Mapping

THE

ENERGY INNOVATION ECOSYSTEM

OF

ZUID-HOLLAND

OrgVue

provincie ZUID HOLLAND

Energy Innovation Board Zuid-Holland

Contents

Executive Summary

Energy transition, or the move from high carbon to low carbon sources of energies is a complex technical, economic and social challenge for the world. It is even more of a challenge for the province of Zuid-Holland, with its high energy consumption, high carbon emissions and population density. Transition will require energy innovation in order to meet the climate change targets of significantly reduced CO_2 emissions. This study explores the idea that effective energy innovation requires an ecosystem: the interaction between research institutions, government, finance, entrepreneurs and the not-for-profit sector.

There is no historical precedent of a country moving to a carbon neutral economy. No-one has definitive answers on what needs to be done. For this reason the government of the province of Zuid-Holland set up the Energy Innovation Delta. Its objective is to develop the energy innovation ecosystem of the province. Does the energy innovation ecosystem of Zuid-Holland have what it takes to realise energy innovation? In order to answer this question, we interviewed over 100 executives from 80 different organisations, and mapped their organisations, the focus of their work, and the challenges they see.

The output is that this study provides a unique overview of which activities are being performed within the energy innovation ecosystem of Zuid-Holland. We take a data-driven approach to the energy innovation ecosystem, analysing in unprecedented detail who is connected to whom, what is being done, what the perceptions of these organisations are, how these compare to each other. This study has mapped out the activities of over 4,300 FTE (full-time equivalent employees) across 80 different organisations. Our data can be viewed from different perspectives: the organisations making up the ecosystem, the fields and stages of innovation.

First, we often found that participants of the study request the government to create a clear vision, or roadmap of its objectives for energy transition and innovation. Second, we found that there is a mismatch between the perceived challenges and time allocation. Perceived important challenges in energy storage, system balancing and CO_2 capture receive the investment of relatively little time. Third, participants of the study indicated that despite some useful initiatives, there is still a lack of capital to fund effective energy innovation – potentially identifying an area for action.

The results of the study are being made available via a launch event in May 2018, at which invited participants will also be able to prioritise recommendations. There are opportunities to submit further questions, and detailed briefings will also be available on request.

If you have additional questions, we would be pleased to capture them through this email address: EIEQuestions@orgvue.com

Foreword by the Energy Innovation Board

At the Province of Zuid-Holland we are enthusiastic about the results and findings of this research. It has given a first overview on the quantities and qualities of the Energy Innovation Ecosystem within this region. Moreover it gives us new insights from multiple angles – into the organisations and the activities that are being carried out, into the perceptions of different participants, including suggestions for improvements.

We find it interesting to see that different persons who were presented this work gave different, answers about what they wanted to know about the ecosystem:

> **"I simply want to know which are the top 5 organisations in each group, and what they are working on!"**

> **"I just need to know how many people are working on geothermal, and where they are"**

> **"What scores did people give to government, and what comments did they make about government?"**

The database that has been created can be quizzed from all these angles and more. This report and the accompanying summary therefore brings out the top questions and gives quick insights and will be available online as well through the website of the Province of Zuid-Holland (http://staatvan.zuid-holland.nl) and Concentra's website. The database itself will remain open for further enquiry until September 2018.

Hopefully these insights gives us a good bases the proceed working on building the Energy Innovation Delta Zuid-Holland in a more proactive manner. So when we consider a update of this study, we will find a even stronger ecosystem.

Han Weber
Regional Minister, Energy, Nature & Recreation and Agriculture

On behalf of the other members of the Energy Innovation Board Zuid-Holland:

- Jaron Weishut, The Green Village
- Paulien Herder, TU Delft
- Nico van Dooren, Havenbedrijf Rotterdam
- Richard Braal, TNO
- Stephan Brandligt, MRDH
- Joep Weerts, Stedin
- Olivier Gueydan, Siemens
- Rinke Zonneveld, InnovationQuarter

Introduction

Energy transition – the move from high carbon to low carbon sources of energy – has been set in full motion in the Netherlands. Still, the country faces huge challenges. Shelves of books address the topic of the energy transition and its sheer complexity and there is no single answer to what needs to be done. The time pressure is becoming acute: European requirements to reduce carbon emissions by 40 percent before 2030 and by 80 to 95 percent before 2050 are currently far from being reached. And ignoring these targets is not an option. In 2015, a district court in The Hague ruled that the Dutch national government must reduce greenhouse house emissions by at least a quarter as soon as 2020.

Within the Netherlands, the province of Zuid-Holland plays a highly relevant role. It is responsible for a quarter of all national energy consumption and one third of all carbon emissions. Taking responsibility for addressing this, the provincial government has developed its own ambitious plan to meet climate change targets: aiming to reduce its CO_2 emissions from 44 megatonnes (MT) in 2013 to 32MT in 2020 and to only 6 MT by 2050.

Innovation in sustainable energy is required to meet the climate change targets. Effective innovation in sustainable energy innovation requires the interaction between various stakeholders: government institutions, research institutions, financial institutions and entrepreneurs, including private sector entrepreneurs and the non-profit sector. To further boost the interaction between these parties the provincial government of Zuid-Holland created the Energy Innovation Delta. The Energy Innovation Delta has developed a strategy to boost sustainable energy innovation in Zuid-Holland, which will involve developing and implementing new approaches to energy generation, storage, distribution, balancing and consumption.

The main objective of this study is to determine whether the energy innovation ecosystem can be made more effective and if so, how. This is done by 'mapping' the energy innovation ecosystem and activities of Zuid-Holland. We show how organisations in Zuid-Holland actually spend their time on energy innovation and the implementation of a low carbon economy. We report expert opinions. We map organisations concerned in energy innovation to enable them to better find and interact with each other. We also expose those fields of energy innovation in which surprisingly little time is spent and we give specific recommendations from experts on improvements needed in the energy innovation ecosystem.

The limitation of this study is that it is a static analysis, showing a picture in time of a cross section of a vast ecosystem. It therefore gives a reasonable approximation to the ecosystem as a whole, yet in no way it is all encompassing. This study is intended to be updated and expanded in future. Concentra Analytics conducted this study on behalf of the Energy Innovation Board Zuid-Holland, contributing its data analysis and visualisation expertise. Through this study, we conducted over 80 different interviews with over 100 executives. This study summarises the output of these interviews.

This report has the following structure:

- **Chapter one** provides an overview of the methodological approach and the organisations participating in this study.
- **Chapter two** provides an overview of the activities within energy innovation in Zuid-Holland; the activities of 4,300 FTE have been mapped out across 800 different activities.
- **Chapter three** provides an overview of the perception of executives operating the Zuid-Holland energy innovation ecosystem.
- **Chapter four** provides an overview of the persons and organisations who are perceived to be the key drivers of energy innovation.

1

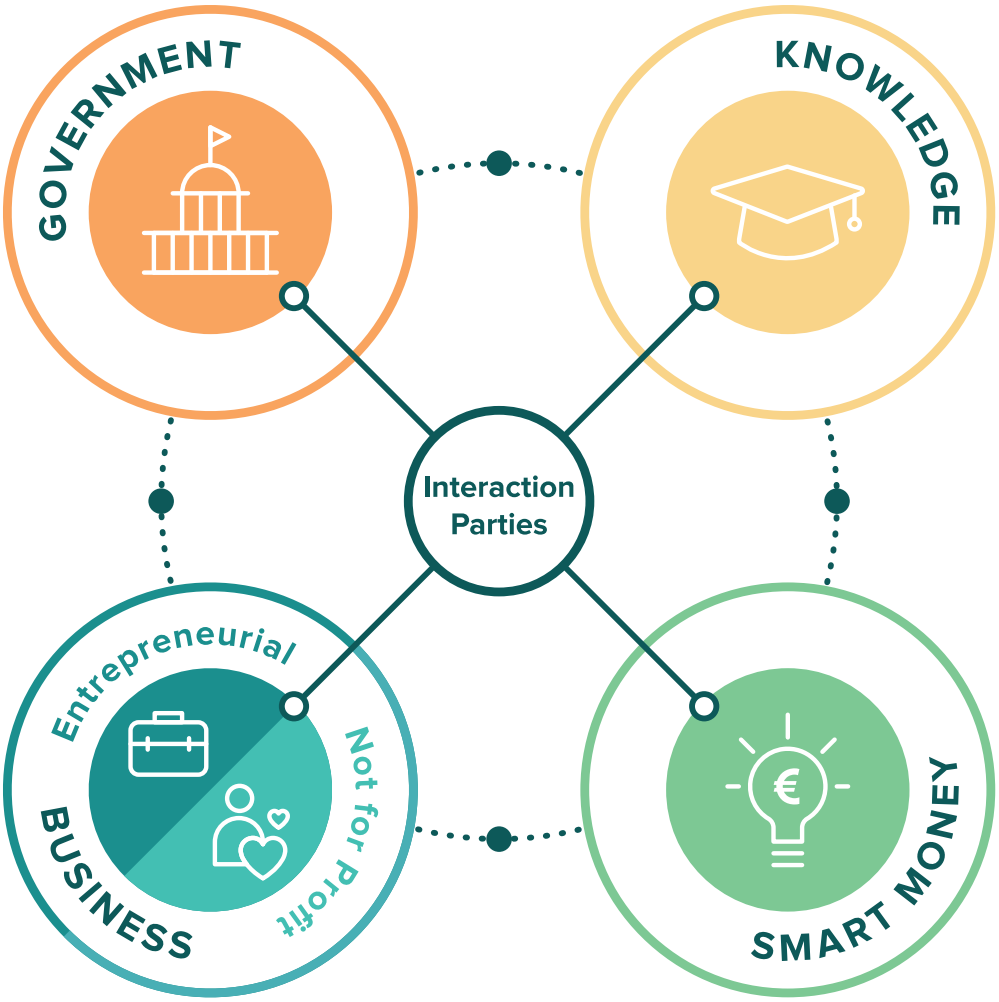
Approach

Energy innovation is a vastly complex topic. A great number of organisations are involved in energy innovation, and most are involved in multiple types of activities.

This study aims at providing an overview of the energy innovation ecosystem. To provide a structure for the overview, this chapter introduces a framework to categorise each organisation and activity.

1.1 The Energy Innovation Ecosystem

Traditionally, innovation ecosystems are described using a 'triple helix' model, in which government, private sector entrepreneurs and knowledge institutions interact with each other. This study adapts the 'triple helix' model, adding 'Smart Money' and Interaction to have five 'pillars' describing the energy innovation ecosystem of Zuid-Holland, as shown in the figure below:



Government

Governmental organisations are all public administration bodies and programs launched by them that are focused on governing. They include ministries, the provincial government, municipalities, water authorities and European government.

Business

Business includes all organisations that are entrepreneurs, semi-public entities and industry confederations. Still, this category encompasses organisations with rather different characteristics. Therefore, a further distinction is made between **entrepreneurial** businesses and those organisations that are **not for profit**. This distinction is used in all analyses.

Not for profit organisations play a key role in the energy innovation ecosystem. These include industry confederations and state owned companies such as the Port of Rotterdam as well as Energy Grid Operators and local energy cooperatives.

Knowledge

To knowledge institutions are added those institutions that supply talent. They include universities, vocational education institutions, private research entities and professional organisations of scientists.

Smart Money

Financiers are needed to provide capital for required investments, or smart money. Financiers are not included in the traditional 'triple helix' model, yet, they are of the utmost importance to sustainable energy innovation. They include banks, venture capitalists and subsidy-issuing organisations.

Interaction Parties

Finally, certain organisations are recognised to have a specific focus on improving the interaction between the above categories within the ecosystem. Each one of these is placed in one of the four main categories, as well as being highlighted as interaction parties.

Overlap

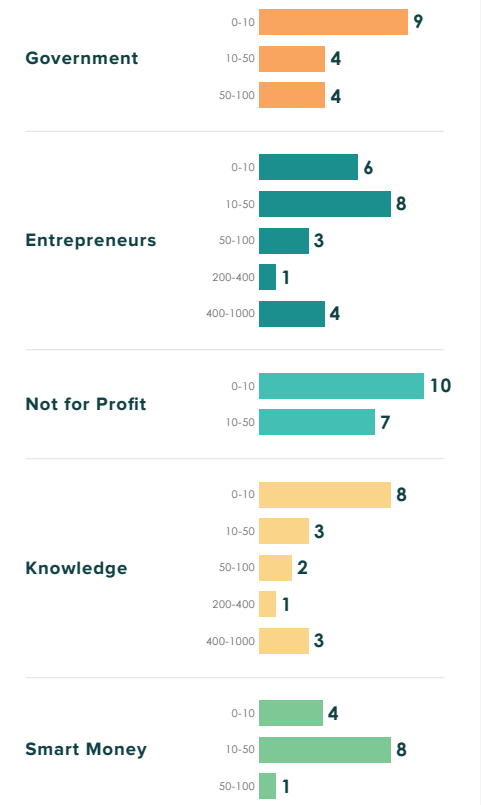
Many organisations can be placed in more than one of these categories. An organisation can be both a business and a research entity; a government organisation can issue subsidies. In such cases, organisations are categorised by the researchers' judgement as to their closest match. The categorisation of each individual organisation in this study is given in annex II.

