A cutting-edge energy system will cut carbon emissions in half!

A bold technological leap at Stanford University

Case story

With more than twenty Nobel laureates in its alumni files, Stanford University is one of the most respected teaching and research institutions in the world. Situated some 37 miles south-east of San Francisco, the university was also instrumental in the development of the Silicon Valley phenomenon. When Stanford in 2012 decided to take a bold technological leap in order to bring down its carbon emissions, Alfa Laval was selected to join this pioneering project. The new energy supply system at Stanford (fully implemented in April 2015) is expected to cut campus emissions of greenhouse gases by 50 percent already in 2015.

A longstanding tradition

For more than three decades, Stanford has played a leading role in the pursuit of minimized environmental footprint derived from campus activities. Within its own extensive campus area (comprising 8 648 acres), measures to achieve this goal have been taken at practically all levels of daily life. Stringent building standards and separate energy metering in all facilities – along with investment in water conservation, renewable energy and sustainable on-campus commuting – have brought notable energy savings over the years. So has (from 1987 and onwards) an energy-efficient cogeneration plant fuelled with natural gas.

Fast facts:

The challenge

Integration of heat exchangers with a new, first-of-its-kind campus heating system, along with start-up assistance and troubleshooting. Flexible interaction with a constantly evolving project scheme combined with a high degree of customizing.

The solution

High degree of technological flexibility thanks to the modular structure of the Alfa Laval system. Continuous on-site presence and intense communication with all people involved.

During the expansion of research and teaching activities at Stanford, however, it gradually became evident that large-scale reduction of carbon emissions called for a holistic, long-term perspective and a highly systematic approach. Therefore, a formal master plan (The Stanford Energy and Climate Plan) for sustainable development at Stanford was launched in 2007.

In pursuit of frontline technology
Joseph Stagner is Executive Director of the Sustainability & Energy Management Department at Stanford. As a consequence of the Climate Plan, he was asked to lead a team scanning the international market and the global scientific community for the most advanced technology available to Stanford in its pursuit of sustainability at all levels of operation.

Joseph Stagner, Executive Director of the Sustainability & Energy Management Department at Stanford.

"It was fascinating journey into a truly futuristic technological landscape."

The final report from the review team revealed, that more than 80 percent of the heating demands (space heating and tap water) on campus could be met by recovering waste heat from the cooling system. This conclusion provided the fundament for development of a cutting-edge energy supply program labelled SESI (Stanford Energy System Innovations) that was approved by the Stanford Board of Trustees in December 2011. This was indeed a critical decision, since 2/3 of the carbon emissions from the campus at that time derived from the energy system.

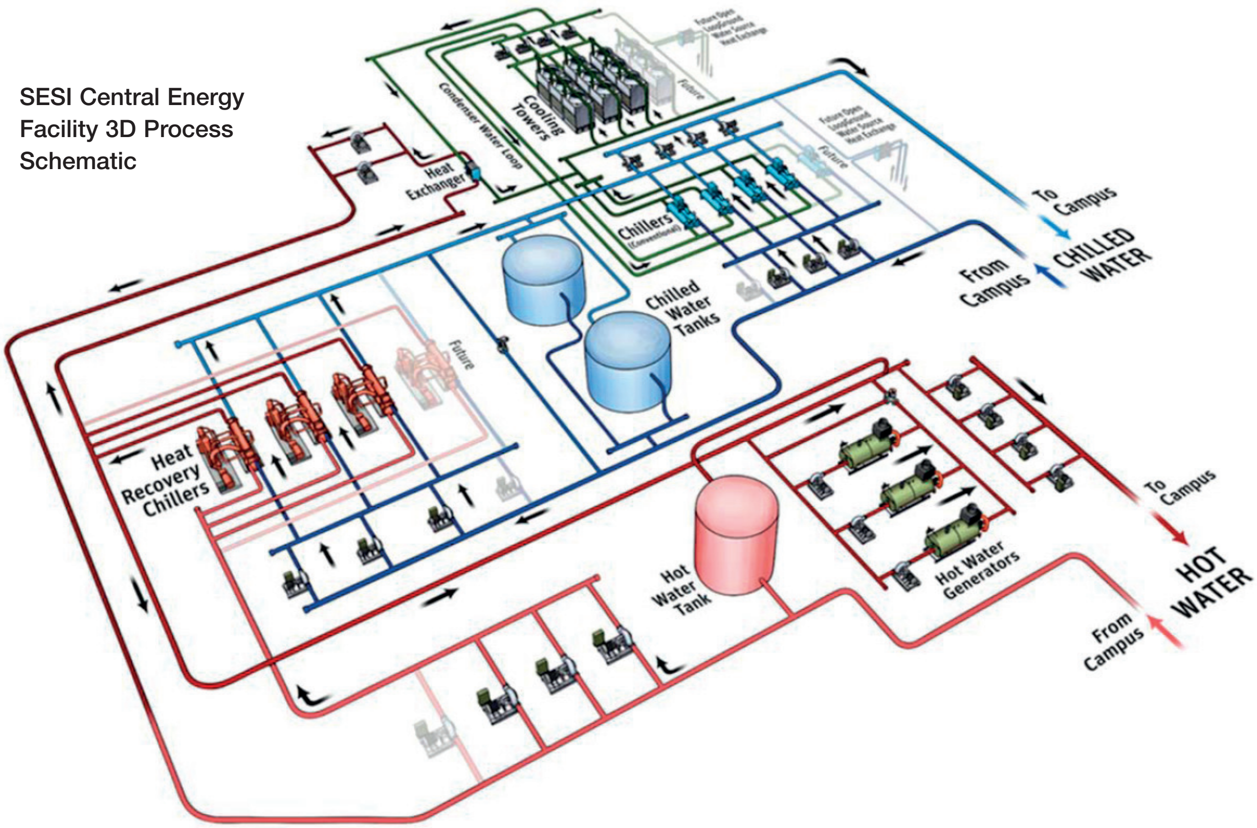
Innovation and proper timing
We asked Joseph Stagner to explain the background of the SESI program.

