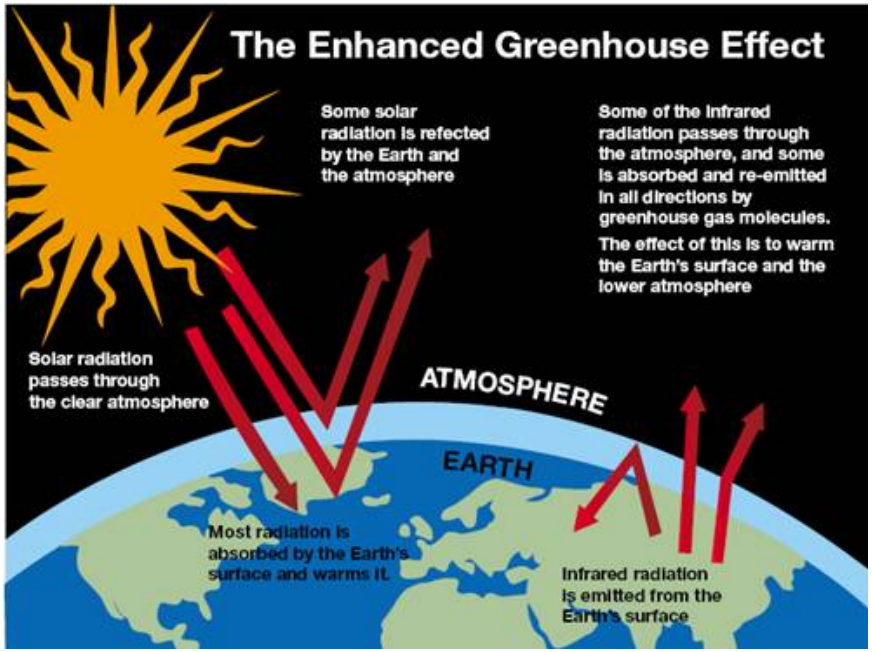
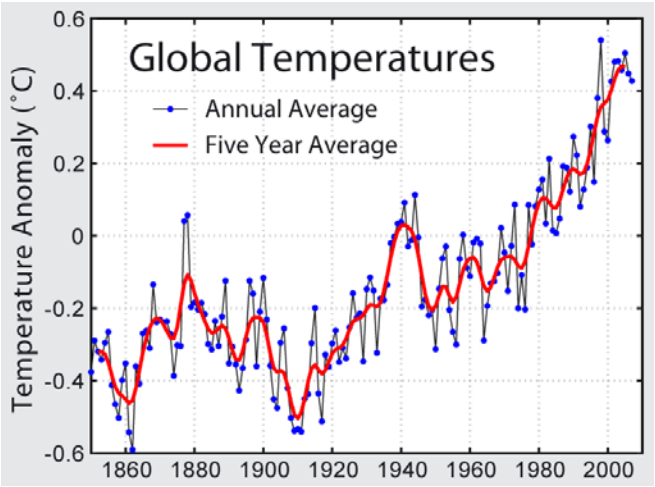
Adaptation measures & requirements to prevent impacts of climate change on road networks
THE CASE OF ATTICA TOLLWAY

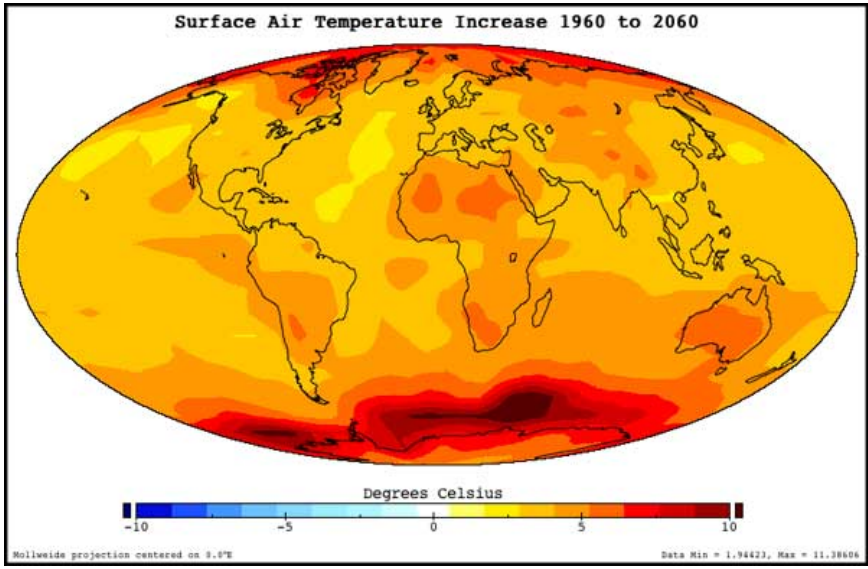
ATTIKI ODOS

Greenhouse effect & Global warming





Think Globally



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Consequences of a 2°C-warmer world

- Mediterranean climate : hotter, drier, more variable
  - Northern Aegean islands : + 2 weeks of heat wave / y.
  - Summer rainfall: -30%
  - Heavier rainfall episodes in western Greece
- Risk of forest fire + 6 weeks / y.
- Stress on agriculture and water
  - Esp. beans, soy beans, lentils
- Overall threat on 50% of plant species

