Sustainable technology & Technology for sustainability : The paths towards Eco-innovation

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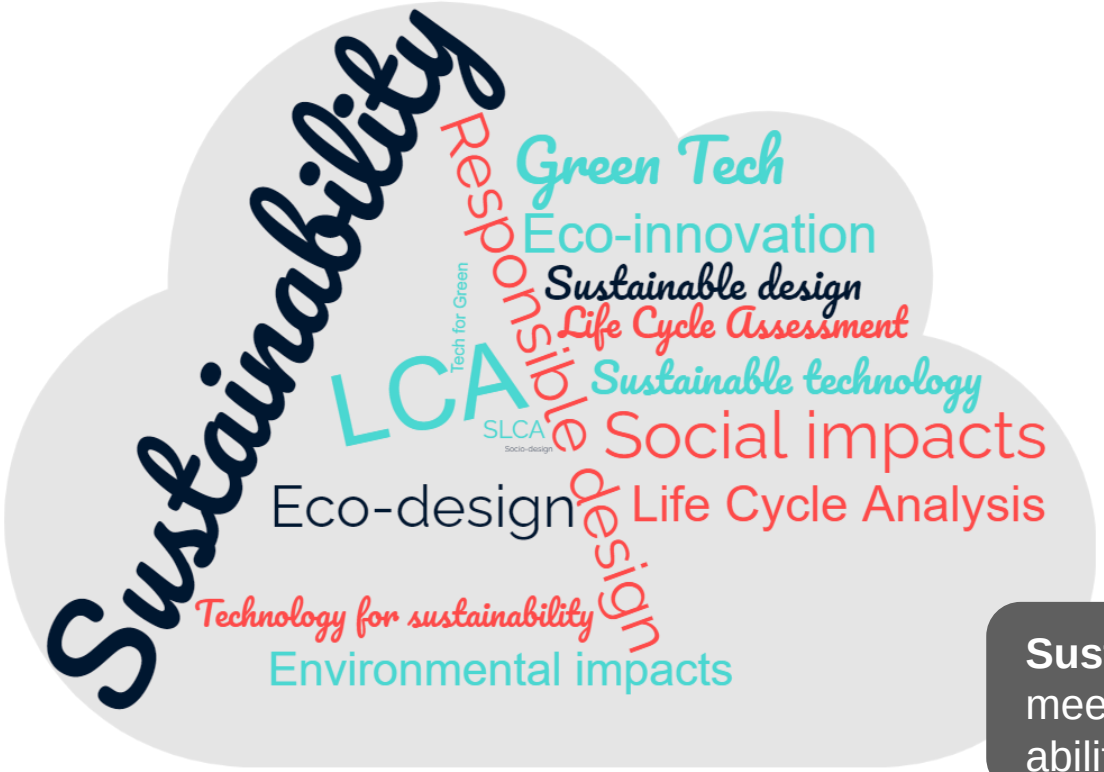
Outline

1. **Sustainability and eco-innovation: analysis of concepts and definitions**
2. **The Eco-Innovation framework**
3. **Case study - mapping with the framework**
4. **Key takeaways & perspectives**

Technology and Sustainability: A maze of concepts

- Wide and wild use of various terms to link technology and sustainability
- Risk of collapse of the concepts



1987

Sustainable development [1] is defined as the ability of meeting the needs of the present without compromising the ability of future generations to meet their own needs

