WP5 – Integration towards full plant concept, assessment and market replication

D 5.4: *Technology dossiers to apply for ETV certification and guidelines*

The project "Full scale demonstration of energy positive sewage treatment plant concepts towards market penetration" (POWERSTEP) has received funding under the European Union HORIZON 2020 – Innovation Actions - Grant agreement° 641661

Deliverable 5.4	*Technology dossiers to apply for ETV certification and guidelines*
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Abstract	This report summarizes the experience of the ETV process during the POWERSTEP project. The reports includes a general description of the ETV process, the selection of the technologies as well as the ETV bodies and finally give feedback from the two technology provider selected for the ETV as well as general recommendations.

Dissemination level of this document

X	PU	Public
	PP	Restricted to other programme participants (including the Commission Services)
	RE	Restricted to a group specified by the consortium (including the European Commission Services)
	CO	Confidential, only for members of the consortium (including the European Commission Services)

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Executive summary

The ETV programme is designed to provide an independent validation of the performance claims of technology suppliers by a qualified third party called "ETV verification body". The "Statement of Verification" delivered at the end of the ETV process can be used as evidence that the claims made about the innovation are both credible and scientifically sound. With proof of performance credibly assured, innovations can expect an easier market access and/or a larger market share and the technological risk is reduced for technology purchasers.

In the POWERSTEP project, 2 technologies were finally chosen after a section process ("quick scan"), **Drum filters for primary treatment** of raw wastewater (supplied by the company "Veolia Water Technologies Sweden – Hydrotech") and the **Biomethanation** process for conversion of biogas or CO_2 into biomethane, using a proprietary biocatalyst and reactor configuration (supplied by the company "Electrochaea").

The report summarizes the how the quick scan was carried out to select the above mentioned technologies, feedback from the two companies of the overall ETV process and their experiences as well as general feedback and recommendation to improve the ETV process in general from the POWERSTEP project point of view. It has to be mentioned that until the end of the POWERSTEP project (30th of June) the ETV verification process is not finished in both cases, so no results or feedback on the outcomes can be presented in this report.

1. Introduction

Within the POWERSTEP project, a selection of innovative processes is demonstrated in pilot or full-scale which should improve the energy balance of a wastewater treatment plant (WWTP), finally enabling the operation of energy-positive treatment schemes. In work package 5 of the project, these processes are assessed in their potential to improve the energy balance of WWTPs, but also in their overall environmental and economic impacts. In addition, the market entry of the innovative technologies should be facilitated with a detailed market analysis and a proof of their performance, using the programme of "Environmental Technology Verification" (ETV) of the European Commission.

The ETV programme is designed to provide an independent validation of the performance claims of technology suppliers by a qualified third party called "ETV verification body". The "Statement of Verification" delivered at the end of the ETV process can be used as evidence that the claims made about the innovation are both credible and scientifically sound. With proof of performance credibly assured, innovations can expect an easier market access and/or a larger market share and the technological risk is reduced for technology purchasers.

In the POWERSTEP project, 5 technologies were foreseen for an ETV at the proposal stage. Following a preliminary assessment of their suitability for ETV ("quick scan"), two technologies have finally been chosen for applying for an ETV:

- **Drum filters for primary treatment** of raw wastewater, supplied by the company "Veolia Water Technologies Sweden – Hydrotech"

  (http://technomaps.veoliawatertechnologies.com/hydrotech/en/)
- **Biomethanation** for conversion of biogas or CO_2 into biomethane, using a proprietary biocatalyst and reactor configuration, supplied by the company "Electrochaea"

  (www. electrochaea.com)

This report describes the process of ETV and the experience that both companies have been made while participating in the ETV programme. Together with the results of the verification, feedback is provided to improve the ETV programme and help this instrument to be a relevant help for innovative companies to reach the market.

In detail, this report contains the following parts:

- Summary of the quick scan results for 5 technologies
- Details of the ETV process for Hydrotech drum filters
- Details of the ETV process for biomethanation of Electrochaea
- General feedback and recommendations to improve the ETV process

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2. Preparation of ETV process

The ETV process is structured in 6 consecutive phases which are presented below (Figure 1). The first step of the process after contacting an ETV verification body is the eligibility check. With this formalised check, the technology supplier (or "proposer") can prove that the specific technology is suitable for the ETV verification scheme. The eligibility depends on the innovation level of the technology, its readiness for market, and lack of existing standards or regulations that could be used to prove its performance against defined criteria.

