UNIVERSITÉ PARIS II
PANTHÉON-ASSAS

LL.M. in In International Business Law

Environment and Sustainable Development Law

Optimizing Societal and Environmental Benefits of Autonomous Vehicle

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Date: Dec. 17. 2021

Class Assignment

Optimizing Societal and Environmental Benefits of Autonomous Vehicle

Background: The role of Autonomous vehicles in fostering sustainable mobility and development

According to the United Nations, 5 billion people will live in cities by 2030. Demand for urban transportation is expected to more than double, requiring a tremendous investment in new roads, parking lots and public transport. On average, cars sit idle 94 percent of the time. Driver less vehicles combining car sharing and ride sharing could remove 80% of private owned cars from the streets. Furthermore, slot-based intersections could allow twice as many autonomous cars to cross an intersection in the same amount of time as traffic lights usually do[1]. The vast areas of urban lands currently occupied by parking lots could be redeveloped to increase the resilience of urban areas to climate change (broadened sidewalks repaved with materials that are permeable to water; trees planted to mitigate heat waves; etc.).

Countries are already making significant investments in autonomous vehicles. For example, Dubai aims to make 25 percent of all transportation autonomous by 2030, based on a strategy launched in 2016 that focuses on environmental and efficiency improvements and is expected to generate AED22 billion ($US6 billion) annually. Masdar City has already transported more than two million people on its Personal Rapid Transit driverless pods since 2010, running on special guideways.

While driverless cars could create overwhelming positive changes in urban transportation as conveyed in the above scenario, they could also result in negative consequences if not managed positively.

The cost of travelling with e-AVs could drop so substantially that people could abandon public transportation, leading to an increase in the number of vehicles in the city. As the technology makes individual transport more pleasant, restful, or productive, it could encourage households to move further away from their workplace and foster high carbon, high ecological footprint urban sprawl. To this must be added the energy consumption of AVs loaded with various equipment: cameras, radars and lidars, sensors, software, which are all energy intensive. Intel has calculated that an hour and a half of autonomous driving could generate 4 terabytes of data, as much as 3,000 Internet users in one day[2].

Combined, these undesired effects could generate epic traffic jams of electric vehicles, increase GHG emissions and hamper ecosystems restoration efforts while jeopardizing the livelihoods of millions of people working as drivers today. A review of the emerging experience from hailing services in San Francisco and New York concluded that: "*Without public policy intervention, the*

1 C. Ratti, A. Biderman, From Parking Lot to Paradise-Scientific American, July 2017

2 Grisoni, Anahita; Madelenat, Jill (2021) : Le véhicule autonome : quel rôle dans la transition écologique des mobilités ? La Fabrique Ecologique, March, https://www.lafabriqueecologique.fr/app/uploads/2020/02/Rapport-Complet_Ve%CC%81hicule-autonome-et-Transition-e%CC%81cologique_La-Fabrique-Ecologique-Forum-Vies-Mobiles-1.pdf

likelihood is that the autonomous future mirrors today's reality: more automobility, more traffic, less transit, and less equity and environmental sustainability"[3].

The impact of AVs will depend on whether they support or become an alternative to efforts to promote and electrify public transports in cities. The experience of cities such as Curitiba in the 1970s demonstrate the importance of public interventions to promote mass transit. In exchange for sorting garbage, people were paid in bus token, a sustainable mobility currency. Today up to 85% of its residents use the bus, and 90 % recycle[4]. While many challenges of the 70s are still with us, urban planners of today must contend with a new generation of challenges and learn how to leverage new solutions. Many of the policies required to optimize the societal impact of new technologies and mitigate the risk of new, unforeseen problems have yet to be developed. Policy ingenuity will need to increase in lockstep with our technological and financial ingenuity to accelerate and steer innovation towards truly green, inclusive, and smart development.

Assignment Question:

Describe how governments can optimize the societal and environmental benefits of autonomous vehicles.

