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Nordic Innovation Centre

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Nordic Water Technology Verification Centers (NOWATECH)

- **Three Nordic Environmental Technology Verification (ETV) test centers have been established**
- **Independent verification of the performance of innovative environmental technologies**
- **Support for Nordic environmental technology industry in both the home market and the global market**



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Abstract: In the NOWATECH project, co-ordinated methods for environmental technology verification (ETV) have been developed and implemented at three centers, and the centers have conducted in total 10 pilot verifications. Continuous dissemination of the results has been ensured through the project web. The role, organization and prospects of ETV in the Nordic countries have been described in reports, papers and presentations, and an extensive consultation process has been done with regulators, authorities and industry at levels from national over Nordic to European and global. The Project has provided a significant contribution to the plans for a European Union based ETV scheme, has contributed to international mutual recognition of ETV and has produced a proposal for a Nordic ETV scheme.		
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1 EXECUTIVE SUMMARY

Environmental Technology Verification, ETV is independent documentation of the performance of innovative technologies. Overall, ETV provides proof that:

- It does what it says on the tin

ETV aims to help society choosing and investing in technologies that reduce climate change and environmental effects, and to choose technologies to monitor these changes and effects. ETV helps reducing risks and scepticism related to investments in new and/or innovative technologies. ETV further helps companies demonstrating the efficiency of these products and to increase market shares.

Nationally recognized programs for ETV exist in the US and Canada, among other countries, and a European ETV scheme is now being established. The project Nordic Water Technology Verification Centers, NOWATECH, supported by Nordic Innovation Centre (NICE) has been initiated to support the Nordic role in and benefits from the emerging European ETV scheme.

The objectives of this project were:

- To support the Nordic environmental technology industry in both the home market and the global market by giving access to accepted and comparable technology verification data.

The sub objectives are:

- To establish four ETV test centers within the water technology sector
- To establish a cooperation with networks of technology providers and users
- To establish a web site with access to technology verification data
- To initiate extension of the test center net

During the project, three ETV test centers were established:

- Test center biological water treatment technologies at Aquateam
- Test center cleaner water treatment technologies at IVL
- Test center water technologies at DHI

While establishing and operating of the two centers planned for DHI, combination of the two centers into one was found more cost efficient and stringent. In order to ensure uniform operation of ETV at the centers, each center has prepared and implemented a quality manual for ETV based upon one common and accepted template.

The selection of technologies and the planning of the test center operation and extension were supported by a technology review on innovative water technologies and a market report for the Nordic ETV.

The centers have done verification of 10 technologies as pilot operations:

- Biowater Technology combined fixed film and activated sludge process
- Krüger Kaldnes moving bed biofilm reactor
- Vilokan evaporator and membrane filter equipment for treatment of cutting oils and degreasing baths
- Vilokan vacuum evaporator and activated carbon filter equipment for treatment of cutting oils
- Vilokan ultra membrane filtration equipment for treatment of cutting oils and degreasing baths
- Nordcap Membrane Consulting ultra membrane and reverse osmosis equipment for treatment of cutting oils and degreasing baths
- Aqua Chameleon UV/Ozone system by ULTRAAQUA for removal of geosmin and MIB in recirculated aquaculture process water
- Aqua Chameleon UV/hydrogen peroxide system by ULTRAAQUA for removal of geosmin and MIB in recirculated aquaculture process water
- Sorbisense GWS40 passive sampler for volatile organic compounds in ground-water
- S:CAN Spectrolyser mulitparameter sensor for wastewater

An expanded network of technology providers, users and regulators has been established through:

- Cooperation with a related project under the NICE focus area Nordic Environmental Technology: NETS.
- Organization of three workshops on ETV in the Netherlands, Copenhagen and Brussels providing information for the technology industry, as well an opportunity for ETV information exchange and consultation.
- Participation in the first steps towards standardization of ETV through CEN Work Shop 32 preparing an agreement on environmental technology verification – soil and groundwater site characterization, monitoring and remediation technologies.
- Presentation of NOWATECH and the concept of ETV to Nordic and Baltic industry networks: Clean Water Norway, Entech Norway, Swedish Environmental Technology Net, Swedish Association of Suppliers of Effluent and Water Treatment Equipment, Baltic 21, Finnish Water and Waste Water Works Association, Finnish Cooperation Forum for Environmental Geotechnics and Green Net Finland.

Resulting from the network expansion in the project is a solid basis for qualified stakeholder interactions and technology solicitation for verification for the three NOWATECH test centers.

The verification reports, presentations of the NOWATECH centers and general information on ETV have been made generally available at web site: www.etvnord.org. The web site now provides an efficient and established tool for Nordic ETV communication.

Based upon inventories and consultations made by the Danish DANETV cooperation, expansion of the ETV emphasis from water technologies to include a broader range of technologies addressing issues of environment and climate is suggested: energy tech-

nologies, air emission technologies and technologies for improving environmental management in agriculture.

Through extensive consultations with national and international authority stakeholders and ETV operators, NOWATECH has been positioned as an accepted ETV partner, globally. Still, with the current delay in establishing the European ETV scheme, the continuation and expansion of the NOWATECH ETV centers were endangered by the lack of a normative reference and framework after project completion. Therefore, Nordic Innovation Centre has offered to process and publish a verification method prepared by NOWATECH as a Nordtest method. Appendix 1 The QA manual is the Nordtest Method ENVIR 011. This method will be updated according to lessons learned by doing verifications. NOWATECH has gratefully accepted this and plan to submit the draft standard text during the winter 2009-2010.

Furthermore, the NICE Board has decided to establish a Nordtest ETV scheme, NTETV, and the NOWATECH partners are preparing for launching of this scheme in cooperation with NICE during the winter 2009-2010.

With these initiatives, the purpose of supporting the Nordic environmental technology industry in both the home market and the global market by giving access to accepted and comparable technology verification data is indeed secured in a long term perspective.

2 ENVIRONMENTAL TECHNOLOGY VERIFICATION

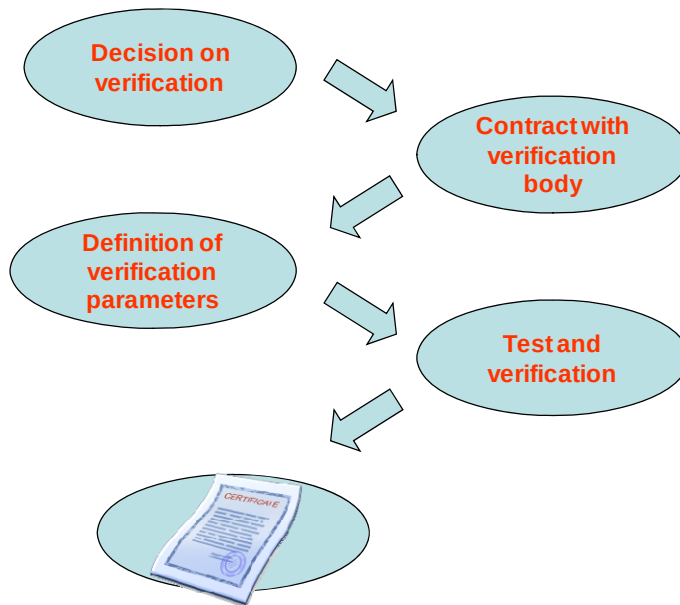
Environmental technology verification, ETV, provides independent verification of the performance of environmental technologies. The performance verification gives measurable, verifiable and comparable data that include but are not restrained to technical and economical performances, sustainability and environmental benefits. The performance verification is done at ETV centers that operate according to an accepted framework and a set of defined methods for technology testing, evaluation and documentation. ETV is thus a form of third party assessment and belongs to the family of conformity assessment measures.

The methods may differ among the different scheme frameworks operating globally in response to the history and purpose of these and to the technology product types reflecting differences in the nature of the technologies and the requirements of the end users. Still, the overall principle is simple, as can be seen from Figure 1.

In words:

- the technology vendor decides to pursue verification of a technology
- the vendor describes the application of the technology
- the vendors contacts and contracts a verification body for doing the verification
- the verification body defines the parameters to be verified and the test data required to do so
- the performance is tested and the test data are evaluated (verified) for the performance parameters
- a verificate or verification statement is issued presenting the application and the verified performance of the technology

Figure 1 Outline of the fundamental ETV process



In reality, a range of variations exists in the simple process outlined due to e.g. different purpose or different scheme history.

2.1 ETV variations with purpose

The simple principle of ETV should be useful to technology buyers, regulators, investors and vendors [1]. In reality though, the way an ETV system is defined, organized, financed and operated is defined by, but also determining the primary use of the system. The two extremes are a vendor driven and a regulator driven system, recognizing that neither extreme would probably be favored by anyone. Selected aspects of these two extremes are presented in Table 1.

In conclusion, a vendor with a new, innovative product will hardly submit a detailed application for access into technology verification with a centralized organization controlled by the authorities, unless it was mandatory. Conversely, the authorities will hardly pay for verification of technologies without a proven public need and a direct control on the quality of the verification, unless the societal benefits with substantial and proven. A compromise is of course needed that solves the key issues, while still recognizing that a system satisfying all interests is probably not feasible.

