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*IST, 7 Outubro 2019*

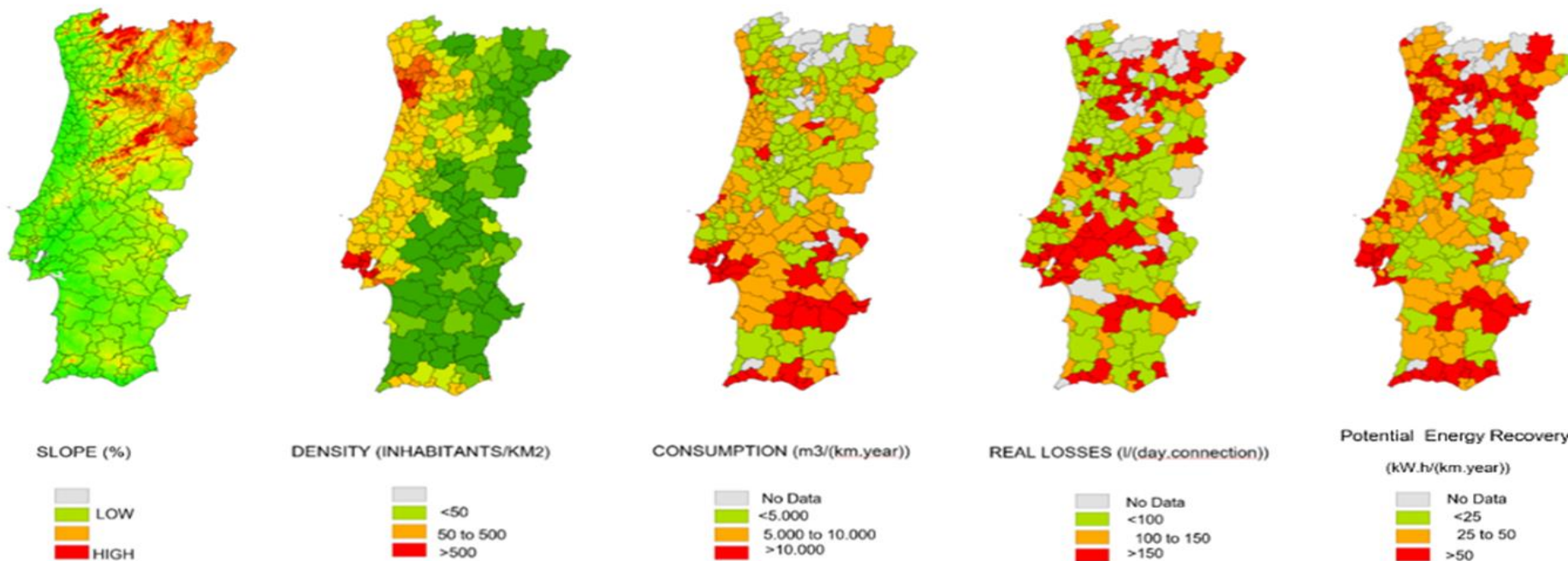
# Microhídricas

“A pessimist sees the difficulty in every opportunity; an optimist sees the opportunity in every difficulty” – Winston Churchill

Avaliação do potencial energético em sistemas de abastecimento

$$V. Recovered (m^3 / (km. year)) = \frac{municipality\ slope\ (\%)}{20} \times 100 \times Consumption (m^3 / (km. year))$$

$$E. Recovered ((kWh) / km. year) = V. Recovered (m^3 / (km. year)) \times \eta \times \gamma \times g \times h (m)$$



As turbinas instaladas estariam operacionais 12h / dia; rendimentos médios de 50%; queda de 2 bar para cada PRV a ser substituída por uma micro-hídrica.

Assim, o potencial de recuperação de energia foi calculado para cada município, conforme ilustrado na figura. Foi estimado que 7000 MWh / ano poderiam ser gerados se todo o potencial de geração de energia fosse explorado.

Figure 62 – Terrain slope (Hasen, 2010), density of inhabitants (INE, 2011), water consumption rates (ERSAR, 2018), real water losses within water distribution systems (ERSAR, 2018) by region, Potential for energy recovery in water distribution systems by region.



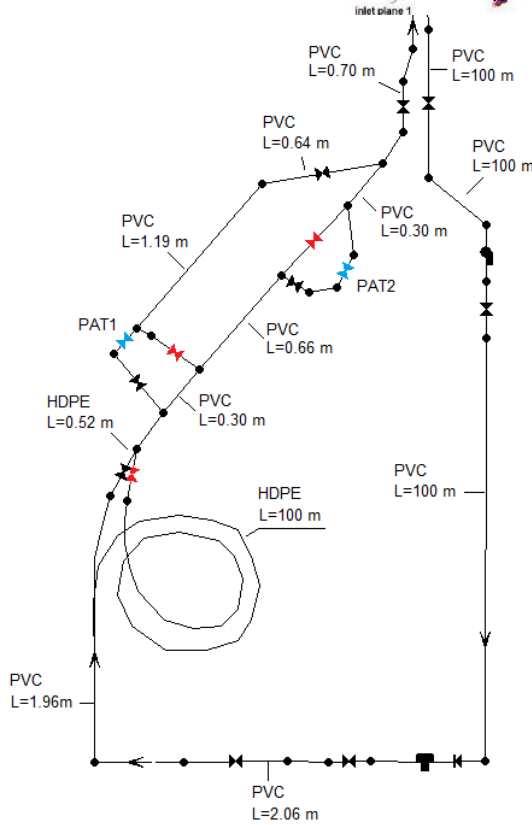
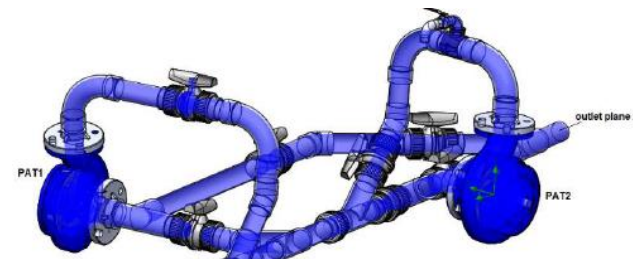
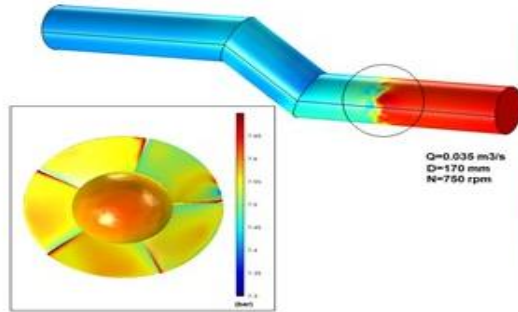
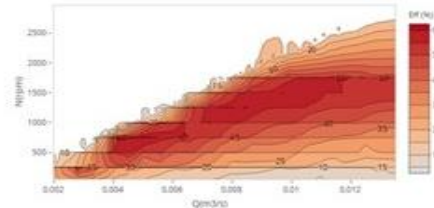
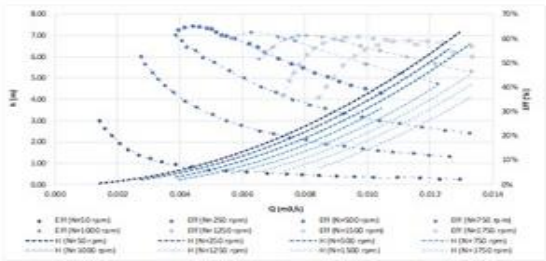
# Investigação no IST

