NASA

NASA INTERNATIONAL SPACE APPS CHALLENGE

COMMUNITY MAPPING CHALLENGE: AIR POLLUTION IN DİLOVASI

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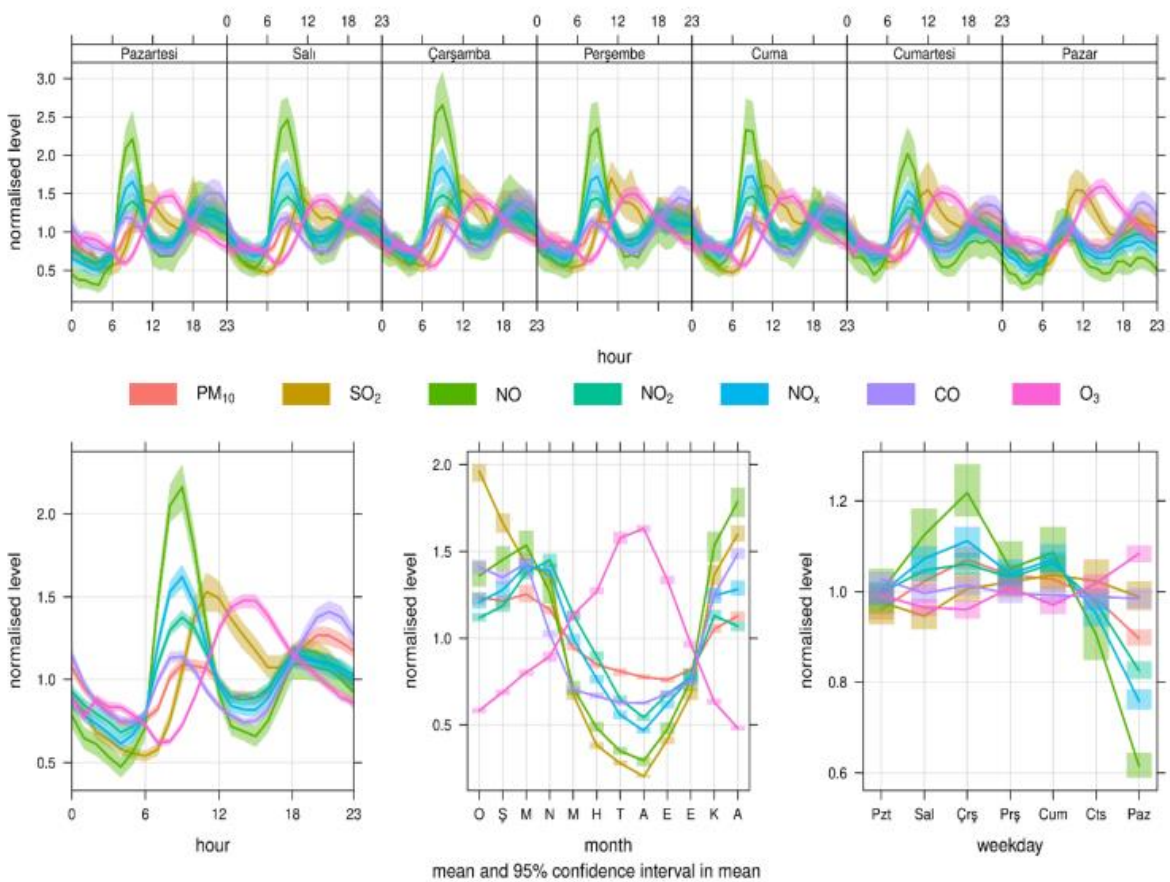
GreenZone.

