Towards sustainability in water distribution networks.

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hidráulica y medio ambiente
dihma


Why?

Why we need to consider sustainable supply?

To adapt

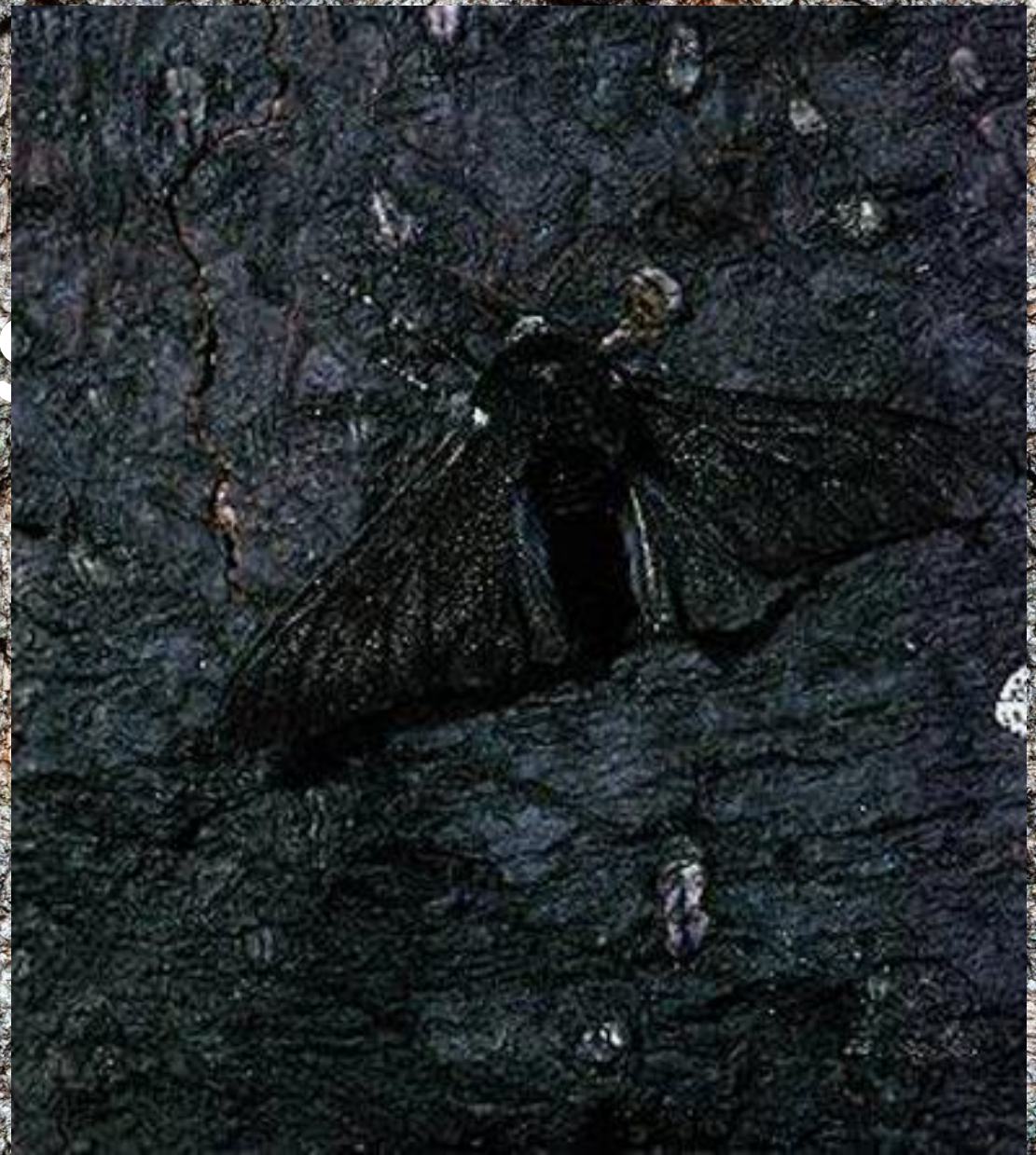
Sustainability: Biston Betularia

The peppered moth, Biston Betularia, occurs in various shades of gray. One hundred and fifty years ago, from the beginning of time, the species consisted almost exclusively of "typical" forms, with predominantly light gray scales interspersed with black.

During the 19th century, England experienced dramatic industrialization that was largely driven by coal-burning plants, the pollution from which would eventually be deposited on tree trunks:

In 50 years, conditions changed dramatically

And they
adapted in less
than 10 years



Same for us


Changing
from here:

…. To here

Across

1. At a glance

Urban water cycle and sustainability

The world is continually looking for ways to improve the way water is used for energy. As population grows, so do the need for natural resources and, in turn, energy needs.

Energy and water are part of the same reality in the urban water cycle.
We cannot forget the use of technologies for clean energy production, energy recovery instead of dissipation, pumping station reprogramming, and hybrid systems.

We also cannot forget the implications for water and energy supply.

2. Urban Water cycle and sustainability

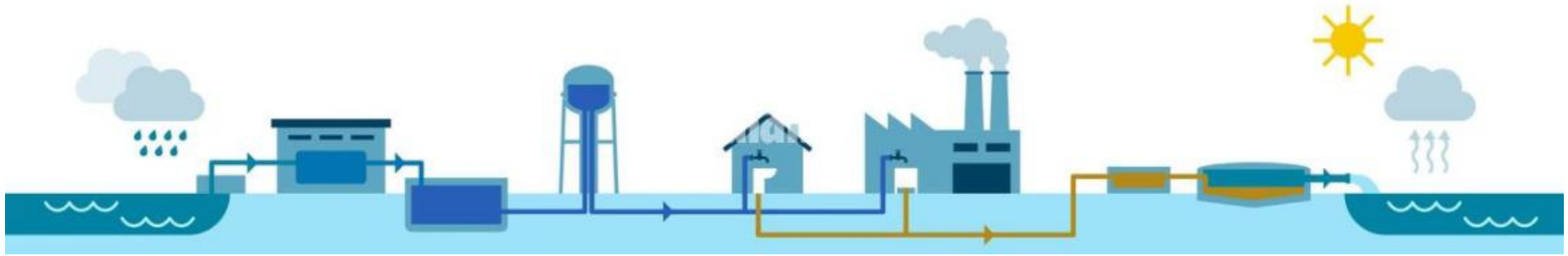
Let's recall the definition of sustainability: "ensuring the needs of the present without compromising the needs of the future."

Water and energy have a very close relationship in terms of sustainability in the urban water cycle.

The water cycle is altered by the action of technology serving society, always maintaining our commitments to future generations.

2. Urban Water Cycle and Sustainability

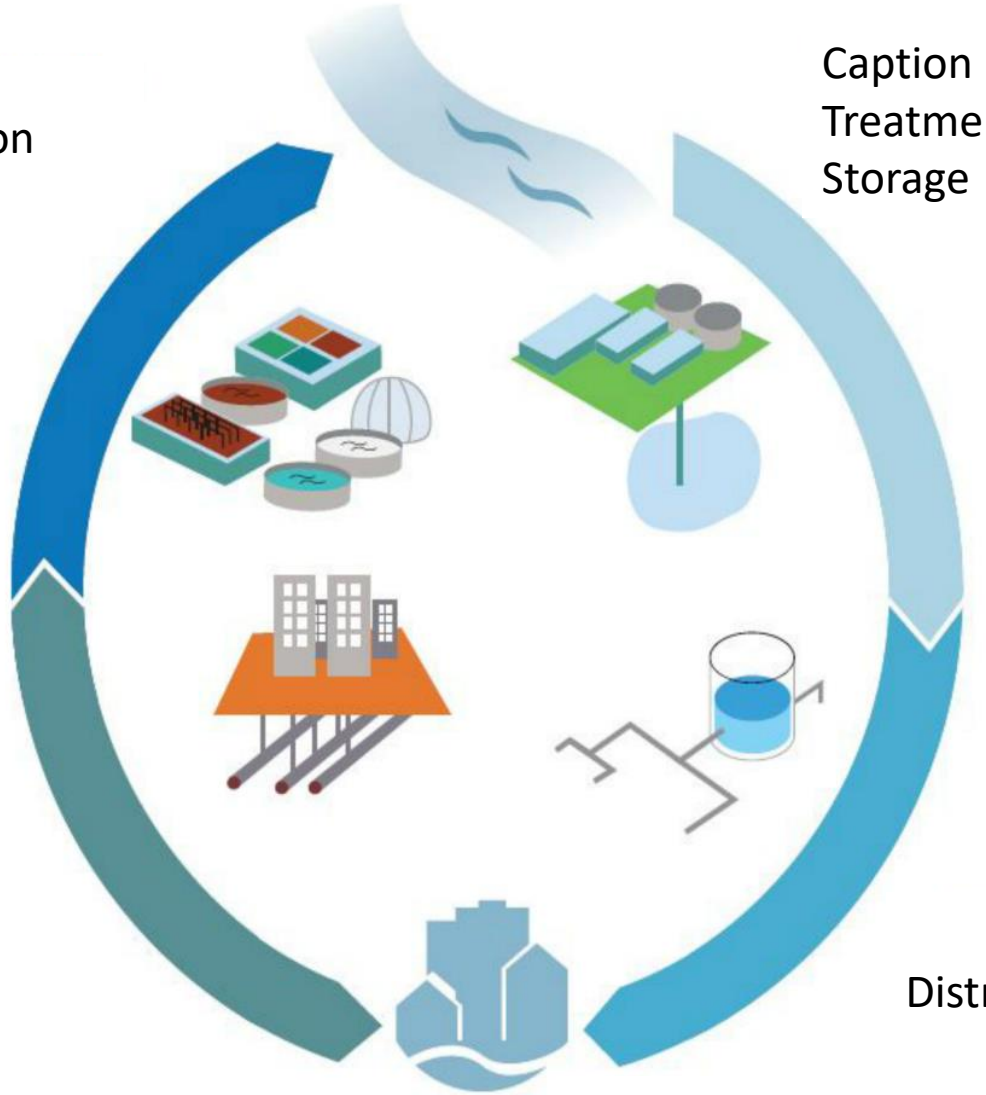
From the line



Caption - Treatment - Storing - Distribution - Use - Drainage- Depuration- spill

2. Urban Water Cycle and Sustainability

To the circle



2. Urban water circle and sustainability

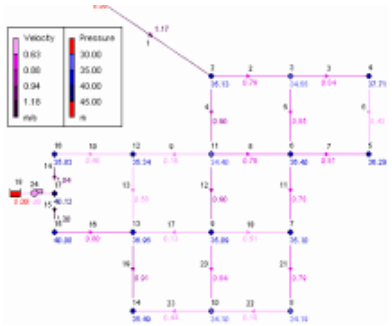
Cost recovering

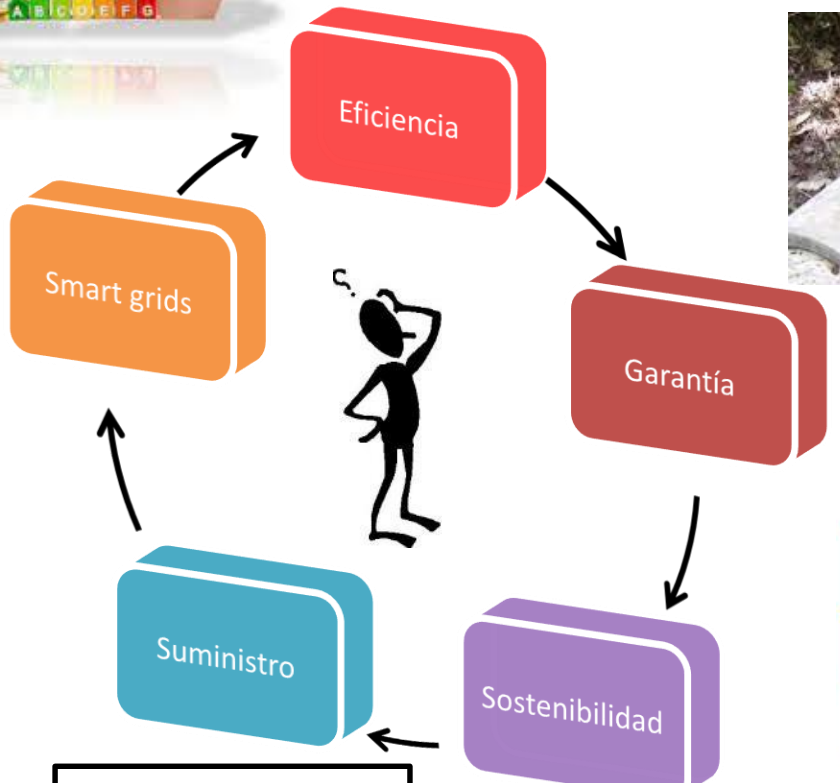
Energy audit

Infrastructures renovation

Sustainability evaluation

Information





Renewable energy

Towards sustainability in water distribution networks

Sustainability evaluation

OBJETIVOS DE DESARROLLO SOSTENIBLE

Towards sustainability in water distribution networks

Energy recovery

Across SGD


OBJETIVOS DE DESARROLLO SOSTENIBLE
1
2
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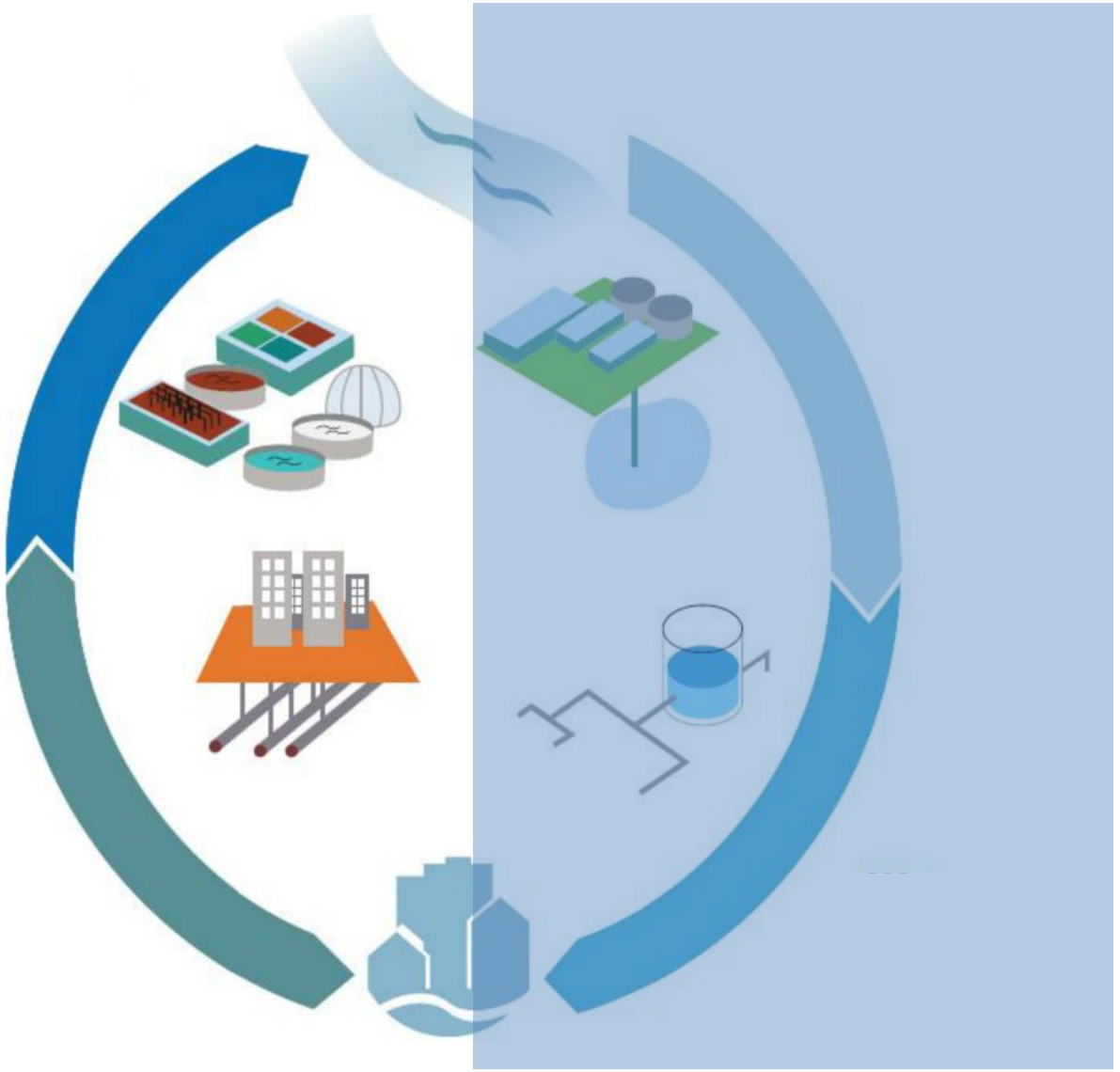
17
OBJETIVOS DE DESARROLLO SOSTENIBLE

3. Where can we improve?

Sustainable development of distribution systems must meet current needs without compromising future capabilities.