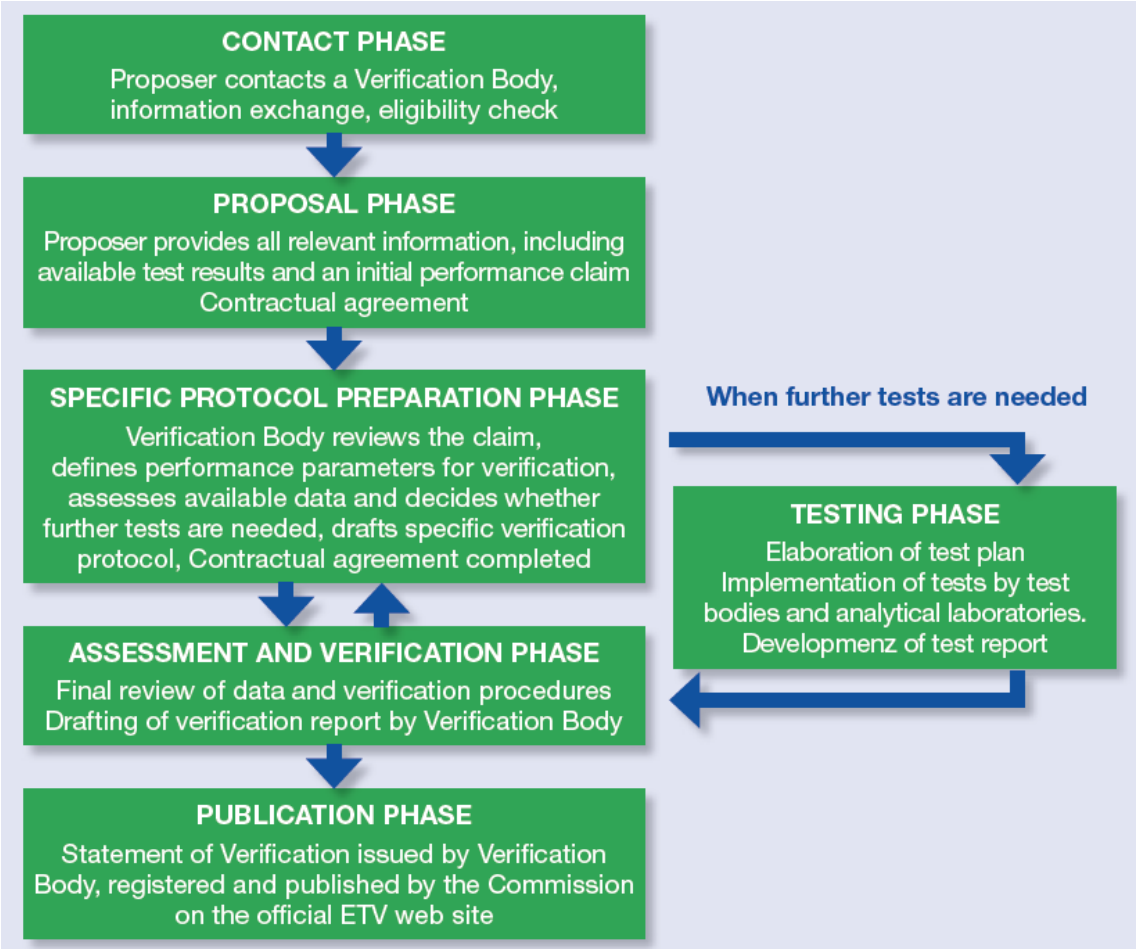

Figure 1: Process of Environmental technology verification (ETV)

The eligibility check (also called "quick scan") can be performed with any verification body and is usually free of charge. Using a pre-defined electronic form, the quick scan requests information about the following aspects:

- Proposer
- General description of technology (context, purpose, principle, relevant alternatives, main claims and related conditions, technical standards)
- Market readiness (availability on the market, stage of development)
- Innovation level
- Environmental added-value (life-cycle based assessment of positive and negative environmental aspects)

- Fulfilment of legal requirements
- Intellectual property rights (ownership of technology)
- Existing data (type and amount of available data)

The verification body reviews the quick scan with a feedback loop to the proposer, and finally concludes on the eligibility of the technology for ETV. A positive quick-scan is a prerequisite for the formal start of the ETV process between the verification body and the proposer. It can also contain a first indication of costs involved for the proposer to enable an informed decision whether to start the ETV process.

