

What are industry transition roadmaps?

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Key messages

- Reducing greenhouse gas emissions from harder-to-abate industries is crucial to achieving the goals of the Paris Agreement and pursuing efforts to reach net-zero carbon emissions by 2050.
- One way to achieve industrial decarbonization targets is through industry transition roadmaps, which are long-range strategic plans that set out actionable measures on innovation, policy, public-private partnerships and the finance required to transform industries.
- Roadmaps are developed not to forecast the future, but to serve as a platform for discussion of future challenges by the actors involved.

In pursuit of a future vision: net-zero carbon emissions

In order to meet the 1.5°C global warming target in the Paris Agreement, global carbon emissions should reach [net zero by around mid-century](#). This will require significant action across all sectors of the economy, not least from industrial sectors. On current trends, global CO₂ emissions from industrial sectors will constitute [60% of global emissions by 2050](#). Reducing greenhouse gas emissions to net-zero is a particular challenge for heavy industries such as steel, cement and petrochemicals, and heavy-duty transport such as aviation, shipping and heavy road transport.

[Several states](#) have already made a commitment to reach net-zero emissions on timescales compatible with the Paris Agreement goals. Many of these states have developed public-private partnerships between government and industry to propose and implement action plans for industry transition to carbon neutrality. It is becoming increasingly common for 'roadmaps' and 'pathways' to be developed as plans and processes that guide the pursuit of decarbonization goals.

Roadmaps and pathways are both tools of futures thinking. While road mapping is a normative approach in which attempts are made to sketch out detailed plans and processes for achieving a desired future state of development, pathways have different meanings and different implications for different studies and research communities. Below, we look at futures thinking, examine the connections between roadmaps and pathways, and explore how these tools have been used to encourage and strategize decarbonization activities in industry and beyond.

Thinking about the future

Roadmaps and pathways are both tools of futures thinking. Futures thinking offers various ways to anticipate, explore and address future challenges and possibilities. Different approaches to and methods of futures thinking are usually classified according to the main goal of the future-oriented exercise – whether the goal is to explore probable, possible, plausible or preferable futures (see Figure 1).

A similar way of conceptualizing the different ways of futures thinking is based on [three fundamental questions](#) that can be posed about the future:

1. What will happen? (probable future)

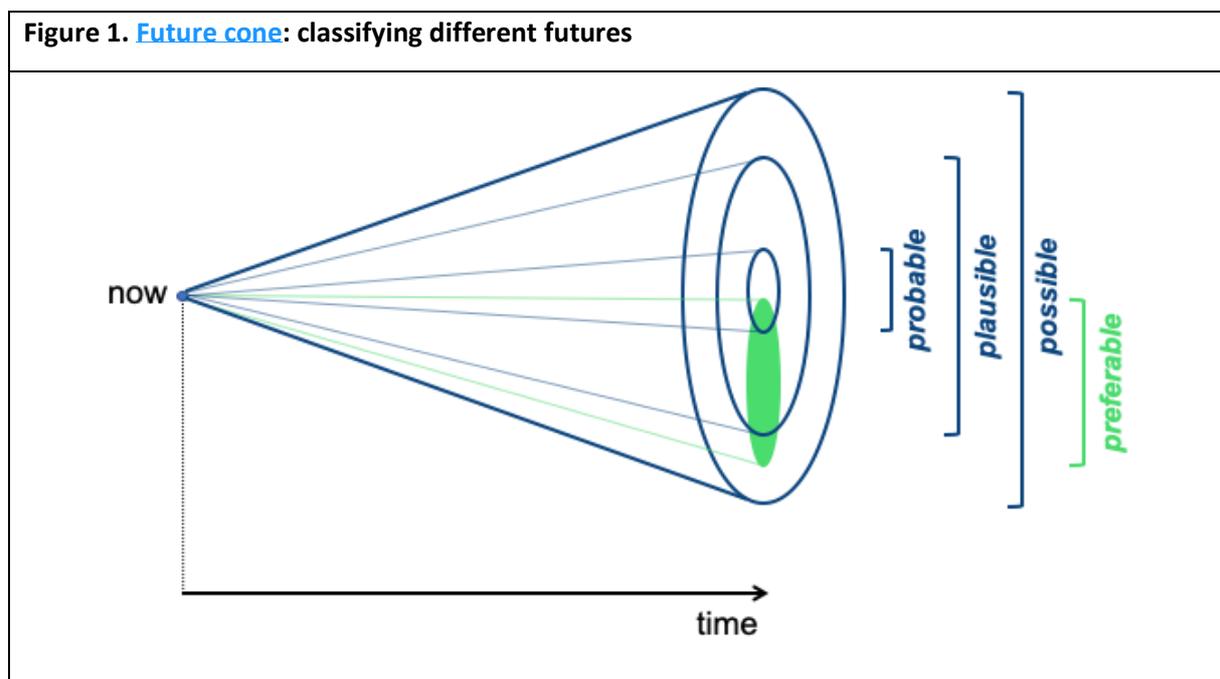
Predictions and forecasts seek to answer the question of what will happen by determining the most probable future alternative. Weather forecasts and quantitative simulation models and projections are obvious examples of predictions.

