**Sustainable Development: How Diverging
Ideas Can Accomplish a Common Goal**

An STS Research Paper
presented to the faculty of the
School of Engineering and Applied Science
University of Virginia

by

Robert C. Donnan
March 27, 2020

**Sustainable Development: How Diverging Ideas Can Accomplish a Common Goal**

In 2018, the Intergovernmental Panel on Climate Change (IPCC) reported that to reduce risk of permanent damage to the planet (e.g. through extreme sea level rise), global warming must be limited to 1.5°C; the current projected rise is 2.0°C by the year 2100. To achieve this, the IPCC warns that human-caused carbon dioxide emissions must fall roughly 45 percent from 2010 levels by 2030 and reach net zero by 2050. This task, however, requires quick and substantial changes affecting industries, cities, energy sources, and uses of land. Nevertheless, global markets still demand economic growth, and world leaders concur. After the GDP grew roughly 3 percent in 2018, President Trump stated that the U.S. "accomplished an economic turnaround of historic proportions" (qtd. by White House, 2019). The benefits of growth are disputed. Economist Richard Easterlin (1974) found that growing wealth does not necessarily entail happiness. This idea, called the *Easterlin Paradox*, raises questions about how the success of a society is best measured.

In her nonfiction work, *Payback: Debt and the Shadow Side of Wealth*, Margaret Atwood (2008) suggests a future in which humanity continues to measure its success by economic metrics. In this world, mankind's quest for endless growth exhausts the earth of its natural resources. Money and power are worthless and primitive survival is the sole motivator. Atwood suggests, however, that we may avoid this dark future if humanity forgoes growth for the sake of sustainable development, as defined by *The Brundtland Report* as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987).

Three communities in particular have raised similar questions about society's motivations: the Beddington Zero Energy Development (BedZED) in Hackbridge, London; Masdar City outside of Abu Dhabi in the United Arab Emirates; and Poole's Land in Tofino, British Columbia. These communities, known as eco-villages, have shifted their mindset about growth in pursuit of sustainable development, however, their approaches and motivations differ. Masdar City and BedZED approach sustainable development through high tech design and thoughtfully laid out infrastructure. Poole's Land employs little-to-no technology and instead is centered around communal and environmental respect. By exploring how these communities converge and diverge in their ideas about sustainable development, we gain insight into how mankind can preserve its future on Earth.

**Review of Research**

*Eco-villages*

The term *eco-village* was defined by Robert Gilman in 1991 as a "human-scale full-featured settlement in which human activities are harmlessly integrated into the natural world in a way that is supportive of healthy human development, and can be successfully continued into the indefinite future." Researchers have investigated many aspects of these eco-villages. Renau (2020) explored the rapid growth of eco-villages in Spain to determine if this growth represented a significant social and cultural shift in the rural environment. In another study, Sherry (2019) used life cycle assessment (LCA) to quantify the environmental impacts of residents of three eco-villages (Sirius Community, Earthaven, and Ecovillage at Ithaca). By tracking the home energy use, transportation

energy use, food consumption, and waste disposal of the residents of these communities, the researchers determined that eco-village residents have significantly lower environmental impacts compared to those of average U.S. residents. Rubin (2019) used Dancing Rabbit, an eco-village in Missouri, as a case study on how communities can benefit from accepting diverse perspectives on the role of technology in sustainable development. None of these studies compares how different attitudes towards technology and community determine the success of multiple eco-villages.

*Poole's Land, BedZED, and Masdar City*

Journalists and researchers have written about these communities as innovators of sustainable development. Poole's Land, in British Columbia, was featured in a 2018 Vice Canada documentary, which explores the ideas, interests, and values of the community and its founder, Michael Poole (Vice Canada, 2018). Zhu et al. (2015) studied BedZED and Masdar City as technical case studies. None have studied and compared the three communities side-by-side.

