

**Final Report:**

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**Swiss know-how and technology transfer for  
wastewater treatment in Colombia**

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## 1. Summary

Colombia is a fast-growing economy facing various environmental challenges. To join the OECD, Colombia enacted strong environmental legislation, one of them being new wastewater levels for discharge into surface water and sewage systems in 2015. Industries face the double challenge of complying with the new law, while maintaining or increasing their competitiveness. The Colombian National Center for Cleaner Production (CNPML), the Swiss wastewater technology provider WABAG, and CIIS joined forces to address the above mentioned challenges and to fill the gap between legal requirements and what is currently common wastewater practice in Colombia. The three project partners jointly developed and implemented a capacity building program to enable local consultants to conduct feasibility studies of integrated industrial wastewater management. The goal of the capacity building program was to identify business models allowing companies to comply with strong environmental regulations, while generating significant cost savings or new revenue streams. Besides CNPML's new, self-sustaining business model in wastewater consulting, the project also aimed at opening new business opportunities for WABAG.

The project included three main steps. First, CIIS and CNPML designed the training program with a view to local wastewater needs and CNPML's priorities in terms of developing niche skills. Second, WABAG and topic experts delivered the training program, which included a study trip to Switzerland and Romania and a hands-on case study. Early in the training program, local companies were contacted and CIIS and CNPML met with their managers to prepare the case study. CNPML then held a conference to highlight the newly acquired skills and present the case studies and CIIS organized a refresher aiming at making sustainable CNPML's new business model of waste consulting.

Results are two-fold. First, in addition to the five CNPML engineers, capacities were built in Colombian companies. As a key competence, the trained engineers are able to deliver feasibility studies in which they describe the technical, financial, etc. aspects of cost-saving measures or new business models related to wastewater treatment. In the case study, the trainees designed a business model for PIMSA, a large industrial park operator providing an additional environmental service. Second, the project yielded two concrete business opportunities for Swiss technology providers. The case study's industrial park operator requested an offer following the case study insights. EPM, Medellín's public utility company, issued a request for information on the potential of industrial reuse of treated municipal wastewater. The latter was the object of the refresher.

Further action will focus on multiplication/replication of the project achievements. (1) In December 2019, CIIS will follow up with CNPML on EPM's interest of selling treated wastewater to industries located in the vicinity of its San Fernando plant. (2) In Early 2020, CIIS will discuss with ZHAW regional competence centres to investigate potential for replication of wastewater capacity-building program in SECO target countries. (3) Additionally, CIIS will meet at UNIDO headquarters to discuss follow-up projects in Colombia in the framework of UNIDO's eco-industrial parks initiative and formalization of capacity-building program. (4) In March 2020, CIIS will submit a full proposal for a REPIC project on capacity building for industrial solid waste management in Peru, based on the Colombian experience. (5) By Mid-2020, CIIS will have investigated opportunities for embedding wastewater capacity-building program with partner universities of the ZHAW School of Management and Law. Currently, CIIS is working on Steps 3 and 4, i.e., preparing a meeting at UNIDO headquarters and recruiting Swiss technology providers to participate in the REPIC project on capacity building for industrial waste management in Peru.

## 2. Resumen en español

Colombia es una economía en rápido crecimiento que se enfrenta a diversos desafíos ambientales. Para unirse a la OCDE, Colombia promulgó una fuerte legislación ambiental, una de las cuales es la de los nuevos niveles de aguas residuales para su descarga en los sistemas de aguas superficiales y de alcantarillado en 2015. Las industrias se enfrentan al doble desafío de cumplir con la nueva ley, al tiempo que mantienen o aumentan su competitividad. El Centro Nacional de Producción más Limpia de Colombia (CNPML), el proveedor suizo de tecnología de aguas residuales WABAG y el CIIS unieron fuerzas para llenar el vacío entre los requisitos legales y lo que actualmente es una práctica común de aguas residuales en Colombia. Los tres socios del proyecto desarrollaron e implementaron conjuntamente un programa de desarrollo de capacidades para permitir a los consultores locales realizar estudios de factibilidad de la gestión integrada de aguas residuales industriales. El objetivo del programa de desarrollo de capacidades era identificar modelos de negocio que permitieran a las empresas cumplir con regulaciones ambientales estrictas, a la vez que se generaban ahorros significativos en los costos o nuevas fuentes de ingresos. Además del nuevo modelo de negocio autosostenible del CNPML en la consultoría de aguas residuales, el proyecto también tenía como objetivo abrir nuevas oportunidades de negocio para WABAG.

El proyecto incluyó tres pasos principales. En primer lugar, el CIIS y el CNPML diseñaron el programa de capacitación teniendo en cuenta las necesidades locales en materia de aguas residuales y las prioridades del CNPML en cuanto al desarrollo de competencias especializadas. En segundo lugar, WABAG y expertos en el tema impartieron el programa de capacitación, que incluyó un viaje de estudios a Suiza y Rumania y un estudio de caso práctico. Al principio del programa de capacitación, se estableció contacto con las empresas locales y el CIIS y el CNPML se reunieron con sus gerentes para preparar el estudio de caso. A continuación, el CNPML celebró una conferencia para destacar las nuevas habilidades adquiridas y presentar los estudios de caso, y el CIIS organizó un seminario de actualización con el objetivo de hacer sostenible el nuevo modelo de negocio de CNPML de consultoría sobre residuos.

Los resultados son dobles. Primero, además de los cinco ingenieros del CNPML, se construyeron capacidades en empresas colombianas. Como competencia clave, los ingenieros formados son capaces de realizar estudios de viabilidad en los que describen los aspectos técnicos, financieros, etc. de las medidas de ahorro de costes o de los nuevos modelos de negocio relacionados con el tratamiento de aguas residuales. En el estudio de reparto, los alumnos diseñaron un modelo de negocio para PIMSA, un operador de parque industrial que prestaba un servicio medioambiental adicional. En segundo lugar, el proyecto brindó dos oportunidades de negocio concretas a los proveedores de tecnología suizos. El operador del parque industrial del estudio de caso solicitó una oferta a raíz de las conclusiones del estudio de caso. EPM, Empresas Públicas de Medellín, emitió una solicitud de información sobre el potencial de reutilización industrial de las aguas residuales municipales tratadas. Este último fue el objeto de la actualización.

