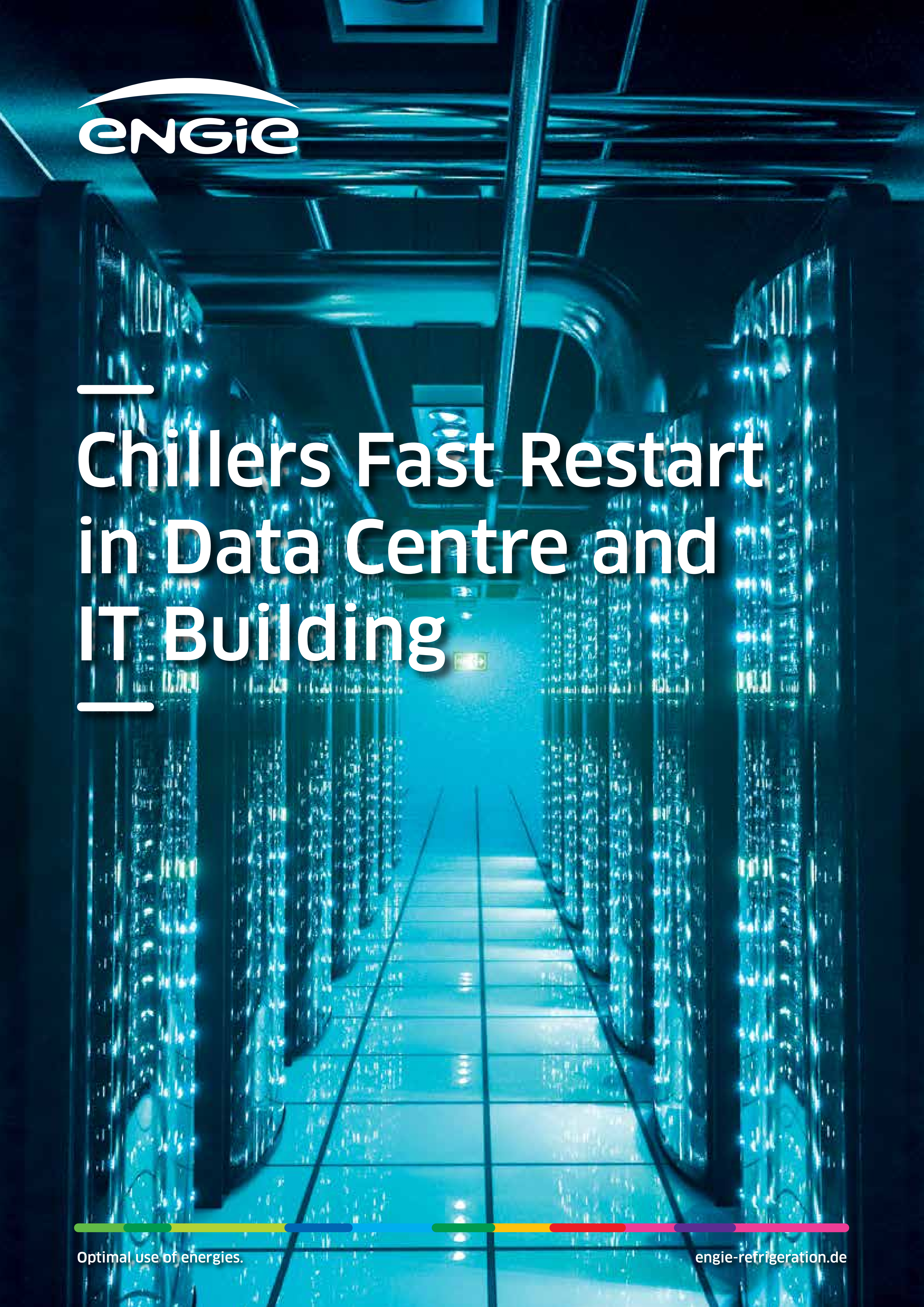

# Chillers Fast Restart in Data Centre and IT Building

Optimal use of energies.