2.1. Results of the eligibility check for ETV ("quick scan")

Within this project, five different technologies have been checked for their eligibility for ETV. As verification body for the first round of quick-scans, the consortium chose to approach WRc (UK) which were also contacted for general information on ETV at the proposal stage of the project. The specific five technologies and the related results of the quick scan are provided below (Table 1).

Filled quick-scan documents were sent to WRc in December 2015 for a first check. After receiving comments of WRc in January 2016, revised versions of the quick scan were sent in February 2016 to WRc for four technologies. For the duckweed bioreactor of APS, it became clear during the quick-scan that the technology was still under development and the supplier was not ready to formulate precise performance claims for this process. Hence, the ETV process was not continued for this technology.

Table 1: Technologies of POWERSTEP which have been assessed for their eligibility to the ETV programme and results of the quick scan

Technology	Proposer	Results of QuickScan	Remarks
Drum filter for primary treatment of wastewater	VWT – Hydrotech	Eligible	Technology is eligible for ETV
Anita™Mox for mainstream deammonification	VWT – Anox Kaldnes	Eligible	Technology is eligible for ETV, but ETV was stopped due to budget constraints and uncertainty about positive outcome of claim verifications
Biomethanation for Power-to-gas plant	Electrochaea	Eligible	Technology is eligible for ETV
Duckweed bioreactor for wastewater treatment	APS	Not eligible	Technology is not mature yet to define and verify precise claims for performance
Membrane stripping for N recovery from sludge liquor	Sustec	Eligible	Technology is eligible for ETV, but partner did not win tender for full-scale plant in POWERSTEP → no test site available for ETV trials

The remaining four technologies were in principle eligible for the ETV programme. However, the planned membrane stripping plant of Sustec was not realized at WWTP

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Altenrhein as the company did not win the related tender (Böhler, Fleiner et al. 2016, Böhler, Hernandez et al. 2018). Hence, no test site was available to conduct ETV trials during POWERSTEP, so that the ETV process for this technology was suspended.

Finally, the results of the quick-scan revealed that three technologies of POWERSTEP could apply for an ETV certification based on the eligibility and availability of a test site.

2.2. Choice of ETV bodies and final decision to start ETV

At this stage of the process, the consortium was informed that the EC did not continue the ETV pilot programme beyond 2016 which provided co-funding for the ETV verification bodies and thus limited the resulting costs for the proposers. As a consequence, WRc decided to leave the ETV programme, and their accreditation as verification body has expired meanwhile.

Consequently, the consortium approached other verification bodies to continue the ETV process. Based on the available ETV verification bodies in the respective field of water treatment and energy, the proposers decided to approach RESCOLL (FR) for water treatment and ETA Denmark (DK) for energy to finalise the quick scan and start the official ETV process.

Another issue to solve was the increase in required budget for the ETV. Originally planned with 10k€ per technology in the proposal phase, the actual costs of ETV rose significantly without EC co-funding of the programme. First quotes indicated that the available POWERSTEP budget was not sufficient to cover all the costs involved for ETV, including costs of ETV verification body (~ 20-30k€ net), but also potential costs of additional analytics etc. which could be required in the trials period. As a consequence, partners had to cover additional costs at their own expense, even though the available total budget for ETV in POWERSTEP (50k€) had been reallocated to the remaining ETV proposers.

2.2.1. Biomethanation of Electrochaea

For Electrochaea and their biomethanation process, the quick-scan with ETA Denmark as verification body was finally evaluated positive, and the parties continued with a formal contracting. Electrochaea agreed to cover all additional costs of the ETV process beyond the POWERSTEP budget at their own expense. The details of the ETV process can be found below (chapter 3).

2.2.2. Drum filter of Hydrotech and Anita™Mox in mainstream of Anox Kaldnes

For these two technologies, separate quotes have been received by RESCOLL for the ETV process. Due to budget limitations, and because both proposers are within the same parent company (Veolia Water Technologies), it was finally decided to skip the ETV for the Anita™Mox system in the mainstream, as this technology is still under development and a positive verification of specific claims could not be guaranteed. Finally, Hydrotech agreed to formally start the ETV process for their drum filter technology with RESCOLL as verification body. Any additional costs beyond the POWERSTEP budget would then be covered at their own expense. The details of the ETV process can be found below (chapter 4).

