**Goal:** share insights on the importance of energy efficiency and the water energy nexus to increase the sustainability of both water utilities and available resources (energy, water)

<table>
<thead>
<tr>
<th>#</th>
<th>Minutes</th>
<th>Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5 min</td>
<td>Water sector status</td>
<td>Status of water utilities and existing challenges.</td>
</tr>
</tbody>
</table>
| 2  | 10 min  | Energy efficiency in WSS                       | Energy inefficiencies, opportunities and holistic approach for electro-
|    |         |                                                 | mechanical components                                                      |
| 3  | 10 min  | Water savings and energy nexus in WSS          | Water losses and existing synergies with the energy consumption             |
| 4  | 5 min   | C2E2 tools and support for RAs                 | Tools and required information                                              |
Block #1

Water Sector Status
Water supply systems: Status

• **Production:** Represents 3-4% of the world power consumption. 80-90% of which is used to pump

• **Consumption:** By 2040 water consumption is expected to increase up to 40%. Need to create awareness of the value of having access to water

• **Regulation:** Planning can bring substantial savings both in resources (energy, water, financial) as well as in equivalent GHG emissions (CO2)
Water supply systems: Status

Energy consumed through the water cycle (superficial source)

- Water extraction
- Purification
- Water transportation
- Sewage collection
- Sewage treatment

Key aspects:

- Water supply represents up to 65% of the total energy consumed in the water cycle
- Water losses represent 25-50% of the water produced
- Large differences between different systems
Block #2

Energy Efficiency opportunities in Water Supply Systems (WSS)
WSS: Energy inefficiencies and opportunities

- The **energy intensity** per unit of sold water links the required energy to supply a cubic meter of water
  - Needs to be normalized
- Individual EE actions have an impact of **10-40%**
- A holistic approach helps to prioritize EE actions, to reduce the required investment and O&M costs
- Payback period < 5 years
WSS: Energy efficiency

<table>
<thead>
<tr>
<th>Technology</th>
<th>Old system</th>
<th>Efficient system</th>
<th>Individual EE increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformer</td>
<td>85%</td>
<td>96%</td>
<td>11.45%</td>
</tr>
<tr>
<td>Power factor</td>
<td>0.8</td>
<td>0.9</td>
<td>-</td>
</tr>
<tr>
<td>VSD</td>
<td>-</td>
<td>95%</td>
<td>20-40%</td>
</tr>
<tr>
<td>Electric motor</td>
<td>90%</td>
<td>95%</td>
<td>5.26%</td>
</tr>
<tr>
<td>Water pump</td>
<td>70%</td>
<td>88%</td>
<td>20.45%</td>
</tr>
<tr>
<td>Total efficiency</td>
<td>53.5%</td>
<td>76%</td>
<td>29.60%</td>
</tr>
</tbody>
</table>

Efficiency gains in the motor-pump set

- **Motor-pump set inefficiencies:**
  - **Motor losses:** Mainly caused because of being oversized, old, outdated and to poor maintenance
  - **Pump losses:** Working out of the operational design points (Best Efficiency Point) because of poor sizing or maintenance

- **Improvement of shaft and coupling connections**
  - Replacement of valves
  - Introduction of variable speed drives
  - Replacement of transformers

30% increase in EE
WSS: Energy efficiency

If local/national regulation is yet not available, energy indicators for efficiency in WSS can be extracted from international best practices

\[ CEN^* = \frac{E \left[ \frac{kWh}{yr} \right] \times 100[m]}{V \left[ \frac{m^3}{yr} \right] \times H[m]} \]

- CEN Allows us to compare different pumping station with different pumping elevations
- Available EE motor standards (e.j. IEC IE1-4) allow to calculate the minimum efficiency that a pump would require to work properly
- Different coupled efficiency recommendations for different sizes and types of components

Traffic light for normalized energy index values \([\text{kWh}/(\text{m}^3\times100)]\) and equivalent motor-pump efficiencies [%] for benchmarking (AA13ab - ESAR, Portugal)