1.2 Distribution of organisations included in the study

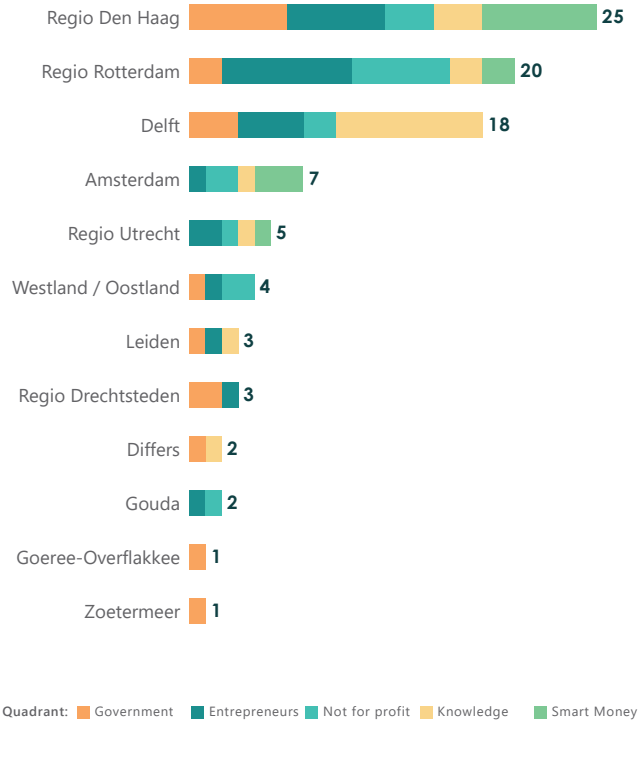
The organisations for which interviewees work were as follows:

1.2.1 Interviewees by pillar

1.2.2 Interviewees by size: according to numbers of Energy Innovation FTE



1.2.3 Organisations by location

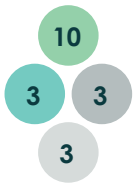


Distribution of organisations in each pillar:

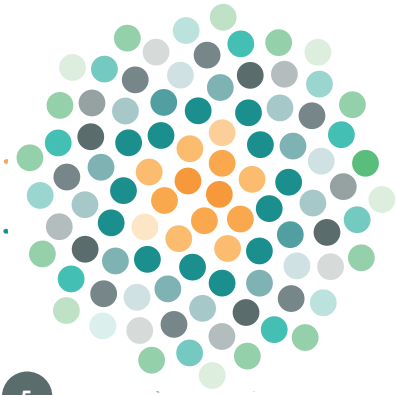
Government

- Municipalities
- National Government and Initiatives
- Provincial Government and Initiatives
- Water Authorities

Knowledge



- Other Schools
- Private Research Entity
- Research Platforms
- Universities and Initiatives



Business

Entrepreneurs

- Accelerators
- Construction Companies
- Energy Companies
- Innovative Energy Startups
- Large Energy Consumers
- SMEs

Not for profit

- Accelerators
- Industry Associations
- Collaboration Platforms
- Energy Cooperations
- Grid Operators
- Semi Public
- Social Associations

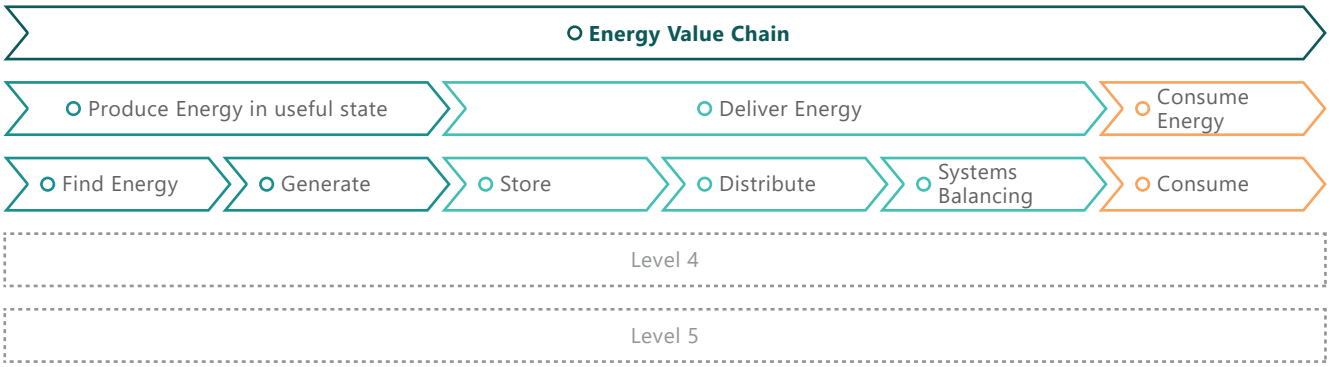
Smart Money

- Bank
- Funds
- Subsidy Issuer
- Venture Capitalist

1.3 The Energy Value Chain

The structure used to categorise activities is based on stages of the energy value chain from finding energy, to ultimately consuming it. The research mapped all activities that aim at reducing CO_2 emissions or fossil fuel usage at any stage of the value chain. Most, but not all, of these activities are then also considered innovative. The energy value chain is depicted below.

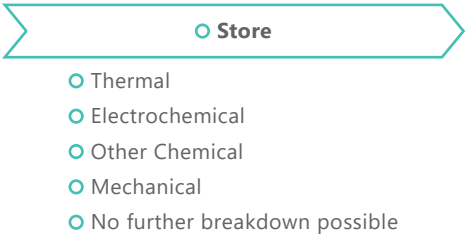
Levels 1–3: The energy value chain



The energy value chain is a technical framework. First, it flows from locating energy sources and converting that energy to a useful state. It then deals with the issue of how to deliver energy, including activities in storage, distribution and balancing supply and demand. Finally it includes activities in consuming energy, like more efficient energy usage. These steps are intended to provide a structured way to categorise all possible activities in sustainable energy innovation.

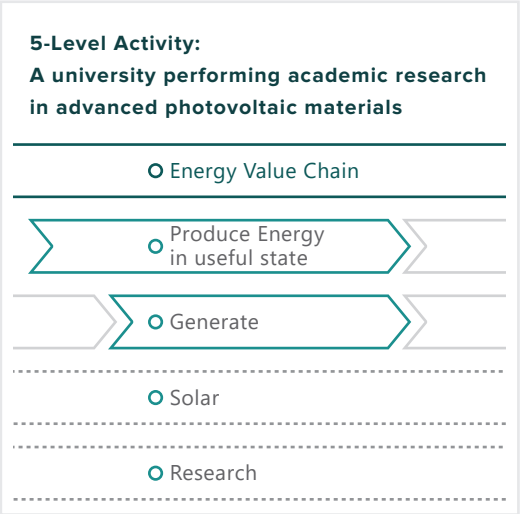
Level 4: Specific field of innovation

For greater insight it is interesting to look at a more detailed 4th level. For example, activities in generation could still range from research in photovoltaic technology to building geothermal sites. The figure below shows such a 4th level for storage.



Level 5: The innovation stage

The first four levels define different energy innovation activities to a high technical detail. However, apart from the technical aspect, activities are also distinct by their innovation stage. Therefore, this study distinguishes seven innovation stages: governing, researching, educating, dealing & funding, designing, building & maintaining and selling. They are the fifth and final level of detail used in this study. An example is shown on the right. This study distinguishes 800 different activities like the one on the right.



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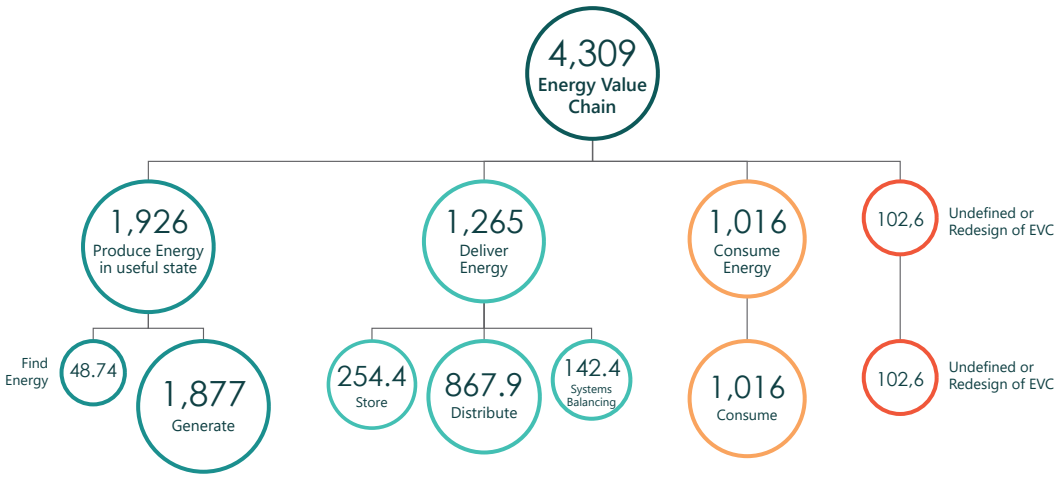
Results in Energy Innovation Activities

This study provides an overview of the activities performed by over 4300 FTE in the energy innovation ecosystem in Zuid-Holland. Using structures for organisation types and activity types, we have been able to analyse the energy innovation activities, perceptions of the current ecosystem and the key people and organisations. The study is based on data which was gathered in a 6 month period between October 2017 and March 2018, providing a point-in-time snapshot of activities which are subject to ongoing change.

The first part of the analysis of energy innovation activities focuses on the question: 'Where do organisations spend their time?' Together, over 80 organisations identified 800 different activities accounting for over 4,300 FTE. So where is all this time spent? What type of activities are being performed? And how do different types of organisations compare to each other?

2.1 Where is time being spent? The big picture

It is interesting to look at what activities are being carried out by the 4,300 FTEs working in energy innovation. We looked at the three top levels of activity. The figure below shows the distribution of time in sustainable energy innovation activities across the full energy value chain in Zuid-Holland.

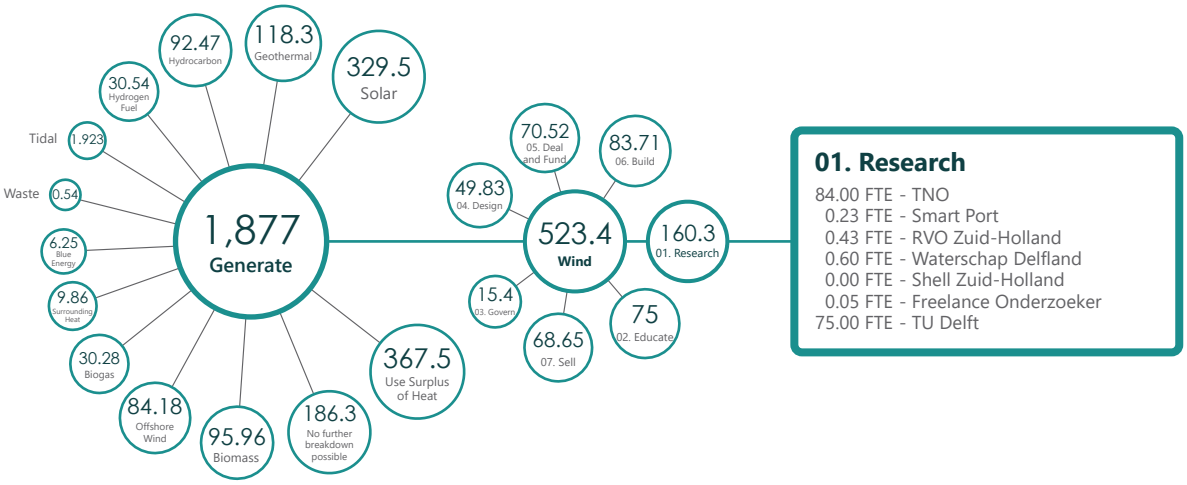


2

At level 2, it is notable that nearly half of the available time is spent in the conversion of energy to a useful state. At level 3, generation and conversion remains the leader, followed by consumption, then transportation and distribution.

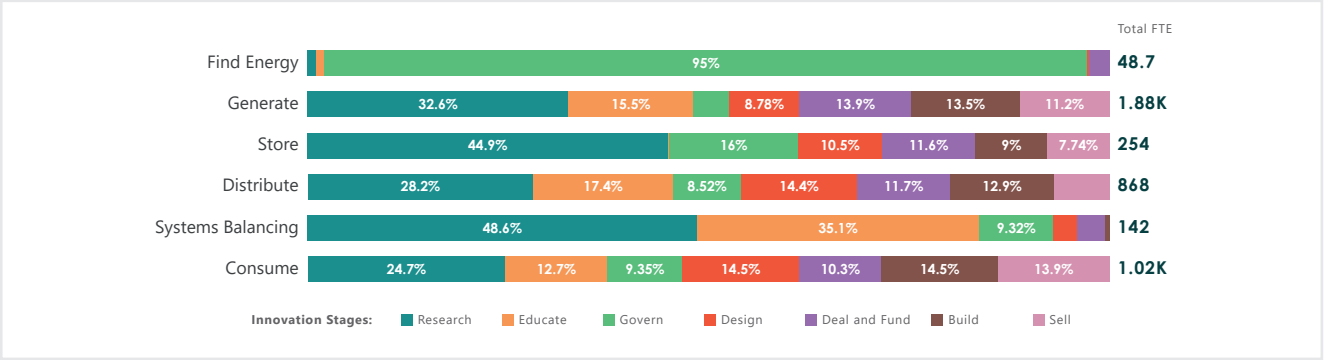
Drilling down to level 4, we can see that innovation in generation mostly focuses on wind, solar and usage of heat. Innovation in consumption focuses on more efficient energy usage like insulation, providing insight in energy usage like smart metering, and transforming existing fossil energy demand to a zero CO_2 emission demand like the development of hydrogen transportation. Innovation in distribution, focuses on either electricity or heat.