3. ETV of biomethanation (Partner: Electrochaea)

The ETV for the biomethanation process of Electrochaea is carried out in cooperation with ETA Denmark (DK) as verification body.

3.1. Timeline of ETV process

The whole process from starting the ETV process until signing the contract nearly takes 2 years in total. An overview of the timeline is available in Table 2.

Table 2: Timeline of ETV process for biomethanation process

Date	Step	Remarks
August 2016	Eligibility of the technology to ETV process	Eligibility of technology for ETV was approved by ETA Denmark
October 2016	1st meeting with testing body	
October 2016	Quick-Scan prepared	
November 2017	Selection of experts	
November 2016	Visit on site of experts	
January 2017	Stand-by until CO2 is available on site	Non-reliable source of CO2 as feed gas prevents to carry out the verification protocol.
June 2018	Formal contract signed	Costs for verification body amount to 18 666 € (net)
December 2018	ETV process finished	Source of CO2 should become reliable by end of summer 2018.

3.2. Development of testing protocol

Electrochaea organised a meeting with ETA Denmark to initiate the ETV process. The technology and the demonstration plant have been introduced to the verification body.

ETA Denmark selected experts and organised a first visit on site, where the existing instrumentation and data-logging have been reviewed. The existing instrumentation and data-logging had been judged satisfying, with the following remarks:

- A mass-flow meter at the process interface with the feed-gas delivery would improve the reliability of the mass-balance, especially when the system is operating with biogas. Electrochaea agrees and had already identified the need and a technical solution. However, the same measuring point is also looked at by the gas and electrical grids regulator (Energinet.dk) and Electrochaea is still waiting for their final statement about how this measuring point should be characterised (sensor technology, accuracy).

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- An additional mass-flow meter on the product gas would consolidate the mass-balance. Electrochaea agreed and installed the additional mass-flow meter.
- The accuracy of the flow-meters in place cannot be precisely characterised once in place, but with the two additional measurements, enough redundancy would be available to reconciliate all the measurements.
- The accuracy of the on-line gas analyser has been questioned, both by the expert and Electrochaea. During the first POWERSTEP campaign (Q1-2017), two gas chromatographs, one operated by Electrochaea, one operated by the gas grid operator, have been sampling the same measuring point. Tests have demonstrated that the on-line analyser was giving satisfying results for the product gas and therefore could be used in the ETV protocol.
- Gas samples can be collected and an ISO-certified laboratory (Danmark Gasteknik Center) is available to characterise the samples.

After the visit Electrochaea prepared the claims of the ETV. From a technical and commercial perspective for Electrochaea it is important to run the ETV process at least with pure CO_2 as a Carbon-feed gas (therefore the planned biogas upgrading plant is needed), and if possible with both CO_2 and raw biogas.

3.3. Execution of test period

As the biogas upgrading plant was not commissioned yet in 2017, Electrochaea preferred to wait for the completion of the upgrading plant and to focus on further improvements of the demonstration plant, such as the addition of mass-flow meters, the erection of the heat exchange from the electrolyser and the quantification of the energy balance. Electrochaea also preferred to acquire enough experience on the operation with CO_2 at the demonstration scale before starting the official verification.

In June 2018, the upgrading plant had still reliability issues, making it impossible to have a stable source of CO_2. Therefore, even the last POWERSTEP campaign which was dedicated to the operation with pure CO_2 has been hard to carry on, and in any case, the stability conditions of supply for entering a verification procedure were not met. Therefore, the ETV process could not be finalised (see expected timeline Table 2).

3.4. Verification of technology claims

For technical reasons out of the control of Electrochaea, the ETV process could not be finalised within the time frame of the POWERSTEP project. However, additional measuring points and improvement of the data logging have been implemented to start the verification test when the conditions will be met.

3.5. General feedback of the technology supplier on ETV programme

The ETV process could not be finalised before the end of the POWERSTEP project as mentioned above. However, Electrochaea can give the following feedback:

- The ETV verification body and appointed experts were professional and diligent, experts raised reasonable and relevant questions

- The test phase of the verification is a significant investment and therefore Electrochaea preferred to have all the right conditions met before starting the actual verification. It requires a good level of technological maturity and stable site conditions before "handing over" the plant to a third party.
- An independent assessment of the performance claims is of course an advantage to convince potential customers or partners. However, the ETV is not yet broadly known and it is also anticipated that really interested customers would actually ask for their own dedicated campaigns.

