

Designing a business case for climate technology in Europe

Key learnings from the U.S. policy approach

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Executive summary

Over-reliance on one pathway, such as focusing heavily on renewable energy and electrification without advancing additional technology options, increases the risk of missing climate targets.

The U.S. policy approach promotes multiple technologies to increase decarbonisation options by supporting technologies with a variety of incentive structures from laboratory to commercialisation, addressing barriers, enabling infrastructure, and providing clarity for large-scale deployment.

To make a successful business case and meet decarbonisation targets, European policymakers should:

- **Support technology innovation and embrace an approach that maximises the number of pathways and solutions available.** In addition to supporting the rapid scale-up of renewable energy, policymakers should support an expanded set of options that includes conventional and next-generation nuclear energy, carbon capture and storage, climate-beneficial zero-carbon fuels, and their enabling infrastructure.
- **Clarify the current technology deployment policy funding landscape across the EU and its Member States,** assessing whether or not it is suited to deliver deployment, and how it could potentially be improved and simplified.
- **Tailor policy to lower the costs.** Policy should bridge the gap between demonstration, deployment, and commercialisation to create a business case to scale up climate beneficial technologies within Europe.
- **Enable faster deployment through regulatory streamlining and self-activating policy instruments** based on clear, pre-existing criteria that do not require before-the-fact, case-by-case approval.
- **Address infrastructure needs with proactive planning and coordination.** This helps surmount barriers standing in the way of building out shared energy infrastructure such as carbon dioxide and hydrogen transport and storage, transmission, interconnection, and others.

Introduction

To ensure energy security, economic growth and decarbonisation, Europe needs a climate strategy that advances a diverse set of technologies and approaches to decarbonise its economy.

It is too risky to bet the future of Europe's power, industrial, steel, cement, and transportation sectors on limited decarbonisation pathways. Europe must commercialise alternative decarbonisation technologies like carbon capture and storage, zero-carbon fuels, and nuclear energy, as well as build enabling and connecting infrastructure. With the European Commission proposing the Net Zero Industry Act and provisions for clean energy manufacturing, it's the perfect time to ask a hard question: how can Europe commercialise and deploy as many climate technology options as possible?

An important input for European policymakers should be the assessment of similar policy efforts around the world, and, in particular, the recent industrial policy push coming out of the United States. While it remains to be seen whether the recent package of climate policies – including the Inflation Reduction Act (IRA), the Infrastructure Investment and Jobs Act (IIJA), and the Energy Act of 2020 – will have the intended galvanising impact on technology development, there are already key lessons to draw from them. This brief re-frames and analyses the U.S. climate policy approach to driving investments across the entire clean technology life cycle and offers recommendations for European policymakers on how to design a business case to advance clean energy.

The U.S. approach summarised

The U.S. approach to clean energy technology emphasises policies in the research and development (R&D), early commercialisation, and expansion stages. The purpose is to shorten the time it takes for clean energy technologies to reach the “take-off point.” The take-off point occurs when the deployment of a technology is extensive enough that it can multiply and rapidly reach wide use worldwide. Recent U.S. laws, IRA and IIJA, and the Energy Act of 2020, put the U.S. closer to being on track to achieve its Nationally Determined Contribution.

Collectively, the three bills:

