Syngas: A Transformative Technology for Waste Circularity

Single-use plastics aren't the problem; viewing mechanical recycling as the only solution is. The Consortium for Waste Circularity says advanced recycling waste-to-syngas technology has the potential to fundamentally transform waste handling.

CONSORTIUM
FOR WASTE CIRCULARITY

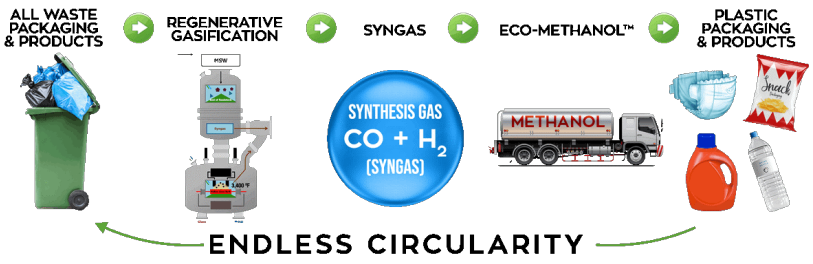
As brand owners large and small struggle to meet ubiquitous sustainable packaging goals for 2025 centered around recyclability and the elimination of single-use plastics, the Consortium for Waste Circularity (CWC) is proposing that they not just "think outside the Blue Box," but that they get rid of the Blue Box altogether.

That was the message conveyed in an educational webinar hosted by CWC in November, "The Future of Packaging Circularity: Creating a sustainability strategy with a circular approach." The CWC, whose founding members include packaging material suppliers, the Flexible Packaging Assn. (FPA), and others, is aligned around creating a world where waste is treated as a valuable resource that can be converted to feedstock for virgin materials. For CWC, this means employing technologies beyond mechanical recycling. Instead, it advocates for investment in and support of robust and flexible science-based solutions, primarily the production of syngas from mixed-waste and difficult-to-recycle packaging.

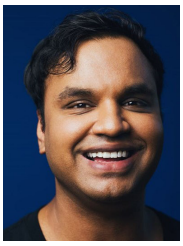
Syngas is a highly versatile feedstock used in the production of chemicals that include methanol, a primary component of plastics. "Plastics produced from syngas are 'virgin plastics' with the same quality and properties of plastics produced from fossil fuels," explains the CWC website. "Waste-syngas-methanol-products/plastics offers a true pathway to the circular economy sustainability."

During the webinar, speakers explained why:

- Traditional mechanical recycling is not the answer to the U.S. packaging waste problem.
- Eliminating single-use plastics because they are not recyclable ignores their many and more-advantageous upstream sustainability benefits versus other packaging materials.
- Suppliers and brand owners must collaborate to promote transformative solutions for packaging waste circularity before they become locked into misguided policies based solely on the use of mechanical recycling technology.
- The use of Regenerative Gasification to produce syngas allows for the most robust variety of feedstock and results in the greatest product versatility.



The Recycling Paradox



According to Dr. Calvin Lakhan, a member of the Faculty of Environmental Studies at York University, Toronto, Ontario, Canada, and a member of the CWC Academic Committee, when it comes to recycling, by having done such an effective job in communicating the importance of recycling to the public, we have become the victims of our own success. “Both households and policymakers now conflate recycling with sustainability,” he told webinar attendees. “If it can’t be recycled, it’s considered bad.”

In fact, he shared, in a study conducted in 2019 by York University to understand the public’s sentiments around various end-of-life waste management initiatives, recycling was ranked as the number-one most effective end-of-life solution, followed by reuse, then composting, and then reduction. “Why is this so problematic?” he asked. “Well, largely it’s because reduce, reuse, recycle isn’t just a catchy phrase, it’s the order in which we’re supposed to do things. Recycling is our third-most-preferred option.”

Given the prevailing perception that recycling is the best route to packaging sustainability, there has been a push within the packaging industry and by policymakers to replace single-use plastics with other materials and focus on investing in the mechanical recycling infrastructure and on developing markets for recycled materials, using Extended Producer Responsibility legislation as a lever. But, Lakhan said, the Canadian experience with EPR for printed paper and packaging waste has been a miserable failure. “The outcome of this approach has been an enormous bill with extremely questionable environmental outcomes,” he said. “For context, the cost of operating Ontario’s Blue Box recycling system has almost tripled in the past 15 years, while recycling rates have actually remained largely unchanged, even declining year over year for the past five years.”

