Europe, environment and urban wastewater treatment: the policy, the economy and the ready-to-market innovations

5 novembre 2015 – Rimini, Italy

THE FIRST FULL SCALE APPLICATION OF THE SHORT-CUT ENHANCED NUTRIENTS ABATEMENT (S.C.E.N.A.) SYSTEM AT THE CARBONERA WWTP (Veneto Region, Italy)

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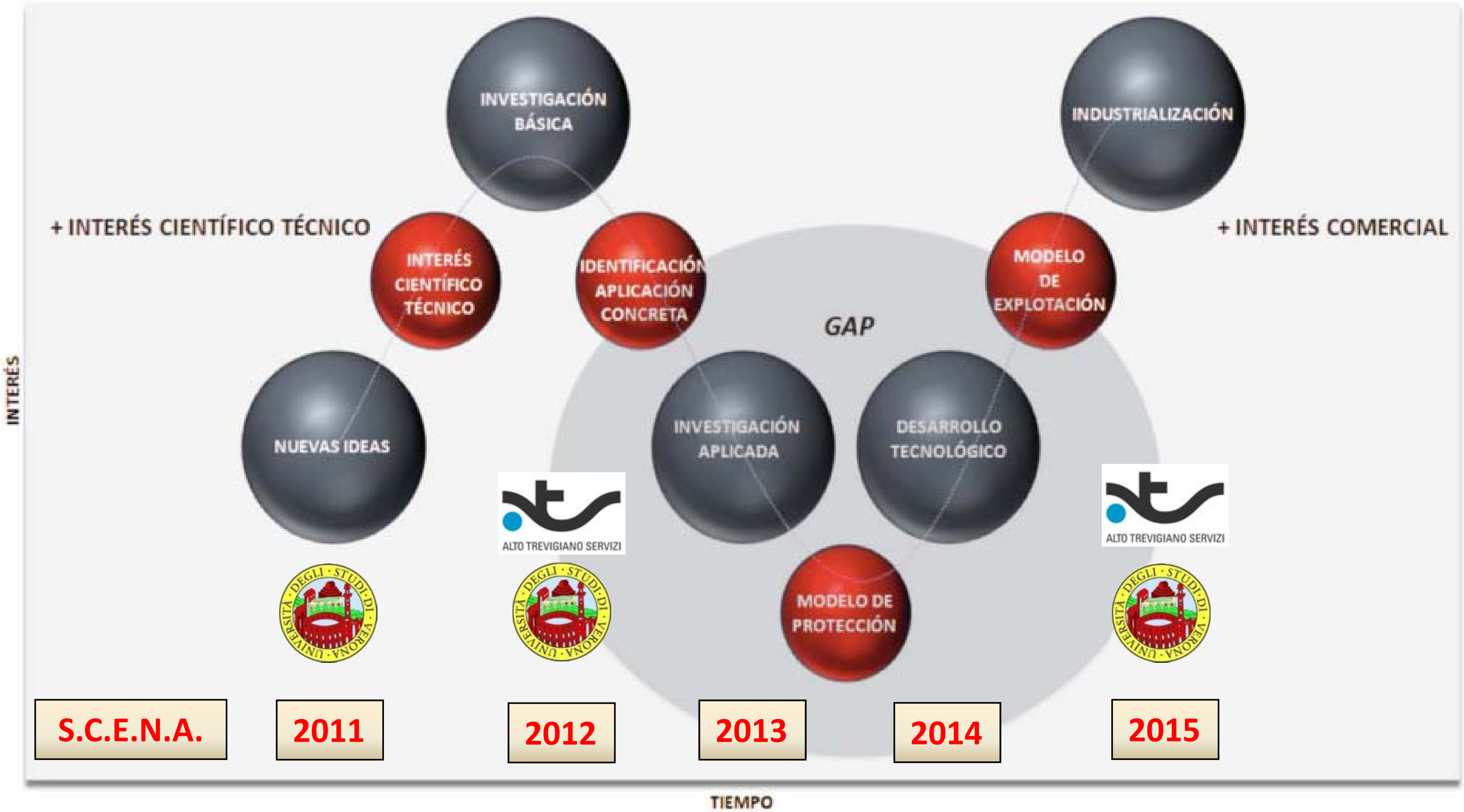
** Group of Environmental Engineering and Bioprocesses, Universidade de Santiago de Compostela , Spain

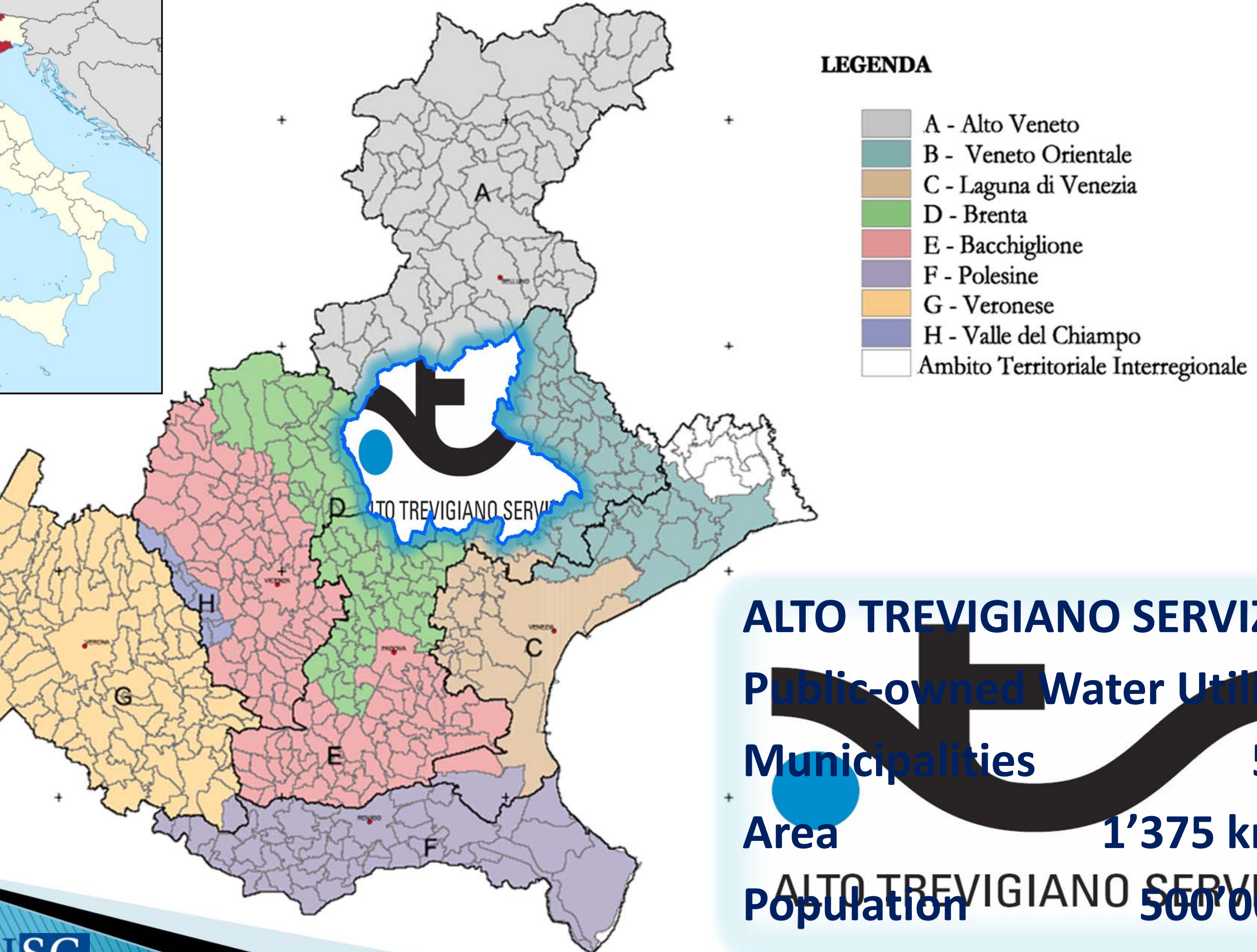
UNIVERSITY & WATER UTILITY
- PUBLIC OVERCOMING OF "DEATH VALLEY" IN INNOVATION -



** M. Cermerón et al (2013) "Ecosistema de innovación sostenible. El conocimiento circular. La Transferencia de Tecnología Universidad – Empresa. Nuevos instrumentos y horizontes. Fundación CYD.*

Courtesy Prof. Juan M. Lema Rodicio - USC

VENETO REGION
The Organization of the Urban Water Service

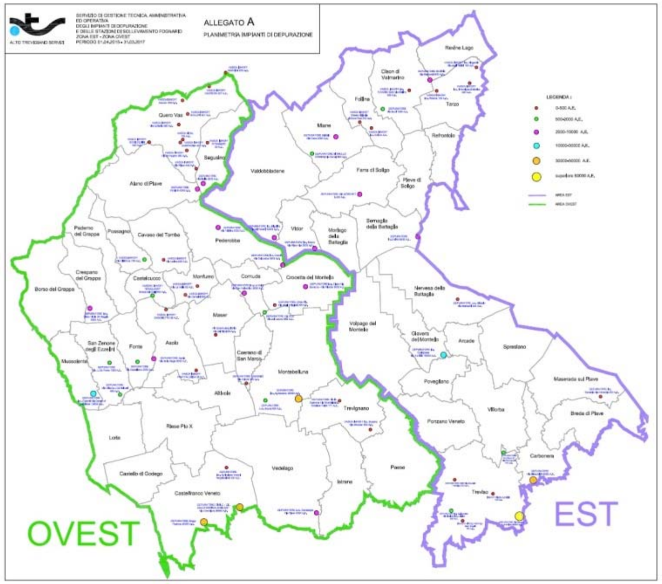


ALTO TREVIGIANO SERVIZI

Public-owned Water Utility

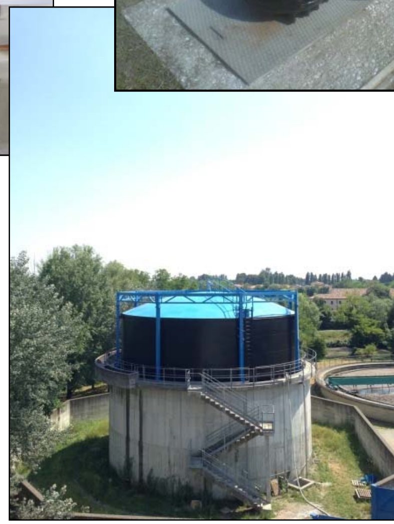
Municipalities	**53**
Area	**1’375 km^2**
Population	**500’000**

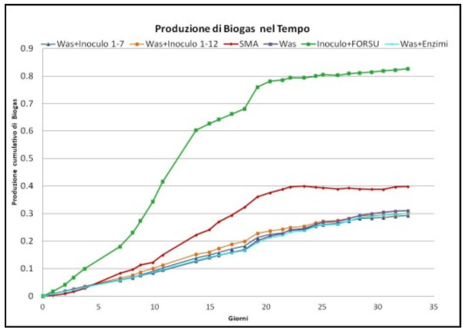
ALTO TREVIGIANO SERVIZI
WWTPs Management & Optimization



- 80 WWTPS (50-70.000 P.E.)
- 150 SEWAGE PUMPS SYSTEMS
- 1.300 KM SEWAGE NETWORK

- O&M
- OPTIMIZATION & INNOVATION
- UPGRADING PLANTS DESIGN





ALTO TREVIGIANO SERVIZI

USC UNIVERSIDADE DE SANTIAGO DE COMPOSTELA

EU,ITALIAN & LOCAL STANDARD FOR DISCHARGE

COUNCIL DIRECTIVE

of 21 May 1991

concerning urban waste water treatment

(91/271/EEC)

30. 5. 91 Official Journal of the European Communities No L 135/49

Table 2: Requirements for discharges from urban waste water treatment plants to sensitive areas which are subject to eutrophication as identified in Annex II.A (a). One or both parameters may be applied depending on the local situation. The values for concentration or for the percentage of reduction shall apply.

Parameters	Concentration	Minimum percentage of reduction (1)	Reference method of measurement
Total phosphorus	2 mg/l P (10 000 - 100 000 p. e.) 1 mg/l P (more than 100 000 p. e.)	80	Molecular absorption spectrophotometry
Total nitrogen (2)	15 mg/l N (10 000 - 100 000 p. e.) 10 mg/l N (more than 100 000 p. e.) (3)	70-80	Molecular absorption spectrophotometry

(1) Reduction in relation to the load of the influent.
(2) Total nitrogen means: the sum of total Kjeldahl-nitrogen (organic N + NH_3), nitrate (NO_3)-nitrogen and nitrite (NO_2)-nitrogen.
(3) Alternatively, the daily average must not exceed 20 mg/l N. This requirement refers to a water temperature of 12° C or more ... tion of the biological reactor of the waste water treatment plant. As a substitute for the condition concerning the ... s possible to apply a limited time of operation, which takes into account the regional climatic conditions. This ... es if it can be shown that paragraph 1 of Annex I.D is fulfilled.

Decreto Legislativo 3 aprile 2006, n. 152

"Norme in materia ambientale"

pubblicato nella *Gazzetta Ufficiale* n. 88 del 14 aprile 2006 - Supplemento Ordinario n. 96

DELIBERAZIONE DELLA GIUNTA REGIONALE n. 842 del 15/5/2012

OGGETTO: Piano di Tutela delle Acque, D.C.R. n. 107 del 5/11/2009, modifica e approvazione del testo integrato delle Norme Tecniche di Attuazione del Piano di Tutela delle Acque (Dgr n. 141/Cr del 13.12.2011).".

