The socio-economic impact of research infrastructures: a generic evaluation framework and insights from selected case studies

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Introduction: Theoretical background

In order to give an account of the socio-economic impact of research infrastructures, it is important to start from a theoretical framework:

1956: R. Solow, “A Contribution to the Theory of Economic Growth” → Technological progress a main but exogenous driver of economic growth → Technological progress (A) = what economists cannot explain because it is not the result of market-driven forces

1986: P. Romer, “Increasing Returns and Long Run Growth” → Endogenous technological progress → Technological progress is the result of the stock of available knowledge (H) and market-driven forces, in particular R&D expenditures (public and private). R&D expenditures can be influenced by incentives, subsidies.

Unlike labour and capital, knowledge and technological progress are not subject to diminishing returns, but increasing returns

Growth factors	Names and main drivers	Corresponding Europe 2020 objectives
L	Labour or Workforce available → Demography	75% of the 20-64 year-olds to be employed
K	Capital or Equipment, machines → Investments in capital goods	-
H	Human capital or Knowledge → Education and training	Reducing the rates of early school leaving below 10% At least 40% of 30-34–year-olds completing third level education
A	Technological progress → Investments in R&D	3% of the EU's GDP to be invested in R&D

If we note Y the production function of an economy, we have Y = Y(L, H, K, A) with

$$\frac{\partial^2 Y}{\partial H^2} > 0, \quad \frac{\partial^2 Y}{\partial A^2} > 0 \quad \frac{\partial^2 Y}{\partial L^2} < 0 \quad \frac{\partial^2 Y}{\partial K^2} < 0$$

Introduction: Theoretical background

What is a socio-economic impact?

- A measure of the variation in the level of welfare among a population of reference, generated in and out of markets (i.e. with or without price mechanism)

In practice, no consensus on a list of impacts… Impacts have to be defined with respect for pre-defined objectives of stakeholders

Reference tool. For the evaluation of socio-economic impacts, the European Commission and the European Investment Bank favor the use of the **Cost-Benefit Analysis**.

The CBA is typically a microeconomic approach enabling the assessment of the project's impact on society as a whole via the **calculation of economic performance indicators**, thereby providing an assessment of expected welfare changes. While direct employment or external environmental effects realised by the project are reflected in the ENPV, indirect (i.e. on secondary markets) and wider effects (i.e. on public funds, employment, regional growth, etc.) should be excluded. This is for two main reasons:

— most indirect and/or wider effects are usually transformed, redistributed and capitalised forms of direct effects; thus, the need to limit the potential for benefits double-counting;

— there remains little practice on how to translate them into robust techniques for project appraisal, thus the need to avoid the analysis relies on assumptions whose reliability is difficult to check.

Consistently with the theoretical macroeconomic approach introduced earlier, this presentation will introduce impacts taken into account in a CBA, **but also indirect and induced effects that are normally left out.**

A specific difficulty: assessing ex-ante the impact of research carried out in a RI

Impacts from research carried out at a RI is difficult to estimate (i.e. put a value on) **ex-ante** as:

→ Radical uncertainty and serendipity make the probability and nature of successful research unpredictable

