RE-CITY
INTERNATIONAL PLATFORM
FOR SOCIAL SUSTAINABILITY

01/19

RAPPORTEURSHIPS "FACING CLIMATE CHANGE"

"HOW TO BUILD RESILIENT CITIES LOCALLY?"

SESSION WITH **PETER NEWMAN.**

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How to build resilient cities *locally*, while being part of a *global* decarbonization process

Invited Speaker: Peter Newman AO. Professor of Sustainability, Curtin University, Australia. Lead Author of IPCC

Contents

This report is a synthesis of the debate carried out with Peter Newman in the conference series 'Facing climate change', organised by Catalunya Europa Foundation in the context of the Re-City project. This session, entitled 'How to build resilient cities locally, while being part of a global decarbonization process' consisted of a public lecture, a seminar with participants from the academic sector of Catalonia and a lunch-debate that brought together personalities from the economic, social, political and business sector of Catalonia. The activities mentioned were held in Barcelona at the Antoni Tàpies Foundation in October 2018. The content order is thematic and does not represent the order in which it was presented by Newman. The conference series 'Facing climate change' is developed in collaboration with BBVA, Generalitat de Catalunya, Àrea Metropolitana de Barcelona and Barcelona City Council.

Biography

Peter William Geoffrey Newman (born in 1945) is an environmental scientist, author and educator based in Perth, Western Australia. In 1972 Newman obtained his PhD in Chemistry from University of Western Australia (UWA) and completed his post-doctoral studies in Environmental Science at TU-Delft University, The Netherlands. In 1973-1974, he completed post-doctoral studies at Stanford University. He began his academic career at Murdoch University in 1974 and he left in 2007 after 20 years as the Director of the Institute for Sustainability and Technology Policy. Since 2008, he has been the Professor of Sustainability at Curtin University and Director of the Curtin University Sustainability Policy (CUSP) Institute. Currently, he sits on the Board of Infrastructure Australia which is funding infrastructure for the long-term sustainability of Australian cities and is a **Lead Author for Transport on the Intergovernmental Panel on Climate Change** (IPCC).

In the second half of the 1980s, he created the term "automobile dependence", which contributed to rise his international academic profile. This term was used to explain how cities at that time - based on sprawling suburbs - were inevitably leading to an extensive use of automobiles. From 1976 to 1980, Newman was elected Fremantle City Councillor of Perth. Since 1979, he has been closely associated with the saving and rebuilding of Perth's rail system, which is now considered as a model for how car dependent cities can evolve towards transit oriented sustainable urban systems (TOD). Between 2001 and 2003 Newman supported the framing of Western Australia's Sustainability Strategy in the Department of the Premier and Cabinet. In 2004-2005 he advised the Sidney government on planning and transport issues serving as Sustainability Commissioner. Since 2010, he has been the Science Director of the Program on Sustainable Urban Development at Cooperative Research Centre for Spatial Information (CRCSI), the Director of the Program on Greening the Urban Environment at National Centre for Sustainable Built Environments, and the Project Leader of Sustainable Cities at Commonwealth Scientific and Industrial Research Organisation (CSIRO).

Throughout his career, Newman has written 20 books and over 330 papers on sustainable cities. His recent books include "Resilient Cities: Overcoming Fossil Fuel Dependence" (2017), "The End of Automobile Dependence: How Cities are Moving Beyond Car-based Planning" (2015), "Decarbonising Cities: Mainstreaming Low Carbon Urban Development" (2015), "Green Urbanism in Asia" (2013), "Resilient Cities: Responding to Peak Oil and Climate Change" (2009) and "Green Urbanism Down Under" (2009).

Summary

"Climate change is perceived throughout the world. The global system is not working." This is how Peter Newman started his speech, opening the conference series "Facing climate change" which is part of the Re-City platform.

“We all share a world that is warming. Although the consequences may be different depending on the point on the planet where we live, the truth is that the effects of climate change imply us all”. Peter Newman, said that this implies great changes in the current system of energy, transport, cities, industry and land use to achieve the objective of a maximum increase of the average temperature at 1.5°C above the pre-industrial temperature, as stated in the last Intergovernmental Panel on Climate Change (IPCC) report. The report has been launched the day Neuman gave his talk, and being one of the authors, he remarked the major changes to go through in order to decoupling economic growth, and the use of fossil fuels. This is: stop depending on fossil fuels to maintain economic growth.

Newman stated that climate change is both global and local. Cities do not have to wait for legislative changes to act. In fact, there are many examples of cities that are at the forefront of initiatives that fight against climate change and affect decarbonization. One of the paradigmatic examples is the use of electric public transport. There are also other less known initiatives, as biophilic cities (which seek to bring nature closer to the inhabitants of large cities to improve life quality and reduce atmospheric CO_2) or other examples explored through its talk. Finally, Newman emphasised the importance of investing in disruptive innovations that improve how cities adapt and mitigate climate change.

How we can globally adapt to and mitigate climate change

The world has been undergoing a globalised warming after the Second Industrial Revolution (Figure 1) caused by the emission of greenhouse gases (GHG), especially the carbon dioxide (CO_2). Newman remarked that the greenhouse effect is needed to maintain life in the Earth, as Earth's average temperature would be approximately -18ºC without it, while nowadays is 16ºC. The problem comes when the emissions of GHG are so large that Earth's mean temperature rises too much. **The Paris Agreement (2015) stated that the Earth's average global temperature must not increase more than 2ºC above the pre-industrial temperature. However**, **the updated IPCC report just published** (on Monday 8th October 2018) **states that this rise must not be more than 1.5ºC**. **Nowadays, the global increase is already 1.1ºC worldwide**. A global increase of 0.5 ºC is relevant since oceans play a major role for world climate, represent 71% of the Earth surface and absorb over 90% of excess heat accumulated in the climate system.