Consequences of a warmer world on Road Infrastructure

Extreme max. temperatures	Reduction of annual rainfall	Extreme Rainfall & Storms	Floods	Hot/Cold Variability
• Asphalt melting, rutting • Thermal expansion of bridge joints • Structure materials	• Road foundations	• Landslides • Bridge undermining, destruction or submergence • Structural Damage • Embankments	• Road scouring • Road subgrade degradation • Risk to embankments • Expansion joint shrinkage due to scouring	• Road pavement scouring • Joint damage • Extreme winter events

Flooding


Freeze-thaw damage


Rutting

Consequences of climate change on road infrastructure can be <u>direct</u>, as stated above, but also <u>indirect</u>, due to interdependencies with other sectors, such as energy and water.

Risks of failed road infrastructure from climate change

Infrastructure Operators	Users	Investors	Insurers	Government
• Loss of revenue • Damaged assets	• Service failure • Dangers	• Economic losses of infrastructure operators • Losses from investments reliant on infrastructure	• Increased risks	• Assistance with losses in extreme circumstances

Adaptability is to climate change what sustainable development is to environment and resources:

An adaptable road infrastructure network is resilient to today's natural hazards and prepared for the future changing climate.

(Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.)

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The need for adaptation

Global Warming

- Global warming is 'unequivocal' and 'most of the observed increase in globally-averaged temperatures since the mid-20th Century is very likely due to the observed increase in *greenhouse gas concentrations*'. *(IPCC Fourth Assessment Report, 2007)*

Climate change

- Extreme temperature events, floods, extreme Rainfall, drought, sea level rise etc.

Mitigation

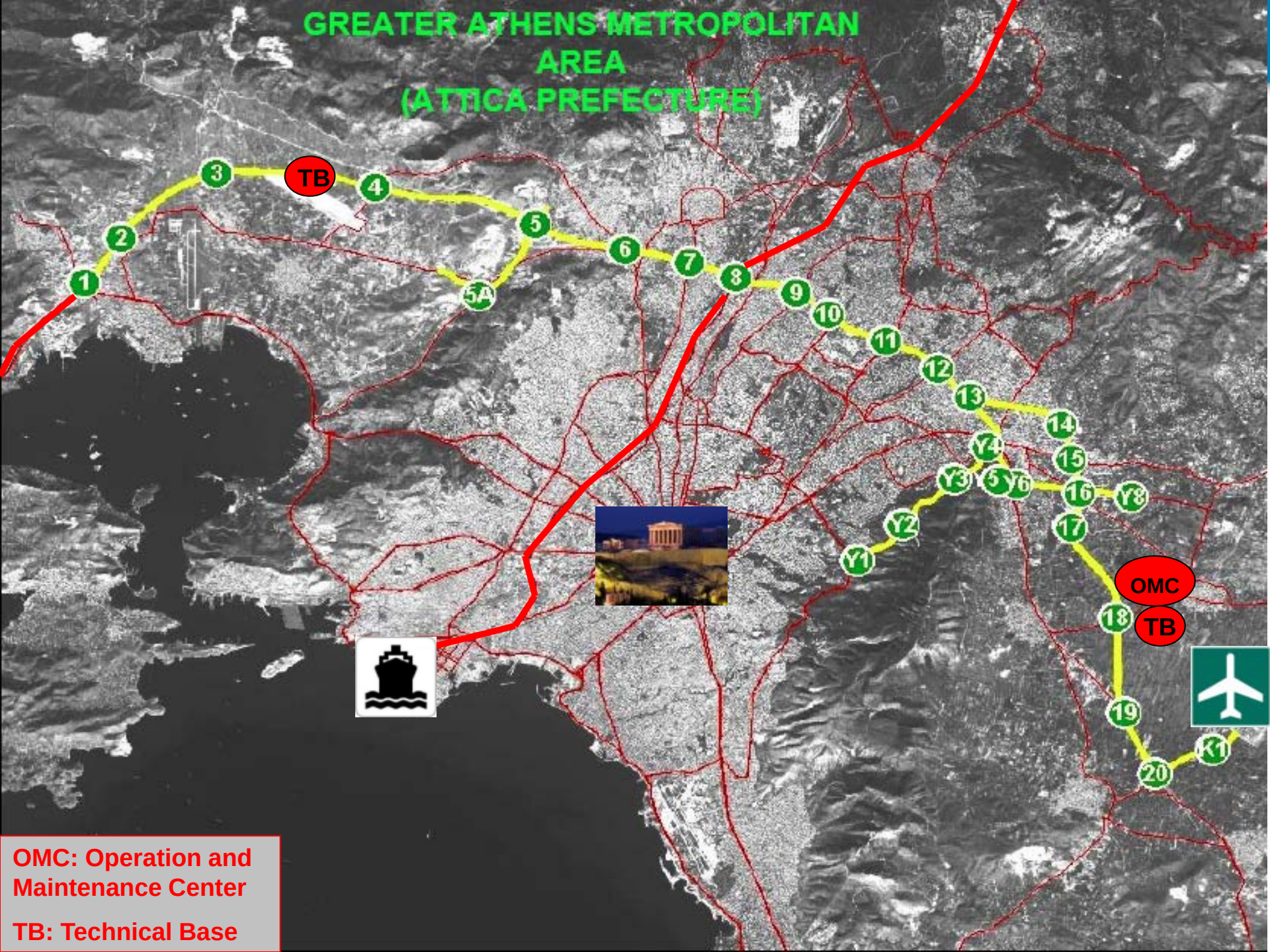
- Addressing the ***causes*** of climate change, e.g. reducing GHG emissions, reducing energy use, green buildings, renewable energy sources , planted areas, etc.