In NOWATECH, the approach has been to work more in the direction of vendor driven verification.

Table 1 Aspects of definition, organization, financing and operation of vendor and regulator driven ETV systems

Aspect <i>Example</i>	Vendor driven system preferences	Regulator driven system preferences
Technology definition	Products grouped after the application (and the market) <i>Devices for disinfection of drinking water</i>	Technologies grouped after basic principles <i>UV treatment for disinfection of water</i>
Organization	Organization of verification facilities in an open market structure with surveillance of quality and mutual recognition of verifications <i>Product certification after EN 45011 with national certifying bodies under national accreditation but with mutual international recognition</i>	Organization with verification bodies selected and controlled by the authorities and with the authorities involved in the verification process <i>Approval of technologies for drinking water treatment by the US Homeland Security authorities</i>
Geography	Local access to verification facilities <i>The vendor of a wastewater treatment system seeks local verification in expectation of lower costs for communication and travelling during verification</i>	One verification facility for each technology under the ETV system <i>The wastewater authorities seeks central verification of a group of wastewater treatment systems in expectation of verifications done under identical conditions and with the economies of scale</i>
Financing	The verification is paid for by the party (vendor) submitting a product for verification <i>The vendor of a new UV device for drinking water treatment pays for the verification in expectation of increased sales</i>	The verification is paid for by the authorities in response to public technology procurement needs <i>The groundwater authorities pays for demonstration of the use of oxygen releasing chemicals at sites with gasoline spills and groundwater contamination in expectation of more cost efficient remediations</i>
Decision on access to verification	The decision to enter the ETV system is taken by the vendor, guided by the verification facility <i>The vendor of a UV device submits the device for verification based upon the commercial benefits from a verification</i>	The decision to allow a technology into the ETV system is taken by the authorities in response to an evaluation of the public need for verification <i>The authorities call for UV disinfection technologies for verification based upon an analysis of public needs, followed by an application and approval process</i>
Maturity of products and technologies in verification	Ready for market and in market products can be verified <i>A vendor in the last stages of pilot operation of a UV device submits the device for verification and designs the pilot operation to provide parts of the data required for verification in cooperation with the verification facility expecting to reduce the total pilot and verification costs</i>	Technologies available for purchase can access verification <i>Authorities in need of verification data for procurement of water treatment devices and would thus only allow products in the market for verification</i>

Aspect Example	Vendor driven system preferences	Regulator driven system preferences
Mutual recognition of certificates internationally	Certificates issued under one ETV system are recognized by other systems. <i>A vendor with a product certified in the EU can have this certificate accepted in the US.</i>	Certificates issued under one ETV system are not recognized by other systems. <i>The US EPA ETV can not accept European verification statements if not subjected to US QA in addition to European QA done.</i>

2.2 ETV and other performance documentation approaches

Credible documentation of the performance of technologies is essential for the vendor, the buyer and the regulator, although for different purposes (supporting sales, enabling informed purchase decisions and protecting public interests, respectively). Different approaches to documentation have accordingly been developed for different phases of the technologies, examples shown in Table 2.

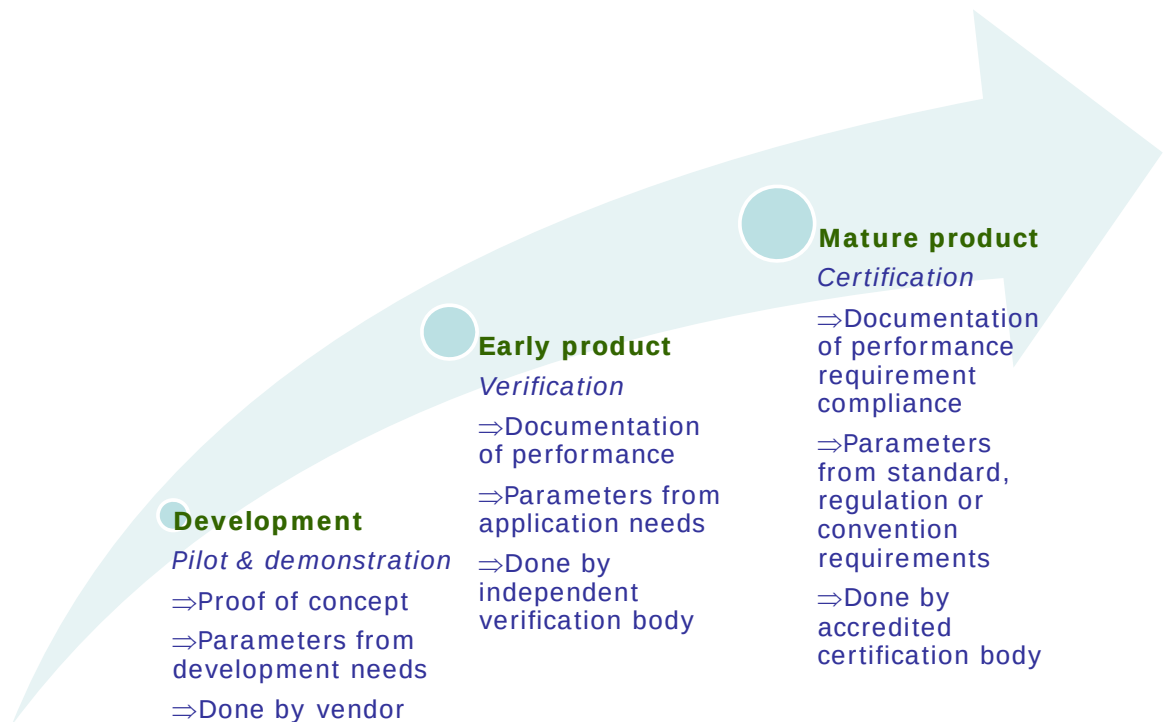
Table 2 Examples of approaches to technology performance documentation, their use in different technology phases and their characteristics

	Pilot and demonstration	Environmental technology verification	Product certification
Technology phase	Late development of product	Product ready for sale	Technology established on market
Documentation reference	Industry practice	EU ETV/2/ US EPA ETV ETV Canada	EN 45011/3/ ISO/IEC Guide 65:1996/4/ ISO/IEC Guide 67:2004/5/
Purpose	Proof of concept and suggestions of improvement	Documentation of performance	Documentation of performance compliant with accepted requirements
Provided by	Vendor	Verification and test body	Certifying body
Status	Not independent	Independent	Independent
Performance parameters and requirements	Parameters set by the vendor of one product	Parameters set by the vendors of a technology/product group and relevant to the users	Parameters and quantitative requirements set in performance standard or similar normative document for the technology/industry
Required additional features	None	None	Surveillance of product compliance after certification
Optional additional features	None	None	Inspection of production facilities

In other words, the favoured documentation approach depends upon the maturity of the technology and the time that it has been on the market (or the time to market introduction). Environmental technology verification (ETV) is intended for innovative technologies ready for the market, whereas (product) certification is intended for products

that have been available for so long that product performance standards have been developed. The interrelations between the documentation approaches are illustrated in Figure 2.

