

US EPA ARCHIVE DOCUMENT

EPA's Environmental Technology Verification (ETV) program evaluates the performance of innovative air, water, pollution prevention, and monitoring technologies. This multimedia program aims to reduce uncertainty and increase confidence in the performance of technologies that have the potential to improve human health and the environment. This article summarizes the program's goals and accomplishments.

### INTRODUCTION

The U.S. Environmental Protection Agency (EPA) established the Environmental Technology Verification (ETV) program in 1995 to verify the performance of innovative environmental technologies that can be used to monitor, prevent, control, and clean up pollution. The program was formed to address the need for credible performance data to help businesses and communities better respond to the available environmental technology choices.<sup>1</sup>

Since its inception, the ETV program has become one of the most comprehensive environmental technology verification programs in the world, covering innovations as diverse as alternative fuels and systems for nitrogen oxides reduction; microturbines and leak-prevention technologies for natural gas pipelines; cryptosporidium and arsenic control in small community drinking water systems; pollution prevention technologies; and monitoring and treatment technologies with homeland security applications for protecting water resources and buildings.

The goal of this voluntary, multimedia program is to provide credible, high-quality data on the performance of innovative commercial environmental technologies. By providing these data to technology purchasers, permittees, financiers, vendors, and the public, EPA hopes to reduce the uncertainty surrounding the performance of new technology, lower the overall cost of regulatory compliance, and help remove real and perceived barriers to innovative technology use in today's marketplace.<sup>2</sup>

### ACCOMPLISHMENTS

The ETV program has achieved many accomplishments since its inception in 1995. As of March 2004, the program has developed 78 testing protocols and completed 261 technology verifications across a broad range of technology categories. Figure 1 summarizes the verifications by technology area/media.

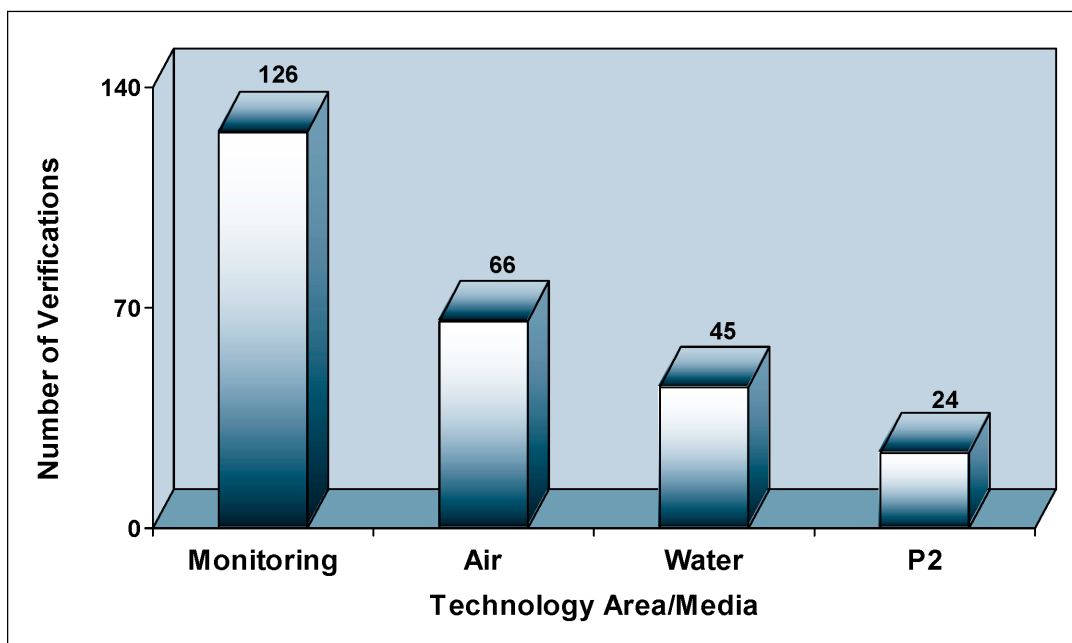
All of ETV's products, including protocols, test/quality-assurance plans, and verification reports and statements, are available on the ETV Web site ([www.epa.gov/etv](http://www.epa.gov/etv)). This Web site receives more than 100,000 hits per month, approximately 10% of which are from international entities. ETV also sends out monthly electronic notices using ETVoice, the program's



listserv of approximately 2500 subscribers. These notices contain information about recent events, verifications, and other ETV news. In addition, the program conducts extensive outreach of verification results via conference exhibitions and presentations, publications in trade journals, press advisories and media events, and information diffusion through ETV stakeholders.

