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Leverage Positive Tipping Points to Scale Low-Carbon Technology

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Executive Essentials: Leverage Positive Tipping Points to Scale Low-Carbon Technology

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Reaching ambitious emissions reduction goals while maintaining growth relies on scaling low-carbon technologies. Executive leaders can use this research to identify strategic industry interventions to trigger low-carbon technology adoption at scale and displace emissions-intensive incumbents.

This research is a collaboration between Gartner and the University of Exeter, a leader in sustainability sciences. Special thanks to Professor Timothy M. Lenton, Dr. Jesse F. Abrams, Dr. Joshua E. Buxton and Dr. Chris A. Boulton for their review and input into this research (see Note 1 for further information).

Capture New Growth Opportunities by Leveraging Positive Tipping Points

The energy transition presents an opportunity for executive leaders to innovate, sell and adopt low-carbon technologies, to drive new revenue and sustainable growth. However, this transition is also not without risks. Many low-carbon technologies will not reach mass adoption, money will be lost as innovations will fail.

But failing to appropriately recognize the energy transition and time response actions can lead to regulatory, consumer and investor pressure. Financial risks include stranded assets and products, where investments suffer a premature write-down or devaluation due to changing market conditions. For example, if carbon prices under the EU's Emissions Trading System doubled, investment in high emitting projects may become financially unviable.

One response to these challenges is innovation. Executive leaders are optimistic that sustainability will drive new product innovation. The 2023 Gartner Drivers of Environmental Sustainability Survey showed that 69% of business leaders are in the early stages of realizing or anticipating realizing new product innovations stemming from sustainability initiatives in the next two to three years. [1]

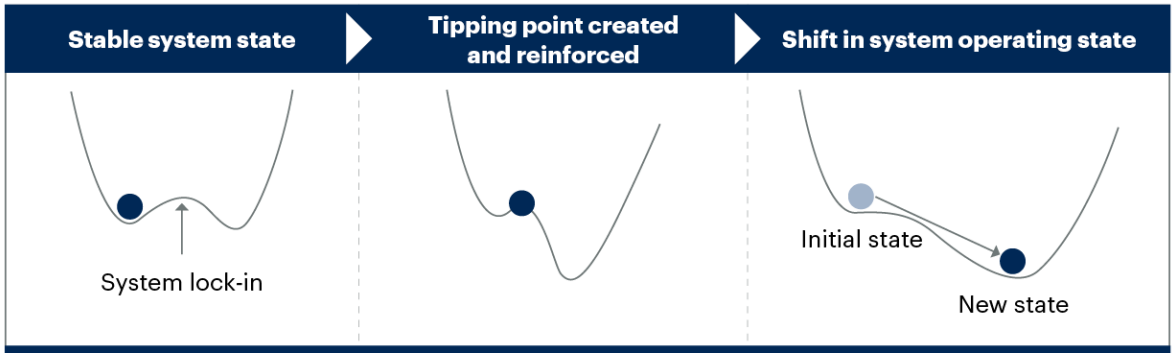
Adopting, developing and scaling new technologies is complex and nonlinear. Executive leaders assess multiple variables from market readiness to ease of consumer/customer adoption, all which influence the rate of low-carbon adoption. This research, in collaboration with the University of Exeter, outlines how leveraging positive socioeconomic tipping points can trigger technology scalability. [2] It shows executive leaders where and when to invest effort when assessing potential for low-carbon technology development and scalability. This research is to help executive leaders increase situational awareness of positive socioeconomic tipping points and to understand their role in enabling technology scalability.

A positive socioeconomic tipping point is where a small intervention can trigger self-reinforcing feedback that accelerates systemic change, enabling scalability.

