Energy Task Team

First Annual Report; 2005 - 2007

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etno

European Telecommunications Network Operators' Association

Contents:

Foreword

It was a sunny day in June 2004 when the ETNO task team on Energy was established in a place called Bergen aan Zee (Mountains at the sea) in the Netherlands. Bergen aan Zee is a small costal resort that suffers from storms every winter during which large parts of the beach are taken by the sea, year after year. The Dutch tackle this erosion using a process known as 'sandsuppletion'. This is a costly but necessary activity that the Dutch must undertake if they don't want their houses and villages to disappear in the sea. The day after the task team was formed, a massive storm arrived; rather unexpectedly, and rather strong for June. It showed the guests from all over Europe, the strength of the sea and the fight the Dutch face. This fight against the sea will grow in vehemence in the forthcoming centuries if we don't take the right action immediately. People all over the world now face their own battle, the battle against Climate Change, caused as a result of their own actions. This is a battle against CO_2 emissions.

Climate change potentially poses a devastating threat to the future of the planet. It is likely to bring about water and food shortages affecting Million of people and put thousands of plant and animal species into extinction. Around the globe, effects of climate change are already felt such as floods, storms, droughts and heat-waves all becoming more frequent and severe.

To combat climate change, at the Earth Summit in Rio de Janeiro in 1992 around 160 nations agreed the Framework Convention on Climate Change (FCCC). The Kyoto Protocol of 1997 requires developed nations to reduce their emissions of greenhouse gases (GHG) by 2010 by 5% on average, compared to 1990. Therefore, it is important that European business and industry seizes this opportunity for sustainable innovation, through the use of 'clean' technologies and actively supporting climate change actions.

Energy consumption is the single largest environmental impact of all telecommunications operators and therefore all ETNO member companies. The bulk of ETNO members' energy use is from electricity consumption, which is used to power, and cool, their communication networks. Therefore it is the responsibility of all operators, through the signing of the ETNO charter, to ensure that energy consumption is kept to a minimum and to seek environmentally friendly alternatives.

Additionally, EU legislation is now forcing business to ensure that the design of electrical and electronic equipment (EEE) minimises the impact on the environment during its life cycle. The aim is to establish a framework for defining eco design requirements for energy consuming products. Lastly, our products and services are developing rapidly. With the introduction of new services such as broadband, the communications industry faces a new challenge if it is to keep its energy consumption to a minimum.

Speed of information and communications technology leads to new demands. At the same time, smart control systems can significantly cut usage and waste. ETNO member companies need the best possible standards to ensure that equipment and usage is as energy efficient as possible. This means removing the least efficient equipment from our networks and encouraging competition between our suppliers to achieve improved products and network equipment and, finally, making it easier for our procurement teams to choose the best equipment and suppliers. Ways to do so include minimum standards, voluntary agreements, procurement policy and better information on product performance. Provided manufacturers are given adequate time to change their product specifications, higher standards should not damage our industrial competitiveness. Indeed, if properly designed, these benchmarks can help European manufacturers predict and meet rising consumer expectations in other parts of the world. The biggest threat to the telecom industry, however, is energy use and the industry must recognise and address this as develop and introduce new products and service solutions.

Going back to the day when the energy task team was proposed, it wasn't only about managing a risk it was also about taking on a challenge to change things. If we want to conserve the lowlands, not only in the Netherlands but all around the world, if we want to preserve the planet as we know it, it's a challenge we all have to accept.

From that day, things have moved quickly. The first meeting attended by energy experts from ETNO companies took place in April 2005 in Amsterdam and since then these experts have met twice a year. Benchmarks have been carried out, case studies prepared, an energy policy has been developed, experiences have been shared, pilots have been initiated and codes of conduct developed.

This first report from the task team is the next step of our development process. We want to share our experience and knowledge with you as a reader, to account for the things we have done so far, as transparently as we can. It tells the story about our first steps on a road that has no way back.

George Tiemstra, KPN, Manager Sustainability & Environmental Affairs and Chairman of the ETNO task team on Energy

Chris Wade, BT, Group Environment Manager and Secretary of the ETNO Task Team

1 – Introduction

The energy task team is a sub-group of the ETNO sustainability working group, the members of which have each signed the ETNO Sustainability Charter. By signing up to the Sustainability Charter each signatory has freely accepted a number of commitments, recognising the importance and the value of doing business in a sustainable way.

Each signatory is aware that signing should not be taken light-heartedly, and that deeds must follow words. The task team initiative is one such demonstration of this commitment.

The task team was established during a meeting of the ETNO WG on Sustainability June 2004. Initially the purpose of the task team, membership, etc, was determined by the chairman and secretary and this was confirmed at a meeting comprising of a small team of people from KPN and BT. At this inaugural meeting formal objectives were set out, a working methodology determined, the first meeting organised and speakers and guests invited.

Objectives:

1. To ensure efficient energy utilisation and the reduction of environmental impacts through improved energy management.
2. To contribute to national and global efforts to reduce GHG emissions.
3. To provide opportunities to market environmental practice and demonstrate the viability of voluntary actions.
4. To share knowledge and best practice among all the Association's members.
5. To benchmark among the members and look for best practice
6. To provide all members with a recommended Energy policy
7. To put pressure on suppliers with a Code of Conduct
8. To carry out innovative pilots

Methodology:

1. To maintain a network of energy experts committed to the use of benchmarking as a means of driving energy efficiency
2. To meet twice a year to exchange views, share knowledge, discuss solutions, work collaboratively, etc.
3. To hold two telephone conference calls between meetings to track on progress and ensure completion of action points
4. To deliver continuous improvement

Meetings:

Meetings held since the formation of the task team are:

01	Amsterdam, Netherlands	20th - 21st April 2005
02	London, United Kingdom	8th - 9th December 2005
03	Stockholm, Sweden	17th - 18th May 2006
04	Paris, France	13th -14th December 2006
05	Sophia Antipolis, France	23rd – 24th May 2007
06	München, Germany	12th -13th December 2007

Members:

The companies who are members of the task team are:

Belgacom	KPN	Telecom Italia
BT plc	Magyar Telekom	Telefónica
CYTA (Cyprus Telecommunications Authority)	France Telecom Orange	Telenor
Cable & Wireless	P&T Luxembourg	TeliaSonera
Deutsche Telekom	Swisscom	Telekom Austria
Eircom	TDC	Verizon

Topics covered at meets to date:

- Ratio/efficiency metrics for data centres
- Kyoto cooling for data centres
- The Energy Efficiency Inter-Operator Collaboration Group initiative
- Energy solutions for cooling in FTT Cabinet architecture
- Heat pipe application for outdoor cabinets
- Technology for Fuel cells; solutions for Mobile networks
- Technology for Fuel cells; solutions for Telecom networks
- Energy conversion factors
- Energy Monitoring/Management System
- Building efficiency rating systems
- Power efficiency ratios
- Cost effectiveness and energy efficiency of selected cooling options for data centres
- Borehole Cooling
- Geothermal Heat Exchanger
- Operational actions & energy reduction
- Increasing room temperature
- Use of frequency converters
- Use of Bio-Fuel
- Purchase of nature-made star eco-energy
- Mistral fresh air cooling – Swisscom

- Fresh Air Cooling in BT Telephone Exchanges
- Simple fresh air cooling – France Telecom Orange
- Purchase of renewable energy – BT, Swisscom and KPN
- Operation of equipment in an open-air environment
- Liquid Pressure Amplification
- Installation of combined solar panel and wind generator
- Energy optimisation using switchable connector strips
- Energy Optimisation in Digital Exchanges
- DC Power Systems - Energy Saving Routine
- Air Conditioning System Fan Replacement Project
- Air Conditioning System Electrically Commutated Fans
- Implementation of Building Optimisation Programme
- Power Saver Plugs
- Include power management requirements into network specifications as part of the Procurement process
- Use of Rest Heat
- High voltage DC Architecture
- Cost effectiveness of different cooling options
- Increasing the temperature in equipment rooms

Looking Forward

The task team has grown rapidly in size and reputation. Its success was communicated to Intelec, a worldwide telecommunications energy conference and exhibition that embraced the idea of a more sustainable way of working, using less and greener energy.

This initiative has generated significant interest, so much so, that it has been emulated by operators in the United States.

But new challenges must be found and this report is a result. This will help companies determine their position and hopefully, ensure that resources are allocated in order to live up to their obligations as determined in the ETNO Sustainability Charter.

2 – Energy Policy

Against the background of energy efficiency, the energy task team has developed and adopted a set of guidelines describing best practices for the implementation of a company policy on energy efficiency and management. Its main goal is to help ETNO Members stake out a general approach to energy management, plan key procedures and define their energy and GHG targets.

Though telecommunications is perceived as an environmentally friendly technology, in reality ETNO member companies do use large quantities of energy and exert a significant impact on the environment. ETNO believes that a recommended energy policy will contribute to reducing this impact.

Telecommunications operators should follow the below principles to create greener ways of working, minimise energy consumption and reduce the effects of global warming.

The recommended principles were sent out to all ETNO member companies so that each could implement them in the most successful way. This was done in 2006.

The 11 principles are:

1. Monitor and measure all types of energy consumption effectively (electricity, gas and oil) in order to identify areas for improvement and set quantitative improvement targets.

2. Identify, monitor and measure all major GHG emissions from direct and indirect activities related to running a telecommunications business.

3. Improve energy and emission efficiency in mainstream processes (networks, buildings, mobility, overhead…) and reduce energy consumption and emissions where practicable relative to business growth.

4. Design energy efficiency into all new equipment and services, including terminals, fixed/mobile network elements, buildings, offices…etc.

5. Increase, where possible, the use of energy from renewable sources and give preference to energy suppliers with less GHG emissions per energy unit.

6. Incorporate energy efficiency criteria in purchasing, supplier selection and subcontracting processes, and work in partnership with suppliers to minimise equipment energy consumption.

7. Educate employees, customers and partners about energy issues, the impact operators have as major organisations and what they can do to help.

8. Share knowledge and good practice with other ETNO members by joining the ETNO Sustainability Charter, and report on energy performance within ETNO's annual sustainability reports.

9. Support and help develop EU initiatives on the reduction of energy consumption (e.g. the Code of Conduct on energy consumption of Broadband Equipment).

10. Comply with all applicable legal requirements, regulations and standards.

One goal for 2008 is to check if they have been implemented and how. Again, this is to learn from one another and improve our results.

3 - Codes of Conduct

The electrical load represented by broadband equipment needed to be addressed by EU energy and environmental policies since there are good indications that broadband equipment relevantly contributes to the electricity consumption of households in European Community.

The European Union, through the Joint Research Centre (JRC) and with the involvement of ETNO, has promoted a Code of Conduct (CoC) on Energy Consumption of Broadband Equipment. It defines power management methods and technical solutions for the containment of energy consumption concerning both customers and providers, without hampering the fast technological development and the quality of services provided.

This Code of Conduct sets out the basic principles to be followed by all parties involved in broadband equipment, operating in the European Community, in respect of energy efficient equipment. It is in force since January 2007 and its final version is referred to July 2007.

Adhesion to CoC is voluntary and so far only two Telecom companies have signed it (Swisscom and TDC Services). Notwithstanding this, several companies are already referring to the energy consumption levels suggested by the CoC. ETNO strongly encourages member companies to sign the CoC and to abide to its principles (see positioning paper in the box below).

Depending on the Broadband penetration level, the specifications of the equipment and the requirements of the service provider, a total European consumption of up to 50TWh per year can be estimated for the year 2015. With the general principles and actions resulting from the implementation of this Code of Conduct the (maximum) electricity consumption could be limited to 25TWh per year, this is equivalent to 5,5 Million tons of oil equivalent (TOE) and to total saving of about € 7,5 Billion per year.

Since work began with the JRC on the broadband code of conduct, members of the team have also started work on two other codes of conduct i.e. European Code of Conduct for Digital TV and European Code of Conduct for Data Centres.

The Code of Conduct for Digital TV is aimed at the design, specification and procurement of Digital TV Services equipment. Discussions cover both sophisticated Set Top Boxes for subscriber services over satellite, cable, ADSL and terrestrial, as well as simple digital to analogue converter boxes for free to air digital transmission. The main aim is to create a broad and shared consensus on the Code of Conduct consumption limits and power management

The Code of Conduct for Data Centres is aimed at the opportunities to address increasing energy consumption in data centres and the need to reduce the related environmental, economic and energy supply security impacts. The aim is to coordinate activities by manufacturers, vendors, consultants, utilities and data centre operators/owners to reduce the electricity consumption in a cost effective manner without hampering the mission and critical function of data centres. The Code of Conduct aims to achieve this by improving understanding of power demand within the data centre, raising awareness, and recommending energy efficient best practice and targets.

ETNO believes these codes represent a significant step forward in improving energy efficiency for our products and services. Just as important, it provides us with an opportunity to get the commitment of our suppliers too.

4 – Benchmarking

Introduction

Benchmarking is a valuable technique that the energy task team has employed to measure and compare the performance and processes in order to identify best in class performance levels so that all member companies can improve their own result. Subjects that can be benchmarked include strategies, operations and processes. Benchmarking allows members companies to identify superior methodology or innovative practice that can contribute to the improved performance of their own organization, usually recognized as best by all other peer organizations.

This section of the report provides some examples of the benchmarking activities of the task team and the results or shared learning experienced by member companies.

4.1 Power & Cooling

Within the communications industry, there is increased competition so margins are under pressure. Added pressure comes from the increased need to innovate and replace old technology with next generation networks capable of delivering new services and solutions. As a result KPN, the Dutch Telecom operator, began searching for smart, simple and cost effective methods to reduce maintenance costs, without concessions to quality and network availability.

One of the most significant costs at KPN is the energy bill and energy efficiency and energy savings without concessions to energy performance, can deliver reductions in cost and CO_2 emissions.

To address the issues KPN started a benchmark initiative to examine how efficiently technical buildings are equipped, how operators deal with energy and cooling in relation to the quality, availability and reliability of the installed equipment and to investigate how efficient use of energy and reduction in costs is associated with energy consumption. Because of its perceived value, the benchmark was adopted by the ETNO energy task team.

Main goals:

- Improve the environment and energy performance with targets to lower costs and energy consumption and also to reduce CO_2 emissions
- Compare on a European level the design of technical buildings to aspects as energy consumption, -management and saving, environment friendly applications, and Cooling.
- Obtain knowledge of smarter and cheaper energy consumption to make further cost reductions and enable corporate social responsibility

- Compare operational/technical matters and watch new developments in the years ahead by building and maintaining a network of relations with nearby operators and suppliers

Basic principles and approach:

An initial question set was devised. It was based on key ratios, reporting items and percentages. The question set consisted of the following:

- 28 basic questions about Energy consumption & management, Environment & energy saving, Power & Cooling
- 44 Supplementary questions about Energy, environment, Power & Cooling plus additional subjects about fire prevention and security

The question set was a mixture of open and multiple-choice questions. However, the open questions gave rise to lot of discussion and interpretation problems. As a result, the answers were too wide spread and were not suitable for comparison. Therefore a second question set was developed, with fewer open questions that required completion in a more prescriptive format.

The revised benchmark covered the following areas:

Energy consumption & management

- Energy efficiency parameters, relationship with traffic load and classification for exchanges for the dimensioning of power supply
- Phasing out old technology when replaced with new, turning off surplus equipment
- Energy consumption: developments and variations in the business cases, a model related to network components, and the influence in the choice of suppliers
- Company interest in forming a consortium in order to reduce energy consumption of new equipment

Environment & energy saving

- Measures to achieve energy savings
- Is a corporate environmental policy available
- The effect of energy-savings
- Percentage of “brown” versus “green” energy,
- Own generated green energy and the (corporate) policy & type of generated energy
- Compensatory measures such as CO_2 certificates, travel for trees etc. related to the Kyoto protocol
- Low energy consumption an conditioning requiring as a subject of conversation by product,- and suppliers choice

Power and Cooling

- Availability and reliability at interface A in accordance with ETSI guidelines
- Use of hardware concepts, back-up time, redundancy, use of elements for powering and cooling and policy changes for the future
- Differentiation in service & quality to different operators/operator groups
- Earthing/grounding in accordance with ETSI guidelines and protection against ESD
- Design criteria for different type of cooling and heat generation/m2
- Fresh air values for room temperatures in relation to outside air
- Alarm settings and failure management, managing of system alarms and remote parameter setting
- Influence of working conditions on room temperatures and use of mobile cooling / ventilation units

Results of revised benchmark

- The first objective of building and maintaining a network of energy experts within Europe from other operators was achieved. This is an area for further consultation, research and exchanging idea's
- The question set provided a broad insight into:
- Energy use and savings by other operators
- Energy management in relation to "next generation networks"
- Use of energy management systems by other operators
- Energy saving projects implemented by other operators
- Use and generation of sustainable energy
- Corporate environmental and sustainability policy
- Broad insight in energy & cooling concepts and their associated availability and reliability figures
- Room temperatures in relation to heat generation and working conditions
- First impression of alarm settings, problem solving and installation management (power and cooling)

Future actions identified

- Organise workshops with participation by other operators.
- Exchanging experience and results
- Optimise the question set
- Establish further "Best Practices"
- Add any additional questions from new operators
- Identify and document case / technical studies
- Maintain and enlarge the knowledge and network through:
    - INTELEC congress and ETNO-working groups
    - Visit to other operators premises

Conclusions from the first 2 benchmark sessions

Benchmarking, establishing and maintaining a network will be a lengthy process that will require a lot of efforts. But a good working relationship (based on trust) will produce a win-win situation

Benchmark Power & Cooling III

After the results of benchmark I and II it was decided to focus more on Power & Cooling. Therefore Benchmark question set III was developed.

This benchmark was based on Best or common practices. These 'Best Practices' were established in two energy workshops (Amsterdam and London) and later improved during the task team meetings in Paris and Sophia Antipolis. The purpose of the benchmark was to examine the implementation level of the defined 'best practices' and to compare the results with other operators.

The aim was to learn from one another and to look for new issues and solutions so that next steps can be defined and taken to improve energy management within member companies.

The Benchmark was split into the following areas:

- Quality, Availability and reliability
- Energy savings
- Appendix - Network quantities and framework

The results and analysis of this benchmark were put in a reference document that is available on the ETNO website. The results are based on the data sent by the participants.

An expert team of KPN Real Estate Services, Wholesales Operations and the environmental department analysed results and drew the first conclusions. During the ETNO energy meeting in Paris all participants where invited to discuss and agree the conclusions. In June 2007 the document was published with the final analysis and conclusions and it was sent to all participants. This included a list of action points and timetable for next steps.

