CleanTech: Energy

Industry overview

FINALLOT

July 2022

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Industry overview

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The situation on the venture capital market in the field of “clean technologies” has changed significantly over the course of the past three years. We have been witnessing a serious influx of capital into the industry since late 2019, driven by three factors:
- increased interest in the climate agenda,
- the appearance of promising new technologies,
- the effort to achieve energy independence.

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The past three months (April–June 2022) have shown that a decline in investment and a significant reduction in the market capitalization of companies is not being observed in the “clean technologies” field (with the exception of the overheated electric and hydrogen-powered vehicle segment), unlike the situation in other VC segments, which are suffering from market uncertainty and an economic recession.

3

It is important to note that the cost of an average deal in CleanTech is significantly higher than in other industries. According to data from PwC, if the average value of a transaction increased nearly four-fold in 2021 compared to the previous year, from $27 million to $96 million, in 2022 this cost increase levelled off, although it did not start to decline. A significant role in this continues to be played by state grants and subsidies.

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Global Trends

The boom in green venture capital projects in 2006–2011 was followed by a decline in interest in this agenda. Venture capital funds had spent more than $25 billion on financing "clean technologies" back then and had lost more than half of their money, according to research from MIT Energy Initiative. The financing of clean power generation companies on the part of venture capital funds nearly dried up completely.

Since late 2019, venture capital money is once again actively flowing into "green companies". According to data from PitchBook, more than $40 billion in venture capital investments flowed into climate technology companies between January 2020 and August 2021, a figure 37% higher than the overall volume of financing over the previous two years. The EU is aiming to become climate-neutral by 2050.

This trend will continue in 2022, because yet another important factor has been added to the climate agenda — rising energy prices and Europe's efforts to achieve energy independence. More than 100 companies, from Microsoft to Unilever, want the European Union to give greater attention to renewable energy sources, inasmuch as the bloc is trying to end its dependence on Russian fossil fuels.

Several important technological changes have taken place since the "clean technologies" bubble burst 10 years ago. Here are but two examples. Renewable energy sources such as wind and solar are beginning to compete with fossil fuels on price for the first time. Electric vehicles are becoming commonplace after progress in the field of lithium-ion batteries has made them an attractive alternative to gasoline and diesel powered automobiles.

At the given moment, the USA and Europe are investing billions of dollars in expanding scientific research and subsidizing breakthrough technologies in this field. This cannot but show results. On the whole, as soon as a technology reaches maturity and works out a tried-and-tested business model, capital starts to flow in rapidly and can help to speed up its adoption.

In summary, a significant quantity of analysts are in agreement that the development cycle for "clean technologies 2.0" shows significantly more promise than version 1.0 did.

The main long duration energy storage technologies

that can be placed into operation in the near term

	description	state of readiness	advantages	shortcomings
Compressed air	Air is stored underground in a compressed state comes out to drive a turbine as necessary	Northern Ireland 268 MW	Longer-lasting than batteries	Requires energy for heating. Requires locations with suitable geology
Gravitation	Any kind of mass is lifted with the use of excess energy; energy is released as the mass comes down	Gravitricity 250 kW under construction	Simple to build in any location Lower cost than battery	Requires locations with suitable geology
Thermal	Solar energy heats and melts salts which then heat water to produce electrical energy	Dunhuang, China 100 MW	Developed technology Scalable	Not very efficient. Requires thermal insulation to reduce heat loss
Hydrogen	Hydrogen is produced by way of electrolysis from excess electrical energy and is subsequently used in fuel cells	Developed technology Long-lasting and inexpensive	Can be transported Can be stored for a long time	High cost of tanks for transportation and storage. Undeveloped infrastructure
Hydraulic accumulator	Water for the accumulation of energy is pumped from a lower reservoir into an upper one and then in reverse order to produce energy	Widely prevalent throughout the world	Developed technology Long-lasting and inexpensive	Serious limitations with respect to the topography of the locale. Large investments for construction
Li-Ion battery	Lithium battery cells in blocks	Hornsdale, Australia 100 MW	Cost of batteries is falling	Cells wear out quickly. Non-optimal maintaining of grid stability. Complexities with disposal
Liquefied air	Excess energy cools air and liquefies it under pressure; upon evaporation it drives a turbine to produce electric power	Bury, UK 5 MW/15 MW	Long service life Flexibility in choice of location. Can be charged and maintain grid stability	Low efficiency 50-60% High activation time
Liquid batteries	An electrolyte is stored in two reservoirs and is pumped through to charge/discharge	Dalian, China 200 MW	Almost no deterioration Long life cycle. Easy scalability and disposal	Lower efficiency than lithium-ion batteries. Significantly larger size

The Situation Today

PwC has identified more than 6000 unique investors among venture capitalists, private investors, corporate venture funds, angels, philanthropists, and state funds. Together, they have financed more than 3000 technology start-ups in the "clean technologies" area in the period from 2013 through the first half of 2021.