Las nuevas medidas se centrarán en la multiplicación/replicación de los logros del proyecto. (1) En diciembre de 2019, CIIS dará seguimiento con CNPML al interés de EPM de vender aguas residuales tratadas a las industrias ubicadas en las cercanías de su planta de San Fernando. (2) A principios de 2020, CIIS discutirá con los centros de competencia regionales de ZHAW para investigar el potencial de replicación del programa de desarrollo de capacidades de aguas residuales en los países objetivo de SECO. 3) Además, el CIIS se reunirá en la Sede de la ONUDI para examinar proyectos de seguimiento en Colombia en el marco de la iniciativa de parques ecoindustriales de la ONUDI y la formalización de un programa de fomento de la capacidad. (4) En marzo de 2020, CIIS presentará una propuesta completa para un proyecto REPIC sobre creación de capacidad para la gestión de residuos sólidos industriales en Perú, basada en la experiencia colombiana. (5) A mediados de 2020, CIIS habrá investigado las oportunidades para integrar a las universidades asociadas al programa de creación de capacidad en materia de aguas residuales de la Escuela de Administración y Derecho de la ZHAW. Actualmente, el CIIS está trabajando en los pasos 3 y 4, es decir, preparando una reunión en la sede de la ONUDI y contratando a proveedores de tecnología suizos para que participen en el proyecto REPIC sobre creación de capacidad para la gestión de desechos industriales en el Perú.

### 3. Starting Point

In a scoping stage, the Colombian National Cleaner Production Center (CNPML), main recipient of the capacity building program, and CIIS had found that many Colombian companies lack know-how and technologies for state-of-the-art wastewater treatment. Such shortfalls aggravate water scarcity, hinder industrial competitiveness, while increasing health risks due to indirect downstream reuse and threatening ecosystem services to fishery, agriculture, tourism, and leisure (see Figure 1). Ultimately, companies are facing challenges to implement the new Colombian legislation regarding wastewater treatment and disposal. Further discussions with CNPML initially identified the sectors food and beverages, utilities and oil and gas to be targeted in the capacity building program. The starting point consisted in meeting simultaneously two separate needs: (i) the need for CNPML engineers (course participants) to acquire consulting skills in industrial wastewater management and (ii) the need for Colombian companies to comply with new, more stringent wastewater legislation, while decreasing water-related costs and/or generating new revenues through technological upgrade.

Insufficient wastewater treatment technology, know-how, and infrastructure leading to overuse and pollution of natural water supplies are, among others, the consequence of missing wastewater consulting capacities. At the project's onset, there was a substantial need for an unbiased entity that collaborates, consults, and advises these industries regarding wastewater management in the private and public sector. CNPML has the mandate, the organizational structure, and the reputation to receive the required consulting capacity, in order to make the greatest impact across Colombia. The selected industrial sectors had several needs pertaining to wastewater treatment. Most importantly, they were in dire need to comply with new Colombian regulations by relying on wastewater technologies only partly available in Colombia and the associated know-how regarding reduction of water consumption and wastewater reuse. There are presently no local, affordable solutions meeting the needs of these industries, according to CNPML.

The two new legislative pieces affecting wastewater treatment in Colombia are:

- Article 2.2.3.3.5.1, of Decree 1076 of 2015 states that every person or company generating wastewater and discharging to surface or marine waters, sewage systems or to the soil, should request and obtain a water discharge permit.
- Resolution 631 of 2015 defines the maximum levels for wastewater discharges into surface water and sewage systems. These values will vary depending on the type of industry generating the wastewater. Seventy-three different production activities are described. The environmental authority can impose more restrictive values of the maximum levels regarding the discharge of industrial wastewater, if necessary.

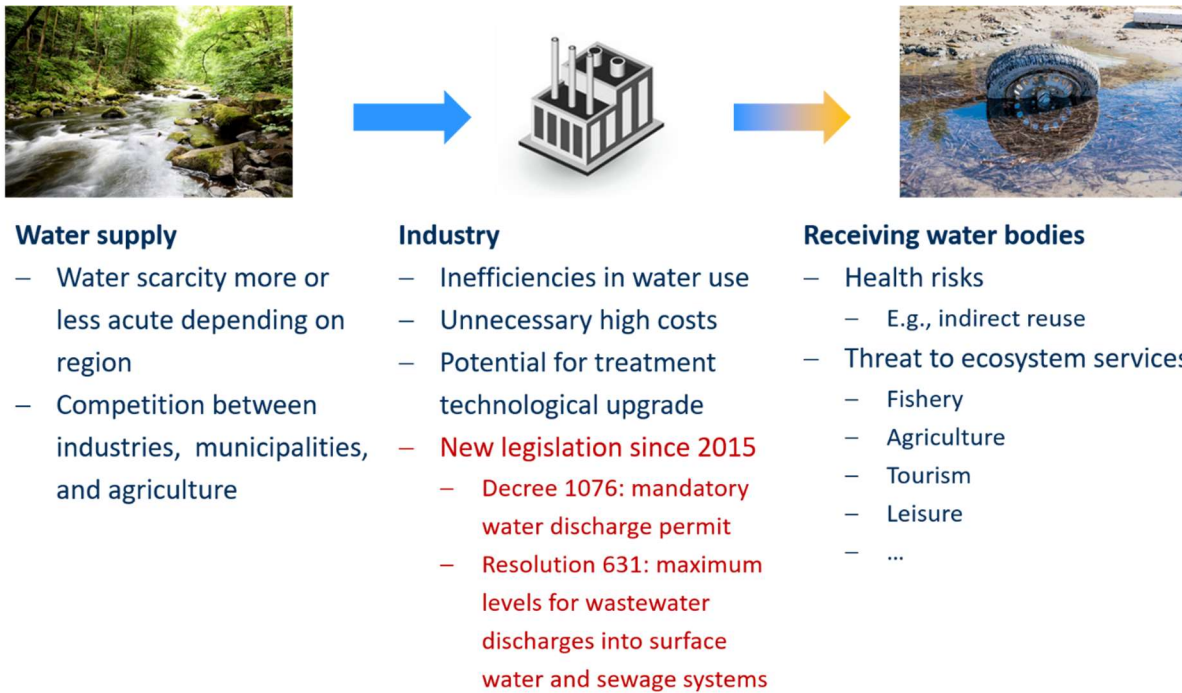


Figure 1 Starting point for the wastewater capacity-building program.

