Whitepaper

Opportunities for energy storage

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Our current energy system is based on using energy when we need it. All we need to do now is burn gas or coal to produce electricity and/or heat. However, renewable energy is only available when the wind blows or the sun shines. This is a system change with enormous impact, because the share of sustainable energy is increasing so that supply and demand no longer always match. In addition to changing our demand patterns and expanding our transport capacity for electricity and heat, we will have to store energy on a large scale and over long periods. Otherwise, supply and demand will no longer match. In the coming years this requires many billions to be invested. These investments offers challenges, but also opportunities.

This white paper provides insight into:

- The developments in energy storage;

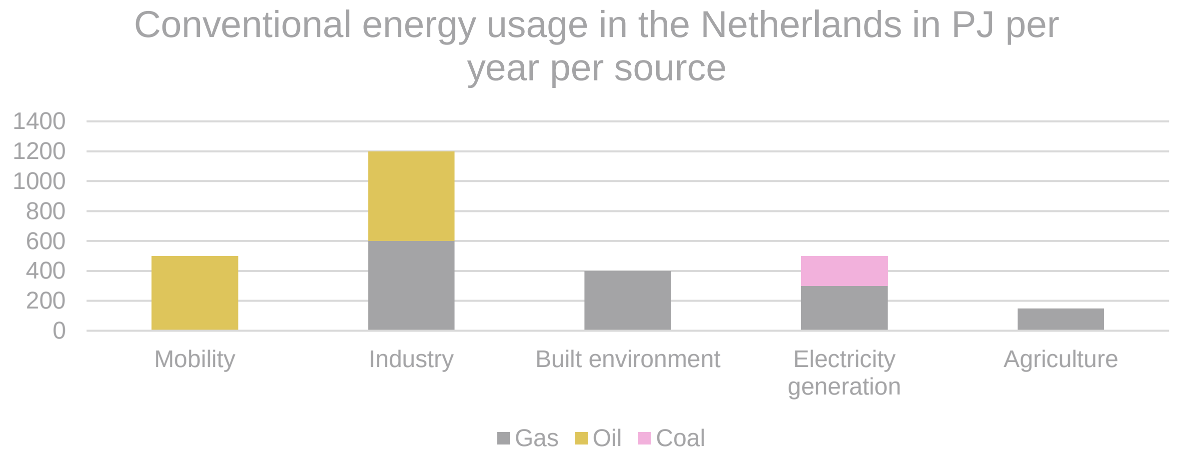
- The most likely (investment) risks;

- Which solution is most suitable for which situation.

This white paper is not intended as a system study but to provide insight into the concrete opportunities for (real estate) developers and investors.

1 The need for energy storage

The current energy transition calls for a new way of thinking about our energy system. The old system is based on massive storage of fossil fuel reserves that we can use for energy production when we need it. The figure below shows the amounts of energy we use annually and which stocks of fossil fuel are used for this:



This will not remain the case. In the coming decade, it is expected that the amount of sustainably produced energy will increase from 5% to 10% of the total energy demand in the Netherlands in 2030. This may not seem like a significant change, but the implications are huge. Both for supply and for the underlying system of demand and supply. It means doubling the amount of electricity that comes onto the grid when it is available. Twice as much electricity that cannot be produced at our convenience, but is only there when the wind blows or the sun shines. Energy will therefore no longer be readily available and that means a lot for demand.

How does it work now?
At the moment, the electricity grid behaves like a huge battery. Your surplus of solar energy at home is delivered to the grid for free, to be collected again for free when you need it. The gap between your sustainably produced electricity and your deferred demand for electricity is filled with gas and coal. This is how we bridge the gap between local supply and demand. However, this will become harder due to the increase of renewable electricity on the grid. More solar energy will be fed to the grid and therefore has to be stored when there is no acute demand. The battery is getting full. At other times, however, there is a high demand and no supply of the sustainable energy. In short: the limits of this system have almost been reached. Waiting times for new grid connections can be as long as 10 years. Moreover, sustainable electricity sources are sometimes switched off as the grid becomes overloaded.

New developments are currently being held back in two ways. As outlined above, it takes longer and longer before projects can be connected to the grid and the full required capacity is not always available. In addition, more and more sustainable energy is becoming available at the same time, which puts pressure on prices for those moments. This also represents an opportunity for energy storage, because at moments of scarcity, prices are extra high.

