The future of bicycling given a world in degrowth: perspectives and lessons based on the Central European project, BICY

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Prepared for the 3rd International Conference on Degrowth
Venice, Italy, Sept. 19-23, 2012
http://www.venezia2012.it/

Theme: Commons
Sub-theme: WS 11. Degrowth in Big Cities

Abstract:

The bicycle offers much for a world correcting through degrowth. As a resource-light vehicle, and long the most energy-efficient form of ground transport, bicycling offers low-carbon, healthy travel with superior mobility characteristics over motor vehicles and public transport for a large share of urban trips.

The cost to provide bicycle infrastructure is also quite low, and the economic benefits far outweigh the costs, in sharp contrast with private motor vehicles. However, in scenarios of degrowth, a variety of challenges to maintaining let alone increase the quantity and quality of bicycle use may emerge: critical infrastructure such as bridges, and quality of roads may decline; personal security and the threat of bicycle theft might improve or decline as well; these different potentialities can conceivably vary enormously. Socio-economic inequalities might also exacerbate, leading to more hostile conditions on roads.

The BICY project (www.bicy.it) found a strong linear relationship (R²=0.802) correlating cycling rates to the length of bikeways per capita (even stronger when only big cities are examined, R²=0.916). This emphasizes the importance of providing appropriate infrastructure, to achieving cycling as a widespread transportation option.

In the context of degrowth, cycling might flourish or perish depending on the vision pursued and the allocation of limited resources. It is important to consider the desired role of cycling and the path to achieve it, when planning for the various possible manifestations of degrowth (conscious or crisis; rapid or slow; resource driven or economic; etc.).

Given the general agreement that peak oil has already arrived, and industrial growth is in a plateau phase before inexorable contraction, and given that governments continue to dally in the face of potentially catastrophic climate change, it is likely that the scenario we face first will be rapid and
crisis-driven. Peak oil is already shown to promise major health and environmental burdens, the chaos of a system in rapid, unplanned contraction will only exacerbate this.

Even if petroleum supplies remain adequate for the growth-dependent system to maintain some stability, other indicators show infrastructure is poised to decline faster than it can be repaired or replaced; roads are already declining and the roadway network is contracting. What would be the best possible response in maintaining a healthy and long-term sustainable transport system in the long term, given that so many other major adjustments and challenges will be underway? Are there new paradigms of roadway, are there rapid adaptations in land use and goods/people movement which achieve the ideals of intentional and best-case degrowth?

**Perils and Degrowth**

Humanity sits on a great precipice overlooking an end to the continual expansion of industrial civilization, a transition with many unknowns and hardships; there is no guarantee of a graceful transition to a new paradigm.

Humans are now extraordinarily dependent upon fossil fuels for every fundamental material need, including food and water. Yet those fuels are finite and in decline; worse, their expenditure is bringing on an era where food and water are even harder to obtain, due to anthropomorphic climate change. Some say we cannot feed the future at this rate (Koning 2009; Meggs and Sfrerios 2010) and at the very least, *public health* is in grave danger for lack of food (Neff et al, 2011).

Moreover, historic inequities could exacerbate in this time. Certainly if food is threatened, transport is threatened. Yet little has been done to prepare (Dantas, Krumdieck and Page 2010). As with impending rail cuts across Europe due to The Crisis, and public transport curtailed globally, it is those who depend on more sustainable commons of transport such as public transport, walking and cycling who are the first to be shorn. Bicycling is likely the most resilient and reliable mode for the masses, over time; public transport is likely the first to go due to fuel prices, technological dependency, labor issues, and fixed costs; walking is inadequate given the realities of distances and loads.

Thus interventions for active transport are recommended by Public Health professionals in the context of crisis fuel shortfalls (Barnett et al. 2011). Yet myriad processes depend upon petroleum inputs, and the disruption has widespread implications for threats to health. An entire special issue of the American Journal of Public Health featured articles on the health implications of Peak Petroleum (2011). Many other essentials, such as phosphorus for fertilizer (White and Cordell) threaten to add to this “perfect storm.” This great turning point is truly terrifying in its scope, and potential implications; while some predict even the extinction of the human species due to runaway climate change (Morrison 2012).

At the same time, such an impending series of compounded crises offers an opportunity to renew the human condition and adjust the practice of living for a more sustainable and equitable model.

The economic trend has been one of constant growth, including globalization, and with it a constant increase in the use of the car and the displacement of human-powered, active transport. Exploiting new resources, particularly energy in the form of petroleum, the face of the planet has changed quickly.

Seeking adaptation to a more sustainable growth pattern, the reformist idea of Smart Growth has emerged, along with a host of proposed measures that may slightly influence future modal share. At the
same the car continues to penetrate the developing world, a world where bicycle use is extremely important (where people are wealthy enough to afford one), yet increasingly deadly and discouraged due to motorization.

There is evidence that “peak car” has occurred, however, and a renaissance of bicycling is sweeping the developed world. Yet ironically at the point of maximum growth, the least opportunity for directing future growth occurs; it is time to adapt what has already been built, even if it is “the most colossal misallocation of resources in the history of mankind” stated historian/geographer James Howard Kunstler, author of *The Geography of Nowhere* criticizing the car-oriented development of the USA. Kunstler has also written degrowth-related books on crisis and decline, including a turn back to a world made by hand (Kunstler 2005, 2008).