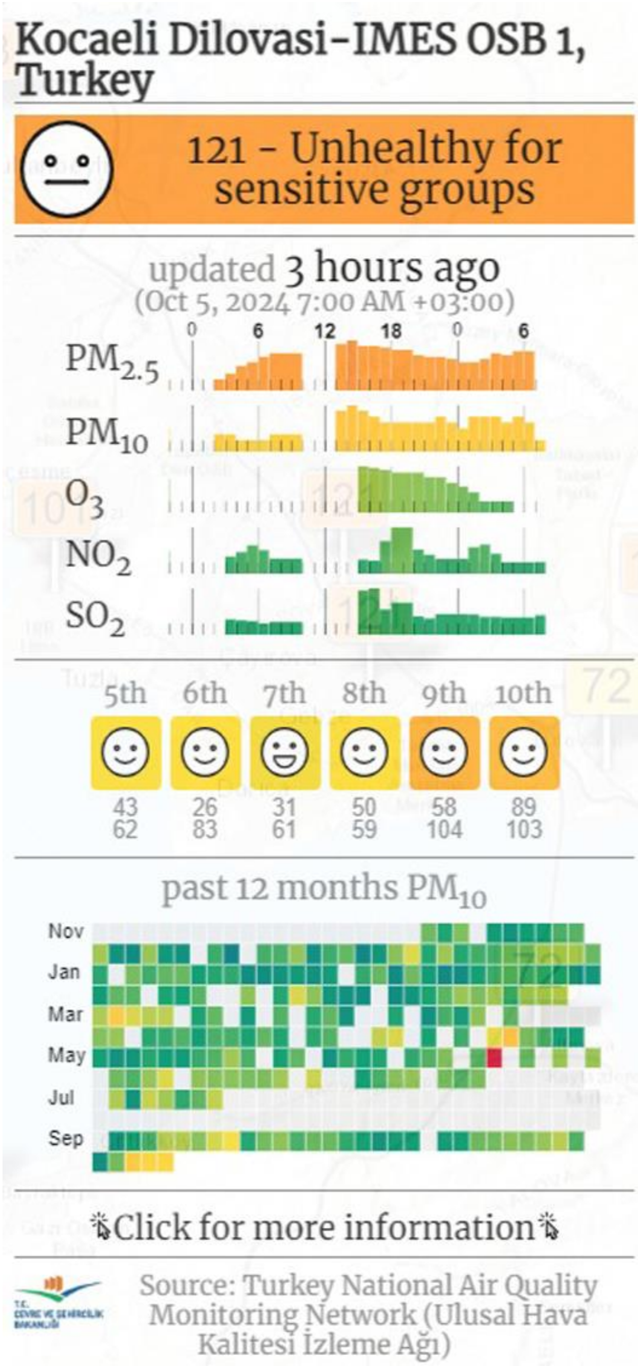
1.Introduction

This report provides a comprehensive overview of the community mapping study conducted to assess the impact of air pollution on human health in the Dilovası organized industrial zone. The study aims to highlight the correlation between industrial emissions and public health concerns, offering insights into the environmental challenges faced by residents in the region.

2. Air Pollution in Dilovası

Dilovası, a heavily industrialized district in Kocaeli, Turkey, faces critical environmental challenges due to air pollution. This area, known for its industrial plants and factories, experiences severe levels of air contaminants that significantly impact public health. Local residents suffer from elevated rates of respiratory diseases, cancer, and early mortality linked to poor air quality. This community map project aims to visually represent the correlation between air pollution levels in Dilovası and its adverse effects on human life, utilizing open data to inform and engage stakeholders in seeking sustainable solutions.





Kocaeli Dilovasi-IMES OSB 1, Turkey
121 - Unhealthy for sensitive groups
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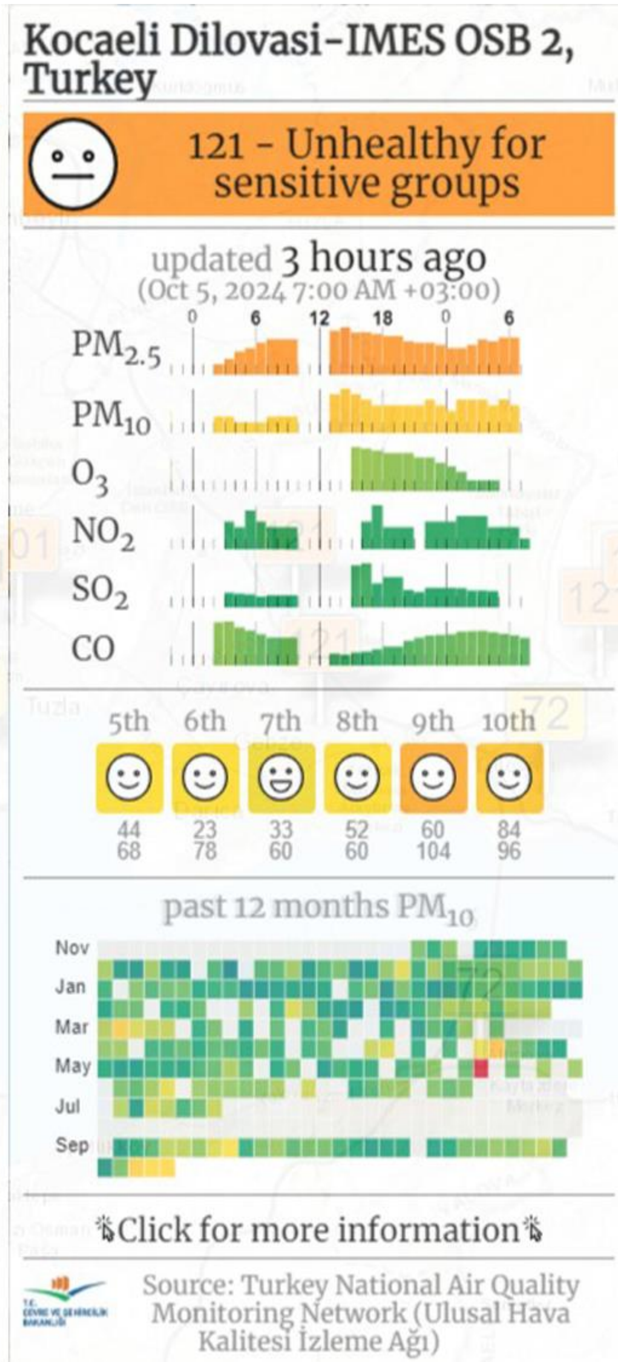
Click for more information
Source: Turkey National Air Quality Monitoring Network (Ulusal Hava Kalitesi İzleme Ağı)