ITALIAN AND LOCAL STANDARD FOR DISCHARGE

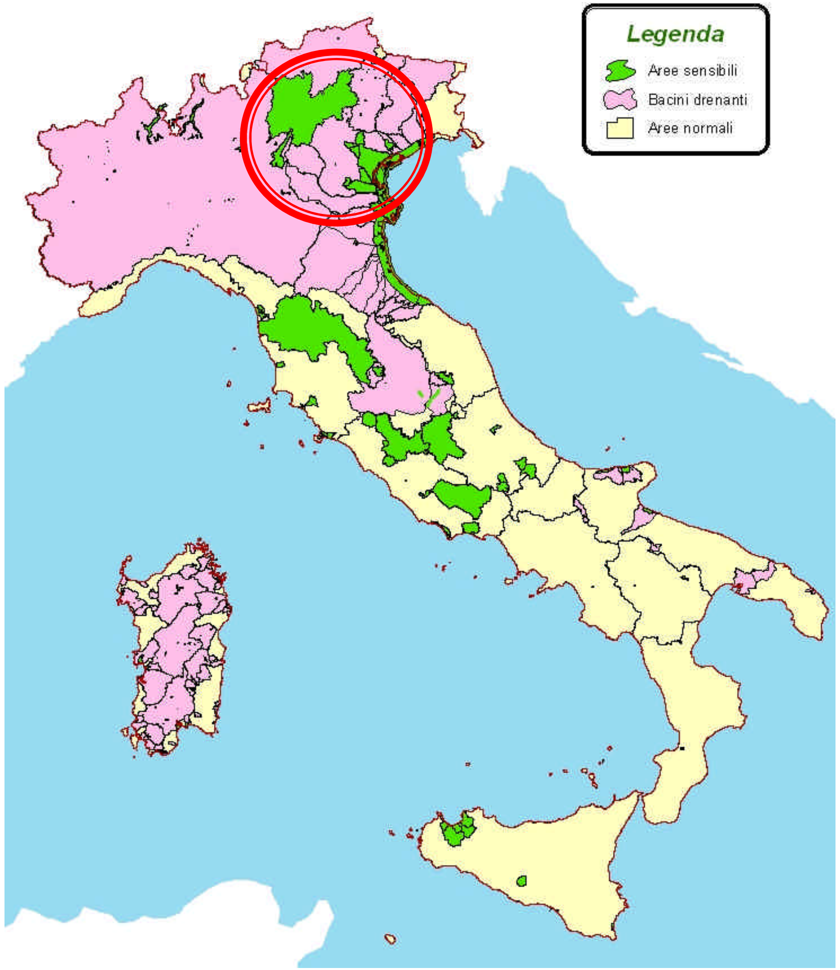
SENSITIVE AREAS

CATCHMENT AREAS
OF SENSITIVE AREAS

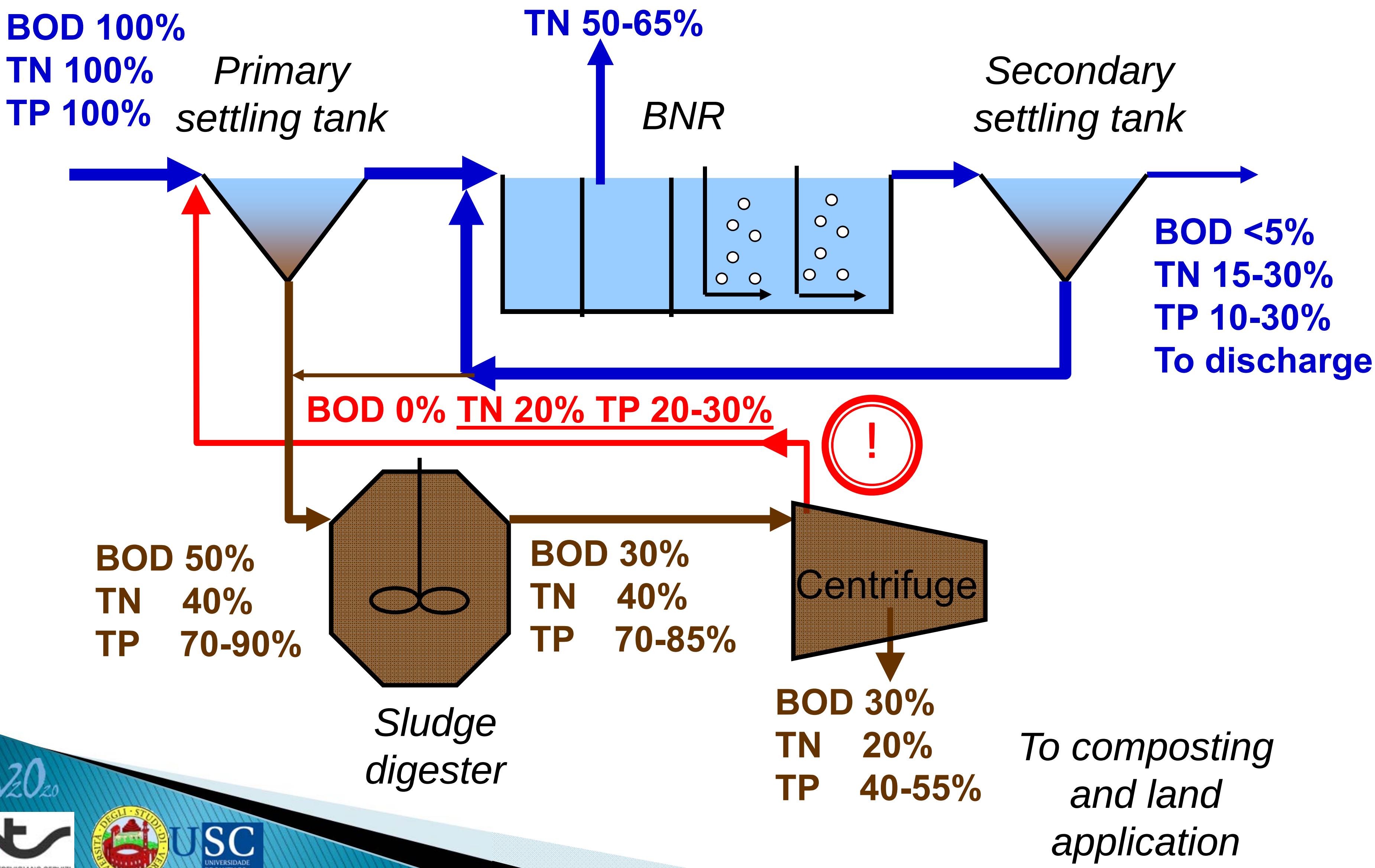
VENETO REGION IS EVERYWHERE SENSITIVE AREA OR CATHCMENT AREA OF SENSITIVE AREA

Alto Trevigiano Servizi WWTPs have to respect the restrictive limits for **TN** AND **TP** **provided by the Directive 91/271/EEC**

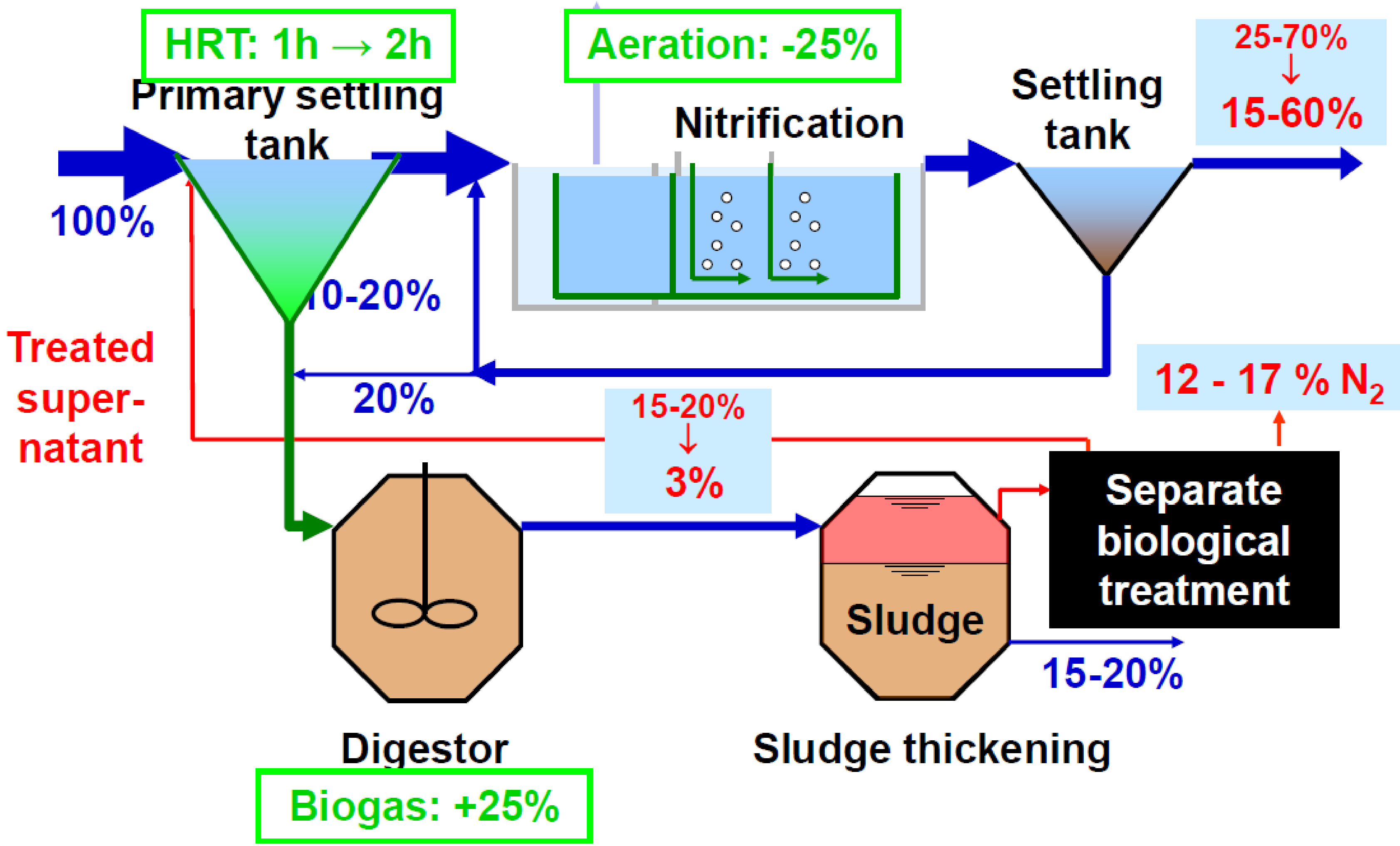
DIRETTIVA 91/271/CEE
ITALIA
Aree sensibili e bacini drenanti in aree sensibili
Situazione aggiornata maggio 2005



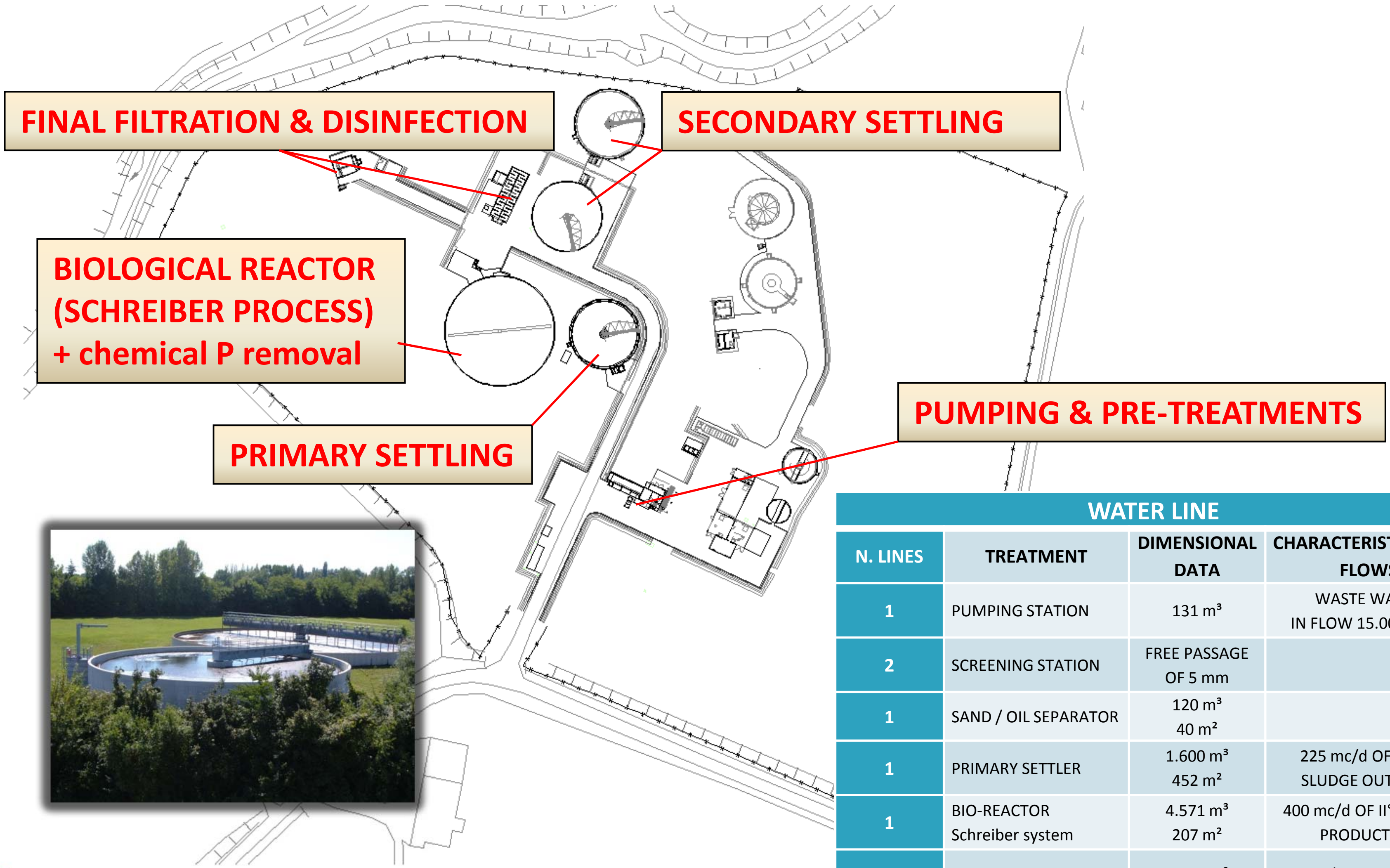
BNR AND ANAEROBIC DIGESTION



REVAMPING AND OPTIMIZATION
PRIMARY SETTLER AS CORE UNIT



CARBONERA WWTP (40.000 P.E.) – WATER LINE



WATER LINE

N. LINES	TREATMENT	DIMENSIONAL DATA	CHARACTERISTICS AND FLOWS
1	PUMPING STATION	131 m³	WASTE WATER IN FLOW 15.000 mc/d
2	SCREENING STATION	FREE PASSAGE OF 5 mm	
1	SAND / OIL SEPARATOR	120 m³ 40 m²	
1	PRIMARY SETTLER	1.600 m³ 452 m²	225 mc/d OF I° + II° SLUDGE OUTFLOW
1	BIO-REACTOR Schreiber system	4.571 m³ 207 m²	400 mc/d OF II° SLUDGE PRODUCTION
2	SECONDARY SETTLERS	2.260 m³ 904 m²	600 mc/h OF SECONDARY SLUDGE RICIRCULATION
1	DISINFECTION	180 m³ 114 m²	
2	FINAL FILTRATION		

W2O20

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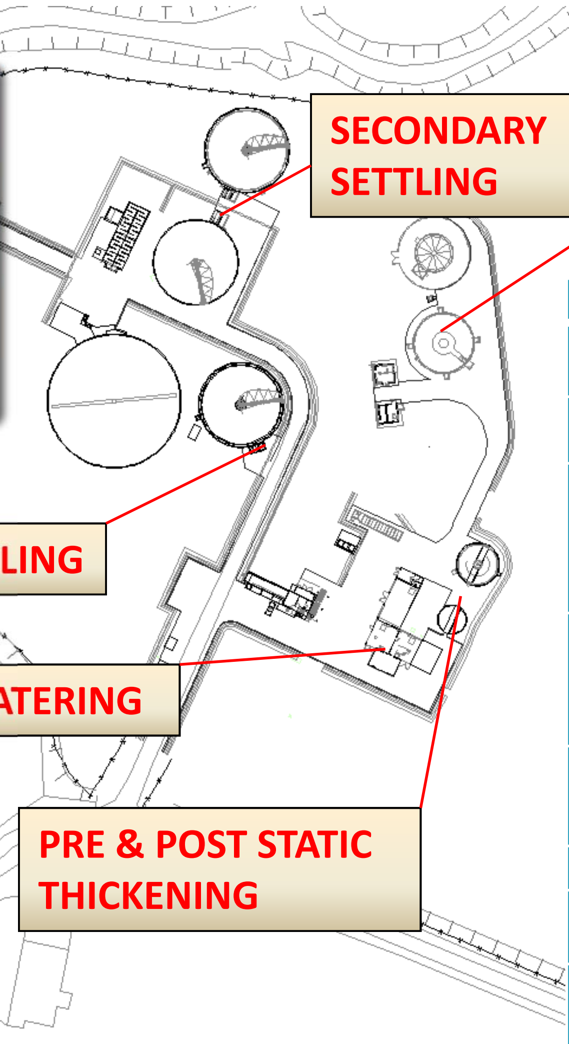
UNIVERSITÀ DEGLI STUDI DI VERONA

USC UNIVERSIDADE DE SANTIAGO DE COMPOSTELA

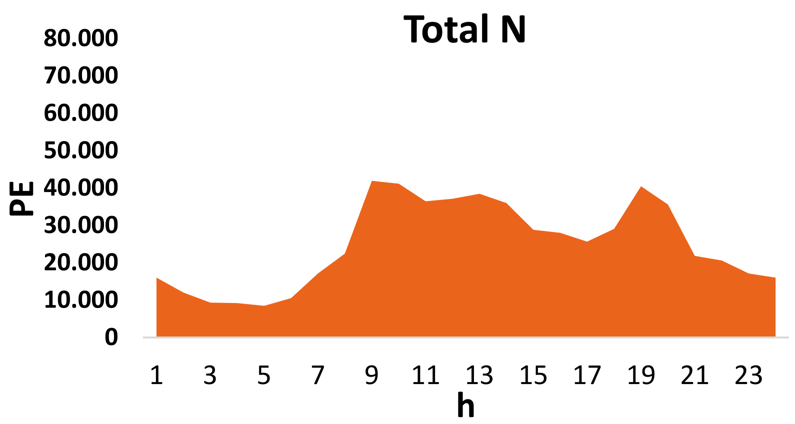
CARBONERA WWTP (40.000 P.E.) – SLUDGE LINE



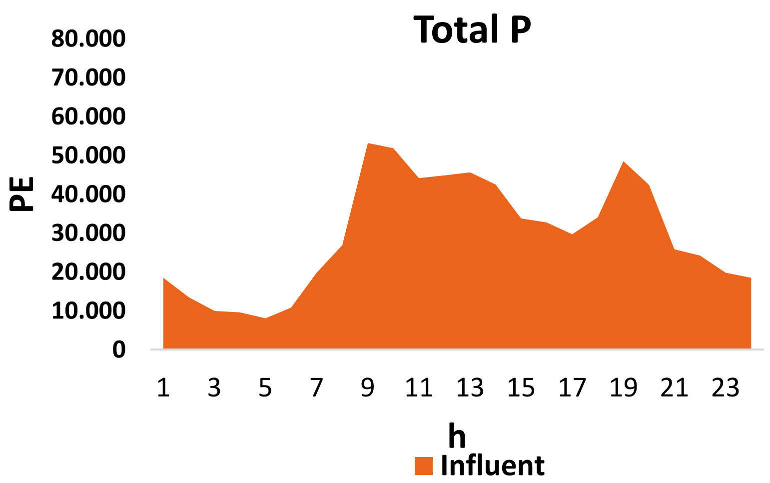
SLUDGE LINE			
N. LINES	**TREATMENT**	**DIMENSIONAL DATA**	**CHARACTERISTICS AND FLOWS**
1	I° + II° SLUDGE STATIC THICKNER	395 m^3 113 m^2	225 mc/d OF I° + II° SLUDGE INFLOW
1	ANAEROBIC MESOPHILIC REACTOR	1.800 m^3 75 m^2	70 mc/d OF THICKENED SLUDGE 25 mc/h OF BIOGAS AT 65 % CH4
1	DIGESTATE STATIC THICKNER	175 m^3 50 m^2	63 mc/d OF DIGESTED THICKENED SLUDGE INFLOW
1	DEWATEREING SEWAGE SLUDGE CENTRIFUGE		55 mc/d OF DIGESTATE