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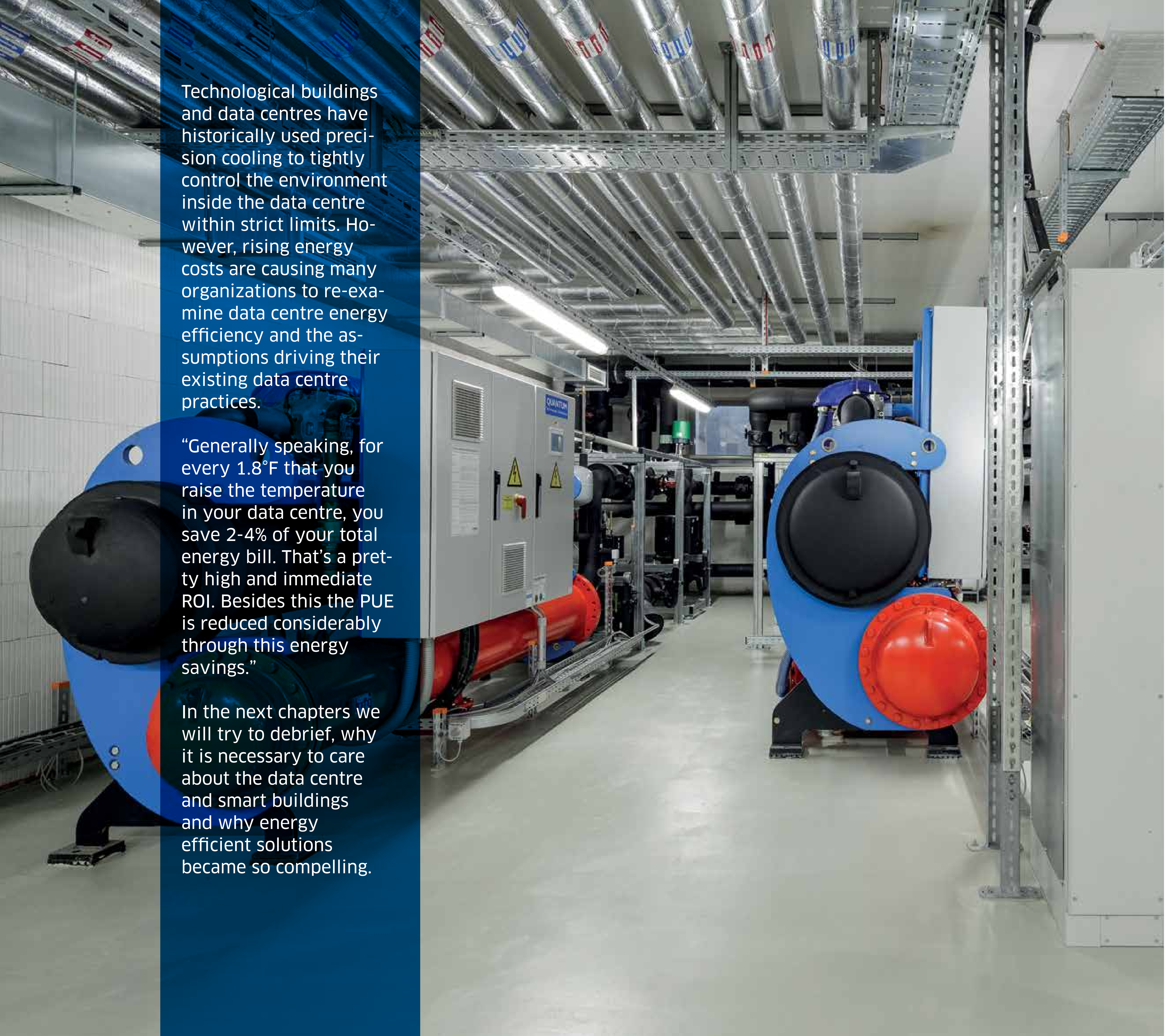


Technological buildings and data centres have historically used precision cooling to tightly control the environment inside the data centre within strict limits. However, rising energy costs are causing many organizations to re-examine data centre energy efficiency and the assumptions driving their existing data centre practices.

“Generally speaking, for every 1.8°F that you raise the temperature in your data centre, you save 2-4% of your total energy bill. That’s a pretty high and immediate ROI. Besides this the PUE is reduced considerably through this energy savings.”

In the next chapters we will try to debrief, why it is necessary to care about the data centre and smart buildings and why energy efficient solutions became so compelling.

