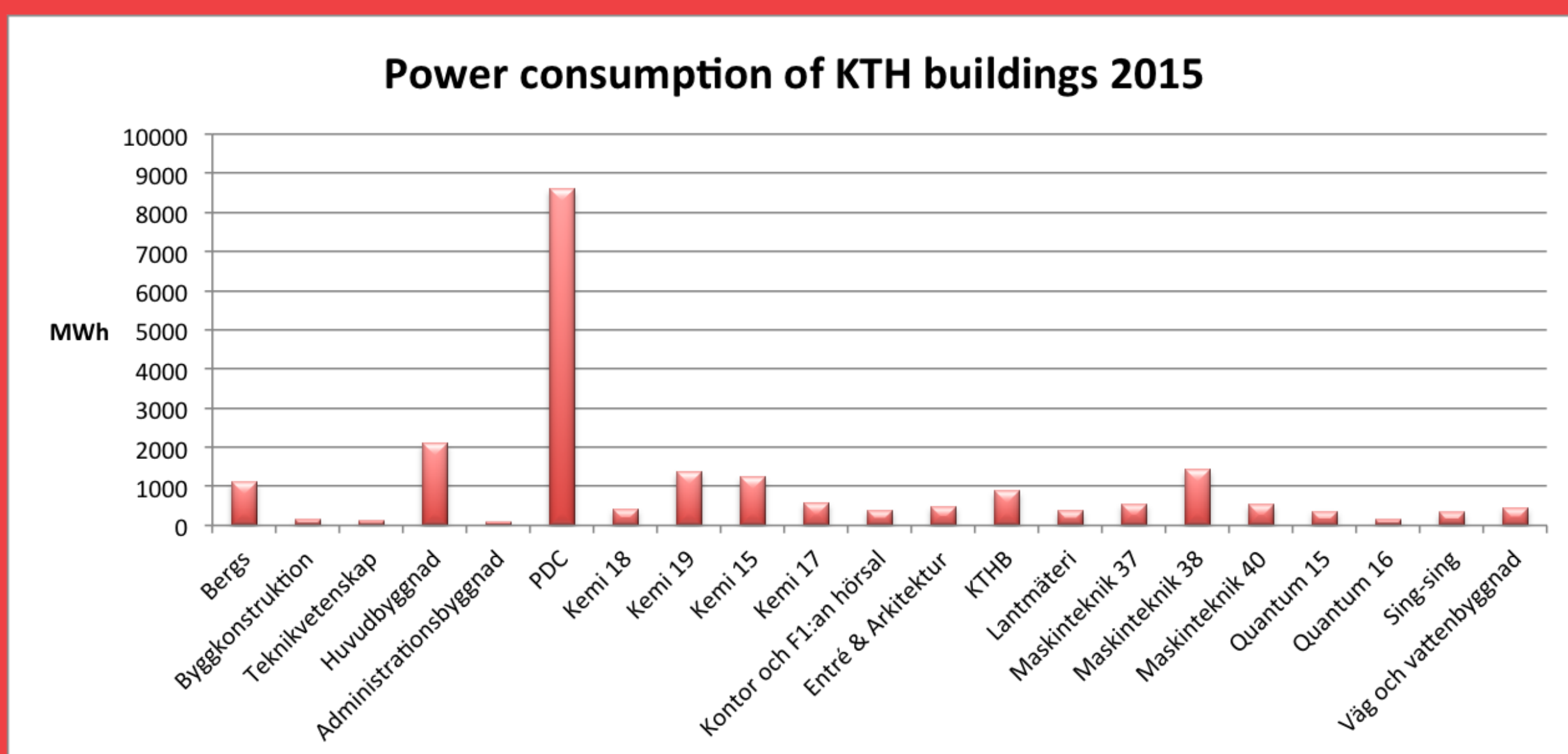




High performance computer systems require lots of power and produce large amounts of heat, so they need some form of cooling, as well as a power supply. The power supply and cooling system, along with the other facilities needed to house and run the computer systems, are known as the infrastructure of a computer centre.