## 4. Objectives

The original project objectives defined in the final REPIC proposal were:

1. Ensure CNPML receives the training to the expected standard.
2. Ensure CNPML can apply the received know-how to ultimately have a self-sustaining business model in wastewater management within Colombia's industrial and utility sectors.
3. Bring the other two objectives together to have a well-designed and implemented training program, which could be used multiple times (internationally or domestically).]

While preparing the training program, it became clear that training in wastewater technologies and systems could not be done separately from training in consulting skills. We therefore merged the original objectives 1 and 2. Yet, this training in wastewater and associated consulting skills can be developed independently from the sectors investigated in case examples, studies, and the refresher. The contribution to specific sectors became a standalone objective. We added an additional objective in order to promote networking between the Colombian and Swiss project stakeholders and thereby by facilitate the implementation of CNPML's new wastewater consultancy business model. The original objective 3 became the fourth objective as reported below.

The project's overarching aim is the assistance of local companies in complying with new wastewater legislation while boosting their economic competitiveness (win-win). The overarching aim was broken down into the following four tangible objectives:

1. Train local CNPML engineers to state-of-the-art wastewater technologies and systems and build capacities in consulting for a new, self-sustaining business model
2. Focus on key Colombian sectors
3. Allow for networking between CNPML, Colombian companies, and Swiss wastewater technology providers
4. Develop replicable training program for other sectors and countries

The paradigm of the project was to consider wastewater as a resource from which water, energy, and biological (e.g., nitrogen and phosphorus) and technical nutrients (e.g., metals) can be recovered and substitute primary resources.

## 5. Project Review

### 5.1 Project Implementation

The approach of the capacity building program consisted in an intense exchange with CNPML to design a training program meeting the needs described above. First, CNPML and CIIS brainstormed topics potentially interesting for the training program. The following criteria were then used to integrate topics into the training program:

- CNPML needs: What consulting (technical, systems, business) skills is CNPML in need of?
- Local company needs: Within the three selected industrial sectors, what are contextual system issues, relevant technologies, and specific business aspects?
- Niche potentials/CNPML priorities: In which topic CNPML wishes to occupy a niche and/or become a first-mover?

The exchange led to a complete needs map, which in turn allowed CIIS to select final topics of the training program, plan lectures, and recruit experts from the partner pool (see Figure 2 below).

Figure 2 shows the original project architecture (CBA became CIIS on 1 January 2019). CIIS managed the project, i.e., ensured the timely delivery of milestones, the coordination between stakeholders, among others. Among project partners and besides CIIS were CNPML, main recipient of the training program, WABAG as wastewater technology provider, and experts from various Swiss organizations, including Eawag, the Swiss Federal Institute of Aquatic Science and Technology. CNPML was considered as a partner on equal footing as it had other responsibilities than taking an active part in the training program, e.g., organizing the conference towards the end of the program to promote its new consulting skillset. The direct beneficiary was therefore CNPML, with the training of five senior and junior engineers. As CNPML and CIIS, during the first project step, reached out to Colombian companies to conduct case studies planned as final module of the training program, staff from these companies decided to join the training program. Indirect beneficiaries were Colombian society as a whole through the preservation of aquatic resources and ecosystems and Colombian industries through the compliance with new wastewater legislation and increased competitiveness thanks to lower costs and/or higher revenues.

The project included three main steps:

1. Design of training program
2. Delivery of training program
3. Conference and refresher

Figure 3 highlights the different training program modules as important steps within the training program delivery (Step 2). The five-module approach itself was defined in Step 1, jointly with CNPML and represents an innovative way to deliver technical (Modules 1, 2, 3), business (Modules 3, 4), and consulting skills (Module 5). Module 2 was significantly adapted with pre-treatment and sludge treatment as additional topics.

The project's main objectives were not modified during the course of the project. However, to achieve them, the approach was detailed and revised. Indeed, Swiss wastewater technology experts and WABAG were originally to design the initial training program. Also, the original program was to be organized in three parallel streams corresponding to the three industries (food and beverages, gas and oil, utilities). Finally, the targeted audience, in the initial proposal, was limited to CNPML engineers.

However, based on a field trip to Colombia, we concluded that the revision of the training program would need to address three elements in order to meet the project objectives:

1. Training program design jointly with CNPML, which helped secure its commitment to the program and a better match to Colombian wastewater needs.
2. Revision of the training program structure, i.e., a holistic training on municipal and industrial wastewater management with focus lectures on technologies relevant to the three different and case studies with local companies of these sectors instead of three parallel training programs on each sector. Such a holistic approach was the starting point for developing a logical structure



(i.e., five modules) allowing for efficiency in knowledge transfer and flexibility in addressing wastewater issues and case studies as the program was unfolding.

3. Participation of additional engineers/managers from local companies in the training program to increase its impact and meet one of the REPIC program's main goal of strong involvement of the private sector.

All three latter points facilitate replication by making the training program adaptable to local needs through the involvement of recipients in the program design phase and independent from the industrial sectors targeted.

