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Stockholm's Ingenious Plan to Recycle Yard Waste

Discarded Christmas trees will be transformed into plant food, biofuel, and carbon sinks—but that's just the beginning.

Feargus O'Sullivan /@FeargusOSull / Dec 20, 2016

Jonas Dahllöf holding a handful of Stockholm's new biochar product. (Kari Kohvakka)

Does your heart bleed a little when you see an abandoned, balding Christmas tree wasting away on the curb? If so, your holiday cheer might last a little longer knowing that a project taking root in Stockholm could make those withering pines truly useful to the very end.

Instead of tossing trees into the shredder, the city is launching a program this month to collect them and turn them into an environmental workhorse known as biochar. This charcoal product can be mixed into soil to greatly improve its drainage and nutrient levels, spurring vibrant growth for more plants. Meanwhile, the heat created by the charcoal-making process will be siphoned off and fed into the city's district heating system.

So far, so great. But while the idea of Christmas trees re-entering the soil and helping new trees to flourish is delightful, it's only the tip of the iceberg here.

That's because Christmas trees are just among the first sources of green waste to be used in what could be one of the most ambitious, potentially influential projects coined by a European city thus far. By bringing together the parks department, the city's waste disposal service, energy providers, and urban gardeners, Stockholm's biochar project will create a virtuous cycle so ingenious—and ultimately so simple—that it could provide a template for cities across the world.

It's a plan whose genesis and workings deserve close attention. And arguably none of it would have happened quite the way it has if not for a Stockholm civil servant's daily train commute. The story of how the plan developed starts around a decade ago...

Trees growing along the streetcar tracks in suburban Stockholm. (Hec Tate/Flickr)

Saving Urban Trees

In the mid-2000s, Stockholm's Tree Officer (yes, they have such a thing) Björn Embrén found himself poring over a persistent problem. Stockholm may be a well-run, attractive city for humans, but if you're a tree, it sucks. Paving over ground with non-porous

surfaces such as concrete and asphalt has caused the city's groundwater level to drop, while constant vibration from traffic and construction has caused the soil to partly compact. This can leave tree roots starved of water and oxygen, a process that is common in many urban areas. Certainly, if you wander through Stockholm, the city by no means comes across as a leafless desert. But many trees reach a certain modest size without ever growing to their full potential.

Except in a few places, that is. Looking out of his train window one day, Embrén noticed that trees growing along the train tracks seemed to be doing a whole lot better. In fact they were flourishing, looking taller and lusher than elsewhere—but why?

According to Embrén's colleague and collaborator on the project Jonas Dahllöf, head of planning and development in the city's waste disposal department, the answer turned out to be the gravel lining the tracks.

"In soil that was covered with gravel, Björn saw some really remarkable growth." Dahllöf told CityLab. "He realized that this is really what city trees need—a very aerated soil matrix that does not become compacted over time."

It seems that the looseness of this soil was what improved growth. Vibration may cause gravel to shift under the train tracks, but it doesn't compact it, meaning that trees planted beneath it had far better aeration and more moisture.

Embrén and his colleagues started helping city trees with a new type of soil covering that proved effective in stimulating growth: crushed bedrock on top of sand, clay, and peat. By making the ground more porous, this substance also helped the ground absorb more stormwater, creating an urban soil management process that has already gained some renown as the so-called Stockholm Solution.

Later on, they started trying out charcoal as a variant of this mix, with dramatic results. Over the course of a two-week summer vacation, a patch of lawn strewn with the stuff by Embrén grew at an almost alarming speed, to become a kind of whispering Jurassic savannah. As Dahllöf explained to CityLab, this charcoal had an almost miraculous effect on the soil, acting "like a coral reef."

"Just as the surroundings of a reef start to teem with life, so does the soil around the charcoal. Valuable fungus, bacteria and microorganisms start to flourish, creating a real concentration of organisms that are useful for healthy soil," he says. "The charcoal also functions like a sponge. It can hold nutrients, and hold moisture in the earth right up until the surrounding plants need it."