Figure 2 Interrelations between different documentation approaches

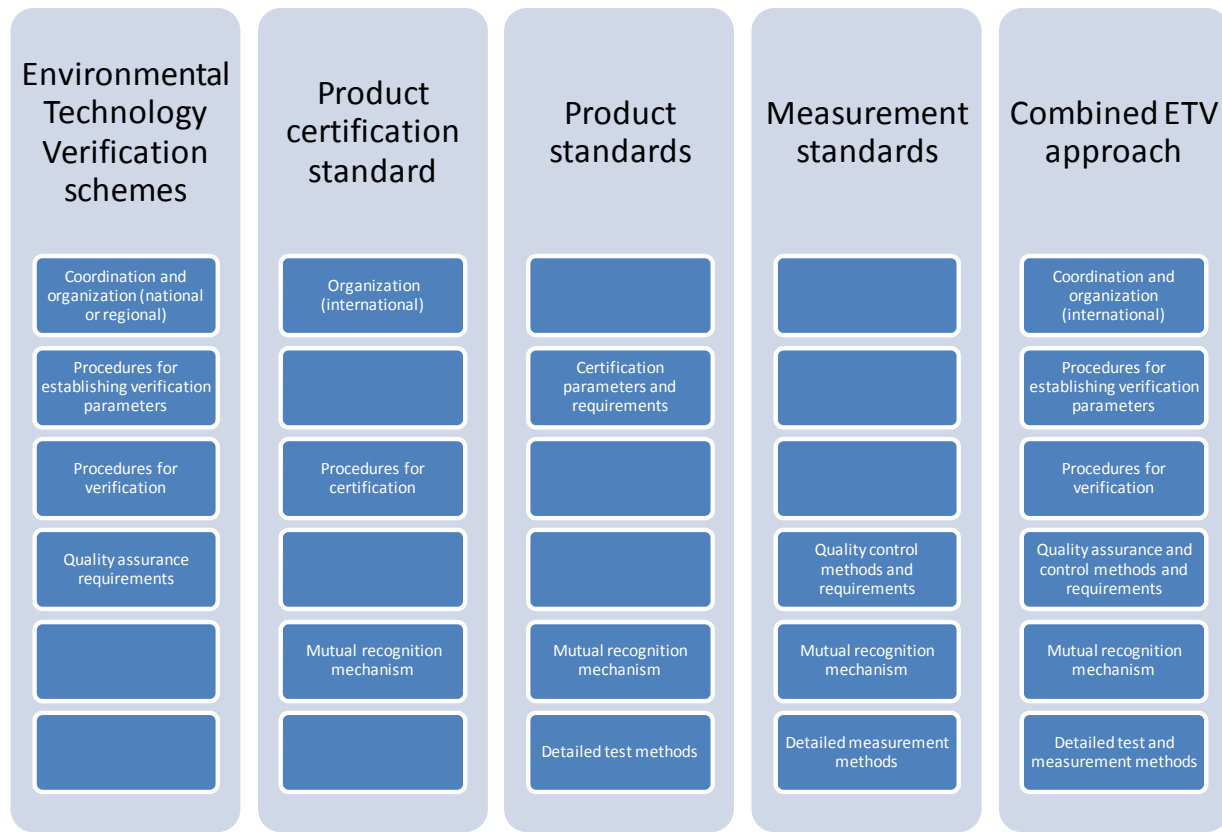


Although the limits between the different phases of a technology may in reality be somewhat fluent, the NOVATECH approach is to work with verification of innovative, early products, when available “at the shelf”, while still recognizing that parts of the required performance data may be obtained in the last phases of development.

International standards may add significantly to comparable and traceable ETV operation. Standards for general quality management (ISO 9001/6/), for quality management of testing and measurements (ISO 17025 /7/) and for measurements can contribute significantly to this aim. Unfortunately, an international standard for ETV operation does not exist, and the standard for product certification does not apply, as demonstrated in Table 2. The approach chosen in NOVATECH to combine the existing elements to the degree possible, see Figure 3, in other words not “to reinvent the wheel”.

Two key issues here are that a standard for establishing accepted performance parameters for verification does not exist, and that a mechanism for cross-scheme mutual recognition of verificates does not exist either.

Figure 3 Combination of schemes, standards and methods to achieve comparable and traceable verifications with maximum reuse of existing material



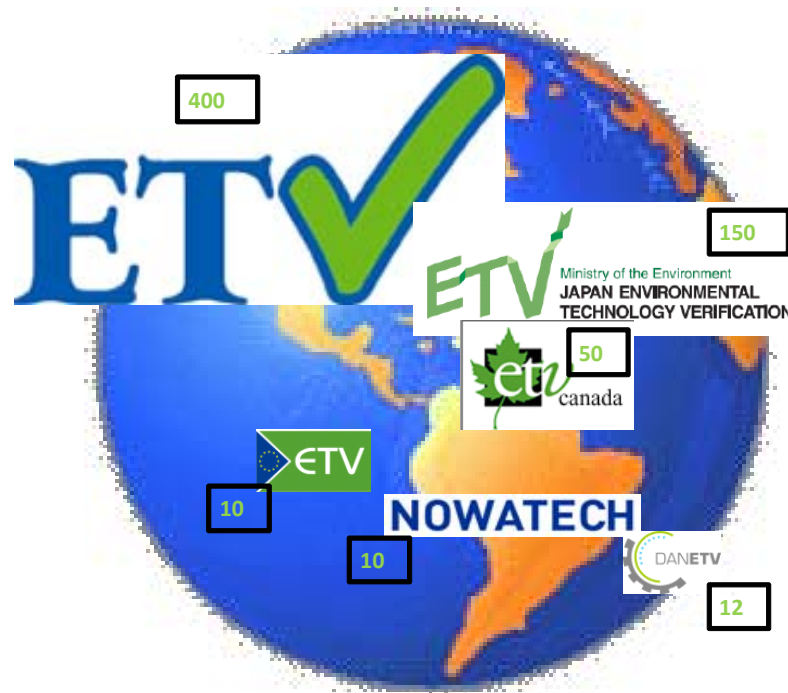
2.3 The international perspective upon ETV

The first national ETV scheme was established by the Environmental Protection Agency (EPA) in the United States (US), followed firstly by a scheme established by Environment Canada and later by schemes established in Bangladesh, Japan, Korea and the Philippines. Project based ETV has been done in the European Union (EU) as part of projects under the 6th Framework Programme for Research (FP6) including TESTNET, AIRTV, PROMOTE and TriTech, and in NOWATECH under NICE, all with an international, but regional approach. In Denmark, a national ETV initiative has been taken, DANETV, in cooperation between 4 Danish technology institutes: DHI, AgroTech, FORCE Technology and Technological Institute, with support from the Danish Ministry of Science, Technology and Innovation.

The US EPA ETV scheme is by far the scheme with the largest body of verifications completed, see Figure 4, followed by the rapidly expanding Japanese scheme and by the Canadian scheme that was established shortly after the US EPA scheme.

In other words, the established ETV schemes have until now been national schemes, and regional schemes are only gradually being established.

Figure 4 Number of completed verifications (2009) in selected ETV schemes (US, Canada, Japan and DANETV) and projects (NOWATECH and EU projects)



2.4 National versus regional and global ETV

Technology vendors expect that the term:

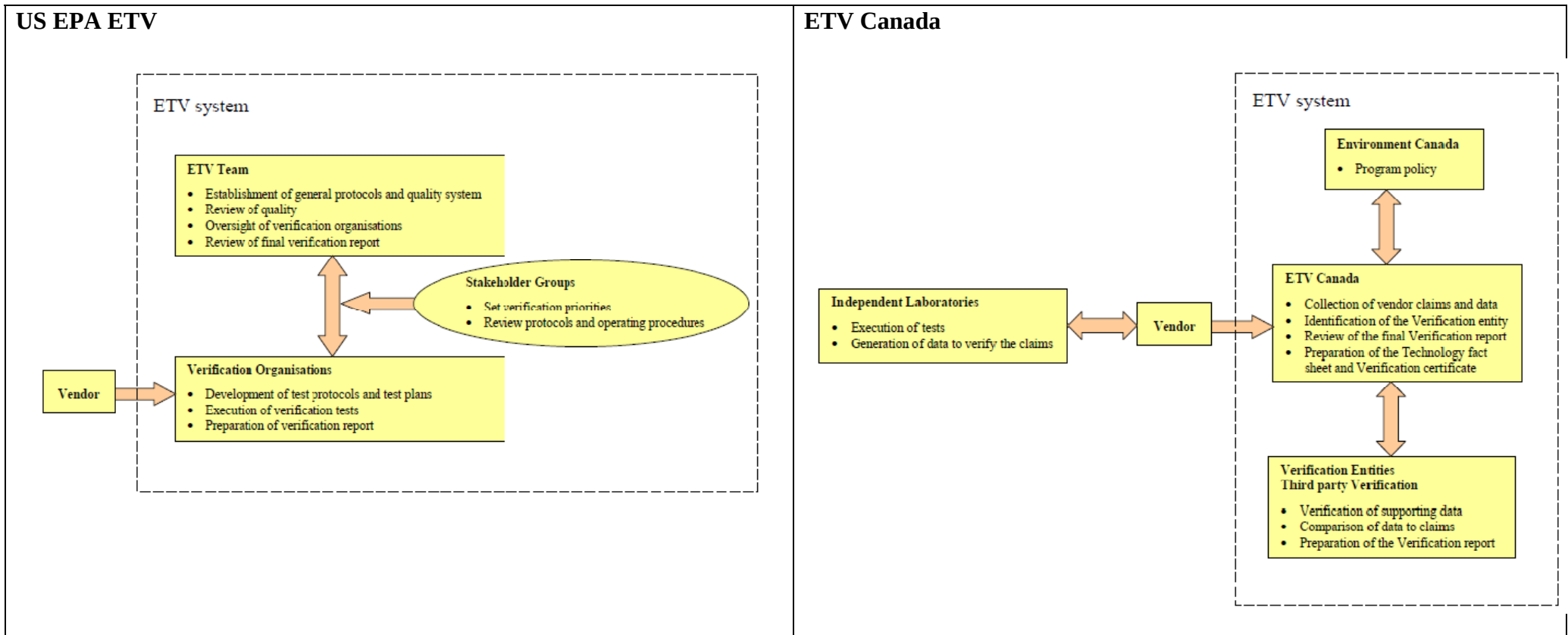
- Verified once, verified everywhere

Is realised in order to reduce cost and optimize the positive effects of ETV. One major barrier for this to happen is the national origin and the derived differences in organization and operation of the established ETV schemes. The diverging approaches is demonstrated for the two North American schemes from the US and Canada in Figure 5.

Considerable efforts are currently devoted to bringing the operation of different national schemes closer to each other.

The approach chosen in NOWATECH to minimize the divergences between the NOWATECH ETV approach and that of the national and other regional ETV schemes has been to compile information on their modes of organization and operation, see /8;9/, taking into account in particular the approach expected to be taken by the emerging EU ETV scheme, see Section 2.5, and to use that information to design a verification approach as close to most other approaches as possible, with the main emphasis upon the EU approach, and striving for extraction of the most efficient elements from each scheme, see Chapter 3.

