Chapter

The Pathway to Sustainable Transport

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Abstract

In 2015 the 17 United Nations (UN) Sustainable Development Goals (SDGs) by 195 countries were developed and agreed. The target is to end poverty, protect the planet, and ensure prosperity for all. Sustainable mobility and transport can be considered one of the main topics within this ambitious plan, considering its transversal influence in many of the 17 goals. In a world driven by global trends like climate change, local emissions, population growth, urbanization, emerging markets, digitalization, etc., a quick proactiveness to shift the mobility and transport to a sustainable way is mandatory. Taking all these drivers into a more practical level directly linked to mobility and transport, we can summarize them into four: congestion, local emissions, climate change, and energy security. There are many technologies and services to work on these areas. We consider three pillars as the umbrella to reach sustainable transport: energy efficiency, alternative fuels, and smart transport. In this chapter we will develop these three main pillars about what we can do already today without waiting some decades (probably will be too late in that case) but also looking into the future to give a neutral and realistic view. Why not begin already with the rolling fleet? If we train the drivers of a transport fleet reducing, for example, a 7% of fuel consumption, the carbon footprint will be reduced with 7% as well. Why wait 20 years until a new technology is developed? There are many opportunities in alternative fuels as well, already with competitive costs. Probably not all of them will be the solution everywhere, but they cannot be rejected. Some other alternatives like biomethane are a global solution for a circular economy with a huge potential to reduce local emissions and climate change and solve problems due to urbanization growth. We will try to explain why biofuels together with electrification are needed and why only electrification is not enough. Smart transport will be also covered speaking about which possibilities are available to make more efficient and safety transport and mobility, like bigger trucks or busses, or the introduction of advance driver assistance system (ADAS) in a new scenario.

Keywords: sustainability, mobility, transport, autonomous driving, truck, bus, car, efficiency, alternative fuel, congestion, emission, climate change, biofuel, biomethane, biogas, electrification

1. Introduction

There is an urgent need to brake the climate change [1]. The planet temperature is increasing quickly, with clear consequences like since 2001 we have had 18 of the 19 warmest years on record [2] (**Figure 1**).

Humanity has probably one of the most important challenges has had ever, and decisions cannot be postponed. Determination and global collaboration are needed to achieve the goal, which does not have a single solution. Each area of the society and economy has the responsibility and the opportunity to collaborate. **Figure 2** shows the CO_2 emissions by sector [3].

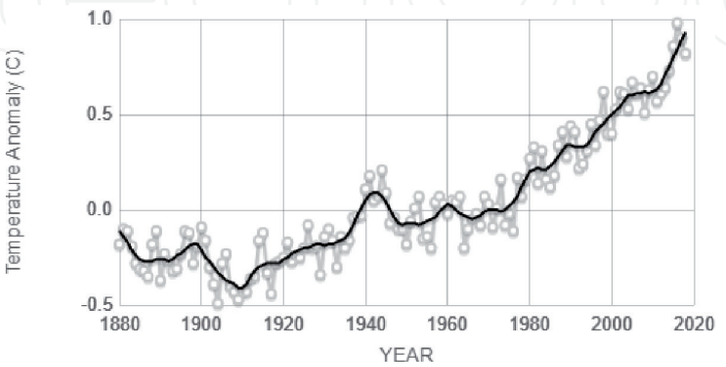

Figure 1.
Temperature evolution on Earth. Source: climate.nasa.gov.

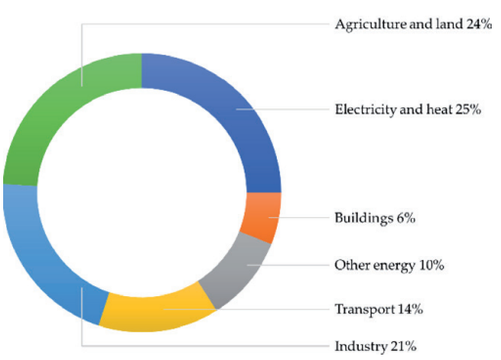

Figure 2.
CO_2 emissions by sector.