Because sustainable electricity cannot be stored somewhere as is the case with fossil fuels such as coal, we will have to take other measures to close the system. This is primarily about eliminating the imbalance between supply and demand of energy. What is required for this is explained in the next chapter.

2 Types of energy storage

There are many ways to store renewable energy so that the imbalance between supply and demand can be eliminated. However, in view of various technical and sustainable trends, three forms of storage are leading.

2.1 Batteries

It is expected that 80% of energy for mobility in this decade will come from electricity rather than from fuel. Since most vehicles are not connected to the grid while driving, they have their own energy storage on board. This is also capacity that is necessary to balance the system.

Electric vehicles already comprise 98% of the Dutch battery capacity for renewable energy. A major advantage of this is that demand can be managed based on the availability of renewable energy. But if you want to drive home after a night of windlessness, there is no sustainable energy charged. So the moment of charging must be made dependent on supply, in order to use the available battery capacity and to be mobile at the same time.

This principle also applies on a larger scale. The built environment and industry have a considerable, and rapidly increasing, demand for electricity. In total, electricity consumption is expected to increase from 400 PJ to approximately 650 PJ per year due to the energy transition. Since periods of sun and wind complement each other considerably in the Netherlands, there is usually sufficient sustainable energy available to meet the demand *throughout* the day. The problem of electrical imbalance occurs mainly *within* a day. This leads to an important opportunity.

Opportunity: By charging batteries daily when there is a surplus and discharging them when there is a shortage, the imbalance in the electricity system can be largely eliminated. At the same time, this ensures that large peaks in both supply and demand of electricity are attenuated so that the grid is relieved. This is therefore an important part of the revenue model for industrial batteries: electricity is bought cheaply when demand is low and supply is high, and then sold expensively during peaks in demand. In addition, a battery can be used in the FCR (primary reserve power) market, where the power can be used by the grid operator to maintain frequency on the electricity grid.

2.2 Thermal storage

40% of our total energy consumption is demanded as heat, rather than electricity or fuel. This is about half of industrial consumption and almost all use in our buildings and agriculture. After possible savings, e.g. through insulation, there still remains a significant heat demand. Significant enough to be of importance in matching supply and demand.

The challenge is to ensure that sustainable heat is produced without fossil fuels. In industry, this is expected to be achieved partly with electricity, but largely with hydrogen. For the lower temperatures, especially needed in buildings and greenhouses, there are more efficient ways to meet the heat demand. By far the most heat is needed in winter, when there is less sustainable energy production. Alternatives such as an air heat pump have a low efficiency at these times. Therefore, in this case it is better to use heat from thermal storage. For the 400 PJ that is needed, a total capacity of about 100,000 GWh of thermal storage is required.

There are applications for this, such as thermal energy storage in an aquifer, a system with a closed source or a storage vessel. In addition, day storage of heat and/or cold can also provide an interesting case. Here too, buffer tanks are used, but heat can also be extracted from the building mass or from Phase Change Material. These are materials that store and release energy by changing phase from solid to liquid and vice versa. The major advantage of day storage is that it can be used to buffer heat at the right times (at low prices) so that it can meet part of the heat demand at peak times of the day. Thermal storage, in various forms, thus offers an important opportunity to match supply and demand for energy, and specifically heat.

Opportunity: We need seasonal heat storage to compensate for fluctuations in heat supply and demand. In this case, buffers can be filled with cheap heat in the summer. Such business cases usually consider storage as an integral part of a heat network including (various) sources of heat where the buffer is one of the sources that can be used in winter. Specifically for a building, buffering on a daily basis can also be a solution.

2.3 Hydrogen

Hydrogen is a gas that is produced rather than extracted. Production takes place by splitting water into hydrogen and oxygen through electrolysis. It is relatively easy to use where we already use natural gas and hydrogen. This is expected to be a maximum of 1,200 PJ per year. About 900 PJ for industry as heat and feedstock, 100 PJ for heavy transport and 200 PJ for electricity production to ensure a stable base load and sufficient controllable power.

Unfortunately, hydrogen is not very efficient; a third of the energy required for production is lost as heat. However, this does provide an opportunity for heat transition in the built environment. We could use some of this residual heat for thermal storage and direct use in buildings and greenhouses.

