



O caminho da
INOVAÇÃO
6ª EDIÇÃO

nÓS TEMOS
água+

04 DE OUTUBRO

WATER REUSE IN MILAN WWTPs, A SUCCESS CASE

ANDREA D'ANNA San Rocco WWTP

ANDREA
D'ANNA



P.zza Bonomelli



Via Brembo



Via Ponzio

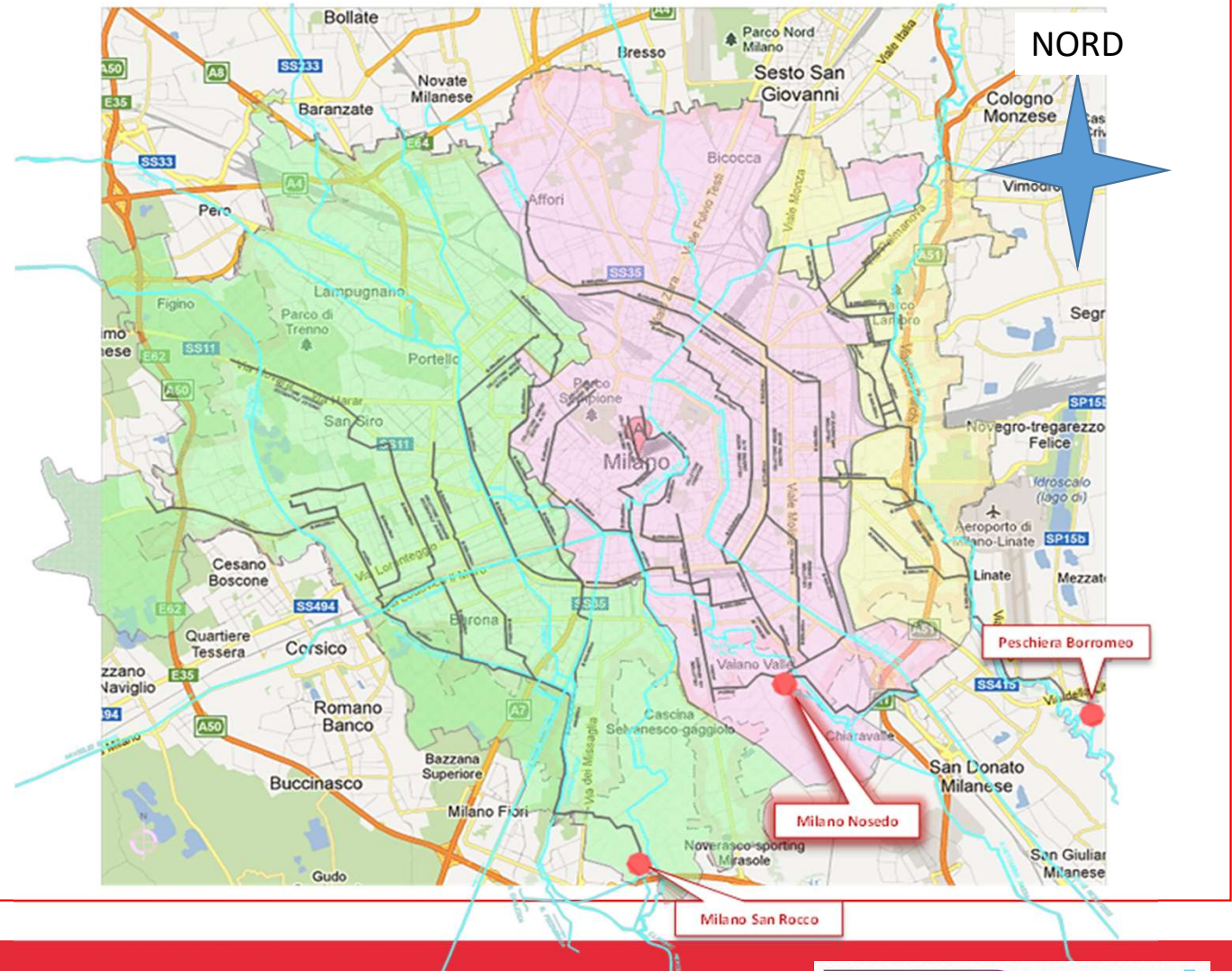
My name is Andrea D'Anna, I am 48 yrs old, I'm married and my wife is a High school teacher; I have three children (7, 11 and 13 yrs old).

I have been working for more than 20 years on environmental field; for the first 16 years for AECOM Technology Corporation; for AECOM I was based on Italian Environmental office. I've followed Remediation Project (Brownfield) and in the last 8 years I was in engineering group and I've designed from BDP to FEED level remediation and industrial Air/Water and Wastewater treatment plants. I've work on treatment for the removal of a wide range of contaminants (from organics to metals). In the last 2 years in AECOM I've designed remediation project with innovative new system based on gas-infusion.

Since October 2015 I have been working for MM SpA which owns the Water and Wastewater system of entire city of Milan. For MM SpA I work in San Rocco WWTP (plant have a capacity of 1.050.000 PE and flow rate of about 4 m³/sec in dry time and up to 9 m³/sec in wet time). In San Rocco WWTP I was Process and Operation manager for 4 years and in the last three years to now I'm Plant General Manager.

Wastewater basins

- 3 basins
- West basin – **San Rocco** – **1.036.000 PE** – 4 to 12 m³/s inlet flowrate – up to 4 m³/s treated for direct reuse in agriculture class A
- Central-East basin – **Nosedo** – **1.250.000 PE** – 5 to 15 m³/s inlet flowrate – up to 11 m³/s treated for direct reuse in agriculture class A
- Eastern basin – **Peschiera** – 250.000 PE



WWTP and Agricultural park – “geographical fortune”

