# The NY Salon presents
## *'The Human Footprint- Has Civilization Gone Too Far?'*
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### It's Not a Footprint—It's an Energy Print by Corey S. Powell

This big-picture environmental question naturally tends to arouse emotional or philosophical responses—responses that tend to leave the argument almost exactly where it began. Allow me, then, to attempt a more analytical approach. The demands that we humans place on our planet depend directly on two broad factors: total population and demographics/lifestyles within that population. Those factors, in turn, are really just components of a more broadly descriptive factor, energy use. Energy is the crucial element for understanding the increasing impact of the human footprint. Fortunately, energy also hints at the solutions in store that may allow us to live much richer lives in the future while treading more lightly on the globe.

So where do things stand now? At first glance the trends are not terribly encouraging. Let's start with the global population, which has been increasing more-or-less exponentially over the past millennium. Such growth obviously increases the pressure on the environment—more people require more food, living space, resources, etc. But we are on the verge of a remarkable turning point. The rate of increase has been declining sharply since the mid-1960s and will probably hit zero within the next few decades. According to the latest United Nations projections, the global population will peak around 9.2 billion in 2075. In other words, we will see a declining world population within a century, much sooner in some parts of the world.

This is an opportunity but also a challenge, since a shrinking population will come with wrenching demographic changes. Today, one person in nine is over the age of 60. By 2050, that fraction will grow to one in five—greater than the population under the age of 14, for the first time in human history. By 2150, the over-60 group will be 1/3 of all humanity. An aging global population will present very different challenges than today's world. Older people in developed countries are less aggressive consumers, which might seem to imply less total resource demands. In reality, late-life care is extremely expensive and resource intensive. Early signs of this are already on display in Western European countries, which contain some of the world's most rapidly aging populations.

Another stunning global demographic transition is the trend toward urbanization. Here, too, we are living close to a remarkable turning point. Sometime within the next two years, more people will be living in cities than in rural areas—again, for the first time in human experience. Cities don't guarantee a lighter environmental load, but at least they

give governments more control in controlling where that load lands. For instance, state and local governments can regulate the siting of power plants and the zoning of which land should be used for agriculture. Urbanization creates problems of water supply and waste management, but again allows more effective policy measures for reducing the environmental impact of these needs. And a more centralized population leaves—in principle—more room for protected, undeveloped land.

But all of this is really just a proxy for the thing that most broadly defines the human footprint, energy use. Even if population declines, in accord with the U.N. projections, energy use will likely continue essentially indefinitely. The footprint implications of that trend depend on where the energy comes from. Right now politicians and environmentalists (and some economists) are wringing their hands over how best to conserve fossil fuels and to nibble away at the edges of our fossil-fuel dependency by expanding the role of more benign alternatives: biomass, geothermal (boosted by a recent MIT study), solar, wind, even updated versions of nuclear fission.

Every energy source currently on the table pose distinct footprint challenges. Biomass absorbs a great deal of arable land and is itself fairly energy-intensive. Geothermal requires massive new infrastructure. Solar and wind, too, have significant manufacturing and placement problems. And even advanced fission still involves environmentally disruptive mining and disposal processes. (I'm leaving hydrogen out of the discussion entirely, since it is merely an energy transportation mechanism, not a primary energy source.)

In this instance, there is nothing remarkable in suggesting that we are living at a transitional time. People have come up with new energy sources repeatedly through history, each one supplanting rather than replacing those that came before. There are several promising candidates for the next big energy source, but I'm placing my bets on a dark-horse candidate: aneutronic nuclear fusion. Physicists have been promising practical nuclear power is just around the corner (usually said to be about four decades away) for half a century now. Conventional fusion reactor designs look to be fantastically complex and expensive to build. Anuetronic power—currently being explored by a handful of labs and companies such as TriAlpha—involves fusion reactions that produce protons, not neutrons, as a byproduct, and it achieves fusion using techniques other than the magnetic bubble, or Tokamak, currently being pursued by most fusion researchers. This approach presents, in some ways, even greater engineering challenges, but it also opens to door to radically different engineering approaches. And if it works, it will allow reactors that are vastly more efficient, compact, and clean than current fusion prototypes like ITER—to say nothing of existing, conventional power plants. The result could be near-limitless and near-pollution free power.