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Click for more information
Source: Turkey National Air Quality Monitoring Network (Ulusal Hava Kalitesi İzleme Ağı)

3. Health Impacts

Air pollution poses a significant threat to public health worldwide, affecting millions of people daily. Exposure to pollutants such as particulate matter (PM2.5), nitrogen dioxide (NO2), and sulfur dioxide (SO2) can lead to a range of serious health issues, including respiratory diseases like asthma and chronic obstructive pulmonary disease (COPD), cardiovascular problems, and even neurological disorders. Vulnerable populations, including children, the elderly, and those with preexisting health conditions, are at an increased risk of adverse effects. As urbanization and industrial activities continue to rise, understanding the health implications of air pollution becomes crucial for developing effective strategies to mitigate its impact and protect public health.

Table 4. Distribution according to duration of life and age groups at death from cancer and other causes in Dilovası.

Duration of living in Dilovası	Age groups			
	≤44 Years		≥45 Years	
	Cancer	Other causes	Cancer	Other causes
≥10 years	4	4	19	29
≤9 years	-	8	3	11
	OR = 0.00		OR = 2.40	

Mantel-Haenszel Chi-Square Analysis OR = 3.83 $P > 0.05$

Table 5. Distribution according to living duration and smoking status at death from cancer and other causes in Dilovası.

	Smoker or Ceased		Non-smoker	
	Cancer	Other causes	Cancer	Other causes
≥10 years	15	15	8	18
≤9 years	3	3	-	16
	OR = 1.0		OR = 0.0	

Mantel-Haenszel Chi-Square Analysis OR = 3.44 $P > 0.05$

The risk of death related to cancer for people who have lived in Dilovası for more than 10 years is 4 times higher than the ones who have lived there less than 10 years (odds ratio: 4.4; CI: 1.05-21.3) (Table 3). Cancer due to living in Dilovası for a period of more than 10 years depends on age groups and smoking habits (Tables 4 and 5).

Table 3. Distribution of the deaths according to duration of life in Dilovası (2004).

Duration of living in Dilovası	Cancer	Other causes
≥10 years	23	33
≤9 years	3	19
	OR = 4.41 (CI = 1.05-21.3)	

Distribution of Cancer Diseases in Dilovası (%)

Reason of Death	
Cancer (malignite)	**33.3**
Lung Cancer	46.2
Stomach Cancer	26.9
Prostate Cancer	11.5
Colorectal Cancer	11.5
Other Cancers	3.9
Other Respiratory Diseases out of Cancer	**16.7**
Cardiovascular Diseases	**14.1**
Other	35.9
TOTAL	**100.0**

4. Community Mapping Approach

Community Mapping is a powerful, participatory approach that enables local communities to collectively identify, visualize, and address environmental challenges, such as air pollution. By integrating local knowledge with geographic data, this method helps capture the real-life experiences and concerns of residents, translating them into actionable insights. It promotes a deep, shared understanding of environmental issues, highlighting how pollution impacts specific areas and populations within a community.

Through collaboration between community members, experts, and authorities, Community Mapping fosters transparency and inclusivity, ensuring that those most affected by environmental hazards have a voice in the problem-solving process. It creates a platform where local insights intersect with scientific data, allowing for a more accurate and comprehensive view of the issue. By mapping pollution sources, vulnerable areas, and the health risks tied to environmental damage, this approach not only identifies problem zones but also helps prioritize actions based on severity and impact.

In essence, Community Mapping transforms environmental challenges into visual, interactive maps that make it easier to analyze and develop targeted solutions. This process encourages local ownership of the issue, empowering citizens to actively participate in creating sustainable, long-term solutions. Whether addressing air pollution, water contamination, or urban planning, Community Mapping serves as a strategic tool to unite diverse stakeholders toward a common goal: improving the quality of life and health for everyone in the community.

5. Solutions for Air Pollution

1) Electrical Public Transportation

The transition to electric vehicles (EVs) in public transportation offers a comprehensive approach to addressing urban mobility challenges while promoting sustainability. One of the most significant advantages of this transition is its positive environmental impact. By replacing fossil fuel-powered buses and trams with electric alternatives, cities can significantly reduce greenhouse gas emissions and local air pollutants, leading to improved air quality.

Additionally, while the initial investment in EV infrastructure may be substantial, the long-term economic benefits are notable. Electric vehicles generally have lower operational costs due to reduced fuel expenses and minimal maintenance needs. Financial incentives, such as government grants and subsidies, can help transit authorities offset these initial costs and encourage the adoption of electric fleets.

The technological innovations that accompany the deployment of electric buses enhance operational efficiency. Smart charging systems and integrated fleet management software contribute to better energy management and scheduling. Furthermore, the public health benefits are significant; improved air quality leads to fewer respiratory issues and other health problems associated with pollution.

Noise reduction is another advantage, as electric vehicles operate much more quietly than their diesel counterparts, creating a more pleasant urban environment and minimizing noise pollution in residential areas.