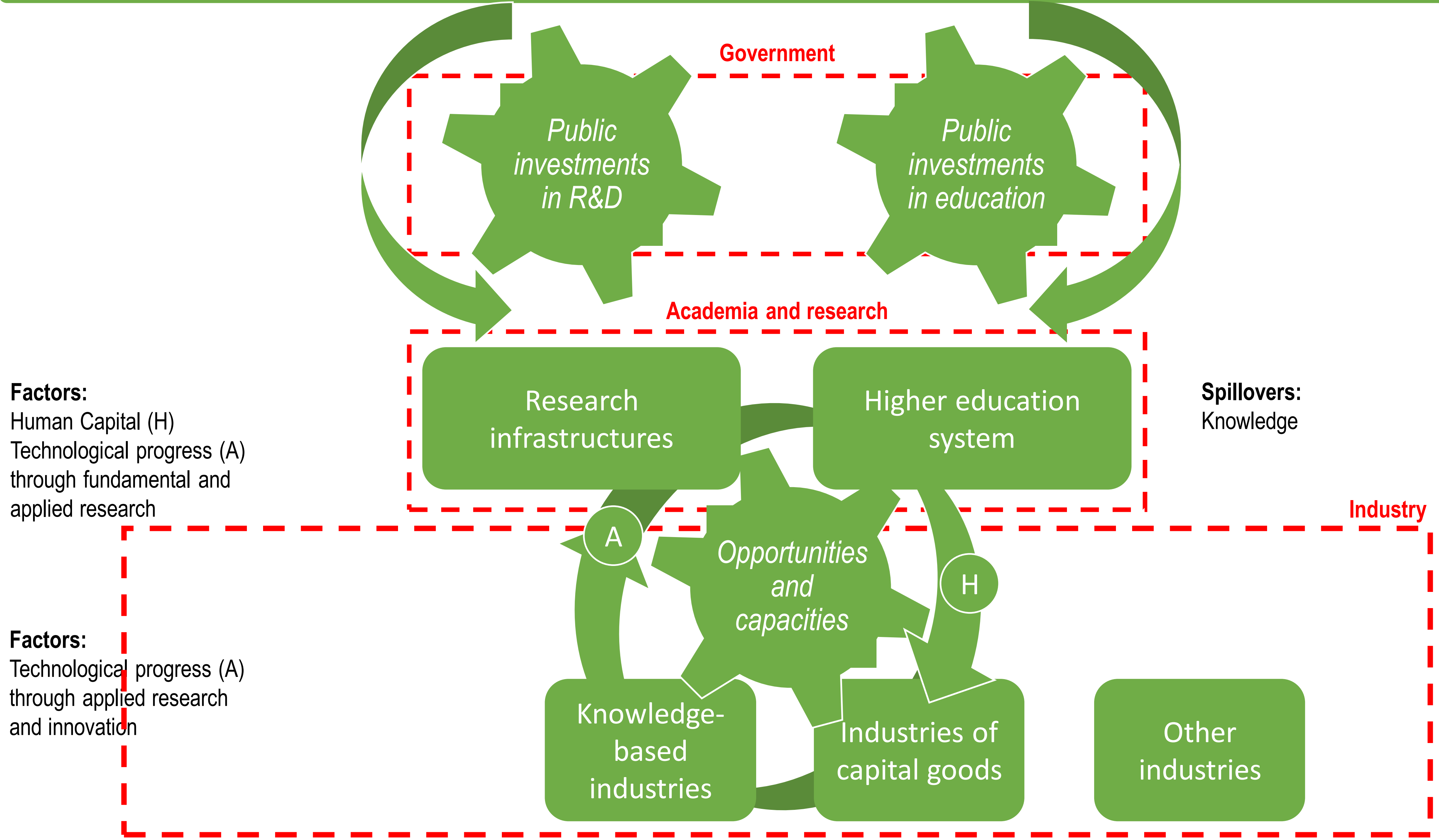
→ The absence of markets and prices explains why defining values for articles, patents, and hours of access is difficult: we can't observe a supply and a demand equilibrate on a market

→ A production vs. transfer issue, as only those outputs (e.g. patents) transferred to the economy generate a socio-economic benefit, and the transfer of technology is induced by a demand on a case-by-case basis

→ A value chain issue, as there is a long way from research to the final socio-economic benefit, several steps (marketing, industrialization process, etc.) can alter (positively or negatively) the impact of the research work, in such an extent that it is difficult at the end of the process to clearly break down the socio-economic benefit between the different causes

However, **ex-post**, those difficulties can be – at least partially – removed. Research can be apprehended from the point of view of actual, observed results, the economic value of which can be defined with respect for the eventual innovations they gave birth to. Relevant markets can be identified, and the commercial potential of a given innovation can be estimated. Yet, the value chain issue remains.

Triple helix and the role of Research Infrastructures



RI outputs influencing the production function ("Opportunities and capacities")

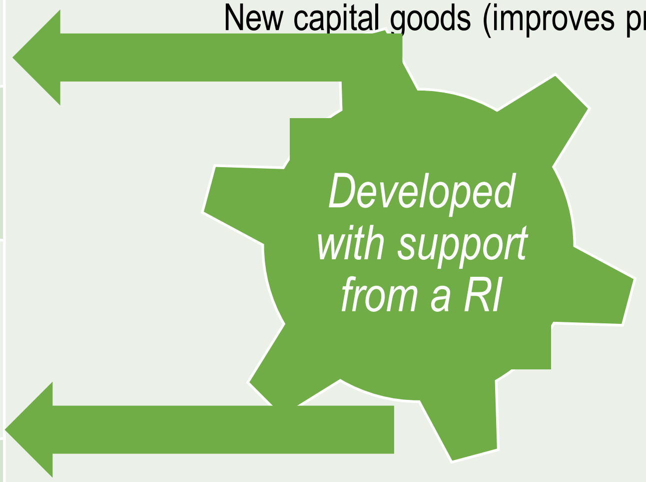
RI outputs	Comments	Impact on
Master and PhD students trained		H
Collaborative projects with industries	Collaborative research projects imply that the research institution and the company(ies) share the costs of the project, and its outcome (i.e. intellectual property over the results, technologies, methods etc. developed)	H, A
Contractual research projects	Research for which the research institution is paid by one or more companies; the resulting intellectual property is owned exclusively by the company(ies)	H, A
Procurement of innovative equipment	Procurement by research institutions or academia of innovative equipment to companies, triggering R&D expenditures and creation of new knowledge by companies	H, A
Scientific publications	Scientific articles, conference presentations	H, A
Patents		A
Pilot plants, demonstrators, prototypes	Pilot plants, demonstrators, prototypes developed at the research infrastructure with commercial potential, to be adapted for commercial exploitation	A
Access to scientific instrumentation by companies	Granting access to scientific instruments to companies for carrying out experiments, providing technical support to companies	H, A