Identified Best Practices

Best practice on Power

- Availability and reliability on interface A
- Design and resilience of the concept
- Back-up time for the No-Break facilities
- Redundancy of the No-Break facilities
- Generator tests & fuel reserve generator set
- Mobile generator sets for emergency purpose
- Protection against ESD in equipment rooms

Best practice on Cooling

- Minimum requirements regarding availability & reliability
- Redundancy of the cooling facilities
- Hardware concept, air distribution, flow pattern an cable management
- Set points on room temperature within full ETSI-climate range
- Mobile Cooling/ventilation units for emergency purpose

Best practice Energy Savings

- Use of variable fan speed for low heat density rooms
- Energy Management Systems
- Coefficient of Performance (COP)
- Use of free-air cooling by low and medium heat density
- Raised floors and floor management
- Filtering
- Use of rest heat from equipment rooms
- Good maintenance on cleaning condensation units

Conclusions - Quality, availability and reliability

- In the chapter on quality, availability and reliability a number of questions were based on best practice. It was possible to determine final best practice for a number of these.
- During the task team meeting in Paris there was still discussion about the figures, and the interpretation of best or common Practice. For those questions where best practice could not be determined, it was agreed that all Operators who had results close to the defined best practice should take action to complete additional analyses in order to better define actual best practice. Presentations of the results were presented to the task team meeting in May 2007.

Conclusions - Energy savings

- Looking at the results of the questions on energy saving there were a number of questions based on best practice. The response to all questions in this chapter was lower than the previous section and several questions in this section need more clarification and explanation before it is possible to define best practice.
- The responses and the implementation levels in this chapter identified excellent opportunities for energy savings. It was agreed that we need to focus on this chapter for future energy savings.
- During the task team meeting in Paris BT took an action point for additional analyses, conclusions and recommendations.

(See Appendix A for full details of best practice)

4.2 Calculating CO_2 emissions for purchased electricity

According to the World Summit for Information Society, electricity demand from the ICT Sector for industrialised countries is between 5 and 10 per cent of total electricity demand and energy consumption is the single largest environmental impact of all telecommunications operators.

The most important concern of Telecom Operators regarding atmospheric emissions is carbon dioxide (CO_2) deriving mainly from electricity use. The increasing trend in electricity consumption is mainly due to the increase in broadband lines and data traffic, to the new services being offered and to the progressive spread of flat rates.

The increased consumption of electrical energy used to power telephone and data networks and premises has caused, in the last years, an increase in CO_2 emissions; hence the need to quantify and reduce total CO_2 emission and Carbon Footprint.

There are wide differences among countries in the amount of CO_2 emitted per unit of electricity used which are mainly function of technologies and sources to produce electricity.

A benchmark has been performed among ETNO companies on CO_2 monitoring in order to improve the quality of the data collected.

As we expected, differences in data and figures used are relevant among countries and telecom operators.

The benchmark emphasizes than 10 out of 13 telecom operators have a single entity (Energy Agency or Principal Energy Supplier) that every year provides information and data.

Almost all ETNO companies know, and in several cases use (4), even if only to compare (7), the GHG Protocol tool to calculate the CO_2 emitted per unit of electricity purchased. In some cases telecom operators use it only for the electricity purchased out of the home country.

One telecom operator, as from the 2007 annual report, decided to change the criterion applied to calculate indirect emissions deriving from electrical energy purchase adopting the GHG Protocol for electricity purchased.

It has been proposed that ETNO Members reported according (also) to GHG Protocol in order to have comparable data.

4.3 Fresh air cooling

Various fresh air cooling solutions for telecommunications centres have been developed and successfully implemented by several operators. A benchmarking of the methods used at Swisscom (SC), France Telecom Orange (OFT) and British Telecom (BT) has been carried out in order to firstly highlight the main advantages of fresh air cooling and secondly to analyse if one method may provide increased benefit compared to the others. The fresh air cooling methods used by these companies are described in chapter 6. The issues considered in this benchmarking were energy efficiency, cost effectiveness, technical issues and acquired experiences using fresh air cooling. A questionnaire including 18 questions was submitted to the participants. For each question the returned answers have been compared and based on this comparison a common practice or the most appropriate practice has been deduced. The main results of the benchmarking show that:

- The common basic idea and goal for using fresh air cooling are primarily energy and cost savings. But the methods may differ from one to another company. BT uses two systems. One is based on fresh air cooling year-round (FA, no refrigeration units) and the other one is a combined solution FA/DX (DX=Direct Expansion). The FA/DX systems use fresh air for approximately 70-80% of the year. DX (refrigeration units) is only used in high ambient conditions. SC and OFT use only fresh air cooling method year-round (FA, no refrigeration units).
- For each company, fresh air cooling solution applies at premises with ETSI compliant equipment
- Fresh air cooling year-round (FA) is currently implemented at 44% of sites at BT, 15% at SC and 5% at OFT. The current rollout of FA at SC is planned at 95% of the whole sites. These rates show that fresh air cooling year-round (no refrigeration units) is a well appropriate and proven cooling solution.
- The energy efficiency of cooling systems is defined by the COP (**C**oefficient **O**f **P**erformance) value. The COP is equal to the ratio of the effective cooling power to the power needs of the cooling system. The higher the COP is the more efficient is the cooling system. A yearly average COP above 20 can be achieved using fresh air cooling year-round. The higher the room temperature setting point(s) is(are), the higher will be the COP. The COP depends on the geographical location i.e. outside air temperature. Lower COP values are expected using combined FA/DX systems. EC (electronic commuted) fan motors as used at BT and SC should be promoted due to their lower energy consumption compared to AC fan motors.
- Usual cooling systems without fresh air cooling ability have a COP of ca. 3. Compared to these systems a reduction of the energy needs for cooling of more than 85% can be reached using fresh air cooling.

- Unnecessary air mixing between warm air removed from the cabinet and ambient air can be avoided by applying hot spot exhaust method as used at SC, thus leading to lower ambient air temperature and a higher COP.
- A separate room for air mixing is used at OFT. Based on the experience at BT and SC, there is no need to use a separate room for the fresh air cooling facilities, thus reducing the required space.
- The number of fans and operating modes are not standardized. Depending on the Company and site requirement fresh air systems have one or more fans which are operated on or off, in fan stages or with varying speed.
- Fresh air cooling is currently implemented up to a heat load of 550 W/m^2 of floor area at Swisscom.
- According to a survey at SC the fresh air cooling method is well accepted from persons in charge of the network. Fresh air cooling year-round is basically specified at sites with no permanent working places. According to the experience at BT fresh air systems are more reliable then DX systems (systems with refrigeration units) at extreme outside temperature.
- Further advantages of fresh air cooling year-round (no refrigeration units) are lower CAPEX and OPEX and no needs of global warming contributing refrigerants. Higher capital cost savings compared to usual cooling systems with refrigeration units are achieved at Swisscom through the implementation of its fresh air cooling method.
- Based on the good experience done in the telecommunications area, the use of fresh air cooling should be promoted in the future for cooling data centres.

5 – Eco-Efficiency Indicators

5.1 Eco-Efficiency Indicator (Telecom Italia)

In the last ten years, ETNO operators have taken strong actions towards more efficient use of the energy and its reduction. As the old network architecture was stable, the effect of these actions was easily measurable. The Next Generation Networks (NGN), all Operators are aiming to install, require a completely different and highly distributed scenario, where most of the network equipment will be deployed in FTTCab - FTTB architecture.

The need for an Eco-Efficiency Indicator rises from the need to link the unchallenged advantage for the community brought by the evolution of network and services to the impact on the environment which has been considered proportional to the energy required. Therefore, the Indicator should become one way to evaluate the Company's sustainability; the higher its value, the better the benefits.

The particular Eco-Efficiency Indicator implemented by Telecom Italia takes into account the ratio between the service delivered (in terms of bits) and the total energy used by the Operator (Joules).

Concerning the numerator, voice and traffic data, both from fixed and mobile network have been taken into account to form a comprehensive indicator. Regarding the denominator, instead, different energy sources have been included: industrial (energy used by the network plants), civil (offices, lighting) and fuels (car and heating fuel).

Year	Kbit/kWh	Bit/Joule
2004	777.248	216
2005	1.311.676	364
2006	2.175.006	604
2007	3.144.283	873

As visible in the table, the values of the Indicator for the period 2004 – 2007 show a significant growth, mainly due to the ADSL penetration and to several power-saving actions launched by Telecom Italia.

Since 2006, the Eco-Efficiency Indicator is officially reported within the annual Telecom Italia Sustainability Report and yearly targets are set.

5.2 Energy efficiency index (TeliaSonera)

An index is supposed to present a model of the development. But an index is not the truth, just an imagination. However, creating an efficiency index is important to be able to measure development. From an environmental management perspective (i.e. ISO 14001) it might be hard arguing for decreased energy consumption targets when the business is growing. But if you instead set the target on increased efficiency, the business environmental load targets becomes easier to fulfil.

Based on Life Cycle thinking, TeliaSonera has created a model using the term "Functional units". By using different network categories, comparing them year by year and measure the energy consumption per category as well it is possible not only to create an energy efficiency indicator but also make it possible to use the index setting efficiency targets in each network category.

The in data used today are:

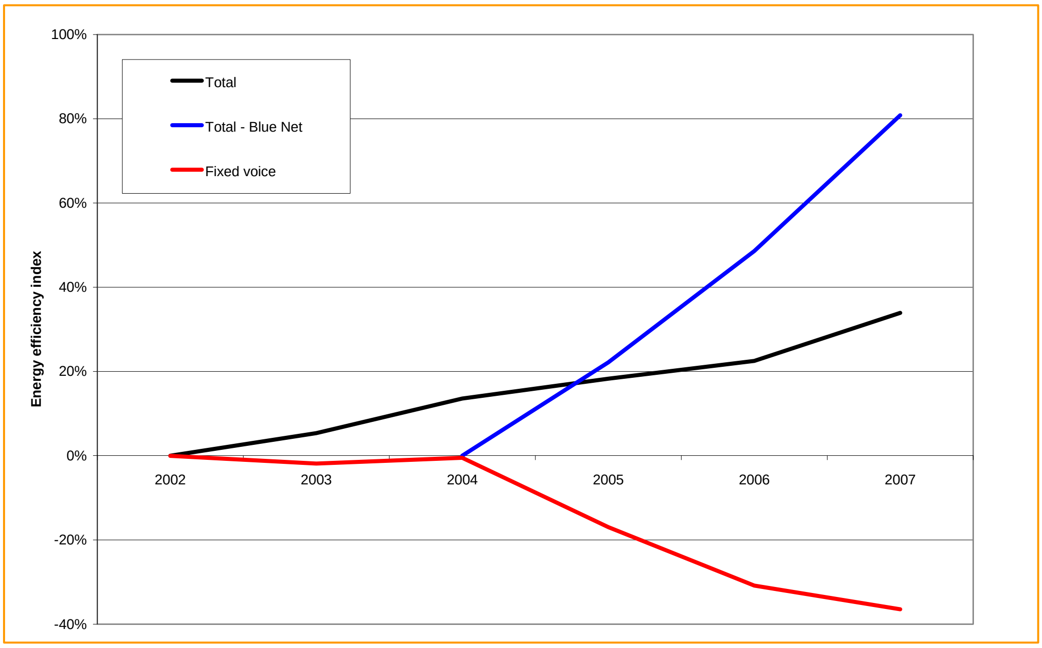
Measurement	**Unit/data**
Electricity consumption (total and per category)	GWh
Transport network capacity	2 Mb equivalents - numbers
Broadband access	Volume – number of possible subscribers
Fixed network	Volume - Number of calls
Mobile network	Volume traffic minutes UMTS, GSM and NMT
Data capacity	Servers – Total storing capacity (Tera Byte)
To be continued…	…?

There are also possibilities adding new data when they are identified.

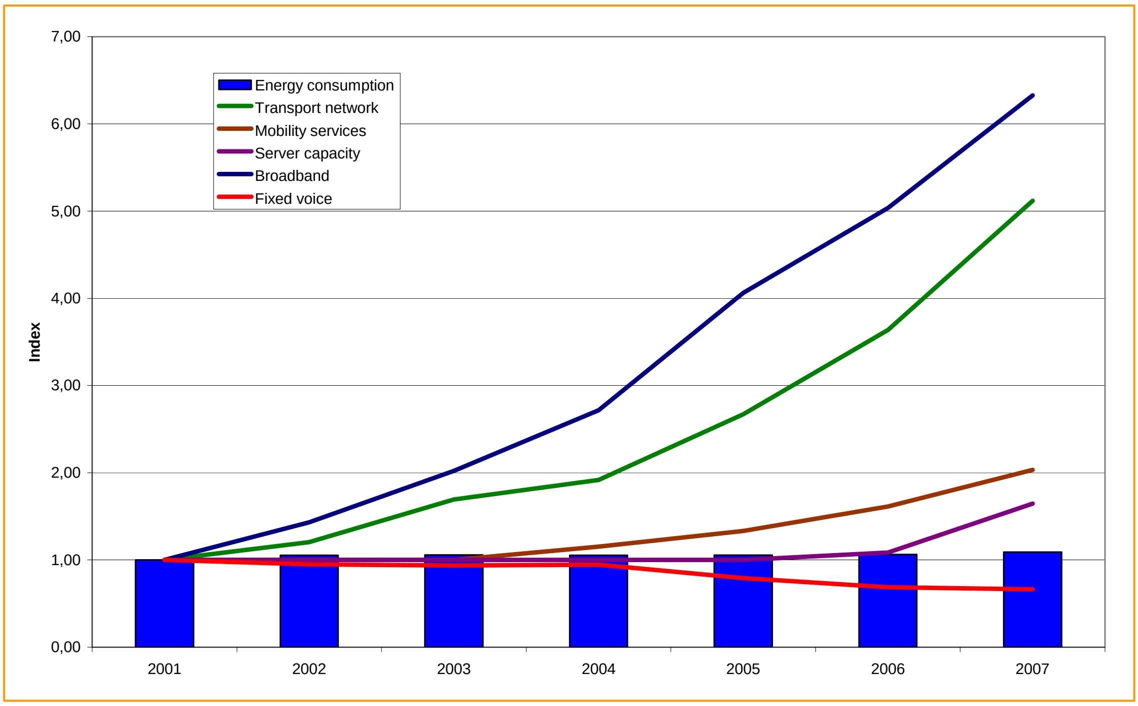
The above stated data is put into the below presented "formula":

$$I_{year2-year1} = \left(\frac{\left(\frac{Broadband_{year2}}{Broadband_{year1}}\right) * K_{Broadband} + \left(\frac{Mobile_{year2}}{Mobil_{year1}}\right) * K_{Mobile} + \left(\frac{Fixed_{year2}}{Fixed_{year1}}\right) * K_{Fixed} + \left(\frac{Data_{year2}}{Data_{year1}}\right) * K_{Data} + \left(\frac{TransportNetworks_{year2}}{TransportNetworks_{year1}}\right) * K_{Transport}}{\frac{Energy_{year2}}{Energi_{year1}}} \right)$$

The results have been quite successful and the increased efficiency in the network is calculated to be app 38% since 2001. The annual increase has been 4-11% since the measuring started. See below the outcome so far: The black line is the total index for al different categories. The blue line was implemented 2003 when we added a couple of new services to the index such as mobility and server capacity.



Another way of showing the results is by comparing capacity vs. energy consumption in an index model. It demonstrates that the electricity consumption has increased by app 6% during 2001 – 2007. But on the same time period the capacity has increased fare more in each of the included categories compared to the electricity consumption increase.



But as was stated in the beginning, an energy efficiency index is only a picture of reality. It is not the real truth.

6 – Cooling at Network Switch Sites

Introduction

In most telephone exchanges, the main cooling medium is fresh air, and air conditioning units only switch in on the hottest of summer days.

The air conditioning industry's approach to refrigeration, and legislative calls to eliminate CFCs and HCFCs, has been to develop alternative refrigerants. However, some ETNO companies have decided to take the more radical step of completely eliminating all refrigerants from new cooling systems. The first step was to ensure that exchange equipment could work over wide temperature and humidity ranges, thereby avoiding the need for close control of room temperature and the provision of energy-hungry humidifiers.

Using such systems not only eliminates the need for refrigerants but has the added benefit of reducing energy consumption and the associated costs to the business.

6.1 Fresh air cooling at Swisscom

A new method for cooling telecom equipment based on the use of fresh air year-round (no chillers) has been developed in 2005 at Swisscom. Simulations and trial results have shown that using solely fresh air to cool the network equipment is feasible. The rollout of this method for equipment of fixed network has been launched at End 2005. Today, more than 120 sites are already equipped with this solution.

The proposed cooling system basically consists of two single-stage exhaust fans located at the top of the room (see Fig. below). Each fan provides 50% of the rated air flow volume. Should one fan fail, more than half of the cooling power would still be available (over 50% redundancy). If lower system availability is required e.g. at sites with low thermal load, only one fan providing 100% of the rated air flow volume can be used. The first fan is switched on at 24 °C and switched off at 22 °C; the second one at 26 °C and 24 °C, respectively. We are now introducing exhaust fans with variable speed and if possible, with electronically commuted fan motors. The rated air flow volume is set to $0.1 m^3/s$ per 1 kW of required cooling power. Rigid or flexible air ducts are mounted above the cabinets so that the exhaust air from the cabinets is directly driven towards the exhaust aperture (hot spot exhaust). Outside air is supplied to the room through an aperture in the outdoor facade.