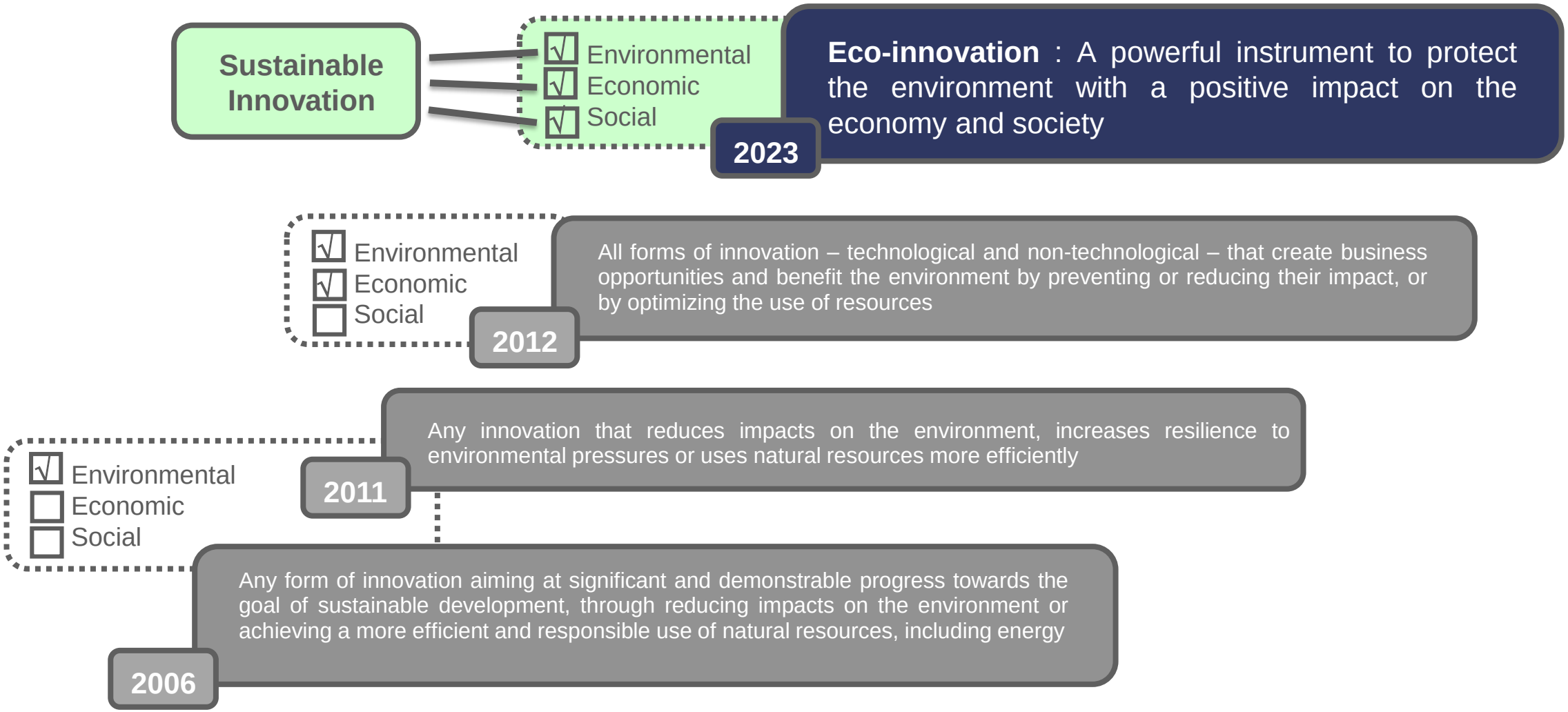
[1] from the Brundtland report, commissioned by the United Nations in 1987

Sustainability: 2 main approaches/visions

1994 Triple Bottom Line – John Elkington with the 3 pillars : Environmental, Social, Economic

[1] from P. Whyte and G. Lamberton, 'Conceptualising Sustainability Using a Cognitive Mapping Method', *Sustainability 2020,*

Eco-innovation : Definition analysis and objective



Definitions of Eco-innovation by the European Commission

Assessing the environmental impacts of a technology

- Life-cycle assessment (LCA): an **international standard methodology** for environmental assessment (ISO 14040/44).

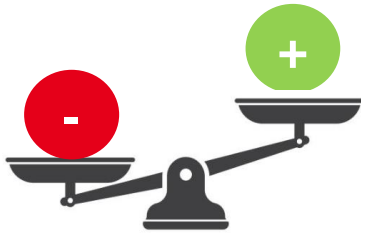
- Used to study the environmental impacts of a product or the function delivered by the product following:
  - ✓ **life-cycle** steps
  - ✓ **multi-criteria** evaluation
  - ✓ based on **metrics**

Figure: Quantis

- It can assess the options available for reducing these environmental impacts in the early design phase. This process is known as **eco-design**.

- In this presentation, LCA is used to assess environmental impacts of **a technology enhancing a solution**.

Focus on the tree of environmental impacts (1/2)



Global Impacts

Comparing the impacts of:
- a solution enhanced by a technology
- with a reference scenario that would have occurred without the technology enhanced solution deployment.

Direct Impacts (1st order impacts)

The impacts that occurs during the technology lifespan.

Indirect Impacts

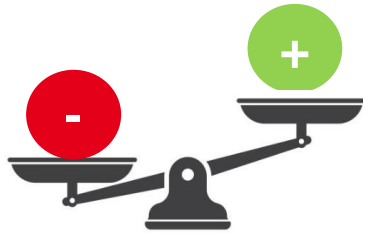
The impacts that occurs outside the technology value chain but resulting from its use

Negative impacts

Positive impacts

Figure and terminology based on International Telecommunication Union, ≪Recommendation ITU-T L.1480,≫ ITUPublications, 2022.

