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PLASTIC TACTICS

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Closing the plastic circle

Making plastic products from renewable sources could transform New Zealand from recycling laggard to a world leader. **by GLENDA LEWIS**

The new economy is circular. On June 13, Florian Graichen, a scientist from Rotorua-based Scion Research, badly jet-lagged and sweating in his best suit and tie, presented to the Ellen MacArthur Foundation's summit in London on "the circular economy".

The set-up was daunting. Blinded by a spotlight, Graichen stood on the end of a runway in the centre of the audience. He knew that somewhere out there was the global editor of *Vogue* and people from adidas, Google and other multinationals collectively worth the GDP of the world's ninth-largest economy, Brazil.

In good faith, he told the big-brand managers exactly what they wanted to hear – that there is an alternative way to make plastic that produces minimal waste, no greenhouse gasses and is powered by free energy from the sun.

The circular economy is the new buzz term. It means there is no net loss of constituent materials in what we make, so we are not constantly mining them from the Earth and producing irretrievable waste and pollution.

What Graichen is talking about is a circular bio-economy – one that mimics nature, which recycles everything. The idea is to move our entire economic base from fossil fuel-derived materials (including plastics such as polystyrene, synthetic fibres and washing liquids) back to renewable biological sources such as algae, wood, bark and other plant fibres (hemp, flax, bamboo, corn husks, wheat stalks and kiwifruit skins), using bacteria as the processing agent.

"Everything that is made from fossil-based materials

today can be made from trees tomorrow," says Åsa Ek, chief executive of Finnish cellulose technology company Cellutech.

The Ellen MacArthur Foundation exists to promote the transition to a circular economy. European countries have dedicated ministries to prepare the way. Scion, a Crown research institute, is drawing on 70 years of forest and natural-fibre research to help make the new circular bio-economy happen here.

Scion envisages several flexible bark bio-refineries that will use a series of mechanical, chemical and biological processes to deconstruct the bark into polymers for plastics, high-value molecules and chemicals, and solid fuel to power and heat the plant.

Graichen estimates that 15 such plants could bring in \$500 million a year and create 3000 jobs, contributing \$1.8 billion in GDP. The refineries would be built next to sawmills or collection yards where logs are de-barked for export – enlivening struggling forestry towns – or near where consumers

of the refinery products are located.

Bark naturally repels water and can provide lightweight materials such as corks used in wine bottles. Its waterproofness also lends itself to a diverse range of products, from paper cups to touchscreen coating. The market for water-repellent polymers is dominated by petrochemicals, but given an informed choice, consumers could be expected to flock to biopolymers if they did the same job at a similar price.

Two weeks after his June presentation, Graichen was in Wellington – again in his best suit and tie and still getting over his jet-lag – economy, of course – to speak

"Everything that is made from fossil-based materials today can be made from trees tomorrow."



1. Florian Graichen.
2, 3 & 4. Wood fibre composite products used to replace or reinforce traditional plastics. 5. Chess pieces made from bio-based plastic composites. 6. Elspeth MacRae.



to a handful of MPs on their dinner break, including Associate Environment Minister Eugenie Sage.

It had already dawned on Sage that a main plank of the Government's climate action plan – the planting of an extra 500 million trees – might, in parallel, grow a new industry that would spin export gold from wood and bark, create high-value jobs and solve our plastic-packaging problem into the bargain.

Bark's waterproofness lends itself to a diverse range of products, from paper cups to touchscreen coating.

THE WOOD FOR THE TREES

Graichen told the MPs that unless there is intervention, the production of plastics will contribute more than 15% of global greenhouse-gas emissions by 2050. The amount of plastic is projected to quadruple in volume by then, thanks to the fast-growing proportion of middle-class consumers.

There is no shortage of horror statistics on plastic waste. Only 9% of all the plastic ever produced globally has been recycled; 12%



Convex New Zealand chief executive Owen Embling; the firm's compostable packaging.

has been burnt, releasing carbon dioxide and toxic chemicals; 74% has accumulated in landfills and in the sea.