Fresh-air-only cooling arrangement at a pilot site in Bern

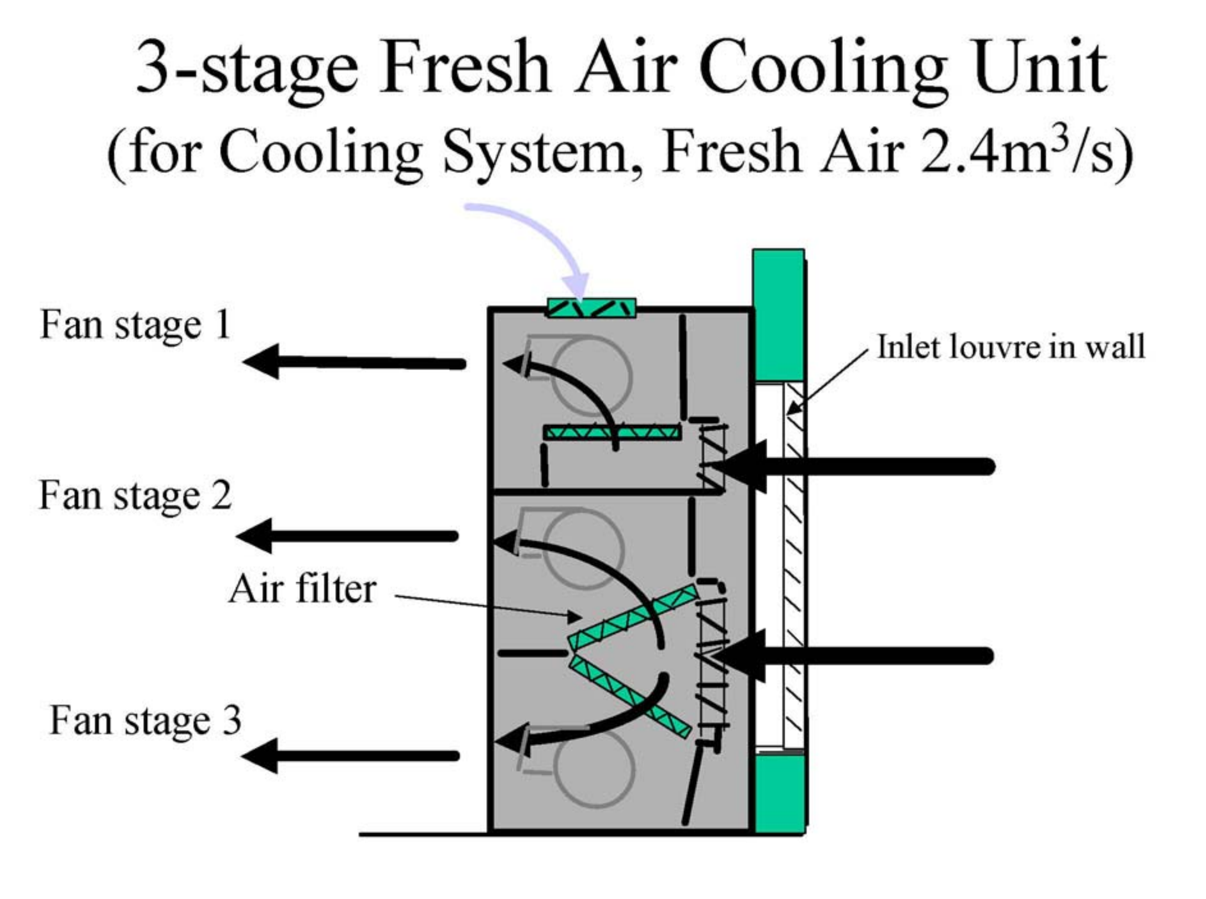
This new method results in capital costs reduction of a factor 3 to 4. According to trial results, a coefficient of performance (COP: ratio of the effective cooling power to the power needs of the cooling system) of more than 20 can be reached using fresh-air-only cooling. A reduction in the energy needed for cooling of 45 GWh per year is expected after full implementation.

Last year, we have also investigated successfully the implementation of this cooling method at sites of mobile networks. Today, more than 30 BTS are already equipped with this cooling solution.

Further environmental advantage of fresh-air-only cooling (no chillers) is that global warming contributing refrigerants are eliminated.

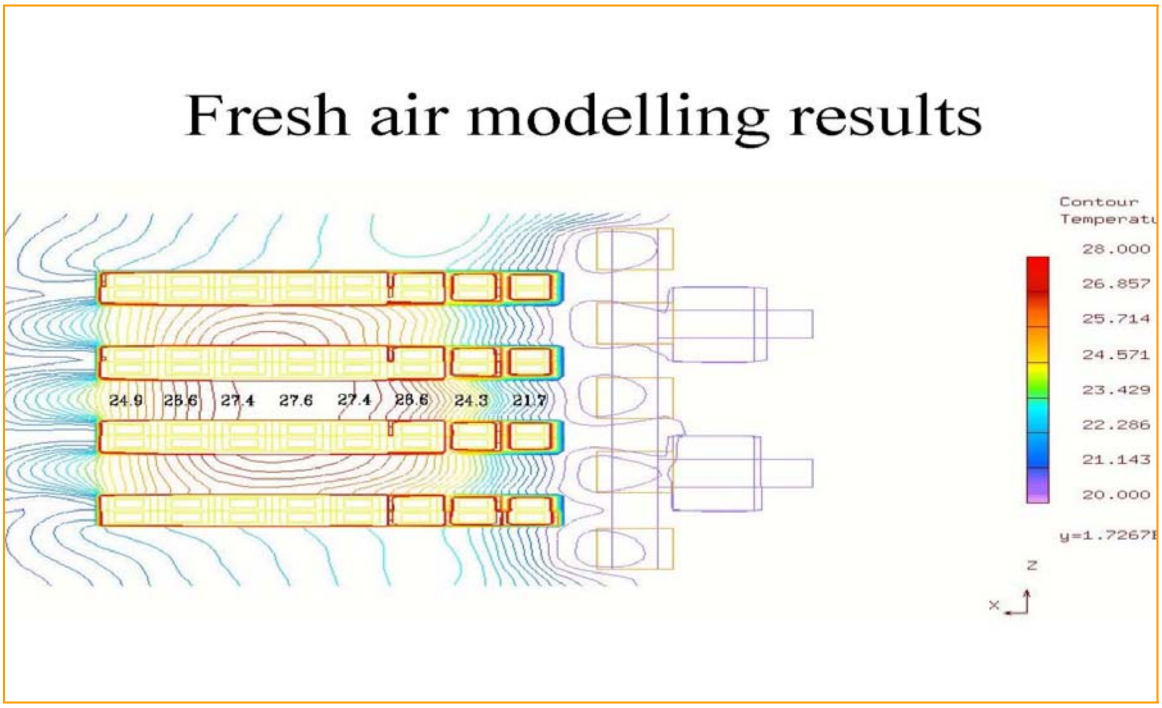
6.2 Fresh air cooling at BT

BT worked with its equipment manufacturers to design for to develop a new cooling system specifically for full operational performance over a wide temperature limit. The key features of the system are the complete absence of any refrigerant and its very low energy consumption.



BT's Network team worked closely with suppliers to ensure that European Telecommunications Standard Institute standards, which allow room temperature fluctuations between -5 and 45°C were met. This was so successful that the team witnessed a telephone exchange working at room temperatures in excess of 70°C!

The biggest problem from an engineering viewpoint is to distribute the air evenly around the room so that no hot spots occur. The need to switch off air fans in stages to keep energy consumption within target precluded the use of the traditional ventilated ceiling and ductwork for air distribution. The solution was found with the aid of Computational Fluid Dynamics (CFD) modelling software.



A computer model of each exchange room, including such details as equipment suites and their heat dissipation, cooling units, pillars and other obstructions enabled the team to predict the precise movement of cooling air in terms of temperature, speed and direction. Careful positioning of the equipment and cooling units ensures that the installation will stay within the temperature limits required by the European Standard.

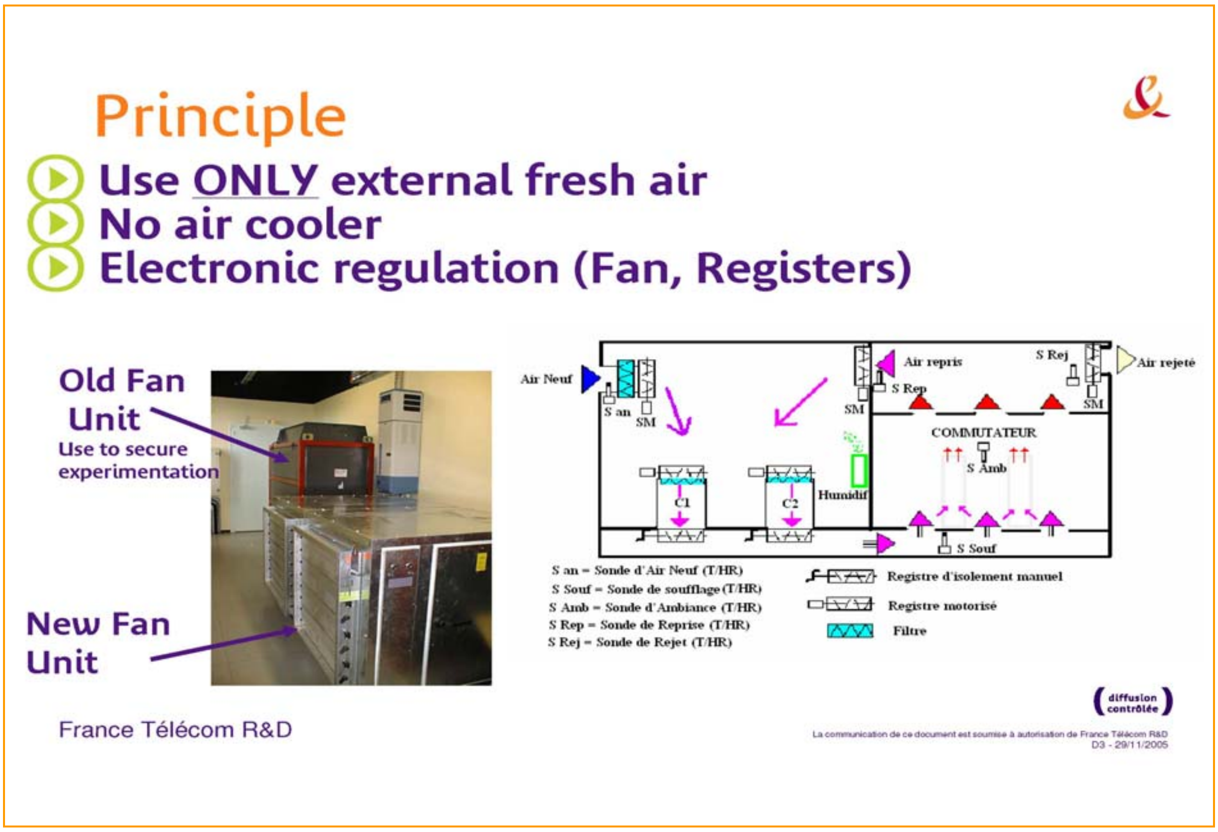
The solution has lived up to expectations. The energy consumption of the cooling system has been halved compared with previous systems, as has the capital cost. The electrical running cost of BT’s 3-Fan Fresh air cooling unit giving a nominal 15kW of cooling is £300.00 per year.

Wherever possible, we now use fresh air to cool our telecommunications equipment, including our new 21st Century network. All new cooling units use an ozone-friendly, chlorine-free refrigerant gas, R407C and are hermetically sealed to prevent leaks.

6.3 Fresh Air Cooling at France Telecom Orange

According to ETSI environment standards, telecommunication equipments can work in a wide range of temperature and humidity and France Telecom Orange is one of a growing number of Telecommunications operators who are increasingly interested in reducing the damage on the environment that cooling causes as well as improving economical methods for cooling switching rooms. Therefore, France Telecom Orange developed a new concept that fits ETSI climatic conditions without the use of any cooling unit. This concept is based on the simple use of the external air.

The maintenance of the environmental climatic conditions inside the temperature and humidity range defined by the ETSI is carried out by a mixing of the hot air from the switching room with fresh air taken from outside. This resulting air is then injected into the switching room by a system of ventilation and filtration. It is then diffused through perforated flagstones laid out on the false floor. This "fresh" air passes normally in the telecommunication racks. The hot air issuing from the racks is evacuated preferably by a hanging ceiling provided with perforated flagstones or by a network of sheath. A part of this air is directly rejected outside while the other part is recycled and mixed with new air before being injected again in the room.



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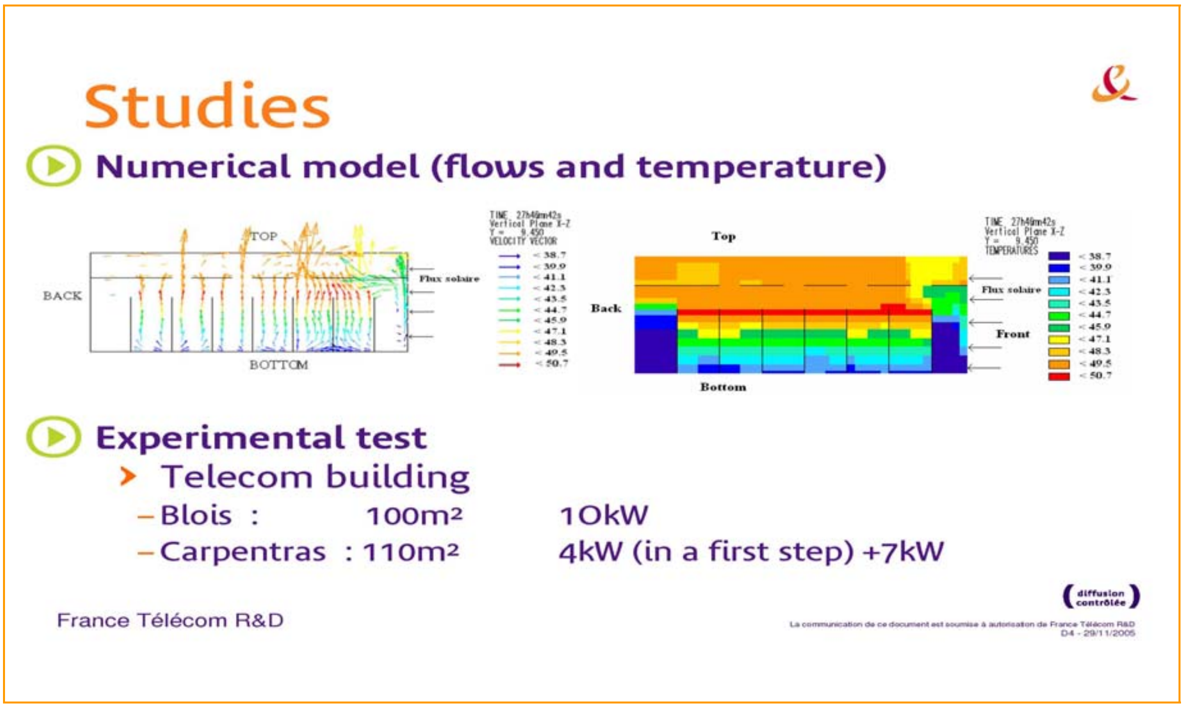


To evaluate the energy savings, we introduced an "energy coefficient", which is the energy consumption ratio between air cooling system and telecommunication equipments. A typical ratio is about 0.35 for a good classical cooling installation. The power consumption of the air cooling system has been divided by a factor, at least, equal to 10 compared to a traditional air-conditioning system.

6.4 Liquid Pressure Amplification

Modern Refrigeration Systems typically work at half their theoretical performance efficiency, therefore add-on benefits can be considered. Liquid Pressure Amplification LPA is a new technology designed to increase the efficiency of refrigeration systems by reducing flash gas.

By installing Liquid Pressure Amplification booster pumps into the liquid line of suitable Chillers at main offices, significant energy reductions are possible. Manufacturer's data indicated potential savings, which were backed up by a paper from the Institute of Refrigeration.

The benefits are dependent of the local ambient temperatures, run times, the size and inherent efficiency of the machine. In the majority of cases the benefit is 30% of the running cost.

In addition to the Energy savings the compressor load is reduced which increases reliability and reduces noise this is done by lowering the head pressure on the compressor. The use of inverter drives on the condenser fans where available, also increases the savings by giving closer controls on the condenser Temperatures/Pressures.

Reducing discharge pressure, with the corresponding reduction of the compressor ratio in a refrigeration cycle can be beneficial in that it can provide increased efficiency and reduce mechanical wear. However, reducing discharge pressure can also result in refrigerant evaporating in the liquid line with a consequential loss in capacity and efficiency.

The solution to achieving drastically reduced discharge pressures, without the negative effects, is Liquid Pressure Amplification (LPA). A magnetically driven pump installed after the condenser/liquid receiver maintains the critical system pressure ensuring a flow of liquid refrigerant to the expansion valve. Now the compressor is only required to raise the refrigerant temperature to 5-15 °C above ambient temperatures.

Liquid pressure pumps are used to increase the pressure level between the condenser / receiver and the expansion valve in direct expansion systems. The increased pressure of the sub-cooled refrigerant increases capacity and system efficiency and also helps to overcome flash gas related problems that often arise in medium sized and larger systems. Significant energy savings of 30-40% and improvements in reliability have been achieved from the use of Liquid Pressure Amplification.

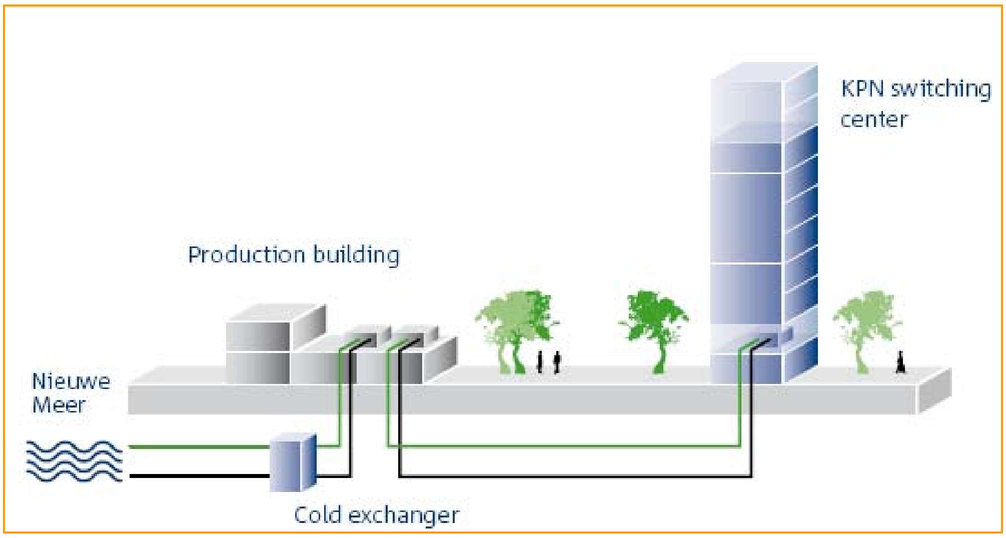
Hermetically sealed magnetic drive pumps are installed in the liquid line between the Condenser/receiver and the expansion valve. The head pressure developed may be only 1or 2 bar but this pressure change is adequate to have the following beneficial effects:

- Helping overcome the effects of pressure drops in the liquid line and its components which reduces flash gas, thereby assisting effective operation of the expansion valve and restoring refrigerating capacity
- Allowing the expansion valve to control well even when the head pressure floats down with falling ambient temperature, so lowering the temperature lift that the compressor sees and reducing energy consumption.
- Improving the return of oil through the improved percentage of liquid to vapour in the evaporator
- Reducing superheat by injecting a small portion of the pumped liquid into the discharge line of the compressor, which effectively reduces discharge temperatures and increases condenser capacity
- The calculated savings assume the plant is maintained to the Manufacturers recommendations and working.