1 Support multiple technologies to create many decarbonisation options

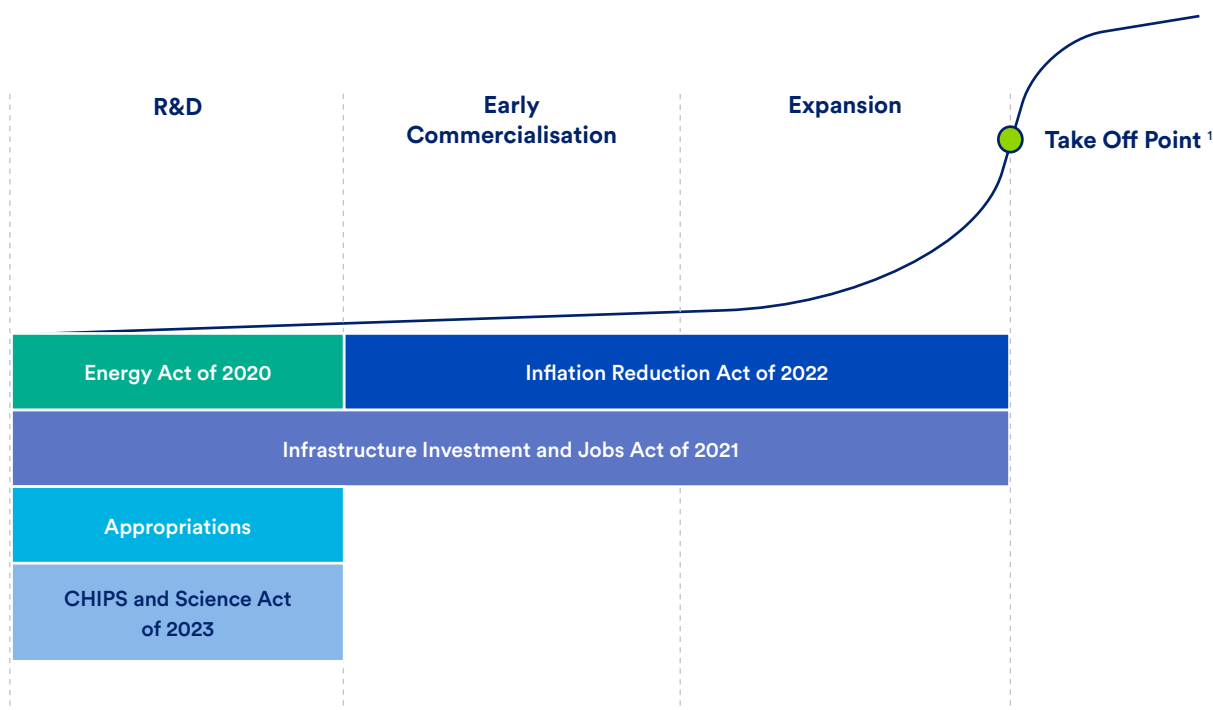
3 Address multiple barriers (not just cost), including barriers to building and connecting infrastructure, accessing financing, and speeding project construction

2 Tailor policy support to fit the needs of each specific development stages

4 Provide clarity and focus on the path to large-scale deployment

The three policy packages fit together, supporting the R&D, Early Commercialisation, and Expansion stages, as shown in the figure on the next page.

The details in each of these laws are documented in this [CATF report](#).



The Energy Act of 2020 focused its support on **research, development, and demonstration (RD&D)** for technologies critical to decarbonisation. It authorised more than \$35 billion in federal investment to support RD&D dedicated to innovative energy sector technologies with a focus on zero-carbon energy and domestic manufacturing. By passing the Energy Act, the U.S. set the stage for innovation by **putting down markers on policy priorities for the next generation of clean energy technologies and made a “down payment” on early-stage R&D**, setting the stage for larger investments in the future.²

IIJA in 2021 built on the Energy Act of 2020 by directing much larger dollar amounts to **demonstration grants and financing for mid-stage technologies**, providing support to move them **from the lab bench to demonstration**, often through hubs or other models with eventual near-term commercialisation in mind. It also provides vital support for enabling infrastructure such as transmission and CO₂ transport and storage.

IRA in 2022 went further, using pre-dominantly tax credits and other forms of financial assistance to incentivise wide-scale deployment of mature technologies. **Commercialisation, expansion, and cost reductions via large-scale deployment are the key aim of IRA.**

¹ **R&D:** This stage is often described in the literature as Technical Readiness Levels (“TRLs”) extending from TRL 1 (concept) through TRL 9 (commercial demonstration). Though helpful in addressing aspects of innovation, the TRL methodology does not speak to a significant segment of the process — the span between demonstration and take-off. And it often ignores the particular set of structural challenges that typically present themselves at each stage.

Early Commercialisation: For technologies involving large plants, this period runs from the first commercially viable plant (first-of-a-kind or FOAK) through the Nth plant (Nth-of-a-kind or NOAK), a progression in which prices fall to a commercially competitive level. But the FOAK-to-NOAK framework is less helpful when a technology relies heavily on factory construction of modular parts (such as solar installations), nor does it fit well when the goal is to convert an end-use technology like marine shipping or heavy-duty trucking to run on hydrogen. For these reasons, we adopt the term “early commercialization” to indicate the period just after RD&D that addresses initial adoption.

Expansion: This stage marks the period after initial costs begin to fall and commercial use climbs towards the “take-off” point. This treacherous period calls for focused policy intervention to avoid stagnation.