Length: 5 to 10 pages

Due Date: 17 December 2021

Additional information: You may work as a group.

[3] Schaller Consulting (2018): THE NEW AUTOMOBILITY: Lyft, Uber and the Future of American Cities
4 McDonough W. (2021): How Cities Could Save us, Special Edition-Scientific American.

Introduction

The features brought about by autonomous electric vehicles can be the solution to many of the problems created by legacy vehicle technologies. Its proponents promise of an environmentally friendly, economically sustainable, and socially balanced future. However, are autonomous electrical vehicles really a panacea to all the existing problems? Will autonomous driving bring about its own environmental, social and economic challenges? What could these challenges be? How can public policy optimize the societal and environmental benefits of autonomous vehicles while keeping negative side effects at bay? In this paper, we will explore all these matters and propose several recommendations to be considered by UAE government and legislatures when devising and implementing their autonomous vehicle strategies.

Current Vehicle Technology and its Challenges

Since Karl Benz introduced his gasoline-powered two-stroke piston Motorwagen in 1886, the basic vehicle design did not fundamentally change. His design included a chassis with an internal combustion engine, four wheels, and a steering wheel. The technology also required a human operator. The development of gasoline-powered vehicles brought a lot of advancement to human civilization as oppose to other means such as domesticated animals. It also provided the flexibility not afforded by public transport such as steam trains. However, as the technology developed from a novelty prevue to futurists and high society into a basic need for the average working person, significant challenges arose. It is estimated that during the year 2021, the world spurred about 1.446 billion vehicles[5]. The huge adoption of a transportation medium based on 19th century technology with few fundamental advancements brought with it many environmental, social and economic challenges including:

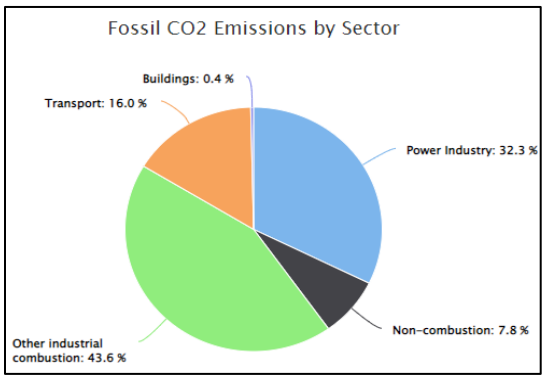
1. Greenhouse gas emissions and air pollution
2. Noise pollution
3. Increased rate of accidental deaths
4. Increased insurance costs
5. Dependency on non-renewable natural resources

[5] https://hedgescompany.com/blog/2021/06/how-many-cars-are-there-in-the-world/

6. Required infrastructure (Parking/Roads occupies vast areas of urban lands)
7. Traffic congestions and decrease economic productivity
8. Inadequate utilization of resources
9. Technology developmental bias for low income household and developing nations

We will briefly discuss some of the above factors with more details.

It is estimated that 28% of total fossil CO2 emissions in UAE (excluding oil industry) is generated by the transportation sector (figure 1)[6]. Furthermore, existing technology depends on non-renewable energy characterized by price volatility. According to UAE's Consumer Price Index (CPI) Report for 2020, transportation cost was the second highest category of expenditure for the average household (figure 2)[7].