All FTEs allocated at the top level are derived from the FTE allocated to some 800 detailed activities below. With all these separate activities, detailed analysis on the sustainable energy innovation ecosystem of Zuid-Holland can be performed. For example, the figure below shows just one detailed activity: researching wind energy generation, which was reported by five of our participants: TU Delft, RVO, Smart Port Rotterdam, TNO and the Water Authority of Delfland.



2.2 Which activities in the value chain are at what stage of innovation?

It is useful to ask 'at what Innovation Stage are particular activities?' This is where the 5th level of detail, discussed in the approach, comes in. The figure below shows the Innovation Stages (colours) of value chain activities at Level 3.

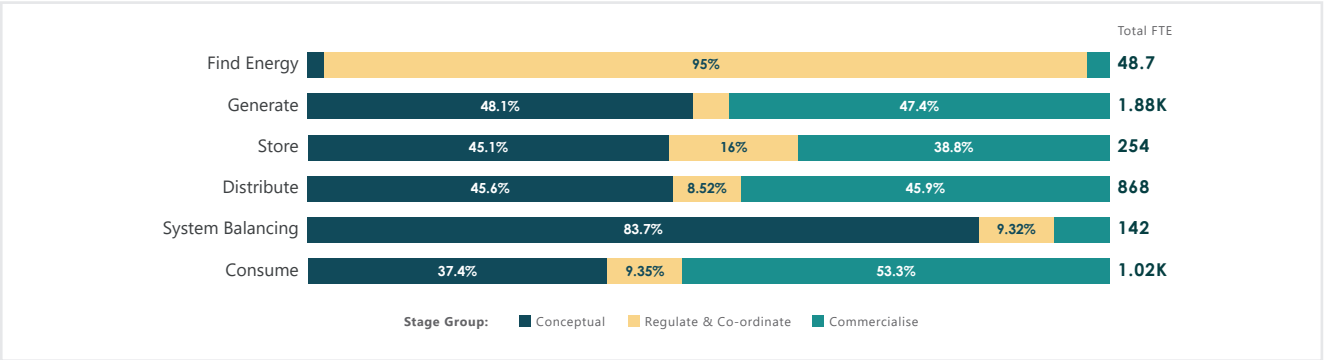


These organisational activities show interesting results. System balancing products have almost no FTE allocated to building or selling, indicating they are in a rather premature stage. On the other hand, consumption has a relatively small percentage of research. For consumption, much more time is spent on designing, financing, building and selling, indicating it is at a more mature stage of innovation.

To assist interpretation of the Level 5 'Innovation Stages' we can categorise the stages into three large activity groups as follows:

- **Conceptual group:** This includes research and education
- **Regulation and Co-ordination group:** This includes governing activities, including liaising.
- **Commercial group:** This includes designing (business cases), dealing & funding, building & selling.

With this reclassification, the graph above can be translated to a view in which innovation phases show more clearly, as in the figure below.



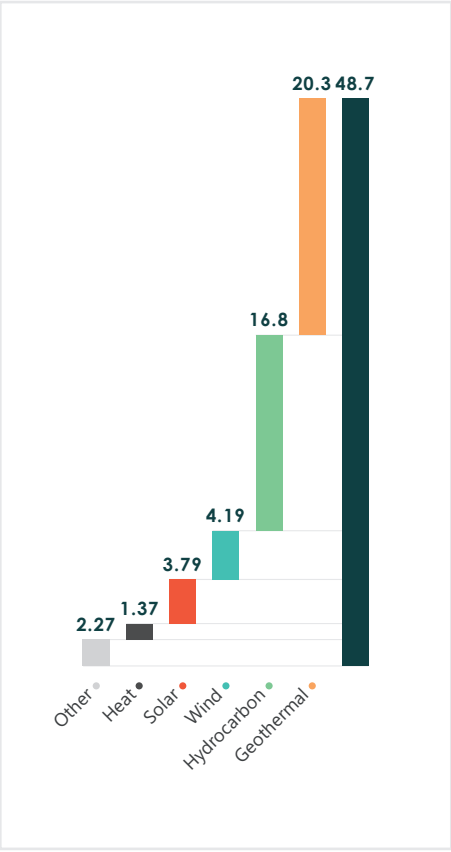
This provides some very interesting takeaways. Firstly, it is easily observed that more than 80% of the effort in system balancing is still in the conceptual stage. This is especially relevant since many interviewees consider system balancing to be the main challenge of sustainable energy innovation in Zuid-Holland. Secondly, consumption, generation and transportation and distribution are the most mature stages of sustainable energy innovation, as they are all highly commercialised. These are also the three largest top level activities (the number of FTE are shown to the right of the bars). Finally, the first step of the value chain, finding energy, has a significantly different distribution from the other five steps. This is due to the nature of activities in finding energy, which are often focused on obtaining the relevant permissions from the government.

2.3 Notable findings on detailed activities

The analyses in the previous section give a good top-level view of the status of sustainable energy innovation in Zuid-Holland. Yet, it is especially interesting to highlight unexpected findings, so this section focuses on noteworthy findings at a more detailed level within the energy value chain.

Find Energy; Geothermal and Hydrocarbon drilling

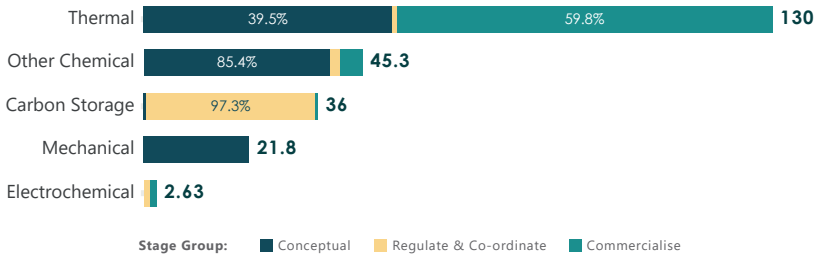
The figure on the right shows a waterfall view of how time is being spend per Energy type within the category 'Finding Energy' which accounts for 48.7 FTE in total. Overall, this study finds that most sustainable energy innovation activity is in wind energy, solar energy and utilisation of surplus heat. However, for finding energy, we find that the focus is on geothermal and hydrocarbon (cleaner fossil) energy instead, as shown in the figure on the left. The mismatch exists because 'finding' geothermal and hydrocarbon energy both require costly and time consuming subsurface exploration. This is reinforced when evaluating the percentage of time spent per energy technology on finding energy, shown in the table below.



Energy Technology	FTE in this Technology	FTE in Finding Energy	% Time in Finding Energy
Geothermal	138.6	20.3	15%
Hydrocarbon	109.3	16.8	15%
Wind	527.6	4.19	1%
Solar	333.3	3.79	1%
Surplus of Heat	368.9	1.37	0%

This suggests that technical expertise such as subsurface modelling - largely present in Zuid-Holland due to the history of oil & gas exploration - remains relevant and may generate a useful network effect given the increasing importance of geothermal energy.

Storage; concepts and commercialised products

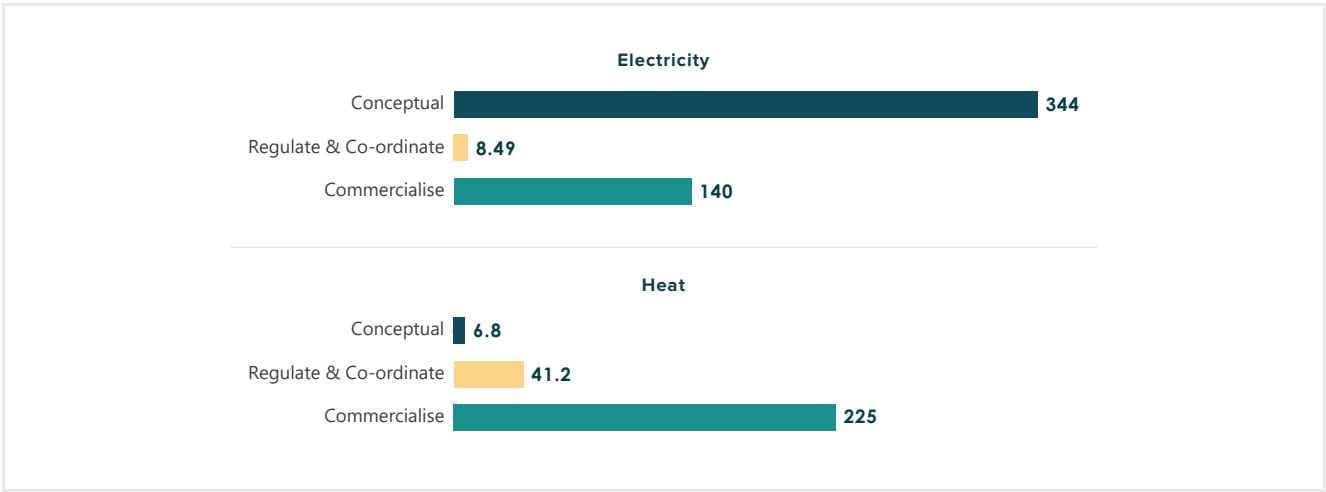


The figure above shows another view of innovation stage groups in storage. Relatively few organisations indicated spending time on it. Thermal storage stands out, however, both in time spent and in the effort going

into commercialising it. Thermal storage accounts for over half of the time spent on energy storage innovation and over 90% of the commercial activity. This method of geothermal heating is widely commercialised in Zuid-Holland. Other chemical storage methods, like hydrogen and ammonia storage are often cited as being vitally important, yet they appear to be in earlier conceptual stages. The same result is found for mechanical storage, such as compressed air.

Distribution; Electricity vs Heat

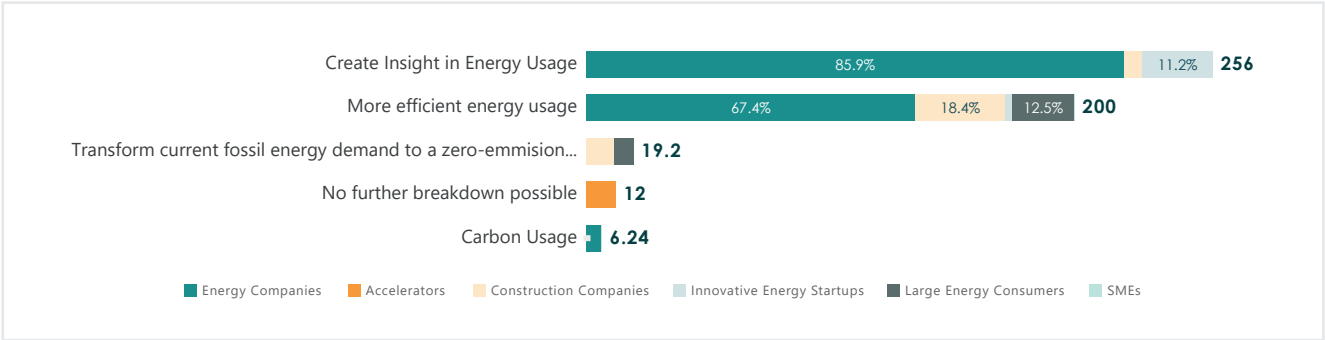
After generation and consumption, the next greatest users of energy innovation effort are transportation and distribution. Over 95% of time in these stages is spent in electricity and heat, and an interesting difference in innovation stages for these two distribution types is shown in the figure below.



This provides a remarkable result. The conventional wisdom is that electricity distribution is relatively well established and settled, whereas heat distribution is an area requiring innovation for energy transition. The numbers show a different story, however, with electricity distribution still investing heavily in early 'conceptual' activities whereas for heat distribution FTE are mostly being allocated to commercialisation. However contradictory this result may seem at first sight, it actually makes a great deal of sense. With a growing number of sustainable energy sources being connected to the electricity grid, electricity distribution is in a transition. This transition is from one-way electricity supply, from large power production plants to final users, to bi-directional electricity supply via a smart grid connecting entities that can be producers or users at different times. In such a smart grid, electricity flows at unpredictable times at different voltages. Also, supply will vary greatly during the day and from day to day and season to season. There may be energy generated at the end user (solar panels, turbines) and energy may be stored and re-supplied to the grid at each step in the transportation and distribution process. This transition is the transport and distribution component of a greater energy transition and it puts a huge pressure on the development of a more sophisticated and flexible electric grid, which is still currently in a conceptual stage. By comparison, heat distribution is a relatively simple and well-understood concept, and thus requires little further research and education. Instead, the innovation is presently in cooperation and regulation, which is critical because heat grids require large investment and multi-party agreements before they can be built. It is therefore interesting to see that many participants classified their activities as commercial exploitation of heat networks – 255 FTE is a significant portion of the overall 4300 FTE in the sector.

Reducing consumption by creating insight: the role of entrepreneurs

Another interesting result is on creating insight in energy usage, like smart meters. 95% of the time spent in creating insight in energy usage is done by 'Entrepreneur' organisations. Zooming in on the activity of entrepreneurial organisations in energy consumption, we see a remarkable result: a staggering 86% of time spent in creating insight in energy usage is spent by energy companies. During the interview stage of this study, numerous participants mentioned that they expect entrepreneurs only to do what is best for their business. Still, energy companies, who earn their revenues by selling energy are – counterintuitively perhaps – working harder than any other group to help customers get insights to reduce their energy consumption. Energy companies are required by law to promote energy savings and our research suggests that this task is taken seriously.



