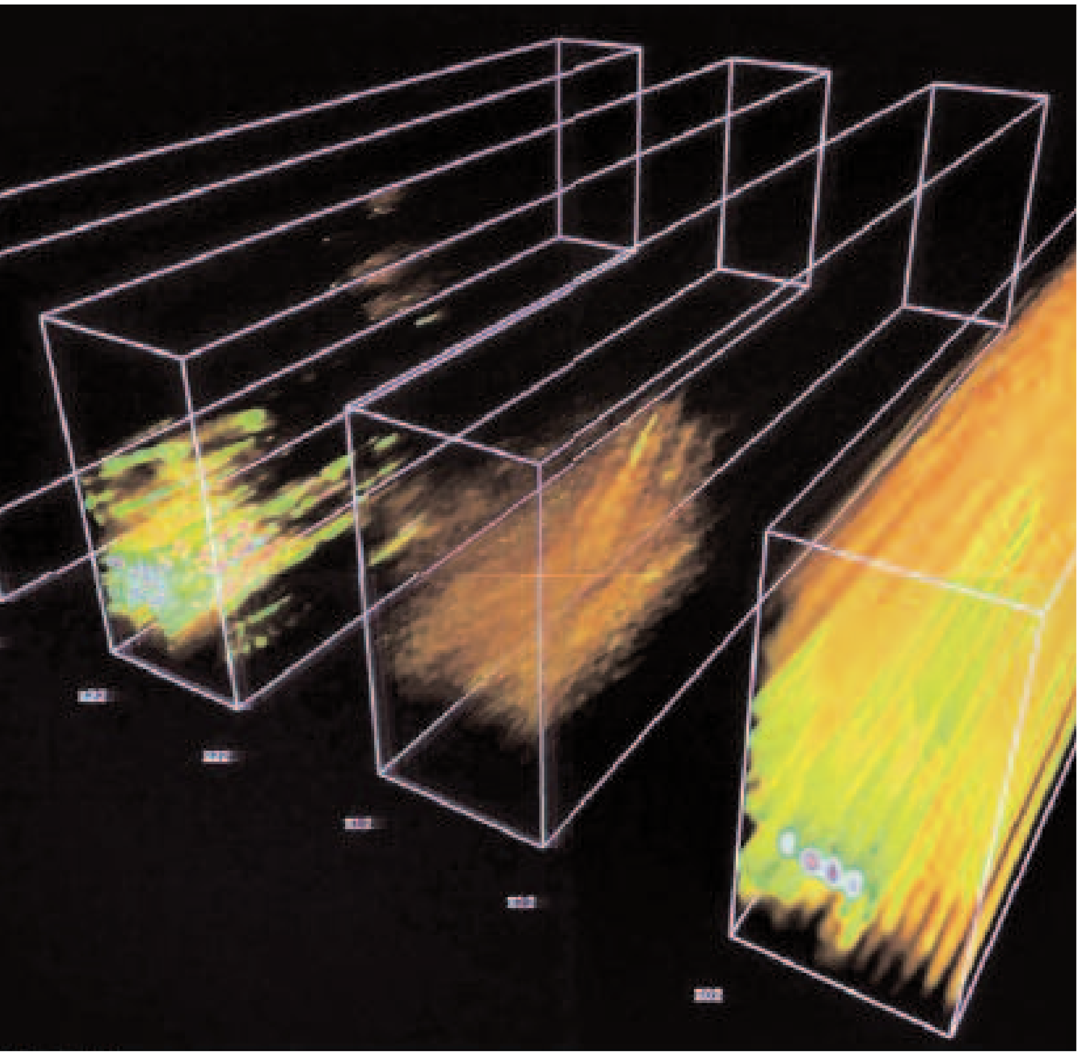
