TECHNOLOGY FUTURES

Shell
GameChanger

Efficiency

Impacts

Previous sections of this book discussed specific energy resources and technologies. Now we turn to how various combinations of technologies could be adopted by society to change the way we live and how we consume energy and manage environmental impacts such as greenhouse gas emissions.

The first part in this section explores how to make better use of existing technology to bring about increased efficiencies in energy use. It looks at the technology that enables this, and also at regulatory intervention to introduce stricter efficiency standards and incentives to change behaviour.

The Distributed and Connected section looks at how technology is changing the way we communicate, do business and interact. These changes in turn have direct impacts on other complex systems including transportation. This is one sector that has been an early adopter of technologies such as global satellite positioning (GPS) that are now finding their way into many aspects of society. GPS, for example, now enables many cargo shipments to be followed around the world from any computer.

The Track and Trace section discusses how tracking technology impacts a range of sectors. This technology offers substantial benefits for global trade, but can also produce unintended consequences if it falls into the wrong hands.

Finally no discussion of impacts would be complete without examining the other liquid that the world depends on: water. The very real prospect of severe water shortages is driving significant developments in areas like desalination. Closely connected to water is the issue of health, and the Water and Health section explores these topics.

Better Use of What We've Got

The continuing population growth and industrialisation of developing countries is driving an accelerating consumer demand for goods and services. Meeting this demand requires the consumption of a finite supply of raw materials. The ability of the planet to absorb the impact of human activity is being tested.

One thing is clear – the current rate of growth is unsustainable. We only have one planet. We are therefore faced with a choice. We either reduce human activity, or do "more for less" by improving the efficiency of use of all inputs and reducing waste. Our expert discussions focused on how we could maintain levels of activity more efficiently, recognising that success will require both the application of technological solutions and changes in behaviour. It was clear that this in turn will only happen if governments and regulators introduce stricter efficiency standards and incentives.

"Can the world's resources support all of Man's current activity? Probably not."

"There's a school of thought that says so much carbon is being emitted and world growth is so fast that you can't stop it going up considerably. So if all the negative thoughts about global warming are true, you can't do anything about it. So you might as well just have a big party."

Fortunately, not everyone thinks this way. From governments down and from lobby groups up, there is a will to stop environmental plunder. The obvious first step is to make better use of available energy resources, and to stop wasting what we've got. A wide range of experiences and ideas were bounced round the discussion rooms. They fell into several categories:

Manufacturing

Heavy manufacturing was identified as one area where small increases in efficiencies can yield large impacts. Steel mills in particular came under scrutiny for two reasons: the predicted massive increase in production needed to satisfy global demand, and the potential savings that new technology can offer.

"Over the last few years, the world's steel production has been going up 6 percent per year, mainly driven by growth in demand from China."

"At least one-tenth of the world's CO_2 production comes from blast furnaces and the cement industry."

"But digital control technology now lets manufacturers specify the thickness of the steel. We are seeing new applications for steel in the building industry, mainly to make it look nice. Previously only a few thicknesses were permitted. This kind of control technology could have a huge impact, with less waste."

Recyling materials is one way to use existing resources more far more efficiently.

"A lot of steel is recycled. It's the best example of things for which an efficient recycling system really does work. There is currently not enough scrap steel in the world."

The primary production of crude steel uses about three times as much energy as recycling scrap steel. However, the growth of steel production over recent years has been concentrated in China, a country without scrap reserves.

"Wood and cellulose are easy to disassemble. Composites are lighter but if you glue composites together you can't disassemble them. The only thing you can do is put the material in landfill and wait 100 years. You can't recycle them. There has been more impetus behind creating composites than taking them apart. What are needed are selective solvents. It's just a technology problem."

Buildings

While developing new technologies can solve some problems, there are also valuable lessons in efficiency to be learned from history. A prime example is how to design a house to prevent the sun from turning it into a hothouse, which then costs energy to cool.

"Building orientation and location can make a 50 per cent difference to energy consumption. We have forgotten classic building knowledge that people used a thousand years ago because they had no air conditioning or heaters. The limiting factor now is often street patterns. Hundreds of years of relatively cheap energy have given us street patterns that don't let us orient buildings correctly."

