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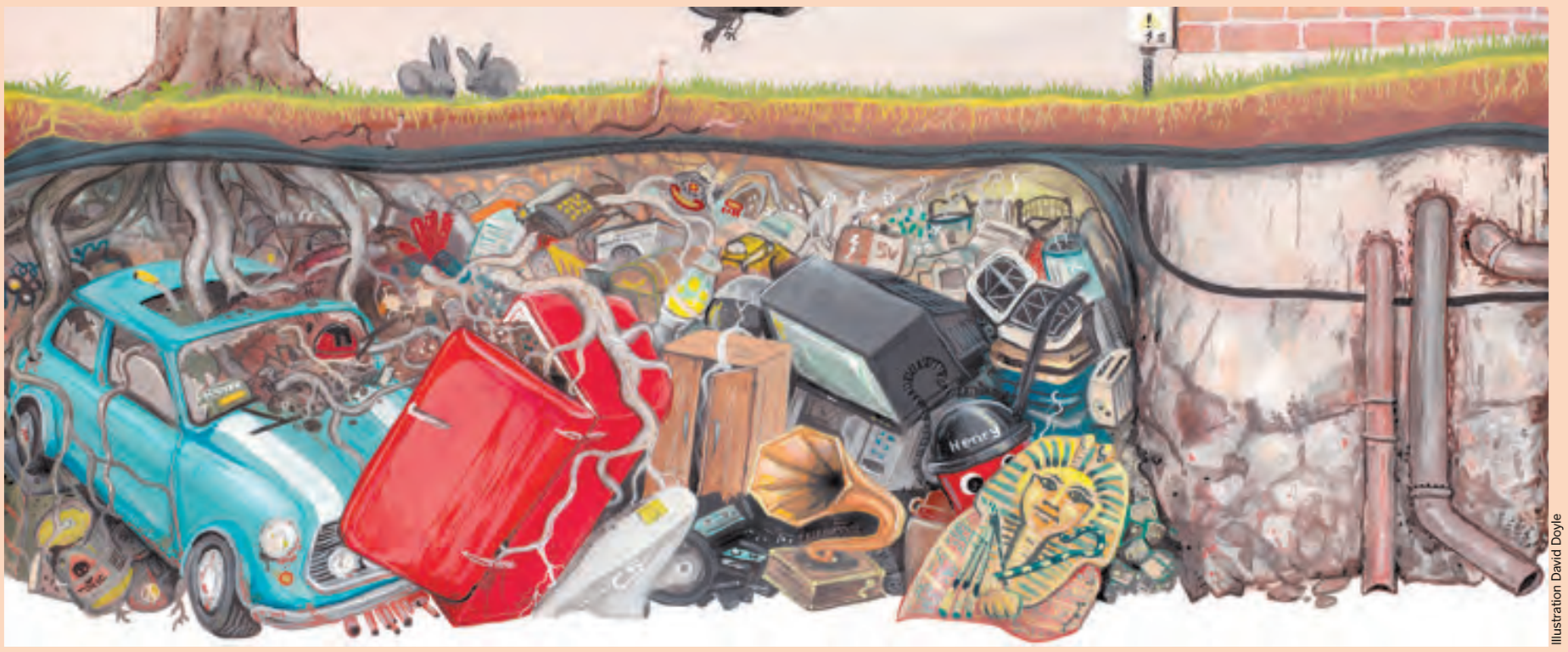

Illustration David Doyle

Waste opportunity

Creative management of landfill and recycling can transform landscape – and generate income. By Sarah Murray

What happens to your rubbish after you take out the bins? This question was asked by researchers at Massachusetts Institute of Technology's SENSEable City Lab, who tracked 3,000 electronically tagged waste items from Seattle. Their study showed that the city does well in minimising landfill waste (more than 75 per cent of the items ended up in recycling facilities, well above the US average of about 34 per cent). Yet huge differences exist in the way our trash is handled around the world – and some places do it better than others. In some cases, landfill has been turned into a valuable resource. In others, it has been avoided altogether.