What can we do?

4. What can we do?



4. What can we do?

i) *Buy only what you need; anything unnecessary, even if it costs just a cent, is expensive.*

We can size networks according to an optimal energy design:
OPTIMIZE

Optimization

Network design optimization: supply growth forecasts: improving hydraulic efficiency

Pumping station optimization, energy analysis: improving energy efficiency

Water treatment process optimization: improving overall efficiency

Maintenance and asset management process optimization: improving economic efficiency

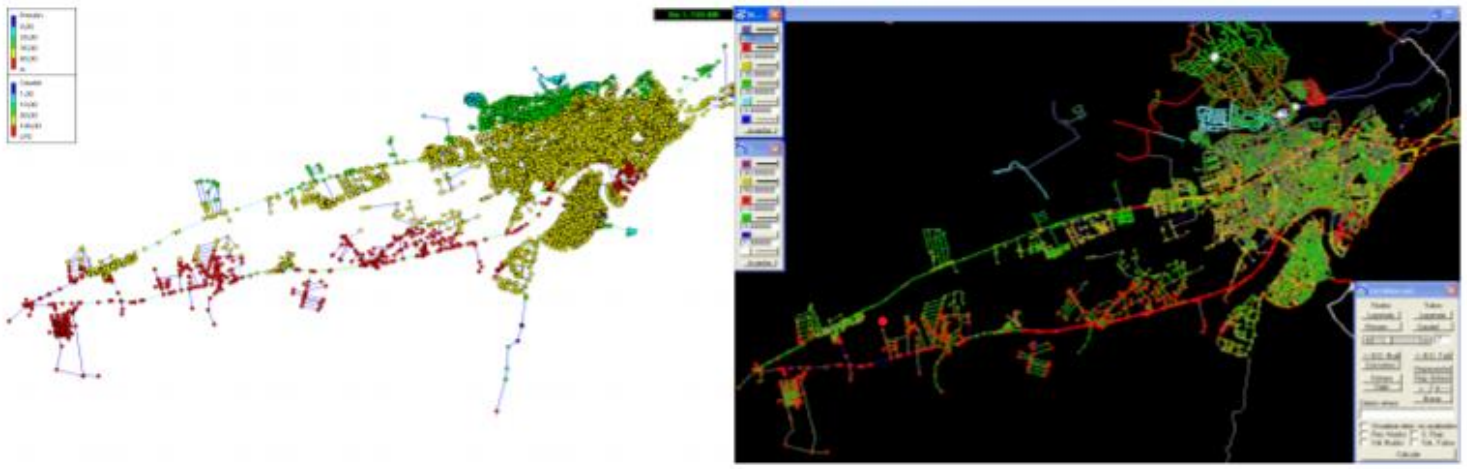
Supply pressure optimization for leak control (and pathogen intrusion): improving volumetric efficiency

General optimization techniques: improving social efficiency

4. What can we do?

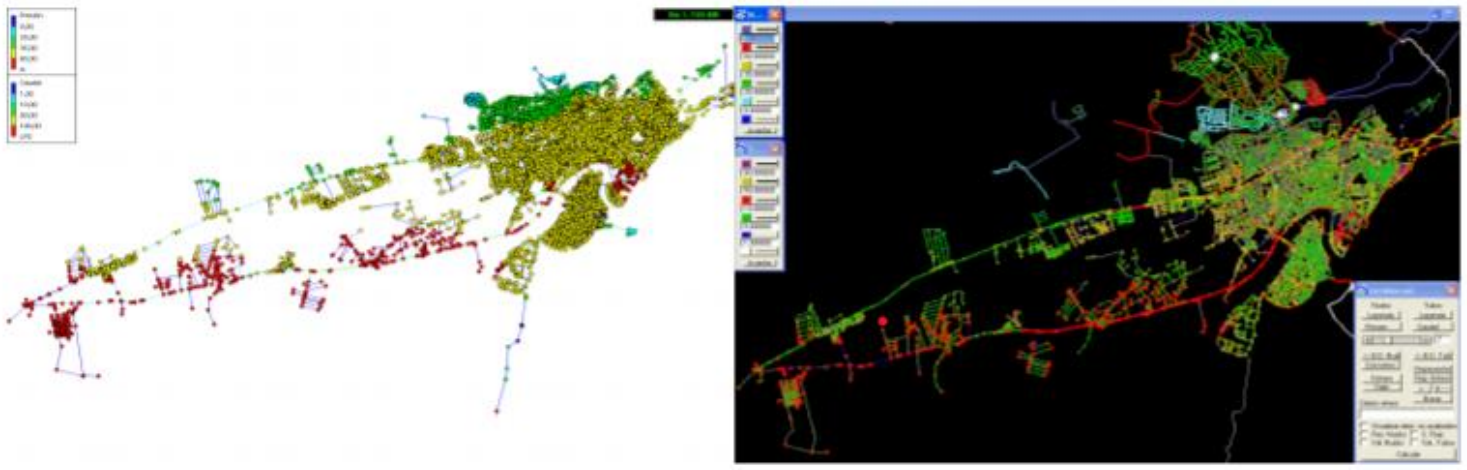
ii) Divide and conquer.

We can sectorize networks in the optimal way based on supply criteria so that we always have the best solutions in terms of pressure and flow: **SECTORIZATION**



Sectorization

- According to supply levels
- According to intermediate reservoirs
- According to network meshing
- According to pumping stations
- According to rechlorination needs



4. What can we do?

iii) *What it is not measured, it does not exist*

We can **measure** many magnitudes: pressure, flow, quality: **MONITORING**

MONITORING

- In the water treatment plants: pressure, flow, quality parameters
- In the pressure patterns along the day
- In the flow behaviour: leackage and pathogen intrusion control
- In the spills

4. What can we do?

iv) *Always look for the least bad solution*

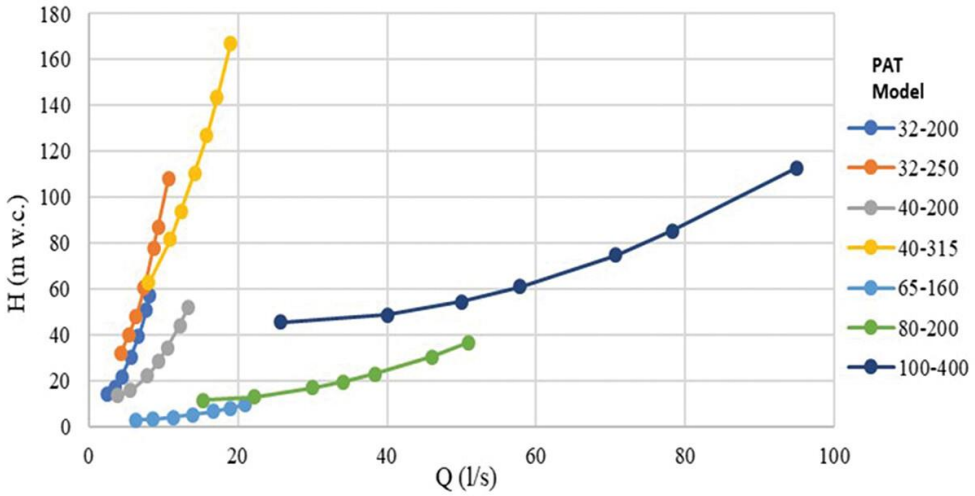
We can go further, proposing energy optimization strategies, for example through micro-hydraulic machinery in networks: energy **RECOVERY**.

Hydraulic Micromachinery:Turbines or Pumps Working as Turbines?

The turbine always allows energy recovery based on its operating curve. But...- Are such small turbines available?- Are their operating curves known for design?- Is it cost-effective to purchase this machinery from grids?- Can it be easily regulated?

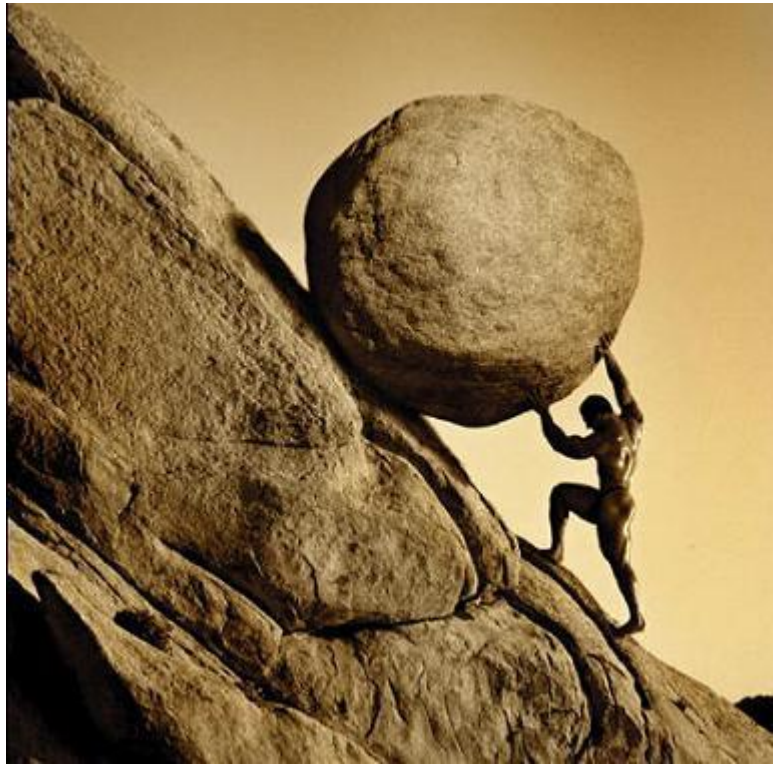
Hydraulic Micromachinery: Turbines or Pumps Working as Turbines?

A pump operating as a turbine can meet this need.Due to its availability Due to its cost and Due to its versatility. But... With what efficiency?



Micro hydraulic machinery

Turbines or pumps working as turbines (PATs)?



Towards sustainability in water distribution networks

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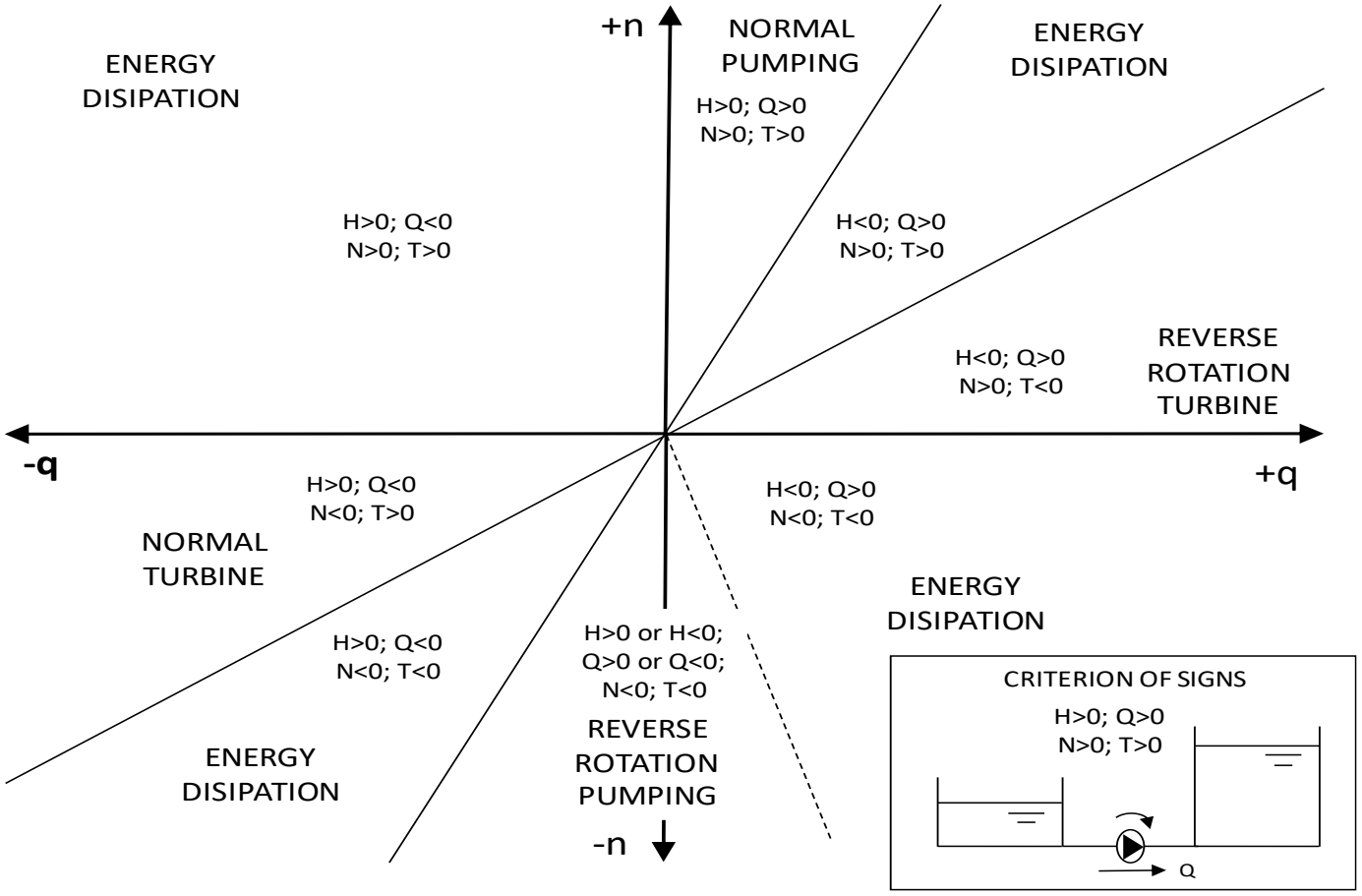
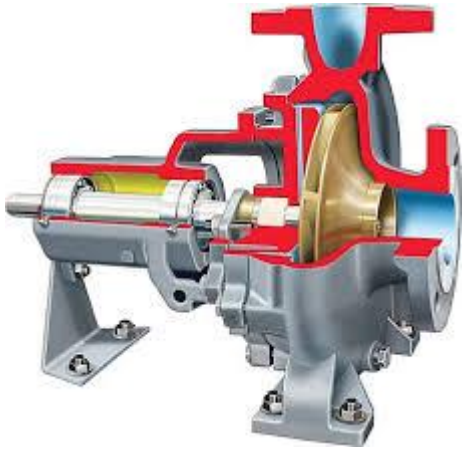
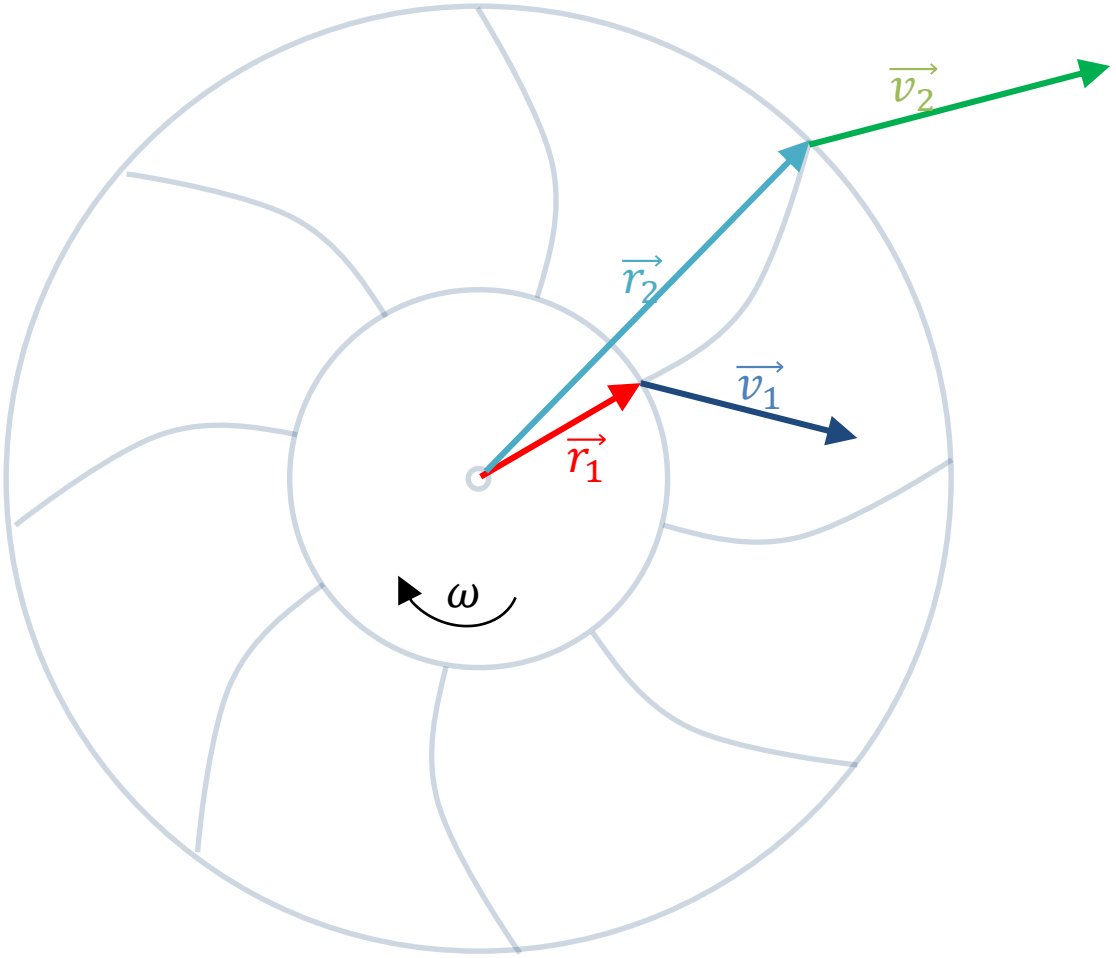


$$\sum \vec{M}_{ext} = \sum_{sal,i} [\rho Q(\vec{r} \times \vec{v})]_i - \sum_{ent,j} [\rho Q(\vec{r} \times \vec{v})]_j$$





