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# *A cradle-to-cradle approach to energy and industrial sytems*

Since mankind existed, substantial efforts have been directed to improve our living conditions. Particularly over last centuries, this meant making buildings increasingly more comfortable, but also more energy-consuming.

Whether or not the world will deplete its fossil fuels reserves in the next future is a highly controversial matter; however, in the words of the former OPEC oil minister, "The stone age didn't end because we ran out of stones". At the time, mankind found a better solution; it is now concretely possible to do the same and progressively reverse our energy consumption patterns.

**Where to start from ?**

The answer is as simple as underexplored: our buildings. In fact, 40 percent of energy is currently consumed in buildings, whose life span is considerably longer than cars and other devices (to which most of current efforts are directed), and where we spend most of our lives.

Small energy-saving habits can be easily adopted in everyday life, but they can only be the first step on a path to disrupt the way life in buildings is conceived. Let us fast forward to 2050 to see how different could the world be if a drastic change of mentality occurs, forever changing the global energy landscape.

The world in 2011 is characterized by a cradle-to-grave industrial system: nearly all products imply considerable energy consumption and pollution throughout their whole lifecycle, in the manufacturing, transportation, usage, and disposal phases. An innovative cradle-to-cradle approach is however starting to be explored: some products are specifically designed to minimize their negative environmental impact and are fully recycled through end-of-life treatments. Indeed, it is intuitive that the most efficient solution must start from the design phase, rather than disposal, where most efforts are currently directed.

Whereas the cradle-to-cradle concept has this far been applied almost uniquely to products, 2050 may show a very different picture: a world where such principle is applied to entire energy and industrial systems. By 2050, everything may be designed so that the outputs of production, usage and disposal of some objects are valuable inputs of other devices, industrial processes, or nature.

This seems utopian in 2011, but the technologies to make this possible partly already exist, partly can come from future technologic advancements, fostered by investments in alternative energies and by increased professional support from consulting companies specialized in designing cradle-to-cradle solutions on a large scale.

The starting point has been envisioned by American architect William McDonough, who envisioned a building that imitates nature, where everything is designed for a purpose (figure 1).


*Figure 1. Building designed by architect William McDonough*

Firstly, its shape is meant to increase stability, maximize space, and contemporaneously reduce the materials employed for construction and the impact of wind. Then, rooftops are covered with ground and green, for thermal insulation as well as filtration and collection of storm water. Indeed, water would experience several recycling processes; from the sky, after greenhouse treatment, it could be used in sinks and bathtubs, then for irrigation of the building's gardens, and after a final cleansing for non-drinking purposes. Green would be placed in several parts of the building, in order to absorb the CO2 produced by human activities, and turn it into oxygen. Furthermore, solar panels would be used extensively, covering a whole façade and providing up to 40% of the building's energetic needs. Finally, a key feature refers to heating and cooling, processes that account for approximately 30% of energy consumption in buildings. Both the rooftop and the building's surface are meant for thermal insulation, whereas heat would be transferred between the building and the Earth thanks to circulation of a heat-absorbing liquid, thus reducing energy consumption.