At the other end of the scale is Kiev. The Ukrainian capital ranked last in the "waste and land use" category of the Economist Intelligence Unit's 2010 European Green City Index, produced for Siemens. It generated almost 600 kilograms of waste per inhabitant in 2007 (the index's 30-city average is 511kg, with Zurich producing just 406kg), putting Kiev's landfill site under extreme pressure.

While it is easy to complain about how waste is managed and rather more difficult to come up with solutions, you have to feel some sympathy for municipal authorities as they struggle to dispose safely of rubbish. Modern lifestyles have precipitated such a phenomenal increase in the amount of refuse we produce that they find it hard to keep up.

The volumes are striking. In 1998, the municipal waste generated in England and Wales could, at 27m tonnes, have covered an area the size of Hyde Park with an 80-foot layer, according to the then department of the environment, transport and the regions. A decade later, the amount of waste managed by regulated facilities in England and Wales had risen to about 150m tonnes.

'Our waste-to-energy plant is a money-making machine. So I always say garbage is gold'

The US is another big generator of household waste. In 2010, Americans produced 250m tonnes of rubbish – roughly the same weight as 685 Empire State Buildings. Even tiny Singapore puts out impressive volumes, producing 6.5m tonnes (about 18 Empire State Buildings) in 2010.

Much of our waste ends up in landfill, eating up precious land and creating air, water and soil pollution. As rubbish decomposes, it generates carbon dioxide and methane (a more powerful greenhouse gas than carbon dioxide) and releases chemicals and pesticides into groundwater. Mercury – produced by items such as fluorescent lights, electrical switches and batteries – is a neurotoxin that can damage the brain and nervous system.

Food waste is a particular problem, releasing methane as it rots. And we throw away staggering amounts of edible substances – some 34m tonnes a year in the US, making this the largest component of municipal solid waste in the country's landfills and incinerators.

Managing what we discard is expensive. Collection alone eats up cash. In London, the cost of collecting waste destined for landfill is about £64 per tonne (in 2008, 6.6m tonnes of London's waste went to landfill). In New York State, collection accounts for 50 to 70 per cent of solid waste budgets.

Waste also puts pressure on residents' budgets – £480 a year is spent by the average UK household on food that is thrown away, according to the Waste & Resources Action Programme. "It's costing us a fortune," says Liz Goodwin, WRAP's chief executive. She argues that householders need to plan more carefully. "Often we go shopping without looking in the fridge to check what we've got," she says.

Authorities' ability to manage waste hangs on more than persuading citizens to become efficient shoppers. Methods and costs depend on everything from topography and infrastructure to the prevailing recycling culture.

In a condominium in Manhattan, for example, residents might toss trash down a chute before placing bottles, plastic containers and newspapers on the floor to be collected every day by building staff for recycling. Meanwhile, from outside Edwardian houses in west London, Westminster City Council's weekly trucks collect recyclable materials placed in council-issued plastic boxes or sacks.

Tighter legislation and taxes designed to reduce waste-to-landfill volumes are increasing pressure to recycle waste. In the UK, for example, it costs on average about £22 per tonne to dump waste in landfill (compared to £49 to incinerate it). However, when you add the UK's landfill tax, the cost goes up to £70 per tonne.

Yet diverting waste from landfill is not always the most environmentally friendly option. In MIT's Trash Track project, Carlo Ratti, SENSEable City Lab director, and Assaf Biderman, associate director, were surprised to discover how far some items travelled to recycling centres. A printer cartridge reported the longest voyage, of 6,152 kilometres. "For some of the household hazardous waste and electronic waste items in our study, carbon emissions due to travel outweighed the expected benefit of recycling," says Ratti.

Nor are properly managed landfills all bad. Heijo Scharff, Netherlands-based chair of the International Waste Working Group task group on sustainable landfilling, cites a recreational area at Spaarnwoude, in the Dutch province of North Holland. To create the park, instead of building expensive artificial hills, the public authority persuaded landfill developers to build a varied, natural-looking landscape from the trash.

The site is now one of the region's most popular destinations, transforming the residential areas around it. "People living next door to Spaarnwoude were once very concerned about the value of their property," says Scharff. "But when the park opened, their property value went up like crazy – suddenly it was a very attractive place to live."