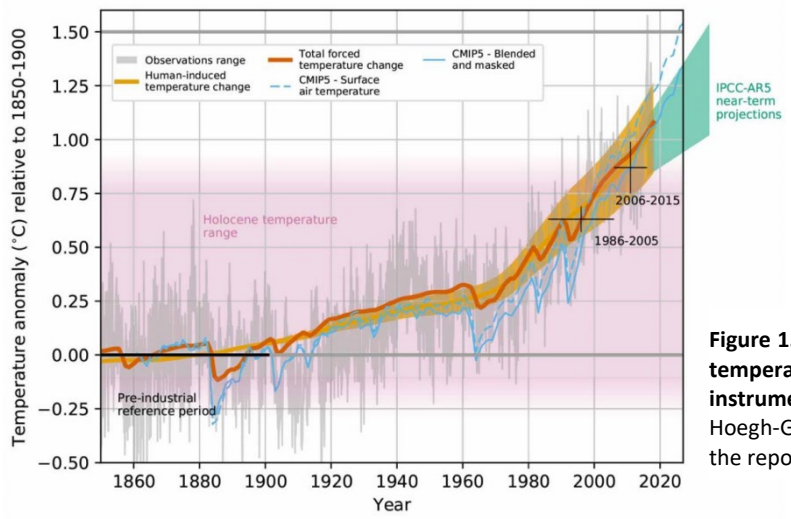


Figure 1. Evolution of global mean surface temperature (GMST) over the period of instrumental observations. Extracted from: Hoegh-Guldberg *et al.* (2018) (Figure 1.2 of the report)

A global increase of more than 1.5ºC above the pre-industrial temperature will cause big serious problems in our cities and agriculture. In Figure 2, it can be appreciated that the major risks for natural, managed and human systems nowadays are the coral bleaching, the melting of Arctic ice and the coastal flooding. In a 2ºC increase context, there will be also relevant disappearance of small fisheries at low latitudes and disturbances in thermohaline circulation. In this context, Newman stated that reducing the carbon going into the atmosphere will reduce the pollution from fossil fuels to land, water and air; diminish the loss of biodiversity; reduce health issues related with particles, chemicals and heat; among other benefits.

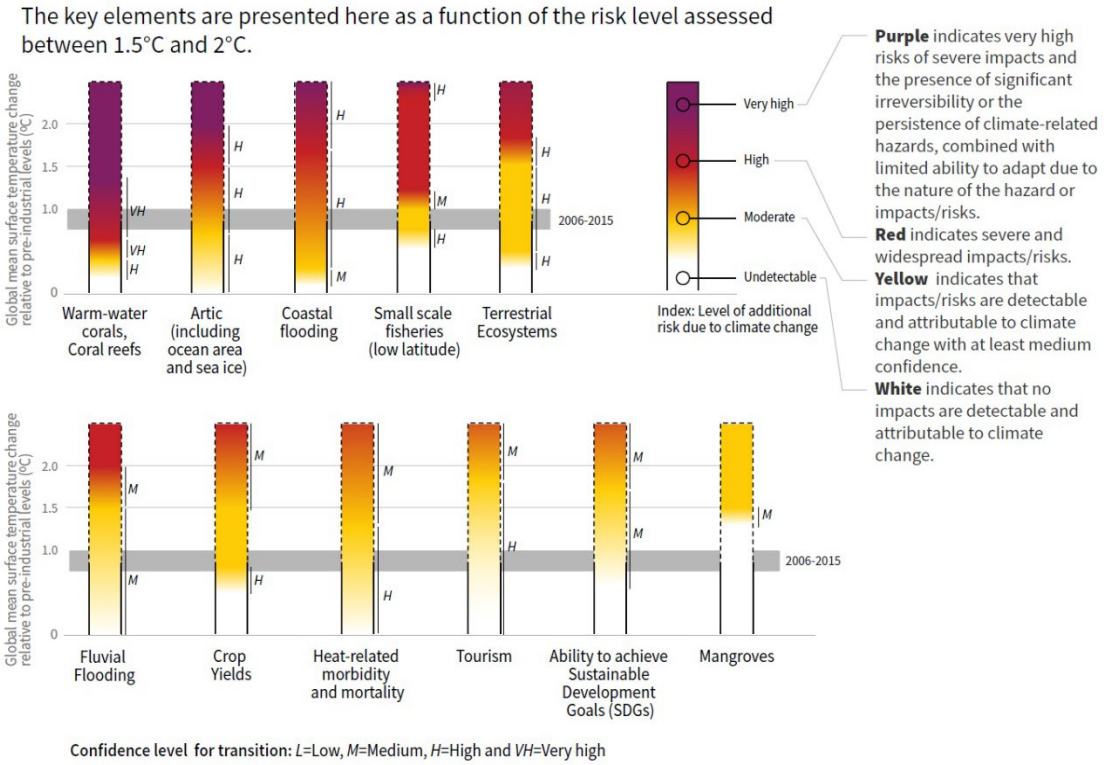


Figure 2. The dependence of risks and impacts associated with selected natural, managed and human systems on the level of climate change; and highlighting the nature of this dependence between 0°C and 2°C warming above pre-industrial levels. The grey bar represents the range of GMST for the most recent decade (2006-2015).

Since the Fifth Assessment Report of IPCC (2014), there have been some progress in different systems (Figure 3):

- **Energy system** has experienced a rapid disruption through the rise of solar and wind energies together with the use of batteries. According to Newman this must be mainstreamed into all grids.
- **Urban system** has multiple examples of zero carbon urban regeneration. Newman also believes that this must be mainstreamed into all urban development, including informal settlements.
- **Transport system** has undergone a disruption through the increase of electric vehicles. This type of vehicles must be mainstreamed, and Newman pointed out that the price has to be lowered. In the case of freight, aviation and shipping, they must transform their power source into biofuel.
- **Industrial system** only has minor examples of low carbon footprint industries. Most of the industries use gas and some use coal, but Newman believes that they will need to shift to renewables or they will not survive.

- **Land system** only has minor examples of progress because forestry, fishery, livestock, etc. all involve carbon dioxide release. However, it has been demonstrated that the transformation can be done quickly. As mentioned by Newman, in America and mostly in emergent countries, deforestation is more extended than reforestation, so there is a global carbon release to the atmosphere. On the other hand, in Europe, reforestation is generally more important than deforestation, so carbon is taken up from the atmosphere through photosynthesis.