Scion's head of innovation and science, Elspeth MacRae, says, "Waste is in everyone's face and has forced the attention of the public."

The infrastructure for recycling in New Zealand is patchy, and what we do have is underused. A lot of recycling ends up at the tip because it is contaminated with broken glass, food and other mess.

We made it China's problem until it banned the importation of plastic waste in January 2018. This month, Indonesia rejected several containers of New Zealand plastics.

Our councils have varying systems and capacities to collect plastics, which add to confusion about what can and cannot be recycled and composted. People become disillusioned when they learn that products they thought were being recycled or composted have ended up in landfills.

Plastic sheet and packaging manufacturer Flight Plastics recently bought a European process to its Lower Hutt plant to recycle clear PET plastics (predominantly soft-drink bottles, meat trays, berry containers and the

like), but can't get enough of them. Flight is the only company in New Zealand recycling domestic PET, paying suppliers the equivalent export value for what it receives. Its capacity is 8000 tonnes a year, about a third of the clear PET we use and far more than is recovered.

A \$7 million recycling plant to be built

People become disillusioned when they learn that products they thought were being recycled end up in landfills.

in Auckland by Australian packaging company Pact Group, with a \$3 million subsidy from the Government's Waste Minimisation Fund, will convert 10,000 tonnes of PET a year into food packaging, including meat and bakery trays. The company would prefer to source PET locally, but until our recycling recovery rate improves, it will import PET waste from overseas.

Traditional physical recycling typically

processes only type 1 PET plastic such as soft drink bottles and type 2 HDPE plastic such as milk bottles. The next challenge is to deal with all the other plastic types that make up the majority of "end-of-life" plastics.

Australian company Licella has patented a chemical recycling process to transform plastic into its chemical building blocks, enabling the constituents to be used over and over. It has just signed a memorandum of understanding with New Zealand pulp, paper and packaging giant Oji Fibre Solutions to investigate the technology's potential here. And industry association Plastics NZ is involved in moves to recycle type 5 polypropylene plastic such as ice-cream containers in New Zealand.

A RECEPTIVE AUDIENCE

Plastic is so cheap it has resulted in extravagant wastefulness, such as the now-banned single-use shopping bags. Its use is deeply embedded in many manufacturing systems. Change can be difficult and expensive, and many manufacturers are stuck for a replacement.

But the sudden fierce consumer and media reaction against it is a wake-up call. Market-research firm Colmar Brunton says that

Right tree, right time

As with forests, plastics made from tree products absorb CO₂ from the atmosphere.

In July, scientists from the UN's Food and Agriculture Organisation and Swiss technological university ETH Zurich identified nearly a billion hectares of marginal land worldwide as suitable for tree planting. Up to 1.2 trillion trees could be planted on this land, which could result in the storage of about two-thirds of the carbon that humans have added to the atmosphere since the 1800s.

New Zealand's planned one billion trees could contribute to this goal. After Ethiopia planted 350 million in 12 hours on one day (July 29), these numbers seem more achievable.

Scion's head of science and innovation, Elspeth MacRae, says that beyond carbon capture, we need to establish what a tree's end use will be. That will determine the type of tree we plant – both natives and exotics will have their place. Some could be left for permanent erosion control and to assist biodiversity; some could be logged; and some used to make bioplastics. The last category of trees could be felled and replanted in a seven-year cycle. "The key thing to remember is that plastics made from trees, bark and other biological feedstock absorb carbon dioxide from the atmosphere rather than adding to it. And they will readily decompose, because the bacteria will 'recognise' the molecular bonds they need to attack to break them down and digest them."

Ethiopia aims to plant four billion trees this year.

the buying decisions of three-quarters of Kiwis are influenced by packaging.