Meanwhile, Staten Island's famous Freshkills landfill is being transformed from giant trash receptacle to nature reserve. When completed in 25 years, Freshkills Park will give New Yorkers hills and wetlands, creeks and rivers, hiking and biking trails in a landscape three times the size of Central Park. The transition could hardly be more radical, helping heal what Eloise Hirsh, the park's project administrator, calls a "psychic scar".

"People in Staten Island felt that the rest of the city of New York was dumping on them for 50 years," she says. Now, they can see that "a place that was so awful could become something so beautiful".

Closing a landfill is not cheap. Containment caps are needed to prevent water from infiltrating the waste, creating "leachate" that could contaminate surrounding water systems. Landfill caps cost from about $80,000 to $500,000 per acre, depending on local availability of materials to build them, such as clay. Systems to collect or destroy landfill gas add another $10,000-$20,000 per acre. Long-term operation and maintenance costs need to be factored in, too. "The production of methane and carbon dioxide slows but this is a very slow process," says Scharff. "It takes 50 to 60 years before it has significantly reduced and it can go on for 100 years."

However, landfills can be sources of income. Freshkills is harvesting and purifying methane from the decomposing waste. While it lasts, this can heat 22,000 homes and, sold to the US National Grid, it raises about $12m a year. And photovoltaic landfill covers are being developed that can turn these sites into solar power generators.

Some cities turn trash directly into energy, avoiding landfill altogether. In Amsterdam, 99 per cent of domestic and industrial waste is converted into energy that powers the city's trams, underground trains and streetlights, as well as 75 per cent of city households. Heat generated during the incineration process provides 12,000 homes with heating and hot water.

Materials that fail to burn during incineration are used, too. The city's waste and energy company, AEB, extracts metals such as iron, copper and aluminium and sends them to specialised recycling facilities, and turns what remains into a construction material for use in roads.

All this generates revenues for the city – the 1m megawatt hours of electricity AEB creates from 1.3m tonnes of waste every year is worth about €47m.

Carolien Gehrels, an Amsterdam City Council alderwoman whose responsibilities include waste management, believes waste should not be seen as a problem but as an opportunity. "That's the mind-shift we have to make," she says. "Our waste-to-energy plant is a money-making machine. So I always say garbage is gold."

Perhaps, then, this is the best approach as we struggle to manage rising mounds of trash. Recycling our waste will only get us so far. And even if all landfilling were to cease tomorrow, existing sites would still need managing. But while landfill dumps and waste incinerators have traditionally been mankind's dirty secrets, with new technology and clever ideas applied to them, much of what we throw away can become useful – and extremely valuable.

Smoke rings with a message

Designing a waste management centre is not a project that might attract many architects. Yet Bjarke Ingels, the young Danish architect causing a stir with his adventures in form and function, wants to create a trash heap like none other. He plans to combine a giant incinerator with a ski slope at the heart of Copenhagen.

The idea is that below the slopes, household and other solid waste will be turned into power to heat the city's homes. "Denmark has been developing the technology of waste incineration and power production since the 1950s and it's matured into a very clean, efficient technology," says Ingels. "This opens the possibility for something normally associated with trash and smoke to be fit for a park."

Another part of the plan is to provide Copenhagen's citizens – who now have to travel to southern Sweden to find mountains – with a ski resort at the heart of their city.

Meanwhile, the incinerator's chimney would be a compression chamber with a mouth producing a giant smoke ring whenever a tonne of carbon dioxide is released, turning pollution into a playful artwork that raises citizens' awareness of climate change (the idea being that improvements in technology would lead to fewer smoke rings).

While most municipalities have approved the project, Copenhagen's City Council has yet to vote on it. Several officials from Copenhagen's infrastructure and urbanism have argued against it since they believe it could raise emissions and argue that the incinerator's capacity should be reduced and the focus on recycling increased.

While the project's ultimate form is uncertain, Ingels argues that all pollution is a by-product that can be repurposed. "Waste is an unexploited resource," he says. "All you have to do is find out what it's good for and how to feed it back into the metabolism of the city."

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