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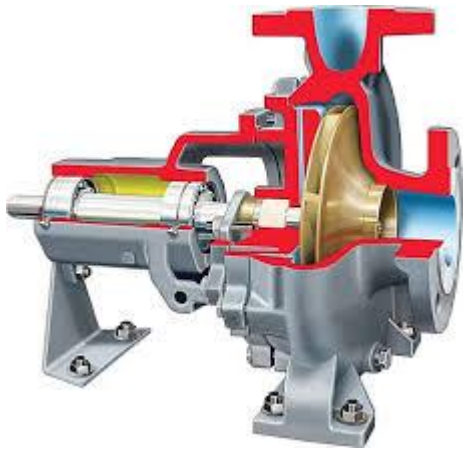
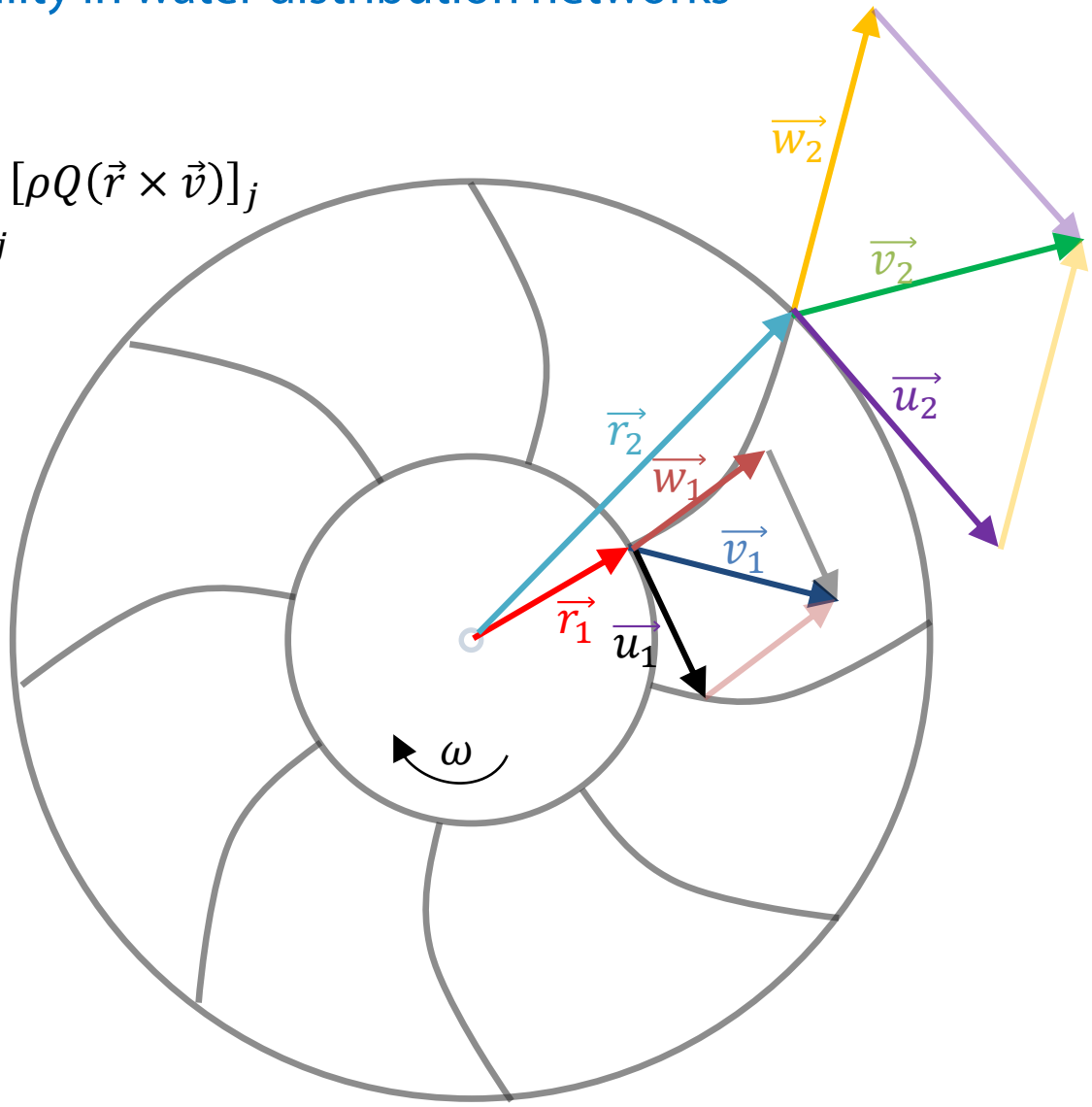
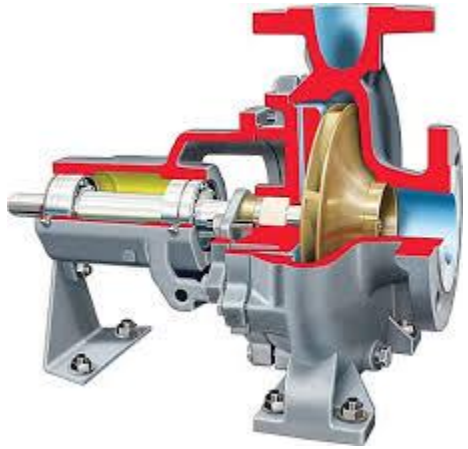
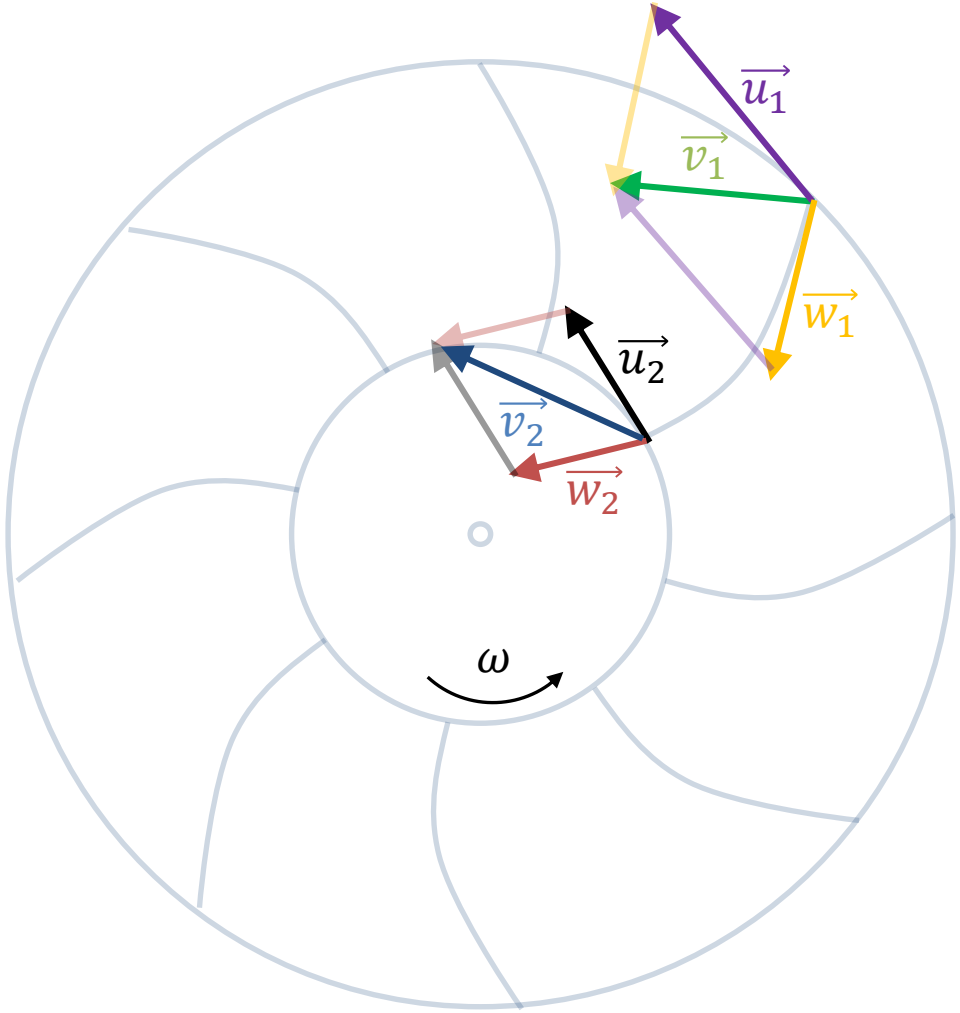
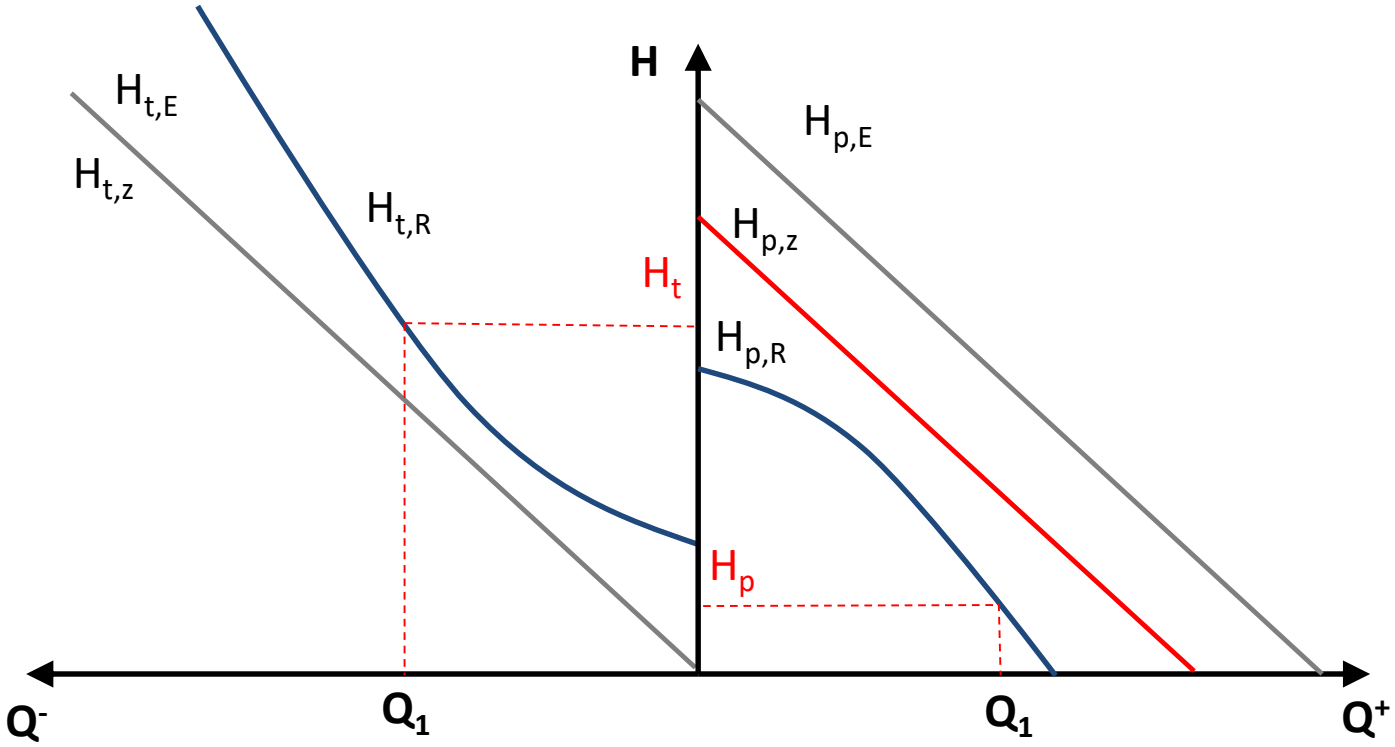




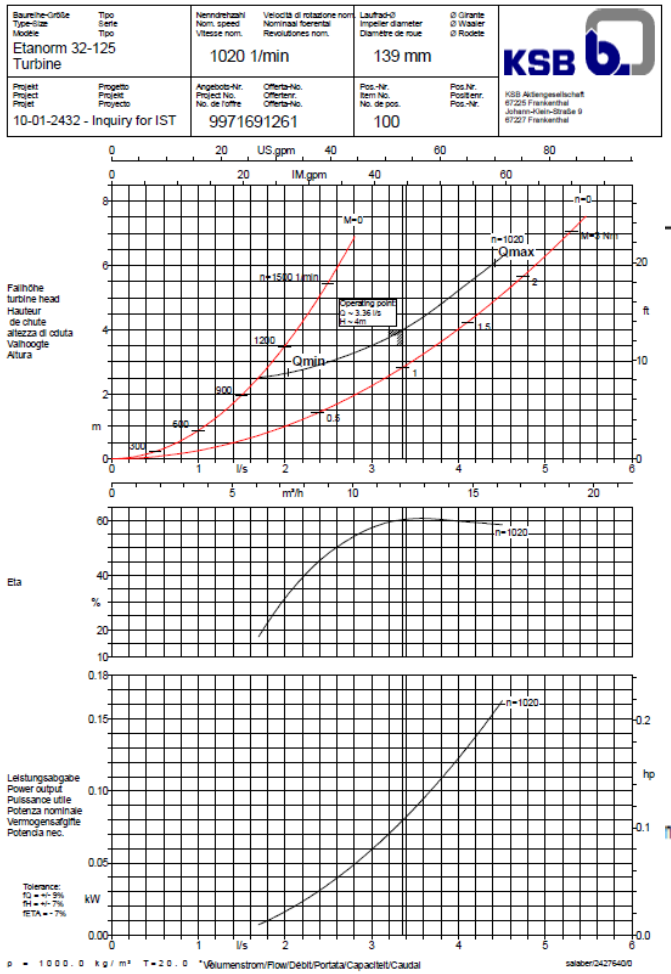
$$H_{tE} = \frac{u_1 v_{1u} - u_2 v_{2u}}{g}$$






H
$H_{t,E}$
$H_{t,z}$
$H_{t,R}$
H_t
H_p
$H_{p,E}$
$H_{p,z}$
$H_{p,R}$
Q^-
Q_1
Q_1
Q^+