EXP  
ND=85 mm

CFD



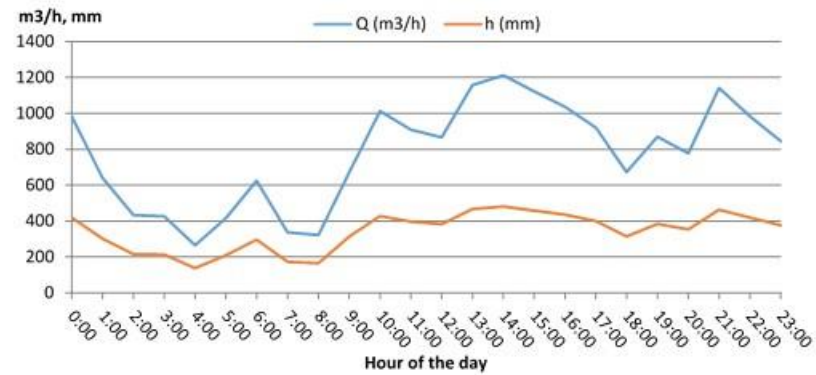
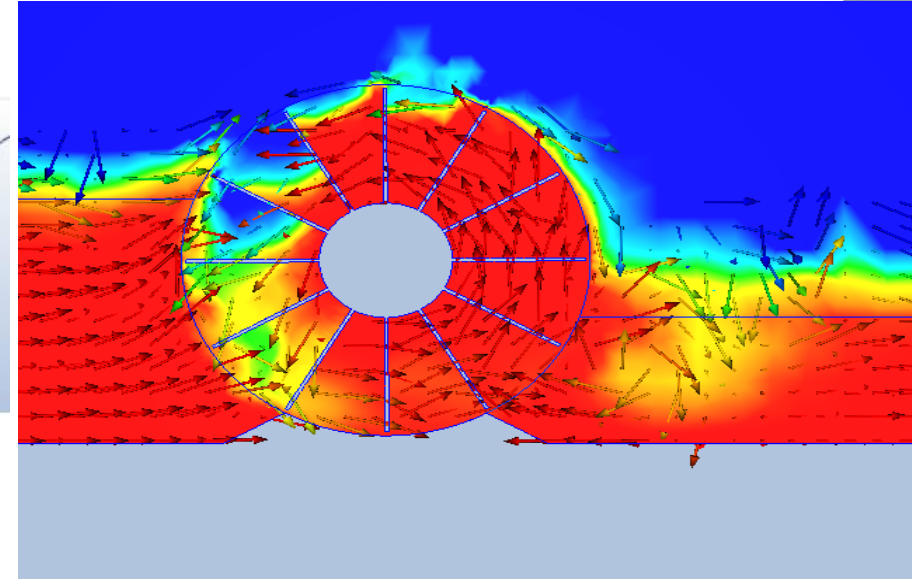
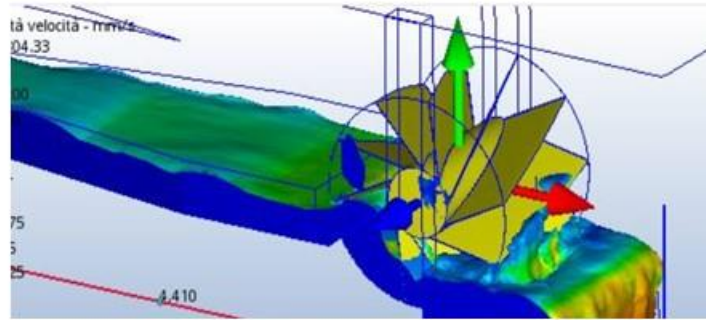
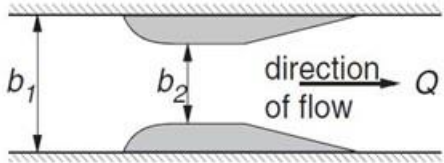
The turbine with DN of 85 mm was tested to experimental campaigns with a larger range of heads and flow measurements to access its performance. These results were extrapolated to other geometrically similar turbine with 170 mm. Both geometries are numerically investigated using CFD models to quantify the potential for hydropower and applied considering different network scenarios



# Análises de CFD para estudar o comportamento do escoamento

Canais de rega

ETAR – canal de saída





# Estudos e projetos



## Madeira – Funchal e Sta Cruz

Water Distribution Systems (WDS)