Back to hydrogen. It is in itself a storage medium, but hydrogen cannot be stacked like coal. Large-scale storage of hydrogen in, for example, empty salt caverns will be necessary in order to provide a stable supply of hydrogen based on a fluctuating supply of sustainable energy.

Opportunity: Storing energy in hydrogen is particularly interesting from a development perspective if the electricity production cannot be connected to the grid. The market expects the demand for hydrogen to increase exponentially in the coming years. Some of this will be produced in the Netherlands and some will be imported.

2.4 Combinations

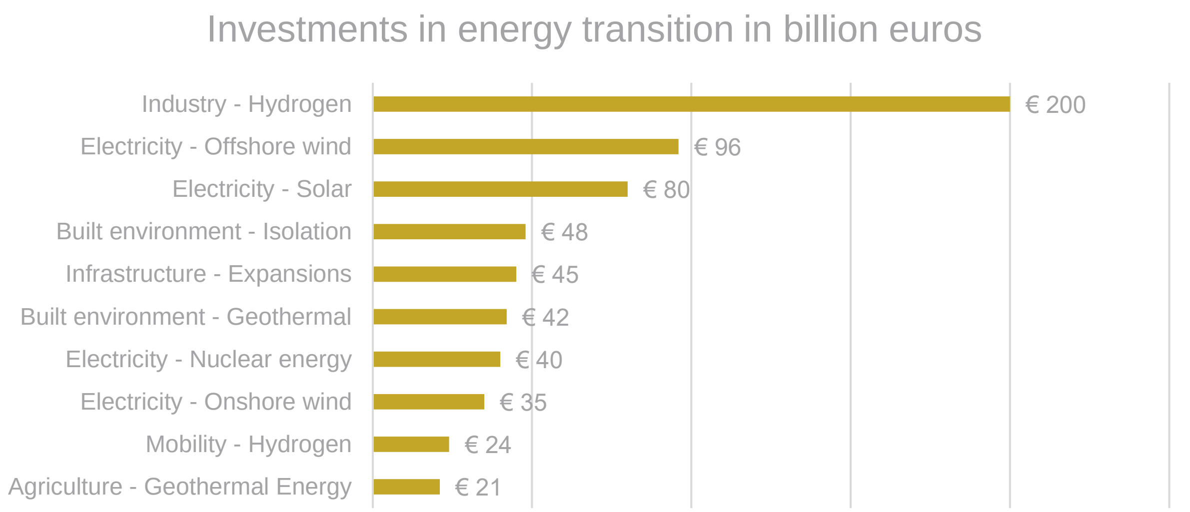
The three forms of energy storage mentioned above can also be combined with each other. This creates upscaling and an advantage that new systems can emerge that benefit from each other.

For example, the installation of a battery near a hydrogen production plant can increase the availability of cheap and sustainable electricity for hydrogen production. At the same time, the heat released from the production of hydrogen can be stored in thermal buffers to be used for a heat network in the winter. By combining different options it is possible to close or even optimise the business case of a project.

3 Required investments

In order to estimate the required investments in energy storage, we calculated a plausible transition scenario with one of the models developed by Sweco. A simple variant of this can be played using the QR code on the right.

In total, according to this scenario, the Netherlands alone would have to invest approximately €700 billion in the energy transition. The top 10 investments in energy generation, transport and conservation are shown below:



However, these investments do not include the full storage component of renewable hydrogen, electricity and heat. Based on an initial analysis by Sweco, the investment in sustainable storage in our system would be around € 360 billion. For this we need to invest in:

Hydrogen: Over €220 billion based on production and storage in the Netherlands. In practice, a large part of the production will take place abroad but terminals, storage facilities and pipelines will be constructed in the Netherlands.

Batteries: Approximately €75 billion. At the current cost level of battery systems of around €300 per kWh and a storage requirement of 250 GWh per day. This figure is based on the scenario above where 650 PJ of electricity is used and assuming a daily mismatch of 50% between generation and consumption. The batteries will be placed at sustainable sources such as solar and wind parks but also at large consumers and at direct connections to the electricity grid.

Thermal storage: Almost €65 billion for the needs of the entire built environment and agricultural sector. This concerns both small-scale systems at district or even block level and large-scale heat networks encompassing cities. This involves the seasonal storage of heat based on a buffer reservoir in the ground or geothermal heat.