"Taxis in Hong Kong have two roofs for insulation so they don't heat up while standing still. The Chinese did the same thing two 2,000 years ago, with homes with double-layered roofs."

"One day someone in Houston Texas will all of a sudden discover something that's called the 'awning' – a new way to keep heat out of the building. They'll think 'wow what an incredible innovation to stop the sun's heat before it gets trapped inside a glass box' – even though we've known how to do that for hundreds if not thousands of years, with people in the south west of the United States of America building their homes with awnings of rock."

"We will rediscover the fact that keeping heat out makes more sense than trying to change it to cool inside the building. Low energy housing is widely adopted in Germany and Scandinavia, but not elsewhere."

"As well as awnings, there are shutters. Those will come back too. Window shutters are common in Switzerland and Germany."

Cities

Although cities cover less than one per cent of the earth's surface, they hold more than 50 per cent of the world's population, consume 75 per cent of the world's energy and are responsible for 80 per cent of greenhouse gas emissions.

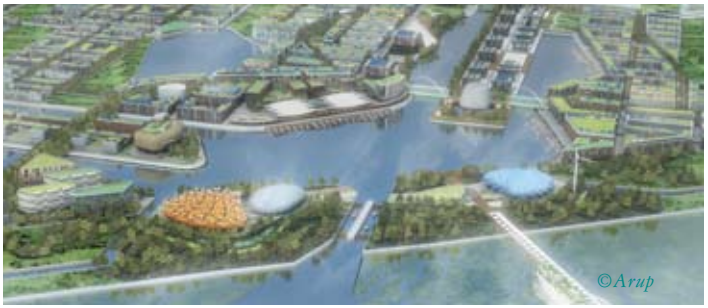
Perhaps the challenge is to learn how to live in cities and re-design the built environment?

"This year, 2007, is the year in which we have become urbanised," an architect told us. "There are more people living in cities now than in the countryside and that trend will continue. Over the next twenty years we'll see cities growing on an unprecedented scale in the developing nations."

"India has Special Economic Zones; satellite towns that are 50 km to 100 km away from the main city centres. The SEZs are self-sufficient integrated cities with commercial businesses and residential buildings, with hospitals and schools and mass transport infrastructure. We could have something like SEZs all over the world."

New towns offer considerable potential to improve energy efficiency. Building environmental and energy considerations into new developments is easier than trying to redesign and retrofit existing urban centres. China may provide the blueprint for the next generation of energy-efficient cities.

"Dongtang is on an island next to Shanghai, in the Yangtze river delta. The site is three-quarters the size of Manhattan. It's an area with huge ecological sensitivity, next to a wetland on a waterfowl migratory path. The Chinese government and the developer have a goal for this completely new city: to achieve close to zero carbon



Dongtan Eco-City

Dongtan is a sustainable eco-city under construction just north of Shanghai on the third largest island in China. Designed by the engineering and business consultancy Arup, the city will use renewable energy, water purification and re-use, combined heat and power systems, and low-energy housing. It will be as close to carbon neutral as possible.

The completion of the first phase of Dongtan is scheduled for 2010, with road and rail links to Shanghai and local airports. By 2050 it is expected that the city will house half a million people.

The city – which also features extensive planning for social, cultural and community developments – will provide a model for other cities around the country that Arup is designing. ■

emissions, with energy and material recycling, sewage capture to fertilise farmland, wind and wave turbines and strict energy conservation rules for the citizens."

Despite having the advantage of starting with a clean slate that allows the use of "best-of-breed" efficient technologies, challenges remain.

"Even when we build completely new cities on green-field sites, as is happening in China, it remains impossible to get individuals' carbon footprints down to the target level."

"It has proved hard to do. In fact it's shown that we are not yet able to design a city that's good enough, even on a green-field site. We now know there's no perfect system. But we have to start somewhere."

"Wherever buildings are built, a lot of energy is used, from manufacturing the materials right through to construction. This 'embedded energy' is a one-off hit but the building structure then continually consumes energy to run. The challenge is to keep the embedded energy and running energy as low as possible."

"Different materials have different levels of embedded energy – cement having the highest. We need to use materials with lower embedded energy."

