Effectiveness of Air Quality Measures in Lisbon

CENSE - DCEA - FCT/UNL
The “early” beginnings → the problem

Lisbon Metropolitan Area Air Quality Action Plan → the solution
- The different evaluated measures
- The selection of measures
- Lisbon Low Emission Zone as central measure
  - Defining the boundaries for application
  - Public communication
  - LEZ monitoring
  - Enforcement

Some lessons learnt / hot topics that will lead work within the 2nd Lisbon Metropolitan Area AQ Action Plan
Air pollution levels have been high (especially PM$_{10}$ & NO$_x$)

- Lisbon Greater Metropolitan Region had widespread uncompliance with the “new EU Air Quality limit values”

Source: qualar.apambiente.pt, 2014
the solutions

- **Formal Air Quality Improvement PLAN**
  launched in 2008
  *Plano de Melhoria e Qualidade do Ar de Lisboa e Vale do Tejo*

- **Operational ACTION PLAN**
  published in June 2009
  *Programa de Execução do Plano de Melhoria e Qualidade do Ar de Lisboa e Vale do Tejo*
  with several policies and measures to be adopted in short term (up to 2 years) and with stakeholder involvement on its’ conception and implementation
the solutions (AQ Action Plan)

- **FOCUS in the TRANSPORT SECTOR**

- **WHY?** It is clearly **THE SOURCE!**

  Most relevant **MEASURES** included:

  - VAO+BUS+E (High Occupancy + Bus and Electrical Vehicles Lanes) in major city accesses;
  - **A LOW EMISSION ZONE (LEZ) implementation in LISBON**
  - Fiscal incentives to retrofit HDV and BUSES with PM traps
  - Other measures for captive fleets (ecodriving, fleet renewals, parking redesing and enforcement optimization, promotion of the park & ride systems already in the field,...)
MOBILITY STRATEGIC VISION for Lisbon from the mobility we have to the mobility we want

Commuting trips in Lisbon
48% are made by car

Modal Shift 2001
- Car: 30%
- P & T: 1%
- Motos & bikes: 21%
- Walking: 30%

Modal Shift 2011
- Car: 48%
- P & T: 1%
- Motos & bikes: 17%
- Walking: 34%

Fonte: Estudo de Avaliação Técnica na Área do Planeamento de Vias e Circulação, PSR Consultores (com base nos Censos 2001 e 2011)
The solutions (AQ Action Plan)

- One of the proposals was to implement a LOW EMISSION ZONE in Lisbon.

*Plano de Melhoria e Qualidade do Ar de Lisboa e Vale do Tejo*

- First design and schedule published in 2009 (defining the start of the implementation in 2010 for HDV)

<table>
<thead>
<tr>
<th>Tipo de Veículo</th>
<th>Zona Ampla</th>
<th>EURO I</th>
<th>EURO II</th>
<th>EURO III</th>
<th>EURO IV</th>
<th>Data/Año</th>
<th>Idade Máxima Véculos</th>
<th>Exceções</th>
</tr>
</thead>
<tbody>
<tr>
<td>PESADOS PASSAGEIROS</td>
<td>eixo Marquês de Pombal/ Terreiro do Paço</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>01-01-2010</td>
<td>14 anos</td>
<td>veículos especiais</td>
</tr>
<tr>
<td></td>
<td>cidade de Lisboa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>01-01-2012</td>
<td>12 anos</td>
<td>veículos especiais</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>01-01-2014</td>
<td>9 anos</td>
<td>veículos especiais</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>01-01-2011</td>
<td>15 anos</td>
<td>veículos especiais</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>01-01-2014</td>
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<td>veículos especiais</td>
</tr>
<tr>
<td>PESADOS MERCADORIAS</td>
<td>eixo Marquês de Pombal/ Terreiro do Paço</td>
<td></td>
<td></td>
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<td>9 anos</td>
<td>veículos especiais</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>01-01-2011</td>
<td>15 anos</td>
<td>acesso ao Porto de Lisboa (norma EURO anterior)</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>01-01-2014</td>
<td>14 anos</td>
<td>acesso ao Porto de Lisboa (norma EURO anterior)</td>
</tr>
<tr>
<td>TÁXIS, LIGEIROS PASSAGEIROS e LIGEIROS MERCADORIAS</td>
<td>cidade de Lisboa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>01-01-2011</td>
<td>10 anos</td>
<td>residentes + veículos especiais</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>01-01-2013</td>
<td>17 anos</td>
<td>residentes + veículos especiais</td>
</tr>
</tbody>
</table>
ZER - LISBON LEZ (3rd stage)