Most installations realise savings of around 32% with average payback of 18 months.

6.5 District cooling (KPN)

District cooling is implemented at one of KPN's largest switches (in Amsterdam). This has resulted in a structural saving in the energy usage needed for the cooling of the site. This sustainable cooling concept has won international acclaim and was nominated for the Green Award for Data Centres 2007 (organized by Data Centres Dynamics). The technique reached the shortlist of four European nominations.



Scheme of district cooling as offered by energy supplier NUON to KPN.

The system comprises a pumping station that pumps up water from a lake on the outskirts of Amsterdam (Nieuwe Meer) from a depth of approximately 40 meters. The water is transferred to a production building via a cold/heat exchanger. Besides cold/heat exchangers the building accommodates a number of cooling machines. The machines ensure that, if necessary, the temperature of the incoming water is always between 5 and 6°C. If the temperature and/or volume of the water obtained from the lake falls short of what is required for cooling, the cooling machines assure the continuity of supply of district cooling. An underground system of pipelines has been installed from the production building to the users of district cooling. A heat exchanger is also used at the user's premises to remove heat from the building. The heated return water (with a temperature of at least 16°C) is routed back to the production building and discharged into the lake via the heat exchanger. KPN is one of the first customers of the district cooling system.

Research has shown that at its present size the system does not disturb the lake's natural balance. At times when the cooling machines are operational, the return water is first routed across a condenser before being discharged into the Nieuwe Meer. In the cold period of the year, the heated water from the Nieuwe Meer is cooled down naturally by the ambient air (atmosphere) to its normal natural temperature.

7 - Other cooling developments

7.1 Energy solutions for cooling in FTT Cabinet architecture (Telecom Italia)

Up to few years ago, the network was fixed and was basically in a steady state: the only traffic was represented by the vocal calls, the issue of the power consumption wasn't felt as strategic, and the actions towards energy savings were limited to port concentrations and replacements of obsolete equipments.

The rapid diffusion of the mobile telephony and, above all, the fixed broadband penetration that started at the end of the nineties caused the addition of new active equipments and, therefore, the progressive rise of the "energy issue". Moreover, the continuous demand for more bandwidth is bringing towards a saturation of the ADSL capacity (the maximum theoretical speed per user is 8 Mbit/s for ADSL and 24 Mbit/s for ADSL2+).

Therefore, new technologies and even new architectures are needed in order to fulfil the new requirements. To this end, almost every Operator is currently deploying its Next Generation Network, which will dramatically change the network architecture, migrating from FTT Exchange to a mix of FTT Cabinet/Curb, FTT Building and FTT Home.

This implies a new paradigm of discontinuity: the network will move from few Central Offices with medium/high electrical load to lots of distributed systems in the access network with small loads.

In particular, the FTT Cabinet architecture is the most critical, because it brings several issues:

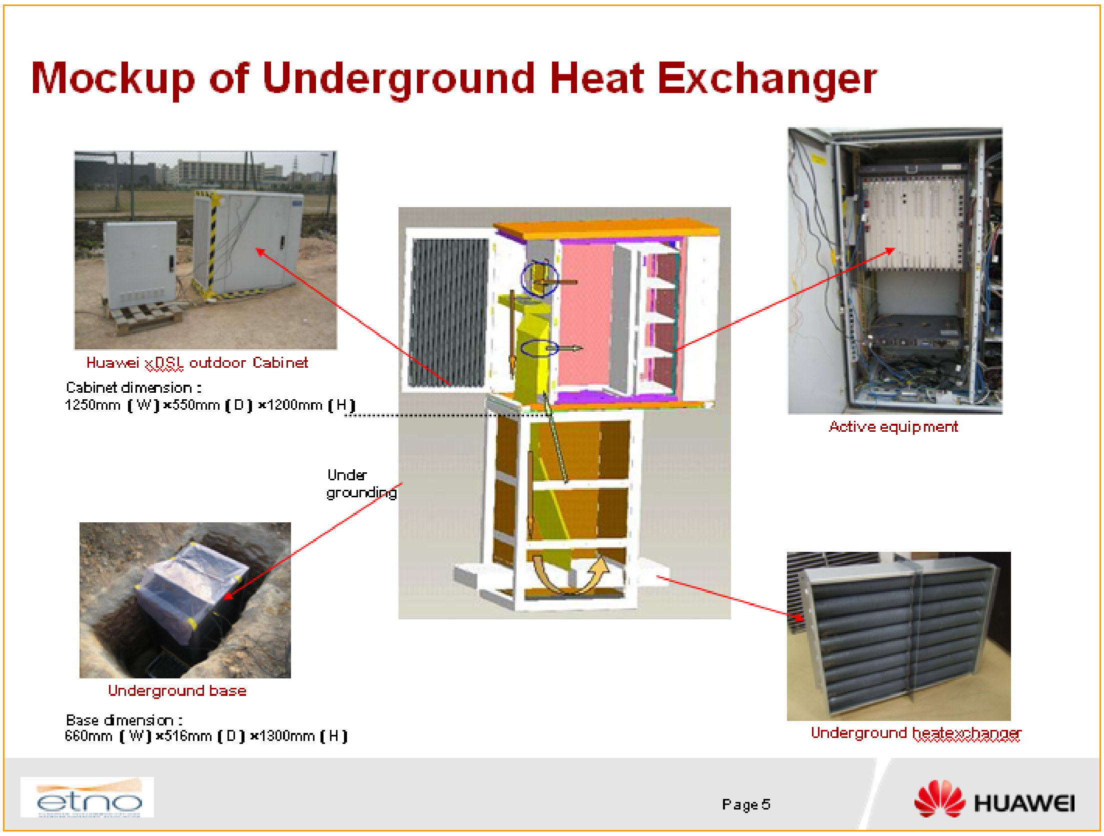
- **Automatic Distribution Frame**: it could avoid lots of OPEX, allowing remote management, but it's still not yet mature (high costs, dimensions and unknown reliability);
- **Cabinet size**: in several cities a quite small depth is required;
- **Powering**: local or remote powering must be deeply analyzed, in order to select the best option from time to time
- **Power consumption and cooling**:
  - high unit power consumption can affect not only the energy bill, but even the feasibility of the overall FTTCab solution
  - the total ONU power dissipation strongly influence the adoptable cooling solution

- In particular, concerning the cooling solutions, lots of different options are currently under evaluation. In the following, a short list of available options is reported:

- **Passive cooling**: the Street Cabinet has no fan and is sealed. This solution is the most efficient but is applicable only to small loads (< 200W)

- **Free cooling**: the Street Cabinet has holes towards the external environment; fans can be used in order to facilitate air circulation. Pollution could be a problem
- **Underground cooling**: the Street Cabinet is sealed and exchanges the heat with the ground through an heat pipe (assumed depth < 1 m)
- **Geocooling**: the Street Cabinet is sealed and exchanges the heat with the ground using air or water as vector fluid (assumed depth > 1 m)
- **Heat exchanger**: the Street Cabinet has a heat exchanger unit (usually on the top). The energy efficiency is quite low
- **Air conditioning**: the Street Cabinet has a unit for mechanical conditioning. On the opposite of the passive cooling, this solution is the less efficient and should be used only for huge loads (>1kW)

It is important to highlight that the less energy hungry the ONU/DSLAM is, the greater is the number or adoptable options. Telecom Italia and Huawei will set up in the next months two trials based on free cooling and underground heat pipe solution (see figure below).



7.2 Borehole Cooling (TeliaSonera)

Mälarhöjden LX is one of TeliaSonera's 30 sites that are chilled by closed ground collector systems for peak cooling.

The cooling system is designed on the basis of a principle minimizing the number of moving parts with 100% free cooling during all hours of the year. Mälarhöjden LX has no chillers and no Freon installed for balancing the process load.

The objectives for the Site have been:

- Low level of service costs due to rugged design with a minimum of moving parts.
- A complete free cooling system with extremely low energy consumption for pumps and fans.
- No service for shifting of filters.
- Low environmental influence due to low energy consumption and total absence of freons.

Technical overview of design

The system at Mälarhöjden LX is one of TeliaSonera's standard systems MFK/9 for ground collectors (GC) with a nominal capacity of 150 kW.

MFK/ 9 systems are possible to purchase both for chillers and for ground collectors with the nominal output of 100, 150 and 250 kW. It has been developed from two in depth analyses with a massive amount of data logging from a wide range of sites varying from approx. 9 kW up to 400 kW. The results of these two projects can be summarized as follows:

- In commonly designed cooling systems, the energy consumption for auxiliary equipment such as pumps and fans etc contribute significantly to the total energy consumption.
- Installation of free cooling is no guarantee to achieve low total energy consumption due to :

    1. Lack of optimized design.
    2. Low coolant temperatures.
    3. High energy consumption for auxiliary equipment.
    4. Automation systems not thoroughly tested at realistic loads, temperatures and conditions.

The system in Mälarhöjden LX works on the principle of displacement cooling in the different rooms to get uniform air distribution with a minimum of hotspots due to low grid driving power and high temperature coolant.

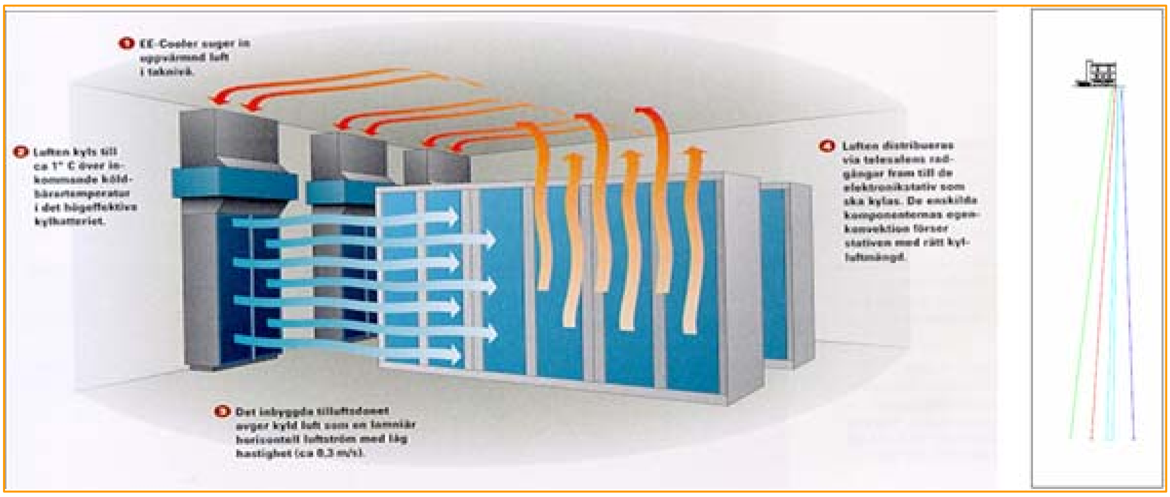


Fig 1 Air distribution principle with EE- Coolers for high temp coolant and closed ground collectors

Economic analysis

The cooling system for Mälarhöjden AXE was modernized in 2005. In this project the old room-cooling system was exchanged to new SEE- 3 Coolers for improved air distribution, lower energy consumption and a severe increase in the working temperature of the coolant.

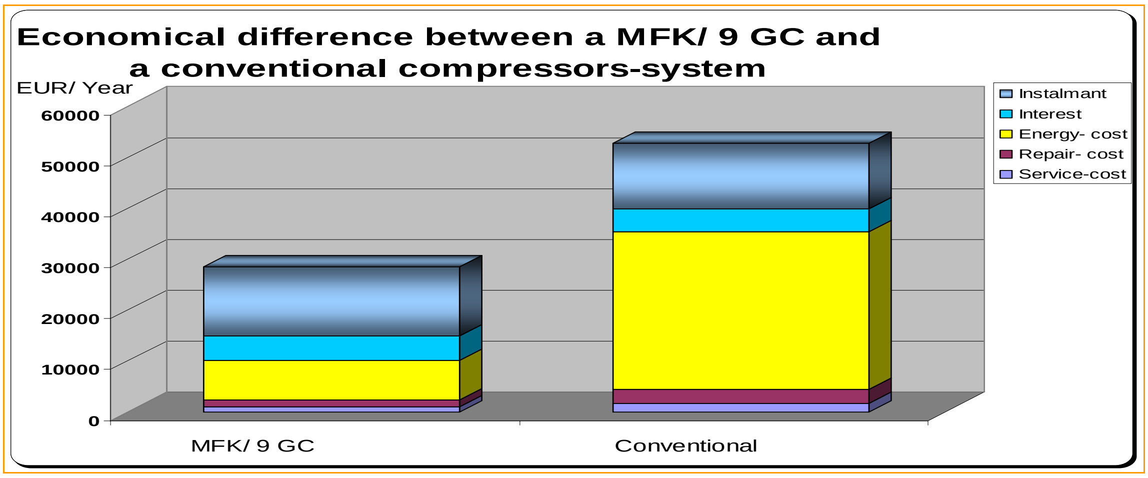


Fig 2 Comparing costs for a MFK/ 9 GC and a conventional compressor system over a period of 15 years.

Energy Consumption

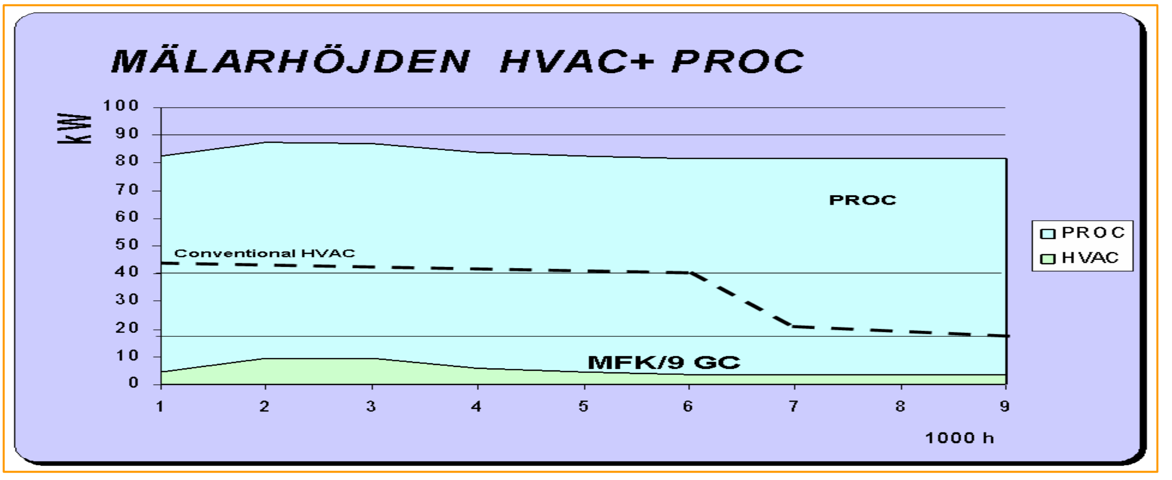


Fig 3 Energy consumption for a MFK/9 GC and conventional compressor system during one year. The calculation gives a total of approx 69MWh for the MFK/9 GC system and approx 341MWh / year for the conventional compressor system.

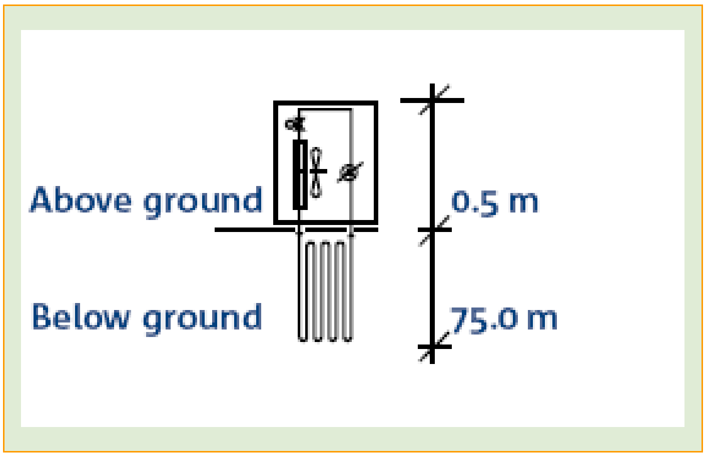
7.3 Soil cooling system for small sites (KPN)

KPN is developing a low-energy cooling system for sites in its mobile network where equipment is installed next to the transmitter masts for mobile networks (like GSM and UMTS). To ensure correct operation, the equipment has to be cooled. However, using traditional cooling (by means of air-conditioning systems) consumes a relatively large amount of energy and, what is more; it uses a fan or compressor that can cause noise nuisance.

KPN has launched a trial using an alternative cooling system to remove the heat generated by the equipment. The system indirectly uses the cooling capacity of groundwater in the soil below the site. At the site one or more pipes are driven vertically into the ground to a depth of up to 75 meters and water is made to flow through them. This system is called a Vertical Soil Heat Exchanger (VSHE). The water cooled by the soil is routed back to the cooling unit in the compartment where the technical equipment is installed. The cooling unit has a heat exchanger that is connected to the VSHE. This makes it possible to cool air heated by the equipment (up to 35°C). A fan in the cooling unit re-circulates the air from the room and routes it across the heat exchanger. Via the closed system of loops in the soil (VSHE), the heated water is sent back to the groundwater in the soil to be re-cooled.

To circulate the cooling water only one small pump is necessary, comparable with a pump used in a home central heating system. Soil cooling is not only energy efficient it requires very little maintenance compared with other systems.

Diagrammatic representation of cooling by means of groundwater.



The system will be evaluated after summer 2008. A decision on wider use of the system will be taken based on experience gained from the trials. A new pilot project planned for 2008 will test the application of cooling by means of groundwater in combination with optimized use of outdoor air for cooling purposes.

