From climate models to informing policy decisions: the end-to-end importance of an effective research infrastructure

The IS-ENES3 Sustainability Working Group

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Outline

0 - The ENES research infrastructure and its mission

1 - Contributions to advances in policy-relevant science

2 - Potential danger of underfunding research infrastructure

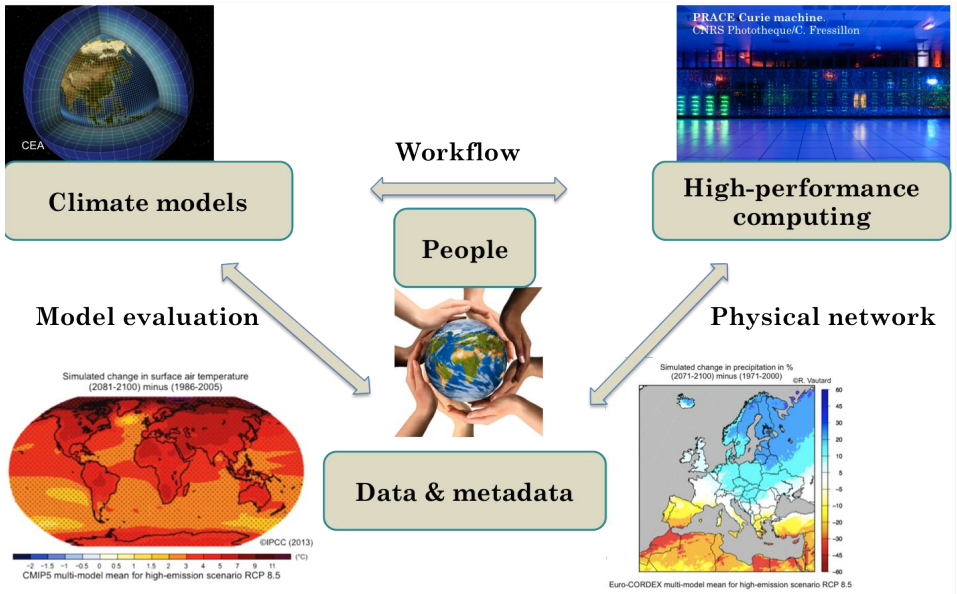
3 - Steps towards a sustained infrastructure

4 - Summary

Strategy of the ENES research infrastructure

Primary focus: the climate modelling research community

- Foster common model development and efficient use of HPC.
- Sharing of expertise, training
- Support exploitation of model data
- Support **WCRP** coordinated experiments (**CMIP** & **CORDEX**)
- Prepare for exascale



Two project streams:

- **IS-ENES**x: Infrastructure for the European Network for Earth System Modelling (since 2009).
- **ESiWACE**x: Centre of Excellence in Simulation of Weather and Climate in Europe (since 2015).

European Network for Earth System Modelling (ENES)

2 EC project streams

IS-ENES projects

Running current models and facilitating the use of the associated data

to progress understanding of climate, improve models, and inform society

ESiWACE projects

Preparing for future generation models and data exploitation running on **future computer architectures**

IS-ENES (2009-2013)

IS-ENES2 (2013-2017)

IS-ENES3 (2019-2022)

Support WCRP internationally coordinated climate model experiments (CMIP & CORDEX)

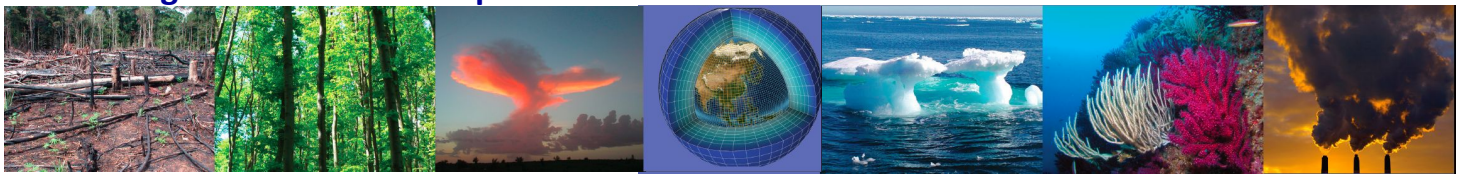
Support sharing of software and expertise