Adaptation

- Addressing the ***impacts*** of climate change, e.g. floods, heat waves etc

Resilient Road

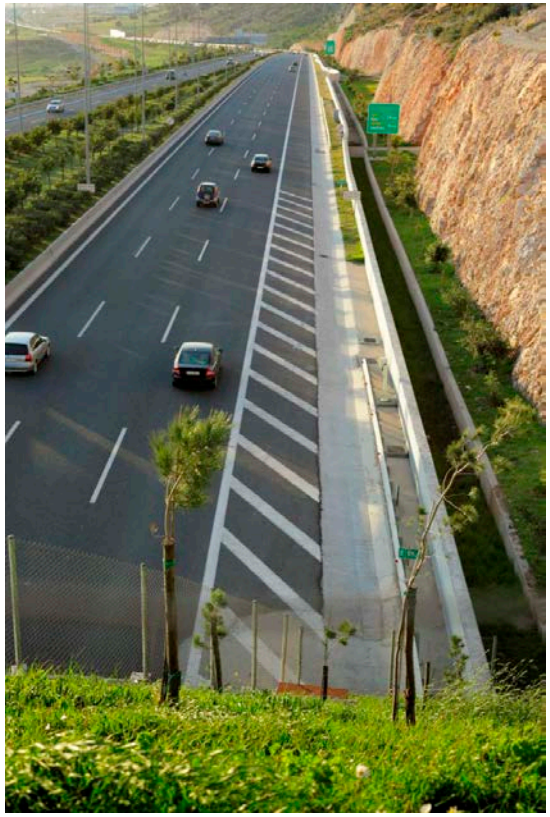
- 5th Generation – Forever Open Road


GREATER ATHENS METROPOLITAN AREA (ATTICA PREFECTURE)
TB
1
2
3
4
5
5A
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Y1
Y2
Y3
Y4
Y5
Y6
Y8
K1
OMC
TB
OMC: Operation and Maintenance Center
TB: Technical Base

ATTIKI ODOS

Technical characteristics

- Total Length 65 km
- Lanes per direction 3 + Emergency Lane
- Toll road Interchanges (I/C) 29
- Toll stations 39/195 L.
- Service/Side road network 150 km.
- Overpasses 100
- Underpasses 25
- No. of bored & cut & cover tunnels 56
- Length of Tunnels & cut & cover sections 15,4 km.
- Length of flood protection works 67 km.
- No. of Motorist Service Stations 4



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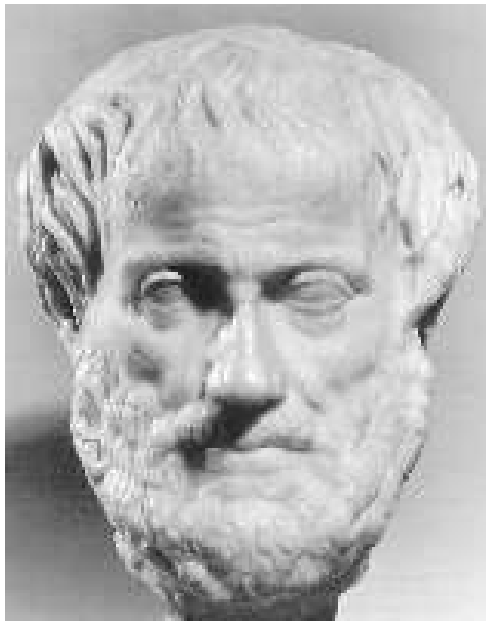
"Excellence is an art won by training and habituation: we do not act rightly because we have virtue or excellence, but we rather have these because we have acted rightly; these virtues are formed in man by his doing the actions; we are what we repeatedly do. Excellence, then, is not an act but a habit."



Nicomachean Ethics

Aristotle (384-322 BC)