At a recent major conference in the United States, an elected official from Syracuse, New York (an industrial town now in marked decline) criticized this as unrealistic optimism. “What we really need is Smart Shrinkage,” he said: “We are now at the point where major infrastructure is failing, and we must choose which to save. Shall we keep this bridge, or that one?” For the purpose of this paper: will that choice be made with bicycling in mind?

Therefore at this perilous juncture, what can we do to create the cities everyone will want, and be able to flourish into such an uncertain future?

**The Form of the City, How we Move**

What will be the means of transport in a world in Degrowth? Will that answer depend on the scenario that precipitates the path to Degrowth? If Degrowth focuses on sustainability and social equity, it seems the bicycle is inherent, indispensable, invaluable. “Socialism arrives on a bicycle” wrote Iván Illich in his seminal work, *Energy and Equity* (Illich, 1974), capturing this essentiality.

The bicycle is the most energy efficient means of land transport, opening up worlds of possibilities beyond the expenditure of fossil fuels; food is the fuel, and a healthier population is a co-benefit.

Not much appears on transportation and land use in the archives of the Degrowth conference. Yet land use has tremendous implications for energy and resources, for society in all respects. How we move is the dynamism of life; it is the hardship, or the joy, of daily existence.

The form of the city determines much with regard to equity, to health, to opportunity. It makes us spend energy or save it. It can let us enjoy life or hate it.

Theorists have grappled with the notion of sustainable city form in many ways. Much has been said about adjusting the dominant paradigm in the high consuming world through various measures (a summary of various recent measures designed to reduce climate change, for example, appears in *The ITACA Handbook: Realizing Sustainable Mobility* (Meggs, Schweizer, Buzzoni et al. 2011).

These measures are typically incremental and slow to be adopted, with no clear vision articulated as to the end result, whether a truly ecological city would appear.

There are important voices for more radical restructuring of urban form, however.
The Ecocity

“The shortest distance between two points is to bring them closer together,” advises Ecocity theorist Richard Register. Register popularized the notion of the Ecocity with his books leading to the formation of an international conference series, the World Ecocity Summit. Register continues his work through the organization, Ecocity Builders (http://www.ecocitybuilders.org/).

An Ecocity is one in which the principles of sustainability have been incorporated intentionally with a comprehensive vision for an outcome that is maximally in harmony with nature while meeting human needs for health and happiness. The Ecocity does not fight natural processes; waterways such as creeks are opened to thrive. The centers are dense and surrounded by nature. The design of the city obviates most use of motor vehicles.

The Carfree City

The notion of the Carfree City, a form of ecocity, emerged and was made real with the publication of Joel Crawford's landmark text, Carfree Cities. The idea was championed internationally with the Towards Carfree Cities conference convened by the World Carfree Network (http://worldcarfree.net/, meeting as part of this conference). Crawford is participating in this Degrowth conference. Crawford's latest work is the Carfree Design Manual, a handbook for the design of carfree cities, and he publishes a regular free online newsletter through the Carfree Institute (http://carfree.com/).

Both Crawford and Register envision a walking city. Crawford's designs precipitate around high-quality mass transport connecting centers (see Figure 1, below). However, bicycles can and surely would play an important role in such cities, at the very least for travel between nodes, particularly across greenways, and certainly for goods delivery.

![Carfree City Diagram](http://carfree.com/topology.html)

Figure 1. http://carfree.com/topology.html

The reference design for Crawford's inquiry has impressive characteristics. In a population of one million, this Carfree City reference design is said to have a longest door-to-door journey of only 35 minutes. Yet 80% of the land is preserved, for natural regions and agriculture, and the energy required to operate the city is dramatically reduced. Walking and bicycling paths can connect these areas more
efficiently as well, including connections across green areas for a direct path through greenspace.

This design can be adjusted for 300,000 to 3,000,000 residents.

It is possible that a modern car city can over time convert to this design through wise policies and incentives. A new city would be the most cost effective means of creating and testing the modern carfree city, although it may suffer for a lack of natural evolution. Crawford tested experimental means of spatially designing the district in person with prospective future tenants, to get a feel for the new neighborhood before it is built (during the York, England TCC IX, 2010).

The Districts can be living districts or working districts, including industrial districts (the gray circles/nodes above).

A closer look at the districts (Figure 2):

![Diagram of districts](image)

**Figure 2.** Industrial nodes connected below residential (living area) districts in the Carfree City.

**The Personal Rapid Transport City**

An idea for a high-service, high sustainability mass rapid transport system mimicking the car, yet taking much less resources to implement, is the theory of Personal Rapid Transport (PRT). Analogous to an horizontal elevator to the city, one simply goes to a stop and enters a destination. An empty car appears for one or more persons, who ride in seated and climate-controlled comfort to their destination, usually conceived as light-weight capsules on elevated guideways.