The idea of positive socioeconomic tipping points is grounded in systems theory. The left-hand side of Figure 1 shows a system is locked into a steady state of operation. For example, the dominance of the internal combustion engine for transport. The steady state is challenged, in this instance, when battery technology for electric vehicles is available at a suitable price, with reasonable range and a supporting charging infrastructure. A new steady state is created when there is mass adoption of the new solution, electric vehicles, and the previous incumbent, the internal combustion engine, is displaced. Tipping from one state to another can take place at different speeds in different markets. Other examples of tipping include the adoption of solar PV and battery technology in homes, mass adoption of mobile phones or the changes in social acceptability around smoking. This research focuses on the scaling of low-carbon technology.

Figure 1: Tipping Point Illustrations

Tipping Point
Illustrations



Tipping point examples		
Energy transition (transport): Dominance or the internal combustion engine for road transport	Government subsidies, range improvement, charging infrastructure, reduce the system lock-in	Battery electric vehicles (BEVs) become the dominant technology for personal transport
Social norms (health): Behaviors such as smoking are socially accepted norms	Government taxes, increased health awareness, smoking bans in public places	Smoking is no longer a typically accepted social norm (varies country by country)

Source: Gartner
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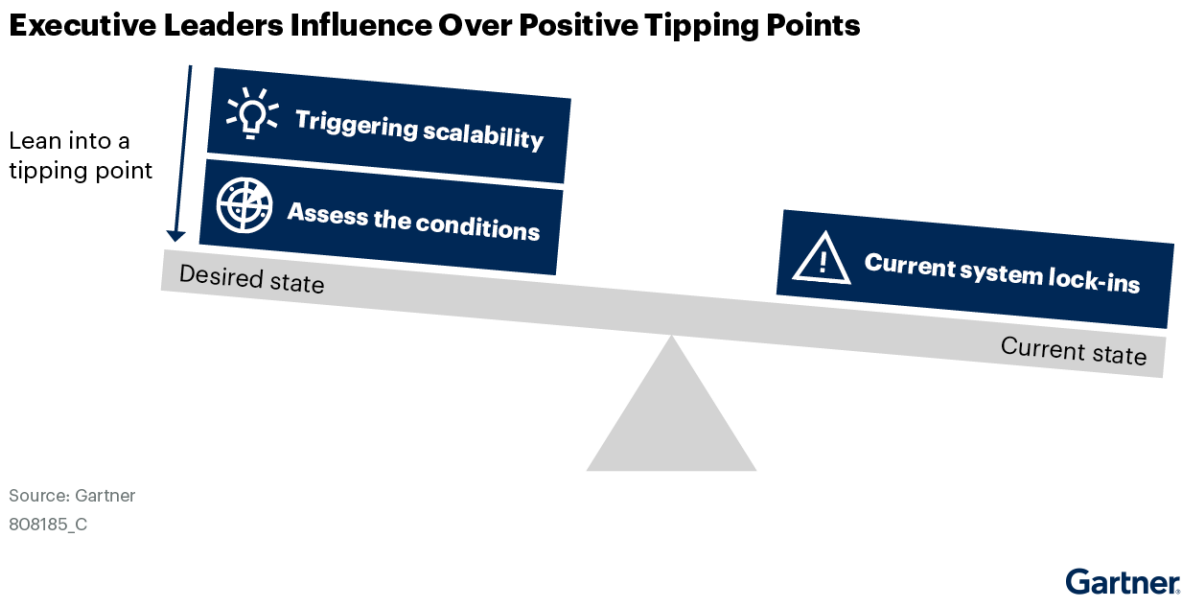
Scaling low-carbon technology requires proactive involvement from executive leaders rather than being a passive activity. The low-carbon solutions discussed in the research are a combination of engineered solutions enabled through digital technology; for example, solar PV, electric vehicles and battery storage. Executive leaders play two roles in enabling positive socioeconomic tipping points, as shown in Figure 2.