GAS LINE			
N. LINES	**TREATMENT**	**DIMENSIONAL DATA**	**CHARACTERISTICS AND FLOWS**
2	BIOGAS COMPRESSORS		233 mc/h OF BIOGAS RICIRCOLATION
1	BOILER		180 kW
1	GASOMETER	362 m^3 75,4 m^2	

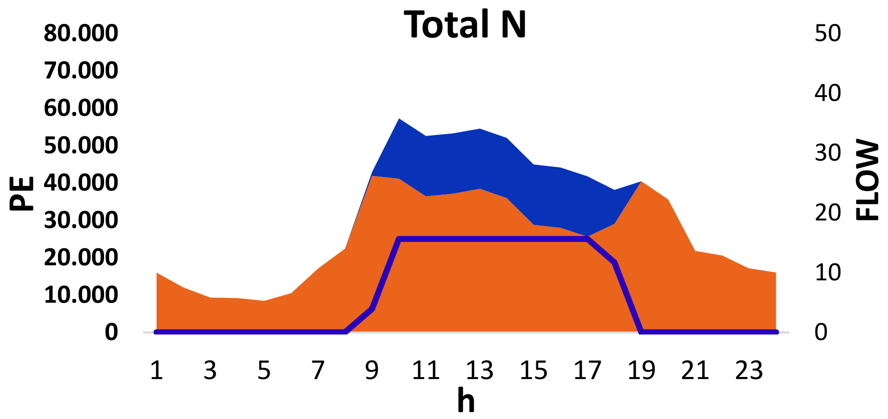
CHARACTERIZATION OF SUPERNATANTS



SEWER INFLUENT		
Parameter	Average Conc. mg/l	Load kg/d
Flow		16.972
TN	16	270
NH_4-N	12	202
NO_2-N	<0.5	
NO_3-N	<0.5	
PO_4-P	1,5	25
TP	2	34

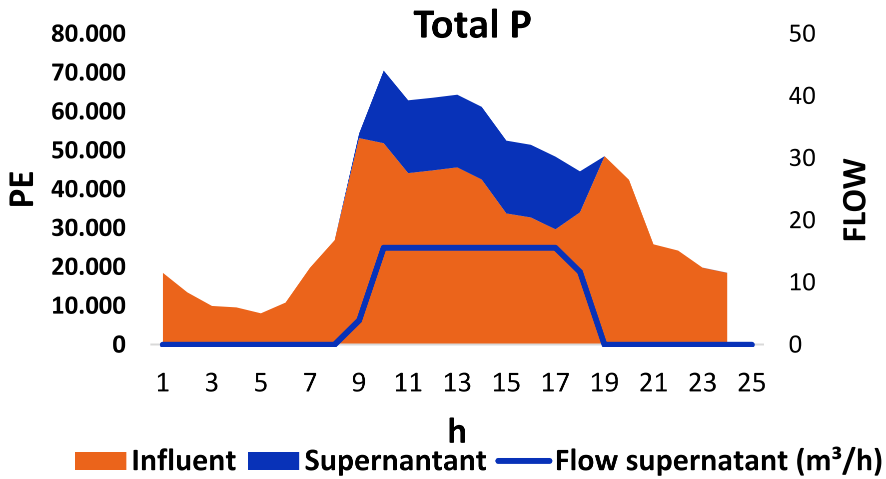


CHARACTERIZATION OF SUPERNATANTS



SEWER INFLUENT		
Parameter	Average Conc. mg/l	Load kg/d
Flow		16.972
TN	16	270
NH_4-N	12	202
NO_2-N	<0.5	
NO_3-N	<0.5	
PO_4-P	1,5	25
TP	2	34

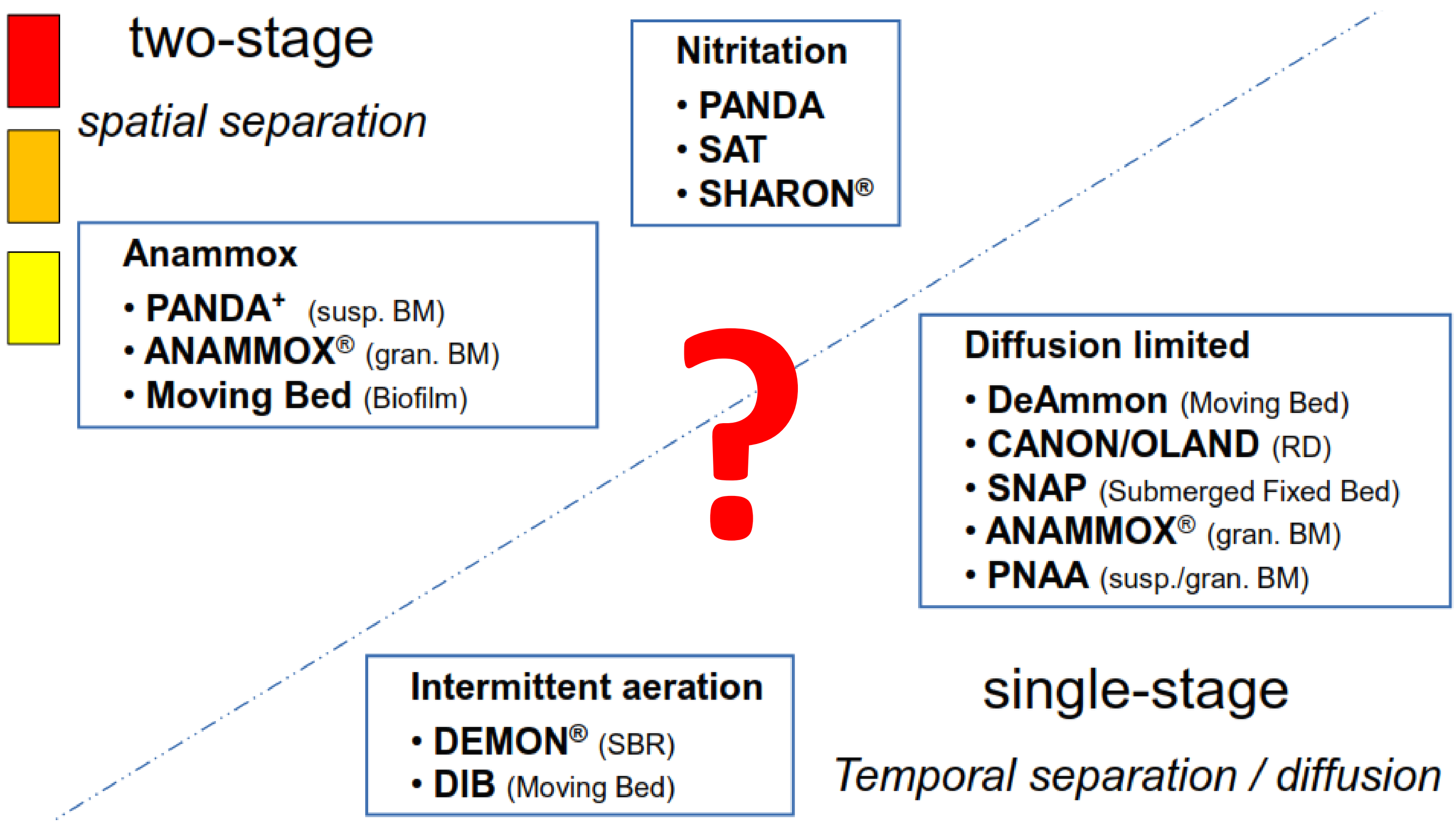
SUPERNATANT FLOW		
Parameter	Average Conc. mg/l	Load kg/d
Flow		134
TN	521	70
NH_4-N	511	68
NO_2-N	<0.5	
NO_3-N	<0.5	
PO_4-P	63	8
TP	89	12



FINAL INFLUENT		
Parameter	Average Conc.mg/l	Load kg/d
Flow		17.106
TN	20	340
NH_4-N	16	270
NO_2-N	<0.5	
NO_3-N	<0.5	
PO_4-P	2,7	33
TP	3	46

21% of TN
23% of TP
from Supernatants

NITROGEN AUTOTROPHIC REMOVAL? OFTEN THE BEST SOLUTION.



More than 100 full scale plants for side-stream treatment

Courtesy Yvonne Schneider

HAMLET'S DOUBT

Anammox

or

Not Anammox

...this is the problem...

WHAT ABOUT THE WATER UTILITY POINT OF VIEW?

- Investment costs (volume, materials)
- Energy demand (aeration, mixing, pumping)
- Chemicals (NaOH, C-source)
- Sludge disposal (treatment, transport)

Carbon footprint

Cost optimization

- Start-up (duration, effort)
- Control system (complexity, degree of automation)
- Experience (pilot & full-scale plants in operation)
- Stability (endurance, resistance against peak loads, inhibition)
- Easy O&M

Guarantee of the discharge

S.C.E.N.A.
SHORT-CUT ENHANCED NUTRIENTS ABATEMENT

A COLLABORATION BETWEEN UNIVERSITY AND WATER UTILITIES >> ARE WE WITHIN W2O20 CONCEPT?

- **The IDEA**: a pilot scale experimantation and prompt full-scale validation to test innovative technologies for Via-nitrite removal of nutrients nitrogen and phosphorus from AD supernatants at Carbonera WWTP
- **The NAME**: S.C.E.N.A. Short-Cut Enhanced Nutrients Abatement
- **The PREVIOUS EXPERIENCE**: test on pilot plant within a co-digestion WAS+OFMSW treatment plant
- **The INNOVATION**: BACS (BEST AVALAIBLE CARBON SOURCE) from sewage sludge fermentation and via-nitrite phosphorus enhanced bioaccumulation
- **AUTHORIZATION** : Decree of the Veneto Region n. 754 of 21.05.2013
  PHASE I (PILOT SCALE) + PHASE II (FULL-SCALE)

VIA-NITRITE PATHWAY IN scSBR

Nitritation | **Denitritation**

$NH_4^+ \rightarrow NO_2^- \rightarrow$ ~~NO_3^-~~ | $NO_2^- \rightarrow NO \rightarrow N_2O \rightarrow N_2$

AOB ~~NOB~~

Pathway

Autotrophic bacteria | **Heterotrophic bacteria**

Short-cut nitrification/denitrification (SCDN)

FA > 1 mg NH_3-N L^{-1}

FNA > 0.02 mg HNO_2-N L^{-1}

DO: 0.5-1.5 mg L^{-1}

T: 30-40°C

pH > 7.5

AOB growth
NOB wash-out

Advantages **S.C.E.NA.**

Up to 25% lower oxygen demand

~~Up to 40% less external carbon source~~

30 – 40% less sludge production

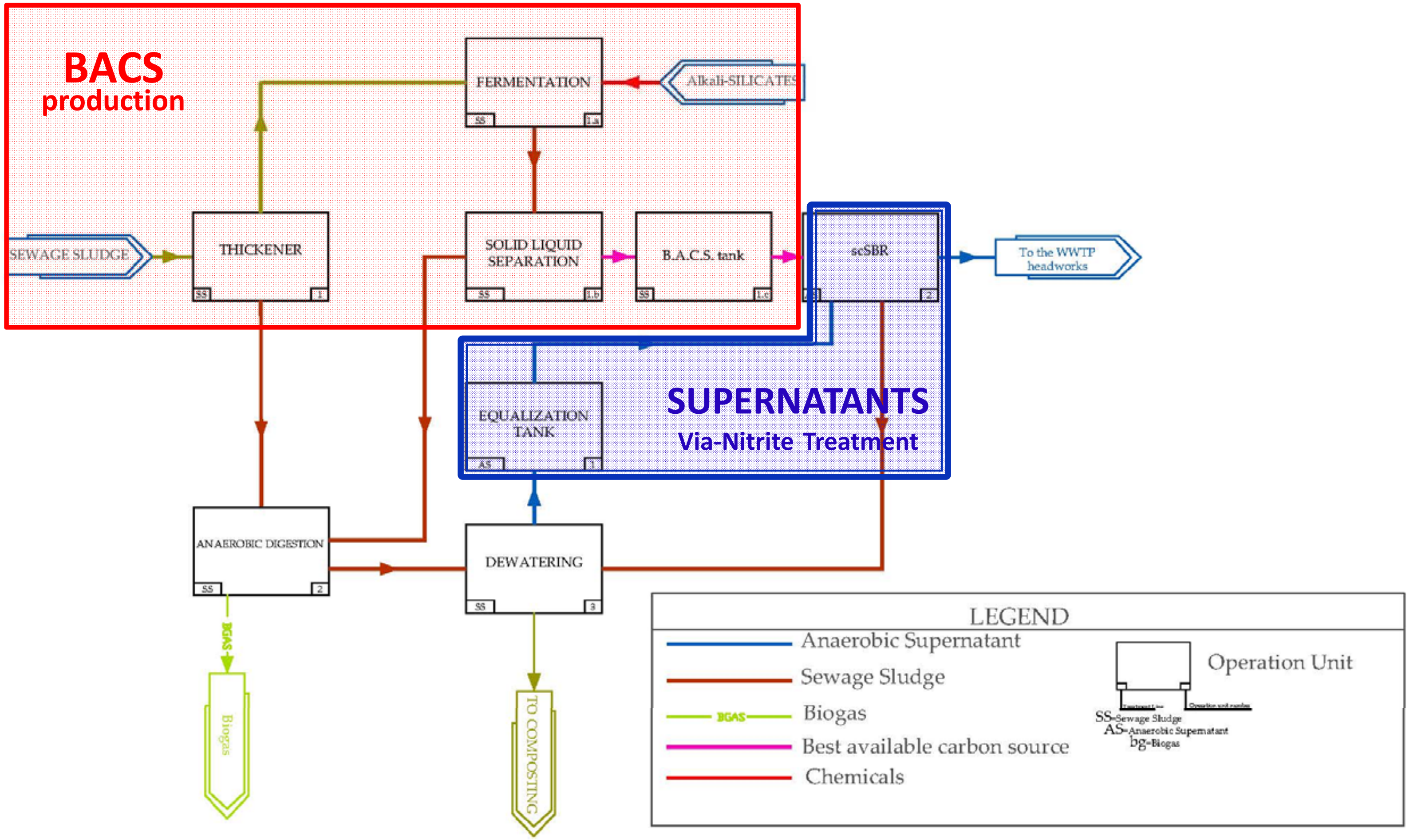
✓ **NO external Carbon source using BACS**

✓ **Possible enhanced P bioremoval**

The application of the process in SBR ensures:

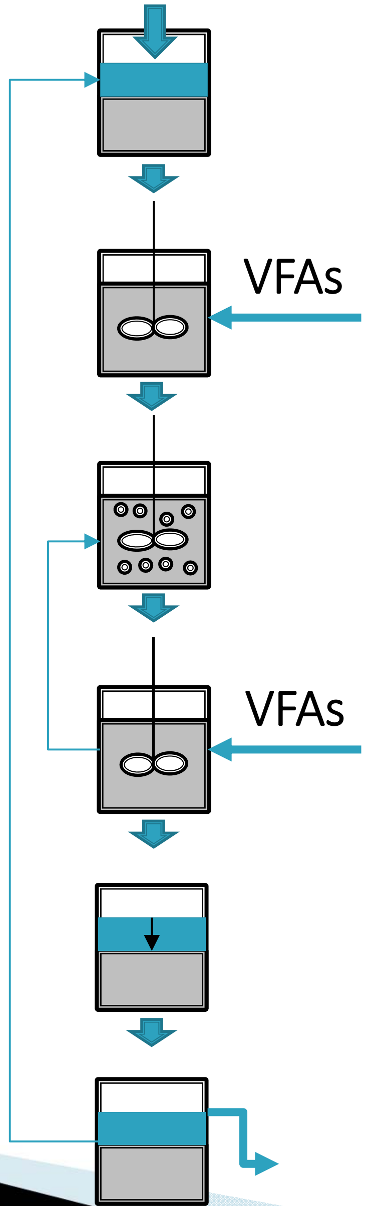
- Higher kinetics
- Less working volume
- Higher flexibility

THE S.C.E.N.A. FLOW CHART



S.C.E.N.A. SBR CYCLE

Nitrogen & Phosphorus Biological removal



1- Filling (10-15 min)

2- Anaerobic (60 min)

BACS Carbon source addition

3- Aerobic (180 - 300 min)

4- Anoxic (50-60 min)

BACS Carbon source addition

5- Settling (30-40 min)