The PRT City is not necessarily an ecological or carfree city, however given the magnitude of the investment and the shift in paradigm, it has much in common and can be an ecocity and/or carfree city. In the BICY Project we found huge potential among the public; many would shift from other modes including the car; it is indicated that in many places over 80% of trips could be made by PRT, given a comprehensive system. Because PRT is to be grade-separated, there would be no conflicts with walking and bicycling. (See Schweizer, Rupi and Meggs 2012a.)
The Bicycle City

The original bicycle city is said to be Shanghai, a very flat city where bicycle use was very high. The bicycle was also heavily used in many western cities. There was a “Bicycle Boom” in the late 1800s in which a great deal of attention was given to the bicycle. Since that time, new initiatives have formed to convert modern cities to function around the bicycle. Perhaps the most successful example is the smaller university town of Groningen, Netherlands, where bicycles are used for 60% of trips.

Social Change and the History of the Bicycle

The bicycle was the biggest revolution in personal transport since the horse and buggy.

Society was changing rapidly in response to the Bicycle Boom. Women's liberation was greatly helped by the bicycle, which was a catalyst for rational dress and the freedom to travel without a chaperone. Everyday workers, children, everyone was given a great new avenue for freedom of travel.

During the boom, the bicycle displaced other entertainment economies and commanded the attention of the best minds. From the bicycle came the first cars, motorcycles and airplanes.

The potential of the bicycle was not realized in the west in many places due to market forces and the hostility of petroleum-fueled travel.

The United Kingdom had very high bicycle use, with London a leading cycling city in history, along with many other places in Europe. Even outside cities, in the countryside, as we see today in the low consuming/developing world, the bicycle was essential as well, particularly given the absence of mass transport and wider distances.

Over time, however, cities were converted for car use, with policies, practices and the outright hostility of the environment reducing the use of the bicycle while every kind of incentive led to dependence and dominance of the automobile, a process which is only slowly being reversed in any way. New cities covered farmland in great swaths of suburban and then exurban sprawl, while historic cities were crammed with cars and entire neighborhoods razed to the ground or split up by morbid, deathly motorways.

The oil industry and its subsidiaries gathered great wealth and power, and through sustained effort obtained a radical monopoly for the gasoline car and for diesel engines in both buses and trains was key in reducing the great potential of the bicycle (Meggs 2005) and electric trams for local travel, and for preventing electrification of long-distance travel in many places, most notably the USA.

The dismantling of electrified transport, and the rise of diesel trucking rather than intensification of rail, the insistence by General Motors in making trains run on diesel rather than adopting the roughly 7X more energy efficient electrification of rail transport, has made goods movement particularly vulnerable to fuel shortfalls, as seen in recent fuel strikes in the trucking industry and the disruptions during recent oil shocks. A conversion of the major fixed route corridors, literally electrifying existing lorries/large trucks to run on electricity, is another avenue of sustainable transport to consider in planning Degrowth due to their efficiency, health benefits, and potential to run on renewable energy (see Meggs, 2012b).
Could the bicycle have remained prominent? Clearly it could have, as it makes a resurgence throughout the high consuming West, with noteworthy cities in Europe such as Copenhagen and Amsterdam having very high and rising levels of bicycle usage.

The historic trend lines of Figure 3 are based on various data sources, assumptions and estimates, which may influence the overall result. The dashed lines indicate that estimates have played a more important part. During WW2 not even estimates were feasible.

![Figure 3: Reconstructed trend lines of bicycle shares. Considered where the modes: bike, car, bicycle, Motorbike and public transport journeys, 1920-1995 (in %)](image)

Source: Fietsberaad Publication number 7

Even many places in the USA were changing for the bicycle, with very high usage. Although data is always sparse, in 1906, almost a decade past the peak of the bicycle boom, Minneapolis’ City Engineer found that bicycles accounted for more than a fifth of downtown traffic, four times as much as cars.” (McShane, 1988)

We also know about units sold. “United States manufacturers alone produced and sold 2,000,000 bicycles in 1897...27.7 bicycles were sold per 1,000 people.” (Sloan) In contrast, “in 1898 there was one car to every 18,000 people in America. Twenty-five years later (1923) there was one car to every eight.”(Gibson) So near the turn of the Century, in 1898, if we count only one year’s bicycle sales, not including imports, bicycles outnumbered cars 500 to 1.

**High Potential for Cycling Remains**

How much could people bicycle, if they had to? In Cuba, when oil was cut off, bicycle use became a major part of daily life. In the West, there are many unused bicycles; in the USA they far outnumber people, so certainly there is at least a widespread opportunity to find one for use. A rapid conversion to
bicycling clearly could occur if conditions of life change in a way that necessitates it – or, invites it.

However, although the bicycle is a great equalizer, and nearly everyone can can bicycle, not everyone can do the same work or travel the same distance in every situation. There are limits to the range and power output of each person, which varies between people, and thus there are limits to the maximal total urban utility of the bicycle, as there are for every mode, in providing for the needs of the people. Land use can adjust quickly (Meggs et al 2011), which can help, but still there is an equation to be considered, trade-offs to be understood, prepared for and responded to. A shortening of geographic scope becomes likely for some. This is a topic being studied by Ian Philips, researcher at the Institute for Transport Studies at the University of Leeds, England (Philips 2012).

At the same time, the conversion to bicycling may increase the scope and freedom for many who are presently unable to travel due to dependence on others. The very young and very old typically fall into these categories, often prohibited from walking or bicycling due to the risks of car traffic. Where bicycling is part of everyday life (e.g., Ferrara and Ravenna, Italy, or throughout Northern Europe), one sees all ages on bicycles, a marked difference from car-dominated areas. This freedom is a net benefit to the health and well-being of these groups, and can prevent disability, disease, and extend life while increasing happiness.