**Community Backgrounds**

*Poole's Land*

Poole's Land is a 17-acre community in the rainforest of Tofino, British Columbia. Established in 1988 by Michael Poole, Poole's Land is home to "wayward souls, transitory workers, travelers, gardeners, and a host of creatures large and small" (Poole 2019). In Vice Canada's 2018 documentary, one resident describes it as "a hostel campground for people who want to feel loved." The facilities of Poole's Land are

minimalist. Residents live in broken-down school buses and shoddily built shacks. The few rules in Poole's Land include: respect all beings, recycle as best as you can, commit no violence, and use no hard drugs (Vice Canada, 2018). For 33 years the community has existed in harmony with Tofino and even Mayor Josie Osbourne has acknowledged that it "confronts our perceptions and our biases about lifestyles and the way people choose to live" (qtd. by Renwick, 2018). However, the future of Poole's land is uncertain as its founder considers pursuit of a new development project (Renwick, 2018).

*BedZED*

Beddington Zero Energy Development (BedZED) is an energy-efficient housing development in Hackbridge (London), England. The project was led by Peabody, a London housing association, and designed by Bill Dunster Architects to be the "first large-scale 'carbon-neutral' development" (qtd. by Hyde et al., 2007, p. 44). Peabody manages the 82 homes in BedZED, promising its residents value for their money, transparent business plans, and a serious approach to climate change (Peabody, 2019). With its car-free roads, open pavilions, and gardens, BedZED has fostered a friendly community. Familiar neighbors, social events, and distinctive character are among what one former resident miss most about BedZED (Smith, n.d.).

*Masdar City*

Masdar City is a developing city project near Abu Dhabi in the United Arab Emirates. The project is led by Masdar, a portfolio company of the global investment firm Mubadala. Masdar (2019a) considers itself a "global leader in renewable energy and

sustainable urban development," and aims to be a "model for the commercial adoption of clean technologies." Construction began in 2008 and two years later the Masdar Institute of Science and Technology became the first tenant. This was part of Deputy Prime Minister Sheikh Mansour's commitment to "the development of human capital as a foundation to drive the country's long-term economic viability" (qtd. by Atef, 2010). Today, Masdar city hosts over 450 companies and acts as a "real-time laboratory to monitor and study how cities, use, conserve and share resources" (Masdar, 2019b).

**The Sociotechnical Spectrum of Sustainable Development**

While the goals of sustainable development are widely agreed upon, conceptions of a sustainable future vary greatly across communities and cultures. This divergence is particularly apparent with regards to the role of technology in humanity's future. For example, the National Research Council (1995) promotes technology as "a means to overcome" the "many obstacles to the transition to sustainable development." They state that technological improvements in energy production, transportation & public infrastructure, water & food systems, manufacturing & mining processes, materials development, and information technology are the key components in achieving a sustainable future.

Although few would disagree with that claim, Munyon et al. (2018) demonstrates that technological improvements do not always achieve their intended effect. The researchers found that a 1% improvement in fuel efficiency was associated with a 1.2% increase in vehicle miles traveled, negating the improvement in efficiency. This concept, known as Jevons' Paradox (1865), explains that an increase in the efficiency of

consumption of a resource (more miles per gallon) is accompanied by an increase in the rate of consumption of that resource (more miles travelled). Jevons' Paradox can be applied to other facets of life, for example, energy consumption at work or home. It raises questions about the real effects of efficient design and the role of technology in sustainable development. Kris De Decker (2020) is another skeptic of pure reliance on technological progress, promoting "the potential of past and often forgotten knowledge and technologies when it comes to designing a sustainable society." In his publication, *Low-tech Magazine*, De Decker (2015) presents how lost technologies, such as the Chinese Solar Greenhouse, can replace or supplement modern solutions.

Technology plays a divisive role when it comes to sustainable development. While some believe that technological progress is key, others argue that the answer is likely overlooked. These positions fit into the framework of the sociotechnical spectrum, ranging from zero tech to future tech (Norton, 2019). Analyzing solutions in our three eco-villages and placing them on this spectrum helps uncover technology's role in achieving a sustainable future.