"Since 1987, our energy has been produced in a cogeneration plant fuelled with natural gas and using steam as heat transfer medium. We were able to utilize the waste heat from the combustion process to produce electricity, while most of the heat generated from the cooling processes on campus was left to evaporate into the sky. We found that these volumes of waste energy could be recovered to meet the bulk of the heating needs within the campus – provided we used pioneering technology. We also found that the timing for a radical transformation was right, since the steam turbines were approaching the end of their

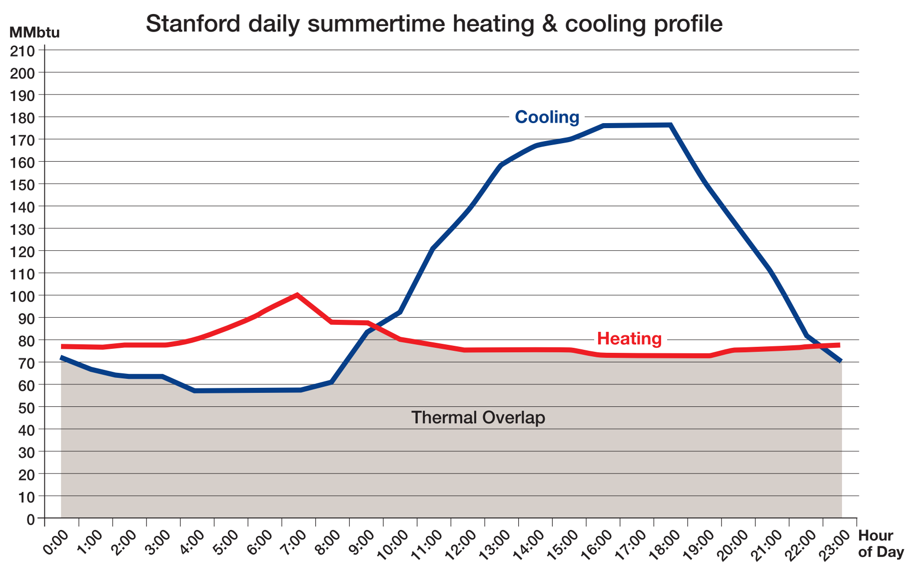
The key elements of the new system

- A new Central Energy Facility (CEF) including a heat recovery plant.
- Direct and continuous access to the California electricity market.
- Conversion of the thermal distribution system from steam to hot water.
- An extensive hot water pipe system (19,8 miles).
- A new electrical substation.
- An advanced, patented control system developed at Stanford.
- Thermal energy storage

SESI Central Energy Facility 3D Process Schematic



life cycle and the contract with the owner of the plant was expiring within the near future. Consequently, we decided to replace the old energy system with one based on the best technology available today. You could rightfully describe this move as a total makeover."