**BICY Findings of Potential Cycling**

In the BICY Project, we identified that in every city studied, there are a large number of potential cyclists who could adopt a bicycle, (Figure 4, below), and a similar number who said that they would in fact adopt a bicycle if conditions were better.

![Potential Regular Cyclists](image)

**Figure 4.** Potential regular cyclists estimated using BICY detailed mobility survey results.

In the BICY project’s survey discussed in this paper, on average 44.5% of those who do not use a bicycle for their regular travel said they would do so given an “uninterrupted bike route (either segregated or in a 30km/hr zone)” (Figure 5, below).
These estimates were found through the BICY survey (a detailed mobility survey with target 1500 respondents), in which people self-reported that they would switch to cycling for their regular trips given better conditions, and in which we identified the distances traveled and the modes currently used.

The survey is described both in a Methodology Manual (Schweizer and Meggs 2012b) and an academic paper which further discusses its use, analysis, accuracy and findings (Schweizer, Meggs, Dehkordi, Rupi and Pashkevich 2012c).

![Non-Regular Bike Users who Would Bike Regularly with a Continuous Good Bicycle Route](image)

Figure 5. Potential new regular cyclists if good bicycle paths were provided, connecting regular destinations. These were self-reported using BICY detailed mobility survey results.

A second means of estimating total potential bicycle usage, we further found a linear relationship suggesting great promise to increase cycling if infrastructure is increased. This is discussed below.

Even goods movement – cargo transport – can greatly be shifted to bicycling, as was common in the past and remains common in many parts of the world, from pedicabs and rickshaws that transport passengers, to cargo bicycles which carry people (including emergency response when motor vehicles cannot move). Bicycle delivery can be faster and more cost effective in cities than motorized delivery. A resurgence in cargo bicycling is already taking place in the high consuming world, with many new manufacturers emerging. An EU project is underway focusing on this very question (CycleLogistics).

We also saw evidence of competition between modes. Investments in one mode affect others; it is possible that society can choose one mode to be dominant over another; there may be a geography of each kind of city which differs, explored in a forthcoming paper (Meggs and Schweizer 2012a).
The Bicycle as a Goal of Degrowth

For Degrowth the bicycle is a particularly potent tool for achieving a wide range of goals. The goal of increasing cycling is widely recognized as essential for meeting a plethora of policy objectives for public health, economic sustainability, energy security and more.

Literally, lives depend on creating new cyclists. Active transportation keeps us happier and healthier as a society. Cycling provides an excellent alternative to combustion-based, motorized transport for a majority of urban trips, reducing deadly air and noise pollution including greenhouse gasses, thus helping protect our living environment at both the local and global scale, including the climate that provides us food and water.

Cycling has a minimum spatial impact on urban environments and a very low price, both public and private. Cycling strengthens and invigorates local economies by refocusing individual economic behavior inward, while further boosting cities' vibrancy and livability by the same turn of the wheel.

For these reasons and many more, the goal of increasing cycling has been widely adopted, in myriad forms from local resolutions to national and international objectives, from every type of organization. However, implementation of this goal has lagged in a majority of urbanities, in part because a clear and reliable understanding of how to increase cycling has been lacking.

Many locales have done little to increase bicycling, let alone to stem car use. If anything, the most common measure taken has been the politically expedient route of relying on soft measures such as promotions aimed at behaviour change (brochures, for example), without taking more definitive steps toward hardscaping a cycling environment; even when positing to increase cycling, many cities have failed to provide a viable place to ride a bicycle to meet daily needs, such as a well-designed, safe, and publicly amenable, comprehensive network of bikeways.

Certainly there are strong anecdotal relationships between infrastructure and levels of cycling. In regarding Europe’s top cycling cities, all have provided a well-used cycling network (Pucher, Dill and Handy 2010).

Is such a network essential? Surveys of the public strongly indicate an affirmative. As we found in the BICY Project (discussed above), separation and safety from motor vehicles was the leading stated preference not just for the public, but also for decision makers in a separate process (providing a network of cycle tracks was by far the top issue identified by stakeholders in facilitated meetings conducted during the project).

True: environmental, cultural, economic and other factors may influence cycling levels. Topography is strongly associated with high cycling rates (flat cities being ideal). Hills can be overcome, however (e.g., San Francisco in the USA is now a leading cycling city despite extreme hills throughout the city). Weather is oft touted as a barrier: however, weather is not a bar to cycling, as high cycling levels exist in cold and wet climates of Central Europe (although cycling rates are reduced in the worst weather). In addition, electric bicycles now make hills much more accessible even to those many who are weak and frail. In extreme historic cases such as dictatorship or energy crisis, cycling levels have surged when no other option was available.

However, in a society aiming to provide individual choice under leadership by markets, where a
hegemony of automobility most often rules the streets, merely providing an equal opportunity is the most fundamental first step to a cycling citizenry, independent of environmental factors.

The 2012 Velo-city Global conference led with the theme that physically separated bikeways (not just painted lanes) are necessary for all people from “8 to 80” to feel safe and accommodated (Peñalosa 2012).

