NERA
Netherlands Energy Research Alliance

Energy research for the energy transition – investments in the future

Executive summary:
For the primary process of energy research as an essential contributor to the energy transition the next items are essential during the following term of office of our government:

- Large coherent interdisciplinary programs that cover the entire knowledge chain, i.e., from fundamental, applied, and application-oriented research to pilots and demonstration projects, in which technical and social sciences are coupled.
- Funding instruments aimed at the realization of such large coherent research programs.
- A coordinated execution plan from a systems perspective

What we want to achieve with this:

- Accelerated reduction of CO_2-emissions by an integral approach (coupling research, demonstration, and implementation)
- Minimal societal costs and a strong contribution to the transition towards a post-fossil economy for The Netherlands
- Maximal societal support by a strongly coordinated execution of the transition – with a strong interface between the national and regional system architecture (a central board with mandate and funds that can interact with regional boards)

Where do we stand?

In a relative short time the societal debate on climate change has changed direction. Since the Paris Agreement in 2015 and the Climate Agreement in The Netherlands in 2019, the societal debate is not anymore on the goal, but on how to achieve this goal. In that same time period, the cost reduction of wind and solar energy has also given us additional building blocks to realize this. However, our current energy system is still focused largely on fossil molecules. We are therefore at the eve of a system transformation that will touch all the aspects of our current energy system (generation, usage, transformation, storage, and transportation). An important aspect is that the nature of our future energy system will be much more dynamic, more decentralized ánd circular. This results in a complex system with a lot of interdependencies. The transition towards such a system asks for enormous changes in a very limited amount of time. Both in the technical system itself, as well as in the economical, societal, and institutional aspects needed to implement and operate this system efficiently. Energy saving and circular (economic) systems form the basis, but it is yet unclear how such a system transformation can be achieved as efficiently as possible.

For some of the upcoming changes a solution is within reach. The source of our future energy system will be largely formed by renewable electricity, mostly generated from solar and wind energy. The challenges here are to implement these technologies in a regional approach, achieving and maintaining a societal support base, optimal usage of existing infrastructure, and an accelerated increase in production. For other changes there are still several solutions possible. For example, the sustainable production of molecules as a resource or energy carrier. To achieve this, it first needs to become clear what technologies can be made cost efficient and what the role of societal acceptance will be (think of nuclear power or CCS). And finally, there are changes that will only be made possible by radical innovation. For example, the sustainable production of steel, or emission free aviation. For all of these changes energy research plays a crucial role. Without energy research the energy transition is not possible – and especially not at affordable costs and with societal support.

Given the short timelines it is important to organize energy research in such a way that it contributes most effectively to the targets set out in the Climate Agreement. To achieve this, the integral knowledge and innovation agenda (IKIA) was developed as part of the Climate Agreement. In this IKIA the most important innovation targets are described in a limited number of missions with underlying multi-annual mission driven innovation programs (MMIP's). Execution and funding of this mission driven innovation policy is organized via existing organizational structures like the Topsectors, NWO, and RVO.

What is the problem?

The past years broad consensus was achieved on the opinion that effective energy innovation should be 'mission driven'. Goal of a mission driven innovation policy is to achieve more impact on societal challenges. To this end, large programs where foreseen that would bring together the entire knowledge chain, in which different disciplines would collaborate closely, and where technological and societal innovation would go hand in hand. However, the choice to put the execution of this mission driven innovation in hand of existing organizational structures with each their own mission, has so far not resulted in the desired large programs. Thereby the needed impact was also not yet achieved, and the agreed targets of the Climate Agreement remain out of reach.

Although there is broad consensus on the importance of mission driven innovation, the concept has only been recently translated in policy in The Netherlands. In the past years The Netherlands has seen a plethora of funding instruments coming up, each aimed at a specific focus group or a specific element of the transition. These programs often have a relative short timeframe (2 to 4 years) and are spread over a large number of TKI-bureaus with only little central overview or direction. They are generally focused on the technological challenges, and have little attention for the interplay between the technical, natural, economical, and societal sciences that is needed to create novel solutions and innovations. On top of that, the division between NWO (focusing on low TRL-levels) and RVO (mid to high-TRL levels) hampers the required knowledge transfer along the innovation chain.