The effectiveness of this process was great news for Stockholm's trees. But digging in peat, sand, and charcoal still meant the city was using finite and thus non-sustainable resources—a B+ solution at best. Stockholm managed to find a better way partly thanks to an unusual quirk of its administration. Until recently, both the

parks and waste disposal services worked under one umbrella, in the city's transit department. This meant that Embrén and Dahllöf just happened to be working in offices a few doors down from each other.

A notice promoting energy company Stockholm Vatten's Christmas tree recycling project.
Stockholm Vatten

Turning Waste Into Heat

While Embrén was worrying about urban trees, the city's waste department had its own problem, albeit one of a more obviously First World variety. Dahllöf and his colleagues were exploring what they could do with green waste collected from the city's gardens. This being Stockholm (named the first European Green Capital in 2010), they'd already come up with a pretty good, sustainable answer. The plant waste the city collected was shredded, then sold as a biofuel that went into green energy production.

This was already a better solution than most cities manage. But when Björn Embrén complained to Dahllöf about the difficulty of getting sustainably produced charcoal for soil improvement, Dahllöf saw an opportunity to make the city's green waste disposal even more environmentally beneficial. The result was the biochar project, whose concept has been steadily refined between becoming a finalist in the 2014 Bloomberg Mayor's Challenge and the project's actual launch of biochar production this month. Together with energy and waste disposal company Stockholm Vatten, the departments have created a charcoal production facility, one whose by-production of heat will also fuel the centralized district heating facilities that provide warmth and hot water to nearby homes. (These facilities account for around 60 percent of Sweden's energy needs.)

The production process works like this. Stockholm's biochar is made by pyrolysis, the process of burning fuel in a nearly oxygen-free environment. Heated up to 800 degrees

Celsius (1,472 Fahrenheit), half of the garden waste becomes carbon-rich, durable biochar, while the other half becomes a pyrolysis gas. In order to keep the conversion process running, this gas itself is also burned. In an ingenious twist, the heat from the burning gas doesn't go to waste: it's used to boil water that is channelled into the local district-heating system.

Biochar being reintroduced into the soil in a Stockholm garden. (Kari Kohvakka)

Using the gas this way does re-release some of carbon dioxide that the plants absorbed when they were alive, but it's far less than what would be released if the plant waste was just incinerated by conventional means. Even that method is a carbon-neutral process, releasing no more of the stuff than the plants absorbed during their lifetimes. And so, with this new process, an already carbon-neutral energy source has been upgraded into something even more environmentally beneficial: a powerful way to pull carbon out of the atmosphere.

Even during trials, the city saw spectacular results. The pilot plant burned 1,200 tons of green waste, trapping carbon equivalent to the annual emissions of 700 cars, Dahllöf says.

"And that's before you take into account the heat and hot water we created, which was enough to supply 80 apartments," he says. "When we are at full capacity, we should be processing five times that amount of waste, which means we'll be taking the equivalent

of 3,500 cars away from the streets, emission wise, and supply heat and hot water for 400 apartments."

Stockholm hopes to close this circle by encouraging garden owners themselves to pick up bags of the resulting biochar and reintroduce it into the soil in their gardens. Other final destinations include the city's many public green areas—indeed, the demand for the charcoal is expected to far outstrip actual production.

Stockholm's current limits don't necessarily have to be the world's limits, however. Dahllöf notes that the city's energy partner is interested in using the project as a prototype for district heating plants elsewhere. These plants could provide ultra-clean green power using the byproducts of agriculture or forestry—a major industry in Scandinavia—providing a char that could then be dug back into fields or forest floors to boost fertility.

Already the concept has spread beyond Sweden and across the Atlantic. California officials have already been in touch with the Stockholm project and have bought the equipment necessary to make their own experiments. The state's priorities are slightly different, though, Dahllöf says. In a region vulnerable to droughts, the Californians seem to be especially interested in biochar's ability to lock slow-release moisture into the soil, reducing the need for irrigation.

California's different tack shows how the combined biochar and energy production process could prove influential far beyond the confines of the Swedish capital. Stockholm Biochar may be starting small by freeing the city sidewalks of sad-looking Christmas trees, but the possibilities are oh so much greater.