Modules 4 and 5 represent the most innovative part of the capacity-building program. The trained engineers could indeed fill skill gaps crucial to compile high-quality feasibility studies in the wastewater field and communicate results in a private sector context:

- Business Module (Module 4)
  - Acquire practical business and managerial knowledge
  - Address the wastewater remediation and reuse needs in a business context
  - Receive necessary tools to competitively conduct feasibility and case studies
  - Understand the mechanisms of a P&L Statement in a wastewater remediation / reuse context
- Case Study (Module 5)
  - Put into practice the acquired skills in a feasibility study
  - Develop consulting and problem-solving skills in the framework of wastewater treatment
  - Interact with companies (also C-level)

The adaptation of the approach had an impact on the budget. In short, the training program design – more participatory as initially planned (time to discuss, travels, feedback loops, etc.) – cost an additional 54%. During the training programme, the Life Science and Facility Management Department at ZHAW contributed less than initially planned, as we relied more on experts from Eawag among others. Savings could be made in the training seminars delivery, as all training sessions were delivered through live distance learning from ZHAW facilities (recordings have been made). Neither filming nor editing were therefore necessary. Additionally, the conference cost less, as WABAG could not attend it (G. Meylan represented the company with a presentation provided by WABAG). In the Refresher, Pöyry replaced WABAG due to a change in regional priorities and supported CNPML in preparing an answer to the request for information (RFI) of EPM, Medellín's public utility company. The answer to the RFI was defined as the Refresher's content. All in all, the project cost 9% more than originally budgeted.

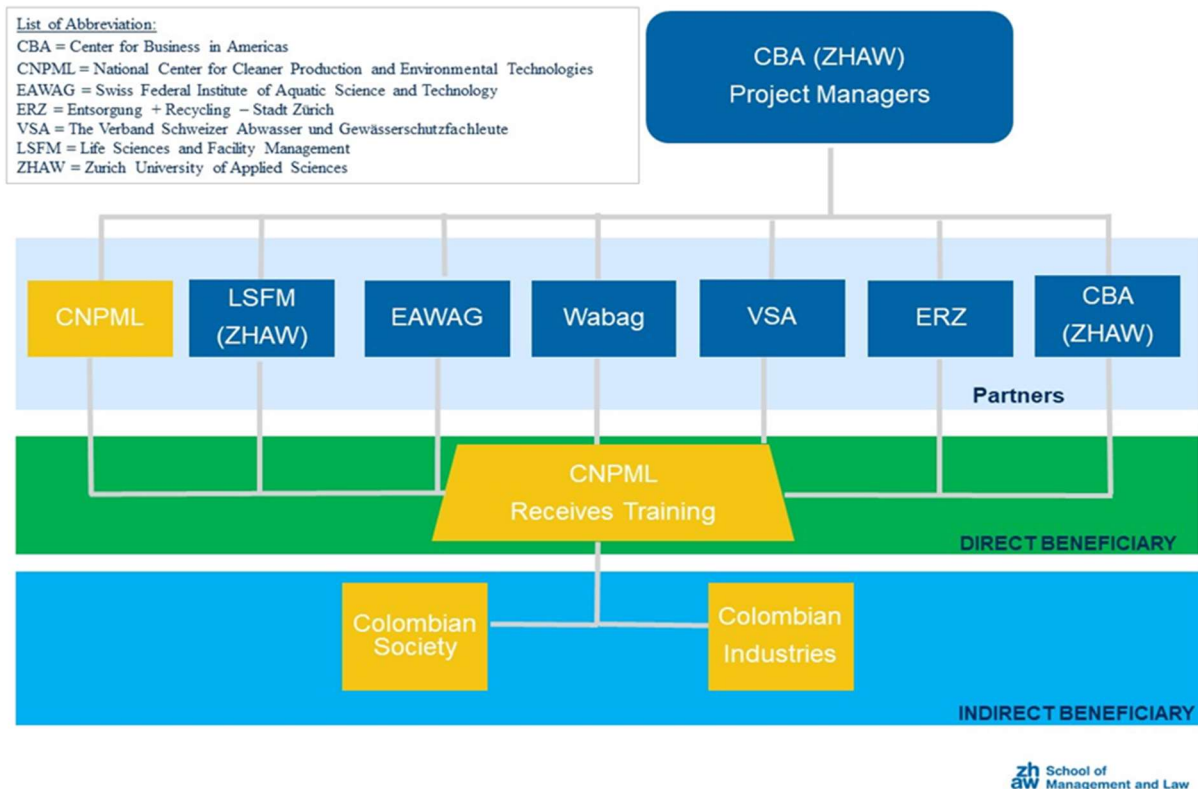


Figure 2 Original project architecture (CBA became CIIS on 1 January 2019).

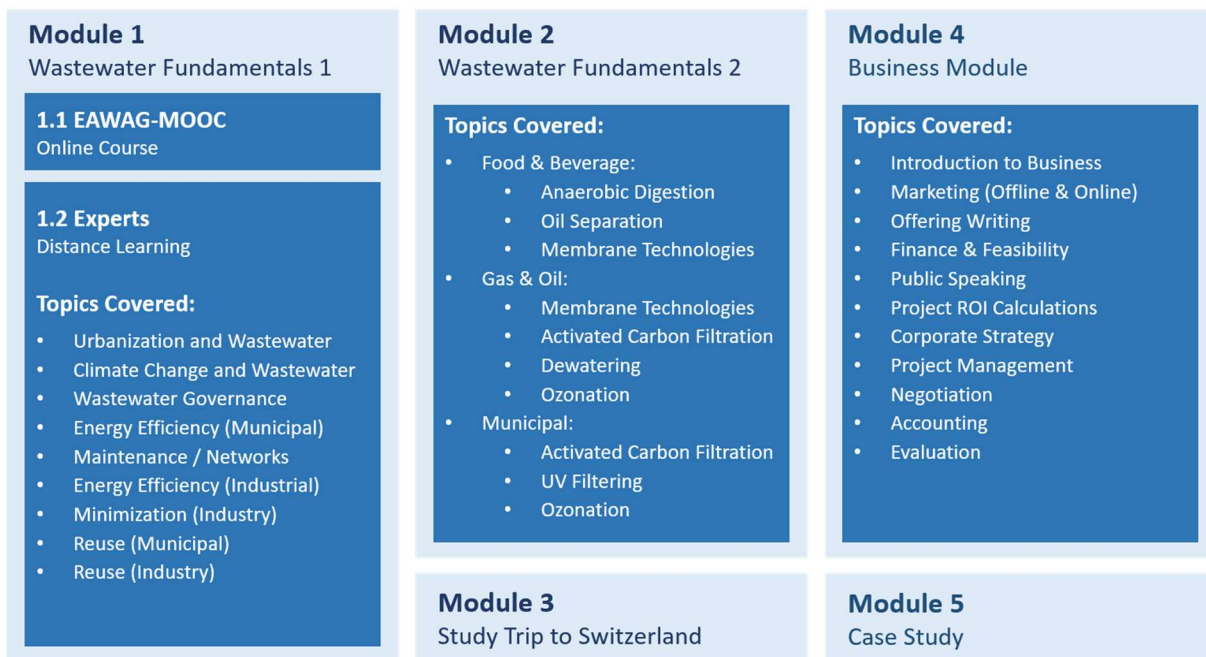


Figure 3 Training program in five modules.