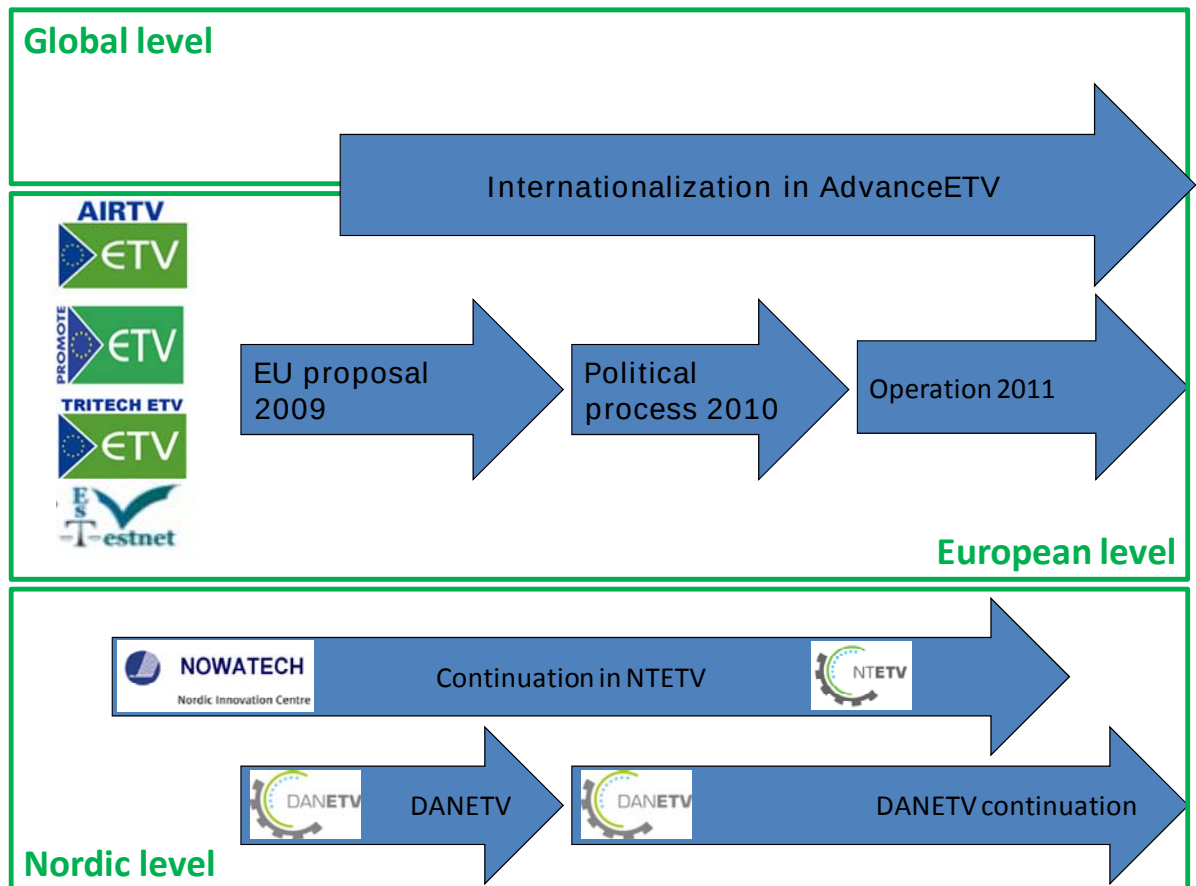
Figure 5 Outline of organization and operation of ETV in the US and Canada, from /10/



2.5 The emerging EU ETV

The European Union is currently in the process of designing and proposing an EU ETV scheme. The design process has been based upon four projects done under the 6th Framework Program of Research and Innovation, see Figure 6, and a public consultation. The continuation of DANETV shown in the figure has recently been secured for the period of 2010-12.

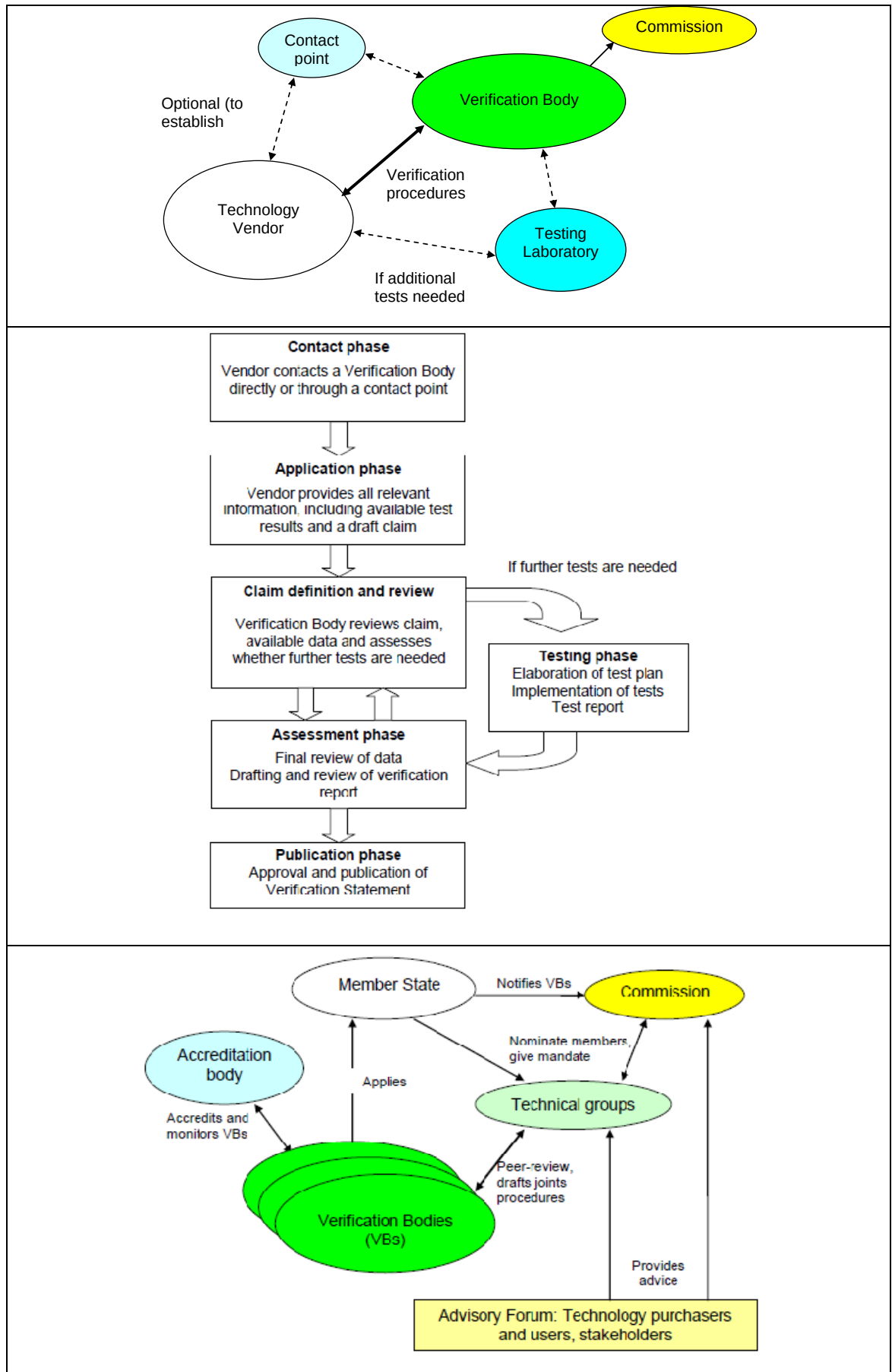
Figure 6 Projects and processes towards a globally accepted EU ETV and the role of Nordic ETV



The current model for operation and organization of the emerging EU ETV is shown in Figure 7. It should be noted that the approach is still in process and may be changed before the final form is achieved. The organization suggests that verification bodies are appointed by the member states and their performance monitored by accreditation bodies in the member states. The EU Commission establishes the principles of EU ETV operation and coordinates operation. Technical groups are established that ensure comparable and sufficient quality of European verifications.

The EU ETV approach as described will allow for the NOWATECH test centers to operate under the emerging EU ETV scheme, if appointed by the national governments, and optionally cooperating under the planned continuation of NOWATECH into a formalised Nordic ETV scheme, NTETV, see Chapter 8.

