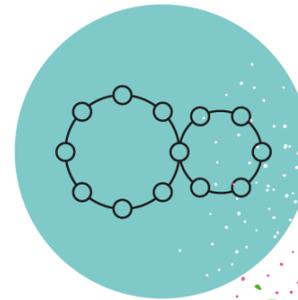


Systems Engineering for Net Zero

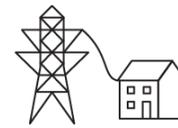
The Foundation for Science and Technology



June 2021

 @EnergySysCat





Potential journeys to Net Zero

30 years



Net Zero Expensive

Net Zero

Cost Effective (>3% GDP)

Damaged UK industrial/manufacturing competitiveness

Exclusively importing innovations



Net Zero Nirvana

Net Zero

Cost Effective (<1% GDP)

UK innovations created new jobs across country

Example to rest of the world (and exports)



Net Zero Political Disaster

Net Zero

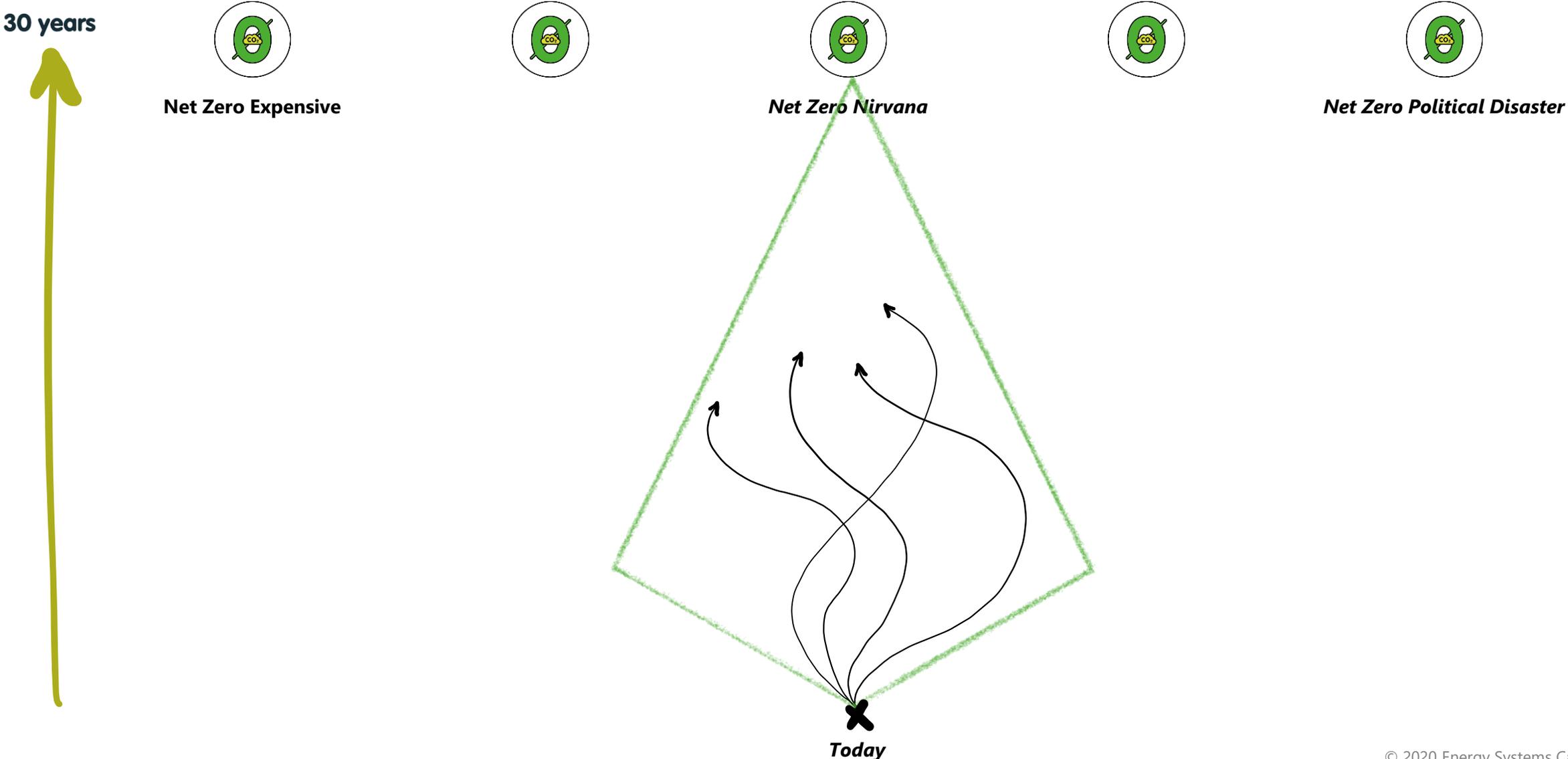
Costs as expected (<2% GDP)

Measures have been unpopular

No UK economic benefit


Today

Systems engineering approach helps you to converge on a desirable pathway



What is systems engineering?