² <https://cdn.catf.us/wp-content/uploads/2022/11/03101429/climate-clean-energy-legislation-2020-2022.pdf>

Key lessons from the U.S. approach:

1. Promote a wide range of technologies for decarbonisation and support them up to take-off

Maximising the options available is important, as **over-reliance on one pathway increases the risk of missing climate targets**. Studies have shown³ that the capacity value of renewable energy and storage declines as more renewables are deployed and low costs would not guarantee accelerated deployment, as they are only part the story. **Having multiple commercialised technology options**, however, including nuclear energy, carbon capture and storage, and hydrogen to provide high temperature heat, enhances pathway flexibility and increases the ability to pivot thus reducing risk.

Creating options starts with understanding how technologies move through development stages, starting with R&D and ending with market saturation. Innovation policies should go beyond R&D to **address demonstration, early commercialisation, and expansion** so that a technology reaches a “take-off” point. If the technology reaches the take-off point, its costs have been sufficiently reduced and it can scale globally to market saturation and contribute to climate neutrality ambitions. Arguably, European incentives for solar and offshore wind have helped these technologies reach this “take-off” point. The U.S. policy package supports **various technology options**, reflecting that a diverse suite of technologies will need to be commercialised and available at scale for emissions reductions across the economy.

2. Tailor incentives to fit the needs of each specific development stage to lead to the take-off point

The Inflation Reduction Act and its peer policies **support technology commercialisation and expansion so that the technology reaches a take-off point, thus becoming an option that delivers on decarbonisation objectives**, via tailored policy and incentive structures. The U.S. policy package recognises that **different technology applications, infrastructure, and readiness levels require different incentive structures**. For example, the bills provide **low-interest loans** for connecting infrastructure including transmission, CO₂ transport and storage, **tax credits** for clean energy technologies including solar, wind, carbon capture and storage for industry and power, direct air capture, hydrogen and nuclear energy, and **grants for demonstrations** of technologies including hydrogen hubs and direct air capture. Finally, even though considered to mostly include incentives or ‘carrots’, it also includes some **calibrated standards** or ‘sticks’, and through technology commercialisation lays the pathways for stricter regulation. One example is the two-fold Methane Emissions Reduction Programme, which provides \$1.55 billion for loans, rebates, contracts, and grants to support the oil and gas sector in reducing methane emissions. It also introduces a charge on methane emissions which exceeds waste thresholds. Additional examples are the carbon capture and storage incentives laying the pathway for [strong technology-based standards](#).

The U.S. approach is different. Europe has focused its efforts on mostly designing policies that regulate the demand side (e.g., carbon tax, emission standards), while supply-side policy instruments remain overlooked. The U.S. package not only makes a difference between comprehensive climate policy and innovation policy, in fact, it recognises that successful innovation policy is the precursor of impactful, comprehensive climate policy.

The U.S. framework has become attractive for companies as the instruments beyond support for R&D help de-risk investments by including investment incentives and tax credits, which are crucial for deployment. Production credits are self-activating policy instruments, particularly important for the expansion phase, which give clarity and security over which projects will qualify for what kind of incentives ahead of time. To enable technology development and

³ Bolinger, M., Millstein, D., et al. (2023) 'Mind the gap: Comparing the net value of geothermal, wind, solar, and solar+storage in the Western United States', Renewable Energy, Volume 205, 2023, Pages 999-1009, ISSN 0960-1481, <https://doi.org/10.1016/j.renene.2023.02.023>.

create industries, it is important that policymakers make use of various instruments across the different technology readiness levels. Below is a taxonomy of instruments that can be used at the stages of technology to support scale-up and market take-up.

	Research & Development	Early Commercialisation	Expansion
INCENTIVES	Government grants Prize competitions	Grants for demonstrations Loans	In the expansion stage, credits that are self-activating are especially important. See note 1 Support for CAPEX: investment tax credits, loans, grants Support for OPEX: Production tax credits, contracts for differences, feed-in-tariffs Other funding options: – Venture capital – Government procurement
MANDATES See note 2	← Policy instruments that serve as ‘sticks’ across the entire lifecycle of technology: technology standards; clean energy standards; regulation (e.g. ETS) →		

Note 1: Self-activating incentives are those that don't involve an application to a government body to secure. In the expansion stage, the large number of projects being built makes it impractical for each project to obtain prior government approval for their use of the incentive. An example of a self-activating policy are tax credits because a taxpayer need only claim them when they file their taxes.