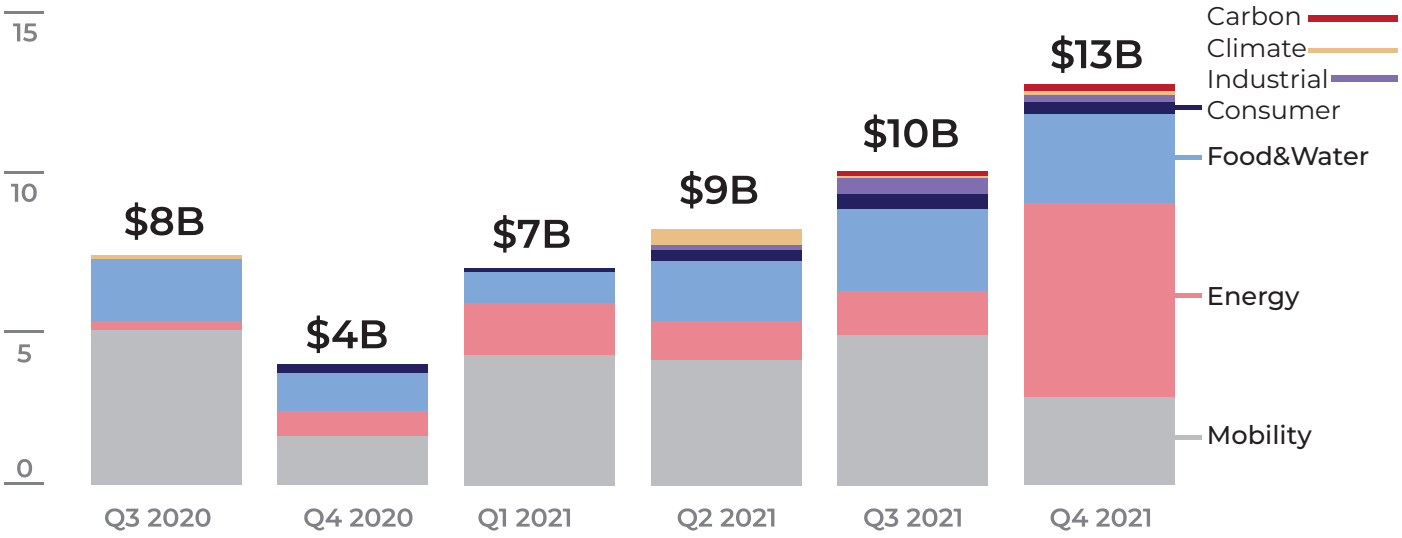
The number of climate technology unicorns has grown to 78. The largest number of such unicorns can be found in the sphere of mobility and transportation (43), followed by agriculture (13), industry, production, and resource use (10), and power generation (9). At the present time, a problem is present in the sector — investments are being disproportionately directed into problem areas with a lower overall emissions reduction potential (ERP), while problem areas with a high ERP and lower-maturity technologies remain underfinanced.

Between the second half of 2020 and the first half of 2021, nearly 65% of venture capital money was directed toward start-ups in the field of climate technologies in the USA ($56.6 billion). The second-biggest region in magnitude is Europe with $18.3 billion, and third is China with $9 billion.

An increase in investments is being observed in the majority of regions over the past 12 months, on average by 208% compared to last year. The increase in investments in Chinese start-ups lags behind the average figure, although it does make up 138%.

The average size of a transaction in the first half of 2021 increased nearly four-fold compared with a year earlier — from $27 to $96 million. Mega-deals are becoming an ever more widespread phenomenon and in large part characterize the recent increase in investments in climate technologies.