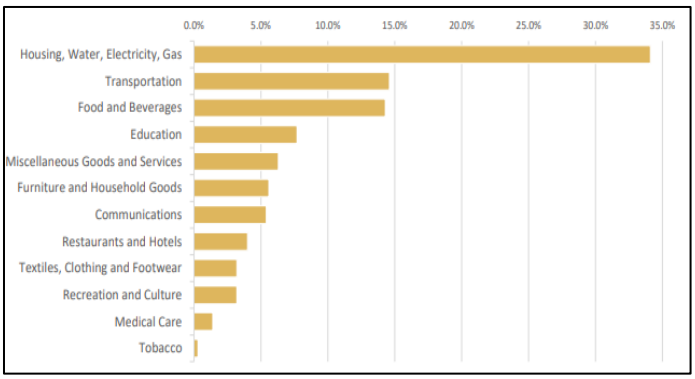
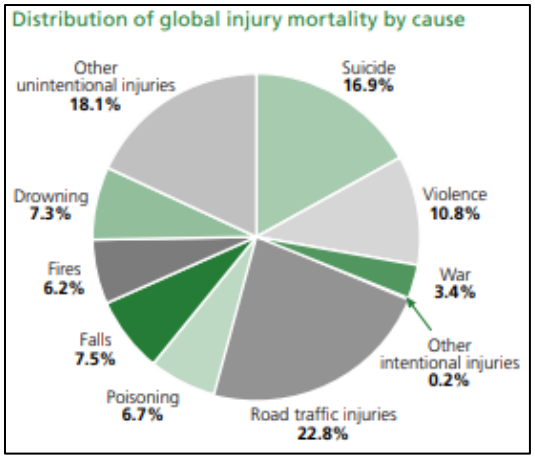


Figure 1 **Figure 2**

Road traffic accidents (usually the result of human error) is the leading cause for global injury mortality according to the World Health Organization representing 22.8% of total deaths (Figure 3)[8]:

[6] https://www.worldometers.info/co2-emissions/united-arab-emirates-co2-emissions/
[7] https://fcsa.gov.ae/en-us/Lists/D_Reports/Attachments/52/English%20-%20CPI%20MAY%202020.pdf
[8] https://www.who.int/violence_injury_prevention/publications/road_traffic/world_report/chapter2.pdf



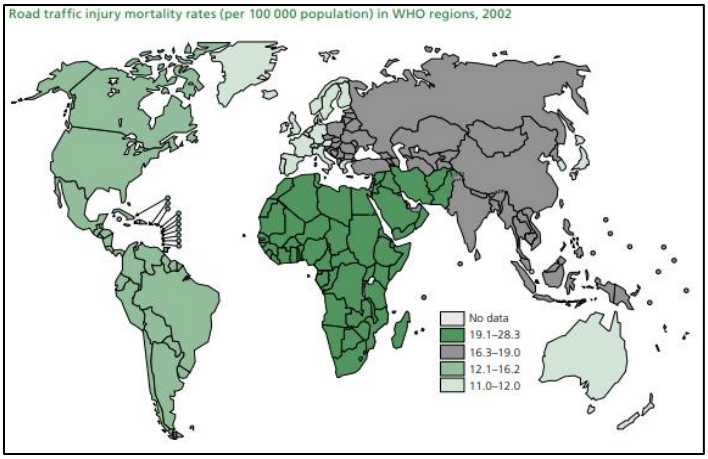


Figure 3 **Figure 4**

In 2002 mortality rates due to traffic accidents in UAE stood at 16.3-19 deaths per 100,000 population which is better than the regional averages of 19.-28.3 but worse than that of developed nations of 11 to 12 death per 100,000. Accordingly, UAE is no different from the rest of the world in terms of the broad category of challenges it faces with current vehicle technologies. However, there are still profound differences that need to be considered by policy makers when considering appropriate solutions some of which we will discuss at a later stage in this paper.

Autonomous or Autonomous-Electric Vehicles?

Autonomous vehicles remove the necessity for a human operator from the basic requirements of current motor vehicle technology. Autonomous driving technology has become synonymous with electric vehicles. The reason for this coupling is the required advanced sensing and computing capabilities. Equipment necessary? for autonomous driving have high electric power requirements, which can be better delivered by electric vehicles as opposed to vehicles based on an internal combustion engine[9]. Furthermore, autonomous driving requires low latency, which is an innate feature of electric propulsion compared to its internal combustion counterparts. As part of a presentation to the US congress energy committee a study found that "58 percent of autonomous, light-duty vehicle retrofits and models are built over an electric powertrain, while a further 21

[9] https://www.gm.com/stories/all-avs-should-be-evs

percent utilize a hybrid powertrain."[10]. It is further expected that as electric vehicle infrastructure advances, almost all future autonomous vehicles will be electric. Therefore, in this paper we will consider how governments can optimize societal and environmental benefits of autonomous-electric vehicles as opposed to only autonomous ones.