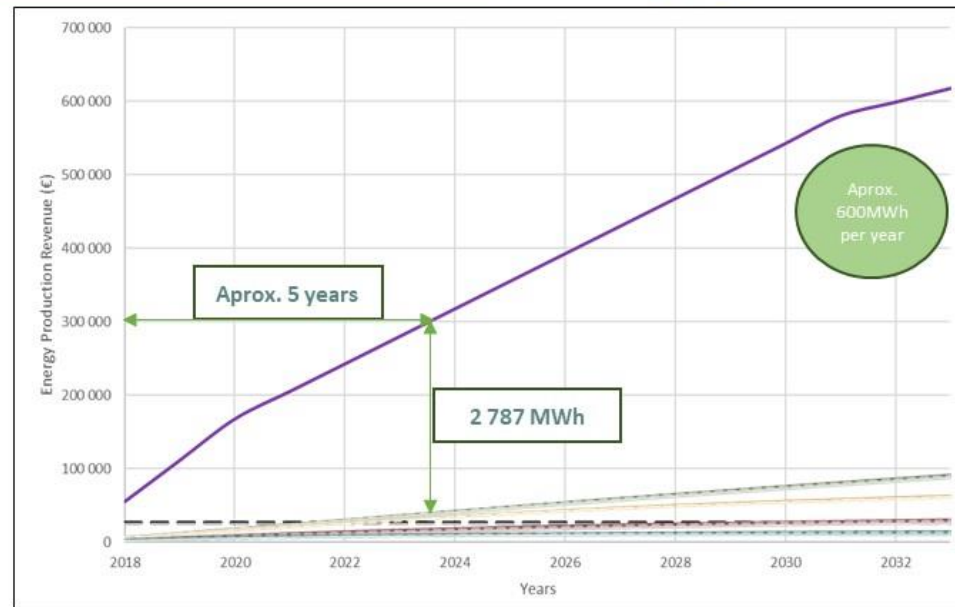
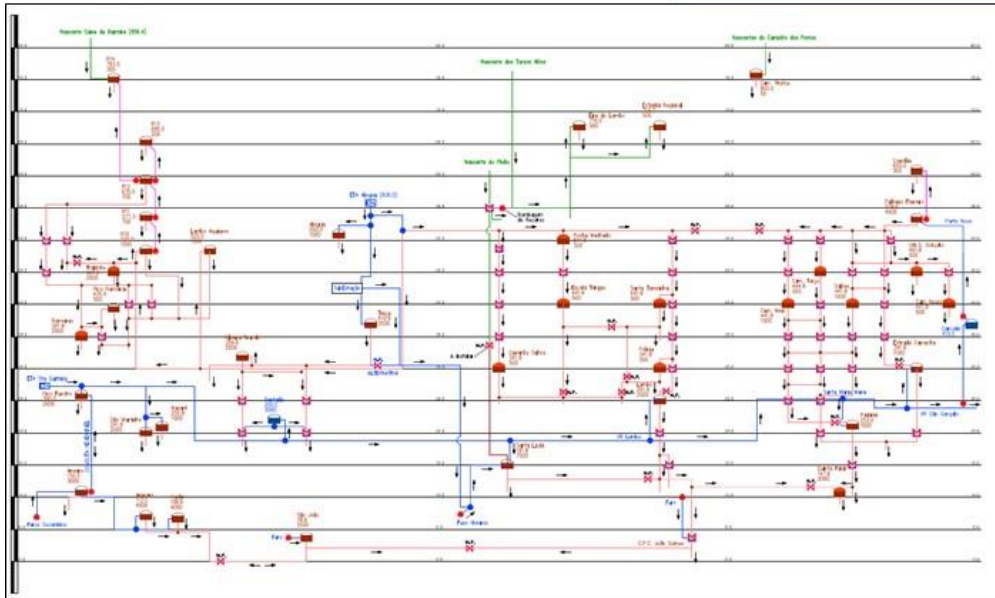
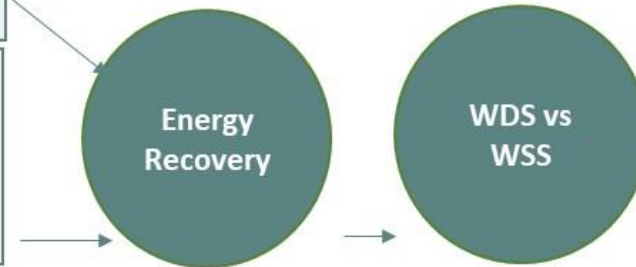
Water Supply Systems (WSS)

- The total consumptions is divided in the network;
- The Hydraulic system is analysed in order to improve its efficiency;
- Pressure Restrictions (Max and Min).

WDS

- Less Pressure restrictions.
- The total consumption is turbinated.
- Constant (or zero) flow.
- Less complexity.

WSS



In WSS

In WDS



# Zonas remotas de África

Aguardam novos desenvolvimentos

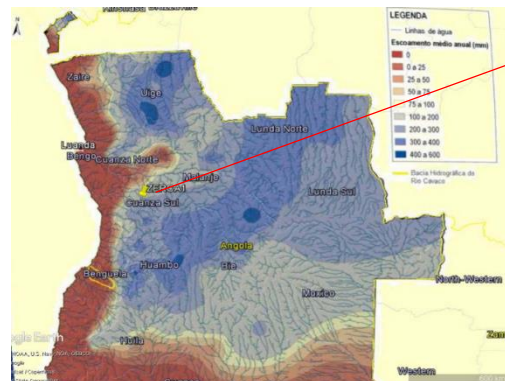
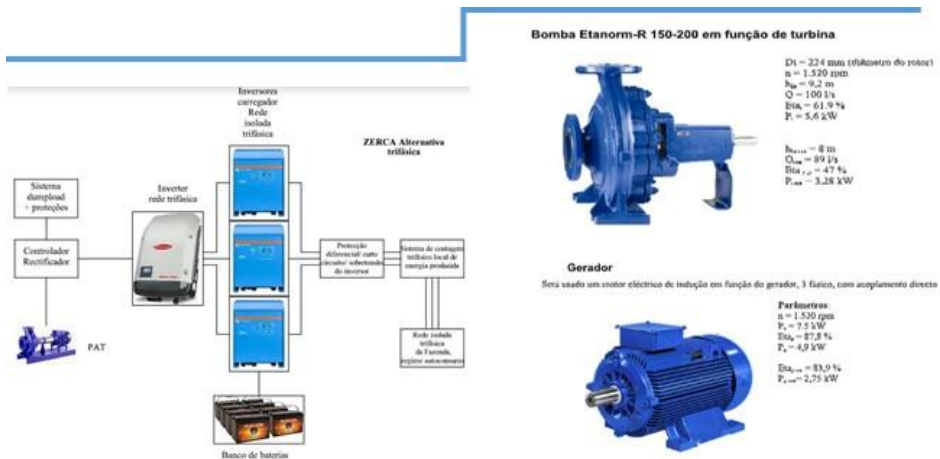
Angola - Zerca