- **Assess system lock-ins:** Low-carbon technologies need to be competitive to thrive. Executive leaders can assess price, performance, quality and accessibility of the proposed solution. New solutions will either fit into the current operating context or transform it. For example, battery storage facilities can connect to existing grid infrastructure with some investment, whereas electric vehicles are reliant on a charging network to be rolled out. Innovations that require large structural changes to the economy are likely to be more difficult to scale. Executive leaders also need to identify the knowledge or behavioral changes that will be needed to adopt the technology. Assessing the enabling conditions allow executive leaders to prioritize candidate low-carbon solutions for further development, or to actively work toward triggering scalability.

- **Triggering scalability:** The scaling of technology and innovations is not automatic. Executive leaders must lean in to foster positive socioeconomic tipping points. This involves actions like influencing policy interventions, increasing awareness through informational campaigns or implementing behavioral nudges. One of the most impactful ways executive leaders can influence low-carbon technology scalability is through engagement with financial markets and economic structures. This can include engaging in venture capital funds, to influencing political policymakers around initial subsidies for low-carbon technologies. [3,4]

Executive leaders must assess how incumbent solutions may respond to efforts to scale low-carbon technologies to strategically navigate potential challenges and opportunities. Incumbent response actions may involve purchasing intellectual property, influencing regulators or adjusting competitive positioning through pricing.

Figure 2: Executive Leaders' Influence Over Positive Tipping Points



Address System Lock-Ins

Low-carbon technology scalability is hindered when current system lock-in effects outweigh the benefits of transitioning to alternative solutions. Put simply, the barriers and cost of change are too high. Executive leaders need to understand how systems get locked into their current state. This enables leaders to identify actionable leverage points to reduce the cost of change by weakening existing system feedback loops. Some examples of responses to current system lock-ins are:

- **Overcome economic lock-ins:** Subsidies to fossil fuel technologies and high costs of capital for new technologies create macroeconomic obstacles to scaling low-carbon solutions (see Quick Answer: Use Green Premium to Assess Viability of Clean Technology). To overcome this barrier, executive leaders will need to engage policymakers in identifying new subsides. For example in the U.K., as part of the Ultra Low Emission Zone (ULEZ) scheme rollout, Transport for London is offering citizens a financial incentive to scrap older, more polluting vehicles. [5]

- **Anticipate incumbent responses:** Dominant market incumbents actively defend their positions through various tactics from adjusting pricing models to undercutting new low-carbon solutions, to buying low-carbon IP, to exploiting, shelving or securing deeper subsidies. Low-carbon solutions rarely scale in a vacuum. An existing technology needs to be displaced to enable scalability. Executive leaders need to anticipate how incumbent enterprises will react when market position is challenged.

- **Work through dependencies:** Despite the effectiveness of low-carbon technologies at a bench level, dependencies such as scarce raw materials or infrastructure limitations can impede or prevent scalability. For example, the manufacture of electric vehicles is dependent on critical materials including, lithium, graphite, cobalt, nickel and rare earths. Many of which are in geopolitically sensitive areas. These critical dependencies can be overcome by adjusting raw materials procurement strategies or collaborating across the ecosystem to collectively overcome dependency challenges. [6]

Executive leaders can gain insights into the current system lock-ins by considering the following questions:

- What factors hamper the adoption and scalability of proposed low-carbon solutions in the current market?
- How might dominant incumbents respond to these proposed low-carbon solutions?
- What actions are necessary to enhance the competitiveness of low-carbon solutions, particularly in terms of improving price/performance curves?
- What dependencies may hamper technology scalability?

