FUJITSU

White Paper

Can Green IT help companies save money?

SAVING ENERGY WITH FUJITSU TECHNOLOGY SOLUTIONS PRODUCTS

CONTENT

INTRODUCTION

When German professional foresters introduced the concept of sustainability in the 18th century, all they thought about was saving their home country's woods. The idea was that forest owners should not be allowed to cut more trees than were likely to grow again. In the times that followed, the term "sustainable" spread successfully on a global scale, partly taking on different forms and meanings before it returned to its country of origin. However, today's debate about sustainable development as an endpoint of economical progress, preferably implemented in cradle-to-cradle cycles, no longer seems to bear much reference to the old principle of forestry that is nowadays successfully deployed throughout Europe. By contrast, the connotations are very obvious in the term Green IT, since healthy forests are green. Only the idea behind it covers many aspects and hence tends to become somewhat imprecise: it may refer to the way computers and computer components are produced and recycled – as Fujitsu does since the inception of its first recycling program in 1988. It may also include planning, optimizing and running data centers according to ecological requirements, as demonstrated by the company at its recently opened site in Augsburg. And there is the option of implementing "green" practices and workflows, some of which will be presented below.

Ecological footprint

On the other hand, some of the trends that will shape future IT landscapes are everything but green. For example, the global demand for data centers is growing constantly due to technical advancements such as smartphones – which are only smart if they can connect to mobile services at the backend – and cloud computing. Despite its suggestive imagery, this latter buzzword describes down-to-earth data center services that span the network of one or more companies. And the infrastructures that provide these services need electricity even if they have been optimized in the aforementioned way – electricity that first has to be produced. According to a Fujitsu survey from 2008, an average data center currently consumes 5 megawatts power per year. In the same study, experts predict that this demand will surge to 50 megawatts by 2020. Simply put, this means that today a single server rack working at an average utilization ratio of 10 to 20 percent already uses as much energy as 12.6 households, and this demand for energy is supposed to increase tenfold. Against this backdrop it comes as no surprise that search giant Google, the company with the largest installed base of data centers worldwide, has expanded its business into power trading and plans to sell waste heat from its data centers as well as surplus electricity.

In order to better understand how Green IT should function, let's work with another analogy from professional forestry. By definition, a forest is a system that not only comprises large and small trees, but also flowers, grasses, ferns, funguses, and of course animals. It is this biological diversity which constitutes a forest. Information technology works very similar, and that means it can only be transformed into a sustainable system if all subsystems (products) and their interconnections (architecture, processes, workflows) come under scrutiny.
This examination also must include the manufacturing process, resource-sparing operations, and disposal/recycling possibilities. In this context, resource-sparing operations require policies that all of a company's employees have to adhere to – because after all, what's the use in deploying desktops with energy-efficient power supplies if users still activate screen savers that have been rendered meaningless since LCD monitors became standard parts of the equipment? Based on such a holistic approach, this Fujitsu White Paper attempts to provide a representative overview of all options companies have to implement Green IT and sums up detailed technical information.

FUJITSU'S GREEN HISTORY

As a IT manufacturer and infrastructure provider, Fujitsu has long been famous for its dedication to environmentally sound production. The following timeline lists some important highlights of this tradition:

- In **1988**, Fujitsu opened its first recycling center for customers to turn in used computers and computer parts. In the meantime, our systems are 98 percent recyclable on average, thus beating respective legal requirements in the U.S. and the EU by far.
- In **1993**, Fujitsu introduced the PCD-4 LsI, the first "green PC" for office environments.
- In **1994**, the company was the first computer manufacturer to receive the German Blue Angel eco-label.
- In **2002**, Fujitsu released the first lead-free "green mainboard" that was built into the SCENIC S2 PCs from October on, which two years later received a Special Environmental Award from PC Magazine. As a result of this pioneering work, Fujitsu met the standards put forth in the European Union's Restriction of Hazardous Substances (RoHS) and Waste Electrical and Electronic Equipment (WEEE) Directives several months ahead of the deadline in 2006.
- In **2008**, the first 0-Watt monitor was introduced. That same year, Fujitsu became a member of The Green Grid, a consortium of IT vendors and pros that pushes for an improvement of energy efficiency in data centers and business ecosystems, thus complementing the sponsorship for the Climate Savers Computing Initiative (CSCI) that was taken on the previous year.
- Early **2009**, Fujitsu launched its 0-Watt PC, which is described in detail later on in this text.