ESiWACE (2015-2019)

ESiWACE2 (2019-2022)

Center of Excellence in HPC for weather and climate (DG Connect)

Support exploitation of pre-exascale systems and prepare for exascale hardware



Services and expertise enabling the Exploitation of Climate Model Data

- **Data Access** (Provide a range of data access services)
- **Metadata and Data Standards** (contribute to the infrastructure and governance of key metadata and data standards, e.g. Climate Forecast conventions for NetCDF, documentation of models and simulations, CMIP data protocols)
- **Represent Needs of Climate Modelling** (European contributions to international partnerships, such as the European Open Science Cloud, the Earth System Grid Federation and the IPCC Data Distribution Centre)
- **Support and Enhance Model Diagnostic Capability** (primarily to support model evaluation and intercomparison) including **Deploying Services, Gathering Requirements, Promoting Standards, Developing Software**
- **Support Climate Impacts Community** (invest in the operation and development of targeted services)

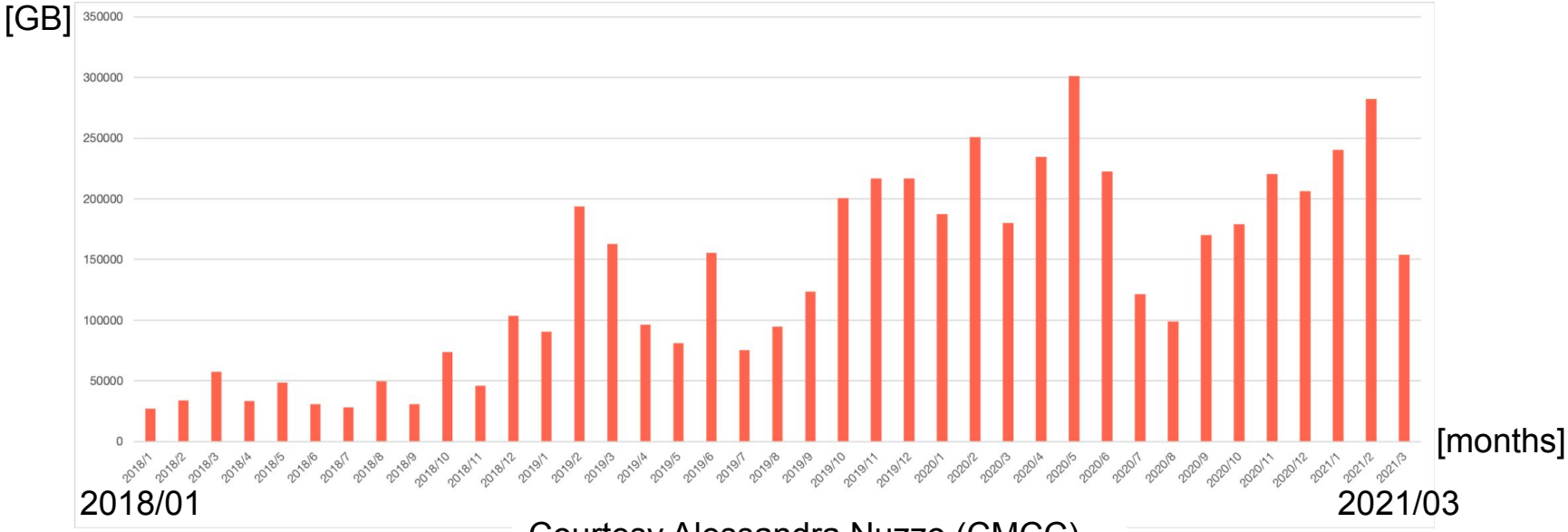
ENES-RI mission: (2) Models, Tools, and HPC

Supporting the development, operation, optimisation and evaluation of climate models

- **Support common development and use** of models, components, and tools
- **Improve the toolchain to manage data** from climate and weather simulations **at scale**
- **Accelerate preparation to (pre-)exascale systems** (foster co-design between model developers, HPC manufacturers and HPC centres)
- **Provide a platform for expertise exchange** to create a fitter and sustainable community
- **Promote the use of new metrics for evaluating model computational performance** and how best to use available HPC
- **Enhance HPC capacity**
- **Explore** new avenues and tools, such as **Machine Learning** and **Artificial Intelligence**

