Air quality in urban planning aspects and implementation low carbon transport development in Riga

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Outline

1. Introduction
2. Riga: air quality
3. Riga: air quality aspects in urban planning
4. Riga: low carbon transport
1. Introduction
Nordic Energy Research PhD project 2004-2007

«NORSTORE»
INTEGRATION OF ADVANCED HYDROGEN STORAGE MATERIALS AND SYSTEMS INTO THE HYDROGEN SOCIETY

NORSTORE: PARTICIPANTS
Joint projects between the partners
5 postdoc and 4 PhD students

Norway
Institute for Energy Technology (IFE)
Prof. V.A. Yartys (project manager)

Sweden
University of Uppsala / Studsvik NRL
Dr. R.G. Delaplane

Iceland
University of Iceland
Prof. T.I. Sigfusson

Denmark
Risø
Dr. A. Schröder Pedersen

Finland
Helsinki University of Technology
Prof. P. Lund

Russia
Academy of Sciences of Russia
Dr. B.P. Tarasov

Russia
St. Petersburg University
Prof. I.E. Gabis

Latvia
University of Latvia Institute of Solid State Physics
Dr. J. Kleparis
Nordic Energy Research PhD project 2004-2007

«NORSTORE» Riga`s Project: Research on New Composite Materials for Hydrogen

Riga`s Team:

Dr. Janis Kleperis,
Doctoral student Liga Grinberga

Institute of Solid State Physics of University of Latvia

Network cooperation:
Dr. A.Schrøder Pedersen
Risø National Laboratory (RNL) Denmark

<table>
<thead>
<tr>
<th>Sample</th>
<th>Alloy 7-10</th>
<th>Composite 7-10 + glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>BET surface area, m²/g</td>
<td>0.27</td>
<td>0.84</td>
</tr>
<tr>
<td>Langmuir surface area, m²/g</td>
<td>0.38</td>
<td>1.31</td>
</tr>
<tr>
<td>Total volume of pores, mm³/g</td>
<td>0.50</td>
<td>2.73</td>
</tr>
<tr>
<td>Δm total, wt%</td>
<td>1.582</td>
<td>1.643</td>
</tr>
<tr>
<td>x in formula ABrH₆</td>
<td>6.966</td>
<td>7.242</td>
</tr>
</tbody>
</table>

The size of hexagonal elementary cell for fully hydrogenated materials (cell dimensions a and c, and volume):

- a = 5.326 Å
- c = 4.234 Å
- V = 104.0 Å³
- a = 5.369 Å
- c = 4.275 Å
- V = 106.76 Å³
2. Riga: air quality
Air quality monitoring stations in Riga - 2015

Station is changed with new and moved to new place in 2015

Street traffic stations (red stars) are in operation from 2003, instruments are outdated and need to be changed

Background stations in City Center (green squares) are placed close enough to traffic air quality monitoring stations (red stars) – distance about 800 - 1000 m.
Hotspot traffic air quality monitoring stations in Riga

Street canyon on Kr.Valdemāra Street 18 in city centre: multi-instrumental classical point type AQMS

Street canyon AQMS on Brīvības Street 73 in city centre: open light beam DOAS technology, light beam 350 m
Monitoring results – traffic AQMS in Riga

All exceedances (dusty days) over 35 days authorized, without deduction of days with salt spreading, trans-boundary etc. There are no PM10 exceedances in City Center background stations.

1) Exceedances of daily limit value in 2012-2013 are reduced by 50 % in comparison with 2007;

2) The increase in 2013, 2014 can be explained with the coldest winter periods and longer summer droughts, compared to period 2009-2012;

3) Exceedances are observed only on canyon-type streets with congested traffic.
Monitoring results – traffic AQMS in Riga

What are sources of particles PM10 on traffic congested street in Riga?