4 Investment risks

Investment involves risk. For the substantial investments required for energy storage, there are three main investment risks: increased costs, uncertainty of the business case and development risks.

4.1 Increased costs

Over the last 10 years, costs in the renewable energy sector have been constantly falling. However, recent macro-economic shifts and political tensions are causing costs to rise. For the time being, there is no prospect of this changing. These higher prices for steel, copper and lithium also make the development of energy storage more expensive. For batteries, for example, the expected price drop to €100 per KWh has been postponed from 2024 to 2026. For many projects, rising wage costs are also a significant component, driven further by the growing shortage of personnel to carry out the work.

Rising energy costs are a driver for many to quickly switch to alternative energy sources. But not everyone has the capacity to invest, especially now that interest rates are rising and the cost of capital is increasing. Besides an opportunity, the high costs of fossil energy are therefore also a risk. For some time now, the active policy of many governments has focused on discouraging fossil energy use by setting prices. As a result, fossil energy users have less budget to invest in, for example, PV panels or to convert their installation to use hydrogen as an energy source.

4.2 Business case

A second risk concerns the uncertain business case for energy storage, especially for batteries. The current system distinguishes between 'producers' and 'consumers'. Consumers pay both energy taxes and transport costs. Batteries are considered consumers under the current regulations, which increases costs considerably. This is not important for batteries linked to a producer or consumer, but is a major obstacle for the deployment of batteries linked directly to the grid. The costs are simply too high.

The market also needs the right price incentives. At the moment, it can still be the case that charging your car at night is cheaper than during the day, while charging when the sun is shining is the best time for the system. The government needs to play a guiding role here in order to support the best system solution. There are sufficient methods for the production of sustainable energy, of which the SDE++ is the best known. This provides a guaranteed business case at a time when market prices for renewable energy are too low. No such instrument exists for energy storage, which means that the business case has a greater risk if revenues are disappointing.

The complexity of the energy storage market is also a risk, especially for incoming cash flows, which are difficult to predict. In addition to buying at low cost and selling at high cost, there are other revenue models. These include reducing grid connections, providing grid balancing services and providing back-up/emergency power services. It is important to stack these models cleverly in order to be able to draw up a balanced business case.

4.3 Development risks

Finally, energy storage projects are subject to the 'normal' development risks. These include the risks of whether or not to obtain a permit, but also agreements with energy companies regarding the connection to local energy networks. With regard to the technological risk, investors naturally look at the core technology of the storage method. In the case of hydrogen, for example, this concerns the electrolyser, whereas in the case of battery storage the reliability of the type of battery is important. The preference is usually for proven technology. This does not always benefit the transition because promising new technologies are then applied less quick and less frequent.

Although not directly related to the technology in question, the risks associated with the construction and/or operation of the storage facility are also important. These are mainly risks related to construction planning and budget control. Ultimately, this risk revolves around the question of whether the frequency of maintenance, and the associated budget, is appropriate to the technological specifications of the storage system. If more maintenance is required due to quality issues, this will have a direct impact on cash flows. The same applies to cost overruns due to insufficient budgets. It is therefore important to have a clear picture of the entire lifecycle of the project and to apply a healthy risk margin in terms of time and money. And it is precisely this aspect that is not always clear with new, unproven technologies. Here too, combining generation and storage forms can offer a solution so that the risk of innovative forms can be covered by proven technologies.