Focus on the tree of environmental impacts (2/2)



Global Impacts

Comparing the impacts of:
- a solution enhanced by a technology
- with a reference scenario that would have occurred without the technology enhanced solution deployment.

Direct Impacts => 1st order impacts

The impacts that occurs during the technology lifespan.

Indirect Impacts

The impacts that occurs outside the technology value chain but resulting from its use

2nd order impacts

Substitution mechanism aims for a positive impact by partially or completely replacing the reference scenario

Optimization mechanism intends to increase the efficiency of operations and processes, or intensify the use of assets and infrastructure.

Higher order Impacts => 3rd order impacts

Changes in human behavioral patterns guided by users' lifestyles and value systems including but not limited to **rebound effects**

Negative impacts

Positive impacts

Rebound effects = reduction of expected gains from new technologies due to behavioral or other systemic responses

Figure and terminology based on International Telecommunication Union, ≪Recommendation ITU-T L.1480,≫ ITUPublications, 2022.

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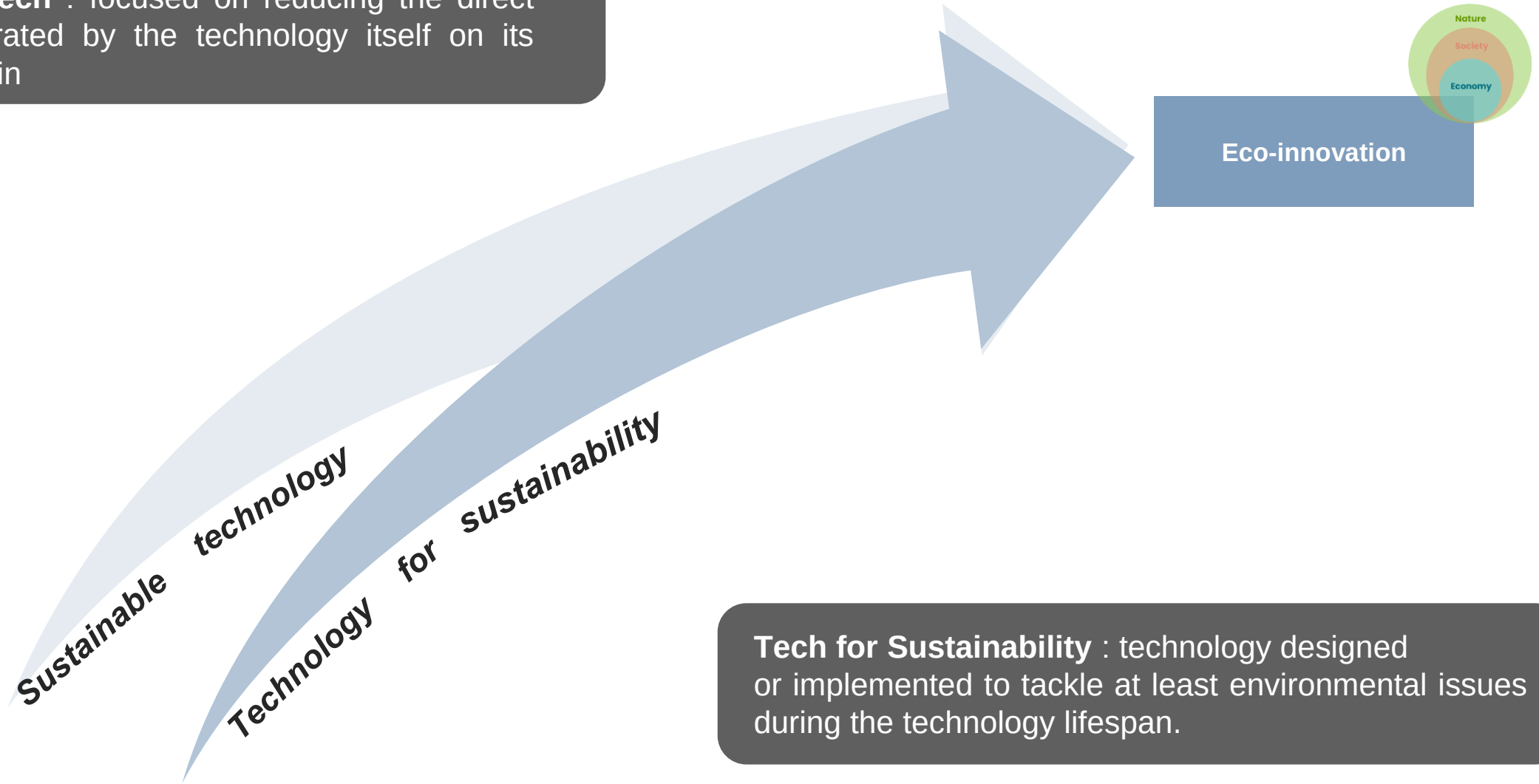
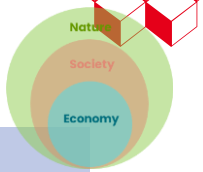
A framework for assessing innovation