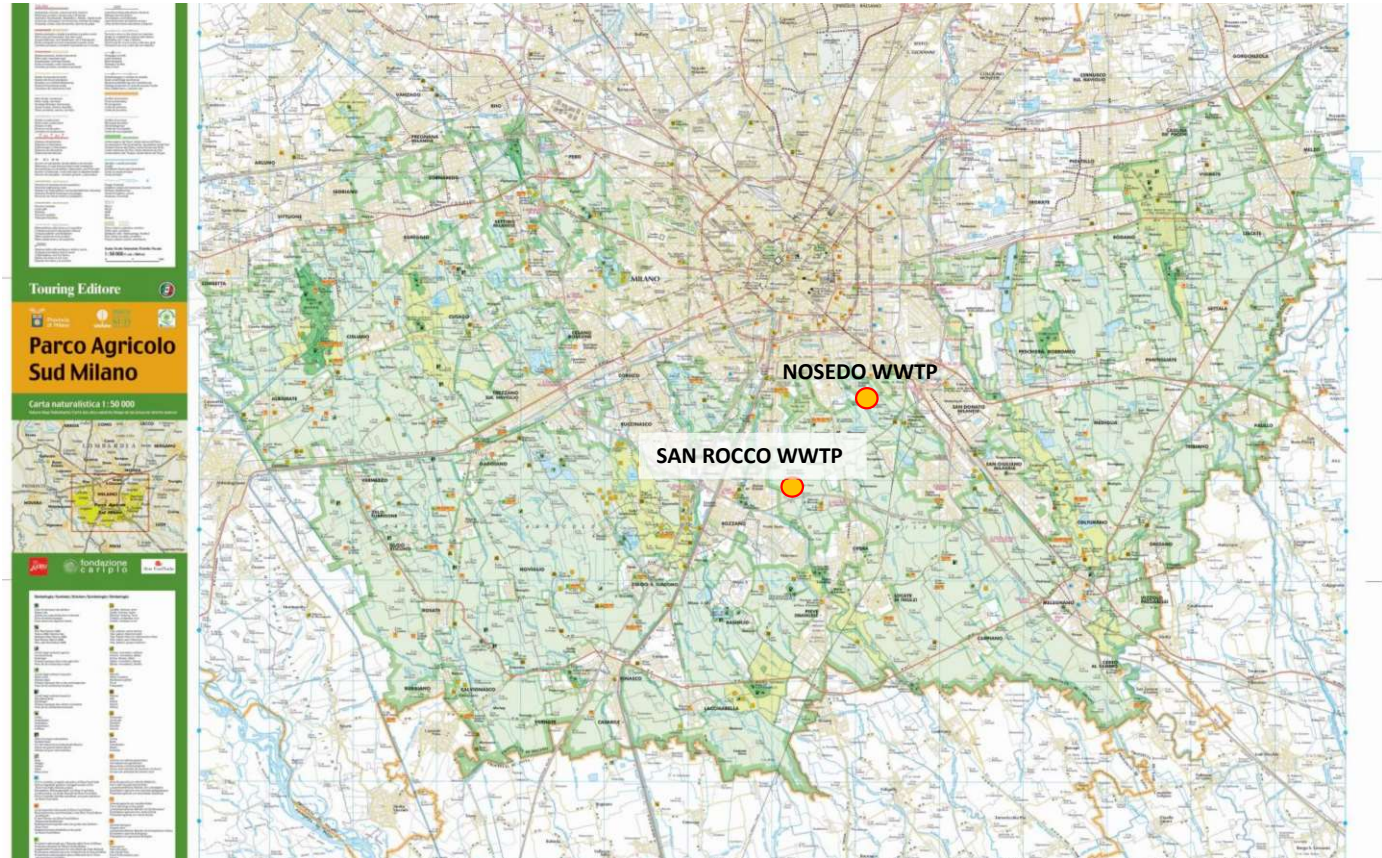
➤ Both WWTP are close to one of the bigger peri-urban agricultural park in Europe (PARCO AGRICOLO SUD MILANO) about 46.300 ha

➤ FLOW RATE FOR AGRICULTURE:

SAN ROCCO: 5 to 15 Mm³/Yr

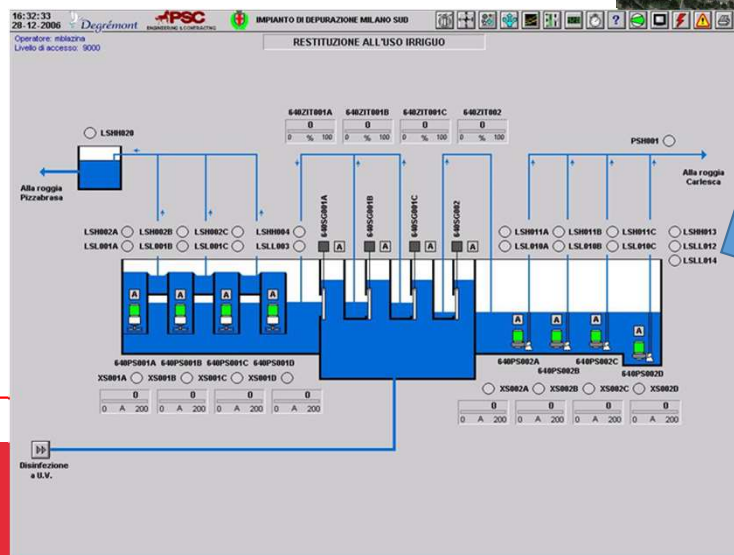
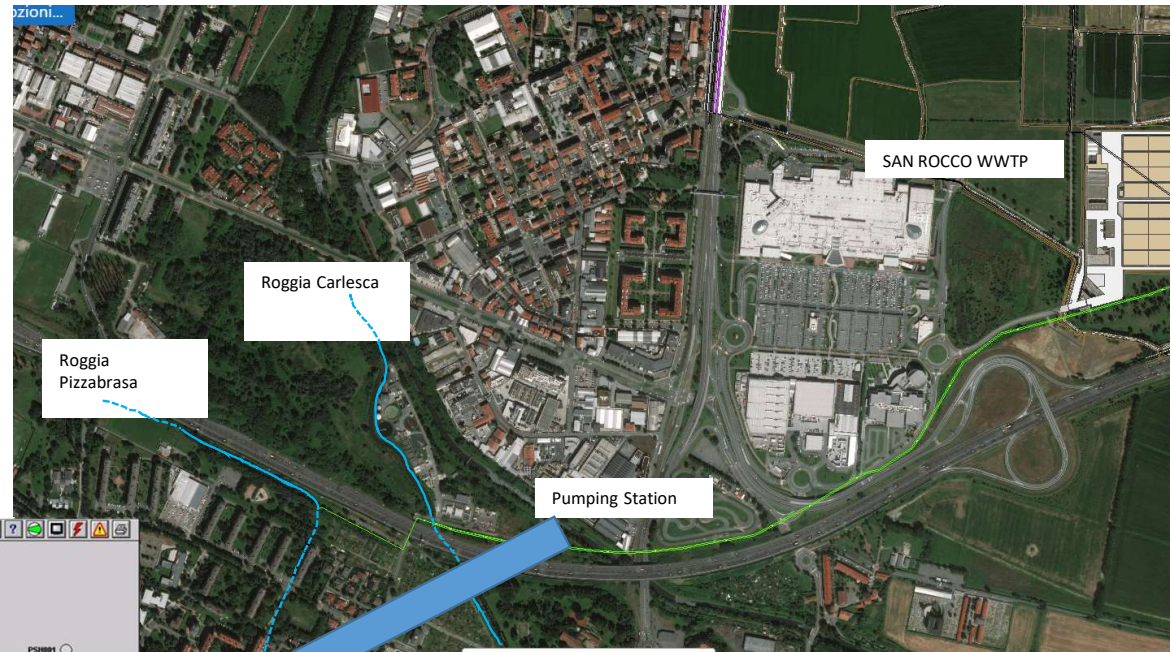
NOSEDO: 40 to 50 Mm³/Yr

TOTAL: 45 to 65 Mm³/Yr



WWTP Pumps final lifting to agricultural channel

- Treated water is 3 m b.g. and so for final use must be lifted of about 5 m!
- Pumping station manage by San Rocco WWTP with:
 - N° 4 centrifugal pump (0,33 m³/sec-cad) for Roggia Calesca
 - N° 4 hydrovore pump (1 m³/sec-cad) for Roggia Pizzabrasa