A falta de energia barata é um obstáculo ao desenvolvimento económico de um país. A rede elétrica não cobre todo o país. Para alimentar energia às fazendas e indústria eles usam geradores a diesel.

- investment cost around 16 000 €

O consumo mensal é à volta de 1000 l de diesel. As despesas dessa matéria prima (diesel) incluindo a distribuição e a manutenção aumenta o custo de energia para cerca de 35€/ dia, 1050€ / mês, 12600€ / ano.

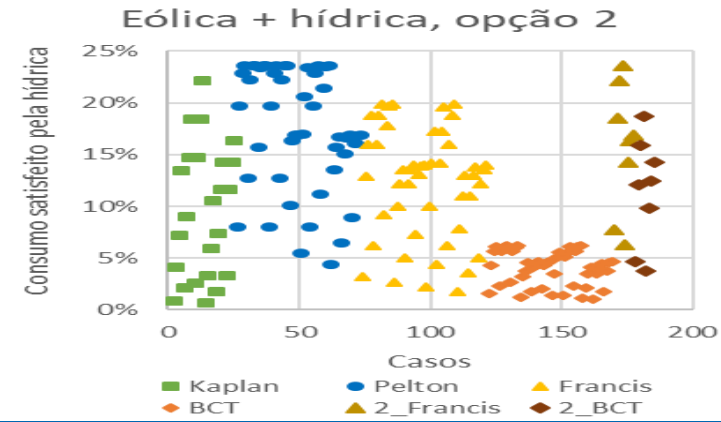
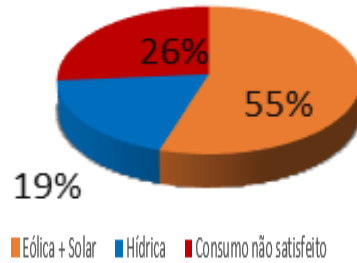
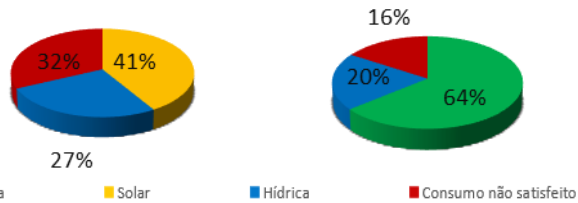
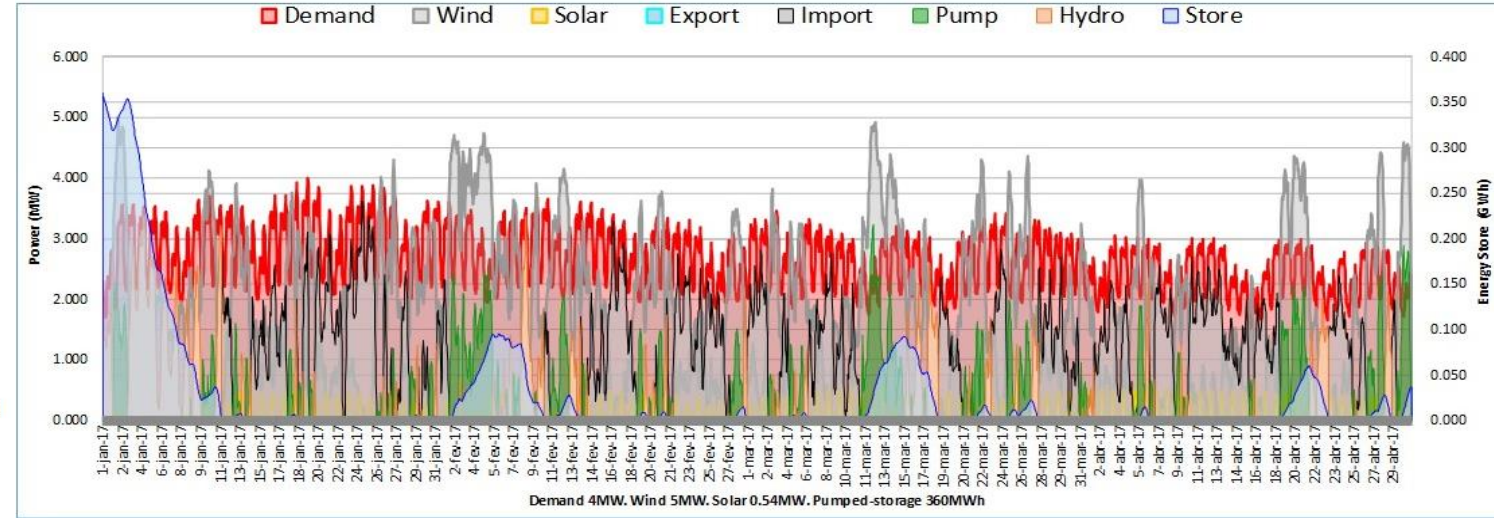
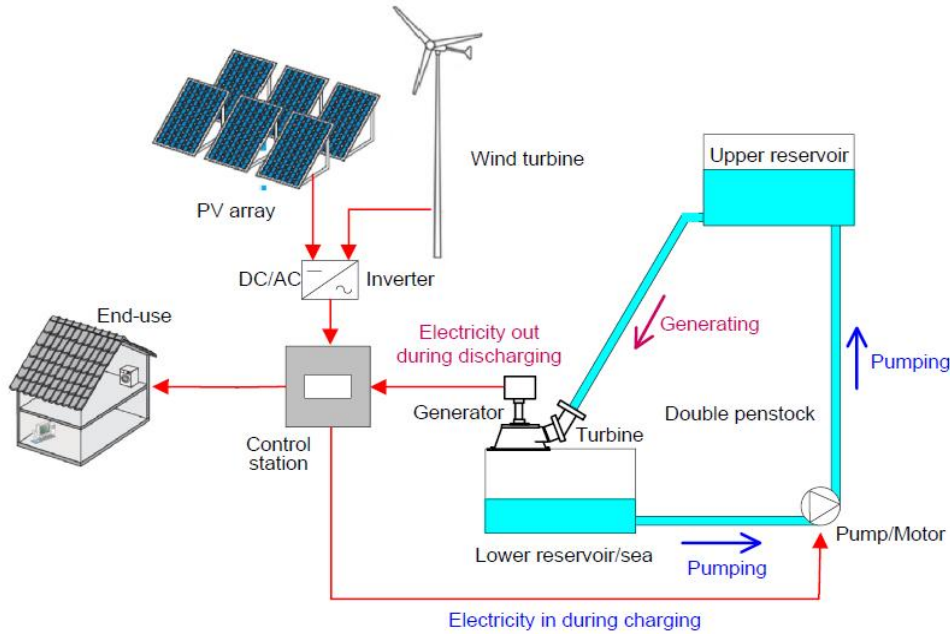
Embora o investimento inicial seja baixo o custo final é elevado