## 5.2 Achievements of Objectives and Results

### Achievement of project objectives

Table 1 shows again the project's four tangible objectives and to what extent they were achieved. We self-assessed the achievement of results on a scale from 1 (red, hardly achieved) to 3 (green, completely achieved). The self-assessment corresponds to Milestone 5 of the initial proposal "Witten report on practical experience and existing gaps [...]". We then discussed the project's results, broken down in results for the trained local engineers and for the Swiss technology provider. We closed this section with a discussion of the overarching aim of assisting local companies in complying with new wastewater

legislation while boosting their economic competitiveness. From the four tangible objectives, two are self-assessed as partially achieved, as (i), to this date, it is not possible to assess the sustainability of the new business model based on the newly acquired skills and (ii) only one case study was conducted, in the food and beverages sector. The trainees did not apply these skills in the two remaining focus sectors of municipal wastewater treatment and gas and oil.

Table 1 Achievement of project objectives and self-assessment.

OBJECTIVE	ACHIEVEMENT	GRADE
Train local engineers (CNPML, the NCPM in Colombia) to state-of-the-art wastewater technologies and systems and build capacities in consulting for a new business model	<p>Five engineers from CNPML were trained. However, no formal final examination or assurance of learning took place. The CNPML engineers passed Eawag’s multiple-question examination and delivered the case study report and presentation to PIMSA’s satisfaction. In addition, attendance to the Business Module (Module 4). To this date, it is not clear how the acquired knowledge and know-how will be transferred to new staff within CNPML. There are signs that the newly acquired skills will endure as a business model. Concretely, CNPML has been contacted by Medellín’s public utility company, EPM, to conduct a feasibility study for industrial reuse of wastewater. This request is a direct outcome of the project and shows the opportunity for CNPML to have new business models.</p> <p>The program design opens the possibility for recruiting more local engineers and consultants who can benefit from both program content (technology and business) and approach (real-world case studies).</p>	
Focus on key Colombian sectors	As only one case study could be completed within the project, not all three focus sectors were addressed in the real-world case studies. A part the insights from Module 3 (Study Trip), during which treatment facilities from all focus sectors were visited, the knowledge acquired in the field of municipal wastewater treatment and oil and gas remain on a rather theoretical level.	
Allow for networking between CNPML, Colombian companies, and Swiss wastewater technology providers	Networking between the three stakeholder groups took place in multiple contexts: during the kick-off visit, especially when CNPML engineers reached out to local companies with CIIS support; during the training between CNPML engineers and Swiss experts (wastewater systems, technologies, representatives of the Swiss technology provider, business); during the Study Tour between CNPML engineers, the Swiss technology provider, its customers and Swiss wastewater experts (e.g., Eawag); during the case study.	
Develop replicable training program for other sectors and countries	The approach to design the capacity building program and the program itself, in its modular and generic form, are replicable in other sectors (e.g., industrial waste, hazardous waste, pump storage) and countries. The program is also adaptable to specific sector needs. For instance, some consultancy methods are more relevant for individual sectors. For instance, life cycle assessment, a method to assess environmental	

impacts of a good or service, belongs to any feasibility study in the field of solid waste management.

## Results

Two concrete business opportunities aroused as a result of the capacity building project in the framework of the capacity building program:

- PIMSA case study (Module 5)
  - Who: Industrial park of Malambo (PIMSA), Atlántico Department near Barranquilla.
  - Problem: Obsolete wastewater treatment plant (constructed wetland), costly off-site wastewater treatment for some park companies.
  - Opportunity: Upgrade to moving bed biofilm reactor (MBBR) allows increasing on-site treatment, thereby creating new revenue streams for park operator.
  - Current status: Park operator requested an offer from Swiss wastewater technology provider, WABAG, which declined due to shifting regional focus within the company. Instead, a leading engineering company, Pöyry Switzerland Ltd., took up the task of preparing the offer.
  
- Answer to EPM's request for information on feasibility study (conducted as Refresher Course after Module 5, see Appendices 4 and 5 as well as Figure 4)
  - Who: Empresas Públicas de Medellín (EPM), large public utilities company.
  - Problem: Cost of municipal wastewater treatment.
  - Opportunity: Industrial reuse of treated wastewater (with tertiary treatment).
  - Current status: Based on CNPML answer, EPM will issue a request for proposals.



Figure 4 EPM's San Fernando wastewater treatment plant in Medellín with activated sludge basins at the forefront.



As for results for local engineers and consultants, capacities were built at CNPML, Postobón (food and beverages), EPM (municipal wastewater treatment), PIMSA (industrial park), and Colcafé (food and beverages). As described in Section 5.1, engineers and managers from companies scanned for case studies joined the training program, which allowed increasing the overall impact of the project. However, it is unclear how the additional trainees will use this knowledge in their current or future positions. That said, CNPML engineers acquired skills ranging from technical know-how to consultancy. One key skill acquired during the program is the ability to recognize promising business models, going beyond cost reduction. For this, CNPML and CIIS jointly developed a canvas of business models for waste recovery and reutilization, adaptable to wastewater (see Table 2).

Table 2 Business models for waste recovery and utilization.