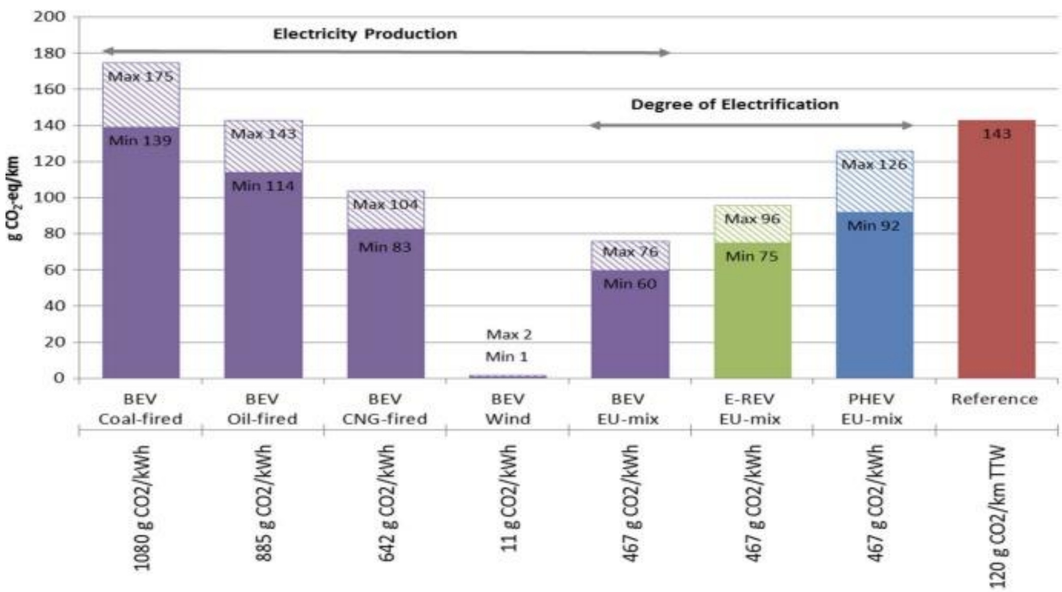
Moreover, the integration of renewable energy sources, such as solar and wind, for charging electric vehicles further reduces their carbon footprint and aligns with global sustainability goals.

To ensure the successful transition to electric vehicles, public acceptance and awareness are crucial. Educating citizens about the benefits of EVs and engaging them in sustainability discussions can foster a culture of eco-friendliness and promote public transit usage.

In conclusion, the transition to electric vehicles in public transportation presents a promising solution for improving air quality, enhancing public health, and creating a more sustainable urban environment. As cities continue to evolve, the successful implementation of this transition will be essential in shaping the future of urban mobility.

Figure 6: carbon footprint of European member states in 2015, and prognosis of EU mix in 2015, 2020, 2030 and 2050. Based on data from [21]

The assumptions for the carbon footprint of the different European countries are based on the report and depicted in figure 6. Sweden and France have a low carbon intensive electricity mix, due to the inclusion of renewables and nuclear sources respectively. Belgium and Spain have an electricity mix with a carbon footprint of 200-290 gCO2/kWh, while in Germany 410 gCO2 are emitted per produced electricity. Poland has the highest GHG emissions to produce electricity (650 gCO2/kWh) due to the inclusion of hard coal power plants. The average European (28 member states) carbon footprint of electricity is 300 gCO2/kWh in 2015 and is expected to drop significantly to 200 gCO2/kWh in 2030 and 80 gCO2/kWh in 2050.



Many LCA studies exist on the vehicle technologies, including battery electric, CNG, FCEV, hybrid electric, etc. However, only a few vehicle-LCA review papers exist. Different results and interpretations are observed in vehicle-LCA literature. The article of Nordelöf investigates the 'lessons learned' from literature and reviews 79 different vehicle LCA papers, reports the main findings and explain the reasons of divergence in literature. The divergence is explained by: variations in systems boundaries, differences in allocated average or marginal electricity mixes and the usage of NEDC or real-life monitored tailpipe emissions for comparisons. Other variations can be explained by: the assumptions of the Life Cycle Inventory of the glider and the lifetime of the vehicle. Choosing a shorter lifetime (e.g. 150,000 instead of 200,000) of the vehicle increases the relative importance of the vehicle production stage. As the battery production has a significant influence on the impact of a BEV, choosing the lifetime of the battery is also of key importance together with the battery chemistry. One of the most important observations in literature is the variation in system boundaries in LCA, which has a significant impact on the interpretation of the results. On one hand, "well-to-wheel" (WTW) studies cover only the life cycle of the energy carrier (i.e. fuels or electricity) used to drive the vehicles. On the other hand, the "complete LCA" includes the production of the equipment cycle. From Well-to-Wheel studies we can learn that the electricity production and the degree of electrification is important. Figure 1 shows the minimum and maximum impact on climate change (in gCO2/km) that is observed in WTW studies.