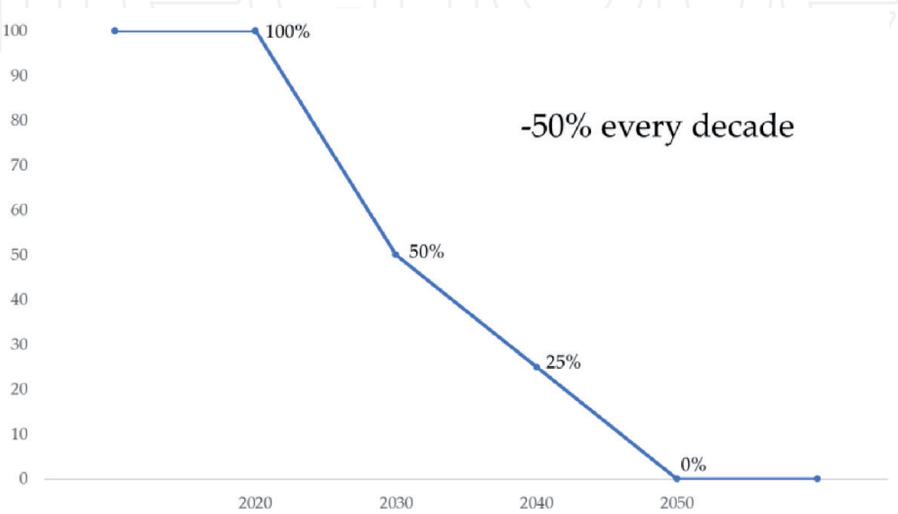

Figure 3.
Carbon law.

In this chapter we will focus on the solutions for transport sector, which represents the 14% of the total emissions, but no sector or country can walk alone to reach such ambitious target. That's the main reason of the Paris Agreement [1] and 17 UN SDGs. Due to their importance, we want to mention this agreement and targets, although it is not the goal of this chapter. We invite the readers to get more information since they will be the base for the coming years' decisions at global industry and economy.

Johan Rockström and some other prominent scientists have published in 2017 in "science" what they call "carbon law" [4]. They propose a strategy with 75% chance to reach the target of Paris Agreement [1] to keep below 2°C the increasement of the average planet temperature compared to pre-industrial temperature. Basically, they say that it must, and can, reduce 50% CO_2 emissions every decade until 2050 (**Figure 3**).

A realistic roadmap of real actions is what we proposed on the following article. Some of them are ready to begin right now, and some others must be developed during the following years. It is needed to work parallel both roads; we cannot only focus today or future but both. Otherwise we will fail.

It is honest and not a demagogy that both authors would like to leave a better world for our children and the coming generations. A strong commitment from everyone is needed, and we have an opportunity to change our daily actions.

We will try to make an easy read article, easy for everyone in or out of the scientist area. The target is so important that this kind of information must be spread everywhere and to everyone.

2. Drivers for mobility and transport

Although we mainly speak about climate change considering the emergency of the consequences it has, in making a deep analysis, we can find more drivers. Solutions will be present during the rest of the article, but it is appropriate to stop and analyze the scenario and problems we are facing to.

There are four main drivers for sustainable mobility and transport:

2.1 Congestion

According to the UN [5], by 2030 it is projected that 68% of the population will live in urban areas, compared to 30% on 1950 and 58% on 2019. These figures mean a lot of good opportunities but also an increase on congestion and pollution. Frequently it is only considering the alternative fuel as a solution for the mobility problems, but we can full the cities of, for example, electric cars and bikes, and that means pollution problem will be solved, but congestion will still remain a problem in the city. At cities like Tokyo with 37 million inhabitants [4], congestion is a real problem.

2.2 Pollution

At the same time, pollution causes millions of premature deaths annually due to household and mobility gases. These are dramatic figures that must be considered by the governments in the action plans of the cities. Some cities in Europe are already making new mobility regulations, restricted access areas for cars, etc., to reduce pollution problem and the consequences it has on the population and economy. Congestion is also very related to these new movements at city governments.

2.3 Energy security

There are financial and economical worldwide strategies among many countries. Energy security is one of the keys nowadays within that scenario. There are lot of movements in the industry and governments looking for being independent of whom could be a competitor on this economic and technological race. Every movement is positive if it helps the common target of achieving a sustainable world.

2.4 Climate change

All drivers are important, but the most urgent and important is climate change. The consequences can be so radical if we do not change anything that actions are mandatory from daily details up to international level.

It is important that everyone works in solution for these drivers in our daily small actions, but for long term and global solution, it is also crucial that an ecosystem is created between the main actors involved into the decisions that can drive the shift to a sustainable transport. From our point of view, it is crucial that this ecosystem of close collaboration must be formed by governments, energetic companies, transport companies, vehicle manufacturer, and end-customer (industry, logistic center, operator, etc.). All must be involved in the decisions as an active part.

3. Three pillars for sustainable transport

Nowadays, there are many areas, concepts, theories, classifications, lists, etc. explained in companies and reports like possible solutions to the problems we are facing to. Digitalization and electrification are frequently identified like the "coolest" and are frequently described in articles. From our point of view, there are three more global areas that we proposed to be the pillars for this pathway for a sustainable transport.