2. What could happen? (possible and plausible futures)

Exploratory futures approaches seek to answer the question of what could happen. Exploratory scenarios are widely used to understand plausible future developments and explore the entire space of future possibilities.

3. What should happen? And how can a specific target be reached? (preferable future)

Normative and goal-oriented approaches to futures thinking are used to determine the most preferable futures and design strategic paths and plans to achieve the determined preferable goals. These approaches answer the question of what should happen and/or how. They are often used to support policy processes and decision making. Future visions, backcasting and road mapping are examples of the normative approaches used in futures studies and strategic foresight processes.



Roadmaps and pathways

Visions are elaborations of desirable plausible futures. In this sense, all decarbonization targets and goals are future visions that societies seek to achieve within a certain time horizon. Once a specific vision has been elaborated, the next question usually concerns how to reach it. The typical answer is by developing a roadmap or pathway. **Decarbonization roadmaps** nearly always start with a predetermined end point – a desirable decarbonization target – and investigate the possible plans, actions and policies required to reach that point. **Decarbonization pathways**, on the other hand, are used in a variety of ways.

Roadmaps

Road mapping was first implemented as a futures thinking approach in technology forecasting processes. The first (technology) roadmap was published by Motorola in 1987, as a means for aligning technology with product strategy. Since then, the method has been adopted and adapted by different sectors in support of strategy and innovation, with applications for private and public sector initiatives.

Road mapping is now a powerful planning technique that is integral to the creation and delivery of strategic thinking and innovation in many different areas. The graphic and collaborative nature of roadmaps supports strategic alignment and dialogue in a context or sector, both across organizations and between a range of actors and stakeholders. As an integrative approach, the method draws on a range of theoretical perspectives on strategy and innovation, systems and industry dynamics, visual science, decision support and psychosocial processes. Roadmaps provide essential understanding of proximity and direction, as well as some degree of certainty in planning and strategic processes.

As a goal-oriented method, road mapping has been increasingly used to develop detailed plans and strategies in pursuit of industry transition. Industry transition roadmaps are actionable plans for achieving decarbonization targets. They are associated with the timelines, strategic processes, actionable measures, decision processes and policies required to transform industries in order to curb greenhouse gas emissions and contribute to global action on adaptation resilience.

As a practical definition, industry transition roadmaps translate global, regional and national climate visions, decarbonization targets and ambitions into a sequence of actions plotted on a certain timeline. For every step and action towards the agreed decarbonization target, industry transition roadmaps provide measures on the innovations, policymaking and decision-making processes, public-private partnerships, technology and finance required to operationalize those actions. In this sense, any strategic plan for decarbonizing industry sectors that sets out timelines, measures and actions towards an end-point target could be considered an industry transition roadmap, regardless of whether this terminology is used.