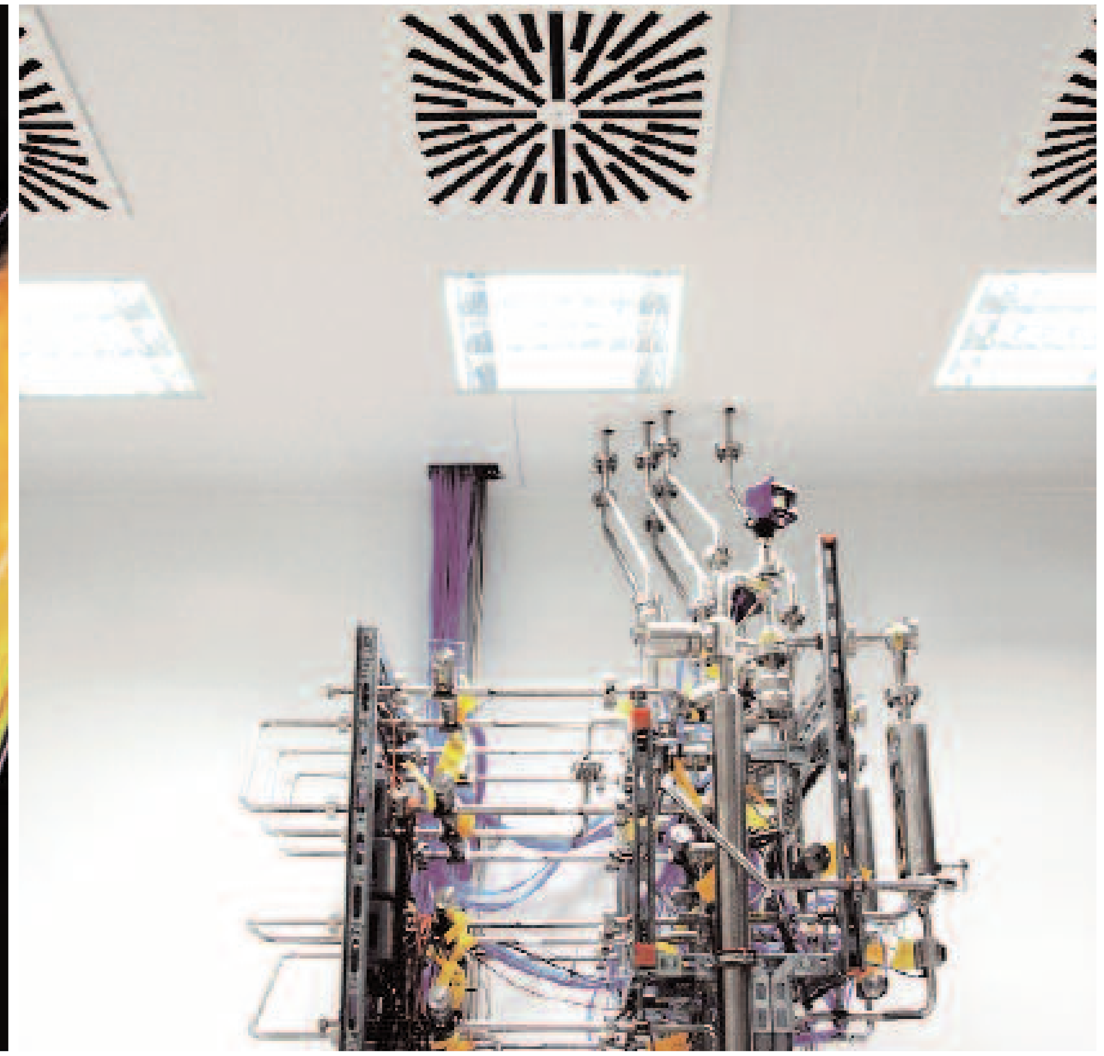