If aneutronic power works (or if we succeed in developing space-based solar or other types of off-Earth power production), the whole energy equation—and hence the whole footprint equation—changes completely. Here I am broadly in agreement with Marty Hoffert, but I'll go further in spelling out the possibilities of cheap, abundant, low-pollution energy. Water availability and water treatment, for instance, depend directly on

energy supply (desalination and sewage treatment take power). Energy is a powerful weapon against poverty, and rural poverty is one of the greatest factors behind environmental degradation. And of course the massive issue of global warming could be eased greatly if the world quickly moves heavily toward non-CO2 power sources. (Note, however, that we are already locked into a substantial warming trend just from existing carbon emissions.) Agriculture can be much more efficient given a sufficient energy input, and in the most far-out schemes an abundant energy supply plus engineered plans or nanotechnology could eliminate much of farming as it is currently practiced.

All of this optimistic, blue-sky talk is, I believe, entirely reasonable and in fact quite plausible. We should be aiming for it now, but we also need to deal with extremely serious interim problems. The real question for the moment is how we will manage the century-long transition to a new energy era. The past gives reason for optimism. For all the problems associated with fossil fuels, for instance, they have allowed the wholesale reforestation of the US and Europe, which is an amazing turnaround. Meanwhile, the Clean Air Act and other regulations have had a stunning effect on the environment. The moral is that pure market forces can do a lot of good, but they are far from sufficient for setting the kind of global behavioral shifts we need right now.

EPILOGUE: **Are we really facing a "footprint" crisis?**

Back, for a moment, to the issue that inspires all the emotions and anxieties to begin with. There is no longer any meaningful debate about whether humans are causing major changes to the environment, ones that could become increasingly detrimental to our own existence. The changes are happening, period, and the measures required to mitigate those changes will become only more draconian over time. Science's primary role now therefore lies in understanding the nature of the changes and in researching practical solutions.

Why the sense of urgency over such long-term problems? Some of the human-triggered changes are irreversible. Species are going extinct at 100 to 1,000 times the natural background rate, and changing land use patterns are expected to move that figure to 10,000 times the natural level, rivaling the mass extinctions in geologic history. Whether or not you accept loss of biodiversity as a direct threat to our well-being, it is certainly a serious loss of the biological wealth of the planet.

With global warming, the human cost is more straightforward. Many scientists feel there may be a tipping point of atmospheric $CO_2$ concentrations, beyond which we will be unable to reverse the trend, and the changes will be for all intensive purposes irreversible, at least at human time scales. A warmer planet will by no means be uninhabitable, but the cost due to extreme weather, drought, disease migration, coastal flooding, and other climate-related problems could easily run into the trillions of dollars. The fourth IPCC report, due out imminently, estimates that current trends will lead to an average temperature rise of 3 degree C over the coming century. Holding $CO_2$ to current levels, which will require substantial energy substitution, will still lead to a 2-degree rise. And

even if $CO_2$ weren't an issue, fossil fuel resources are being depleted and we will need to find replacement; it is only a matter of when.

The irony in much of the current environmental debate is that people on both sides often talk of the situation as something beyond our control. But it is the amazing power of human invention that created these current threats, and it almost surely will be the power of human invention that carries us past them.

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NOTES:


1. UN Population Aging Chart, 2006.
2. World Population to 2300. UN, 2004.
3. "World first: In 2008, most people will live in cities." UN forecasts as reported in *CSM*, 12 Jan 2007. http://www.csmonitor.com/2007/0112/p25s02-wogi.html
4. US State Dept: *Green Cities: Urban Environmental Solutions* "Innovative Solutions Create Urban Sustainability." 2000 http://usinfo.state.gov/journals/itgic/0300/ijge/gj-04a.htm
5. "Europe Faces Challenge of Aging Population." Michael Drudge 07 March 2006 http://www.voanews.com/english/archive/2006-03/Europe-Faces-Challenge-of-Aging-Population.cfm
6. US Global Change Research Information Office, 2004. http://www.gcrio.org/CONSEQUENCES/vol3no1/biodiversity.html
7. UN Millennium Ecosystem Assessment, 2005.
8. "Debate on climate shifts to issue of irreparable change." http://www.washingtonpost.com/wp-dyn/content/article/2006/01/28/AR2006012801021.html
9. "Returning forests analyzed with the forest identity." *PNAS* November 13, 2006. P E Kauppi et al. http://www.pnas.org/cgi/content/abstract/0608343103v1 (in popular press: http://outside.away.com/outside/news/20061115_1.html)