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4. ETV of drum filter (Partner: Hydrotech)

The ETV for the Hydrotech Drumfilter was carried out in cooperation with RESCOLL (FR) as verification body. The initial claims of the microscreen technology for primary treatment were related to the efficiency to remove a specific amount of substances from raw municipal wastewater into the backwash water of the filter:

- 30-95% total suspended solids removal
- 20-90% BOD removal
- 20-95% P removal
- 20-75% COD removal

The removal efficiency could be tuned, in average, by adjusting:

a) the chemical dose added upstream of the filter unit (typically 0-10 mg-Al/L and/or 0-5 mg-polymer/L)

b) the mesh size installed (20-100 micron).

Direct filtration without chemical pre-treatment would lead to the lower removal values in the above ranges (30% for TSS, 20% for BOD, 20% for TP, and 20% for COD). Chemical pre-treatment with 10 mg-Al/L and 5 mg-poly/L would yield to the higher removal values listed (up to 95% for TSS, 90% for BOD, 95% for TP, and 75% for COD). Dosing values in between 0-10 mg-Al/L and 0-5 mg-poly/L would lead to a water quality within the ranges stated above. The higher the dose, the higher the removal.

The exact claims on removal were to be defined after the verification protocol has been completed. The above treatment demands are within the values requested in the European water directive where N removal is not required.

4.1. Timeline of ETV process

The whole process extended over 2 years in total, not taking into account the time to issue the Quick scan documents required to initiate the process. An overview of the timeline is available in Table 3.

Table 3: Timeline of ETV process for drum filter

Date	Step	Remarks
09.02.2016	Final version of quick scan issued by Hydrotech	
28.06.2016	Eligibility of technology for ETV was approved by RESCOLL	Offer delivered to Hydrotech
28.04.2016	ETV Verificaction contract issued by RESCOLL	
05.12.2016	Internal decision regarding which Powerstep technologies go through ETV	
07.03.2017	Purchase order sent by VWT-Hydrotech	Costs for verification body amount to 19750 € (net), excluding lab analyses
13.04.2017	Order confirmation issued by Rescoll	

Date	Step	Remarks
21.04.2017	Verification experts selected	
18.05.2017	Technical experts trained on ETV and ISO 17020	
02.06.2017	First draft of verification proposal issued by RESCOLL	
07.12.2017	Appointed expert visits the test site for the first time and performs an audit of the install equipment	Test site was the Sjölunda WWTP in Southern Sweden
14.12.2017	Verification proposal approved by VWT	
11.01.2018	Testing protocol sent for validation to RESCOLL and testing campaign started	
28.03.2018	Testing protocol reviewed by RESCOLL, one claim had to be left out due to lack of time	
19.06.2018	Testing period expected to finish	
30.06.2018	ETV expected to finish	

4.2. Development of testing protocol

Actual discussions on the verification protocol with the Verification Body started in March 2017, after issuing a purchase order on the ETV certification. Two technical experts working at the Swedish Environmental Institute were selected and they started working on the project after signing a non-disclosure agreement and getting training from the Verification Body on the ETV certification process and ISO 17020. The first version of the Verification Protocol was sent in late August 2017. This first version reflected a clear lack of competence of the person drafting the document on phisico-chemical wastewater treatment, the specifics of the technology under assessment and showed an unrealistic expectation level on the monitoring needs and test periods.

The major concern by the technology provider was the applicability of the verification results. Hydrotech has more than 50 models in their catalogue: machines with different sizes, but having the same working principle. The Verification Body neglected using the term Hydrotech microscreen, covering all the models available, and insisted in applying the claim to the specific model used in the verification. A holistic claim would have required 50 verification processes.

Hydrotech was not ISO17025 accredited, required by the ETV program, and had to outsource all the analytical needs in the course of the verification to an accredited lab, which increase significantly the cost of the certification.

The final Verification protocol was issued in December 2017, 9 months after issuing the purchase order. Due to lack of time and technical issues on the site where the verification protocol had to be executed, only 2 out of 3 claims could be tested:

Hydrotech drumfilter HDF2001-1H allows to maintain the effluent at a NTU/TSS concentration corresponding to a TSS-removal of 60% or higher of the average TSS concentration in the influent despite daily variations (flow and pollutants) using

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chemicals. Without chemicals, Hydrotech drumfilter HDF2001-1H allows to remove an average percentage to be defined after the tests.