6- Discharge (10-15 min)

scSBR VIA-NITRITE OPTIMIZATION LOGIC CONTROL

DATA CYCLE

IDENTIFICATION OF FAULTS

PROFILES SIGNAL PROCESSED

INTELLIGENT CONTROL SYSTEM

- ELECTRICAL CONDUCTIVITY
- DISSOLVED OXYGEN
- pH

% Ntot removal

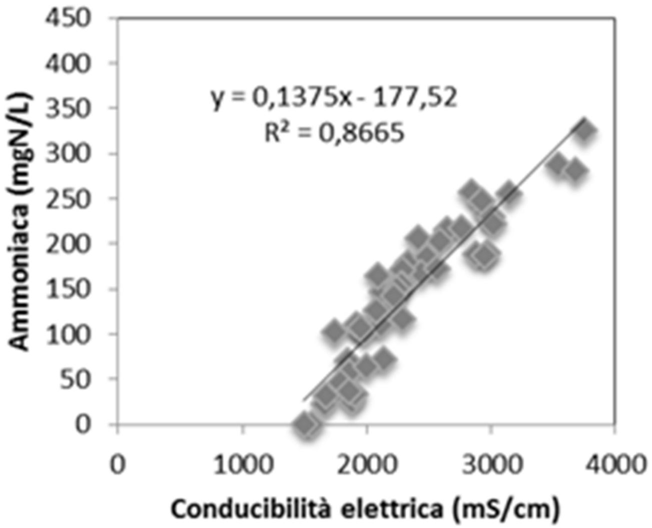
N-N0$_2$ production

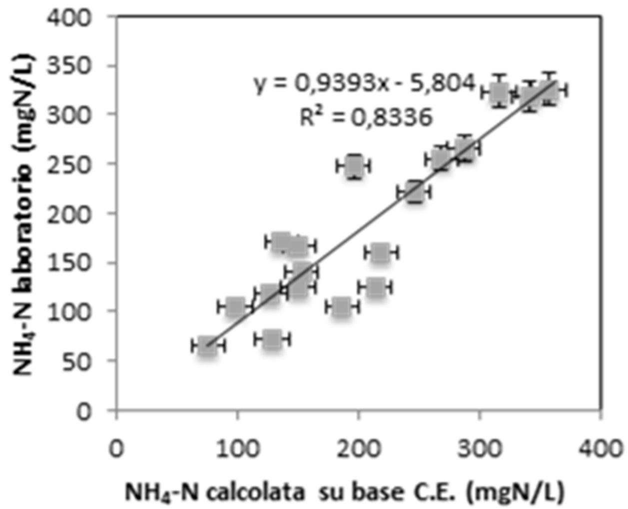
Dosage BACS for N&P biological removal

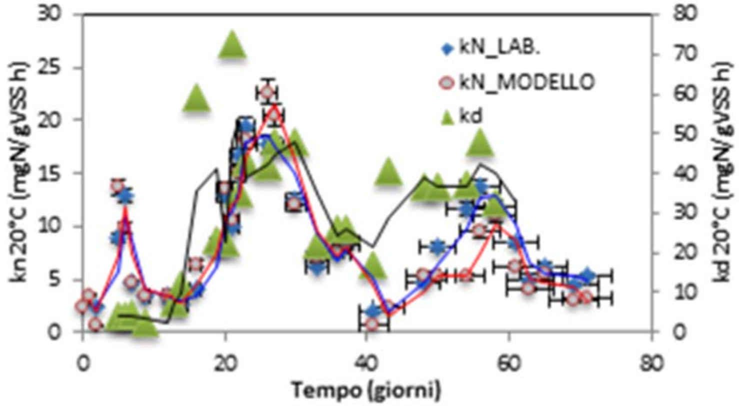
RESULTS: CONTROL POINTS OF IDENTIFICATION

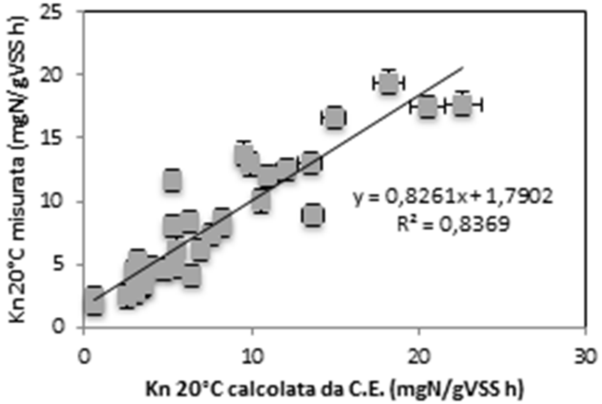
MOVE TO THE NEXT STEP

scSBR VIA-NITRITE CONDUCTIVITY CONTROL

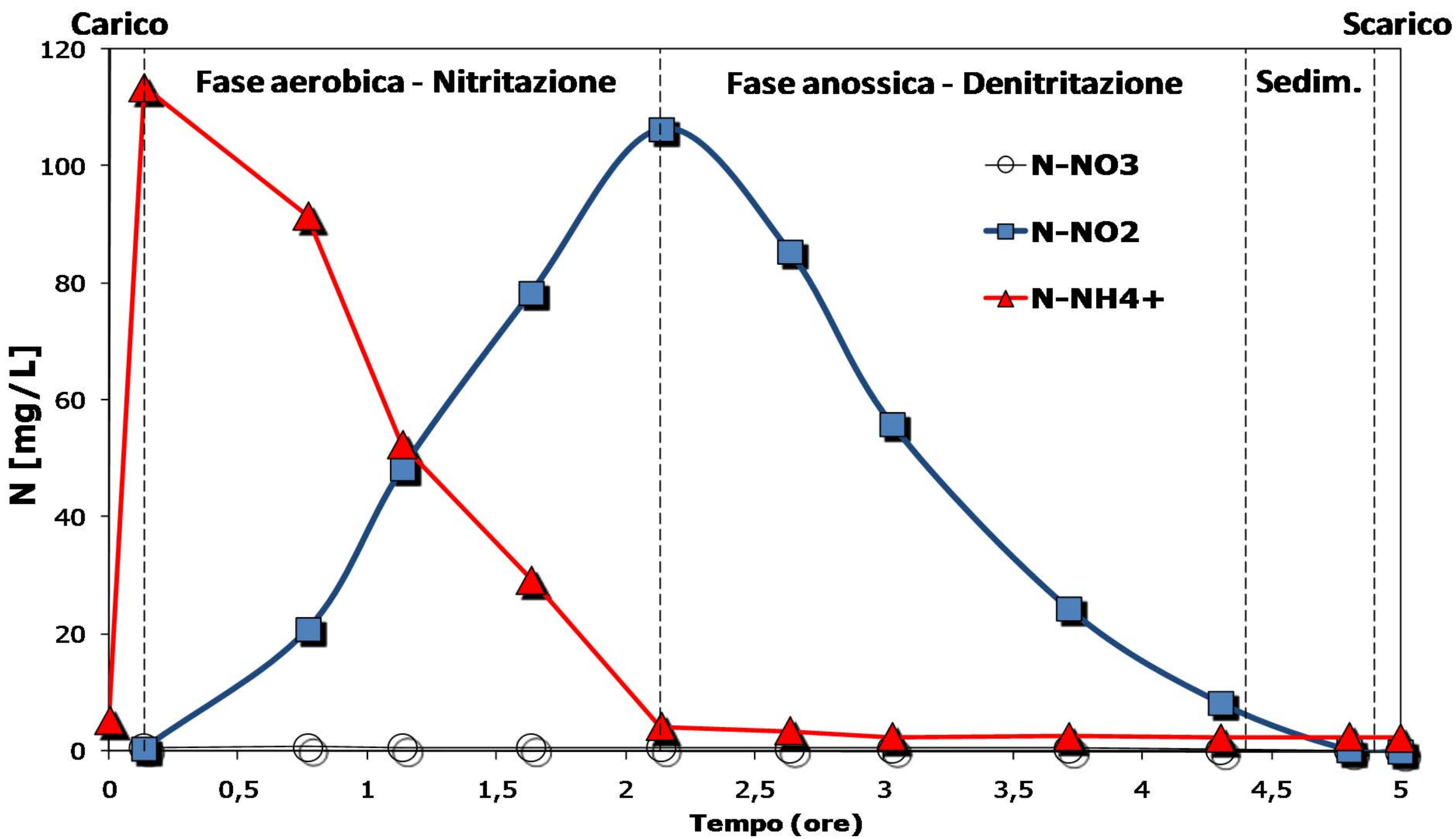








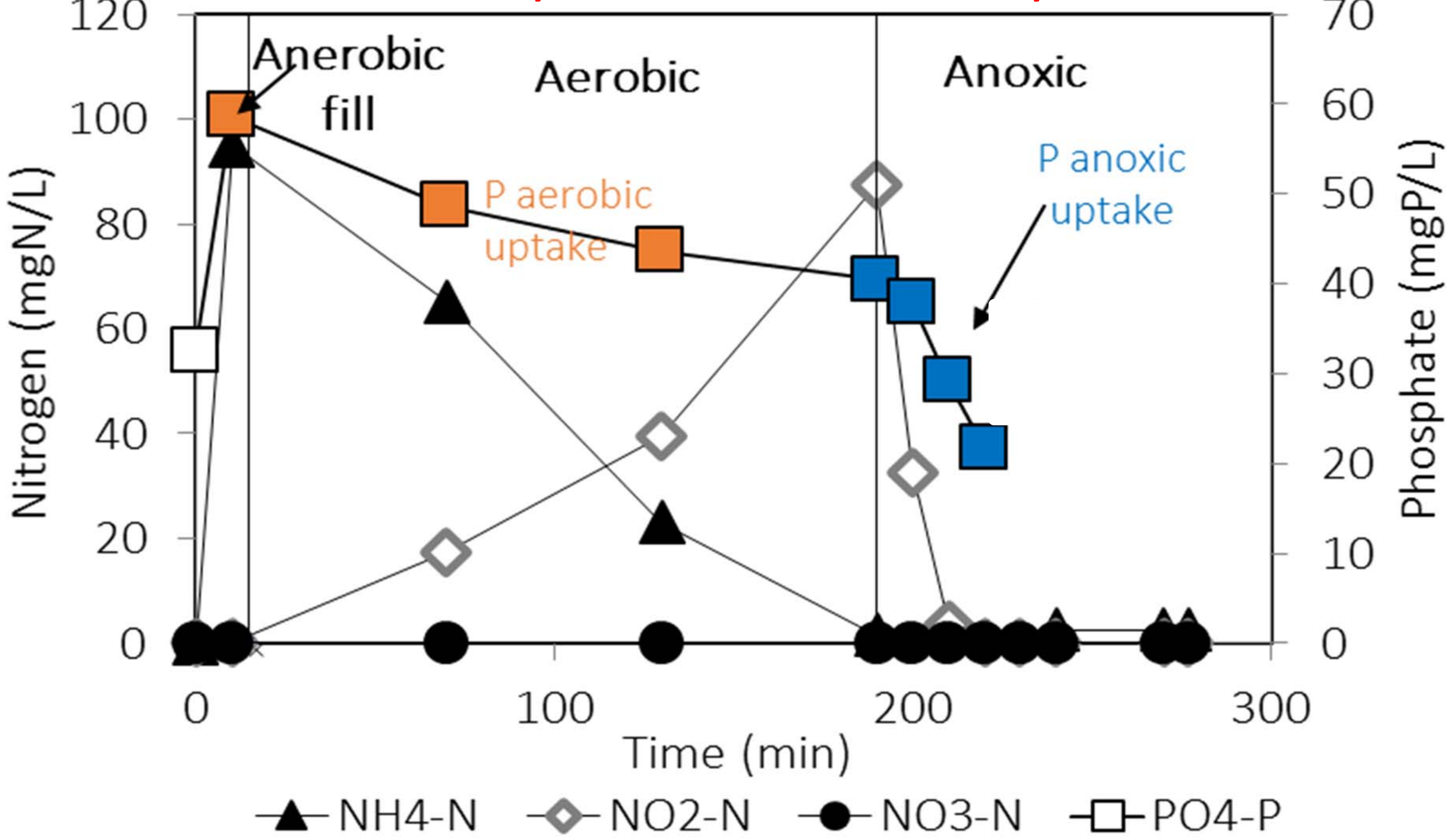
S.C.E.N.A. NITROGEN REMOVAL CYCLE



S.C.E.N.A. NITROGEN & PHOSPHORUS REMOVAL CYCLE

3 mgP/gMLVSS*h
Aerobic Uptake

15 mgP/gMLVSS*h
Anoxic Uptake



BACS: A MIXTURE OF SCFAs FOR DENITRATION&EPBR

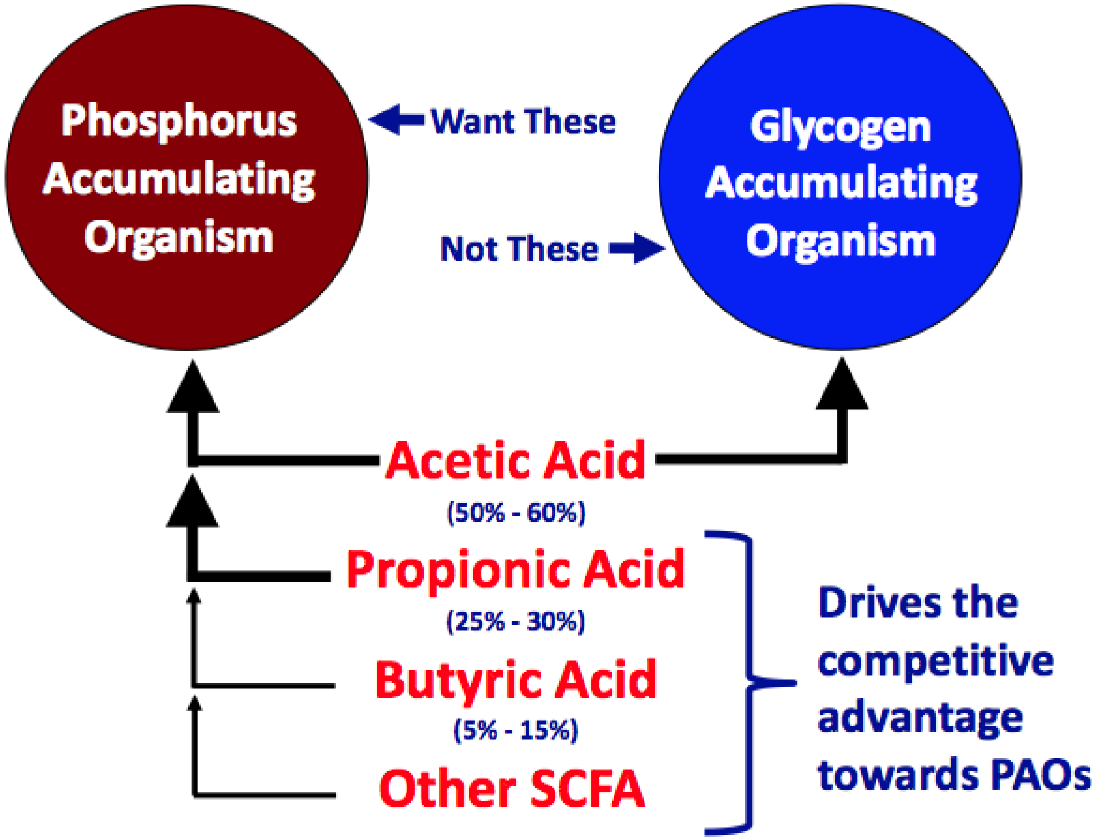
PHOSPHOROUS REMOVAL

CH_3COOH

CH_3CH_2COOH

$CH_3CH_2CH_2COOH$

$CH_3CH_2CH_2...COOH$



Fermentation promotes production of acetate and propionate as primary by-products

Zeng, et al (2006)
Bouzas, et al (2000)

THE S.C.E.N.A. DEMO PILOT

0,5 m³ for mixed sludge (primary and secondary)

3 m³ SBR reactor to treat supernatant using via-nitrite process

UF membrane filtration skid

START-UP
NOVEMBER 2013

W2O20

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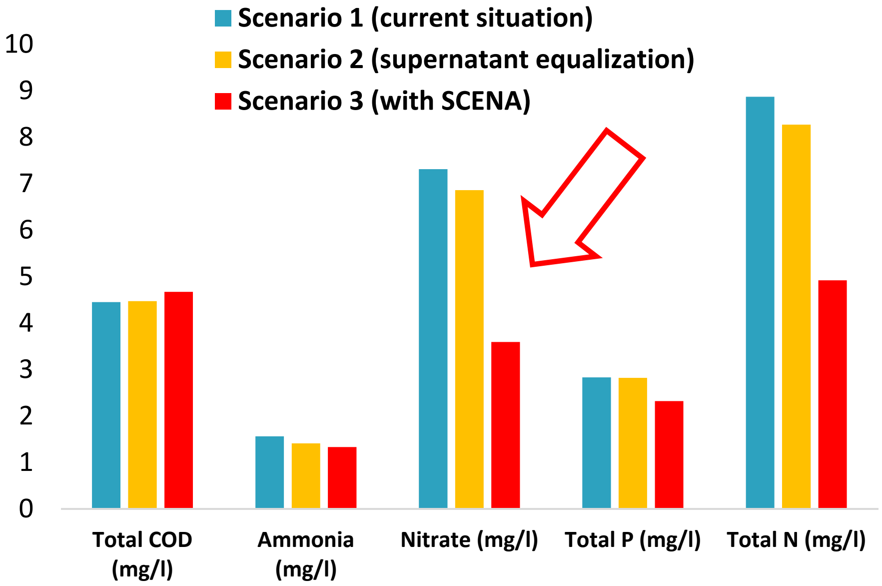
UNIVERSITÀ DEGLI STUDI DI VERONA

USC UNIVERSIDADE DE SANTIAGO DE COMPOSTELA

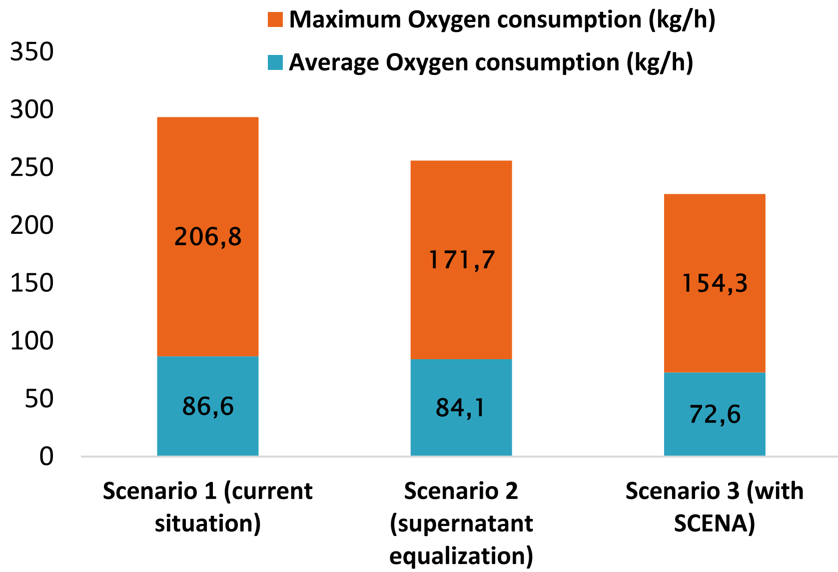
AFTER DEMO-PILOT RESULTS :
COULD BE GOOD TO DEVELOP ON FULL SCALE?