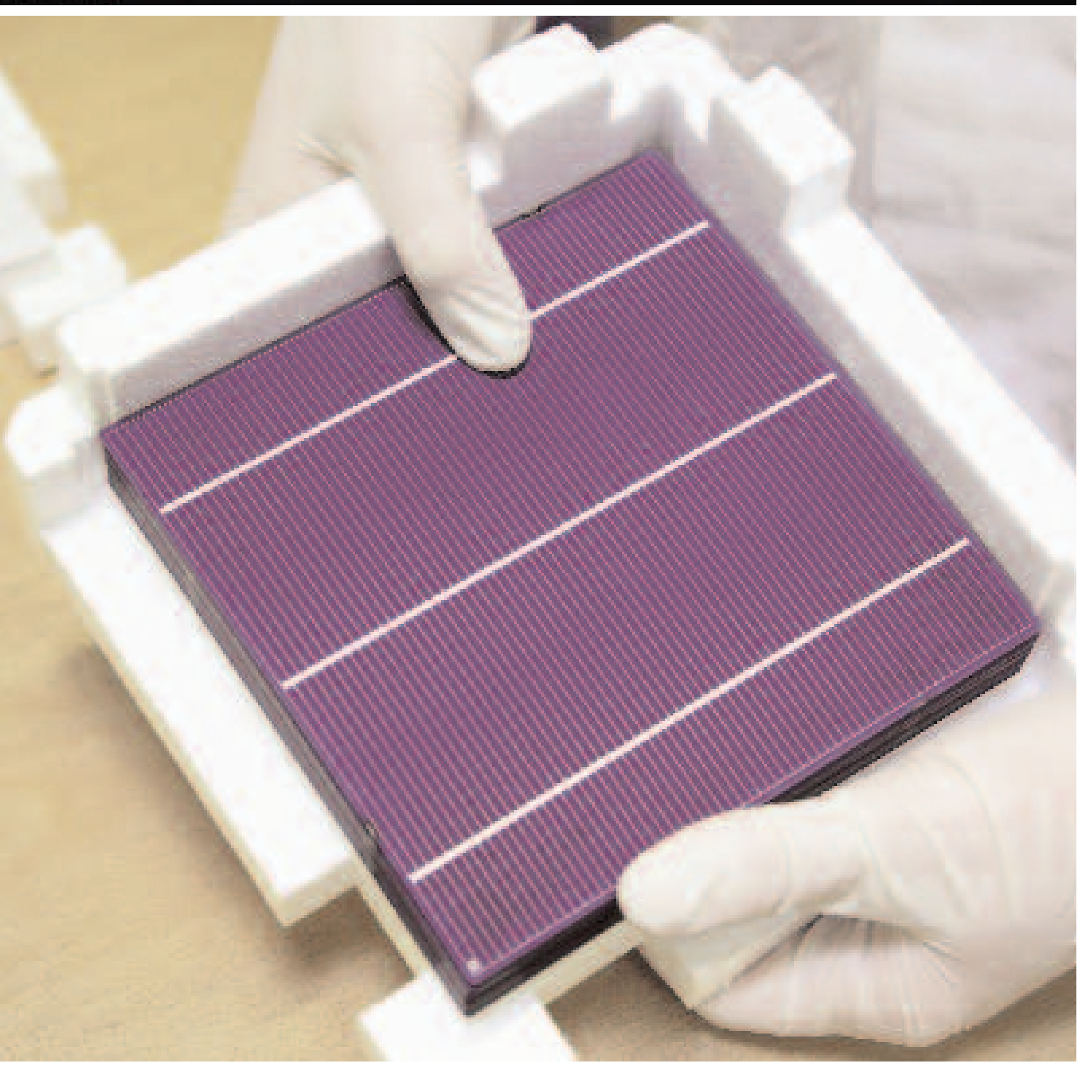