Sustainable tech : focused on reducing the direct impacts generated by the technology itself on its own value chain



Tech for Sustainability : technology designed or implemented to tackle at least environmental issues during the technology lifespan.

The Eco-innovation framework (1/3)



Direct Impacts
(1st order impact)

Life Cycle Sustainable Assessment
of an existing technology

Level 1

Eco-socio design
taking into account social and economic considerations

Level 2

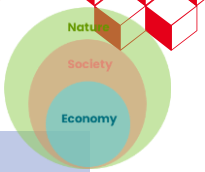
Eco-innovation

Level 3

Sustainable technology

Technology for sustainability

The Eco-innovation framework (2/3)



Life Cycle Sustainable Assessment
of an existing technology

Level 1

Eco-socio design
taking into account social and economic considerations

Level 2

Eco-innovation

Level 3

Sustainable technology

Technology for sustainability

Level 1

Technology development to solve **sustainability issues**

Level 2

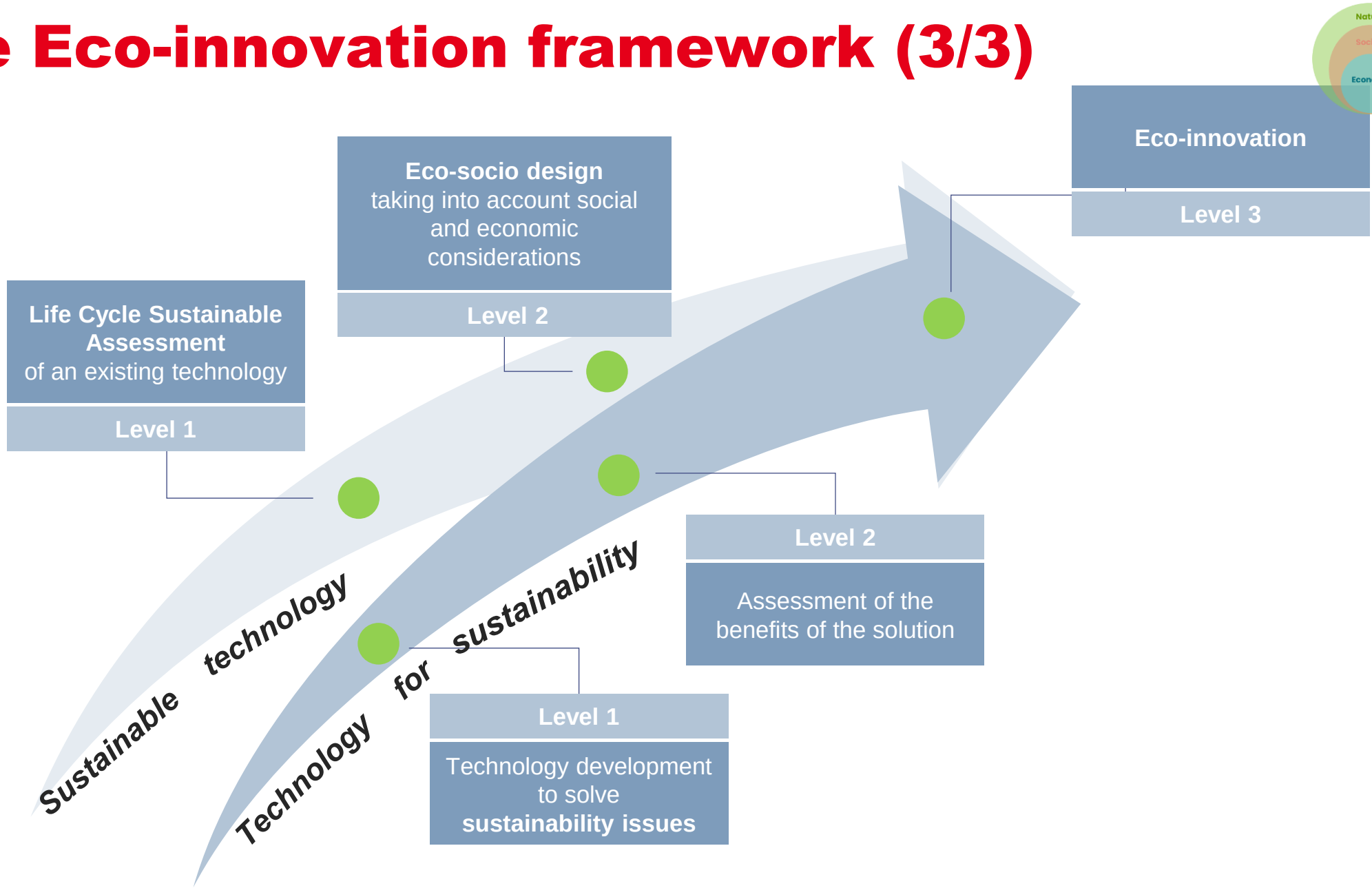
Assessment of the benefits of the solution