Enquanto que a estimativa de uma PAT ~ 10 m (**low head and high flow**) (cost of PAT ~7 k€ equipamento)



## Energia renovável híbrida com armazenamento por bombagem



## Dependendo da capacidade instalada

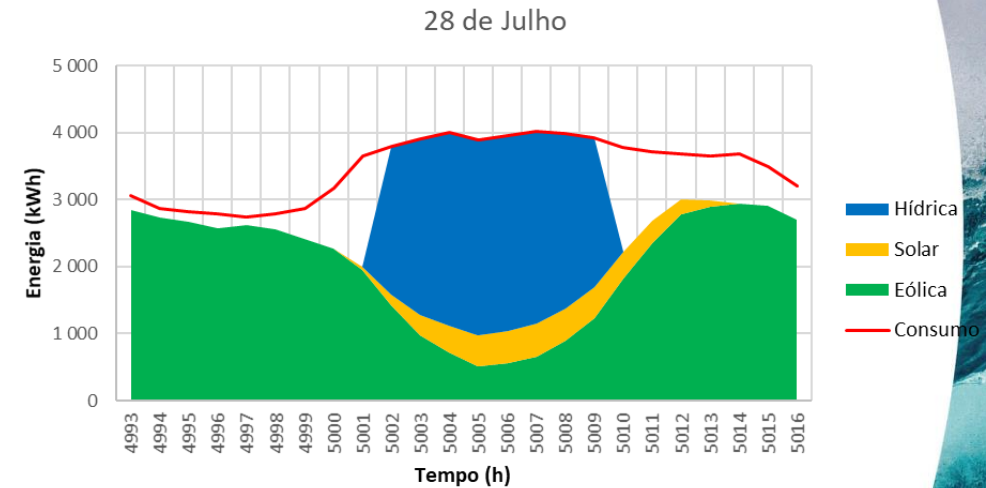
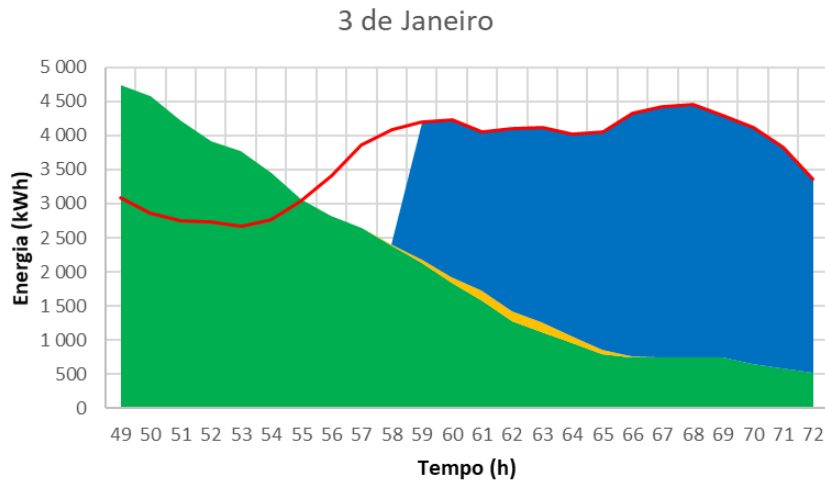
### ❖ Solução híbrida projetada:

- Satisfação do consumo total anual: 81 %
- Geração: 22,96 GWh anuais
- Bombagem: 11,05 GWh anuais