System	Progress since AR5....	Needed for 1.5ºC....
Energy	Rapidly disrupting through solar and wind with batteries.	Mainstreaming into all grids and new systems for those without power
Urban	Multiple examples of zero carbon urban regeneration.	Mainstreaming into all urban development, including informal settlements
Transport	EV's disrupting.	Mainstreaming EV's; freight, aviation, shipping must improve
Industrial	Minor examples only.	Big industries using fossil fuels as heat and carbon source are lagging; C-sequestration poor; LNG poor.
Land	Minor examples show it can be done quickly.	Major changes needed in all land systems to regenerate land using carbon via photosynthesis and new technologies eg biochar.

Figure 3. Progress made since the release of Fifth Assessment Report of IPCC (AR5 2014) and innovations needed to limit the temperature rise to 1.5ºC. Different systems have been considered. Retrieved from: https://www.re-city.net/admin/assets/uploads/files/96a63-barcelonanewman_part1.pdf

Apart from the above-mentioned innovations needed to accomplish the 1.5ºC, a new technology has arisen to fight against greenhouse effect: the commonly called **geoengineering**. There are two different technology categories. On the one hand, **Carbon Dioxide Removal (CDR)** refers to a number of technologies that have as the main goal the large-scale removal of carbon dioxide from the atmosphere. Among these technologies are bio-energy with carbon capture and storage (BECCS), biochar and direct air capture when combined with storage. **Bio-energy** is derived from biomass, which is a renewable energy source that serves as a carbon sink during its growth. During industrial processes and in biomass fuelled power plants, the biomass combusted releases the CO_2 into the atmosphere. The carbon capture and storage technology serve to intercept the release of CO_2 into the atmosphere and redirect it into geological storage locations. Carbon dioxide is trapped in geologic formations for very long periods of time. **Biochar** is a fine-grained, highly porous charcoal that helps soils retain nutrients and water. The use of biochar from agricultural waste as a soil enhancer can hold carbon, boost food security, increase soil biodiversity, improve the quality of water and discourage deforestation. Finally, another option is to **capture CO_2 from the atmosphere** instead of capturing it from CO_2 sources such as power plants, industries,

etc. The process focusses on capturing carbon dioxide, concentrating it and pressurizing it for storage or further usage.

On the other hand, **Solar Radiation Management (SRM)** tries to reduce global temperature through an increase in the planetary albedo, thus increasing the sunlight reflection. However, Newman was not very confident in this latter technology because it does not reduce greenhouse gas concentrations in the atmosphere and thus does not address problems such as ocean acidification.

Climate change confusion and scepticism: False myths

Newman pointed out that it is important to distinguish between myths and facts in order to face climate change confusion and scepticism.

Myth 1. It was warmer in the time of Christ.

Newman showed that this is not true using the graph in Figure 4. Temperature in 2016 was the highest since AD 0 and this temperature increase is still going on, so it was colder in the time of Christ.

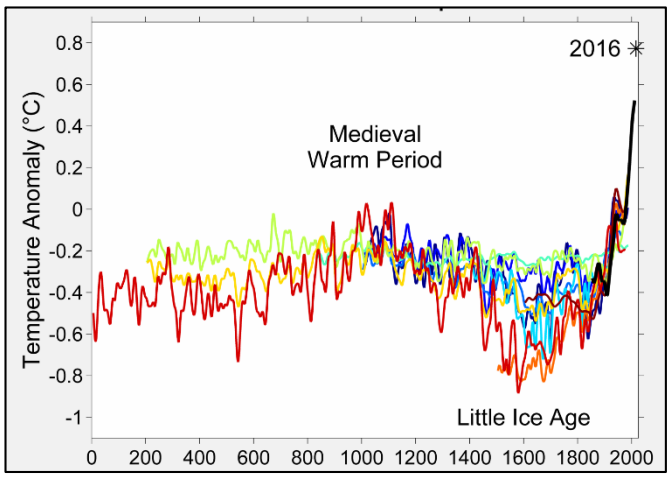


Figure 4. Reconstructed temperature from AD 0 to 2000. More recent reconstructions are plotted towards the front and in redder colours, older reconstructions appear towards the back and in bluer colours. An instrumental history of temperature is also shown in black. Retrieved from:

https://en.wikipedia.org/wiki/File:2000_Year

Myth 2. Most CO_2 comes from natural sources not human.

Newman stated that 20% of the temperature increase is explained by natural factors such as volcanic activity or changes in incoming solar energy, and the other **80% is caused by anthropogenic activity like industrial and car emissions of GHG and massive deforestation.**

Myth 3. It has been cooling lately while CO_2 has been rising.

As shown in Figure 5, temperature has been increasing since the beginning of the Second Industrial Revolution (*c.a.* 1870) following the rising of CO_2 concentration in the atmosphere. Some years are cooler than the previous ones because there are fluctuations, but Earth's temperature is globally undergoing a very marked increase.

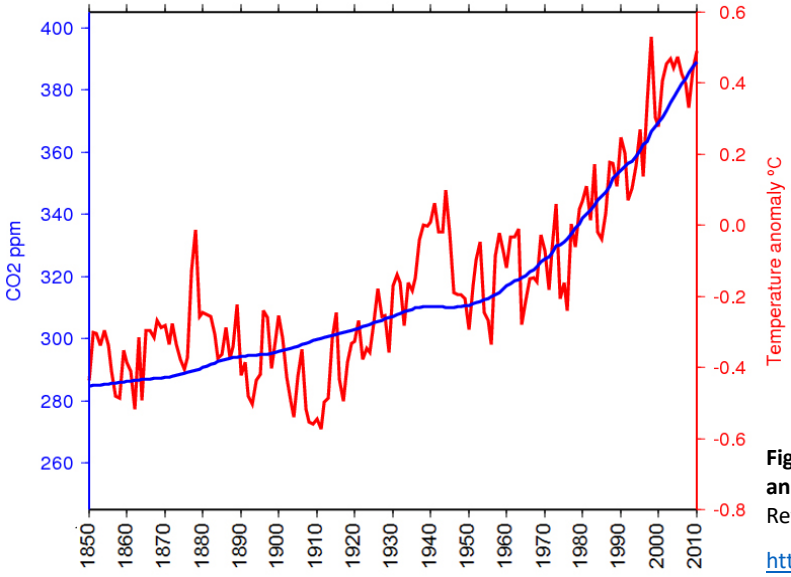


Figure 5. Reconstructed temperature and [CO_2] from AD 1850 to 2010. Retrieved from:

https://www.skepticalscience.com/ne

Myth 4. It does not matter if we get warmer.