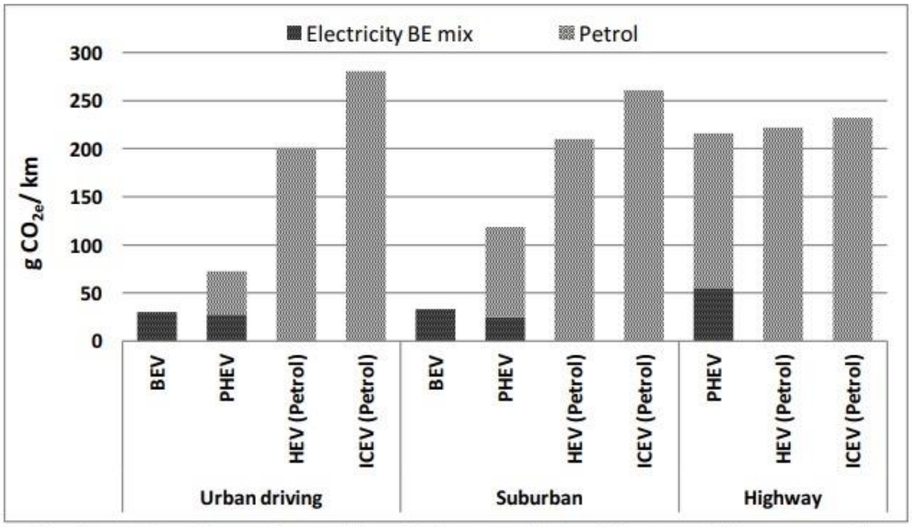


Figure 2 Impact of real world driving and traffic conditions on the WTW environmental performance of vehicles [3] (Data for BEV are obtained from [4])

According to the literature review done by, there is compelling evidence that official laboratory tested (NEDC) fuel consumption and CO2 tailpipe emissions do not correspond well to real-life driving conditions. A difference of 30%-40% is reported between official measurements and real-life driving are found for conventional vehicles. Many factors contribute to the differences including: vehicle characteristics (power, configuration, air drag, weight, auxiliaries, tyre pressure), traffic conditions, driving behaviour, altitude, road surface and weather conditions. Emissions from electric cars are highly impacted by the electricity mix and its carbon footprint which is continuously changing in function of the demand supply (in Belgium a factor 2 difference is observed), the charging profile itself can influence the GHG emissions of BEVs.

2) Hydrophilic and Photocatalytic Surfaces

Photocatalytic Coatings: Photocatalytic coatings (for example, titanium dioxide-based coatings) can be used on surfaces of buildings and infrastructure to reduce air pollution. These coatings react with sunlight to break down airborne pollutants like NOx and convert them into harmless compounds.

Hydrophilic Surfaces: The impact of pollution can be reduced by using hydrophilic materials in infrastructure elements in industrial areas. These materials allow rainwater to wash away pollutants, preventing them from accumulating on surfaces and enabling natural cleaning.

1. Average Factory Size

While factory sizes can vary, the average exterior surface area of a production factory is typically around 10,000 m^2. This size serves as a reference point for the surface area to be painted.

2. Cost of Photocatalytic Paint

The average cost of photocatalytic paints ranges from $15 to $25 per square meter. Using this range, the cost can be calculated as follows:

Factory Size: 10,000 m^2

Paint Cost: $15-$25 per m^2

The total installation cost can be calculated as:

Low Cost: 10,000 m^2 x $15/$m^2$ = $150,000

High Cost: 10,000 m^2 x $25/$m^2$ = $250,000

This cost only covers the paint material. Application costs, similar to paint prices, can typically range from $2 to $5 per square meter. If we include application costs:

Application Cost: 10,000 m^2 x $2-$5/m^2 = $20,000-$50,000

Total paint and application costs:

Low Scenario: $150,000 (paint) + $20,000 (application) = $170,000

High Scenario: $250,000 (paint) + $50,000 (application) = $300,000

This represents the initial investment cost of coating an average factory with photocatalytic paint.

3. Return on Investment of Photocatalytic Paint (Long-Term)

A. Energy Savings

Photocatalytic paints can reduce energy consumption due to their light-reflective properties. They can lower indoor temperatures in buildings during summer, thereby reducing air conditioning usage. These paints can provide around 10-20% energy savings.

Annual Energy Cost: The annual energy cost of an average-sized factory can be around $100,000 (this may vary by region and sector).

Energy Savings: 10-20% energy savings could yield an annual gain of $10,000-$20,000.

In this case, over 10 years, energy savings would be:

Low Savings Scenario (10%): $10,000 x 10 years = $100,000

High Savings Scenario (20%): $20,000 x 10 years = $200,000

B. Savings on Maintenance and Cleaning Costs

The self-cleaning properties of photocatalytic paints can also reduce the costs associated with cleaning facades. In industrial areas, cleaning buildings can be a significant expense.

Annual Cleaning Cost: The annual cleaning cost for an average factory's exterior can range from $15,000 to $30,000.

Photocatalytic paints can reduce these costs by up to 50%. Thus:

Low Scenario: If the annual cleaning cost of $15,000 is reduced by 50%, it results in savings of $7,500.

High Scenario: If the annual cleaning cost of $30,000 is reduced by 50%, it results in savings of $15,000.