#### ETV's Goals

- ✓ To provide credible, high-quality data on the performance of promising commercial-ready environmental technologies to technology purchasers, permittees, financiers, vendors, and the public.
- ✓ To accelerate the entrance of new environmental technologies into the domestic and international marketplace.



**Figure 1.** ETV verifications by area/media (1996–2004).

The ETV program has received national recognition, including commendations from the National Advisory Council for Environmental Policy and Technology and EPA’s independent Science Advisory Board (SAB). SAB stated in its review of ETV, “The scarcity of independent and credible technology verification information is one critical barrier to the use of innovative environmental technologies. Therefore, the verification testing information provided by the ETV program fulfills an essential need of the environmental technology marketplace.”<sup>3</sup>

Vendors also report that they use ETV information in marketing their performance-verified products. More than 80% of the vendors surveyed during the program’s pilot period (1995–2000) rated their overall experience with ETV as positive, and more than 90% said that they would recommend ETV to others.<sup>4</sup> There is also a growing interest in the program from international vendors; ETV has verified the performance of 30 technologies developed by 22 vendors from outside the United States. The program is also being used as a model by various international organizations interested in establishing similar verification programs.

## STRUCTURE

The ETV program operates through six verification centers and one pilot program, as well as separate efforts aimed at verifying technologies for monitoring and treatment of intentional contaminants in buildings and public spaces. This program structure allows for the verification of a wide spectrum of environmental technologies, as illustrated in Table 1. The program operates as a public–private partnership through agreements between EPA and the five nonprofit

private testing and evaluation organizations listed in Table 1. These verification organizations (VOs)—with input from the vendors and EPA technology experts—develop efficient and quality-assured protocols and test plans for verifying technology performance. They are responsible for planning and performing the verification tests, as well as developing verification reports and statements designed to communicate test results to

decision-makers and the public. EPA provides oversight of the VOs and the verification tests, ultimately assuring the credibility of the program as a whole, including the verification process and data.<sup>1</sup>

In addition to EPA and the VOs, the program relies on the active participation of environmental technology information customers in technology-specific stakeholder groups. Stakeholders are chosen for their general knowledge and expertise in specific technology areas. They represent the interests of technology developers; technology buyers; consulting groups; financial interests; industry associations; public interest groups; and federal, state, and local governments. ETV stakeholder groups assist in developing testing protocols, prioritizing the types of the technologies to be verified, reviewing documents, and designing and implementing outreach activities to the customer groups they represent. By partnering with more than 800 stakeholders in numerous stakeholder groups, the ETV program is able to ensure that relevant, high-quality, objective information is provided to the environmental technology marketplace.<sup>1,2</sup>

Vendors, private-sector entities, and federal, state, and local government agencies share costs with EPA to complete priority ETV protocols and verifications. Since 1996, ETV vendors have contributed more than \$3.8 million to verification. From 2001 to 2002, ETV funding contributions from other organizations increased 370%, and funding from vendors increased 52% as a percentage of program expenditures. From 2002 to 2003, vendor contributions increased from approximately \$696,000 to more than \$1 million. Verification testing “in-kind” contributions, which include things such as laboratory and test facilities and analytical support,