Climate data use - ESGF download stats

ESGF climate data volume downloaded from European nodes by European users



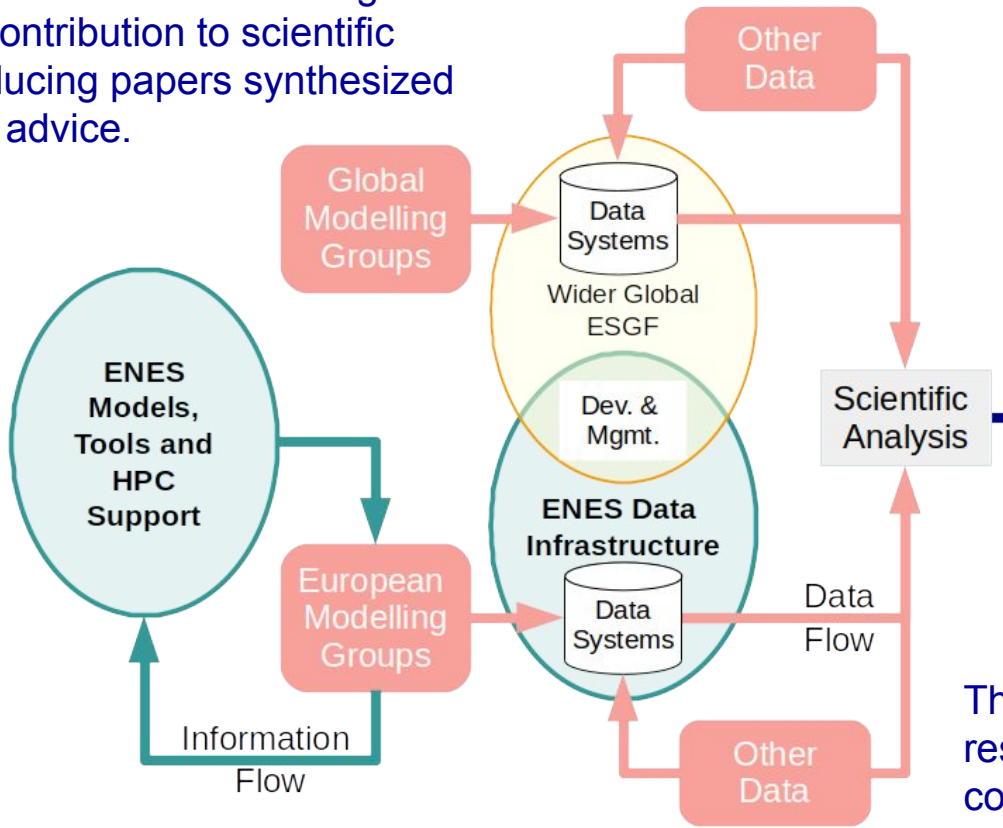
Courtesy Alessandra Nuzzo (CMCC)

Growing use of climate model data from the ENES-RI highlights the relevance of of our database beyond the pure research usage.
Administrations and climate services are important users of the database.

ENES-RI contributions to advances in policy-relevant science

IPCC

Results from climate modelling are a major contribution to scientific data producing papers synthesized for policy advice.



IPCC

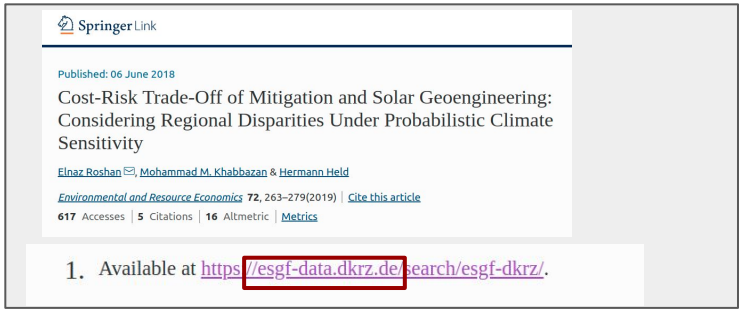
The IPCC reports summarises the latest research advances of the climate community and is widely used to inform policy decisions.