Eólica + Solar + Armazenamento hídrico  
51 % + 30 %

-8 956 tonCO<sub>2</sub>

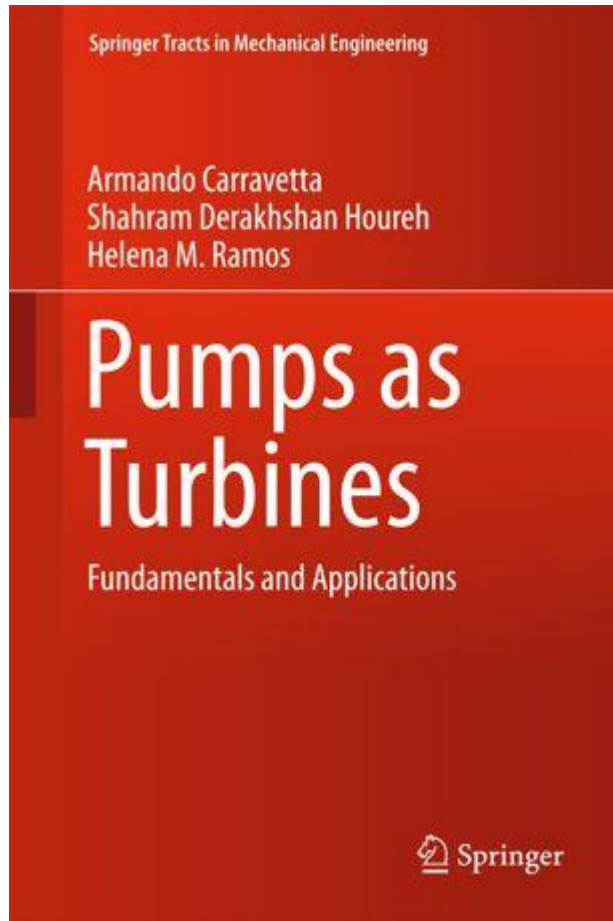
6 % energia não consumida



- ❖ A **integração conjunta das energias renováveis intermitentes** é uma boa solução para a produção de energia elétrica, uma vez que apresentam uma elevada **complementaridade**;
- ❖ O **armazenamento por bombagem** é uma solução eficaz para colmatar as falhas das **energias renováveis intermitentes**.



## 2 Livros sobre bombas a funcionar como turbinas Inglês Espanhol (em curso)



Transitorios en bombas que funcionan como turbinas BFTs.

Pérez-Sánchez, M<sup>e</sup>, Sánchez-Romero, FJ<sup>e</sup>, Ramos, HM<sup>e</sup>, .López Jiménez, PA<sup>e</sup>

<sup>a</sup>Departamento de Ingeniería Hidráulica y Medio Ambiente. Universitat Politècnica de València. Camino Vera s/n, 46022 Valencia (España)

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### 1.1 Resumen

El conocimiento de las condiciones transitorias en redes de agua presurizadas que están equipadas con bombas que funcionan como turbinas (BFT) es de suma. Esta investigación caracteriza

Vários artigos científicos (16 entre 2018-2019) com uma equipa de trabalho em vários países

# Instalações piloto no projecto REDAWN

Na irrigação, em processos industriais e em sistemas de abastecimento em diferentes países da área atlântica (i.e. Espanha, Portugal e França)

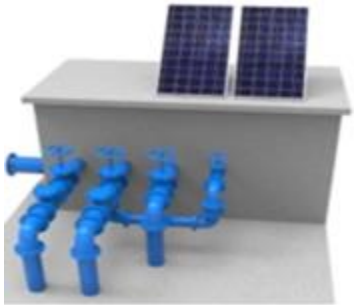
Pilot Plant in irrigation network: it is installed in the left bank channel of the Genil river (GMI) irrigation district, Palma del Río, Cordoba, Spain.

Pilot Plant in the industry water network: it will be built in the paper factory company RENOVA, Portugal.

Pilot Plant in water distribution network: Will be located in St Pair and Avranches, inlet of WTP managed by SMPGA/Veolia, France.



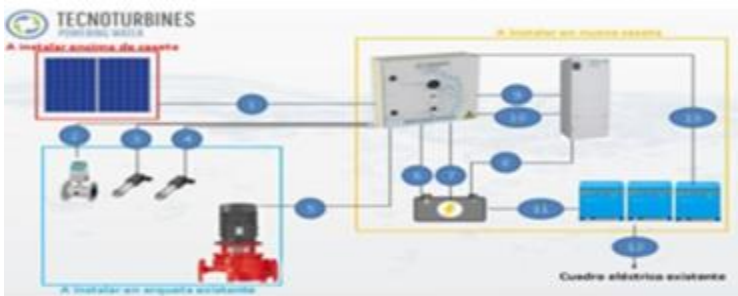
# Spain Pilot demonstration - Irrigation system



PAT  
replaces the  
diesel  
generator

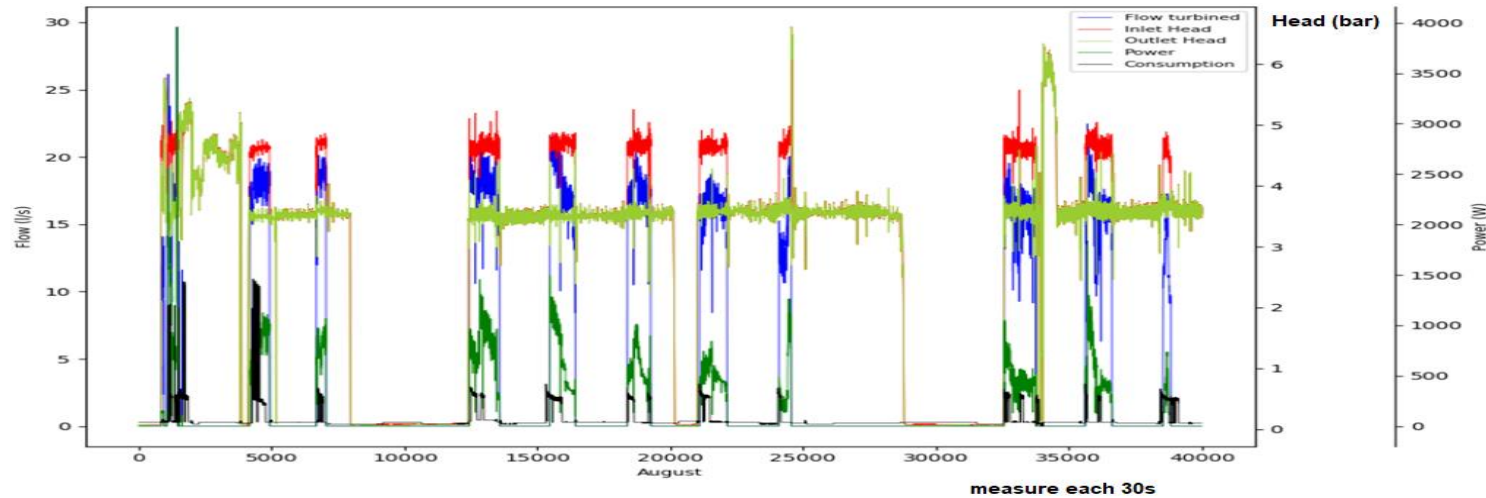
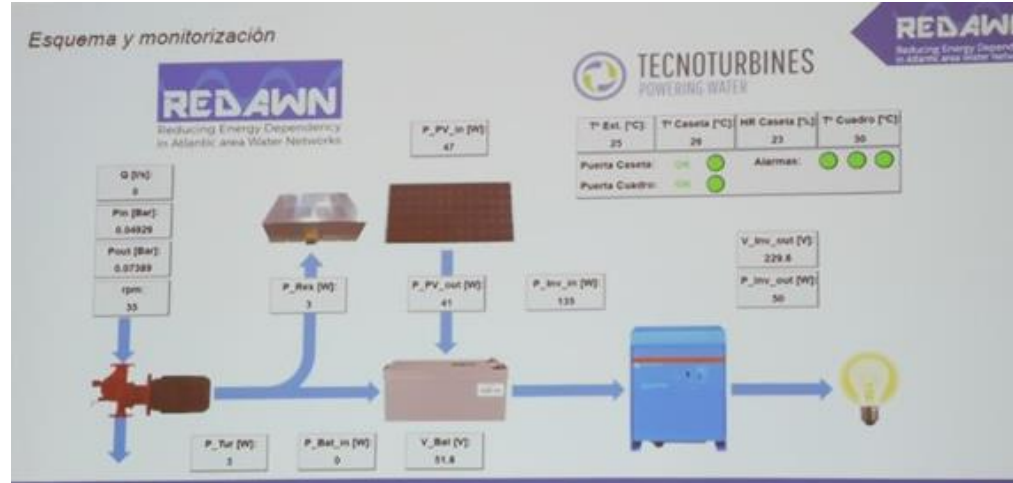