Influence the Enabling Conditions

Executive leaders play a vital role in influencing the necessary enabling conditions for the scalability of the low-carbon solutions. Enabling conditions are where there are stakeholders reinforcing feedback and interventions that may contribute to triggering a positive tipping point. Not all enabling conditions have equal impact in tipping a system from one state to another. Some have a disproportionate impact in driving change. Executive leaders must assess the enabling conditions across several dimensions:

- **Assess customer centricity:** Determine the number of customers/consumers that would need to adopt the technology to enable scalability. For example, nuclear energy only requires approval from half a dozen states to scale, whereas electric vehicles need uptake by early adopters to form an initial majority, enabling scalability (see Hype Cycle for Low-Carbon Energy Technologies, 2023). Assess opportunities to increase adoption, such as improving usability. New necessary capabilities or technical skills may present barriers to adoption.
- **Examine the price/performance relationship:** Compare the price and performance of the low-carbon solution to incumbent technologies. Define the price/performance range that is likely to drive initial, then mass adoption of the technology. For example, solar energy is cheaper than coal generation, but it still suffers from intermittency of supply.
- **Study economies of scale:** Familiarize yourself with economies of scale, where as the quantity of output increases, efficiencies are gained, resulting in a reduction in cost per unit. Basically, the more a product is made, the more efficient the production process becomes. Economies of scale help to reduce pricing barriers to enable low-carbon technology adoption.
- **Learn by doing:** Review the concept of learning by doing where the more something is made, the better it gets and/or the better we get at making it. Creating one or two items will usually be a small-scale, custom-made activity, but making thousands typically relies on production lines. This generates learning and improves speed, cost and effectiveness of production.
- **Improve quality:** Increase performance or quality by implementing a new solution that surpasses that of the incumbent technology, and the probability of displacement also increases. For example, from a use perspective, solar photovoltaic (PV) technology with battery backup may be perceived as more reliable in communities reliant on diesel generators and providing upfront costs can be overcome.

- **Review desirability:** Examine how the individual will be perceived by peers when adopting low-carbon technology or solutions. This social perception or desirability will vary by culture and market, influencing adoption rates. For example, consumers are willing to pay a price premium for some electric vehicles, such as Tesla.

- **Partner with reinforcing technologies:** Facilitate the scalability of low-carbon solutions through strategic partnerships with adjacent solutions Reinforcing technologies have a significant impact on driving low-carbon technologies. For instance, scaling low-carbon generation (wind and solar) depends on advancements in battery technology — which is being enabled by the electric vehicle sector — to address supply intermittency.

Executive leaders can assess and influence current conditions for low-carbon technology scalability by considering the follow questions:

- How does the social contagion of technology adoption improve consumer literacy and uptake?
- How does the price of the low-carbon solution compare to incumbent technologies and what actions can improve this?
- How does the low-carbon solution compare to incumbent technologies in terms of performance or quality of impact?
- How socially acceptable is the low-carbon solution and what factors influence its acceptance?
- Are concurrent scalability efforts of supporting technologies necessary to unlock the scalability of the low-carbon solution?

Trigger Low-Carbon Technology Scalability

Identifying when a tipping point is reached that allows a low-carbon solution to scale is essential to avoid wasted efforts and investments on nascent solutions. Triggering a positive tipping point typically requires a coalition of support rather than an individual action. Various interventions or systemic shifts can trigger tipping:

- **Crisis:** Unforeseen crises, from geopolitical tensions to the rate of climate change surpassing expectations, can create the conditions and will for action. For example, if the cost of damage from climate change exceeds the costs of acting — then acting becomes more likely. However, our research shows that business leaders are undervaluing carbon costs to reduce emissions today, and future carbon liabilities associated with climate change. Geopolitical tensions also drive change. The initial stages of the Russian invasion of Ukraine saw several EU countries highlight concerns around energy security. [7]

- **Iterate on innovation:** Enhance product capabilities and drive scalability through continuous learning and improvement. Rapidly iterating on innovation, particularly with tools like AI, can lead to significant improvements in price and performance.

- **Learn policy intervention:** Study the regional and national policy landscape and assess how changing political leadership will impact policy dynamics. Policy interventions like subsidies and taxation, can either help or hinder the scalability of low-carbon solutions.