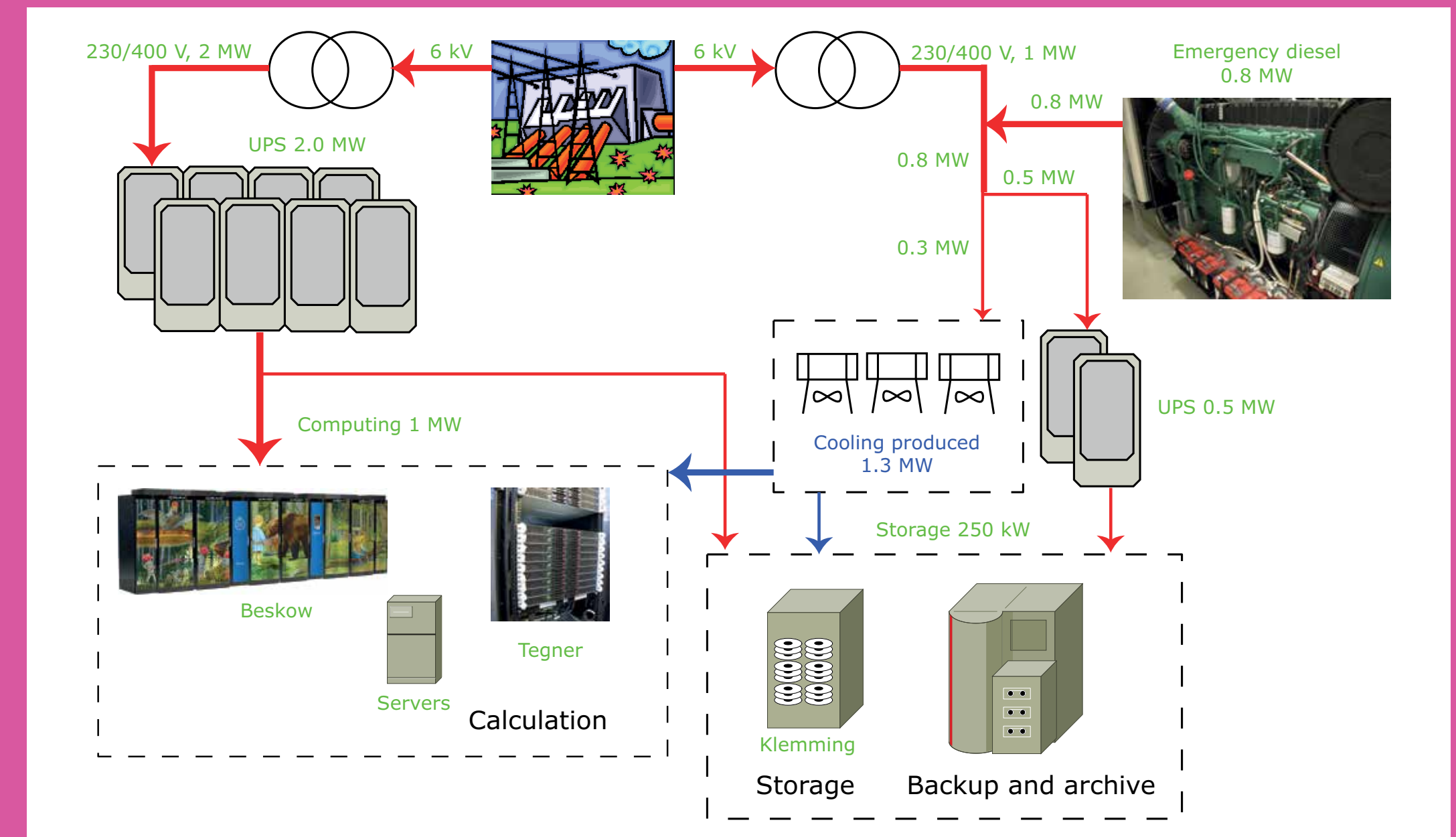
The infrastructure needs to be highly reliable, particularly when it comes to power and cooling because large amounts of important data could be lost if the systems overheated or if the power failed. This means PDC needs to have backup systems in case the main power or cooling supplies fail. The power and cooling infrastructure also needs to be very efficient so energy is not wasted.