-

+

Indirect Impacts

The Eco-innovation framework (3/3)



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Zoom on a case-study

AI solution for HEAT-PUMP (AI4HP project)

Heat Pump (HP) system challenges :

- Key role in energy systems and their decarbonization
- Current HP controllers do not sufficiently take into account variability of external conditions

CEA's scope of work

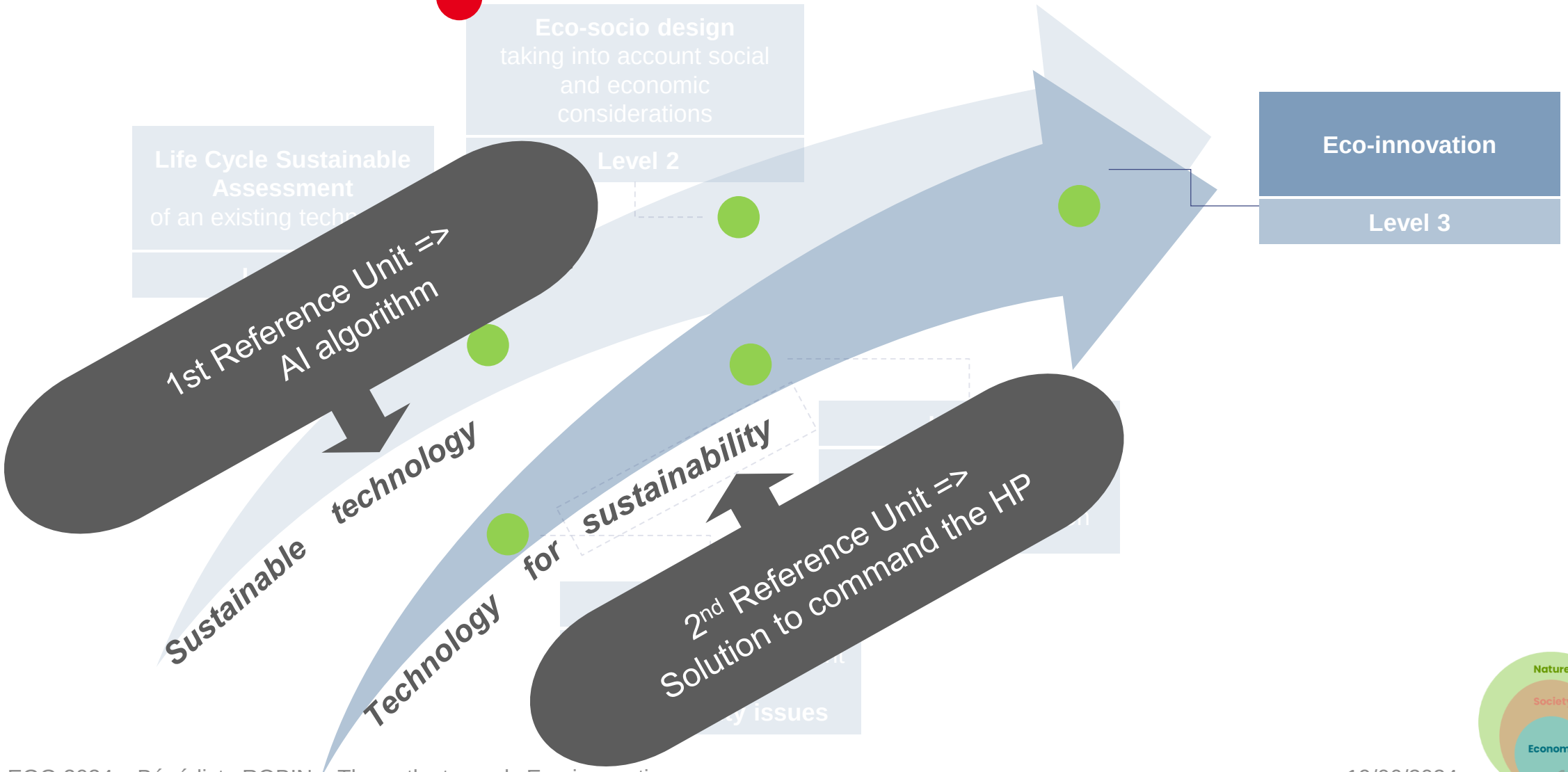
- Introduction of an innovative incremental Artificial Intelligence (AI) algorithm in the command system to forecast hot water needs depending on dynamic factors