- In 2010 Fujitsu has adopted Stage VI of its Green Policy Innovation, which in turn is a building block of Green Policy 21, a long-term sustainability initiative. Among multiple key performance indicators Fujitsu stipulated the target to reduce the company's own carbon dioxide emissions by 7 million tons. As a result of this policy, data centers and production sites are planned and built in an environmentally compatible manner, and cooling as well as water circulation are continually optimized. On the product side, Fujitsu introduced the Zero Client, a front-end device designed as an "intelligent display" that requires no traditional hard- and software components, thus again reducing power consumption by orders of magnitude.

While such initiatives are scheduled to take effect in the long term, there is one truth Fujitsu and other vendors cannot escape: the lion's share of energy is used during computer operation, not during production or recycling processes. According to a Gartner survey from 2008, PCs and monitors cause 39 percent of a company's "IT power demand", whereas servers (with cooling included) and landline communication only are accountable for 23 and 15 percent, respectively. The most energy-hungry components in each system include power supplies, processors, chipsets, and graphics cards – in addition to the monitors already branded as a source of waste. That means, each company will achieve the most substantial energy and cost savings only if every workplace is optimized according to ecological standards.

SUSTAINABLE CLIENTS TECHNOLOGY

In this context, the EuP guidelines passed by the EU in 2005 are of major importance for every enterprise. EuP stands for "Energy-using Products", a categorization that subdivides all products included into so-called lots. As can be easily imagined, these subcategories often pertain to equipment usually managed and maintained by the IT department. For instance, lot 3 deals with PCs, notebooks, monitors and servers, lot 6 is supposed to limit standby power loss in electrical devices, lot 7 references battery chargers and other external power supplies, and lot 26 will define restrictions on standby power loss in networked devices. Once EuP guidelines become obligatory, all IT and IT-related products are expected to work with an average power efficiency of 85 percent, meaning that 85 percent of the electricity drawn is net energy that goes into computer operation. Power supplies from Fujitsu already surpass this efficiency factor today with a value of 89 percent in the ESPRIMO 0-Watt PC (CSCI Silver level). This small difference alone allows for savings of € 7 per computer per year – and even more when compared to regular power supplies from other vendors which provide efficiency factors of 67 percent max and thus miss the upcoming EU norm by far.

Equally important is lot 26 concerning power losses in LAN devices on standby ("Networked standby"). Many vendors support Wake-on-LAN functionalities that enable administrators to call up systems from sleep mode. However, contrary to what may be expected computers still draw electricity even when they are sent to sleep. In order to solve or at least reduce this problem, Fujitsu introduced the 0-Watt PC in 2009, which has since set standards for energy efficiency. An additional BIOS functionality permits administrators to define a time slot during which they may start a PC at night, for instance to install new software. This new technology facilitates savings of € 1.85 per PC per year when compared to traditional hardware. Assuming a company opts to manage a few hundred or thousand PCs like this, the seemingly negligible amount will add up to substantial cost reductions. What is more, 0-watt technology even turns off the monitor along with the desktop in order to avoid a waste of energy. That way, display power consumption may be reduced by up to 10 percent annually, rendering even greater cost savings possible.

Still, under the terms of the holistic approach mentioned above it should be clear that 0-Watt technology is only one in an ensemble of "green" solutions Fujitsu provides. Also of note are sensors that trigger the dimming of TFT displays in accordance with ambient lighting, which help cut current consumption by 30 percent. Finally, Fujitsu notebooks are equipped with an "EcoButton" that enables users to switch between energy-saving and high-performance mode in the wink of an eye.

Next to consider are "ecologically correct" configurations. Computers that mainly run ERP or office applications typically don't call for a dedicated graphics card and/or processor but may use onboard capabilities instead. This allows for savings of about 35 kWh per year. In other cases, it may be helpful to replace conventional desktop computers with thin clients or notebooks – due to their slim architecture, full-fledged business notebooks save up to 35 percent electricity versus regular "fat clients". On top of that, Fujitsu's ESPRIMO Q, a desktop equipped with notebook technology, provides 50 percent more energy efficiency than the 0-Watt PC[1]. The same can be said for thin clients: research results from the Fraunhofer Institute for Environmental, Safety and Energy Technology show that they require half as much energy throughout their lifecycle – from manufacturing through operation to retirement/recycling – as traditional PCs do; a prerequisite, however, is that those thin clients connect to servers that in turn exhaust their own power savings potentials.

