EMMETT GREEN BV
Professor Snijdersstraat 2
2628 RA Delft

hallo@emmettgreen.nl
T: +31 (0)85 06 06 485

Bank NL36 TRIO 0379 4720 23
BTW NL8592 72 138 B01
KvK Den Haag 72881437

Emmett Green - Hydrogen Services

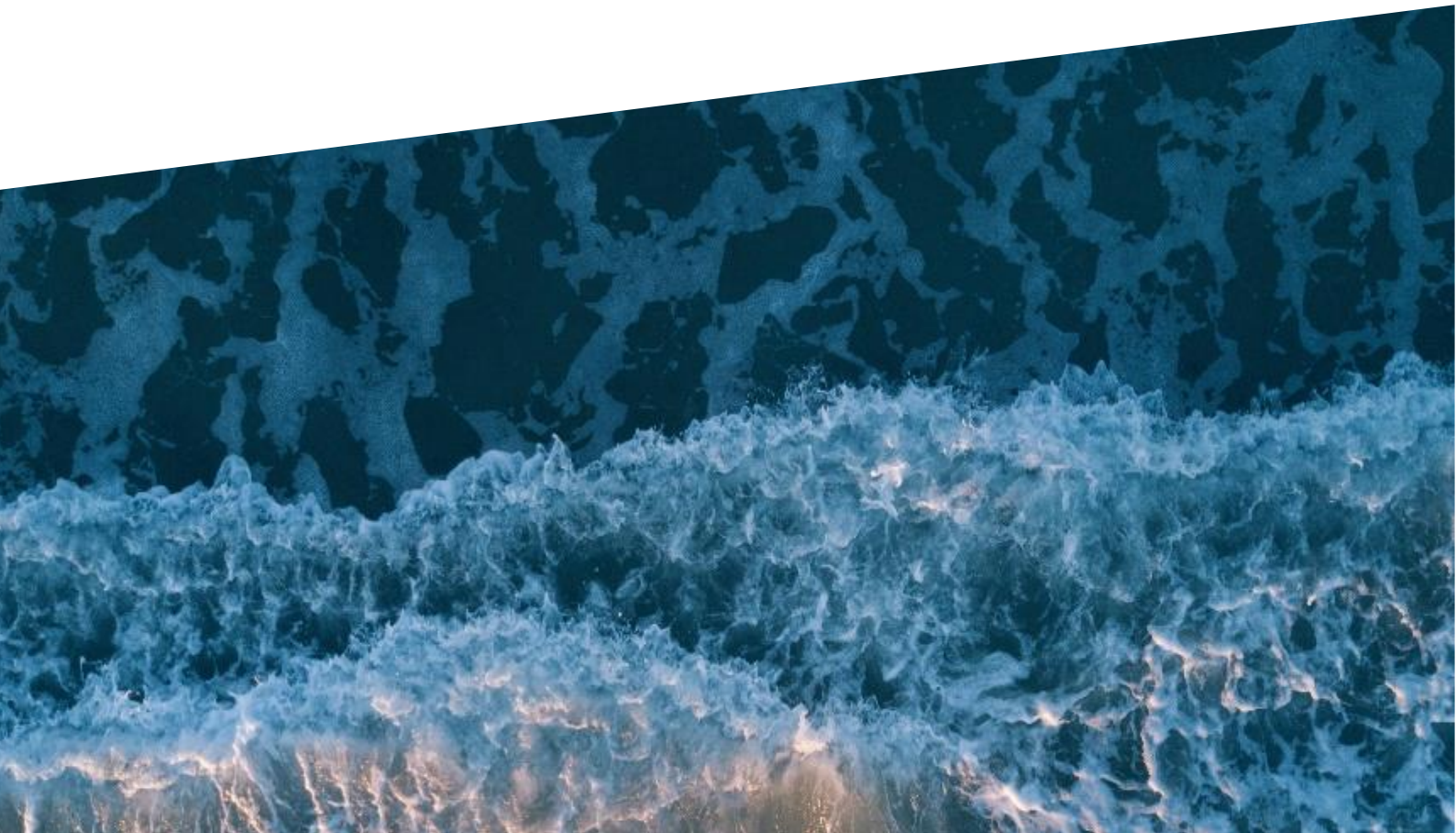

Table of Contents

Questions regarding Hydrogen?

Don’t hesitate to contact us.

+ 31 (0)85 06 06 485

hallo@emmettgreen.nl

Professor Snijdersstraat 2
2628 RA Delft, Nederland

Our experts are ready to help you!