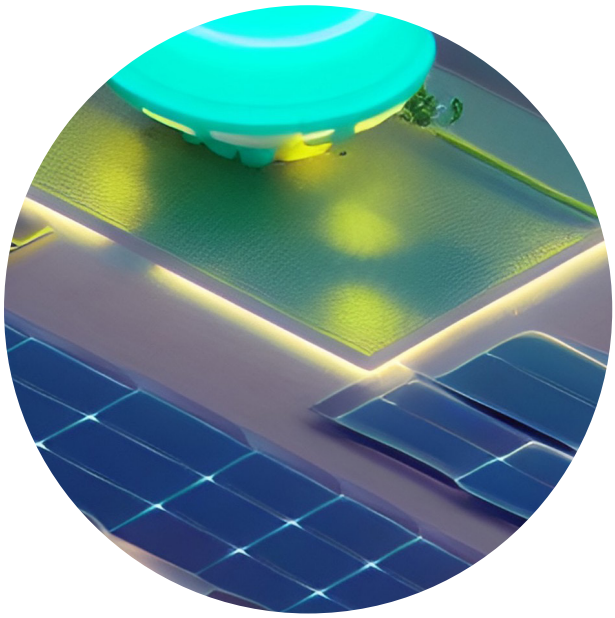
Venture capital investment by sector



Promising Projects

Heating and cooling

Energy efficiency in homes and industry, heat pumps



According to data from the European Commission, 50% of all the energy consumed in the EU is used for heating and cooling. In such a manner, from the point of view of CleanTech and the intention to achieve a state of "net zero" emissions, this segment can be said to be a key one. The following technologies can be identified within it: heat pumps, thermal batteries/heat accumulators, capillary mats, and the like. Worth mentioning separately are heat leakage control systems, as well as technologies and materials for improved thermal insulation: insulation, paints and spray coatings, and energy-efficient glass.

In the opinion of Kevin Krause, principal with Affiliated Engineers, 4th generation (2020–2050) energy system principles will need to be implemented in Europe in the next 10 years:

- **district heating;**
- **heat recovery;**
- **low-temperature hot water;**
- **central heating and cooling;**
- **electrical and thermal energy storage;**
- **combined heat and power generation systems;**
- **biomass as an energy source;**
- **geo heat exchange through geothermal pumps;**
- **renewable energy: solar and wind energy.**

The complexity of this segment consists of the commoditization of many technologies and the absence of serious technological breakthroughs that could give a specific start-up a key advantage and a chance to defend its market position.

DeWarmte (Netherlands)

Description of company: They have developed a renewable heating system. With the help of a special apparatus, it is possible to retain the heat of household wastewater, extract the heat from it, and subsequently store it in order to supply households with hot water and heat. Up to 27°C can be saved daily in such a manner, while carbon dioxide emissions are reduced by 20%.
Earnings: No data available.
Investments received: No data available.

Heaten (Norway) — Series A

Description of company: A Norwegian company focused on accelerating the electrification of heating. They produce heat pumps for industrial purposes capable of achieving 200°C without using fossil-fuel energy in so doing. They are a leader in innovation in "very-high-temperature heat pump" (VHTHP) technologies. In March of 2022 they signed an agreement with AVL Schrick GmbH to install Heaten's first pump.

Earnings: No data available.

Investments received: They have received a total of $10.3 million over three periods between September 2020 and January 2022.

The principal investors: the Norwegian state fund Nysnø, Azolla Ventures, Shell Ventures, and Valinor AS.

4energy (UK) — Corporate round

Description of company: They have created equipment and software for optimization of IT equipment cooling. The technology allows for easy installation and minimal servicing.
Earnings: No data available.
Investments received: The principal investors are Catapult Ventures and Claret Capital Partners (debt capital).

SatelliteVu (UK) — Series A

Description of company: A satellite thermography service allowing for the temperature of any building on the planet to be monitored, the movement of fuel to be tracked, for example gas or oil in pipelines; and the thermal pollution of water to be monitored. In February 2022 they signed an agreement with SpaceX for the launch of the first satellite towards the end of the year.
Earnings: No data available.
Investments received: They have received a total of $27 million over a span of two years.
The principal investors are: Contrarian Ventures, Seraphim Capital, and Tech Nation.

Triple Solar (Netherlands)

Description of company: They have created a system for heating a house and water, together from the generation of electricity, with the help of solar batteries. Thanks to the special design of the batteries, the system is capable of collecting not only solar energy, but surrounding heat as well. In such a manner, everything can work efficiently and continuously. The collected heat and electricity gets transferred into a heat pump, which heats water to be used in the house.
Earnings: No data available.
Investments received: No data available.

Energy storage

Batteries, supercapacitors, gases, electrolytes, kinetics

Energy storage systems are a key link in the more efficient use of renewable sources of energy and optimization of the use of energy from traditional sources. Disparities between production and consumption of energy lead to significant losses. Thus, emissions of greenhouse gases into the atmosphere are being reduced by 30%, but when batteries are connected to solar panels this figure rises to 80%.