[1] It should be noted here however that "notebook technology" means reduced hardware equipment: the ESPRIMO Q features one hard disk drive and integrated graphics while optical drives are optional. Therefore, usage is limited to office environments.

COMPARISON OF A 5 YEAR OLD PC SYSTEM AND A CURRENT PC SYSTEM			
		5 year old desktop PC	New platform ESPRIMO E900
Electricity rate	0.15€/kWh		
Power consumption: Maximum (S0*, running appl., CD in use)		185 W	80.7 W
Power consumption: Idle (S0, running OS, Idle-mode)		73 W	19.5 W
Power consumption on mode (90% idle + 10% maximum)		84.2 W	25.6 W
Power consumption: Standby (S3*, energy saving mode, WOL enabled)		2.51 W	1.07 W
Power consumption: Minimum (ACPI status S5*, soft off, WOL enabled)		1.0 W	0.52 W
Power consumption: Minimum (ACPI status S5, soft off, wake up power button)			0 W
Product lifecycle	3 years		
Working days per year / work-free days per year	260 / 105		
Number of PC's	2000		
Power-Management on	15% savings		

5 YEAR OLD CRT MONITOR		
Energy admission in pursued	100	W
Energy admission - Energy saving mode (Stand-By-; Suspend-; Off-Mode)	8	W
Energy admission - Soft Switch Off	3	W
Typical Annual Energy Consumption (w/o Power management)	259[2]	kWh

DISPLAY B19-5 (NEW MONITOR)		
Energy admission in pursued	18.6	W
Energy admission - Energy saving mode (Stand-By-; Suspend-; Off-Mode)	0.1	W
Energy admission - Soft Switch Off	0.1	W
Typical Annual Energy Consumption (with Power management / energy saving)	27.5[2]	kWh

ENERGY VALUES 5 YEAR OLD SYSTEM			
	With Monitor	**Without** Monitor	
Typical Annual Energy Consumption (WOL enabled) (w/o Power-Management)	468.90	209.9[3]	kWh/ year
Consumption number of PC's in period of utilization (w/o Power-Management)	2,813,400.00	1,259,948.28	kWh/ period of utilization
Energy costs (w/o Power-Management)	422,010.00	188,992.24	€/ period of utilization

ENERGY VALUES OF NEW SYSTEM			
	With Monitor	**Without** Monitor	
Typical Annual Energy Consumption (WOL enabled) (including Power-Management)	84.5	57.0[4]	kWh/ year
Consumption number of PC's in period of utilisation (including Power-Management)	507,000.00	342,000.00	kWh/ period of utilization
Energy costs (including Power-Management)	76,050.00	51,300.00	€/ period of utilization

SUMMARY			
	With Monitor	**Without** Monitor	
Consumption ESPRIMO E900	507,000.00	342,000.00	kWh/ period of utilization
Energy costs ESPRIMO E900	76,050.00	51,300.00	€/ period of utilization
Savings in percent(costs) compared to 5 year old system:	**81.98%**	**72.86%**	

2 Accoding to Energy Star Calculator http://www.eu-energystar.org/en/en_008b.shtml

3 formular 4 + 15%

4 Used formula: On mode = 0,9*Power consumption Idle + 0,1* Power Consumption Maximum; Typical annual energy consumption = ((8h * Power consumption on mode + 2h *Power consumption Standby +14h *Power consumption Minimum WOL enabled) *260d+105d *Power consumption Minimum WOL enabled*24h)/1000

The power consumption of a PC system depends on a lot of different components, e.g. the chosen hard disk drive like solid state disk, 2,5-inch or 3,5-inch hard disk drive. Within the following table, we want to show the difference with an example of the energy consumption of the ESPRIMO E900 0-Watt.