These pillars are alternative fuels, energy efficiency, and smart transport. We will try to explain each one in the following points.

4. Alternative fuels

We consider three factors to classify an alternative fuel: climate impact, availability, and cost. These factors are the key to evaluate if a technology is mature enough to expand or if at least can be used in an area of the planet or if it must be discarded. For example, in the transport sector, the operative cost is crucial to keep alive the company; we cannot forget it, so cost is important as well. But it cannot be the decision point, since everyone knows that for a new sustainable technology, there is an implementation curve with a higher price at the beginning. The solution is a close collaboration within the ecosystem before mentioned. There must be opened partnerships and dialogs involving all actors to facilitate the implementation of these new sustainable technologies, with enough availability and affordable price. The final customer, private company or only one actor of that ecosystem, cannot support the total cost.

On the other hand, alternative fuels are commonly identified as electrification. Of course, electrification will be crucial on the change to a sustainable transport, but it alone will not be enough. There is a race to reduce CO_2 emissions as quickest as possible. Otherwise, if we wait too much to act, nature inertia will be even more difficult to stop.

But there is good news. There are already available several alternative fuels that can be used today reducing emissions considerably and fulfilling the three criteria exposed. We will describe the main options available today and during the coming decades.

Before going into details, it is basic to be clear and give a realistic and complete picture of the alternative fuels. Alternative fuels have something that we call "life cycle assessment" (LCA), which means to consider the emissions coming from the whole process of the fuel life until recycling, including production (also batteries and minerals needed), transport, etc. Other ways to do it are only considering a part of the process: well-to-wheel (WtW), well-to-tank (WtT), or tank-to-wheel (TtW). There must be several ways to measure and analyze a process; it is positive depending on the use we give to the fuel. But there must be a final target and a complete cycle must be considered. There are fuels working in a combustion process, for example, biogas, that in the whole cycle can have much lower greenhouse effect than a battery electric vehicle (BEV). As much as realistic we consider the analysis, it will be much helpful for the target which is to reduce climate effect. Otherwise, we are lying ourselves.

4.1 Biofuels

We need to slope down quickly the emissions. To reach that in a big scale, the only and immediate alternative option we have are biofuels used in combustion engines.

Within biofuels we can find many options. Not all of them are available in every country, but taking the opportunity of what is reachable in the area is the correct action to move forward. We will try to mention the most relevant options available in the market.

Biogas, also called as renewable gas or biomethane when applied at mobility, is probably the most extended and accessible everywhere. The reason is because the resource is also everywhere: it is produced mainly from farm and city wastes. Speaking before about the considerable increase of inhabitants per city during the coming decades, we are also speaking about a potential problem on how to handle that huge amount of waste, or we can speak about a tremendous potential of biogas production for energy at industry, buildings, and mobility.

Already today, countries like Sweden have 94% of gas used for mobility with origin bio [6]. This is a perfect example of circular economy. What could be a problem is transformed into an opportunity. Swedish society is very well aware that there is a strong dialog between the actors in the ecosystem. Legislators, industry, customers, etc. have a common target (**Figure 4**).

At Sweden, 64% of gas produced ends up into upgrading mainly for mobility [7] (cars, trucks, busses, and engines).

There is another important fact regarding biogas: it is the base for the coming hydrogen economy. High percentage of industry and infrastructure will be valid for hydrogen technology. We will not go into details about hydrogen as biofuel since it needs a book itself, but we wanted to emphasize the importance of its link with biogas.

Hydrotreated vegetable oil (HVO) is also an interesting alternative fuel, produced by renewable raw materials. It can be used in diesel engines partially blended or 100% pure. Depending on the source, it can reduce 50–60% or even up to 90% CO_2 and can also reduce local emissions like NOx. HVO has better long-term storage stability and cold climate properties. It is already used frequently blended at commercial diesel fuel to reach bio quota.