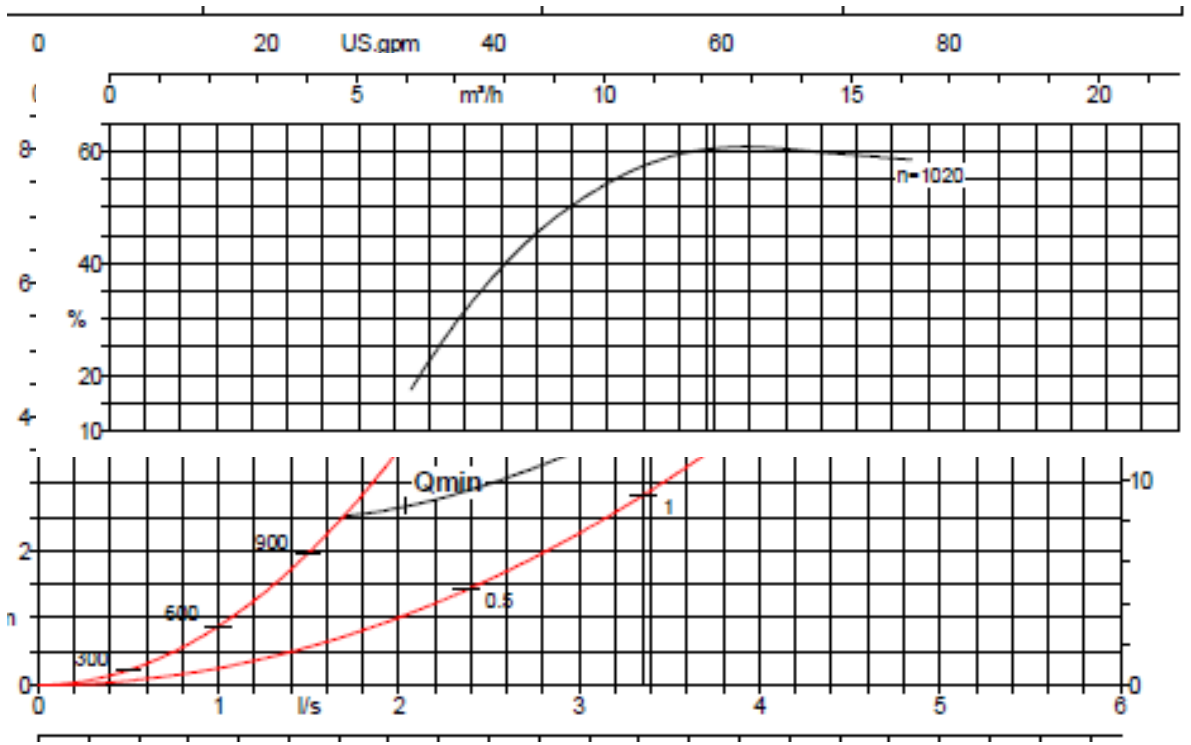
Towards sustainability in water distribution networks

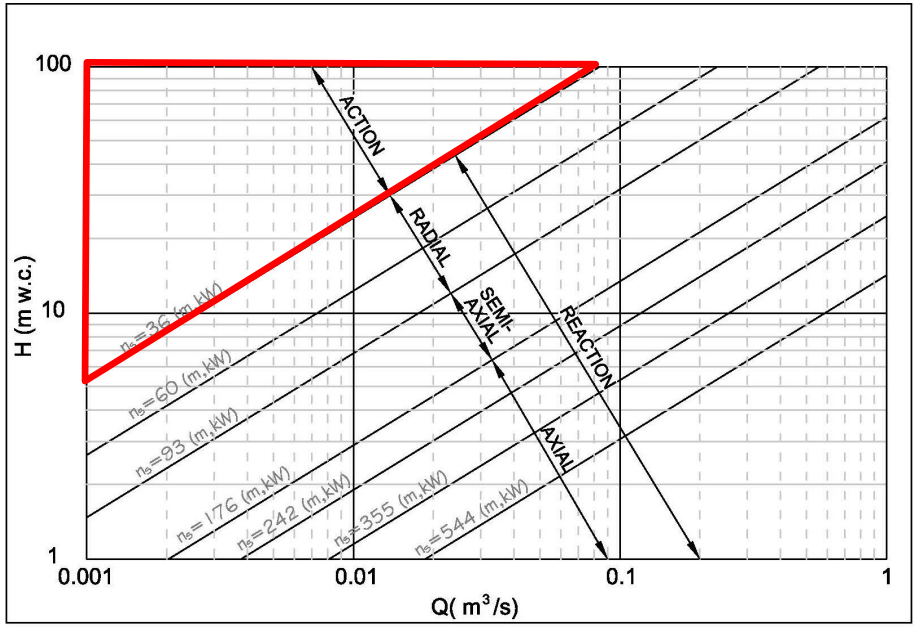


$$H = fn\,(Q)$$

$$\eta = fn\,(Q)$$

$$\Rightarrow \quad P = fn\,(Q)$$




100
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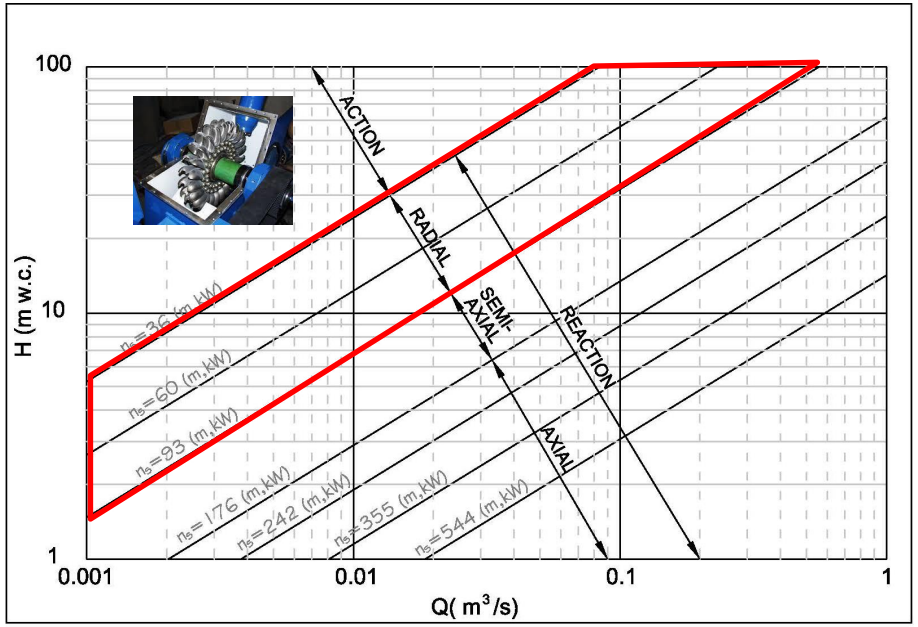
H (m w.c.)
0.001
0.01
0.1
1
Q(m³/s)
ACTION
RADIAL
SEMI-AXIAL
REACTION
AXIAL
ns=36 (m,kW)
ns=60 (m,kW)
ns=93 (m,kW)
ns=176 (m,kW)
ns=242 (m,kW)
ns=355 (m,kW)
ns=544 (m,kW)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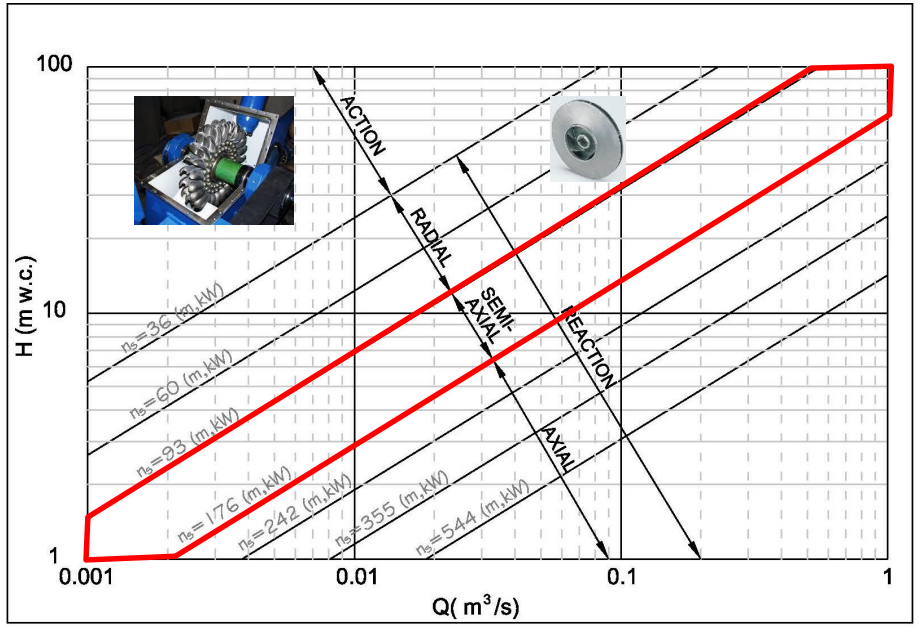
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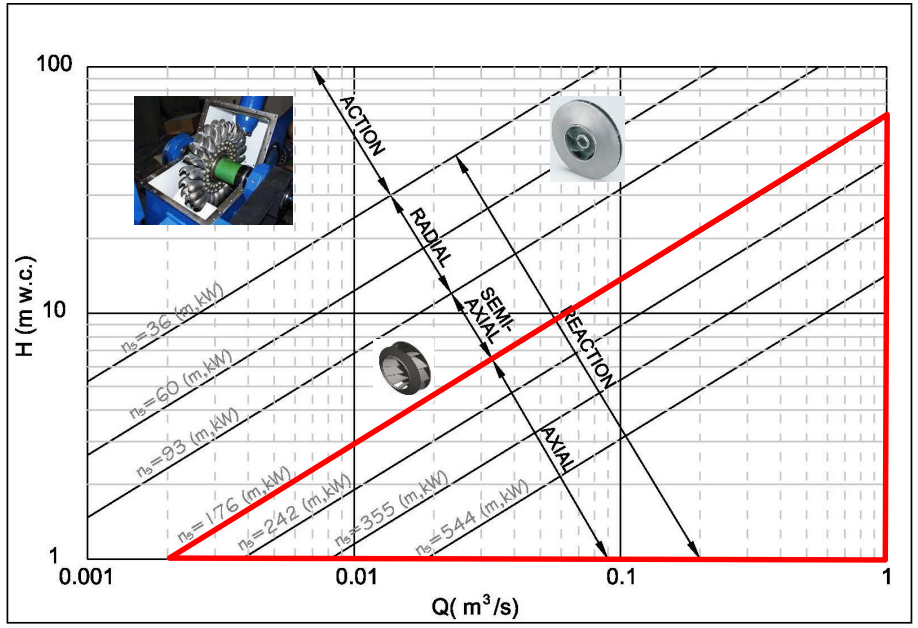
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ns=355 (m,kW)
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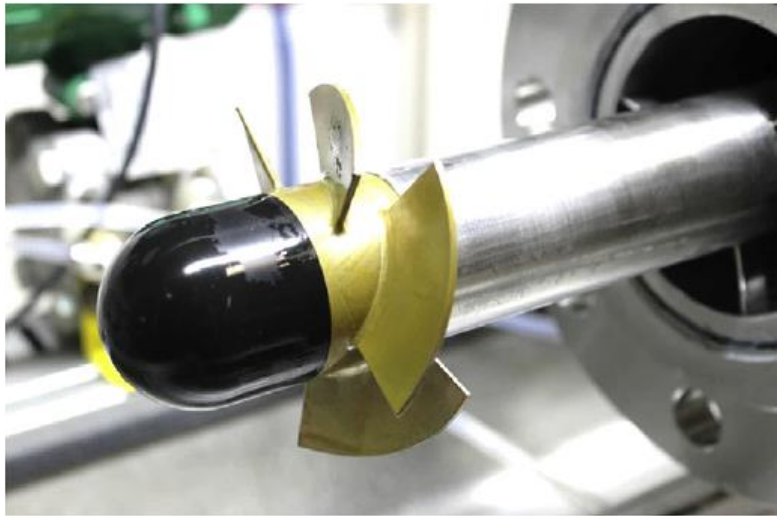
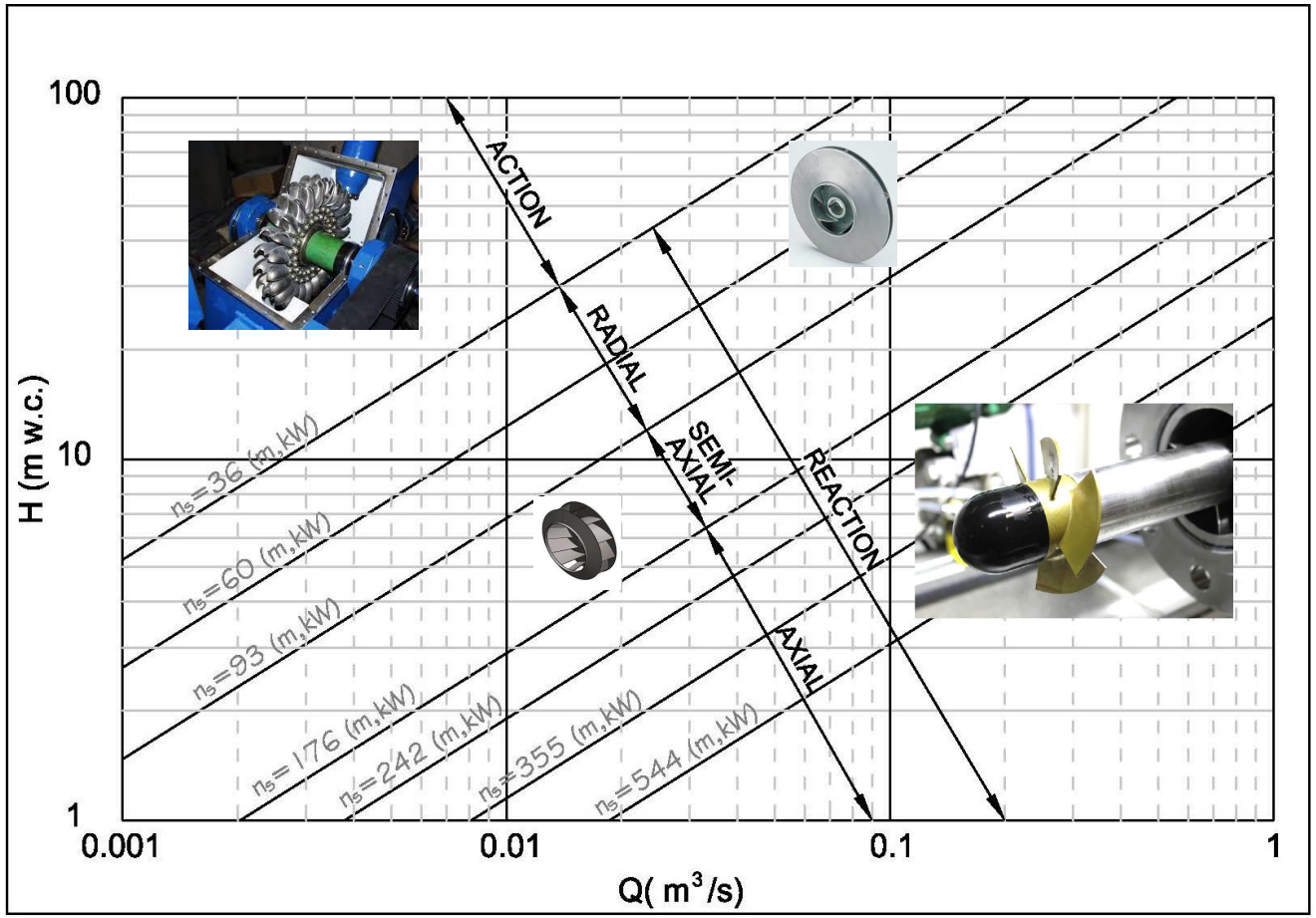
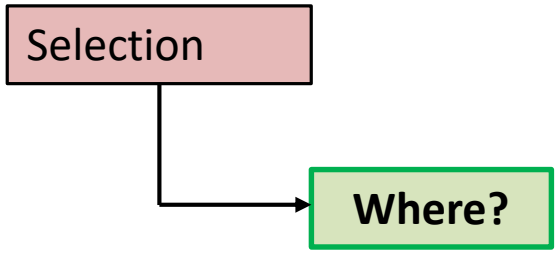


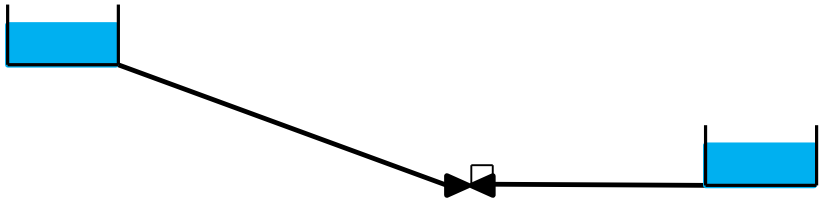
Towards sustainability in water distribution networks