*Poole's Land*

Poole's Land serves as an extreme example of zero tech sustainability. Manual labor and simple tools replace many modern conveniences. Nestled in the rainforest, the community utilizes the resources around them for building materials and supplements them with a variety of recycled items. Food is grown by residents in simple greenhouses and work is distributed on the basis of personal accountability (Hofmann, 2014). Michael

Poole himself grows a wide range of crops to feed the members of his community, even recycling human waste to fertilize his produce (Krishnan, 2018).

It costs 10 dollars a night to stay in Poole's Land, however, travelers are able to earn their stay through labor. Despite employing zero technology, this transaction embodies Poole's own personal convictions about sustainability. He believes that humans need to be "responsible for our own lives," instead of enabling the inhumane working conditions that exist abroad (qtd. by Hofmann, 2014). Through this he has fostered both an individual and communal sense of responsibility that reflects in how residents treat one other and nature.

*BedZED*

BedZED employs a wide range of solutions across the sociotechnical spectrum. Some aspects of the residence employ little-to-no technology, while others approach the future tech end of the spectrum. Before design began, an engineering firm developed a method called energy grading to help match renewable energy sources to demands (Twinn, 2003). This low tech methodology ensured the most efficient use of renewables once design began. The architects were intentional in the materials used for building. With advanced knowledge of materials science, they were able to identify the thermal capabilities of materials and match them to a precise function. This knowledge, along with an understanding of physics and heat flow, led the architects to design a structure that required little additional heating or cooling, greatly reducing energy requirements (Marszal et al., 2010). They were also intentional in the sourcing of their materials. By

using locally sourced and recycled building materials, the environmental impact of BedZED's construction was reduced by 20-30% (Lazarus, 2002).

Apart from the structure itself, BedZED's design includes many other efficiency solutions across the sociotechnical spectrum. A simple, but innovative bio-fueled combined heat and power (CHP) system was constructed to supplement other energy sources, however, it was shut down due economic infeasibility on such a small scale (Hodge & Haltrecht, 2010). Intelligent water systems, solar panels, electric cars, and information technology infrastructure are among BedZED's medium to high tech sustainability solutions; however, BedZED approaches future tech with its heat recovery wind cowls. These wind cowls were designed specifically for the residence and provide ventilation and heat recovery to each home. This technology, combined with the intelligent design of the structure eliminated the need for all components of traditional temperature control, allowing for a totally renewable system (Twinn, 2003). Similar to Poole's Land, BedZED employs many zero tech approaches to sustainable living, however, these methods will be discussed in a later section.

*Masdar City*

Of the three eco-villages, Masdar City employs the most modern technology at the largest scale. The community was planned to operate at net-zero carbon levels, with power supplied a 22-hectare field of 87,777 solar panels, as well as additional panels on the roofs of buildings (Kingsley, 2013). They do not, however, intend to solely rely on existing photovoltaic technology for its power supply. In 2020, the Khalifa University of Science and Technology announced the installation of a first-of-its-kind solar

concentrator at the Masdar Institute campus. This marked the "first step in the development of a scalable high-temperature concentrated solar power system (CSP)," an innovative approach to harnessing solar energy (Oommen, 2020).

In order to maximize the effect of these renewable energy sources, a number of consumption reduction methods were introduced. An electric, automated personal rapid transit (PRT) was originally conceived for Masdar City to replace inefficient conventional transportation. While this seemingly future technology seemed promising, the program was scrapped due to economic and logistic infeasibility (PRT Consulting, 2010). Other mass transit, including electric busses are planned to replace the PRTs (Walsh, 2011).

The designers of the Masdar City likely understood Jevons' Paradox and intentionally reduced residents' tendency to over-consume resources. They replaced water taps and light switches with movement sensors (Kingsley, 2013). The architects also designed the community with short, narrow streets and self-shading facades. This design, coupled with the carefully selected materials to distribute the desert heat, greatly reduces the temperature of Masdar City, reducing the required energy for cooling (Foster + Partners, n.d.). This combination of low and high tech solutions is why buildings in Masdar City are capable of utilizing 54% less water and 56% less energy than conventional buildings in the UAE (Patel & Griffiths, 2013).