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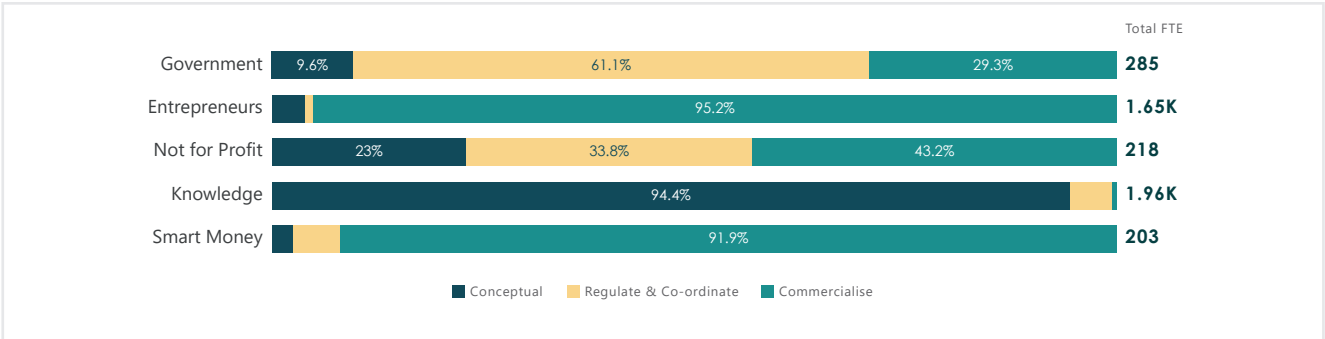
2.4 Innovation stage of the different pillars in the ecosystem

So far, this study has analysed the different energy innovation activities within the energy value chain. However, it is also interesting to look on a macro level at which type of organisation spends time in which innovation stage. The figure below shows this macro view.



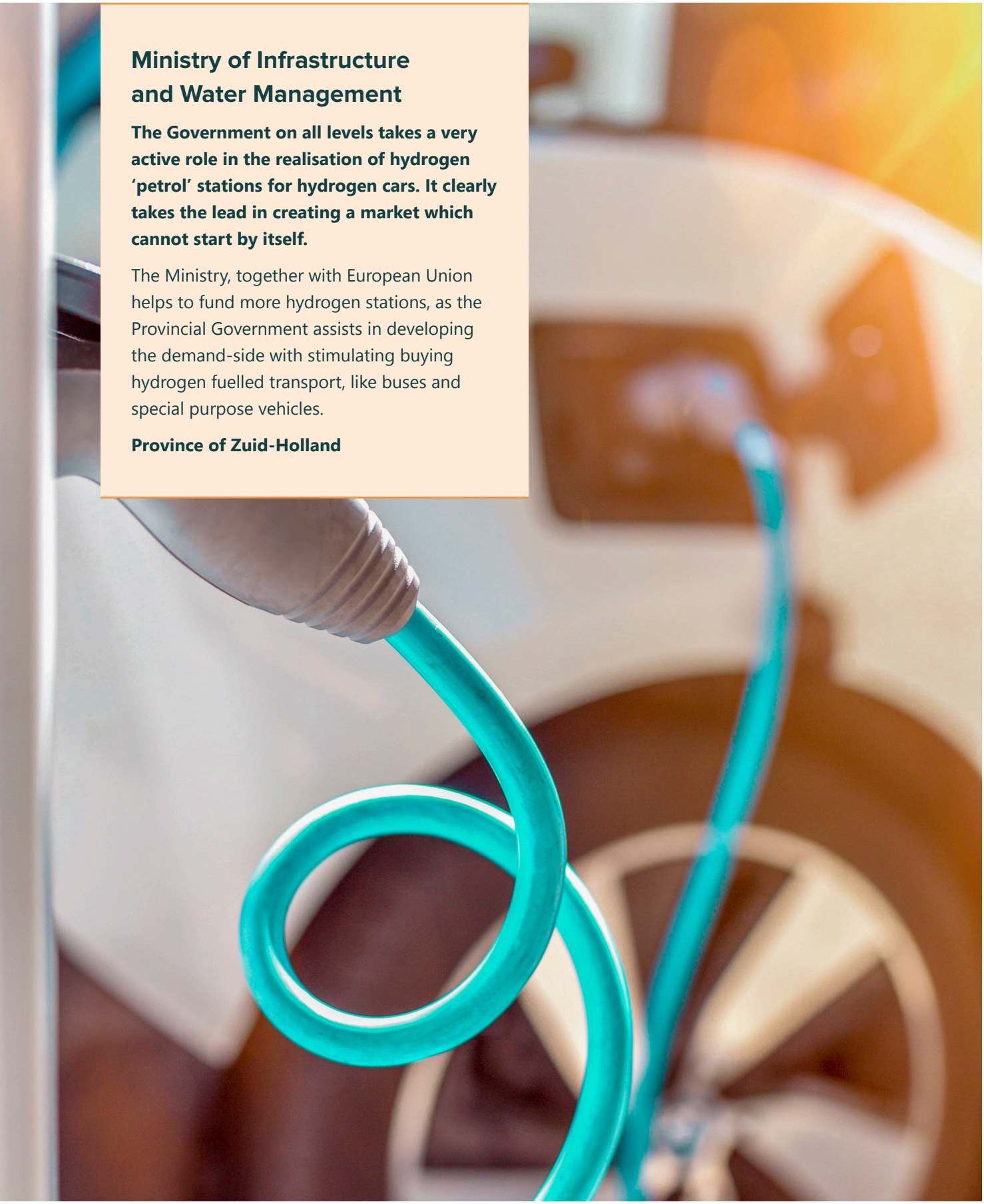
Some results here are as would be expected. Knowledge organisations are in the conceptual stage, entrepreneurs are commercialising and financiers are also mostly in commercial activities. This figure however clearly shows the importance of not-for-profit organisations, as they are able to focus on conceptual, regulatory and cooperative issues as well as commercial issues. As such, they are the organisations that are able to cover all innovation stages. The most interesting finding here, however, may be in government. A large number of participants believe government should take an active role, setting an example by innovating their own energy supply and usage. And in fact, based on the bar chart above, this is starting to happen: a large amount of governmental activity is actually commercial, like designing, funding and building sustainable energy innovation. One example of such activity is shown on the right.

Ministry of Infrastructure and Water Management

The Government on all levels takes a very active role in the realisation of hydrogen 'petrol' stations for hydrogen cars. It clearly takes the lead in creating a market which cannot start by itself.

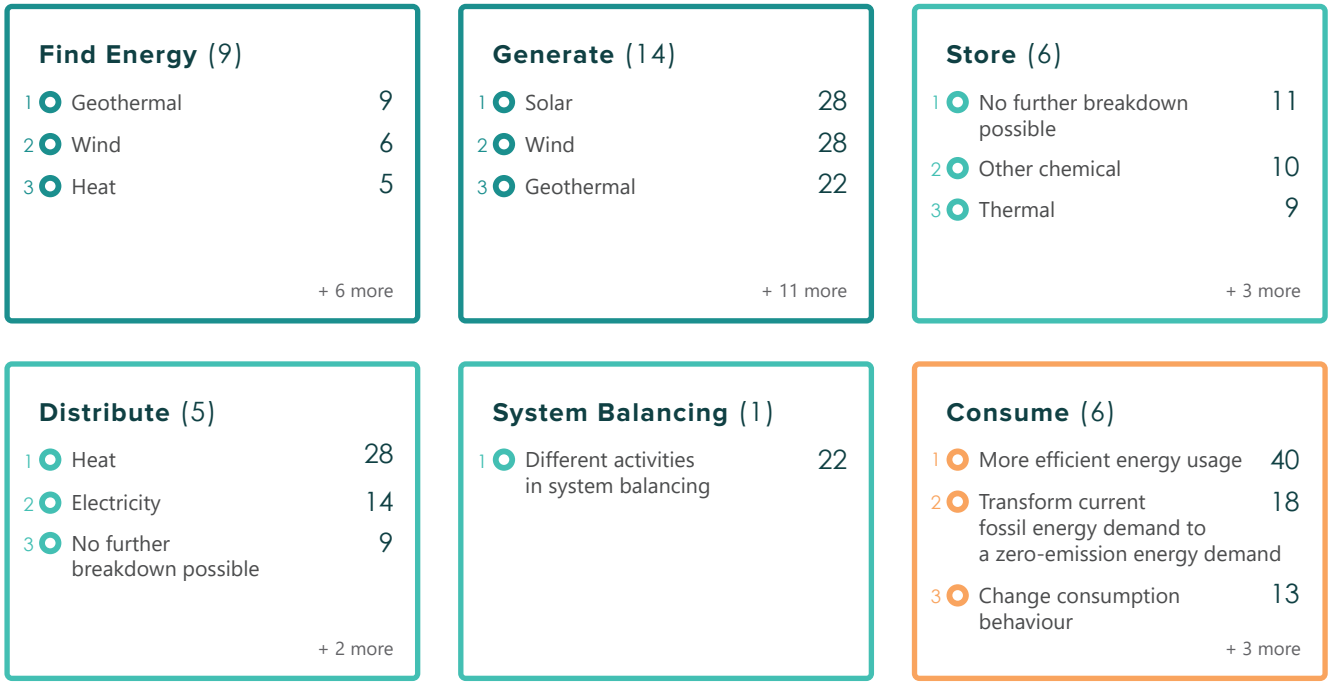
The Ministry, together with European Union helps to fund more hydrogen stations, as the Provincial Government assists in developing the demand-side with stimulating buying hydrogen fuelled transport, like buses and special purpose vehicles.

Province of Zuid-Holland



2.5 How many different organisations work on which innovation?

The previous analyses were based on the number of FTE involved in a particular activity. Yet, this study includes large organisations as well as freelancers. Therefore, it is valuable to look at how many different organisations work on each specific field of innovation. In this analysis, it is especially interesting to look at activities on which a large number of participants spend time. The graph below shows the activities which had most organisations involved.



A few particular activities stand out. Half of the 80 organisations participating in this study spent time on more efficient energy usage. And on both solar and wind energy, 28 organisations are involved. This describes a balanced approach to CO_2 reduction in which organisations attempt to be more efficient in their energy usage, while at the same time being involved in generating sustainable energy, such as via solar and wind energy. Another interesting observation from the figure above is that 28 organisations are involved in heat, whereas only 14 organisations are involved in electricity. However, electricity is more concentrated - earlier in this study, it was shown that more FTE are working in electricity innovation than are in heat energy innovation.

2.6 The missing piece of CO_2 capture and storage

One very significant aspect stands out; very limited time is spent on CO_2 capture or storage. This study mapped out the activities of 4,300 FTE across 80 different organisations, only 7 organisations and fewer than 40 FTE are involved in CO_2 capture and storage. Given that there was a political commitment in the 2015 Paris agreement to reducing the stock of CO_2 in the atmosphere[1] – which is a significant step beyond only 'emitting less CO_2 in future' – the figure of 40 FTE working in Zuid-Holland on CO_2 capture and storage may not be enough to meet agreed climate change targets. We note that the FTE counted here might have been higher if the Netherlands Ministry of Economic Affairs and Climate Policy, which has an initiative in this area, had been included in this study.

[1] The Economist (2017) 'Greenhouse gases must be scrubbed from the air': <https://www.economist.com/briefing/2017/11/16/greenhouse-gases-must-be-scrubbed-from-the-air>

Lux Research

Some problems with a large carbon impact simply cannot be fixed with current technology. They include three key uses: fossil fuels in shipping, aviation fuels and industrial applications. The requirement is for enough sustainable energy supply to meet the full energy demand – not just the electricity demand.

Lux Research is an international business with 10 people in Amsterdam. They are focused on innovation but with a special interest in these energy innovation challenges. It is collecting and monetising knowledge in these areas. Despite being outside Zuid-Holland, they are therefore a key player in accelerating the spread of ideas in energy transition in Zuid-Holland as soon as they become available.

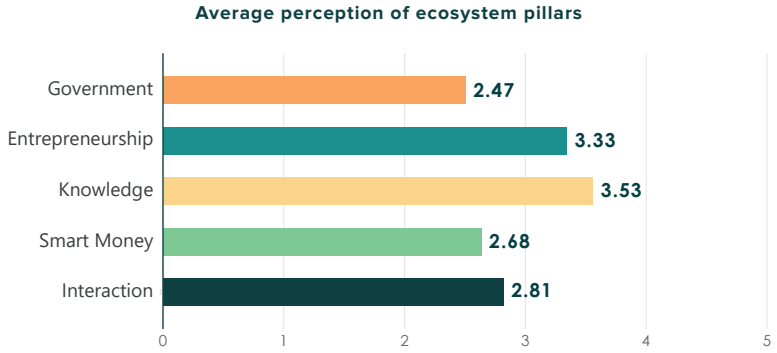
3

Perceptions of Energy Innovation in Zuid-Holland

The interviewees covered in this research have very different roles in the ecosystem. All are influential – given that they have been cited by other experts in the field – and most have vast experience in either energy or innovation. So what do these experts think of the current energy innovation ecosystem? Where do they see challenges? And how does that compare to where their organisations actually spend their time?

3.1 Perceptions of the Energy Innovation Ecosystem

How effective are the different types of organisation? What are they good at, and what should they improve? Interviewees were asked: 'how effective is each category of organisations in promoting sustainable energy innovation in Zuid-Holland?' Participants rated the different sections of the ecosystem on a five point scale. The overall ratings are shown in the bar chart below, with further analysis of sections of the ecosystem with unusually high or low ratings and interesting comments.



Government

On average, the government pillar is perceived as less effective than others in promoting sustainable energy innovation. Also, there were many interesting comments on the roles government should have.

A large majority of participants believe that government should be **more active** in promoting energy innovation. Specifically, participants wanted government to create the right conditions for innovation by setting stricter regulations and having a clear long term innovation vision. These opinions are shared by a large majority of organisations from all segments of the ecosystem.