We were reminded that concrete is sometimes shipped by air in China – "if you are building something that needs to be finished in a hurry, concrete becomes a high value good"– which increases the level of embedded energy and the cost.

Vehicles

From stationary buildings, the conversation moved on to how to build more efficient vehicles for mobility. Previous sessions had made clear that our experts doubted any significant move towards automated road travel would occur within 20 years. So what can be done to improve existing transport systems?

"Frankly it's very difficult to see how the developing world can get the transportation it needs while also respecting the needs of the environment."

"Today's transportation is almost 100 per cent dependent upon petroleum. Right now the only thing you can use as an energy source for personal transportation is oil. Physical infrastructure is slow to change. A building will last for 50 years; a road will last for 20 years. Usually you can't widen roads, you can only build more levels. And typically a vehicle lasts 5 to 10 years, or even 20 years."

"Vehicle technology will be completely modified during those years."

"You come back to the fact that electricity is the universal interchange mechanism. The grid already exists. You can generate electricity from any kind of fuel; from solar or from wind or geothermal or nuclear or hydroelectric, and send it out over the grid and the car can use it. So it doesn't have to depend on oil."

The biggest potential efficiency gains in transportation, however, may require a change in the current paradigm. The approach to a better system may lay in a total re-examination of some of the central tenets of the way people view their vehicles.

"We need radical re-thinks. Rather than transporting a 3,000 pound car to carry a 200 pound person we should focus on how we get that 200 pound person around. Eighty per cent of car fuel is used for engine tick-over, only 20 per cent to move the vehicle."

"Yes, one thing we can do is to stop moving air. The car is a big heavy box full of air".

"How many times do you get in the car and not need all its space? It would be so much better to use just what you need, just the seats and engine. You don't need the boot or trunk. A modular car, like automotive Lego, could be configured to suit what you need."

"With automotive Lego you don't buy a car, you buy a transport solution. Maybe it floats on an air cushion instead of wheels. Maybe it's inflatable to change the size. Or maybe the more practical solution is just to have two cars and use whichever one is best for the day's job. Perhaps we'll buy a 'ticket to drive' which will become a tradable commodity, just as some people already sell parking rights they do not use."

"Or perhaps we just belong to a pool of cars and borrow what's needed."

Perhaps the most publicised recent attempt to change the way people view personal transportation was the development of the Segway. A two-wheeled electric device, the Segway resembled an old "push mower" that was used to cut lawns. It relied on a complex set of motors driven by a gyroscope to prevent people from falling off while moving. Although the Segway failed to reach mass adoption, our group of experts saw it as a potential step in the right direction.

"Why did the Segway fail? Because it made people look silly. But things may be different in 20 years' time."

So how easy will it be in practice to introduce this kind of new thinking? The difficulty in developing new directions for transportation is the number of people that have a vested interest in the outcome. Unlike the power generation industry – where there may be several thousand companies to negotiate with – in transportation there are hundreds of millions of users.

Government intervention can be the key, and a charismatic leader – such as "Governator" Arnold Schwarzenegger – can make a huge difference.

"After years of being famous for smog, the state of California is at the leading edge in terms of emissions from cars and so is actually driving the industry across the country and maybe across the world."

Segway PT

Like a gadget from Star Trek, the Segway Personal Transporter is a futuristic two-wheeled device able to balance on its own, allowing users to stand upright and zip around safely.
When humans lean forward, the brain recognises when the body is about to lose balance and triggers an impulse to put a leg forward to prevent falling over. If the leaning forward continues, the brain will keep putting the legs forward to keep the body upright. Instead of falling, the body walks forward, one step at a time.

The Segway PT does very much the same thing, except it has two wheels instead of legs, a motor instead of muscles, a collection of microprocessors instead of a brain and a set of sophisticated tilt sensors and gyroscopic sensors instead of the brain's inner-ear balancing system. Like the brain, the Segway knows when it is leaning forward. To maintain balance, it turns its wheels at just the right speed, to remain upright. This is called dynamic stabilisation.

An intelligent network of sensors, mechanical assemblies and propulsion and control systems control the Segway PT. The second a person steps on the machine, five micro-machined gyroscopic sensors and two accelerometers sense the changing terrain and the body position at 100 times per second – faster than the human brain can think. ■

"Status could be a driver for good. People are proud to own a hybrid car. It's like bragging."