**Table 1.** ETV structure.

Center/Pilot/Effort	Verification Organization	Technology Areas/Media
ETV Advanced Monitoring Systems Center	Battelle	<ul style="list-style-type: none"> <li>• Air, water, and soil monitoring</li> <li>• Biological and chemical agent detection in water</li> </ul>
ETV Air Pollution Control Technology Center	RTI International	<ul style="list-style-type: none"> <li>• Air pollution control</li> </ul>
ETV Drinking Water Systems Center	NSF International	<ul style="list-style-type: none"> <li>• Drinking water treatment</li> <li>• Biological and chemical agent water treatment</li> </ul>
ETV Greenhouse Gas Technology Center	SRI	<ul style="list-style-type: none"> <li>• Greenhouse gas mitigation and monitoring</li> </ul>
ETV Water Quality Protection Center	NSF International	<ul style="list-style-type: none"> <li>• Stormwater and wastewater control and treatment</li> <li>• Biological and chemical agent wastewater treatment</li> </ul>
ETV Building Decontamination Technology Center	Battelle	<ul style="list-style-type: none"> <li>• Biological and chemical agent decontamination of buildings and surfaces</li> </ul>
ETV Safe Buildings Monitoring and Detection Technology Effort	Battelle	<ul style="list-style-type: none"> <li>• Biological and chemical agent detection and monitoring in buildings and on surfaces</li> </ul>
ETV Safe Buildings Air Filtration and Cleaning Technology Effort	RTI International	<ul style="list-style-type: none"> <li>• Building air filtration and cleaning</li> </ul>
ETV Pollution Prevention (P2) Coatings and Coating Equipment Pilot	Concurrent Technologies Corporation	<ul style="list-style-type: none"> <li>• Pollution prevention for coatings</li> </ul>

have also increased over the life of the program.

Participation in the ETV program is strictly voluntary—no vendor is required to submit a technology for verification. No approvals are granted, and no guarantees or recommendations are made by ETV. The program sponsors the evaluation of environmental technologies through rigorous and objective testing, and verifies that such technologies perform at the levels reported. By “evaluate” and “verify,” ETV means the careful examination and testing of technologies under conditions of observation and analysis and under specific, predetermined criteria or protocols. ETV does not certify technologies. High-quality data, responsive to customer needs, are ETV’s product. ETV seeks to give decision-makers the information they need to make informed technology choices and to create a more sustainable environment.<sup>2</sup>

**CURRENT FOCUS**

**Air**

Two ETV centers, the Greenhouse Gas Technology (GHG) Center and the Air Pollution Control Technology (APCT) Center, focus exclusively on verifying air-related technologies. The GHG Center verifies promising greenhouse gas mitigation and monitoring technologies through a partnership with Southern Research Institute (SRI). The APCT Center addresses control technologies for both stationary and mobile air pollution sources through a partnership with RTI International. The APCT Center’s main focus is on technologies that control particulate matter, volatile organic compounds, nitrogen oxides, and hazardous air pollutants. In a related effort, RTI International is verifying

the performance of building and ventilation products for homeland security applications.

Currently, the APCT Center is verifying a number of mobile source and dust-suppression technologies, while the GHG Center is concentrating its efforts on the verification of fuel cells, microturbines, biogas technologies, universal cams, and axle lubricants. ETV’s current focus on biogas and mobile source technologies is particularly relevant to a number of high-profile regulatory and environmental issues, as well as growing markets in both areas. By verifying building filtration and cleaning technologies, ETV is also responding to a critical information need identified for the post-9/11 era. The importance of ETV’s efforts in these areas is discussed in more detail below.

*Mobile Source and Biogas Technologies.* The control of mobile source emissions continues to be a national issue, in part because certain areas of the country are not in attainment with ambient air quality standards. Technologies that harness biogas from livestock manure management facilities are also of growing interest to the energy, agricultural, and regulatory communities. Technology vendors have responded to this interest by developing a number of new mobile source and biogas technologies. Both the APCT and GHG centers are at the forefront of these environmental issues, and are verifying the performance of applicable technologies to the benefit of both the vendors and purchasing/permitting communities.

In accordance with ETV’s commitment to partnerships, both





The GHG Center verifies the fuel economy and emissions performance attributable to the use of a rear axle gear lubricant.

centers received monetary and/or technical assistance from the following organizations during these verifications: New York State Energy Research and Development Authority and the Colorado Governors Office of Energy Management and Conservation—GHG (biogas); EPA's Office of Transportation and Air Quality and the California Air Resources Board—APCT (mobile sources). ETV partners also lend support by reviewing test plans, helping coordinate testing activities, and providing onsite technical assistance. Table 2 lists current ETV partnerships.