Attica Tollway and Mitigation

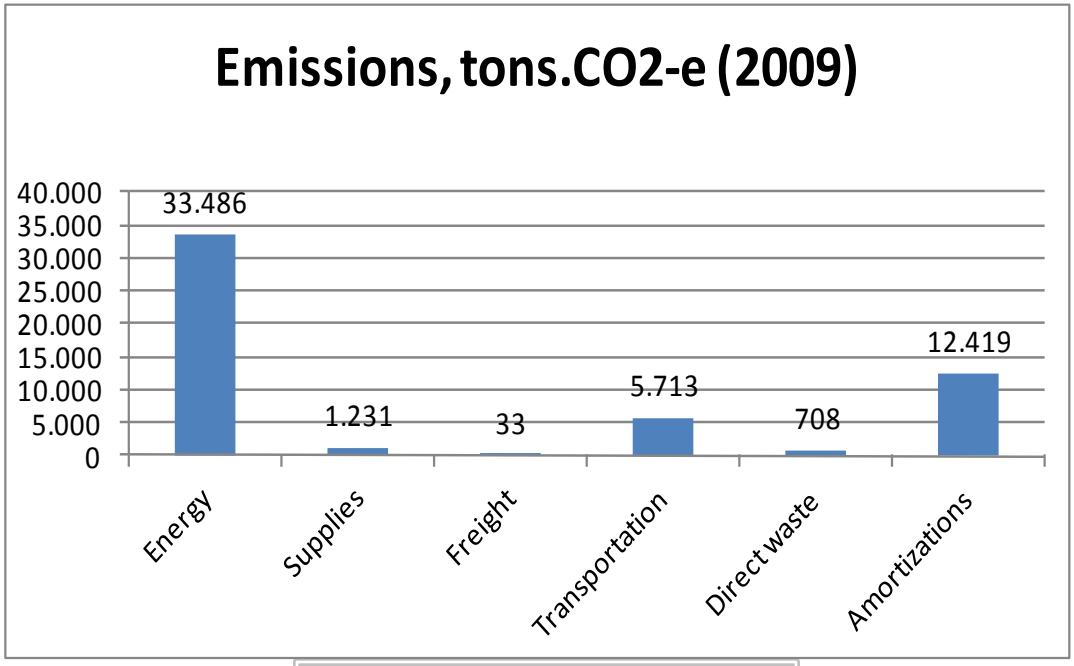
Prize "Décibel d' Or" in the category "City and Transport" (2003) from Conseil National de Bruit (CNB), for the program "Management and reduction of Road Noise Pollution from the Operation of Attica Tollway".

1st Global Road Achievement Award in the category of Environmental Mitigation (2008)
from the International Road Federation (IRF),
for its continuous efforts in mitigation of environmental impacts of tollway.

Green Recognition
in "myclimate Awards 2011"
(in the category: Green Leader – Carbon footprint Assessment and Mitigation)
from the Centre for Sustainability and Excellence (CSE), for its Carbon footprint assessment.

The carbon footprint of Attica Tollway

- **Energy consumption** (mainly fuel and electricity) is the main contributor to CO_2, hence the company's efforts have targeted these areas, yielding significant financial advantages, as well.



- **53.590 t CO_2eq**
- **62% energy**
- **23% amortizations**
- **11% transportation**

Changes in tunnel and open road lighting technology, as well as changes in constitution of vehicle fleet, has led to significant reductions in electricity and fuel consumption.

Carbon footprint reduction from 2009 to 2011: 10%

Attica Tollway and Adaptation

Climate change affects maintenance cycles and condition of infrastructure. Our mission is to provide safe, comfortable and efficient trips to our Users, so our adaptation processes currently include:

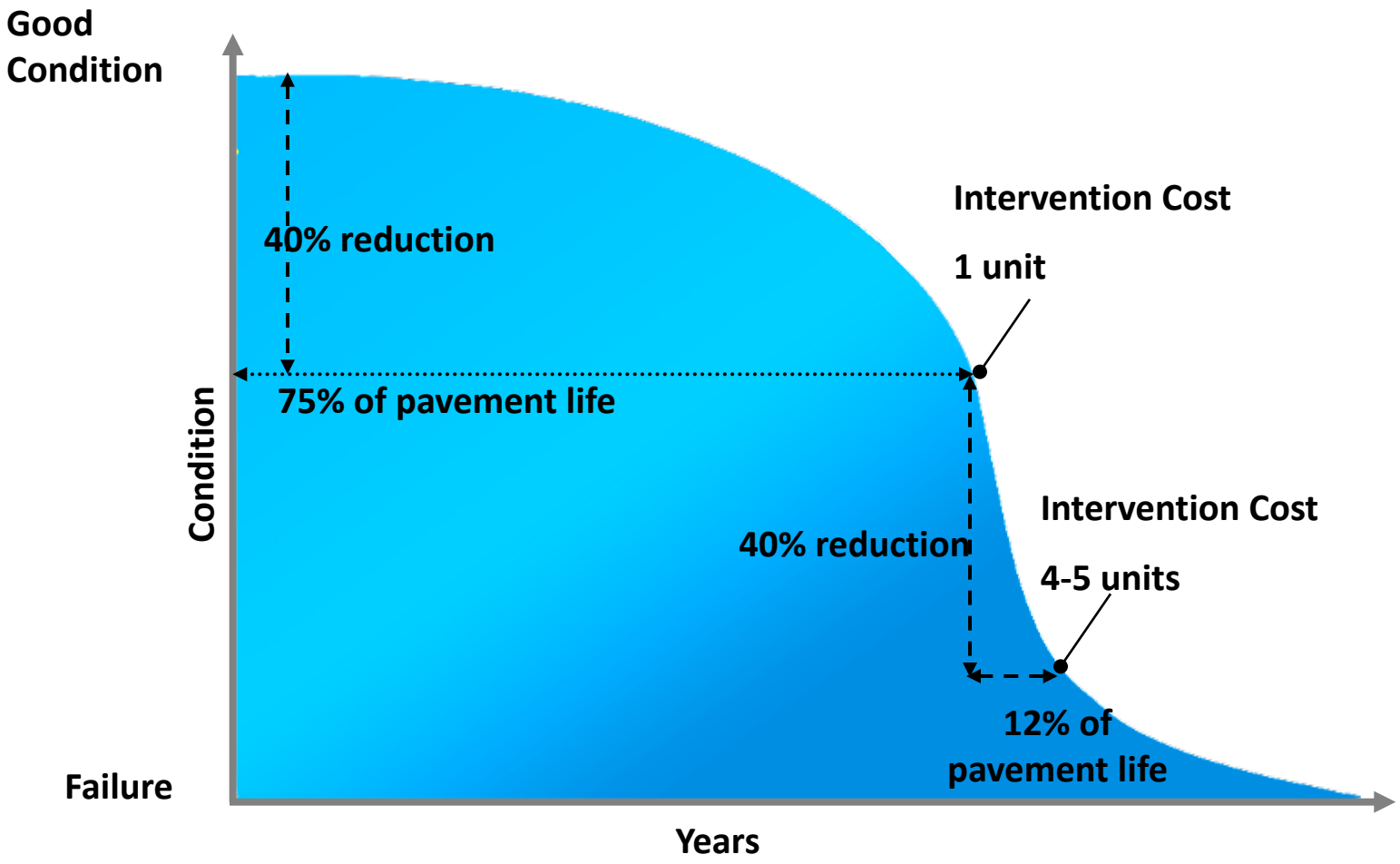
1. Flood Management
2. Pavement Maintenance
3. Meteorological stations
4. Proactive Management / Action plans, Inspections & monitoring of infrastructure condition

