 0.040 |
| <i>Employment multiplier core activities (total of direct, indirect and induced jobs / jobs directly at an RTO)</i> | <i>1.77</i> | <i>1.68⁹</i> |
| <i>Fiscal leverage core activities (fiscal return core activities / operational grant)¹⁰</i> | | |
| TECHNOLOGICAL SPILLOVER EFFECTS | | |
| Knowledge transformation & transfer through contract research | | |
| Total employment creation (HC / FTE) | 4,182 / 3,734 | 4,886 / 4,345 |
| Total turnover creation (billion euro) | 0.526 | 0.616 |
| Total value added creation (billion euro) | 0.254 | 0.290 |
| Fiscal and parafiscal return (billion euro) | 0.108 | 0.125 |
| Spin-off activities¹¹ | | |
| Total employment creation (HC / FTE) | | |
| Total turnover creation (billion euro) | | |
| Total value added creation (billion euro) | | |
| Fiscal and parafiscal return (billion euro) | | |

⁹ In 2016, for each 1 job in DTI, another 0.68 jobs were created elsewhere in Europe due to the core economic activities of DTI (on top of the 1 direct job in DTI).

¹⁰ The fiscal multiplier cannot be calculated because DTI did not receive an operational grant from its national government.

¹¹ DTI does not have spin-offs.



| | 2015 | 2016 |
|--|---------------|--------------------------|
| TOTAL AGREGATED EFFECT | | |
| Total employment creation (HC / FTE) | 6,082 / 5,511 | 6,818 / 6,154 |
| Total turnover creation (billion euro) | 0.753 | 0.853 |
| Total value added creation (billion euro) | 0.305 | 0.335 |
| Fiscal and parafiscal return (billion euro) | 0.147 | 0.165 |
| <i>Overall employment multiplier (FTE core activities, contracts and spin-offs/FTE employed directly at an RTO)</i> | <i>5.49</i> | <i>5.73¹²</i> |
| <i>Total fiscal leverage (fiscal return core activities, contracts and spin-offs/operational grant)¹³</i> | | |

Source: IDEA Consult based on RTO data

¹² In 2016, for each 1 job in DTI, another 4.73 jobs were created elsewhere in Europe due to both the core economic activities of DTI and their technological spillover effects (on top of the 1 direct job in DTI).

¹³ The fiscal multiplier cannot be calculated because DTI did not receive an operational grant from its national government.



In the economic footprint study for EARTO, we applied European parameters to the aggregated total of the 9 RTOs. To calculate the individual DTI results in this study, we apply the same European parameters, as well as a number of calculated ratios based on the 9 RTOs in the study. Thus, we did not apply the national parameters or DTI specific ratios, like it would be the case in a stand-alone economic footprint study of an individual RTO. This implies that the results presented here, aim to show the 'DTI-part' in the overall EARTO results and are not to be quoted as tailor-made DTI indicators, or used for comparison purposes with other individual RTOs. Within this context, we discuss the DTI indicators to show the order of magnitude of DTI's economic footprint and its share in the EARTO study's results.

3.2 DTI core activities

DTI, as one of the smaller RTOs in the EARTO study in terms of employees, is responsible for 2.2% of the direct employment effects in 2016 and for 2.1% of the direct turnover creation in the EARTO study in 2016. The share in the direct value added (including grants) is 0.1%. However, DTI is the only RTO in the study that does not receive an operational grant. The direct value added of the other RTOs excluding their grants is often below zero, while DTI has a positive value added of 0.004 billion euro (3.5 million euro) in 2016.

Both the share of the first order indirect effects (purchases) and the share of the total indirect effects is around 1% of the EARTO total for 9 RTOs. This means that on the one hand, DTI's spending at its suppliers are on average lower compared to its direct turnover, but that on the other hand the output multipliers of the sectors in which these purchases are concentrated, are on average similar to what we observe for the other 8 RTOs. The induced effect – which is based on the direct and indirect effect - amounts to 2.0% of the EARTO total in terms of employment, 1.7% in terms of turnover and 1.8% in terms of value added.

The employment multiplier of core activities is lower than the EARTO total for 9 RTOs in 2016, but above 1: 1.68 compared to 2.31. This means that for each person employed directly at DTI, another 0.68 people are employed elsewhere. This indicator is influenced by the relatively lower total indirect effects compared to the total in the EARTO study.

The fiscal returns of the economic effects from DTI core activities correspond to around 1.5% of the total EARTO effect. The fiscal return through employment creation and turnover creation corresponds to respectively 1.6% and 1.5% of the total EARTO effect, the return through value added to 0.6% of the total EARTO effect.

3.3 Knowledge transformation and transfer through (outflow of) research staff

The number and share of researchers working in the RTO is a good indication of the knowledge input and absorptive capacity in the RTO. 1,107 people work at DTI in 2016, corresponding to 1,074 FTE. 772 or 72% of all FTEs are researchers, which is more than in total across the 9 RTOs (56%).