3

'The government should behave more predictably in the long term'

'The government should develop road maps and dare to make choices'

Jan Willem van Hoogstraten
Chief Executive Officer, Energie Beheer Nederland

On regulations, many participants suggested government could achieve more by setting a **higher price for carbon emissions**, or by forcing change through local or national regulation. This is perceived as a vital role of government in order to drive innovation.

'Once CO_2 emissions have a fair price, innovation will be truly stimulated'

Pieter van Aartsen
Manager Regulatory & Government Affairs, Gasunie

'Municipalities must be forced to detach neighbourhoods from the gas supply'

'In order to achieve a sustainable system, we should not only stimulate sustainable innovation, but also tear down the current system by discouraging all that is not-sustainable. Only *then* we can effectively create the niches for the new economy and grow new business. For this a strong vision, clear policy and legislation is needed'

Gemeente Westland

Gemeente Westland, whose biggest town is Naaldwijk, recognised that banks were not prepared to lend money against geothermal projects. It reserved 5-10 million euros to be the guarantor of investments in geothermal projects. The money has now been used to back about 10 projects including with the newest, most innovative geothermal drilling going 3 kilometres deep and – most importantly – the money has never been called on to pay back a failing loan. This means it has remained available to back further cycles of investment. This is a clear example of government taking responsibility to enable energy transition projects that would otherwise not be able to launch.

Despite these criticisms, participants were consistent in praising the intention at all levels of government to realise energy transition and the efforts made by government institutions to bring together diverse parties to **create an innovative climate**.

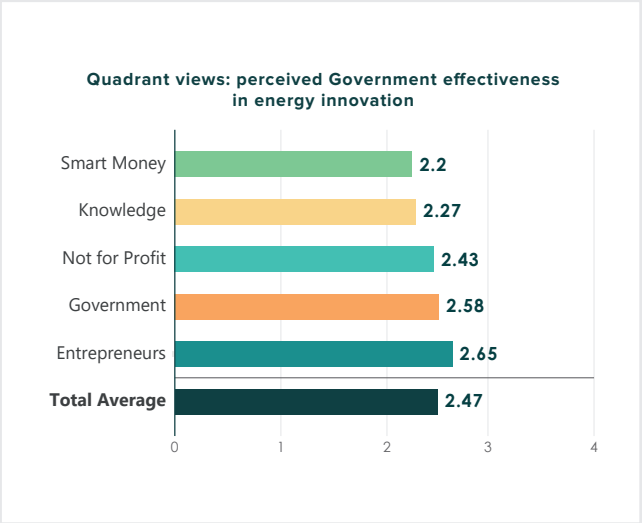
> **'Municipalities are increasingly aware of energy innovation'**
>
> Nellie van de Grind
> Faculty Director, Haagse Hogeschool

> **'We are very positive about the provincial government's effort to bring us in contact with relevant parties'**

In contrast, when it comes to the **financial role** of governments, opinions varied widely. Some participants believe that government should significantly increase the amount of available subsidies whilst actively investing in energy innovation; others believe that government lacks the knowledge and expertise to invest in energy innovation and is rather randomly distributing its available financial resources. The views on this issue vary too significantly to speak of general perceptions. It is interesting to note though, that for both stances, participants are generally dissatisfied with government. That is, they are either dissatisfied because government should invest more actively or they are dissatisfied because government should not invest at all.

> **'Risks should be mitigated by parties like Innovation Quarter, the government and ourselves'**
>
> Jean-Paul Schaaij
> Directeur, Nationaal Groenfonds

> **'The government has no idea on how to invest properly'**



Many participants say they would like to see the government develop a clear vision or action roadmap while at the same time accepting that this is an unrealistic expectation. In terms of ratings, government achieved 2.47 on a five point scale, the lowest of all pillars. The figure on the right shows how government is rated on average by each group of participants.

Comment: It is notable that both the provincial government of Zuid-Holland and the national government of the Netherlands have issued roadmap documents. Interviewees' comments could therefore be an indication that these documents have not received adequate attention, and could be communicated more effectively.

On the other hand, participants' comments may highlight the delicate role government institutions have in moving the economy from one equilibrium solution to another, for example by:

- facilitating the decision making process to move to the selection of a future energy solution
- supporting multiple possible solutions during a discovery phase
- encourage or mandate a selected solution in the scale up phase
- establishing regulatory principles, within which participants operate

The art of government is in choosing when to move from discovery to decision, and how to communicate the process.

Communicating is vital as the government's communication is itself an act – it has an economic function in helping create the common knowledge of the new solution.

Participants' desire for the government to establish a roadmap reflects the importance of this interplay of economic actors at different geographical levels (from municipality up to national government), and between different pillars of the energy ecosystem. Interestingly, our researchers' overall sense was that participants valued consistency over speed in responsiveness from government.

Entrepreneurship

Entrepreneurship is generally rated positively for its effectiveness in supporting sustainable energy innovation, however fewer clear themes emerged in the comments. It is noteworthy that opinions differed on the impact of start-ups versus SMEs versus large corporates.

3

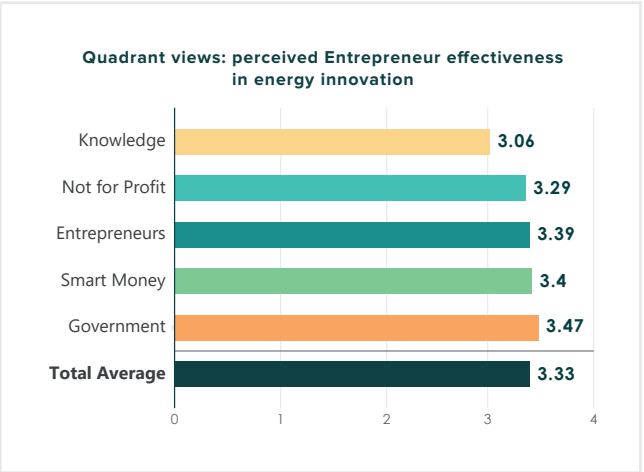
Large corporates and start-ups are both perceived as being on the right track. **Large corporates** are seen to incorporate sustainable energy innovation in their long term visions. **Start-ups** are seen to be the sources of ever more innovative, potentially disrupting concepts. The figure on the right shows how entrepreneurship rates on average by each group of participants.

Participants do however express concerns about **SMEs** (companies of 10-250 FTE). In contrast to large corporates and start-ups, they often lack the luxury of long term visions like corporates and may not have the initial innovative energy of start-ups. However the SMEs are seen as critical to 'scale-up' innovations effectively but there is concern that they are currently not innovating actively enough. Still, there are several exceptions, where specific SMEs have innovated spectacularly.

Overall, entrepreneurship received mostly positive ratings, averaging 3.33 on a five point scale. The figure on the right shows how entrepreneurship rates on average by each group of participants.

'Businesses need to be nudged to help them translate sustainability into everyday business life and business cases that serve the sustainable development of the region'

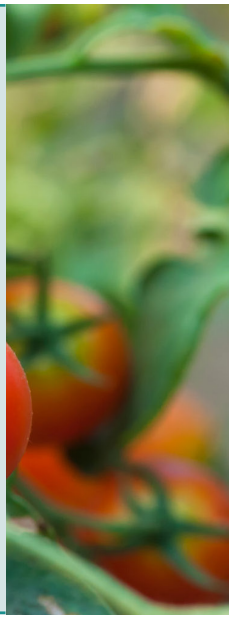
Heleen Weening
Directeur, Duurzaam Den Haag



Duijvestijn Tomaten

In the greenhouse sector, energy transition and innovation has a remarkably long history. DT is a 100-person family business, founded in Pijnacker 4 generations ago. In its own history, it has transitioned its energy sources from Peat, to Coal, to Oil, to Gas, to Geothermal. DT observed a clear demand from its international clients as early as 2008 for vegetables with a low carbon footprint.

For its long-term business strategy it invested in its own geothermal energy sources to heat its greenhouses. It also participated in a 20km underground pipeline to transport CO_2 from Rotterdam Port to its greenhouses, and it is still currently implementing wind, solar and efficient greenhouse technologies. DT is already fully energy neutral and is a net CO_2 reducer, and even anticipates becoming a net energy contributor in the next 10 years.



Knowledge

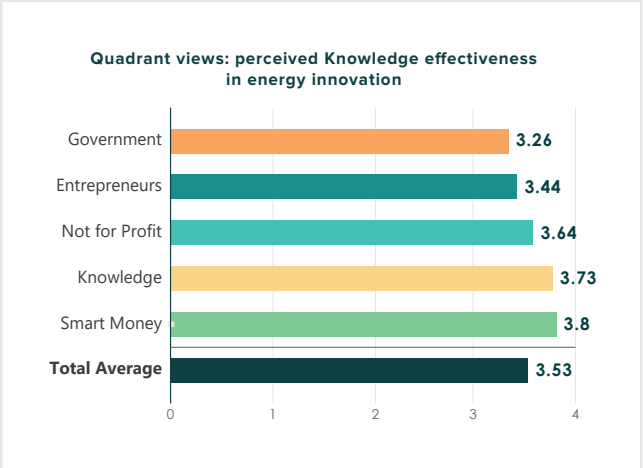
The Knowledge pillar was rated highest (3.53) for its impact on effective sustainable energy innovation. Participants consistently praised the availability of knowledge, mostly from Zuid-Holland's three major universities: Rotterdam, Leiden and Delft. In addition there is a large number of applied science institutions and vocational training centres.

Despite these positive reviews, participants identified two relevant issues within Knowledge: first, students trained at university level do not always have the practical skills required to enter the labour market effectively, but second, **vocational workers,** whose technical level is lower, but who have practical skills are not always mobile enough to be available to implement innovations.

> **'Engineers with advanced degrees tend to be more mobile in the international labour market while engineers on vocational level education tend to be more rooted'**

The figure on the right shows how each groups of participants rated the Knowledge pillar.

Participants from the business sector generally praised the R&D capabilities of the research institutions and universities but did comment that these organisations should innovate for today and not the long distant future.



Smart Money

The availability of capital for effective sustainable energy innovation was rated slightly below average (2.68). It should be noted that when it comes to the availability of capital, participants find it difficult to focus on a specific region as capital flows freely across national borders. Still, there is one very strong consensus among nearly all participants; there is **no lack of money** in general, there is just a lack of money with the relevant **risk** and maturity appetite.

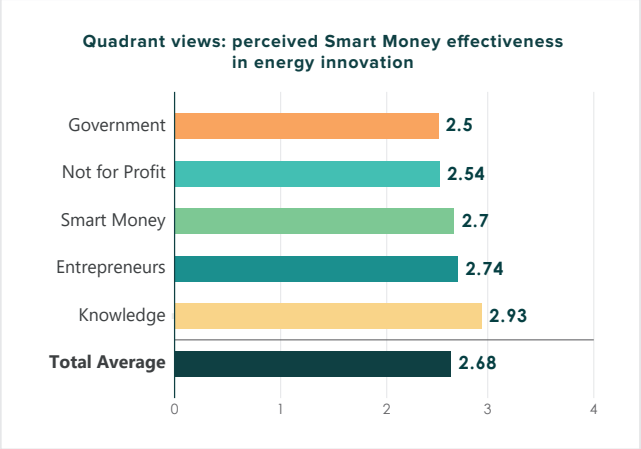
However, participants often believe that financial institutions themselves cannot be blamed for this ineffectiveness, but rather believe that national government should re-design the regulatory environment to encourage entrepreneurship and improve the availability of capital. In this context, the creation of the energy innovation fund EnergiIQ by the Province of Zuid-Holland (and managed by Innovation Quarter) was widely welcomed.

The figure on the right shows how each group of participants rates the impact of the availability of capital on sustainable energy innovation within Zuid-Holland.

"I personally spend four out of five days sourcing capital for growth'

Sanne Castro
Founder & Chief Executive Officer, Simgas

'The Dutch government should change the bankruptcy protection laws – that would enable more investment'



3

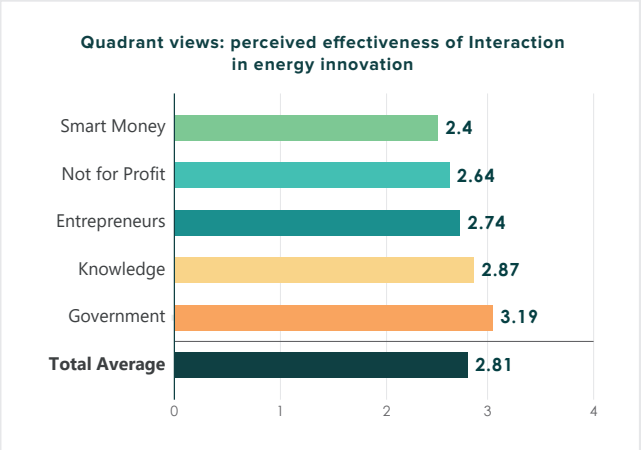
National Investment Agency

The National Investment agency helps to fund local and regional governments in the Netherlands. It has created the energy transition finance facility (ETFF) to address market failures when private sector investors are not willing to take the risk. Its objective is to finance energy innovation initiatives such as geothermal energy, energy storage and biomass. The ETFF can provide loans up to 25 million EUR for a period of up to 15 years.

Interaction across the ecosystem

The general perception of interaction across the sustainable energy innovation ecosystem of Zuid-Holland was slightly positive. Interviewees were asked to grade the effectiveness of the interaction itself.

