Electricity from the Tap

This article introduces a creative approach to producing electricity from available currents and flows as one of the 100 innovations that shape “The Blue Economy”. This article is part of a broad effort to stimulate entrepreneurship, competitiveness and employment.

The Market

The world market for sanitary and kitchen fittings in 2010 is estimated at $15 billion worldwide. This well-defined line of products ranging from kitchen and bathroom taps, shower heads, faucets, basin mixers and hoses has emerged as a high growth market. These mechanical tools are present in every home around the world that has running water. As middle class consumers increase in Asia, and while Europeans upgrade their home facilities, this market segment emerges as one of the early indicators of economic growth. China’s growth is greatly influencing this market of residential and commercial real estate.

The global market leader is Grohe AG, the German manufacturer which controls approximately 10 percent of the world sales. The private equity owned company employs some 5,000 people with factories on three continents. This category of consumer products requires nearly one million pounds of processed copper and brass (a blend of copper and zinc, sometimes including nickel and manganese) in fittings each year and growing. This volume represents 11 percent of the world market, outpacing demand for these non-ferrous metals by industrial machinery. The raw material prices, mainly copper and brass have tripled over the past few years forcing the sector to embrace material efficiency and material substitution in order to remain price competitive. This has led to an increased use of plastics.

While the growth in demand for copper and brass pushes prices up, these metals play a central role in controlling biofilm. Pathogens like MRSA (Methicillin-resistant Staphylococcus aureus) and Clostridium difficile which can spread through contact, will die in a few hours on copper/brass surfaces. Stainless steel or plastics do not benefit from this control mechanism. It is therefore obvious that quality and performance conscious sanitary and kitchen fittings will continue to rely on these key materials. Fortunately, brass is widely recycled and in most Western countries manufacturers use almost 100 percent scrap.
The Innovation
The merger of kitchen and bathroom fittings with electronics has become one of the new tendencies of the sector. Infrared sensors permitting touch-free water discharge and stop functions, have all permitted further advances on hygiene that reduce the risk of transfer of harmful bacteria, while at the same time securing a better control of water consumption. The drawback is that a traditional mechanical product with a lifetime in excess of 40 years, is now subject to shorter life cycles and more maintenance costs. In addition, a further broad use in private and commercial real estate does further increase electricity consumption even when its individual use per contact point seems marginal.

Professors Daniel Kwok and Larry Kostiuk from the University of Alberta, based in Edmonton (Canada) observed how some atoms in solids are released when they are in contact with a running fluid. This forms negative electrons that are free to roam, and creates positive ions. Some will flow with the fluid leaving the solid with a net charge. If the solid is not conductive, then the charge is localized. This attracts oppositely charged ions, and repel equally charged ions. This creates a thin charged layer inside the pipes. The professors progressed in their research by making water flow through tiny channels of the size of "the electric double layer", which is between nanometers and micrometers thick. This flow leads to charges on either side of the channel, thus creating a voltage between the two ends.

Although the power generated from a single channel is extremely small, millions of parallel channels can be used to increase the electric power output to useful levels. Just like the whale succeeds in pumping a thousand liters of blood each heart beat, relying on 70 millivolts of electricity generated in its cells, one day this insight could power larger devices. The application of this electricity generating concept in micro-electronic devices offers the opportunity to power all the electronics that power sanitary and kitchen fittings, directly from flowing water through micro-channels.

The First Cash Flow
The Industrial Technology Research Center (ITRI) based in Taiwan, has been studying the options of using the flow of water through pipes for generating energy for use in commercial products. ITRI engineers have recently demonstrated prototypes of bathroom and kitchen faucets equipped with an LED light, visually indicating if the water is cold, luke warm, hot or too hot to be used. The power for these temperature sensors and LEDs is generated by the flow of the water. These light indicators add an important safety component to the existing micro-electronics embedded into faucets and fittings. This creates multiple benefits from an available source of energy (the flow of water) extending to the recovery of energy through the generation of electricity, while advancing on health and safety. This is one of the characteristics of the Blue Economy.
The Opportunity

ITRI has developed a series of additional practical applications which are at the point of being commercialized. The water hose used by fire fighters was equipped with the same electricity generating turbines as well as a powerful 50W LED lighting up the water flow in the air, thus permitting the firemen to follow its exact direction into the flames. Continuing along the line of safety in case of fire, the engineers equipped the water sprays inside buildings that are activated by a fire alarm with the same device. This permits the redesign of the whole system, overcoming one of the greatest challenges in safety management. The spray device when activated shows the way to the emergency exit thanks to a bright light powered by the flow of water. Since the power for the devices is generated by the flow of water itself, and the lamps are highly efficient LEDs, this system reduces the amount of wiring, eliminate special electric circuits with a separate power supply, including water proof batteries.

In addition to these macro-size applications that improve the performance of the building industry without further stressing electric resources, these devices could one day provide power to MEMS (Micro-electro-mechanical systems). These small devices driven by electricity are used in inkjet printers, airbag deployment systems, pressure sensors, optical switching devices. As the innovative insights of Professors Kwok and Kostiuk navigate their way from laboratory to industrial scale, and as ITRI evolves its commercial strategies towards miniaturization, this novel source of energy that uses the powers of gravity and pressure will ensure that future innovations could be powered locally. It seems that this offers a broad platform for entrepreneurship.

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