In the 2000s, a multitude of participant-companies in the German initiative Desertec began developing the idea of creating the largest solar farm in the world on the territory of the Sahara. The project was supposed to put an end to Europe's dependence on oil and gas. However, problems began to appear during the planning, for example — the transportation of energy. Since the farm was supposed to produce energy for Europe, methods of transporting it over distances of more than 3,000 kilometers were required. This, even with the help of the most advanced technologies of that time, turned out to be not efficient financially, because the greater part of the energy would get lost en route. With the development of technologies for the storage and transportation of energy, such plans may once again become a reality, although other problems remain. There is very little infrastructure in the region of the Sahara, and this deficiency would first need to be remedied in order for such a project to move forward. Likewise, this region can be politically unstable, because of which investors are hesitating to get on board. Finally, since the 2000s, the cost of solar panels has dramatically fallen, which has allowed Europe to build farms on the continent on a massive scale at costs that can compete with fossil-fuel energy. In 2020, after a 25 million euro state program for the development of energy storage capability was announced in Germany, 88 thousand household storage units were installed in the country, while their total number reached 272,000. According to the forecasts of the German solar industry association BSW-Solar, the capacity of the energy storage systems in Germany by 2030 should increase from today's 2.4 GWh to 18 GWh.

At the beginning of 2022, a report by Aurora ER was published in Britain, in which it is said that the further introduction of LDES (long duration energy storage system) solutions could reduce the UK's dependence on gas by 40% and provide for 2 billion pounds in savings. The key problem is the inefficiency of traditional battery systems.

Technologies that can help: flow batteries, capacitors, kinetic storage units, and water-, salt-solution-, and liquefied-gas-based thermal batteries/heat accumulators. Chemical technology for energy conservation (not counting traditional batteries).

Energy storage systems — the most efficient and accessible technology for maintaining stable operation of energy grids today

	Nuclear		Storage		Connectivity
	NPP	SMR	Short-term (up to 4 hours)	Long-term (over 4 hours)	EC
Commercial availability	working	not ready	working	nearly ready	working
Performance	81%	data not available	12-74%	95%	49-90%
Startup time	12 hours	30-60 minutes	less than a minute	1-10 minutes	30 minutes
CAPEX (GBP)	4000-5000 kw	3600-4500 kw	250-950 kw	600-5500 kw	600-700 kw
CO2 emissions	0	0	0	0	low
Comments		can be used where NPPs cannot be built	limited range of application	many technologies	limited capacity

Powervault (UK) — Crowdfunding

Description of company: They produce storage systems for solar and other excess energy in the home. The system allows clients to reduce their electricity costs and their impact on the environment, and to earn money from the excess electricity. As electricity prices rise, the quantity of solar panels on private homes is increasing, which allows for the private energy storage market to expand.

Earnings: No data available.

Investments received: Over 4 years they have raised $5.4 million through crowdfunding.

Principal investors: European Innovation Council and Crowdcube.

EnergyVault (Switzerland) — IPO

Description of company: A system for storing excess renewable energy in the form of gravitational potential energy that can be used as required. Using cheap excess energy, special blocks are lifted and stored in an elevated position; then, as required, they are lowered, by means of gravity, activating a generator. In July 2020, they completed construction of a working prototype in the form of a tower intended for both functionality and demonstration purposes. The basic system, EVx, was introduced in the form of a large building, like a warehouse. EVx is a modular technology, capable of being expanded in 10 MWh increments.

Earnings: They earned $42.9 million in the first quarter of 2022; however, there was no profit.

Investments received: They have received $280 million in all. In August 2018, SoftBank invested $100 million, and then two years later a multitude of other investors invested yet another $100 million in the company, including: SoftBank and Saudi Aramco Energy Ventures. They became a publicly traded company in February of 2022.

Convion (Finland) — Series A

Description of company: A solid-oxide fuel cell system for the production and storage of electrical energy. This method is one of the most efficient, and likewise can easily become modular. It is likewise capable of producing both electricity and heat. In 2021, Covion's technologies became the principal energy generator in the state project LEMENE — a miniature version of the national electrical grid.

Earnings: No data available.

Investments received: The European Innovation Council invested €50 thousand in the company in December 2014.

VoltStorage (Germany) — Series B

Description of company: They produce two variants of batteries for storing energy: commercial and long duration. Both variants are based on flow battery technology, a more reliable and practical storage system that does not have a strong impact on the environment. Unlike the commercial batteries, intended for more rapid use, the long duration batteries are capable of producing electricity over a span of longer periods of time, thereby allowing for the production of clean energy to be efficiently maintained. Since these batteries are based on more accessible elements — iron, salt, and water — the cost of the batteries drops significantly, and they are likewise safer and have a minimal impact on the environment.