Over 10 years, this savings would be:

Low Savings Scenario (50%): $7,500 x 10 years = $75,000

High Savings Scenario (50%): $15,000 x 10 years = $150,000

C. Contribution to Air Quality and Community Impact

While the environmental impact of photocatalytic paints may not directly provide financial gains to the factory, improving air quality can reduce health costs and penalties associated with air pollution in the region. Participation in government incentives or sustainability programs can indirectly enhance the factory's reputation.

4. Long-Term Returns and Payback Period

By combining the costs of photocatalytic paints and the savings generated, we can evaluate how long the investment will take to pay off:

Low Scenario:

Initial Cost: $170,000

Annual Return: $10,000 (energy) + $7,500 (cleaning) = $17,500

10-Year Return: $175,000

In this scenario, savings at the end of 10 years would be nearly equal to the initial cost.

High Scenario:

Initial Cost: $300,000

Annual Return: $20,000 (energy) + $15,000 (cleaning) = $35,000

10-Year Return:$350,000

In the high scenario, a profit of $50,000 could be obtained by the end of 10 years.

5. Conclusion

The initial cost of coating an average factory with photocatalytic paints can range from $170,000 to $300,000. However, this investment can lead to significant long-term savings in energy and maintenance/cleaning costs, allowing it to pay off within 10 years. In factories with higher energy consumption and more substantial cleaning requirements, this payback period could be even shorter.

Depending on the region where the factory is located and the level of air pollution, this technology can contribute to sustainability goals and enhance the factory's reputation.

3) Biourban

This report explains the installation costs, annual maintenance expenses, and cleaning capacity of the Biourban electric air purification system. Biourban is equivalent to the air purification capacity of 368 trees and is specifically utilized to combat air pollution in urban areas.

Installation and Operating Costs of the Biourban System

Installation Costs: The installation costs of the Biourban system vary based on several factors. Generally, the cost for a system equivalent to 368 trees ranges from $50,000 to $100,000. This cost can fluctuate depending on the system's size, filter technology used, and energy efficiency optimizations. Smaller systems may have lower costs, while expenses increase for larger areas in big cities. The installation duration typically takes 1-2 months, with completion possible within a few weeks, depending on environmental factors and local infrastructure.

Annual Maintenance Costs: The annual maintenance costs for the Biourban system consist of energy consumption and technical maintenance expenses. The energy consumption ranges from $1,000 to $3,000 per year, while technical maintenance, which includes filter changes and performance checks, typically ranges from $5,000 to $10,000 annually. Thus, the total annual operating cost amounts to $6,000 - $13,000.

Air Purification Capacity

CO2 Capture: The Biourban system, assumed to operate at the power of 368 trees, has an annual CO2 filtration capacity of 10 - 15 tons. This system filters emissions equivalent to what 368 trees can clean annually. With an average tree filtering about 20-22 kg of CO2 each year, the Biourban system effectively absorbs 10-15 tons of CO2. It can also filter harmful gases like nitrogen oxides (NOx) and sulfur dioxide (SO2) and has the capacity to clean approximately 30-50 kg of fine particulate matter (PM) annually.

Coverage Area: A Biourban system is effective in an area ranging from 200 to 500 square meters. Installing multiple systems increases the air purification capacity over a broader area. When strategically placed, these systems can have a significant impact on large urban areas.

Long-Term Benefit-Cost Analysis of the Biourban System

Over a decade, the total operating costs are estimated between $145,000 and $195,000, considering both the initial installation costs and average annual maintenance expenses of around $9,500. The system can filter an average of 100-150 tons of CO2 over this period, contributing to a considerable impact in fighting urban air pollution. Additionally, implementing air purification systems can lead to substantial indirect savings in health expenses, as clean air reduces respiratory diseases and alleviates burdens on the healthcare system.

Conclusion

The Biourban system serves as an effective technological solution for improving air quality, especially in densely populated urban areas. With its capacity to filter significant amounts of CO2 and other harmful pollutants, it offers a favorable benefit-cost balance over the long term. While the high initial installation costs may seem prohibitive, the resulting clean air and reduced health expenses can make it a strategic investment for cities.

4) Air Quality Sensors

These advanced sensors are designed to detect harmful pollutants in the air, such as nitrogen dioxide (NO_2) and ozone (O_3), which are significant indicators of air pollution. The technology behind these sensors enables hyper-localized spatial measurements, meaning they can assess air quality in highly specific areas. This level of precision provides more detailed and accurate data compared to traditional methods.

The sensors rely on fluorescence-based detection, a method that significantly enhances their sensitivity to pollutants, allowing for faster and more accurate readings. This innovation marks a substantial improvement over older techniques used for air quality monitoring. Additionally, these sensors are cost-effective and locally manufactured in Turkey. This reduces the country's reliance on more expensive, imported devices while making air quality monitoring more accessible on a larger scale.

By deploying these sensors, Turkey can enhance its air pollution monitoring system, enabling real-time tracking of environmental health. This improvement will allow for faster responses to changes in air quality, contributing to better public health outcomes, particularly in urban and industrial areas where pollution levels tend to be higher

5) Economic and Environmental Impact of Carbon Tax on Coal-Fueled Factories in Turkey

The introduction of a carbon tax in Turkey will have significant economic and environmental effects, particularly on factories in regions with heavy industry. A carbon tax is a policy that requires industrial facilities to pay taxes based on the amount of carbon emissions they release into the atmosphere, aimed at reducing greenhouse gas emissions. This report evaluates the impact of a carbon tax on factories using coal in Turkey and calculates potential annual gains.