Figure 7 Current model for operation and organization of the merging EU ETV scheme, from /11/



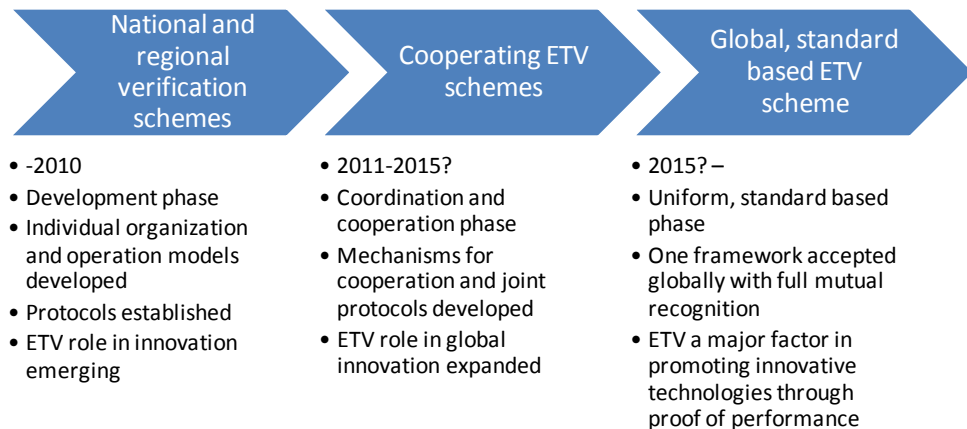
2.6 Towards a global ETV scheme

With the diverging origins, organizations and operation models of the current and emerging national and regional ETV schemes, direct and immediate merging into one common scheme is unfortunately not possible currently. Accordingly, the ultimate objective of “verified once, verified everywhere” is pursued in international cooperation, see Figure 6, all aiming ultimately at mutual, international recognition of ETV results.

Development of processes for joint verification (where a technology, product, or process undergoes a single verification process carried out collaboratively by two or more verification schemes using mutually recognized verification procedures, processes, and quality management systems) and co-verification (where verification is performed under one verification scheme and recognized by one or more other verification schemes based on initial agreement upon verification requirements and final assessment of the compliance of the verification with the agreed requirements as done on a verification by verification basis) are being developed under the EU FP7 project AdvanceETV in cooperation with operators of the US EPA ETV and ETV Canada schemes. ETV Canada is in parallel reviewing the options for applying the already established conformity assessment mechanisms for ETV /12/.

The process from national and regional schemes towards one, uniform and standardized ETV scheme at the global scale is illustrated in Figure 8.

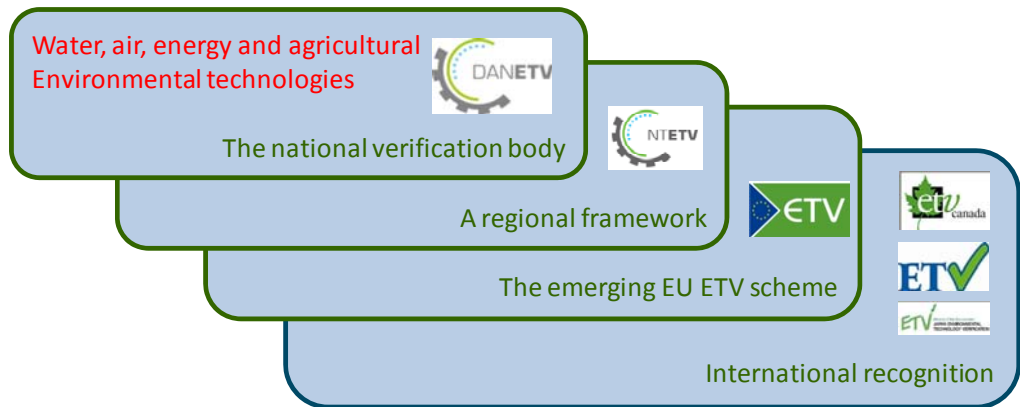
Figure 8 The process from national to global ETV



For the Nordic ETV centers (and for the Nordic technology industry) the challenge is to approach the uniform phase as soon and as much as possible in order to gain a key position globally as early as possible, see Figure 9.

The approach chosen in NOWATECH is participate as far as possible in the international processes towards mutual recognition, while at the same time supporting the national (e.g. in DANETV) and regional cooperation (e.g. by suggesting the Nordtest ETV scheme, NTETV).

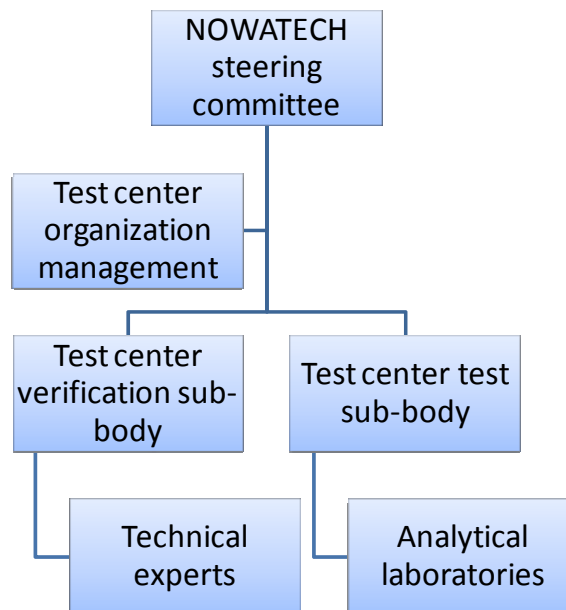
Figure 9 The organization of mutual recognition of ETV as seen from a Nordic position



3 THE NOWATECH ETV APPROACH

The test centers in NOWATECH have been organized under the NOWATECH project steering committee at Aquateam, DHI and IVL (test center organizations) with separate sub-bodies for test and verification, Figure 10, to comply with the organization expected for the EU ETV scheme.

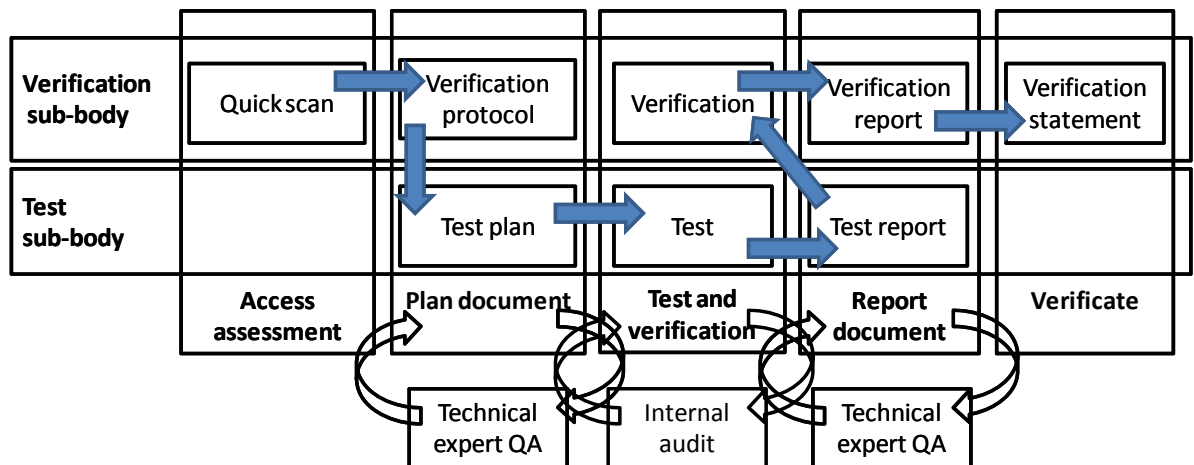
Figure 10 NOWATECH test center organization



It should be noted, that whereas the verification and test sub-bodies in the NOWATECH test centers have been sub-bodies to the test center organizations, the verification body of a test center may choose to use an external test center organization, using the test requirement chapter of the verification protocol, see below, as the order form.

The flow in operation and the organizational units responsible for the activities are shown in Figure 11.

Figure 11 NOWATECH verification work process and responsibilities



A vendor approaches the verification sub-body, and a quick scan is done defining the application of the vendor's technology and the prospects of the verification in discussed with the vendor. It is a key activity of the quick scan process to derive and agree upon a precise definition of the application of the technology that the vendor wishes to have verified, see Table 3.

Table 3 Terms in application definition

Matrix	Effect	Targets
The type of material that the product is intended for. Matrices could be soil, drinking water, ground water etc.	The way the target is affected. The effect could be concentration reduction, decrease in treatment period, pH increase etc Additional parameters: Other effects that will be described but are considered secondary. The additional parameters could be product costs (including also energy consumption and chemical consumption), environmental health and safety and user manual quality etc	The measurable property that is affected by the product. The target could be nitrate concentration, MW/ton etc Operational parameters: Measurable parameters that define the application and the verification/test conditions. Operational parameters could be production capacity, concentrations of non-target compounds in matrix etc.

If the vendor decides to proceed with the verification, the verification process is contracted between the vendor and the verification sub-body (contract template available in the quality manual template, included as Appendix 1), and the verification protocol (verification protocol template is available in the quality manual template) preparation is started. In preparing the verification protocol, a systematic derivation of relevant verification parameters and ranges is done in order to ensure that vendors for future verifications for the same application will accept same verification parameters and ranges, and that technology buyers will receive the performance information from the verificate that they can with reason expect. The verification protocol further describes the data that will be required to perform the verification, the conditions under which the data shall be obtained (test plan requirements) and the evaluations that will be done including e.g. statistical methods. The quality assurance of the verification process and the quality control requirements for the tests are included.