Earnings: No data available.

Investments received: Over 4 years, they have been able to raise $13 million, from SOSV, InnoEnergy (EIT), Energie360º, Korys, and Bayern Kapital.

Northvolt (Sweden) — Series B

Description of company: They are the first company to begin producing batteries in Europe. The Company creates different variants of lithium-ion batteries (from standard round ones to special ones made to order), aspiring to reduce their impact on the environment. Using only renewable energy, the batteries' carbon footprint has fallen by 80%. The first battery came off the assembly line at the new factory at the end of 2021.
Earnings: They have $30 billion in contracts to supply batteries from companies such as: BMW, Volvo, Volkswagen, and Fluence.
Investments received: Over 4 years, they have raised $6 billion from 47 investors, among whom the largest are Volkswagen Group and the European Investment Bank.

Energy Dome (Italy) — Series A

Description of company: The company has developed a method for storing energy with the help of carbon dioxide, which under pressure can be stored in liquid form and, unlike other gases, does not require low temperatures. In order to "discharge" and obtain electricity, the pressure is lowered, and the liquid once again becomes a gas and fills a space with a turbine. Subsequently, the gas returns to the chamber, from where it can once again be "charged". In March 2022, the company entered into its first licensing contract with Ansaldo Energia.
Earnings: No data available.
Investments received: Over two years, the company has raised $22 million from 5 investors, among whom are Barclays Sustainable and Impact Banking, 360 Capital, and CDP Venture Capital.

ESS (USA) — IPO

Description of company: Analogous to the German company VoltStorage (examined earlier), ESS produces flow batteries with a salt and iron based liquid. This allows the batteries to be cheap, safe, reliable, and efficient, as well as reducing the batteries' impact on the environment.
Earnings: Over the first quarter of 2022, the company has yet to receive income.
Investments received: The company went public in October 2021, having raised $250 million after the IPO, which brought overall investments up to $297 million.

Form Energy (USA) — Series D

Description of company: They produce batteries for storing energy in an electrical grid. The battery is based on the "reverse rust" process. In such a manner, when the battery discharges, it breathes in oxygen, converting the iron inside into rust; and when it is charging, with the help of electricity the rust takes on its previous form as iron, and the battery breathes out oxygen. Such batteries can be modular and can easily increase their capacity; likewise, not having any dangerous elements, they can be recycled relatively simply.
Earnings: No data available.
Investments received: Over 4 years they have raised $368.8 million from such investors as: The Engine, Prelude Ventures, ArcelorMittal, and Breakthrough Energy Ventures.

Antora Energy (USA) — Series A

Description of company: They have created a method for storing energy for electricity and heating. Blocks of carbon are heated with the help of excess energy, after which they discharge heat and electricity. Such blocks are capable of storing energy for several days, can be charged rapidly, and are modular.
Earnings: No data available.
Investments received: Over 4 years they have raised $51.5 million. The principal investors are: Breakthrough Energy Ventures, Shell Ventures, and the National Science Foundation.

Malta (USA) — Series B

Description of company: A method for storing electricity in the form of heat, with the help of molten salt. Excess electricity is used in a heat pump, creating two chambers with different temperatures: a hot one, in the form of molten salt, and a cold one, in the form of a liquid. When electricity is required once again, both chambers are mixed together in a heat engine. Such a technology allows for cheap, durable, and flexible storage that does not require special geography.
Earnings: No data available.
Investments received: Over four years they have raised $86.9 million from Breakthrough Energy Ventures, Alfa Laval, Proman, Piva Capital, Concord New Energy Group, and Chevron Technology Ventures.

Optimization of energy distribution

Balancing consumption, grid and energy distribution management

Appearing along with the development of solar and wind power generation was the phenomenon of the "duck curve". It is named for the form of the graph that reflects the effective load on a grid in the course of a day. The term was introduced by the electrical grid operator California Independent System Operator. The disparity between the load and hourly energy tariff rates and the vulnerability of electrical grids increases as the duck curve phenomenon becomes more prevalent. A significant quantity of energy is not used during generation peaks; there is insufficient energy during consumption peaks. To optimize the load on the grid and consumption, it is important not only to have systems for storage of energy, but also efficient IT solutions allowing tariffs, the load on the grid, and energy consumption to be optimized.