IMPACT ON SECONDARY EFFLUENT



ABOUT **-16 % OF AVERAGE OXYGEN CONSUMPTION** IN THE MAIN BIOLOGICAL REACTOR
AND
– 25% OF THE MAXIMUM OXYGEN CONSUMPTION

IMPACT ON AERATION



ABOUT **-50% OF TN**
AND
– 20% OF TP
IN DISCHARGE OF MAIN LINE

ALTO TREVIGIANO SERVIZI

FROM DEMO TO FULL SCALE… TECHNOLOGICAL CHANGES

WHICH S/L SEPARATOR COULD BE BETTER?
About

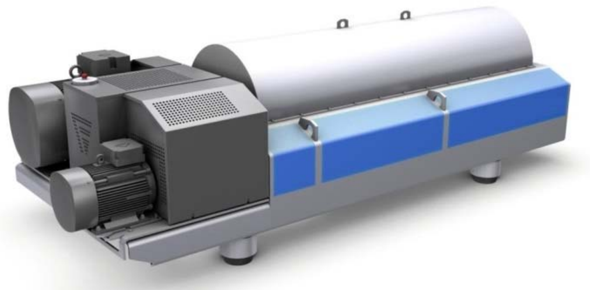
- Energy demand
- Maintenance costs
- Easy O&M

15 - 20 kWh/mc

ULTRAFILTRATION MEMBRANE

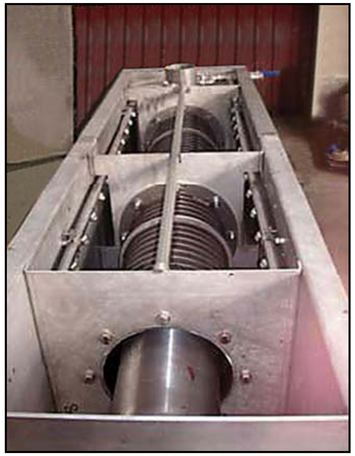
1,5 – 2,0 kWh/mc

CENTRIFUGAL SLUDGE EXTRACTOR

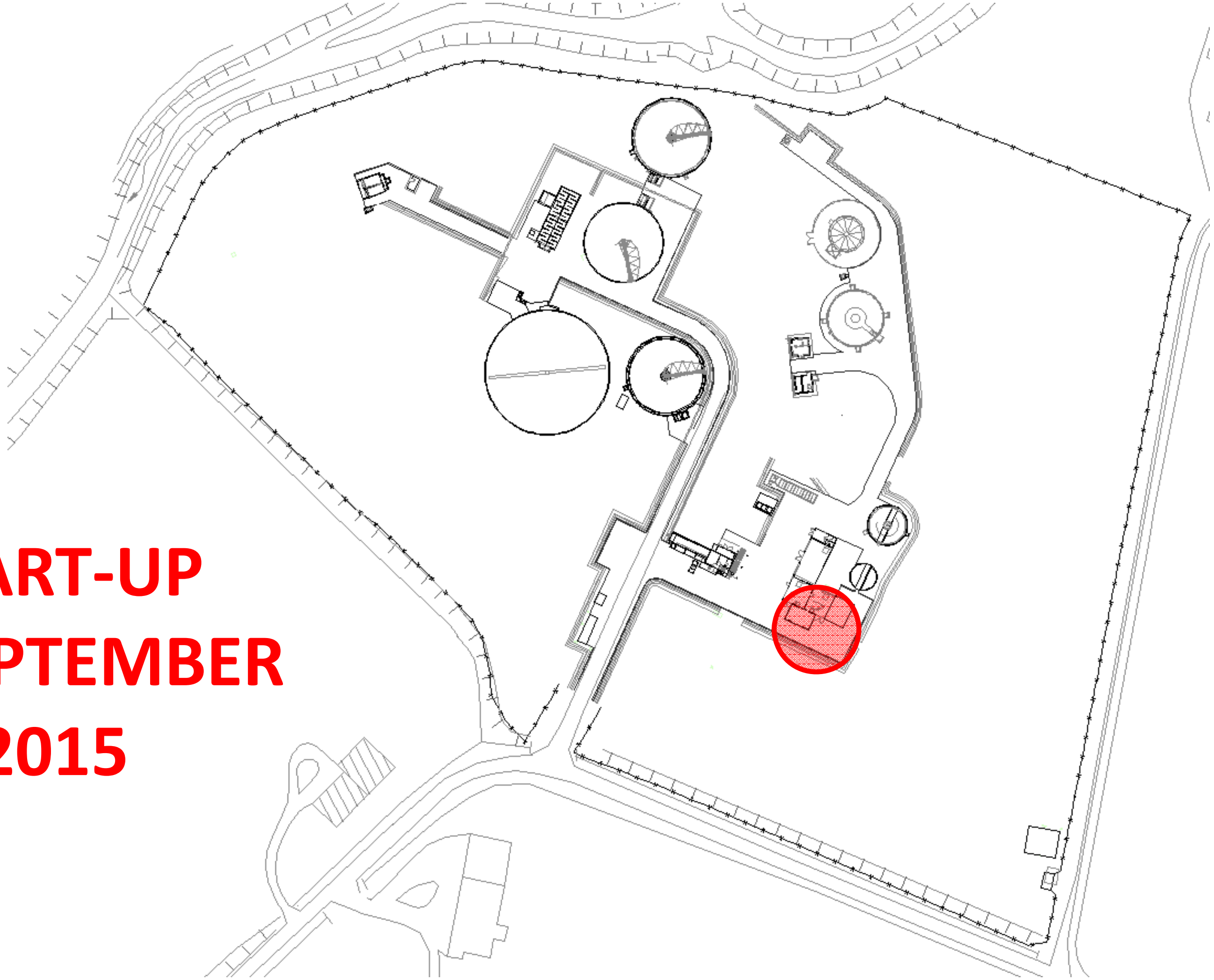


0,12 - 0,20 kWh/mc

SCREW - PRESS



S.C.E.N.A. FULL SCALE

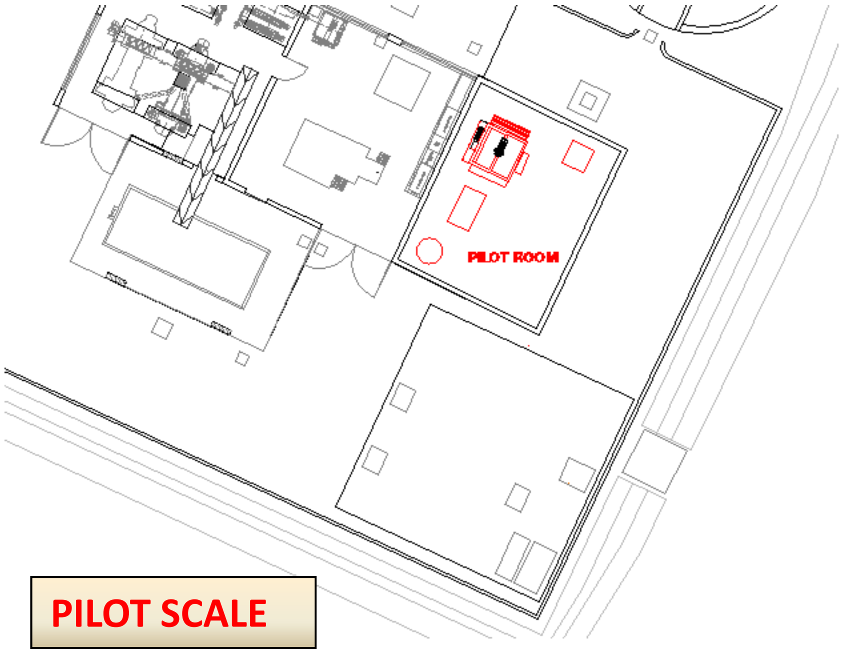


START-UP
21 SEPTEMBER
2015

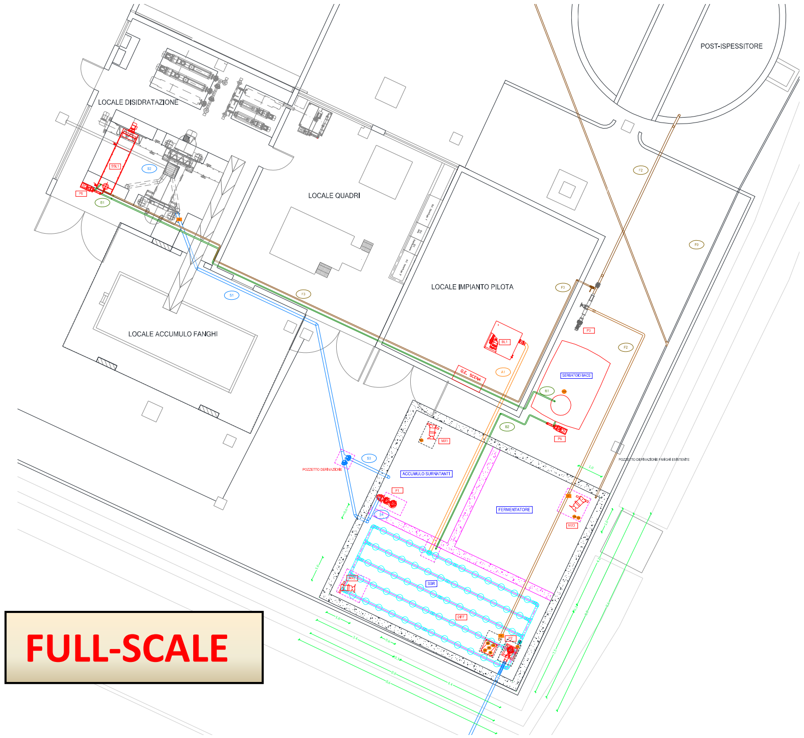
ALTO TREVIGIANO SERVIZI

UNIVERSIDADE DE SANTIAGO DE COMPOSTELA

S.C.E.N.A. FULL SCALE



PILOT SCALE



FULL-SCALE

	VOLUME	TANK
STORAGE/EQUALIZATION SUPERNATANT	40 m^3	Ex Storage of Liquid Waste
scSBR BIOLOGICAL PROCESS	70 m^3	Ex Storage of Liquid Waste
FERMENTATOR FOR BACS PRODUCTION	50 m^3	Ex Storage of Liquid Waste
BACS STORAGE	10 m^3	External tank