Owen Embling, chief executive of Hamilton company Convex New Zealand, has been making customised, home-compostable (it doesn't need high temperatures to decompose) wood pulp and GM-free corn starch-based packaging products, such as coffee bags, for more than 20 years. He says more companies are knocking at his door. Scion is also fielding approaches from businesses looking for sustainable product and packaging solutions.

Rachel Brown, founder and chief executive of the Sustainable Business Network, is running seminars in Auckland with representatives from the plastic packaging sector, including government agencies, suppliers, manufacturers and materials experts. "I could run these around the country, but

"We could become a world leader and exporter of new, well-designed bio-materials."

we are constrained financially," Brown says. "The whole plastics and packaging system needs a complete reboot."

The big brands are jumping on the bandwagon. On July 31, Coca-Cola announced that by the end of this year, all plastic bottles smaller than one litre and water bottles of all sizes will be made in New Zealand from recycled plastic sourced overseas.

The 6 Rs of the plastics circular economy

REFUSE
REDUCE
REUSE
RECYCLE
REDESIGN (products and packaging)
RENEW (the product and packaging are made from sustainable sources and all constituents can be recovered and reused without loss of quality, or are compostable)

Asked why the firm won't be using locally recycled PET, Coca-Cola Oceania general manager Richard Schlasberg says that is the company's preference but "there is no recycled plastic produced in New Zealand that meets our specifications".

"We hope that by using 2900 tonnes of rPET [recycled PET] in our bottles, we will create the demand for manufacture of this high-quality rPET in New Zealand."

EDIBLE PLASTICS

It's not that there is anything intrinsically wrong with plastic – it is lightweight, strong, washable and cheap to produce and transport. "Plastic isn't the problem," Erik Solheim, the former head of the United Nations Environment Programme, wrote in a 2018 report. "It's what we do with it. And the onus is on us to be far smarter in how we use this miracle material."

MacRae agrees. "Without lightweight plastics, humans would not be airborne or have landed on the Moon, and cars would be very much heavier and less energy-efficient," she says.

"With bioplastics, we can have our cake and eat it, too. It will be a form that can either be recycled in perpetuity or fully decomposed by bacteria. Some bacteria make polymers – a term for the carbon and hydrogen molecules that characterise plastic and fossil fuels. It's their way of storing energy, just as we use glycogen and plants use starch. These and other species of bacteria can also eat the new bioplastics, releasing carbon dioxide and water, which are then reabsorbed by plants and algae in a continuous energy and material loop.

"In short, we've got the science; now we have to work on scaling it up and, together with government and industry bodies, support manufacturers to take safe baby steps into trying these new bio-based materials.

"There will be costs upfront, but it will pay off in the long run – for everyone. We will design plastics that can fit into existing recycling processes, such as the one used by Flight Plastics."





1. Juliet Gerrard.
2. Erik Solheim.
3. Harry Burkhardt.
4. Richard Schlasberg.
5. Jeremy Jurgens.



Packaging NZ president Harry Burkhardt has been in the plastic-recycling business for more than 20 years, with plants in Pakuranga, Ashburton and Melbourne. Whether we have fossil-fuel or bio-based plastics, he says, we're going to need systems that separate recycling streams at source from households and businesses.

In Scotland, all interested parties got together to work out the best system for plastic recycling and concluded it should all go into "the one basket", which could be collected at the kerbside and sent to a processing centre. An "advanced plastics recycling facility" is planned.

NEW ZEALAND'S ADVANTAGE

MacRae says New Zealand's recycling protocols definitely need work but are only part of the answer. In the "six Rs" of plastic-waste reduction, refuse, reduce and reuse come before recycling.

"The public and the media have certainly started to embrace these and the level of interest is getting everyone moving. This is something practical we can all rally behind to help limit climate change.

"New Zealand has a big advantage in the shift to a circular bioeconomy. We have land and grow plants and trees well. We don't have much existing infrastructure to

render redundant and so cause resistance to change.