5 Next steps

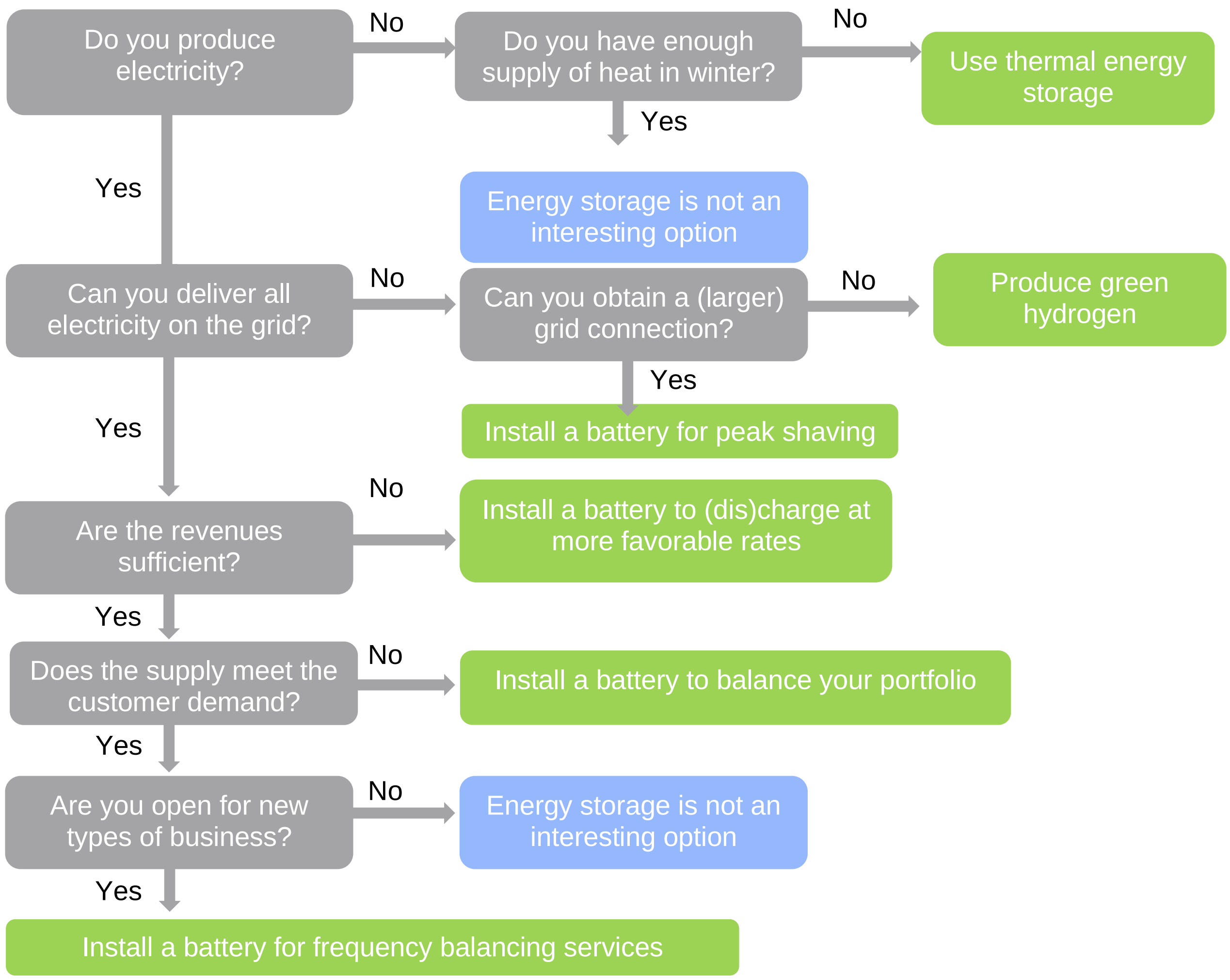
As mentioned, renewable energy cannot simply be piled up, so we need new ways of storing energy. This can be seen as both a threat and an opportunity. A threat because it will become more difficult to obtain a grid connection due to grid congestion and because the prices for sustainably produced energy will come under pressure. But also an opportunity, because energy prices will rise at times of scarcity. Energy storage makes it possible to reduce grid congestion, paid for by higher revenues and lower costs.

The expected investments for the various forms of storage are more than € 360 billion in the Netherlands alone. The main risks for investors are rising development costs (due to lagging efficiency improvements), rising costs of (scarce) materials and higher labour costs and the initially higher system costs during the transition. In addition, the business case for providing storage services for sustainably produced energy is still uncertain. Finally, there are the development risks, which increase as free space becomes even scarcer and various tasks compete for available space, both physically and in terms of environmental burden, such as nitrogen or PFAS.