Wastewater treatment plants

WWTP MILANO NOSEDO

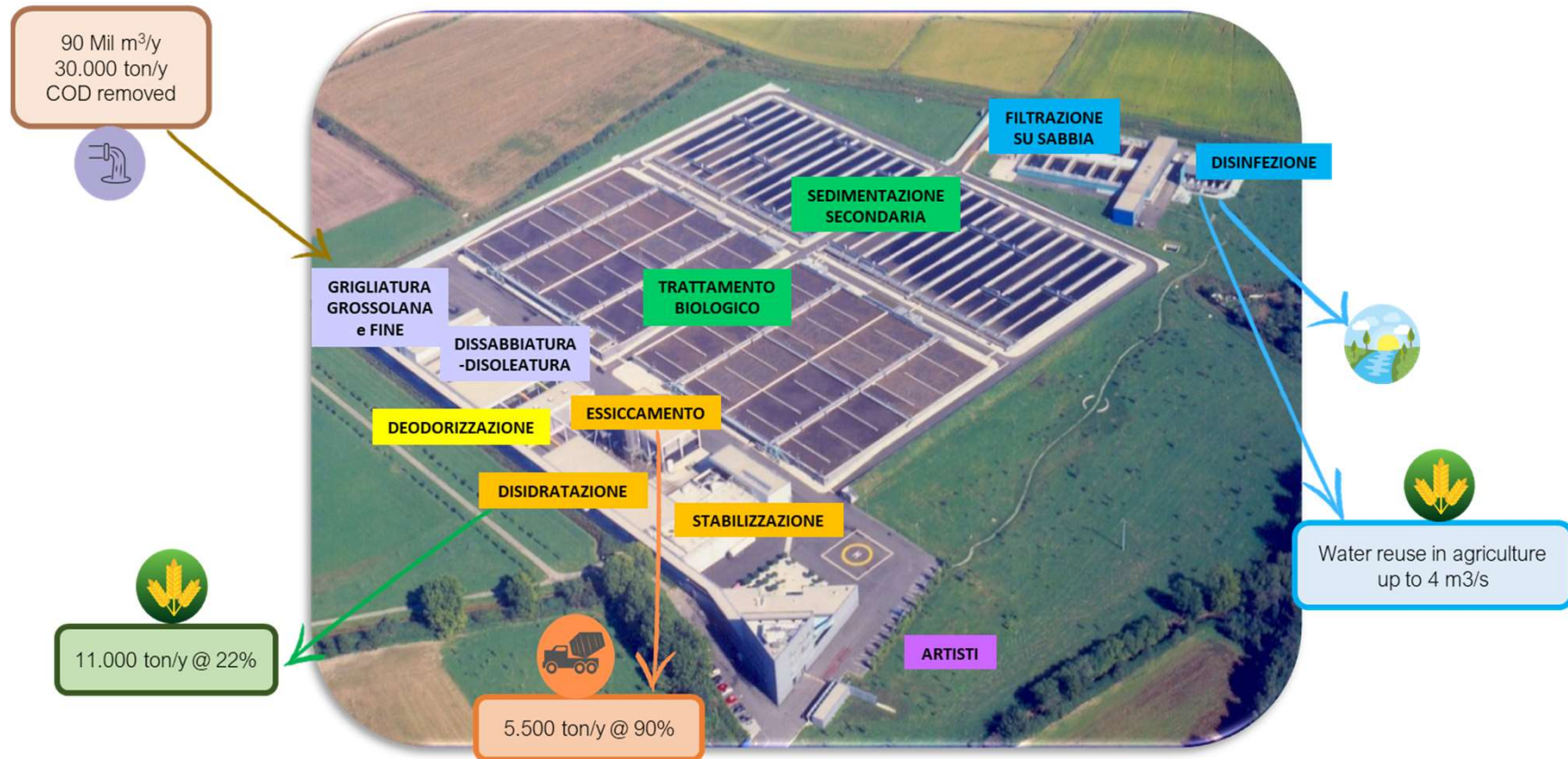


WWTP MILANO SAN ROCCO



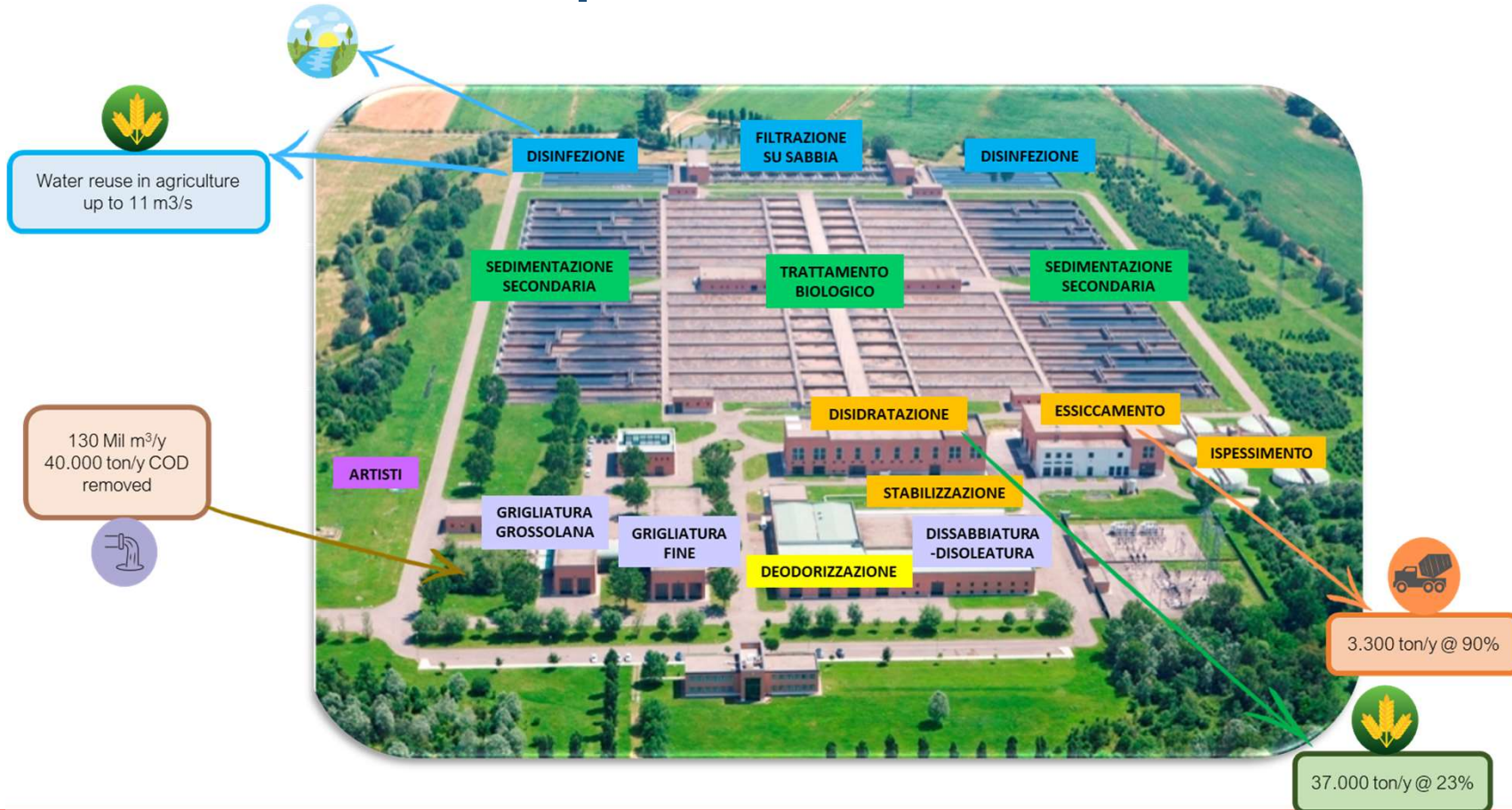
Wastewater treatment plants

WWTP MILANO SAN ROCCO

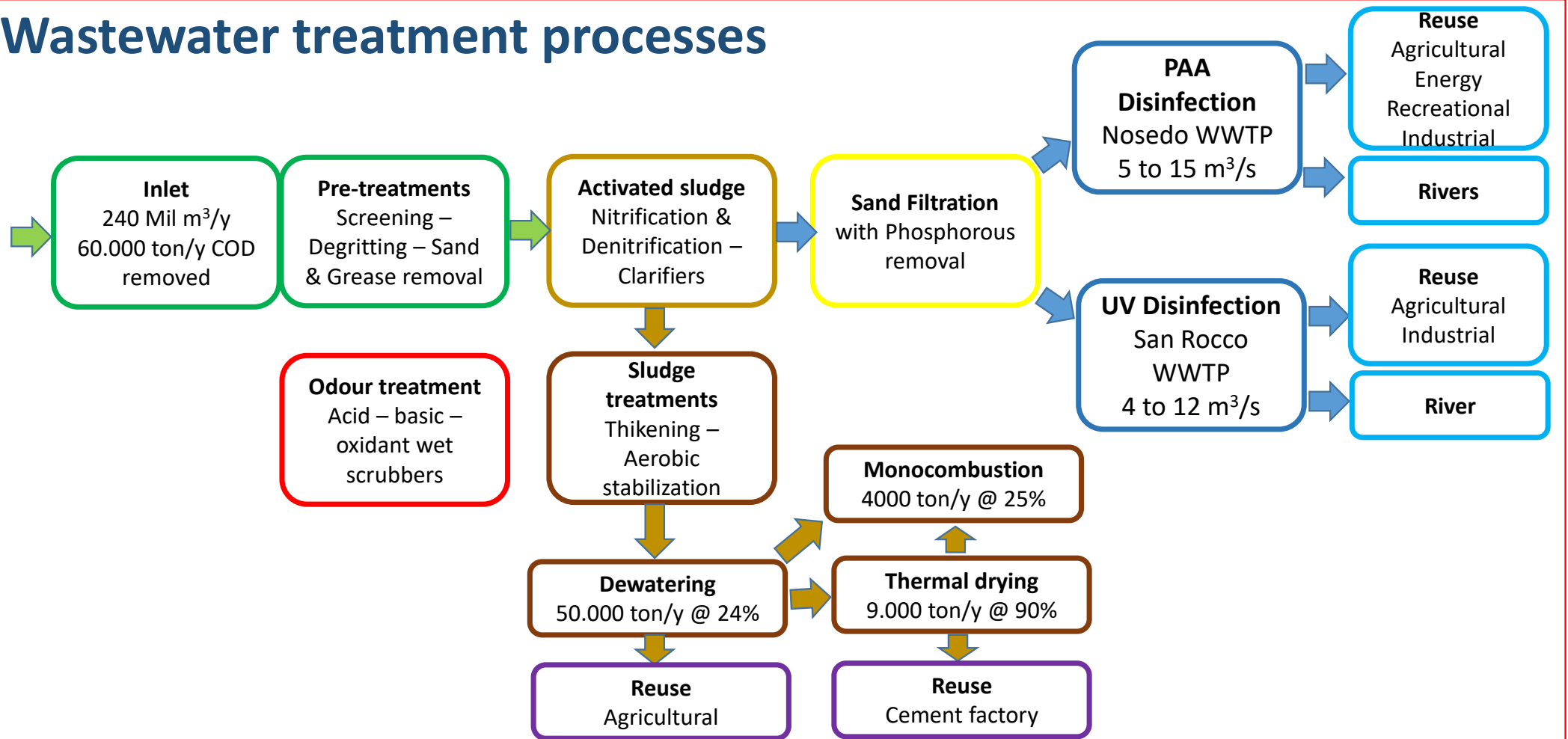


Wastewater treatment plants

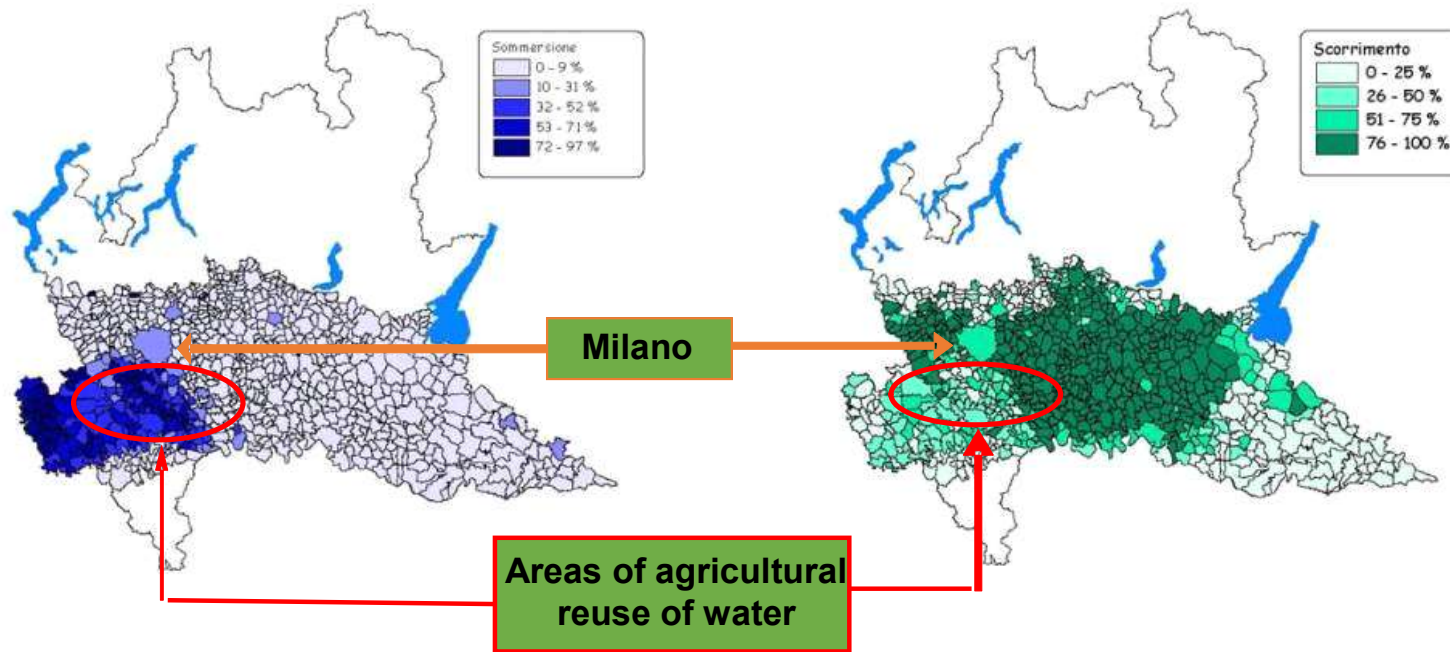
WWTP MILANO NOSEDO