Methods for generating energy on a small scale have begun to be developed in recent times, for example solar panels on private houses. These units are called distributed energy resources (DER), and such technologies have great potential, but difficulties lie ahead as well. They are capable not only of supplying the houses on which they are found, but entire electrical grids as well, relieving the burden on suppliers, but likewise placing a burden on grids that are unequipped to handle this. The additional energy can destabilize the electricity in other houses, which is why detailed monitoring of everything that takes place is required.

The Economist magazine conducted a survey of some developing technologies capable of turning DER from a hindrance into a driver of new electrical grids. In May, the Chinese company Huawei released a new version of FusionSolar — a system for the home that combines solar panels with batteries for storage. This system trims the frequency of the grid in the home to that of the main grid. The Australian charitable organization EnergyWeb is coming out with similar intentions as well, hoping to give private DERs an opportunity to connect to the grid and sell energy. However, practicably connecting a DER with an energy grid is only part of the problem. Nowadays, when a multitude of such technologies is connecting to the grid, it is becoming ever more complicated to manage it.

For this reason, Google is developing a platform by the name of Tapestry in its incubator X. This system is supposed to furnish detailed and super-precise information about everything taking place in a grid, allowing it to be managed at a hitherto unattainable level. All these technologies, together with developing electrification (for example of heating or of cars), are allowing for the creation of a new, more flexible grid, since devices (heat pumps or electric cars) are capable of adapting how much energy they take and when. In such a manner, a flexible energy grid could reduce electricity prices for consumers by 10–17% (by 75% for electric cars), and even for suppliers, optimizing delivery.

Besides the large companies developing technologies, successful start-ups have appeared in the past few years engaging in electric power price arbitrage and the distribution of loads within the grid.

Fuergy (Slovakia)

Description of company: They have created an "Energy-as-a-Service" system that allows consumers to get cheaper and cleaner energy without needing to buy equipment. They have developed a system for managing energy consumption based on AI, and are likewise creating a system for the storage of excess or solar energy in batteries. At the given moment they are developing an ancillary system for the sale and distribution of energy. They likewise have a series of systems aimed not only at consumers, but at electricity suppliers as well, for example systems for monitoring and management.
Earnings: No data available.
Investments received: No data available.

Hydrogrid (Austria)

Description of company: Optimization and forecasting algorithms for hydroelectric power stations. The system is capable of automating the servicing of the stations by anticipating weather, prices, and the production of energy and planning of its dispatch, and by furnishing reports.
Earnings: No data available.
Investments received: Over a span of 3 years they have raised a total of $2.8 million. The principal investors are: SET Ventures and CNB Capital.

Enervalis (Belgium) — Series A

Description of company: A forecasting system for buildings and electrical micro-grids. With the help of artificial intelligence, machine learning, and forecasts of the weather and user habits, it forecasts demand for energy and adjusts the electricity supply.
Earnings: No data available.
Investments received: Over three years they have raised $7.7 million from ABB Technology Ventures, LRM, Nuhma, and Elia System Operator.

JiTiV (Poland)

Description of company: A SaaS company that offers consumers a system for monitoring and regulating energy consumption with the help of artificial intelligence, expanded analytics, and equipment allowing a reduction in prices of as much as 40%, as well as automation of the majority of optimization. They are oriented both at households and at industry.
Earnings: No data available.
Investments received: No data available.

Svea Solar (Sweden) — Series B

Description of company: The company aims to digitize clean power generation. They produce and supply solar panels, batteries, and charging stations for electric cars, as well as having created software that allows owners to keep track of and manage all these technologies. Main clients are considered to be private homes. In August 2021 they began working jointly with IKEA.
Earnings: No data available.
Investments received: In all they have raised $118.5 million in 3 years from Altor and D-Ax Corporate Venture Capital.

DEPsys (Switzerland) — Series B

Description of company: They have created a system that helps monitor, manage, optimize, and automate an electrical grid. The system uses special sensors to furnish precise information in real time. Likewise, the company offers the ability to configure a system to meet the requirements of an individual grid. Germany's big energy distributor Syna GmbH became a DEPsys client in 2021.
Earnings: No data available.
Investments received: Over 9 years, the company has raised $18.5 million from 9 investors. The principal investors are: SET Ventures, BNP Paribas, and EASME.

Octopus Energy (UK)

Description of company: A British electricity supplier that specializes in clean / renewable energy. The company aims to furnish clean and cheap electricity, with the help of technologies such as efficient and flexible energy distribution software, as well as special tariffs. As of 2022, Octopus Energy has become the fifth-largest supplier of energy in Great Britain. It is a subsidiary of Octopus Group, an asset management company.
Earnings: No data available.
Investments received: Since 2020 they have raised $1.5 billion from Origin Energy, Canada Pension Plan Investment, Generation Investment Management, and Tokyo Gas.