- Compare the environmental impacts of the AI algorithm if implementation:
  - on the cloud
  - directly in the HP controller (generic device as specialized device)

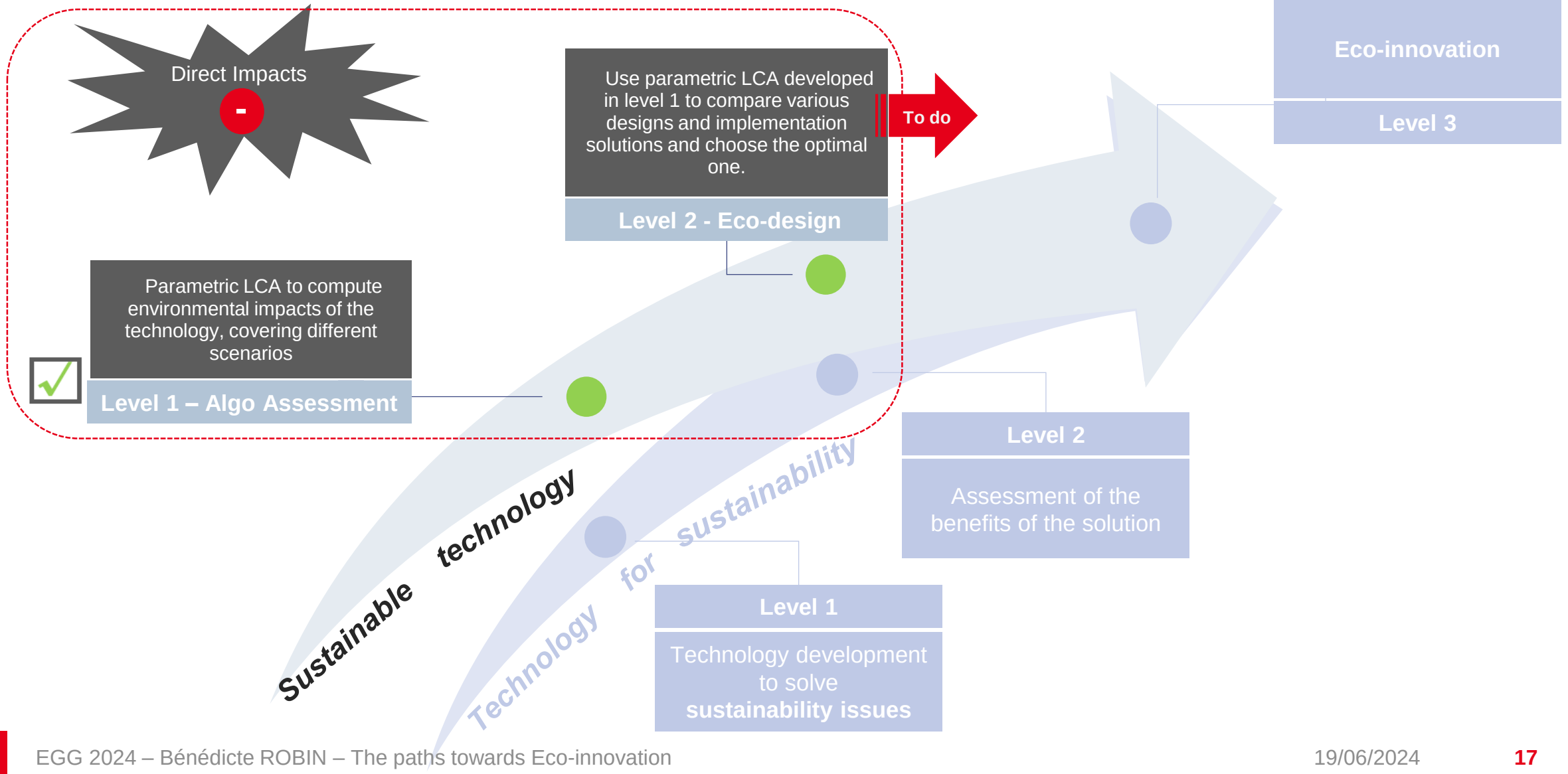
Coordinator: Lilli Frison (Fraunhofer ISE)
Incremental AI technology: Marina REYBOZ (CEA LIST)
Laboratory tests: Hugues Bosche (EDF R&D)