Wastewater treatment processes



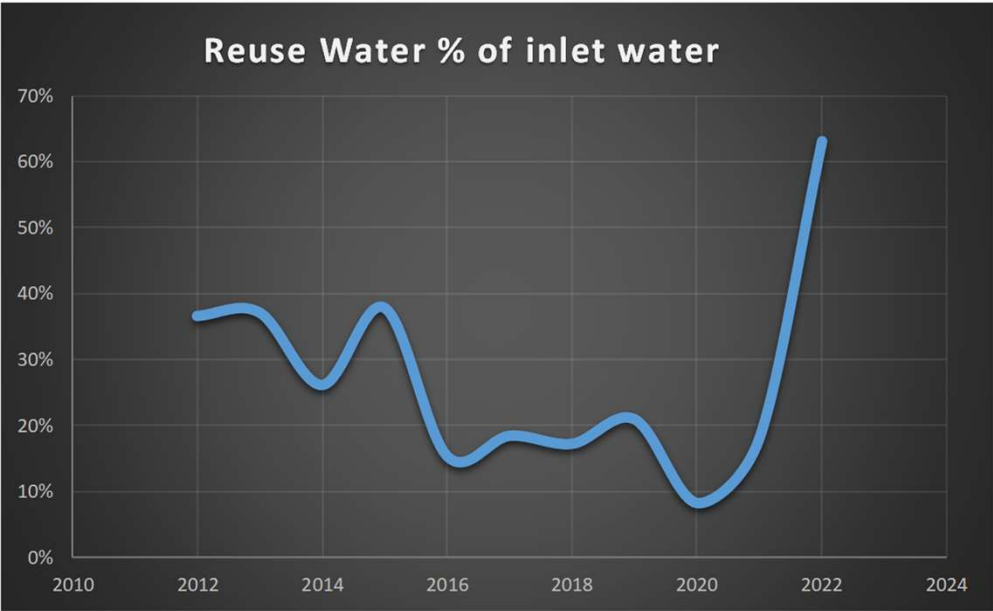
South Milan agricultural area of water reuse



YEAR 2022
the driest
year of all

NOTE: Water flow for agricultural do not depend on the plant potential (which is equal to 4 m³/sec) but on the requests of the agricultural consortium. Summer 2022 is the most dry season in the last 20 years!

