

PROFEEDBACK POLICY BRIEF

TRANSFORMATIVE INNOVATION POLICY FOR THE GREEN TRANSITION: POLICY PATHWAYS FOR SYSTEMIC CHANGE

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Executive summary

The transition to a sustainable, low-carbon economy is crucial to tackling climate change and protecting the environment. However, current innovation policies largely focus on incremental improvements and fail to address the systemic challenges necessary for transformative change. Fragmented efforts across sectors and insufficient support for high-risk innovation hinder holistic, impactful solutions.

Transformative innovation policy is an important framework that emphasises the need to integrate economic and societal goals in order to tackle complex challenges such as climate change and inequality. It advocates systemic change through collaborative governance, reflexivity and a mixed policy instrument approach. Major global initiatives such as the United Nations Sustainable Development Goals and the Horizon Europe missions support this paradigm shift towards sustainable and inclusive innovation.

To effectively facilitate the green transition, this policy brief makes several policy recommendations: increasing awareness of transformative innovation policy, setting a clear direction for systemic change, adopting a comprehensive, demand-driven policy framework, improving cross-sectoral coordination, fostering systemic innovation at all governance levels, committing to long-term investment and promoting educational initiatives that build innovation capacity. By implementing these strategies, policymakers can drive systemic change, align innovation efforts with societal needs, and ultimately support a sustainable and just transition to a low-carbon economy.

1. Background

The world is facing an urgent need to make the transition to a sustainable, low-carbon economy to combat climate change, resource depletion and environmental degradation. However, current innovation policies and frameworks, while contributing to technological advancements, have not sufficiently addressed the systemic challenges required to drive such a transformative shift. Most policies focus on incremental innovation (small improvements within existing systems) rather than the transformative changes needed to fundamentally reshape key sectors such as energy, transport, agriculture and industry.

One of the main obstacles to a successful green transition is the fragmentation of innovation efforts across sectors and policy domains. Many existing policies are designed to promote innovation in specific sectors (e.g. energy or manufacturing), but lack the cross-sectoral collaboration needed to address interlinked environmental and societal challenges. This sectoral approach limits the potential for holistic, system-wide change, as innovations are often not scalable or cannot be integrated into other parts of the economy.

Current innovation strategies tend to prioritise short-term economic gains and technological competitiveness, often at the expense of long-term sustainability goals. Traditional innovation policy is focused on incremental advancements and immediate market returns, which do not necessarily contribute to the systemic transformation required for a green transition. This focus results in a limited scope for addressing large-scale societal challenges, such as climate mitigation and adaptation, resource efficiency and circular economy practices.

Another challenge is insufficient support for high-risk, high-reward innovations that could lead to system-level change. While traditional policies support incremental innovation, there is a lack of funding, governance and strategic frameworks for experimental and breakthrough innovations that can redefine markets and societal practices. This is particularly true for green innovations, which are often associated with higher initial costs and longer time to market. Without adequate financial and policy support, transformative eco-innovations struggle to progress beyond the research and development stage.

The global nature of the green transition also introduces new competitive dynamics. Countries and regions are competing to lead the development and commercialisation of green technologies, which creates disparities in innovation capacity.

This competition can exacerbate inequalities as regions with less developed innovation ecosystems struggle to keep pace with leading innovators. The lack of equal access to resources, knowledge and technological infrastructure across regions further limits the global ability to achieve the green transition collectively.

The EU's Green Deal and similar international initiatives set ambitious sustainability targets, but without transformative innovation policies that can trigger far-reaching change, the achievement of these targets remains uncertain. Without such actions, the green transition could be slow and inefficient and unable to achieve the necessary environmental and societal impacts within the desired timeframe. This policy brief explores how transformative innovation policies can bridge these gaps and drive systemic change across all sectors.

2. Innovation policy - from economic growth to transformative change

At its core, innovation policy seeks to develop and implement strategies that maximise the beneficial impacts of research and innovation, fostering an environment that encourages revolutionary findings, technological advancements, sustainable economic growth and social well-being. Over time, however, the influence and context of innovation processes and systems have evolved, reflecting shifts in societal and technological needs. The historical evolution of innovation policy has gained considerable attention in recent academic discussions, largely due to the expanding focus on the transformative innovation policy. Scholars generally agree that innovation policy can be understood through three main paradigms (Diercks et al., 2019; Schot & Steinmueller, 2018):

- Science and technology policy - R&D-driven growth,
- Innovation systems policy,
- Transformative innovation policy.

