The MENA Region Initiative as a model of NEXUS Approach and Renewable Energy Technologies (MINARET)

Sustainable Transpotation
From the prospective of
Water & Energy Nexus

October, 2017

1. Introduction

The climate debate and action often focuses on energy and industrial activity as the key sectors contributing to greenhouse gas emissions. However, the transport sector, which is responsible for one quarter of energy-related greenhouse gas (GHG) emissions worldwide, with its emissions increasing at a faster rate than any other sectors, must be included in any effective policy response to climate change and in order to keep the global temperature increase below the two-degree Celsius. Furthermore, sustainable transport must be viewed and integrated as an essential ingredient in sustainable development strategies. Transport infrastructure lasts for decades, which means that the decisions that the local and national governments make today will have long-lasting impacts on urban development and form, as well as climate[1].

The role of transport in sustainable development was first recognized at the 1992 United Nation's Earth Summit and reinforced in its outcome document – the Agenda 21. Several chapters, as for example Chapter 9 on Atmosphere and Chapter 7 on Human Settlements recognize Transport as a key development issue.

The role of transport in sustainable development was first recognized at the 1992 United Nation's Earth Summit and reinforced in its outcome document – the Agenda 21. Several chapters, as for example Chapter 9 on Atmosphere and Chapter 7 on Human Settlements recognize Transport as a key development issue.

In undertaking the five-year review of the implementation of Agenda 21 during its nineteenth Special Session in 1997, the General Assembly noted that, over the next twenty years, transportation is expected to be the major driving force behind a growing world demand for energy. It is the largest end-use of energy in developed countries and the fastest growing one in most developing countries.

Further, in 2002, the role of transport was captured in the Johannesburg Plan of Implementation. The outcome document of the 10th Anniversary of the World Summit on Sustainable Development provided different anchor points for a mobility policy from which environmental and health could benefit, in the context of consumption and production, **natural resources** as a support of the Kyoto and Montreal.

World leaders recognized at the 2012 United Nations Conference on Sustainable Development (Rio +20) outcome document: "**The Future We Want" that transportation and mobility are central to sustainable development and emphasized the important role of municipal governments in setting a vision for sustainable cities.**

Sustainable transport is essential to achieving most, if not all, of the proposed Sustainable Development Goals (SDGs) and the 2030 Agenda for Sustainable Development. **Although sustainable transport is not represented by a standalone SDG, it is mainstreamed across several SDGs and targets, especially those related to food security, health, energy, infrastructure and cities and human settlements[2].**

---

[1] https://sustainabledevelopment.un.org/topics/sustainabletransport

[2] https://sustainabledevelopment.un.org/topics/sustainabletransport

2. Water Consumption in Petroleum Refining Industry & Transportation

Vehicles powered by petroleum, electricity, natural gas, ethanol, biodiesel, and hydrogen fuel cells consume water resources indirectly through fuel production cycles, and it is important to understand the impacts of these technologies on water resources. Previous investigations of water consumption for transportation fuels have focused primarily on key processes and pathways, ignoring the impacts of many intermediate, interrelated processes used in fuel production cycles[3].

Petroleum refineries utilize a combination of fuels, electricity and hydrogen for processing crude oil into finished products. Each of these process inputs carries embedded water consumption, which contributes to the water consumption associated with the finished products. The contribution of the recovery operations, refinery processes,and these other process inputs were analyzed as shown in Figure 1 [4].