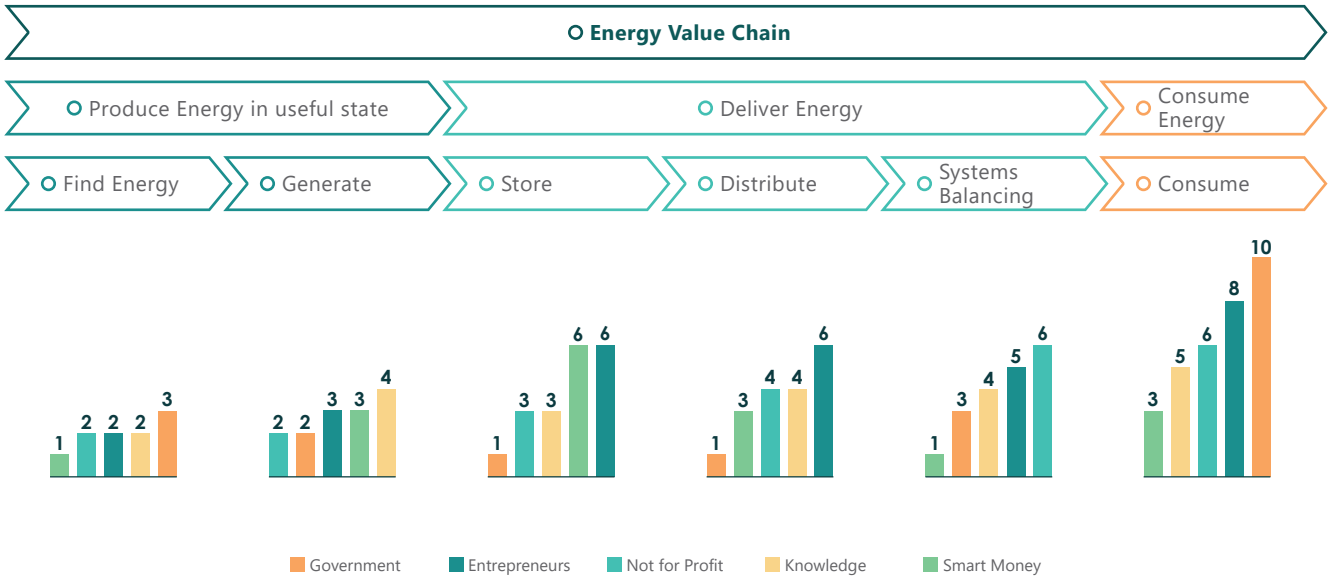
Participants from government organisations were the most satisfied with the level of interaction within the energy ecosystem in Zuid-Holland. Smart Money and Business, by contrast, reported that interaction between the parties is not sufficiently part of everyday practice. Entrepreneurs were often frustrated by the lack direction from the interaction, in other words; the interaction would not result in clear decisions and actions.



> **'It is not necessarily the lack of interaction in Zuid-Holland; due to the large amount of different ´innovation clubs' the landscape is fragmented'**
>
> Rick Heerink
> Innovation & Change Manager, Stedin

3.2 Perception of the Energy Value Chain, what are the challenges?

Perceptions of different pillars in the ecosystem gives one view of how the ecosystem could improve, but it is also relevant to ask: 'Which steps of the value chain do we actually need to tackle in order for energy innovation to materialise?' The figure below shows which the steps of the value chain were reported as challenges by each pillar of the energy innovation ecosystem in Zuid-Holland.



The consensus seems to be that the majority of the challenges are located at the end of the energy value chain; when the energy is consumed. Furthermore, it should be noted that most participants were not hesitant in answering this particular question, yet their answers differed greatly.

Find Energy

Only a few participants of the study identified challenges in finding energy from sustainable sources such as wind and solar. The main issue highlighted was obtaining planning permission to build wind- or solar farms. Onshore windfarms in particular are considered difficult as they have to be built in unpopulated areas, which are rare in a densely populated province like Zuid-Holland.

> **'It is extremely difficult to attain permits for wind turbines on-shore in the Netherlands'**

Generate

Again, few participants saw challenges in generating energy from sustainable sources, such as windfarms, solar farms and biogas installations. Some participants expressed a preference for investments in well-established energy generation methods rather than seeking innovations in generation. Others expressed concerns about the subsidies which coal fired power plants are currently receiving.

> **'Now is the time to focus on implementing existing technologies rather than postponing implementation for the sake of researching new ones'**

> **'Fossil energy is being subsidised, people just don't believe that is right'**

Store

Currently there is no effective large scale method to store energy, other than the thermal storage solutions described in section 2.1.3. There have been some pilot projects to install large scale batteries in residential areas but these are relatively small projects. Participants often identified the effective storage of energy as the holy grail of energy innovation, especially in the long term. The analysis of time spent, however, (section 2.1), clearly shows that very little time is actually spent on storage. This exposes an important mismatch between what participants think the ecosystem should be doing and what participants are actually doing. Interestingly, participants in the government segment did not share this perception, as only one out of sixteen governmental interviewees identified energy storage as a challenge.

Technolution

Technolution is a 200-person consulting and engineering innovator based in Gouda. It tries at all times to be ahead of the wave of technical change, on the grounds that it will only be able to have a technical & competitive edge in the newest spaces.

It is working currently in blockchain, AI, machine learning and energy innovation and transition. It finds the most exciting current work in energy being done in system balancing focused on the electricity grid through smart technology.

Distribute

The distribution of energy is considered to be a challenge by a large number of participants of this study, who highlighted particular challenges with electricity and heat. The electricity distribution challenge is mostly seen as being technical, for example in connecting offshore windfarms to the mainland. Those commenting on the distribution of heat, however, see a major challenge in financing change. A large amount of surplus heat exists in the Rotterdam area, with its many industrial sites, refineries and chemical plants. However, currently most of this surplus heat cannot be utilised as it cannot be distributed. Socialising the costs (the government paying centrally) is usually considered the only option, yet respondents pointed out that a further key underlying problem preventing the development of a heat grid: that it is disadvantaged relative to the gas grid, to which the government still requires all houses to be connected.

This governmental obligation will be removed by law from the 1st of July, 2018.[1]

'The market for heat energy in 2018 is where the electricity market was in the 1930s'

'The cost of heat distribution networks should be socialised'

'The current obligation to connect houses to the gas grid is aggressively stalling energy transition'

System balancing

A system balancing solution that better matched supply and demand for energy would increase the market for alternative energy solutions, and would decrease the peak demand for energy. Many participants expected system balancing to be the most prominent challenge in the future, and it was rated second biggest overall. Businesses in particular were concerned about the ability to **integrate all energy systems**. The biggest concern is that if most sustainable energy is not regulated, it might not be possible to deliver energy to the grid at all times. Participants who foresaw a problem in system balancing often considered storage to be a problem as well, which is logical as effective storage units could balance systems on their own.

Consume

The consumption of energy from sustainable sources is considered to be the biggest challenge within the energy value chain. Participants especially highlighted the lack of consumer awareness, arguing that demand defines supply and that currently energy is still used inefficiently. At the same time respondents noted that approximately 80% of the current energy demand is not electric, and that either reducing this fossil energy demand or converting it to a sustainable alternative like electricity or hydrogen is both very important and challenging.

'The cheapest energy is the energy you don't use'

'We saw a clear need to provide an overview of carbon emission across global supply chains in order to create awareness'

René Kleijn
Associate Professor, University of Leiden

[1] https://www.rvo.nl/sites/default/files/2018/05/Factsheet%20Gasaansluitplicht%20Amendement%20Jetten_BZKenEZK.pdf

Wanneer gaat het in? Inwerkingtreding wetsvoorstel Voortgang Energietransitie
Het amendement gaat gelden per 1 juli 2018. Het inwerkingtredingsbesluit is op 8 mei 2018 gepubliceerd in het staatsblad.

4

Key People and Organisations

It is argued that innovation requires a stimulating, well-functioning ecosystem. Yet there is another important driver of innovation. These are the doers, the individuals and organisations who drive change, accomplish real innovation and inspire others. They are the necessary leaders of the energy innovation. Who are these drivers of change? Why are they considered vital individuals? Which organisations are vital in the ecosystem?

Participants were asked to identify the (top 5) key people and organisations that drive energy innovation within Zuid-Holland. More than 400 people were identified. As this study was initiated by Han Weber and worked outwards from the Energy Innovation Board, it is not surprising that he is cited most often as an influential energy innovator in Zuid-Holland; what is interesting is who else was frequently cited as an influencer in this space.

4.1 Top 40 Influencers of Energy Innovation in Zuid-Holland

The list below shows the 40 people cited as being key to the energy innovation ecosystem in Zuid-Holland. Each one in the top 10 has a short biography, highlighting educational, government and commercial linkages. Individuals are listed in order of number of references – highest, first.

1. Han Weber

**Regional Minister,
Energy, Nature & Recreation
and Agriculture,
Province of Zuid-Holland**

Han Weber is regional minister for energy, recreation and rural affairs in Zuid-Holland. Han has started various initiatives to promote energy innovation, including the creation of an energy innovation fund EnergiIQ, and the Energy Innovation Delta. Participants of the study highlighted Han Weber's key role in connecting stakeholders across the Province.

2. Allard Castelein

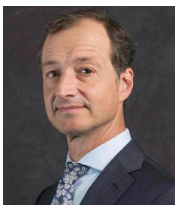
**Chief Executive Officer,
Port of Rotterdam**

Allard Castelein is the Chief Executive Officer of the Port of Rotterdam. Allard previously held senior management positions at Shell, and is a graduate in Medicine from the University of Rotterdam. Participants of the study cited Allard Castelein's ability to align all companies operating in the Port of Rotterdam behind the vision of becoming the most sustainable and energy efficient harbour in the world.

3. Ad van Wijk

**Entrepreneur & Professor
Sustainable Energy,
Delft University of Technology**

Ad van Wijk is professor in sustainable energy at the Technical University Delft. He holds a PhD in physics from the University of Utrecht. Ad won the award of master entrepreneur in the year 2007. Ad is admired for his insightful reports, his advocacy for a green hydrogen economy and his role in creating the Green Village in Delft.



4. Eric Wiebes

**Minister of Economic Affairs
and Climate Policy,
Ministry of Economic Affairs
and Climate**

Eric Wiebes is Minister of State for Economic Affairs and Climate change in the Netherlands. Eric studied mechanical engineering at the University of Delft and holds an MBA from INSEAD. Eric started his career at Shell before taking consulting roles at McKinsey and OC&C. Participants consider Eric Wiebes to be one of the key drivers of energy innovation due to his intervention in reducing gas extraction in Groningen.

5. Maya van der Steenhoven

**Programme Director,
Warmte/Koude
Zuid-Holland**

Maya van der Steenhoven is programme director at Warmte/Koude Zuid-Holland, a cooperation between public and private sector actors in the Province whose objective is to utilise heat from sustainable sources. Maya studied Law at the University of Leiden and held various senior positions promoting sustainability. Maya van der Steenhoven is considered to be a key driver of energy innovation by creating public awareness of the need for change.

6. Paulien Herder

**Professor in Engineering Systems Design,
Delft University**

Paulien Herder is professor in Engineering Systems Design in Energy and Department Head of Engineering Systems and Services. She has an MSc degree in Chemical Engineering and a PhD degree in the Engineering Sciences. Paulien chairs the Delft University Energy Initiative, which brings together over 400 FTE working in energy research. Paulien is a member of the Dutch national Topteam Energie, which is responsible for advising the national government. Recently she shifted focus towards electrification of the industry (E-refinery).

7. Jan Rotmans

**Professor in Sustainability Transitions,
DRIFT**

Jan Rotmans is Professor in Sustainable Transition at the Dutch Research Institute for Transitions in Rotterdam. Jan studied Mathematics at the University of Delft. He has published 20 books and 180 articles on climate change and the energy transition. Jan is the founder of the International Centre for Integrated assessment and Sustainable development and Urgenda. He is also one of the drivers behind the Roadmap Next Economy for the Rotterdam-Den Haag metropolitan region.

8. Nico van Dooren

**Director Energy and Industry,
Port of Rotterdam**

Nico van Dooren is Director of Energy and Industry at the Port of Rotterdam. Nico held various senior management roles at the Port of Rotterdam and Royal Haskoning. He also is a member of the Energy Innovation Board ZH and is admired for his drive in fighting climate change.

9. Stephan Brandligt

**Deputy Mayor,
Municipality Delft**

Stephan Brandligt is Deputy Mayor for the Municipality of Delft. Stephan studied Aerospace Engineering at the University of Delft. Stephan started his career at Coopers & Lybrand (now PWC) and founded his own internet company after that. Stephan is considered a driver in energy innovation due to the many initiatives he is involved in, in Delft. He also is a member of the Energy Innovation Board ZH, representing the Metropole Region Rotterdam The Hague (MRDH). His political party GroenLinks won the recent municipal elections in Delft.

10. Rinke Zonneveld

**General Manager,
Innovation Quarter**

Rinke Zonneveld is the General Manager of Innovation Quarter. Innovation Quarter is responsible for implementing economic development within the Province Zuid-Holland. Rinke studied Economics at the Free University of Amsterdam. Prior to his current position Rinke held a number of senior posts in the Dutch central government. Rinke is considered a key driver of energy innovation as Innovation Quarter attracts business investment which provides investment and employment. He also manages the EnergiIQ-fund.

The table below lists in order of the number of references the next 30 people cited as being key to the energy innovation ecosystem in Zuid-Holland. For all others referred to, please see Annex II.