From a socio-cultural perspective, it is easily argued and demonstrated that for the vast majority of individuals, when perceiving that they have no place to ride, they simply will not. In contrast, to provide a place to ride imparts much more than a sense of safety; it provides a message of cultural acceptance, an invitation and encouragement to adopt bicycling in everyday life, a supportive environment typically lacking in low cycling cities.

What then is the relationship of investments in infrastructure, to resultant levels of cycling? Can we in fact purchase specific levels of cycling behavior through those investments? And if so, can we model the expected benefits of investments, thus arriving at a cost-benefit equation?

Unfortunately, to answer these questions requires observation and comparison, yet many cities lack even basic data on travel behavior, let alone detailed data on cycling. The data gap for cycling is particularly wide and presents a major barrier to scientific study and policymaking. The BICY project convened a round table to discuss standards for bicycle data collection and research at the Velo-city Global conference (Schweizer, Meggs, Bertoni and Pashkevich 2011).

An effort to provide a unified body of data was made. By surveying a spectrum of cities in a variety of ways, the BICY project aimed to create a useful dataset enabling valid and meaningful comparison. By focusing on low cost, replicable methods, the project hoped to allow this dataset to grow. For example, mode shares were acquired for 14 cities, many of which had little or no bicycle data before the BICY Project (Figure 6, below). This method could potentially be replicated by volunteers, and is already rapid and low cost with each survey taking approximately 4.5 minutes, 2 euros to complete.

![Figure 6: Mode share for some BICY cities (all modes, left; just bicycle, right).](image)

From this data and more, models were sought describing the conditions which influence cycling.

The ideal model in this context would allow prediction of future cycling levels given an intervention or
set of interventions designed to increase cycling. Modal splits found using the survey, and in particular the bicycle mode share, are fundamental to constructing such a model, as bicycle mode share is the target outcome. Because the survey is cross-sectional, no data exists for a longitudinal analysis. After testing the hypotheses detailed above in section 2.3, the “Cycling Index” was found to give the strongest association describing the relationship of policy action/intervention to intended response of increased cycling levels (Meggs, Schweizer, and Rupi 2012c).

When including all study area cities in a scatterplot crossing survey Bicycle Mode Share with Cycling Index, the fit line has a very high $R^2$ value (0.802). See Figure 7, below.

![Figure 7: Bicycle Mode Share and Cycling Index: a nearly linear relationship.](image)

It is important to note that the two high-cycling cities are a bit atypical, even outliers, as they are coastal towns which attract tourism. However, the people who were surveyed are regular year-long residents, not tourists. The presence of many bikeways is one reason tourists are attracted. It is also important to note that the slope found for cities is larger than towns, meaning that a faster response is seen for each investment.

The Cycling Index is a measure of the length of bikeway network per person. These two data points are among the most reliable: population and network length. Quality of data certainly does not explain the strength of this association entirely. By focusing on population and its relation to the network, it is expected that spatial relationships are captured by proxy.

There can be a difference between towns and larger cities, which was also explored.
When the study areas were separated into groups comprised of cities and towns, the relationships were even stronger ($R^2=0.916$ for cities with population larger than 100,000; see Figure 8, above). This relationship was also stronger when only the smaller towns were compared ($R^2=0.891$, see Figure 9, below). The slopes were different; there was more “bang for the buck” indicated for larger cities, which could be explained by many things (less hostile traffic in small towns, fewer medium-and-longer distance trips which are best served by bicycle, etc.).

This type of relationship was also demonstrated for cities in the United States, during the BICY project (Pucher, Buehler and Seinen 2011). Pucher’s analysis found there was no influence on cycling by hills. However, the strength of the linear relationship was weaker when many cities were included. (Note that because cycling levels are low in the USA, the error of source data may be effectively larger. It is not known how accurate the measurements of bikeways length are. It’s also important to consider that in the USA, there are almost no cycle tracks, having been prohibited until recently, and the conditions can be very severe in many areas due to high traffic and very low cycling levels.

**Figure 8:** Cities’ Bicycle Mode Share and Cycling Index: a nearly linear relationship.

**Figure 9.** Towns, a smaller slope.
Rapid Adoption and Adaptation of Bicycling

Bicycling is cheap. It is easy and quick to make provisions for bicycling. The primary barrier again and again is political will. In Barcelona, a rapid installation of low-cost protected bikeways was associated with a rapid increase in bicycling. If the armada of cars comes to a halt due to energy shortfalls or other economic changes, every street could be an instant paradise for bicycling, walking and other forms of nonmotorised transportation. But what if the shortfalls are segregated by class? What if there emerges an elite that will continue to drive, at the expense of the broad public good? What if resources continue to be gobbled up for driving alone?

Moreover, even if there is no driving, and/or no resources to continue to provide major infrastructure for driving, how suitable for everyday bicycle transport will a system in decline be? Are there new methods of providing “good roads” and paths, simply a smooth surface, to facilitate longer distance bicycling? In some places cobblestones, providing a rough but reliable surface, exist (Figure 9, below); in other places, deep holes would be found instead.

![Figure 9: the cobblestones below the street. As asphalt erodes for lack of resources, will it be better or worse for bicycling? What alternatives can people utilize to provide smooth, safe, comfortable bicycle facilities that connect all destinations? How can those destinations move closer together?](Photo by Jason Meggs in Gdansk, Poland.)