The outflow of highly-qualified staff towards industry contributes strongly to the availability and absorption of highly-valued knowledge enterprises and their related industries. In terms of outflow of staff, DTI reports that 104 people have left DTI in 2016, which is 9% of the total number of employees. This compares to 14% in the estimation for all RTOs¹⁴. 60 employees (58%) move to private enterprises within Denmark, compared to around 50% for the RTOs in total. 8 employees (8%) go to public organisations within Denmark and 36 employees (35%) go to other sectors (of which 35 in Denmark and 1 in another EU country).

3.4 Knowledge transformation and transfer through contract research

Compared to the total in the EARTO study, DTI takes up 3.5% the overall economic effects of contract research in terms of employment, turnover and value added. This is due to the fact that DTI's share of contract research in the total for the 9 RTOs is also 3.5%. DTI's share in contract research (3.5%) is thus relatively higher than its share in the direct employment and turnover at the RTO (2%).

The downstream interactions can also be analysed through input-output tables¹⁵. Given the 0.069 billion euro of contracts that DTI has in Europe in 2016, the downstream interactions through input-output tables result in an

¹⁴ Results for all RTOs with regard to outflow of staff are to be interpreted with care due to missing data.

¹⁵ This analysis provides additional insights in the results of technological knowledge transfer in economic terms. However, it is important to take note of the fact that the input-output analysis captures only the monetary value of the research contracts; therefore not 1) the discounted present value of future potential, yet unknown, income streams that are due to the knowledge produced, 2) the scientific value, 3) environmental value, 4) societal benefits. It is therefore considered a lower boundary to the real effects. The analysis based on the contract research data and technology multiplier captures at



input multiplier of 1.89 for DTI, slightly below the value as in total for the 9 RTOs (1.96). This is explained by the sales patterns, with DTI selling relatively more to a number of specific sectors with lower input multipliers than other sectors e.g. the wholesale sector, food products and food service sector, real estate sector and creative sector. The multiplier shows that for each euro sold or contracted by DTI, another 0.89 euro can be sold by other sectors. In total, this implies an additional output of over 0.061 billion euro in the European economy in 2016 (indirect) – on top of the 0.069 billion of contract research at DTI (direct). In other words, with the research services of DTI the economy is able to generate another 0.061 billion euro turnover in the EU. As in the total EARTO study, the total of 0.130 billion euro is low compared to the value for turnover found in the analysis based on the technology multiplier (0.616 billion euro). The IO analysis captures only the monetary streams and not scientific or other impacts on contracts and sales, and does not take into account the discounted value of future potential output streams that may stem from the RTOs research findings.

3.5 Knowledge transformation and transfer through spin-off activities

DTI's knowledge conversion strategy does not work through spin-offs, so no activities are reported here.

3.6 Total multiplier effects

The total aggregated effects (core activities + contract research) correspond to between 2.0% (value added) and 2.4% (employment and turnover) of the EARTO study's total (compared to a share of DTI of around 2% in the direct effects). The total fiscal return is 2.5% of the EARTO total.

The total employment multiplier of DTI amounts to 5.73 compared to 5.24 in the EARTO study for 9 RTOs in 2016. While the employment multiplier of only core activities was lower than for the 9 RTOs in total, the employment multiplier including contract research (and spin-off activities in 7 other RTOs) is higher for DTI. This higher value for the employment multiplier is thus driven by the strong effects through contract research. The multiplier indicates that for each employee at DTI, another 4.73 people are employed elsewhere in the economy.

3.7 DTI infrastructure: Combined technology infrastructure projects

Finally, we include the case of the DTI infrastructure project in this note, one of three illustration in the EARTO study to illustrate the order of magnitude and specific characteristics of these specific and non-recurrent projects and of their effects. The Danish Technological Institute (DTI) aims to provide unique facilities that allow their customers to test technologies without having to make costly investments first. In 2015 DTI invested 4 million euro in buildings and property and equipment, with around 2 million euro that can be linked directly to technology infrastructure projects:

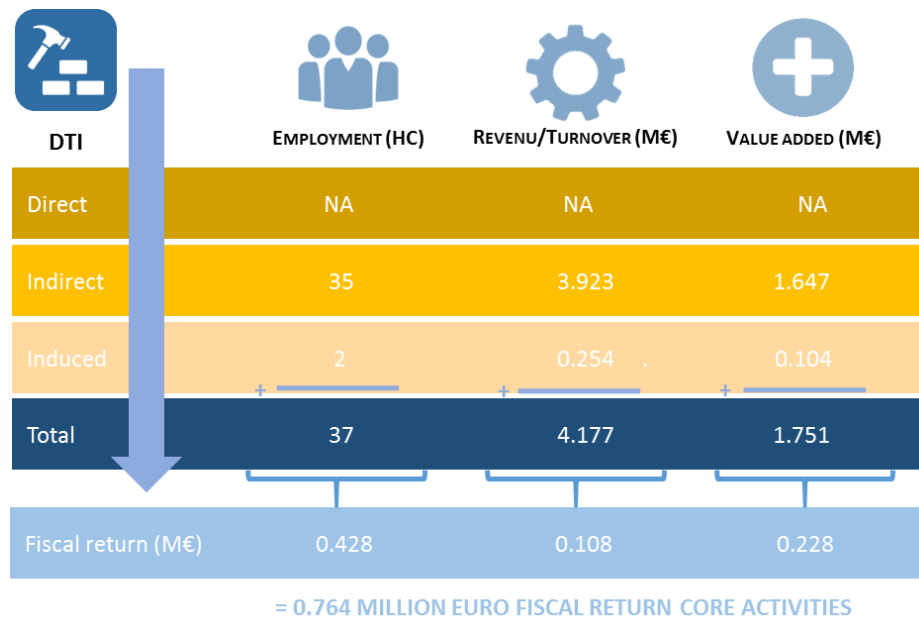
- ▶ In 2014 DTI built a new domicile to DMRI (Danish Meat Research Institute) of 6600 square meters. In 2015 this building was finalized with new state of the art research facilities, thus consolidating DMRI's position as Denmark's leading food center.
- ▶ Furthermore, in 2015 DTI upgraded its laboratory facilities for advanced packaging development. This will provide much better opportunities for supporting Danish enterprises in their development of new packaging. Moreover, the furniture testing facilities have been improved with renovation of the rooms and investments in new test machinery, making the laboratory one of the most modern laboratories in Europe.

least part of the technological and scientific impact through the technology multiplier and as such will be higher than the results based on the monetary flows in the input-output analysis.



- ▶ The Institute's largest investment in 2016 is the purchase of an ion accelerator from Danfysik A/S. The ion accelerator will, besides assisting in the development of new surface coatings, be used to produce the unique low-friction coating IBAD-DLC. It makes it possible to shape packaging for canned goods without harming the protective polymer layer that is on top of the metal to prevent direct contact between metal from the can and, for example, highly corrosive foods. Furthermore, the accelerator will be used for the production of the special chromium nitride Super-Slip (CrN-SS) coating that reduces the distortion effects in connection with injection moulding significantly. This coating has, among other things, made it possible for the company Winther Mould Technology A/S to develop a fully automatic injection moulding production platform that can increase productivity by up to 50% without compromising on quality. The ion accelerator opens up for entirely new perspectives and development options for Danish industry. The importance of it was recently highlighted in Innovationfonden's new material push at the end of 2016, where they specifically chose to grant DKK 21 million to a large Danish-Swiss project called "SUPER-MOULDS." The project will develop new coatings to improve the efficiency of injection moulding in order to ensure increased competitiveness in high-wage countries like Denmark and Switzerland.
- ▶ The Institute has also in 2016 established a new dry concrete laboratory where it is now possible to carry out pilot productions of very dry concrete that needs to be vibrated and pressed into shape. With the equipment one can, for example, make a full-scale test of recipes and develop new types of concrete based on the materials used. Beyond this, the equipment can also be used to develop and document products for climate change adaptations, such as, for example, permeable cobblestones that allow water to pass through them.

An overview of the economic effects resulting from the construction of this kind of infrastructure for one year (2016), is given in the figure below. The results are part of the total results presented above, and are thus not to be considered as additional effects. The numbers are very similar for 2015 data, given that the investments were of a similar range in both years.



- ▶ **The total economic effect of this 2 million euro investment by DTI in 2016 corresponds to 37 HC jobs, a turnover of 4.2 million euro and a value added of 1.8 million euro.**

The investments in technology infrastructures by DTI add up to 2.0 million euro in 2015 and 1.9 million euro in 2016. This investment in 2016 generates 35 indirect jobs (HC) at the suppliers and further upstream and another 2 jobs (HC) through induced consumption effects. 3.9 million euro indirect and 0.3 million induced turnover is created, as well as 1.6 million euro of indirect value added and 0.1 million euro of induced value added.

This economic effect of DTI's investments in the creation and upgrade of technology infrastructures only accounts for the year 2016. Similarly in 2015, the effects add up to 38 HC jobs (34 FTE), a turnover of 4.3 million euro and a value added of 1.8 million euro.

- ▶ **The total fiscal return of the infrastructure project by DTI adds up to 0.8 million euro in 2016.**

Both in 2015 and 2016, the total fiscal return amounts to almost 0.8 million euro. For both years together, this means that around 1.5 million euro of fiscal returns were generated in Europe.