**Safe Buildings Air Filtration and Cleaning Technologies.**

Buildings that house the nation's workforce and public meeting places may be targets of future terrorist attacks. They represent locations where hundreds or thousands of people congregate for employment, recreation, transportation, shopping, or education during a typical day. ETV, through an agreement with RTI International, is developing protocols and testing technologies used in building heating, ventilation, and air conditioning (HVAC) systems, for cleaning building ventilation air contaminated with chemical and biological warfare agents. Ten verifications of ventilation air filters using uncharged media have recently been completed. Four additional air filters using uncharged media are scheduled to be tested in 2004. Devices based upon other air cleaning technologies, including electronic air cleaners, devices based on ultraviolet (UV) radiation or plasma, and sorption devices

for gaseous contaminants, are expected to be tested later in the year.<sup>5</sup>

**Water**

The ETV program partners with NSF International in the management of two centers that focus exclusively on the verification of water technologies: the Drinking Water System (DWS) Center and the Water Quality Protection (WQP) Center. The DWS Center verifies drinking water systems for the treatment of contaminants with potential public health impacts, with a special emphasis on systems that address the treatment of common small community problems (i.e., arsenic, micro-biological contaminants, particulates, and disinfection

byproducts). The WQP Center verifies technologies that protect groundwater and surface water from contamination, including technologies that prevent contamination and maintain the quality of both groundwater and surface water supplies that may be used for drinking water sources, and control and treat the increased volumes of storm water runoff during wet weather events.

**Table 2.** ETV partners.

ETV Partners	Technology Areas
U.S. National Oceanic and Atmospheric Administration	Multiparameter water probes
U.S. Coast Guard	Ballast water treatment
U.S. Department of Energy, State of Massachusetts	Continuous emission mercury monitors
U.S. Department of Defense	Monitors for explosives; polychlorinated biphenyls in soils; dust suppressants
U.S. Department of Agriculture	Ambient ammonia monitors
U.S. EPA Natural Gas Star	Vapor recovery unit for the oil and gas industry
States of Alaska, Pennsylvania, and Nevada	Drinking water arsenic treatment
States of Georgia, Kentucky, and Michigan	Stormwater treatment
States of New York and Colorado	Waste-to-energy technology



An inside view of a stormwater treatment system being verified by the WQP Center.

NSF International is also developing protocols and testing technologies with applications to water security, including devices for point-of-use (POU) treatment of biological and chemical contaminants in drinking water, and technologies for treating wastewater resulting from the decontamination of buildings.<sup>5</sup>

A wide array of technologies has been prioritized for verification by these two centers. In 2004, DWS is focusing its efforts on verifying arsenic treatment technologies, diatomaceous earth filters, and reverse osmosis-based POU devices for homeland security applications. WQP is currently in various stages of testing and reporting on a number of treatment, control, and rehabilitation technologies, including decentralized wastewater treatment systems for residential nutrient reduction, infrastructure rehabilitation technologies, watershed protection technologies (i.e., animal waste treatment), high-rate UV disinfection technologies, flow meters, stormwater treatment, high-rate solids separation, runoff collection models, and a decontamination treatment system for water security applications. WQP is also developing a testing protocol, in collaboration with the U.S. Coast Guard, to verify technologies designed to control invasive species in ballast water.

**Arsenic Treatment Technologies.** ETV's responsiveness to small communities and states is highlighted by its recent focus on the verification of arsenic treatment technologies. These technologies are designed to help small communities comply with the reduction of the arsenic drinking water maximum

contaminant level (MCL) from 50 to 10 parts per billion (ppb) by 2006. At present, EPA estimates that 4000 of the 74,000 U.S. drinking water systems currently regulated by the new standard will have to install treatment devices or take other steps to comply with this MCL. These devices are also critically needed in countries such as India and Bangladesh, where shallow drinking water wells expose millions of people to arsenic poisoning from naturally contaminated groundwater.<sup>6,7</sup>

To date, four arsenic treatment technologies have been verified by the DWS Center, and three verification tests are in process, with three others under consideration. As with other ETV ef-

forts, DWS worked to ensure that the final verification reports are useful to local, state, and federal agencies and offices (e.g., to support permit applications, regulatory programs, and voluntary programs). The results of a survey conducted by the Association of State Drinking Water Administrators (ASDWA) in 2003 (see sidebar opposite) provide evidence that ETV verifications and protocols are being used by the states.<sup>8</sup>