Pathways as roadmaps to desired futures

In the literature on decarbonization and industry transition, the terms roadmap and pathway are sometimes used interchangeably. In such cases, both refer to long-range paths and plans for decarbonization and a sequence of measures designed to meet a range of desirable targets.

- [EU Roadmap 2050](#) A project that aims to draw up and analyse pathways to achieving a low-carbon economy in Europe. It uses roadmaps and pathways interchangeably as paths from now to achieving decarbonization targets in 2050.
- [The Science-based Targets Initiative Sector Decarbonization Pathways](#) Introduced the Sectoral Decarbonization Approach (SDA), whereby roadmap and pathway are used

interchangeably to show how emissions from a sector must decrease over time to achieve the net-zero target.

- [Deep Decarbonization Pathway Project](#) (DDPP) aims to develop a national blueprint of the changes in physical infrastructure, deployment of technologies, sectoral investment and associated behaviour patterns required to achieve decarbonization; clearly states that pathways in this initiative ‘are best seen as roadmaps of options and enabling conditions’.

Pathways as normative scenarios: multiple ways to reach a desired future

In other cases, pathways depict a range of alternative routes to a desirable vision while a roadmap indicates a preferred direction to guide a society or sector to the desired end-point. In this sense, pathways show all the possible ways in which a target could be achieved but the roadmap is the preferred way.

There might, for instance, be different roads or paths to reaching net-zero emissions. One might be to immediately shut down all fossil fuel-based power plants while another might suggest an incremental approach that phases out fossil fuels over a specific time period. Each pathway would present different practical challenges and have its own implications and requirements. Having chosen one of the envisaged pathways, a roadmap would determine a precise timeline and the appropriate mix of regulatory push, demand pull, long-term strategies and industry reorientation, among other things.

- The [International Energy Agency technology roadmaps](#) and [Exponential Roadmap 2030](#) projects are examples of this approach, whereby each roadmap contains a clear statement of the desired outcome followed by a specific route to achieving it that sketches out goals, milestones, gaps and barriers, action items, priorities and timelines.

Pathways as exploratory scenarios: multiple ways to reach a plausible future

In a third approach, pathways refer to explorative scenarios that demonstrate a range of plausible future directions without any normative indication or predetermined goal.

- In the United Kingdom’s [industrial decarbonization and energy efficiency roadmaps to 2050](#), pathways represent three alternative future scenarios:
 - i) no decarbonization interventions;
 - ii) incremental improvements to existing decarbonization processes and technologies; and
 - iii) maximum possible technical potential for decarbonization.

In this initiative, the roadmap is an umbrella strategic plan that identifies the next steps in terms of technology needs, policy levers, leadership and finance requirements for each alternative pathway in order to make progress on decarbonization and energy efficiency.

- The climate research community defines pathways in a similar way, where global scenarios on future developments are known as ‘[shared socioeconomic pathways](#)’.

Industry transition roadmaps: actionable plans to reach decarbonization targets

Industrial transition requires action on the part of both industry and government. Such action should be complementary, which requires joined-up thinking. Industry transition roadmaps are developed not to forecast the future, but to serve as a platform for discussion among the relevant actors involved – notably governments and industry sectors – of the future challenges facing industrial decarbonization.

It is important to emphasize that achieving industrial decarbonization targets will require public-private sector partnerships. Industry sectors must take game-changing decisions and implement new strategies for transformation. At the same time, governments must incentivize industry transition by reinforcing positive policies through regulation and legislative processes.

Industry transition roadmaps must be produced by implementing participatory processes and dialogues between all key actors. For industry roadmaps to be legitimate, feasible and successful, the road-mapping process must be the product of government-industry collaborations that are owned by all the stakeholders involved and framed at the level of national or regional jurisdiction.