We are also constantly adapting and investigating methods and technologies for the road's adaptation to climate change.

1. Flood protection and management

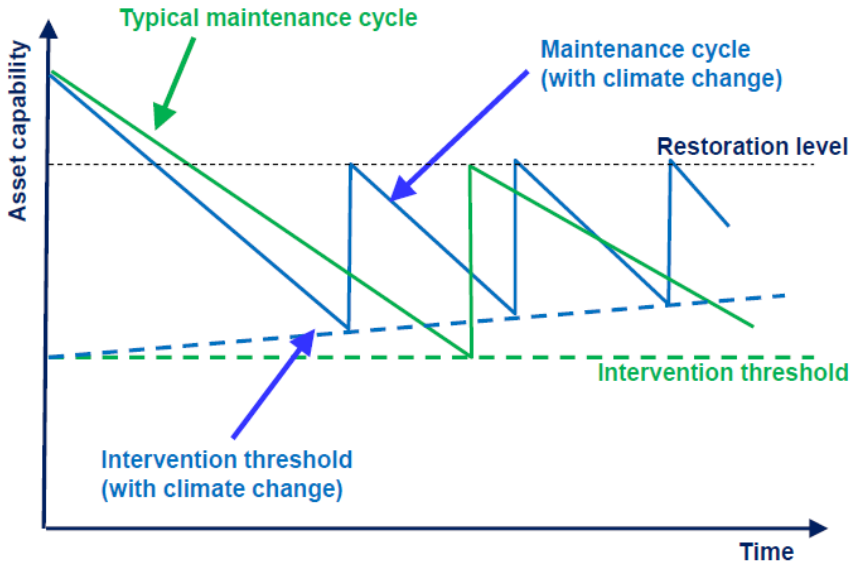
- Construction of extensive sewerage and flood protection works for collecting the superficial runoff (few remaining natural receptors)
- Maintenance of 67km-long flood protection works to collect water runoff and improve the overall flood protection of the city of Athens
- Areas that used to be threatened by floods before Attica Tollway are now protected. Tollway is also protected.

2. Pavement Maintenance

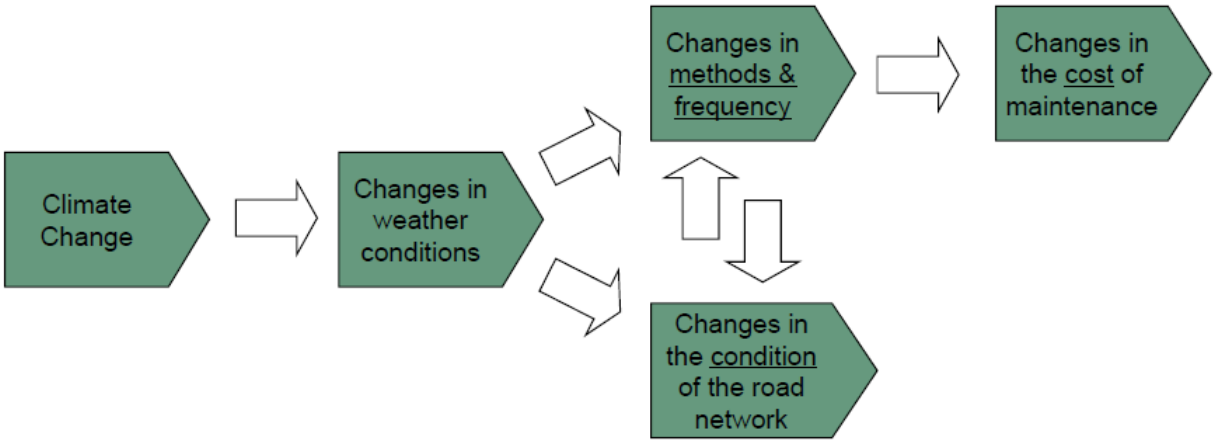


Climate change and road maintenance

Climate change in road infrastructure greatly affects maintenance cycles:



Based on the UK Agency Climate Change Adaptation Framework (2009)



"*Impact of climate change on road maintenance*", Finnish Road & Traffic, 2009

Pavement measurements and characteristics

Falling Weight Deflectometer (FWD)

Laser Profiler

Grip Tester

Ground Penetrating Radar (GPR)

Structural characteristics

Layer's thicknesses

Structural indicators

Functional characteristics

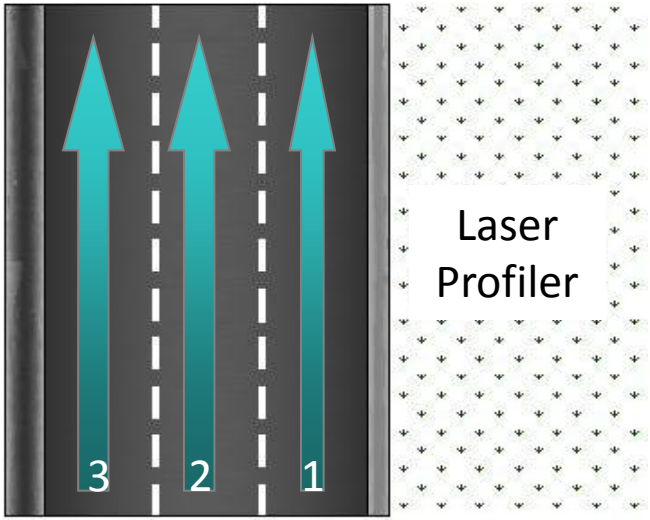
Roughness

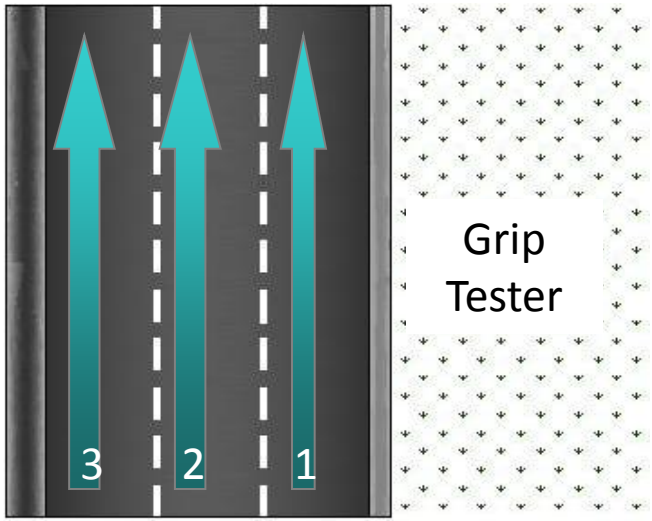
Rutting

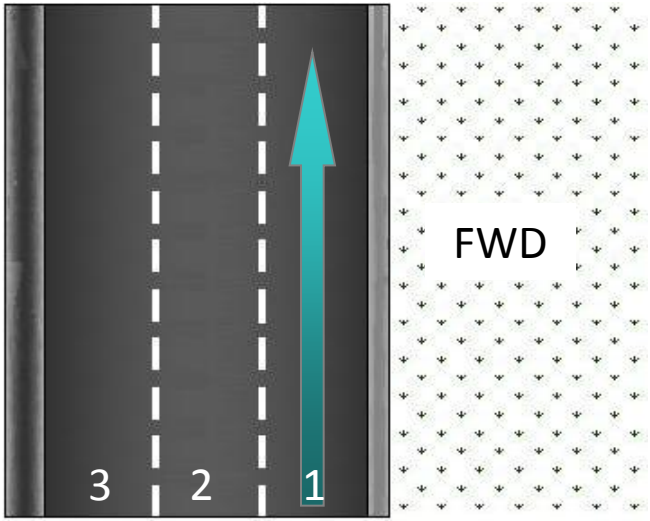
Skid resistance

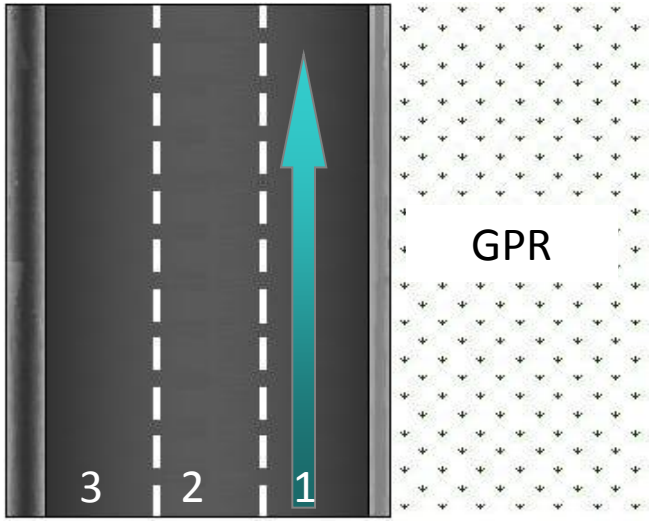
Texture

Location of measurements









1:RL

2:ML

3:LL

Periodicity/Density of measurements

Measurement	Periodicity / density	Intervals
Roughness	Annually / continuous	10m
Rutting	Annually / continuous	10m
Skid resistance	Two times per year / continuous	10m
Texture	Two times per year / continuous	10m
Structural Condition	Annually / every 200 m	200m
Layers' thicknesses	Once at the beginning of the research/ continuous	10m

Use of pavement monitoring data

- Pavement monitoring is carried out along the whole length of the motorway and at least once a year.
- Skid resistance and texture, as they are sensitive functional characteristics, are measured twice a year, to obtain data regarding both the winter season, as well as the summer season.
- Historic data has been collected from the start of operation of the tollway, enabling us to check indicator values and variability throughout the years and to identify potential sources of concern and trends.

3. Meteorological stations

- There are 3 meteorological stations located along the length of Attica Tollway, providing real-time data regarding the prevailing weather conditions.
- Information can be used to prepare operator, as well as users of the tollway, regarding extreme weather conditions.