Each paradigm emphasises different aspects of innovation, from economic growth to systemic transformation and the impact on society. Transformative innovation policy, the third paradigm, has gained prominence as it is increasingly recognised globally that existing policies are not sufficient to address complex and intertwined challenges such as climate change, inequality and sustainability.

The first frame of innovation policy, which emerged after the Second World War, emphasised science and technology-driven economic growth. This model was based on the linear innovation model, where innovation was seen as a straightforward process, moving from scientific research to technological development and ultimately to commercialisation. While effective in promoting industrialisation and technological

progress, this approach largely focused on economic expansion and neglected the broader societal and environmental impacts of innovation. Its limitations became apparent as it failed to address complex challenges such as inequality, sustainability and the negative externalities of unchecked growth.

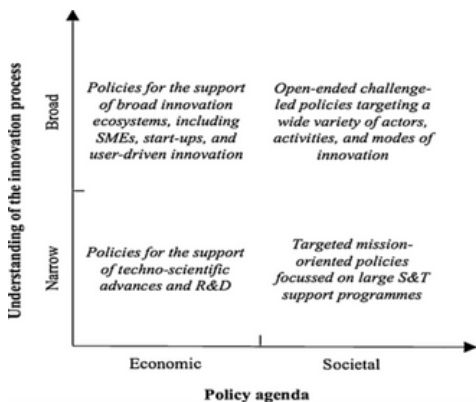
The second frame shifted the focus to national systems of innovation, recognising that innovation does not occur in isolation but is the result of interactions between various actors, including businesses, universities and governments. This frame emphasised building absorptive capacity and fostering collaboration within a national context. However, while it improved the understanding of innovation systems, it too fell short in addressing the urgent global challenges of our time, such as sustainability and social equity.

The third frame, known as transformative innovation policy, emerged more recently as a response to the limitations of the previous frames. It is rooted in the idea that innovation must not only drive economic growth but also transform socio-technical systems to address critical societal challenges like climate change, resource depletion and social inequality. This shift in thinking has been driven by global environmental and social crises, along with the realisation that incremental improvements in existing systems are insufficient to achieve the scale of change required for sustainable development.

It is important to point out that the third frame does not replace the previous frames, but rather offers a different perspective and a different set of priorities. Its features can successfully complement the elements of the first and second frameworks in policy making.

The three policy paradigms can be distinguished by categorising innovation policy along two main dimensions: the policy agenda (from an economic to a societal focus) and the understanding of the innovation process (from a narrow, linear view to a broader, systemic approach). The science and technology policy paradigm is located at the narrow end of the innovation process and focuses mainly on economic goals such as national competitiveness and growth. Innovation systems policy takes a broader, systemic approach to innovation, but remains primarily economically oriented and emphasises factors such as industry collaboration and national capabilities. Finally, transformative innovation policy combines a broad understanding of the innovation process with a strong societal focus (Figure 1). This paradigm addresses complex societal challenges such as sustainability and equity by involving different actors and promoting systemic change across sectors and policy areas.

Figure 1. A framework to compare discourses on innovation policy



Source: Diercks et al., 2019.

This framework suggests that a transformative innovation policy integrates both the economic and societal dimensions with a broader, more collaborative approach to innovation. This paradigm shift aims to enable more inclusive and resilient policies that go beyond traditional market-driven objectives and emphasise collaborative approaches to global challenges.

Each innovation policy framework has the potential to address the challenges of sustainable development, but they differ in their interpretation of how the policy impacts on social, economic and environmental goals. The conceptual framework shown in Figure 2 illustrates how innovation policy can address social and environmental issues while fostering economic growth. The first and second frameworks focus mainly on economic growth, based on the assumption that public welfare benefits will eventually follow. In contrast, transformative innovation policy reverses this perspective by emphasising that prioritising environmental issues and public welfare through systemic change can facilitate sustainable economic growth. Furthermore, this framework introduces the ideas of directionality and sustainability pathways and proposes a redefinition of economic growth that considers not only its occurrence, but also its quality and its ability to address societal challenges (Schot et al., 2017).