He posited that the reason for this is because Ontario’s existing waste management system is not configured to recycle lightweight, multi-resin plastics, which are increasingly making up a larger share of the overall waste stream. As a result, Canada has even banned some single-use, multilayer plastics. The thinking is, “after all, if we can’t recycle it, why should we be using it?” he said.

However, a fixation on recycling fails to consider the many upstream benefits of lightweight, flexible, single-use plastics, he explained. Primarily, packaging made from lightweight plastics uses less material, thus meeting the most-preferred waste management strategy: Reduce. As Lakhan outlined, the lighter weight of single-use plastics versus materials such as glass or paperboard results in logistical efficiencies, reducing the amount of GHGs emitted during transport, and its ability to provide greater durability and a longer shelf life allows for discretionary consumption by the consumer, which in turn reduces food waste.

To reap the upstream environmental and economic benefits of lightweight, single-use plastic packaging while at the same time ensuring it never becomes waste, Lakhan said he likes to tell people, “We need to start thinking outside of the Blue Box.” He added, “It’s important to recognize that we have more tools in our toolbox than just mechanical recycling. Both companies and legislators continue to look toward mechanical recycling as the solution to our packaging waste problem. But isn’t insanity trying the same thing over and over again, expecting a different result? We’ve done it [mechanical recycling]. We’ve tried for the better part of 30 years, and we’ve done an amazing job. But it’s simply not working anymore.

“When we look at proposed [EPR] legislation put forward in states such as Oregon, Maine, and New York, it’s forcing a mechanical recycling solution, and I can’t imagine why we would achieve a different and preferable environmental outcome, given the experiences we’ve had in Canada.”

While mechanical recycling has its place in a sustainable waste management system, it’s not the be-all and end-all, Lakhan concluded. “As a result, we need to embrace alternative forms of recovery, such as syngas, and increase awareness surrounding it and why it should be used and when it can be used.”

Syngas offers a transformative path to circularity

According to Dr. Bruce Welt, a Professor of Packaging Engineering at the University of Florida and a member of the CWC Academic Committee, unlike traditional reduce, reuse, recycle strategies, which offer incremental advantages, syngas has the potential to fundamentally transform waste handling. "Syngas is an advanced downstream end-of-life process that takes materials and makes them available for new manufacturing," he explained. "In this way, we have to have to think differently about waste handling and think of it more in terms of manufacturing."

With the current industry mindset, upstream changes in packaging are often made more for marketing points, rather than to create real impact, Welt noted. For example, in the case of Keurig Dr Pepper, a switch to polypropylene from polystyrene for its coffee capsules sounds like a sustainable win. But, in order to recycle the package, consumers must peel the lid from the capsule and empty the grounds, a process that requires diligence from the consumer and has resulted in the development of more materials in the form of tools that can be used to dismantle the capsules. "And, at the end of the day, if you speak with the material recovery facilities, regardless of whether you dissect a K-cup or not, they will say, 'It's too small. It goes through the screens and ends up in a landfill anyway,'" Welt said. "What's the benefit there?"

Another example he shared of erroneous attempts to create more sustainable packaging would be companies that switch to biodegradable materials. "If biodegradable materials end up in landfills, which most of the material will, they will degrade anaerobically and generate methane, which is a very potent greenhouse gas. Moving to a biodegradable package and putting it in a landfill is ultimately going to be worse than using traditional plastics. These things are individual, they're short-lived, and they're not really improving the situation."

Instead, Welt suggested that the greatest gains can be realized by looking downstream—at an advanced recycling infrastructure that is more robust and where the benefits can be quantified because "we know how much material we're taking in."

There are several advanced recycling options that can be used for packaging waste. Among them are depolymerization, which is a process used to chemically recycle PET. While effective, it can only be used with PET and only produces virgin PET, "so it doesn't solve the complexity that we're dealing with in the marketplace right now," explained Welt. Another technology, solvent recovery, uses specific solvents to dissolve different substrates. The need for different solutions for different materials is one drawback, another is the issue of the solvents themselves. "Drawing a box around these processes and where the solvents come from becomes kind of shady," noted Welt.