Protecting and conserving the energy effort of the bicyclist is essential. In some places (most notably the USA), frequent stopping has been introduced, which is wasteful, discourages cycling, and in fact is associated with increased injury and fatality for cyclists (Meggs 2012d, Meggs 2012e).

*The future of roads*

Are there more environmentally beneficial roadway construction methods (higher permeability for water, for instance) which would work if we changed something about our approach? I'm aware of emerging technologies in "green roads" (which typically look much like existing asphalt roads) although I'm not convinced they go far enough.
Are there ways to avoid tearing up roads for maintenance so soon after resurfacing, as often happens today with new technologies going in, and old water pipe infrastructure failing?

Can pavement priorities go to areas that most need perfect surfaces, such as bicycle routes?

There are efforts to make existing asphalt roadways more "green," which are still quite new. The cost is generally higher but it's been dropping quickly in some cases at least (e.g., reportedly in Chicago, 3X cost came down to 1.25X). Some involve permeability; some involve re-use of old tires, or old concrete. Some methods are projected to last longer, helping justify the cost.

Paying more up front for a longer lasting more sustainable/green roadway job makes sense in theory but in practice faces the same hurdles as all the good paradigm-shifting green ideas and good practices (bottom line short-term decision making rules, and problematic at best NPV theories cajole); in addition, under current financing we've passed 'Peak Roads,' to coin a term, and cannot maintain what we currently have, with the cost spiraling out of control as failure to maintain in the short-term means exponentially higher future repair costs.

Would the funds and resources committed to roads be better used in another part of the system if there was a new paradigm?

Roads existed for millennia before asphalt was introduced. Dirt is the default, but to advocate for dirt alone is a slow roads movement indeed, given the irregularities and muddy impassibilities that may result. However the industrial world has become firmly committed to asphalt, even as it becomes more and more costly. The industry is powerful and well established.

At the breaking points, however, asphalt that could not be repaired has been shredded – rendered into bits for improvised gravel, in rural areas. The San Francisco Bay Area region in the state of California, USA, is a very wealthy region. Yet its regional plan recently declared that over 1/3 of the total transport budget was to be spent on maintaining existing roads, but would not be enough, and without major investment now would become much more expensive to repair. At what point will this collapsing paradigm be abandoned, and what will replace it? For the instant question, will it be better or worse for bicycling?

In theory, local/residential streets do not need extraordinary pavement solutions. Rough surfaces means slower speeds, means less deadly traffic and higher quality of life. However, bicycling arguably is the mode most in need of smooth pavement. Can we picture designs which leave a place for bicycling, but reduce the development of pavement for parking, and for motor vehicle travel? What about heavy vehicles? It is said, the first heavy truck takes years off the life of the pavement. Why not find alternatives to heavy trucks on local streets?

Thus we must consider the many ways degrowth can play out, and formulate strategies.

*The quality of bikeways*

Simply placing a stripe on the ground is not enough to make a good bikeway network. Much attention must be given to the width, the surface quality, the connectivity – ultimately the utility – of the network as a whole and in the fine details. Comfort is important.
Extremely important are the intersections. Are there long delays? Are there needless conflicts? Are there dangerous conflicts? The great weakness of protected cycle tracks are the conflict points, a risk made worse by the fact that less experienced and capable cyclists are more likely to use protected cycle tracks.

A discussion of best practices in bikeway infrastructure design is presented in the BICY Project’s State of the Art Report (Meggs and Schweizer 2012f).

Other infrastructure and program needs

Infrastructure is not limited to bikeways – parking facilities, for example, are critical wherever theft is a problem. And infrastructure is not the only realm that matters.

Programs to train cyclists, to repair bicycles, to encourage and reward cyclists, are all important. Where there are large numbers of cyclists, many social support mechanisms appear organically. Where there are few, however, cyclists are more isolated, less provided for, and more at risk in myriad ways.

Fundamental respect and hostility

Anyone who has tried cycling in a diversity of environments knows it can range from pure bliss (e.g., in Northern Europe, particularly The Netherlands) to pure hell (a vast array of places). The attitudes of drivers are very important to this experience. Aggressive driving means more people hurt and killed.

![Bicyclist Feels Respected by Car Drivers](image)

**Figure 10:** Of the high cycling cities in the BICY Project, many fewer felt respected in the Italian cities and towns. How can cyclists remain protected if inequities increase, and the driving class becomes even more elite and callous toward human life?
In the City of Bologna, Italy, in the past year it was reported that 11 deaths occurred on the roads. All of these were bicyclists and pedestrians. These fatalities lie, however, for the true human cost is always much larger. Many are struck and essentially killed, but not recognized as such: left with disabilities, brain damage, perhaps even in a coma, these injuries are not recognized for their severity. Many times victims of collisions with automobiles die as a result of these catastrophic injuries, but the cause of death is not correctly attributed to the car crash. This can occur weeks and even years later.

As shown in Figure 10, above, not every country is equal in terms of the experience reported by bicyclists. Do they feel respected? How can it be that cyclists in Prague, where conditions are very bad, feel so respected by car drivers, while in Italy, in places with many more facilities, and better general conditions for bicycling, those who bicycle feel so profoundly and widely disrespected? How will this change in a major shift toward degrowth? Does it threaten the potential of cycling?