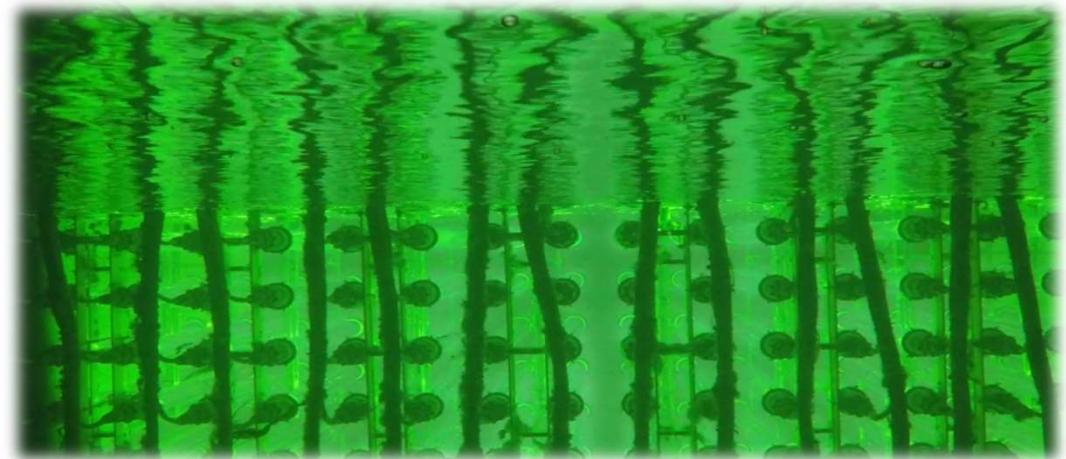
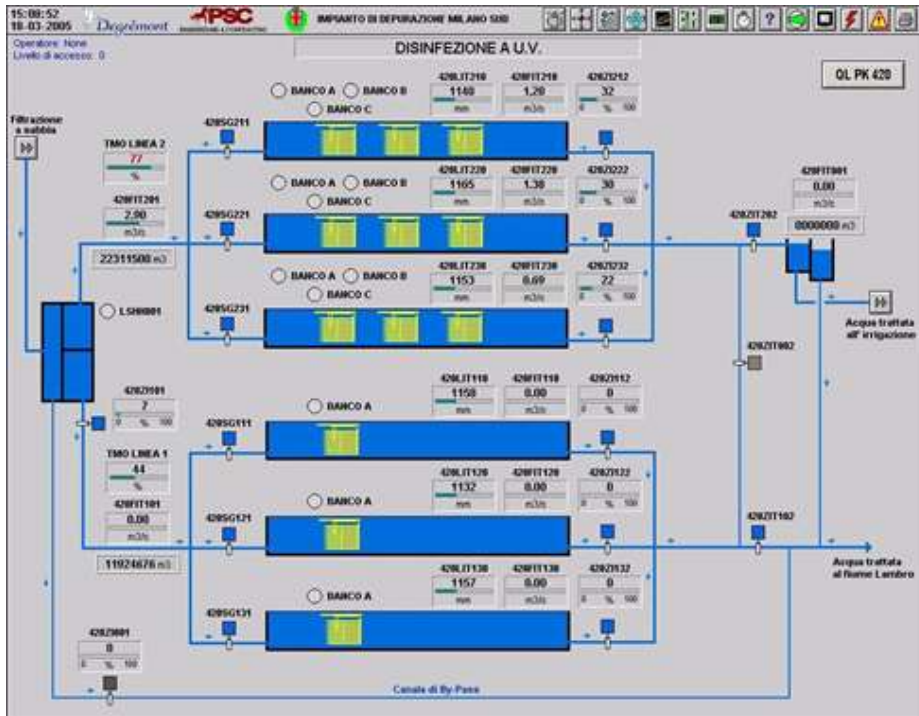
YEAR	INLET FLOW RATE (m3)	REUSE WATER (m3)	Reuse Water % of inlet water
2012	26.457.592	9.676.620	37%
2013	24.825.493	9.210.708	37%
2014	18.855.603	4.932.432	26%
2015	25.575.646	9.671.112	38%
2016	25.141.636	3.873.960	15%
2017	23.772.060	4.389.660	18%
2018	24.520.668	4.230.468	17%
2019	24.750.759	5.189.256	21%
2020	24.699.716	2.050.488	8%
2021	20.533.998	3.730.212	18%
2022	23.534.223	14.827.788	63%
TOTAL		71.782.704	27,2%



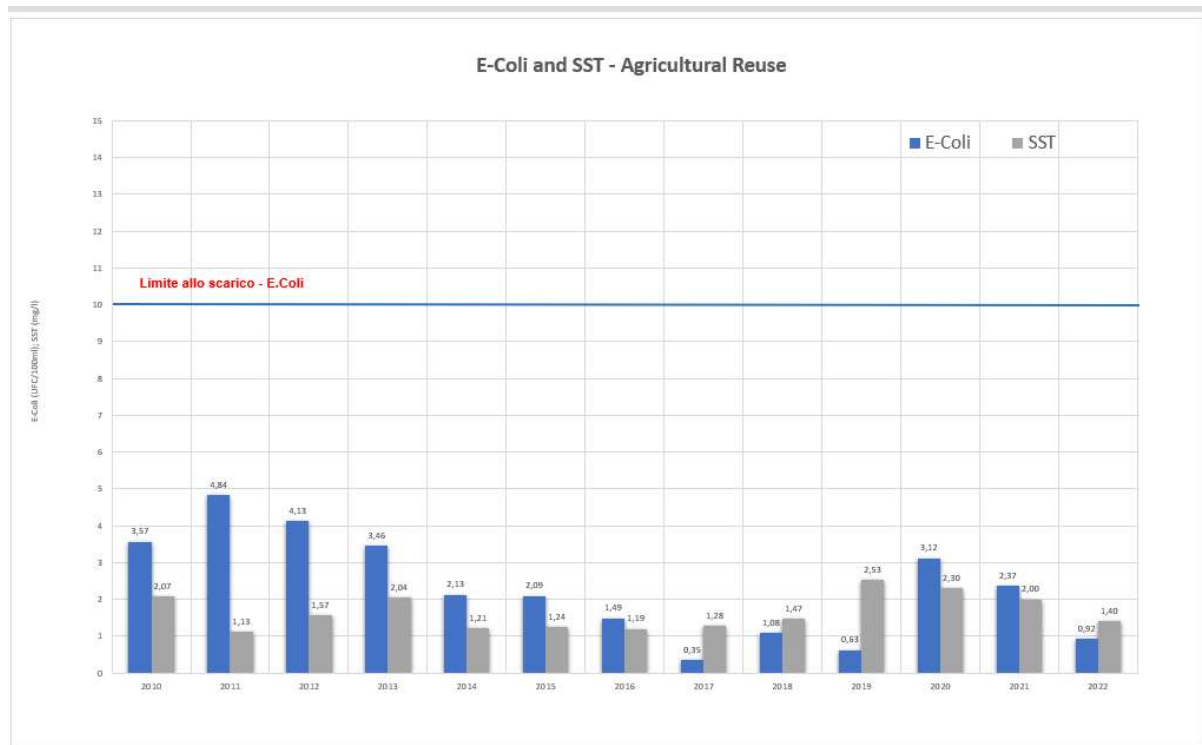
WWTP MILANO SAN ROCCO
% of reuse water is only in the reuse season