\* Consumo específico de energía eléctrica normalizado (CEN)
WSS: Energy efficiency

Viability of replacements

- Costs depend on the local market
- Efficient components are more expensive, but provide larger savings throughout their lifetime
- Payback period (PBP):
  - Optimal ≤ 36 months
  - Good ≤ 48-60 months
- Technologies lifetime ≤ 10-15 years
  - Older technologies must be replaced
  - Technologies without a proper maintenance age worst
  - Efficiencies below recommended values (e.g. 46% motor-pump sets)

\[
E_{savings}[\text{kWh/yr}] = \sum (CEN_{actual,i} - CEN_{efficient,i}) \times V_i \times \frac{H_i}{100}
\]

\[
E[\text{kWh/yr}] = \sum \left( \frac{0.2725}{\eta_{technical} \times 100} \right) \times V_i \times \frac{H_i}{100}
\]

\[
C_{savings}[\text{USD/yr}] = E_{savings}[\text{kWh/yr}] \times P_{electricity}[\text{USD/kWh}]
\]

\[
Payback[\text{yr}] = \frac{\text{CAPEX[USD]}}{C_{savings}[\text{USD/yr}]}
\]
Study case: Energy efficiency in Guyana

I. 6% of the national power demand => 60% of the water utility costs

II. Water losses of 70% and lack of consumption metering

III. Energy audits found larger EE savings in existing power factors, electric motors and water pumps. Average electro-mechanical efficiency of 46%

Solutions:

• New water tariffs that reflect the real cost of water- US 0.3 to US 0.55 per cubic meter

• Motors and pumps replaced in 34 supply points (25% of the energy consumed by the utility)

• An investment of US 160,000 increase the EE a 29%, bringing a total annual savings of US 700,000 => 3 months payback

• Energy savings of 2,000 MWh/year and 2,000 tCO2
Block #3

Water and Energy Efficiency opportunities in Water Supply Systems
WSS: Water losses and Non-Revenue Water (NRW)

- **Physical losses.** Due to filtrations during the whole cycle. The main cause is the lack of a correct operation and maintenance.
- **Commercial losses.** Lack of real consumption metering, census inaccuracies and illegal connections.
- **Authorized consumption not billed.** Firefighting, watering gardens or given to certain social strata with risk of social exclusion.

NRW is the difference between water produced and billed.
WSS: Reduction of water consumption

**Impact of climate change in water supply systems:**
- Damage to water supply systems
- Shortage of water

**Solutions**
- Water Demand Management (WDM)
- Preventive maintenance instead of corrective maintenance and better control systems (SCADA)
- Public campaigns for citizen awareness on the correct use of water and its value

Less water means less energy required, less peak energy consumption and not overexploiting the water reservoirs, reducing the **energy intensity and increasing the sustainability of the available resources**
Study case: SANASA, Brasil

In value:

- 6% of the national electricity demand
- Reduction of physical losses
- Tariff optimization by storing drinking water in tanks during off-peak hours
- Replacement of obsolete electro-mechanical equipment

Results:

- Increase of 22% of the population supplied to 98% (mostly low income households)
- 6% reduction in water losses
- Electricity consumption remained constant, reducing energy intensity
Benefits of energy and water efficiency actions

- Energy consumption reduction (MWh/yr)
- Water volume produced reduction (m3/)
- Financial savings through lowered costs and higher income (USD)
- Reduction of equivalent emissions (ton eq. CO2)
- Short payback period (yr)
Block #4

C2E2 Available Tools and Support
Inputs

• Water volume pumped/sold
• Status of existing electro-mechanical components (transformers, motors, pumps...)
  – Size
  – Efficiency
• Metering
  – Yes/No
• Automated control and operation
  – Yes/No
• Expenses of the system
  – Electricity price (USD/kWh)
  – Other costs (labour, maintenance...)
• Existing policies and regulations
Thank you

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