Enel X (Italy) — Grant

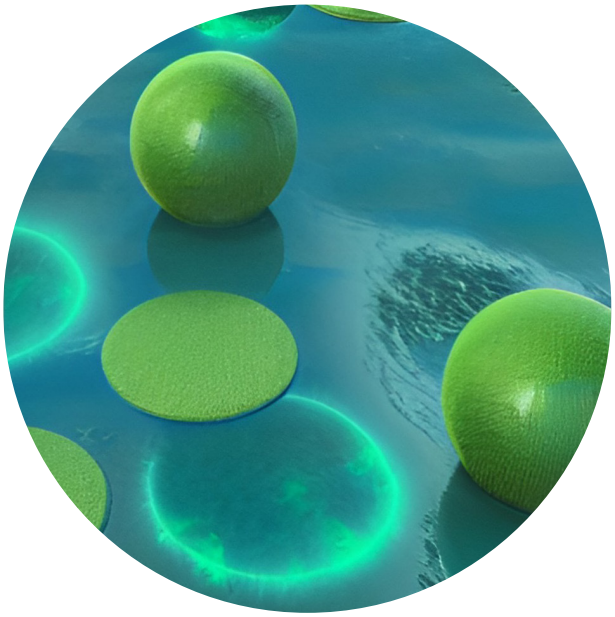
Description of company: A company developing ideas and technologies for the more efficient use of energy. Main focus — urban lighting, for example adaptive light on roads, first introduced in Bologna in 2018. This light adjusts its intensity based on the quantity of cars, the weather, and other factors. Likewise, the company is focused on more efficient urban transit.
Investments received: In September 2020 they received a grant in the amount of $200 thousand from the Massachusetts Clean Energy Center.

Gasunie (Netherlands)

Description of company: Suppliers of electricity and heat, developing clean energy in The Netherlands. The company has several spheres of activity: natural and clean gas, hydrogen, heating and management, carbon storage and use. The company is working on a multitude of projects with partners in order to provide the country with clean energy, as well as to reduce the quantity of carbon dioxide.
Earnings: In 2021, the company's Earnings comprised €1,386.3 million. Net profit for 2021: €310.7 million.

Green hydrogen

Production, energy storage, and use



Chemical energy conservation technology is primarily about the production and use of hydrogen. Start-ups in this field are represented by three clusters: efficient green production of hydrogen, its storage and transportation (compressed hydrogen, ammonia, formic acid, polypropylene gas transportation system), and its use (fuel cells). At the present moment, the development of hydrogen energy is being actively subsidized at the state level in the USA, Japan, Korea, and the EU countries.

There was a discussion in The Economist magazine of how production fueled by green hydrogen energy might look. In the opinion of the authors, much more of it will be required in order to continue working in the same way as with fossil-fuel energy. As an example, if only Germany's two largest factories — the chemicals producer Ludwigshafen and the steel producer Duisburg — switched to clean electricity, demand in Germany would increase by 10%. **Despite the steep plunge in prices for renewable energy — including hydrogen now as well — transitioning to this technology may be complicated.**

Let us take the heating of buildings. In contrast with natural gas, burning hydrogen in a boiler gives less energy than is required to produce it. Because of this, heating is going to have to be implemented with the help of heat pumps. An analogous problem arises in industrial factories where, in order to not exceed a 1.5°C rise in global temperatures, the quantity of pumps must increase to 35 million by 2030. In industry, where high temperatures are required (in excess of 500°C), it is possible to use hydrogen as a fuel, but certain processes and equipment will still need to be changed nonetheless. Bottom line, the majority of industry will be able to switch to clean energy, but it will always be under the influence of the past — for example, carbon is still going to be needed for chemical purposes in the production of steel.

H2GO Power (UK) — Grant

Description of company: H2GO specializes in the storage of hydrogen in solid form for energy. In May of '22, they received £4.3 million from the state for the development of a "smart" energy system on the Orkney Islands (Scotland). The system, which works with the help of AI, is supposed to replace up to 28,500 liters of diesel and eliminated 90 tons of carbon dioxide emissions per year.

Earnings: No data available.

Investments received: In March 2021 they raised £2.4 million in crowdfunding. Earlier, they have been receiving support from Cambridge University. In May 2022 they received a state grant in an amount of £4.3 million.

H2PRO (Israel) — Series B

Description of company: A two-step electrolysis process has been developed for obtaining hydrogen and oxygen from water separately, with efficiency exceeding 95%. In March 2022, they announced the start of construction of their first production facility.