Towards Eco-innovation / the Eco-innovation framework

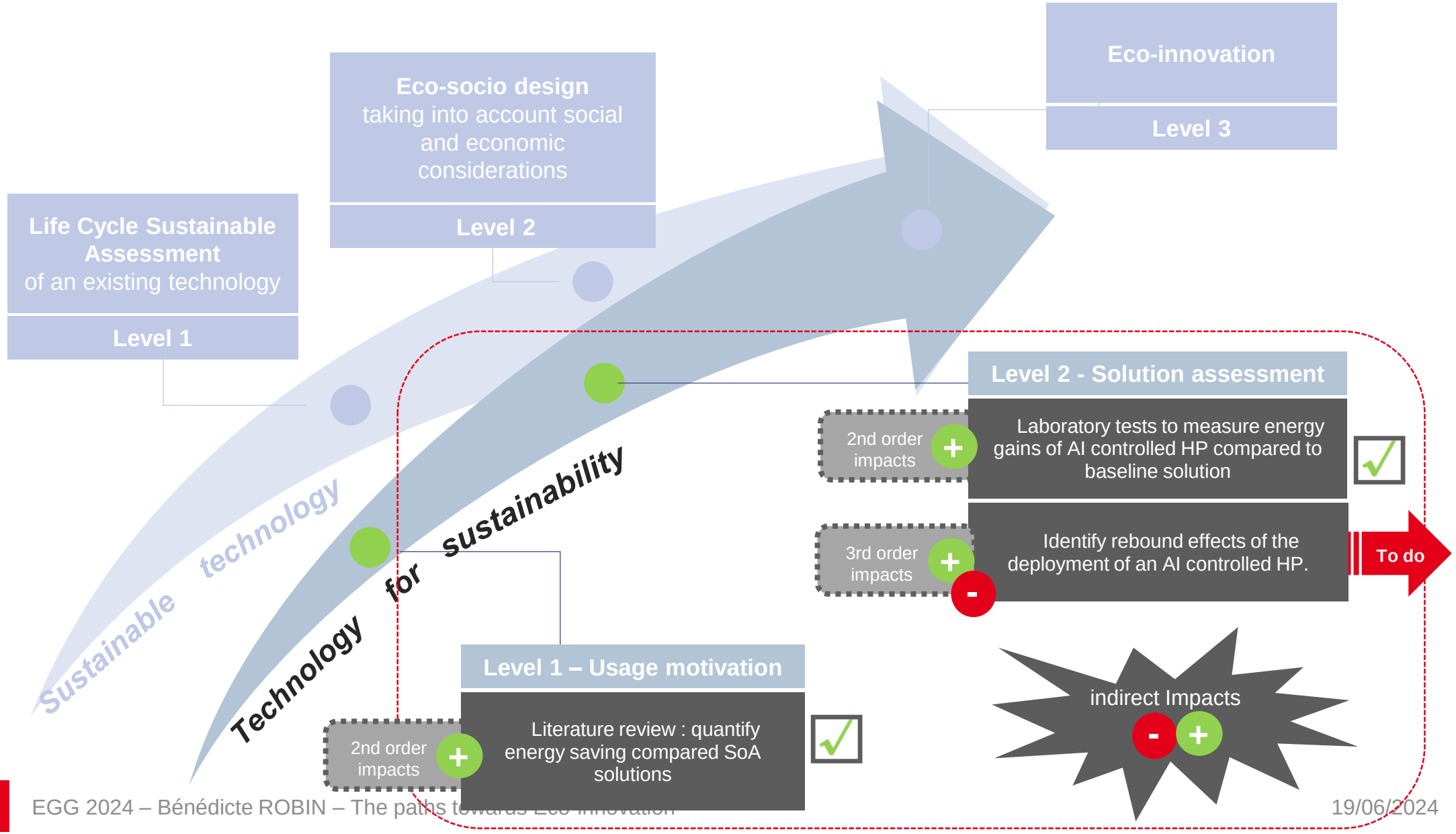
2 reference units to analyze + - impacts with the introduction of the AI algorithm