6 kVA generator to be replaced



It is the model INLINE 080-B of 4 kW of nominal power, which takes advantage of a drop of pressure of 20 m and a flow of 30 l/s.

# Andaluzia



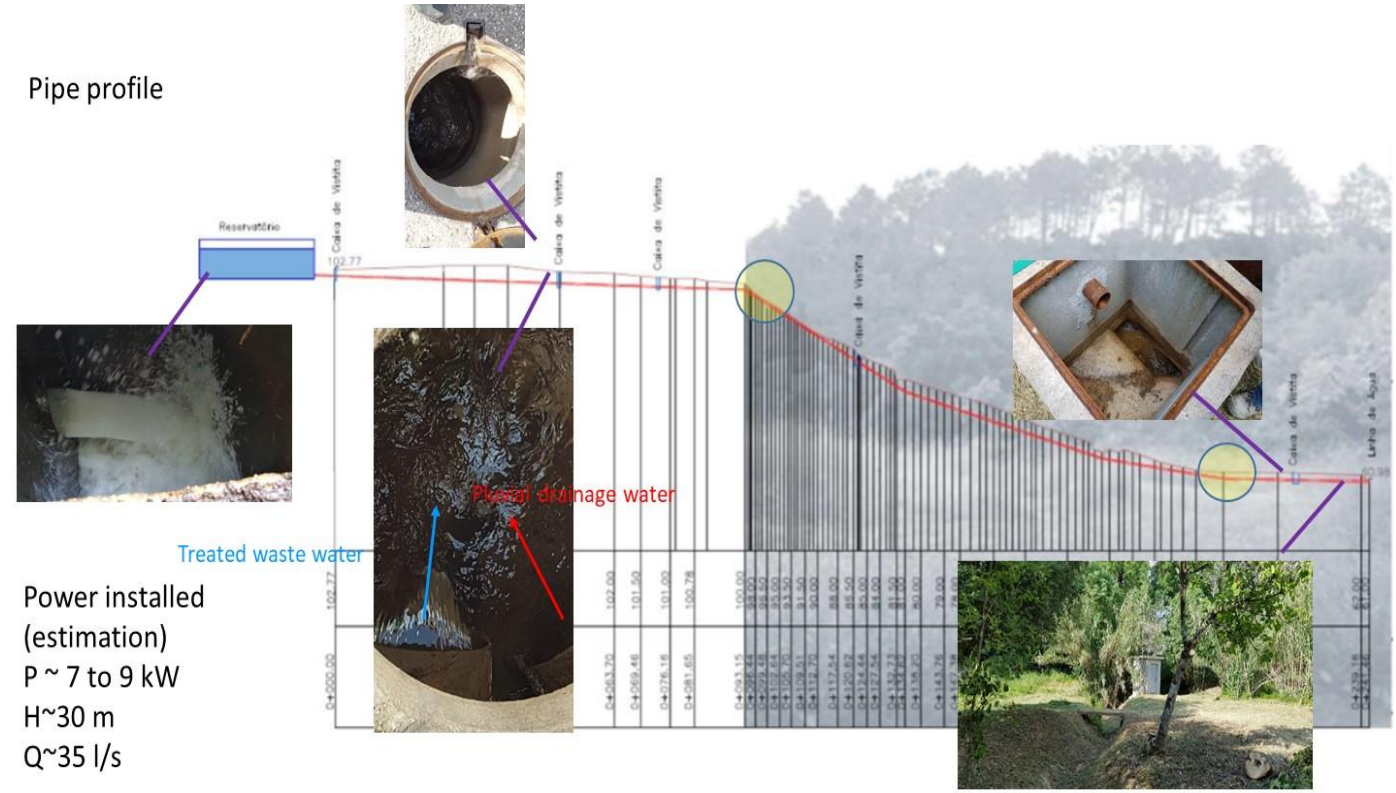


# Portugal - Process industry – RENOVA

- Fábrica de papel da RENOVA



Pipe profile

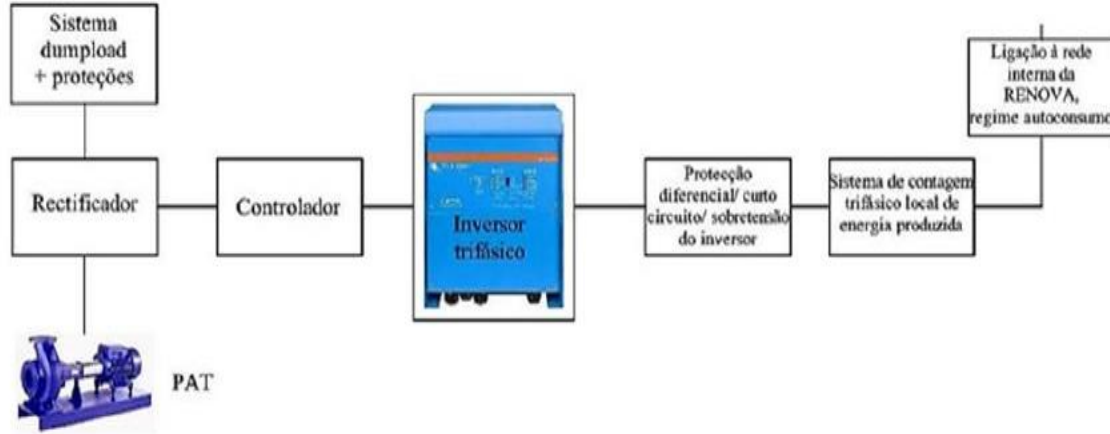


Power installed (estimation)  
 P ~ 7 to 9 kW  
 H ~ 30 m  
 Q ~ 35 l/s



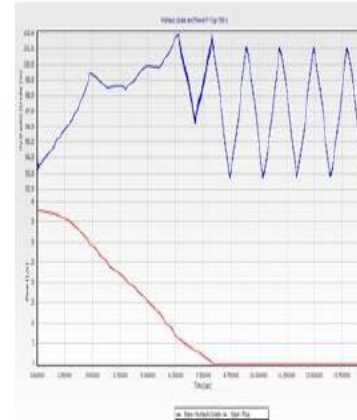
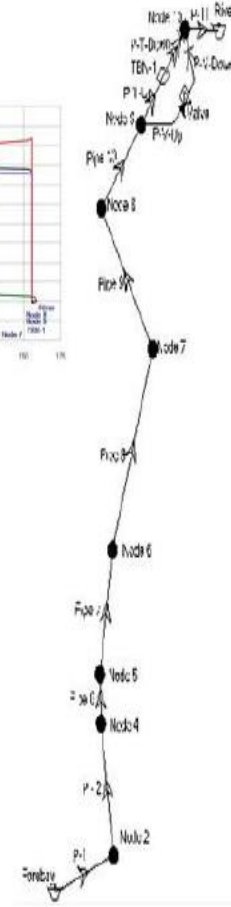
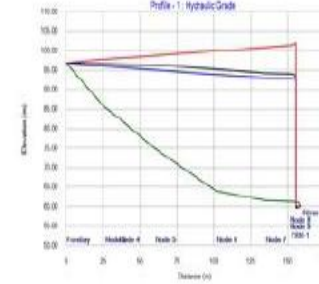
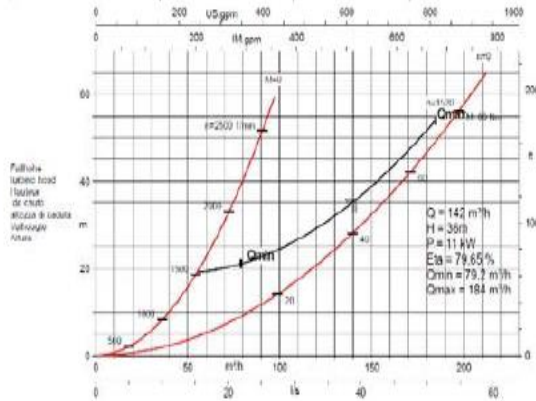
	ENERGY PRODUCTION ESTIMATION (kWh)
Jan	2 700.11
Feb	3 117.42
Mar	4 183.28
Ap	2 902.31
May	2 769.81
Jun	3 818.49
Jul	4 113.62
Aug	5 483.77
Sept	6 711.45
Oct	5 591.12
Nov	4 381.64
Dec	3 573.80
<b>Total</b>	<b>49 346.81</b>

### RENOVA, PORTUGAL



Em ano médio

Designação	Tipo	Apresentação	Unidade de medição	Unidade de medição	Unidade de medição	Unidade de medição