Similar to BedZED, the developers of Masdar City were conscious of more than just energy savings when approaching sustainable development. The community was built with "unique, locally sourced materials," including recycled aluminum, sustainably sourced wood, and low-emissions concrete made on-site (Patel & Griffiths, 2013).

According to developers, 80% of water is recycled and a large recovery facility recycles and composts the city's solid waste, reducing landfill needs by 50% (Palca, 2008; Patel & Griffiths, 2013).

**Fostering a Sense of Community**

*Importance of Community*

As discussed previously, Poole's Land is rooted in acceptance and accountability. Therefore, residents treat both the Earth and their peers with respect. This same ideology exists among BedZED residents today. As a community designed with efficient energy systems, it seems at risk exemplifying Jevons' Paradox, where an increase in residents' consumption negates the effects of the technology. In reality, this is not the case as dwellers share a common respect similar to Poole's Land. One resident writes, "there's a real strong sense of shared values as well as a strong community feel at BedZED" (qtd. by Bioregional, n.d.). It is these shared values of the residents that enable the technologies employed in BedZED to reach their full energy saving potential.

*Community by Design*

An eco-village has the advantage of attracting individuals with a common care for sustainability. The designers of BedZED, however, did not solely rely on this idea. Instead, they recognized the importance of relationships & comfort and intentionally designed to promote a sense of community. Many features foster a social environment and a create a shared sense of green living. Accessible to residents are "sky gardens" that sit atop the apartments as a communal space. There are also a number of troughs

available to all residents to grow vegetables. These opportunities to share a common experience is what led one resident to note, "the social side is almost the best bit" (qtd. by Slavin, 2006).

The layout of the entire space itself serves the function of fostering community. A community playing field and village square promote frequent social gatherings. Once a month, a community bar is run in the main pavilion where adults and children alike unwind and socialize. Weekly gardening sessions led by residents promote comradery in green living (Smith, n.d.). Lastly, its electric car club and bike-friendly streets allow residents to share in the experience of ditching fossil fuels for more sustainable transportation methods (Bioregional, 2017). This sense of community both attracts and retains BedZED's residents and promotes environmental responsibility. Without it, there is greater risk that Jevons' Paradox comes into play and reduces the efficacy of sustainable design. With this in mind, as Masdar City matures and hosts more residents, it will be important to observe if they will need to foster this same sense of individual responsibility in order to achieve their goals.

**Success and Shortcoming**

*Motivations for Sustainable Development*

Before assessing the degree of success or failure that an eco-village has achieved, it is important to understand the motivation for each of the projects. Although emissions statistics are important metrics in sustainable development, it would be shortsighted to assume they are the sole indicator of success. Conceptions of a sustainable future vary

greatly; however, as shown by the three eco-villages, sustainable development means more than just achieving low carbon emissions.

In 1988, Michael Poole purchased the 17.5 acres that became Poole's Land for $50,000. Depleted of all funds, Poole allowed travelers to camp on his property in exchange for their help in developing the land. From then on, Poole's land served as a communal living space, free from the structure of modern life. Others have since attached their own labels to the community, however, Poole himself describes it as an "anarchist experiment" (qtd. in Renwick, 2018).

BedZED was conceived by sustainability charity Bioregional and green architect Bill Dunster in 1997 (Bioregional, 2017). The community was founded under the principles of achieving the sustainability 'triple bottom line,' which includes social amenity, financial effectiveness, and reduced environmental impact (Hyde et al., 2007). Its purpose was to serve as an example that a high level of sustainability can be practical and cost-effective in large-scale construction (Twinn, 2003).

The Masdar Initiative was founded in 2006 by the Abu Dhabi government to address the high per-capita carbon emissions in the UAE. Attempting to incubate the development of renewable energies in Abu Dhabi, Masdar City was envisioned to serve as a clean energy "research hub and test-bed" (Patel & Griffiths, 2013). The city was designed to house up to 50,000 people and 1,500 business, with over 60,000 workers expected to commute to the city each day (Center for Public Impact, 2018). The Masdar Institute of Science and Technology was established to become a leader in tertiary education, specifically focusing on sustainable technologies (United Arab Emirates, 2007).