1. About Emmett Green

Emmett Green BV is a consultancy and (co)developer of innovative renewable energy projects including in the field of hydrogen, large-scale grid adaptations (Closed Distribution Systems GDS) and energy storage systems such as mega-batteries. Emmett Green also carries out simulation and control of flex assets with an in-house developed application and optimisation algorithm. In addition, Emmett Green has its own engineering office in the field of medium and high voltage (Emmett Green Engineering) and a finance boutique focused on modelling, business case development and financing of renewable energy projects (Emmett Green Finance). Emmett Green regularly collaborates with universities on research and development projects.

2. Introduction Emmett Green Hydrogen Services

Emmett Green's Hydrogen services focus mainly on the technical and economic aspects in the development phase of the entire green hydrogen chain. In some scenarios, this chain can be very broad and complex, and even part of a larger energy hub. It is important, therefore, to consider this broader picture during the development phase. For this, we rely on the technical expertise of the Emmett Green Engineering branch and the economic knowledge coming from Emmett Green Finance.

An important part of our services is our EMS (Energy Management System), which allows the entire chain to be simulated, optimised and controlled in detail based on the connected components. With this, we accurately predict, analyse and improve the performance of each link in the chain, resulting in an efficient and cost-effective solution for our customers.

Our services include Project Development and Management, Hydrogen Quickscan, Hydrogen Simulations, Engineering Services, and Business Case Development and Financing Strategies. With this wide range of services, we provide everything needed to support clients with their hydrogen projects, from the initial concept phase to final implementation.

At Emmett Green, we strive to create value across the hydrogen supply chain and guide our clients through every step of their journey towards a sustainable future.

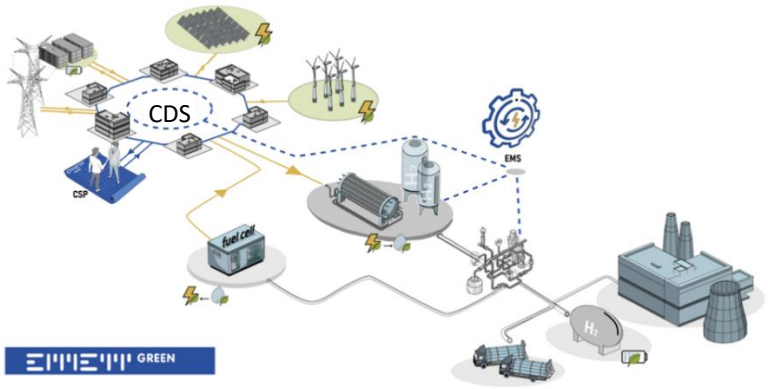

Figure 1 Representative P2G hydrogen chain that Emmett Green can help develop for you

3. Project Development and Management

The complex and continuously evolving hydrogen landscape presents both significant opportunities and challenges. Volatile energy markets and changing regulations have already led to significant delays in several well-known hydrogen projects. In this challenging environment, effective project management is crucial to ensure success. As a project manager, Emmett Green plays a key role in making your hydrogen projects a reality. We work closely with you and your partners to transform your hydrogen energy vision into feasible and successful projects.

Our collaboration starts as early as the conceptual phase. Emmett Green works closely with you to define the core of the project. This includes identifying project requirements, opportunities, and the strategic interests that support your goals. With our specialised knowledge in the hydrogen sector, we assist you in drafting and evaluating possible solutions that seamlessly match your ambitions. This process includes developing customised solutions and proposing 'no-regret' choices. These choices are limited to the immediate needs of the project and are designed to maintain flexibility. This allows development to proceed steadily without being constrained by previous decisions in the future. This strategic approach ensures that the project can adapt to new circumstances and progressive insights.

After choosing the design, we help you prepare detailed project plans and designs that include timelines, budgets and critical milestones. This helps to structure the project and provide clear directions to all parties involved. We also take on project management and ensure effective stakeholder and baseline management. Initially, after the design selection, the focus will be on preparing the design for the permit application and structuring the financing for the project. Emmett Green supports you in navigating through this complex process. We guide you in structuring financing for the project, taking into account both traditional funding sources and specialised green investments. Our experts help identify and apply for relevant grant programmes that can ease the financial burden of the project. At this stage, it is also important to maintain active engagement of all stakeholders, from investors to local communities, and ensure transparent and continuous communication to ensure support and understanding for the project.