<p><b>Supplying material resources to manufacturing</b></p> <ul style="list-style-type: none"> <li>➤ Waste becomes a valuable raw material</li> </ul> <p>Example: sludge treatment yielding phosphorus for fertilizer production</p>	<p><b>Supplying energetic resources to manufacturing</b></p> <ul style="list-style-type: none"> <li>➤ Waste becomes a source of energy</li> </ul> <p>Example: sludge treatment yielding biogas for the energy-intensive industries</p>
<p><b>Providing an environmental service</b></p> <ul style="list-style-type: none"> <li>➤ Treating wastewater</li> <li>➤ Purifying air</li> </ul> <p>Example: PIMSA treats additional wastewater</p>	<p><b>Providing a material resource to environmental services</b></p> <ul style="list-style-type: none"> <li>➤ For water treatment</li> </ul> <p>Example: membrane based on whey protein for wastewater treatment</p>

**Progress on the overarching aim**

With the PIMSA case study and its results, the project partners demonstrated the possibility to increase competitiveness, while solving an environmental problem, to stakeholders in Colombia (mainly through the project’s conference) and beyond (UNIDO, SECO). With the upgrade of its wastewater treatment plan, PIMSA, as industrial park operator, taps into new revenue streams. The company now costly trucking its wastewater for offsite treatment has the possibility to treat locally, thereby significantly saving



Figure 5 CIIS and CNPML visiting the EPM plant.

costs. As to environmental problems, the upgrade allows achieving higher quality of treated wastewater discharged into the natural environment, while saving CO<sub>2</sub> emissions from wastewater trucking. CNPML is applying the same approach to the planned project proposal for EPM, as the latter plans to sell wastewater treated in its San Fernando plant (Medellín) to industries located in its vicinity.

To summarize, the project effectively promoted a mindset for tackling environmental issues in companies which departs from the traditional cleaner production approach of reducing costs. Instead, there are clear

and viable opportunities for Colombian companies to tap into new revenue streams if wastewater is seen a resource through its multiple components, i.e., water, energy, and biological and technical nutrients. The generic business models shown in Table 2 are certainly a useful heuristic for making progress with respect to this mindset.

### 5.3 Multiplication / Replication Preparation

Initially, i.e., in the project proposal, the replication was planned at a single level, through a new business model within CNPML. UNIDO is very active in Colombia with its eco-industrial parks initiative, so that the work done at PIMSA has a high replication potential in other industrial parks in the country, which UNIDO is considering to become eco-industrial parks. UNIDO has acknowledged the high quality of the case study assessment and wishes to work with CIIS in other Colombian industrial parks in the framework of its eco-industrial parks initiative. During the course of the capacity building, other replication paths appeared as promising.

- Colombia is facing wastewater issues encountered by many other countries. Having in mind SECO country priorities and WABAG's geographical presence, CIIS compiled an initial list of countries where there could be interest for a capacity-building program in wastewater treatment (see Table 3). Replication will depend on WABAG's willingness to participate in new capacity building endeavours for the sake of entering a new market. If needed, alternatives to WABAG, such as Pöyry, will be sought in order to preserve the unique private sector involvement of the capacity-building program. CIIS has initiated discussions with regional competences centres of ZHAW in order to initiate corresponding project proposals. The goal is here to implement capacity building in a financially self-sustaining way.
- There is potential for replication at the university level as well, even though no contacts have been established yet in this regard with Colombian universities. Part or whole of the capacity building program can be embedded in the master's program of environmental science and/or engineering and/or chemical engineering.

Table 3 Country scoping for replication of capacity-building program.

COUNTRY	SECO STANDING	SECO ACTIVITIES	WABAG PRESENCE	COMMENTS
Peru	SECO economic development cooperation in the South	An important ingredient of sustained and regionally balanced economic growth is an integrated development of cities. Urban areas should have reliable infrastructure. SECO supports emerging medium-sized towns in their ability to provide basic public services, such as clean water, sanitation and waste management.	No (Pöyry yes)	Certainly interesting, as large country and proximity to Colombian context
Egypt	SECO economic development cooperation in the South	SECO contributes to inclusive and sustainable urban development. It improves access to basic infrastructure and services such as water and waste management, and possibly energy efficiency and renewable energy.	Yes	Strong Eawag presence
Tunisia	SECO economic development cooperation in the South	SECO improves basic infrastructure and services such as water supply, sanitation, waste treatment and transport in rural and urban areas. Thereby, SECO strives for eco-friendly and affordable facilities that benefit the whole population.	Yes	SOFIES, a consultancy active in Industrial Ecology, is very strong here
South Africa	SECO economic development	SECO supports the private sector in utilising resources	No	

COUNTRY	SECO STANDING	SECO ACTIVITIES	WABAG PRESENCE	COMMENTS
	cooperation in the South	more effectively and efficiently. It promotes environmentally sound technologies and efficient production processes. SECO also works to ensure that public utilities offer a sustainable water and power supply. Given South Africa's dominant position in the region, it also supports projects that incorporate other countries.		
Vietnam	SECO economic development cooperation in the South	SECO supports Vietnam's fast growing cities in sustaining their role as economic and social hubs. It promotes long-term urban planning. Moreover, SECO helps cities deliver reliable public services in the waste and transport sector.	No (Pöyry yes)	
Albania	SECO transition cooperation in the East (priority countries)	SECO is working to improve public services at a local level. It helps the authorities deliver an affordable and reliable supply of running water and build an efficient sanitation and waste management system. SECO also contributes to improving energy security. It encourages the use of different fuels and helps to safeguard a more reliable and efficient supply of energy from existing sources.	No	EU accession?
Bosnia and Herzegovina	SECO transition cooperation in the East (countries with complementary measures)	SECO is working to improve public services at a local level. To build up the urban infrastructure, for example, it encourages investment in a sustainable clean water and sanitation system.	No	EU accession?
Kosovo	SECO transition cooperation in the East (countries with complementary measures)	SECO supports Kosovo to establish a modern, eco-friendly infrastructure system. For example, it has helped set up an efficient water supply and sanitation system. SECO is also committed to improving efficiency in the supply and use of energy in Kosovo.	No	
North Macedonia	SECO transition cooperation in the East (countries	SECO is committed to ensuring a reliable supply of clean water for Macedonia's	No	Small country but interesting

