



HEAT PUMPS IN ROTTERDAM

Welcome to Rotterdam, host of the 12th IEA Heat Pump Conference 2017

With participants from over 30 countries, 12th IEA Heat Pump Conference is a key event for policymakers, executives and representatives from industry, utilities and the public sector, R&D managers and technology supporters, energy managers, planners, consultants.

What a place to be, according to Lonely Planet, Rotterdam is in the Top 10 of cities to visit. Those looking for heat pumps will have to do more as many of these are hidden under all those smart facades. This small guide is only describing a few of these.

'We're from Rotterdam - we'll keep going!' appeared on a placard just days after the city was devastated by the WWII aerial bombings on 14 May 1940. This motto in many ways typifies the resolute character of Rotterdam and its inhabitants. In the war's aftermath, a buzzing metropolis was built literally on the post-blitz ruins, including a heating-network throughout the centre. Around the area of the Central Station an area of high rise buildings appeared, which was at the time a revolution in the Dutch landscape. On the south bank of the river the former rather neglected harbour quarters at the Kop van Zuid a complete new district is being redeveloped into a new city centre. The Erasmus Bridge is the link between these two districts. In another part of Rotterdam, being the city centre, the renovation of the World Trade Centre was followed by the high rise buildings around Blaaktoren and the spectacular, much appraised Market Hall, opened in December 2014.

BEST PRACTICES

Rotterdam is synonymous with innovation, whether it is in architecture, the creative sector or the port. Home to Europe's

largest port, Rotterdam is often a trendsetter. For sustainability the city is participating in the important '100 resilient cities' project by the Rockefeller Centre and so very active with many sustainability projects (<http://www.resilientrotterdam.nl/>).

So, how do heat pumps relate to the development of the city of Rotterdam? Construction projects in Rotterdam demonstrate the very best practices of sustainable development, namely by combining heat pumps with thermal energy storage (ATES) in principal almost always in combination with district heating. Sustainability is an important element of Rotterdam's vision. The thermal energy-plan for the underground makes room for heat pump projects. Room for innovation, but also literally: room to prevent interference between different thermal storage projects. Rotterdam shows that having district heating does not exclude heat pumps nor energy storage, having this base load opens opportunities. Rotterdam strives for the optimal combination of different sustainable solutions, and the examples shown below prove that this approach works.

A large section of the large new buildings, like Central Station, the Markhal and Calypso have heat pumps installed, also the World Trade Centre the venue of our Conference. These being the most eye catching examples of sustainable developments there are also miscellaneous projects in and around the Rotterdam area, also in industrial sectors and the greenhouse sector. This guide is giving an overview of a number of projects in the different parts of the city.

A MODERN CITY WITH AMBITIOUS BUILDING PROJECTS ALSO MUST HAVE A HEART FOR DURABLE CONSTRUCTION.



1. WHAT IS THE PROJECT ABOUT?

The Timmerhuis in Rotterdam, designed by the world-famous architect Rem Koolhaas, OMA is thanks to the heat and cooling system of Eneco awarded a BREEAM 'Excellent' rating. "The Timmerhuis together with the World Trade Centre is the most energy-efficient building that the city of Rotterdam currently in use has," says Michiel Bakker, System Engineer at Eneco.

2. WHAT DOES THE PROJECT INCLUDE?

In the new Timmerhuis Rotterdam complex, there is an underground garage of approximately 120 parking spaces. The ground floor accommodates shops and space for general use. Above the ground floor, 4 floors are offices for commercial purposes. The remaining floors is composed of a mix of large and small apartments.

3. HOW ARE HEAT PUMPS INTEGRATED?

"A few years ago together with the municipality of Rotterdam, Eneco had conceived the plan to the Timmerhuis to connect it to a large cold distribution network in the inner city, from the Maas to the Rotterdam train station," says Bakker. "When those plans were delayed, we continued to be involved in the project, from our knowledge and experience, implement a sustainable heat and cold storage system through ATES and Heat Pumps." The ATES-installation in the Timmerhuis is equipped with two ETP heat pumps (ETP HWS4400) and two source pairs, which in the heat and cold of the municipal offices, 3,500 m² store features 84 homes and restaurants. In addition, the district heating as a backup and peak supply for the heat demand in the rest of the building. In accordance with the BREEAM requirements is the complete installation with various detection systems to detect any leaks, and quick to catch. The Heat and Cold system is extended to up to 4,100 kW

cooling and 3,230 kW heat output. The overcapacity is used in adjacent World Trade Centre. The heat-and cold distribution network can be extended and linked to other networks in the area.