Coal Consumption and Emissions

Coal usage in industrial facilities accounts for a significant portion of Turkey’s energy demand. For instance, in 2021, Turkey's total coal consumption was approximately 100 million tons. When coal is burned, it releases a considerable amount of carbon dioxide (CO_2). On average, 1 ton of coal burned results in 2.86 tons of carbon dioxide emissions.

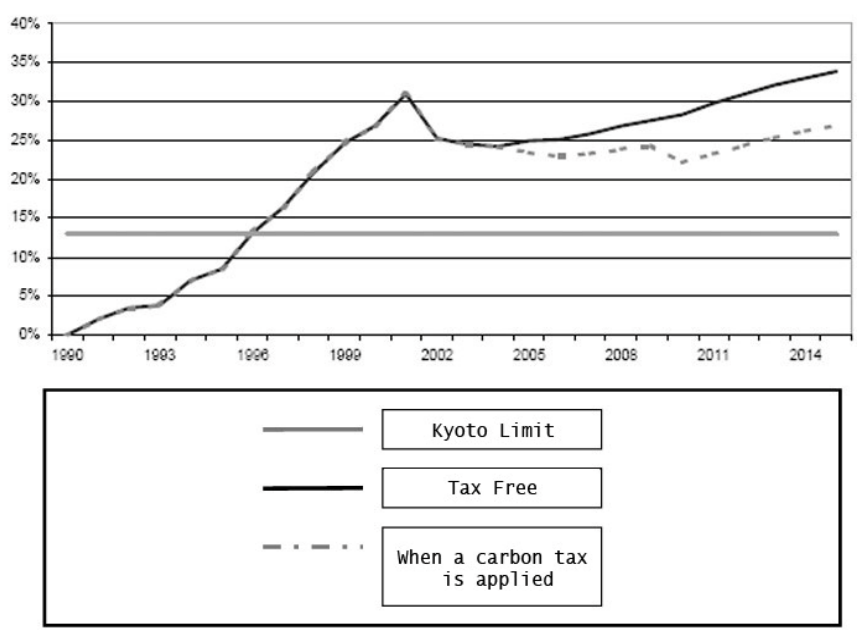
Industry	Effect(%)
Coal	63%
Heavy Fuel Oil	39%
Natural Gas	31%
Electric	15%
Residential and Commercial Sector	
Light Fuel Oil	18%
Natural Gas	13%
Electric	13%
Transportation	
Gasoline	6%
Diesel	9%

A large proportion of the industrial facilities in the Dilovası region are coal-powered factories. These factories consume an average of 10 million tons of coal annually, and their total emissions can be calculated as follows:

10 million tons × 2.86 = 28.6 million tons of CO_2

Implementation of Carbon Tax

Carbon tax rates vary globally. While EU countries apply carbon taxes ranging from €25 to €50 per ton, countries like Sweden have taxes as high as €137 per ton. If Turkey's carbon tax is aligned with EU standards, a rate of approximately €30 per ton could be expected.



Source: Bergin and his friends(2001,s18)

The annual carbon tax calculation is as follows:

28.6 million tons × €30 = €858 million

Based on this calculation, factories in the Dilovası region would pay an annual carbon tax of €858 million for their carbon emissions.

Table 1.2: Carbon Taxes in Some OECD Countries (Ton/Dollar)

Countries	Oil and Petroleum Products	Natural Gas	Coal	Total
France	351	38	0	228
Italy	317	80	0	223
Sweden	268	13	6	214
Switzerland	224	2	18	198
Norway	258	0	0	182
Austria	267	39	0	150
Denmark	297	110	0	147
Portugal	205	13	0	147
Irland	277	4	0	139
New Zeland	235	0	0	117
Spain	176	19	0	112
Finland	200	0	0	107
England	297	0	0	107
Germany	212	23	0	95
Holland	221	27	0	89
Belgium	162	35	0	86
Japan	130	2	0	75
Australia	178	0	0	61
Canada	108	0	0	52
America	65	0	0	28

Long-Term Benefits

With the introduction of a carbon tax, industrial facilities will be forced to improve energy efficiency and shift towards cleaner energy sources. In the long term, such incentives will lead to:

Increased energy efficiency and reduced coal consumption, leading to lower emissions.

Increased investments in renewable energy and a shift towards more sustainable sources of energy in industry.

Improved air quality, resulting in lower healthcare costs and increased labor productivity.

A more competitive position for Turkey in international carbon markets.

In a hypothetical scenario, if carbon taxes and energy transition policies are effectively implemented, annual coal consumption could be reduced by approximately 5%. In this case, over a period of 10 years, coal consumption and associated carbon emissions would decrease significantly. In the first year, coal consumption of 10 million tons would drop to around 6.3 million tons by the end of the 10th year. This would also reduce the carbon tax burden.