Once the permit and financing are in place, the Final Investment Decision (FID) can be taken. After the FID moment, we help refine the detailed design and guide the procurement processes. This ensures optimal selection of suppliers and materials that meet the project requirements. With an established detailed design and financing in place, we move to the actual execution of the project, closely monitoring progress and steering where necessary. Upon commissioning (comissioning), we can also provide the quality and integrity inspections as well as provide an installation manager. The system is then carefully monitored until it is certain that normal operation can be guaranteed. Finally, the site can then be further managed and optimised by the EMS.

In conclusion, Emmett Green combines thorough and adaptive project management with strict risk management and quality assurance. This ensures that your projects will not only meet current standards, but also remain flexible for future challenges. This is how we help you bring your idea to a realised project.

4. Hydrogen Quickscan

At Emmett Green, we understand that exploring the potential for hydrogen technologies such as electrolysers and fuel cells is crucial for developing sustainable and efficient energy solutions. To support our customers in this regard, we offer the "Hydrogen Quickscan". This service is designed to quickly and effectively identify the technical, financial and organisational opportunities for using hydrogen in your company or project.

Our Hydrogen Quickscan is an essential first step for organisations considering hydrogen as an energy source or carrier. Through this scan, we can quickly assess which hydrogen technologies are most suitable for your specific situation. Here, we look not only at technical feasibility, but also at economic and environmental aspects.

The process starts with a quick analysis of your current energy needs and infrastructure. Then our experts assess the potentially applicable hydrogen technologies and the extent to which they can contribute to your sustainability goals. This approach ensures that we can provide you with concrete recommendations tailored to your unique needs and ambitions.

The results of the Hydrogen Quickscan provide a clear picture of the attractive options and establish a solid foundation for starting your hydrogen project. With this knowledge, you will be better prepared to make informed choices that will pave the way for innovation and sustainability within your organisation. If you are interested, do not hesitate to contact us.

5. Hydrogen Simulations (EMS Simulation Model)

The EMS simulation model allows one to model the operation of green assets, such as a solar farm, battery, electrolyser, fuel cell, etc., according to their specifications and operational constraints as well as any additional operational policies. This allows one, if desired or relevant, to simulate the behaviour of the several green assets within a wider energy hub on a detailed level and optimise the entire supply chain making the EMS unique. In addition, one can also determine the dynamic behaviour per asset using personalised rules and customer-specific conditions. An important feature of the simulation model is that one takes into account flexible and/or delayed nature of certain green assets, such as, for example, the longer start-up time of a type or brand of alkaline electrolyser, and thus one can better schedule and tune the production to the availability of green energy (wind/solar), hydrogen price, hydrogen demand, grid congestion, and so on. Hence, a true digital counterpart of the asset is created.

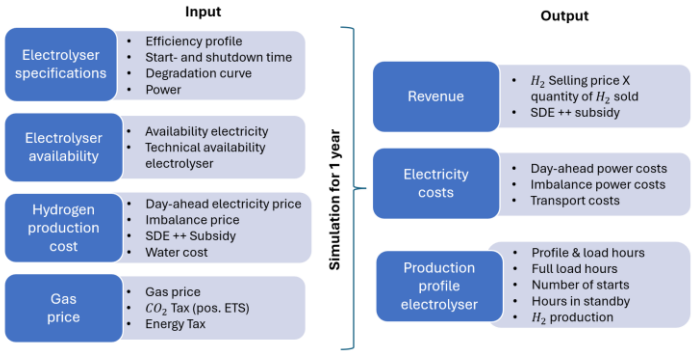

Figure 2 Example electrolyser model that could be used in simulations

Moreover, the simulations use actual historical market data and/or future price models in combination with real market data. This results in very detailed simulations on time-scales ranging from minutes to seconds, depending on which electricity markets are included. This also means that the results obtained from our simulation variants are highly representative of the EMS controller counterpart that can be deployed during the operational phase to manage the electrolyser, and when applicable an entire energyhub.