4. WHY WOULD YOU DEFINE THIS PROJECT A BEST-PRACTICE EXAMPLE?

The advantage of the joint installation is that there is only one installation is required. All the heat and cold from the installation is used in an optimal way. In addition, in the basement of the Beurs-WTC there is much space saved. On one side, the builders had to deal with installations in a monument. Which is why strict rules apply on construction. The other side was that the new build construction is being done within a set steel prefab-cage. The plumbing had to go in between those steel pipes. It is a paradox to integrate the new and the old, yet mission was accomplished. No other building like this ever got the BREEAM Excellent**** certificate.





CASE: MARKTHAL

1. WHAT IS THE PROJECT ABOUT?

Situated in the heart of the centre of Rotterdam just next to the current marketplace, the new Markthal provides space for a variety of functions. The hall, which opened on October 1, 2014, measures no less than 80,000 square meters (861,000 square feet). It accommodates 20 shops, 8 restaurants, a supermarket, a parking garage, 228 apartments, and a market square with approximately 100 food stands.

2. WHAT DOES THE PROJECT INCLUDE?

In order to achieve maximum sustainability for this bow-shaped complex, a thermal storage system was installed to provide cooling and heating for the Markthal as well as the office building located next to it. As the building serves multiple functions, hot and cold air can be exchanged between the shops and the apartments. In order to make this hall even more green, a passive, zero-energy ventilation system was also implemented. Outside air streams in at ground level and rises up to the roof, where fifteen chimneys function as exhaust piping. An information panel in the Markthal displays the results of all these efforts. It shows the energy consumption of the building and the resulting reduction of CO2 emissions in real time.

3. HOW ARE HEAT PUMPS INTEGRATED?

- Total size of the project: 80,000 square meters, including 228 apartments

- Heat Pumps: 2 Carrier screw compressors of 250kW
- Open Ground source with a capacity of 120m³/hour
- The open ground source is shared with the adjacent building Blaak.

4. WHY WOULD YOU DEFINE THIS PROJECT A BEST-PRACTICE EXAMPLE?

What Markthal makes special, is the exchange of hot and cold air between the shops and apartments and the thermal storage with heat pumps. Embedded in the district heating-system makes Markthal an example for every modern city centre.



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CASE: CENTRAL STATION



Onno Kleefkens

1. WHAT IS THE PROJECT ABOUT?

Central Station is fitted with the biggest solar panel roof ever to be found in a European train station. Of the roof's 30,000 square meters, 10,000 square meters is covered in solar panels, an area larger than a football field. The solar power plant of 130,000 solar cells is expected to yield 340 MWh per year, which will provide ample energy supply for the escalators, lighting and elevators at the station. This is similar to the energy consumption of approximately 100 households. The sunroof achieves a CO2 reduction of about 8 percent.

2. WHAT DOES THE PROJECT INCLUDE?

- 10,000 square meters of solar panels, 340 MWh per year
- CO2 reduction of about 8 percent
- Energy savings of about 30 percent for heating and cooling
- Annual savings in CO2 compared to conventional sources of energy of about 20,000 kg
- Average COP of free cooling and watercooled machines of 7.2 compared to 3.5 for individual cooling
- Complete renovation totaling 617 million euros

3. HOW ARE HEAT PUMPS INTEGRATED?

Additionally, the station makes use of thermal storage. The shops

and offices of the Rotterdam Central Station are connected to a thermal storage circuit and are kept warm and cool by the currents released from the station. Moreover, the cold and warm air are not only stored but also constantly reused.

4. WHY WOULD YOU DEFINE THIS PROJECT A BEST-PRACTICE EXAMPLE?

Rotterdam Central is expected to save about 30 percent on energy costs from this form of renewable geothermal energy. This will result in an annual savings in CO2 versus conventional sources of energy of about 20,000 kg.





1. WHAT IS THE PROJECT ABOUT?

Sustainability and quality play a vital role in the design. With a view to future users, the development of FIRST Rotterdam is based on a long-term vision. The sustainability of the building will in the first place be determined by its unique position, directly alongside one of the largest public transport centres of the Netherlands. Moreover, sustainable materials will be used as much as possible in the construction process, while energy consumption will be cut drastically. The design envisages an energy efficient building with excellently insulated roofs and facades, smart technical systems, including monitoring facilities. Extremely high standards have been set for the new build construction. The ambition is BREAAAM Excellent. BREAAAM is the quality mark for the sustainability of new and existing buildings. What does the project include?