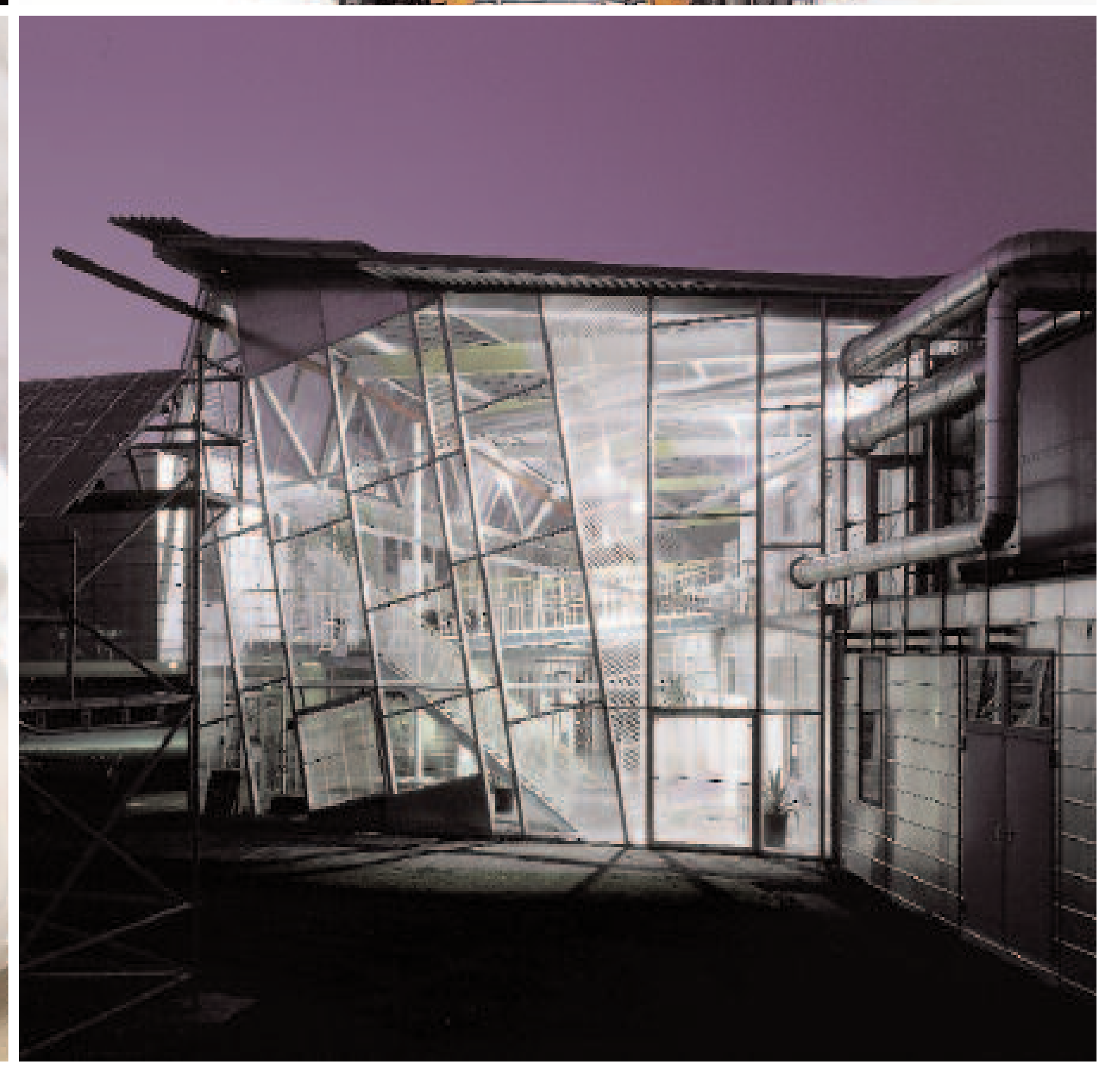