According to Newman, it matters because climate change threatens cities and regions. The ocean absorbs over 90% of excess heat accumulated in the climate system and gets warmer, thus mitigating the increase in temperature of the atmosphere. Besides the storage**, the ocean redistributes large amounts of heat around the globe via ocean currents called "conveyor belt". The more temperature rises at the surface ocean, the more it heats the air and increases the amount of water evaporating into the atmosphere. Therefore, the water cycle and the general circulation of the atmosphere change**[1]. While warming oceans may not produce more tropical storms and hurricanes, these storms will be more intense and with longer dry spells between them. This will increase the risk of wildfires. There are many actual examples: Pakistan region are experiencing the worst floods ever, European lands are suffering the worst fires ever, Perth is drying out and catching fire, biodiversity of wildlife is being reduced, etc.

[1] https://ocean-climate.org/?page_id=3830&lang=en

Myth 5. There is no hope that we can make the changes necessary.

Newman highlighted that changes can be made. He defended that is better to have hope and be optimistic. According to him, **humans should work at small scale but from many places around the world**. For example, water supplies have halved in Perth during the last decades because of the reduced rainfall. The solution to this problem was to use a wind-powered desal, so now 55% of Perth's water come from renewably-powered reverse osmosis of sea water, so they can adapt to climate change while using renewable energies.

Planning locally whilst being globally responsible

Newman proposed a series of actions that can be taken locally to adapt to and mitigate climate change.

How can planning help cities adapt to a warming world?

To help cities adapt to a warming world, Newman proposed building more resilient and sustainable options. Figure 6, extracted from Newman's 2017 book *Resilient Cities*, sets out a process of change that has been emerging over the past decade in how we seek to frame the kind of cities we want in the future.

Resilient cities have the city wealth associated with fossil-fuel reduction. In Newman's 1999 book *Sustainability and Cities*, the **sustainable city** was defined as one that is reducing its environmental footprint (resource consumption and associated wastes) while improving its liveability (economy, health, and community). The more that a city can minimize its dependence on resources such as fossil fuels in a period when there are global constraints on supply and global demand is increasing, the more resilient the city will be. Moreover, **regenerative cities** push us further to go beyond the reduction in impact to a new vision of how cities can operate in a way that is regenerative in terms of energy, water, waste, food, and biodiversity while continuing to improve liveability – i.e. to assure that they do not just become resource-efficient and low carbon emitting, but that they positively enhance rather than undermine the ecosystem services they receive from beyond their boundaries.

One example of building regenerative cities, as suggested by Newman, is sewage recycling by the means of a **water-sensitive urban design** (**WSUD**), **using natural systems to minimize irrigation and recycle waste water.** WSUD reduces water pollution and flood risk, gives greater security of water supply, can improve ecosystem health, helps community connect with water and reduces the urban heat island effect. Some example of WSUD are implemented in Singapore[2], Rotterdam[3], Mexico City [4]and Vitoria (see Kevin Winter Session's Report).

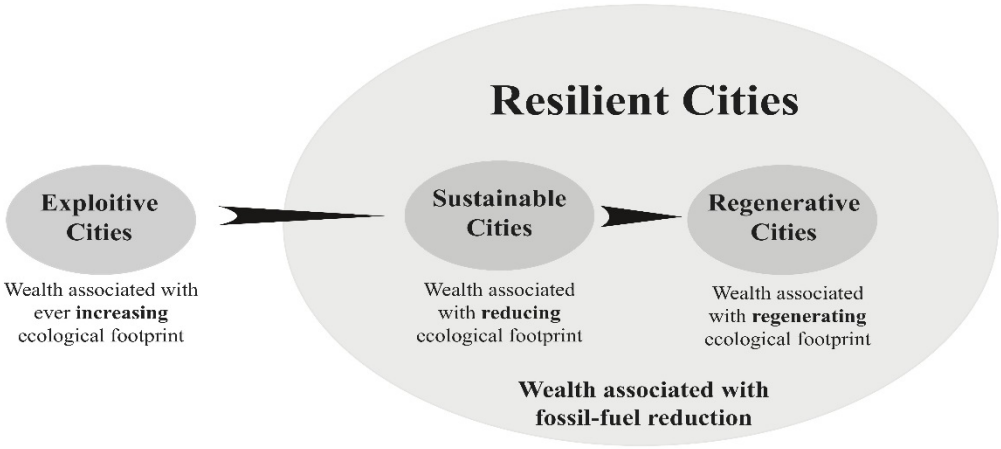


Figure 6. Resilient cities as cities in which wealth is associated with fossil-fuel reduction. Extracted from: Newman, Beatley & Boyer (2017)

According to Newman cities have always been based on a spirituality that either makes them based on frivolous consumption, warfare and violence, destroying their environments and finally collapsing, or they are able to make themselves think in a long-term and adapt to it. In this context, Newman stated that city regeneration should be considered a long-term process.

Newman brought out the concept of city "jewels". These jewels are different types of things built into the city based on hard work and legacy, such as galleries or public spaces. According to Newman, in previous years, values, hard work and money had allowed Barcelona to be a city with many jewels. He believes that this development cannot be broken because if this tradition stops, the frivolous consumption will destroy Barcelona.

[2] https://worldlandscapearchitect.com/kallang-river-bishan-park-singapore-atelier-dreiseitl/#.XDXk-RNKhmA

[3] https://land8.com/waterplein-benthemplein-reveals-the-secret-of-versatile-water-squares/

[4] http://ecoducto.mx/

How does biophilic design cool cities?