Potential Benefits of Autonomous Electric Vehicles

The progress of autonomous-electric vehicle technology could fundamentally change the existing status quo and address many of the problems caused by existing technologies. The projected positive impact on the environmental, societal, and economic spheres makes transitioning to autonomous electric vehicles exciting. Below we will discuss some of the most sought-after benefits of the transition and its positive effects on challenges brought by human operated internal combustion vehicles.

Lower Energy Consumption

Ceteris paribus autonomous-electric vehicles could significantly bring down energy consumption. There are several reasons for energy savings including enhanced traffic flows and improved driving performance. Autonomous vehicles can choose shorter most efficient routes, avoid traffic congestions, and drive at energy efficient speeds therefore reduce energy waste. Computers also have faster reaction times therefore reducing traffic tidal waves due to suboptimal driving styles delayed reaction times. Autonomous traffic control systems can coordinate the movement of autonomous vehicles further improving traffic flows and reducing traffic caused by accidents[11]. The lower risk of accidents can result in removing some of the heavy vehicle safety components such as ABS breaking systems, and the elongated front ends with crumble zones, safety cages, and reinforced chassis. This will in turn result in lowering the overall vehicle weight and the energy required to move it. According to some studies, 30% of traffic flows in city centers were vehicles cruising for a parking slot. Autonomous vehicles can be sent independently to the nearest available parking therefore reducing energy waste.

[10] https://www.govtech.com/fs/why-autonomous-and-electric-vehicles-are-inextricably-linked.html
[11] https://www.tu-auto.com/tidalwave-streams-traffic-service-for-connected-cars/

Lower Green Gas Emissions

Globally around 14% of the annual greenhouse gas emissions come from means of transportation while 72% of those emissions are attributable to vehicles[12]. Autonomous-electric vehicles do not emit green gases as they do not depend on fossil fuels. Unfortunately, autonomous-electric vehicles will still ultimately contribute to green gas emissions albeit indirectly. Energy sources required to generate electricity on which electric autonomous vehicles depend are still largely based on non-renewable sources such as gas, coal and liquid fuel. Fortunately, as technology advances it is expected that renewable energy will constitute up to 62% of global power generation sources by 2050 (figure 5)[13].