ENES-RI contributions to advances in policy-relevant science
Use cases examples

ENES-RI → Scientific outcomes → **Use cases**

ENES-RI → via C3S → Scientific outcomes

Examples:
- Management and conservation planning
- Development of tool to help local adaptation to regional climate change
- Evaluation of cost-risk trade-off of mitigation and geoengineering


Springer Link

Published: 06 June 2018

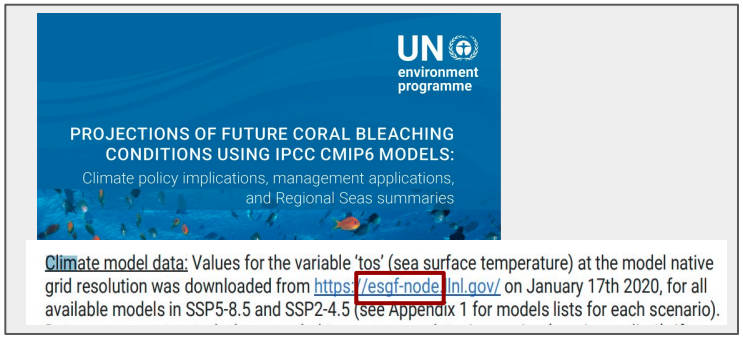
Cost-Risk Trade-Off of Mitigation and Solar Geoengineering: Considering Regional Disparities Under Probabilistic Climate Sensitivity

Elnaz Roshan, Mohammad M. Khabbazan & Hermann Held

Environmental and Resource Economics **72**, 263–279(2019) | Cite this article

617 Accesses | 5 Citations | 16 Altmetric | Metrics

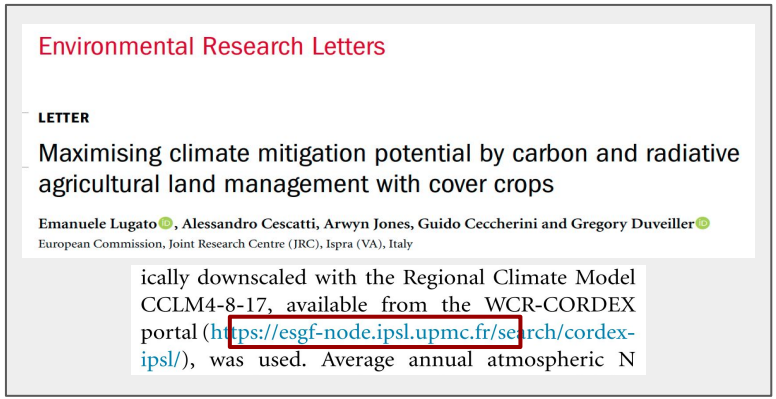
1. Available at https://esgf-data.dkrz.de/search/esgf-dkrz/.


UN environment programme

PROJECTIONS OF FUTURE CORAL BLEACHING CONDITIONS USING IPCC CMIP6 MODELS:

Climate policy implications, management applications, and Regional Seas summaries

Climate model data: Values for the variable 'tos' (sea surface temperature) at the model native grid resolution was downloaded from https://esgf-node.llnl.gov/ on January 17th 2020, for all available models in SSP5-8.5 and SSP2-4.5 (see Appendix 1 for models lists for each scenario).


Environmental Research Letters

LETTER

Maximising climate mitigation potential by carbon and radiative agricultural land management with cover crops

Emanuele Lugato, Alessandro Cescatti, Arwyn Jones, Guido Ceccherini and Gregory Duveiller

European Commission, Joint Research Centre (JRC), Ispra (VA), Italy

ically downscaled with the Regional Climate Model CCLM4-8-17, available from the WCR-CORDEX portal (https://esgf-node.ipsl.upmc.fr/search/cordex-ipsl/), was used. Average annual atmospheric N

Results from climate modelling data analyses have largely contributed to local / regional decisions on adaptation, mitigation or conservation planning ; as well as development of tools for adaptation.

ENES-RI contributions to advances in policy-relevant science
Towards exascale and Digital Twins

Towards exascale - ESiWACE

Enables very high resolution modelling of weather and climate on the upcoming (pre-)Exascale supercomputers.