*Assessment of Success*

It is clear that each eco-village was established with a unique set of goals. Michael Poole sought to create an environment of acceptance, apart from the expectations and conventions of modern life. Bioregional and Bill Dunster wanted BedZED to serve as an example of practical sustainable development and motivate others to pursue similar projects. Recognizing their role in the proliferation of greenhouse gas emissions, the UAE conceived Masdar City to both reduce their carbon footprint and to establish themselves as a global hub for sustainable commerce and technological development.

Poole's Land has achieved precisely what Michael Poole sought to create when he first developed the land in British Columbia. By fostering mutual respect for the earth and others, the community has left a negligible carbon footprint and has provided refuge for the 20,000 visitors it hosted over its lifetime (Renwick, 2018). Due to Poole's desire to pursue his next stage in life and increasing pressure from the Tofino government, the community is coming to an end after 31 years in the rainforest. While the original land may be sold, Poole intends to help purchase new land to accommodate for the displacement of residents (Bailey, 2019).

BedZED has received criticism for failing to meet goal of carbon neutrality, especially in its early years before its CHP system was entirely scrapped (Slavin, 2006). BedZED households, however, have proven to use 45% less electricity, 81% less gas, and over 50% less water than local averages (Hodge & Haltrecht, 2010). On top of these emissions savings, BedZED has received great demand from those interested in economic, sustainable living (Bioregional, n.d.). Classifying BedZED as a success or

failure depends on the standard it is held to. If the standard is achieving carbon neutrality, it may be deemed a failure. On the other hand, if the 'triple bottom line' is the standard, BedZED appears as a complete success.

Similar to BedZED, Masdar City was intended to achieve net zero carbon emissions. This goal however, was qualified by the design manager of the community, stating that "as of today, it's not a net zero future… it's about 50%" (qtd. by Goldenberg, 2016). The completion date for the project was pushed back by 5-10 years due to the global financial crisis, delaying the arrival of residents and workers (Walsh, 2011; Stanton, 2010). As of 2016, less than 30% of the planned area had been developed, fewer than 2,000 were employed, and only the 300 students of Masdar Institute lived within the community (Goldenberg, 2016). Despite these shortcomings, Masdar City has become host to important organizations such as the International Renewable Energy Agency (IRENA) and conglomerates such as Siemens and General Electric (IRENA, 2015; Mazzoni, 2014). The Masdar Institute of Technology has also facilitated the development of innovative new technologies, such as their breakthrough in concentrated solar power systems. Therefore, depending on the standard to which it is held, Masdar City can either serve as a case study for success or failure in sustainable development.

**Conclusion**

As the IPCC warned, extensive actions must be taken to prevent irreversible damage to the planet. This preservation, however, is only feasible if humanity is able to shift its mindset about growth and instead focus on sustainable development. In order to gain insight into how humanity can manage this shift, three eco-villages were explored in

depth. Solutions across the sociotechnical spectrum were examined and their role in sustainable development was established for each eco-village. Next, the importance of community in achieving sustainable living was identified, followed by an assessment of the motivations, successes, and shortcomings of the communities.

While Poole's Land solely utilizes low tech means, BedZED and Masdar City employed sustainability solutions across the entire sociotechnical spectrum to achieve their goals. These communities displayed how different ideologies lead to different interpretations of sustainable development. Poole's Land and BedZED displayed the importance of fostering a shared set of sustainable values. Masdar City showcased how large investments into sustainability can fuel technological innovation and incite corporate participation.

These eco-villages show the importance of utilizing a combination of solutions across the sociotechnical spectrum and help guide an approach to sustainable development. The first step is to understand human behavior. Once this is done, then clear goals can be defined for any sustainable system. Only after these steps have been taken should technologies be assessed or developed for implementation. Otherwise, the risk that the technology does not meet the needs of the system increases substantially. If world leaders follow these principles when approaching sustainable development, then this world may be safeguarded for future generations.