In a ex-ante Cost-Benefit Analysis, those outputs are considered as sources of impact, a value is given to each of them: this assumes that all outputs from the RI are actually integrated by the economy/society (a strong assumption in our view).

Socio-economic impact of research infrastructures: building a typology

Typology of impact

Type of impact (production function)	Comments	Impact on	Impact on output
Direct impact (changes in the outputs of the industry caused by outputs from research infrastructures)			
Net creation of R&D jobs	In companies the activities of which are boosted by collaborations with research infrastructures	H	New products or services on the market New capital goods (improves production efficiency)
Net creation of non-R&D jobs	In companies the R&D&I activities of which are boosted by collaborations with research infrastructures	L	
New investments	To upgrade or maintain the production process (use of new production technologies developed at/in collaboration with RIs)	K, A	
Spin-offs (from RIs)	Number of jobs (R&D, non-R&D) created in newly-created companies Investment in equipment	L, H, K, A	
Induced effects			
Non-permanent job creations	e.g. civil works related to the construction of a new research facility	L	Increase of output from other industries
Permanent job creations	Throughout the economy	L, H	Increase in outputs from all industries (consumer goods) to satisfy additional demand



Socio-economic impact of research infrastructures: building a typology

Typology of impact

Type of impact	Comments
Externalities	
Improvement in the quality of life	e.g. reduction in pollution due to new production processes based on new, more efficient technologies
Effect on life expectancy (reduction of mortality)	e.g. reduction of mortality due to new medical treatments
Preservation of natural resources	e.g. new technologies to recycle used materials

Externalities = cost or benefit that affects a party who did not pay or receive compensation for it.

Socio-economic impact of research infrastructures: building a typology

Introducing time and space

Impact type	Dimension	Examples of effects	Ex-ante estimation	Ex-post verification
Impact from implementation at local level	Local	Impact from construction on output and employment	Possible (using macroeconometric models)	Possible
Impact from R&D expenditures	Worldwide	Procurement of custom-made equipment	Difficult (suppliers unknown)	Possible
Impact from employment and consumption	Local/National	Number of jobs created (R&D personnel and non-R&D personnel)	Partially possible (direct employment at the research infrastructure)	Possible
Impact from scientific output	Worldwide	Scientific publications, patents	Highly speculative	Possible (a few years after first scientific results)
Other impacts	Local	Procurement of other goods and services	Possible	Possible

Radical uncertainty, serendipity, absence of markets and prices, production vs. transfer issue, value chain issue

Optimising the impact of Research Infrastructures

Research Infrastructures are enablers: they provide the economic system with a set of opportunities and capacities.

- → Trained workforce (Master and PhD graduates)
- → Collaborations for research, development and innovation
- → Pool of patents, demonstrators, pilot plants, designs, etc to tap in
- → Access to high-value scientific instruments and databases

For a RI to deliver a maximum socio-economic impact, an ecosystem should exist that makes the most out of the opportunities and capacities offered by the RI:

- → Critical mass of researchers (from the public and private sectors) to use the Research Infrastructure (i.e. access the scientific instruments and databases)
- → Knowledge-based industries willing and able to absorb graduates (the activities of the private sector should be consistent with research carried out at the RI)

The quality of the immediate economic environment is what determines the level of socio-economic impact.