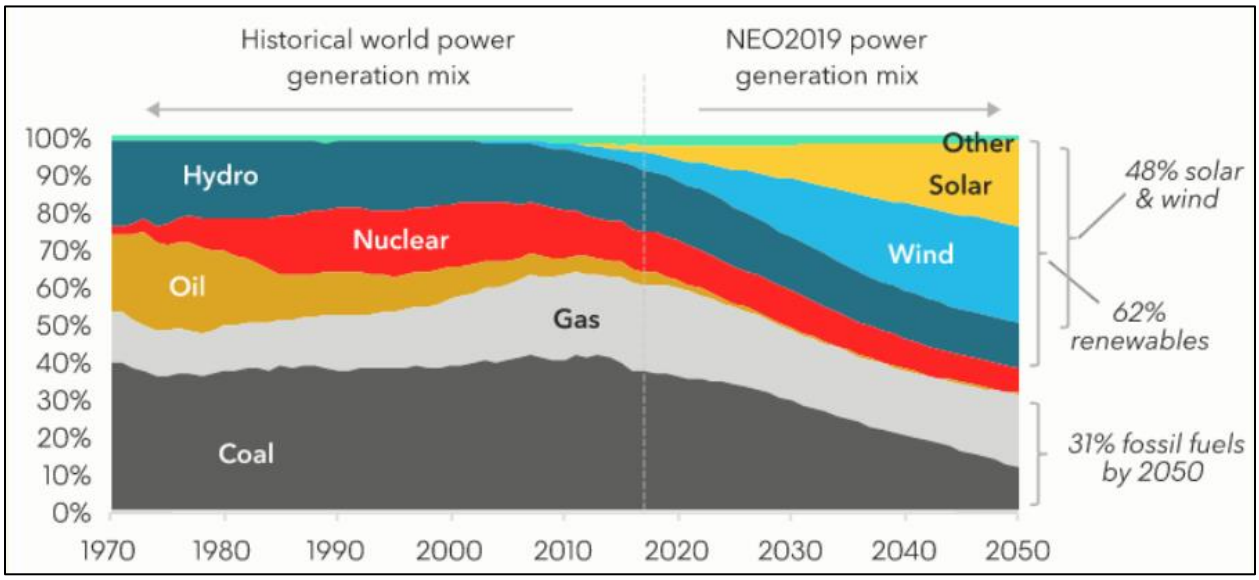


Figure 5

Lower Air and Noise Pollution

At higher speeds, both electrical and classic vehicles generate noise from wind resistance and tires, but compared to the noise generated by internal combustion engines electric cars are virtually silent. Electric cars are so silent that some regulators consider requiring manufacturers to install artificial sound sources to be activated at lower driving speeds[14]. When it comes to air pollution as can be seen in figure 5, it is predicted that 69% of electric power generation will be based on low

[12] https://www.globalcitizen.org/en/content/cities-car-bans-greenhouse-gas-emissions/
[13] https://renewablesnow.com/news/wind-solar-power-to-reach-48-of-global-mix-in-2050-bnef-658853/
[14] https://cleanchargenetwork.com/noise-pollution/

polluting technologies such as renewables and nuclear power. This coupled with the lower energy consumption previously discussed, autonomous-electric vehicles could significantly decrease the levels of air pollution caused by current technologies.

Efficient and Effective Utilization of Resources

One of the most prolific advantages of autonomous-electric vehicles is the ability to significantly increase car-sharing and decrease private car ownership. The environmental, social, and economic implications of car sharing are so significant, it cannot be exhausted in this paper. We will, however, briefly discuss it and attempt to describe some of its implications. Autonomous-electric vehicles can increase utilization of public transport by facilitating access to public transport stations. Populations living in cities with less developed infrastructure or areas with low population densities need to travel long distances to reach public transport. This in turn results in higher utilization of private vehicles and lower utilization of ecologically friendly and power efficient public transport. In developing states, the lack of accessible private transport and high cost of private transportation may result in limiting travel altogether and therefore hindering economic activity. UAE's extreme humidity during summer months make utilization of public transport very difficult. Even brief exposure to external elements may render one's apparel moist and uncomfortable greatly decreasing preference for public transport. Autonomous cars can solve these issues by providing a convenient; cost efficient and fast way to bring populations to the nearest public transport points. Furthermore, studies show that private vehicles are idle 94% of the time. Large households may require big SUVs in order to accommodate larger number of travelers but will still have to use them for trips with limited number of occupants. This results in inadequate and wasteful utilization of resources. Car-sharing can significantly increase vehicle utilization and tailor vehicle size to the specific user needs. futuristic one person's pods can bring commuters to work or the nearest public transport station while larger muti-seat vehicles can be used by families for weekend trips. Another aspect to consider is the average time utilized by the workforce on driving whereby they could be engaged in other productive tasks. In UAE where unskilled labor is relatively cheap, a significant number of households and business executives employ private drivers to free up driving time to other more productive tasks. In the United States up to 10% of

the workforce is currently engaged in the transportation sector[15]. Autonomous-electric vehicles can free a large number of the work force from repetitive low value-added tasks to other more productive areas that require higher levels of intellect.