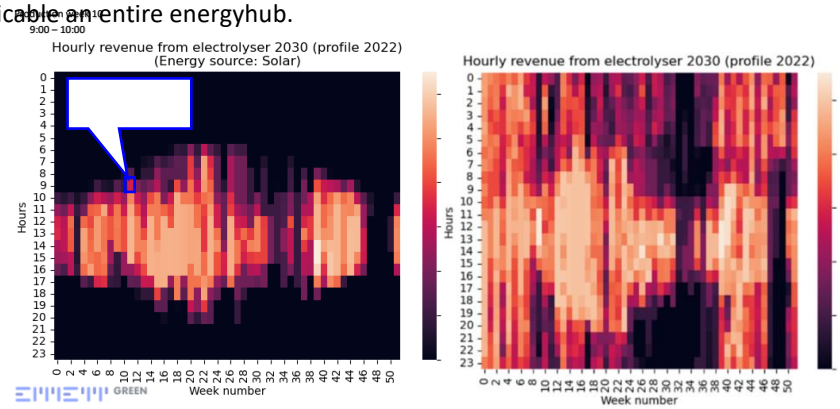

Figure 3 Simulated annual overview for hydrogen production in scenario with a solar farm only and with both a solar and wind farm for a 2030 energy market. Profile based on 2022.

How to interpret the graph?
The indicated coloured block at hour 9 indicates the hour from 9.00-10.00, along with the total production or yields at that hour for that particular week (i.e. 7 hours in total). The lighter the colour of a block, the higher the yields/production in that time slot.

Emmett Green offers a comprehensive range of engineering services within the hydrogen sector. Our team of experts can support you in technical feasibility studies, site engineering design, equipment selection, and electrical design independently of a supplier. We specialise in the design and realisation of both electrolyser and fuel cell applications. For this, we are in close contact with several suppliers.

For hydrogen production, we assist in choosing between different electrolysers, including alkaline and PEM electrolysers, depending on your specific needs. We provide thorough technical feasibility analyses to ensure the viability of your project. In addition, as an integrator, we guide the technical design of your production site, which is crucial for obtaining the necessary permits. This includes working out both electrical and detailed designs that we help realise.

Our capacity includes projects ranging from a few kilowatts to large multi-megawatt production sites with multiple off-takers and storage, such as a recently designed 20 MW site.

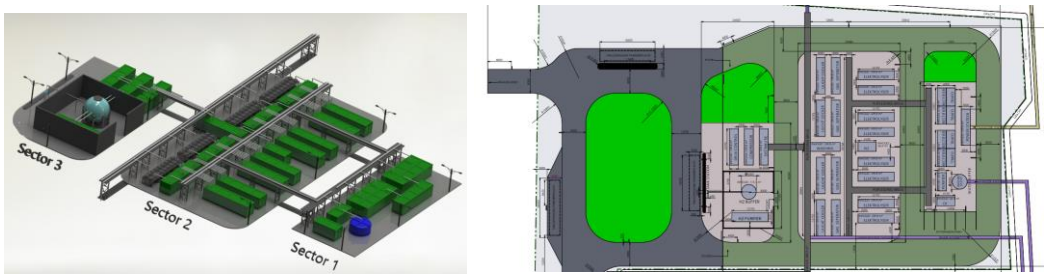

Figure 4 Green hydrogen production site (20 MW) with buffering and distribution station

Besides green hydrogen production, Emmett Green also has experience in developing and designing fuel cell projects. In the last few years, for example, we have developed a Fuel Cell Battery Pack (FCPB) concept which can be used for charging electric vehicles at construction sites with a limited grid connection.

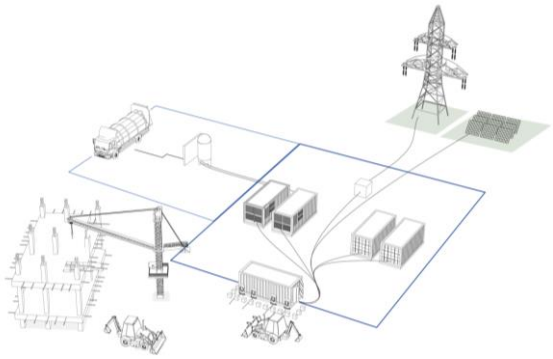

Figure 5 Fuel cell battery pack combination for (semi-)off-grid sites designed by Emmett Green

7. Business Case Development and Financing Strategies for Hydrogen

The Emmett Green financing boutique specialises in developing business cases, identifying and analysing financial risks, and financing renewable energy projects. Specifically for hydrogen, a financial model has been developed to help vet the various business cases. In part due to its extensive technical knowledge and relationships with electrolyser and fuel cell manufacturers, the Emmett Green financing boutique managed to create a comprehensive and detailed financial model for both fuel cells and electrolysers, as well as larger energy hubs. The modular model allows different options and possible manufacturers to be weighed up against each other over the total lifetime of the project.