Researches based on statistical analysis of data, particle morphology and composition is done to establish the origin:


“Application of SEM-EDX and Principal Component Analysis for PM10 Characterization and Source Apportionment: A Street Canyon Case Study” by J.Jr Bikshe, I.Steinberga, J.Kleperis, J.Bikshe, COST ACTION TD1105 EuNetAir; BOOKLET, Cambridge, 18 - 20 December 2013

Some findings:

1) Air temperature shows strong negative correlation with PM10 hourly values, which indicates ineffective fuel burning processes in car engines during cold winter season and intensive usage of anti-acers (mixture of NaCl-sand), what leads for extremely high PM10 concentrations during spring time;

2) Low air humidity values (40% - 50%) negatively correlate with PM10 pollution, quite intensive resuspension from car wheels, low air humidity and dry periods without precipitation leads to extremely high PM10 pollution levels during all spring season;

3) About 50 % of PM pollution at urban street level could be associated with traffic exhaust emissions and classified as soot; from mass fraction point of view these are 70 % of pollution level; about 8 – 9 % of particulate matter pollution possible to associate with abrasion processes;

4) About 40 % of total PM are of natural origin (including sea salt, street sanding and resuspension).
Monitoring results – NO₂

Nitrogen dioxide annual average value exceeds a threshold without tolerance (40 μg/m³) in the canyon-type streets with heavy traffic loads. From 2011 to 2015 (up to 01.01.2015) Latvia had the tolerance of 50% for the threshold of NO₂.

In City center background station (Rainis Bld 19) there is no exceedances of Nitrogen dioxide annual average value threshold 40 μg/m³.
In 2010, 2013, 2014 years Latvia received European Commission's notice of the infringement procedure in Case No 2008/2195 that the measures to reduce PM10 pollution are not effectively and excesses will continue.

In 2010 Latvia received 50% tolerance to annual limit value of NO$_2$ for 4 years, but by 2015 it came to an end and as it is seen from monitoring results, we did not succeed to reduce NO$_2$ concentrations in city center streets;

Now we are waiting the second notice from EC of the infringement procedure that the population in the center of Riga for a long time is living in a polluted environment.
3. Riga: air quality aspects in urban planning
Integrated approach to improve air quality in the city
✓ activities for 7 years
✓ investment projects for 3 years

Improvement of living, working, recreation conditions in the city

**STRATEGY 2030**

**Action Directions and projects**
Support from EU Structural Funds (2014-2020) will be effectively used.

**AD 10 Convenient international accessibility**

- Priorities and key principles
  - Centre release from transit cargo (use of ring-roads of Riga for transit)

- Investment projects:
  - The Segment 1 of the Riga Northern Transport Corridor (“Brivibas Dublieris”)
  - Construction of Eastern bypass (Ieriķu street – Vīetalvas street section)
Riga – the capital city of Latvia
Traffic pressure on Riga city infrastructure is growing year by year

Annual Average Daily Traffic volumes on main roads around Riga 2013
Settings and Measures from air quality action plan is implemented in Riga`s planning documents through:

**Priority row:**
- Pedestrian – cyclist
- Public transport
- Private transport – trucks

**Green corridors:**
- Implementation of the air quality programme: monitoring and indicators
Settings and Measures from air quality action plan is implemented in Riga`s planning documents through:

**Mobility**

Existing and planned bicycle lines
It will take decades when new traffic infrastructure develops in Riga:
Action Programs to improve air quality in Riga

The first Action Program was developed for a five-year period from 2004 to 2009. Selected measures and their efficiencies:

a) To set air quality as a compulsory criterion during the development and evaluation of Riga`s city development plan – Accomplished: air quality as a compulsory criterion both at the level of measures and of indicators has been introduced into the Riga Long-term Development Strategy until 2025 within the Objective M14 (Clean and Green city)

b) Total reduction of the number of vehicles in the historic centre of Riga by 35% in comparison to 2002, alongside with the traffic flow optimization – Partly accomplished: opening of new Dienvidu Bridge in November 17, 2008 (ramps at both ends of the bridge was completed in 2013, total costs about 440 MEur), who has removed 8-26% transport of the other bridges and 8-12% of Brīvības Street in City Center (Table):