Safer & Socially Friendly Transport

Autonomous vehicles can provide greater independence and workforce inclusion for people with disabilities, decreased mobility or otherwise people that cannot operate or maintain private vehicles. Self-driving could potentially decrease mental disease, exhaustion, and improve the quality of life for large portion of the population by decreasing the stress associated with driving. Interconnected autonomous traffic control coupled with machine learning can make traffic accident a rarity and therefore safeguarding human life.

Possible Drawbacks of Autonomous-Electric Vehicles

Unfortunately, we will not know if the positive effects of adopting autonomous-electric vehicles will actually materialize in the way previously described until it is adopted on a mass scale. Academic research on the subject is greatly undetermined and varies between two extremes. Some research predict a massive decrease in environmental, social, and economic issues developed by traditional vehicle technologies. Other research predicts that autonomous-electric vehicles will actually exacerbate or even doubling existing problems. Below we will briefly discuss the rationale behind some of the pessimistic predictions and their root causes.

Increased Energy Consumption Green Gas Emissions & Air Pollution

With vehicles as drivers, people who currently do not use cars such as children or elderly people will start using them. Travel will become easy and stress free so people will start driving for longer distances to work or to leisure destinations. For example, it takes four and a half hours to travel between Dubai and Muscat. It is therefore unlikely that a Dubai resident will decide to make a

[15] https://data.bts.gov/stories/s/Transportation-Economic-Trends-Transportation-Empl/caxh-t8jd/

weekend trip to Muscat for leisure purposes. This is true since the driver will spend half of the time driving and will arrive back exhausted and not ready for the workweek ahead. If one could do the trip in an autonomous vehicle, such a trip would be much more likely. One could enjoy sightseeing and relax in the safety of their autonomous vehicle while the autopilot does all the driving. Another issue is the potential decrease in the use of public transport caused by the convenience offered by autonomous-electric vehicles and reduced energy costs. Some of the main drivers for intercity travel by means of public transport is the convenience of not having to navigate your vehicle for hours and the high costs of gasoline prices. Autonomous-electric vehicles could make public transport less appealing due the even greater convenience offered and the low cost of electric energy as opposed public transit fees. The safety offered by autonomous-electric vehicles may result in much faster driving therefore increasing energy consumption. Overall Autonomous-electric vehicles are predicted to reduce energy consumption, green gas emissions, and air pollution per kilometer traveled. However, the possible increase in the per capita miles traveled, an increase in the speed of travel, and the reduction of public transport utilization can actually result in an overall increase in energy consumption green gas emissions & air pollution. A recent study by the US Environment Protection Agency estimated that overall energy consumption by vehicles could increase by 200%[16] if autonomous vehicle technology were adopted.

Environmental Degradation

Due to the convenience of autonomous driving and the lower cost of electric energy as oppose to fossil fuel, people may be willing to live further away from city centers. Autonomous-electric vehicles will allow people to be productive while traveling further increasing this possibility. Living outside of the city maybe appealing as it will be cheaper than living in the city, will allow for bigger living spaces, cleaner air, and reduced levels of noise. This may result in the expansion of human occupied territories and the subsequent effect of destroying natural habitat of animals and plants, reducing natural vegetation, and increasing air and water pollution.

[16] https://www.energy.gov/sites/prod/files/2020/08/f77/SMART-CAVS_Capstone_07.22.20.pdf

Decreased Privacy & Personal Data Protection

Autonomous-electric vehicles will have high speed network connectivity and will employ computer systems along with location tracking technologies. These technologies maybe employed to assist with virtually all type of everyday tasks such as delivering groceries, playing music while commuting, and taking the children to school among other things. Such vehicles could also be programmed to use biometric data to allow for vehicle access similar to that currently employed by mobile phones. Consequently, smart autonomous-electrical vehicles will have access to every intricate, private, and sensitive detail of a natural person's life. This could ultimately result in decreased level of privacy either through legal means such as through consumer consent or illegally through hacking and other forms of electronic piracy.