"We could become a world leader and exporter of new well-designed biomaterials. If we can make money out of shipping raw unprocessed logs, we can certainly make money out of a range of custom-made packaging that is light and sustainably pro-

"If we can make money out of shipping unprocessed logs, we can certainly make money out of custom-made, sustainable packaging."

duced and doesn't cause a nightmarish toxic rubbish problem.

New Zealand has an opportunity to move its plastics importation bill to the positive side of the ledger, MacRae says.

"There is huge export potential lying on the pine plantation floor – millions of tonnes of wasted bark, set to double with the Government's planting programme.

"And a ban on methyl bromide use without recapture or destruction of emissions by October 2020 means that only debarked

logs will be able to be exported. At present, only small amounts of bark are collected for boiler fuel, potting mix and mulch."

The Ministry for Business, Innovation and Employment has given Scion \$10 million to develop the bark bio-refinery concept, and Sage has asked the agency to "build a roadmap" for a new plastics economy – government-speak for a plan. The minister also wants more information about how materials such as compostable plastics, laminated materials and paper degrade. "We want to ensure that products labelled as compostable don't contain elements such as microplastics that cause contamination issues in the final product."

PLAYING CATCH-UP

The Government has made plastic and landfill waste-reduction a priority. Colmar Brunton reported that plastics were the No 1 public environmental concern for New Zealanders. Prime Minister Jacinda Ardern has received more letters from concerned children about plastic than any other topic.

Reforms in the pipeline include improved kerbside collection and processing systems; standardised council contracting systems; proposed increases and extensions to the landfill levy; a regulated product stewardship scheme making producers responsible ▶

Energy from waste: burn or digest?

Different approaches to converting waste to energy have differing fortunes.

Plans to build a waste-to-energy plant on the job-hungry West Coast have not gone smoothly. Buller ran the idea out of town; now Hokitika promoters are failing to sell the already politically blighted scheme to the town's citizens. Renew Energy's proposed \$260 million plant would take train- and truckloads of general waste from a contractor in Christchurch and burn it to generate enough electricity to power the region. The company says the technology is low-emission and is used safely around the world.

"Westland, not Wasteland", argue objectors, unimpressed by the prospect of a new industry that could involve hundreds of trucks that at present return to the West Coast empty – but would create tonnes of ash to dispose of and mar the region's scenic image.

In Sweden, burning waste has worked

"A waste-to-energy plant is a beast with a big appetite, and that may be an incentive to continue as we are."

well as part of an advanced integrated waste system, which has high rates of recycling. The country has matched its energy output with commercial and residential demand for heat and electricity to extract much greater efficiency from the scheme.

"Burning waste and getting some return from it may be preferable to badly managed, overstuffed landfills leaking chemicals and rubbish into the environment and giving off methane and carbon dioxide," says Scion's Florian Graichen. But only as an interim solution.

"If you are trying to build a circular economy, burning waste is the very last resort. You first do everything you can to reuse, upcycle, recycle and redesign products to avoid waste or find renewable



Ecogas director Andrew Fisher; a newly opened anaerobic digestion plant in England.

alternatives.

"Once you have built a multimillion-dollar waste-to-energy plant, it will be a beast with a big appetite, and that may be a strong incentive to continue on as we are, instead of investing in a proper redesign of the system."

The Westland community has already seen the catastrophic result of an old and insecure landfill collapsing in an extreme-weather event. The type of plant proposed would burn dry waste, including plastic packaging.

At Reporoa in the Waikato, Ecogas plans an anaerobic digester plant that will take source-separated food waste, such as orange peels, banana skins, tea bags and rotten sandwiches that cannot be diverted to food-rescue programmes or stock feed.

Paul Bennett, science leader of clean technologies at Scion, says the plant is "a fundamentally different process" to waste incineration.