<table>
<thead>
<tr>
<th>AADT</th>
<th>Average 2005-2008</th>
<th>Average 2009-2015</th>
<th>Relation after/before, %</th>
<th>Reduction, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salu Bridge</td>
<td>85405</td>
<td>62916</td>
<td>73,7</td>
<td>26,3</td>
</tr>
<tr>
<td>Vanšu Bridge</td>
<td>60367</td>
<td>54104</td>
<td>89,6</td>
<td>10,4</td>
</tr>
<tr>
<td>Akmens Bridge</td>
<td>53091</td>
<td>48887</td>
<td>92,1</td>
<td>7,9</td>
</tr>
</tbody>
</table>
Action Program to improve air quality in Riga

The first Action Program (2004 – 2009)

c) With reference to this programme Riga City Council Binding Regulation No 60 has been adopted that prohibits opening of new permanent pollution sources in the areas where the air pollution exceeds the set standards in conformity with the Riga City Urban Planning Map.

d) Also the Riga City Development Plan 2006-2018 contains information on the measures that will have an impact on the air quality in Riga.

Yellow zone – NO₂ annual average concentration > 40 µg/m³
Action Program to improve air quality in Riga

Second Action Program 2011 - 2015 was elaborated because assessment of air quality in Riga 2008-2010 shows that implementation of the first Action Program has yielded good results, although the set targets of pollution reduction in the city centre have not been achieved to the full extent due to the problems encountered in achieving the limit values of nitrogen dioxide and particulate matter:

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>1 h limit value</th>
<th>8 h limit value</th>
<th>24 h limit value</th>
<th>Annual limit value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphur dioxide</td>
<td>Not exceeded</td>
<td>Not exceeded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
<td>Exceeded within the permissible range</td>
<td>Not exceeded</td>
<td></td>
<td>Exceeded in stations on Brīvības Street and K. Valdemārs Street</td>
</tr>
<tr>
<td>Ground-level ozone</td>
<td>Not exceeded</td>
<td>Exceeded within the permissible range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>Not exceeded</td>
<td>Not exceeded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Particulate matter (PM$_{10}$)</td>
<td>Not exceeded</td>
<td></td>
<td>Exceeded in stations on Brīvības Street and K. Valdemārs Street</td>
<td>Exceeded in stations on Brīvības Street (2008) and K. Valdemārs Street (2008, 2010)</td>
</tr>
<tr>
<td>Benzene</td>
<td>Not exceeded</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
Action Program to improve air quality in Riga

PM$_{10}$ zoning map 2014

Brown zones – PM$_{10}$ annual average concentration > 40 µg/m$^3$

NO$_2$ zoning map 2014

Yellow zones – NO$_2$ annual average concentration > 40 µg/m$^3$
Action Program to improve air quality in Riga

New measures aimed at reduction of particulate matter and nitrogen dioxide pollution and improvement of air quality in Riga. Next sectors were involved:

<table>
<thead>
<tr>
<th>Objective</th>
<th>Turning Riga into a green city with high quality environment</th>
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</thead>
<tbody>
<tr>
<td>Task</td>
<td>Implementation of measures aimed at improvement of air quality</td>
</tr>
</tbody>
</table>
| Transport sector | • Streamlining of traffic flows aimed at reduction of pollution  
|             | • Ensuring appropriate infrastructure to promote the use of low or zero emission vehicles  
|             | • Reduction of pollution from car exhaust gases  
|             | • Reduction of pollution caused by friction between car tyres and road surfaces |
| Energy, industry and building sectors | • Considering the air quality aspects in choice of fuels  
|                                      | • Supporting of efficient energy production  
|                                      | • Efficient treatment of flue gases  
|                                      | • Reduction of particulate matter emissions generated by handling of dusty materials |
| Households | • Reduction of pollution caused by domestic heating  
|            | • Reduction of heat energy consumption  
|            | • Compliance with the air quality standards for building in the polluted areas |
| Providing of data | • Maintenance of the air quality monitoring network  
|            | • Providing of data needed for the air quality assessment |
| Public awareness | • Public awareness campaigns on air quality |