COUNTRY	SECO STANDING	SECO ACTIVITIES	WABAG PRESENCE	COMMENTS
	with complementary measures)	population and business sector. It supports the development of efficient sanitation and solid waste management systems. In doing so, SECO aims to contribute to environmental protection and raise the general awareness of greener practices.		developments (EU candidacy).
Uzbekistan	SECO transition cooperation in the East (countries with complementary measures)	The Swiss cooperation with Central Asia complies with the demands and priorities of the three partner countries Tajikistan, Kyrgyzstan and Uzbekistan. SECO supports especially efficient water systems in urban and rural areas in Uzbekistan.	No	

#### 5.4 Impact / Sustainability

The first impacts could be felt during the project conference and the ensuing meetings CIIS had in Bogotá with key stakeholders, i.e., SECO, UNIDO, and the Inter-American Development Bank (IDB). As PIMSA took recently the centre stage of UNIDO's eco-industrial parks initiative in Colombia at UNIDO/SECO, stakeholders met were keen on learning about the case study conducted there resulting in a demand by PIMSA's senior manager for a detailed offer. In particular, they acknowledged the holistic approach at the interface between technology and business and insisted that CIIS should strive for replicating the work in one way or the other. To follow up on this, CIIS launched a new REPIC proposal for a capacity-building program on industrial solid waste management in Peru, triggered by a new, ambitious law. Additionally, CIIS will meet with key UNIDO decision-makers in Vienna in early 2020 to discuss next steps in Colombia in the framework of its eco-industrial parks initiative and possibilities for formalizing the capacity-building program.

The project reached out to a new, key stakeholder region, when the globally active engineering firm, Pöyry, accepted to prepare an offer for the upgrade of PIMSA's wastewater treatment plant. Pöyry Switzerland Ltd. aims to team up with local firms to upgrade the plant on the basis of the feasibility study produced in Module 5 of the training program. For Pöyry, the offer represents a unique opportunity to strengthen its position in Latin America. The symbiosis with local firms should stimulate local know-how, industrial demand and employment.

Ecological	Unit	At the REPIC Project's Completion
Installed renewable energy capacity	[kW]	NA
Renewable energy produced	[kWh]/year	NA
Amount of fossil fuel energy saved	[kWh]/year	If plant upgrade concretized: fossil fuels saved by treating wastewater on-site instead of off-site treatment requiring truck transportation
Greenhouse gas reduction	[t CO <sub>2</sub> -eq]/year	If plant upgrade concretized: GHG emissions reduction achieved by treating wastewater on-site instead of off-site treatment requiring truck transportation
Newly collected and separated waste	[t]	NA
Newly recycled waste	[t]	NA



<b>Economic</b>		
Energy costs (LCOE)	[Rp/kWh]	NA
Triggered third-party funding/investments (we have an approximate investment figure)	[CHF]	Expected investment by PIMSA industrial park in wastewater treatment plant upgrade
Local private income generated	[CHF]	<ul style="list-style-type: none"> <li>- Expected new income for PIMSA industrial park operator</li> <li>- Costs savings for company located in PIMSA industrial park thanks to envisaged on-site treatment</li> </ul>
<b>Social</b>		
Number of beneficiaries	[Number]	If plant upgrade concretized: additional demand for wastewater treatment plant components (e.g., civil engineering, pumps, automation equipment)
Number of new jobs	[Number]	NA
Number of trained personnel	[Number]	5 trained CNPML engineers and 6 engineers and managers from Colombian companies

## 6. Outlook / Further Actions

### 6.1 Multiplication / Replication

The next steps for multiplication/replication are:

1. December 2019: Follow-up on EPM interest on selling treated wastewater to industries located in the vicinity of its San Fernando plant (consortium between CNPML, Pöyry, and possibly CIIS).
2. Early 2020: Discussion with ZHAW regional competence centres to investigate potential for replication of wastewater capacity-building program in SECO target countries (with WABAG or Pöyry?)
3. Early 2020: Meeting at UNIDO headquarters to discuss follow-up projects in Colombia and formalization of capacity-building program within the UNIDO framework.
4. March 2020: submission of full proposal for a REPIC project on capacity building for industrial solid waste management in Peru.
5. Mid-2020: Investigate opportunities for embedding wastewater capacity-building program partner universities of the ZHAW School of Management and Law.

Currently, CIIS is working on Steps 3 and 4, i.e., preparing a meeting at UNIDO headquarters and recruiting Swiss technology providers to participate in the REPIC project on capacity building for industrial waste management in Peru.

Hurdles for successful multiplication/replication depend on the type of multiplication:

- CNPML business model: Much will depend here on CNPML's ability to effectively team up with Pöyry to submit a proposal to EPM for industrial reuse of wastewater treated in San Fernando.
- Replication of wastewater training program in other countries: Before reaching to other countries, CIIS needs to align the goals of such a replication with ZHAW regional competence centre, including countries to target based on the list of Table 3. In a second phase, CIIS and the partner regional competence centre will screen technology providers for participation in the capacity-building program. Both tasks require investments in terms of time and human resources. A main issue here will be the cost of the training program.
- University level: As this replication at this level is so far uncharted territory, it is difficult to identify hurdles now. As the training program would target students and not environmental consultants/engineers, this endeavour would probably require a market analysis.

## 6.2 Impact / Sustainability

Table 4 presents the effects expected during the multiplication phase, as per the three replication levels. Concretely, CNPML has the opportunity to tackle the water aspects of UNIDO's eco-industrial parks initiative. In terms of resource efficiency, such an increase in water use efficiency could result in reduced competition between agriculture, households, and industry for fresh water. When replicating the training program in other countries, CIIS will consider adding components on a needs basis. One of such components certainly considered in upcoming capacity building is life cycle assessment (LCA) or environmental footprinting. In some countries, LCA is recommended for decision-support in the field of waste management (e.g., EU) or carbon credit markets make carbon footprinting (based on LCA methodology) necessary for quantifying credits.

Table 4 Sustainable effects expected during the multiplication phase.