Power consumption for buildings at KTH



The graph shows that the PDC building needs much more power than other KTH buildings.

Power system



KTH has a high-voltage (6 kV) ring network around the campus. In the building with the PDC computers, we have two transformers that convert the high-voltage into normal 230 V.

To keep the computers running during shorter power outages, we have several large battery banks which are connected to Uninterruptable Power Supplies (UPSes). Each UPS controls the charging of its batteries and converts AC power to DC and vice versa. UPSes generally lose some energy in the process of doing these conversions during normal operation. Therefore we use the energy-saving mode on the UPSes so that, if the usual power supply fails, the UPSes take over the load in 2 ms thereby avoiding the conversions that usually happen during normal operation. The power in the batteries lasts 15-20 minutes which is enough to keep our systems running through most outages in Stockholm.

For the most sensitive equipment (like the disk servers) we also have diesel generators that can run forever (as long as they keep being refuelled). We normally have enough fuel stored to last for several days.

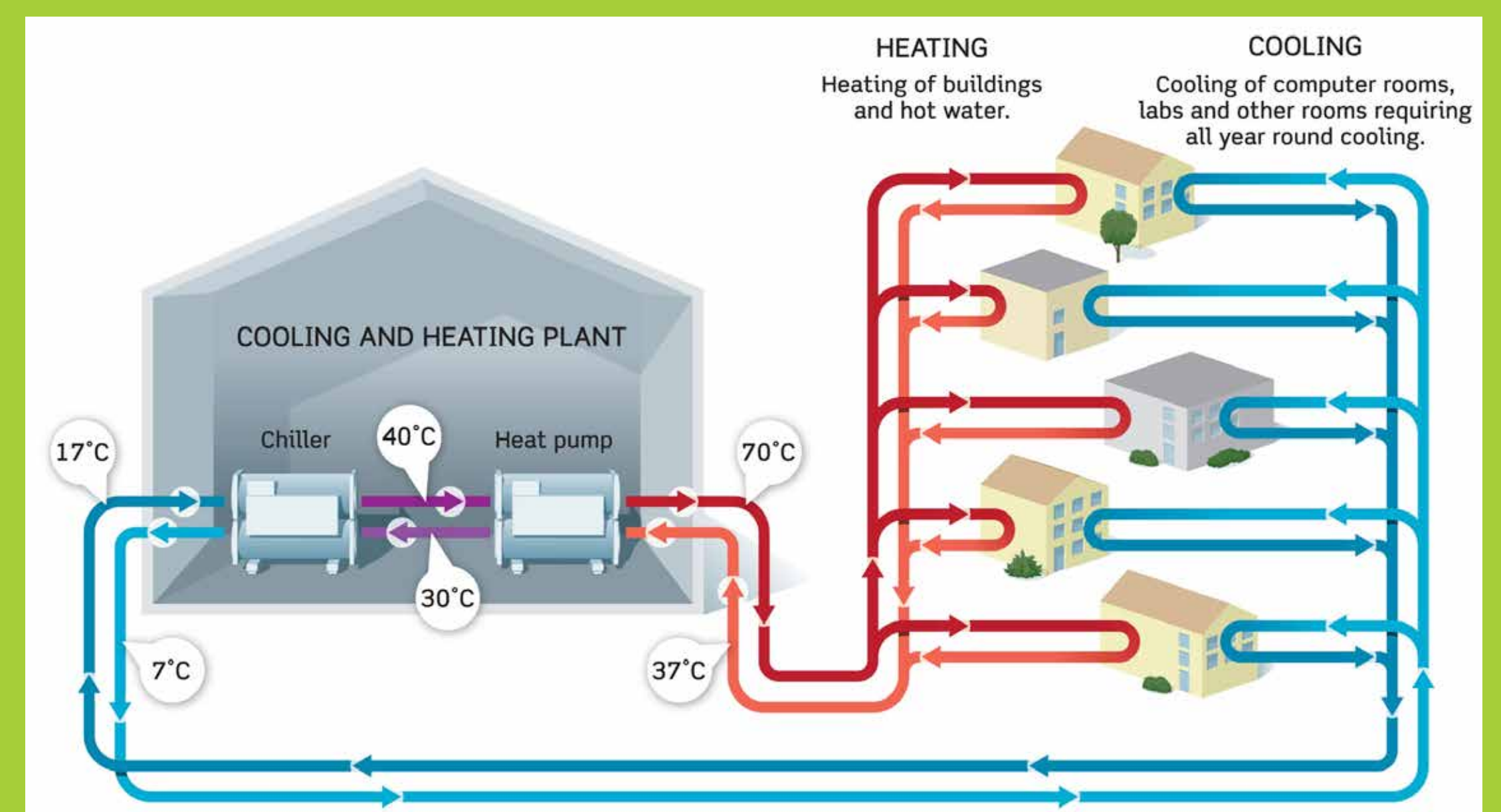
Cooling

KTH has a local district cooling system with pipes carrying cold water all over the campus. The cold water is produced locally with outdoor coolers, or as a by-product of producing heat (to warm up the facilities in the winter) with a large heat pump. The cold water enters the basement of the PDC building and goes to several heat exchangers. One reason is to form smaller closed loops of piping in the building with water that is of the appropriate temperatures for the different cooling methods that we use. PDC uses three different types of cooling (which are representative of different generations of cooling solutions):

1. Computer Room Air Conditioners (CRAC) which cool the entire computer room,
2. encapsulated cooling where all the heat from the computers is encapsulated in an enclosure and then cooled, and
3. water cooling where water of a somewhat higher temperature cools the computer directly (and no heat is emitted to the room).

As the district cooling is not 100 % reliable, we also need backup cooling and we use different backup methods for each of the three alternatives above but all are based on ordinary tap water with or without compressors.

Heat re-use



The supercomputer systems at PDC generate an enormous amount of heat, so PDC and KTH have developed an environmentally-sound method of re-using that heat, rather than wasting it.