Heat recovery – the heart of the SESI concept

The new all-electric facility has continuous access to the California electricity grid, thus securing access to the most cost-efficient electrical power available at any given time. This system also will also allow Stanford to procure part of its energy from renewable sources – e.g. wind and solar power.

The new energy plant will allow Stanford to recover up to 70 percent of the waste heat from the cooling system. Instead of having this energy volume evaporated, it will be used to meet some 80 percent of the campus heating demands during periods when buildings are being heated and cooled at the same time. At Stanford this is the case during 60 percent of the year – primarily due to the local climate and the continuous need for refrigeration within the research facilities. The new system will also use both hot and cold water storage. Joe Stagner again.

"Heat recovery and continuous access to cost-efficient electrical power are two vital efficiency parameters. A third one is a patented control system developed here at Stanford. By continuous tuning of the vital system functions to the load forecast, they will work and interact at an optimal level. By new and more efficient pipes, we have also cut the energy losses in the thermal distribution network from 14 to 4 percent."

Scouting in Scandinavia

The new energy facility and its distribution network will supply heating and cooling to all amenities (more than 1,000 buildings) within the campus area. For more than four years, Stagner and his team spared no effort to find the best equipment suppliers for this rather challenging venture.

"From the perspective of carbon emissions, a university campus is an example of complex interaction at multiple levels. This calls for a holistic approach, but also for high efficiency in each separate function. The system must also have the overall flexibility necessary to accommodate future solutions."

Product facts:

129 district energy ETS substations
Configurations include: domestic hot water only/ space heating only/combination of the two

Technical data
Design pressure: 150 psi
Temp parameters: space heating 125-155 °F – domestic hot water 75-140 °F
Plate materials: 316 stainless
Capacity: 250 MBH – 12,500 MBH

Since heat exchangers and substations are crucial to the overall thermal efficiency, no effort was spared to find the best technology within this specific field. Patrick Kantor is Project Manager for the contractor handling the installation of the new system, Whiting Turner.

"The Scandinavian countries have an impressive record when it comes to district energy systems. So, when scouting for a supplier of thermal transfer equipment, we established contact with a couple of major Scandinavian companies. Our final choice was Alfa Laval, a Swedish company with unmatched global experience within this specific field.

Joe Garcia, Alfa Laval.

From start to finish, everyone really appreciates the effort that the whole Alfa Laval team has put into the SESI project. Their representative Jarmo Rissanen was a key component to take the preliminary plan throughout engineering to the complete 3D model. He helped everyone understand how the heat exchanger system worked, but also explained how to integrate it with the existing building system and the new campus district heating system.

The key for us was to have a supplier that was capable of executing a plan to fabricate 130+ energy transfer stations. Plus more than the capability, it was crucial to have a partner that could be flexible with a continuously evolving schedule. Lastly, we really appreciate having Mike Mohney for all start-up and troubleshooting. The continuity that he provided was a key to help verify that the each different system was functioning correctly prior to the turnover to Stanford. "

Despite the vast experience from a great number of applications worldwide, the Stanford project was unique experience for Alfa Laval. *Joe Garcia* is Project Manager, Engineering & Supply at Alfa Laval.

"The Stanford SESI project posed many challenges for our team, one of which was taking our European ETS models and adapt them not only for the US market, but also to meet the space constraints, functional demands and seismic requirements for each building.

A couple of key factors in overcoming these challenges was our expert team in Finland and the flexibility of the modular design of our system. Another challenge we had to overcome was the fluid project schedule and constant changes to the design specifications. But thanks to Patrick Kantor of Whiting-Turner and Joe Kearney and Adam Dell of Stanford University we were able to adapt and

resolve issues quickly to ensure that the project schedule remained on track. The start-up of systems were performed by our experienced technicians, who were able to optimize the performance and efficiency of the ETS units, which meet and often exceeded the expectations of the Stanford SESI team."

A giant leap

Already in 2015, the new energy facility is expected to cut carbon emissions by 50 percent and water use by 18 percent. Over the next 35 years, it is expected to save USD 300 million. Joe Stagner concludes:

"We are taking a giant leap from 30 years of combined heat and power production by natural gas to a combined heat and cooling process based on electricity. You could rightfully talk about a shift of paradigm, since we are working in harmony with nature instead of using the technology to harness it. Our heat recovery system exploits the specific climate conditions in this part of California and we can utilize the growing volumes of electrical power available from renewable sources."

Alfa Laval reserves the right to change specifications without prior notification.

How to contact Alfa Laval
Up-to-date Alfa Laval contact details for all countries are always available on our website at www.alfalaval.com