The Coalition of Finance Ministers for Climate Action

Technology Catalogues: the experience from Denmark

Danish Energy Agency (DEA)

A contribution to the 'Compendium of Practice from a Global Community of Ministries of Finance and Leading Organizations: Economic analysis and modeling tools to assist Ministries of Finance in driving green and resilient transitions'

Topic: Addressing the climate policy questions facing Ministries of Finance: the economic and fiscal impacts the green transition

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Access the full Compendium at www.greenandresilienteconomics.org

This contribution was prepared at the request of, and with guidance from, the Ministry of Finance of Denmark as Lead of the Coalition's Helsinki Principle 4 initiative 'Economic Analysis for Green and Resilient Transitions' and its Steering Group, with input from its Technical Advisory Group. The views, findings, interpretations, and conclusions expressed are those of the authors. While many Coalition members and partners may support the general thrust of the arguments, findings, and recommendations made in this contribution, it does not necessarily reflect the views of the Coalition, its members, or the affiliations of the authors, nor does it represent an endorsement of any of the views expressed herein by any individual member of the Coalition.

Since the 1980s, the Danish Energy Agency (DEA) has produced Technology Catalogues (TCs) to support informed policymaking and long-term energy planning, promoting a least-cost approach within the green transition. These provide consistent, reliable data and projections on energy technologies, helping policymakers evaluate energy system scenarios, the security of supply, environmental impacts, and climate strategies, through socioeconomic analyses. They serve as a standard reference for Government Agencies, energy operators, researchers, and industry stakeholders.

Energy planning and policy development must rely on the most accurate data available, particularly because energy sector investments have long lead times. Achieving climate goals and transitioning to new technologies require up-to-date assumptions and collaboration between public and private sectors.

Beyond being inputs to energy system modeling and economic analyses for energy infrastructure planning, the TCs are also essential for evaluating the impacts of policies and identifying the technical potential for emissions reduction. These evaluations are conducted by the Ministry of Climate, Energy and Utilities in partnership with the Ministry of Finance.

A well-established and comprehensive publication

A TC is a comprehensive report describing various energy technologies. Each TC includes the following:

1. Qualitative information: A nontechnical explanation of how a given technology works, its inputs/outputs, benefits, challenges, environmental impacts, and maturity, as well as examples of real-world applications and the technology's anticipated performance and cost development.
2. Quantitative data: Standardized data sheets contain key technical, environmental, and financial metrics for current technologies and their anticipated future development.

TCs follow a uniform structure, ensuring comparability across technologies.

First introduced in the 1980s for municipal heat planning, which required up-to-date benchmark cost data for planning purposes, as of 2024 the TCs covered nine key energy sectors:

- Electricity and district heating generation
- Distributed heating systems
- Renewable fuels
- Energy storage
- Energy transportation infrastructure
- Industrial process heat
- Commercial road freight and passenger transportation
- Commercial maritime freight and passenger transportation
- Carbon capture, transportation, and storage

The Danish Technology Catalogue is still, by law, the economic reference data for assessing public municipal heat supply planning investment decisions, if project-specific data are not present or documented. Beyond that, TCs provide financial data for other energy technologies as part of governmental energy planning, considering, e.g., subsidy assessments, tariff designs, and price ceilings for consumers.

A shared point of reference, tailored to the local specifics

Establishing the TC has provided a shared reference point for energy technology data, ensuring consistency in national and regional planning. While private and international data sources (e.g.,

International Energy Agency [IEA], the International Renewable Energy Agency [IRENA], and Bloomberg New Energy Finance [BNEF]) also exist, they may lack key local details or alignment with specific system assumptions, making the TC uniquely relevant for Denmark's energy planning.

Using the TC enhances transparency in energy modeling and planning by standardizing assumptions, allowing discussions to focus on analytical results rather than data discrepancies.

The dedicated Technology Catalogue Development Team in the Danish Energy Agency

The DEA manages the TC with input from external consultants and experts to ensure accuracy and impartiality. A team of seven full-time staff in the Systems Analysis and Innovation department oversees the project.

The DEA also promotes the TC internationally as part of its collaborations with 25 partner countries. The country-specific TCs are jointly developed and ultimately published by the DEA and the partnering governmental institutions, focusing on building capacity within partner countries for increased engagement in further project iterations.

The inclusive and rigorous process underpinning Technology Catalogue development

The TC's development in Denmark has evolved into a participatory, step-by-step process involving sector experts to ensure its validity:

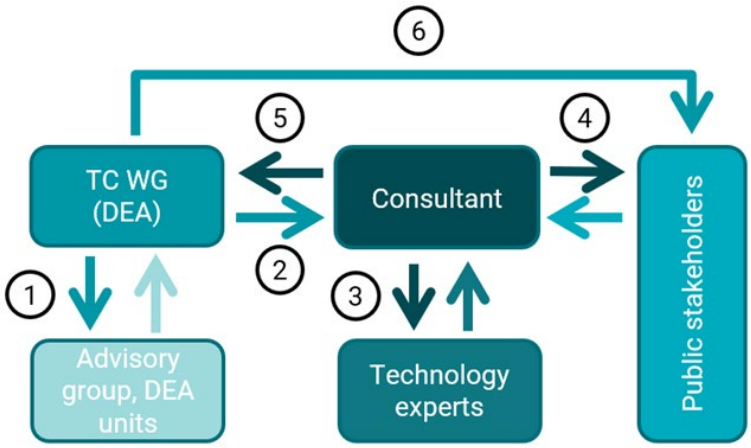
1. Advisory group consultation: Experts guide the TC's scope and priorities.
2. Consultant input: External consultants ensure objectivity in data preparation.
3. Industry and research contributions: Technology experts provide detailed data.
4. Stakeholder review: Drafts are shared for feedback to improve quality and gain broader acceptance.
5. Finalization: DEA and consultants finalize the catalogue.
6. Publication: The TC is released as a free public resource.