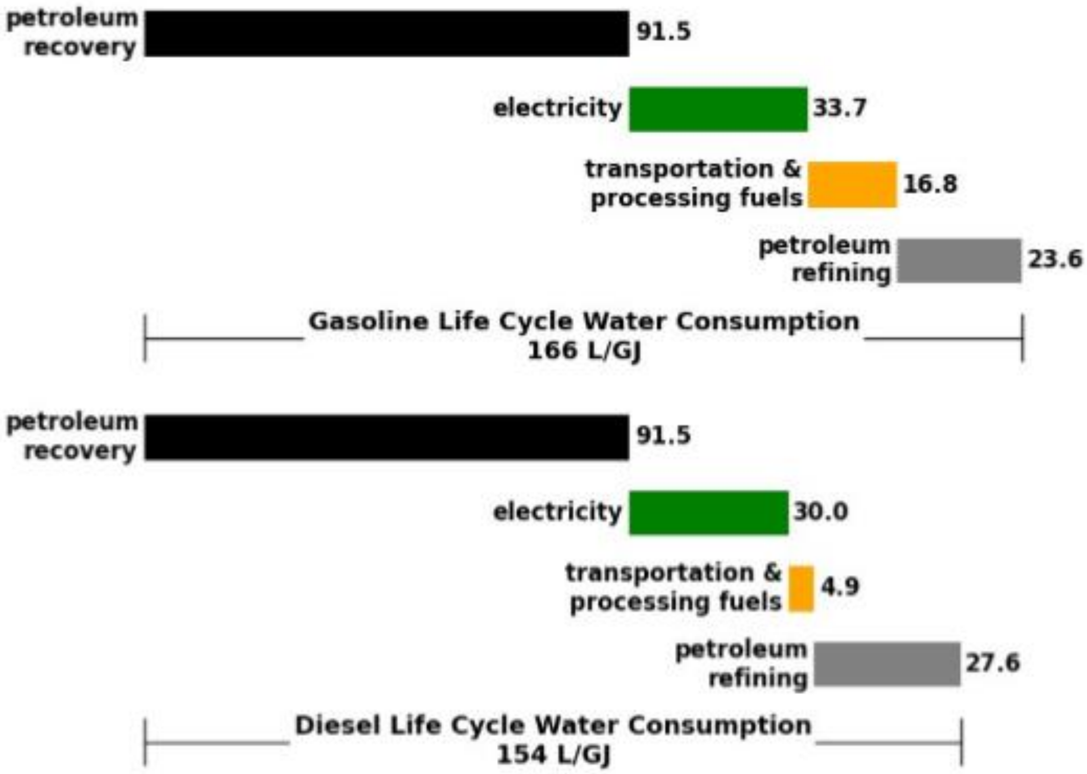


Figure 1: Petroleum gasoline and diesel life cycle water consumption breakdown.

As shown from Figure 1, the life cycle water consumption for gasoline production is 166 liter/GJ (around 6.14 liter of water per liter of gasoline), whereas the life cycle water consumption for diesel is 154 liter/GJ (around 6.16 liter of water per liter of diesel).

[3] Wells to Wheels: Water Consumption for Transportation Fuels in the United States, David J. Lampert,∗a Hao Cai,a and Amgad Elgowainya

[4] Same source of reference 3.

In another study conducted by the Mexican Institute of Water Technology which indicated that the water demand in refineries is up to 3 m^3 of water for every ton of petroleum processed (US EPA, 1980, 1982; WB, 1998). Almost 56% of this quantity is used in cooling systems, 16% in boiling systems, 19% in production processes and the rest in auxiliary operations. The water usage in the Mexican refineries is almost 155 millions m^3 per year; it is 2.46 m^3 of water per ton of processed petroleum (PEMEX, 2007). The water supply and distribution for the different uses depend on the oil transformation processes in the refineries, which are based on the type of crude petroleum that each refinery processes and on the generated products. The cooling waters are generally recycled, but the losses by evaporation are high, up to 50% of the amount of the used water5.

According to this study which considered two types of refineries (R1 & R2), surface water, such as water from river reservoir and lagoon, are the main water sources for both refineries (R1 and R2). The water consumption and the fresh water distribution for the different uses are presented in Table 1. The wastewater quantities represent 48%of the consumption in both refineries. It is clearly seen from Table 1 R1 consumes 2.10 m3 of water per ton of petroleum products, whereas R2 consumes 2.8 m3 of water per ton of petroleum products.

Table 1: Water consumption in petroleum Refineries

Refinery	Fresh water consumption	
	Water-flow, L/s	Consumption, m^3/t processed petroleum
R1	384	2.10
R2	467	2.28

[5] Water Management in the Petroleum Refining Industry Study- Petia Mijaylova Nacheva, Mexican Institute of Water Technology Mexico www.intechopen.com

3. Summary of Current Situation for Municipalities Fleets

3.1 Karak Municipality

Karak municipality has about 111 cars and vehicles which use diesel and gasoline, the municipality uses the cars and vehicles for different activities and services for the local community in Al-Karak.

The municipal fleets consume a huge amount of fuel oil and Gasoline that negatively impact the environment and put heavy financial burdens on on the municipality. About 111 cars and vehicels consumes about 900,000 litre/year of diesel and 10,714 litre/year of gasoline and contributes in generating about 2427.54 tons CO_2 eq.

3.2 Jdaidat Al-Chouf Municipality

Jdaidat Al-Chouf municipality has about 5 cars and vehicles which use diesel and gasoline, the municipality uses the cars and vehicles for different activities and services for the local community in Jdaidat Al-Chouf.

The municipal fleets consume a huge amount of Fuel Oil and Gasoline. The Municipality's fleet consumes about 842.3 litre/year of diesel and 3249.9 litre/year of gasoline and contributes in generating about 9.69 tons CO_2 eq.