- **Public information:** Public perception of sustainability issues can create favorable conditions for low-carbon technology scalability. For example, concerns about respiratory illness in cities may increase openness to renewable energy or electric vehicles. Documentaries highlighting the impact of plastics on the ocean have shifted public perception on single use plastics. Executive leaders need to anticipate how the public perception may change over time, and how this creates risks and opportunities for the enterprise.

- **Initiate behavior nudges:** Create behavioral nudges to promote the adoption of low-carbon technologies. For example, incentivize electric vehicle adoption through tokenization, as seen with BYD in China. [8]

The willingness of executive leaders to lean into positive socioeconomic tipping points will depend on the enterprise's risk appetite. When assessing the readiness of a tipping point or when deciding to lean into identified tipping points, executive leaders should consider the following questions:

- How can public perception around relevant sustainability issues be influenced to enable technology scalability?

- What actions can be taken to rapidly iterate on the innovation to improve price/performance?

- What influence does the enterprise have with policymakers, and how can it build a coalition of support to influence policy positions?
- What types of behavioral nudges can be put in place to enable the adoption of low-carbon solutions?

Analysis

About This Research

Next Steps

Executive leaders should take the following three actions to identify and respond to the positive tipping points to scale low-carbon technologies:

- Address current system lock ins by reviewing market economics, dependencies on other technologies or solutions for scalability and how incumbent organization are likely to respond to the new low-carbon technology
- Influence enabling conditions for the tipping point and scalability of the low-carbon solution by reviewing the price/performance, quality and desirability of the new technology compared to the incumbent solution.
- Trigger scalability by identifying opportunities for policy intervention, increasing public awareness around low-carbon technologies and putting behavior nudges in place to enable low-carbon technology scalability.

Acronym Key and Glossary Terms

Positive tipping points	A positive socioeconomic tipping point is where a small intervention can trigger self-reinforcing feedback that accelerates positive systemic change, thus enabling scalability.
Negative tipping points	A negative tipping point is a rapid and irreversible change in the earth system. Examples include the loss of the Greenland ice sheet, resulting in rising sea-level risk and Amazon Rainforest dieback, resulting in the loss of a carbon sink.

Evidence

[1] **2023 Gartner Drivers of Environmental Sustainability Survey.** This survey sought to understand how enterprises are responding to environmental sustainability opportunities and risks, with the goal of identifying strategies that can unlock climate-related business resilience. The survey was conducted online from October through November 2023 among 204 respondents from North America (48%), Europe (37%) and Asia/Pacific (15%). Qualifying organizations had annual revenue of at least $50 million or equivalent and spanned a wide variety of industries, including banking and investment services, energy, healthcare, manufacturing, IT, retail, telecommunications, and utilities. Qualifying respondents were sustainability leaders at the director level or above who were involved in strategy, policy, investment or funding related to environmental sustainability. Disclaimer: The results of this survey do not represent global findings or the market as a whole, but reflect the sentiments of the respondents and companies surveyed.

[2] Tipping Points: Our Positive Tipping Points Are Bringing Change to the Climate Crisis, University of Exeter.

[3] Operationalizing Positive Tipping Points Towards Global Sustainability, University of Exeter.

[4] Leverage Points: Place to Intervene in a System, The Donella Meadows Project.

[5] Scrappage Scheme, Transport for London.

[6] The Role of Critical Minerals in the Clean Energy Transitions, International Energy Agency.

[7] Russia's War on Ukraine, International Energy Agency.

[8] Vechain Partners With China's Largest Electric Car Manufacturer BYD, VeChainInsider.

Note 1: Research Collaboration

This research was produced as a collaboration between the Global Systems Institute at the University of Exeter and Gartner. The University of Exeter is a Russell Group University, with thought leadership in global systems and positive socioeconomic tipping points. For additional information on the research conducted by the University of Exeter on tipping points see:

- Tipping Points: Our Positive Tipping Points Are Bringing Change to the Climate Crisis, University of Exeter.
- Global Tipping Points, University of Exeter.

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