7.4 Heat Pipe cooling concept in junction boxes (KPN)

The more the Netherlands communicates by means of broadband technology, the more requirements KPN impose on the broadband network. To connect households to the fibre-optic network and ultra high-speed Internet, KPN will install between 15,000 and 25,000 junction boxes all over the country in the coming years.

The hardware in the boxes produces heat. The heat density in the junction box will be somewhere between 1200 – 2000 Watt, depending on the IT-configuration in the cabinets. It is necessary to cool the junction boxes to keep the equipment within the ETSI-climate chart. KPN wants to use a cooling method in the boxes that uses three to four times less energy than conventional cooling methods. The conventional cooling method that is used nowadays is an air to air heat exchanger with an electrical consumption somewhere between 150 – 200 Watt.

A good solution is to install a heat pipe to bring the ambient temperature in the junction box within the ETSI-climate conditions. The Heat Pipe is a closed pipe that takes away heat by means of condensation. The principle underlying the Heat Pipe has been used in the past. What is new is that KPN will install the pipe partly in the soil beneath the junction box. This allows us to use the cold stored in the earth. That is in theory what makes this cooling method exceptionally efficient.

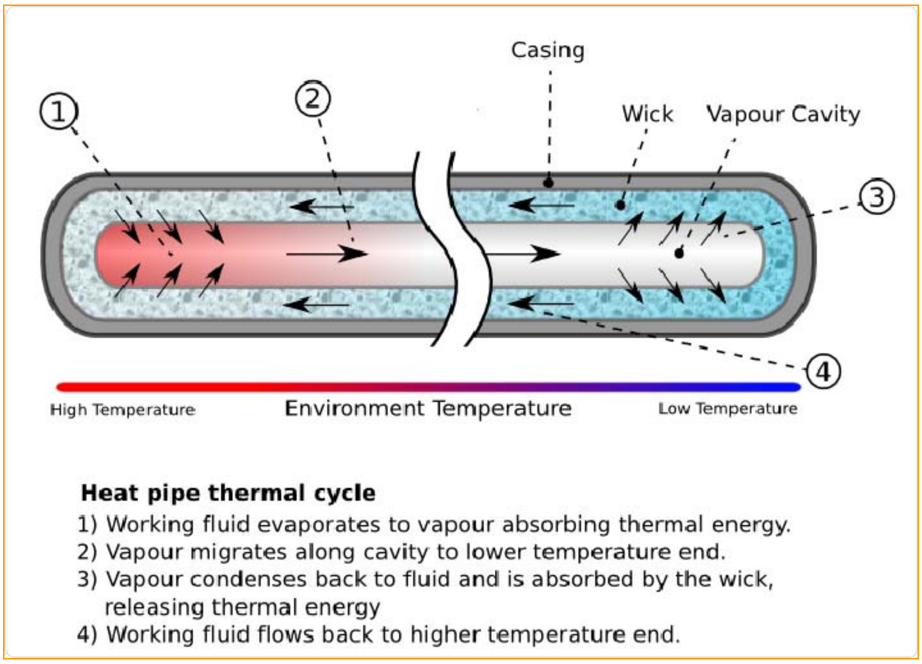
Only a small fan is needed to blow the hot air into the duct with the heat pipe to a depth of approximately 1.5 metres. The cooled air flows back into the box. The KPN Heat Pipe concept consumes 50 Watts for the airflow (fans), 3 to 4 times less than traditional cooling methods.

The new method will be tested in Bunnik (test site in the middle of the Netherlands, close to Utrecht) from October 2007 until October 2008. In this period all seasons and weather influences will pass during the test. This means outside temperatures from -10 to +35^{o} Celsius, sun, rain, snow and storms. At year-end 2008 the study will be completed and KPN will decide whether it is possible to use this cooling concept nationwide. (Will theory meet practice?)

During the test several temperatures are measured using a remote monitoring system. In the field trial KPN also investigate if the system is stable, reliable, and maintenance free as suggested by the manufacturer. If all the conditions are between the expected values the heat pipe could be a cost and energy efficient solution. Below you can see find a schematic drawing of the test configuration.

What is a heat pipe?

The heat pipe technology is used for several decades in the micro electronic industry. The heat pipe is in fact a heat exchanger. The heat pipe is a heat transfer mechanism that can transport large quantities of heat with a very small difference in temperature between the hotter and colder interfaces.

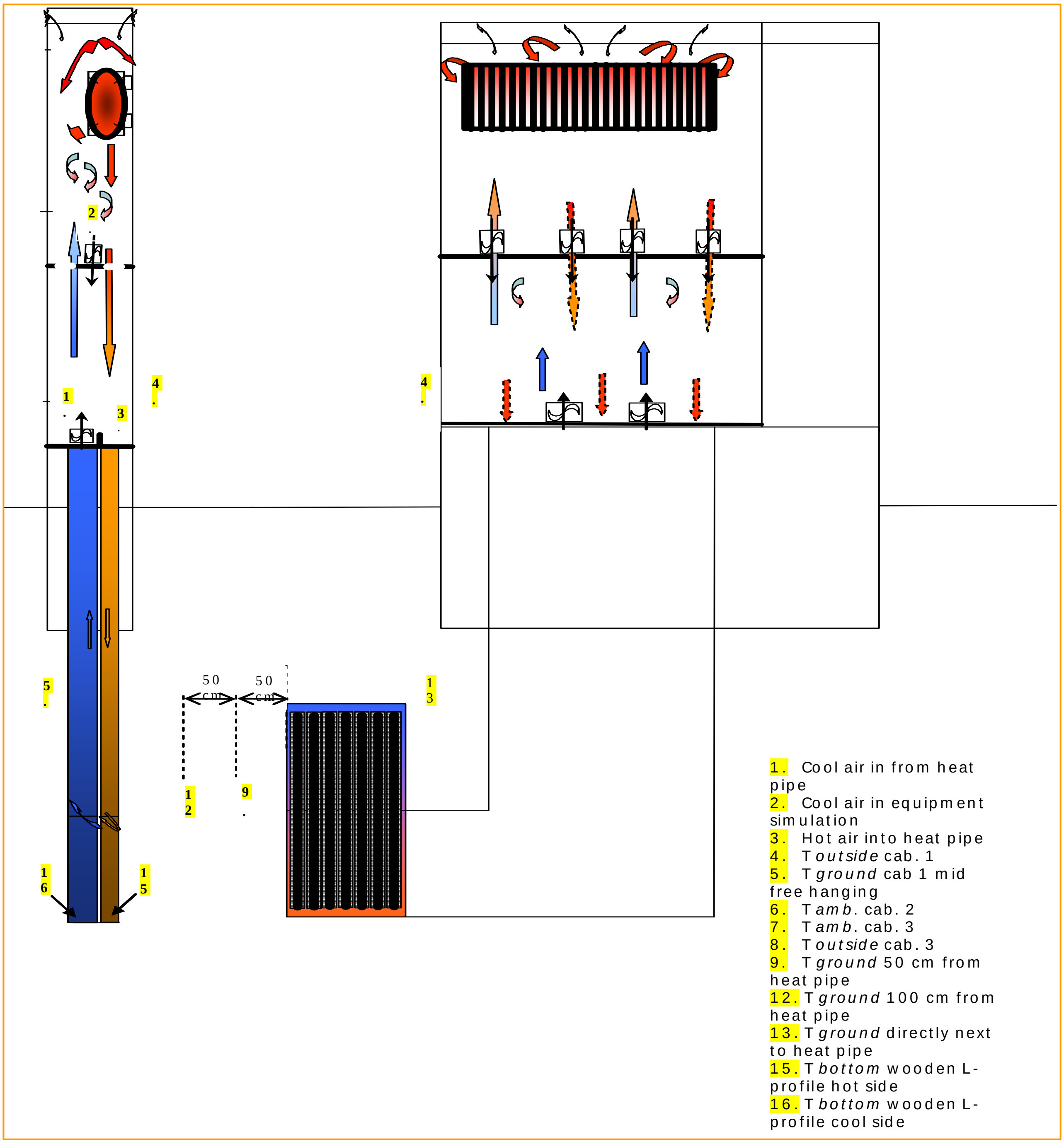


Inside a heat pipe, at the hot interface a fluid turns to vapour and the gas naturally flows and condenses on the cold interface. The liquid falls or is moved by capillary action back to the hot interface to evaporate again and repeat the cycle.

A typical heat pipe consists of a sealed pipe or tube made of a material with high thermal conductivity such as copper or aluminium. A vacuum pump is used to exclude all fluids (both gases and liquids) from the empty heat pipe, and then the pipe is filled with a fraction of a percent by volume of working fluid, (or coolant), chosen to match the operating temperature. Some example fluids are water, ethanol, acetone, sodium, or mercury. Due to the partial vacuum that is near or below the vapour pressure of the fluid, some of the fluid will be in the liquid phase and some will be in the gas phase.

Heat pipes contain no mechanical moving parts and typically require no maintenance, though non-condensing gases (that diffuse through the pipe's walls, result from breakdown of the working fluid, or exist as impurities in the materials) may eventually reduce the pipe's effectiveness at transferring heat. This is significant when the working fluid's vapour pressure is low.

The advantage of heat pipes is their great efficiency in transferring heat. They are a much better heat conductor than an equivalent cross-section of solid copper.



1
2
3
4
4
5
50 cm
50 cm
12
9
13
16
15
1. Cool air in from heat pipe
2. Cool air in equipment simulation
3. Hot air into heat pipe
4. T *outside* cab. 1
5. T *ground* cab 1 mid free hanging
6. T *amb*. cab. 2
7. T *amb*. cab. 3
8. T *outside* cab. 3
9. T *ground* 50 cm from heat pipe
12. T *ground* 100 cm from heat pipe
13. T *ground* directly next to heat pipe
15. T *bottom* wooden L-profile hot side
16. T *bottom* wooden L-profile cool side

8 - Data centre developments

8.1 Data Centre Energy Consumption

Energy is one of the most compelling and important issues facing IT data centre management. It relates to all elements of data centre efficiency and productivity and future IT growth requirements. To understand and manage data centres efficiently, there is a need to measure and understand total data Centre energy consumption in order to introduce and measure the effectiveness of best practice, new techniques, technologies and metrics, all requirements for increased efficiency and productivity.

Guidelines and resources needed to drive change are:

- Guidelines and standards of energy measurement
- Clear roadmaps for future data Centre design and operation

The Green Grid

The Green Grid is a global consortium bringing together industry leaders and end users from critical segments of the data Centre ecosystem to develop a unified voice around data centre efficiency issues.

The Green Grid is dedicated to developing and promoting energy efficiency for data Centres by:

- Defining meaningful, user-centric models and metrics
- Developing standards, measurement methods, best practices and technologies to improve performance against the defined metrics
- Promoting the adoption of energy efficient standards, processes, measurements and technologies

Membership is open to any company developing products and technologies aimed at the data Centre market, as well as information technology professionals tasked with data Centre operations

The Green Grid Technical Work Groups

The Green Grid operates a number of technical working groups covering the following areas:

- Data Collection and Analysis - data Centre characteristics and performance metrics
- Data Centre Technology and Strategy - existing and emergent technologies for data Centre efficiency
- Data Centre Operations - use models, operational strategies, best practices and equipment standards
- Data Centre Metrics and Measurements - data Centre subsystem performance characteristics.

Creating a framework for best practices

To create a framework for best practice the Green Grid are:

- Creating shared definitions, benchmarks and metrics to enable real-time measurement monitoring and control of data Centre efficiency and productivity
- Creating baseline 'state-of-the-industry' documentation including benchmark architectures and a repository of data Centre efficiency knowledge
- Creating a comprehensive technology roadmap for future data Centre design to maximize efficient and productive operations
- Assessing new and alternate data Centre technologies
- Monitoring progress on all fronts and provide periodic updates

Members of the ETNO Energy task team attend the green grid meetings and feed back to the task team at its plenary meetings. The task team are also working on a number of initiatives on data centre efficiency. See sections 8.2 and 8.3 below for more detail.

8.2 Energy Efficiency in Data Centres

According to a study of Laurence Berkeley National Laboratory (LNBL) the total electricity use worldwide for servers including the associated cooling and auxiliary equipment has raised by more than 50% in the last 5 years (see Fig. 1). This consumption represents 0.8% of the estimated 2005, world electricity sales. As it can be seen in this figure about the same amount of electricity is used for servers and associated cooling and auxiliary equipment. There is therefore an urgent need for increasing the energy efficiency in DC. Energy efficiency metric and corresponding target values for DC as well as appropriate cooling options should be defined.

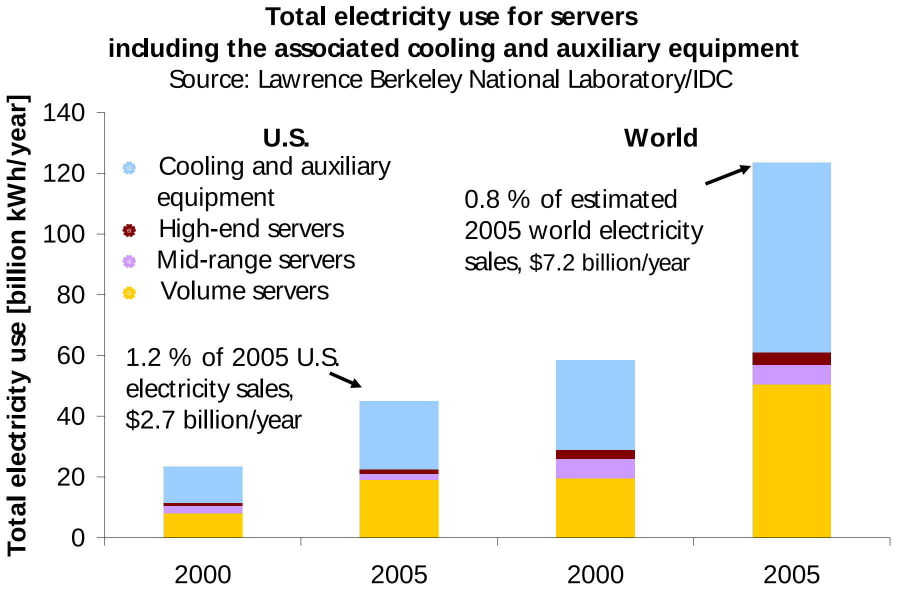


Fig. 1: Total electricity use in U.S. and worldwide for servers including the associated cooling and auxiliary equipment (Source: Laurence Berkeley National Laboratory (LBNL) / IDC)

Energy efficiency metric and corresponding target values for DC

In order to select best practices for enhancing the current situation energy efficiency ratio should be defined and associated target values should be set based on the state of the art in matters of IT engineering and infrastructure technology.

The *Green Grid* initiative has proposed the following energy efficiency ratio for DC:

- **Power Usage Effectiveness (PUE):**

$$PUE = \frac{\text{Total Facility Power}}{\text{IT Equipment Power}}$$

- **Data Centre Efficiency (DCE):**

DCE = 1 / PUE (reciprocal of PUE)

- **Data Centre Performance Efficiency (DCPE):**

$$DCPE = \frac{\text{Useful Work}}{\text{Total Facility Power}}$$

The definition of both first ratio PUE and DCE is illustrated in Fig. 2. For the DCPE ratio an appropriate and measurable value of useful work has still to be defined.

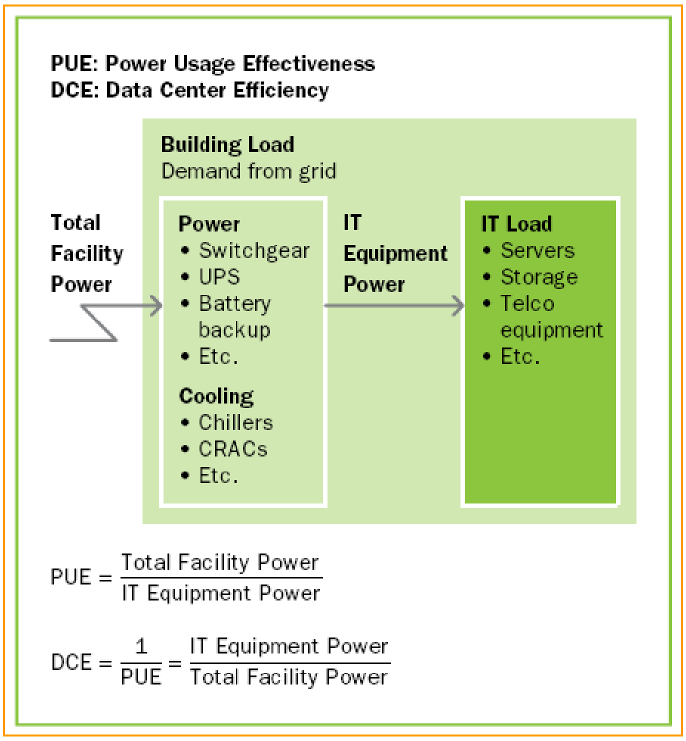


Fig. 2: Power Usage Effectiveness (PUE) and Data Centre Efficiency (DCE) ratio as defined by *The Green Grid* initiative. Detailed information on these ratios is available on:
http://www.thegreengrid.org/gg_content/Green_Grid_Metrics_WP.pdf

As an environmentally committed and ISO 14001 certified Company, Swisscom has already set energy efficiency target values for new data centres. These target values are shown in Fig. 3. The target value for cooling of <20% is based on a recommendation from the Swiss Federal Office of Energy called „*Energieeffizientes Kühlen von IT-Räumen – auch ökonomisch interessant*". The energy breakdown in Fig. 3 corresponds to a PUE < 1.39 and a reciprocal DCE > 0.72.