# References

Atef, M. (2010). Inauguration of Masdar Institute campus at Masdar City underscores Abu Dhabi's commitment to build a knowledge-based economy (Press release). Archived at www.webcitation.org/69UWkmUIL?url=www.zawy a.com/story/ZAWYA20101123121153/

Atwood, M. (2019). *Payback: debt and the shadow side of wealth.* Toronto: Anansi.

Bioregional (n.d.). BedZED – the UK's first large-scale eco-village. www.bioregional.com/projects-and-services/case-studies/bedzed-the-uks-first-large-scale-eco-village

Bioregional (2017). The BedZED Story. storage.googleapis.com/ www.bioregional.com/downloads/The-BedZED-Story_Bioregional_2017.pdf

Brundtland, G.H. (1987). Report of the World Commission on Environment and Development: Our common future. www.un-documents.net/our-common-future.pdf

Centre for Public Impact (2018). Masdar City in Abu Dhabi. www.centreforpublicimpact. org/case-study/masdar-city/

De Decker, K. (2015). Reinventing the greenhouse. www.lowtechmagazine.com/ 2015/12/reinventing-the-greenhouse.html

De Decker, K. (2020). What is Low-tech Magazine? Low-Tech Magazine. www.lowtech magazine.com/ about.html

Easterlin, R. A. (1974). Does economic growth improve the human lot? Some empirical evidence. *Nations and Households in Economic Growth: Essays in Honor of Moses Abramovitz, 89-125.*

Gilman, R. (1991). The Eco-village challenge. *In Context, 29, 10.* Archived at web. archive.org/web/20041213201638/www.context.org/ICLIB/IC29/Gilman1.htm

Goldenberg, S. (2016). Masdar's zero-carbon dream could become the world's first green ghost town. *The Guardian.* www.theguardian.com/environment/2016/feb/16/ masdars-zero-carbon-dream-could-become-worlds-first-green-ghost-town

Hodge, J., & Haltrecht, J. (2010). BedZED seven years on: The impact of the UK's best known eco-village and its residents. UK: BioRegional Development Group.

Hyde, R., Watson, S., Cheshire, W. Thompson, M. (2007). *The Environmental brief: Pathways for green design.* London: Taylor and Francis.

IPCC (2018). Intergovernmental Panel on Climate Change's summary for policymakers of IPCC special report on global warming of 1.5°C approved by governments. www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/

IRENA (2015). IRENA opens doors on new permanent headquarters in Masdar City. www.irena.org/newsroom/articles/2015/Jun/IRENA-Opens-Doors-on-New-Permanent-Headquarters-in-Masdar-City

Jevons, W.S. (1865). *The Coal Question; An Inquiry Concerning the Progress of the Nation, and the Probable Exhaustion of Our Coal Mines.* London: Macmillan and Co.

Kingsley, P. (2013). Masdar: the shifting goalposts of Abu Dhabi's ambitious eco-city. *Wired.* www.wired.co.uk/article/reality-hits-masdar

Krishnan, M. (2018). I joined an anarchist commune expecting to hate it, but coming home sucked. *Vice.* www.vice.com/en_us/article/vbab33/i-joined-the-pooles-landing-anarchist-commune-expecting-to-hate-it-but-coming-home-sucked

Lazarus, N. (2006). Toolkit for Carbon Neutral Developments. Vol 2. UK: BioRegional Development Group.

Marszal, A.J., Heiselberg, P., Bourrelle, J.S., Musall, E., Voss, K., Sartori, I., Napolitano, A. (2011). Zero energy building: a review of definitions and calculation methodologies. *Energy and Buildings, 43(4), 971-979.* doi.org/10.1016/j.enbuild.2010.12.022

Masdar (2019a). About us. masdar.ae/en/about-us

Masdar (2019b). Facts and awards. masdar.ae/en/about-us/useful-links/facts-and-awards

Mazzoni, M. (2014). Siemens, GE open up shop at Masdar City. www.triplepundit.com/story/2014/siemens-ge-open-shop-masdar-city/46361

Munyon, V.V., Bowen, W.M., Holcombe, J. (2018). Vehicle fuel economy and vehicle miles traveled: An empirical investigation of Jevon's Paradox. *Energy Research & Social Science, 38, 19-27.* doi: 10.1016/j.erss.2018.01.007

National Research Council (1995). *The Role of Technology in Environmentally Sustainable Development.* Washington, DC: The National Academies Press. doi.org/10.17226/9236.