Earnings: No data available.

Investments received: In January 2022 they raised $75 million, where the principal investors were the Singaporean state company Temasek Holdings, and the Luxembourg company Arcelor-Mittal, the Irish company Yara Ventures, and the American company Breakthrough Energy Ventures.

H2Fuel (Netherlands)

Description of company: They have invented a method for the production / storage of hydrogen that does not require either high pressure or low temperatures. Required for production / storage are pure water and sodium borohydride (NaBH4) in powder form. In such a manner, the process of transporting becomes simpler, while storage time is unlimited. One cubic meter can furnish up to 9 MWh of energy. Likewise, the residue after the chemical reaction can be processed and used anew in the subsequent process.

Earnings: No data available.

Investments received: No data available.

HySiLabs (France)

Description of company: The company specializes in the storage of hydrogen in liquid form. «HydroSil» technologies allow a special liquid to be charged with hydrogen, which can then be easily transported or stored under ordinary temperatures. Likewise, this technology does not require additional energy besides heat to extract the hydrogen and produce energy.

Earnings: No data available.

Investments received: $13.95 million has been mobilized, over the span of 4 years (2016–2020), from 7 of Europe's investors: the European Innovation Council (EIC), the EIC Fund, the European Institute of Innovation and Technology (EIT) InnoEnergy, EIT Climate-KIC, Paca Investissement, Région Sud Investissement, Bpifrance.

Sylfen (France)

Description of company: They have invented a system for buildings that allows for excess energy to be used to charge a battery and produce hydrogen (with the help of electrolysis). After this, when more energy is required, the charge of the battery is used up, and likewise used is a part of the hydrogen, which returns through the electrolysis apparatus, which is capable of producing energy from the hydrogen. Using the battery and the hydrogen simultaneously results in more reliable and efficient energy storage. The company is focused mainly on buildings that collect their energy (for example with the help of solar panels), stabilizing the reserve of energy.

Investments received: In May 2022 they raised €10 million. The principal investors are: CEA Investissement, EIT InnoEnergy, and IDEC Group.

Enapter (Germany) — IPO

Description of company: The company specializes in apparatuses for electrolysis. Using Anion Exchange Membrane technology, they are capable of greatly reducing the size of the apparatus, furnishing it not only to clients in industry, but to individual consumers as well, for use in homes. In March 2022 they released the 4th version of the apparatus, standardized and intended for mass production.

Earnings: For 2021, the company had Earnings of €155.8 thousand; profit was not observed, however.

Investments received: The company has raised $105.6 million over 4 years. In October 2021, the company won a prize in an amount of £1 million from Earthshot Prize.

Corre Energy (Netherlands) — IPO

Description of company: The company is building underground storage chambers for hydrogen. In such a manner, it is possible to store energy in the form of hydrogen under pressure, for very long periods of time (in excess of 35 years) and in large quantities, at relatively low expense. At the given moment, the company is working on the Green Hydrogen Hub Denmark project.

Earnings: For 2021, the company had Earnings of €5 thousand; profit was not observed, however.

Investments received: The company went public in September 2021, after which in May 2022 it raised €10.9 million (Post-IPO). The principal investors are: Bloomsbury Holding Limited, Lorlen Investments Limited, and Air Corre Limited.

Important Funds in the Segment

The experience of the following funds is worth studying in greater detail:

Breakthrough Energy Ventures ($2.2 billion) EU

A venture capital company founded by Bill Gates in 2015, focused on the development of clean energy and the elimination of carbon dioxide pollution. The members of the company are 28 wealthy investors besides Gates. Together they created in 2016 a $1 billion fund aimed at fighting climate change through investment in clean energy innovations.

Energy Impact Partners ($2.3 billion) USA

The company is focused on reducing carbon dioxide emissions, and on achieving a carbon-neutral world more quickly. They make use of their expansive connections in the finance, technology, and infrastructure sectors to analyze potential companies for investments in detail, creating a successful portfolio, and allowing the venture capital company to furnish more expertise for each partner in the portfolio.

Energize Ventures ($480 million) USA

The company's focus is digitalization of the clean energy industry. The company is interested in process automation, decentralization, electrification, optimization, and risk reduction. They prefer to invest in Series A, B, and C start-ups, often playing the role of principal/leading investor. The average amount of an investment comprised $10–20 million.

ETF Partners ($400 million) UK

The company invests in innovations in the clean energy sphere and technologies aimed at environmental sustainability. They prefer impact investing, seeking out start-ups with high potential and impact. They are one of the leading venture capital companies in the sphere of clean / sustainable technologies.

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