In the cities, the average temperature increases approximately 3ºC compared to the surrounding countryside because of the use of energy and because little vegetation and evaporation causes cities to remain warmer. This is called the urban heat island effect. **Deaths from urban heat have tripled and are expected to triple again by 2050**. To diminish this effect, Newman proposed the use of cool whitish pavement instead of dark pavement and, above this, the development of biophilic cities. Dark pavements get hot in the sun because they absorb 90% of sunlight (Figure 7). Hot pavements aggravate urban heat islands by warming the local air, and contribute to global warming by radiating heat into the atmosphere. This kind of pavements can comprise about one

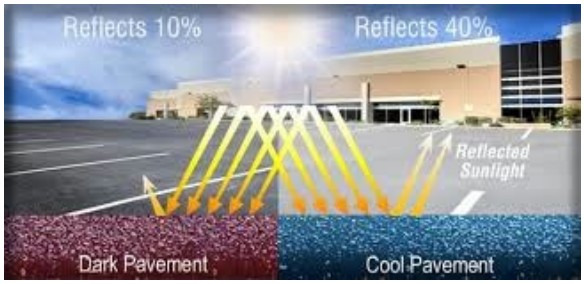


Figure 7. Dark Pavement versus Cool Pavement sunlight reflection.

https://heatisland.lbl.gov/

third of urban surfaces.

The term "biophilia" was created by E.O. Wilson, and it means that human beings need nature. Biophilic design means building natural systems into and onto every building for resilience and sustainability, and even regeneration. An example of this approach can be seen in Figure 8 . Newman mentioned that **biophilic cities constitute both an**

Figure 8. Photography of Park Royal Hotel Singapore as an example of a biophilic construction.

Retrieved from:

http://www.fcl.ethz.ch/content/specialinterest/dual/fcl/en/research/high-density-cities/dense-and-green.html

adaptation and a mitigation strategy. Greening inside and outside the building cools the city several degrees, and birds, fish and other wildlife can live in the urban core. Moreover, the removal of freeways reduces the traffic as people choose to take public transport. Also, it has been demonstrated that biophilic design has improved healing rates in KTP hospital of Singapore.

Few cities around the world have made the shift[5], such as Singapore or Vitoria-Gasteiz, and many cities from United States.

In Barcelona, large amounts of money are spent on water use when maintaining parks and streets. Newman is aware that the Barcelona's dry weather, characteristic of the Mediterranean region, makes it more difficult to enhance the use of water in order to transform the city into a biophilic one. However, he is confident about this transformation as it will have a cooling effect. Moreover, people will be more productive and less stressed, and it has been proven that this can improve healing rates in hospitals and nurseries. In this context, Newman believes that Barcelona can take the lead in greening in Europe.

To decouple the process of wealth from the use of fossil fuels

From 1850 to 2000, total carbon emissions experienced a rapid increase following the rise of the use of coal, oil and gas. However, in 21st century, GHG emissions have reached the plateau and even have peaked and decreased during the last 3 years, mostly in developed countries (Figure 9). Despite this reduction, Gross Domestic Product (GDP) has continued growing up, so a decoupling process of wealth from the use of fossil fuels is going on, mostly in Europe. Denmark is an example of a country that has experienced

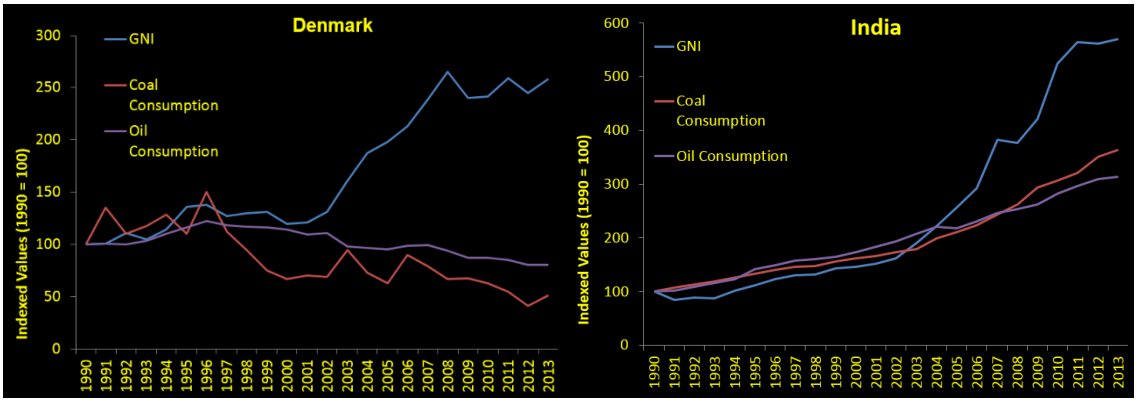


Figure 9. Evolution of Gross National Income (GNI) and coal and oil consumption in Denmark (left) and India (right) from 1990 to 2013. Retrieved from: https://www.re-city.net/admin/assets/uploads/files/96a63-barcelonanewman_part1.pdf

the decoupling through the rise in the use of wind and solar energies. Other European countries are undergoing this process, such as Germany or United Kingdom. Newman is convinced that **the economy can continue growing as the environmental impacts diminish**. On the other hand, this decoupling process has not been achieved yet in emergent countries like India or China (Figure 9), which have a massive economic growth

[5] http://biophiliccities.org/

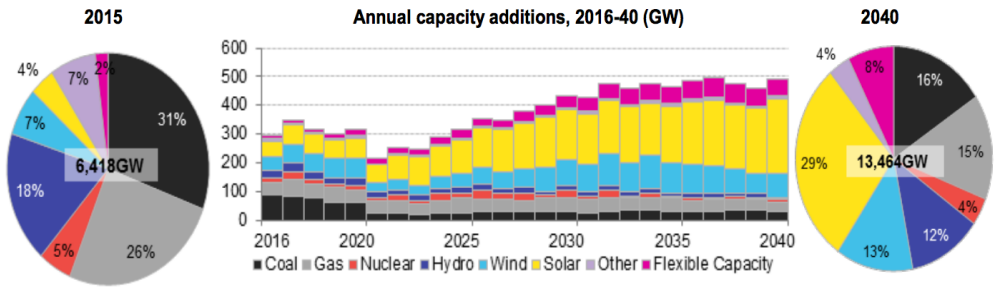
going on, so the use of coal and oil is increasing as well. However, there are lots of programs being applied in India to improve solar and wind energies.

