The contribution of Water to Circular Economy
Practices of water reuse across Europe

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Members Salon
European Parliament, Brussels

Chaired by:

Michel Dantin MEP
Chair of the "Agriculture and Water Management" Working Group of the EP Intergroup on "Climate Change, Biodiversity, and Sustainable Development"
Italy- The case of Milano-Nosedo municipal WWTP

Ing. Roberto Mazzini Milanodepur President
Dr. sa Francesca Pizza process & Laboratory Manager
Brussels 12-1-16
Milano WWTP NOSEDO

• INDEX

• Nosedo- key data
• Water Reuse
• Thermal energy Recovery from treated WW
• Sludge:
  – Nutrient Recovery
  – Energy Recovery
• Wwtp comunication
Milano - 864,000 m³/day

- 300 millions m³/year
- 10 m³/sec - Dry w.
- 30 m³/sec - wet

Nosedo - 432,000 m³/day

- 150 millions m³/year
- 5 m³/sec - dry w
- 15 m³/sec - wet

Population: 1,250,000 e.h.
MILANO NOSEDO WWTP Joint Venture

Type of contract: 19 year concession
Design-Built-Operate and Transfer
This was the first BOT scheme in Italy in water field (2000-2019)
Milan and the main Italian rivers

It’s the largest WWTP serving the city of Milano.

It treats sewage coming from the central and eastern area of the city, that means about 150,000,000 m$^3$/year of wastewater.

- Total surface area involved: 40 ha
- Area occupied by the plant: 16 ha
- Population served: 1,250,000 p.e. *

Milano

RIVER PO VALLEY
PIANURA PADANA

The most important agricultural area of Italy
The WWTP of Milano Nosedo

Flow sheet

Nosedo WWTP
Inlet flow = 5 to 15 m$^3$/sec

Pretreatment
Screening (coarse and fine); grit and grease removal phase

Activated sludge
Nitrification-oxidation and denitrification; final settling

Sand filtration
with P removal

Disinfection
Peracetic acid

Reuse

Sludge treatment
Thickening
Aerobic stabilisation
Dewatering
Thermal drying

Sludge valorisation

Odour treatment
The WWTP of Milano Nosedo

Main features

Dry weather average inlet flow: 5 m$^3$/s - 430,000 m$^3$/d

Max. inlet flow (wet weather): 15 m$^3$/s of which 11 m$^3$/s to complete treatment (4 m$^3$/s subjected only to pretreatment)

Average values of incoming and treated wastewater

<table>
<thead>
<tr>
<th>Parameter</th>
<th>IN mg/L</th>
<th>OUT mg/L</th>
<th>% Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD$_5$</td>
<td>170</td>
<td>&lt; 5</td>
<td>99</td>
</tr>
<tr>
<td>COD</td>
<td>300</td>
<td>&lt; 15</td>
<td>97</td>
</tr>
<tr>
<td>Nitrogen tot.</td>
<td>27</td>
<td>6.5</td>
<td>76</td>
</tr>
<tr>
<td>P tot.</td>
<td>3.5</td>
<td>0.9</td>
<td>74</td>
</tr>
<tr>
<td>TSS</td>
<td>190</td>
<td>&lt; 5</td>
<td>99</td>
</tr>
</tbody>
</table>
**Milano-Nosedo WWTP**

*Treated water quality: contractual, legal and actual values*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>CONTRACT</th>
<th>LAW 185/2003</th>
<th>ACTUAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BOD\textsubscript{5}</strong> (mg/l)</td>
<td>10</td>
<td>20</td>
<td>&lt;5</td>
</tr>
<tr>
<td><strong>COD</strong> (mg/l)</td>
<td>100</td>
<td>100</td>
<td>&lt;15</td>
</tr>
<tr>
<td><strong>E.Coli</strong> (UFC/100ml)</td>
<td>10</td>
<td>10</td>
<td>&lt;10</td>
</tr>
</tbody>
</table>
A large agricultural district, just on the outskirts of the city...

Indirect reuse

Roggia Vettabbia stream
Consorzio di Roggia Vettabbia: General Data

<table>
<thead>
<tr>
<th>Description</th>
<th>Area (ha)</th>
<th>Length or Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total surface irrigated by Roggia Vettabbia</td>
<td>4108</td>
<td>approx 22 km</td>
</tr>
<tr>
<td>Consorzio’s area – original permission</td>
<td>3168</td>
<td>approx 30 m</td>
</tr>
<tr>
<td>Cavo Taverna surface addition</td>
<td>940</td>
<td></td>
</tr>
</tbody>
</table>

**Length of Roggia Vettabbia**
- from Milano to Melegnano: approx 22 km
- Difference in height between Center of Milan to mouth in Melegnano: approx 30 m
VETTABBIA Farmers Consortium

- 84 farmers members; 90 farms
- Irrigated Area: 4100 ha
- Farmers pay 1827.42 euros/year as a concession value to Regione Lombardia, to have the concession rights to take water from the Vettabbia stream
Milano-Nosedo WWTP: agricultural reuse of treated wastewater