Figure 2. Innovation policy frames in addressing economic, social and environmental challenges



Note: Red colour – first frame, blue – second frame, green – third frame. A solid line – an aspect that has been explicitly addressed by the frame. A dashed line – an aspect that is expected to follow.

Source: Chataway et al., 2017.

A transformative innovation policy is driven by both top-down and bottom-up initiatives at regional, national and macro-regional level. These initiatives aim to align innovation efforts with broader societal and environmental goals and emphasise the need for systemic change. As innovation is increasingly seen as a tool to address global challenges, transformative innovation policy has emerged as a framework that goes beyond economic and technological goals and focuses on sustainable and inclusive development. Several important initiatives have contributed to this shift:

- **Sustainable Development Goals (SDGs) as a catalyst:** The United Nations' SDGs, launched in 2015, marked a turning point by underscoring the need to address global issues such as poverty, inequality, and climate change through comprehensive and systemic innovation strategies. Unlike earlier approaches focused on economic growth, the SDGs call for innovation that fosters sustainability and inclusivity, signalling a new direction for policy.
- **Horizon Europe Missions:** Introduced by the European Commission, this new concept, distinct from the previous Horizon 2020 programme, aligns closely with transformative innovation policy. These missions aim not only to advance science and technology, but also to address complex societal challenges through structured, goal-oriented initiatives.

- **STI for SDGs Roadmaps:** In 2019, the UN Task Team on Science, Technology, and Innovation launched the Global Pilot Programme on STI for SDGs Roadmaps, helping countries like Ghana, India, Kenya, Serbia and Ukraine align their innovation policies with the SDGs. By promoting cross-sector collaboration, these roadmaps embody the core principles of transformative innovation.
- **International Decade of Sciences for Sustainable Development (2024-2033):** Recently proclaimed by the UN General Assembly, this ten-year initiative highlights the importance of science and technology in achieving sustainability goals. It promotes international scientific collaboration and the integration of science into policymaking, reinforcing transformative innovation by addressing social and environmental challenges systemically.

In addition, regional bottom-up initiatives, such as mission-oriented innovation programs in Latin America and Southeast Asia, empower local actors to pursue mission-driven innovation, advancing the transformative change agenda. Together, these initiatives demonstrate a global shift toward inclusive, systemic and mission-oriented innovation policy, positioning innovation as a key driver for addressing the pressing societal challenges of our time.

Transformative innovation policy aims to create systemic change instead of making incremental improvements. It focuses on restructuring sectors and addressing complex societal challenges. The design, implementation and evaluation of a transformative innovation policy should have the following characteristics:

- **Directionality and flexibility:** this involves setting a clear direction for policy objectives (such as sustainability or decarbonisation) while remaining adaptable to changing conditions or new information. It implies a commitment to transformation while allowing flexibility in approaches as contexts evolve.
- **Reflexivity and learning:** this principle emphasises the need for continuous learning, self-assessment and adaptation within the policy process. Reflexive policies encourage feedback loops that allow policymakers to refine strategies based on outcomes, stakeholder input and unexpected challenges.
- **Stakeholder engagement and mobilisation:** involves active collaboration with a broad range of stakeholders, including businesses, communities and civil society, to co-create solutions and build consensus. Mobilising different stakeholders is important to gain support and ensure that innovations are aligned with societal needs.
- **Policy instrument mix:** a transformative innovation policy typically uses a combination of tools, such as funding, regulatory incentives and education programmes, to effectively address complex challenges. This mix enables a comprehensive approach in which different instruments work together to promote system-wide change.

- **Flexible multi-actor governance:** this dimension involves creating governance structures that are adaptable and inclusive and often require coordination between multiple actors and institutions. This flexibility supports collaborative governance that can respond to dynamic social and environmental changes (Brodnik, 2023).

These characteristics suggest that transformative innovation policy aims to create a robust, adaptive framework that can address pressing global challenges in a coordinated, inclusive, and strategic way, moving beyond isolated sectoral solutions to foster genuine societal transformation.