Norton, P. (2019, Nov. 8). Back to Sustainable Urban Mobility (lecture). Innovation, Business, and Law Center, University of Iowa College of Law, Iowa City.

Oommen, A. (2020). Masdar City hosts UAE's first solar concentrator at the MISP. www.constructionweekonline.com/projects-and-tenders/262091-masdar-city-hosts-uaes-first-solar-concentrator-at-the-misp

Palca, J. (2008). Abu Dhabi aims to build first carbon-neutral city. NPR. www.npr.org/templates/story/story.php?storyId=90042092

Patel, P., & Griffiths, S. (2013). Masdar City showcases sustainability. *MRS Bulletin* 38(6), 450-451. doi:10.1557/mrs.2013.140

Peabody (2019). About us. www.peabody.org.uk/about-us

Poole, M. (2019). About. www.poolesland.com/about-2/

PRT Consulting (2010). Why has Masdar personal rapid transit (PRT) been scaled back?. Archived at web.archive.org/web/20131213234856/www.prtconsulting.com/blog/index.php/2010/10/16/why-has-masdar-personal-rapid-transit-prt-been-scaled-back/

Renau, L.D. (2020). Ecovillages in Spain: Looking for an emancipating social transformation? *Documents D Analisi Geografica, 66(1), 209-231.* doi: 10.5565/rev/dag.527

Renwick, M. (2018). For years, it was an ecovillage and a commune. Now, Poole's Land in Tofino, B.C., is up for sale. *Globe and Mail.* www.theglobeandmail.com/canada/article-pooles-land-a-modern-day-anarchist-experiment/

Rubin, Z. (2019). Ecovillagers' assessment of sustainability: Differing perceptions of technology as a differing account of modernism. *Sustainability, 11(21).* doi: 10.3390/su11216167

Sherry, J. (2019). The impact of community sustainability: A life cycle assessment of three ecovillages. *Journal of Cleaner Production, 237.* doi: 10.1016/j.jclepro.2019.117830

Slavin, T. (2006). Living in a dream. *The Guardian.* www.theguardian.com/environment/2006/may/17/energy.communities

Smith, S. (n.d.). Bye bye BedZED. www.bioregional.com/news-and-opinion/bye-bye-bedzed

Stanton, C. (2010). Masdar City completion pushed back, but total cost falls.
www.thenational.ae/uae/environment/masdar-city-completion-pushed-back-but-total-cost-falls-1.532529

Twinn, C. (2003). BedZED. *The Arup Journal, 38(1), 10-16.* London: Arup.

United Arab Emirates (2007). ADEFC signs a cooperative agreement with The Massachusetts Institute of Technology (MIT). Archived at web.archive.org /web/20090210101525/www.ameinfo.com/111720.html

Vice Canada (2018). Welcome to Poole's Land, an anarchist commune in the Canadian rainforest. *Vice.* www.vice.com/en_ca/article/ev3aw4/pooles-land-an-anarchist-commune-in-the-canadian-rainforest

Walsh, B. (2011). Masdar City: The world's greenest city? content.time.com/time/ health/article/0,8599,2043934,00.html

White House (2019). Economic growth has reached 3 percent for the first time in more than a decade thanks to President Donald J. Trump's Policies. www.whitehouse.gov/briefings-statements/economic-growth-reached-3-percent-first-time-decade-thanks-president-donald-j-trumps-policies/

Zhu, D., Kung, M., Zhou, L. (2015). Analysis of sustainable energy systems in ecovillages: A review of progress in BedZED and Masdar City. *Low Carbon Economy. 6. 1-6.* doi: 10.4236/lce.2015.61001