Although tax revenues would decline in line with reduced emissions and coal usage, if these revenues were reinvested into green energy and environmental improvement projects, Turkey could achieve long-term economic and environmental gains.

Conclusion

The enactment of a carbon tax in Turkey would be an effective tool for reducing carbon emissions, especially in coal-powered industrial facilities. In the early years, factories would pay high amounts in carbon taxes, but over time, they would be compelled to transition to cleaner energy sources and increase energy efficiency. This would lead to significant environmental and economic benefits. In regions with heavy industry like Dilovası, a carbon tax would play a crucial role in reducing air pollution and contribute positively to the health and quality of life for residents in these areas.

8. References

Topal, O. Establishment of Business Perfromans Model for Electric Buses in İstanbul Real Road, Journey and Times Conditions Against Diesel and CNG Buses. Ph.D. Thesis, Yildiz Technical University, Institute of Science and Technology, İstanbul, Turkey, 2016

Topal, O., & Nakir, İ. (2018). Total Cost of Ownership Based Economic Analysis of Diesel, CNG and Electric Bus Concepts for the Public Transport in Istanbul City. Energies, 11(9), 2369.

BNEF Research Services Report 2018

Electric Vehicle Outlook Report “Global EV Outlook 2018”

EGO Genel Müdürlüğü, Kurumsal Tanıtım; https://www.ego.gov.tr (erişim tarihi 10.01.2019)

ENGİN V., GÜLSOY U. ,(2016), “Osmanlı'dan Cumhuriyet'e İstanbul'da Elektrik “ İstanbul, İETT.

Kurumsal Yayınlar, (2013),”Dünden Bugüne ESHOT Genel Müdürlüğü 70. Yıl anısına”İzmir , ESHOT

İETT İşletmeleri Genel Müdürlüğü Toplu Ulaşım Yönetim Sistemi Projesi “Enerji Yönetimi”

Topal O. ve diğerleri (2017). İstanbul Toplu Ulaşım Sisteminin Emisyon Analizi, Transist 10. İstanbul Ulaşım Kongresi

“Elektrikli Otobüslerin Kamu Toplu Taşıma Sistemi İçerisindeki Yeri” Dr. Orhan TOPAL, İTÜ Elektrikli Araçlar Zirvesi 2018 (konferans konuşması)

EGO- YEGM Elektrikli Otobüs Protokol https://www.ego.gov.tr/tr/haber/4266/egoda-elektrikli-otobus-donemi (erişim tarihi 10.01.2019)

https://mapmaker.tomtom.com/styles/dG9tdG9tQEBAREN1Zk5relBYcW5BOFFNdzsyOTBmYmI5Mi02NzQyLTQ4MmUtYjMyYS0xZjBjNjQ4MzhkNDk=/0#14.59/40.78604/29.5472

https://tr.wikipedia.org/wiki/Dilovas%C4%B1

https://tr.wikipedia.org/wiki/Karbon_vergisi#:~:text=Bu%20maddenin%20daha%20do%C4%9Fru%20ve%20g%C3%BCvenilir%20bilgi%20sunmas%C4%B1%20i%C3%A7in%20g%C3%BCncellenmesi%20gerekmektedir.,-Daha%20fazla%20bilgi&text=Avrupa'da%20baz%C4%B1%20%C3%BClkeler%20enerj

i,%C4%B0sve%C3%A7%2C%20%C4%B0svi%C3%A7re%20ve%20%C4%B0ngiltere%20dahildir

https://www.iklimhaber.org/sinirda-karbon-duzenleme-mekanizmasindan-hangi-sektorler-nasil-etkilenecek/#:~:text=Uygulama%20kapsam%C4%B1nda%20karbon%20ka%C3%A7a%C4%9F%C4%B1%20riski,%C3%BCzere%206%20sekt%C3%B6r%20yer%20al%C4%B1yor

https://dergipark.org.tr/en/download/article-file/1108559

https://sciencediscoveryengine.nasa.gov/app/nasa-sba-ej/#/ej/results?query=%7B%22name%22:%22query_ej_primary%22,%22text%22:%22%22,%22filters%22:%5B%22%22,%22Health%20%26%20Air%20Quality%22,%22sourcecsv14%22,%22health%20%26%20air%20quality%22%5D%7D

https://sim.csb.gov.tr/Services/AirQuality

https://acikveri.org/

https://research.itu.edu.tr/tr/projects/t%C3%BCrkiye-geneli-hava-kirleticilerinin-istatistiksel-analizi-ve-cov

https://dergipark.org.tr/tr/pub/tcd/issue/31131/319264

https://atlasbig.com.tr/kocaeli-dilovasinin-mahalleleri

https://waqi.info/#google_vignette

https://journals.tubitak.gov.tr/cgi/viewcontent.cgi?article=3567&context=medical

https://projects2014-2020.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1512059889.pdf

https://solarimpulse.com/solutions-explorer/biourban

https://www.2kshops.com/siemens-qpm2180/

https://dergipark.org.tr/en/download/article-file/1108559

https://www.ttb.org.tr/kutuphane/dilovasirpr.pdf