SUPERNATANT TREATING ON S.C.E.N.A. FULL - SCALE	
mc/d	65
kgN / d	35 - 50
Kg P / d	3 - 5

W2O20

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FULL SCALE - COLLABORATING PRIVATE COMPANIES

INNOVEN
INNOVATION FOR THE ENVIRONMENT

xylem
Let's Solve Water

SCAE
MACCHINE E TECNOLOGIE PER L'AMBIENTE

TWINCAD
WWW.TWINCAD.EU

HACH
Be Right™

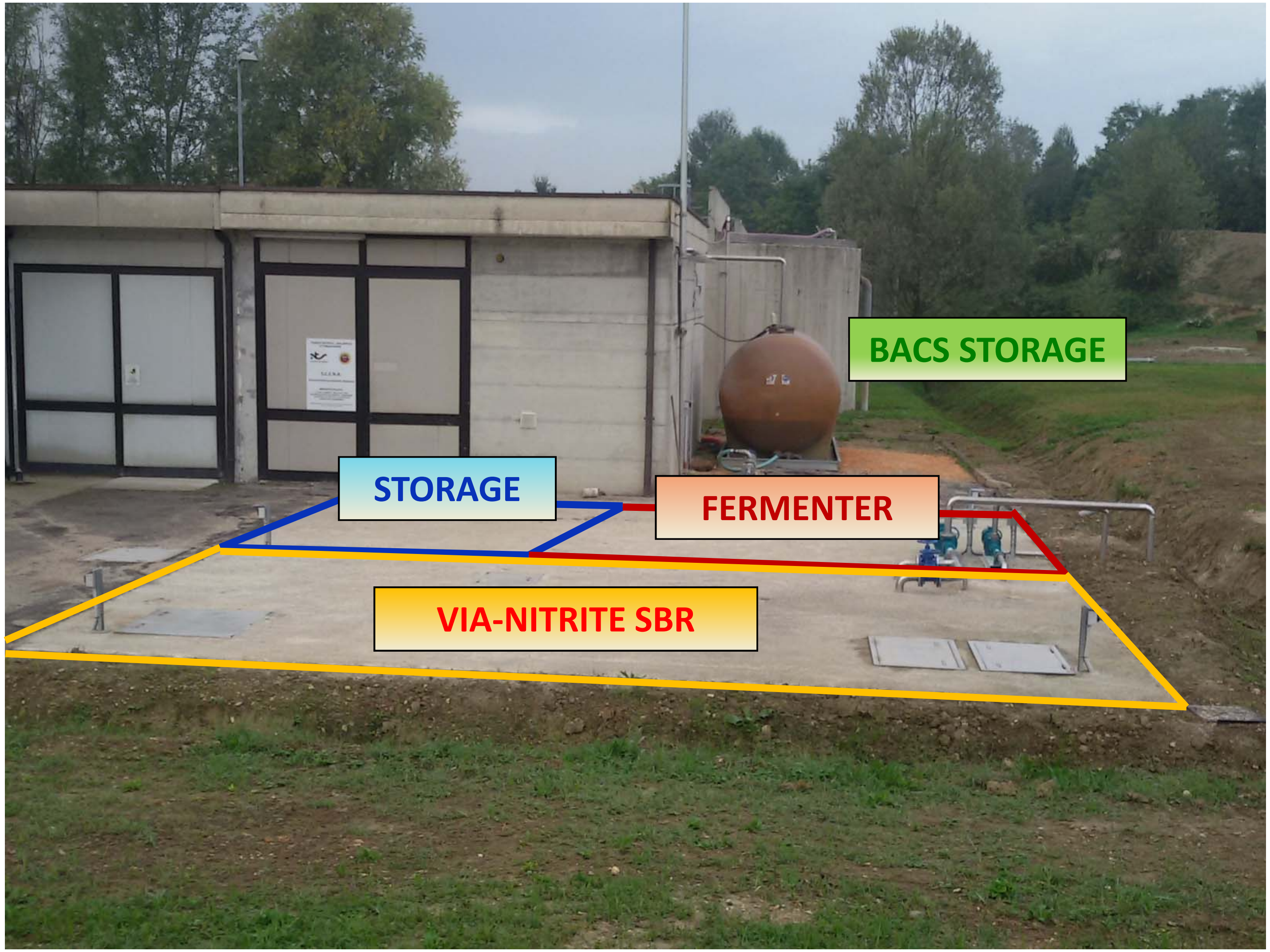
SIEMENS

ROBUSCHI®
PUMPS·BLOWERS & COMPRESSORS

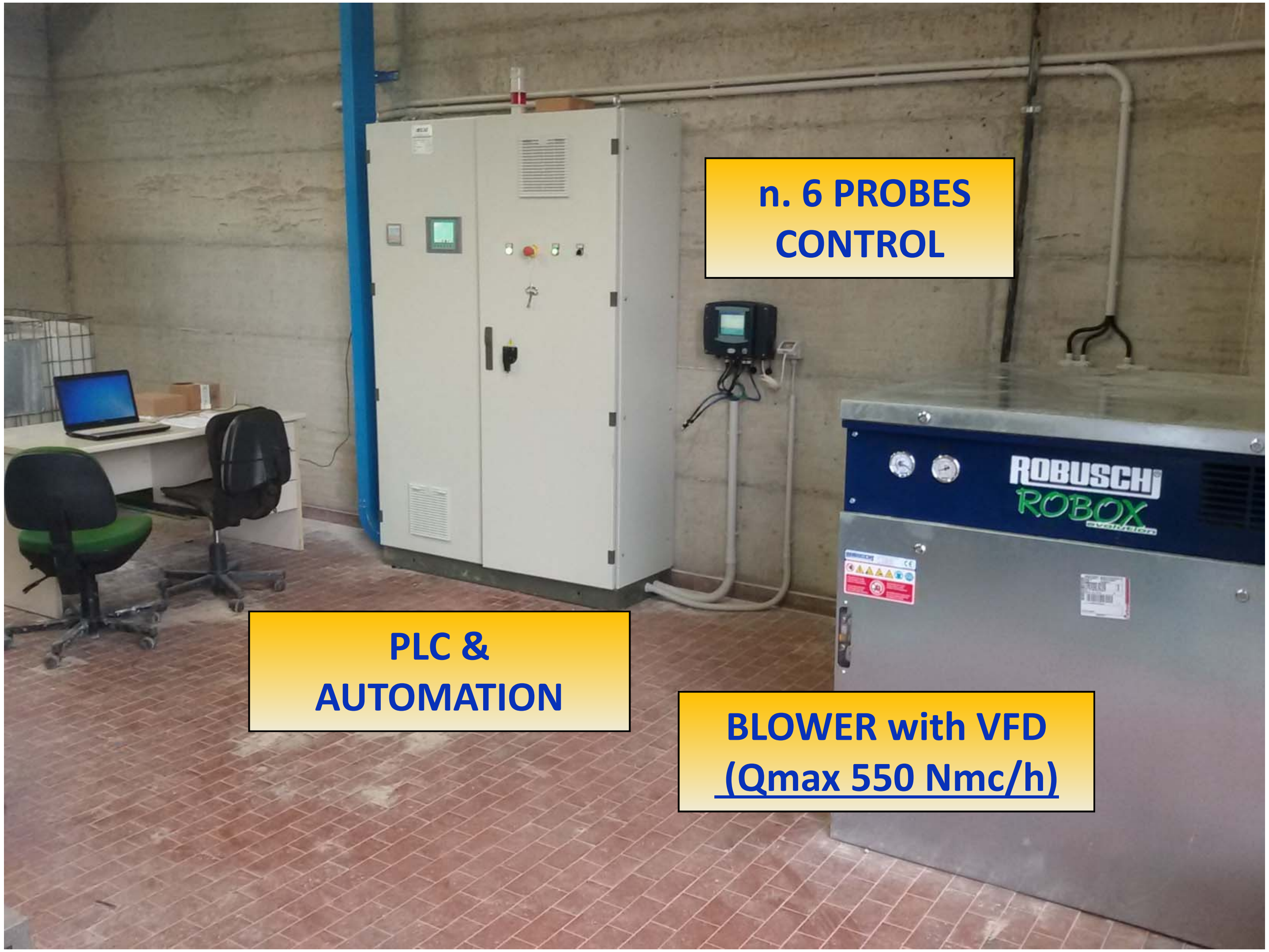
invent®
umwelt und verfahrenstechnik

amotec
Home, Building & Industrial Automation

S.C.E.N.A. FULL SCALE

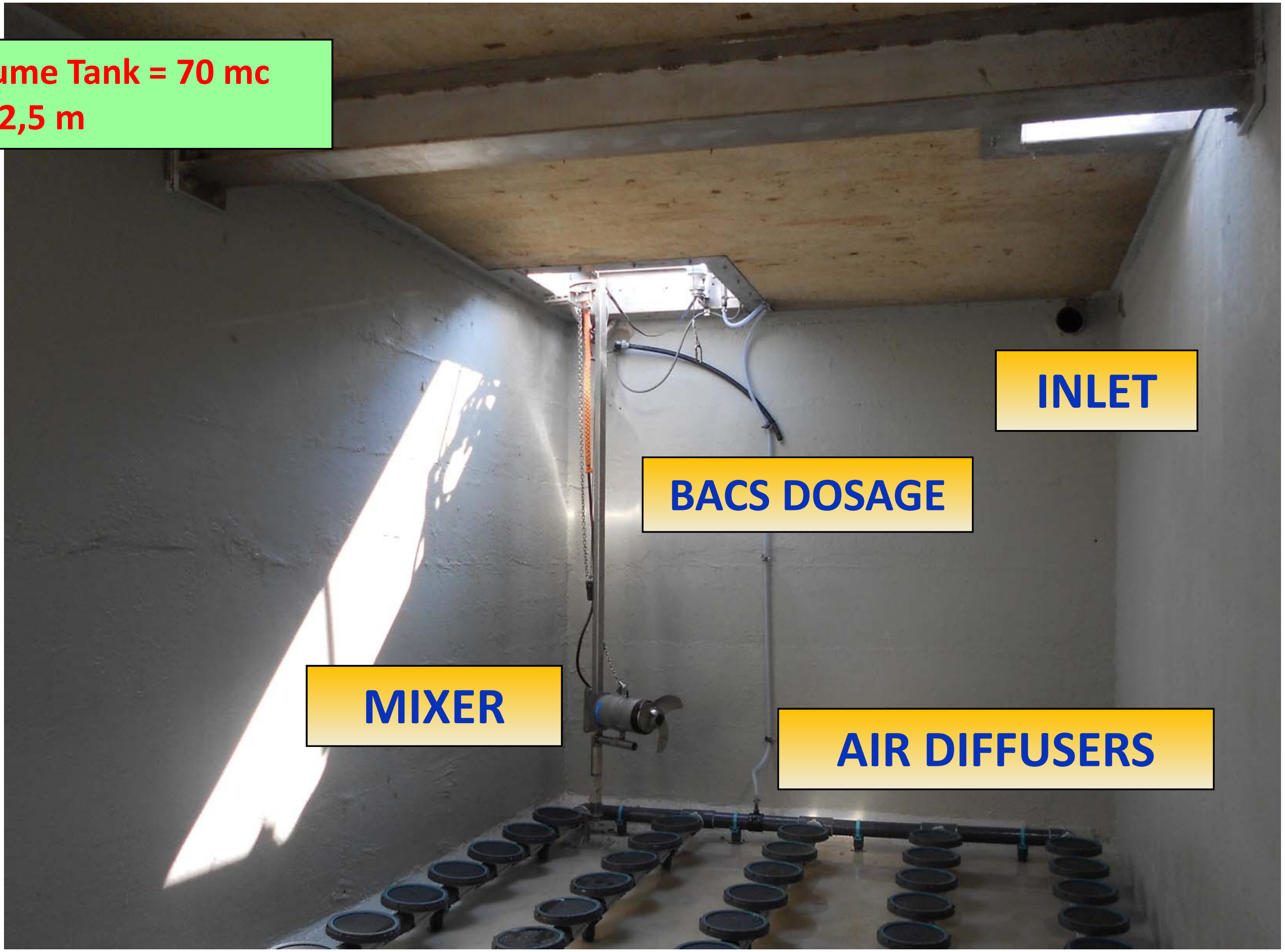


S.C.E.N.A. FULL SCALE

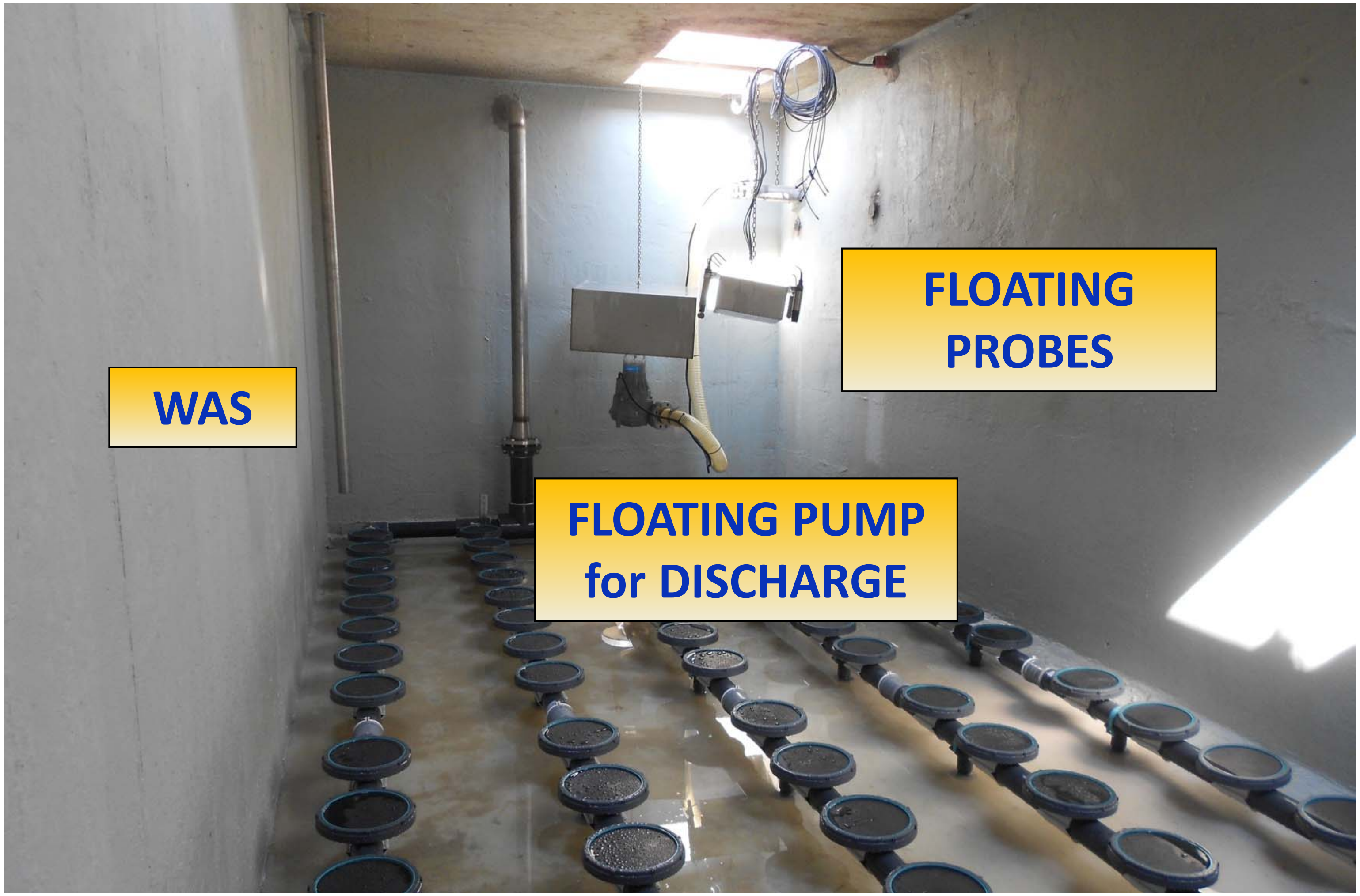


FULL SCALE - VIA NITRITE SBR

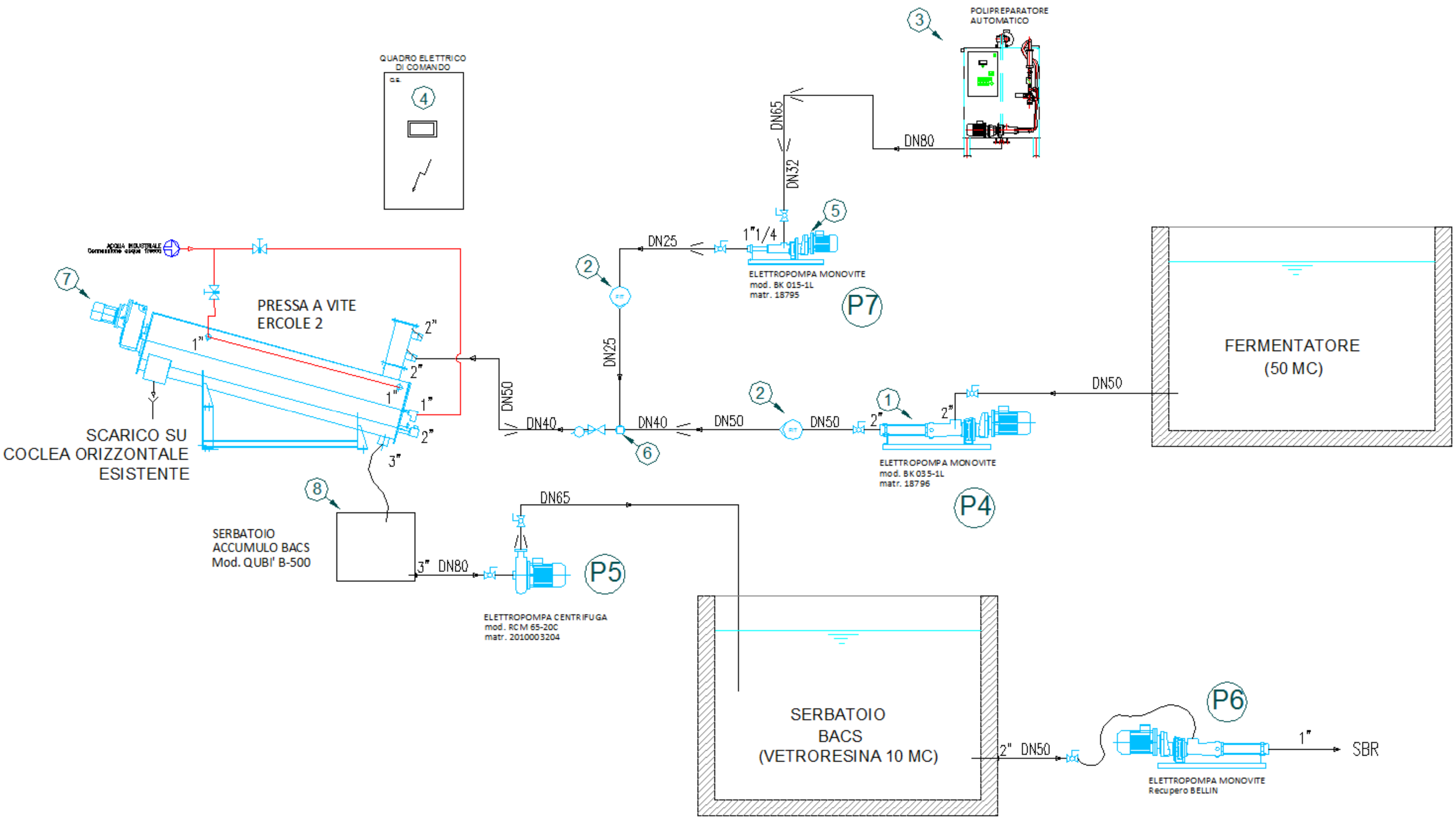
Volume Tank = 70 mc
H = 2,5 m



FULL SCALE - VIA NITRITE SBR

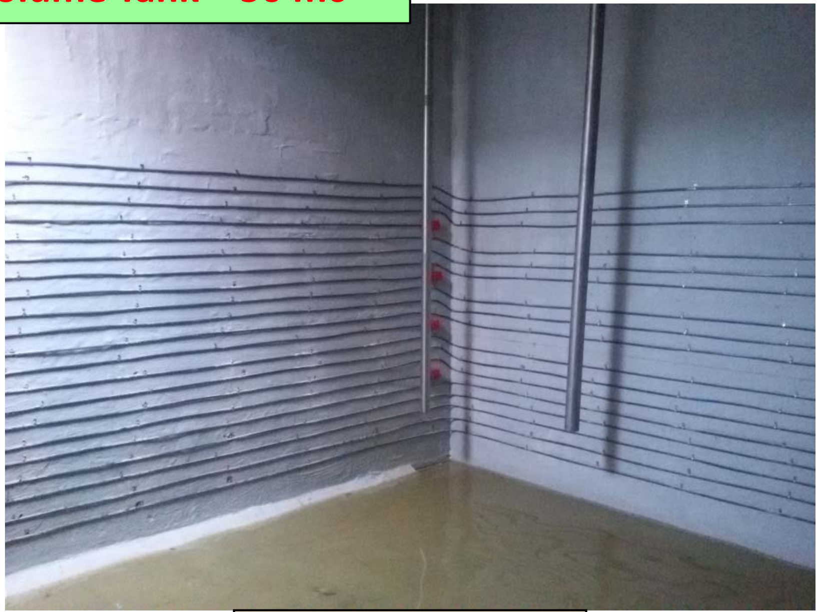


FULL SCALE - BACS PRODUCTION LINE



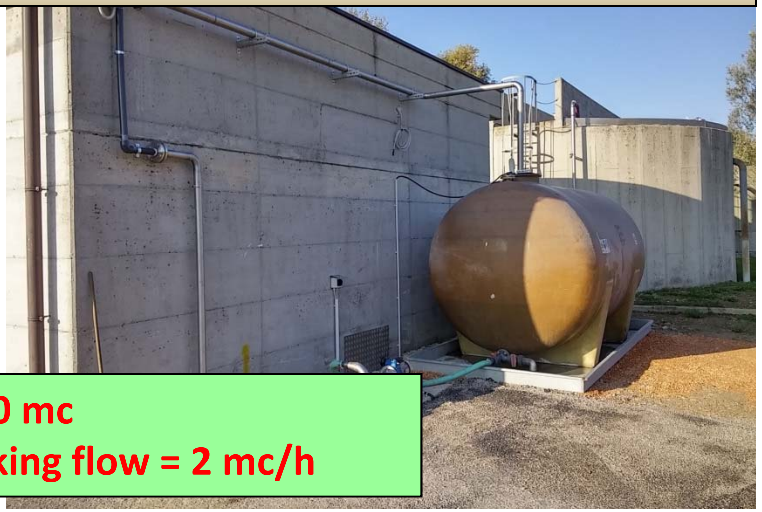
FULL SCALE - BACS PRODUCTION LINE - SEPARATION S/L

