Cities as Forces for Good

Insight

Growing Profits from Growing Rainbow

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Growing Profits from Growing Rainbow

A few months ago, we wrote a piece on Growing Blue to Grow Rainbow. We now attach some hard, monetary estimates to that earlier argument, to convey a rough sense of the cross-sectoral profit-benefit streams to flow from technological innovations in the water sector — Growing Blue, to Grow Rainbow, to Grow Profits, in other words. Our results are based on an analysis for London, UK.

To Recap: Growing Rainbow

Think of the metabolism of the city and its knot of tightly bound interactions and multi-sectoral intersections among the water, food, energy, and waste-handling sectors. Picture this as a knot of intricately interwoven flows of water, energy, carbon (C), nitrogen (N), and phosphorus (P) brought into the city, transformed there in the city's social and economic life, and flowing out, as "wastes" and economic goods and services.

Removing the quotation marks (" ") from "wastes" and re-branding them as resources or commodities is what our analysis is all about. How much money is there to be made from this? How much fertilizer and biofuel — and how many carbon credits — are recoverable from the metabolic "waste" in wastewater (from the food consumed). How much from the food not otherwise utilized? Or how much can be made, for that matter, from the exhaust gases and ash residues of fossil-fuel combustion?

We aspire to Growing Rainbow, quite specifically, from Growing Blue. We focus solely, therefore, on water-sector innovations, i.e., on technological interventions addressing the material-energy resources in wastewater.

Growing Blue: Water-sector Innovations

We take four innovations, assume that each could occupy 100% of its market niche in the metabolism of London, and compute the resulting annual flows of benefits, i.e.: savings in water consumption; generation of (renewable) energy within the water sector; and recovery of N-based fertilizer and P-based fertilizer. Today's market price for each commodity is used to calculate monetary value, i.e., profit potential. We likewise compute the accompanying value of carbon credits generated *inter alia* from the

recovery of the fertilizers within London, as opposed to their first-manufacture and first-extraction elsewhere. We do not account for any benefits to accrue from the costs avoided in the transport *not* undertaken to bring those fertilizers from remote locations beyond the city to relevant places for their application in agricultural-food production.

In short, we are assessing the monetary gains across the water, food, and energy sectors (Growing Rainbow) from interventions in the water sector alone (Growing Blue). The four technologies are: (i) urine separating toilets (UST), with subsequent production of the primarily P-based fertilizer struvite and the primarily N-based fertilizer of ammonium sulfate; (ii) consolidation and co-treatment of household organic waste (COW), based on the use of food grinders for kitchen organic waste and where recovery of C-based materials (as gases) is the primary goal downstream at the wastewater treatment plant; (iii) pyrolysis of separated sewage sludge, likewise downstream in the system, with a focus on the recovery of C- and P-based fuels and fertilizers; and (iv) algae production in wastewater treatment facilities (AWW), for the generation of biofuels, with the added benefit of removing CO_2 from the atmosphere.

Growing Profits

For the purposes of illustration, resource recovery valued at about $20M is generated under current arrangements for London, i.e., the present Business as Usual (BaU) (all figures quoted are an annual income). This return derives almost entirely from the production of biofuels and electricity. At the opposite end of the spectrum, were all four technologies to be implemented, in excess of $125M in potential additional revenue would accrue, along with nearly $250M in expenditure reductions, i.e., a total value of resources recovered or saved of roughly $375M.

The large reduction in expenditures is due solely to the introduction of UST, which by itself saves just under $250M in water not consumed with this device, together with just under $20M worth of energy (associated with the pumping not undertaken). In the scenario with all four technologies implemented, the energy savings from UST are balanced out by the additional energy expenditures required to operate the other three technologies, amongst which AWW and COW are relatively much more energy-expensive. This notwithstanding, AWW, COW and PSS, when implemented together (in the absence of UST) generate some $80M in revenues from recovered biofuels.

UST is by far the most promising innovation with respect to N-based fertilizer recovery and by far the single, best innovation in respect of overall performance in terms of profits and savings (in excess of $300M).

PSS would be the preferred choice for recovery of P-based fertilizer, opening up access thereby to revenues approaching $30M.

The most successful strategy in respect of generating C credits is that of introducing the triplet of PSS, AWW, and COW technologies. However, at the present very low price of just $1.4 per tonne of CO_2, the value of this benefit stream is a mere $0.9M.

In the bigger picture, we observe that net benefits in the energy and food (fertilizer) sectors are of the order of tens of millions of dollars, whereas savings in the water sector are of the order of hundreds of millions of dollars.

All these potential benefits do not come without their price, of course.

Barriers to Realizing Opportunities

In the case of London specifically, we note that COW would not presently be favored, because of the implied stress of its additional material flow on an already fully utilized sewer capacity. C recovery from the separation at source of fats, oils, and greases (FOG) would be preferred, although this (strictly speaking) would not then constitute an intervention in the water sector.

Besides cross-sectoral synergies, within-sector “antagonisms” can inadvertently be touched off. For example, being applicable far upstream in the wastewater infrastructure, the UST technology would leave significantly fewer nutrient resources for the far downstream AWW and PSS innovations to exploit beneficially. Elsewhere, COW — technically a mixed upstream and downstream intervention — would benefit both AWW and PSS for the additional organic and nutrient materials it would deliver to them, yet possibly oblige yet more N to be unproductively emitted to the atmosphere through downstream biological denitrification.

Above all, the radical future alternative of city-wide UST installation — i.e., source-separation, with possibly then significant decentralization of the urban wastewater infrastructure — will be highly socially disruptive. It would be more so, we suspect, than introducing the upstream element of COW; and certainly more so than either of the downstream AWW and PSS innovations, which could take advantage of current, centralized arrangements for wastewater treatment. The UST strategy is also highly likely to be especially costly in its re-engineering, in spite of the promise of its outstanding positive returns.

Beware … of Optimizing the Part, Pessimizing the Whole

It is not that easy to close with some resounding, crisp advice: Choose to innovate with this single technology (UST, COW, PSS, or AWW here)! Choose, in other words, to adopt the single, proverbial "magic bullet". The manner of our analysis — multiple strategic technological choices with economic and performance impacts joined up across multiple sectors — does not render facile the choice of how to take that vital first step "tomorrow".

Besides, there is an essential tension between interventions upstream and interventions downstream. A private-sector business innovating profitably downstream, with patent-protected technology for recovering fertilizer at the wastewater treatment plant, should view with foreboding any other business entering the market place with a socially well attuned device for upstream nutrient recovery in the home, or at a sports stadium. Who then would hold the ring to adjudicate on what is best for the city-watershed couple as whole — never mind the various and many businesses operating in and across the other constituent parts of that system?

Added to which, "tomorrow", when the first practical step towards growing these profits is to be taken, might only come when commodity prices for fertilizers, fuels, and C credits rise above some critical, break-even points. We hesitate, however, to include water in this, hence to label it a commodity — a quite provocative notion in the eyes of some. Once more, one is struck by indeed the special nature of water and of water-sensitive economic development, i.e., Growing Blue.