"SUVs, Sports Utility Vehicles, became unfashionable in US when the price of gas passed three dollars a gallon. That was the tipping point."

"Right now the United States is the dominant car market, but America's not going to be the dominant market for very long. China's going to take that over. India's coming up strong. And as people have more money, they want to buy cars, they want to drive. That's just the way it is."

"As the economy develops, people have more money, their economic threshold of pain increases. It is getting harder to make it uneconomic to travel."

The idea of automated travel came up again. It's an idea that just won't go away, however many technical obstacles there are.

An expert with close connections to the military argued:

"Army tanks already give the driver a chance to stay safe inside and rely on cameras and radar outside. Why not a car? And if the car can talk to other cars and drive itself, the driver needs no windows. There could be a virtual reality display with synthetic noise for background while the driver reads a book or plays a game."

"Or perhaps virtual travel may one day reduce physical travel," someone countered. "You could watch a holiday on your wallpaper instead of flying to the destination. Now that would save even more fuel."

Air and Rail Travel

Although the price of road vehicle fuel continually increases, the cost of air travel remains surprisingly low.

"There have been no physical, technical or economical constraints on air travel growth. It is growing 5 per cent year on year."

"Right now planes fly on roads through the air from Point A to Point B. Planes can't just go wherever they want. What if you could go from anywhere to anywhere? Airlines could then be flexible. Of course there would be regulatory and infrastructure issues. There would have to be no-fly zones over military areas and there would be perceived safety issues. But flexible flying would give big fuel savings."

While new business models may lead to increased energy efficiencies, big fuel savings are also the drivers behind the deployment of new technologies in commercial aircraft.

"The new Boeing 787 uses new technologies, such as composites, which reduce the aircraft weight to claim a 20 per cent performance improvement. Flying from Los Angeles to Hong Kong saves 20 per cent on the fuel burnt."

Boeing expects the airline market will need about 2,900 new aircraft over the next 20 years, and the lean-burning 787 will fit the bill. One fear our experts expressed was that this means flying could become even less expensive so there could be an overall increase in carbon emissions. The airlines will need to think hard about how to respond to critics.

Composites in Airplanes

In composite materials, resins and high-strength fibres of glass, boron, carbon or graphite are blended to produce lighter, stronger, and more corrosion and fatigue resistant materials than traditional metal alloys. They are commonly used in the construction of modern aircraft and, increasingly, in high-end sporting equipment such as bicycle frames and performance cars.

Composite materials are expensive, and their use in the military drove their early development. The B2 Stealth bomber was one of the first aircraft to extensively use composites. In 2005 Raytheon launched a business jet with a carbon fibre/epoxy honeycomb fuselage. Automated fibre placement machines place every strip of carbon in exact position to achieve maximum strength with minimum weight. Construction takes about one week, which is considerably faster and more efficient than the traditional process.

Boeing has used composites in commercial aircraft for many years, with the tail of the 777 being completely composite. However, with the development of the 787, the company is the first to launch a full-size commercial airliner in which almost half the aircraft – including the fuselage and wings – will be made of composites. By manufacturing a one-piece composite fuselage section, the company eliminates one and a half thousand aluminium sheets and around 40,000 fasteners.

"OK then. How about an airline that only flies thin people – or charges lower fares because there is less weight to transport and so less fuel used?"

Will heightened security and airport delays act as a brake?

"Train travel is taking business away from the airlines. It's more relaxed, with fewer security problems. It's easier to travel to Paris by train than fly. But what happens when the first Channel tunnel train is blown up?"

"Rail will attract terrorists. It could all change very quickly. Look at the Madrid bombings."

"Rail security will catch up and the airlines will find new ways to get passengers through airports more quickly. With radio-frequency identification (RFID) and iris scans, people will be able to run through to planes again".

"It may make sense to invest more in police intelligence than security checks."

"Security could rely on personal data transfer – your data describing you travels electronically. Mobility butler software tells you the best way to get somewhere from any starting point, by road, rail or train. Then you have the option to travel in ways that make security searching much easier and quicker."