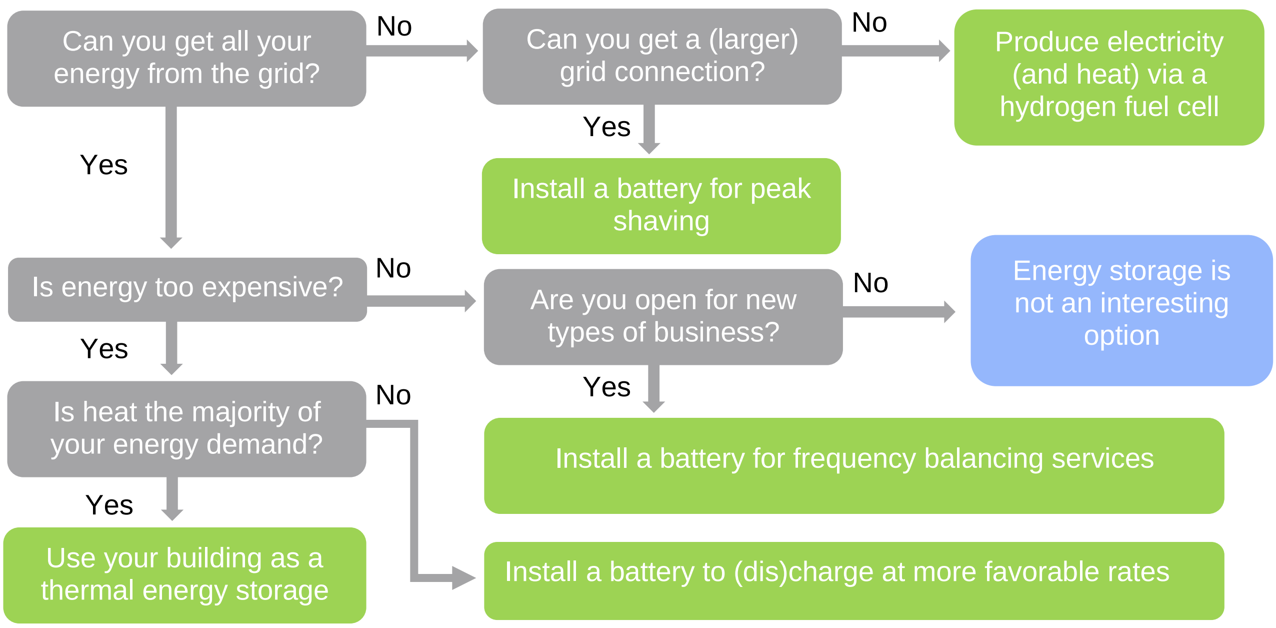
Until now, energy storage was something that was of no interest to the general public. This is now changing rapidly. As a result of grid congestion and the greater imbalance between supply and demand for energy, many parties need to deal with issues such as gridlock and large price differences. This has shifted the storage of energy into a much larger domain and therefore the sharing of knowledge about it has become more important.

Sweco can draw on a great deal of knowledge and experience in this respect. We are involved in the first green hydrogen plant in Europe, we work closely with the industry in their ambitions to become more sustainable, we have extensive knowledge of investment models and business cases and we are partners in many projects with stakeholders to guide them through the transition. The decision trees below are an initial tip for project developers to come up with plans for energy storage. It is an indispensable item in any form of plan development. We are happy to discuss specific opportunities in more detail.

Storage opportunities for energy production



Storage opportunities for energy consumption



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As project manager Energy & Sustainability at Sweco, Daniel leads daily projects involving the gerenation, transport, storage and use of energy. The usefulness and necessity of storage for our energy transition is an important part of this. In order to make informed choices with his clients, he often helps them with feasibility study at post-it level. If the traffic lights are still green, it's time for the second step and Daniel likes to think along with you.

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At A.S.R. Real Asset Investment Partners, Diederik supports its institutional clients with their infrastructure portfolios. In this capacity, he advises on investment strategies, facilitates the implementation of these strategies and actively follows up on the investments. Based on his investment and technical knowledge, he has a keen insight into risks & returns of infrastructure assets. Before joining A.S.R. Diederik worked as a Project Finance consultant on a wide range of infrastructure transactions.

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As Business Director Energy Transition, Bert is committed to accelerating the energy transition together with hundreds of colleagues. Raised on a farm in Flevoland, Bert always felt connected to nature. His ambition is to help Dutch companies reduce their footprint on the earth. He enjoys turning big words into simple actions. And he believes that we can achieve progress by investing in a sustainable future. There is no need to wait until tomorrow.

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