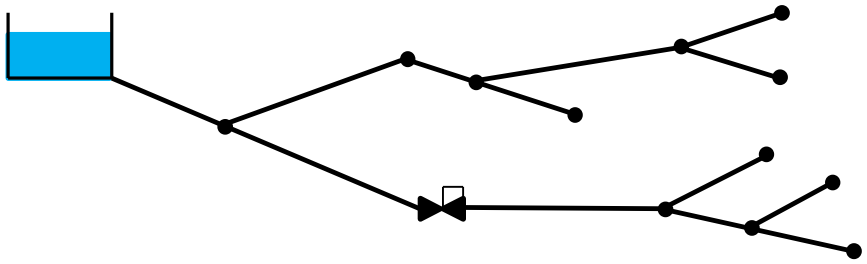
Machinery selection



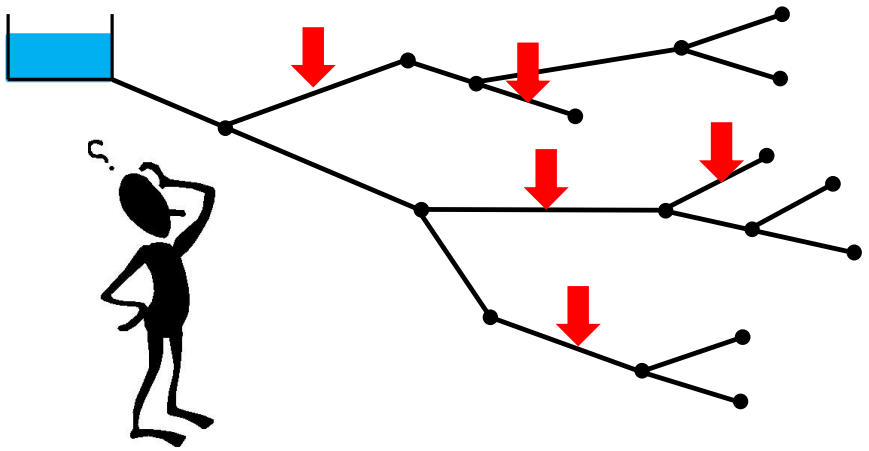
Case A

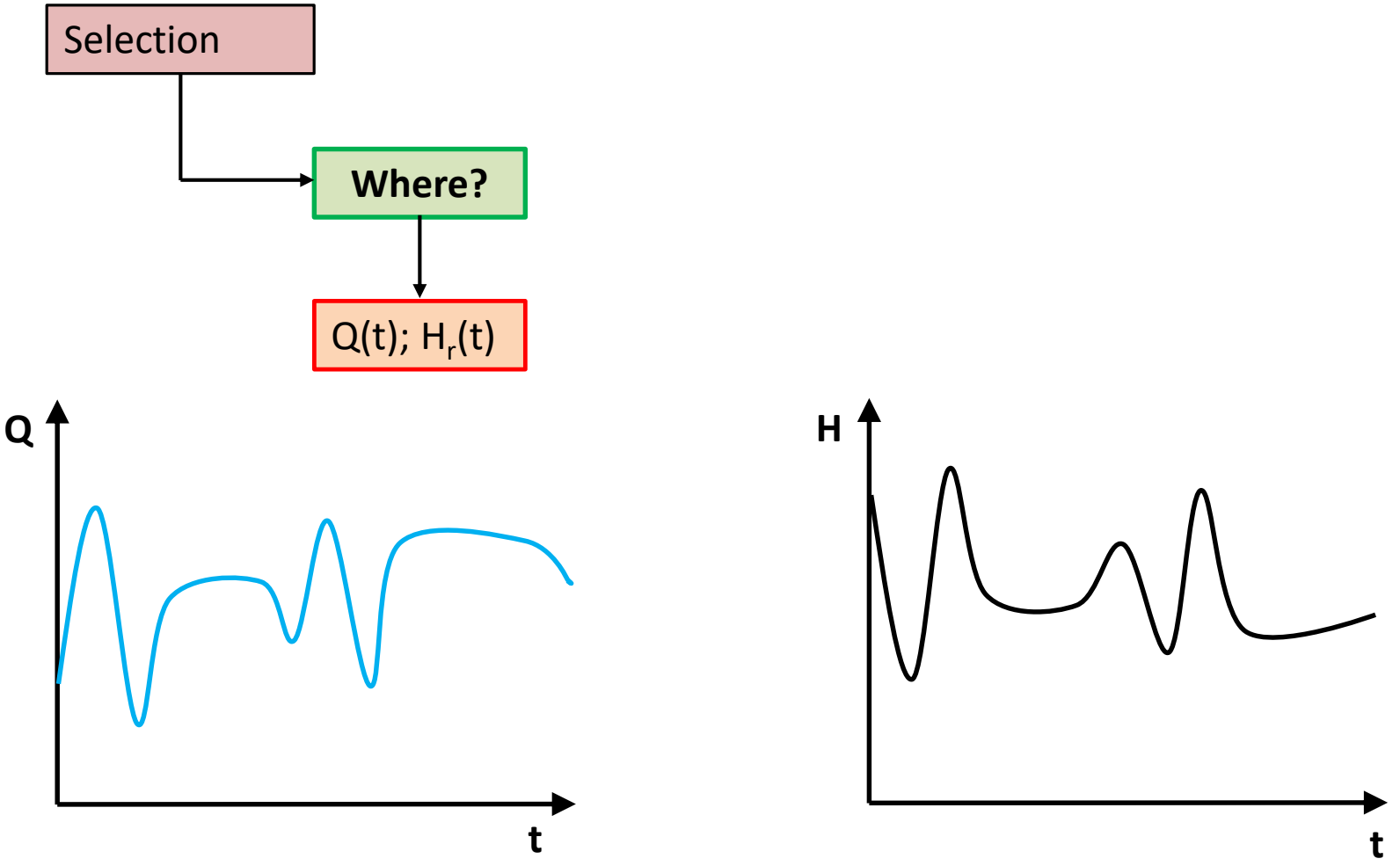


Case C



Case C



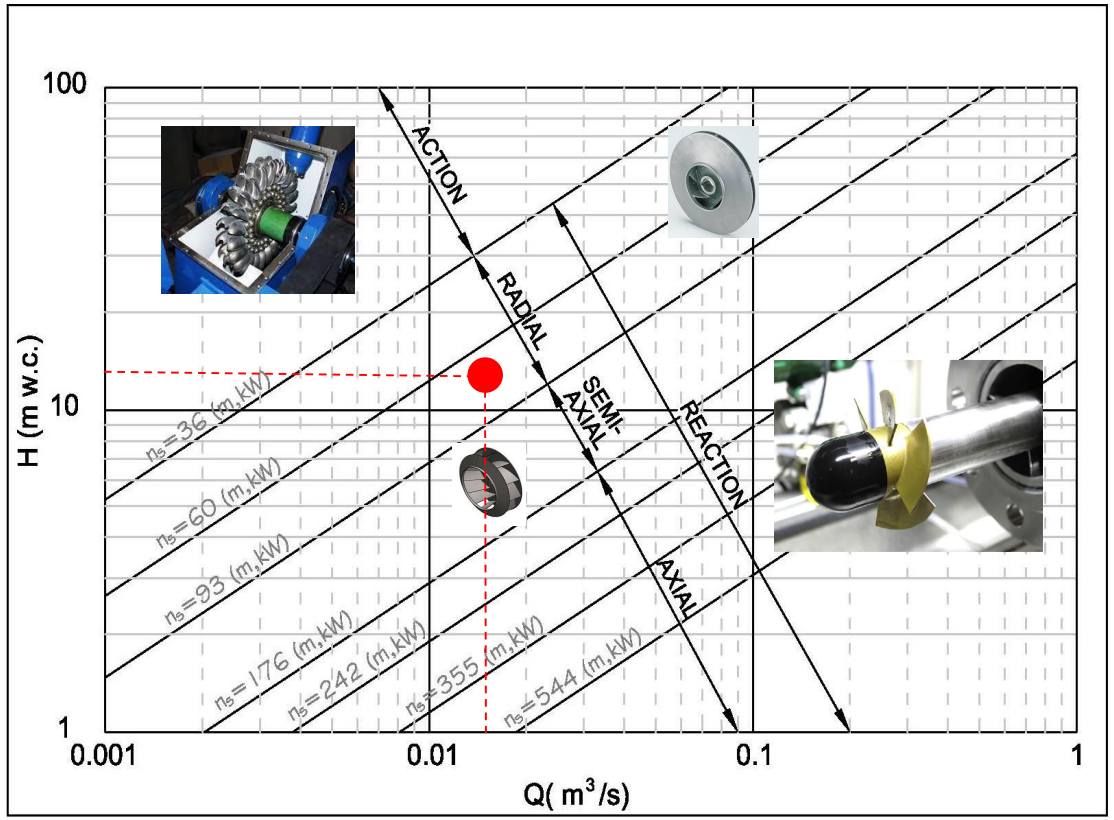

Selection
Where?
Q(t); H_r(t)
Q
t
H
t

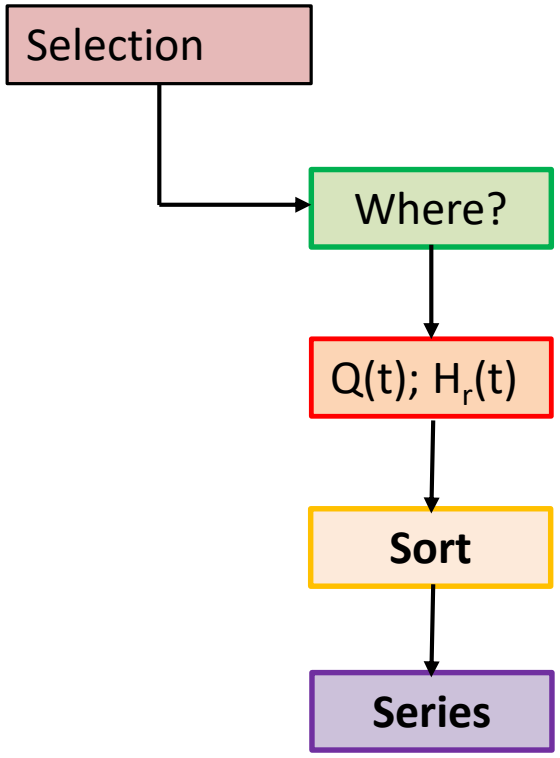
Selection

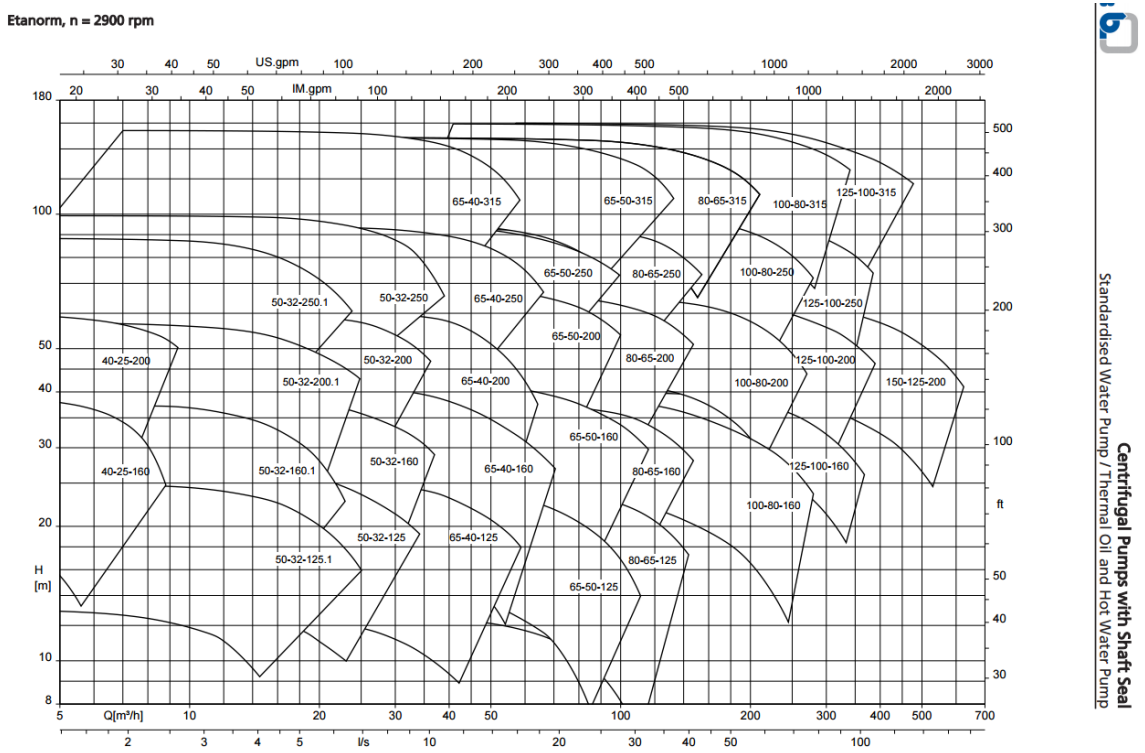
Where?

Q(t); H_r(t)

Sort




Selection
Where?
Q(t); H_r(t)
Sort
Series


Etanorm, n = 2900 rpm
US.gpm
IM.gpm
Q[m³/h]
l/s
H [m]
ft
65-40-315
65-50-315
80-65-315
100-80-315
125-100-315
65-50-250
80-65-250
100-80-250
125-100-250
50-32-250.1
50-32-250
65-40-250
65-50-200
80-65-200
125-100-200
40-25-200
50-32-200
50-32-200.1
65-40-200
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150-125-200
65-50-160
40-25-160
50-32-160.1
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65-40-160
80-65-160
125-100-160
100-80-160
50-32-125
65-40-125
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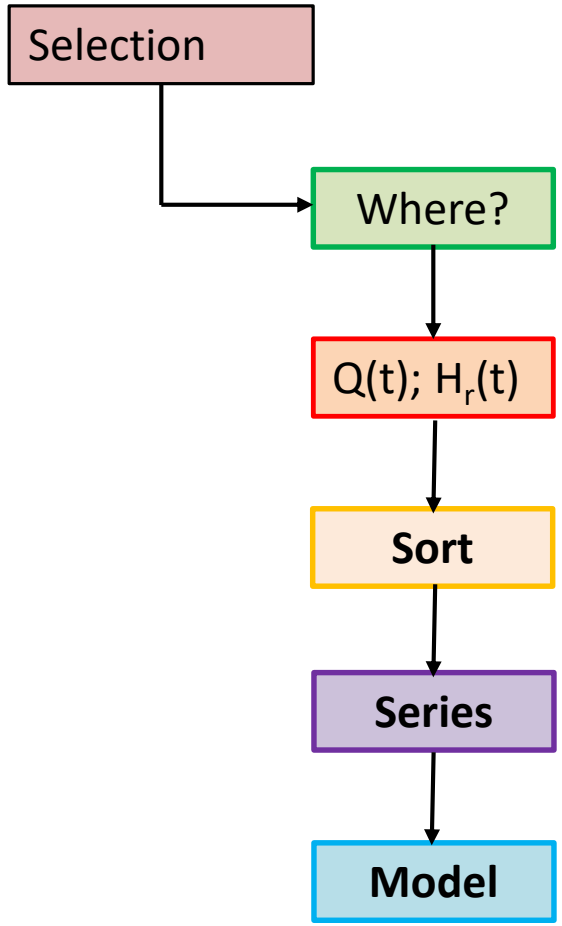
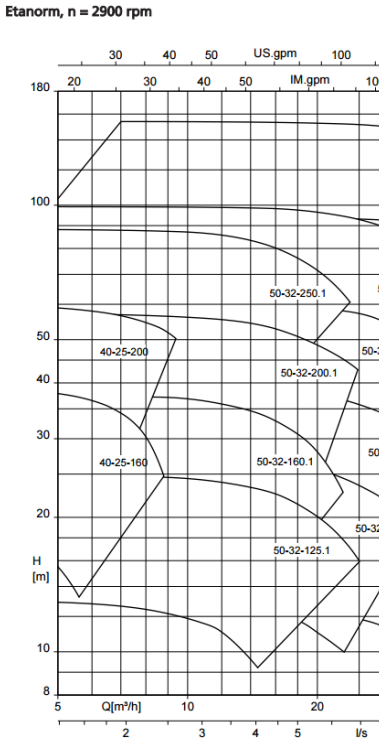
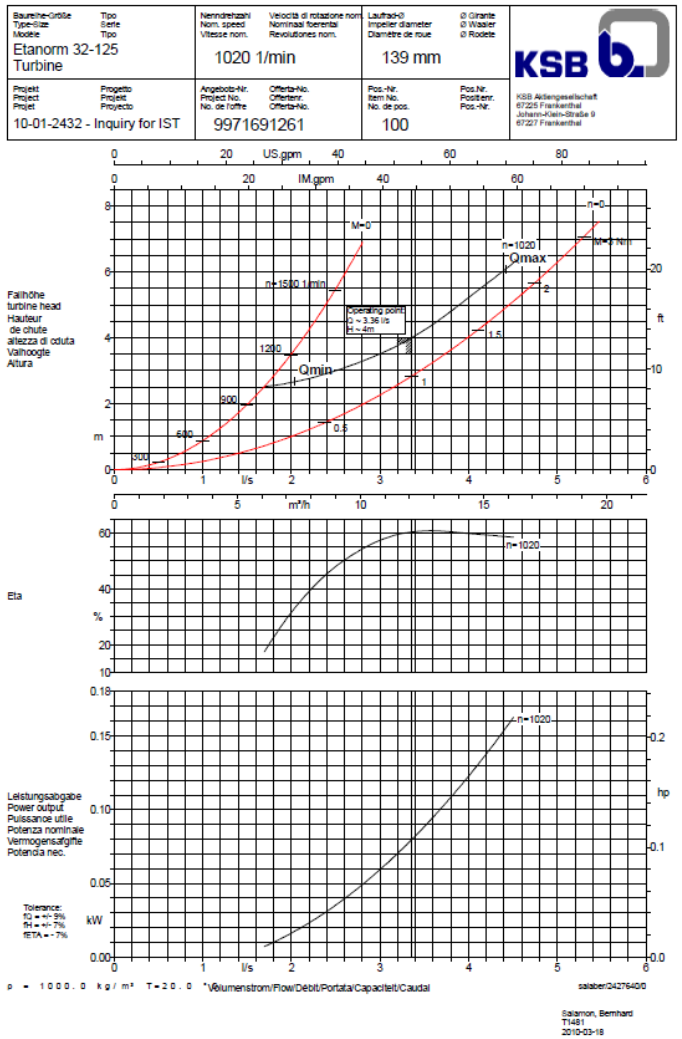
65-50-125

