Introduction
This report is a reflection on the design process of my master thesis at the studio Architectonic Engineering at the Technical University Delft. It is meant to give a short overview of the process that lead to the final design of Integration of active solar energy in the Industrial heritage building of Van Gendt Hall, Amsterdam. The main goal is to make the building a- towards a net-zero and zero-emissions building.

The new function/design of Van Gendt halls is conceived with two primary objectives:
• To serve as a laboratory for the integration of solar technologies in existing buildings.
• To be a hub for the study of Integration of Active solar energy Techniques.

Some of the most important considerations and arguments for the major design aspects are to keep the present environment of the building and use the envelope of the building for the energy Integration.

Research and Investigation
Van Gendt halls form an important part of the factory Werkspoor Stork Oostenburg in Amsterdam. The five terraced halls have been built in several phases between 1898 and 1910. The building has a status of a national monument and is also the symbol of Dutch developments in Iron and shipping Engineering. Therefore, it’s important to adopt the principle of reuse before putting a layer of solar technology in design. One of the most important factors is that traditional buildings are also not generally designed to be heated to current comfort levels. This represents a risk to historic fabric and its moisture balance which during the change can suffer great damage due to the rapid adjust to changed environment. The installation of air conditioning systems in historic buildings should be avoided if possible, and consideration taken of not only the physical damage to the fabric due to the installation requirements, but also the effect on interior air conditions, requiring specific elements such as humidification systems in order to avoid extensive long term damage. Furthermore, the selected systems must also be related to the energy conservation systems; For example the internal insulation with cavity and hot water
central heating systems can provide background heat for maximum exploit of solar gains. As a final step, when possible, it is important to minimize the impact of the energy consumption in use by considering passive strategies of solar energy.

Relation to Studio: Technical building design

**Design Strategies | Energy**
The following design strategies are explored and applicable to new use of halls as they address the integration of energy conservation and production that help work towards a net-zero and zero-emissions goal.

**BUILDING MASSING/ ORIENTATION**

*Passive heating:* The already built building provides a challenge to maximize passive heating along the north-south axis versus the east-west axis. To optimize the sun energy it was appropriate to place the functions to achieve greater benefit of solar gain according to occupant’s requirements.

*Day lighting:* The analysis found that implementing day lighting can provide the most annual energy cost savings with the smallest payback period. Interrelated spaces and “one function” approach has been adopted to optimize daylight. The corridors are avoided to minimize the circulation area. The open spaces are used to promote day lighting and cross ventilation. Since the quality of light is different depending on the facade orientation and time of day/year, interior and exterior treatments are considered to control the desired quality and quantity of light on a seasonal basis.

*Natural ventilation:* Despite existing buildings to the south and west, the site provides good access to breezes for natural ventilation. Given the predominant southern (south-east to south-west) breezes during the cooling season the building plan, section, and massing can be easily configured to provide natural ventilation. If double-loaded corridor configurations are used they should include operable apertures on interior walls to facilitate cross ventilation.

**ENVELOPE SYSTEMS**

*Building integrated photovoltaic facade (BIPV):* New solar technologies provide creative and multifunctional solutions to common building components. One example is the building integrated Photovoltaics. This system uses built-in photovoltaic to create energy and natural light because of transparency. Office spaces connected to the facade have proper light and generate electricity for
heating and cooling. Furthermore, a BIPV have been used as an educational piece that defines a contemporary aesthetic.

**Energy-efficient glazing:** Specifying the duel function of photovoltaics. The use of high-efficiency glazing will increase energy performance compared to standard glazing. A double-glazed window, for example, is 3-5 times more energy-efficient than a standard double-glazed window, assuming the same frame type and size.

**Super insulation:** Increased building insulation and highly insulated wall types can improve energy performance compared to baseline code compliance. The analysis revealed that by using an (structurally insulated panel) envelope, for example, instead of a standard brick cavity envelope, energy use intensity (EUI) was cut by 13 K BTu/m², assuming all other parameters remained constant.

**Active (Photovoltaic) Roofs:** Available roof area has been used for energy production. Pitched roofs have been replaced with for PV integrated panels. The existing tilt of the roofs has been optimized for equinox sun angles and spaced far enough apart for maximum solar collection. The optimal tilt 36° - 45° are the best opportunities for both occupied space and energy production.

**Solar thermal collectors:** Energy produced from solar thermal panels can be used for heating domestic hot water. These have been installed on south wall on hall 5 for future considerations.

**Process**

The process of adapting a building requires creative solutions.

In finding the right balance, adaptive reuse projects should integrate five principles into the design as stated by

- Perform the functions well for which they are redesigned
- Be long lasting and adaptable to new uses
- Respond well to their surroundings and enhance their context
- Have a visual coherence and create ‘delight’ for users and passers-by
- Be sustainable – nonpolluting, energy efficient, easily accessible and have a minimal environmental impact

I followed the same approach for space organization of the van Gendt halls but every heritage building is unique and has its own requirement. So I tried to make most out of it. In the process I consider value of building like evidential value, historic value, and aesthetic value...Construction materials...Public interest etc. I divide the building energy solutions into two main clusters: Passive solutions (resulting from design and change in user behavior) and Active energy solutions. The solutions are further grouped into five areas of intervention (building envelope, windows, ventilation, active and passive solutions) -all of which are interlinked. All the solutions look very reasonable but the reality of the building is different. Retrofit of all the principles seemed easy but it was not so. Especially when discussing energy efficiency
in historic buildings one of the first issues usually addressed is insulation. Insulation further contributes significantly to reduce heat loss. As a matter of fact it is not possible in Van Gendt halls. The building has so many uncontrollable cold bridges e.g. the old system pipes which are running almost around the façade and the old factory iron elements stuck inside the outer walls. Most of the steel columns along the boundary are inserted into the walls for support. Although I provide the cavity insulation to avoid the damage to original wall and my most of the time is spent on finding the right solution. As a result I have very less time to calculate the energy production by photovoltaic and could not give such time to my climate description into the building as I wished. Nevertheless, during all this process I came to know all the structural elements/components, material, and each damage of the Van Gendt halls and I am able to give the practical energy solutions to this building. It’s just the matter of time, which always runs so fast.

Social Considerations
Awareness is an important concept when energy reduction strategies are the responsibility of the resident. The building with the new functions (offices/research center, expo.conference halls, and auditorium) is a gateway to Solar Energy education creating awareness of Integration techniques and energy efficient systems. The purpose is to promote the frequent use of innovative solar techniques & applications and focusing on empowering society at large to make Zero-energy buildings to overcome the deficiency of energy resources. Moreover, Van Gendt hall is physically disconnected with the city by water and infrastructure and has no permanent function at the present moment. The new functions can motivate the people to visit the building and make new connections.

To achieve the ambition of a 75% reduction in CO2 by 2040, the existing buildings must attain a minimum energy efficiency of certificate B. Additional innovative measures will be necessary to achieve this. Smart networks and control engineering will ensure the optimum use of energy. The use of solar energy will have become particularly beneficial for both houses and businesses.
**P5 - Reflection:** Integration of Active Solar Energy in Van Gendt halls, Amsterdam

After P4 presentation there is no change but few more details. Since my research was about the integration of active solar energy, specifically in building envelop, thus in my P-4 presentation, my emphasize was on this topic. In fact I wanted to show that how much energy a building envelope can produce with proper integration of Photovoltaics. Moreover I wanted to give maximum information in 30 minutes. As a result my presentation was a storm of words. So I am asked to change the presentation style and show architectural design too.

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