





Convegno Sezione Automazione ANIMP

SISTEMI DI AUTOMAZIONE: NUOVE SFIDE E OPPORTUNITA'

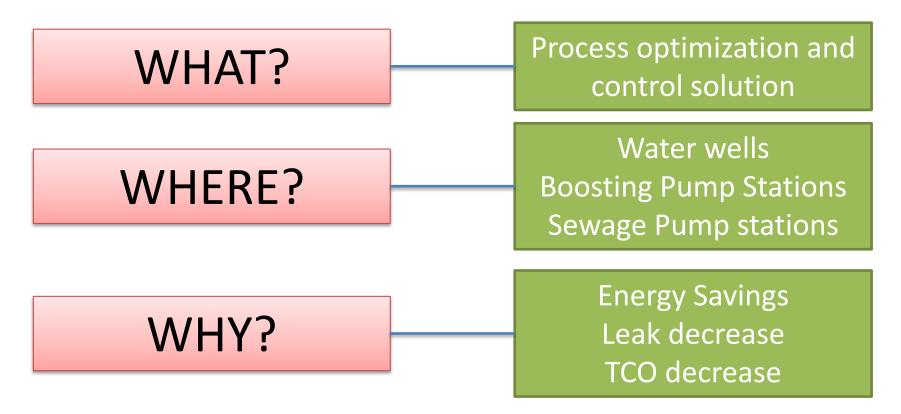
6 ottobre 2016 c/o Auditorium Maire Tecnimont (Milano)

Control and optimisation of water distribution systems in big cities By Marco Clerici

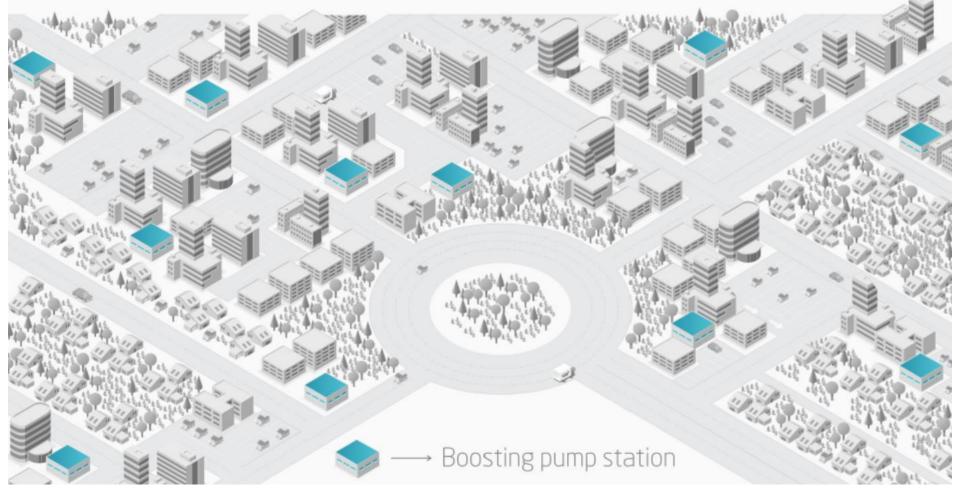
- What is Aquatoria
- Operational aspects
- Optimisation aspects
- Aquatoria structure
- Telemetry solution
- Optimisation principles
- The cases of Minsk and Cairo







BOOSTING PUMP STATIONS ARE LOCATED ALL OVER A CITY



EFFICIENT BOOSTER PUMP STATIONS OPERATION ASPECTS

EXCESSIVE WATER PRESSURE AT CONSUMER SITE ELIMINATION

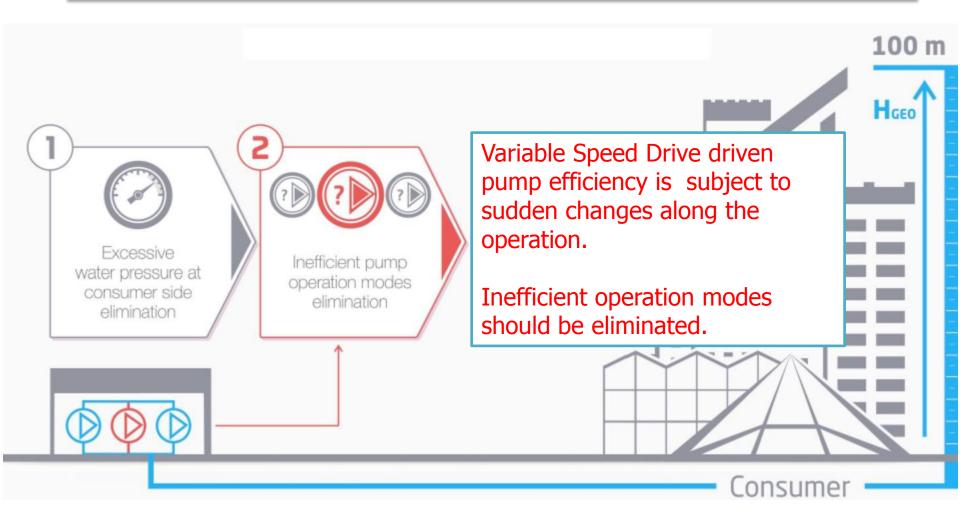
INEFFICIENT PUMP OPERATION MODE ELIMINATION