2. HOW ARE HEAT PUMPS INTEGRATED?

The choice for heat pumps from Energie Totaal Projecten on a thermal storage system (ATES) was driven by reasons of planning and the requirement that FIRST provides sustainable energy generation right from the start. Point of departure is to realise a high level of comfort using advanced climate control ceilings. Radiant cooling and heating ensure that the

office spaces achieve the highest comfort class. Sustainability principles have also been applied to water consumption, such as the use of water efficient toilets, whereby use is made of collected rainwater.

3. WHY WOULD YOU DEFINE THIS PROJECT A BEST-PRACTICE EXAMPLE?

A key point of attention in urban development is the 'urban heat island' effect, whereby the temperature in a city environment can rise quickly during the day, while cooling only slowly and relatively slightly during the night. A too hot environment reduces comfort levels, causing people to function less than optimally. Sustainability also means that FIRST may not contribute towards the heating up of its surroundings. It is therefore being studied how FIRST can be connected to a new, yet to be laid, sustainable cooling network, which makes use of water from the river 'the Maas'. This cooling system will make it possible to achieve the sustainability ambition at area level and significantly reduce the 'urban heat island' effect. The total package of energy-saving measures results in an energy reduction of 30 - 40% compared with the statutory requirements (savings depending on building section).

1. WHAT IS THE PROJECT ABOUT?

With the construction of the Maastoren, the Rotterdam skyline gained a new icon. Erected in the Kop van Zuid area, the Maastoren has a height of 165 m, making it the tallest building in the Netherlands. Its floor space is approximately 57,000 m², of which approximately 35,000 m² is reserved for office space, 17,000 m² for parking (both underground and street level), 4,000 m² is reserved for the entrance and facilities and 700 m² for technical space.

2. WHAT DOES THE PROJECT INCLUDE?

A practical but flexible and sustainable design within a strict budgetary framework: this was the design assignment that Techniplan Adviseurs received from OVG Projectontwikkeling for the Maastoren project in Rotterdam. Techniplan Adviseurs' commitment to sustainable energy earned them the engineering award De Vernufteling in 2007. One of the most interesting aspects of this project is that the water of the nearby Maas River – complementary to the other sources of aquifer thermal energy storage – is used to generate heating and cooling energy in the building as well as supply the sprinkler system. This allowed the designers to reduce energy sources to half their original size, which in turn meant that the building no longer had to be connected to the district heating system. Overall, this strategy has cut CO₂ emissions in half.

3. HOW ARE HEAT PUMPS INTEGRATED?

The Maastoren is standing besides the river Maas. That is where the building gets its cooling capacity from. The water in the river cools and heats with the seasons, but slower than the outside air temperature. So in spring the cooling from the river is used, but in autumn the warm water warms the building. This way, the also installed heat pump with the soil as core can be smaller.

4. WHY WOULD YOU DEFINE THIS PROJECT A BEST-PRACTICE EXAMPLE?

The combined effect of intelligent installation measures in the area of occupancy detection, maximum daylight utilisation, space and energy-saving lift traction systems, heat recovery from ventilation air and optimum building-physical measures aimed at reducing the overall installation size has resulted in a design with an Energy Performance (EPC) that is 35% lower than legally required. Further, the Maastoren is compliant with the strict financial framework that applies to commercial utility architecture. Finally, thanks to the intelligent elevator concept, the space reserved for the installation core throughout the entire building has been reduced by some 800 m², a space savings that has been directly added to the rentable floor space.



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CASE: CALYPSO

Eneco World

WALLS OF PLANTS AND SOLAR PANELS.

With its mission of providing The Netherlands with 100% green energy in 2030, it was natural for Eneco to want a high-tech, sustainable office. OVG commissioned architect Diederik Dam to design a building that suits Eneco down to the ground, sprinkled with innovative green.

It therefore not only has solar panels on the roof but also The Netherlands' largest solar panel facade, underground thermal energy storage, roof gardens and a 'green wall' two stories tall that not only insulates but also purifies polluted air from the environment.

An updated layout for the office areas, flexibly accommodating 1,400 people, has also introduced an open and interactive approach to work. A building that interacts with its users just as sustainably as with its environment certainly deserves an A+ label.

"In particular the solar energy and TES systems were installed at 'Eneco's explicit request."

The Eneco energy company has a brand new headquarters built in Rotterdam. This energy efficient (A+) building is located

near the (underground) railway station Rotterdam Alexander and the A20 highway.