Note 2: Using both incentives and mandates together can create synergies. Incentives are often time-limited and provide funding to build first projects and drive substantial growth in the expansion stage, but eventually, they phase out. Mandates, such as the ETS, send a long-term price signal that drives decarbonisation for decades. However, the price signal from mandates is often low at the outset to prevent market disruption and increase with time. Consequently, mandates alone can be insufficient to drive early clean technology adoption. However, when governments use incentives and mandates together, they re-enforce each other. Incentives bridge early cost gaps, while mandates ensure technology deployment over decades. These synergies create the certainty needed to foster private investment in R&D and large-scale deployment that yields cost reductions from learning by doing. These conditions create new industries that can deploy clean technologies at the scale needed to address climate change.

3. Address multiple barriers (not just cost), including building enabling and connecting infrastructure, access to financing, and speed of project construction

Beyond support for technologies, IRA and IIJA are also designed to overcome the ‘infrastructure challenge’ or the basic “chicken-and-egg” problem. As an example, it is difficult to invest in a carbon capture facility without established transport and storage infrastructure, but investing in the latter is also difficult without the former. Developing shared enabling infrastructure (such as transmission or CO₂ pipelines) is a major ecosystem barrier and an enabler for driving projects if available. Once shared infrastructure is secured, it enhances investor confidence and lowers risks. Further elaborating on the example of carbon capture and storage, companies will not invest in capital-intensive capture equipment without access to needed infrastructure to dispose of the CO₂, specifically, pipelines, and storage sites. IIJA dedicates \$2.1 billion in low-interest loans and grants to building out supersized carbon dioxide transport infrastructure in addition to \$2.5 billion in cost-share grants and ton-for-ton tax credits for capturing CO₂. By investing in the full technology value chain (CO₂ capture, transport, and storage), the bills simultaneously increase the likelihood that **technology and infrastructure will be developed and deployed in parallel, and projects reach a final investment decision.**

4. Provide clarity and focus on the path to large-scale deployment

With the package aiming at lowering the costs of technology development via technology deployment, an essential step for aiding industries and consumers is **supporting faster project development**. Permitting for infrastructure projects has long been an obstacle for deployment not only in the U.S. but also in other jurisdictions. To address this issue – and some would argue the U.S. package does not go far enough – the bills also include additional funding

for staffing for regional and federal permitting. The Inflation Reduction Act provides some financial support for environmental reviews to ensure environmental permitting processes that are timely, robust, and transparent. **Every new project is crucial for reducing costs**, thus policies that facilitate rapid and predictable permitting reviews are an integral part of deployment policy.

Recommendations for European Policymakers:

A key consideration is that Europe is in a different, and arguably more vulnerable position compared to the U.S.. The energy crisis has shown the importance of long-term planning and risk mitigation. That is why, in addition to strengthening industry, the EU and Member States must formulate climate policies which **commercialise multiple decarbonisation options** to avoid dependence on a single decarbonisation pathway. A well-designed, **options-driven long-term vision for 2040** and beyond will provide investors with clear signals and funding to guide the urgent industry transformation. Policymakers should consider the following key principles as they design climate-forward innovation policy.

De-politicise technology innovation and embrace optionality

Europe must deploy as much renewable energy as possible. But to ensure cross-sectoral emissions reductions and around-the-clock power reliability across diverse national economies, policy must also support conventional and next-generation nuclear energy, as well as carbon capture and storage, climate-beneficial zero-carbon fuels, and their enabling infrastructure. Europe must urgently address methane emissions with proper regulation. Investments are crucial for commercialising visionary solutions like permanent carbon dioxide removal, nuclear fusion, and [superhot rock geothermal](#).

Clarify the current technology deployment policy funding landscape across EU and Member States

Research has shown that Europe spends just as much or more on tech deployment than the United States with its latest policy packages.⁴ However, the funding is scattered across EU-level and Member States and it is unclear whether or not it is suited to deliver deployment, and how it could potentially be combined. Policymakers in the EU and Member States should work to deliver funding clarity. Moreover, the National Energy and Climate Plans could help to map and align policy, funding, and planning.