The financial model offers investors insight into all the necessities for achieving a positive business case, and helps to identify the biggest financial risks associated with the project. Through innovative uncertainty analyses, where multiple thousands of scenarios can be analysed, the financial model also provides robust insights into the dynamics and possible mitigations of the financial risks. With an innovative link between the financial model and the aforementioned EMS simulation model, one can efficiently review and prepare different business cases. Moreover, one can have more confidence in the feasibility of the business case predictions because the simulation model respects the constraints and complexity of the sustainable assets and includes them in the optimisation.

Besides advising on the hydrogen business case, Emmett Green Finance offers support in exploring financing options for your hydrogen project and clarifying relevant grant schemes. We can also help you prepare grant applications. Emmett Green has already successfully guided several grant applications for hydrogen projects. These range from national programmes such as SDE++ and OWE to more competitive European grants such as the JTF programme and the European Hydrogen Bank.

8. Controlling Hydrogen Assets (EMS Controller)

A key function of the EMS is its operational counterpart to the simulation model. Based on the same principles as the simulation model, this variant, the EMS Controller, can control and manage the energy chain and all its components directly. Having a digital counterpart of the site that is used for both simulations and control makes the EMS unique. It enables the EMS Controller to optimise the energy chain accurately and in real time. The EMS Controller maximises the total revenues of the entire chain during production based on the different energy markets, hydrogen prices and off-take demand, while respecting the safety standards of all parts of the chain.

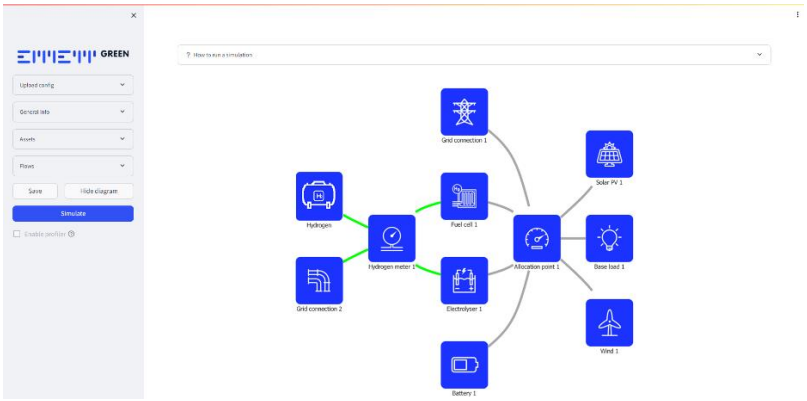

Figure 6 EMS digital twin of your site

In addition, the EMS features a dashboard that allows you to monitor your assets live. This dashboard provides real-time insight into the performance and status of the entire hydrogen chain and allows you to react proactively to changing market conditions, disruptions or fluctuations in demand.

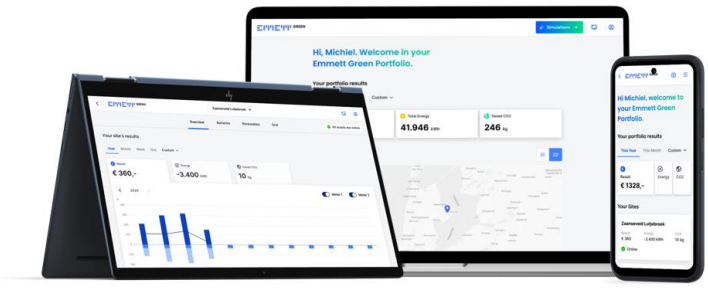

Figure 7 EMS Dashboard for monitoring your site

The EMS Controller is designed to optimally manage and control your hydrogen plants, resulting in efficient and reliable operation of the entire chain. This ensures maximum yields and sustainable management of your hydrogen infrastructure.

9. White Label Services

At Emmett Green, we offer the opportunity to offer our advanced technical and economic services under your own brand name. This allows you to seamlessly integrate our solutions into your existing product offering, allowing you to present a more comprehensive and attractive service package to your customers.

These services include not only white label options for our consultancy and analyses, but also for customised simulations using the EMS simulation model. Each element of the service can be tailored specifically to your requirements, allowing you to deliver exactly what your client needs without the need for in-house technical expertise.

By using our white label services, you can leverage Emmett Green's reputation as a leader in renewable energy solutions, while still maintaining and reinforcing your own brand identity.

10. Towards a sustainable future with Emmett Green

Emmett Green is committed to the advancement and implementation of renewable energy solutions, including hydrogen technology. As a leader in this sector, we offer not only cutting-edge technical services, but also strategic guidance essential for successfully integrating hydrogen into your operations.