Operational mode	Power Consumption with SSD	Power Consumption with 2,5-inch HDD	Power Consumption with 3,5-inch HDD
Power consumption: maximum	75.3 Watt	78.4 Watt	80.7 Watt
Power consumption: idle	14.9 Watt	15.4 Watt	19.5 Watt
Power consumption: standby	1.07 Watt	1.07 Watt	1.07 Watt
Power consumption: Minimum	0.52 Watt	0.52 Watt	0.52 Watt
Typical Annual Energy Consumption	47.3 kwh/year	48.9 kwh /year	57.0 kwh /year
Typical Energy Consumption (TEC), ENERGY STAR® 5 based 5)	52.7 kwh /year	54.4 kwh/year	68.8 kwh/year

"GREEN" DATA CENTERS

So far such potentials were comparatively easy to calculate. However, with regard to servers this process becomes considerably more complex. For example, current consumption may be assessed at different levels, with a view to departmental or enterprise platform servers as well as to entire data centers. In such cases, an individual status quo analysis is mandatory for every company. This task is best carried out with the assistance of service consultants from Fujitsu's one-stop shop. Only with this assessment completed can a company proceed to reduce energy consumption while simultaneously optimizing IT performance. Special attention should be paid to effective power consumption, an often overlooked variable in common network configurations: servers that operate in high-performance mode 24/7 – even outside office hours or when they are idle – are a popular method to waste energy and therefore the equivalent to the already mentioned screen savers.

At Fujitsu, the first step towards substantial energy savings takes place during production. Our PRIMERGY line of industry standard servers features several models that comply with the U.S. Environmental Protection Agency's Energy Star® 1.0 Program Requirements for Computer Servers introduced in May 2009 and actually exceed these strict standards by up to 45 percent. Smaller models, such as PRIMERGY TX100 S 1 and TX120 S2, have received an Energy Star® 5.0 recommendation for small-scale servers. These servers will send themselves to "deep sleep" after being left idle for a given amount of time, where they consume less than 2 watts. In addition, they are extremely quiet, which qualifies them for usage in office environments.

Energy Star® 1.0-compliant servers on the other hand help companies save up to 30 percent power consumption during sustained continuous operation when compared to conventional hardware, primarily because they come with highly efficient power supplies, handpicked voltage regulators, and power-saving BIOS settings. Additionally, these servers also benefit from Fujitsu's patented Cool-safe™ Design that ensures a permanent airflow within the system through extra large ventilation ducts. Moreover, Energy Star 1.0-compliant servers along with their management software also offer advanced power management features and controls that encompass all server types – including virtual machines – and enable administrators to deploy special settings for night operations. These power consumption controls not only help visualize a server's current drain, but also the heat emitted and the airflow caused by exhaust air, thereby providing important basic data for server room design.

Customers may use the Fujitsu System Architect or Power Calculator to determine how energy-efficient their server hardware should be. This tool can help them find adequate power supplies with varying efficiency factors of 85 and 87 percent (CSCI Silver and Gold certifications). Moreover, upcoming PRIMERGY generations will be equipped with Platinum-labeled PSUs that boast an efficiency level of 92 percent.
Costs and energy consumption can be dramatically lowered across IT operations, also in storage as 15%–20% of the data centre's power consumption is storage based. Therefore Fujitsu is very keen on evaluating new technologies and strategies to reduce the current energy consumptions. MAID (Massive Array of Idle/Inactive Disks) and SSD (Solid State Disks) are only two examples.

WE RECOMMEND A THREE STEP APPROACH

1. OPTIMIZE DATA MANAGEMENT

This is the part where you can save the most energy – almost for free

- Delete unused data
- ILM (Information Lifecycle Management) – store data according to performance and security needs (tape vs. disk / SAS vs. SATA etc.)

2. OPTIMIZE INFRASTRUCTURE

Consolidation is the key

- Consolidate direct attached storage to one external array
- The ETERNUS CS solution family offers outstanding data protection for dynamic infrastructures.

3. OPTIMIZE DEVICE

Save real money by using state of the art technology

- A new ETERNUS DX80 with 6 SATA disks consumes only 10% of the power needed for an old FibreCAT S80 with 56 FC disks (both with 4 TB storage capacity for comparison).
- This saves you over 2.500€ of energy costs per year.
- ETERNUS CS High-End allows for a seamless migration from one data protection technology to another

