Prediction and management of emergent noise in the tomorrow’s sustainable city
Context

- Triple crisis: energy / ecology / economy
- Health, comfort & social stakes
- CSTB research program on *Sustainable Cities*
- "Prediction and management of urban noise (2050)"
- Need of sound emission DB of building equipments
Studied site

Cours Jean-Jaurès, Grenoble

The “straightest” Avenue In Europe (8km)
Studied site Model

LAeq 1sec en dB(A)

- **Leq Nuit**: 62.2 dB(A)
- **Leq Soirée**: 67.3 dB(A)
- **Leq Petit Matin**: 67.3 dB(A)

**temps en hh:min:sec**

- 19:12:00
- 19:40:48
- 20:09:36
- 20:38:24
- 21:07:12
- 21:36:00
- 22:04:48
- 22:33:36
- 23:02:24
- 23:31:12
- 00:00:00
- 00:28:48
- 00:57:36
- 01:26:24
- 01:55:12
- 02:24:00
- 02:52:48
- 03:21:36
- 03:50:24
- 04:19:12
- 04:48:00
- 05:16:48
- 05:45:36
- 06:14:24
- 06:43:12
- 07:12:00
- 07:40:48
- 08:09:36
- 08:38:24
- 09:07:12
- 09:36:00

**Evening**

- 20:00
- 22:00

**Night**

- 06:00
- 08:00

**Early morning**

**Evening**

- Boulevard Façade
- Boulevard pedestrian

**Night**

- Backyard Façade
- Backyard pedestrian
Surface transport noise
Possible future scenarios

Scenarios

<table>
<thead>
<tr>
<th>Description</th>
<th>Speed</th>
<th>Traffic distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>50 km/h</td>
<td>🚗: 9% (5%) 🚹: 91% 🚕: 0%</td>
</tr>
<tr>
<td>Speed reduction</td>
<td>30</td>
<td>🚗: 9% (5%) 🚹: 91% 🚕: 0%</td>
</tr>
<tr>
<td>Electric LV with HV</td>
<td>50</td>
<td>🚗: 9% 🚹: 0% 🚕: 100%</td>
</tr>
<tr>
<td>Current. No HV</td>
<td>50</td>
<td>🚗: 0% 🚹: 100% 🚕: 0%</td>
</tr>
<tr>
<td>Scenario 2</td>
<td>50</td>
<td>🚗: 0% 🚹: 0% 🚕: 100%</td>
</tr>
<tr>
<td>Scenario 3</td>
<td>30</td>
<td>🚗: 0% 🚹: 0% 🚕: 100%</td>
</tr>
</tbody>
</table>

Joël LELONG, Roger MICHELET, “Passenger cars. Power unit and tyre-road noise, driving behaviour: what are the stakes?” (2001)
Noisy building equipments

- Heat pumps (avenue side)
- Heat pumps (backyard side)
- MEV (Mechanical Extract Ventilation) (roof)
- Wind turbines (roof)
Noisy energy building equipments

• Heat pumps (avenue side)
  • Heat pumps (backyard side)
• MEV (Mechanical Extract Ventilation) (roof)
• Wind turbines (roof)
Altherma Heat pump by Daikin

$L_w = 64 \text{ dB(A)}$

Values given by the CETIAT
(Centre technique des industries aérauliques et thermiques)
Results – Heat pumps Emergences

25 heat pumps on Boulevard façade working 100% time
Noisy building equipments

- Heat pumps (avenue side)
- Heat pumps (backyard side)
- MEV (Mechanical Extract Ventilation) (roof)
- Wind turbines (roof)
Results – Heat pumps
Emergences

110 heat pumps on Backyard façade working 100% time
Results – Heat pumps
Emergences vs number of pumps

Emergences at the 3rd floor on backyard
Pumps on Backyard façade working 100% time

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Noisy building equipments

• Heat pumps (avenue side)
• Heat pumps (backyard side)
• MEV (Mechanical Extract Ventilation) (roof)
• Wind turbines (roof)
Development of double-flow systems
Model CVEC 240 by Aldes (10 flats) \( L_w = 63.6 \text{ dB(A)} \)
Model VEC 321B by Aldes (20 flats) \( L_w = 70.6 \text{ dB(A)} \)
Results – MEV Emergences

1 MEV per flat working 100% time
Noisy building equipments

- Heat pumps (avenue side)
- Heat pumps (backyard side)
- MEV (Mechanical Extract Ventilation) (roof)
- Wind turbines (roof)
Wind turbines
Noise emission

Quiet Revolution


Institute of Sound and Vibration Research Consulting, Wind turbine noise measurements (2007)

L_w = 78.3 dB(A)
Results - Wind turbines Emergences

Emergences for 3 Quiet Revolution wind turbines

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Results - Wind turbines

Emergences at the 5th floor on backyard side
Conclusions

• Large parametric study vs possible future traffic scenarios and noisy energy building equipments

• Heat pumps:
  • Max emergences < 3 dB(A) when located on boulevard façade
  • Very high max emergences on backyard side when loc. on backayrd façade

• MEV, 1 per flat:
  • Max emergences < 3 dB(A) on boulevard façade
  • Max emergences from 2 to 12 dB(A) on backyard side

• 3 wind turbines, night:
  • 5th floor backyard: Max emergences > 6 dB(A), up to 20 dB(A)
  • Avenue: Max emergences < 2 dB(A)
Perspectives

• Database of sound emissions and signals
• 3D sound restitution
• Bi-aural listening
• Perceptive approach
Thank you for your attention