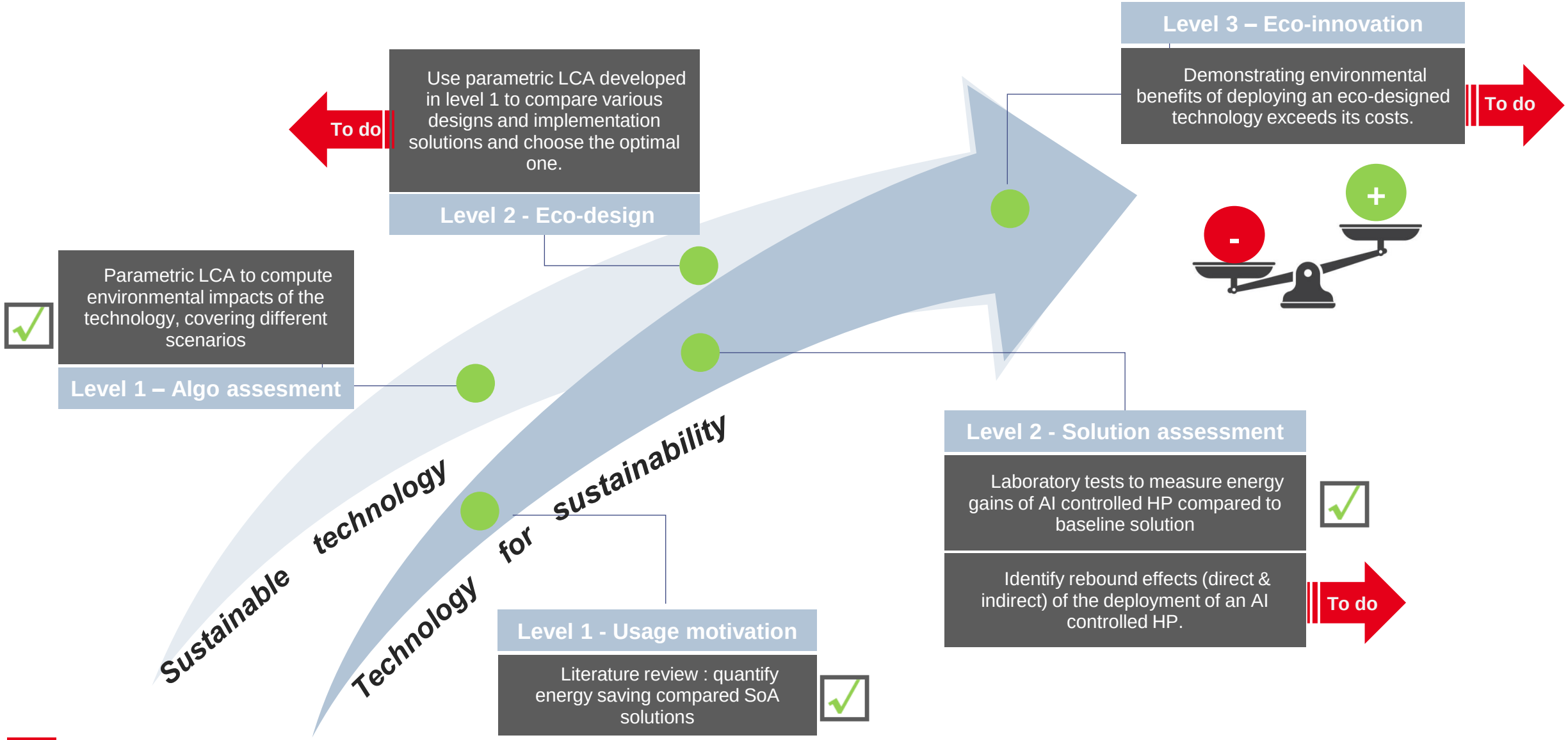
Towards Eco-innovation for the AI4HP project (1)



Towards Eco-innovation for the AI4HP project (2)



Towards Eco-innovation for the AI4HP project (3)



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Key takeaways

- Clarification of key concepts
- Framework proposal to structure approaches linking technology and sustainability **towards eco-innovation**.

& Perspectives

- How to democratize the framework?
  - Finalize use-cases until the Eco-innovation (Level 3)
  - Include Social and Economic dimensions
- Link with the levels of maturity (TRL)
- Integrate planetary boundaries concept

Thank you for your interest

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