4.3. Execution of test period

In order to validate the above claims, it was required to measure:

- Concentration of total suspended solids (SS) before Hydrotech drumfilter HDF2001-1H - [mg/L or g/m^3]
- Quantity of coagulant before Hydrotech drumfilter HDF2001-1H – Calculation from dosed volume. If coagulant was dosed upstream the filter, residual concentrations of the used metal salt would have to be analysed as well downstream the filter.
- Flow before Hydrotech drumfilter HDF2001-1H – [L/unit of time]
- Water temperature [°C]
- Measure of pH (before and after Hydrotech drumfilter HDF2001-1H)
- Concentration of alkalinity (before and after Hydrotech drumfilter HDF2001-1H) - [mg/L or g/m^3]
- Concentration of BOD (before and after Hydrotech drumfilter HDF2001-1H) - [mg/L or g/m^3]
- Concentration of Total phosphorus (before and after Hydrotech drumfilter HDF2001-1H) - [mg/L or g/m^3]
- Concentration of TOC (before and after Hydrotech drumfilter HDF2001-1H) - [mg/L or g/m^3]
- Energy consumption of the Hydrotech drumfilter HDF2001-1H [MJ per unit of time] or [kWh per unit of time]
- Consumption of backwash water [L/L of treated water]
- Consumption of cleaning materials [L or g]

And each of the claims had to be evaluated after 3 weeks of testing under each of the following conditions:

- Constant maximum flow = Qmax
- Low flow = 0.2 x Qmax
- Varying flow similar to true influent = Qavg

Even though a wastewater treatment would only very rarely be operated at a constant flow. All and all, the expectations of the Verification Body (based on the lack of experience in the process and this particular technological area), resulted in a lengthy and expensive verification period, which is doubtful anyone would be willing to go through unless there was a push in terms of legislation.

4.4. Verification of technology claims

The proposed claims will be released in June. In order to keep the deadlines of the verification protocol realistic, it is recommended to run the verification process in a full-scale site and not in a test site as done here, where the technology provider does not have any control on the availability of wastewater for testing or the representability of the pollutant loads in it.

4.5. General feedback of the technology supplier on ETV programme

The Verification Body did not have the background to understand the proposed technology, its application, and how to measure the proposed treatment claims. This situation derived in discussions that took a long time to complete, expensive sampling and analytical programs, and action plans that took months to agree on. The Verification Body had to write the Verification Protocol with the input from the selected experts, but there was an obvious gap between these two parties. The author of the protocol did not seem to have the background required to understand the expert and incorporate his/her input into the written documentation.

The proposed technology is scalable: all models operate under the same principle and the same filtration material. The actual model proposed to an eventual client is based on the flow and TSS pollution load to treat (more TSS load, more filtration area required, bigger filter model offered). The Verification Body insisted in verifying one specific microscreen model (with a defined size) instead of the group of machines working under the same principle. It is unrealistic to expect that a technology provider will be willing to validate each machine in their catalogue. Even less, when it takes 27 weeks to test and verify 3 claims of a physico-chemical process.

It is very unlikely that the ETV verification will lead to any market success or benefit for Hydrotech due to lack of knowledge of the market on this type of verification and the lack of legislation that technology providers have to comply with in order to prove their claims.

All and all, it is strongly suggested that the European Commission highlights the advantages of going through the verification program and gives examples of technologies that are a good fit to participate. Please note that technology providers often issue Process Guarantees in order to back up their claims (this is the market standard now).

In order to make the process smoother, it would be advised to:

a) Re-evaluate the ETV certification abilities of the existing verification bodies
b) Create Verification Bodies of excellence in the EU for different environmental areas (water, air, soil, noise, energy). We believe that having the technical competence in the verification body could lead to shorten the time period required to agree on a verification protocol and its execution.

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5. Recommendations for ETV programme

Summarizing the experience concerning the ETV program within the POWERSTEP project from the quick-scan to the verification process the following important points have to be mentioned for improving the overall ETV process:

- The quick-scan is a good possibility to have a first overview if the process is developed far enough to run through a ETV process or not
- There should be a EC level based screening process of candidates who want to become ETV bodies (e.g. for having the right competence for performing ETV in their area)
- There should be more transparency concerning costs of the ETV process

6. References

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Böhler, M., A. Hernandez, J. Fleiner, W. Gruber and A. Seyfried (2018). Deliverable D4.3: Operation and optimization of membrane ammonia stripping. Dübendorf, Switzerland, EAWAG.

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