Why cannot nuclear energy play a major role in the decoupling process? Newman makes it very clear. The average time needed to construct a nuclear power station is 17 years. On the other hand, solar and wind farms are constructed quicker than nuclear power stations. In Perth, administrations facilitate the founding and the permissions needed to install solar photovoltaic panels, so people can have the installation done by the next day practically. According to Newman, this is the reason why renewable energies have risen so much in Perth. In other regions, such as USA, the entire process can take a few months. In this context, Newman believes that investments in nuclear, coal or oil energy are riskier than investments in renewables. For this reason, non-renewable energies have no future, as renewable energies are growing more and more every year.

The **decoupling process is going on because of disruptive innovations based on green industry**. Newman remarked that some innovations are not the cheapest, but they are what people demand. Prevailing technologies find it hard to see innovation as they are looking at supply price – this is called the Kodak effect. Disruptive technologies for climate change are:

- Solar energy, batteries and blockchain: Local-shared renewables systems.
- Electric cars, bikes and transit: Local-shared mobility systems.

According to the International Renewable Energy Agency (IRENA), from 2010 to 2016, solar energy grew by 66%, wind energy grew by 30% and batteries grew by 50%. A projection model of evolution of resource's use is showed in Figure 10.



Source: Bloomberg New Energy Finance. Note: Flexible capacity includes power storage, demand response, and other potential resources.

Figure 10. Global installed capacity in 2015 and 2040 and projected capacity additions, by technology.

GW = Gigawatt. Retrieved from:

Newman stated that a safe integration of renewable energy is one of the greatest challenges for the operation of the electric system. In Spain, the national electricity grid is operated by *Red Eléctrica de España* (REE), which is a partly state-owned and public limited Spanish corporation. REE's focused efforts to integrate renewables is made evident every day through Control Centre of Renewable Energies (Cecre), which is a world reference centre in renewables integration. The work of Cecre has made it

possible for renewable energy generation to have represented nearly 40% of the annual energy production in the Spanish peninsular electricity system in recent years (2016).

However, a major problem in Spain is that there is an electric oligopoly that reduces the possibilities of innovation to enhance solar energy although having a lot of daily sunlight. Newman also pointed out that the system is mostly centralised. The main disadvantage of this model is that there are energy losses during the transport process from the energy generation point to the demand localisation. For this reason, Newman mentioned that the **next step will be to transform the system into a local-shared distribution system.** In fact, it has been recently approved by the Spanish government (in October 2018) the abolition of the "Sun tax" ("*impuesto al sol*" in Spanish). This tax was the one that the authorities asked to pay for the costs of distribution and maintenance of the electrical grids in Spain. Therefore, those who were using solar panels had to pay taxes for doing so. In addition, the self-consumers also had the obligation to give the surplus energy to the network free of charge, i.e. they were giving their unused energy to the general network without receiving anything in return. These obstacles have caused self-consumption installations in Spain to barely exceed the thousand units, while in Germany 1.5 million installations have been done. Therefore, the abolition of the "Sun tax" should enhance self-consumption installations in Spain and allow a local-shared distribution system.

Furthermore, Newman stated that **the energetic transition must be applied to new buildings but also to already constructed ones**. In Perth, 30% of the houses shifted to solar power (photovoltaic, PV) in 7 years, mostly in the outer suburbs. This transformation had nothing to do with the government. Five years ago, the installation of solar panels in Perth costed 8000 Australian dollars. Nowadays, the installation costs 2000 Australian dollars, so lower-middle-class families can afford it, and it is worth

Figure 11. Photography of the White Gum Valley (WGV) residential development. Retrieved from: https://www.abc.net.au/news/2016-04-13/solar-home-precinct-launched-in-white-gum-valley/7321468

because you will have free of charge electricity once the installation's costs are amortized. Newman showed the example of Josh's House, which has solar-batteries and is carbon positive, produces more energy on site than the house requires and feeds it back to the grid. This model still needs the grid in order to share the excess of energy generated –this excess can be partly directed into an electric vehicle. At a higher scale, shared solar panels and batteries can be used in social housing, as we can find in Perth's suburb White Gum Valley (Figure 11). The design, planning and construction stage of this suburb was completed in 2016. This model is zero carbon, zero waste, has a sustainable transport and water use, etc. Some of the roles of local planning are to enable innovation, engage the community or prove that the model works.

In the case of informal settlements, the main target is not to rebuilt but to refit the place. Newman believes that rebuilding is worse than refit because community must be willing to perform technological changes and it is necessary to maintain the strong community bonds. One option **to refit the place is to install individual solar PV with community-shared batteries**, since individual batteries are still too much expensive.

Solar, batteries and electric vehicles are growing as costs are dropping during the last decade. Until few years ago, renewable energies had never experienced such a large growth, so it has been difficult to predict their evolution. Therefore, Newman exposed that disruption defies projection modelling. On the other hand, autonomous vehicles and big data can be non-disruptive innovations because they may not be able to make better cities. In fact, autonomous vehicles could extend car dependence and sprawl. However, autonomous transit technology is being applied to buses, trains and for local-shared mobility in a transformative way. **Trackless trams**[6] are a good example of it. This type of tram is an autonomous electric vehicle with batteries on the roof that can reach 70 kph and carry 300 people (Figure 12). It works with solar energy and recharges its batteries while being stopped at the stations. It has a good ride quality since the tram is stable and no tracks are needed. For this latter reason, this type of tram is cheap –it

Figure 12. The battery-powered trackless tram in operation in Zhuzhou.

Retrieved from:

https://indaily.com.au/opinion/2018/09/28/why-trackless-trams-are-ready-to-replace-light-rail/

[6] https://www.youtube.com/watch?v=bXB87NWHvDg

costs a 1/10th of light rail. The installation of this tram causes no disruption to services and local economy during the construction period.