	Name	Job Title	Organisation
11	**Jeroen de Haas**	Chief Executive Officer	Eneco
12	**Astrid Madsen**	Programme Manager Energy Transition	Gemeente Rotterdam
13	**Marjan van Loon**	President-Directeur Shell Netherlands	Shell
14	**Alice Krekt**	Programme Director	Deltalinqs
15	**Marc van der Linden**	Chief Executive Officer	Stedin
16	**Marco van Soerland**	Manager Heat networks	HVC
17	**Leon Ammerlaan**	Founder	The Green Innovator
18	**Paul de Krom**	Chief Executive Officer	TNO
19	**Fred van Beuningen**	Director	Clean Tech Delta
20	**Frank Schoof**	Chairman	Platform Geothermie
21	**Marcel Galjee**	Director Energy	Akzo Nobel
22	**Ted Duijvestijn**	Founder	Duijvestijn Tomaten
23	**Michiel van den Berg**	Managing Director District Heating/Cooling	Eneco
24	**Jan Kempers**	Manager Sustainable Development	Heineken
25	**Diederik Samsom**	Executive Advisor	HVC
26	**Pieter van Oord**	Chief Executive Officer	van Oord
27	**Joris Wijsmuller**	Alderman	Gemeente Den Haag
28	**Adriaan Visser**	Alderman	Gemeente Rotterdam
29	**Annelies van Ewijk**	Programme Manager	Provincie Zuid-Holland
30	**Bernard Fortuyn**	Executive advisor ECN / TNO	ECN / TNO
31	**Jaron Weishut**	Managing Director	The Green Village
32	**Chris Hellinga**	Sustainability Program Manager	TU Delft
33	**Sjaak van der Tak**	Chairman	LTO Glaskracht Nederland
34	**Teun van Bokhoven**	Chairman TKI Urban Energy	NVDE
35	**Reinier Gerrits**	Head of unit Energy and Climate	VNCI (Vereniging van Nederlandse Chemie Industrie)
36	**Co Hamers**	General Manager	Warmtebedrijf Rotterdam
37	**Meindert Jansberg**	Partner	Catena Investment
38	**Jean-Paul Schaaij**	General Manager	Groenfonds
39	**Petrus Postma**	Founding Partner	BLOC
40	**Jan Willem van Hoogstraten**	Chief Executive Officer	Energie Beheer Nederland

4.2 The top 40 Energy Innovation Organisations of Zuid-Holland

The table below provides an overview of the organisations which are perceived to be key in driving energy innovation in Zuid-Holland, featuring many research and government organisations as key drivers of energy innovation. Organisations were ranked by aggregating the number of references to individual people working for them.

1	**Delft University of Technology**	Knowledge
2	**Province Zuid-Holland**	Government
3	**Port of Rotterdam**	Not-for-Profit
4	**Ministry of Economic Affairs and Climate**	Government
5	**Eneco**	Entrepreneur
6	**Stedin**	Not-for-Profit
7	**Gemeente Rotterdam**	Government
8	**TNO**	Knowledge
9	**HVC**	Not-for-Profit
10	**Shell**	Entrepreneur
11	**DRIFT**	Knowledge
12	**Deltalinqs**	Not-for-Profit
13	**Gemeente Leiden**	Government
14	**Warmte Koude Zuid-Holland**	Government
15	**Innovation Quarter**	Smart Money
16	**Gemeente Delft**	Government
17	**LTO Glaskracht Nederland**	Not-for-Profit
18	**Heineken**	Entrepreneur
19	**van Oord**	Entrepreneur
20	**Gemeente Den Haag**	Government
21	**Gemeente Dordrecht**	Government
22	**Vereniging van Nederlandse Gemeenten**	Government
23	**Gas Unie**	Not-for-Profit
24	**Akzo Nobel**	Entrepreneur
25	**The Green Innovator**	Entrepreneur
26	**The Green Village**	Knowledge
27	**Clean Tech Delta**	Not-for-Profit
28	**Platform Geothermie**	Not-for-Profit
29	**YES! Delft**	Not-for-Profit
30	**Rabobank**	Smart Money
31	**Duijvestijn Tomaten**	Entrepreneur
32	**Gemeente Westland**	Government
33	**Ministerie van Binnenlandse Zaken**	Government
34	**Groenfonds**	Smart Money
35	**NVDE**	Not-for-Profit
36	**MRDH**	Government
37	**Catena Investment**	Smart Money
38	**Greenchoice**	Entrepreneur
39	**Warmtebedrijf Rotterdam**	Not-for-Profit
40	**Siemens**	Entrepreneur

In interpreting the references to key individuals, we should note a possible bias in perceptual prominence. There are fewer government institutions and knowledge institutions than commercial institutions, and they are more clearly geographically associated with the Province of Zuid-Holland.

For both reasons, references to them are likely to be more concentrated, which may lead them to dominate the 'top 40' list. But it is not just a statistical artefact; the very function of government is to centralise and co-ordinate decision making, so we might expect that its representatives should be ranked high on the list of influencers. Likewise, universities, whose role is to concentrate and cross-fertilise learning, might expect to see key individuals taking influential roles in promoting research-led innovation. Interestingly, while TU Delft is at the very top of the list, Rotterdam and Leiden do not feature in the top 40.

Conclusions

For the Province Zuid-Holland, energy transition will bring significant challenges as households, businesses and whole industrial areas move away from fossil fuels. Meanwhile, innovation in energy transition will bring opportunities, and potentially environmental, economic and social benefits.

On the basis of interviews with executives from 80 different organisations working in energy innovation the key points from the study are summarised as follows.

Activities

- Thermal storage was the only area of significant activity in storage, accounting for over half of the time spent on energy storage innovation and over 90% of the commercial activity. This was a surprise, given that storage had been identified as a challenge
- In distribution of energy via grids, we found a useful, unexpected result: in heat grids, most innovation FTE are going into commercialisation whereas in electricity grids, more than half the innovation FTE are still in research, suggesting there are still many issues to be resolved in the electricity grid area
- Fragmentation & concentration. Fragmentation: over ½ of all interviewees were working on making their own energy use more efficient, and 1/3 of all organisations were working on solar or wind or both. These are mature, well understood technologies that are being well exploited. The health of the ecosystem can be shown by the large number and different names of organisations from different pillars working in different stages of these transition technologies.

Perceptions

Perception scores for government were lower than for any other pillar. But respondents requests for government action are starting to be addressed in several areas: road maps, funding and setting examples:

- In road maps, some ecosystem participants asked that governments set stronger direction, yet others acknowledge the existence of roadmaps, and most prefer stability and overall consistency rather than rapid unpredictable change;
- In funding, many interviewees called for government to provide early stage funding, as energy transition business models were too early stage to obtain commercial funding. Yet examples do exist of government intervention in funding, including loan guarantees for investments in emerging technologies (such as the geothermal funding in Gemeente Westland) and the establishment of the energy innovation funds, such as EnergiIQ;
- In setting the right example, government is criticised for not doing enough with its own assets, yet government initiatives do happen: government organisations report spending significant time (approximately 30% of their time) on commercial activities such as generating energy, not just governing & regulating.

Connections

- Government institutions are high on the list of perceived influencers, but when it comes to universities, TU Delft is the only one in the top 40

- The top 10 connectors in the ecosystem are all people on public payroll (knowledge or government), showing that it is unusual for any single entrepreneurial organisation to take the lead.

Misalignments or opportunities

- Both storage and system balancing were seen as big challenges, but we found that relatively very little time is spent on them: these are potential areas of opportunity;
- The Province of Zuid-Holland has long-term climate change commitments to reduce net carbon emissions to close to zero, however relatively little time is spent on CO_2 capture and storage.

This study has gathered data from multiple dimensions: the many parts of the ecosystem, the different energy sources they address, the activities they are undertaking to capture the benefits and their perceptions of blockages and opportunities. This multi-dimensional approach has allowed us to analyse data about each aspect of the ecosystem and about the connections between them. The most interesting findings from these rich data sets are summarised in our report, but of course many additional questions could still be asked.

If you have additional questions, we would be pleased to capture them through this email address: EIEQuestions@orgvue.com

Annex I: Methodological Background

For this study, interviews were conducted between October 2017 and March 2018 with executives from 80 organisations. All interviews were conducted with a standardised interviewing guide, using a definition of energy innovation as 'any development which reduces the use of fossil fuels and/or reduces carbon emissions.'

Scope of the research

The organisations invited to participate for this study are active in the province Zuid-Holland. A number of organisations participated in this research without being located in Zuid-Holland; these organisations were included as they play a key role in Zuid-Holland despite the fact that they are not physically based there. A selection was made of organisations across the four quadrants of government, entrepreneurship, business and smart money in order to get a balanced sample of organisational types in Zuid-Holland. The study gathered interviewees' recommendations for action, and will use them for further feedback, but does not make policy recommendations itself.

Data validation & limitations

One of the objectives of this study is to map out and quantify effort spent on energy innovation activities. During interviews, interviewees estimated the number of FTE in their organisation working in various energy innovation activities. The numbers given could not be verified externally, and therefore can only be taken as an indication of the number of people in Zuid-Holland working in energy innovation. In addition to accuracy of self-reporting, the study is subject to selection bias of those agreeing to be interviewed (who we might expect to have greater focus on energy innovation than those that declined to participate) and a missing multiplier effect (with downward bias, as many organisations may contract with third parties to carry out some of their activities in energy innovation).

Suggestions for further research:

This study could be expanded by gathering more detailed activity and perception data via further interviews or online surveying. This study could also be repeated in a time series, to show trends in energy innovation in Zuid-Holland, or could be repeated in other provinces in the Netherlands, or other international regions to show geographical comparisons.

Annex II: Overview of the Ecosystem covered

The following persons & organisations have been named in the **Government** quadrant. Those printed in bold have been interviewed. Those organisations marked with a star (*) are also considered organisations specifically focussed on interaction.

• ANVS	Ton Vermeulen
• **De Bouwagenda***	**Ben Spiering**
	Bernard Wientjes
• The European Commission	
• Gemeente Barendrecht	Jan van Belzen
• **Gemeente Delft**	**Stephan Brandligt**
• **Gemeente Den Haag**	Joris Wijsmuller
	Martin Andriessen
• **Gemeente Dordrecht**	Martijn van den Bosch
	Niek de Wit
	Rik van der Linden
	Rein Meester
	Ronald Kooman
	Roosmarijn Sweers
• **Gemeente Goeree-Overflakkee**	**Erik Roeland**
• Gemeente Gouda	Hilde Niezen
• Gemeente Krimpenerwaard	Marco van Oosterwijck
• Gemeente Leiden	Boudewijn Kopp
	Fred Goedbloed
	Marcel Belt
• Alliantie Duurzaam Rijnmond	Ferry Beerepoot
• **Gemeente Rotterdam**	Adriaan Visser
	Ahmed Aboutaleb
	Astrid Madsen
	Chantal Olvers
	Fred van Akerboom
	Ingeborg Berger
	Miranda Janse
	Pex Langenberg
• Gemeente Schiedam	Patricia van Aaken
• Gemeente Vlaardingen	Frank van Zelst
• **Gemeente Westland**	**Theo Duijvesteijn**
• **Gemeente Zoetermeer**	**Peter Verheggen**
	Robin Paalvast
• Gemeente Zwijndrecht	Jacqueline van Dongen
• **Hoogheemraadschap Delfland**	Michiel van Haersma Buma
	Ries Smits
• **Hoogheemraadschap Rijnland**	**Jeroen Haan**
• **Hoogheemraadschap Schieland & Krimp.**	**Agnes van Zoelen**
	Hans Oosters
• Kansen voor West*	Ruud van Raak
• Koningshuis	Koning Willem-Alexander
• Ministerie van Binnenlandse Zaken	Chris Kuijpers
	Ferdi Licher
	Kajsa Ollongren
• Ministerie van Economische Zaken en Klimaat	Bert de Vries
	David Pappie
	Eric Wiebes
	Erik ten Elshof
	Ingrid Straathof
	Peter Alderliesten
	Vera Pieterman
• **Ministerie van Infrastructuur en Waterstaat**	**Dirk Schaap**
	Peter Heij
	Roald Laperre
• **MRDH***	Broer Duursma
• PBL NEAA	Peter Heij
• Provincie Noord-Brabant	Wim van der Donk
• **Provincie Zuid-Holland***	Adri Bom-Lemstra
	Annelies van Ewijk
	Floor Vermeulen
	Gerdien Priester
	Han Weber
	Hans Schouffoer
	Jeanette Baljeu
	Marco van Steekelenburg
	Martijn Hildebrand
	Rik Jansen
	Tanja Haring
	Ton Jonker
	Wiebe Brandsma
• Rijkswaterstaat	
• **SER**	Alexander van der Vooren
	Maarten van der Gaa
	Mariette Hamer
	Rob Weterings
• Staatstoezicht op de Mijnen	Theodor Kockelkoren
• **Topsector Energie***	**Jorg Gigler**
	John Post
• Tweede Kamer	Rob Jetten
• Vereniging van Nederlandse Gemeenten*	Edward Stigter
	Henk van den Berg
	Marjon Bosman
• **Warmte Koude Zuid-Holland***	**Maya van der Steenhoven**
• **Waterschap Hollandse Delta**	**Cok Sas**

The following persons & organisations have been named in the **Entrepreneurship** quadrant. Those printed in bold have been interviewed. Those organisations marked with a star (*) are also considered organisations specifically focussed on interaction.