Volume Tank = 50 mc



FERMENTER

S/L SEPARATOR OF FERMENTED SLUDGE



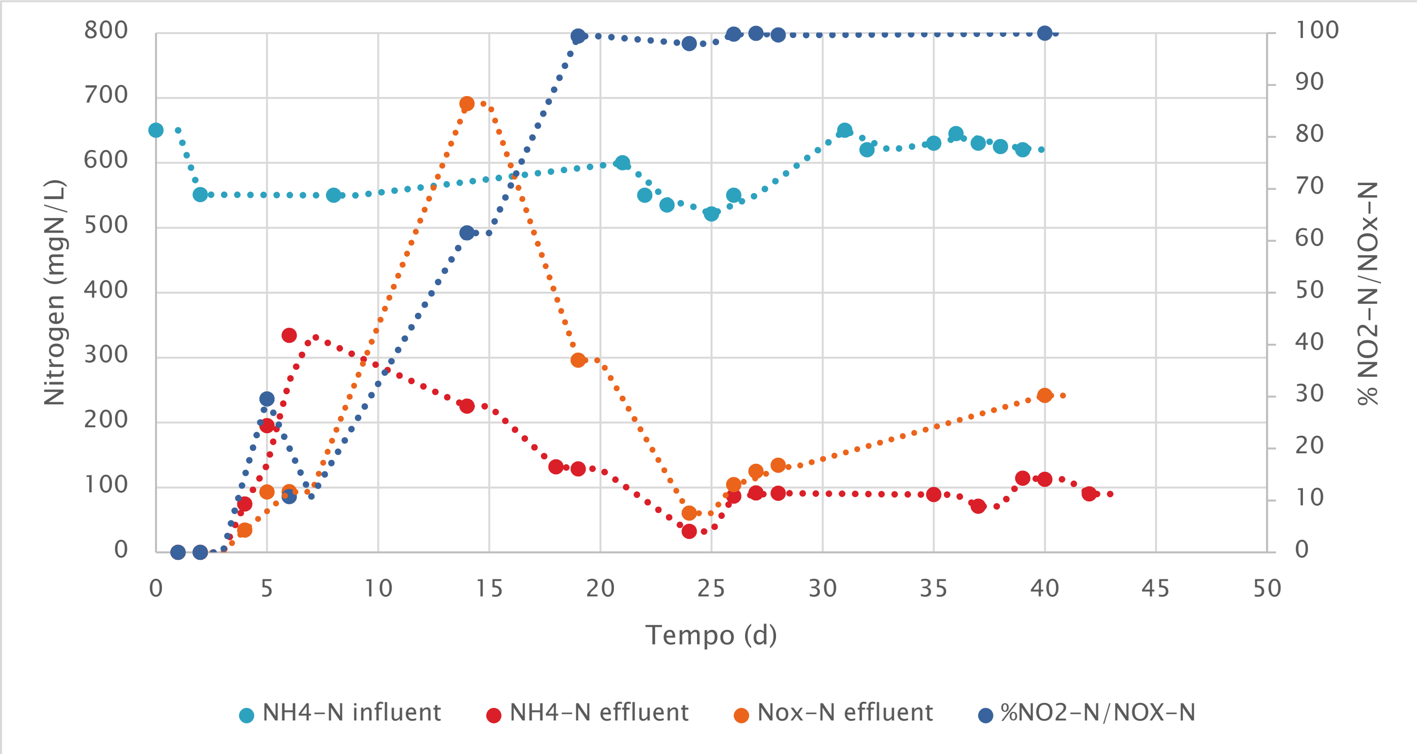
Volume Tank = 10 mc
Screw Press working flow = 2 mc/h

S.C.E.N.A. FULL SCALE - OPERATION

SETTLEABILITY

BACS
Best Avalaible
Carbon Source

S.C.E.N.A. FULL SCALE – FIRST RESULTS

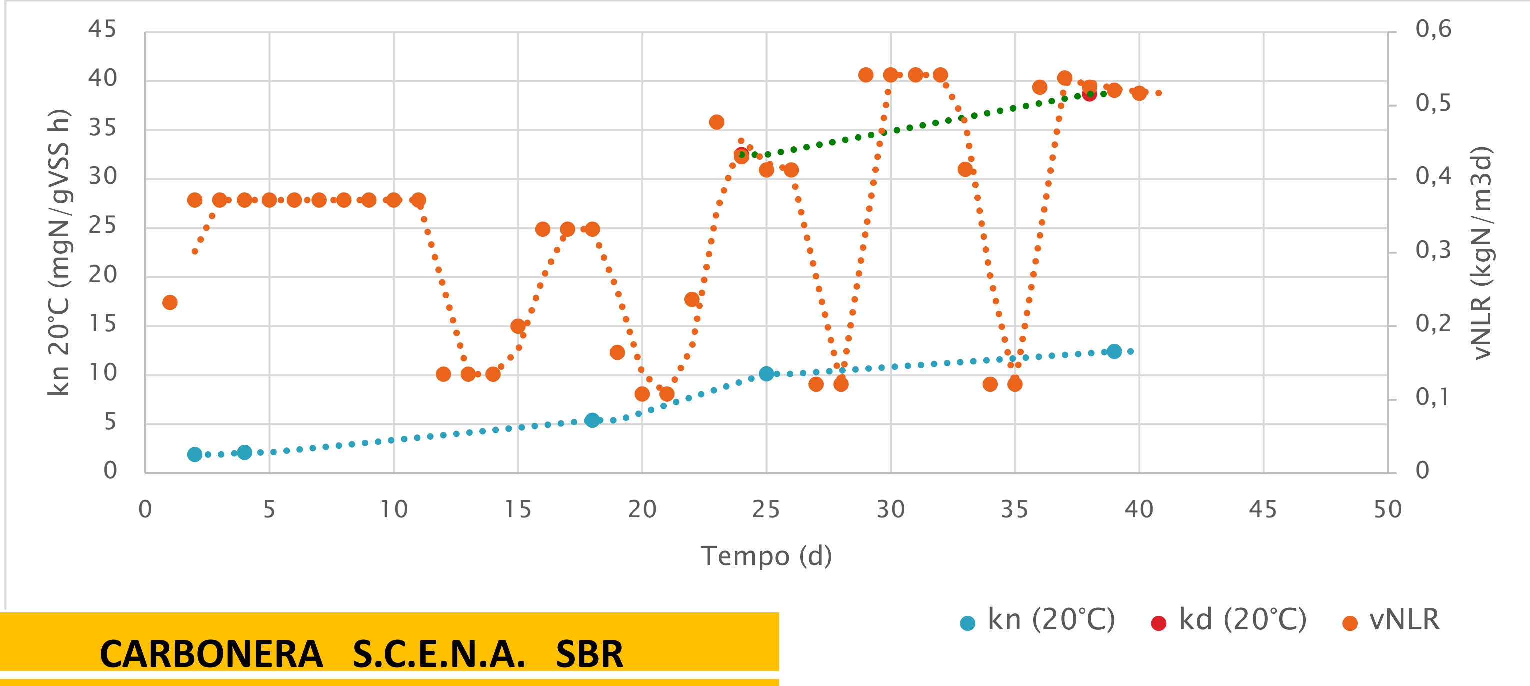


- ✓ **After 10 days → Complete Via-Nitrite pathway (NOB inhibition)**
- ✓ **After 15 days → Start with BACS dosage**
- ✓ **After 18 days → No N-NO_3 in discharge**

Now → we are optimizing BACS quality

S.C.E.N.A. NITROGEN KINETICS

BACS dosage is automatically dosed in the denitritation phase of the scSBR operation to remove nitrite and in the same time phosphorus.



CARBONERA S.C.E.N.A. SBR	
SPECIFIC NUTRIENTS REMOVAL RATES - (T = 20 °C)	
sAUR (mgN/gVSS*h)	12 - 15
$sNUR_{BACS}$ (mgN/gVSS*h)	35 - 40

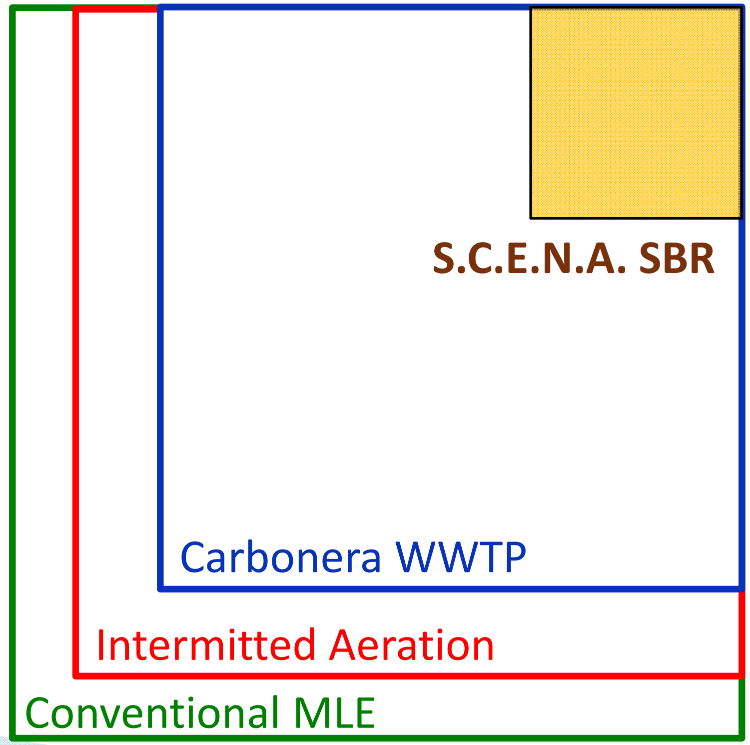
CARBONERA WWTP MAIN LINE	
SPECIFIC NUTRIENTS REMOVAL RATES - (T = 20 °C)	
sAUR (mgN/gVSS*h)	1.5 – 2.5
sNUR (mgN/gVSS*h)	5 - 6

FOOTPRINT : S.C.E.N.A. VS. CONVENTIONALS

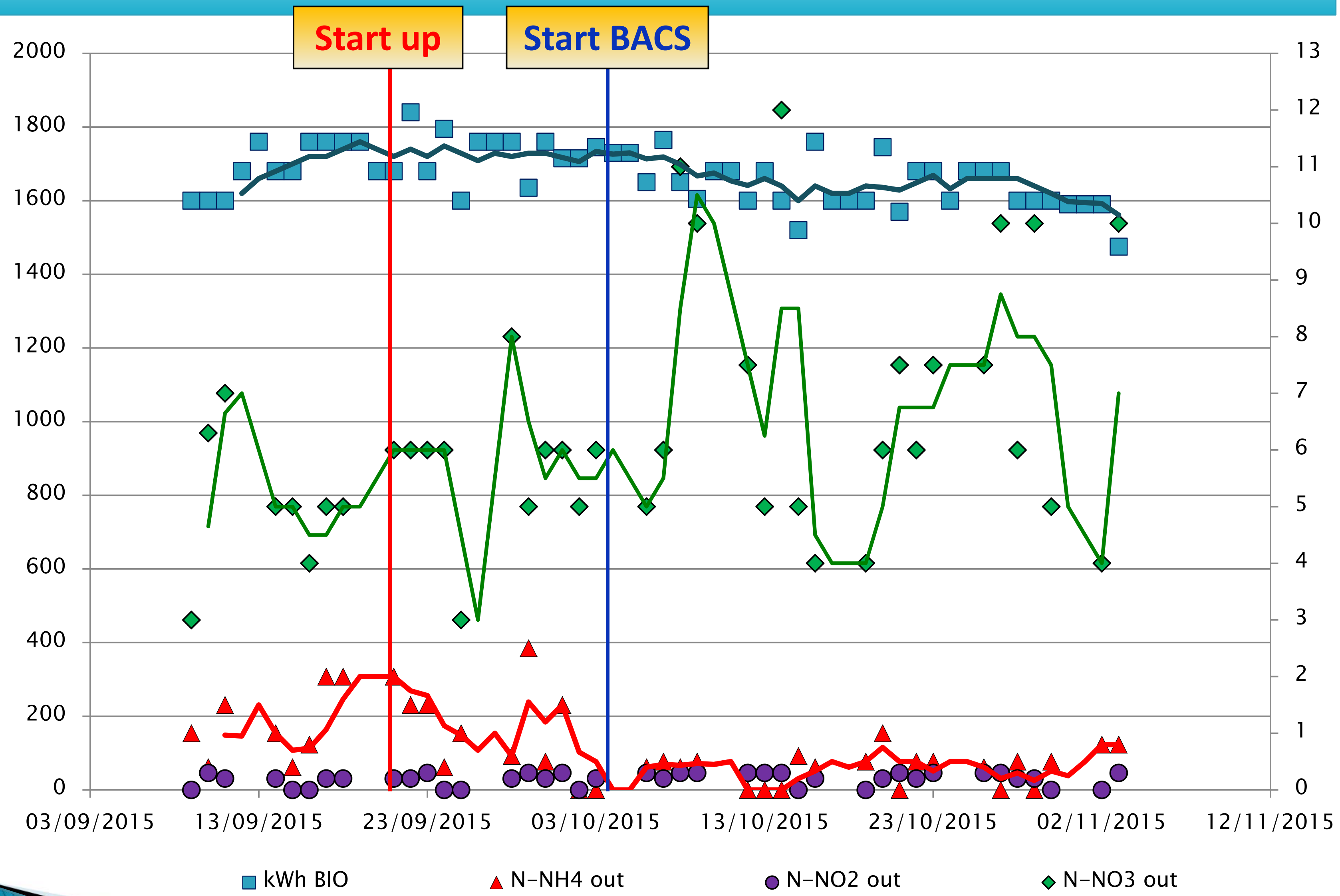
How much VOLUME of Biological Reactor to treat the same Load?

	lt Reactor/P.E.	OTHERS/S.C.E.N.A.	VOLUME (mc)
Conventional MLE	180	12	**840**
Intermitted Aeration	150	10	**700**
Carbonera WWTP Main line	114	7,6	**533**
Carbonera S.C.E.N.A. SBR	15	1	**70**

- ✓ **Less impact on the landscape**
- ✓ **Lower costs of costruction**



CARBONERA WWTP MAIN LINE....FIRST RESULTS



SPECIFIC OPERATIONAL COSTS FOR SUPERNATANT TREATING ON ACTUAL START-UP OPERATION

Load= 35 kgN/d									€/kgN rem ...+ Prem
ENERGY CONSUMPTION						kWh/d	130		0,72
STORAGE SUPERNATANT						kWh/d	9	7%	0,05
Storage mixer	kW	1,5	h/d	6	kwh/d	9		7%	0,05
SBR						kWh/d	56	43%	0,31
Filling pump	kW	1,3	h/d	0,6	kwh/d	0,78		0,6%	0,00
Discharge pump	kW	1,3	h/d	0,6	kwh/d	0,78		0,6%	0,00
Mixer SBR	kW	1,5	h/d	6,3	kwh/d	9,4		7,2%	0,05
Air Blower	kW	3,0	h/d	15,1	kwh/d	45,4		34,8%	0,25
FERMENTER						kWh/d	48	37%	0,26
Fermenter Mixer	kW	2,5	h	6	kwh/d	15		11,5%	0,08
Heating System	kW	5,5	h	24	kwh/d	33		25,3%	0,18
S/L SEPARATOR						kWh/d	17	13%	0,09
Sludge load pump	kW	0,4	h/d	6	kwh/d	2,4		1,8%	0,01
Screw Press	kW	0,37	h/d	6	kwh/d	2,22		1,7%	0,01
Bacs pump to storage	kW	4	h/d	2	kwh/d	8		6,1%	0,04
Poly pump	kW	0,4	h/d	6	kwh/d	2,4		1,8%	0,01
BACS dosage pump	kW	1,5	h/d	1,3	kwh/d	2		1,5%	0,01
POLYELECTROLYTE DOSAGE						kg/d	8,5		0,4
Dosage solution poly-water	lt/h	270	h/d	6	lt/d	1620			
Dosage poly	% vol	0,5%	kg/l	1,05	kg/d	8,51			
SLUDGE PRODUCTION						tonn/d	0,07		0,17
PERSONELLE									0,21
MAINTENANCE									0,10

Carbonera WWTP
3,4 €/kgN rem
reduction of supernatants OPEX – 53%

1,61 €/kgN rem...+ Prem

Optimizing at 50 kgN/d → 1,1 - 1,3 €/ kgN rem...+ Prem

Investment PBP ≈ 4,5 years

BACS VS EXTERNAL CARBON SOURCE

External Carbon Source (eg. Acetic Acid)

- ✓ Stable N removal in denitrification
- ✓ Instable BIO P removal
- ✓ Higher Carbon Footprint
- ✓ Commercial product
- ✓ Cost 1,58 €/kg N rem

Best Avalaible Carbon Source BACS

- ✓ Stable N removal in denitrification
- ✓ Stable and linear BIO P removal
- ✓ Lower Carbon Footprint
- ✓ Homemade Product
- ✓ Cost 0,92 €/kg N rem…+ P rem

How should we imagine/design the 2020 WWTPs?