The verification protocol is then passed on to the test sub-unit, where a detailed test plan (test plan protocol template is available in the quality manual template) is prepared. The test requirements are here translated into a detailed plan with instructions, staffing, time-table, quality control activities and references to methods and equipment to be used.

The verification protocol and the test plan together constitute the plan document, which is submitted to external review by the technical experts selected for the verification (review report template is available in the quality manual template). The importance of the review is that it ensures that the protocol and plan are addressing relevant issues, are of sufficient quality and are reflecting technical state of the art through the involvement of specific experts on the field of application and the technology. At the least one of the two experts in the expert group must be external. After revision of the plan document to reflect review comments, the tests can start.

If changes are made to approved protocol or plans in advance of performing verification and tests, an amendment form is filled in (amendment form template is available in the quality manual template) and sent to the reviewers of the expert group for approval. If changes are found necessary during execution of test and verification, a deviation form (deviation form template is available in the quality manual template) is filled in. The potential impacts of amendments and deviations upon the test and verification credibility and applicability are assessed in the verification report, and the forms are included in the verification report appendices.

After completion of the tests and associated quality control measures, all data are reported in a test report (test report template is available in the quality manual template) by the test sub-body and submitted to the verification sub-body for evaluation of the data. The verification sub-body performs the evaluation and prepares a verification report (verification report template is available in the quality manual template) including the test report, that is then submitted to review by the technical experts. The test and verification reports are merely the protocol and plan, with sections on results and evaluations added.

The process of operation and the documentation prepared in NOWATECH ETV is summarized in Table 4.

The organization and operation of ETV in NOWATECH is further detailed in the Center Quality Manual Template found as Appendix 1. Each test center has implemented the template as a test center quality manual.

All quick scan reports, verification protocols and test plans should be published on the NOWATECH project web site, www.etvnord.org, when completed, and all verification reports and verificates are posted on the project web upon completion.

Table 4 Summary of NOWATECH ETV process operation and documentation

Document	Function	Body preparing document
Test center quality manuals	Gives the principles of operation and quality assurance of the center	Test center

Document	Function	Body preparing document
Quick scan report	Evaluates whether a technology product is likely to pass the verification, recommendation for access or refusal	Test center, verification sub-body
Plan document		
Verification protocol	Describes the overall verification process and the test methods to be used for a group of technology products, including the performance parameters and ranges to be verified	Test center, verification sub-body
Test plan	Describes the implementation of a verification protocol for one test occasion (one or more technology products) including staffing, schedule and subcontractors	Test center, test sub-body
Report document		
Test report	Describes the results of the tests	Test center, test sub-body
Verification report	Evaluates the test results against the criteria, includes the test report as appendix	Test center, verification sub-body
Amendment and deviation forms	Documents changes in protocols and plans introduced before or during verification and testing	Test center, test and verification sub-bodies
Review reports	Documents internal and external quality assurance of the plan and report document	Test center, verification sub-body and technical experts
Verification statement with logo	A brief summary of the application and criteria passed for the technology product	Test center, verification sub-body

4 THE NOWATECH VERIFICATIONS

Ten verifications in total have been conducted according to the NOWATECH approach, partly in order to support practical implementation of the ETV processes and organization in the test centers, partly in order to position the NOWATECH test centers as verification and test bodies internationally, and partly to provide selected vendors with the benefits of verification of their technologies.

The detailed verification data are available from the project web site, but the applications and the verified performances are summarized below.

4.1 *Biowater Technology combined fixed film and activated sludge process*

Matrix	Effect	Targets	Technologies
Wastewater	Removal of organic matter, nitrification and partial denitrification	Effluent concentrations: <2 mg BOD ₅ /L 0.4 mg NH ₄ -N/L ≥ 65 % removal of total N	Biological water treatment technology with integrated fixed film and activated sludge (IFAS) process and pre-denitrification.

Testing was done in pilot-scale at the TAU wastewater treatment plant outside Tønsberg, Norway. It should be recalled that in a pre-denitrification process, the nitrogen removal is limited by the recirculation of nitrate to the pre-denitrification reactor and by the amount of organic matter in the incoming wastewater.

4.2 *Krüger Kaldnes moving bed biofilm reactor*

Matrix	Effect	Targets	Technologies
Wastewater	Removal of organic matter and nitrogen Additional parameters: Energy consumption: 0.24 kWh/m ³ Chemical consumption as external carbon source consumption: 1.8 g COD/g total N removed.	Effluent concentrations: < 2 mg BOD ₅ /L < 0.4 mg NH ₄ -N/L 3 mg total N/L	Biological water treatment technology with combined denitrification moving bed biofilm reactor process for removal of organic matter and nitrogen.

Testing was done in full-scale at the Nedre Romerike Avløpsselskap wastewater treatment plant outside Strømmen, Norway.

4.3 *Vilokan evaporator and membrane filter equipment for treatment of cutting oils and degreasing baths*

Matrix	Effect	Targets	Technologies
Industrial waste water containing cutting oils and degreasing bath residues	Reduction of pollutants in the effluent Additional parameters: Consumables, man power, waste generated, user manual, occupational health, listed, see report	Effluent concentrations: Non-polar aliphatic compounds: ≤1 mg/L Cr: ≤0.05 mg/L Ni: ≤0.05 mg/L Zn: ≤0.05 mg/L P _{tot} : ≤1 mg/L BOD: ≤ 3 mg/L COD: ≤ 30 mg/L BOD/COD: ≥0.3	Evaporators, membrane filter equipment and activated carbon filters

Testing was done in full-scale at the Volvo Construction Equipment plant at Eskilstuna, Sweden.

4.4 Vilokan vacuum evaporator and activated carbon filter equipment for treatment of cutting oils

Matrix	Effect	Targets	Technologies
Cutting oil bath	Reduction of pollutants in recirculated cutting oil used in the manufacturing process Additional parameters: Consumables, man power, waste generated, user manual, occupational health, listed, see report	Cutting oil emulsion quality: pH: >8.6 Oil (total hydrocarbon) concentration: 4 - 6% Bacteria: ≤ 1000 CFU Biocide concentration: > 200 mg/L	Evaporators and activated carbon filters

Testing was done in full-scale at the Volvo Construction Equipment plant at Eskilstuna, Sweden.

4.5 Vilokan ultra membrane filtration equipment for treatment of cutting oils and degreasing baths

Matrix	Effect	Targets	Technologies
Alkaline degreasing bath	Reduction of oil in degreasing bath Additional parameters: Consumables, man power, waste generated, user manual, occupational health, listed, see report	Degreasing bath quality: Oil (total hydrocarbon) concentration G02: < 5 g/L Oil (total hydrocarbon) concentration G03: < 1 g/L	Ultra filtration membranes

Testing was done in full-scale at the Scania plant at Oskarshamn, Sweden.

4.6 Nordcap Memembrane Consulting ultra membrane and reverse osmosis equipment for treatment of cutting oils and degreasing baths

Matrix	Effect	Targets	Technologies
Industrial waste water containing cutting oils and degreasing bath residues	Reduction of pollutants in the effluent Additional parameters: Consumables, man power, waste generated, user manual, occupational health, listed, see report	Effluent quality: Total extractable aliphatic compounds: <5 mg/L COD: < 800 mg/L	Ultra filtration (UF) and reversed osmosis (RO) membranes

Testing was done in full-scale at the GETRAG All Wheel Drive at Köping in Sweden.

4.7 ***Aqua Chameleon UV/ozone system by ULTRAAQUA for removal of geosmin and MIB in recirculated aquaculture process water***

Matrix	Effect	Targets	Technologies
Process water in recirculated aquaculture	Removal of taste and odour compounds	Taste and odour compound removal in treated process water: Geosmin > 1 µg/hour 2-MIB > 0.5 µg/hour	UV/O ₃ advanced oxidation technology

The removal capacity of geosmin and MIB was tested in 5 repeated full scale batch degradation tests. The removal capacities were calculated based on a typical taste and odour concentration of 15 ng/L. Statistical data quality indicators were calculated for all water quality and process variables during the tests.

4.8 ***Aqua Chameleon UV/hydrogen peroxide system by ULTRAAQUA for removal of geosmin and MIB in recirculated aquaculture process water***

Matrix	Effect	Targets	Technologies
Process water in recirculated aquaculture	Removal of taste and odour compounds	Taste and odour compound removal in treated process water: Geosmin > 1 µg/hour 2-MIB > 0.5 µg/hour	UV/H ₂ O ₂ advanced oxidation technology

The removal capacity of geosmin and MIB was tested in 5 repeated full scale batch degradation tests. The target removal capacities were calculated based on a typical taste and odour concentration of 15 ng/L. Statistical data quality indicators were calculated for all water quality and process variables during the tests.