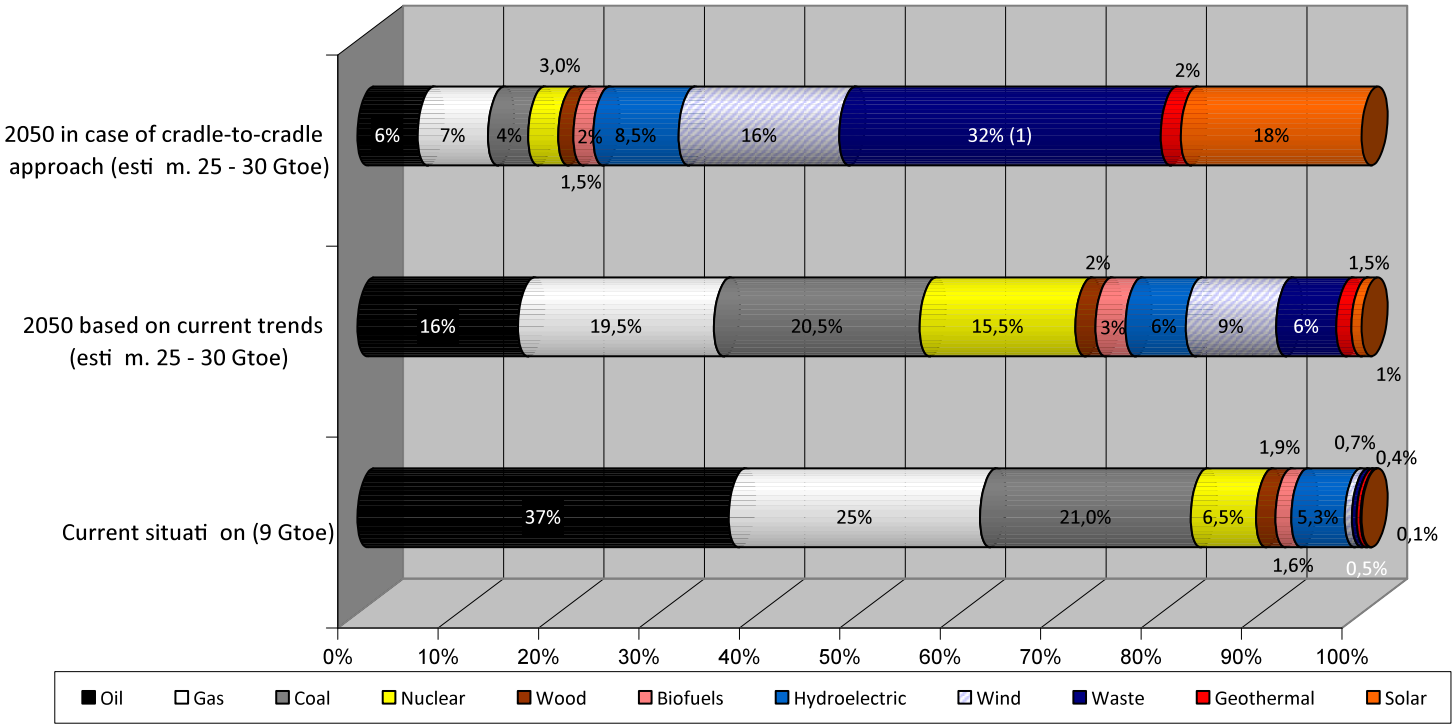
While the presented solution is undoubtedly appealing, by 2050 it will be possible to do much more. First of all, renewable energy sources will be significantly cheaper; while, for example, the cheapest solar power option currently costs at least $0,2 per kilowatt-hour, it is constantly becoming cheaper. If we look at ongoing trends, solar power went in average from $300 to less than $2 per watt between 1956 and today. It is therefore reasonable to expect that within the next 40 years it could provide the majority of a building's energetic needs at a competitive price. Moreover, energy from wind power is currently produced through turbines far from the point of usage. In the future, smaller turbines may be integrated in buildings, contributing to the overall energy supply and rendering them entirely self-sufficient, thus making oil- and gas-fuelled heat/power plants redundant. A breakdown of two possible scenarios for 2050 is displayed in Figure 2.

Secondly, anything from heating/cooling in buildings, lighting in urban environments, and even manpower can be optimized. Consider how much energy is currently used, for example, to lit cities at night. Through sensors it would be possible to heat/cool environments, or light streets, only when and where somebody is actually present. Also, energy produced by physical activities in gyms can be harvested to make such facilities autonomous or fed in the electric grid.

Finally, when the cradle-to-cradle principle will be applied not only to all products, but also to all aspects of human life, different parts of a city will operate similarly to different parts of a human body. Some may constitute a source of clean air for the whole system, others provide clean water or supply raw materials, and others again manage disposal of waste, which would consist of separating all products in their components, processing and recycling them to be used over and over again.