The measures were updated in 2014
Organizations responsible for implementation of measures and activities under the Riga City Air Quality Improvement Action Program

<table>
<thead>
<tr>
<th>Responsible bodies</th>
<th>Transport sector</th>
<th>Energy, industry and building sectors</th>
<th>Households</th>
<th>Availability of relevant data</th>
<th>Public awareness</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEPRD*</td>
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<tr>
<td>LEGMC*</td>
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<tr>
<td>Riga City Council City Development Department</td>
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<td>Riga City Council Housing and Environment Department</td>
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<tr>
<td>Riga City Council Transport Department</td>
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<tr>
<td>Riga City Building Board</td>
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<tr>
<td>Riga City Energy Agency</td>
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<tr>
<td>&quot;Rigas satiksme&quot; Ltd.</td>
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<tr>
<td>JSC &quot;Rūgas siltums&quot;</td>
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<tr>
<td>&quot;Rūgas gaisma&quot;</td>
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* MEP RD - Ministry of Environmental Protection and Regional Development; LEGMC - Latvian Environment, Geology and Meteorology Centre
Under process is development of Action Plan to improve air quality in Riga 2016 – 2020

Why necessary?
Air quality monitoring results 2010-2014 showed that in Riga:

• Annual limit value for human health exceed for NO$_2$ and PM10 in street traffic stations;
• 24 hour limit value for human health exceed for PM10 in street traffic station;
• Upper assessment threshold for human health protection exceeded for NO$_2$, PM10 in city center street traffic station and background station; for benzene exceeded in industrial AQ monitoring station;
• Lower assessment threshold for human health protection exceeded also for benz(a)pyrene in street traffic stations
4. Riga: low carbon transport
Already implemented electric public traffic units in Riga

Enterprise "Rīgas Satiksme" the total fleet consists of 1,076 transport units containing 478 buses, 346 trolleybuses and 252 trams.

Every day the Riga public transport (excluding minivans and night buses) is used by about 500 000 people, but during the year 150 526 484 people (2014).
Supporting activities with EU co-financing

Public transport:
- Low floor trams (26 trams on line in 2014)
- Hydrogen engine trolleybuses (project in process)
- Euro6 buses (175 in 5 years; 35 in 2014)

Municipal transport:
- Electric engine vehicles (14 units in RCC, of 85 total 2015)
Developing electric traffic units in Riga

Registered electric cars in Latvia on January 1, 2016: 226 units
Introduction of hydrogen transport in Riga

From 2017 in streets of Riga the hydrogen trolleybusses will drive

10 hydrogen trolleybusses with infrastructure – hydrogen filling station for 16.1 million euro
Introduction of hydrogen transport in Riga
„NewBusFuel” - hydrogen filling station engineering solutions in Riga’s Urban public transport depot
Introduction of hydrogen transport in Riga
Conclusions

Starting from 2003 up to now Riga is performing air quality monitoring in city centre canyon-type streets with heavy traffic, and regular exceedances of annual limit values for NO₂ and PM10 are observed. Two realized Action plans to improve air quality in Riga (2004-2009; 2011-2015) gave small improvements, not enough to stop exceedances of limit values.

Riga has not yet tackled the traffic restriction at the center, not with the peak hours charge, and not to ban old cars to enter the center (Green Zone). The city center still can not shut down for traffic because there is no installed bypass roads. In addition, in the city center is located Riga`s Municipality and also the Government of country - the Saeima, the Cabinet of Ministers, and any traffic restrictions are politically sensitive.

There are poor developing of Park & Ride system in Riga. The city develops Public Traffic, and there are tickets incentives, but in spite of that the number of cars in the streets continues to grow. While the fuel will be burned in internal combustion engines, no decrease of NO₂ and PM10 is expected. Carbon free vehicles will be a solution.
Thanks for attention!

Looking on air quality monitoring results in street canyons creates a depression.