An additional difficulty is that the targets of the Climate Agreement never have been translated into a nationally agreed upon vision of how the future energy system should look like. Making such a systems architecture is a crucial step. The lack thereof makes that the mission driven programs cannot be assessed properly on their contribution or progress towards the targets set in the Climate Agreement. Similarly, a consistent long-term vision is needed for companies to invest in new technology and business models.

What is needed?

Centralized management
To make the right choices centralized management is necessary. This was also advised by the Taskforce Innovation Climate Agreement (see their Advice Structural Governance IKIA Climate and Energy – in Dutch). They advise as a last step in the evolution from the Topsectors to a mission driven innovation policy the transformation of the TKI's towards a structural and integral governance, in which the large innovation programs takes are managed by a centralized Innovation Council Energy and Climate. NERA supports this advice strongly and would like to see it implemented as soon as possible. Doing so, the technical, economical, and societal changes should be approached integrally in the system architecture that needs to be made. This architecture also should fit well with the plans of neighboring countries and the EU.

In doing so, the Innovation Council will have to decide on questions like: what knowledge and technology do we want to develop in The Netherlands, and what do we buy elsewhere? What are the priorities in the execution of the mission driven innovation programs? Also, we need to couple energy innovation stronger to circularity: how will we make the building blocks for our future process industry? And what critical materials will we need large quantities of when scaling up the different technologies? Finally, the interdependencies between different missions need to be considered. For example: waste heat of the industry is not a solution for the heat demand from the built environment if that same industry will not generate waste heat anymore after transformation into a more sustainable industry. And capture of CO_2 at point sources does not make much sense if these sources are to disappear soon. In that case the technology could be better focused on direct air capture. When setting up a systems architecture, all these topics come together. It is also important to realize that such a systems architecture is not static. The complexity and fast changes ask for a continuous reorientation. The Innovation Council should therefore be continuously involved to update and adjust the missions during their execution in accordance with relevant developments.

Large multi-annual interdisciplinary programs with associated funding
The basis of this systems architecture also provides guidance for the development within the MMIP's. To achieve maximum impact these should now be organized and executed as large, multi-annual innovation programs – with appropriate funding. In these programs the entire knowledge chain that is needed to achieve the targeted (sub)mission needs to be brought together: the various disciplines of knowledge institutions, but also the relevant companies (SME's as well as the major players), and the societal organizations. Proper funding of such programs would require an additional investment of M€ 300 in energy research. This amount is not new, but was – as many of the topics in this document – advised and motivated before by the AWTI in the report *Oppakken en doorpakken*. As a comparison: the United Kingdom recently invested 12 billion GBP in a climate program existing of 10 topics – 1 billion of this aimed specifically at research and development[1], France invests 1,5 billion Euros in the development of an hydrogen fueled airplane[2], and Germany invests 9 billion Euros in cost reduction of hydrogen production.[3] It is important to take care of the right division along TRL-levels with such large funding initiatives, in order to strengthen the entire innovation chain. The plans of the VSNU to set up a national framework program could be used to guarantee the right balance in funding of the different TRL-levels.

A new funding instrument
Such a structure of large innovation programs cannot be realized in the current funding schemes. Primarily not because of the division between funding organizations for scientific research and those for pilots and demonstrators, that would result in a loss of coherence in programming along the different TRL-levels. But also because in that case the Innovation Council would not have sufficient mandate to adjust the funding mechanisms in order to allow the MMIP's to contribute maximally to the systems architecture. On top of that, the current funding instruments already have their own 'target audience' that would not fit with the new approach along the entire knowledge chain advocated here.

Therefore, we advise to install a new funding scheme for which the centralized Innovation Council would be responsible. This instrument should be open to large consortia – one per MMIP – that would be assessed upfront in a sand pit type procedure. Funding should have a long horizon, for example 10 years with a mid-term assessment (go/no-go) after five years. The necessary flexibility should be given to phase in/out new program parts or partners. We advise also to install an international advisory board next to the centralized Innovation Council. Good examples of such programs can be found abroad or in the past, e.g., ADEM, CATO, FLOW, NanoNed, or NanoNext. Also relatively smaller energy innovation within SME's and application oriented research (a.o. the MIT program) should receive a place in this to connect parties across the entire innovation chain.