Centrifugal Pumps with Shaft Seal
Standardised Water Pump / Thermal Oil and Hot Water Pump

Towards sustainability in water distribution networks







Centrifugal Pumps with Shaft Seal

Towards sustainability in water distribution networks

Improving eficiency

↓

Energy audit

↓

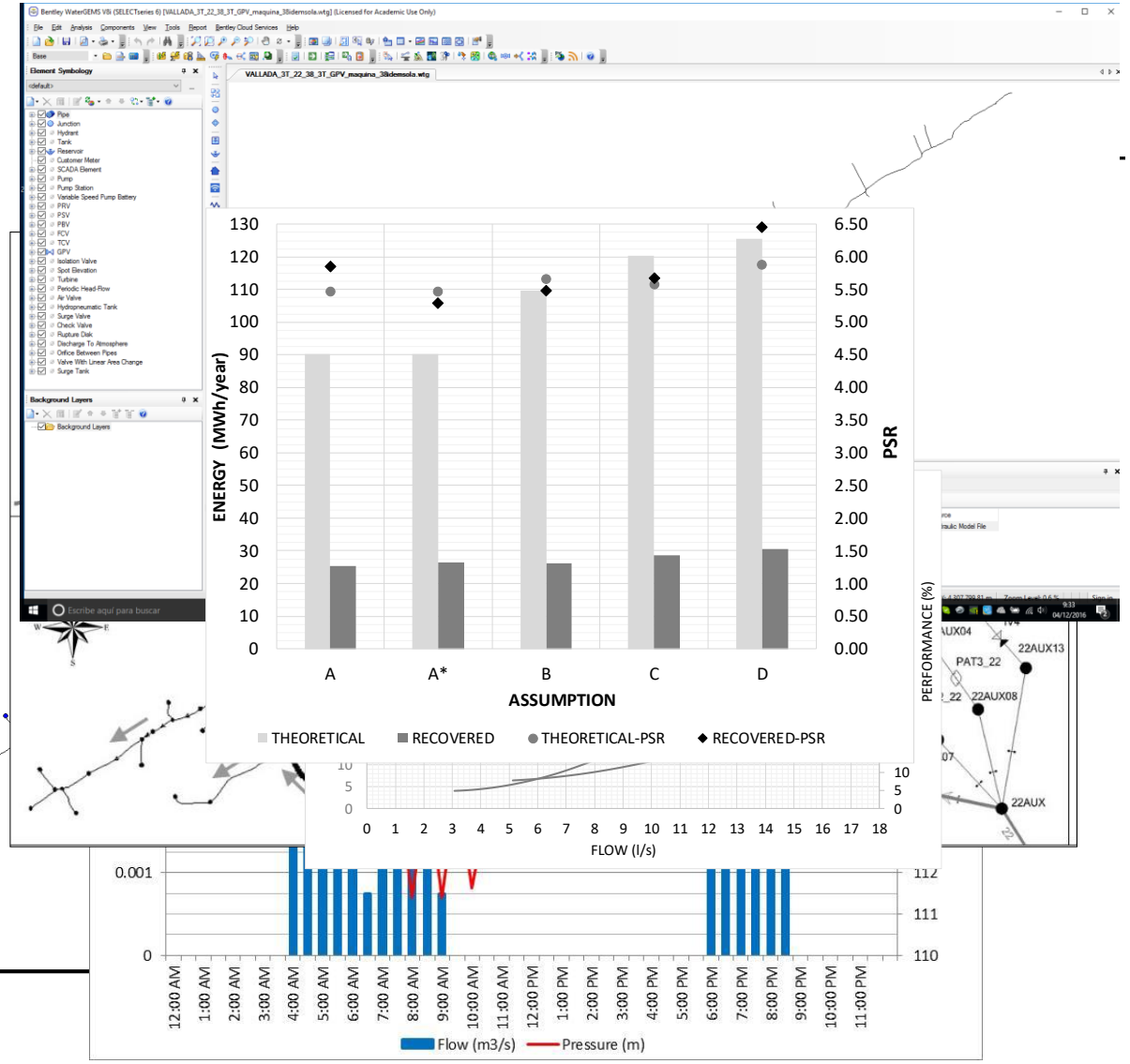
Energy balancce

↓

Flow and pressure

↓

Maximizing recovered energy



4. What can we do?

v) *Do not use the future generations resource:* **REUSE**

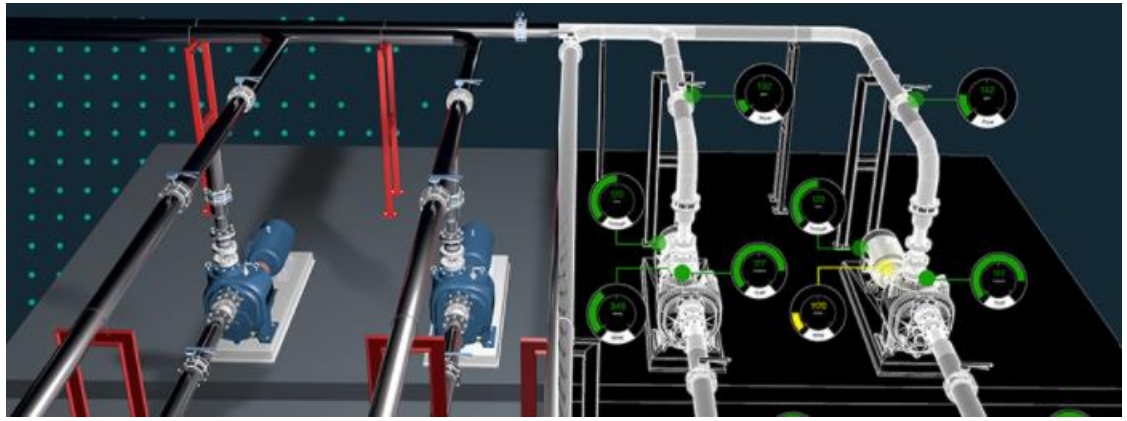
Using renewable energy in the maximum pumping stations

Solar pumping stations

4. What can we do?

vi) *Have a plan: Better a bad model than no model*

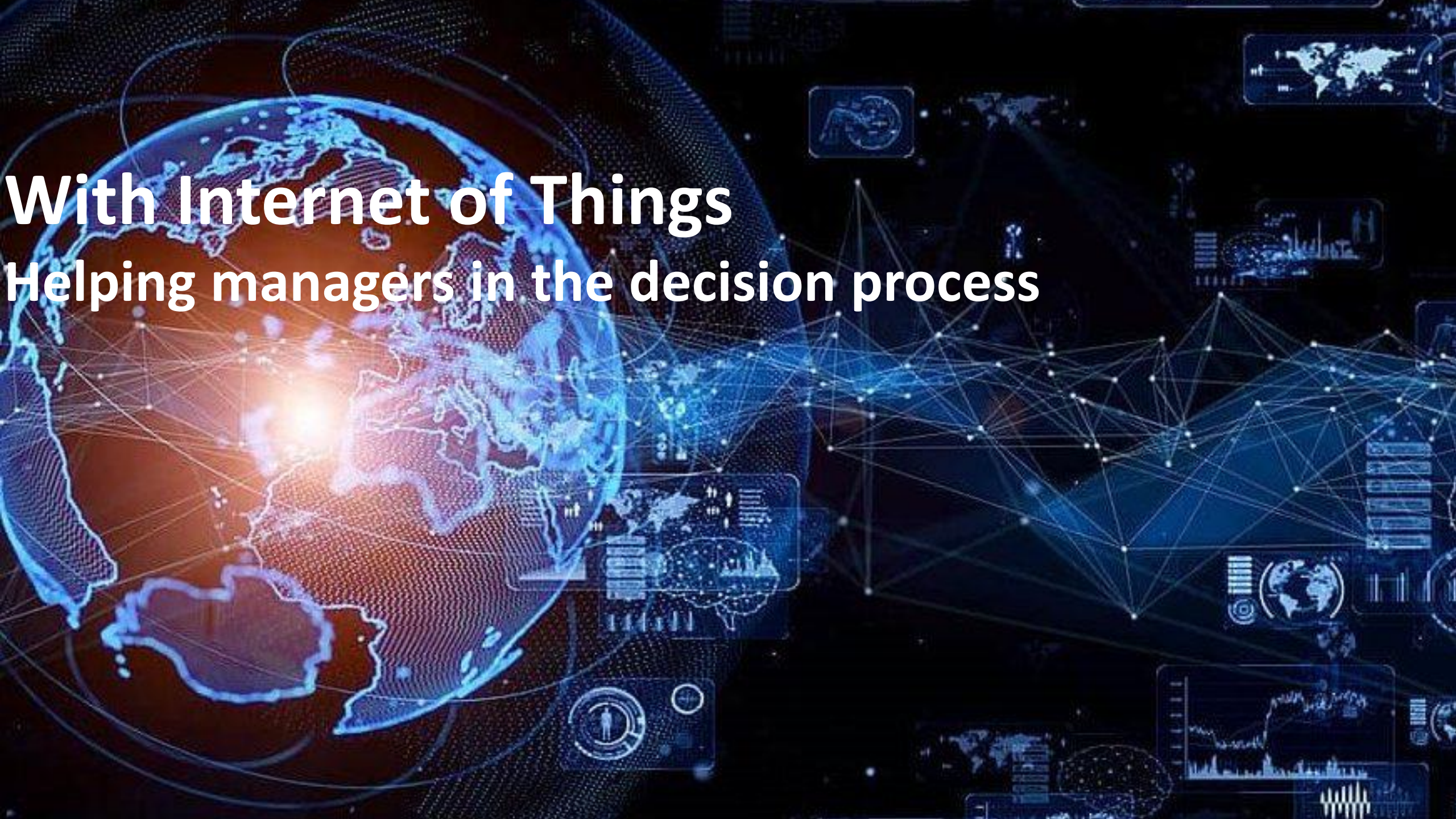
Maximizing **control** of leakages, transients and non desired actions. **DIGITALIZATION** is the best friend: **digital twins**



Across the digitalization pillars

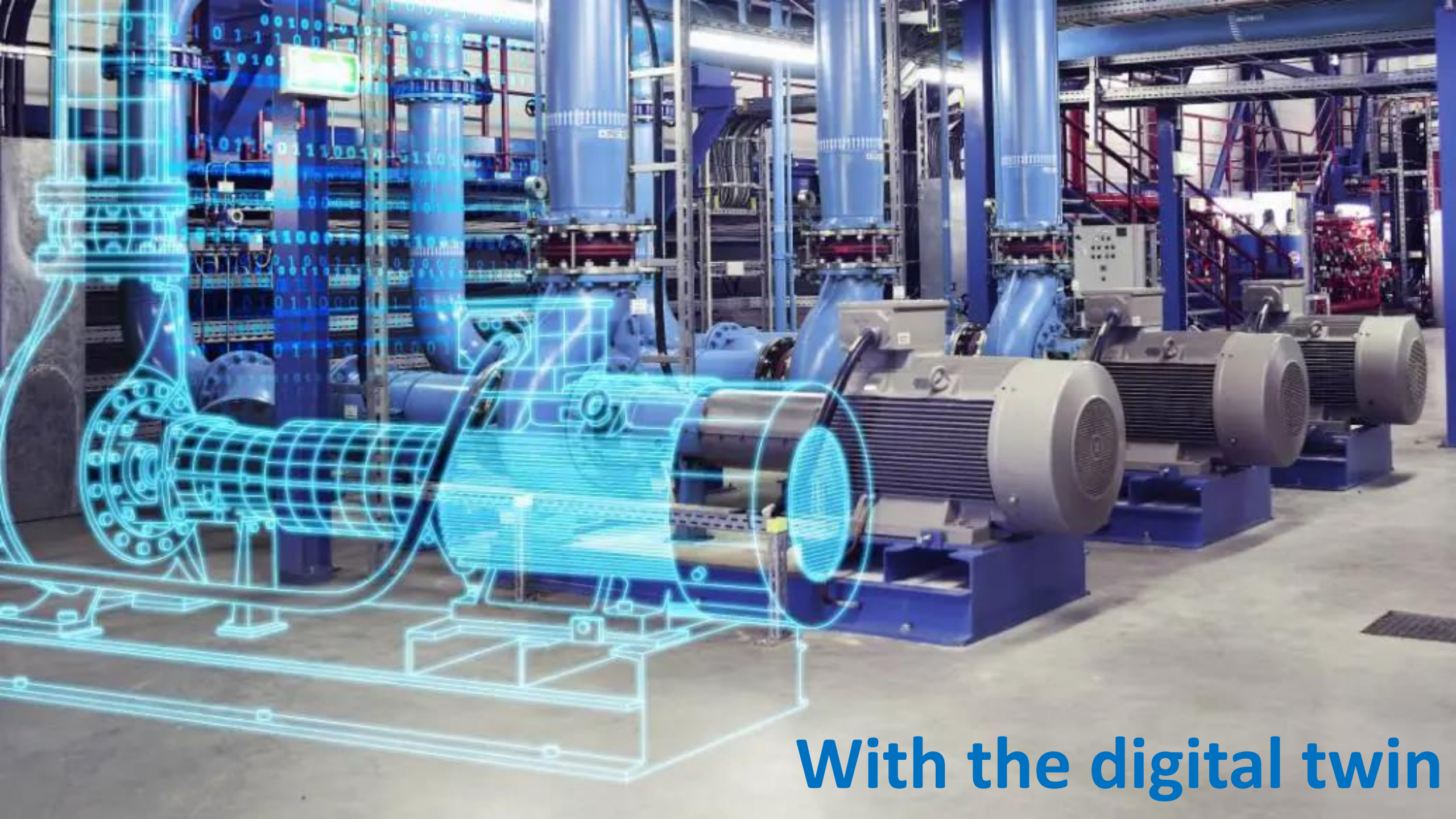
Sensoring

Modelling:
Model open the door of the Digital Twin


With Internet of Things
Helping managers in the decision process

With Artificial Intelligence

With rich data we will have precise decisions


With the digital twin

4. What can we do?

vii) *Anticipating*
Climate change and extreme events in cities.

Valencia.

October 14
1957

4. What can we do?

vii) *Anticipating*

Climate change and extreme events in cities.

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1957

4. What can we do?

vii) *Anticipating*
Climate change
and extreme events
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Valencia.