True, a population that must cycle, or believes in cycling on principle, will generally do so even if conditions are bad, as long as there is a way they will do so – even if unacceptable deaths and disabilities continue to occur, as they do today. However, today’s cyclists in this position are a minority, and cycling does not grow – therefore degrowth does not progress.

Thus disrespect for cyclists exacerbates inequity, damages lives and life, and is not an outcome consistent with the principles of the degrowth movement. Protection of cyclists must be made a high priority. The quality of life, the right to life, is an essential goal. Thus we can consider scenarios, and discuss preparations.

Scenarios of Degrowth: Good or Bad for Bicycling?

What will bring on Degrowth? Will it be fast or slow? Conscious, or unconscious?

Will it be a conscious, enlightened decision to shepherd “Spaceship Earth” toward an egalitarian, ecological utopia? Will it be a major disaster such as global pandemic of disease outbreak, or ecological collapse due to accelerated climate change? Or will it be a crashing and burning, with possible outcomes including total war and world dictatorship, or collapse, massive die-off, and widespread isolation and rebuilding? Assuming degrowth is inevitable, we must consider the many paths.

This is not the only forum to consider these issues, but they are considered too seldomly in the public eye. Perhaps the best founded criticism of doomsday warnings, by Prof. Vaclav Smil (2006) relies on continued use of ever lower grade finite resources, while calling those who predict a faster collapse a “Catastrophist Cult”.

One noteworthy treatment of four paths was given in Chapter 8 of the book Plan C: Community Survival Strategies for Peak Oil and Climate Change (Murphy). Murphy discusses Plans A and B (business as usual, perhaps with a green twist) in which the people loook to “the government and corporations to make the necessary changes – a guilty producer – innocent consumer perspective.” In Plan D, we have die-off: humans have gone, or will go, past the tipping point from which there is no saving us (war, starvation, and more may ensue). Murphy advocates for Plan C: Community and Curtailment, in which resource use is not just “conserved” but cut short; a serious lifestyle change and
major change for global economies. In the concept of degrowth, the first two plans are also rejected, and so one hopes is the third; thus Plan C, a conscious curtailment, seems the closest to the goals of degrowth.

However we do not have control of the process of billions of humans and the many organizations, natural forces and other actors, so here let us consider a related but different perspective on possible paths to degrowth.

We can use our imagination and our ideals, or our cynicism, to arrive at many scenarios. The question then becomes, how shall we prepare for these scenarios, what will be the best response wherever we find ourselves?

Scenarios considered:

A. Voluntary, gradual
B. Voluntary, rapid
C. Involuntary, gradual
D. Involuntary, rapid

A preliminary discussion of these four scenario concepts:

A. Voluntary, gradual. Given the forecasts of doom, we may be fortunate to have the luxury of a voluntary, gradual shift to degrowth resulting in overall improvements. Much is already understood, that can help people everywhere choose a different trajectory for the future. However, this requires unprecedented global unity and compassion, and changes in lifestyle which some would consider major sacrifices. Bicycling and other sustainable transport can only grow in this scenario. Is it possible to steer society to this in time, despite the addiction to growth, to petroleum, to carbon expenditures?

B. Voluntary, rapid. Here we have the optimistic solution of A, on a timeline that is much more likely to prevent disaster. Is it even more unlikely? Can society suddenly become convinced to change? Again because it is voluntary, inclusion and adoption of healthy, active transport is presumed to be assured.

C. Involuntary, gradual. Here the forces of nature, of resource limits, of social movements, of all the conceivable forces that would change the industrial juggernaut from its crash course, win and there is a progression to a new future. This future may be more painful than the voluntary one, although it may take less time. We can only speculate. It seems certain that active transport will be prominent in the outcome of this form of degrowth, however the quality of the experience may vary widely, depending on whether equity is increased rather than decreased. Will there be an elite that uses cars, and controls resources for personal motorized transport? This is already the case in developing places such as India, where the poor are suffering more and more for the creation of a city for cars, even though the ones who use them comprise only a small percent of the total population (Shiva 2010, nicely summarised in Mattick 2010).

D. Involuntary, rapid. Here the greatest wild cards appear. Overnight, in a crisis, the streets could fill with bicycles, and a completely new social norm, a more physical norm, can emerge. The air and noise pollution that has plagued the disadvantaged, could be greatly equalized. Accessibility might be even lower, however, in the near term, due to distances to services, unless longer distance transport is provided. This is the optimistic case. In the rapid scenario, great suffering might ensue: overnight jobs and access to essential services, and even food and water, can become scarce or completely non-
existent in a crisis scenario. Yet crisis comes with opportunity. Will the opportunity be squandered, or worse, exploited, and lead to greater inequity, and further the path of unsustainability toward ruin? Is a preparation necessary, and possible, to prepare for these windows of opportunity when the public at large, many of whom are not engaged in a public discourse and reconsideration of how we collectively live on our shared home, will proceed? There is much to be hopeful for; many examples exist, wherein “the incredible community spirit that can arise amid disaster” takes hold (Solnit, 2009). However in the important question of how the lowest economic group will survive and transport is not addressed; if inequity means nothing is done to provide for safe, comfortable and convenient transport; if space is not shared, and respect is not given; even though bicycling may rise from necessity, it will not be a happy condition and its overall utility and value can be expected to be reduced.