4.9 ***Sorbisense GWS40 passive sampler for volatile organic compounds in groundwater***

Matrix	Effect	Targets	Technologies
Contaminated groundwater	Measurement of concentrations of volatile organic contaminants Additional parameters: User manual: complete Cost structure: listed, see report Health and safety: no classified compounds used	Volatile organic compounds Detection limits: 0.3-75 µg/L Linear range: up to 1.000-2500 µg/L Trueness: 85-170% Robustness: 65-120% Precision: <15% relative standard deviation False negatives: yes False positives: yes	Sorbisense passive sampler with tracer based calculation of the amount of water that the sampler has been exposed to and quantification by sampler extraction and head space GC-MS

The volatile organic compounds were: mono-, di-, tri- and –tetrachloroethenes, benzene, toluene, ethylbenzene and xylenes (BTEX) and methyl-*tert*-butylether (MTBE). The target performance data are given as ranges for all compounds. Robustness is given as

the trueness relative to trueness under reference conditions for ionic strength, sampling depth and sampling time variations. Precision is given from laboratory and stand pipe pilot scale tests.

The verification was done as a joint verification with US EPA ETV as operated by Battelle in the function of the US EPA ETV Advanced Monitoring ETV Center. A joint verification statement is issued.

4.10 S:CAN Spectrolyser multiparameter sensor for wastewater

Matrix	Effect	Targets	Technologies
Waste water	Online measurement of nitrate, COD and suspended solid (SS)	Nitrate Detection limit: 0.2 mg/L Linear range: 0.2-60 mg/L Trueness: 94-98% Robustness: 93-107% Precision: 0.19-0.38% relative standard deviation COD Detection limit: 6 mg/L Linear range: 6-950 mg/L Trueness: 99-103% Robustness: 96-104% Precision: 0.71-1.1% relative standard deviation	UV-VIS spectrometry based sensor where target compound light absorption is measured by a detector over a range of wavelengths

Laboratory testing was planned for nitrate, chemical oxygen demand (COD) and suspended solids (SS). It was though not possible to make stable reference samples for SS, and the SS testing was excluded.

In the field testing, all 3 parameters were included, but only the results for nitrate could be evaluated. The reason was that it was not possible to create a set of different COD and SS values, as all concentration at the study site were similar.

The tests for the verification were done under the EU FP6 project TESTNET.

5 THE NOWATECH ETV NETWORK

Exploiting the full potentials of ETV relies upon dissemination and discussion of the methods and advantages of ETV. Acknowledging this, extensive information exchange was established with technology networks in the Nordic countries:

- Green Net Finland
- Finnish Association of Environmental Enterprises
- Finnish Cooperation Forum for Environmental Geotechnics
- Clean Water Norway
- Green Business Norway
- Swedish Association of Suppliers of Effluent and Water Treatment Equipment
- Danish Industry Association

- Danish Water Forum

Additional information exchange with technology industries have included, besides the vendors of technologies verified:

- Kemira
- Liquum
- Krüger/Veolia

and further with the national authorities for the environment in the four countries.

Regionally, NOWATECH participated in the workshop in Copenhagen, 11 September 2007 organized by the NETS project under the NICE focus area Nordic Environmental Technology providing information on NOWATECH.

At the European level, NOWATECH has contributed to the work in CEN Work Shop 32 preparing an agreement on environmental technology verification – soil and groundwater site characterization, monitoring and remediation technologies exploring the potential for expansion into this sector. Also, partners from NOWATECH have participated in the ETV projects TESTNET, PROMOTE, AIRTV and in the LIFE+ ETV project TriTech under the 6th EU Framework Programme for Research and Technological Development (FP6). Partners in NOWATECH are now partners in the ETV internationalization project AdvanceETV under the 7th EU Framework Programme for Research and Technological Development (FP7), a project done in close co-operation with the key ETV organizations globally: the EU Commission and the ETV schemes of the United States Environmental Protection Agency (US EPA) and Environment Canada, expanding the network to a global level.

The dialog and information exchange has further been supported by co-organization by NOWATECH of three conferences:

- A joint workshop with the EU FP6 projects TESTNET and TECHNEAU and with Kiwa Water Research in Nieuwegein, the Netherlands on 25-26 October 2007.
- A joint workshop on ETV for technology developers, authorities and investors with the Danish Industry Association and the Danish Environmental Protection Agency on 7 April 2008 in Copenhagen, Denmark.
- A conference with the EU FP6 ETV projects PROMOTE, TESTNET and AIRTV in Brussels, Belgium, 15-16 September 2008.

As the result of the networking activities, the idea of ETV as a tool for documenting innovative water technologies through ETV disseminated to Nordic technology producers, buyers and regulators, while the NOWATECH ETV concept has been recognised internationally.

6 NOWATECH ETV SCOPE EXPANSION

The original NOWATECH scope was water technologies brought to the Nordic markets and featuring in particular water monitoring, biological waste water treatment, advanced oxidation based waste water treatment and cleaner technologies in water recycling. Also, the need for ETV is basically within innovative technologies, as described in Section 2.2.

In a review of innovative Nordic water technologies done as part of the NOWATECH project /13/ it was concluded, that in spite of a good initial position for the Nordic water technologies in the global market, Nordic innovation is currently limited for e.g. the drinking water area, perhaps because water scarcity is lacking as a regional technology development driver. The areas with most innovative, Nordic activities were identified as:

- Sensors
- Monitoring
- Membrane treatment
- Water treatment for recycling
- On-line data handling, transmission, modelling and decision support

It is also noted the innovative water technology industry in the Nordic countries is dispersed through the region.

In an assessment of the market for ETV in the water sector in the Nordic countries /14/, the main conclusions are that an outreach for the technology buyers in Asia would provide increased usefulness of ETV for the technology industry. Also, it is noted that ETV could have a role in continuous updating of the EU BAT (best available technology) notes that are important tools in regulating European pollution prevention from industry.

The scope of the emerging EU ETV scheme is currently /11/:

- Monitoring techniques
 - Air emissions sensors, analysers and monitors,
 - Water monitoring techniques, including test kits, probes, analysers
 - Soils monitoring, pollution detection and measurement, sampling devices,
- Water and soils treatment technologies
 - Drinking water techniques, such as filtration or disinfection
 - Wastewater treatment, separation techniques, nutrient reduction, disinfection
 - Soils remediation techniques
- Renewable sources of energy and energy efficiency
 - Microturbines, Fuel cells, Biomass burners and boilers
 - Combined Heat and Power, Heat pumps, cooling systems
 - Photovoltaic systems and equipments, solar water heaters
 - Wind energy equipments, sea energy systems and equipments (tidal, wave)
- Air pollution abatement including green house gasses (GHG)

- o Abatement of pollution from stationary sources, indoor air quality products
- o Technologies related to the combustion of fossil fuels (mobile sources devices)
- o Technologies related to the combustion of waste
- o Technologies, equipments and systems for Carbon Capture and Storage
- Clean technologies including waste and resource recycling
 - o Buildings materials, energy efficiency in buildings
 - o Cleaner or low-carbon industrial processes, coating equipments
 - o Environmental technologies in agriculture
 - o Separation or sorting techniques for solid waste (vehicles, plastics, metals)
 - o Recycling techniques for batteries and accumulators, for chemicals

The investigations of the options for an expanded ETV net have been initiated through coordination with a Danish initiative on ETV within energy, environment (air and water) and agriculture: DANETV, as well as with the European Commission DG Environment, the Danish Environmental Protection Agency and the initiative for verification of agricultural technologies, VERA, including also the Environmental Authorities in Germany and the Netherlands.

Considering the Nordic technology strongholds, the planed EU ETV scope and the feedback from the NOWATECH network and consultations with stakeholders, a broad scope of ETV, water, air, energy, agricultural environment and sustainable technologies, seems to be called upon for Nordic ETV.

Taking into account the current trend from national over regional to internationally recognizable ETV schemes, see Section 2.6, and the current delay in establishing the EU ETV scheme, a regional ETV supporting the Nordic ETV centers established through NOWATECH would serve the purpose of making credible ETV easily available to the Nordic technology industry aiming at application on the global market. In this context, it is essential that the current efforts to position the Nordic ETV centers and approach in the global ETV cooperation are continued.

7 BARRIERS AND SOLUTIONS

From the public consultation on the first draft of an EU ETV scheme /2/, it can be inferred that:

- ETV is most important for small and medium sized enterprises (SME)
- Low costs are mandatory, in particular for SME
- European and international recognition of verificates is of paramount importance
- Accessibility in terms of language and proximity is important

The experiences from NOWATECH operation have indeed supported these finding, in particular after the start of the current recession (2009), with respect to SME being the main type of vendors with an interest in ETV and to the importance of low costs. The current version of the proposal for an EU ETV scheme suggest that the costs of verifica-

tion should not exceed 20.000 € per technology/vendor verified and suggest EU funding for the ETV infrastructure and for verification of SME owned technologies /11/.

The lack of a normative framework for ETV operation in Europe until the EU ETV scheme has been implemented, probably some time during 2011, see Section 2.5, is indeed a barrier for recognition of verificates obtained in the Nordic countries and in Europe. As an international standard for ETV operation does not exist, see 2.2, using the established conformity assessment routes is not possible.

One possible approach is to prepare an accepted method, such as a Nordtest method, for ETV operation and implement this method in an international organization, such as Nordtest. It must be emphasized that such a solution would only be the first step towards first a broader regional (EU) ETV scheme and later a standard based ETV process, see Figure 8, but as such a viable bridge into the future for the Nordic technology industry and the Nordic water technology test centers.