OPTIMAL PUMP SELECTION

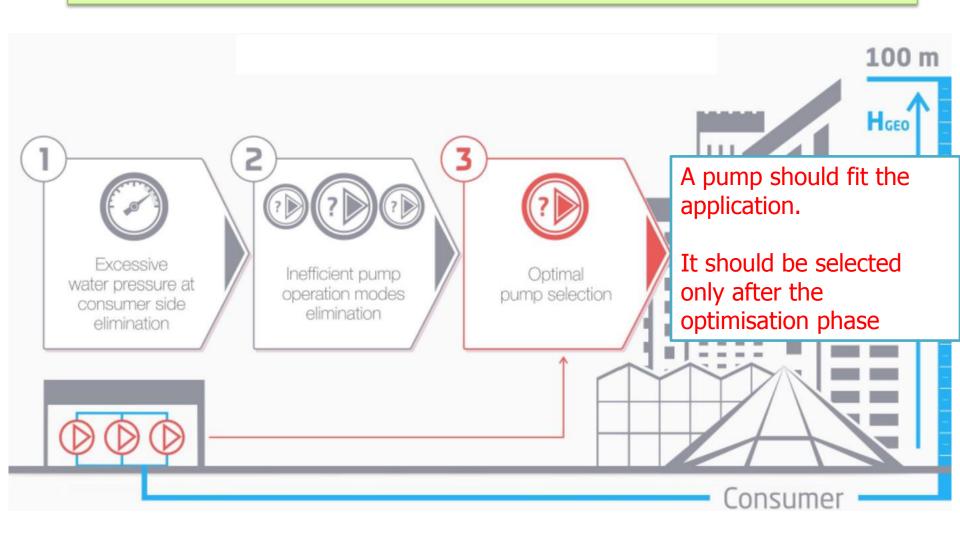
EFFICIENT BOOSTER PUMP STATIONS OPERATION ASPECTS