3. Transformative innovation policy: examples from practice

Based on the transformative innovation policy framework, the following cases illustrate how this approach is applied in practice to address specific regional and national challenges. Each example - from Catalonia's Shared Agendas promoting local collaboration, to Finland's Bio and Circular Economy Programme driving sustainability, to mission-oriented strategies in the Czech Republic, the UK and Sweden - highlights the different ways in which transformative policy can mobilise multi-stakeholder action, adapt to local contexts and achieve systemic, long-term impact. These initiatives offer an insight into the practical mechanisms and strategic collaborations that are essential for transformative innovation.

Shared Agendas for Collective Action (Catalonia, Spain).

Since 2020, the Catalan government, in collaboration with the Ingenio research centre and regional stakeholders, has been pioneering the implementation of a transformative innovation policy called Shared Agendas. Shared Agendas are participatory frameworks that bring together different local actors to tackle complex challenges through coordinated, collective action. This initiative embodies the essence of transformative innovation by focusing on adaptive, community-driven solutions that evolve based on local needs, long-term impact and lessons learned from successes and setbacks.

The first Shared Agendas projects are part of the Catalan research and innovation strategy for the Smart Specialisation framework (2014–2020) and include three pilot projects: Bioeconomy in Terres de Lleida, Health in Bages and University Transformation at the Autonomous University of Barcelona. These agendas follow a cross-sectoral, collaborative approach involving over 50 organisations through workshops, interviews and structured meetings. Each agenda has established a theory of change and basic plans for ongoing evaluation, helping Catalonia to create a replicable model for locally rooted, transformative solutions in Europe.

Building on this success, the updated Catalonia 2030 Smart Specialisation Strategy has adopted and scaled the Shared Agendas approach to address the SDGs and the transition to sustainability. In 2023, a cross-departmental structure involving all 12 Catalan universities was established to coordinate systemic, transformative innovation efforts for local challenges with a holistic, ecosystem-driven perspective.

More info on:

- <https://tipconsortium.net/transforming-innovation-policy-in-catalonia-an-interview-with-tatiana-fernandez-sirera/>
- <https://fonseuropeus.gencat.cat/web/content/ris3cat/documents/angles/ris3cat-2030-en.pdf>

Bio and Circular Finland programme

The Bio and Circular Finland program was developed by Business Finland, the country's official agency for trade, investment promotion, innovation funding, tourism and talent attraction. Launched for the period 2019-2022, the program aimed to foster globally competitive bio-based and circular economy solutions and ecosystems from Finland. Its goals included creating innovations with global market potential, boosting the export growth of Finnish solutions, attracting investments to Finland and transforming industry business models.

The program provided €150 million in innovation funding, focusing on key areas such as textiles, plastics, packaging, industrial circular economy, construction and real estate and consumer business. Its main priorities were bio-based solutions, circular economy manufacturing, new business models, industrial symbiosis and digital solutions. The program provides a range of services, including funding, building networks, identifying market opportunities, developing skills, and scaling businesses. It offers five funding streams, with grants and loans that cover up to 50% of costs, tailored to the needs and size of companies. Co-creation funding is available for research organizations partnering with companies. Foreign firms can also benefit from investment opportunities in Finland, with support for data collection, location management, and networking (Janssen et al., 2023).

The program's funding is provided by the Ministry of Economic Affairs and Employment, following national laws and evaluation criteria such as job creation and revenue growth. While Business Finland cannot change the governing laws, it can adjust funding criteria to increase impact and focus on specific sectors, in line with EU guidelines. They collaborate closely with companies, research centres and

universities to identify investment opportunities, although larger companies are seen as more resistant to change (Janssen et al., 2023).

More info on:

- https://www.baltic.org/wp-content/uploads/2016/04/Business-Finland_Absetz.pdf

Mission-Oriented RIS3 Strategy (Czech Republic)

The Czech Republic has positioned itself as a pioneer in adopting a transformative innovation policy within the European Union by moving from the S3 approach to the more progressive S4 framework, which emphasises sustainability and inclusiveness. This shift, reflected in the Czech Republic's recent S3 update, is in line with the principles of mission-oriented innovation, which focuses on specific societal challenges within the framework of the European Green Deal and the United Nations SDGs.

In this context, the Czech S3 strategy has introduced two key missions: improving the material, energy and emission efficiency of the economy and strengthening the resilience of society to security threats. The first mission deals with the efficient use of resources and aims to shift the Czech economy towards sustainable production processes and reduce dependence on external sources. The second mission focuses on preparing for and responding to unforeseen societal challenges, with an emphasis on prevention, adaptation and resilience.