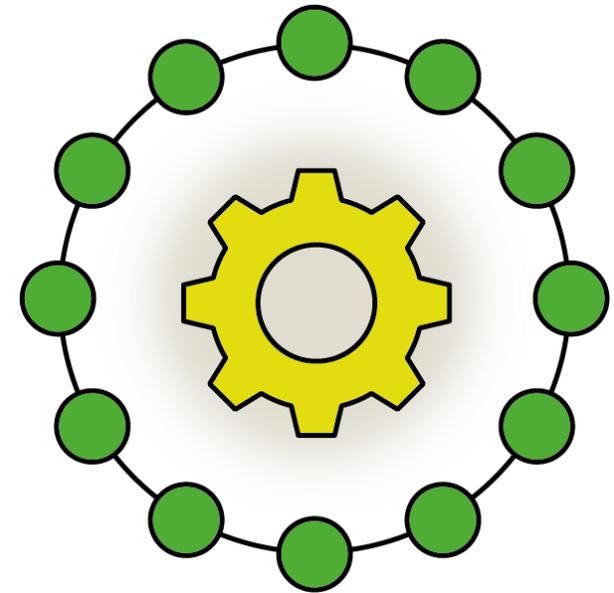
Systems engineering is a structured, multidisciplinary approach to problem-solving that transforms a set of needs into a balanced system solution. It is about **solving the right problem in the right way**.

Used to address **complex** and often **technologically challenging problems**.

It takes a '**whole system**' approach where physical factors (infrastructure, novel technologies) are considered at the same time as economic, behavioural and social issues.

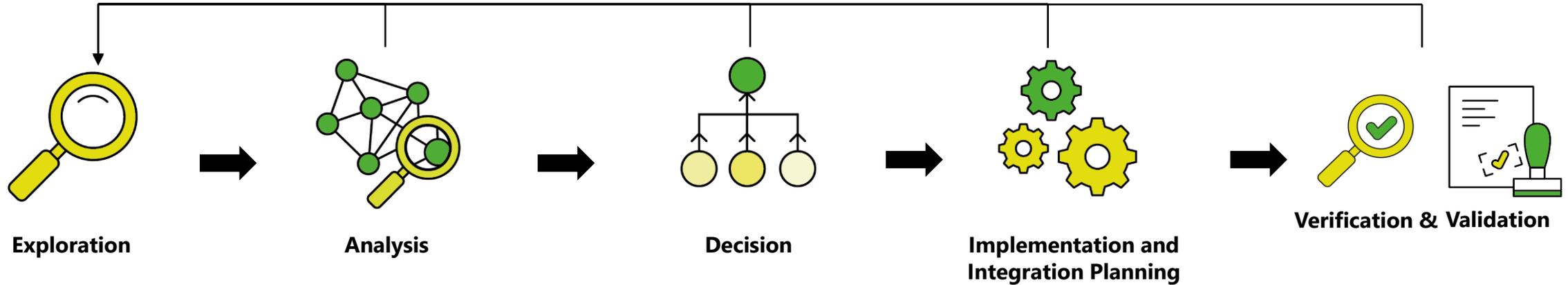
It is a discovery process that allows participants to consider the **interactions, trade-offs and synergies** between different parts of the system, using quantitative and qualitative tools, methods and skills. If implemented well, it can **lower costs** and **speed up implementation**.

It provides a structured process for engaging **stakeholders**, allowing the capture of their expertise.



Simplified Systems Engineering Approach for Net Zero

Iterate and maintain long-term view



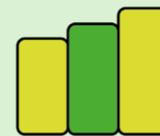
- Define objectives/needs, and questions
- Engage with multi-disciplinary, multi-sector stakeholders
- Identify key interactions
- Identify solution options
- Construct system of systems map

- Simulate, model and test possible solution options
- Measure/acquire and analyse data
- Helps to answer "How do I achieve X?" or "What happens if I do Y?"