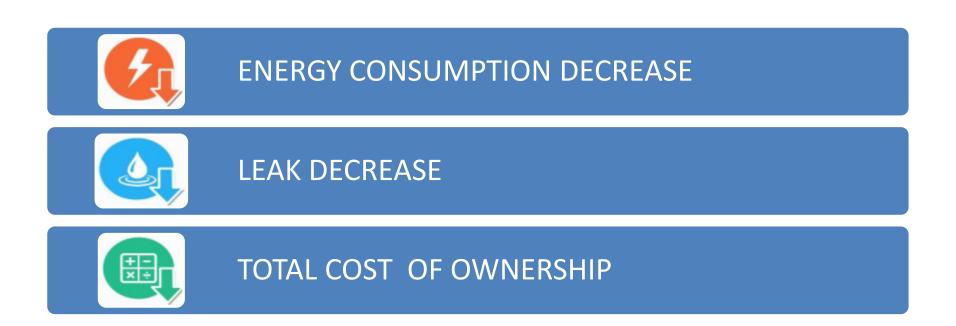
EFFICIENT BOOSTER PUMP STATIONS OPERATION ASPECTS

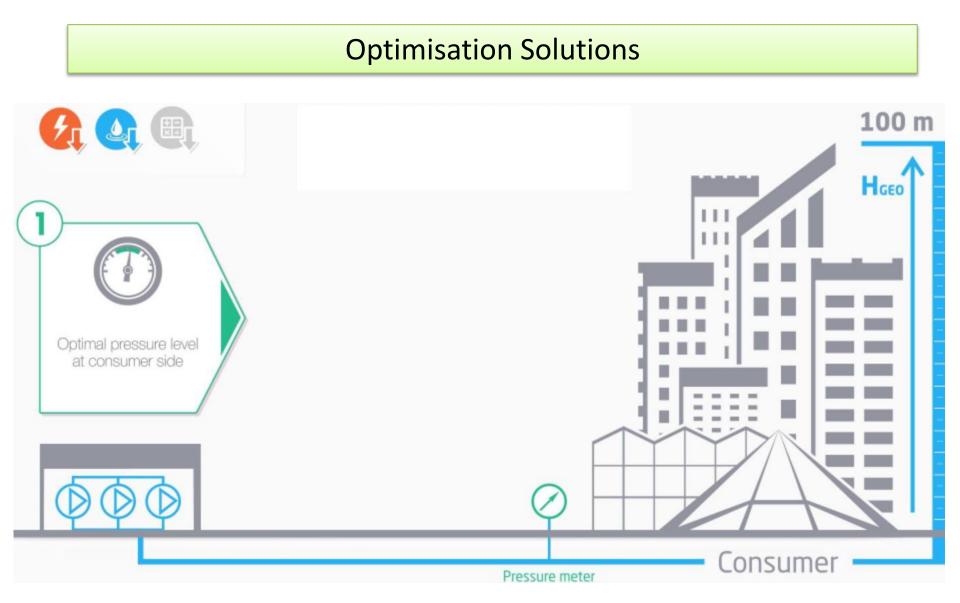


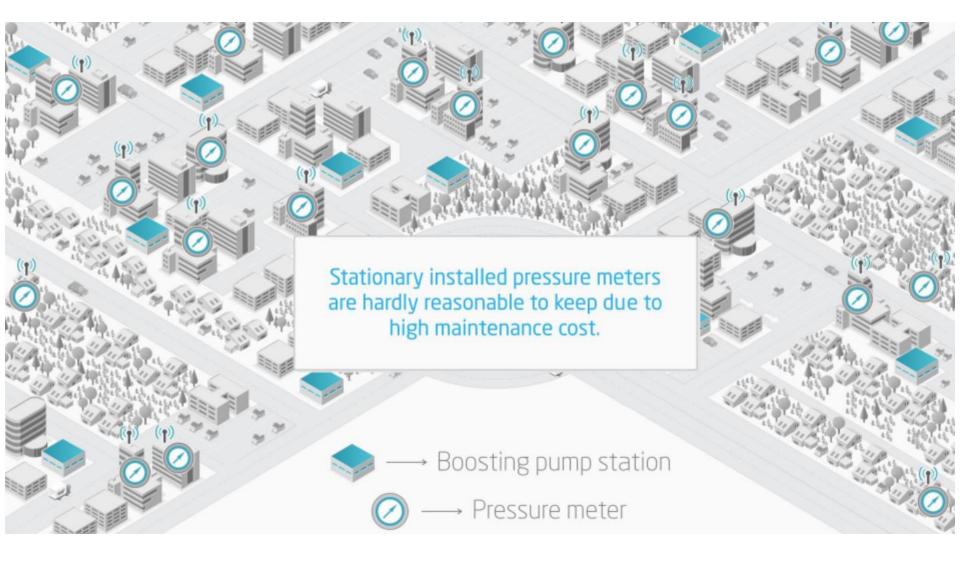
EFFICIENT BOOSTER PUMP STATIONS OPERATION ASPECTS

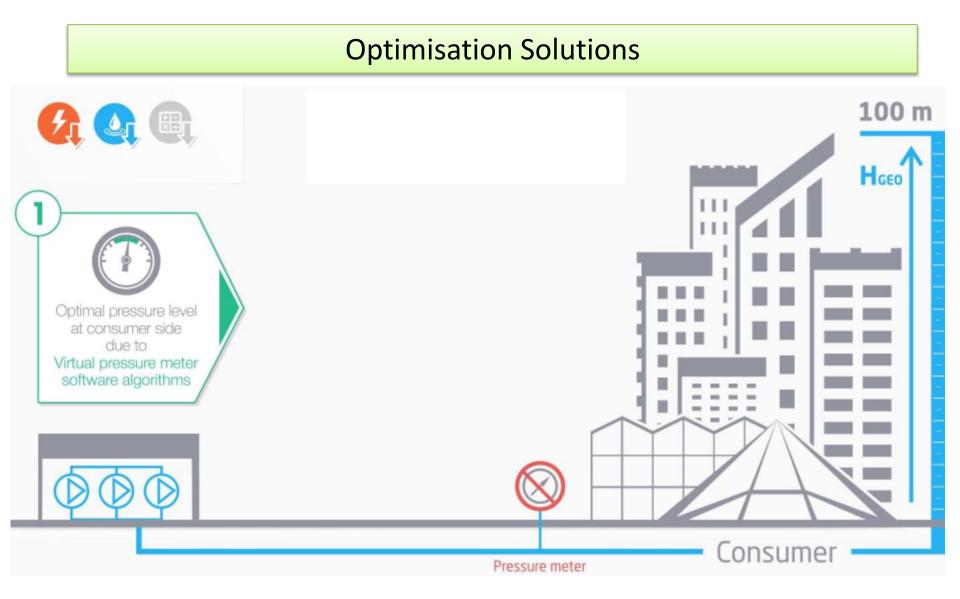


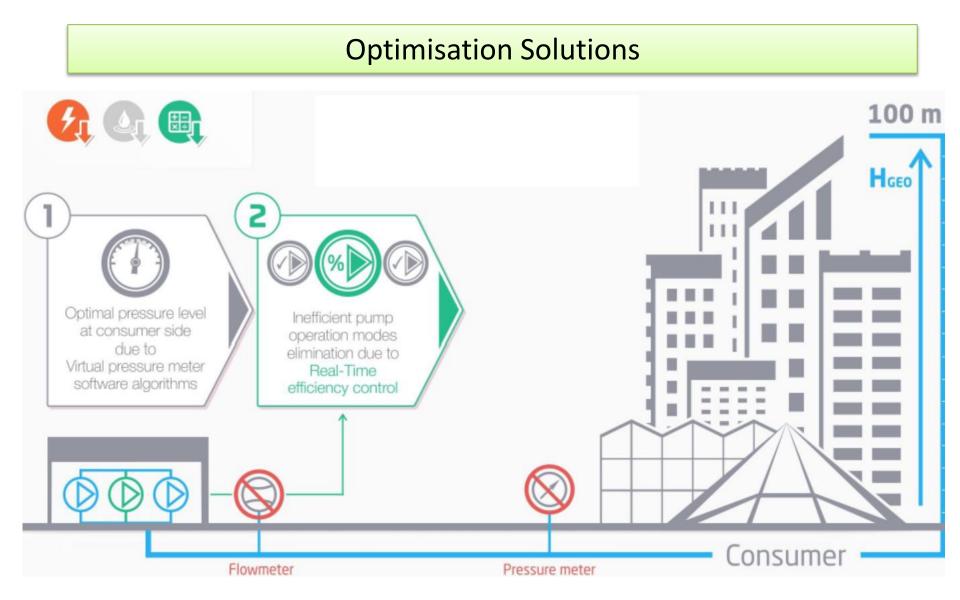
OPTIMISATION SOLUTIONS

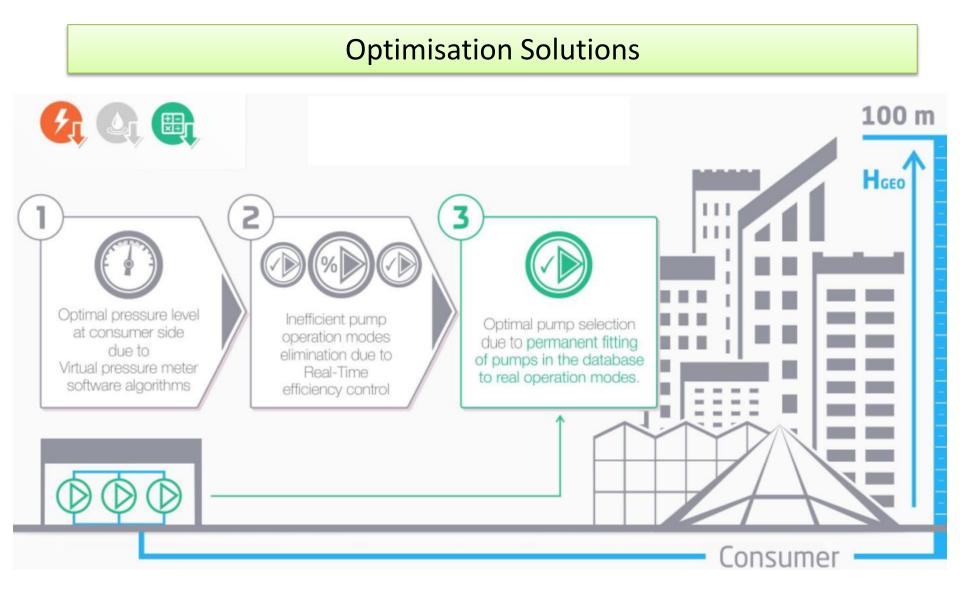












Aquatoria solution structure

Aquatoria workstation control software

Telemetry equipment

Control cabinets

Aquatoria solution structure

Aquatoria control software is based on control algorithms, parametrization and monitoring pages inside a SCADA system

SCADA SYSTEM							
	Application Configuration	 System TCO decrease (staff costs reduction) 					
VISUALIZATION	Adaptive Control	 Energy saving alghoritms for pump station control 					
ALARM HANDLING	Analitycal reports	 Leak decrease due to comprehensive process analisys 					
	Pump Selection Tool	 Energy saving due to proper pump selection. 					
TRENDS	Geo Module	 Localization for maintenance intervention, easy parametrization. 					
	Process Analisys Tool	 Energy savings (due to precise monitoring) Leaks decrease (due to precise monitoring) 					
ARCHIVING							