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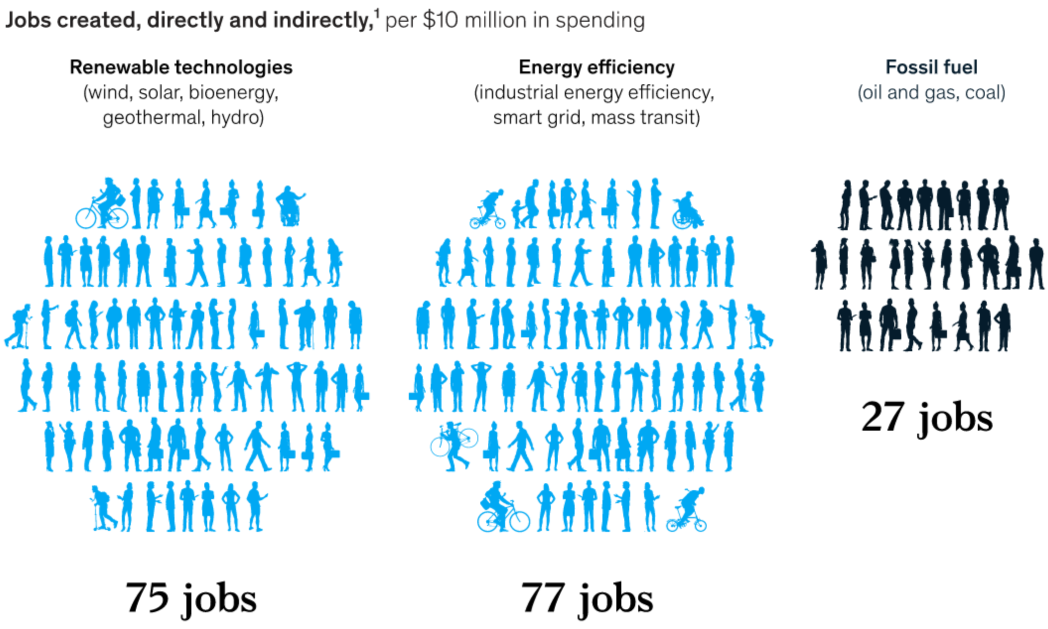
[1] https://www.gov.uk/government/news/pm-outlines-his-ten-point-plan-for-a-green-industrial-revolution-for-250000-jobs
[2] https://www.reuters.com/article/us-health-coronavirus-france-aerospace-idUSKBN23G0TB
[3] https://www.reuters.com/article/us-health-coronavirus-germany-stimulus-idUSKBN23B10L

What will this achieve?

The transition towards a sustainable energy system is probably one of the largest societal challenges of our generation. Energy research should be regarded in that perspective. It seems costly, but the return on investment greatly outweighs the upfront costs. Innovation to make products better and cheaper will make the energy transition more affordable in the end. But the economic importance is larger than that. If we succeed to remain in the front group of the international competition, we will not only be one of the first countries to achieve a better living and cleaner living environment, but also have built up a new sustainable industry with associated economical gains. For example, Roland Berger calculated that the transition towards a chemical industry based on CO_2-free production of hydrogen alone already results in maintaining 66.000 jobs in the fossil sector that would have otherwise been lost, creation of 60.000-104.000 one-off labor years to realize the transition, but also the creation of 23.000-41.000 structural new jobs. Or, in other words, maintaining 16,9 and an adding 14-26 billion Euros yearly turnover to the Dutch economy (source: growth fund proposal Groenvermogen). And this is just the chemical industry – not taking into account the energy transition in mobility or the built environment. Also there, the investment in energy research will result in new economic opportunities. Both in The Netherlands, as well as in the export of the knowledge and technology, as we did before and are still doing with the technology required to realize the Delta works. Investment in energy research will pay off!

But maybe even more important than the economical benefits: the export of the generated knowledge and technology will also accelerate the energy transition beyond our borders. And for a country with only 50% of its area above sea level that is definitely relevant.



[1]Excludes induced jobs.
Source: Heidi Garrett-Peltier, "Green versus brown: Comparing the employment impacts of energy efficiency, renewable energy, and fossil fuels using an input-output model," *Economic Modelling*, pp. 439–47, 2017