Ever since the beginning of the 20th century, economists have tried to observe patterns from which they could infer the capacity of an economic environment to consistently produce impact:

- → Pooling of industries, research/academic institutions, and eventually human resources in a geographical area (« cluster »)
- → Research shows that collaborations between institutions/companies located more than 2.5 hours by transport from each other tend to fail significantly more often
- → Importance of the financial sector and government, to provide the right legal framework, fiscal incentives, and financial resources

The case of ELI-NP

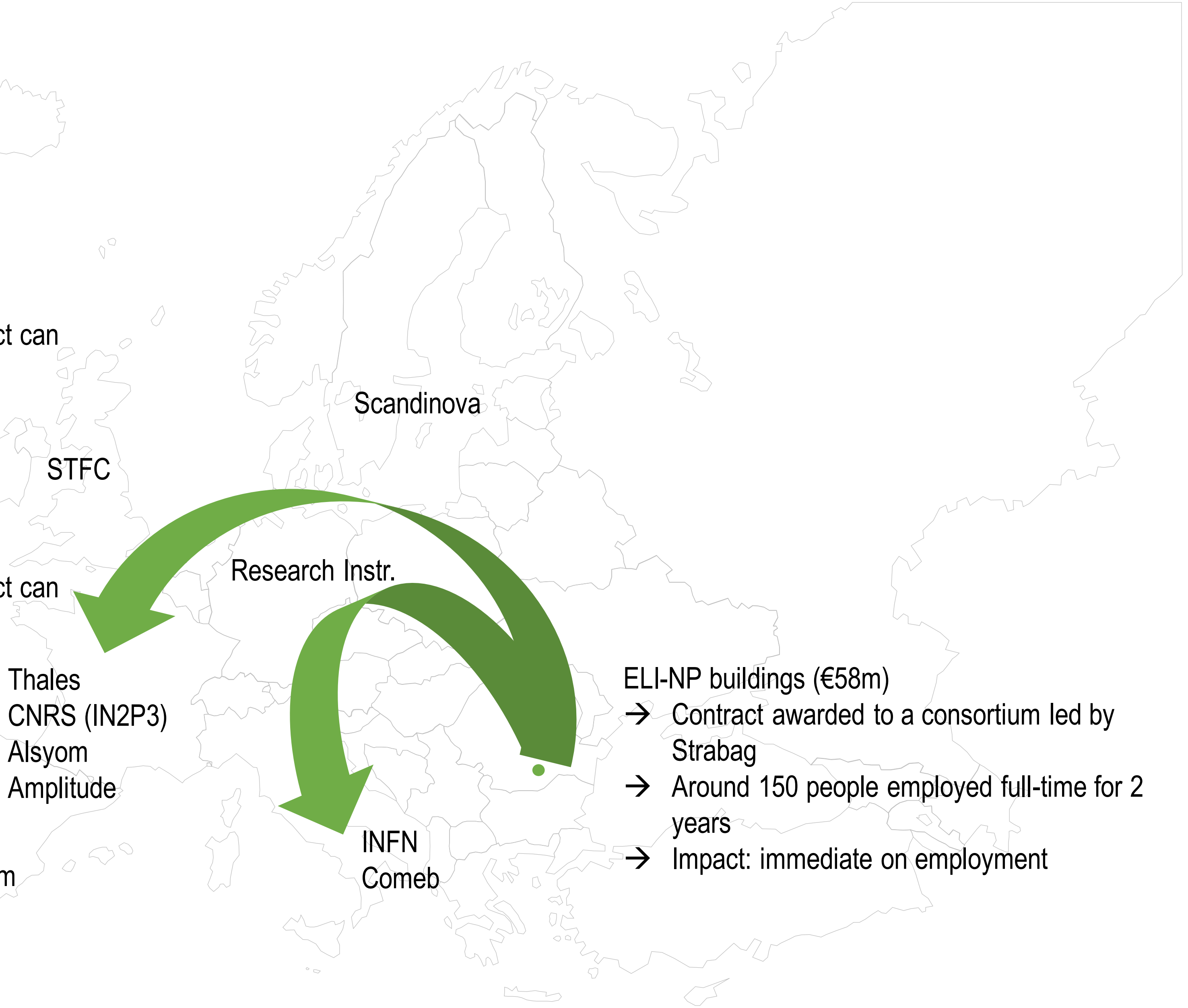
Example:

Impact of ELI-NP on the French photonics industry:
→ Procurement of innovative equipment:

2x10PW laser system: €61.5m
- → Major technological challenges
- → Price includes R&D costs incurred by the suppliers
- → Technologies developed in the context of this particular project can be used for new products
- → New R&D jobs

19.5MeV γ-beam accelerator: €66.9m
- → Major technological challenges
- → Price includes R&D costs incurred by the suppliers
- → Technologies developed in the context of this particular project can be used for new products
- → New R&D jobs

An ex-post evaluation would alllow to define:
- → New jobs created as a result of the ELI-NP contracts
- → Number of patents, technological designs, etc. produced
- → New products and services resulting from those contracts
- → Market potential for each new product or service resulting from R&D carried out in the context of ELI-NP contracts



ELI-NP buildings (€58m)
- → Contract awarded to a consortium led by Strabag
- → Around 150 people employed full-time for 2 years
- → Impact: immediate on employment

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