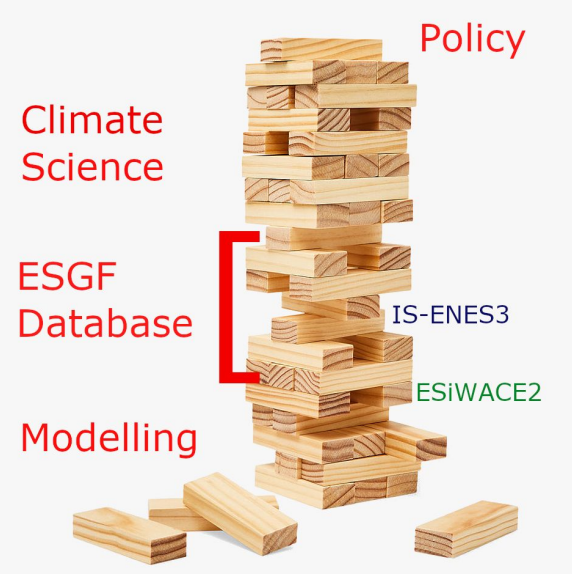
Improved weather forecasts and climate projections are crucial for informing decisions on emission reductions as well as adaptation strategies for housing, cities, farming, coastal defenses and other parts of society.

Destination Earth - the Digital Twins

Development a very high precision digital model of the Earth (Digital Twin) [...] to develop and test scenarios for:

- more sustainable development and achievement of the EU green deal objectives
- saving lives
- avoiding large economic downturns
- support EU policy

Funding reduction post 2022 - potential implications



The ENES-RI provides essential infrastructure which underpins the production of synthesized research informing climate policy.

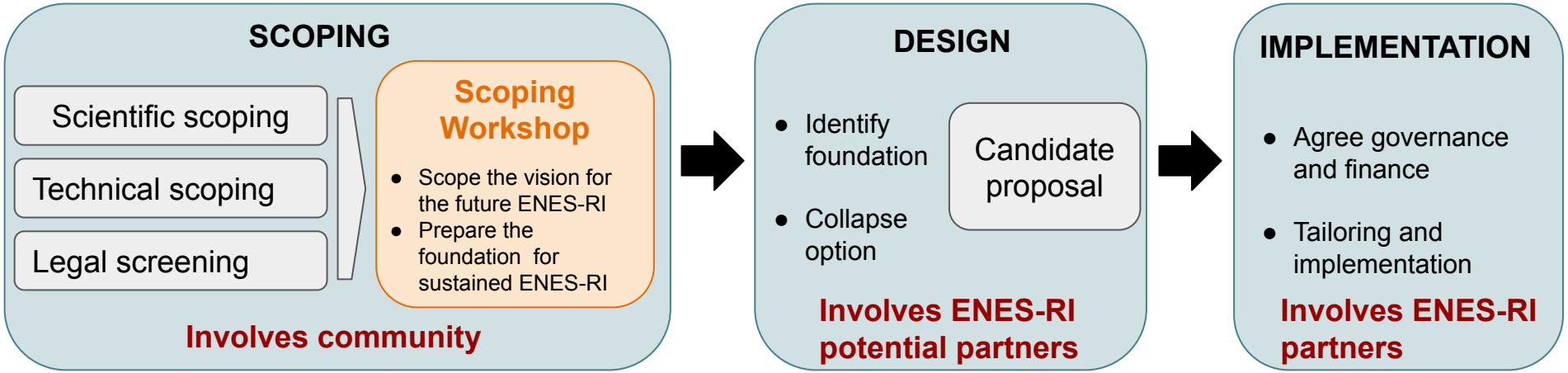
The ENES-RI currently largely relies on EU funding from both IS-ENES3 and ESiWACE2 projects.

EU funding ends Dec 2022.

=> Underfunding of RI will slow down science outcomes and prejudice adequate policy advice.

We are working toward sustaining our ENES-RI.

Steps towards a sustained infrastructure



A dedicated ENES Sustainability working group is working towards establishing a sustained research infrastructure.