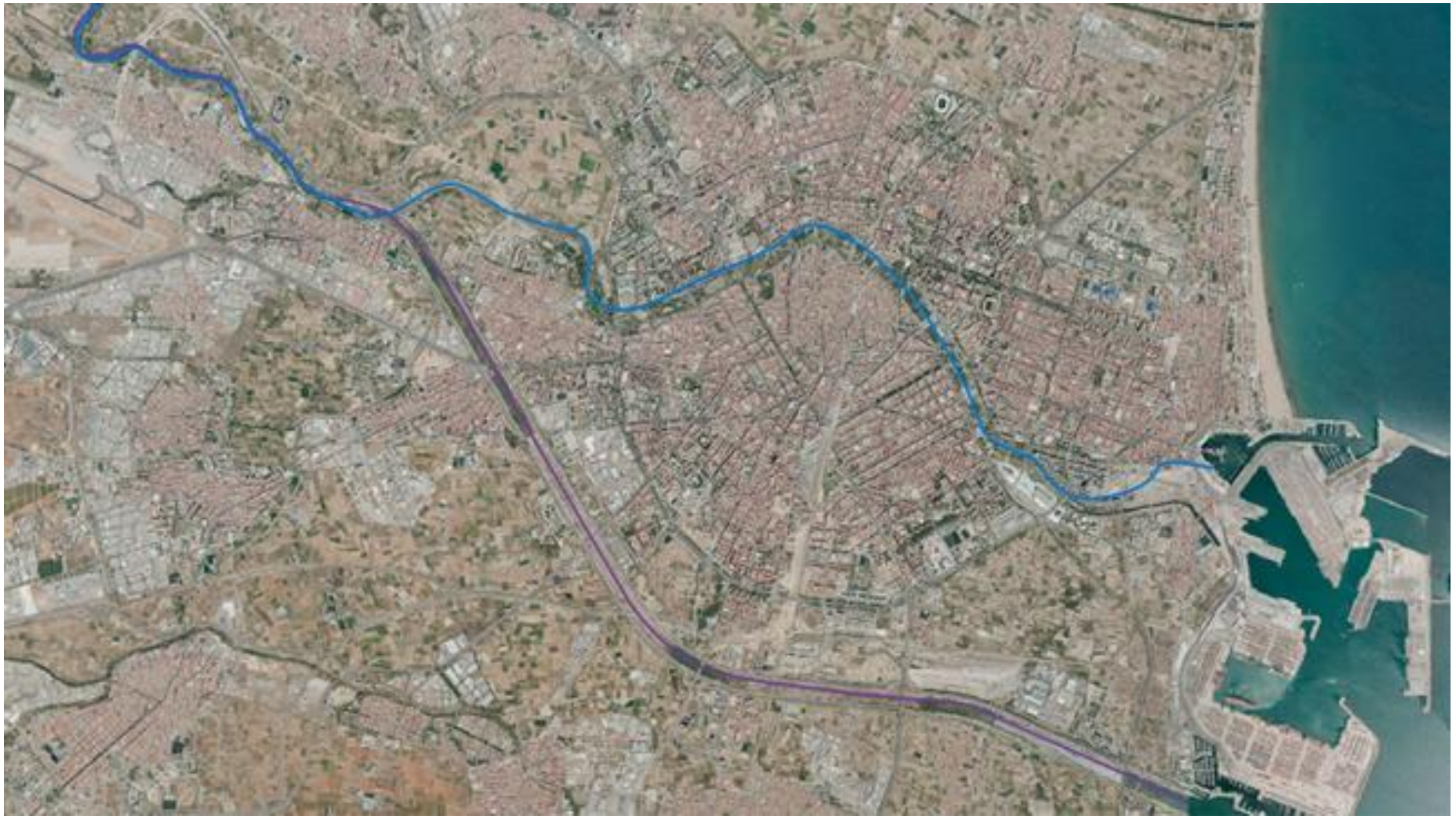
October 14
1957

4. What can we do?

vii) *Anticipating*
Climate change and extreme events in cities.

Valencia.

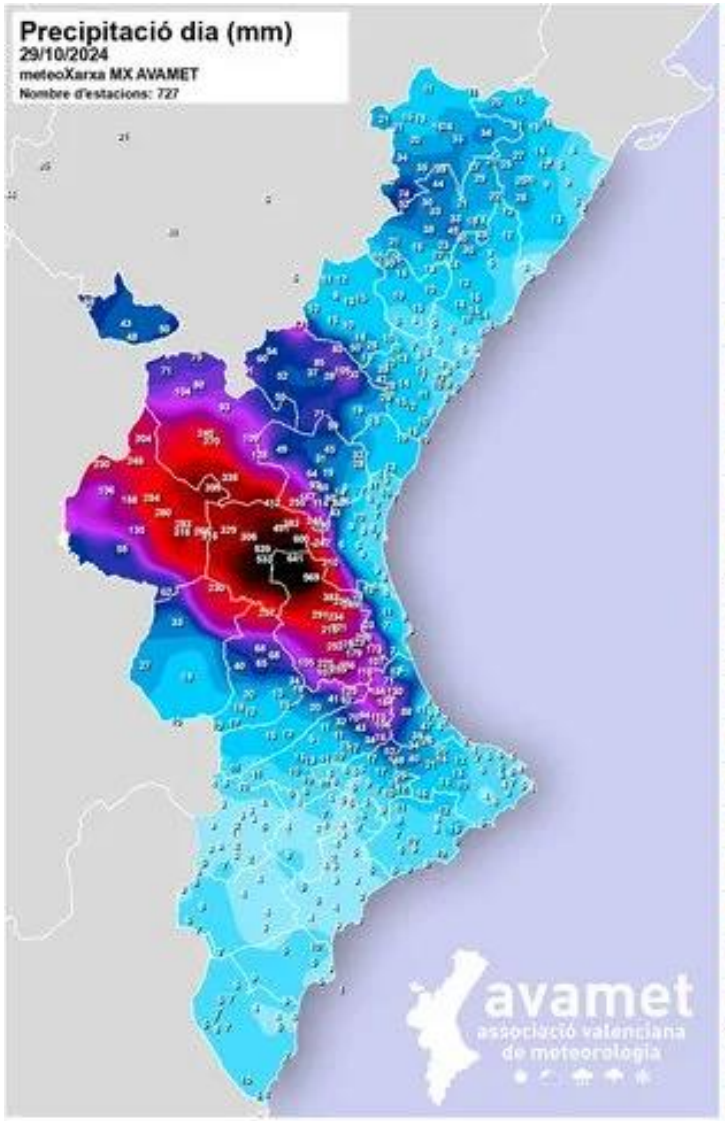
Plan SUR



4. What can we do?

vii) *Anticipating*
Climate change and extreme events in cities.

Valencia. October 29 2025

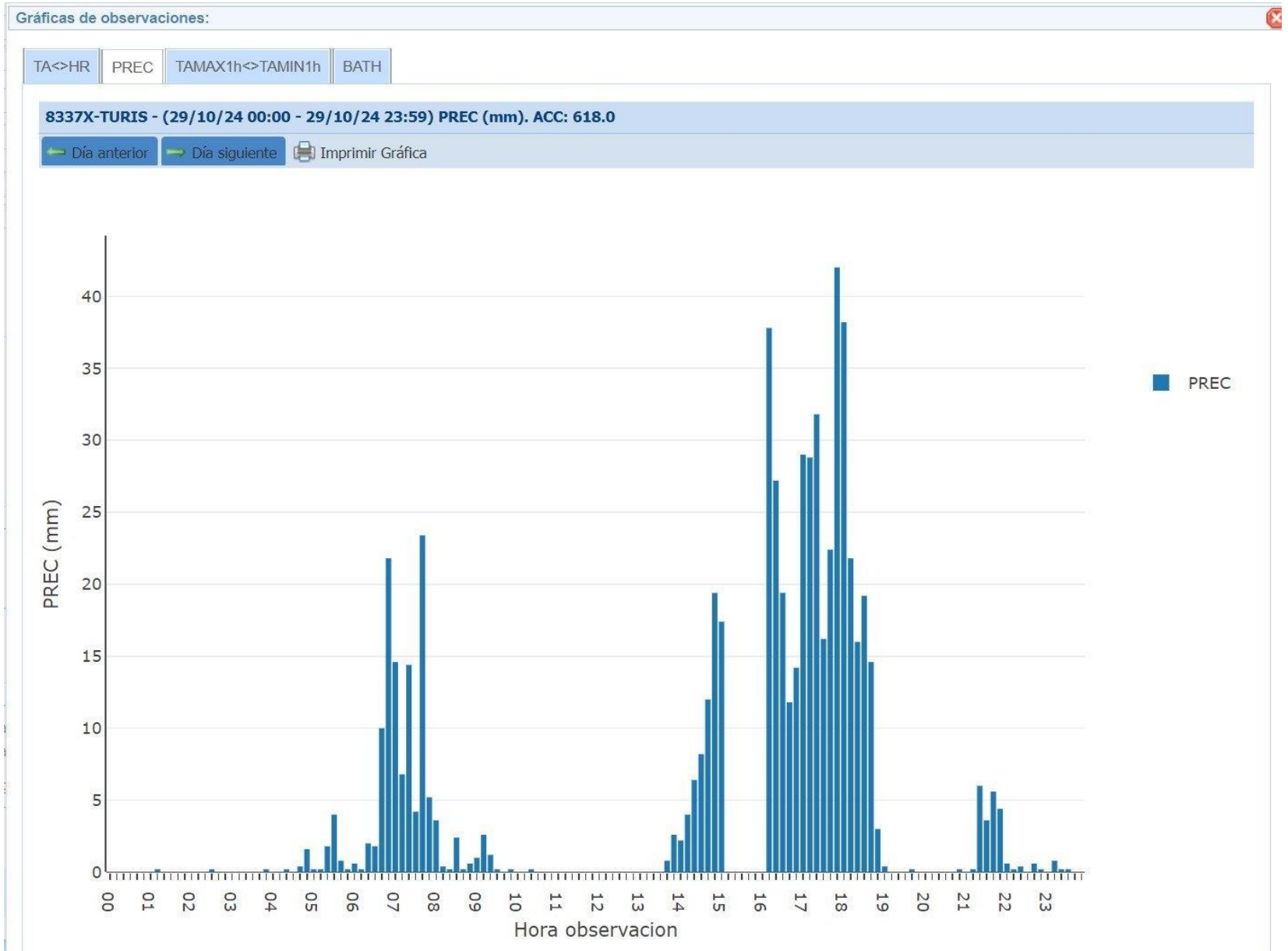


Torís	Canyapar	640,8	Carlet GP Suministros	256,0
Chiva	Los Felipes	600,2	Vilamarxant	La Pedrera	255,0
Real		569,2	Castelló	poble	253,4
Buñol		539,2	Massalavés		251,8
Macastre		533,0	Alginet	Urb. Los Lagos	250,0
Chiva		491,0	Alginet		249,0
Buñol	Partior	448,6	Loriguilla	Pozalet	247,8
Pedralba	Cueva del Terrero ivia	411,8	Utiel	**La Torre** Coop. S.Antonio	247,6
Chera		399,2	Chiva	Calicanto	241,6
Alfarb	el Puntal	382,8	Chelva		240,0
Cheste	centro	382,6	Carlet	Ajuntament	233,6
Siete Aguas		329,4	Vilamarxant	Mas de Teulada	232,8
Sot de Chera		327,8	Cortes de Pallás	**Venta de Gaeta**	230,2
Requena	Finca San Blas	318,4	Camporrobles	el Campillo	230,2
Requena	El Rebollar (Casa Ejarque)	316,4	Gavarda		227,0
Montserrat	Casadalt	309,6	Gavarda	la Travessa	225,4
Buñol	Alto Gordo	305,8	l'Alcúdia	Ajuntament	220,8
Carlet	Caseta del Banc	291,0	l'Alcúdia	Carriona	215,4
Utiel	este	284,0	Guadassuar	Complex de Valorització de Residus	210,2
Requena		283,2	Sinarcas	La Rallla	204,0
Requena	**San Antonio**	280,0	Riba-roja de Túria	la Reva	190,0
Calles	Parque de Emergencias	270,0	Caudete de las Fuentes	Ayuntamiento	187,8
Requena	**El Rebollar** (Coop. Nuestra Señora del Rosario)	266,0	Pinet		184,4
Alginet	sud	265,4	Simat de la Valldigna	**Pla de Corrals**	184,4
Alzira	nord / Polígon	258,6	Alzira	est / l'Alquenència	179,8
Millares		256,8	Carcaixent		179,2
la Pobla Llarga	IES Pere d'Esplugues	256,0			

4. What can we do?

vii) *Anticipating*
Climate change and extreme events in cities.

Valencia. October 29 2025



4. What can we do?

vii) *Anticipating*
Climate change and extreme events in cities.

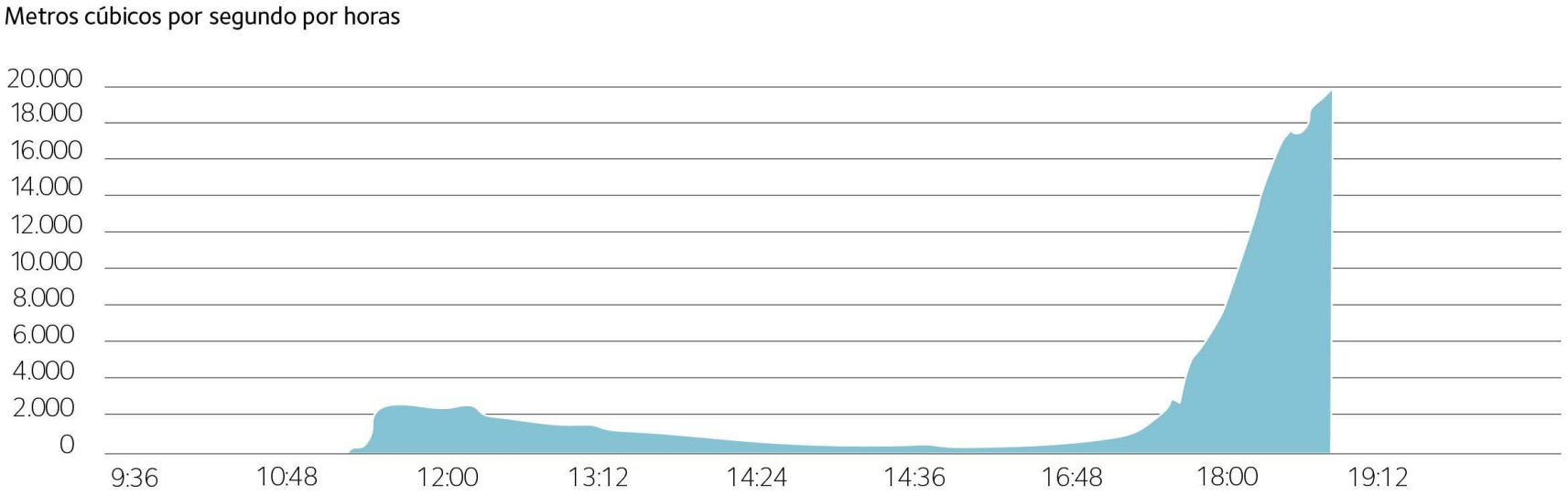
Valencia. October 29 2025

4. What can we do?

vii) *Anticipating*
Climate change and extreme events in cities.