**ENGIE Refrigeration GmbH in figures (2016)**

Active worldwide

**135**

years of experience in industrial cooling technology

**450**

dka refrigeration training courses since 2004

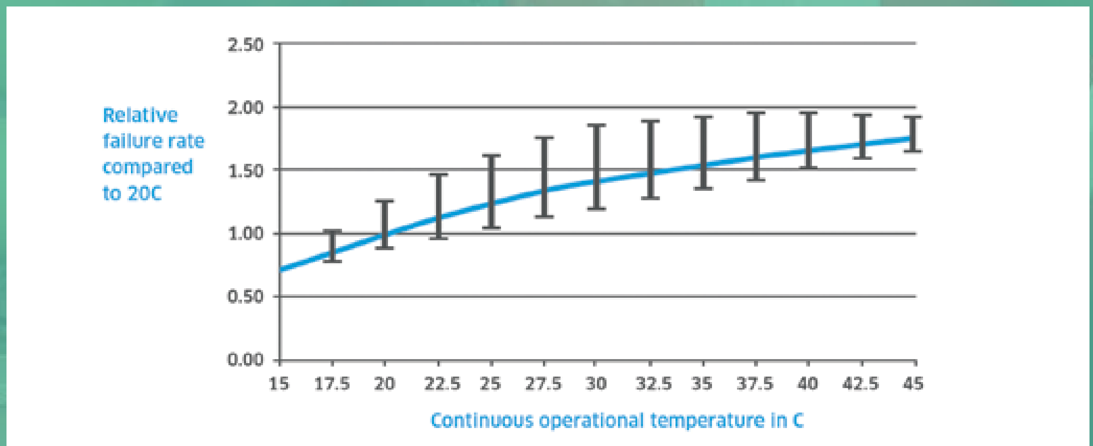
**2.560**

QUANTUM chillers sold

## The influence of the room temperature in data centres and IT devices reliability

The device failure rate shown here is normalized to 1 at 20°C: Thus, Figure 2 demonstrates that for continuous operation at 35°C the failure rate is close to 1.6 times higher than for continuous operation at 20°C.

Relative server failure rate with temperature



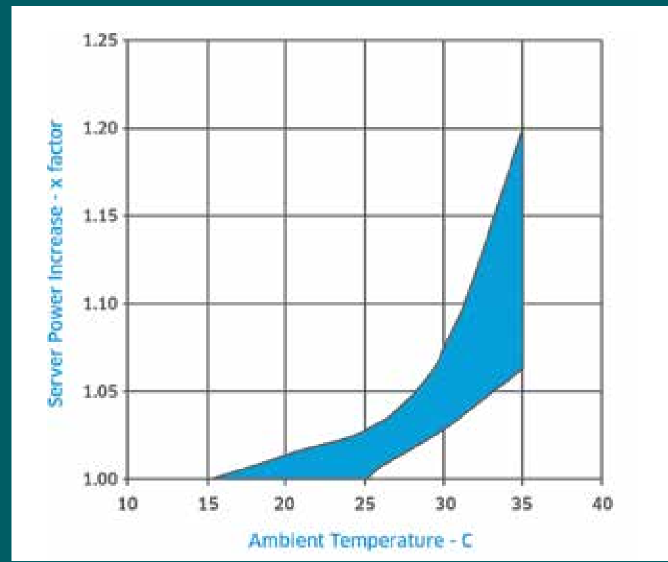

Source: ASHRAE 2011 Thermal Guidelines for Data Processing Environments - Appendix C, reformatted
Figure 2: ASHRAE 2011 Relative failure rate with temperature for volume servers

## Relationship between room temperature and data centre devices power consumption

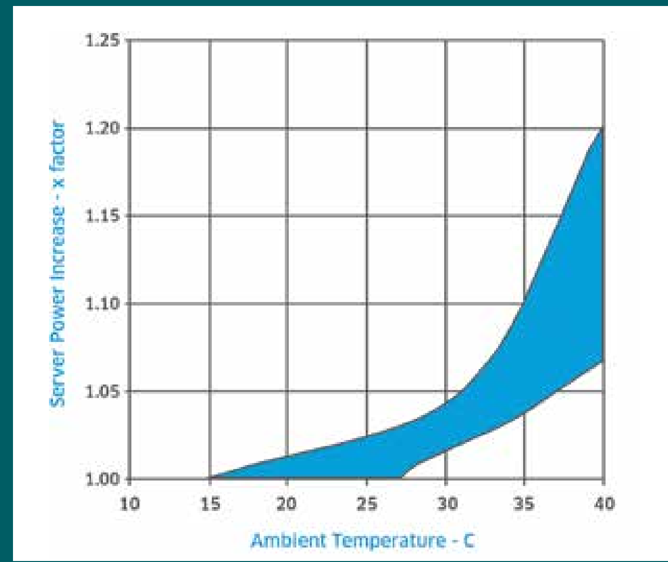
There are two factors that primarily determine the increased demand for power in relation to a rise in temperature. The first is the increase in fan power that is used to boost the volume of airflow, which correspondingly provides adequate cooling of the processor and other components.