8 NTETV AND A NORDTEST ETV METHOD

To address the current, intermediary lack of a normative framework for ETV operation in Europe, the NICE Board has decided to publish a Nordtest method ENVIR 011 for ETV operation, Nordtest ETV method, and to establish a Nordtest ETV scheme, NTETV. The NOWATECH partners are preparing for launching of the method and the scheme in cooperation with NICE during the winter and spring 2010.

The Nordtest ETV method ENVIR 011 will be based upon the NOWATECH Center Quality Manual Template (Appendix 1) after adjustment to the more generic form and format requirements of Nordtest methods.

The Nordtest ETV scheme, NTETV, will be established based upon:

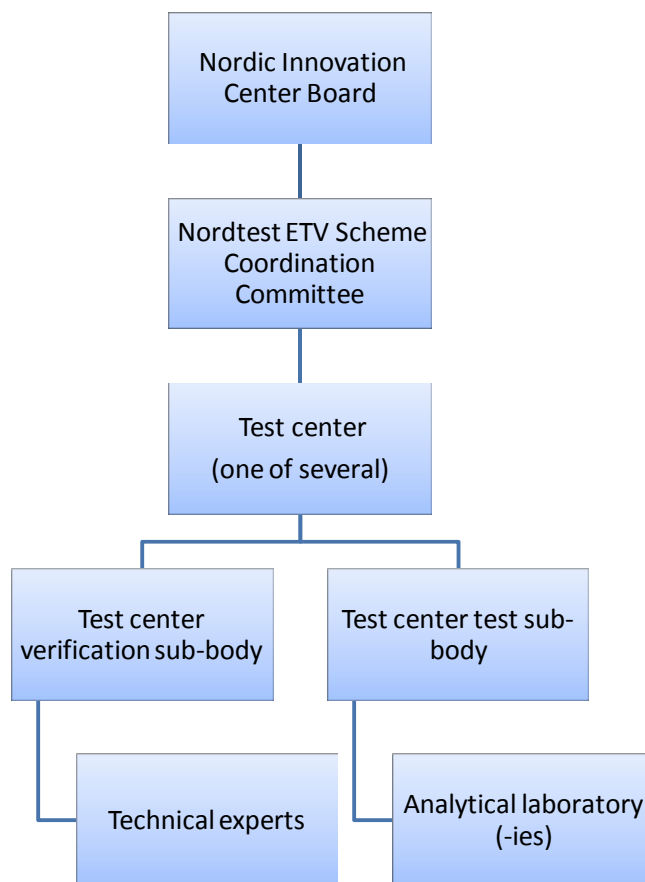
- The Nordtest method ENVIR 011 for ETV extracted from the NOWATECH manual

and shall include:

- A Nordtest ETV scheme handbook based upon the NOWATECH Center Quality Manual Template
- A transnational, Nordic coordination committee

The overall organization is shown in Figure 12.

Figure 12 Organization of the NTETV scheme



The Nordtest ETV scheme is established to include environmental technologies in a broad sense: water, air, energy, agriculture and sustainable technologies.

The establishment of a Nordtest ETV scheme was supported by a broad range of Nordic organizations, Table 5 Organizations supporting establishment of NTEV.

As part of preparing the Nordtest ETV method ENVIR 011 and establishing the NTETV scheme, the method and the scheme will be subject to public, Nordic consultation (remiss).

Table 5 Organizations supporting establishment of NTEV

Organization	Technology sector	Country
DHI	Water Technologies and services	Denmark
Danish Industry Association	Technologies	Denmark
Samson Agro A/S	Environmental technologies in agriculture	Denmark
Danish Environmental Protection Agency	Environmental technologies	Denmark
AgroTech	Environmental technologies in agriculture	Denmark
Force Technology	Energy and air pollution environmental technologies	Denmark
Svibmo Aps	Environmental technologies in agriculture	Denmark
PurLiq ApS	Environmental technologies in agriculture	Denmark

Organization	Technology sector	Country
Danish Technological Institute	Environmental Technologies	Denmark
VTT	Sustainable technologies	Finland
Finnish Ministry of Environment	Environmental Technologies	Finland
Aquateam	Water Technologies and services	Norway
Green Business Norway	CleanTech	Norway
Clean Water Norway	Water Technologies and services	Norway
IVL	Sustainable technologies	Sweden
The Association of Swedish Environmental Technology Industries	Environmental technologies	Sweden

9 OUTLOOK

The challenges facing the NOWATECH ETV test centers in the years ahead can be summarized as:

- Consolidating their role as ETV test centers serving the innovative, Nordic technology industry
- Establishing their role as competitive, reputable verification and/or test bodies in the emerging EU ETV scheme
- Enhancing the access to and use of ETV for documenting the performance of innovative technologies

The establishment of NTETV based upon a Nordtest ETV method will be an important step in addressing these challenges.

Based upon the observation that the innovative water technology industry in the Nordic countries is dispersed through the region, it is suggested in the assessment of the market for ETV in the water sector in the Nordic countries /14/, that regional networking between innovative water technology industries should be further supported, possibly using the NOWATECH ETV test centers as nodes. This should in particular provide improved possibilities of cooperation between industries with similar interests in exploiting the large international market for innovative water technologies. Furthermore, it would strengthen the ties between the NOWATECH ETV test centers and the innovative, Nordic water technology industries.

Promotion of the use of ETV to facilitate market entrance of innovative technologies could be enhanced in order improve the brand value of ETV – in the Nordic and the global market. Awareness raising among authorities and technology buyers would be required to achieve this objective.

Finally, field test sites are generally required to provide credible verification of many technologies and the costs associated with establishing these, including baseline data, are often beyond what is affordable for the test centers and the vendors. Establishing a “farm” of field test sites that allows access by the Nordic ETV centers for testing and where baseline data are available would significantly reduce ETV costs and thus enhance the use of ETV and the competitiveness of the Nordic ETV centers on the emerging European ETV market.

10 CONCLUSIONS

In the NOWATECH project, co-ordinated methods for environmental technology verification (ETV) have been developed and implemented at three centers, and the centers have conducted in total 10 pilot verifications. Continuous dissemination of the results has been ensured through the project web. The role, organization and prospects of ETV in the Nordic countries have been described in reports, papers and presentations, and an extensive consultation process has been done with regulators, authorities and industry at levels from national over Nordic to European and global. The Project has provided a significant contribution to the plans for a European Union based ETV scheme, has contributed to international mutual recognition of ETV and has produced a proposal for a Nordic ETV scheme.

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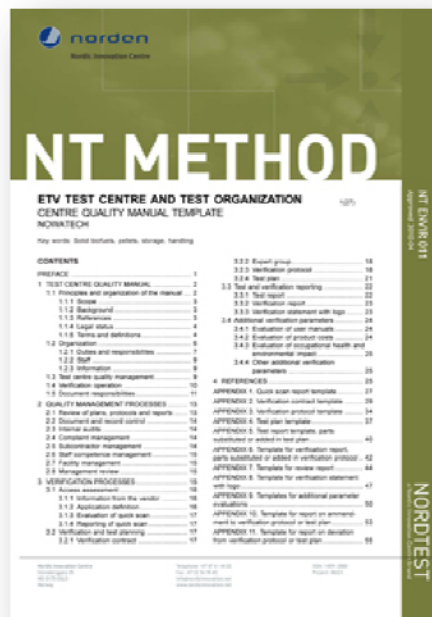
APPENDIX 1: CENTER QUALITY MANUAL TEMPLATE

NORDTEST Method ENVIR 011 ETV Test Center and Test Organization Center Quality Manual Template

For practical reasons, the "Appendix 1" as referred to in this final report from the NOWATECH project, has been published as a separate document called "ETV Test Center and Test Organization– Center Quality Manual Template" NORDTEST Method ENVIR 011.

The test center quality manual template provides the framework for organization, operation and quality management of the NOWATECH test centers established in compliance with the emerging EU ETV system.

The template is implemented at each NOWATECH test center. The quality manual has the form of a conventional quality manual with the test center quality manual giving the overall principles, organization and operation (strategic level, Chapter 1), the general procedures of center quality management and verification operation at the next (tactical level, Chapters 2-3) and the specific instructions, documents etc at the lowest, operational level (Appendices 1 to 11).



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Both this final report from the NOWATECH project and the appendix "[Center Quality Manual Template](http://www.nordicinnovation.net/center-quality-manual-template)" can be downloaded for free from the Nordic Innovation Centre website at www.nordicinnovation.net.

The direct download link for Appendix 1 is <http://www.nordicinnovation.net/nordtestfiler/envir011.pdf>



norden

Nordic Innovation Centre

Nordic Innovation Centre

The Nordic Innovation Centre initiates and finances activities that enhance innovation collaboration and develop and maintain a smoothly functioning market in the Nordic region.

The Centre works primarily with small and medium-sized companies (SMEs) in the Nordic countries. Other important partners are those most closely involved with innovation and market surveillance, such as industrial organisations and interest groups, research institutions and public authorities.

The Nordic Innovation Centre is an institution under the Nordic Council of Ministers. Its secretariat is in Oslo.

For more information: www.nordicinnovation.net