- Identify decision gates and key data
- Conduct decision making process
- Obtain consensus

- Sequenced implementation plans
- Integrate into wider system
- Check interoperability

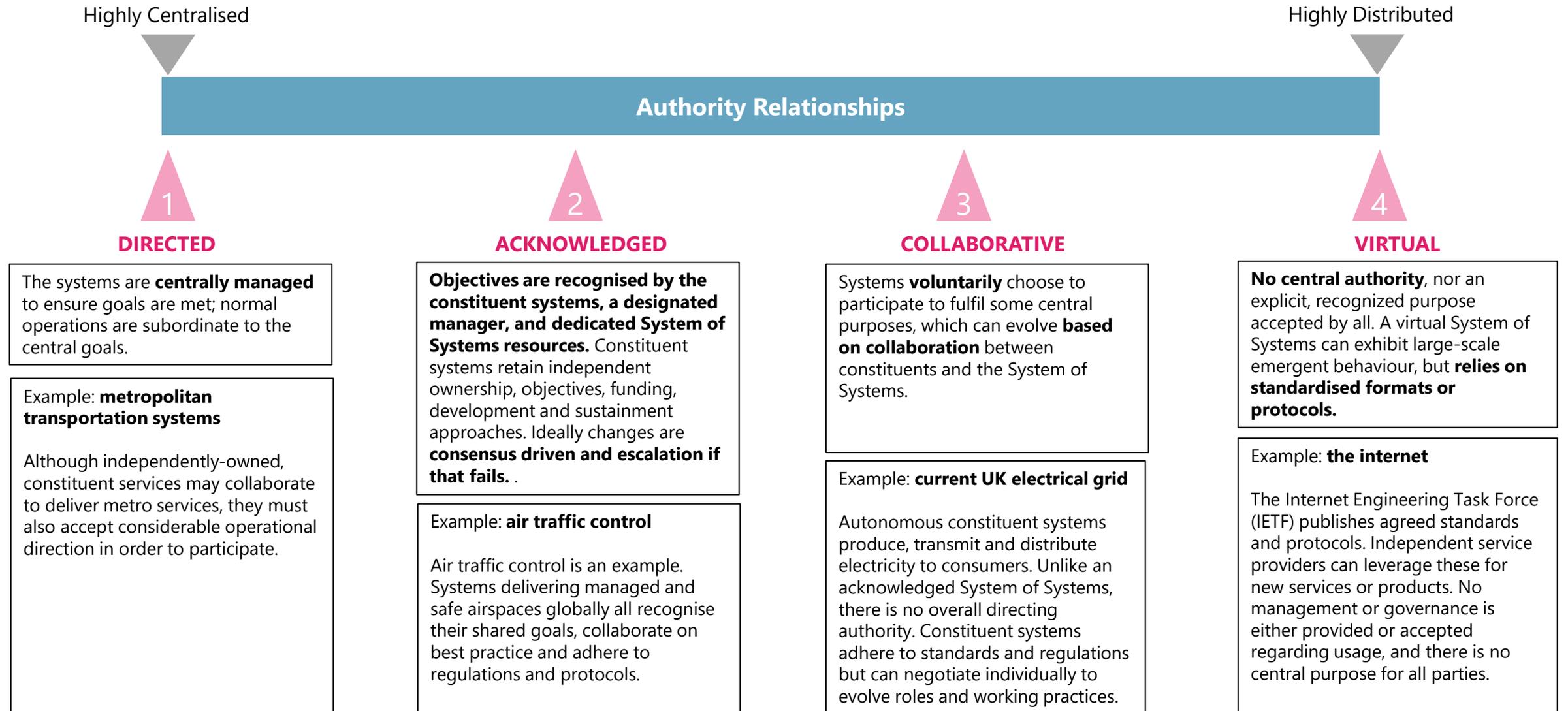
- Update System of Systems map, test interactions
- Check solution meets requirements and stakeholder needs



Continuous improvement



Core question for Net Zero: what degree of central coordination does it require?



What tools would we build if we were serious about a systems approach to Net Zero?



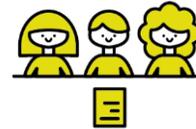
System of Systems Map -- creates a 'live' repository for **institutional memory and knowledge**. Enables an adaptive approach and easy sharing of information.



Agile governance and regulation -- a '**systems architect**' using a framework to test and learn about viable options, identify gaps and update knowledge, including a structured approach for **managing stakeholder input**.



Whole system **market simulation tools** to design future market arrangements. To support techno-economic models.



Real-world trial environments to co-create future energy market. **Living Labs** provide a place to iterate market arrangements, consumer offers, consumer protection, digital standards and **Pathfinders** to test at scale



Allows the building of a **credible, viable and adaptive** 'living roadmap', with clear timelines/sequencing and dependencies