The second factor is silicon leakage current in server components. Figure 3 illustrates the relationship between server power consumption and temperature for a range of industry standard servers.

Class A2




Class A3




Source: ASHRAE 2012 Third Edition, Thermal Guidelines for Data Processing Environments
Figure 3: Relative increase in server power against inlet temperature for ASHARE class A2 and A3

# Data Centre Cooling and **Power Failure**

IT equipment in data centres, laboratories, manufacturing facilities etc. use to be backed up by uninterruptible power supply (UPS). These devices provide continuous power while a back up generator comes on-line after a major utility power failure.

On the other hand, pumps, chillers, CRAC, CRAH... are typically not connected to UPS, but to the back-up generators. Consequently IT equipment temperature can rise after a major power failure, meanwhile the cooling system comes back to operation.

Building and facility designers use to struggle predicting the cooling performances in the event of utility power failure. Nevertheless, planning the eventual power shut down becomes critical due to the consequent IT room temperature rise, furthermore with the recent trend of building high density computer racks.

There are different strategies to deal with the eventual utility power failure and the transition period to get back-up generators on line:

- Maintain enough reserve of cooling capacity.
- Connect cooling equipment to the back-up power.
- Design and use cooling systems with short start time.
- Design and use thermal storage to cover the re-start time.



# Chiller **Fast Restart**

The updates in chiller technology and chiller plant design has reduced the restart time. It is also clear that fast chiller restart is not only important, after first utility shut down, but also to the transition from utility network to back-up generator and vice versa, when the ATS (automatic transfer switch) operates.

In a data centre, UPS connected to the IT devices and all cooling systems connected to the back up generator through an ATS, the room temperarture rises quickly immediately after a power failure, while the room temperature remains fairly constant.
Re-setting of the generator set could take around 1-2 minutes to start powering the AHU, fan coils, pumps, as well as the chillers. In the first minutes the thermal storage (buffer tanks) will provide the necessary temperature (i.e. chilled water 10°C-15°C), to cool the room and IT devices.

Nevertheless, a classical technology chiller could take up to 10 minutes to restart and deliver full capacity: power up, chiller controller reboot, electrical loop check, refrigerant loop check, water flow rate loop check, compressors loading cascade etc.

The restart time could lead to insufficient installed thermal storage. In addition, the IT devices could also influence the room temperature consequently exceeding the allowable time threshold. It is under this scenario when chiller fast restart technologies take an important role, in order to secure not exceeding IT devices temperature above the acceptable set point. Reducing the timing for chiller to restart and deliver full capacity is also important to reduce the need for thermal storage, in other words, to optimize the size of necessary buffer tanks.

# Chiller Fast Restart

### Combining two actions here:

- Connecting the chiller controller to a UPS
- Using Fast Restart chiller options

actually brings clear advantages on reducing the buffer or thermal storage capacity. This contributes to optimize the mechanical rooms' space, as well as reducing construction costs. On the other hand, problems related to non desired temperature rise on the computer rooms, can be kept under control while, increasing safety operation on the IT devices. On the next page we can see typical QUANTUM chiller behavior once the chiller controller is connected to a UPS and fitting the fast restart option.

### We can differentiate in a chiller restart cycle, after a power failure, the following time segments:

1. Voltage returning after blackout or ATS transition time.
2. Chiller controller (PLC) rebooting (usually 45 sec – 1 minute)
3. Chiller completely controls all the loop checks, and compressors are requested to start.
4. Refrigeration production start
5. Full refrigeration capacity achieved.

If the chiller controller is provided with a double connection, enabling to be powered by a UPS, the rebooting time can then be reduced. The Fast Restart option is a software function integrated within the chiller controller:

- able to reduce the loop check timing
- override the standard chiller loading control based on demand
- facilitate all compressors to start and reach the full

The standard loop check can be reduced from 200 sec up to 25 sec, and then, total starting cycle goes from 410 -420 sec, to 210 sec, cutting in half the necessary time to have the chiller ready to deliver full load capacity after a major utility power failure.