As previously stated, the use of electric cars is increasing day by day. This is particularly important in the peri-urban region, where there is more car-dependency. However, people living in this peri-urban area of Barcelona and owning an electric car still worry about finding a recharge point before running out of battery. For this reason, most of them prefer to buy a non-electric car. Similar case can be found in the installation of solar photovoltaic technology. Nowadays, the installation of a rooftop photovoltaic power station is very expensive and there is little funding available to undergo this shift into renewable energy. However, Newman believes that **every transformation needs a leader to show the problems that do not allow the shift.** People owning an electric car must expose the needing of installing more recharge points in Barcelona's city centre as well as in the peri-urban region because currently there are only few of them scattered around the area. This transformation is happening in other countries such as Norway, where 30% of the cars are electric nowadays. Moreover, people must expose the need of a better funding for installation of renewable power stations. This **social contribution to innovation must become especially important when there is almost no political implication**. For example, if there are few bicycles for rent, people should not use their car –instead, people should buy their own bicycles and maybe share them within their community. This promotes local-shared mobility, that is needed to reduce the carbon footprint of the city.

A major part of the society is aware about the need of a shift into zero-carbon systems. However, many people believe that there is still a lot to do. In the public and private mobility market, businesses want to be committed to society and sustainability, but sometimes it is not possible. In Barcelona, these businesses believe that there should be more recharge points and more investment in infrastructure. Furthermore, car manufacturers must invest in the improvement and the enhance of electric vehicles. Barcelona has a large fleet of buses, so **the shift into hybrid or renewable urban transport system will help to reduce the carbon footprint of the city** (The Metropolitan Area of Barcelona has 269 hybrid buses in the urban service, which means that 25% of the fleet (1,085) is Diesel-electric or gas-electric). For this purpose, and considering the difficulties of the transformation, Newman recommends working in terms of a **local-shared mobility**. Moreover, **if investment in electric vehicles is not possible, Newman propose the use of biodiesel vehicles**. This type of vehicles sometimes has a lesser carbon footprint than electric vehicles, like in the case of electric trucks.

Can the Theory of Urban Fabrics help?

Barcelona is the densest European city. However, the use of private passenger transport energy is very low. **The Theory of Urban Fabrics states that there are 3 types of "cities" or "fabrics" existing in all cities: Walking, Transit and Automobile City Fabric**. These 3

models are related to the urban density and the use of private transport. The Walking City Fabric is a model involving high urban density and low car-dependence, while in the Automobile City Fabric we find the opposite. According to Newman, there should be more Walkable Fabrics in the city centre, so vehicles will not be as necessary as they are in the other two fabrics. Moreover, he believes that there should be an improved Rail Transit Fabrics in the suburbs. This approach has to be accompanied with the **decoupling of wealth from car use**, mostly in the cities with rail investment and great centres. A good example of green public transport system is the trackless tram (see above).

The Theory of Urban Fabrics can help to reduce Barcelona's carbon footprint. In Barcelona, the peri-urban fabric and the bioregional fabric have a different metabolism compared to the centre fabric –they differ in their energy and water use, in car-dependence, etc. We need to reduce the metabolism of these fabrics through their regeneration. New technologies are needed to improve organic communities –electric transport, batteries and solar PV among others. All these innovations will be based on local-shared energy and mobility. To achieve so, Barcelona also needs that specialists of several disciplines such as ecologists, economists, designers, architects or engineers work together. The change into the use of electric vehicles is happening in Barcelona, as we can see for example with the increase of the use of electric scooters in the city centre during this last year. These vehicles are carbon-free.

To promote a cultural transformation

The rise in GDP while decoupling it from the use of fossil fuels is definitely very important for the sustainability of the city. All innovations needed to make this shift are relevant. However, it is not enough. According to Newman, we need a deep change in the way people are related to each other and to the planet to overcome this sustainable crisis. In this context, Newman stated that **a cultural transformation is required in order to change the city into a more sustainable one**. Sustainability will need changes in technology and in city design as well. However, we have to consider that the Green Revolution could not bring us a better world. It is possible that the rise in GDP that we are experiencing will not be related to an increase in standard of living. Despite this, Newman insisted that we have to try, and that we should have hope in the sustainable development.

Permaculture systems integrate land, resources, people and the environment imitating the no waste, closed loop systems seen in diverse natural systems. The philosophy behind permaculture is to work with, rather than against, nature. It aims to provide food, energy, shelter, and other material and non-material needs in a sustainable way and it can be developed at individual systems, localised systems or large-scale grids, i.e. at house, neighbourhood and urban scale.

The most known polluting molecule is carbon dioxide gas. However, methane gas (CH_4) has an impact eight times stronger for each molecule than carbon dioxide. Luckily,

methane emissions are globally less large than carbon dioxide ones. Moreover, methane molecules stay for a shorter time to the atmosphere than carbon dioxide ones, so reducing methane emissions will reduce quickly methane atmospheric concentration. With this knowledge, **Newman proposed dietary changes as part of the solution to climate change**. Eating less meat could imply having less livestock, which is the main source of methane emissions. Newman is aware that other ways are possible, such as injecting substances to animals to reduce methane emissions, but these techniques are still not used. Another possible solution would imply changes in the agriculture feeding the livestock, but this is still not working nowadays. Further, livestock also implies deforestation and land system pollution. Hence, it is better to reduce the use of meat in our dietary.

How do cities bounce forward while bouncing back from climate disasters?

This can be achieved by building and rebuilding without depending on fossil fuels. Newman believes that cities should be rebuilt through decentralised, small scale, clean-tech powered, infotech-enabled ways. For example, in September 2018, Hurricane Florence crippled electricity and coal, while solar and wind were back the next day. The rebuilding of cities can be done at different the 3 different scales (house, neighbourhood and urban).

Large centralised infrastructures are vulnerable to climate change and "peak oil". Contrarily, energy, water and food that are being delivered via networked, localised production and consumption systems lower carbon footprint, increase efficiency, build resilience and strengthen local economies. This concept is known as the **"distributed" system model**.

Furthermore, centralised infrastructures are essentially based on linear metabolism. This model must move to **circular metabolism through decentralised green infrastructure**. Therefore, the next urban economy has to be based on **local shared technologies in a city-wide grid system**, and city building must reduce carbon emission by using renewable and electric power sources.

What are the areas in climate change policy that still need big changes?