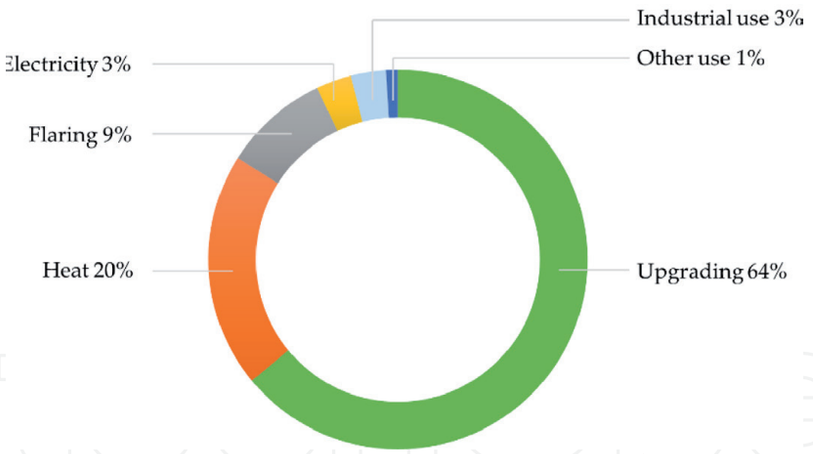

Figure 4.
End use of biogas production at Sweden.

HVO seems to be a perfect fuel from a technical property point of view, but it has very limited availability because of market reasons. Production is very limited worldwide, there is a high demand of HVO to be used and blended, so the price is high. On the other hand, availability at public stations is very limited in some countries like Sweden, and in many others, there is no even local provider.

We have tried several times to bring it to Spain for commercial operations, but it failed due to business case. Hopefully it will be a positive scenario in the market for the coming years to use in more extended way these kinds of biofuels.

Bioethanol is also a very important biofuel. It is produced by fermentation of sugars coming from feedstocks like wheat or corn. It can work blended with petrol or can be used blended with 95% additive like at Scania engines.

Bioethanol does not produce SO_2 or NOx and can reduce CO_2 up to 90% depending on the production cycle and source.

As in the HVO case, infrastructure is not developed, and in the case of being interested, the infrastructure must be customized and developed for the customer.

In the case of biofuels like biogas, HVO and bioethanol, a collaboration between ecosystem actors to develop appropriate production availability, infrastructure, tax regulation, and clear information to end-customer is urgent.

An argument frequently used against biofuels is that if they increase the production, food price will also increase. In case they come from waste, it is not true or in case if they come from crops either. It is a polemic issue, and there are many literatures speaking about positive or negative impacts. We can easily conclude based on **Figure 5** (source: Food and Agriculture Organization of the United Nations, FAO [8]) that vegetable oil price has no relation to prices of sugar, meat, cereals, or dairy products.

4.2 Electrification

There are many information about electrification mobility. We will not add new technical information but will try to make a sustainable approach and reflections.

Electrification is one of the most important keys in the pathway to a sustainable mobility. But it must be clear that nature will not wait until a mature technology is developed totally for passenger cars and, more difficult, for trucks and busses. Bear in mind the current autonomies and prices for the technology and infrastructure for a "simple" passenger car and then compare it to the requirement demands when transporting 40 or 60 tons at 4000 kilometers or when transporting 55 people in a bus. Even more, those transports cannot only be possible but also profitable.

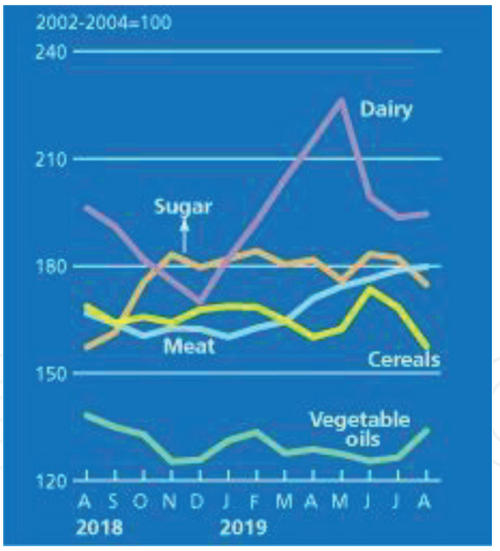

Figure 5.
FAO food commodity price indices.

This is the main reason to justify that society and scientist community must forget the war between technologies, keeping only a war against climate change where must be place for technologies that allows to reduce CO_2 footprint. That's the reason of a very high importance of biofuels for the coming decades. Carbon law becomes crucial when speaking about the pointless question of "which is the only valid and saving technology?" The answer is none, but several are needed quickly in a first step. Nobody knows the alternative fuel scenario at 2050, but surely will not be one single energy and will have to coexist several.

Still speaking about electrification, there are good electrification and bad electrification. We must consider the LCA of the vehicle, including mineral extraction and recycling or second life of the batteries. Then, the technology is valid and positive. The same case with electricity source must be considered. If we use the energy coming from a coal plant, for example, we can speak about zero emissions locally, but we are lying to ourselves speaking about climate change.