The waste streams are blended to



create a "feed", which is pumped into a controlled oxygen-free tank. Inside the tanks, micro-organisms convert the waste food into biogas, which is 60% methane and 39% carbon dioxide (CO₂). It is an alternative to the fossil fuel-derived natural gas comprising 90% methane and 9% CO₂, that industry and households receive in the North Island.

Anaerobic digester plants are tried-and-true technology. There are more than 2000 in Europe, including in Sweden, with many facilities more than 30 years old. Scion has helped Ecogas test and prove the technology.

The Reporoa plant is co-funded by Ecogas (created by community-owned power generator Pioneer Energy and Auckland firm Ecostock) and a \$7 million loan from the Provincial Growth Fund. It will be built next to T&G Global glasshouses, which can use heat, electricity and biogas from the plant.

Ecogas director Andrew Fisher says the plant will sequester 3500 tonnes of carbon a year, the equivalent of 546ha of trees or annual planting of 218,400 trees.

Most of New Zealand's food waste at present goes to the 134 landfills throughout the country. The company is talking to local businesses, iwi and councils about sourcing additional food waste to add to that already committed.

Fisher has spent more than two years operating a pilot anaerobic digester plant in Wiri, Auckland, with the support of the Bio-Processing Alliance. "It has been a 12-year process to get to this point."

He says this country needs to be open to all pathways if it is to meet its zero-carbon targets, "and it starts by piloting real-world science here in New Zealand".

He sympathises with what proponents of the waste-to-energy plant on the West Coast are trying to achieve but thinks they've gone about it the wrong way.

"To date, the West Coast communities have not seen the science proven in a safe pilot-scale operation or seen the results in a local context, so community confidence has not been established. It's not surprising that the reaction has been negative.

"As well as the lost productivity and business growth, the carbon footprint of all those empty trucks returning to the Coast remains."



for end-of-life disposal of problematic goods such as tyres and agrichemicals; and a "recycle right" public-education campaign.

Last month, the Government committed funds towards a container refund scheme, to be finalised by August next year. Many countries, including Australia, have introduced schemes in which a small deposit is added to the cost of containers and refunded on collection.

It has also earmarked \$40 million from the Provincial Growth Fund to invest in projects that convert and reuse waste products.

Another task is to find an alternative to the billions of fruit and vegetable branding stickers that cannot be recycled. Consumers often complain about these and query the need for them in the first place. In fact, Convex has already designed and made bio-stickers, but the fruit industry is reluctant to use them because of warranty issues with the US-designed and maintained sticker machines.

Juliet Gerrard, the Prime Minister's chief science advisor, has set up a Rethinking Plastics Project to provide evidence to guide policy.

"We've got plenty of information now about the scope of the problem internationally but a startling lack of data about New Zealand," Gerrard says.

The issue needs to be attacked on multiple fronts, she says. "As well as investigating recycling and bio-based technologies, we have psychologists on our panel with insights into how to inspire cultural transformation.

"What works in other countries may be

Flight Plastics chief executive Keith Smith, left, and director Derek Lander.

quite impractical and uneconomic here because of our small population and long, physically divided country.

A STARTER'S CHANCE

Based on international studies, 99% of the 250,000 tonnes of plastic sent to our landfills each year could be diverted through improved product design, product reuse and recycling. There is intense excitement, but also measure, in Graichen's voice when describing our dream green future.

"We have 10 years to turn things around. When President Kennedy announced that the United States was going to the Moon, the technology to make it happen did not

exist. In less than 10 years, they were lowering the landing gear.

"We have a goal of similar dimension, and the same timeframe – the difference is that this goal is of existential importance and we are actually further ahead with the science at the start."

The World Economic Forum shares Graichen's optimism. It has rated bio-plastics No 1 in its top-10 list of emerging technologies. Making the list involves more than promising major benefits to the world, says Jeremy Jurgens, the forum's technology chief.

"The emerging technologies must positively disrupt the existing order, be attractive to investors and researchers and expect to achieve considerable scale within the next five years."

"We have 10 years to turn things around. This goal is of existential importance."