Geo module Aquatoria

New Pump addition

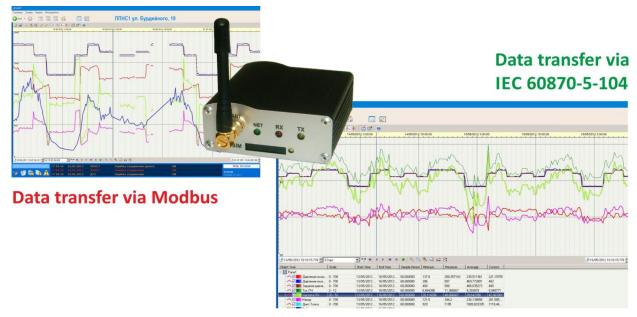
CODENIE TYPE:	Object runner Address: RFPC 129(2) number 1111 L. + Crossensous.80										urevitue operador:		Statement of the Owner, where the Owner,						
Booking PS	ITHC L	79(3D number	1111 1. •	Стороненика	#,80					300.341	2311344, 89	64799		P3C-811,29663	545	A 1244440+311			
Objects list																Object des			
Issian	Public	10210	identification.	Red	Balling	Parati	1907 544	1002368	3654	Nulse service	Pose antes	Contractor	1.2398	Land ble	PREF	Tar	Running Pf		
- 114	Desits.	#Mc-101		-			star ins	sider had	Variation (M)		manauroc-	C/FM	**	2010-10-01	100 100 100 100	have.	and the		
104	inesting.	mino ma	1111.1223	risian califie	110		PMF 748	1987 148	Page 101	MOD-84+ 291.	manufac-	0.01		30742-01-01	102 116 116 194	(A.14 ma)	Dana		
194	inere that	8940-003	*****	Damas-	-	4	107.748	1001100	Partie 84	300-ber 271.	TT (TRAPPO-	OWN	10	2015-10-01	102 108 106 100	S. Schrid Sciences	10Py		
100	lane little	37942-008	1000 0000	Planancipulat	124	4	PRF 248	PAR NO.	Permission (Mrd	WIDC Rev 2912	ITLIBLADC.	0.01%	193	20102-00.01	102 110 110 110	C Shine pears	100%		
140	(per 167	Aluci elli	10001-001	(Internet	4	3	25/ 1eg	14/146	Vactor No.	#00.6ex (01	ITUTAPAC.	0/74	ALER.	3043-6641	102 104 125 107	Press.	*		
140	(percent)	Milest 167	30155.005	Press	4	1	197114	NUM	Vanish 1811	100.041 201	TTLETBARMO.	(CHW	41.9%	2010.01.01	102 108 128 187		10116		
100			Sector Sector		Contraction of	1012010							and the second	and the lot of the lot of		ine .			
rela	IF A55.		Street		Bukfry	1.1	PS new	/#IHC-138		LOCADON:			¥: 52.91	100	Att	24.54			
ipes139	192.168.1	30.130	Cropsieleoae		· 36	1.10	laterest faces	CIEN		1 7 9	+ + +		4 10 11		100	Operating segmentary	BX(8+)		
Sector	Philar service		From service tow						_		310.81.18	4	1. 1. 1	CHARLES -	10000	Personance and the	IT DRUKK		
Pagement (41)	- (MOC 65A 38	11010.000100 -	Th (1993,F90)-6 = 388	- min							and thirds		Same and the owner of	and a	Change		-		
					Heads		Salar, tran	Angeland	(H)			Carlos de a	and the second second	A 200-		-	-		
a Parter	Dept	ates Poes	tim Pressen	alities (2.ml)		- 15	autori terro	81.15.250	- 12-1		72.3	10.00	2 100	12,000	Delete				
· IT menet	106.0	18	10800			- 15	1Chose	144				1.1.5	Sect 100	200					
W Perel	748.8	246	2808			- 11				1000		1000		100.00	Add design				
W(Parel)	148.0	18	2816					17.0852											
W Parel	198,0	15	2810			- 11	-			St.			VIV-						
		15		4			oriti Li carte	orginal and		1	-		W/						
W Parel	198,0	15	2810	-	ŝ.		999 248	1410 1 m		1	-		V.		Defete tags				
W Parel	198,0	15	2810	an .	1	1	Last servers dates	URD 1 to Day 244	ta datta	T	1								
W Parel	198,0	15	2810	in .	1		Jane 242 Last service date 10.01.2012	100 1 m	a Anna Li Sire	T	F		1						
W Parel	14.1		100	Å.	1		Jan 243 Lat serves fate 18.01.2812 Serves secon	arts 1 m har ma bar and bat are farmed	a Anna Li Sire	T.	The second		1						
W Parel	14.1		2810	1	j.		Jane 242 Last service date 10.01.2012	100 1 m	a Anna Li Sire	A STA	A.		10						
a formation	BP		100				(ner 243) Latt servere Ada 10.00.2012 Servers sector [10]	arts 1 m har ma bar and bat are farmed	a Anna Li Sire	A. A.	A A								