UV Disinfection at San Rocco

- Farmers asks the amount of water needed
- Agricultural season May – September
- Avg 10 Mil m³/y – 20 to 25% of year treated water
- Total dry weather inlet flowrate could be treated to A class reuse quality
- Only pumping energy payed by final users (1 €cent/m³)



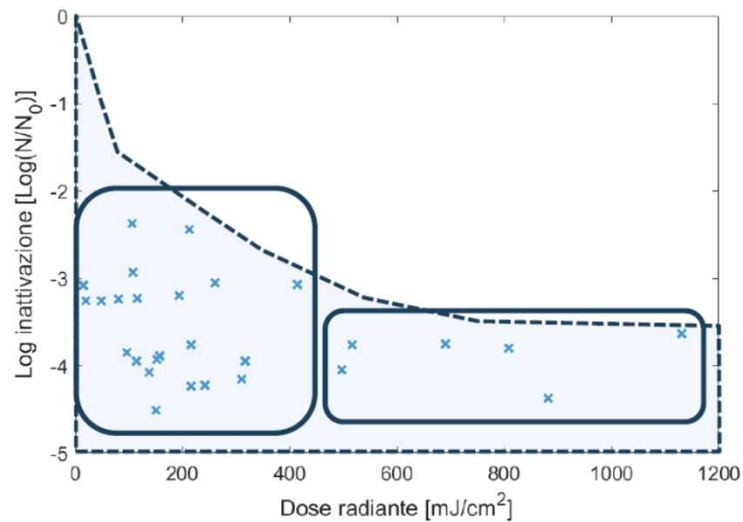
E Coli and SST concentration during Agricultural season – San Rocco WWTP



E. Coli limits are:

- 5.000 UFC/100 ml for fresh water discharge,
- 10 UFC/100 ml for Agricultural reuse (Discharge authorization)

UV Disinfection at San Rocco



It has been tested that a dose higher than 400mJ/cm² is enough to reach 3-4 inactivation logs and renders almost null the variability of the process and the concentration of the bacteria.

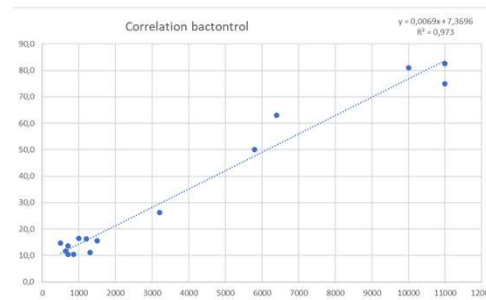
There is no need, in our case to apply a dose higher than 400 mJ/cm, regardless of flow and concentration.

Automation

On-line automated instrument for the detection of microbiological activity in water. It measures the specific enzymatic activities :

1.β-Glucuronidase → *E.coli* activity

Good correlation ($R^2=0,97$) with lab data (verified by previous studies and on going studies)

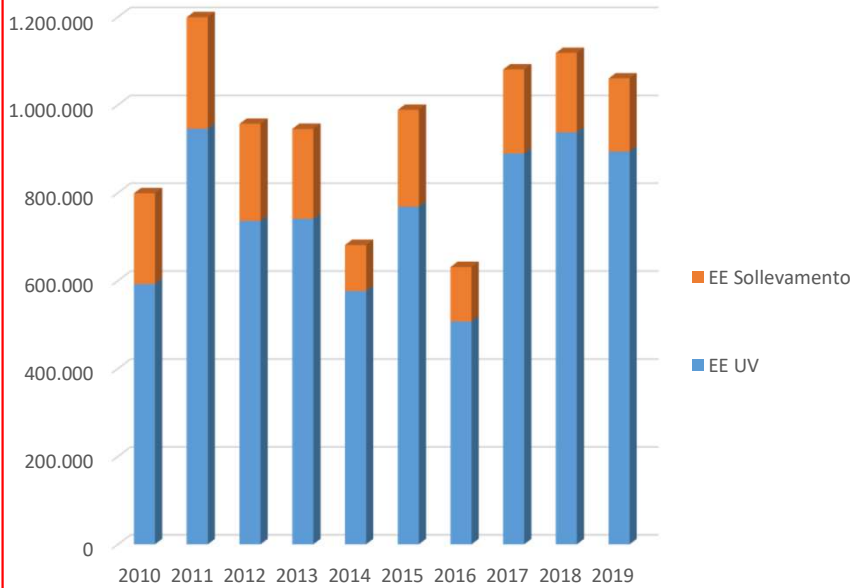


Automatic cleaning system, short period for measurement (1-2 hours), Specific for *E.coli* or Coliforms, amount of water utilized between 25-100 mL, easy to use and robust

Future connection with our SCADA system to automate turning ON or OFF of lamps and eventually intensity of UV lamps

UV Disinfection at San Rocco

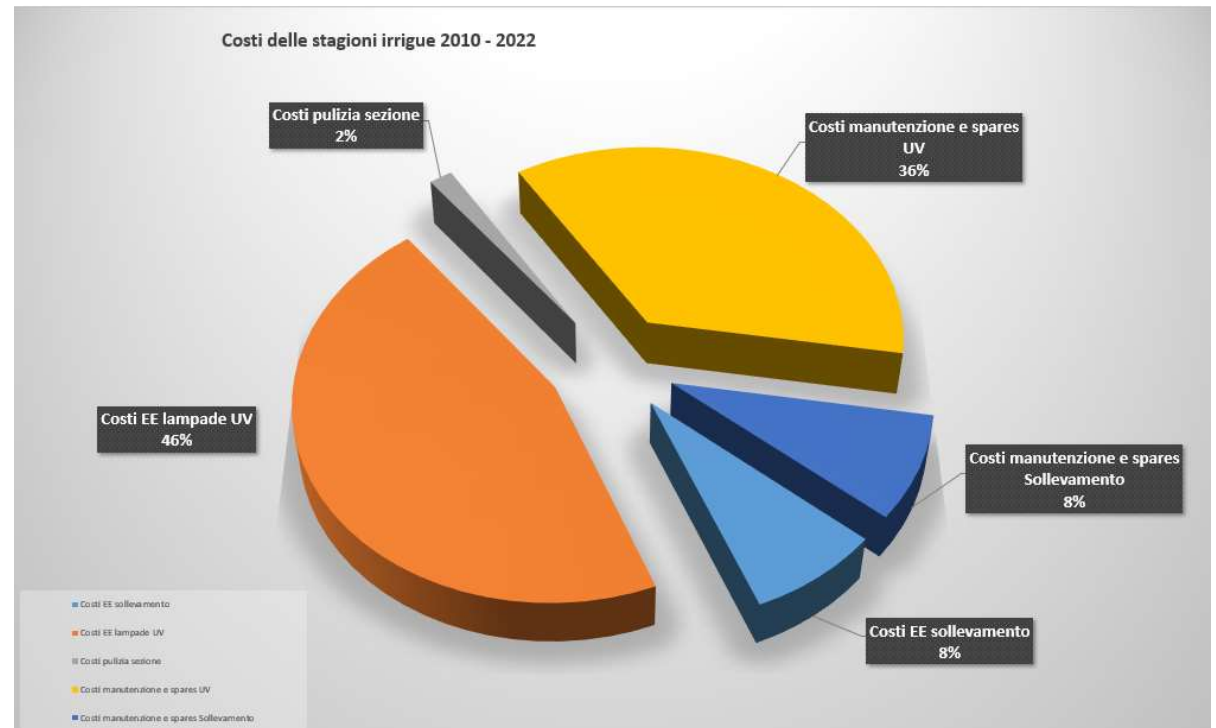
Energia elettrica dedicata al riutilizzo irriguo