Tailor policy to bridge gap between commercialisation stages to lower cost

Policymakers should consider the entire technology development cycle, understand costs, and design policies that target critical stages for the technology take-off. Research has shown that the steepest cost reductions are available during the demonstration and expansion phases, which means that multiple commercial demonstration projects play an outsized role in driving cost reductions. Support for these stages is therefore crucial for avoiding the risk of having a pre-commercialisation period without financial support or the so-called “valley of death”.⁵

Reports indicate that the EU excels at laboratory research and early deployment, however, commercialisation and mass deployment of EU technologies happen in other markets.⁶ That’s why **bridging the gaps between demonstration, deployment and commercialisation is key for creating a business case for climate –beneficial technologies in Europe**. Currently, much of EU funding fails to target spending at these stages and mainly uses grants

⁴ Kleimann, D., N. Poitiers, A. Sapir, S. Tagliapietra, N. Véron, R. Veugelers and J. Zettelmeyer (2023) ‘How Europe should answer the U.S. Inflation Reduction Act’, Policy Contribution 04/2023, Bruegel p7

⁵ Elia, A., Kamidelivand, M., Rogan, F., Ó Gallachóir, B. (2021) Impacts of innovation on renewable energy technology cost reductions, Renewable and Sustainable Energy Reviews, Volume 138, 2021, 110488, ISSN 1364-0321, <https://doi.org/10.1016/j.rser.2020.110488>.

⁶ Cincera, M., Frietsch, R., Leijten, J., et al. (2015) The Impact of Horizon 2020 on Innovation in Europe, Volume 50, 2015 · Number 1 · pp. 4–30

which entail slow bureaucratic processes. The EU Innovation Fund provides good demonstration incentives, but is limited in size and potentially inflexible with regards to technologies and instruments. It is not designed to drive cost reductions through continuous deployment of the multiple technologies it supports.

To lower cost and accelerate commercialisation, policy should:

- Provide multiple types of instruments beyond grants, such as contracts for difference and low-interest loans, which should be flexible depending on the type of technology or project.
- Seek to enable building not only first-of-a-kind but multiple simultaneous projects, particularly large industrial projects, to reduce rent-seeking, enable a rolling workforce, and allow for the instant application of lessons learned to gain swift cost reductions.

Enable faster deployment through regulatory streamlining and self-activating policy

To reach the EU decarbonisation targets and meet energy demand, zero-carbon deployment needs to be faster and coupled with CO₂ emissions reductions and the build out of enabling infrastructure.

Apart from introducing the regulatory sand boxes which are suggested in the NZIA, policymakers can support regulatory coherence in the Member States by encouraging **standardisation of key processes (e.g. permitting) and inputs for a single project, to further facilitate the simultaneous development of many similar projects.**

Incentives at a national level are also important and need to be “**self-activating**” — that is, based on clear, pre-existing criteria that do not require before-the-fact, case-by-case approval. **This incentive design increases certainty that expected support will actually arrive;** this, in turn, reduces the deployment cycle time.

EU-level guidance on expediting and regularising the development of demonstration projects is a key step for commercialising technologies. This helps replicate the technology, thus proving the value of the technology and giving a clear signal to investors. During the initial years of market diffusion, new clean technologies will require continued support, just at a different level and of a different kind. The NZIA makes use of the power of public procurement. However, experience with solar PVs has shown that clean energy production incentives can be most effective in making the technology widely available and able to scale up quickly. While the tax credits present in IRA might not be instruments that can be introduced on an EU-level due to limited competency, the principle of supporting production of green energy, de-risking investments and securing infrastructure build-out is still applicable in the European context.

Overcome ecosystem barriers by addressing infrastructure needs with proactive planning and coordination

The EU must identify, map, and address infrastructure barriers and market failures that are not directly related to a given zero-carbon technology or its market costs but that nevertheless could hinder that technology from reaching market maturity and limit the speed of its deployment. Such barriers affect many shared energy infrastructure projects necessary to facilitate broader technology deployment, such as CO₂ and hydrogen transport and storage, transmission, interconnection and other related infrastructure. Surmounting these will require new proactive planning approaches suited to each technology and its present stage of development. Early on, innovations may benefit from targeted infrastructure policies offering grants and loans. Later, the support of national or sub-national infrastructure planning authorities would help reduce barriers and market failures, reduce the permitting and citing burden, and speed up deployment by de-risking enabling infrastructure that can be shared by many users. Permitting pathways will need to be developed throughout, from the first demonstration project, through take-off to market maturity.

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Sources: [Building a Clean Energy Economy: A Guidebook to the Inflation Reduction Act's Investments in Clean Energy and Climate Action](#)