R Persel	BP		100				pror 248 call servers data 15.01.2812 Servers pector To To To To To To To To	1410 1 ve Prer Prei Last any Series a Te	n lann U SP eind		A A								
a formation	BP		tion designer	i. E E	= ••• =		(ner 243) Latt servere Ada 10.00.2012 Servers sector [10]	1410 1 ve Prer Prei Last any Series a Te	n lann U SP eind	and									
a formation	BP HH HH HH H	S corfigurat	tion designer	н <u>.</u> н			pror 248 call servers data 15.01.2812 Servers pector To To To To To To To To	1410 1 ve Prer Prei Last any Series a Te	n Lann Li - Str chal		A A A								
R Persel	BP H	S configurat	tion designer	1 <mark></mark> H			pine 248 Last series date (10.00.2012) Series sector (10 Napi 1.00) Series bell bench	1410 1 ve Prer Prei Last any Series a Te	n lann Li Tar- cini		Al .								
R Persel	BP HH HH HH H	S corfigurat	tion designer	н <u>.</u> н			ine yes Last servers date (0.11.2012 Servers sector (0.) http://dl/_exerve.bot (0.000) (0.000	IND 2 to For 744 Sector 2 Sector 2	n Anno Li Dr- chel D	en foto-jum	ALL								
=	BP HH HH HH H	S configurat	ton designer	н <u>.</u> н			For 248 Last server fate (10.00_2012) Server sector (10 http://dl/journe.bol boltz Execution (20 boltz)	IND 2 to For 744 Sector 2 Sector 2	n Anyo Li (p- conti)))))))))))))))))))	en Deur ann McChi (20197	ALL								
=		S configurat	tion designer				Inter 244 and servers data (10.11.2012) Servers social (11 app 1.64) (speces bot) Date: 5 Date: 5 Date	IND 2 to For 744 Sector 2 Sector 2	n Anja U ()- cital)))))))))))))))))))	NAME AND ADDRESS OF AD	2								
= **** :	BP	S configurat	tion designer	-	E 1944 3 19 19		Jone 244 Latt server data (Latt 2012) Server press (2) Server press (2) Se	IND 2 to For 744 Sector 2 Sector 2	n Jaya J (j* celi	ni DAn min ni DA atrifi ni DA atrifi ni DA atrifi ni DA atrifi ni DA atrifi									
= **** :			tion designer				prof 260 sait areas also later areas also lateras partial serves partial al allocations of source servers (%) servers (%) serv	IND 2 to For 744 Sector 2 Sector 2		PA EVER (ME) PALOS 20197 ALOS 20197 ALOS 5 PALOS 5 PALOS 5 PALOS 5									
=	8P		tion designer				per tes tat mens des l'atta tess des des des des l'atta tess des des des des l'atta tess des des des des des l'atta tess des des des des des des des des l'atta tess des des des des des des des des des	IND 2 to For 744 Sector 2 Sector 2		PA EVER (ME) PALOS (20197) ALOS (20197) ALOS (2 PALOS (2) ALOS (2)									
		S configurat Hin Han Han Han Han Han Han Han Han Han Ha				2	prop 246 Latt arrests data (Linth, 242) Servers partial (P lattices are set (P lattices are set (P lattices are set) (P lattices are se	IND 2 to For 744 Sector 2 Sector 2		PA EVER (ME) PALOS 20197 ALOS 20197 ALOS 5 PALOS 5 PALOS 5 PALOS 5									
			tion designer				prop 246 Latt arrests data (Linth, 242) Servers partial (P lattices are set (P lattices are set (P lattices are set) (P lattices are se	IND 2 to For 744 Sector 2 Sector 2		PA EVER (ME) PALOS 20197 ALOS 20197 ALOS 5 PALOS 5 PALOS 5 PALOS 5									
		S configurat Hin Han Han Han Han Han Han Han Han Han Ha				2	prop 246 Latt arrests data (Linth, 242) Servers partial (P lattices are set (P lattices are set (P lattices are set) (P lattices are se	IND 2 to For 744 Sector 2 Sector 2		PA EVER (ME) PALOS 20197 ALOS 20197 ALOS 5 PALOS 5 PALOS 5 PALOS 5						feer			