% of energy:

79% for lamps

21% for water pumping



PAA Disinfection at Nosedo

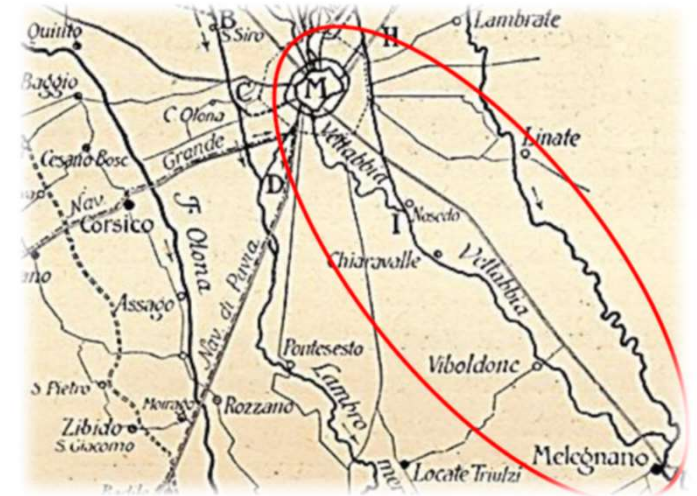


- Farmers asks the amount of water needed
- Agricultural season April – September
- **Avg 50 Mil m³/y – 85 to 95% of treated water**
- Total dry weather inlet flowrate could be treated to A class reuse quality
- Free of charge for final users

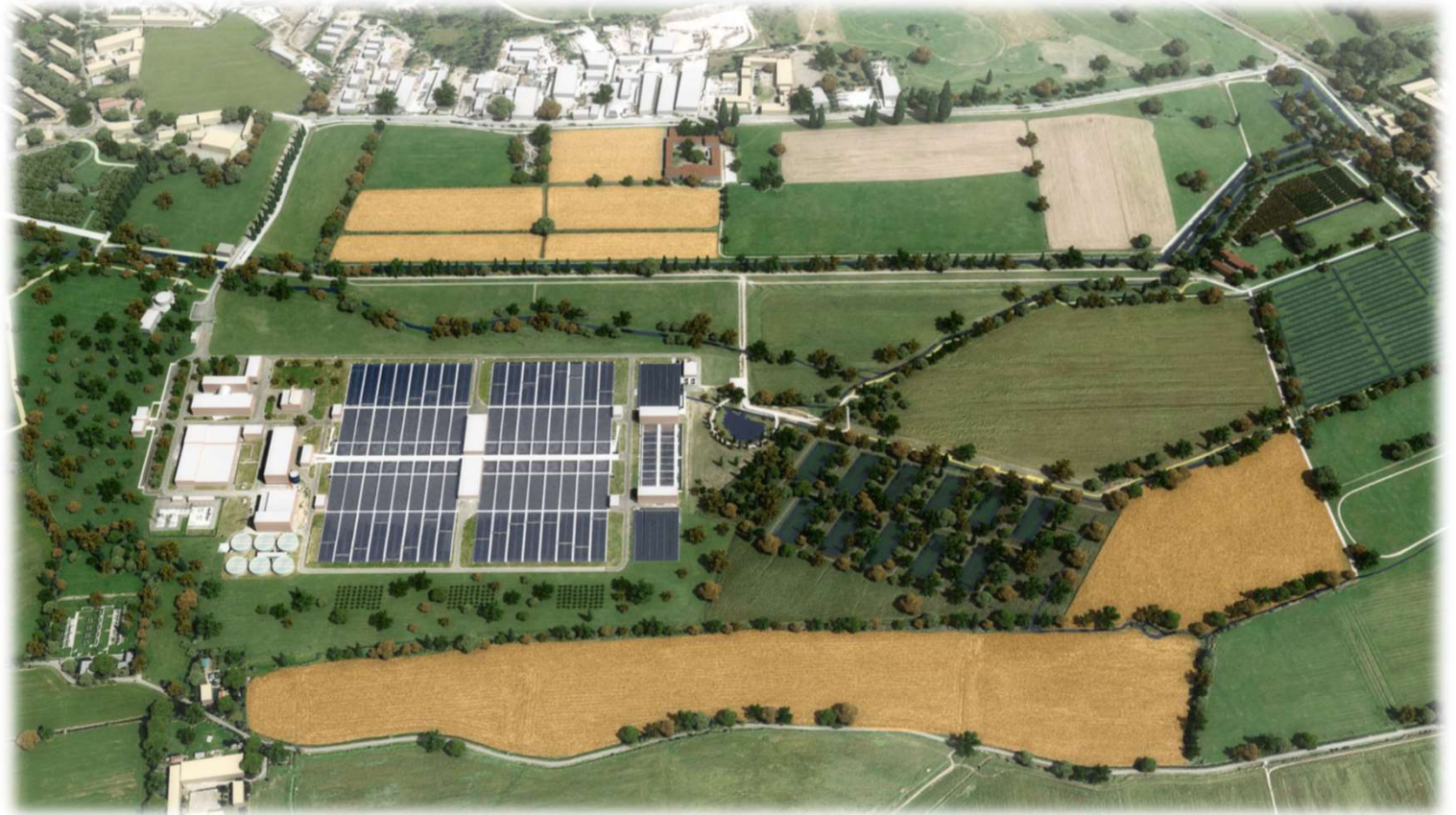


Middle ages historical wastewater reuse

- In the middle ages period wastewater was collected by Roggia Vettabbia
- Between Milan and Melegnano, Vettabbia water was used for agricultural meadows in order to biologically remove organic pollutants and at the same time fertilize terrains – they were able to boost cattle breeding
- Monks from Chiaravalle and Viboldone Abbeys are thought to be the founders of agricultural reuse of Vettabbia waters since 1200 d.c.
- Now called the “Monks valley trail”



Wetlands and meadows reuse



Types of crops

- 45% Corn
- 15% Rice
- 40% Forage



Wetlands and Nature based solutions

- 30.000 new trees and 100 ha
- Small rivers and canals rebuilt
- 55.000 m² wet woodland
- Cycling paths
- Restored meadow
- Ancient fruit trees courtyard



Recreational reuse

- Circular economy
- Ancient abbey mill restored
- Treated wastewater through mill



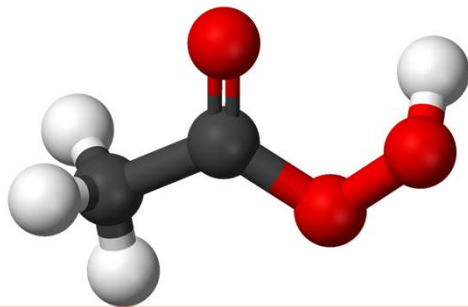
UV Disinfection San Rocco VS Nosedo

Overall cost estimation

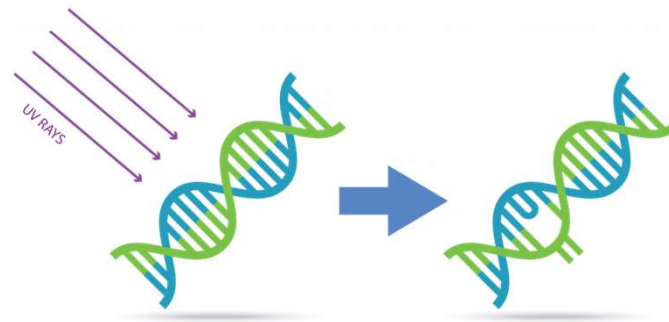
Peracetic Acid Disinfection (Nosedo): About 0,008 to 0,01 €/m³ (only peracetic cost) and up to 0,02 €/m³ with section maintenance, cleaning of section (no final pumping @ irrigation channels).