4. Proactive Management / Action Plans/ Monitoring / Inspections

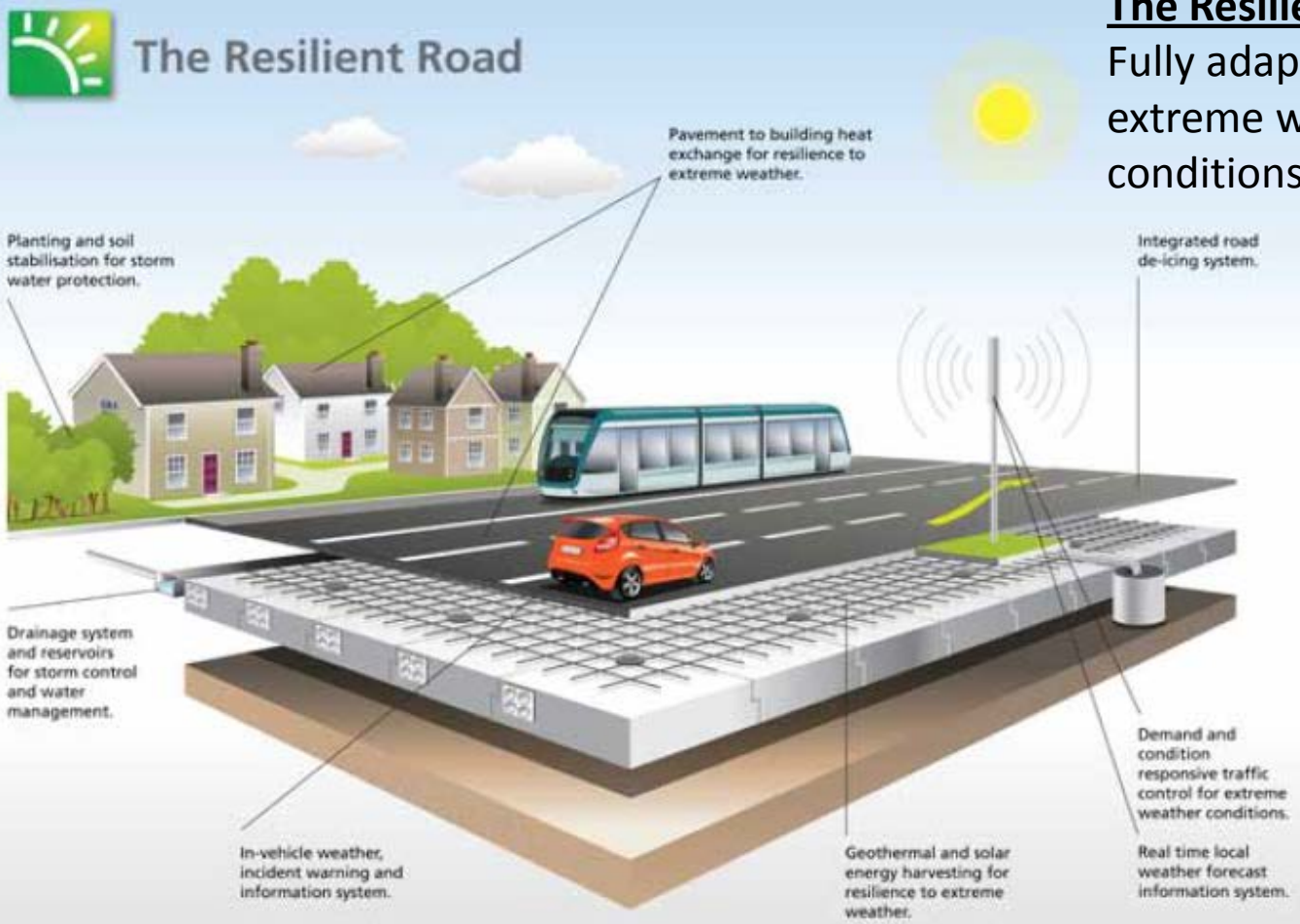
ATTIKI ODOS

5th Generation Roads

FOREVER OPEN ROAD

Redefining Road Transport for the 21st Century

FEHRL's Flagship Programme



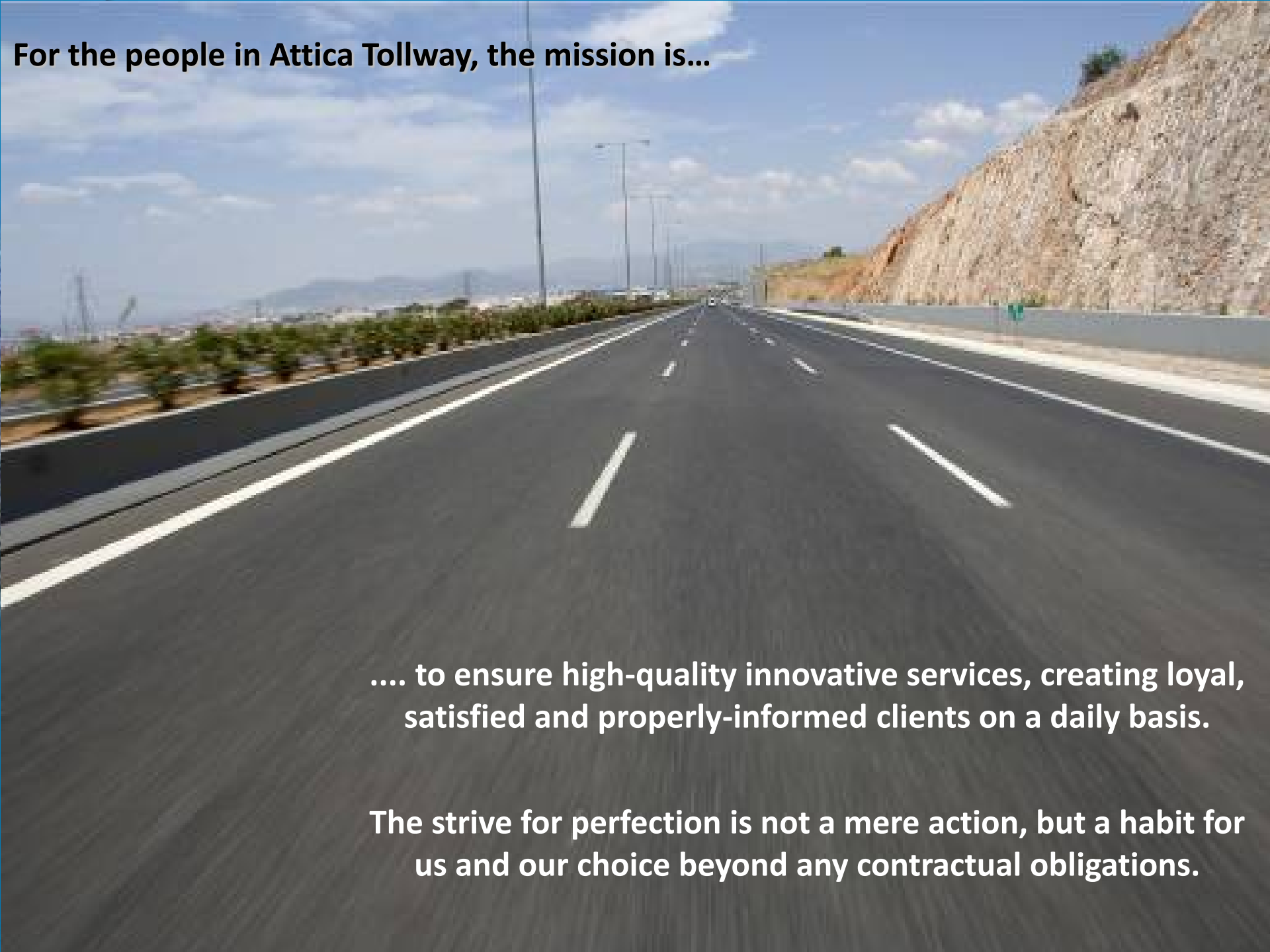
<u>The Resilient Road</u>: Fully adaptable to extreme weather conditions

ATTIKES DIADROMES S.A.

Green Public Procurement and Life-cycle Analysis

Green Public Procurement (GPP)
"a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured."

A **life-cycle assessment** (**LCA**, also known as **life-cycle analysis**, **ecobalance**, and **cradle-to-grave analysis**)
a technique to assess environmental impacts associated with all the stages of a product's life from-cradle-to-grave (i.e., from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling).



For the people in Attica Tollway, the mission is…

.... to ensure high-quality innovative services, creating loyal, satisfied and properly-informed clients on a daily basis.

The strive for perfection is not a mere action, but a habit for us and our choice beyond any contractual obligations.

Attica Tollway – paving the way

Thank you!

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Strategic & Organizational Manager
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