Let’s talk about storage.

If you advocate the use of renewable resources to generate power, you also need to consider **HOW ENERGY CAN BE STORED**. Scientists are currently researching methods of storing electricity that will make it available as needed.

World economic growth rose by a sizeable 5.3% in 2006, pushing up the power consumption figure at the same time. That, says the “BP Statistical Review of World Energy 2007”, is chiefly due to the demand in energy-hungry China. In just ten years, power consumption in the People’s Republic has nearly doubled.

The good news is that renewables now deliver 13.1% of the global electricity requirement. Most of that comes from biomass and hydro-electric plants, though electricity is increasingly being bought from wind and solar farms too.

Though the debate over using renewable resources to generate power has subsided, the extent to which they can replace fossil fuels is still an open question.

Over half the electricity used worldwide is needed to power motors, and scientists estimate that around 50% of that is already lost before being turned into mechanical power. A worthwhile approach would be to target efforts at preventing those power losses.

Though today’s average industrial company spends no more than 1 to 3% of its running costs budget on electricity, that item is soon likely to cost more as a result of rocketing prices for fossil fuels. Another factor is the envisaged worldwide emission rights trading scheme that is intended to curb carbon dioxide emissions in the long term. Does the future hold a solution in store, a new form of energy? How will globalized business manage to satisfy its demand for electric power five to ten years hence?

Professor Dirk Uwe Sauer of the Rhineland-Westphalia Technical University (RWTH) in Aachen puts a damper on any euphoric hopes that someone will by then have invented a technology capable of supplying electricity in abundance. “Developing power generating systems takes a lot longer than technologies like IT,” he says. It would be impossible to get a system capable of making a significant contribution within the power industry ready to launch ten years from now unless it were already a mature development now. But the research labs have not yet come up with any miracle technologies.

Currently scientists are focusing on optimizing the technologies that already exist, working on projects like four-stroke engines able to run on a single litre of rape-oil or sugar-cane “diesel”, ethanol as a petrol substitute and accumulator batteries that are kept topped up by their own electricity supply. But the key areas are pushing up efficiencies, recycling waste heat and mechanical energy and finding new, more effective ways to store energy.

Storing electricity from the time it is generated to when it is needed has always been a challenge – and still is. “Generating 20% of the supply from wind

Power-hungry.
Computers processing data (top left), industrial manufacturing systems (top right) and the homes people live in (bottom right) – they all need power. 13.1% of the worldwide demand is already being sourced from renewables like solar energy (bottom left). Yet even today about 50% of the power generated is lost before reaching the point where we can use it.

power takes us very close to grid capacity limits," says Professor Sauer who supervises a workgroup at the RWTH specially set up to investigate power storage system technology (the only one in Germany working in this area). Electricity generated from sustainable sources tends to fluctuate, and this can be partly compensated by intelligent control of the machines using the supply. But evening out irregularities is mainly the job of storage systems. "Obviously you can't expect an industrial facility to switch machines off just because it doesn't happen to be a windy day," says the researcher. Even now there are few systems capable of storing power on a large scale and distributing a constant wattage over long distances. Pumped-storage power stations are a classic example, but mountainous regions are practically the only suitable sites and the number being built in Central Europe is dwindling due to conservationist opposition.

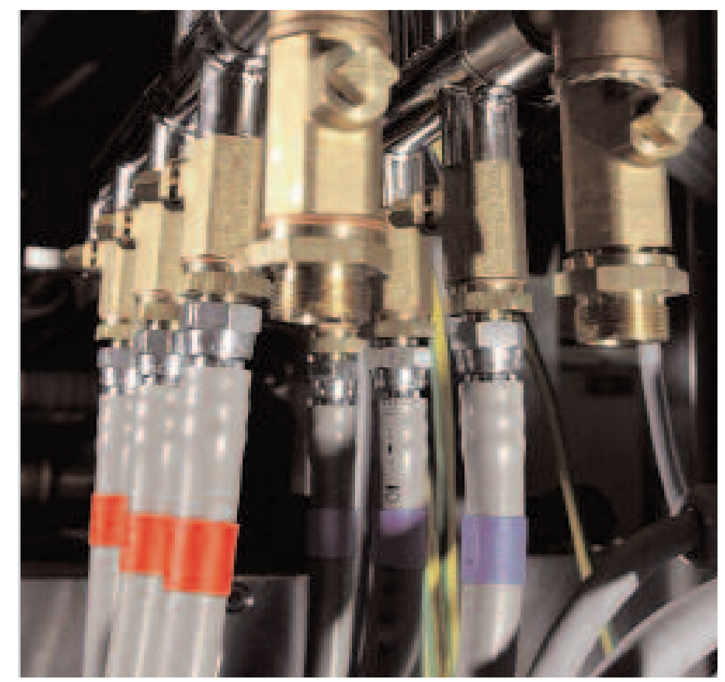
The problem is receiving attention particularly in the US where the distances to be covered are long and power failures common due to inadequate grid equipment. Here, booster stations are seen as a way to maintain and improve supply dependability. Across Europe, consumers are still reaping the benefits sown earlier by state-owned electricity monopolies that used to keep their networks well-maintained. "The liberalization of the energy market may well affect Europe too by putting a question mark over power supply stability," comments Wolfram Jörss, coordinator of energy research at the non-profit-making Institute of Future Studies and Technological Evaluation (IZT) in Berlin. For one thing, a large proportion of the electricity price goes towards running the network, which in Europe is about twice as expensive as generating the power itself and costs even more in the US. For many manufacturing facilities a stable power supply is also an absolute necessity.