**Conclusion**

An "Enertopia" is actually possible in the future, what stands between us and that goal is the way we think energy.




(1) In the cradle-to-cradle approach, waste has a major role, since all goods and processes are designed to make disposed materials/substances valuable inputs for other goods and processes

*Figure 2. Worldwide energy consumpti on by energy source. Elaborati on f or Generati on Energies - Saison*

## NOTES AND SOURCES

Gtoe = Gigatons of Oil Equivalent. The tonne of oil equivalent (toe) is a unit of energy: the amount of energy released by burning one tonne of crude oil, approximately 42 GJ (as different crude oils have different calorific values, the exact value of the toe is defined by convention ; several slightly different definitions exist).

**Business 2.0 Magazine 2007** – *Growing Green Buildings*. By John Heilemann. Available at: http://money.cnn.com/magazines/business2/business2_archive/2006/11/01/8392027/index.htm

**Ecoimagination** – *When will solar go mainstream?* By Eric Wesoff. Available at: http://www.ecomagination.com/when-will-solar-go-mainstream/

**Energy Information Administration 2006 –** *World consumption of primary energy by energy type and selected country groups.* Available at: http://www.eia.doe.gov/pub/international/iealf/table18.xls

**Fortune Magazine 2006** - *The tower of tomorrow*. Available at: http://money.cnn.com/popups/2006/fortune/future_tower/index.html

**International Energy Agency –** *Energy to 2050: scenarios for a sustainable future.* Available at: http://www.iea.org/textbase/nppdf/free/2000/2050_2003.pdf

**Lawrence Livermore National Laboratory 2010** - *US Energy Flow 2009.* Available at: https://flowcharts.llnl.gov/content/energy/energy_archive/energy_flow_2009/LLNL_US_Energy_Flow_2009.png

**Nathan S. Lewis**, California Institute of Technology - *Chemical Challenges in Renewable Energy.* Available at: nsl.**caltech**.edu/_media/**energy**:**energy**_notes.pdf

**Pierre-René Bauquis** - *A reappraisal of energy supply and demand in 2050.* Available at: http://www.speitaly.org/pages/events/download03/1103Articlebaquis.pdf

**Popular Science 2009** - *The Future of Energy: A Realist's Roadmap to 2050. Which technologies will finally free us from oil?* Available at: http://www.popsci.com/environment/article/2009-06/future-energy-realist-roadmap-2050

**PriceWaterhouseCoopers 2008** - *The World in 2050: Can rapid global growth be reconciled with moving to a low carbon economy?* Available at: http://www.pwc.com/en_GX/gx/world-2050/pdf/world_in_2050_carbon_emissions_08_2.pdf

**Royal Society Publishing** - Philosophical transactions of the royal society: biological sciences - *Traversing the mountain-top: world fossil fuel production to 2050*. By Richard Nehring. Available at: http://rstb.royalsocietypublishing.org/content/364/1532/3067.full

**The Future of Energy: analyzing the options** (online book) – *US Energy use*. Available at: http://energyfuture.wikidot.com/us-energy-use

**The New York Times 2009** - *Energy Outlook 2050: Lower Carbon, But Not So Renewable*. By Matthew Wald. Available at: http://green.blogs.nytimes.com/2009/04/08/energy-outlook-2050-lower-carbon-but-not-so-renewable/

**U.S. Energy Information Administration** – *Annual Energy Review 2009*. Table1.3, Primary Energy Consumption by Energy Source, 1949-2009 (August 2010). Available at: http://www.eia.doe.gov/energyexplained/images/charts/role_of_renewables_in_us_energy-large.jpg

**World Changing 2005** – *Leaving the Stone Age*. By Jamais Cascio. Available at: http://www.worldchanging.com/archives/002678.html

**Worldwatch Institute:** State of the World 2004 – *The Cradle-to-Cradle Alternative*. By William McDonough. Available at: http://www.mcdonough.com/writings/cradle_to_cradle-alt.htm