The reason for building a new office was due to the fact that the organization was located in six different offices throughout Rotterdam. The new office in the Alexander district in Rotterdam was delivered unfurnished in August 2011 by property developer OVG. On the outside, its planted walls and impressive solar power system integrated façade catch the eye. The building's interior will be furnished by Eneco. There will be eight hundred Photovoltaic panels installed on the roof, able to supply power to 51 households annually.



1. WHAT IS THE PROJECT ABOUT?

'De Calypso' is re-emerging where the Holiday Inn Hotel, the Pauluskerk and the former Calypso cinema once stood. Seeming to be in constant movement thanks to its design and sloping façade panels, the striking and colourful building accommodates 407 flats, space for offices and shops and 500 parking spaces. The building will also house the new Pauluskerk.

Calypso is remembered most for her role in Homer's Odyssey, in which she keeps the fabled Greek hero Odysseus on her island to make him her immortal husband. Calypso enchants Odysseus with her singing as she strolls to and from across her weaving loom, with a golden shuttle. Right in the center of Rotterdam the mythical building has risen: 'De Calypso'. With over 400 apartments, 10,000 square meters of retail space and a church, the complex is a striking combination of living, shopping and contemplation. But just as striking is the installation and financing.

VAANSTER

Under the undulating exterior is an interesting energy solution. The complex uses a heat pump with a capacity of 120 m³ per hour from an open source. There is installed a buffer tank of 25 m³. A peak in the demand for domestic hot water is picked up by district heating.

The investment will be as innovative. Vaanster, an investor in

corporate sustainability projects, has adopted the project on the basis of design, build, maintenance and control. Vaanster provides not only the operation but also the realization of sustainable power.

The responsibility for the whole installation lay with Vaanster, so the development team had nothing to worry about the installation during construction. Another important advantage was the financing for the realization. Vaanster paid executive parties directly, so the developers could save on financing.





CASE: BLAAKTOREN

1. WHAT IS THE PROJECT ABOUT?

The 'Blaaktoren' is situated at a remarkable spot in the heart of Rotterdam, close to Blaak train station, the famous 'Cube Houses' and the recently completed Markthal. This location posed a challenge, as there was a rather limited amount of space for construction work and installations. Another matter of concern was municipality rules, established by the city of Rotterdam, that apply restrictions on groundwater sources for the purpose of heating and cooling buildings. A building that is state-of-the-art, both architecturally and in a sustainable way.

In order to obtain an A+ energy performance certificate for the Blaaktoren, a literal 'high level' climate installation was implemented. The so called COWAKO installation is situated at the top floor, 70 meters above ground level. A COWAKO installation is

able to provide heating and cooling at the same time, as it offers passive cooling using the cold groundwater source. However, this 'high level' installation required some adjustment. At ground level, an extra exchanger between the groundwater source and the COWAKO installation was installed .

- Size of the project: 22,500 square meters
- Height: 18 floors (70 meters)
- Thermal energy storage (475 MWh/season/delivery rate 50 m3/h) with heat pumps
- Energy energy performance certificate: A+
- Reduction in annual CO2 emissions: 120 tons



CASE: UNILEVER

The Blue Band factory from Unilever at the Nassaukade in Rotterdam is over 120 years old and at the moment the world largest factory for margarine, with an output of more than 200,000 tonnes of margarine and 10,000 tonnes of peanut butter. Over that period of 120 years many changes in building, expansion and machinery have been done and a large overhaul of the complete production and building has never been undertaken, which results in a complex situation. When in 2009 the boiler-room was going to be renovated, the 40 years old steam boiler had to be replaced. Of the installed capacity more than 40% was not used because the new production lines have a lower energy. The production line for margarine and peanut butter uses various heat and cold streams for the process:

- Hot water at several temperature levels
- Steam
- Warm water for space heating
- Ice water

All of the hot water and steam is generated by the old steam boiler on which the heat demanding processes run independent from each other and can run on partial load. The complete energy demand of the existing factory has been mapped and simulation and pinch models were used to design the new heat generating process. The basic thought is to make the plant as energy friendly as possible and robust for the next decade with a focus to use as much waste heat when occurring as possible. The heat demand could be split into low temperature heat (<70oC) and high temperature heat (>90oC). For the low temperature heat the condenser heat from the NH3 chiller is used in a Greenco add-on heat pump to generate temperatures up to 80oC. This construction is called an add on heat

pump. The specifications of the installation are:

- Heat capacity: 1400 kW at a temperature of 65 °C of the heated water
- Heating COP: 5,5
- Annual hours of operation: 6.000
- Annual energy savings: € 220.000
- Annual reduction of CO2 emission: 1.600.000 kg
- Pay back time: ca. 2 years