3.3 Monastir Municipality

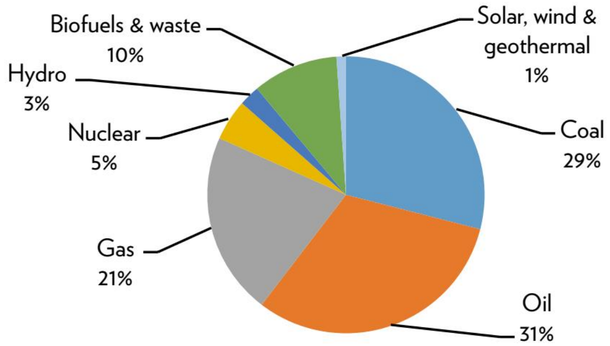
Monastir municipality has about 35 cars and vehicles which use diesel and gasoline, the municipality uses the cars and vehicles for different activities and services for the local community in Al-Monastir.

The municipal fleets consume a huge amount of Fuel Oil and Gasoline. The Municipality's fleet consumes about 225,000 litre/year of diesel and 13,390 litre/year of gasoline and contributes in generating about 631 tons CO_2 eq.

4. Green Mobility/Sustainable Transportation

The world depends on fossil fuels for more than 80% of its primary energy supply (Figure-1), with oil supplying the largest share (31%). Renewables, including biomass and hydroelectricity, contribute just 14% of primary energy, and nuclear power 5%. When it comes to final energy carriers, the world remains highly dependent on petroleum fuels, which account for 41% of total final energy consumption (TFEC) and over 90% of transport sector energy (International Energy Agency [IEA] 2015).

Figure-1: Share of word primary energy supply by source, 2012 (International Energy Agency **IEA**, 2015)



IEA forecasts that global demand for oil could grow by 14 million bpd (barrels per day) to 104 million bpd (a 16% increase) by 2040 (2014). Most of the net extra demand is projected to come from the transport sector in emerging economies. However, it is not just economic growth that will drive up energy demand, but also rising living standards. Across the developing world, lifestyles are shifting towards more energy-intensive patterns of consumption. As sizeable middle-classes emerge, they purchase motor vehicles that are thirsty for fuel and a wide array of household appliances that are hungry for electricity. For example, the China Auto Association anticipates new commercial and passenger vehicles sales to top 25 million units in 2015 (Murphy 2015).

The transport sector including both freight and passenger transport offers massive scope for improved energy efficiency through travel demand management, improved vehicle design and modal shifts. Substantial fuel savings are possible in freight transport through the use of more efficient truck design (e.g. improved aerodynamics, reduced rolling resistance and more efficient engines) and ship design (e.g. low-drag hull coatings, air floatation devices, and advanced propeller technology) (Lovins, Datta, Bustness, Koomey & Glasgow 2004; UNEP 2014), which can be fostered via mandatory fuel efficiency standards. Even greater energy savings could be achieved through modal shifts, especially from road to rail (Gilbert & Perl 2008). Rail efficiency can be boosted through innovations such as better aerodynamics, regenerative braking and lighter rolling stock, as well as improved logistics (UNEP 2014).

Similarly, very large energy conservation and efficiency improvements are possible in passenger transport (IEA 2005; Gilbert & Perl 2008; Kendall 2008). Measures can start with improved traffic management, which results in less fuel wasted in idling vehicles, and the promotion of eco-driving techniques and optimum vehicle maintenance through public-awareness campaigns. Improvements in vehicle efficiency can be stimulated by mandatory fuel-efficiency standards, vehicle fuel-economy labels, and taxes (e.g. on emissions) (IEA 2011b). A switch from internal combustion engines to more efficient electric hybrid and drive systems can be encouraged by feebates (taxes on inefficient vehicles and rebates for more efficient models), the provision of charging infrastructure for electric vehicles, and public procurement (Kendall 2008; UNEP 2011; UNEP 2014).

5. International Best Related Practices

UNIDO, United Nations Industrial Development Organization

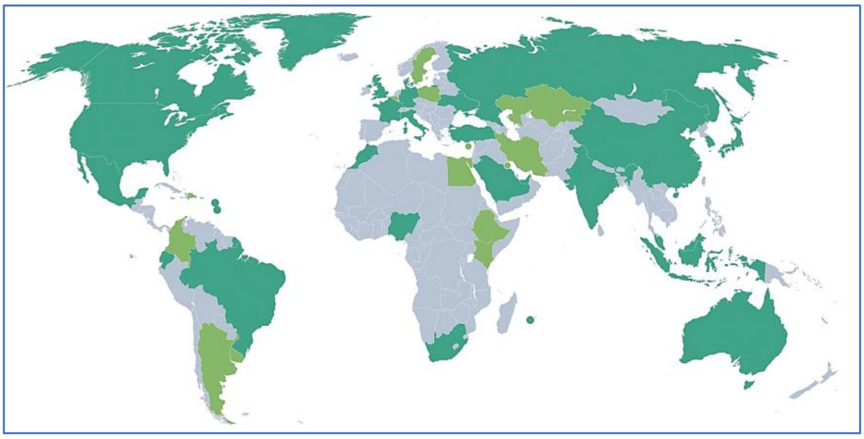
UNIDO is implementing a project on the promotion of energy-efficient, low-carbon transport in South Africa, in cooperation with the South African National Energy Development Institute (SANEDI). The objective is to promote the widespread use of electric vehicles (EVs) and non-motorized transport (NMT), as well as the development of the necessary infrastructure, as part of the Green Transport and Green Cities initiatives of South Africa.