The Czech government's transition from S3 to S4 has been carefully structured, starting with the selection of SDG-aligned priorities, a comprehensive situation assessment and the establishment of a monitoring system. This approach not only strengthens the Czech Republic's commitment to sustainable development, but also serves as a model for other regions seeking to integrate mission-oriented innovation into their own strategic transformations.

More info on:

- <https://www.ris3.cz/en/priorities/missions-and-societal-challenges>

UKRI Industrial Strategy Challenge Fund

The Industrial Strategy Challenge Fund (ISCF), managed by UK Research and Innovation (UKRI), is designed to drive research and innovation to address the UK's major industrial and societal challenges. It focuses on key areas outlined in the 2017 Industrial Strategy, including an ageing society, artificial intelligence and data, clean growth and the future of mobility.

The aim of the ISCF is to develop solutions to the UK's key industrial and societal challenges through a challenge-driven R&I funding programme. UKRI has launched 20 specific 'challenges', each of which promotes collaborative, cross-sectoral R&I in a particular sector or theme. These challenges were introduced in three phases of funding. The ISCF aims to achieve five key objectives: boost UK business investment in R&D and enhance R&D capabilities, promote multidisciplinary research in challenge areas, foster business-academic collaboration, encourage partnerships between smaller and larger companies and attract overseas R&D investment to the UK (Zakaria et al., 2023).

The fund is supported by £2.6 billion of public investment, with an additional £3 billion in matched funding from the private sector. The ISCF Challenges are designed and managed through challenge-level governance structures, which report to a fund-level governance body overseen by the ISCF Steering Board. These governance structures include program boards, advisory groups, Challenge program teams and Challenge Directors - industry leaders from relevant sectors providing strategic support. Each Challenge allocates ISCF funds through various funding mechanisms designed to achieve both the specific Challenge goals and broader fund objectives (Zakaria et al., 2023).

More info on:

- <https://www.ukri.org/what-we-do/ukri-challenge-fund/>

Strategic Innovation Programmes in Sweden

The Strategic Innovation Programmes (SIP) aim to strengthen Sweden's global economic competitiveness and develop sustainable solutions to global challenges. This is achieved by fostering collaboration among universities, companies, civil society organizations and government agencies within an innovation system framework (EC-OECD, 2024). Coordinated by the Swedish innovation agency Vinnova, in partnership with the Swedish Energy Agency and the Swedish

Research Council for Environment, Agricultural Sciences and Spatial Planning, these programmes offer a relevant case for examining the capabilities and obstacles involved in integrating both vertical and horizontal policies to achieve transformative, system-wide impacts (Grillitsch et al., 2019).

This initiative initially funded large networks of partners in emerging ecosystems rather than individual projects. In the first phase, moderate funding was given to many projects to develop Strategic Innovation Agendas (SIAs). In the second phase, only groups that met certain SIA standards could apply for Strategic Innovation Programmes (SIPs). Introduced in the 2012 Research and Innovation Bill, four SIP calls were issued between 2013 and 2016, resulting in funding for 17 SIPs over up to twelve years, divided into four stages. Each stage's funding depended on prior evaluations. SIPs include diverse actors across sectors and stages of the innovation process, with collective governance bodies for decision-making. A key feature is the delegation of strategic agenda formulation and implementation through these SIPs (EC-OECD, 2024).

More info on:

- <https://stip.oecd.org/moip/case-studies/11>

4. Policy recommendations

Based on a comprehensive literature review and analysis of real-world cases, it becomes clear that transformative innovation policies play a crucial role in facilitating the green transition. To achieve the ambitious goals of international agreements such as the EU Green Deal and the Paris Agreement, innovation policy should go beyond incremental improvements. It must drive systemic change in different sectors such as energy, transport, agriculture and industry. This means promoting innovations that fundamentally change the way these sectors operate and create sustainable, low-carbon alternatives. The following key policy recommendations outline strategies to accelerate this systemic shift:

Increase awareness and understanding of transformative innovation policy - As transformative innovation is a relatively new concept and many policy makers are used to focusing on economic growth as the primary goal of innovation policy, it is important to broaden their perspective to include societal benefits. For transformative innovation policy to be truly effective, policymakers need to understand the key principles and the long-term potential of this policy to address complex societal challenges. Targeted awareness-raising programmes such as workshops, seminars and collaborative study groups can provide policymakers with a better understanding of these concepts and practical applications. Awareness programmes should also include real-life examples and case studies that show how transformative policies have led to significant progress in other regions. With this knowledge, they will be better able to implement policies that prioritise sustainable, systemic solutions and promote the growth of resilient and inclusive economies and societies.