Geographical limits ZER Lisboa

(ZONA/ZONE 2)
Roughly 1/3 city limits

(ZONA/ZONE 1)
“Inner old town”

- Started in Jan, 15th 2015
- Stage I started in ZONA 1 in July, 4th 2011
- Stage II started in April, 1st 2012

- MONDAY to FRIDAY, 7:00AM to 9:00PM
- HDVs, BUS, passenger cars (petrol and diesel) included

- TECHNOLOGICAL REQUIREMENTS
  ZONE 1 at least Euro 3/III
  ZONE 2 at least Euro 2/II

- EXEMPTIONS:
  emergency vehicles, reduced mobility private cars, historical vehicles, city resident vehicles, NG & LPG powered vehicles, motocycles, police and military vehicles, taxi fleet (different scheme & calendar)
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Lisbon LEZ traffic signs & data collection
ENFORCEMENT METHOD

- MANUAL ENFORCEMENT throughout License Plate direct observation
ZER Lisboa - some other specs

ENFORCEMENT METHOD:

- Throughout MANUAL FISCALIZATION
- Direct observation of the vehicle registry
- Complemented with the so called “LEZ DAYS” (“DIAS ZER”) in which fiscalization is made in parallel with detailed explanations of the concept, the objectives and the results obtained to date
EMISSIONS BALANCE PRE Phase I and POST Phase II

less traffic volumes AND newer car fleets \( \rightarrow \) less emissions

- tendency observed all across the city of Lisbon
- more pronounced effects within LEZ
ZER LISBOA - Up-to-date RESULTS
AIR QUALITY - LEGAL ASSESSMENT Av. LIBERDADE MONITORING STATION

**PM$_{10}$**

<table>
<thead>
<tr>
<th>Ano</th>
<th>Annual average concentration (µg/m$^3$)</th>
<th>Number exceedances to daily LV</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>80</td>
<td>0</td>
</tr>
<tr>
<td>2009</td>
<td>92</td>
<td>2</td>
</tr>
<tr>
<td>2010</td>
<td>88</td>
<td>10</td>
</tr>
<tr>
<td>2011</td>
<td>113</td>
<td>30</td>
</tr>
<tr>
<td>2012</td>
<td>75</td>
<td>22</td>
</tr>
<tr>
<td>2013</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>2014</td>
<td>32</td>
<td>45</td>
</tr>
<tr>
<td>2015</td>
<td>67</td>
<td>44</td>
</tr>
</tbody>
</table>

**NOTE:** 2015 dataset is not officially validated
ZER LISBOA - Up-to-date RESULTS

AIR QUALITY - LEGAL ASSESSMENT Av. LIBERDADE MONITORING STATION

**NO$_2$**

**NOTE:** 2015 dataset is not officially validated
ZER LISBOA - Up-to-date RESULTS
AIR QUALITY - LEGAL ASSESSMENT ALL LISBON MONITORING STATIONS

PM$_{10}$
ZER LISBOA - Up-to-date RESULTS
AIR QUALITY - LEGAL ASSESSMENT ALL LISBON MONITORING STATIONS

$\text{NO}_2$
ZER LISBOA - Up-to-date RESULTS
TRAFFIC FLOWS - Average DAT in March 2011-2015

**Daily Average Traffic Flows**

**TMD médio**

<table>
<thead>
<tr>
<th></th>
<th>Mar 2011</th>
<th>Mar 2015</th>
<th>diferença</th>
</tr>
</thead>
<tbody>
<tr>
<td>Média</td>
<td>20.015</td>
<td>24.729</td>
<td>24%</td>
</tr>
<tr>
<td>Dentro ZER</td>
<td>20.686</td>
<td>23.722</td>
<td>15%</td>
</tr>
<tr>
<td>Fora ZER</td>
<td>19.120</td>
<td>26.072</td>
<td>36%</td>
</tr>
</tbody>
</table>

**FONTE:** Gertrude
Traffic composition counts
Traffic composition counts

2011 pré-ZER

2015 ZER FASE 3

Traffic fleets compositions during ZER implementation

ZER LISBOA - Up-to-date RESULTS

Ligeiros de passageiros
Ligeiros de mercadorias
Pesados de passageiros
Pesados de mercadorias
Táxis