Process analisys tool TD 2293.P3C-6 + 29 whenter

Telemetry solution

The telemetry structure of Aquatoria is based on following principles:

- \checkmark Standard PLC on the market, to comply with existing installations
- ✓ Complete data transfer, no loss of data in case of missing communication
- $\checkmark\,$ OPC technology for interface of field equipment to the SCADA
- \checkmark Single database of the process data for adaptive control implementation



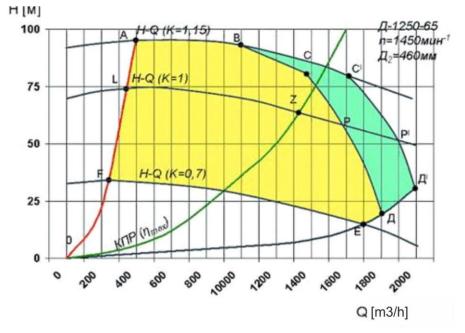
Principles of the optimization

The PLC in control cabinet collects information from pressure sensor, power consumption and pump rotation speed. These data are used in the math model in the PLC program and SCADA to calculate:

- Current pump efficiency running from an inverter
- Water pressure in remote control point

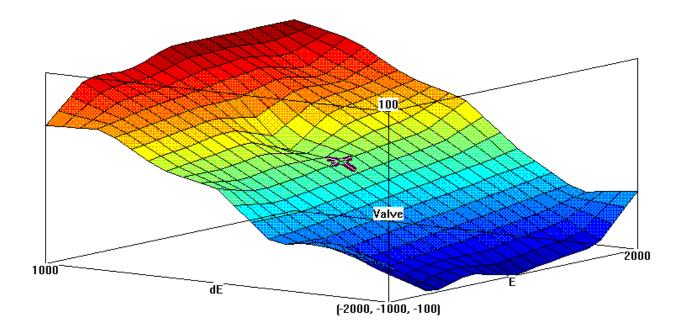
Thus, making the following possible:

- Low efficiency pump switch off
- Selection of optimal pump model based on real running modes



Principles of the optimization

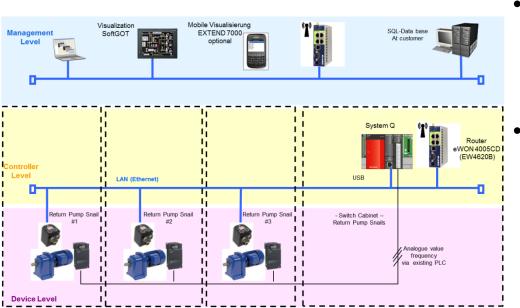
The model is actually used in a Fuzzy Control Algorithm that looks to minimize the energy consumption of groups of pumping stations linked on a common hydraulic network.



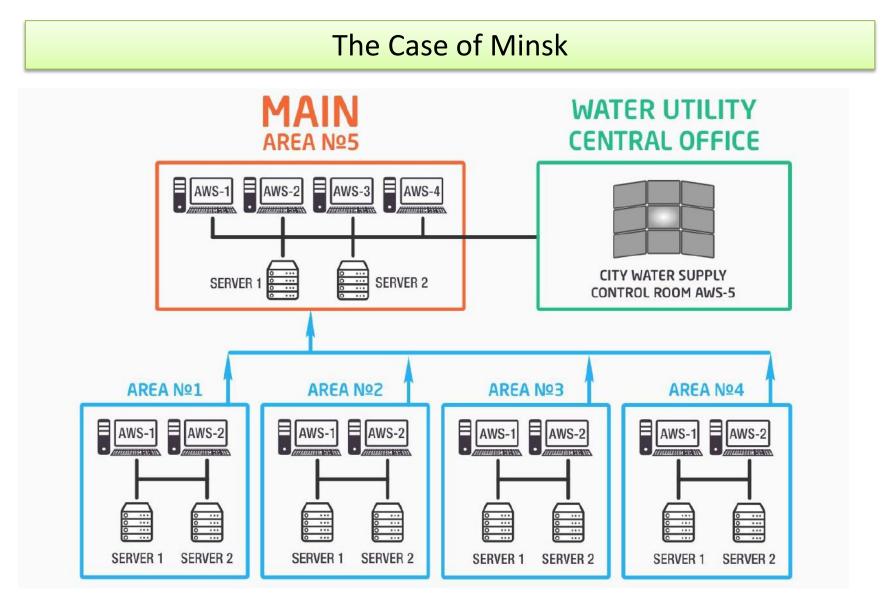
Principles of the optimization



Addition of Condition Monitoring solutions for predictive maintenance on pumps

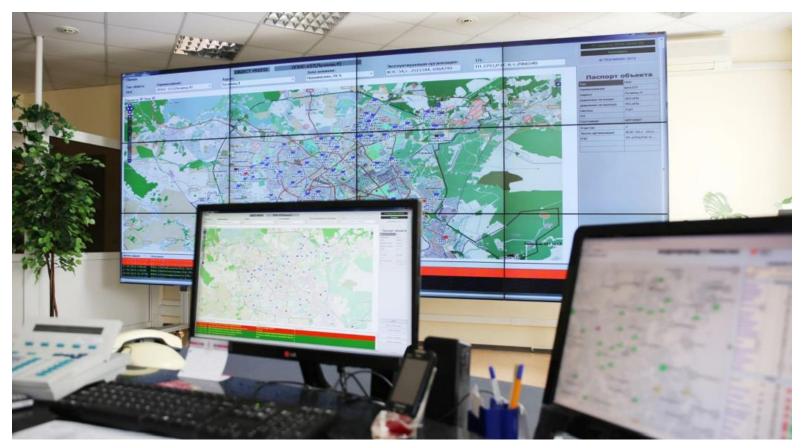


- Based on vibration and temperature sensing
 - Early detection of possible failure and indication of precise cause
- Data collection directly over telemetry to SCADA system
 - Reduction of personnel costs
 - Reduction of spare parts inventory



The Case of Minsk

The complete city of Minsk (around 2 Million people) is covered by Aquatoria solution