	<b>CNPML MODEL</b>	<b>BUSINESS REPLICATION OUTSIDE COLOMBIA</b>	<b>EMBEDDED UNIVERSITIES</b>	<b>IN</b>
<b>ENVIRONMENTAL ASPECTS</b>	Compliance with new wastewater regulations Contribution to greening industrial parks	Possibility to include environmental footprinting into training program	Long-term establishment of unique wastewater expertise in Colombia	of
<b>SOCIO-ECONOMIC ASPECTS</b>	Increased competitiveness of Colombian industries	Contribution to SECO's country-specific goals for economic cooperation and development <sup>1</sup>		
<b>CO<sub>2</sub> RELEVANCE</b>	Reduced truck transportation of waste water (see PIMSA case study)	Possibility to include carbon footprinting into training program		
<b>RESOURCE EFFICIENCY</b>	Industries require less network or well water thanks to reduced consumption or reuse	Contribution to SECO's country-specific goals for economic cooperation and development	Awareness raising for a mindset for cleaner production going beyond cost savings and towards new revenue streams	

## 7. Lessons Learned / Conclusions

The lessons learned are dealt with at two different levels, project management and project impact. For each level, corresponding recommendations are provided, followed by the main conclusions. In closing testimonials of two key stakeholders of the project are submitted.

### Lessons learned for project management

- CNPML and CIIS had different understandings on project goals in general
  - Promote open discussion on and mutual understanding of learning goals
  - Foster buy-in to local benefits
- Deadlines were not always met (project completed ca. 6 months later than original plan)
  - Close project management (e.g., with project planning software)
  - Foster local ownership
- CNPML and CIIS had different understandings on project goals related to educational impact
  - Give value to education
  - Take cultural aspects into consideration (what does lecturing mean in Colombia?)

<sup>1</sup> <https://www.seco-cooperation.admin.ch/secocoop/en/home/laender.html>

## Lessons learned for project impact


- Only five consultants trained at CNPMP (plus the 6 company participants)
  - Open training program to other local consultants (against participation fee)
- Recruiting local companies for companies turned out to be a tedious task for CNPML, until CIIS intervened
  - Commit companies with letters of intent
  - Involve local companies even earlier to prepare case studies (before project launch)
  - Aim for more than one case study
- Only one Swiss cleantech company involved, which increases project vulnerability to company dynamics
  - Recruit further Swiss cleantech companies, e.g., representing different technologies or different stages on value/supply chain

## Conclusions

The project demonstrated that it is possible to train engineers to state-of-the-art wastewater consulting (linking needs, technologies and business aspects), while opening new market opportunities for Swiss technology providers. That said, as observed in the PIMSA case study, these new market opportunities are easier to concretize if partnerships can quickly arise between Swiss entities and local companies, be it hardware suppliers (e.g., pumps and automation equipment) or engineering firms responsible for treatment plant design in which key Swiss components would fit in. Such partnerships would in turn benefit local expertise and the economy. The trained CNPML engineers plan to replicate the case study for EPM and with the support of Pöyry. Swiss technology providers involved have acknowledged the potential of such an approach in creating business opportunities in new, emerging markets. Finally, local companies highly appreciated both training and consultancy and requested a certificate of attendance to the training program.

## Stakeholder testimonials

**Carlos Arango**, Head of CNPML, Email of 6 Mai 2019

 Carlos Arango <carlos.arango@cnpml.org> | 11 | 06.05.2019  
Re: REPIC project wastewater Colombia - case study

Gracias Gregoire,

Queremos agradecer a ti y a todo el equipo de ZHAW y WABAG por todo el apoyo. Esperamos seguir cooperando conjuntamente, tanto para terminar este proyecto de Wastewater, como para fortalecer relaciones futuras en este tema y en otros nuevos a discutir.

Now in english, thank you very much to you and all the teams from ZHAW and WABAG for all the support and cooperation. We hope to work together with you in the future, both to close this wastewater project, and new ones in other topics.

Un abrazo,

Carlos

**Alfredo Caballero Villa**, Director of PIMSA, Email of 8 May 2019

**Von:** Alfredo Caballero <[gerencia@parqueindustrialmalambo.com](mailto:gerencia@parqueindustrialmalambo.com)>

**Gesendet:** Mittwoch, 8. Mai 2019 15:45

**An:** Meylan Grégoire (melg) <[melg@zhaw.ch](mailto:melg@zhaw.ch)>

**Betreff:** RE: REPIC project wastewater Colombia - case study

Estimado Grégoire,

En nombre del Parque Industrial Malambo SA (PIMSA), queremos agradecer a Usted y a todo el equipo de la Universidad de Zúrich - ZHAW, WABAG, ONUDI y el CNPML todo el apoyo brindado, en el desarrollo del proyecto REPIC y el caso de estudio para el proyecto de tratamiento de aguas residuales en el Parque Industrial Malambo.

En el día de hoy estamos presentando y discutiendo dentro de nuestra empresa su implementación, el cual considero ampliamente beneficioso.

Quisiéramos seguir trabajando con Ustedes, para llevar a la realización de este importante proyecto para el PIMSA y continuar fortaleciendo nuestras relaciones empresariales e institucionales.

Quedamos atentos y a sus gratas órdenes.

«[...] We would like to thank you and the entire ZHAW and WABAG team for all your support. We hope to continue cooperating together, both to complete this Wastewater project, and to strengthen future relationships on this and other new issues to be discussed. [...]»

## 8. References

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Meylan, G. (In preparation). Feasibility studies for eco-industrial parks - Case study in Colombia. *Journal of Cleaner Production*.

Meylan, G., Ortiz, C., Estrada, J. S., Cadavid, C. F., Kimmenauer, T., & Qvist-Sørensen, P. (2019). Building capacities for a competitive circular economy – The case of wastewater in Colombia (Presentation). Geneva: World Resources Forum Conference 2019.

## 9. Annex

- 1: Training program (13.11.2018)
- 2: Case study report (14.05.2019)
- 3: Conference program (10.04.2019)
- 4: EPM Request for Information (21.06.2019, refresher course)
- 5: EPM feasibility study project plan (08.08.2019, refresher course)
- 6: Three intermediate reports
- 7: Budget