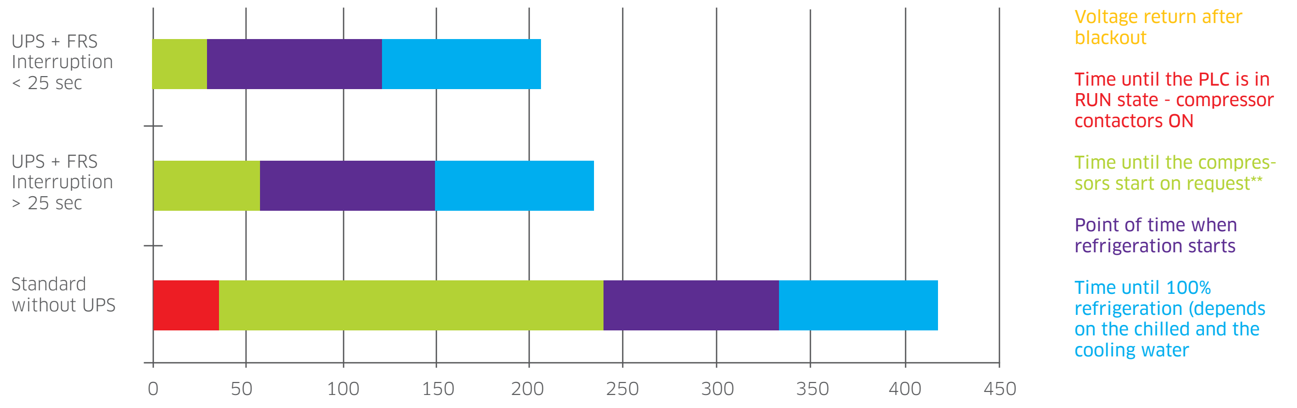
Advantages of this strategy have been already mentioned in this article, but to summarize them:

- Reduced buffer volume (savings in cost and occupied space)
- Enhanced IT devices safety thanks to secured room temperature.



### Start-up behavior of the QUANTUM III after a power failure / interruption

| Variation | Short description | Voltage return after blackout | Time until the PLC is in RUN state - compressor contactors ON | Time until the compressors start on request** | Point of time when refrigeration starts | Time until 100% refrigeration | Total time |
|---|---|---|---|---|---|---|---|
| Standard without UPS | Power supply 400VAC without under-voltage monitoring **without** external UPS (230VAC - control voltage) Interruption time until voltage return 0 until ~sec | 0 | 35 | 205 | 90 | 90 | 420 |
| UPS + FRS Interruption > 25 sec | Power supply 400VAC **with** under-voltage montoring **with** external UPS (230VAC - control voltage) **with** software function FRS. Interruption time until voltage return 0 until > 25 sec* | 0 | 0 | 60 | 90 | 90 | 240 |
| UPS + FRS Interruption < 25 sec | Power supply 400VAC **with** under-voltage montoring **with** external UPS (230VAC - control voltage) **with** software function FRS. Interruption time until voltage return 0 until < 25 sec* | 0 | 0 | 30 | 90 | 90 | 210 |




**A proper balance between the different applicable strategies to preview and overcome the problems related with a major utility failure in data centre power supply is always the answer to customize the solution building by building, and application by application.**

**The actions that can be taken in what chillers and chiller plants are concerned, can be summarized as follows:**

- **Power critical components by UPS: i.e. chillers controllers to reduce those reboot timing.**
- **Use Fast Restart software function within chillers, to reduce the necessary time to get full refrigeration capacity available**
- **Balance the restart timing with thermal buffer to ensure room temperature during transition period, and chiller plant delivering again full capacity.**

ENGIE Refrigeration supplies the right cooling for every process: from efficient chillers, environmentally friendly heat pumps and modular re-cooling systems to turnkey solutions such as refrigeration containers or modules. Efficiency, sustainability, cost effectiveness and first-class expertise in technical solutions are hallmarks of every ENGIE Refrigeration project. Our individualised advice and comprehensive services are centred around our customers and their requirements. As a member of the worldwide ENGIE Group, we have a global network of specialists at our disposal and can realise our refrigeration solutions both at home and abroad.

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