Modelo	Modelo	Modelo	Modelo	Modelo	Modelo	Modelo
Etanorm 80-250 Turbina	1520 1/min	260 mm				
PaT3	4002700181	400				





Estimation:

in these measurements an available head will be around **13 m** more or less. The flow for the power of around **9kW** will be **~118 l/s**.

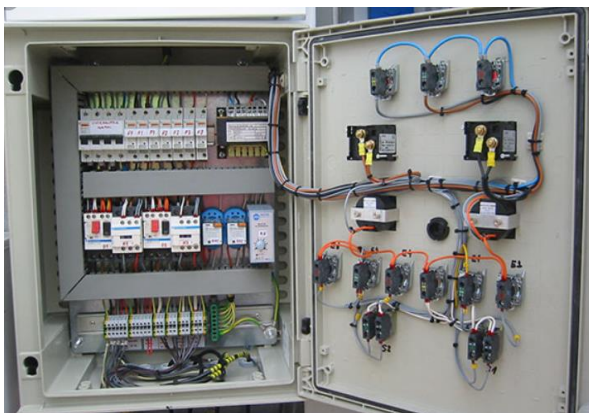
- Tecnoturbines confirms a fully viable installation and they can do it using a PAT, in order to produce the same pressure drop than the existing valve that actually works partially open
- Remember the noise of that valve during the visit which means cavitation problems with reducing the lifespan of the valve
- A good point of that installation is that the energy can be used locally, contributing to reduce the energy bill of the Treatment plant



Autoconsumo

Carregamento de veículos elétricos

Carregamento telemóveis







Obrigada pela vossa atenção

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