Traffic composition counts

Euro 6
Euro 5
Euro 4
Euro 3
Euro 2
Euro 1
pre-EURO

Euro 6
Euro 5
Euro 4
Euro 3
Euro 2
Euro 1
pre-EURO
ZER LISBOA - Up-to-date RESULTS

TAXI FLEET EVALUATION DURING ZER IMPLEMENTATION

TAXIS registry on CML (2011, 2014)

Chart showing the distribution of taxi fleet evaluative results for the years 2011 and 2014.
ZER LISBOA - Up-to-date RESULTS

Statistical analysis & modelling

For NO$_2$
Avoiding peaks

**NO\textsubscript{2}**

**PM\textsubscript{10}**
1. Improvements were clear in PM and NO\textsubscript{2} since 2011 but 2015 results show they are not enough... 2015 is clearly a bad year and there are multiple reasons for it:

- Traffic flows EXPLODED in 2015
- It was a meteorological adverse year
- Avenida da Liberdade Monitoring Station (most problematic)
- LEZ (ZER) effect is much clearer on fleet compositions
2. Looking to the overall period of implementation (since 2011) results are encouraging; only 2015 seems to be out of the apparent trend

3. Enforcement methods are scarce and might also lead to a general perception that nobody needs to apply the rules; if this is the case, than ZER LISBOA would be only “theoretical” and would fail

4. LEZ (ZER) needs to be accompanied by other major complementary measures that enforce the signals that it delivers
**ZER Lisboa - Up-to-date LESSONS**

_Evaluation of EMISSIONS SHOW HIGHER REDUCTION POTENTIAL_

<table>
<thead>
<tr>
<th>ZER Lisboa Faixa I (EURO 1 na Zona 1)</th>
<th>Viaturas abrangidas /dia</th>
<th>% total a entrar na cidade diariamente</th>
<th>Emissões PM evitadas (kg/ano)</th>
<th>% Emissões PM concluidas</th>
<th>Emissões NO2 evitadas (kg/ano)</th>
<th>% Emissões NO2 concluidas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>788</td>
<td>0,20%</td>
<td>73</td>
<td>0,10%</td>
<td>624</td>
<td>0,03%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ZER Lisboa Faixa II (EURO 2 na ZONA 1 + EURO 1 na ZONA 2)</th>
<th>Viaturas abrangidas /dia</th>
<th>% total a entrar na cidade diariamente</th>
<th>Emissões PM evitadas (kg/ano)</th>
<th>% Emissões PM concluidas</th>
<th>Emissões NO2 evitadas (kg/ano)</th>
<th>% Emissões NO2 concluidas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50.010</td>
<td>13%</td>
<td>18.607</td>
<td>25%</td>
<td>162.175</td>
<td>85%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ZER Lisboa Faixa III (EURO 3 na ZONA 1 + EURO 2 na ZONA 2)</th>
<th>Viaturas abrangidas /dia</th>
<th>% total a entrar na cidade diariamente</th>
<th>Emissões PM evitadas (kg/ano)</th>
<th>% Emissões PM concluidas</th>
<th>Emissões NO2 evitadas (kg/ano)</th>
<th>% Emissões NO2 concluidas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>124.034</td>
<td>31%</td>
<td>32.312</td>
<td>43%</td>
<td>329.338</td>
<td>16%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ZER Lisboa Faixa III + EURO 1 para TÁXIS</th>
<th>Viaturas abrangidas /dia</th>
<th>% total a entrar na cidade diariamente</th>
<th>Emissões PM evitadas (kg/ano)</th>
<th>% Emissões PM concluidas</th>
<th>Emissões NO2 evitadas (kg/ano)</th>
<th>% Emissões NO2 concluidas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>124.413</td>
<td>31%</td>
<td>37.211</td>
<td>49%</td>
<td>336.266</td>
<td>16%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ZER Lisboa Faixa III + EURO 2 para TÁXIS</th>
<th>Viaturas abrangidas /dia</th>
<th>% total a entrar na cidade diariamente</th>
<th>Emissões PM evitadas (kg/ano)</th>
<th>% Emissões PM concluidas</th>
<th>Emissões NO2 evitadas (kg/ano)</th>
<th>% Emissões NO2 concluidas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>125.189</td>
<td>32%</td>
<td>40.287</td>
<td>53%</td>
<td>343.896</td>
<td>17%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ZER Lisboa Faixa III + EURO 3 para TÁXIS</th>
<th>Viaturas abrangidas /dia</th>
<th>% total a entrar na cidade diariamente</th>
<th>Emissões PM evitadas (kg/ano)</th>
<th>% Emissões PM concluidas</th>
<th>Emissões NO2 evitadas (kg/ano)</th>
<th>% Emissões NO2 concluidas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>126.096</td>
<td>32%</td>
<td>43.448</td>
<td>57%</td>
<td>371.848</td>
<td>18%</td>
</tr>
</tbody>
</table>
AIR QUALITY ACTION PLAN