Systems for PRIMARY SETTLEMENT + FERMENTER + S/L SEPARATOR
→ BACS...in each plant....
to enhance Nitrogen & Phosphour BIO removal
more BIOREMOVAL, less CHEMICAL ADDITION

S.C.E.N.A. PAPERS

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journal homepage: www.elsevier.com/locate/biortech

Recovery of volatile fatty acids from fermentation of sewage sludge in municipal wastewater treatment plants

S. Longo [a], E. Katsou [a], S. Malamis [a,*], N. Frison [b], D. Renzi [c], F. Fatone [a]

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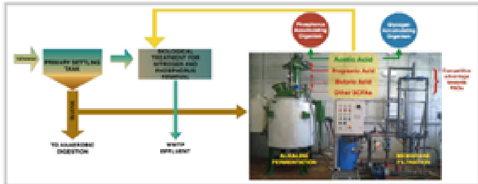
[b] Department of Environmental Sciences, Informatics and Statistics, University Ca' Foscari of Venice, Dorsoduro 2137, 30121 Venice, Italy
[c] Alto Trevigiano Servizi srl, Via Schiavonesca Priula 86, 31044 Montebelluna, Italy

HIGHLIGHTS

- Wollastonite use during fermentation resulted in low nutrient release in the liquid.
- Higher SCFAs in the liquid phase with the use of caustic soda.
- Wollastonite enhanced the sludge dewatering characteristics and filterability.
- Fermentation liquid improved nutrient removal rates compared to acetic acid.

GRAPHICAL ABSTRACT



Chapter 16

Short-cut enhanced nutrient removal from anaerobic supernatants: Pilot scale results and full scale development of the S.C.E.N.A. process

Daniele Renzi[1], Stefano Longo[2], Nicola Frison[2], Simos Malamis[2], Evina Katsou[2] and Francesco Fatone[2,]*

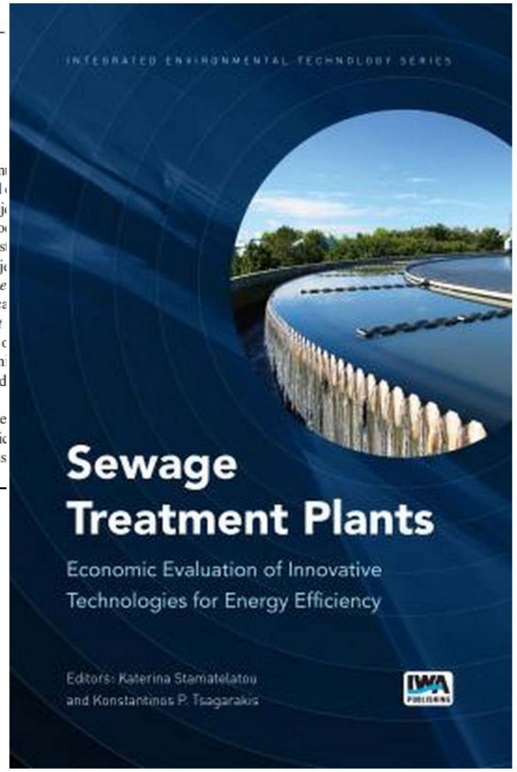
[1]*Alto Trevigiano Servizi srl, Via Schiavonesca Priula, Montebelluna – Treviso (Italy)*

[2]*Department of Biotechnology, University of Verona, Via Le Grazie 15, Verona – Italy*

**francesco.fatone@univr.it –*

16.1 INTRODUCTION

Enhanced nutrient removal in m
be partly and efficiently carried
reject water (other terms for rej
or 'sludge digester liquid') pro
sludge in order to meet more s
the nitrogen flow from the rej
(Cervantes, 2009; Gustavsson e
concentration in reject water ca
2006; Pitman, 1999; Ivanov et
when anaerobic co-digestion
(Malamis *et al.* 2014; Battiston
the activated sludge process and
stream of municipal WWTPs.
In addition, innovative sche
WWTPs consider the anaerobic
from sewage sludge. As a cons



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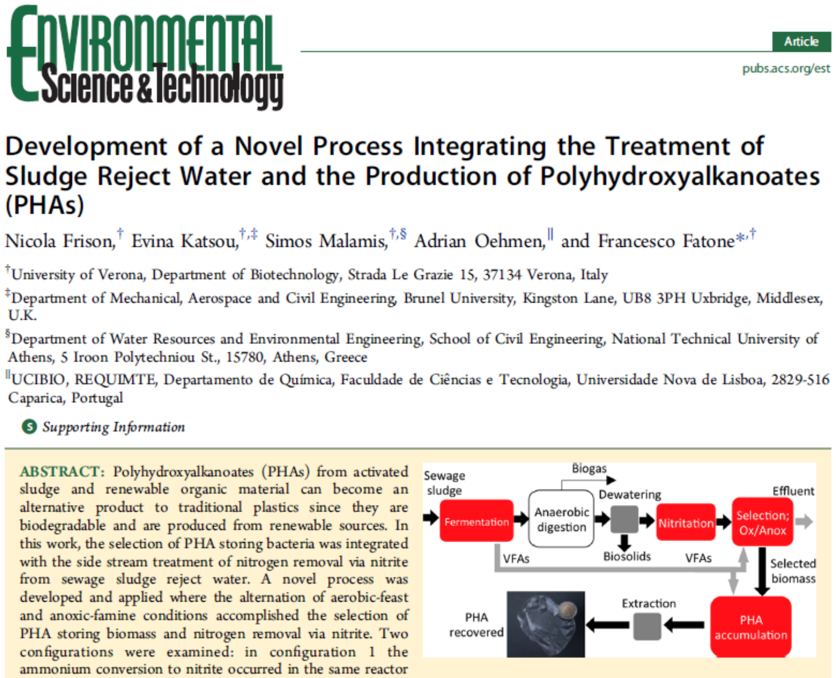
USC UNIVERSIDADE DE SANTIAGO DE COMPOSTELA

FUTURE PERSPECTIVES ...NOT SO FAR...2016 !


Environmental Science & Technology

Article

pubs.acs.org/est

Development of a Novel Process Integrating the Treatment of Sludge Reject Water and the Production of Polyhydroxyalkanoates (PHAs)

Nicola Frison,[†] Evina Katsou,[†,‡] Simos Malamis,[†,§] Adrian Oehmen,[∥] and Francesco Fatone*[,†]

[†]University of Verona, Department of Biotechnology, Strada Le Grazie 15, 37134 Verona, Italy

[‡]Department of Mechanical, Aerospace and Civil Engineering, Brunel University, Kingston Lane, UB8 3PH Uxbridge, Middlesex, U.K.

[§]Department of Water Resources and Environmental Engineering, School of Civil Engineering, National Technical University of Athens, 5 Iroon Polytechniou St., 15780, Athens, Greece

[∥]UCIBIO, REQUIMTE, Departamento de Química, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, 2829-516 Caparica, Portugal

Supporting Information

ABSTRACT: Polyhydroxyalkanoates (PHAs) from activated sludge and renewable organic material can become an alternative product to traditional plastics since they are biodegradable and are produced from renewable sources. In this work, the selection of PHA storing bacteria was integrated with the side stream treatment of nitrogen removal via nitrite from sewage sludge reject water. A novel process was developed and applied where the alternation of aerobic-feast and anoxic-famine conditions accomplished the selection of PHA storing biomass and nitrogen removal via nitrite. Two configurations were examined: in configuration 1 the ammonium conversion to nitrite occurred in the same reactor

EXTRACTION OF **PHA BIOPOLYMERS** FROM WWTPS SLUDGE FOR THE PRODUCTION OF BIOPLASTICS

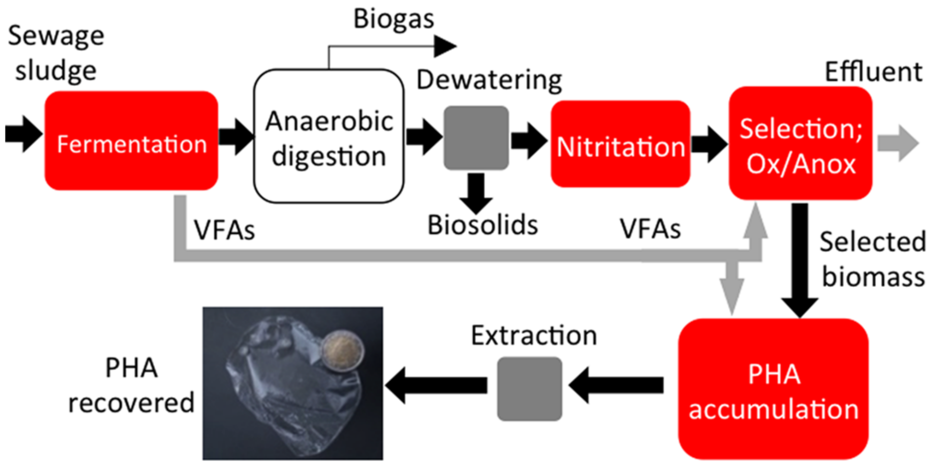


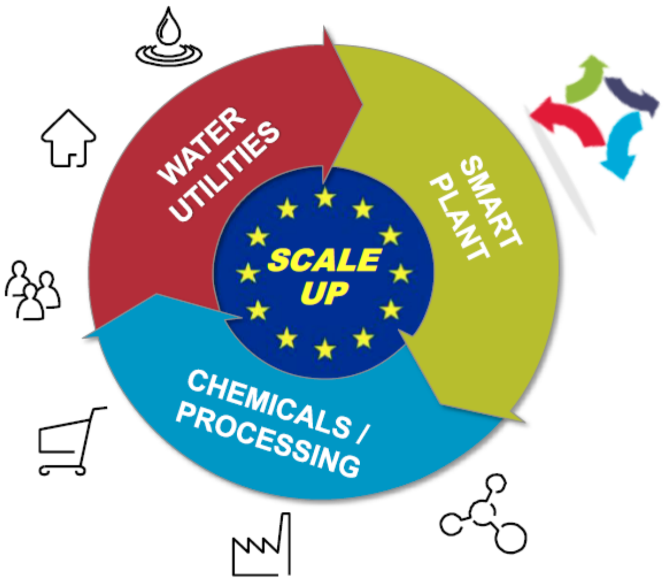
IMAGE OF THE FIRST BIOPOLYMER PRODUCT AT UNIVERSITY OF VERONA LABORATORY FROM **CARBONERA WWTP'S SLUDGE (SPRING 2014)**

PROPOSAL FOR EUROPEAN FUNDING
HORIZON 2020 WATER 1B-2015

Horizon 2020
European Union Funding
for Research & Innovation

European Commission

SMART-Plant



Title of Proposal:

Scale-up of low-carbon footprint MAterial Recovery Techniques for upgrading existing wastewater treatment Plants (SMART-Plant)

Participant No	Participant organisation name	Acronym	Type	Country
1 (Coordinator)	Università degli Studi di Verona	UNIVR	RES	Italy
2	Università di Roma La Sapienza	UR	RES	Italy
3	Brunel University	UBRUN	RES	UK
4	Cranfield University	CU	RES	UK
5	Universitat Autònoma de Barcelona	UAB	RES	Spain
6	Universitat de Vic	UVIC-UCC	RES	Spain
7	National Technical University of Athens	NTUA	RES	Greece
8	Berlin Centre of Competence for Water	KWB	RES	Germany
9	Biotrend S.A.	BIOTR	SME/TP/SP	Portugal
10	Socamex S.A.	SOC	LI/TP/ENDU	Spain
11	BYK Additives Ltd	BYK	SME/TP	Germany
12	SCAE srl	SCAE	SME/TP	Italy
13	AGROBICS Ltd	AGRB	SME/TP	Israel
14	Salsnes Filter A.S.	SALSNES	LI/TP	Norway
15	Instituto de Biologia Experimental e Tecnológica	IBET	RES/SP	Portugal
16	Athens Water Supply and Sewerage Company	EYDAP	SME/ENDU	Greece
17	Alto Trevigiano Servizi S.r.l.	ATS	SME/ENDU	Italy
18	Mekorot Water Company Ltd	MEKOROT	LI/ENDU	Israel
19	Aiguas de Manresa S.A.	AdM	SME/ENDU	Spain
20	BWA B.V.	BWA	SME/TP	Netherlands
21	Execon-Partners Gmbh	EXC	SME/SP	Switzerland
22	SEVERN TRENT WATER Ltd	STW	SME/ENDU	UK
23	JV Aktor SA and Athina SA	AKTOR	SME/TP	Greece
24	Vannplastics Ltd. (Ecodek)	ECODEK	SME/TP	UK
25	Wellness Smart Cities SLU	WSC	SME/TP/SP	Spain

RES=Research Organization; SME=Small/Medium Enterprise; LI=Large Industry; TP=Technology Provider; SP=Service Provider; ENDU=End User

W2O20

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CONCLUSIONS

- ✓ SHORT-CUT NITRITATION AND DENITRITATION (**SCND**) WITH BACS **IS SOLID AND RELIABLE PROCESS** TO TREAT LIQUID EFFLUENTS ORIGINATED FROM ANAEROBIC DIGESTION >> STATE-OF-THE-ART
- ✓ **STABLE AND ROBUST WASH-OUT OF NITRITE OXIDIZING BACTERIA** CAN BE ACHIEVED WITHIN **10-15 DAYS** TREATING ANAEROBIC SUPERNATANTS OF DIGESTATE SLUDGE, **WITHOUT INFLUENCE OF ORGANIC OVERLOADS**

LOW NOVELTY

- ✓ THE **SHORT-CHAIN FATTY ACIDS** PRODUCED BY THE ALKALINE FERMENTATION OF SEWAGE SLUDGE AVAILABLE IN WWTPS MAY ENHANCE THE **SIMULTANEOUS BIOLOGICAL REMOVAL OF NITROGEN AND PHOSPHORUS VIA-NITRITE PATHWAY**.
- ✓ THE **APPLICATION OF S.C.E.N.A. PROCESS IN FULL SCALE WWTP** LET'S ACHIEVE A **BETTER QUALITY OF DISCHARGE** (TN, TP), **REDUCING ENERGY CONSUMPTION AND FLUCTUATIONS**

HIGH NOVELTY

- ✓ THE **TREATMENT OF ANAEROBIC SUPERNATANTS USING S.C.E.N.A. PROCESS** CAN REACH **OPERATIONAL COST OF ABOUT 1.2 - 1.5 €/KG VS. 3 - 5 €/KG OF NITROGEN** TREATING THE SAME FLOW IN FULL-SCALE PLANT, **CONSIDERING THE REMOVAL OF BOTH TN AND TP**.

This is a READY to MARKET Technology for 2020 WWTPs

APPLICATION

Europe, environment and urban wastewater treatment: the policy, the economy and the ready-to-market innovations

5 novembre 2015 – Rimini, Italy

THANKS FOR YOUR ATTENTION

Info & visits to S.C.E.N.A. plant

drenzi@altotrevigianoservizi.it