Our ETERNUS DX disk storage systems are amongst the most energy-efficient storage systems in their class. Eco-mode reduces energy consumption and heat dissipation by using MAID functionality, which »spins down« idle drives. In addition to that, the systems use energy-efficient SSDs (Solid State Disks) and offer market-leading price/performance ratio.
ETERNUS LT tape automation systems offer the possibility to get started in automated backup in an economical way and energy consumption is even lower thanks to the introduction of LTO-5. They are designed for high investment protection leveraging the existing drives in preparation for an update to a larger system.
Reknowned analysts agree that ETERNUS CS for mid-range and enterprise businesses offers the maximum data protection available for dynamic infrastructures. It enables the consolidation of storage devices for data protection thus simplifying data protection administration, saving energy and lowering the total cost of storage, while making efficient use of the most cost-effective technologies.
Given such basics, it goes without saying that Fujitsu's data center offerings are equally comprehensive. Switching from a traditional to a Dynamic Infrastructure may help customers save up to 40 percent energy costs by way of extensive virtualization. The main task in creating such flexible infrastructures is to adequately size the underlying server and storage pools: on one hand these must provide enough capabilities to fulfill everyday business requirements while on the other they should create little or no overhead for peak loads that literally "blow off" energy being kept on permanent standby. The potential for power and cost savings was recently highlighted in the so-called Padergreen Project, an EU-financed study carried out by Fujitsu and Wincor Nixdorf. The task was to consolidate and simultaneously virtualize a set of 150 older server models from different generations. Status quo analysis showed that some application servers only worked to 10 percent capacity on average and to 50 percent at best. Therefore, it was a logical decision to swap these applications to virtual machines running under VMware. After the old equipment had been replaced with a PRIMERGY BX600 S3 Blade EcoSystem and BX620 S4 server blades, subsequent analysis showed that hardware had been reduced by a factor of 6 and energy savings amounted to 75 percent – while at the same time performance had measurably improved.

Other methods for improvement at this level include the reconstruction or relocation of data centers. According to the McKinsey study "Data centers: How to cut carbon emissions and costs" from winter 2008, modular construction of a building and incorporating "natural cooling effects" from the surroundings may help achieve energy savings that are comparable to those deriving from server virtualization. Consequently, free cooling became a major design principle when Fujitsu planned and built its new Augsburg data center.

The reason for this was that at Fujitsu we believe that in order to promote Green IT, you not only need an adequate product policy – instead, you also have to set a good example. Therefore, we not only produce resource-sparing PCs, notebooks, displays, zero and thin clients, and servers, but are constantly upgrading our company's own infrastructure. For instance, 10,600 desktops have been equipped with our Now2Client, a program that turns off hard drives and monitors after an idle period of 10 minutes and puts the whole system on standby after 20. If a PC isn't used for more than an hour, the machine is sent to hibernation after the memory content has been stored on the hard drive. By working with such optimal settings, we are able to save 212,000 kWh or € 40,000 p.a., which equates to the demand of 70 households. Additional savings potential derives from our Customizing Program that originally was created for corporate clients, but is now subsequently used throughout the company itself: using bulk instead of individual packaging not only decreases packaging and transport costs, but also helps minimize the "waste quota" amassed during container lifecycles from production through disposal.

Altogether, Fujitsu maintains several data centers for development and testing of hard- and software solutions at its Augsburg site. The total number of servers in these centers amounts to more than 2,000; two transformer stations provide them with 11 million kWh per year. All systems are typically cooled by three modern chillers; however in winter operations are switched to free cooling, which means that cooling energy is drawn from outdoor air. Moreover, detailed research has convinced Fujitsu to power down its air conditioning systems at night and on weekends, keeping them in a sort of economy mode that prevents temperature variations of more than 5° Celsius. (Otherwise, projected energy and cost savings would be lost upon returning to standard operation mode.) This highly efficient cooling system alone has enabled Fujitsu to cut operational expenditures and power consumption by € 150,000 or 1.5 million kWh annually while at the same time the company's carbon footprint is reduced by 530 tons. This equates the annual demand of 300 4-person-households.

In addition, Fujitsu has taken some "invisible" measures that pertain to the entire factory premises as well as to the offices. For example, old light bulbs were replaced with energy-saving lamps that are controlled by motion detectors in all corridors. This change alone has induced cost savings of 20 percent (€ 50,000) and CO2 emissions cuts of 259 tons p.a. All new office buildings have been fitted with so-called active glass that automatically dissolves dirt when exposed to sunlight whereupon the next rain washes it off. That way, electrical equipment for window cleaning is no longer needed. Aside from these energy-saving measures, it should be noted that Fujitsu has also launched an eco-friendly waste and wastewater management system that facilitates annual savings of € 240,000. Conclusion: Green IT involves more than just saving energy.