Flywheels, for instance, are one way in which an uneven flow of current can be levelled. They belong to the category of high-capacity storage systems which can temporarily store high bursts of energy and subsequently release it. Flywheels can achieve efficiency figures of 85%, enabling them to smooth out transient spikes, and work by transforming electrical into kinetic energy. Friction losses are kept to a minimum by using magnetic or superconducting axles and operating the flywheel in a vacuum, but a little added power is still needed to make up for the remaining loss. Even the flywheel is not a perpetuum mobile.

New sources utilized more efficiently.
The auto industry is now focusing more on designing cars powered by new energy sources. BMW for instance is prioritizing hydrogen-powered vehicles (top left). LEDs (top right) are also innovative in that they emit light using very little power. Transporting power over long distances (bottom left) is also a form of storage, but as yet only a few systems have that capability.

Operating at a speed of 5,000 rpm, large flywheels can now achieve an output in the order of several megawatts. There are also models that can run at 100,000 rpm. These store the same amount of power but have a much smaller rotating disc, making the system more compact. The reason why the size of a wheel cannot be increased indefinitely lies in the material. The enormous centrifugal forces acting on a wheel running at over 25,000 rpm would shatter anything over a metre in diameter. Research is therefore concentrating on new composite materials capable of withstanding such stress levels, but it will still take about 15 years to prepare them for use in the field.

Alongside high-capacity storage systems, scientists are also making efforts to advance the development of high-energy storage, and compressed air power storage systems are one of the areas being investigated by US and European developers. The first power plant of this type was built back in the seventies in Huntorf, Germany. Ten years later it was followed by another in McIntosh, Alabama.



Water cooling at Hauni.
Using a water cooling system (bottom right) on M-generation PROTOS lines is a way to save energy costs. The heat generated by the running machine is not released into the ambient factory air but instead is collected for use. This halves the power needed to cool the shop floor, effectively reducing factory air-conditioning expenses.

The principle of compressed air storage systems resembles the pumped-storage reservoir in a hydroelectric plant. The problem that still exists with compressed air storage is that the heat generated when compressing the air is not stored. Many industrial facilities also still waste a lot of the energy-laden hot air which escapes as a by-product of the compressed air commonly used to drive engines and turbines. Currently work is proceeding in Ohio/US and in Germany on the design and construction of new compressed air storage power plants where, instead of using the usual complex system to cool the air compressor, its heat is transferred to a concrete block. This works like an outsize night storage heater, storing the thermal energy until needed – in other words, when electricity is to be generated from the compressed air. So rather than using natural gas to heat the air, it goes through the heat storage system instead. Calculations indicate that this process can help compressed air plants to reach efficiencies up to 70%.

A storage medium presently used in small-scale applications that might be a candidate for high-capacity storage is hydrogen. This process involves electrolysing water, splitting its molecules into hydrogen and oxygen. This process releases energy, as we may remember from the noisy experiments we did with oxyhydrogen in the school lab. "All forms of storage involve turning energy into a different form," says Dirk Uwe Sauer. So electricity is transformed into kinetic, thermal or chemical energy and back to electricity which cables can carry as current.

Passing current along cables is in fact a form of storage in itself. Electricity now travels across Europe, for instance, in a new type of DC cabling. "The ideal setup is one where you generate electricity and first distribute it via the grid to the points where it can be used," says Sauer, adding that this is still more efficient than storing it in one place. Like IZT research scientist Jörss, he maintains that the technology most urgently needed in the near future is a modern energy management system capable of coordinating supply with load so efficiently that storage on the scale of a power plant becomes virtually unnecessary. ■