UV disinfection (San Rocco): About 0,03-0,015 €/m³ (@0,597-0,29 €/kWh) and up to 0,05 €/m³ with section maintenance, lamps replacement, cleaning of section and final pumping @ irrigation channels.

So Peracetic disinfection is less expensive (half of UV) than UV but is less stable for exit value of E-Coli and have more security issue (due to dangerousness of reagent)



VS



Water Reuse in EU

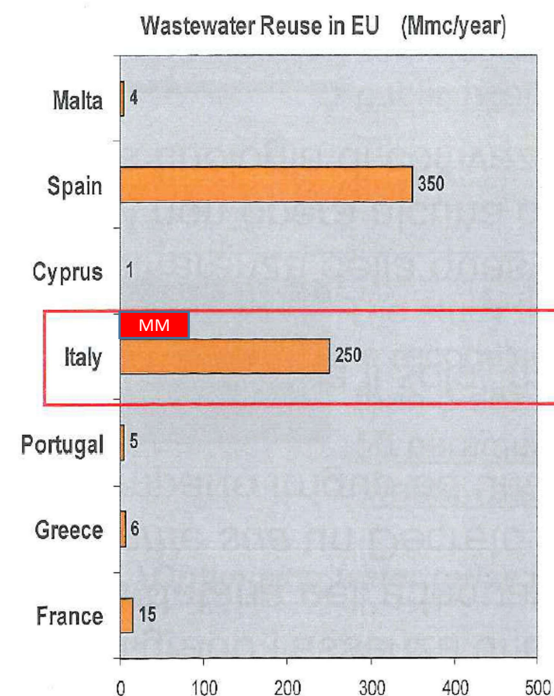
In 2006, the total volume of reused treated wastewater in the EU amounted to **964 million m³/year**, accounting for 2.4% of the treated urban wastewater (about 1 billion cubic metres)

Table 3.1 Reuse of treated wastewater (2006)

Country	Volume, million m3 per year
EU	964
Spain	347
Italy	233
Germany	42
Greece	23

Source: TYPISA (2013)

Spain and Italy jointly accounted for about 60% of the total EU treated wastewater reuse volume



Elaborazione da: A.N. Angelakis Quality of Recycled Water and its Application in Agriculture, 27 april 2012, Limassol, Cyprus

Water Reuse - Legislation

- Water reuse for agricultural purposes is achieved at the WWTP of Milano San Rocco, thanks to a very efficient tertiary treatment since 2004.
 - WWTP authorization for reuse have DM185/03 and E.Coli max value 10 UFC/100 ml)
- The Italian Legislation, via the Decreto Ministeriale 12 giugno 2003 n° 185 sets the limits for effluent water to be utilized in agriculture (limits are very low).
- On a European level, in 2020 a new regulation (Regolamento UE 2020/741 del 25 maggio 2020) sets the minimum requirements for water reuse.

REGOLAMENTO (UE) 2020/741 DEL PARLAMENTO EUROPEO E DEL CONSIGLIO
del 25 maggio 2020
recante prescrizioni minime per il riutilizzo dell'acqua
(Testo rilevante ai fini del SEE)

REGULAMENTO (UE) 2020/741 DO PARLAMENTO EUROPEU E DO CONSELHO
de 25 de maio de 2020
relativo aos requisitos mínimos para a reutilização da água
(Texto relevante para efeitos do EEE)

“The purpose of this Regulation is to guarantee that reclaimed water is safe for agricultural irrigation, thereby ensuring a high level of protection of the environment and of human and animal health, promoting the circular economy, supporting adaptation to climate change, and contributing to the objectives of Directive 2000/60/EC by addressing water scarcity and the resulting pressure on water resources, in a coordinated way throughout the Union, thus also contributing to the efficient functioning of the internal market.”

Water Reuse - Legislation

Table 3.5 Differences in maximum limit values for selected parameters considered in national standards for water reuse

Parameters	Cyprus	France	Greece	Italy	Portugal	Spain
E coli (cfu/100ml)	5-10 ³	250-10 ⁵	5-200	10	-	0-10,000 ⁶⁹
Faecal coliforms	-	-	-	-	100-10 ⁴	-
TSS	10-30	15	2-35	10	60	5-35
Turbidity (NTU)	-	-	2-no limit	-	-	1-15
Biochemical oxygen demand (BOD 5) (mg/l)	10-70	-	10-25	20	-	-
Chemical oxygen demand (COD) (mg-l)	70	60	-	100	-	-
Total nitrogen (mg/l)	15	-	30	15	-	10

Source: Reproduced from JRC, 2014. '-' indicates that there is no value set for the parameter in the national legislation

Water Reuse - Legislation

Table 1 – Classes of reclaimed water quality and permitted agricultural use and irrigation method

Minimum reclaimed water quality class	Crop category ⁽¹⁾	Irrigation method
A	All food crops consumed raw where the edible part is in direct contact with reclaimed water and root crops consumed raw	All irrigation methods
B	Food crops consumed raw where the above ground and is not in direct contact with reclaimed water, processed food crops and nor crops used to feed milk- or meat-producing animals	
C	Food crops consumed raw where the above ground and is not in direct contact with reclaimed water, processed food crops and nor crops used to feed milk- or meat-producing animals	
D	Industrial, energy and seeded crops	

Table 2 – Reclaimed water quality requirements for agricultural irrigation

Reclaimed water quality class	Indicative technology target	Quality requirements				Other
		<i>E. coli</i> (number/100 ml)	BOD ₅ (mg/l)	TSS (mg/l)	Turbidity (NTU)	
A	Secondary treatment, filtration, and disinfection	≤ 10	≤ 10	≤ 10	≤ 5	<i>Legionella</i> spp.: < 1 000 cfu/l where there is a risk of aerosolisation Intestinal nematodes (helminth eggs): ≤ 1 egg/l for irrigation of pastures or forage
B	Secondary treatment, and disinfection	≤ 100	In accordance with Directive 91/271/EEC (Annex I, Table 1)	In accordance with Directive 91/271/EEC (Annex I, Table 1)	-	
C	Secondary treatment, and disinfection	≤ 1 000			-	
D	Secondary treatment, and disinfection	≤ 10 000			-	

Circularity in Milano San Rocco WWTP - flash

Solar Roof FV: 2.055 MWh/year



Energy from Sludge (cement production)

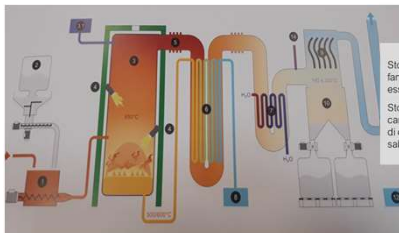
PCI over 15.000 KJ/kgDM



Heat exchanger for reuse of thermal heat of WW in Nosedo and San Rocco – (building)

Pilot test of Hydro Thermal Carbonization of biological sludge

First in Italy: Monocombustion plant – Reuse of Hoven heat for thermal drying - Phosporus recovery from ashes



Ashs (7-8% of P_{tot})



Hydrochar



Conclusion

- WWTP are a circular economy innovation hub (water-sludge-waste-energy)
- WWTP are improving the neighborhood and environmental quality
- Natural habitat recreated for wildlife
- Recreational areas for citizens
- Agricultural activities maintained
- There is a lot of potential for future
- We can make a difference in so many ways...



Grazie

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