Another process outlined by Welt is pyrolysis/cracking, which results in a char product, pyrolysis oil, and synthesis gas. If the material being pyrolyzed is exclusively biomass, the char is usable; if mixed waste is used, then the char becomes waste. In addition, the pyrolysis oil needs to be refined, meaning the yield, in terms of conversion of waste into new recycled content, is relatively low. "What we end up having to do is mix that pyrolysis oil from waste in with fossil material, so the contribution in terms of recycled content gets diluted—we're talking single digit-type numbers," he explained.

Another process that is well established is gasification, which uses carbon-based materials to produce synthesis gas for use by major chemical companies, such as Eastman Chemical. "They've been gasifying coal for the purpose of making synthesis gas, which we could use to make primary feedstock chemicals that go into plastics and all kinds of other things," said Welt.

But the mission of CWC is to take gasification one step further, to create an advanced recycling process that offers the greatest feedstock robustness and product versatility in the form of Regenerative Gasification. Explains the consortium website, "Regenerative Gasification is a process that achieves higher temperatures than

gasification, in excess of 3,400 °F. At such temperatures, organic chemical bonds are broken, and inorganic materials are melted down. Carbon-rich organics are primarily converted into synthesis gas ('syngas'), comprised mostly of carbon monoxide and hydrogen. Metals and inorganic oxides (i.e. glass/metals) are melted down and recovered as ingots and glassy materials. All products become feedstocks for subsequent value-added commercial applications."

It adds that syngas is a highly versatile chemical feedstock. "There is nothing that can be made from fossil fuels that can't be made from syngas. Ideally, syngas will be converted into feedstock chemicals such as methanol, ethanol, dimethyl ether, acetic acid, etc. to be used for subsequent synthesis by the chemical industry."

Feedstock for Regenerative Gasification can include any type of mixed-waste packaging, including multilayer plastic materials, shrink labels, adhesives, packaging contaminated with food waste, and other hard-to-recycle materials. "It doesn't matter if there's a metal fitment, if there's foil or metallization, the process can handle all of these things, and the primary output would be synthesis gas," said Welt. "This type of a robust process would simplify the collection of our trash, because we would not only be able to think outside of the Blue Box, but we could also get rid of the Blue Box. We could truly do single-source collection. And then, what we would do is change the idea of sorting—we'd be selecting, not sorting. We need to really think of it that way. When we have a robust process that can capture everything, it doesn't mean we have to, there are healthy recycling markets for many of the materials in there [the Blue Box]. We could be much more selective about what we're pulling out of the waste stream, which would enhance the value of the mechanical recycling we're doing now."

The remaining materials would then be recycled via Regenerative Gasification to produce syngas. Explained Welt, "The first simple molecule we can make from syngas is methanol. Methanol is essentially a fungible primary feedstock chemical that chemical companies use to make virtually everything. There's not a chemical company in the world that would say no to a truckload of methanol that was produced from waste and counts as recycled content."

This Eco-Methanol™, explained Welt, "is the vehicle that will carry recycled content back into the circular economy."

A shared vision is essential for progress

Currently gasification is being done all over the world. In Asia, coal is used as feedstock; in Europe and North America, it's natural gas. Among the industries competing for a piece of the syngas pie are the airline industry for jet fuel, the auto industry for fuel cells, and the agricultural industry for fertilizer.

Advised Welt, "The point here is that the packaging industry needs to recognize that there's competition for the waste, and so we have to have a shared vision that if infrastructure is going to go in, the syngas gets converted into methanol, and that is our best hope for gaining that recycled content."

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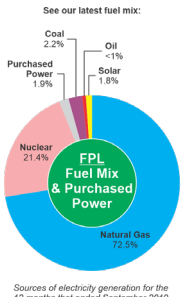
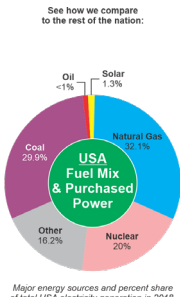


Sources of electricity generation for the 12 months that ended September 2019.



Major energy sources and percent share of total USA electricity generation in 2018.