On the other hand, electrification is commonly linked to batteries, but there are many other ways to electrify a route. For example, there are some electrified roads where some dozens of trucks are running in Sweden, Germany, and soon in Italy. Probably it seems strange to go back to pantograph technology, but the results until now show that infrastructure is cheaper and results are impressive. The target is not

Figure 6.
Real e-highway in Germany.

the installation in every road but only in some main transport routes. The impact is still under study, but preliminary figures say that only a small percentage of main route trucks working with this technology would save millions of CO_2 tons per year.

The truck can run on diesel or biofuels when is out on electrified road, and during the time connected can also charge a battery to run the vehicle on electric out of the road for around 10 km (**Figure 6**).

We would like to leave a very positive message for electrification but also a responsibility strong message that it is not so easy to think electricity is equal to clean electrification. No, we must go deep in the details and get a real clean electrification.

5. Energy efficiency

This is the simplest pillar to understand and reach: keep the most efficient level of the technology you already have, the way of working, the operations you make, and your daily actions. Simple. For example, if you use the car with a colleague to the office every day instead of going alone, you are doubling the efficient emissions and cost. Another example, if you can reduce the fuel consumption of your vehicle 10%, you will also reduce your cost in the same percentage, but also emissions will be cut the same amount.

This is a very important idea to be considered in our life and businesses. It does not matter what technology to use, but an efficient way of doing things will impact into a more sustainable operation. Another way to explain as we mentioned before, a traffic jump road is the same mobility problem with BEV or petrol cars. The sustainable mobility does not depend only on the energy but also on the efficient way in which we move people and goods.

Another example is the trend of making transport to city center shopping areas during the night with big trucks using alternative fuels. The centers of big cities have tough congestion problems during the day, and an easy way to solve them is to deliver the goods during the night.

Connectivity and digitalization are the key to reach the top efficient level in mobility and transport. On 2012, transport market began to change thanks to connectivity. Until that moment, no transport company had information about what was happening on the truck. The company only knew the fuel consumption and incidents afterwards, but no information have the detail information enough to take decisions and make the company more efficient, more sustainable, and more profitable. For example, basic information like if the driver brakes too strong or driving with idling. When connectivity appeared, driver environment changed completely. Today it is possible to train the drivers not from a theoretical way, but doing it customized for each driver, each person, help him to improve all areas of their daily job.

There are already driver training programs for long term. Our experience is that when training a driver, probably next day he will drive in the same way he was used to before training. But thanks to a coaching program we can follow the driver and way of driving and figure and help him to improve his skills as much as possible.

There is a huge potential on this area, with a tremendous quick and easy implementation opportunity.

6. Smart transport

We consider smart transport in every new advanced technology that helps transport and mobility to be more efficient and sustainable, for example, bigger trucks where we increase the Tn/km-liter or m3/km-liter.

New technologies like platooning or autonomous driving are helping already to make a more suitable transport.

Autonomous driving is already implemented in real operation test at closed environments like mines and probably soon in other scenarios like close logistic centers, airports, bus depot, etc. This will be a reality in a very short term. Those closed places, which because of security or healthy reasons are more positive to have an autonomous driving truck or bus, will be more sustainable (**Figures 7** and **8**).

It is not the moment to make a deep analysis of autonomous driving, but we clearly see this technology with a predominant role in the sustainable transport for coming decades.

Platooning is another way of transport to improve sustainability. It is not a technology itself, but it takes advantage of every technology available. The main target is to reduce the distance between three of four vehicles to reduce air resistance. As lower distance, better aerodynamic, so better fuel consumption and much lower emissions. Companies like Scania are making this kind of transport since 2014 between its factories at Sweden and Netherlands (**Figure 9**).

This is possible because of the philosophy "right here, right now." It means that it is not needed to wait decades for a new technology; we can already begin with current technology. Frequent platooning is related to autonomous driving and probably in the future will be. But today we can already begin to do it with the current

Figure 7.
Autonomous driving Scania truck working in a closed area.

Figure 8.
Truck working in an underground mine. An example where autonomous driving can help.

Figure 9.
Platooning truck transport.

technology available at the truck, like advance control cruise. As technology evolves, the improvement will be even higher and emissions will be lower. The most important message is that we can already begin today and improve as the technology does.

7. Conclusion

Sustainable mobility and transport are crucial. We urgently need help from every area of the society to fight against the climate change. Human beings are not aware about the problem they are facing to, and we have a short time to react.

But we would like to leave a positive message. There are a lot of opportunities right here that can lead to the solution, and it is totally in our hands. As we have tried to explain, there are many solutions, technology, services, etc. that can already begin today to reduce emissions and even more in the coming decades.

We have the tools, and it is upon us to reach the target.

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