THE PLACE TO START IS YOUR OWN DESKTOP

On the other hand, users who want to contribute to "green IT practices" can do so without running huge data centers or production site. The place to start is everyone's PC – a maxim even Fujitsu acts upon: by default, all desktops delivered in-house are set to power-saving mode. Oftentimes, the simple question whether a desktop, monitor or notebook can be turned off facilitates genuine advancements: many companies keep all their PCs and displays in standby mode over the weekend, even though they are hardly used – if at all. According to Canadian surveys, PCs are only busy about 12 percent of the time that users keep them turned on. This waste of energy can easily be remedied by changing the settings of each individual client – Windows as well as other desktop operating systems offer easy-to-handle yet efficient power management features. As a first step, you should configure your system in such a way that it turns off the monitor after 10 minutes of inactivity (notebooks in battery mode: 5 minutes), powers down the hard disk drive after 15 (10) minutes, switches to standby after 20 (15) minutes and goes to hibernate or soft off after an hour. Fujitsu's LIFEBOOK Series of notebooks comes equipped with an "EcoButton" that supports further energy savings – one push ensures that the laptop is set to "green" mode and turns off the optical drive, the IEEE1394/FireWire port and the PC card slot when they are not in use. As a reward, notebook users will benefit from one hour extended runtime when their system is operating on batteries. In addition, all LIFEBOOKS come with modern LED displays that use less power and are easier to recycle than their predecessors.

OVERVIEW OF ENVIRONMENTAL CONSCIOUS FEATURES

LIFEBOOK NOTEBOOKS

- Nordic Swan, ENERGY STAR® and EPEAT certificate
- LED backlight display
- EcoButton
- Ambient light sensor
- Pre-installed power management
- 0-Watt AC Adapter

ESPRIMO DESKTOP PCS

- Blauer Engel, Nordic Swan, ENERGY STAR® and EPEAT certificate
- 0-Watt functionality
- Halogen-free mainboard
- Pre-installed power management
- Power consumption with less than 0.5 watts in stand-by mode
- Up to 89% energy efficient power supply
- Switched monitor outlet

CELSIUS WORKSTATIONS

- Blauer Engel, Nordic Swan, ENERGY STAR® and EPEAT certificate
- Halogen-free mainboard
- Pre-installed power management
- Up to 85% energy efficient power supply

PRIMERGY SERVER

- ENERGY STAR® certificate
- Enhanced Power schemes
- Up to 92% energy efficient power supplies
- Different power supply options ranging from 450 to 700 watts
- Power consumption Management enhancements
- Cool-Safe™ design
- 0-Watt Server TX100 S2

STORAGE

- Eco-mode with MAID technology (drive spin down)
- Significant power savings with LTO-5 drive technology
- Power efficient storage design (power supplies, cooling, ...)
- Highest IOs per second and per Watt with Enterprise SSD

CONCLUSION AND PROSPECTS

With its "eco tradition" of more than 20 years, Fujitsu ranks among the top providers of Green IT worldwide, supporting and promoting advancements based on the latest research results. Ecological standards are applied throughout each product's entire lifecycle, from development and production through delivery and operation to recycling and disposal – which also means that we are constantly trying to meet and exceed environmental protection laws and regulations. In doing so, we have often set standards; for our customers, this means they can be sure to obtain Green IT equipment and environmentally sound innovations that enable them to reduce power consumption and save costs.

Among the most recent projects to rise ecological awareness is our Product Carbon Footprint (PCF) campaign. First launched in Japan in 2007, it has helped reduce CO2 emissions during production by 7 million tons over the next three years. For the 2009–2012 periods, emissions are supposed to drop another 15 million tons; and for the upcoming decade until 2020, the goal has been set to 30 million tons. Fujitsu's German branch joined the campaign in March 2010 and is currently implementing a pilot project that is based on experiences of the Japanese colleagues and overseen by the Bifa environmental institute in Augsburg and the Fraunhofer Institute for Reliability and Microintegration (IZM) in Berlin. The first goal is to provide our customers with reliable PCF key figures as soon as standards are defined; the second step will be to permanently improve these figures in our quest for even "greener" production.

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