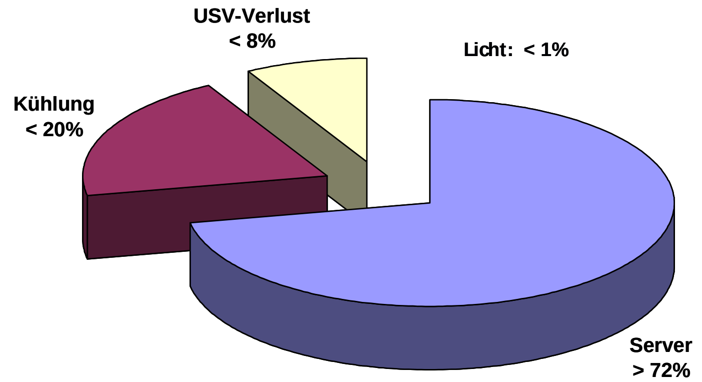


Fig. 3: Energy efficiency target values for new DC at Swisscom (Kühlung = cooling; Licht = light; USV-Verlust = uninterrupted power system (UPS) loss)

In order to enable an easy and meaningful benchmark based on DCE ratio or reciprocal PUE ratio some conditions have to be set preliminary:

- For practical reasons the reference point for the measurement of *IT equipment power* should be set at the UPS power output. The energy loss by switchgears and the power distribution is assumed to be low compared to the *IT equipment power.*
- Because Total facility power varies throughout year, yearly averaged DCE power values should be used for benchmark purposes.
- A correction factor should be included for considering the yearly average outside temperature of the considered site.
- Heat recovery (heat re-use) has a positive overall impact on energy balance, but locally it results in higher electricity consumption for cooling

thus leading to lower DCE value. In order to promote heat recovery two DCE target values should be therefore set, one with and one without heat recovery.

Considering these conditions and the current state of the art of IT and DC engineering the energy efficiency targets based on DCE metric as shown in Fig. 4 have been proposed at the ETNO Task Team Energy for energy optimization at existing DC or inclusion by the planning of new DC.

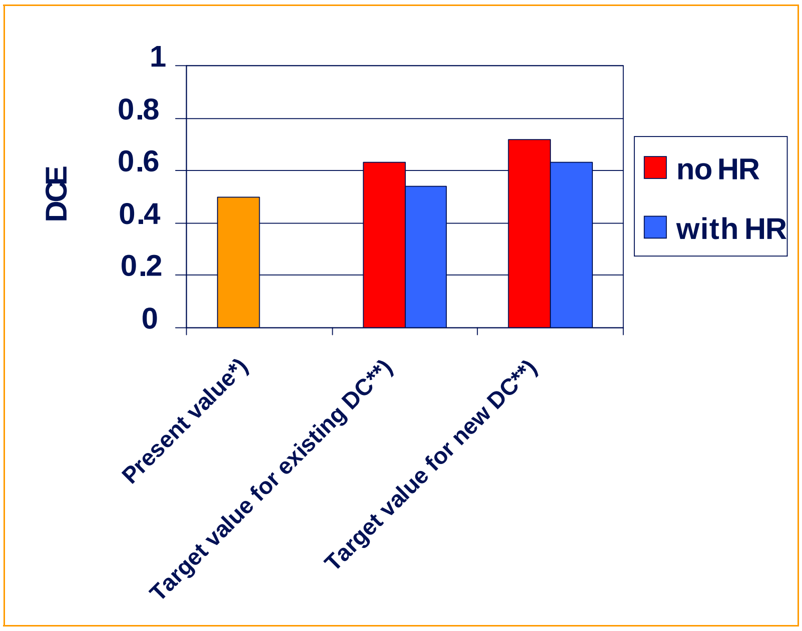


Fig. 4: Energy efficiency target values based on DCE metric for existing and new DC respectively. For each category i.e. existing or new DC two target values are set: one for DC with heat recovery (with HR) and one for DC without heat recovery (no HR). *) The present value is an average DCE value of existing DC worldwide according to Fig. 1 and results of measurements completed by LBNL on 22 DC which show DCE values in the 0.33 to 0.77 range (respectively PUE values between 3.0 and 1.3) [5]. **) DCE target values ***with HR*** apply at DC with heat recovery rate above 50%. At DC with rate below 50% DCE target values shall be increased linearly. For heat recovery rates below 10% the target values for DC ***without HR (no HR)*** shall be applied.

Reference [5]: Greenberg, S., E. Mills, B. Tschudi, P. Rumsey, and B. Myatt. (2006). "Best Practices for Data Centres: Results from Benchmarking 22 Data Centres." Proceedings of the 2006 ACEEE Summer Study on Energy Efficiency in Buildings. [http://eetd.lbl.gov/emills/PUBS/PDF/ACEEE-dataCentres.pdf]

Cooling options for data centres

The heat dissipation produced by IT equipment has to be removed in order to keep the room temperature within safe limits, thus preventing equipment failures resulting from excess temperature. Due to the fast increase of IT equipment densities in Data Centres (DC), solutions for energy efficient cooling at high heat load are needed. Most DC's are currently cooled using circulating air with specific heat loads usually below 1 kW per m^2 of floor area. But new IT rooms for heat loads of >2 kW per m^2 of floor area are already planned today.

Air cooling efficiency decreases when air flow rate i.e. air velocity is increasing. As it can been seen in Fig. 1, the fan power needs increase with the cube of air velocity. Noise power increases approximately with air velocity to the 5^{th} power. Cooling power increases less than linear with air velocity

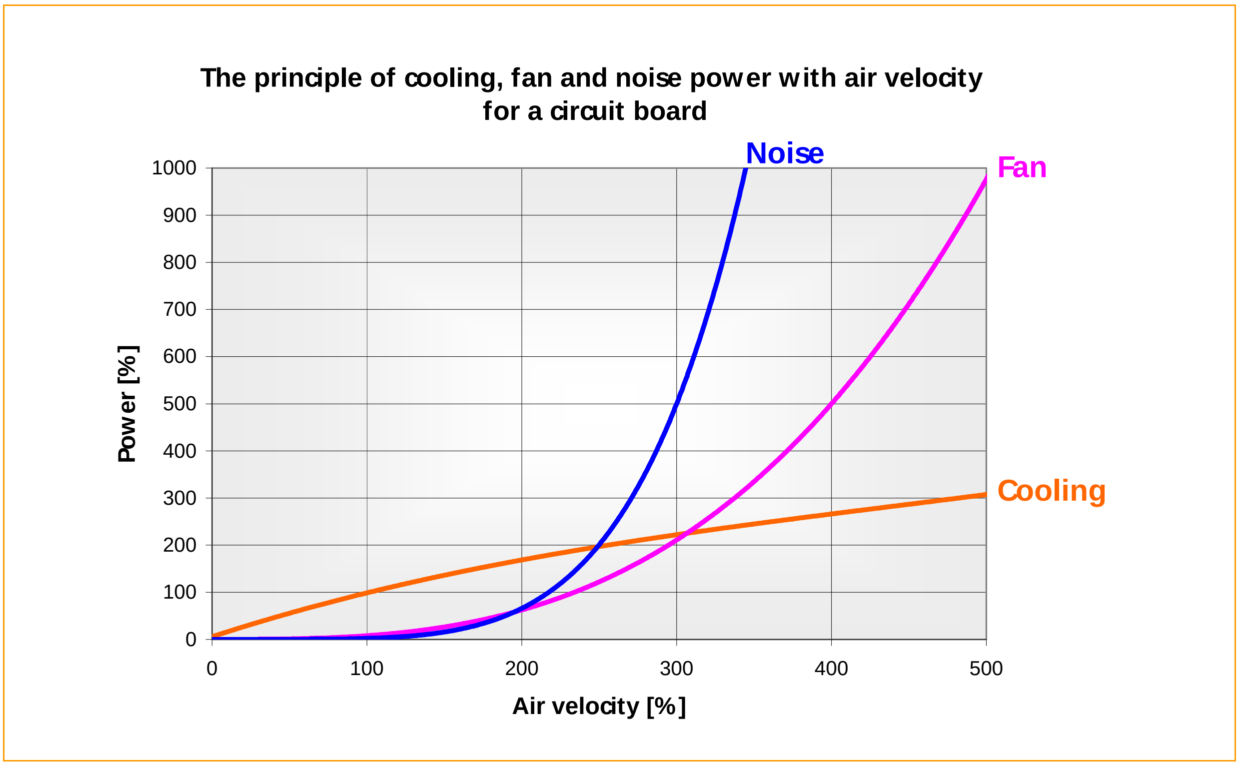


Fig. 1: Variation of cooling, fan and noise power with air velocity for a circuit board

In order to keep high cooling efficiency at high specific heat loads usual air circulating method should be replaced by the use of water-cooled racks for cooling IT equipment. The heat transport per volume unit is 3200 times and the heat transmission 100 times higher with water.

Different cooling options have been theoretically investigated at Swisscom with varying server densities per rack. These options are described in the caption to the Fig. 2. A common study case has been chosen for benchmarking the capital and energy costs of the cooling options. An IT room for 2'000 servers with a power need of 500W each has been considered. The energy costs are based on a rate of 10 Euro cents / kWh. The results of the investigation are illustrated in Fig. 2. In this figure, one can observe that using usual air circulating method, the attempt to increase the number of servers per rack from 8 (@ 500 W each) to 16 would result in an increase of the total power needs for cooling by a factor 7. This strong increase is mainly caused by the power needs of air circulating units. If water-cooled racks with a dense design i.e. 40 servers per rack (20 kW per rack) are used, the power needs for cooling can be kept below the power needs of option 1 with air circulating method and 4 kW per rack.

The capital costs for each option are illustrated in Fig. 3. The water-cooled racks solution is the less expensive option. Compared to the option 1, capital costs for building are considerably reduced by the option 3.

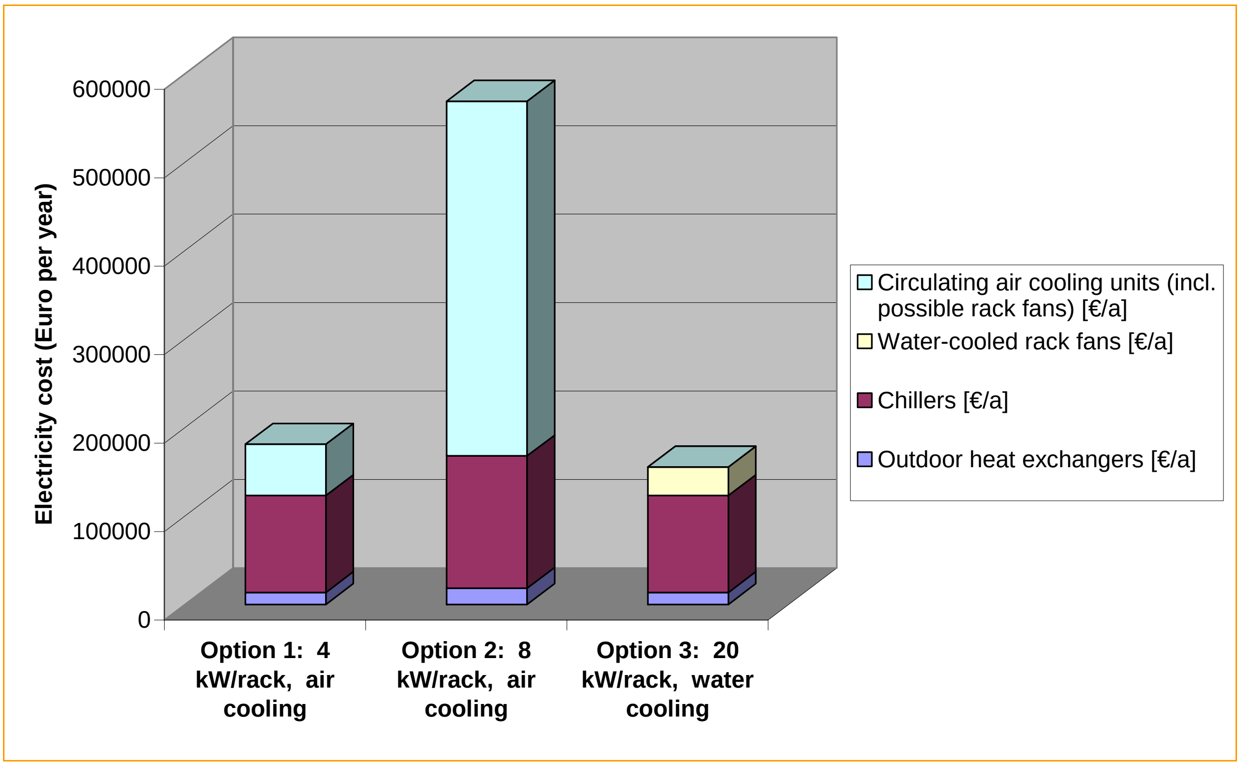


Fig. 2: Electricity costs for each cooling part and for different cooling options. The case study for all three options is an IT room with 2000 server @ 500W each, i.e. a total power of 1MW. The energy costs are based on a rate of 10 Euro cents / kWh. The options are defined as follows:

Option 1: Usual air circulating method (250 racks @ 4 kW per Rack; ca. 1.3 kW per m^2 of floor area)
Option 2: Usual air circulating method (125 racks @ 8 kW per Rack; ca. 2.6 kW per m^2 of floor area)
Option 3: Water-cooled racks (50 racks @ 20 kW per Rack)

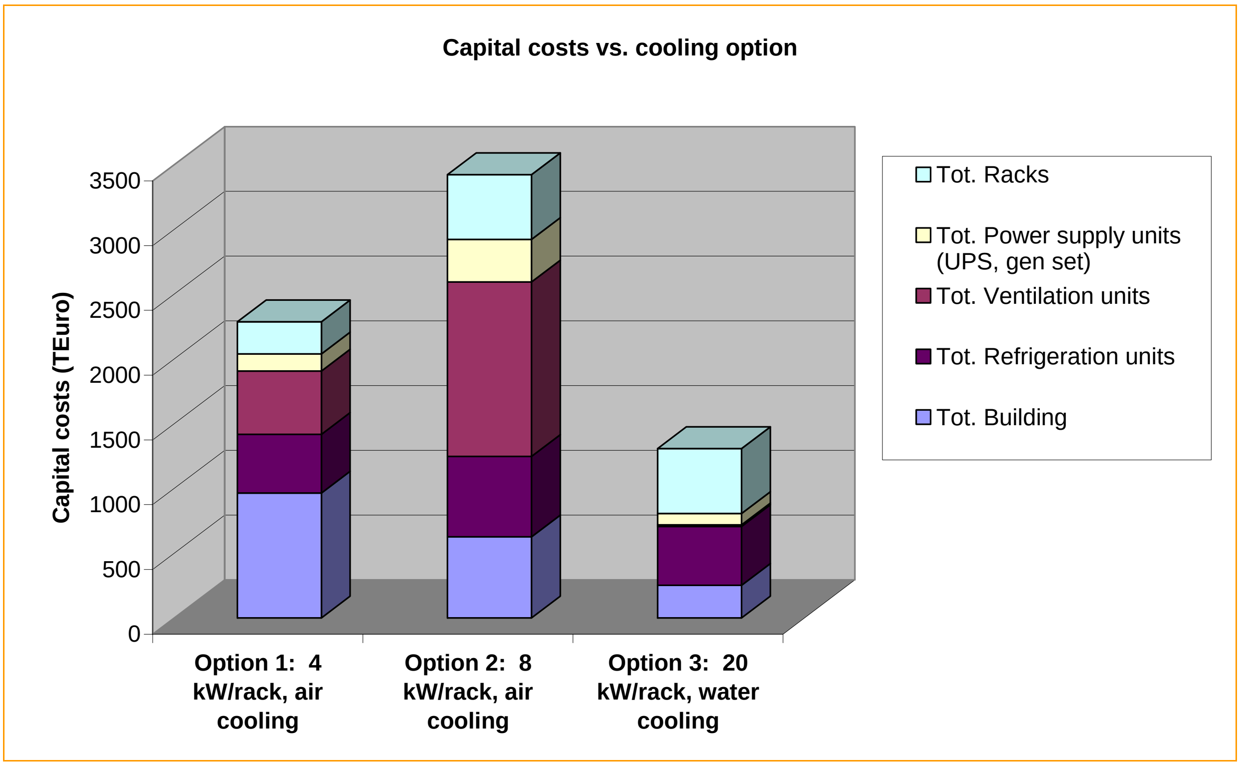


Fig. 3: Capital costs versus cooling option. The study case for all three options is an IT room with 2000 server @ 500W each, i.e. a total power of 1MW. The options are described in Fig. 2.

Based on the results of this investigation our recommendations for cooling of DC's are shown in the Fig. 4. The double definition of the x-axis is based on the reference value that 1kW per m^2 of floor area corresponds to about 3 kW per rack. For heat loads below 1 kW per m^2 of floor area the usual air circulating method is appropriate. The use of fresh air cooling year-round or, at least as longer as possible throughout year should be investigated for that heat load range. For the extension of existing DC above 1 kW per m^2 of floor area, the IT room should be shared in two parts thus enabling the composition of old with new IT technology: one part with usual re-circulating air cooling (max. 3kW per rack) and one part with water-cooled racks (> 10 kW per rack). When racks with > 3kW (>1kW/m^2 floor area) are planned at new DC water-cooled racks (> 10 kW per rack) should be used from the beginning. For higher IT densities above 100W per CPU the combination of water-cooled racks and direct CPU cooling is needed. Such technology is today not available on the market.