Annual volumes of treated water suitable for irrigation reuse

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated water (Mm³)</td>
<td>143.8</td>
<td>143.4</td>
<td>137.9</td>
<td>136.3</td>
<td>148.6</td>
<td>157.4</td>
<td>149.0</td>
<td>148.7</td>
<td>152.3</td>
<td>157.4</td>
</tr>
</tbody>
</table>

Crops cultivated in the Vettabbia area:
- 45% Corn
- 15% Rice
- 40% Grass and grains
One of the most important «key to success» of the water reuse scheme in Milan is the existence of a very old complex network of irrigation canals and an ancient agricultural activity that dates back to the Middle Ages, when the Cistercian monks realized the first land reclamation.
and the Monks continue to control
Milestones in Water Reuse
The Best Success Stories
Valentina Lazarova, Takashi Asano, Akiça Bahri and John Anderson

Production of high quality recycled water for agricultural irrigation in Milan
Roberto Mazzini, Luca Pedrazzi and Valentina Lazarova
Thermal energy Recovery
Renewable energy source: exploit the thermal value of wastewater

Milano Nosedo WWTP - Temperature of treated wastewater
Jan 2009 - Jan 2012

- Minimum temperature: 14°C
- Maximum temperature: 24°C
The realized system for heating/cooling of buildings located into the WWTP

A DEMONSTRATIVE PLANT

installed to improve the pre-existent air conditioning system

Total volume of the two buildings ≈ 5100 m³
The realized system for heating/cooling of buildings located into the WWTP

Total Power 400 kW
C.O.P. = 4.5 - E.E.R. = 5.5
The realized system for heating/cooling of buildings located into the WWTP

**Savings obtained**

<table>
<thead>
<tr>
<th>Monitoring period</th>
<th>Total energy consumption</th>
<th>Energy saving</th>
<th>CO₂ emissions reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[days]</td>
<td>[kWh]</td>
<td>[%]</td>
<td>[kg]</td>
</tr>
<tr>
<td></td>
<td>Air-to-water system</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water-to-water system</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Summer air-conditioning</strong></td>
<td>167,184</td>
<td>39.13%</td>
<td>-28,340</td>
</tr>
<tr>
<td>(April 16&lt;sup&gt;th&lt;/sup&gt; - August 2&lt;sup&gt;nd&lt;/sup&gt;)</td>
<td>101,764</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Winter air-conditioning</strong></td>
<td>113,363</td>
<td>37.50%</td>
<td>-18,416</td>
</tr>
<tr>
<td>(November 1&lt;sup&gt;st&lt;/sup&gt; - April 15&lt;sup&gt;th&lt;/sup&gt;)</td>
<td>70,852</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The plant is located in an area where it could be possible (and relatively easy!) to create an «heating and cooling» district, based on heat pump system exploiting treated wastewater. Fluids produced at the WWTP Central System could feed:

- **An heating network at high enthalpy** (90°C/65°C) for existing buildings;
- **An heating system with low enthalpy** (50°C/35°C) for new buildings with low temperature heating systems;
- **A network of cooling** (7°C/15°C) for new buildings with air conditioning/heating.
NOSEDO THERMAL STORAGE UNIT

- MWT
- Thermal

- HC
- New APARTMENTS

- At 1000 m from WWTP
- Cold and hot water

IEO hospital
Sludge Nutrient Recovery

C-N-P

Sludge: Energy Recovery
SLUDGE
55,000 tons/year
dewatered

QUALITY
high

NUTRIENT RECOVERY
71%

ENERGY
22% inc. + 7% cement factory
SLUDGE

DEWATERED 25%

WATER CONTENT 75%

DRIED 90%
SLUDGE

• NUTRIENT Recovery C-N-P
  – Special attention to Phosphorus recovery - not renewable resource
  – Conflict in areas with intensive breeding - manure disposal or Biogas plant with digestate to be disposed.

• A cement plant: thermal energy Recovery
  – renewable fuel, but the wwtp operator pay cement factory
The growing demand for energy, food and water resources, linked to the rise and development of the world population, puts WWTPs at the center of this issue, given the chance to get from the wastewater treatment WATER AND NUTRIENTS FOR AGRICULTURE and RENEWABLE ENERGY.
COMUNICACIÓN
WWTP of Milano-Nosedo
A plant open to citizens...
WWTP of Milano-Nosedo
...open to agriculture and local farmers...
WWTP of Milano-Nosedo

... and open also to artists!!!
Concluding remarks: the successful reuse of urban treated wastewater

- Delivery of high quality recycled water, ensured by an optimal treatment efficiency and by daily controls operated by qualified staff
- Cheap water resource, available all year
- The nourishing value of the nutrient enriched effluent improves the crop yields, and so the farmers’ revenues (is difficult to have a figures per hectar)
- Reduced need of artificial fertilizers
- Valorisation of historical heritage and peri-urban agriculture (“zero-kilometer products”)
- Public education programs and collaborations with non-profit organisations, research centers and Universities
Thank you!
Grazie
http://www.depuratorenosedo.eu
Roberto.Mazzini
Francesca Pizza