Figure-4: Launch of a Solar PV Charging Station for Electrical Vehicles (EVs) for the City of Johannesburg at the IDC office in Sandton, during the Low-carbon Transport Project Event

IRENA's REmap programme:

REmap is the International Renewable Energy Agency's (IRENA) global roadmap to significantly increase the share of renewable energy in the world's energy mix by 2030. REmap is a global study of renewable energy potential built from the bottom up, analyzing 40 countries that represent over 80% of global energy use, and working closely with them to determine the potential of renewables. In addition to the power sector, the report looks at the end-use sectors of agriculture, buildings (residential, commercial, public, and services), industry and transport.

Figure 5: Map of countries participating in IRENA's REmap programme (***Note:*** *26 countries participated in 2013 (dark green), 14 countries joined in 2014/2015 (light green)*)



6. Key Findings & Recommendations

- **Demand for energy in the transport sector** is growing rapidly, energy use in transport will grow from 106 exajoules (EJ) in 2013 to 128 EJ globally by 2030 – an annual growth rate of about 1%. While the **transport sector** today accounts for around a quarter of all energy-related global carbon dioxide (CO_2) emissions, the results show that emissions growth in the **transport sector** is the highest of all sectors, and is expected to increase by over one-third by 2030.

- **In addition to climate change, the need to reduce air pollution in cities will remain a major driver for renewables in the sector.** Cities and their surroundings consume approximately 75% of global primary energy supply. **Transport's** share of all energy used is 30% globally, therefore, the largest contributor to local air pollution in many cities is the **transport sector**.

- **Energy security is another driver of the shift to renewables in the sector, as oil products make up a significant share of transport's total energy demand, and many countries rely on imports of crude oil or oil products.**

- **However, describing the share of renewables used by electric vehicles (EVs) in terms of passenger kilometers would boost the share of service EVs provide to as high as 14% of total passenger road activity in Remap.**

- **In REmap, the total number of EVs would reach 160 million, around 10% of the passenger car fleet, amounting to average annual sales of 10 million vehicles to 2030.**

- **Transportation is yet another area where the nexus between water and energy can be addressed specially when we are talking about resource efficiency and urban nexus through integration of all urban activities & sectors.**

- **Fuel combustion emissions from transport result in significant external costs in terms of their impact on human health and agricultural crops.**
  Worldwide, the external costs of air pollution related to the use of fuels in the transport sector were in the range of USD 460 billion-2,400 billion per year in 2010, and this is expected to increase by 40% by 2030 to as high as USD 3,300 billion annually. The REmap Options would reduce external costs by between USD 40 billion-210 billion per year, when taking into account lower costs related to the reduced health impact from air pollution.

- **Responsible Consumption and Production**
  The use of natural resources will help in reducing waste and pollution and improve resource efficiencies. For example, building a solar plant to charge the batteries of the electric cars rather than using the grid that relies on burning fossil fuels or using the conventional cars that relies on diesel or gasoline.

- **Industry, innovation, and infrastructure**
  Increasing the share of electric cars that relies on renewable energies and energy efficiency technologies will lead to Building resilient infrastructure promoting inclusive and sustainable industrialization and fostering innovation.

- **Reduced Water Consumption**
  Contrary to conventional cars, electric cars charged from renewable energies don't use fosil fuel for powering the car, the water needed for producing fuels (Gasoline & Diesel) in the refinery will be avoided in this case.

- **Decent work and Economic growth**
  The use of new technologies will enable and employment opportunities. On other word, the use of electric cars could lead to the creation of new jobs for engineers, as well as higher wages and diversified income streams. Moreover, encouraging new technologies could also lead to scientific research funding – will each directly benefit countries' energy industries.

- **Municipalities Acting as a Role Model**
  Transportation plays a significant role in urban planning and development. It provides access for local communities to markets, educational centers, work places, health centers and other services. In cooperation with other players and concerned institutions, municipalities have to paln and invest wisely in the infrastructure for urban transportation. By Introducing electrical vehicles powered by renewable energy to the existing municipalities' fleet, it becomes as a role model and will pave the way for green and sustainable transportation within the municipality's borders. This in turn encourages local community to follow the steps of their municipalty especially when the municipality allows people to use the renewable energy charging station located at the main Municipality building to charge their electric vehicles. On later stages, the municipality may deploy/build other renewable energy charging stations under its affiliation and suppervision.