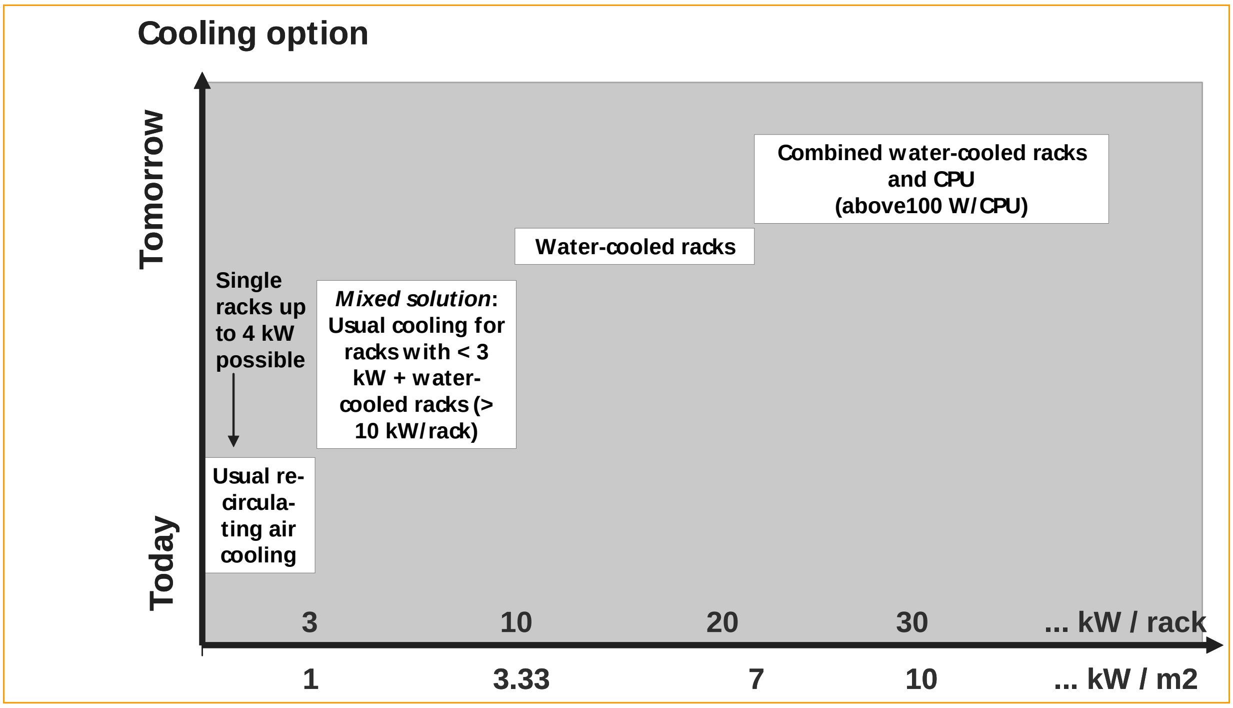


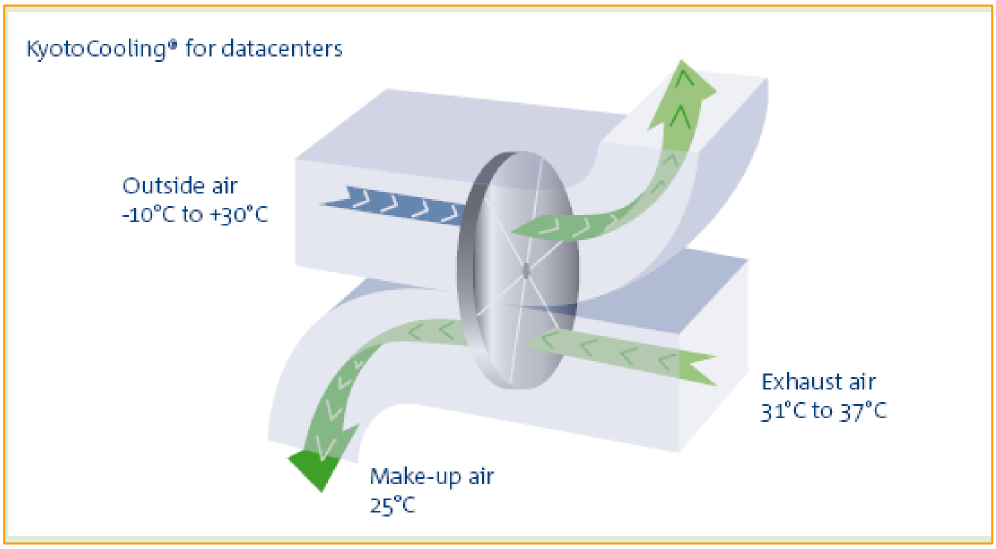
Fig. 4: Recommended cooling methods depending on the heat load per rack, respectively per m^2

8.3 Data centre cooling with Kyoto Cooling® (KPN)

The energy consumed by ICT hardware is mainly converted to heat. Therefore, cooling is necessary. KPN is constantly on the lookout for ways of cooling the hardware in a sustainable way. This has resulted into several new concepts: district cooling, soil cooling and 'KyotoCooling®'. District cooling was developed in 2006 and is now in production since mid 2007 on one site. For soil cooling we have now trials on two sites. KyotoCooling® is operational since autumn 2007 on one test site.

The equipment (servers, storage equipment and so on) in data centres produce a great deal of heat, and therefore need cooling. With KyotoCooling® the cooling capacity of the outdoor air will be used maximally and the use of conventional air-conditioning is minimized.

The air cooling system that KPN uses (in the test site) is called KyotoCooling® and was developed by Uptime Technology, a company with which KPN cooperates closely. A large, slowly rotating 'heat wheel', consisting of aluminium strips, travels half through outdoor air and half through the warm air of the data centre. Outside, the panels obtain the temperature of the outdoor air. They then rotate indoors where they absorb the heat of the server room. This is how the wheel cools down the server area. The advantage is that the outdoor air does not need to be blown into the data centre, which means the indoor air humidity is unaffected.



Scheme of KyotoCooling©

Usable year-round KyotoCooling® can be used provided that it is not hotter than 22°C outdoors. This situation occurs 97% of the year in the Netherlands. For the remaining time it is necessary to use a conventional cooling system as a back-up. But in this respect KyotoCooling® is no different to other methods, because conventional cooling systems also need a reserve system. This approach yields a potential energy saving of 50% compared with conventional cooling.

KyotoCooling® is a young technology. It does have to be built straight into the data centre at the time of its construction. It is difficult if not impossible to implement the technology at existing data centres.

For more information see www.kyotocooling.com

8.4 High Voltage Direct Current (HVDC) Architecture

As a result of some studies and experience of HVDC, France Telecom Orange used the ETNO meeting in Paris as a good opportunity to discuss the new HVDC power architecture with a presentation and demonstration by the INTEL Corporation at the meeting.

During early 80's, 300 to 400VDC were of special interest for France Telecom Orange as an alternative to 48V solution. However, it wasn't until 1997 that a common article with Alcatel was published on 300VDC option for the INTELEC Conference, followed by a NTT paper by 1999. More recently in 2006, DC workshop gathered in Washington, laboratories, universities and providers to discuss of HVDC opportunities and future trends. In addition to this short history, it can be noticed that the 400 VDC option is mentioned in the standard ETSI EN 300 132-3 published in 2003.

Where are the current main losses?

- in UPS: system efficiency varies between 75% and 92%
- in server equipment: power supply efficiency varies between 65% and 75%
- The interest of HVDC is based on an overall energy efficiency increase due to architecture simplification:
- External architecture stage: 480 VAC (3phase)/380 VDC
- Protection and connector stage: HVDC plug and security devices
- Server stage: 380 VDC/12VDC and internal distribution to lower voltages

- This lead to advantages such as:
- cost < 230 V UPS and 48 V DC
- compared to 48V: 30 time less copper, 6 time more compact rectifiers, battery centralization compared to decentralized 48V, cooler area for battery(lifetime and weight)
- compared to UPS: suppressing UPS inverter stage, more simple for engineering and operation, more reliable
- overall power loss decrease lead to less cooling and higher energy efficiency
- overall efficiency increase between 5 to 10%

The first INTEL data centre demonstration in US lead to the main following conclusions:

AC system		380 VDC system	
Load (kW)	Input (kW)	Load (kW)	Input (kW)
23,29	25,91	22,70 *	24,10

- input power saving of about 7%
- confirmation of theoretical evaluation

* ratio of DC load power to AC load power = 0,974 reduced due to elimination of AC/DC stage in server

The demonstration at the Paris ETNO meeting showed the operation of the concept of HVDC on the base of new generation HVDC servers from INTEL and HVDC power from Netpower Company. The future will tell if this first short experience shared by European telecom operators will be the beginning of a mutation of the legacy 48 VDC power supply.

For the time being, many activities are in progress on the topic of HVDC:

- on industrial aspects by the main servers providers
- in Green Grid association
- on standardization by CENELEC TC 23Bx WG7 for plugs and protections and possible abbreviation change
- for integration of this architecture solution in Data Centre Code of Conduct
- in ETSI EE for grounding and liaison with CENELEC
- on users general acceptance

9 - Fuel cell developments

9.1 Trials at TeliaSonera

TeliaSonera is currently field testing PEM fuel cell systems as backup power for telecom equipment. The overall goal for the trial was to test if fuel cell technology might be a sustainable solution to be used as backup power in the future replacing fossil fuel based generators and batteries (NiCd/Pb). As a bi-effect we wanted to increase our own knowledge.

The two first fuel cell systems were put into operation in the summer of 2005, the third system was put into operation in the autumn of 2006 and a fourth system was put into operation in the autumn of 2007.

- The two first systems have an output power of approximately 1 kW@-48VDC and was supplied by Cellkraft (Sweden) and IdaTech (USA).
- The third system has an output power of 3 kW@-48VDC and was supplied by ReliOn (USA).
- The fourth system has an output power of 3 kW@-48VDC and was supplied by IdaTech (USA).

The Cellkraft and ReliOn systems are both direct hydrogen fuel cell systems. IdaTech's both systems are run by hydrogen derived from reformed a methanol/water mixture.

TeliaSonera's experience from the field tests show that the availability issues need be considered and also that the fuel logistics need to be considered.

The two first systems have had some teething problems, both in the fuel cell itself (stack etc.) but foremost in the surrounding or complementing system parts (such as converters, electronics etc). The two latest systems have shown a considerably better availability and telecom system integration maturity.

Furthermore, the conclusion has been drawn that a fuel cell systems is at its best economically (compared to traditional batteries and diesel generators) at lower power requirements (today perhaps less than 5 kW) and longer back-up times (>8 hours).

Identified questions that need to be answered:

- Fuel cell system availability (MTBF, etc.)
- Fuel availability and logistics, especially during critical circumstances such as extreme weather conditions and natural disasters
- Appropriate service intervals
- Quantification of fuel consumption and spare parts during a total lifetime
- Production prices when serial production starts?

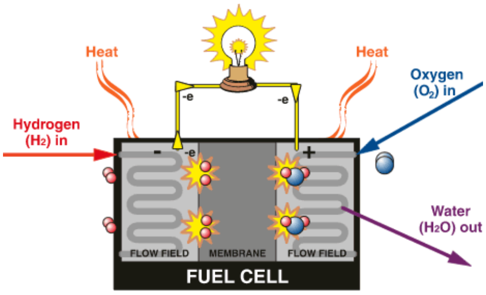
TeliaSonera believes that most of the major remaining problems could be solved within the coming five years and that fuel cell systems in that same period could be implemented foremost in niche applications.

The field test will formally end on December 31st 2008, but a prolonging of the field test for 2009 is planned.

Partners in the TeliaSonera field test are The Swedish Defence Materiel Administration and The Swedish Post and Telecom Agency.

9.2 Trials at Deutsche Telekom

The operating principle of fuel cells is based on the controlled electrochemical reaction of hydrogen with oxygen forming water while using the electric energy output.



Fuel cells offer a sustainable approach to a CO_2-reduced power supply; given its high level of efficiency, it is also an ideal substitute for diesel generators with electricity generation, too.

Application of fuel cells by DT Power & Air Solutions

Application area	**Deployed as**	**Runtime/year**	**Type of fuel cell**	**H2-Support**
Fixed network	Backup system; virtual controlled power plant*, load management*	120 h/year	PEM	Storage, Reformer
Mobile network	Autarkic base station*	< 10%/year (876 h max.)	PEM	Electrolysis, Reformer
Data centre	Power supply; Waste heat utilization (absorption chiller)	100%/year (8000 h)	MCFC, SOFC	Biogas, natural gas
Outdoor cabinets	Backup system*	Approx. 1h/year	PEM	Storage

*pilot phase or to be realized soon

Operating experience

PEMFC (Polymer membrane FC) are particularly suitable as backup-system for telecommunication – 6 PEMFC as a pilot
MCFC (Molten Carbonate FC) are particularly suitable as a permanent power supply with cogeneration in data centres – more than 20.000 h of runtime until now

Status Quo and outlook

Today vendors of PEMFC (for Backup-power) guarantee 1.500 h to 4.000 h of running. MCFC-Stacks (as a permanent power-supply) work max. 35.000 h.

In Germany the "National Innovation Program NIP" and all over Europe the "European Hydrogen and Fuel Cell Technology Platform HFP" are aimed to speed up the development and deployment of this technology and also to make it cost-competitive. These programmes are supposed to support hydrogen and fuel cell based energy systems and component technologies for applications in transportation, stationary and portable power.

Economic efficiency

Due to the high manufacturing costs and the "short" product life today the fuel cells cannot yet compare to current technologies.
Fuel cells for early markets (PEMFC as a backup system) will be cost-effective within 4 years.

Advantages

The advantage besides the ecological aspects is the high electrical efficiency and, concerning MCFC the feasibility of cogeneration. Fuel cells also may be used as a virtual power plant.

Subsidies (in Germany – without the "NIP" mentioned above)

Subsidies help to develop fuel cell technology to a cost-competitive and marketable product in the medium term. Subsidies Power & Air Solutions got:
50 % provided by the Federal Ministry of Economics for one MCFC for a data centre
33% provided by the state of Nordrhein-Westfalen for six PEMFC (backup power) and two SOFC (permanent power supply)

10 – Energy Management/Monitoring systems

10.1 Energy monitoring system (EMS) (France Telecom Orange)

Introduction

Equipment conception and power architecture are normally the focus for energy efficiency measures. As a secondary step however, software devices for remote management and energy monitoring should also be used to further improve energy savings during operation.

As part of the France Telecom Orange project "Visio ET" the following was set up:

- Remote analysis with monitoring of running parameters (temperatures, flow rates, hygrometry, voltage, current, etc), alarms monitoring, main events log books.
- Remote controls: tests, remote management of running parameters, load-shedding
- Maintenance: accurate preventive maintenance, shorter time to repair due to a remote diagnosis.
- Remote management is a key factor for limiting travel to site by car and thus limiting CO_2 emissions.

Monitoring is also a suitable tool for energy consumption optimization and in particular, for the following reasons:

- Energy control: continuous measurement of electrical consumption and power requirement, better allocation of resources within sites, anticipation of overspends, help with choice of electricity supplier
- Productivity gains: cost reduction for curative maintenance due to less on-site interventions, savings on car trips and less pollution, prevention of outages by early failure detection, shorter time to repair due to better remote diagnostics, extension of equipment lifetime due to accurate preventive maintenance, cut down on battery investments (lifespan increased by 1 year)
- Improvement in customer care
- Energy consumption metering and follow-up: electricity consumption, instantaneous power, plotting of load charts, assessment reports, sites comparison and methods benchmarking

In addition, operating procedures are safer due to:

- Customized control displays for each profile (maintenance engineers, supervisors, managers, etc.), global shared vision of facilities, right information provided to the right person at the right time, best practices sharing

- Improved people security and better working environment due to less physical interventions, less car trips, less stress.

ETSI monitoring standard

One of the difficulties of Energy management and monitoring is linked to software aspects and format data provided by the various pieces of equipment. Recently, within ETSI EE it became obvious that a format and structure for harmonization is required for simplification and to enable interoperability with multi-vendor equipment. Due to legacy monitoring systems, it will also require a progressive migration from present management network to the future TCP/IP-XML on various network support (fixed, mobile). XML is very flexible and is highly recommended to build structured information.

The ETSI multi-part standard ES 202 336 aims monitoring and control of Infrastructure Environment i.e. power, cooling and building environment systems for telecommunication centres and access network locations. The document has been split in a core generic part 1 (available document) and other parts (on process and soon publishable) dedicated to typical subsets (DC system, UPS, AC distribution, backup generator, cooling system, other building monitoring).

Benchmark between operators

Some data was provided by ETNO operators but comparisons and benchmarks are difficult and no particular conclusion can be drawn as to best practice. Monitoring and remote supervision is in permanent evolution and many data collecting technologies, protocols and fieldbus are used. This fact shows that the new ETSI monitoring standards are in line with the need of more harmonization.

	Big sites % of remote monitoring	**Small sites % of remote monitoring**	**% Data Centres**	**Link**	**Type of field bus High level Low level**
BT	500 100%	5500 55%		X25	RS232/485
Belgacom	1200 buildings, 700 alarm collector devices, X25, IP or specific protocol				
FT	534 37%	13336 41%	3%	X25 or IP	Jbus, Mod & Lon
KPN	160 99%	1140 33%	100%	PSTN or IP	N2 Mod & Lon
Swisscom	60 100% (alarms and cooling management)	2140 14% (alarms)			
Telia Sonera	314 64%	7692 65%		TCP/IP modem	RS232/485/IP Lan, CAN

10.2 Telecom Italia's EMS

Telecom Italia is currently adopting and using, as EMS. The key features are as follows:

- An informative system for the "reading" of electrical energy consumption, both at "power meter" level (i.e. point of connection with the Mains distribution network, defined as E TOT) and at energy station level (defined as E TLC). Information is collected on the site by assurance personnel (monthly or each six months, depending on the TLC site). This is useful to monitor the energy performance of the site (E TLC / E TOT) and to manage energy for OLOs. The system will be extend to mobile network sites;
- An informative system for managing of electrical energy's invoices from suppliers, with addition of some technical data (e.g. total energy amount, quality factors). This procedure is managed from the energy purchasing dept. of TI and gets (via ftp) input data (e.g. hourly consumption curves) from supplier's informative systems;
- A procedure for energy and air cooling systems' management, both as asset and as assurance activities management;
- Remote management and control system for the automated breaking of electrical energy supply from public Mains (so called "*interrompibilità*") when the electrical energy network manager has to face possible congestions and needs to reduce the electrical load on its network (implemented on a sub-set of TI's network sites).

Telecom Italia's next steps for EMS:

- Telecom Italia is starting the field deployment (target of 100 Central Offices for 2008) of Wireless Sensors Network (WSN) technology (e.g. Zig-Bee) to correlate energy, power and air conditioning system's status with other data (e.g. external temperature, humidity). The goal is to improve energy efficiency through a real time monitoring
    - Pros: reduction of intervention's time and field's truck rolls, useful for maintenance purposes, new energy and air-cooling system have input/output interfaces for remote monitoring and management
    - Cons: implementation is not simple, the system must be simple and effective
- Telecom Italia is moving to deploy automatic systems for the "reading" of electrical energy consumption on mobile and fixed network sites, with an hourly base data collection, power factor (cos Φ) monitoring for control and minimization of reactive electrical power
- It will be important to correlate the different EMS already deployed in the network through a common access interface

11– ETSI

The ETNO energy task team agreed that there was a need for better knowledge of ETSI activities and to develop specific connections to standardization bodies on energy topics. The ETNO Stockholm and Paris meetings were the first places of fruitful contact and presentations and in May 2007, ETSI hosted the ETNO meeting in its Sophia Antipolis premises in France.

What is ETSI?

The European Telecommunications Standards Institute is one of the 3 official standards-making bodies in Europe and is responsible for standardization in the field of ICT. Created in 1988, this is a not-for-profit organization, entirely open and thus free from pressures of competing commercial interests. It operates through the voluntary consensus of participants taking into account full account of the views of all interested parties (network operators, manufacturers, service providers, national administration, universities, research organizations, users). ETSI works with worldwide collaboration on specific subjects with other important standardization and recommendation entities as shown on figure 1. ETSI seeks to have its standards adopted worldwide.