Leading Expertise
Our expertise in hydrogen simulations, engineering and business case development makes us an indispensable partner for organisations striving for sustainability. Our in-depth knowledge and experience enable us to provide customised solutions that seamlessly match your specific needs and ambitions.

Strategic Partnerships
We believe in building long-term relationships with our customers and partners. Our approach is collaborative and we aim to work with you to implement the most effective and efficient hydrogen solutions. This means that we not only assist you with technical implementation, but also provide strategic support for financing and market access.

Continious Innovation
In a rapidly changing world, Emmett Green continues to innovate to stay at the forefront of hydrogen technology. We continuously invest in research and development to improve our services and ensure our customers have access to the latest technologies and processes. For the EMS too, we are in close contact with several electrolyser and fuel cell suppliers to ensure it is seamlessly aligned with developments along their side.

Your Invitation
We invite you to explore the possibilities of hydrogen energy with us. Whether you are at the beginning of your hydrogen initiative or already further ahead, Emmett Green offers the expertise needed to take your projects to the next level. Contact us today to see how together we can make a difference in your transition to a cleaner, more sustainable future.

Contactgegevens
For more information about our services or to arrange a meeting with our team, visit our website or contact us directly using the contact details below. We look forward to the opportunity to work together towards your renewable energy goals.

Contact

+ 31 (0)85 06 06 485

hallo@emmettgreen.nl

Professor Snijdersstraat 2
2628 RA Delft, Nederland

A. Appendix: Reference Projects

1. Veenkoloniën Hydrogen – Development of hydrogen P2G chain for local industry

The Veenkoloniën Hydrogen is an innovative project involving the development of a complete hydrogen Power-to-Gas (P2G) chain. The chain starts from locally generated green electricity (solar and wind) which is then converted into green hydrogen through electrolysis. This is then taken via tube trailers and direct pipelines to nearby (high thermal) industry, where it will initially be blended with natural gas. In essence, the chain is best described as a kind of hydrogen energy hub. Emmett Green was one of the initiators in the original feasibility study that confirmed the potential of the project. Subsequently, Emmett Green was the party that found the final investing party for the project. More recently, Emmett Green played a crucial role in the initial development phase and was responsible for the technical design, economic model and associated simulations, as well as guiding both the permitting and subsidy process for the plant.

2. Green Planet FCPB project – Design fuel cell powerbank combination

The FCPB project in collaboration with Green Planet involves developing and implementing a semi-mobile integrated fuel cell power bank combination (FCPB combination) specifically for charging battery-electric tools on-site at construction and infrastructure works. Emmett Green is responsible for the research, development, and implementation of the combination on both technical and economic levels. Additionally, the EMS team is developing a smart energy management system that allows the modules to work together integrally.

3. NRG2ALL Haalbaarheidsonderzoek – Evaluation of multiple potential locations

Emmett Green conducted a feasibility study for NRG2ALL on implementing a hydrogen electrolysis project in the North Brabant region. In this project, the supply and demand of renewable hydrogen are directly connected through a decentralized hydrogen chain. Multiple locations were assessed on technical and economic aspects. The economic aspect was evaluated using a specific exploitation model for electrolysis, with revenues determined through simulations. Additionally, an analysis was conducted on the stakeholders, permit conditions related to the technical design, and possible project subsidies.

4. H-Vision – Projectmanagent during project definition phase

H-vision is a collaboration among various companies working together to reduce CO2 emissions in the port of Rotterdam through hydrogen solutions. Emmett Green delivered a project leader for H-vision on behalf of Deltalinqs to reach an investment decision of go/no-go. Specifically, Emmett Green provided support in inventorying, drafting the main project proposal, and managing the project during this phase.

5. OV-bedrijf Groningen-Drenthe – Feedstudy en preliminary design of 10 H2 busses

Development of a 110-ton green hydrogen installation for 10 buses of the public transport company Groningen-Drenthe (2018-2019). The project includes 3 parallel electrolysers, compression, storage, cooling, and high-speed dispersion. Emmett Green assisted in drafting the approach plan, as well as the feed study and preliminary design. Emmett Green also engaged in negotiations with banks regarding financing, suppliers, and the client.

6. EnTranCe – Research on dynamic control of an alkaline electrolyser

Along with EnTranCe, the Emmett Green EMS team tests and refines the dynamic control of an alkaline electrolyzer by our EMS. Our team is actively monitoring and controlling an electrolyzer at the EnTranCe test site based on various energy markets and scenarios. This practical experience allows us to further develop our EMS and better adapt it to the installations.