HOT TOPICS for the 2nd ACTION PLAN

A. Document is being produced (since July 2015)
B. FOCUS is (again) on TRANSPORT RELATED SOURCES + INDUSTRY in one isolated area
C. LEZ will continue to have a central role on the overall strategy
OVERALL GUIDANCE FOR THE MEASURES TO INCLUDE NOW

A. MAGNITUDE OF THE IMPACT. Only quantifiable measures which isolated or in groups have, at least, 1% of impact on emissions inventory for NOx or PM will be included.

B. FEASABILITY OF ITS’ IMPLEMENTATION. We would love to have a full reconversion for electric mobility up to the end of 2016 but...

C. ENSURING THAT ENFORCEMENT IS AN ISSUE. No matter what new or “old” measures are taken into account they have to be really in place.
AIR QUALITY ACTION PLAN

HOT TOPICS for the 2$^{nd}$ ACTION PLAN

OVERALL GUIDANCE FOR THE MEASURES TO INCLUDE NOW

**D. COHERENCE WITH DIAGNOSIS.** Proposed measures will tackle problems identifies so we’re getting into measures like...

- **ROAD TRAFFIC IN LISBON DOWNTOWN**
  - MODIFY ROAD TRAFFIC CIRCULATION SCHEMES DURING SOME PERIODS. It would allow to test alternatives forcing the majority of traffic volumes using other areas
  - EVALUATE SPOTS WHERE ONLY ELECTRIC MOBILITY IS ALLOWED. In smaller areas this would allow that micrologistics, in particular goods transport, would be only possible using electrical vehicles. This will open some “stages” for having more valuable pedestrian noble areas
  - IMPLEMENT MOBILITY PLANS TO MEDIUM/LARGE COMPANIES AND OTHER “TRAFFIC GENERATORS”. There is already works published about Mobility Plans applied to traffic generators which allow workers and companies to take advantage of incentives to promote daily trips using less pollution intensive transport modes
AIR QUALITY ACTION PLAN
HOT TOPICS for the 2\textsuperscript{nd} ACTION PLAN

OVERALL ORIENTATION FOR THE MEASURES TO INCLUDE NOW

D. COHERENCE WITH DIAGNOSIS. Proposed measures will tackle problems identifies so we’re getting into measures like…

- ROAD TRAFFIC IN LISBON DOWNTOWN
  - INTENSIFY THE EFFORTS IN HAVING A BETTER INTEGRATED INTERMODAL URBAN TRANSPORT NETWORK. Several measures are to be taken in this field, in particular a better integration between transport modes and a bigger effort in having fully integrated tickets
  - BUILD SOME AREAS WHERE EMPHASIS IS TO SOFT MODES INSTEAD OF ROAD TRAFFIC INFRASTRUCTURES. In some selected cases soft modes would define the urban design, replacing road traffic infrastructure to some point
  - RASINING PUBLIC AWARENESS THROUGH A COMMUNICATION PLAN. Not doing it would be to ruin the previous points in terms of public opinion
OVERALL ORIENTATION FOR THE MEASURES TO INCLUDE NOW

D. COHERENCE WITH DIAGNOSIS. Proposed measures will tackle problems identifies so we’re getting into measures like…

- INDUSTRIAL AREA
  - EXPLORE FURTHER IF ALL ABATEMENT TECHNOLOGIES ARE IN PLACE. Best Available Technology have to be the requirement for the area to ensure that levels are controlled
  - EVALUATE THE POSSIBILITY OF ALTERING THE PRODUCTION INTENSITY DURING EPISODES. From the historical data evaluation it seems clear that, in some adverse meteorological situations, production might be reduced (especially when all local mitigation measures are in place) so a clear definition of these cases, in conjunction with Air Quality forecasts should define the basis for smaller “Local Alert Action Plans”
Effectiveness of Air Quality Measures in Lisbon

AIRUSE Final Conference
Barcelona | 19 APR 2016

Grateful for your attention,

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