• =OM!*	Rense van Dijk
	Andre Dippell
• ABB	Daan Nap
• Agro Energy	Rien Bot
• **Alliander DGO**	**Andre Schiltmans**
• Air Liquide	Jaap Oldenzeel
• Akzo Nobel	Marcel Galjee
	Marco Waas
• Ampyx	Richard Ruiterkamp
• ATAG	
• **AVR**	**Michiel Timmerije**
• **BAM**	**Hans van Hoven**
	Jaap Hazeleger
	Nico Lamerichs
• Ballast Neddam	Onno Dwars
• BLOC	Petrus Postma
• BNR	Remco de Boer
• Boskalis	Peter Berdowski
• **BP**	**Corne Boot**
• **Buccaneer**	**Seriena Bal**
• **CIC Rotterdam***	**Melissa Ablett**
• Cirkellab	
• Cliamte Focus	Adriaan Korthuis
• CMAG	Gert Jan Otten
• Corbion	Marcel Wubbolts
• **DSM**	**Ton Ruigt**
	Thom van Eijk
• **Duijvestijn Tomaten**	**Ted Duijvestijn**
• Dura Vermeer	Lowick Barg
EAZ	Timo Spijkerboer
• EBN	Jan Willem Hoogstraten
• Ecoshape	Henk Nieboer
• **Efficiator**	**Sander Hartwig**
• **Eneco**	Bram Phoet
	Edwin Postma
	Gijs Postma
	.Jeroen de Haas
	Kees-Jan Rameau
	Marc van Pelt
	Michiel van den Berg
	Ron Wit
	Wiert-Jan de Raaf
	Youri Kamp
• **Eneco Ventures**	**Yme Bosma**
• **Engie**	Guido Frenken
	Jeanke van der Haar
	Ingrid Voit
• **Fokker**	**Steven Soederhuizen**
• Esso	
• Ernst & Young	Errol Scholten
• Global E-Systems	Ad Kwakernaak
• Greenchoice	Evert den Boer
	Jeroen van Zon
	Ruben Veefkind

• Greenpoint	Tonnie van Peperstraten
• H2 Fuel Systems	Peter Molengraaf
• Halmos	Ed Rooijakkers
• **Heineken**	**Jan Kempers**
	Willem de Jong
• Holland Solar	Ammelie Veenstra
• **HVS**	Chris Kuijten
	Diederik Samsom
	Dion van Steensel
	Marco van Soerland
	Willy Heus
• Innovators Papendrecht	
• **Koole Terminals**	Pascal Spiekerman van Weezelenburg
• KOTUG International	Koos Smoor
• **KPN**	Jan Kees de Jager
	Jeroen Cox
• Kraajivanger Architecten	Hans Goverde
• Kwekerij Zeurniet	Jos Scheffers
• Lemnis Advies	Erik Brugman
• Nerdalize	Chris Mooiweer
• Next City	Emile Klep
• **Nuon**	Arno van Gestel
	Michiel Houwing
• Over Morgen	Anne Janssen
	Jeroen Roeloffzen
• Pitpoint	Erik Kemink
• **Plugwize**	**Norbert Vroege**
• Porta Nova	Leon Dukker
• Posad Generation Energy	Boris Hocks
• SCW Systems	Gerard Essing
• **Simgas**	**Sanne Castro**
• **Shell**	Ben van Beurden
	Ewald Breunesse
	Jos van Winsen
	Marjan van Loon
	Willem de Goede
• **Siemens**	Joanne Meyboom-Fernhout
	Leo Freriks
	Olivier Gueydan
• Smits Bouw	Hans van der Krogt
• Squarewise	Leonie van der Steen
	Marcel Heskes
• Stukton	Gerald Sanderink
• TATA Steel	Theo Henrar
• **Technolution**	**Wilbert Prinssen**
• The Green Innovator	Leon Ammerlaan
• **Uniper**	**Sytse Jelles**
• Van Oord	Paul Verheul
	Peter van Oord
• Vopak	Frits Eulderink
	Leo Brand
• **Zero Emission Fuels**	**Hessel Jongebreur**

The following persons & organisations have been named in the **Not for Profit** quadrant. Those printed in bold have been interviewed. Those organisations marked with a star (*) are also considered organisations specifically focussed on interaction.

• Aedes	Marnix van Norder
• Alliander	Jochem Garthoff
• **Clean Tech Delta***	**Fred van Beuningen**
• **DAGO***	**Martin van der Hout**
• De goede woning	Mariette Heemskerk
• **Deltalinqs***	**Alice Krekt**
	Bas Jansen
	Steven Lak
• Deltawind	Monique Sweep
• Duurzaamheidsfabriek*	Daan Wortel
• Economic Board Drechtsteden*	Sjoerd Vollebrecht
• Economic Board Zuid-Holland	Linco Nieuwehuijzen
• Energie Nederland*	Medy van der Laan
	Wolter Ruijgbrok
• Energieke Regio*	Krijn Ratsma
• Energy Innovation Board Zuid-Holland	Saskia Elissen
• **Gasunie**	Eelco Vermeulen
	Han Fennema
	Hans Coenen
	Pieter van Aartsen
• **Greenport West-Holland***	**Jolanda Heistek**
• **HOT Nederland***	**Rob van den Ende**
• HTM	Jaap Bierman
• IVBN	
• LTO Glaskracht Nederland*	Hans van den Berg
	Piet Broekhart
	Sjaak van der Tak
• Next wave Innovation*	Rene Honig
• **NVDE***	**Teun Bokhoven**
• **ODE Decentraal***	**Siward Zomer**
• **Platform Geothermie***	**Frank Schoof**
• **Port of Rotterdam**	Allard Castelein
	Erik van der Schans
	Jouke Goslinga
	Nico van Dooren
	Ronald Paul
	Ruud Melieste
	Stijn Effting
• RET	
• Rockstart*	Oscar Kneppers
• Rotterdam Climate Iniative*	Jeroen van der Veer
• Rotterdam Economic Board*	Jan Peter Balkenende
• **Smart Port Rotterdam***	**Michiel Jak**
• Start-Up Delta*	Prins Constantijn
• **Stedin**	Albert van der Molen
	Arjan Neugebauer
	Arno Horssen
	Henri Bontenbal
	Joep Weerts
	Lennard Seriese
	Marc van der Linden
	Marco Kruithof
	Rick Heerink
	Tom Brugmans
• Stichting de Verre Bergen	Roelof Prins
• TenneT	Thomas Aksan
	Mart van der Meijden
	Mel Kroon
• Universal Right	Arash Aazami
• VEMW*	Hans Grunfeld
• Vestia	Arjan Schakenbos
• **VNCI***	**Reinier Gerrits**
• VNO / NCW*	Frits de Groot
• VNPI*	Erik Klooster
• **Warmtebedrijf Rotterdam**	**Co Hamers**
• Warmtebedrijf Westland	Gerhard Hofman
• Warmteinitiatief Den Haag	Barend van Engelenburg
• Warmtesysteem Westland	Nico van Ruiten
• Werkgevers Drechtsteden	Bert de Winter
• Westland Infra	Frank Binnekamp
• **Windvogel**	**Siward Zomer**
• Woonbron	Karin Schederhof
• Woonstad	Maria Molenaar
• Yes!Delft*	Evert-Jaap Lugt
	Michiel Lensink

The following persons & organisations have been named in the **Knowledge** quadrant. Those printed in bold have been interviewed. Those organisations marked with a star (*) are also considered.

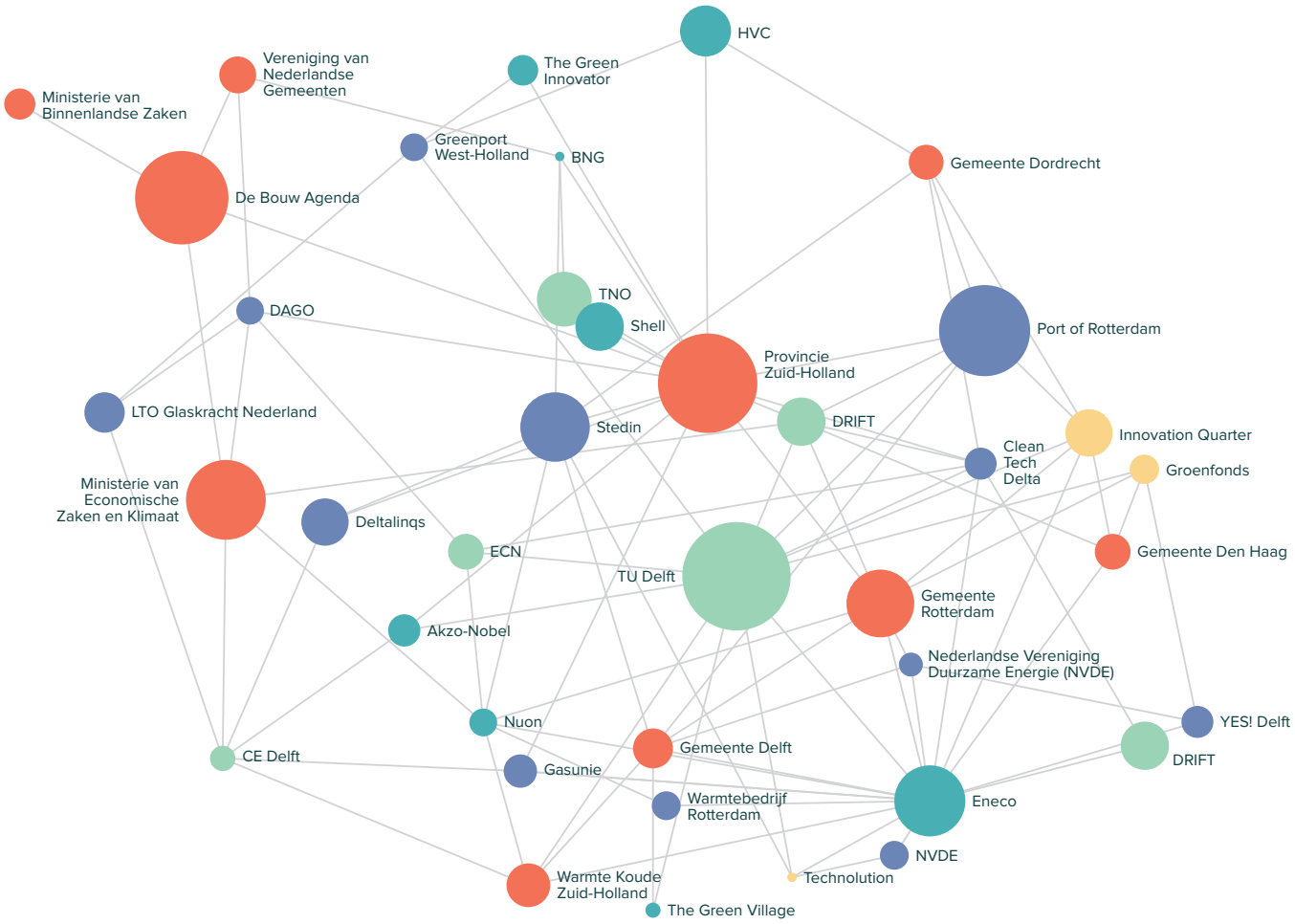
• **CE Delft**	**Frans Rooijers**
• De Bouw Campus*	Ben Homberg
• **DRIFT***	**Derk Loorbach**
	Jan Rotmans
• ECN	Sander Lensink
	Bernhard Fortuyn
• Erasmus Centre for Future Energy Business	Marcel van Oosterhout
• EUR	Wolf Ketter
• European Centre for Climate Change Solutions	Ruurd Koornstra
• **Green Village***	Alexander Hable
	Jaco Reijerkerk
	Jaron Wijshut
	Rene Tamboer
• **Haagse Hogeschool**	**Nellie van de Griend**
	Nico Persoon
• Hogeschool Rotterdam	Robbert-Jan't Hoen
• **Lux Research**	**Arij van Berkel**
• NERA	Paul Korting
• **ROC Mondriaan**	**Pierre Heijnen**
• Stichting Gelijkspanning	Pepeyn Wilgenburg
• Techniekpact*	Doekle Terpstra

• **TNO**	Egbert Jan Sol
	John Zegwaard
	Jos Keurentje
	Nienke Maas
	Paul de Krom
	Rene Hooiveld
	Richard Braal
	Sven van der Gijp
• **TU Delft**	**Ad van Wijk**
	Andre Ouwehand
	Andrea Ramirez
	Andy van de Dobbelsteen
	Chris Hellinga
	Kornelis Blok
	Paul Althuis
	Paul van Brouwer
	Paulien Herder
	Tim van der Hagen
• **Universiteit Leiden**	Ab van der Touw
	Rene Kleijn
• **Universiteit Utrecht**	**Gert Jan Kramer**

The following persons & organisations have been named in the **Smart Money** quadrant. Those printed in bold have been interviewed. Those organisations marked with a star (*) are also considered organisations specifically focussed on interaction.

• ABN AMRO	Hans van Cleef
• **ASN**	**Jan Willem Nieuwenhuys**
• **BNG**	**Paulien Bieringa**
	Edwin van Veenhuizen
• Catena Investmen	Meindert Jansberg
• DOB Foundation	
• EIRIS	
• European Investment Bank	
• **Fonds 1818**	**Murat Aslancik**
• Icos Capital	Peter van Gelderen
• **ING**	**Dirk-Jan van Swaay**
• **Innovation Quarter***	**Jonne Klaver**
	Nienke Vledder
	Rinke Zonneveld
• MKB Katalysator Fonds	Roos van den Werf
• **Nationaal Groenfonds**	**Jean-Paul Schaaij**
• **Navus Ventures**	**Eduard Meijer**
• **NIA**	**Bert Mulders**

• NIBC	Chris Niekerk
• Oikocredit	
• Pywymic	
• Port of Rotterdam Fund	Bastiaan van der Knaap
• Pro Credit	
• Quadia	
• Rabobank	Jaap Breugem
	Jaap Wielaart
	Jan Verhagen
• **RVO**	**Gerhard Rinsma**
	Jorn ter Have
• Start Green Capital	Coenraad de Vries
• **Stichting DOEN**	**Maarten Derksen**
• Stroomversnelling	Maarten Hommelberg
• Sustainabalitics	
• The Next Economy*	Hans Beekman
• Triodos Bank	
• True Costs	



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