The industry system needs some transformations. One of the most relevant is the application of solar-batteries-blockchain systems in the industry in order to reduce their carbon footprint. To achieve this goal, Newman believes that smart technologies should be applied to energy savings and renewables.

Another area that still needs big changes is the land-use of the urban and peri-urban region. According to Newman, land systems need to regenerate to be the main actors

that remove atmospheric CO_2 by the means of waste recycling, natural ecosystems improving, etc. Photosynthesis must be enhanced to take carbon from the atmosphere, so Newman remarked the relevance of reforest the land and avoid deforestation at the same time. Simultaneously, livestock, that is one of the main carbon sources derived from the land-use, should lower its total emissions.

Furthermore, cities also can play a major role in facing climate change. In the cities, Newman believes that the next step could be to make plantations in order to be carbon neutral cities like Paris. Cities and organizations can become carbon neutral and rebuild their bioregional fabric. In Barcelona, architecture will play a major role in urban development as the regeneration of buildings to make them sustainable is needed. However, actual legislation can be very restrictive and could not allow to innovate in architecture. Moreover, Barcelona City Council and the Government of Catalunya have sometimes different plans and different opinions about the developmental agenda. Social contribution becomes very important when there is a lack of political implications. According to Newman, Barcelona has gone through ups and downs in its history. When there are political restrictions, architects and designers have to wait for the right opportunity while pushing and fighting for the green development. For this goal, specialists of several disciplines need to gather at least 20 people and work together. They need to be prepared to show their proposals at the right moment. For example, in Australia, the government is hopeless about sustainable development, but there have been improvements carried out from the cities. In order to achieve the best regeneration not only partnership projects are needed, but we also have to take ideas from other cities and improve them.

To share experiences and information with other cities.

For Newman, New York and Paris are examples of cities with good practices. In 2018, 19 mayors from around the world –including these two cities–, connected through the **C40 Cities network**[7], signed the Net-Zero Carbon Buildings Declaration to cut greenhouse gasses in their cities by ensuring that all new buildings operate at net-zero carbon by 2030. This Declaration will see the cities pledging to work together with state and regional governments as well as the private sector in order to be committed to Paris Agreement (2015). In addition, 13 of the cities involved –including Paris but not New York– have committed to owning, occupying and developing only assets that are net-zero carbon by 2030.

[7] https://www.c40.org/other/net-zero-carbon-buildings-declaration

The document "**New Paris Climate, Air and Energy Plan**[8]" is a draft adopted by the Paris Council meeting 2017 that exposes the transformations needed to become a carbon-neutral city by 2050. One of these transformations is the shift into an energy system powered by 100% renewables and decentralised. This will require nearly 20% of roofs in Paris to be equipped with solar power units by 2050. In addition, the city is committed to participating in the development of the following supplementary production capacities:

- 50 km² of solar panels by 2050
- 3000 wind turbines by 2050
- 9 TWh of biogas by 2030

In the mobility system, the city of Paris has set itself the target of phasing out diesel-powered mobility by 2024 and petrol-powered mobility by 2030, as well as running low-carbon public transport services by 2025. Moreover, Paris will facilitate cycling on all routes in Paris and will develop new cycle paths, providing more bicycle parking spaces and reducing the speed limit to a maximum of 30 km/h on all roads apart from the main routes by 2020.

One example of good practices in Paris is the Clichy-Batignolles area[9]. This area of 54 hectares is a former industrial wasteland which has been transformed into a model of sustainable development and the city's first "eco-neighbourhood" –homes are equipped with solar panels, clean geothermal energy is used for heating, rainwater is channelled towards wetlands and household waste is collected through an underground pneumatic system. The Clitchy-Batignolles area of 54 hectares is built around a 10-hectare park that acts as a "green lung" and an "island of coolness" for the neighbourhood.

Similarly, some states and regions have been recruited in partnership with **The Climate Group's States & Regions Alliance and are part of the Under2 Coalition** –these include Catalonia and Navarra (Spain), Yucatan (Mexico) and Baden-Württemberg (Germany). Damià Calvet, current Minister for Territory and Sustainability of the government of Catalonia, said: "30% of the energy consumption in Catalonia takes place in buildings, therefore, is a key area of action to achieve climate neutrality in 2050". The Government of Catalonia requires updating energy assessments and emissions inventory and applying reduction measures according to its **Energy Efficiency Plan and Climate Change Act**.

After the 21st United Nations Framework Convention on Climate Change (UNFCCC) held in Paris in 2015, which resulted in the adoption of the Paris Agreement, Barcelona engaged with climate by the means of the Climate Plan. This plan gives an integrated

[8] https://cdn.paris.fr/paris/2019/07/24/1a706797eac9982aec6b767c56449240.pdf

[9] http://constructionclimatechallenge.com/2018/10/16/paris-pioneers-zero-carbon-social-housing-cut-urban-emissions/

overview of the measures to tackle climate change, allowing the objectives of the new Covenant of Majors for Climate and Energy, which Barcelona City Council has signed, to be achieved by 2030. The **Climate Plan**[10] includes both short term (2018-2020) and medium-long term (2021-2030) objectives and strategic measures, divided in 4 axes: mitigation, adaptation/resilience, climate justice and the promotion of citizen action. As mitigation actions, there are the 40% reduction of the emissions, the addition of 1.6 km^2 of green urban area, to limit the daily water consumption to 100 litres per person and to lower waste generation.

The role of Catalunya Europa Foundation in the transformation.

Newman defended that in order to plan a regenerative city, specialists of several disciplines must work together, such as ecologists, economists and designers. This is happening in Barcelona thanks to projects like Re-City. Newman remarked the important role of Catalunya Europa Foundation in setting up the partnership needed to change the city and to be committed to the IPCC report and the Paris Agreement through good practices and innovations brought out in the project sessions. He encourages Catalunya Europa Foundation to keep trying to reduce Barcelona's carbon footprint. In order to achieve the best regeneration not only partnership projects are needed, but we also have to take ideas from other cities and improve them.

[10] https://www.barcelona.cat/barcelona-pel-clima/sites/default/files/documents/pla_clima_cat_maig_ok.pdf

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