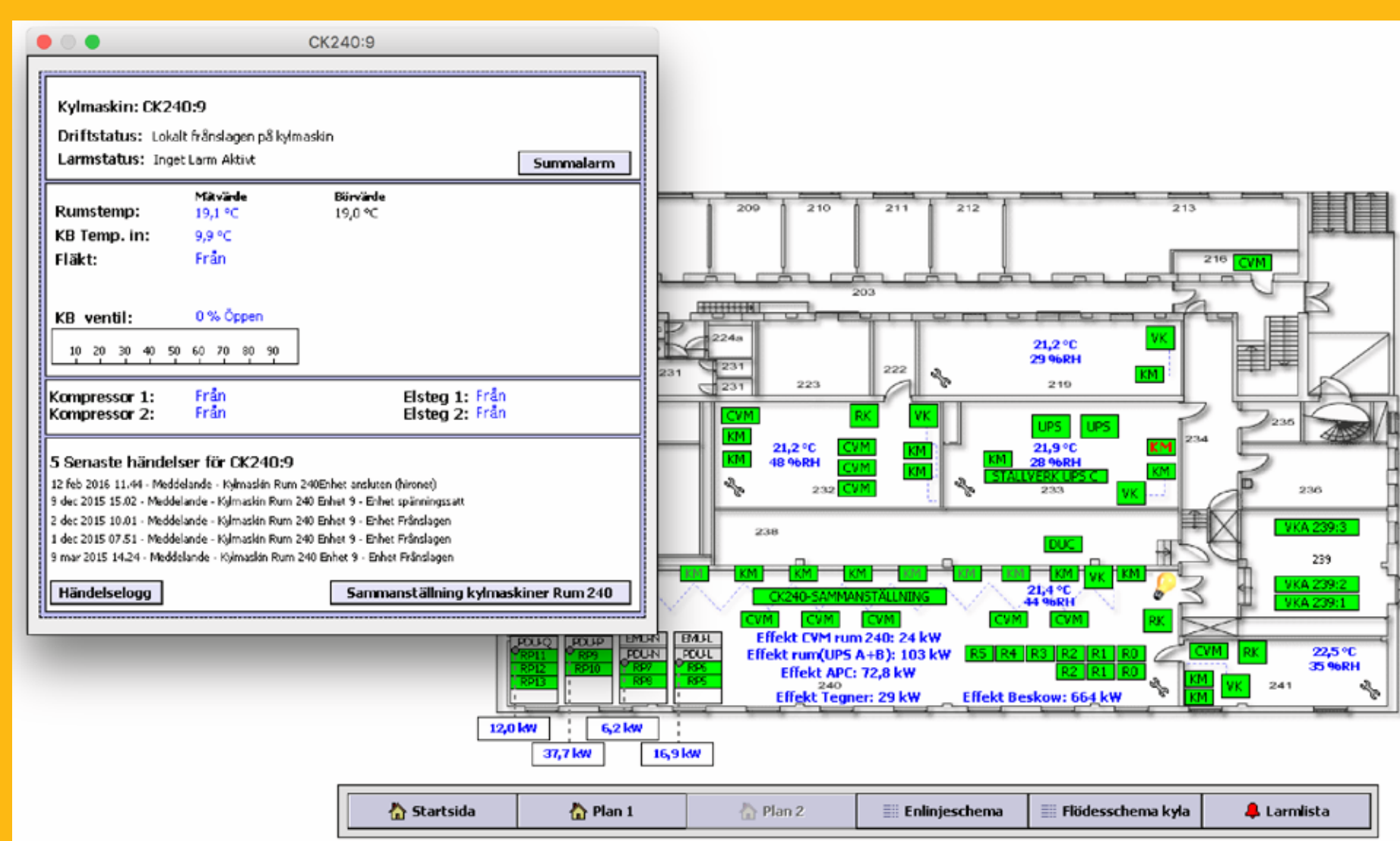
The KTH main campus has a hydronic (water-based) heating and cooling system, so the buildings are linked by networks of pipes carrying hot and cold water. KTH produces heating and cooling from its own plant, but the network of pipes is also connected to the Stockholm city district cooling and heating systems in case extra cooling or heating is needed.

The heat from the PDC supercomputers is captured (by heating water) and transferred, together with heat produced in other KTH buildings, to the central heating and cooling facility through the network of water-filled pipes. This heated water is not quite hot enough (17 °C) for heating purposes, so heat pumps increase the temperature enough that the water can be used for taps and for the hydronic radiators in the buildings at KTH. PDC's supercomputers are the single largest sources of heat for the KTH heat pump.

This environmentally friendly approach saves PDC from having to purchase large amounts of cooling from the Stockholm district system in order to cool the supercomputers, and it also cuts down on the amount of extra heating that KTH needs.

Web tool for infrastructure monitoring

The equipment that is used to keep the computer systems at PDC running can fail sometimes and hence needs to be monitored continuously. Therefore we have all the PDC infrastructure equipment connected to a monitoring system. This system collects any alarms from the individual units, and also measures the temperatures, pressures and so forth at many points in the infrastructure to check that the values are within the normal range. The monitoring system includes the web tool above which indicates alarms or measurements outside the acceptable range in red. If there is an alarm, the tool can also send an email to alert PDC staff to the problem.



Access QR codes or visit www.pdc.kth.se for more information.