Set a clear direction for transformation - For innovation to drive long-term change, policymakers must create a compelling vision that clearly outlines the path forward, such as the goal of a sustainable future. This vision serves as a guide for all stakeholders, from businesses and governments to researchers and communities, to align common goals and facilitate effective collaboration. When a clear direction is set, companies gain the confidence to invest in transformative areas that are backed by government support and strategic planning.

Furthermore, innovation policy should not only set the direction, but also **encourage companies to mobilise resources and explore new opportunities**. Through effective policy instruments, policy can encourage companies to invest in areas that advance societal goals such as sustainability and resilience, laying the foundation for lasting change.

Adopt a holistic, demand-driven innovation policy - An effective innovation policy should take into account a comprehensive range of factors that support the entire innovation ecosystem. This includes not only direct funding and capability-building initiatives, but also stimulating demand for innovative products and services. Policies

should actively promote the development of solutions to pressing societal needs, such as renewable energy and sustainable agriculture, to ensure that innovations are both applicable and valued in the marketplace. By prioritising both supply (e.g. technology and research funding) and demand (e.g. incentives for market uptake), innovation policy can promote solutions that are both effective and easily adopted, driving progress across all sectors.

Improve cross-sector and cross-policy coordination - Policy makers should improve coordination between different sectors such as energy, transport, agriculture and industry by breaking down silos that often prevent comprehensive solutions. This includes supporting an ecosystem that enables cross-sector collaboration and encourages experimentation that can lead to breakthroughs in addressing societal challenges. Policies must therefore prioritise long-term commitments that align with societal goals and focus on inclusive, sustainable and equitable outcomes.

Fostering systemic innovation at all levels of governance - Promoting transformative innovation should take place at all levels of governance, from local to national, to incorporate both technological and social elements. By supporting region-specific initiatives, the government can tailor its efforts to the environmental and economic needs of each area. In addition, establishing a centralised platform for sharing best practices would help policy makers and stakeholders implement successful models of transformative innovation.

Long-term investments in groundbreaking innovations are necessary - transformative innovation often require high-risk, long-term investments that may not yield immediate economic returns. However, without these investments, particularly in green R&D and infrastructure, sustainable transformation will be slow.

Public investment should be also directed toward **establishing innovation hubs and platforms that enable dynamic interactions among government, academia, industry and civil society**. Such platforms are crucial for supporting the exchange of ideas, the development of new technologies, and the fostering of community-driven solutions.

Policy makers should develop coherent frameworks that can be adapted to technological and societal changes and enable **regular evaluations to ensure alignment with transformative goals**. By embedding evaluation processes into the policy framework, the impact of transformative innovation policy can be regularly assessed, allowing approaches to be recalibrated and refined based on real-world outcomes.

To embed transformative practices at the grassroots level, policies should encourage **educational programmes that build innovation capacity from a young age**. Investment in STEM education, complemented by entrepreneurial training, equips future generations with the skills necessary to address complex societal issues. In parallel, vocational training and upskilling initiatives can strengthen innovation capabilities across diverse populations, ensuring an inclusive approach to

transformation. Building on the points discussed above, the core components of a transformative innovation policy framework aimed at supporting the green transition are outlined in Box 1. Each component represents a foundational policy approach for fostering sustainable and systemic change.

Box 1: Key policy pathways for achieving systemic change

1. Policy alignment – aligning national innovation strategies with international frameworks (EU, OECD or UN).
2. Cross-sector collaboration – fostering collaboration across industries, public-private partnerships, and civil society.
3. Mission-driven projects – developing and funding mission-oriented innovation projects focusing on sustainability challenges (e.g. clean energy, circular economy).
4. Adaptive policy frameworks – creating flexible and adaptive governance structures to support systemic experimentation.
5. Evaluation and learning – implementing mechanisms to evaluate and scale successful experiments and policies.

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