This collaborative approach ensures the catalogues remain comprehensive, accurate, and widely trusted as a reference for energy planning and policy development, ensuring consistency, and an accurate and up-to-date long-term perspective.

The country-specific TCs developed collaboratively by the DEA and its international partners aim to replicate the streamlined, step-by-step approach used in Denmark. During the initial development phase, the collaboration focuses on building a strong foundation through introductory workshops and follow-up sessions. These sessions are designed to clarify the TC concept and encourage active participation from local stakeholders.

As the collaboration progresses, with subsequent iterations of TC publications and expansion to cover additional energy sectors, the process becomes increasingly refined. This evolution ensures that the methodology aligns with the needs of each partner country while maintaining the consistency and rigor of the original Danish framework.

Figure 1. The working process on the Technology Catalogues

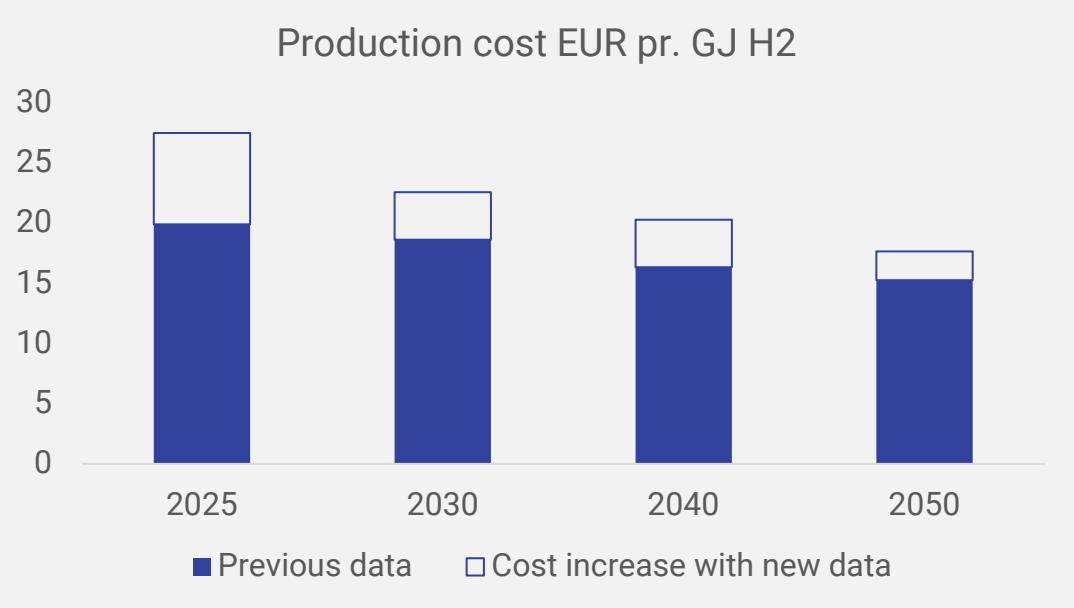


Source: Authors, based on the Concept of the Technology Catalogues

Examples of content: keeping up with technology developments—and costs

In 2021, the DEA published a chapter on hydrogen production via electrolysis in the TC. The landscape for hydrogen production has evolved significantly, and this chapter was updated in January 2024. This new edition offers a more detailed explanation of the components of a green hydrogen production plant and includes updated techno-economic data.

Figure 2. Estimates of producing green hydrogen based on large-scale electrolysis in a Danish context (covering plant construction, operation, and procurement of power)



Source: Authors, Technology Brief: Update of hydrogen production via electrolysis in the Technology Catalogue, January 2024

Advances in the technology, alongside rapid changes in the industry, have reshaped expectations, particularly regarding the complexity of establishing green hydrogen plants.

Recent insights, drawn from detailed project designs and lessons from real-world projects, have deepened the understanding of the technical and economic conditions required for green hydrogen

production. A key realization is that the complexity of construction of these plants was not fully appreciated a few years ago.

For instance, electrolyzer stacks—the core technology that converts electricity into hydrogen—account for only about one-fifth of the total investment in a large-scale industrial hydrogen plant. By contrast, approximately one-third of the costs stem from the "balance of plant" components, including water treatment, nitrogen supply, cooling systems, and control systems. Additional costs, such as infrastructure and indirect expenses (primarily related to Engineering, Procurement, and Construction [EPC]), further highlight the multifaceted nature of such projects.

The updated chapter and financial data aim to provide policymakers, industry stakeholders, and researchers with a more precise and realistic foundation for planning and evaluating hydrogen production projects.

Further reading

More details about the Danish Technology Catalogues can be found on the DEA website at https://ens.dk/technologydata. Additional information about the update of hydrogen production via electrolysis can be found in the DEA's 2024 Technology Brief, Update of hydrogen production via electrolysis in the Technology Catalogue (January 2024), available at https://ens.dk/media/3352/download.