

Brightsite

Transforming industry

Steam study

Cost-effectively reducing CO₂ emissions by saving on steam requires Chemelot-wide approach

Brightsite is committed to creating a sustainable chemical industry. At Chemelot, a complex steam network is already being used to handle the demand for and supply of steam in a sustainable manner. Brightsite is carrying out the steam study to map out for Chemelot where steam-related efficiency measures may create extra room. The intention is to make optimum use of the steam system and jointly achieve cost-efficient saving options. Any knowledge and experience gained could also be interesting for other sites.

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Why save on steam?

Preventing unwanted climate change requires limiting greenhouse gas emissions. Various energy efficiency measures may help to reduce these emissions. The reduction and smart use of generated steam can contribute to this. Steam is a key energy carrier within the chemical industry. It is frequently used to heat and drive processes because it is efficient and safe.

Whilst steam condensation yields a lot of energy, steam production also requires a lot of energy. Saving on steam therefore creates opportunities for appealing projects to reduce CO₂ emissions. "Brightsite and Chemelot therefore want to increase the room available for steam saving projects. The first step in that direction is mapping out the potential for steam saving projects and the flexibility in Chemelot's steam system," explains Joris van Willigenburg, Chemical Engineer at Sitech Services.



Site users connected by steam

Companies at Chemelot are connected through a high-quality steam network managed by USG (Utility Support Group). There are several networks at various pressure levels that are interconnected. Site users can both feed steam into this network and take steam from it. "There are plants that generate more steam than they need. This steam can be supplied to USG via the steam network, and in turn they use it elsewhere at Chemelot where there is a demand for it," explains Sonny Schepers, who is responsible for sustainability projects at USG. "At present, about 2,000 metric tons of steam are used per hour at Chemelot. About half of that is generated and used by the plants themselves; the other half runs via the USG network. The difference between the demand for steam and the steam produced by the plants is generated by a combined heat and power plant (WKC-S) and the steam boilers of USG. In addition, these steam boilers supply the operational spare capacity to quickly scale up steam production in case a plant shuts down.

The steam boilers mostly run on residual gases that are produced by the plants."

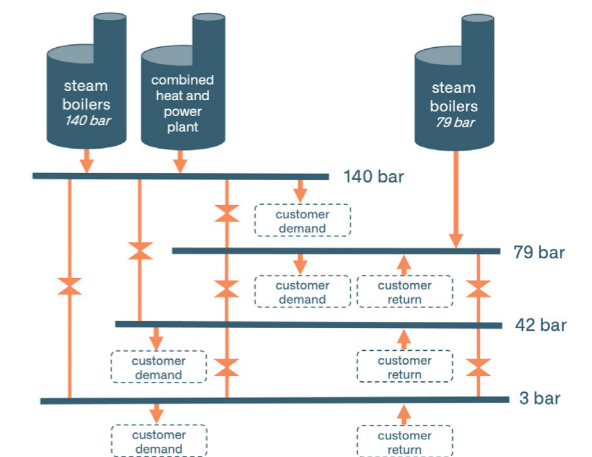


Figure 1: Impression of the steam system Chemelot (simplified view)

Limited room for savings

When the steam network was constructed at Chemelot, the demand for steam was expected to increase further, but this demand is now decreasing due to the completion of sustainability projects. “As a result of this, we are hitting the bottom limit of the system. We must keep a minimum number of boilers in operation to meet the requirements of the system, this concerns the processing of the supplied residual gases and the availability of sufficient revolving spare capacity. If the net demand for steam drops below USG’s minimum steam production, we will be dealing with a steam surplus that has to be vented. That would be a waste, as you will then be destroying energy and not reducing any emissions,” states Schepers.

The demand for steam at Chemelot is indeed expected to drop below the minimum steam production of the USG steam boilers. This involves quite a few challenges: How can we increase sustainability as much as possible without venting steam? How can we meet all the requirements regarding minimum steam production and save as much steam as possible, limiting emissions as a result?

We want to increase the room for steam saving projects and choose the most beneficial projects for the site. This is a complex issue, as the network involved is complex and extensive, and needs to be balanced. This requires lots of information and insights.

Steam study assessment

To obtain this information the steam study as part of Brightsite’s program line 5 - which is aimed at transition scenarios - is being carried out by Sonny Schepers (USG), Joris van Willigenburg and René Slaghek (Sitech Services) and Carlos Sánchez Martínez (TNO), in consultation with the Chemelot Sustainability Team in which all the sustainability managers of the major companies at Chemelot are represented.