The above scenarios should be further discussed in light of “cynical realities” or “worst case” outcomes, versus “idealistic potentialities” or “best case” outcomes.

Conclusions

Preparation is essential. As with food, “strong preparation and advance investment may mitigate the extent of dislocation and hunger” (Neff et al. 2011). Transport is a commons, a massive interdependent system, one influenced and influencing all aspects of life to our very survival.

Cycling is an essential tool for degrowth, indispensable as a means of mobility beyond oil, a healthy and ultimately powerful, nearly universal, and equitable, means of transport, but a vulnerable and sensitive one particularly where major power imbalances occur (such as investments solely in motor vehicles, lack of provision for riding, lack of access, and ill and inequitable treatment in society).

In the context of degrowth, cycling might flourish or perish depending on the vision pursued and the allocation of limited resources. People will bicycle, given a place to do so. That place has been denied many people, and cyclists are often treated as second or third class citizens, who can even be killed without repercussions.

In successful degrowth, protection, respect and access might at last be provided, but this is far from assured, particularly if degrowth is a time of great challenge precipitated by crisis. While the sudden sweeping of motor traffic from the streets obviates the need for protected facilities, and encourages everyone who can to use a bicycle en masse, the challenges to provide basic infrastructure will threaten this new phase, and the old problems of inaccessibility may be worsened until land use can adjust.

It is important to consider the desired role of cycling and the path to achieve it, when planning for the various possible manifestations of degrowth (conscious or crisis; rapid or slow; resource driven or economic; etc.). Today, cycling is typically given the last consideration, the least road space; yet cycling promises great benefits to all. If conditions tighten, bicycling will be even more necessary, yet potentially even less provided for.

Given the general agreement that peak oil has already arrived, and industrial growth is in a plateau phase before inexorable contraction, and given that governments continue to dally in the face of potentially catastrophic climate change, it is likely that the scenario we face first will be rapid and crisis-driven. Peak oil is already shown to promise major health and environmental burdens, the chaos of a system in rapid, unplanned contraction will only exacerbate this. “Smart growth” ideas must be rapidly adjusted to “smart shrinkage” if every growth-borne social and economic system destabilizes.
Even if petroleum supplies remain adequate for the growth-dependent system to maintain some stability, other indicators show infrastructure is poised to decline faster than it can be repaired or replaced; roads are already declining and the roadway network is contracting. What would be the best possible response in maintaining a healthy and long-term sustainable transport system in the long term, given that so many other major adjustments and challenges will be underway? Are there new paradigms of roadway, are there rapid adaptations in land use and goods/people movement which achieve the ideals of intentional and best-case degrowth? Can humans collectively care for their commons before catastrophe, even extinction, is assured (Figure 12)?

What will be the means of transport in a world in Degrowth? Will it depend on the scenario precipitating a path of Degrowth? If Degrowth focuses on sustainability and social equity, certainly the bicycle offers a great deal to any society. The bicycle is the most energy efficient means of land transport, opening up worlds of possibilities beyond the expenditure of fossil fuels; food is the fuel, and a healthier population is a cobenefit.

Preparation for the a graceful and best-case degrowth must include many scenarios, with the most likely, and most risky, being the crisis-driven scenario. Crisis is an opportunity for change and adjustment. The risk is that inequities will exacerbate. Bicycling would be only one of many things to suffer in that case.

Bicycling is essential to degrowth. People will bicycle when they have to, if it can possibly done. But the quality of life and effectiveness of using a bicycle depends much on how we organize the land and the streets, and whether we provide protections, and connections, for those under wheel. The treatment of bicycling, and bicyclists, has been very poor in the past. Without creating a sacred place in society, now and for the future, in good times and bad, the cycling space will continue to suffer, and the best potential of degrowth will not be achieved.

**ENERGY SUMMARY**
- As a component of the thermodynamic cosmos Earth's energy gradient is similarly Chaotic, fractal and sensitive to any altered input.
- As an interchangeable expression of the Earth's crust its bios is also a component of the planet's energy-dispersion machinery.
- Each species' survival is therefore strictly determined by its energy budget. Species that extract too little or too much energy are swiftly eliminated. (Inadequate energy extraction leads directly to energy starvation and population collapse; Conversely, excess energy extraction produces exponential reproduction, and this too, leads to energy starvation and population collapse.)
- Our Homo genus evolved as an Ice Age primate omnivore some 2.5 million years ago, and survived well for most of that time.
- Threatened by global warming, 10,000 years ago our Homo sapiens ancestors switched to agriculture to augment their nutrient intake.
- Boosted by the development of combustion engines, fossil fuels, monoculture, intensive irrigation, petroleum-based fertilisers, pesticides, and mechanised fishing techniques, food became abundant during the 19th and 20th centuries, triggering a global plague of H sapiens.
- This abundance of food and fuel has now come to its inevitable end, and as mysticism reveals its Faustian face on a global scale in waves of civil unrest and fear-charged aggression, population growth will grind to a halt and our species will enter its terminal decline phase.
- In accordance with the laws of thermodynamics this collapse is now unavoidable and will prune H sapiens back to its genetic roots.

**Figure 12**: Final slide for humanity. (Morrison, 2012)
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