# Large-Scale Projects: Guidelines for Input

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## Introduction

It is anticipated that a number of proposals for large-scale research projects – including, but not limited to, particle colliders and collider detectors – will be submitted as input to the strategy process. These proposals are likely to vary in scale, anticipated timeline, and technical maturity.

'Large-scale' should be interpreted as meaning 'occupying the resources and efforts of an appreciable fraction of the European particle physics community for a number of years'. In financial terms, this indicates a capital investment of at least 250 MCHF.

In addition to studying the scientific potential of these projects, the ESG wishes to evaluate the sequence of delivery steps and the challenges associated with delivery, and to understand how each project could fit into the wider roadmap for European particle physics.

In order to allow a straightforward comparison of projects, we therefore request that all large-scale projects submit – in addition to their physics case and technical description – a standardised set of technical data. This will allow comparison and presentation of projects on a like-for-like basis without the need for re-interpretation of inputs. It is recognised that careful consideration of the entire scope of the strategy inputs, beyond summary data, will be needed when coming to conclusions. It is also understood that depending on the current level of technical planning, projects may be able to provide greater or lesser detail or certainty of estimates in response to each question.

The additional information may be contained in an addendum to the main submission.

## Definitions

Since most major infrastructures will proceed through several stages of construction, upgrade, and potential re-use, we define a 'project' as 'the pursuit of a clearly-defined scientific programme using a major research infrastructure'. A given infrastructure (e.g. the LEP/LHC tunnel) may support multiple projects in its lifetime. Moreover, we assume that each project may have multiple stages with varying scientific goals. An example would be the use of the LHC machine and its detectors in their original form and then as the upgraded HL-LHC complex.

The choice of how to divide the lifetime scientific programme of an infrastructure into projects and stages is left open, though we suggest this is done in such a way that successive stages of construction / operation with different parameters are made distinct.

# Questions for projects

1. ## Stages and parameters
    a. The main stages of the project and the key scientific goals of each
    b. Whether the ordering of stages is fixed or whether there is flexibility
    c. For each stage, the main technical parameters
    d. The number of independent experimental activities and the number of scientists expected to be engaged in each.
2. ## Timeline
    a. The technically-limited timeline for construction of each stage
    b. The anticipated operational (running) time at each stage, and the expected operational duty cycle
3. ## Resource requirements
    a. The capital cost of each stage in 2024 CHF
    b. The annual cost of operations of each stage
    c. The human resources (in FTE) needed to deliver or operate each stage over its lifetime, expressed as an annual profile
    d. Commentary on the basis-of-estimate of the resource requirements
4. ## Environmental impact
    a. The peak (MW) and integrated (TWh) energy consumption during operation of each stage
    b. The integrated carbon-equivalent energy cost of construction
    c. Any other significant expected environmental impacts
5. ## Technology and delivery
    a. The key technologies needed for delivery that are still under development in 2024, and the targeted performance parameters of each development
    b. The critical path for technology development or design
    c. A concise assessment of the key technical risks to the delivery of the project
    d. An estimate of financial and human resources needed for R&D on key technologies
6. ## Dependencies
    a. Whether a specific host site is foreseen, or whether options are available
    b. The dependencies on existing or required infrastructure
    c. The technical effects of project execution on the operations of existing infrastructures at the host site
7. ## Commentary on current project status
    a. A concise description of the current design / R&D / simulation activities leading to the project, and the community pursuing these
    b. A statement of any major in-kind deliverables already negotiated
    c. Any other key technical information points in addition to those captured above, including references to additional public documents addressing the points above.

# Notes

1c: For particle colliders, this should at least indicate the centre-of-mass collision energy, integrated luminosity, peak luminosity, and number of collision points/experiments.

1d: ‘Experimental activities’ means ‘the activities of a formal collaboration of scientists working towards a well-defined set of scientific goals’.

2a(i): ‘Technically-limited’ means ‘with consideration for a realistic sequence of approval, territorial negotiation, R&D, design, prototyping, industrialization, production, and installation given the capacity of the field’ but not limited by capital funding or external political delays.

2a(ii): The timeline should include the intermediate steps/goals of the R&D program.

2b: Duty cycle means the fraction of each year spent in physics operations. For guidance, a past report documenting anticipated operational parameters of future colliders is available.

3a(i): ‘Capital cost’ here corresponds to the usual ‘core cost’ model of CERN, including purchases, materials, equipment, but not human resources.

3a(ii): Costs should be broken down at top level where possible, e.g. into R&D, civil engineering, infrastructure, contracts, and support costs.

3a(iii): The costs of infrastructures (e.g. colliders) and associated scientific equipment (i.e. number of detectors and their estimated CORE costs) should be stated separately.

3a(iv): Costs should be expressed as a time profile over the project duration where possible.

3b: Include maintenance, power, and other support costs.

3c: This should include ‘direct’ costs associated with staffing and running the project. ‘Indirect’ costs including those of data-handling and computing should not be included, but further information may be given under item 7.

3d: Projects should provide an assessment of the maturity of estimates, and a concise explanation of how the estimates were arrived at. Where possible, please use AACE standards for classification of uncertainties.

4c: Include use of land area and consumption of other natural resources, e.g. significant consumption of water, helium or significant use of rare earth materials.

5b: Include any critical decision points on technology choices yet to be made.

6c: For example, the sequencing of construction with existing scientific programmes.