Broadening Country Development Gaps

Autonomous-electric vehicles will have high cost of implantation. Several technologically advanced infrastructure investments will be necessary before this technology can be implemented on a mass scale. This infrastructure includes among others 5G networks, EV charging stations, and electric production facilities to address increased demand on electricity. Furthermore, the cost of purchasing an autonomous-electric vehicle will be significantly higher than that of legacy type technologies. Accordingly, the technology could only be implemented in developed nations further increasing the developmental gap between countries.

How can the UAE Government Optimize the Societal and Environmental Benefits of Autonomous-Electric Vehicles?

The UAE government needs to consider social, environmental, and economic factors when optimizing the benefit of Autonomous-Electric Vehicles. We propose that UAE decision makers adopt the following methodology to optimize the benefits of autonomous-electric vehicles:

1- Assess UAE's existing social economic and environmental factors:
    - Public transport development and utilization
    - Power generation capacity infrastructure

- Renewable energy sources and expected power demand
- Available state of technology and infrastructure
- Natural habitats, required protection, and pollution levels
- Urban planning considerations
- Economic objectives and growth strategies
- Labor force structure and transition strategies
- Social wealth distribution and social equality
- Health and safety considerations
- Culture and societal progress

2- Adopt an appropriate environmental philosophy given above UAE particularities
    - Utilitarianism – if focus is economic growth
    - Institutionalism – if the economy is at an advanced stage of development
    - Egalitarianism – if focus is socioeconomic
    - Naturalism – if focus is environmental sustainability
    - A mixed approach to cater to varying needs

3- Develop a public policy on adoption of autonomous-electric cars. Example of policy considerations may include:
    - Phasing out internal combustion engines
    - De-incentivize longer travel distances
    - De-incentivize uneconomic travel speeds
    - limit private ownership of autonomous-electric vehicles
    - restrict private owned cars from driving in particular zones
    - Strategize Autonomous vehicles to complement public transport
    - limit autonomous vehicle electric energy sources to renewables
    - Penalize vehicles that drive unoccupied and reward full occupancy
    - Adopting an AI ethics code
    - Consider Autonomous-electric vehicle recycling consideration
    - Protect personal information and date rights

- Allow for socio-economic justice in technology adoption
- Limit urbanization deforestation and destruction of natural habitats

4- Select an appropriate mix of instruments to implement devised public policies. Below are the broad categories of potential public policy instruments
    - Information and empowerment instruments (ex. education, awareness)
    - Control and regulatory instruments (ex. Macro-prudential regulations, zoning)
    - Economic and market instruments (ex. Subsidies, taxes, incentives)
    - Institutional instruments (ex. Green banks, R&D networks)
    - Financial instruments (ex. Public sector investments)

5- Develop key metrics and performance indicators and monitor the success of public policy implementation through quantitative and qualitative measures

6- Review results and trends and make necessary adjustments to above factors, policies, tools, and methodology

Other References

1. Payton Chang, '*Self-Driving Cars and Their Environmental Impact*' September 30, 2018, http://large.stanford.edu/courses/2017/ph240/chang-p2/ accessed 17 December 2021

2. Justin Worland, '*Self-Driving Cars Could Help Save the Environment-Or Ruin It. It Depends on Us*', September 8, 2016 https://time.com/4476614/self-driving-cars-environment/ accessed 17 December 2021

3. Neil Halligan, '*UAE Cabinet approves plan to test self-driving vehicles*', Nov 9, 2021 https://www.thenationalnews.com/uae/government/2021/11/09/uae-cabinet-approves-plan-to-test-self-driving-vehicles/ accessed 17 December 2021

4. Ryan McCauley, *'Why Autonomous and Electric Vehicles Are Inextricably Linked*' https://www.govtech.com/fs/why-autonomous-and-electric-vehicles-are-inextricably-linked.html accessed 17 December 2021