This involves 3 phases:

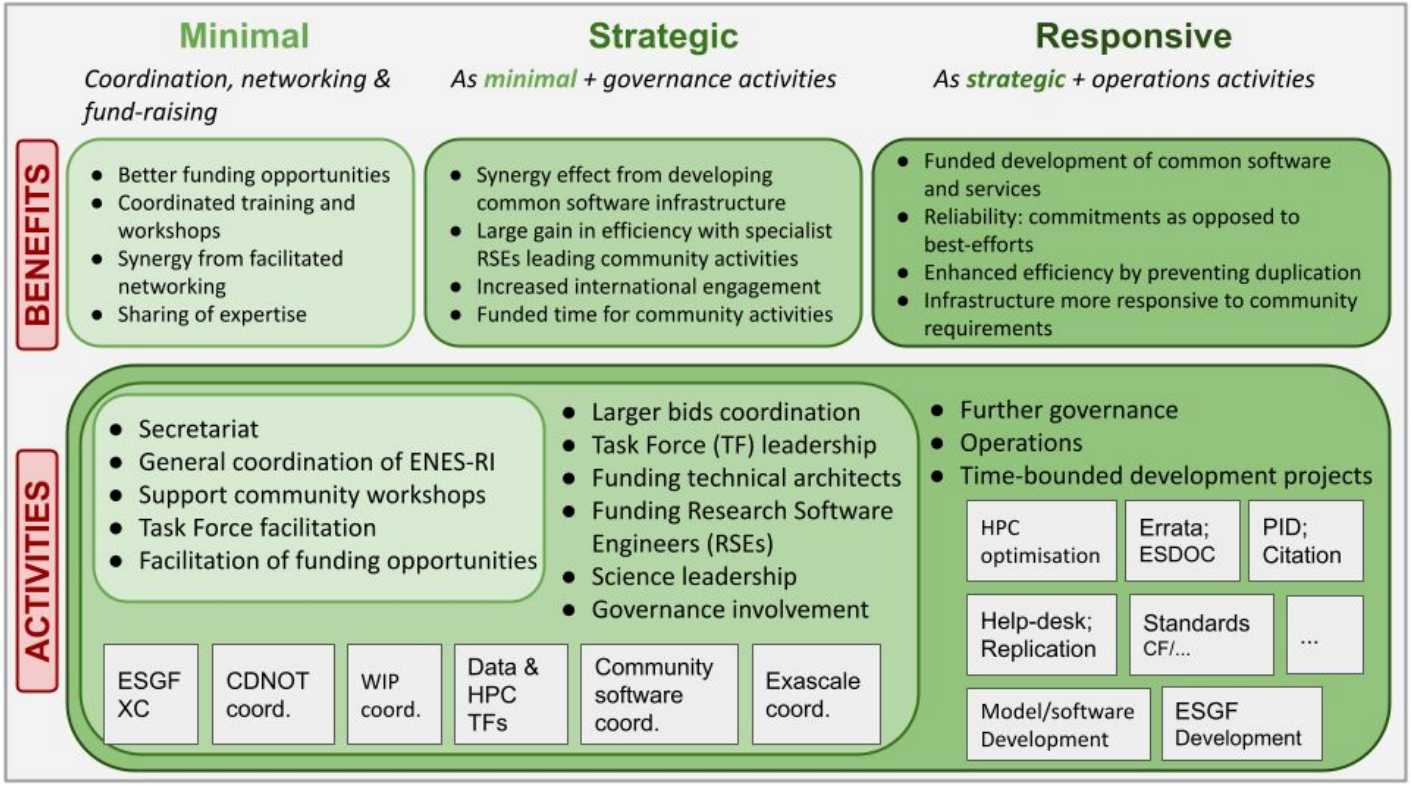
- The scoping phase assesses the needs of the community and scope the vision for the future RI.
- The design phase prepares a candidate proposals and involves potential partners of the legal entity.
- The implementation phase finalises the governance, and the legal and financial organisation of the structure.

Example of possible designs

Proposition of 3 possible shapes (Minimal, Strategic and Responsive), involving an increasing participation of the RI in community activities when colors get darker.

The benefits for the partners are highlighted.

The possible activities are listed.



Summary

- The ENES-RI provides essential infrastructure which underpins the production of synthesized research informing climate policy.
- Underfunding of RI might slow down science outcomes and prejudice adequate policy advice.
- We are currently taking steps towards making the ENES-RI sustainable.
  We need the support from other national research communities.
  As a project, we can only support the process of making the RI sustainable.