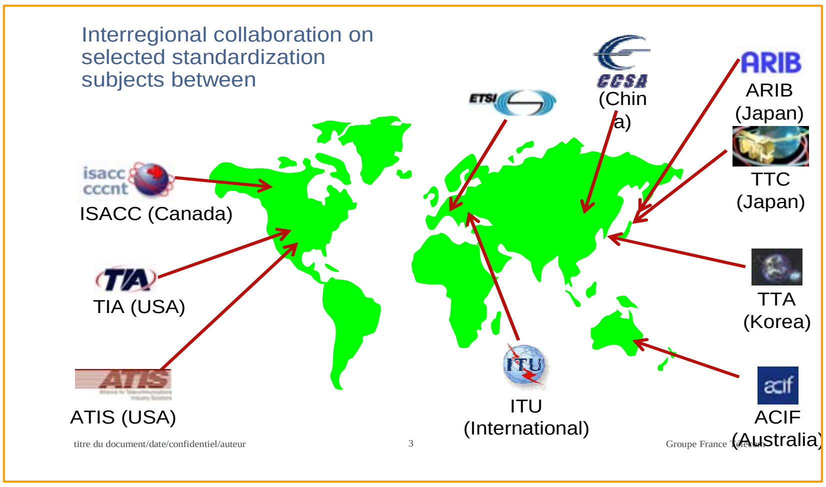


Fig. 1: Map of other standardization or recommendation bodies in links with ETSI.

Figure 2 explains relations with national CEN/CENELEC standard to provide EN document, and co-operation with ITU-T and R on one side and IEC, ISO, Asiatic FORA on the other side.

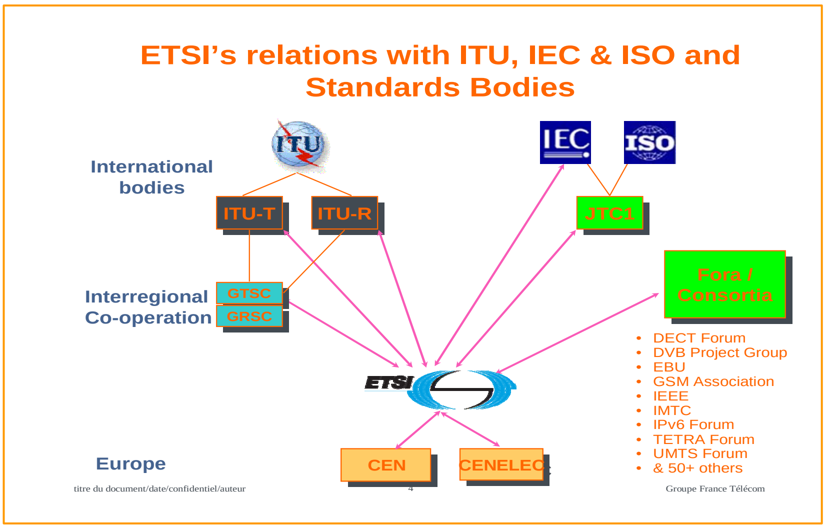


Fig. 2: ETSI relations with Europe, interregional and International Standard bodies.

By 2006, ETSI had 651 Members from 60 countries, across 5 continents. It provides a range of different deliverables adapted to the need and users (technical report, specification, standard, etc) and 17,000 publications are available.

Two main committees are of special interest for the Energy task team:

- ETSI AT/TM involved in Access and Terminals/Transmission and Multiplexing which can have actions on equipment intrinsic conception and power consumption.
- ETSI EE involved in Environmental Engineering since 1992. The subgroup EE2 is in charge of power supply interface, earth and mass bounding, control and monitoring interface. The subgroup EEPS is in charge of product specification oriented toward sustainable development, it works in line with European directives and code of conducts. There are also subgroups on telecom/datacom infrastructure conditions (thermal, dust, mechanical size, chemical aggression definitions) not currently active. EE have 2 meetings a year with an average of 25 participants (more information at: http://www.portal.etsi.org/ee/ee_tor.asp).

As examples, the last documents adopted and currently or soon published are:

- TS 102 533: Energy consumption in BB Telecom Network Equipment
- ES 202 336: Power and cooling system control and monitoring interface. Part 1 is the core part and other parts are on dedicated data table and XML structure for each equipment class (i.e. DC, AC, DEG, UPS, cooling)
- TR 102 530: The reduction of energy consumption in telecommunications equipment and related infrastructure

- TR102 531: Better determination of equipment energy consumption for improved sizing of power plant

Indeed, ETNO and ETSI have to collaborate closely, the activity of the Energy task team based mainly on benchmarks, field experiences and best practices can be the basis for new standardization and specification programs. During the last ETSI EE meeting (April 2008), many new work items have occurred in the field of energy efficiency so for the future a reflection will be needed between the 2 bodies in order to define the most suitable collaboration way for getting fast improvement in energy efficiency.

12 - Future

As explained in the foreword, energy is of vital importance to the communications industry and is therefore, one of our key risks. And, due to the expansion of networks and services, continuity of supply must now also be considered along with energy efficiency.

The use of energy will increase enormously; by 2010 global data traffic is predicted to increase six fold! As the demand for energy increases, associated CO_2 emissions will rise; unless action is taken. European operators use a significant amount of energy and, given the latest developments, this may triple in the years to 2010. This is because of new internet services requested by customers, and which we supply.

Luckily, there is a strong motivator for operators to cut on energy use and to be as efficient and effective on this matter as possible. Less energy not only means less CO_2 emissions but more important, reduced costs; a real Win-Win situation. This should be an effective cost driver to encourage operators to reduce energy use. So the arguments are there, now for the solutions.

Working together adds weight to our efforts; or in other words, synergy or an added dimension. So together, we can make 1 + 1 = 2.5.

The synergy of working together as the combined operators in Europe, unified in ETNO makes the battle much easier. The benefits of working together in the ETNO task team on Energy are there but we can do better. What's needed is a joint venture with suppliers.

During task team meetings to date, suppliers have been invited and more and more attend to show what they're busy doing and to discuss the need of operators.

Until now, this is done on an 'open' basis but to make it more effective, it needs a more structured approach. There lies the benefit in the future, working together with suppliers; discussing needs and demands, explaining requirements and specifications, etc. Until now, this has only been done on an informal basis with no obligations. To make progress, this must change. Therefore, the constitution of ETNO should change or, operators may look to different organisations or platforms to enable this proposition.

If it is to happen within ETNO, it can be achieved if suppliers are allowed to become members, signatories of the ETNO energy task team. And, as said before, this can be done when ETNO develops and agrees a revised membership policy for this, in which it allows suppliers to become members of the energy task team. Then, Suppliers as well as Operators will be able to make a real contribution and work as one with us to reduce energy consumption and drive up efficiency.

Another possible issue is the geography in which both operate i.e. suppliers operate on a worldwide basis but ETNO operate only in Europe. Therefore, the revised membership policy should be developed to take account of this. Then our goal to reduce our use of energy and CO_2 emissions really could be realised.

The structure and organisation must be capable of supporting the greater goal that we are all aiming to achieve.

There remains only one more issue to resolve once the issue of membership has been solved, and that is to set a goal for the future. An ETNO goal, an industry goal; accepted by both parties. Setting and fulfilling such a target, is the real challenge for the years to come; this will increase the synergy making 1 + 1 = 3.

Appendix A - Power & Cooling Benchmark detailed Results

Participants of the Power & Cooling benchmark initiative

The following European operators joined this benchmark initiative:

	Operator	country		Operator	country
Belga	Belgacom	Belgium	Swiss	Swisscom	Switserland
BT	Brittish Telecom	UK	TA	Telecom Austria	Austria
BT-G	Brittish Telecom Global	Netherlands	TD	Telia Denmark	Denmark
C&W	Cable & Wireless	UK	TDC	TDC Denmark*	Denmark
CYTA	Cyprus Telecommunications A	Cyprus	TF	Telefonica**	Spain
DT	Deutsche Telecom	Germany	TH	Magyar Telekom, T-Com	Hungary
Eircom	Eircom***	Ireland	TI	Telecom Italia	Italia
FT	France Telecom	France	TS	TeliaSonera	Sweden
KPN	KPN Royal Dutch Telecom	Netherlands		= no contribtion	

* No contribution because of reorganizations, and definition problems within the benchmark
** Became participant after the deadline for benchmark Power & Cooling III

General Results – Benchmark II

- 14 of 17 operators returned the questions
- 19 open questions, 15 multiple choice, 9 fill in questions
- 30 questions with a response > 90%, 9 questions between 80 en 90 % and 4 questions < 80% response.
- Average response all questions 87% and 6 operators above 90%
- 75% of the approached operators re-act and returned the questions
- The questions where received and understood well, average response 87%
- The answers given match well with the questions

General Results – Benchmark III

- 13 out of 17 operators sent in the questionnaire. That is over 80% response, not counting in Telefónica (they join the this task team for the first time)
- The average response on the questions was 85%. Questions 1 (power), 8 (cooling) and 2, 3 and 5 (energy saving) where difficult to answer.
- The appendix was more or less completed by 6 operators. This data appears to be hard to collect and maybe also confidential. We like to discuss this point during the meetings. Publication of these figures was applied if there is consensus within the task team. There was a contribution by France Telecom Orange on this subject during the task team meeting in Paris.

Summary of responses to questions by participants

	§ 1. Quality, Availability and reliability											
	quest. 1	*quest. 2*	*quest. 3*	*quest. 4*	*quest. 5*	*quest. 6*	*quest. 7*	*quest. 8*	*quest. 9*	*quest. 10*	*quest. 11*	*quest. 12*
Belga	x	x	x	x	x	x	x	x	x	x	x	x
BT	x	x	x	x	x	x	x	x	x	x	x	x
BT-G	x	x	x	x	x	x	x	x	x	x	x	x
C&W	—	x	x	x	x	x	x	—	x	—	x	x
CYTA	—	x	x	x	x	x	x	—	x	—	x	x
DT	—	x	x	—	x	x	—	—	x	x	x	x
FT	x	x	x	x	x	x	x	x	x	x	x	x
KPN	x	x	x	x	x	x	x	x	x	x	x	x
Swiss	x	x	x	x	x	x	x	—	x	x	x	x
TA	x	x	x	x	x	x	x	x	x	x	x	x
TH	x	x	x	x	x	x	—	x	x	x	—	x
TD	x	x	x	x	x	x	x	x	x	x	—	—
TI	x	x	x	x	x	x	x	x	x	x	x	x
Percentage (%)	77	100	100	92	100	100	85	69	100	85	85	92

	§ 2. Energy savings								Percentage	
	quest. 1	*quest.2*	*quest. 3*	*quest. 4*	*quest. 5*	*quest. 6*	*quest. 7*	*quest. 8*	*%*	*Appendix*
Belga	x	x	x	x	x	x	x	x	100	x
BT	x	x	x	x	x	x	x	x	100	x
BT-G	—	—	—	—	—	—	—	—	60	—
C&W	x	—	—	x	x	x	x	x	75	—
CYTA	x	x	x	x	x	x	x	x	85	—
DT	x	x	x	x	x	x	x	x	80	—
FT	x	x	x	x	x	x	x	x	100	—
KPN	x	x	x	x	x	x	x	x	100	x
Swiss	x	x	x	x	—	x	x	—	85	x
TA	x	—	—	x	—	x	x	x	85	—
TH	—	x	x	x	—	x	—	x	75	x
TD	—	x	—	—	x	x	—	x	70	x
TI	x	—	—	x	x	x	x	x	90	x
Percentage (%)	77	69	61	85	69	92	77	85	85	54

	Fill in question			Best Practice

Best practice Results

Question 1:

Subject	**Availability related to the configuration for 48 VDC power supply in the fixed network on interface A**
Definition	The availability of 48VDC power on interface A within the ETSI standard is strongly dependent on the design and configuration of the power supply and the failure time when a power breakdown or a technical male function in the equipment occurs.☐The design of the power supply can be build up with several configurations: 1. Main utility supply only with 48 VDC battery back-up 2. Main utility supply with a generator set and 48 VDC battery back-up Availability depends on the back-up time of the batteries and the number of generator sets (redundancy) that are used.
Best Practice	The availability of the fixed network, within the ETSI standard, for 48 VDC power supply on interface A: Availability > 99,999% and a time of failure < 2 hours Best practice on availability for the power supply on data centres, mobile network en outdoor cabinets not defined, because no relevant information is available.

Question 2:

Subject	**Design and resilience of hardware concept for powering the IT and technical infrastructure equipment**
Definition	The Design of the concept is corresponding to ETSI standardization for No Break power, earthing & grounding, and to ENSI-TIA standard for Data centres. The resilience of the concept is about the construction and redundancy of the power supply in combination with generators.
Best or common Practice	<u>Design of the concept corresponding to:</u> 1. ETSI 300 132-1 & 2 standardization as a minimum for No Break power 2. ETSI 300 253 as a minimum for earthing & grounding 3. ENSI-TIA-942.2005 as a standard for Data centres (common practice) <u>Resilience of the concept:</u> 4. DC-power is preferred, in combination with AC Generator* (common practice) 5. UPS (230/400 VAC) with generator* (Best practice for data centres no common practice found for fixed network) 6. 2 battery strings as a minimum * use of mobile generator set also applicable

Question 3:

Subject	**The use the different configurations of utility supply for 48VDC power.**
Definition	The use of different configurations of a utility supply for 48 VDC power is strongly related to the availability of the configuration on interface A. Starting from the main utility supply, there are several configurations with or without a generator set and varying battery back-up times as a norm for the availability. The use of redundancy within the concept can also make a difference. On the other hand there must be a balance between the costs of the concept and the amount of parts that are used.
Best Practice	1. Main Utility supply ONLY (no generator) with >4hr 48V battery back-up 2. Main Utility supply + N only generator with >2hr 48V battery back-up Note: The battery back-up time must be related to the flexibility and the response time of the service organization.

Question 4:

Subject	**The use the different configurations of utility supply for 230/400VAC UPS power.**
Definition	The use of different configurations of a utility supply for 230/400 VAC UPS power is strongly related to the availability of the configuration on interface A. Starting from the main utility supply, there are several configurations with or without a generator set and varying battery back-up times as a norm for the availability. The use of redundancy within the concept can also make a difference. On the other hand there must be a balance between the costs of the concept and the amount of parts that are used.
Best Practice	Main utility supply with redundant UPS N + 1 with > 1 hour battery back-up Note: The battery back-up time must be related to the flexibility and the response time of the service organization.

Question 5:

Subject	**Redundancy of the No Break facilities.**
Definition	This question is still being investigated by Deutsche Telecom and should be completed by the next task team meeting.

Question 6 & 7 (combination with question 7, questionnaire benchmark Power & cooling III)

Subject	**Generator site tests & fuel reserve**
Definition	When a generator set is used as a part of the hardware concept for powering the IT and technical infrastructure equipment, you need to run frequently generator site tests, including power down test (black start), to secure a reliable power supply with high availability. Secured delivery of fuel and enough fuel reserve is also important for the availability of the power supply. When mobile generator sets are used, delivery, installation, and preparation time must be defined related to the number of remote sites per generator set.
Best Practice	1. Engines run for at least 1 hour every 3 month and minimum of once a year for power down test. At least 25% of the tests are done with load. 2. Operational fuel reserve at least 48 Hours (bandwidth 25%) 3. The number of mobile generator sets related to locations is at least 1 generator set per 20 sites. Mobile generator set within 4 hours fully operational

Question 8:

Subject	**Redundancy of the No Break facilities.**
Definition	For this question no best practice defined. Only 4 operators (Belgacom, BT-G, TD en TD) delivered sufficient information and a larger number of responses are required to effectively formulate best practice.

Question 9:

Subject	**Redundancy of the Cooling facilities**
Definition	Depending on the thermal load of equipment rooms the cooling facility can be designed for central cooling (mostly >> thermal load) or a decentralized concept, mostly for << thermal load. In both concepts (centralized and decentralized) redundancy is applied. For the central concept the redundancy is based on N + X chillers with or without separate cool water supply to the equipment rooms (A + B) For the decentralized concept the redundancy is based on N + X separate units in the equipment rooms, with or without a lower value for X related to a maximum for N in one equipment room.
Best Practice	1: N + 1 (X =1) for central cooling facilities, Redundancy on cooled water distribution circuits is always suggested (faults and maintenance needs) 2: N + 1 (X =1) for decentralized cooling facilities, unless there are more than 4 units in an equipment room applied. In which case the redundancy is N + 0.

Question 10:

Subject	**Hardware concept for cooling IT & TI equipment.**
Definition	This question is still under examination by BT Global Services. Determination of best practice is difficult because of the variations in answers and problems with subject definitions. Hopefully, this will be completed by the next task team meeting.

Question 11:

Subject	**Set points and alarm settings on room temperature related to standardization**
Definition	For climate conditions within equipment rooms are several methods of design to reach the performance that is suitable for the telecom equipment. There are several standardizations defining set points on room temperature. The most common design standards are: • Room temperature design on ETSI 300 019-1-3 class 3.1. standard • Room temperature design on ANSI TIA 942.2005 for data centres The room temperature within these standards can be fixed on one value. Another possibility is to vary the room temperature with the outside air within certain values.
Best Practice	For telecom equipment rooms with heat-density less then 750 W/m2 within the climate chart, designed on ETSI 300 019-1-3: 1. When a fixed room temperature is applied, with a ambient room temperature between 27°C and 32°C the alarm settings are: a) 1^{st} temperature alarm setting = 3 K above room temperature setting b) Maximum temperature alarm setting = 6 K above room temperature setting. 2. When variable room temperature is applied, with maximum use of the range within the climate chart: a) Normal conditions between 5°C and 40°C b) Maximum temperature alarm setting = 36°C **Best practice for data centres not yet defined**

Question 12:

Subject	Mobile cooling / ventilation units for emergency purpose
Definition	When problems occur in the equipment rooms related to room temperature and/or the failure of the installed cooling facility, a mobile cooling / ventilation unit can be a short term solution to keep the IT-equipment up and running. When mobile units are used you need to define the capacity of the units, minimum delivery, installation, and preparation time and the number of sets related to the locations you can install them.
Best Practice	1. The cool capacity of the units between 5 and 6 kW 2. The minimum delivery, installation, and preparation time is less than 4 hours 3. Number of sets related to locations: " 1 sets for 20 locations

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