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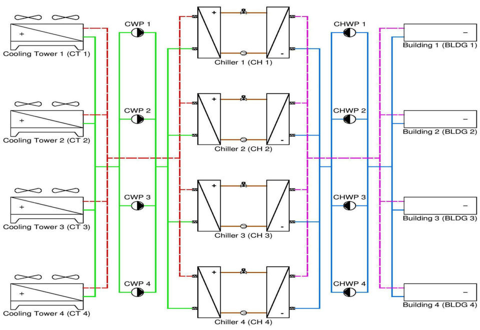
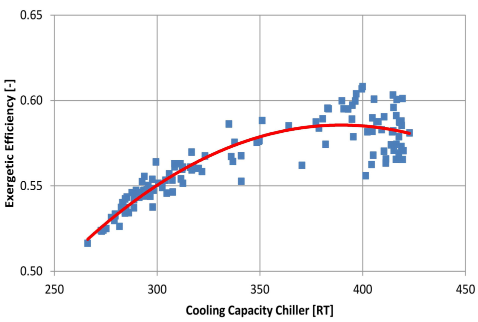
# Enhancing Existing Chiller Plant Performance in Tropical Climate

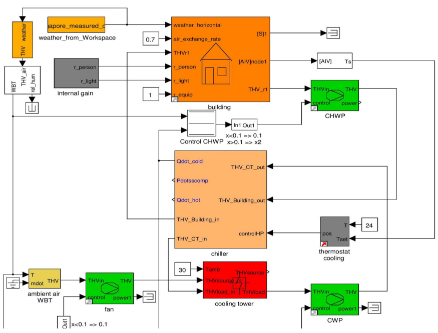
## Simulation of an Existing Chiller Plant at Nanyang Technological University, Singapore




Basic circuit diagram of existing chiller plant




Second thermodynamic law efficiency at part load



Simulation model Matlab / Simulink

Introduction: In ambitious countries with hot and humid climate conditions like Singapore, chiller plants consume a substantial amount of the entire electricity. Furthermore, most of the alternative and renewable energy sources are not avail- able for the city-state and electricity is mainly produced by fossil fuels. The project tackles the fact that changing operation of the different components at part load can result in a better overall efficiency of the chiller plant, even though some com- ponents might not operate at the best efficiency. The goal is to find an operation point for every component as a function of cooling demand, building conditions, and weather conditions in order to reduce the power consumption of an existing chiller plant as much as possible.

Proceeding: To reach the mentioned target, measured data of an existing chiller plant at Nanyang Technological University are evaluated. Moreover, a realistic thermal building simulation is set up. After it is proven that the simulated model represents the reality, it is modified and the dependencies of the different compo- nents are displayed. A combination of fundamental equations, which describe the dependencies of the different components on each other and a numerical calcula- tion help to evaluate the overall chiller plant efficiency dependent on the power consumption of each component. With the mentioned expression it is possible to find an operation point of each component for different circumstances which re- sults in higher chiller plant efficiency close to the optimum. To prove that the modified operation points result in better chiller plant efficiency, they are stored into a look-up table and the simulation is re-evaluated.

Result: The simulations show that varying the condenser- and evaporator flow-rates that a constant delta-T on the condenser- and evaporator side results im-proves chiller plant efficiency compared to constant flow-rates. Nevertheless, it is demonstrated that a low delta-T for low cooling loads and a high delta-T for high cooling loads resulting in an optimal operation and chiller plant efficiency can be improved even more. With the evaluated close-to-optimum operation of each component the power consumption of the focused existing chiller plant can be re- duced by 7%. This is equal to a yearly saving of 312 $MWh_e$, 135 tons of $CO_2$-eq.-emissions, or 80’000 S$. The next step is to implement the results into the build- ing energy management system of the existing chiller plant to verify that the re- sults obtained in the simulations can be achived in reality. Additionally, the same procedure can be adapted for other chiller plants to reduce the environmental im- pact.