The office building 'De Brug' of Unilever Bestfoods in Rotterdam, the Netherlands is well-known in Holland for its remarkable architecture and because it is prominently present at the shore of the river Maas. However, not too many people know that this building is a classic example of the application of 'low temperature heating' (LTH, by Low-H2O technics) in combination with radiators. What is even more: no wall – or underfloor heating is getting used here. Merely the combination of low temperature heating radiators of Jaga with ceiling cooling is sufficient to create a comfortable temperature. Already in 2001, at an early stage of development of this building, it was decided that sustainability should be one of the key factors, regarding heating and cooling as well. This was not an easy task, given the fact that the steel construction containing four levels with 15.000 square meter of office space in total, had a façade which almost solely consisted of (double pane) windows. As a solution for this challenge, low temperature heating radiators were applied to counteract the downdraft of cold air. The low temperature radiators as well as the cooling system in the ceiling use river water as a source. The temperature of this water is uplifted by a heat pump.



CENTRAL CITY AREA

1. **Blaak 31:** This office building in a fantastic high-profile location adjacent to the Market Hall in the Laurenskwartier neighbourhood. The building has 11 floors and is an eye catcher, thanks to its spectacular overhang and the spacious entrance with a 7-metre free height.
2. **Laurenschhof**, is a multifunctional apartment/office building in the center of Rotterdam, being completely redeveloped by OVG.
3. **Blaaktoren** is situated at a remarkable spot in the heart of Rotterdam, close to Blaak train station, the famous 'Cube Houses' and the recently completed Markthal. This location posed a challenge, as there was a rather limited amount of space for construction work and installations.
4. **100Hoog Rotterdam** is a residential building at Wijnhaven at the corner of winegrowers and Posthoornstraat in the center of Rotterdam. With a height of 105.5 meters and 33 floors of the tower gets a spot in the city skyline.
5. **New construction and redevelopment "Forum"** The monumental ABN AMRO building on the Coolsingel will be fully integrated and given a prominent role in the new plan as the base for the new development. The design has led to a BREEAM design certificate with four stars (Excellent), which was awarded in 2013
6. **COOL 63** renovation at the Coolsingel where within the plan 15 beautiful apartments are realized opposite the Hilton hotel.

KOP VAN ZUID

7. **The Kop van Zuid** The Kop van Zuid is a new district in Rotterdam. This former port area on the south bank of the river is being redeveloped into a new city center. The Erasmusbrug (Erasmus Bridge) is the link between these two districts. The development of the Kop van Zuid has a positive effect on adjacent areas such as the Kop van Feyenoord, Katendrecht and the Afrikaanderwijk.
8. **Laan op Zuid** a striking 18 storey office building which is a joint development of OVG and AM Realty. The property is among the top ten most sustainable office buildings realized in the Netherlands. This top 10 is based on the ambitious Greencalc yardstick used RGD as leading measurement system for

commercial buildings.

9. **New Orleans** (158 m) This project includes several parts: A residential building "New Orleans", a parking garage for 750 cars and an Arthouse. New Orleans has a sunny, light appearance.
10. **Cité**, is a residential building for young people, consists of two towers and a substructure along the Laan op Zuid. The towers are connected by a base that connects to the expansion of technical Universities which has been designed by Erick van Egeraat Architects (EEA). This foundation will act as a bridgebuilding between the two Citétorens and the existing building of InHolland and be built on the metro route.

Miscellaneous

- **Victoria** office building that is characterized by its design and material use as a modern and prestigious property is situated on one of the most prominent office locations, Brain Park III in Rotterdam.
- **Port City Rotterdam** is a new strip of reclaimed land along the banks of the nearby harbor. The area has an area of 33,000 square meters. The four office buildings (all approximately 8,000 m²) and underground parking which arise here, show a clear link with port activity, which so characterize the environment of the area. The energy needed by the Port City buildings for heating and cooling is provided via port and cold groundwater. Energy extraction from surface, combined with energy storage (cold and heat) is an energetic gold mine, which is increasingly used in built up areas. The sprawling port of Rotterdam is a perfect location for this.
- **Heijplaat Smart City**, a harbor town in the Port of Rotterdam, will become completely energy neutral with the implementation of locally generated wind and solar power, renovation and new construction of homes and subsequently the implementation of smart grids. Furthermore, the partners in this project are looking for ways in which residents are stimulated to be more sparing in their energy consumption. This can be achieved, for example, by implementing feedback systems and active controls. The pilot project has to demonstrate which innovative social, technical and economic resources achieve the best results.