Valencia. October 29 2025

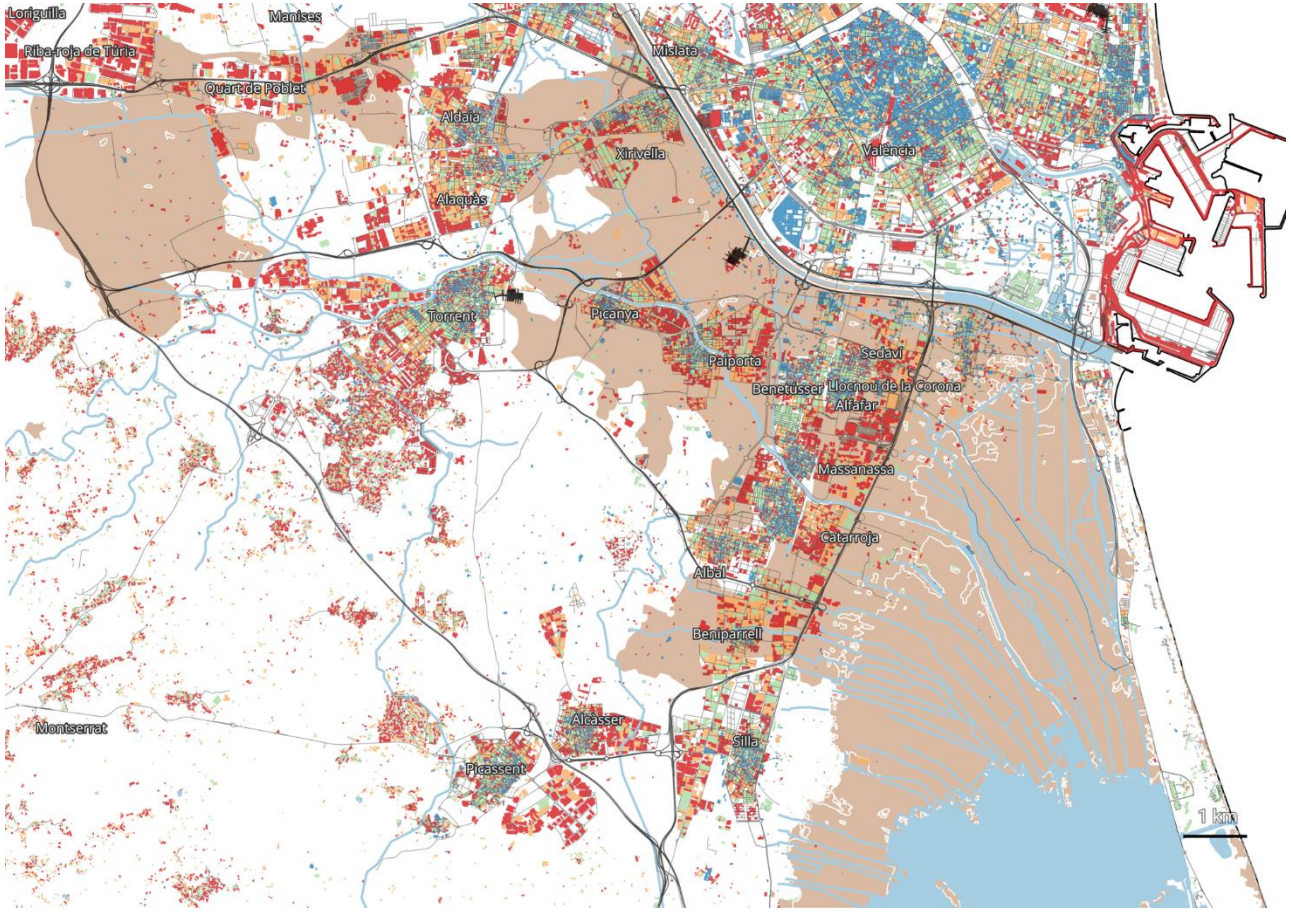
Flow in Barranco del Poyo

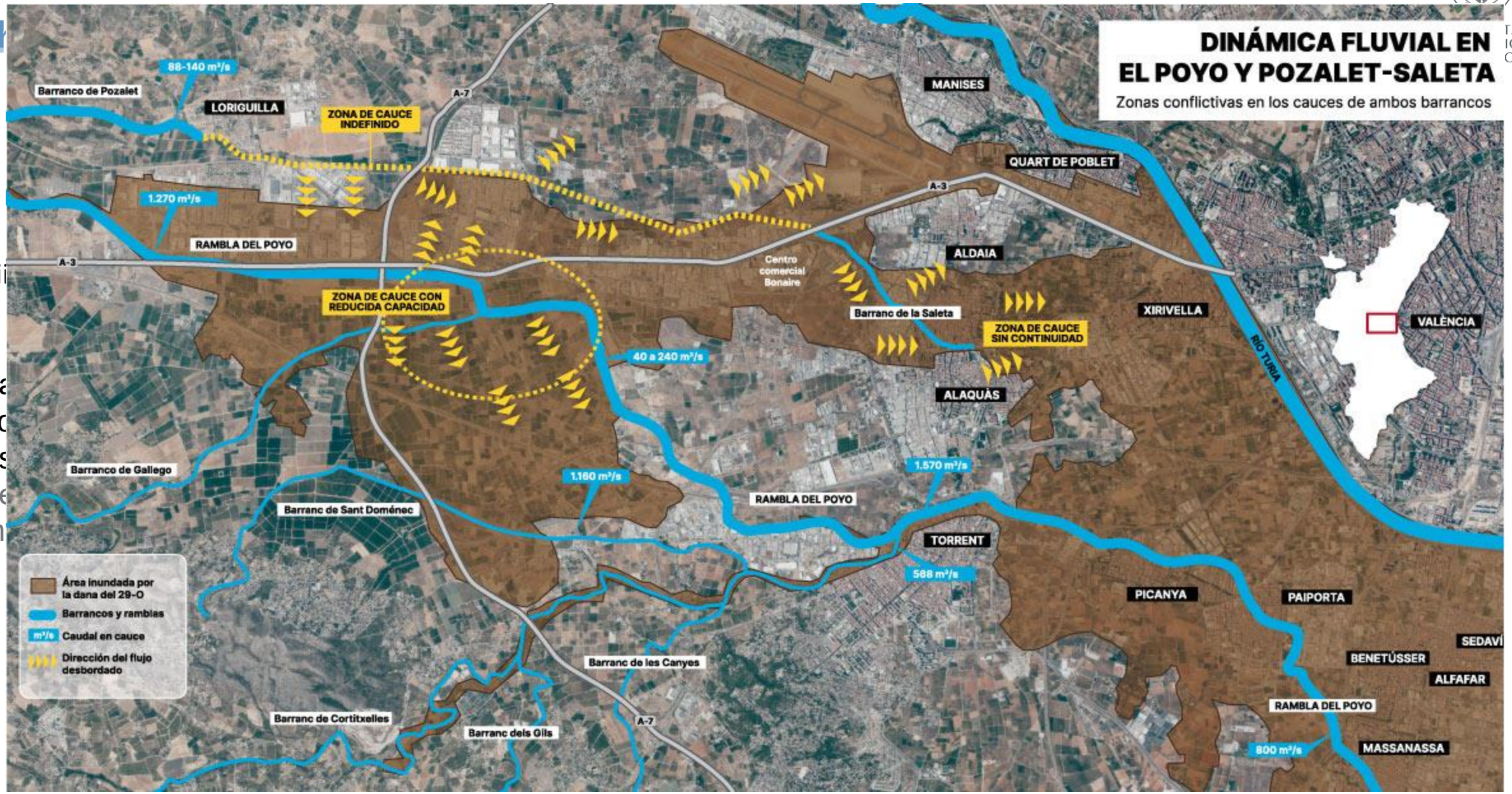


4. What can we do?

vii) *Anticipating*

There is one characteristic that makes these two ravines especially dangerous: a very high density of population and industry in their flood zone.




DINÁMICA FLUVIAL EN EL POYO Y POZALET-SALETA
Zonas conflictivas en los cauces de ambos barrancos
88-140 m³/s
Barranco de Pozalet
LORIGUILLA
ZONA DE CAUCE INDEFINIDO
A-7
MANISES
QUART DE POBLET
A-3
1.270 m³/s
RAMBLA DEL POYO
A-3
Centro comercial Bonaire
ALDAIA
ZONA DE CAUCE CON REDUCIDA CAPACIDAD
Barranc de la Saleta
ZONA DE CAUCE SIN CONTINUIDAD
XIRIVELLA
VALÈNCIA
RIO TURIA
40 a 240 m³/s
ALAQUÀS
Barranco de Gallego
1.160 m³/s
1.570 m³/s
RAMBLA DEL POYO
Barranc de Sant Doménec
TORRENT
588 m³/s
PICANYA
PAIPORTA
SEDAVÍ
BENETÚSSER
ALFAFAR
Barranc de les Canyes
RAMBLA DEL POYO
Barranc de Cortitxelles
Barranc dels Gils
A-7
800 m³/s
MASSANASSA
Área inundada por la dana del 29-O
Barrancos y ramblas
m³/s Caudal en cauce
Dirección del flujo desbordado

4. What can we do?

vii) *Anticipating*

If we do not invest in anticipation, we will have to repair

UPV
departamento de ingeniería hidráulica y medio ambiente
dihma

4. What can we do?

vii) *Anticipating*

If we do not invest in anticipation, we will have to repair

4. What can we do?

vii) *Anticipating*

If we do not invest in anticipation, we will have to repair

4. What can we do?

vii) *Anticipating*

This is not the way towards sustainability in water circle

4. What can we do?

vii) *Anticipating*

Somethings can not be replaced

DANA >

Los juzgados elevan la cifra de fallecidos por la dana a 227 personas

El cómputo surge tras declarar como muertos a dos de los tres desaparecidos tras la mayor catástrofe natural que ha sufrido Valencia

Monitoring

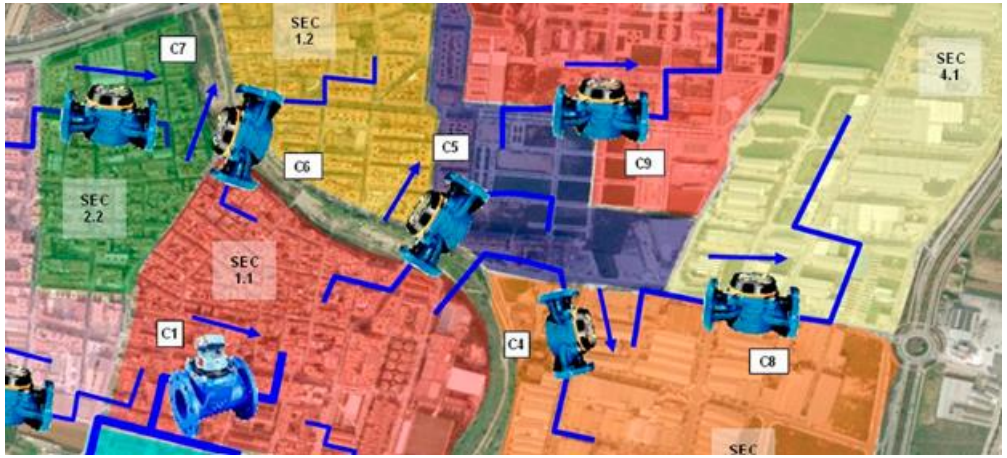
Digitalizing

Optimizing

Anticipating

Sectorizing

RECOVERING

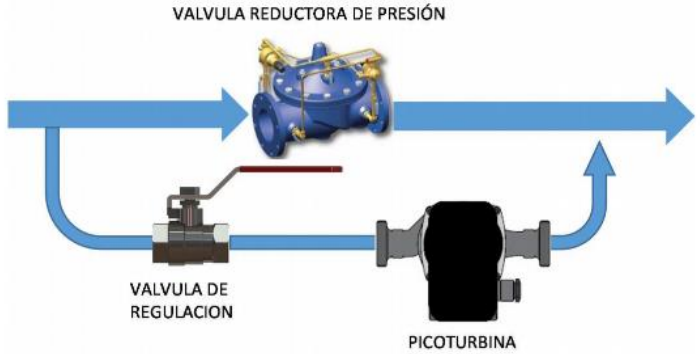


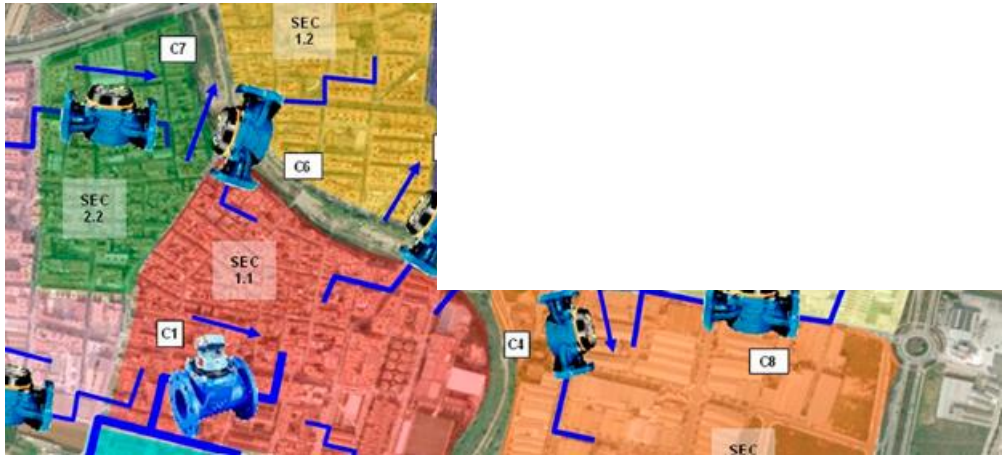
Monitoring

Optimizi

Sectorizin

Renewable





Combined with

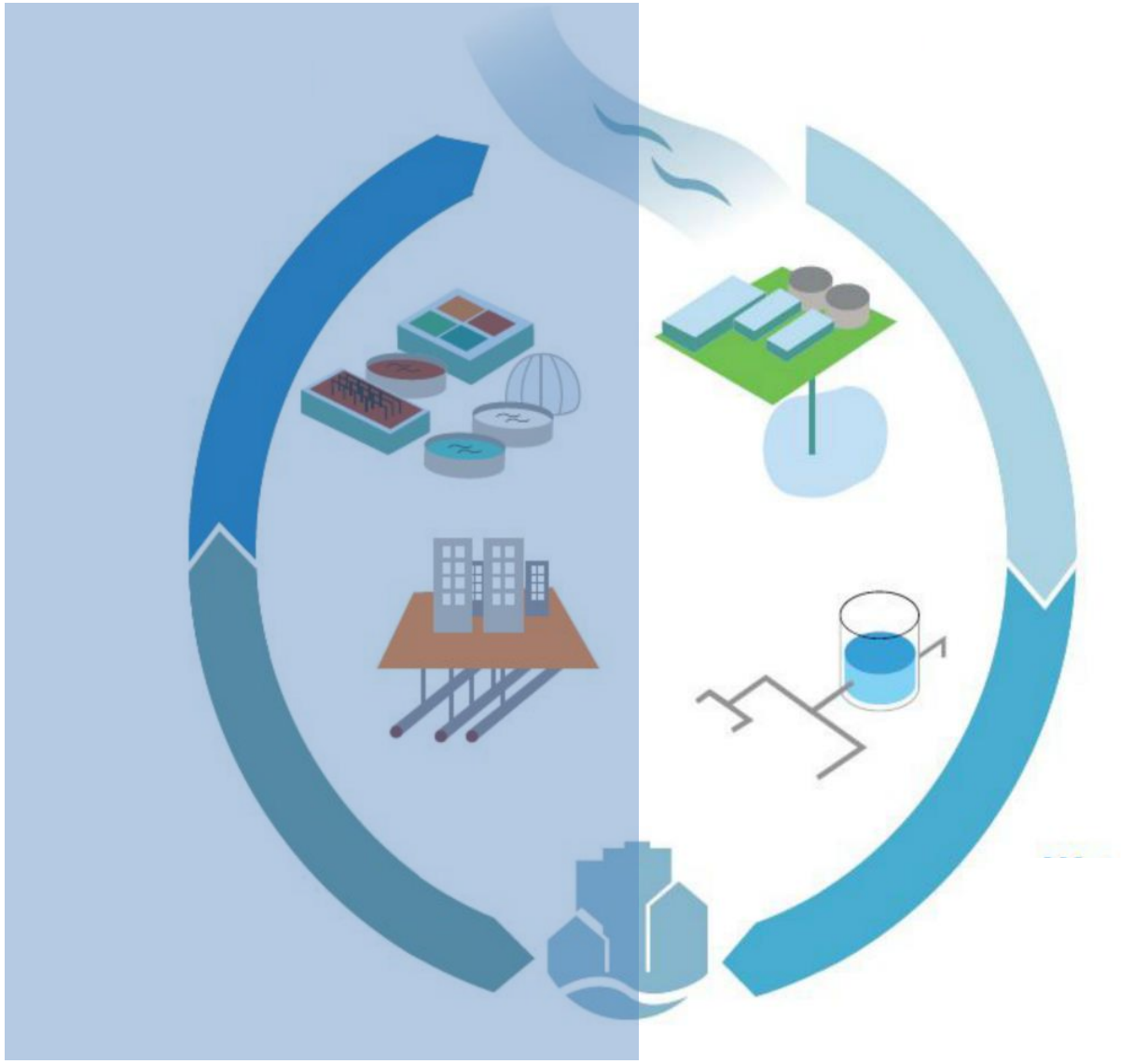
Drainage: SUDS

Depuration: Water reuse

Combined with:

Depuration: Re-Use

Drainage: SUDS



Towards sustainability in water distribution networks

This is the way

Optimizing
Sectorizing
Monitoring
Digitalizing
Recovering

Anticipating


THANKS!
P. Amparo López Jiménez. palopez@upv.es

Towards sustainability in water distribution networks.

P. Amparo López Jiménez

palopez@upv.es

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