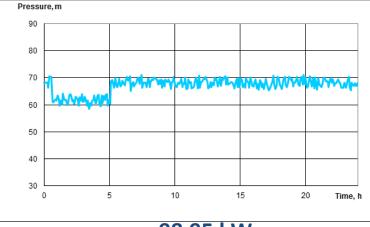
The Case of Minsk

The complete city of Minsk (around 2 Million people) is covered by Aquatoria solution



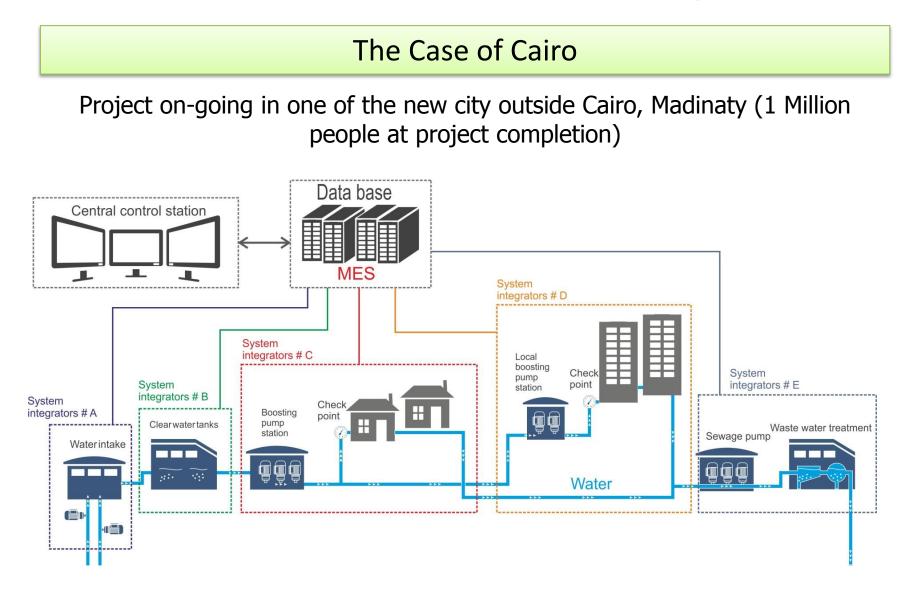
Pressure at the consumer side before optimization

Pressure at the consumer side after optimization

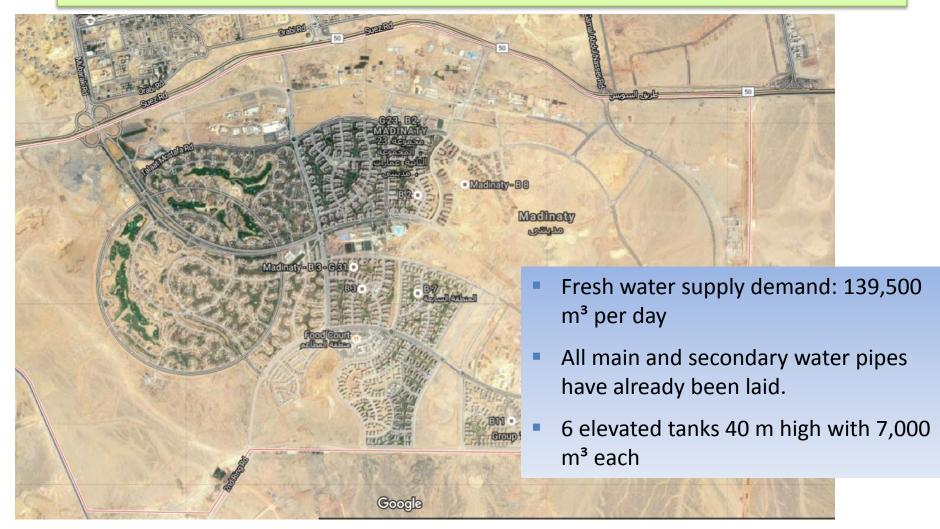


98,95 kW

N⁰	Characteristic	Rate
1.	Boosting pump station monthly energy consumption	786,56 kWh
2.	The average relative reduction in energy consumption by one local pump station	17,5 %
3.	Overall relative reduction in energy consumption within 11 local pump stations	16,8 %







The Case of Cairo

- ✓ Installation of electronically adjustable Pressure Reducing Valves (PRVs) in the city with remote control functionality: pressure fluctuations significantly decrease after PRV implementation on the tanks outlet.
- ✓ Leakages also decrease due to general water pressure decrease. Valves and PVC pipelines breakdown decrease.
- ✓ Implementation of a central SCADA system enabling the monitoring and control of the system and thus the water pressure
- ✓ Excessive water pressure reduction after implementation of adjustable PRVs with 3 pressure presets is saving approx. 5,177.5 m³ of water per day and 705.4 kWh of energy per day (annual savings: 1.9 million m³ and 257.5 MWh per year).

Grazie per la cortese attenzione