The project is subdivided into an assessment phase and an optimization phase. A large part of the assessment phase has been completed. “Improving sustainability and saving on steam are hot topics among site users, but the developments will now be accelerated.

The difference is that we are now looking at the greater whole. Although companies are obviously mainly interested in the possibilities for their own plants, they do see opportunities to achieve common savings by means of a joint approach,” says Van Willigenburg.

“We are developing a method that can create the optimum combination of steam saving projects.”

Room for savings

The room for saving on steam in the current situation has been determined for each pressure level, of which there are 10 in total at Chemelot, varying from 3 to 140 bar. Among other things, the high pressure levels are used for power to drive compressors; the lower levels are used for heat. “This analysis is indicative, as certain aspects were not taken into account, like daily variations in the demand for steam. The analysis does, however, clearly show that the room for savings varies quite a lot between pressure levels,” explains Schepers.

Selection of most promising projects

The assessment identified dozens of possible projects. Most projects focus on electrification, the use of electric motors, heat pumps and general process optimization. “Our assessment shows that the total maximum steam savings from projects greatly exceed the current room for saving on steam. To make these additional steam savings possible, it was also checked if the companies themselves can reduce their steam production. As steam that companies produce themselves is often a by-product of the processes, saving on steam production is not always evident or useful for companies. We have concluded that there is more potential than room for saving on steam. It will therefore be necessary to select the most promising projects,” concludes Van Willigenburg.

“There are potentially a lot more steam saving projects than room for saving on steam.”



Site users enthusiastic

“It is great that this study considers all the possibilities at all the plants. This yields a clear overview and gives us as companies new insights,” says Ruud Swarts, Manager Technology and Energy at OCI Nitrogen. “Improving sustainability is best done together. This study clearly points out once again that steam provides energy-saving opportunities and that we will be running into problems in the future. We all have to deal with the same issues, our plants are all connected and we need to rely on each other when it comes to investing and jointly resolving problems,” says Swarts.

SABIC is also one of the major buyers and producers of steam. “When you are looking to improve your energy efficiency, you quickly end up at steam projects,” confirms Bart Eurlings, Senior Engineer Sustainability & Energy at SABIC. “This study sets mutual interactions relating to saving on steam in motion, and that is valuable.

Until now, everyone has been working on steam projects separately, but that may not be the best thing for the site. We need to look for joint ‘no regrets’ options. That is not just a challenge for now; things will need to be reassessed all the time because you do not know what the future holds,” emphasizes Eurlings.

“Improving sustainability is best done together.”

Method for optimum combinations

Making a selection of projects will require a method that can create an optimum combination of energy saving projects, 'enabler' projects and infrastructure projects. "The difficulty is that this is an optimization problem with a sheer endless number of variables and possibilities. Furthermore, some projects exclude each other or need to be combined with another project. We have therefore tested a selection method using a list of energy projects and the steam balance of SABIC's Olefins 4 naphtha cracker. This alone yields hundreds of logical combinations of energy projects. By using an Equation-Oriented method (essential for highly integrated systems), it turned out to be possible to calculate all the combinations of options at the level of a single plant in a very short space of time. But not for the entire site," says Carlos Sánchez Martínez of TNO, who is responsible for the development of the systemic method for steam saving projects. "We are also looking at specific optimization software, including mixed-integer linear programming

(MILP). In the end, our intention is to create a method for all of Chemelot starting with a method for a single plant. This method could then also provide added value for other chemical clusters."

Utilizing the potential now

The first part of the steam study yielded a lot more projects than initially expected, although the profitability and practicality of a number of projects has yet to be examined in detail. It is great that there is so much potential, but it also requires us to make quite a few complex choices. The next step is to prepare a shortlist with the most promising projects and then jointly select a combination of the most appealing measures for Chemelot. It is important to start right now, enabling Chemelot to take concrete steps to make the site more sustainable and to achieve the reduction targets of 2030.

Does your company recognize itself in the working method of Brightsite?

We strive for greenhouse gas reduction through implementing the most cost-effective measures and by ensuring production at the same time. Do you want to contribute to this, get more information or do you want to use our services? Then contact us.

René Slaghek

Program line manager Transition
Scenarios and System Integration
rene.slaghek@sitech.nl
+31 (0)6 200 159 35

brightsitecenter.com