The widespread acceptance of ETV test data by states has led to reduced costs for pilot testing; in some cases, significant reductions. For example, a vendor of a disinfection by-product treatment technology reported to ETV that pilot-testing costs in excess of \$60,000 per site were avoided at two small communities in Alaska as a result of data available from the ETV verification test.<sup>9</sup> An arsenic treatment technology vendor also reported that the amount of pilot testing needed for state drinking water approval was significantly reduced after the states reviewed the ETV verification report.<sup>10</sup>

**Nutrient Reduction Technologies.** The reduction of nutrients in domestic wastewater discharged from single-family homes, small businesses, and similar locations within watersheds is important for two reasons: (1) reduction of watershed nitrogen helps meet drinking water quality standards for nitrate and nitrite; and (2) reduction of nitrogen and phosphorus helps protect surface and groundwater quality, and helps prevent eutrophication and subsequent ecological, commercial, recreational, and aesthetic losses. The WQP Center recently verified



five on-site residential nutrient reduction systems designed to reduce nitrogen in domestic wastewater from individual residences; three additional residential nutrient reduction technologies are expected to be verified in 2004.<sup>11</sup>

Not only are these verifications meeting an important information need, the nutrient reduction protocols used to collect these data—as well as the WQP wastewater treatment protocols—have been specified by the North Carolina Department of Environment and Natural Resources for use in generating data for innovative wastewater treatment system installation requests. Table 3 highlights the adoption and use of ETV protocols by different national and state organizations.

### Monitoring

Effective verification of monitoring technologies is needed to assess environmental quality and to supply cost and performance data to select the most appropriate technology for that assessment. The Advanced Monitoring Systems (AMS) Center, operated through a partnership with Battelle Memorial Institute, verifies the performance of commercially available technologies that monitor natural species and contaminants in air, water, and soil. In addition, AMS is verifying technologies that can detect and monitor intentional contamination of public drinking water supplies. The center is currently focusing its verification activities on a number of important technology areas, including ammonia continuous emission monitors (CEMs) for gas turbine facilities, portable multigas emission analyzers, airborne ammonia sensors, mercury CEMs, multiparameter water

**Table 3.** ETV protocol use.

- **North Carolina Department of Environment and Natural Resources** specified Nutrient Reduction and Wastewater Treatment protocols for use in generating data for innovative wastewater treatment system installation requests.
- **Association of State Energy Research & Technology Transfer Institutions/U.S. Department of Energy** plan to use ETV protocols in national standards.
- **ASTM** has adopted the ETV Generic Verification Protocol for Baghouse Filtration Products (October 2001) as a new ASTM Method (i.e., ASTM D6830 “Characterizing the Pressure Drop and Filtration Performance of Cleanable Filter Media”).
- **Association of State Drinking Water Administrators** reports that 26 states are planning to use ETV Drinking Water System protocols and test plans for surface water and groundwater systems applications.

quality probes, portable water detectors for arsenic, portable cyanide analyzers, rapid methods for pesticide (atrazine) detection in water, rapid broad spectrum toxicity screening methods, immuno-assay screening methods for biotoxins in water, beach monitoring technologies, rapid polymerase chain reaction screening methods, and enzymatic test kits for chemical agents. Several of these areas are highlighted below.

**Ambient Ammonia Sensors.** Agricultural activities and waste from livestock are a significant source of atmospheric ammonia, which can have adverse environmental and human health effects. AMS is completing verifications of ambient ammonia sensors to gauge how well these technologies provide continuous data on ammonia emissions from agricultural sources. The center is partnering with the U.S. Department of Agriculture (USDA) on these verifications and testing was conducted at USDA animal feeding operation facilities. The verification reports for these ammonia sensors will be completed in 2004.

**Mercury Continuous Emission Monitors.** Mercury CEMs provide mercury concentration measurements, which are necessary to gain a better understanding of mercury emission sources, transport, and fate in the environment. AMS has completed two phases of verification testing of mercury CEMs and is currently planning a third verification test. Phase I testing, conducted in partnership with the Massachusetts Department of Environmental Protection, verified the performance of CEMs to measure mercury in flue gases. The center recently completed a phase II evaluation of CEMs to measure mercury emissions at the Toxic Substances Control Act Incinerator at the East Tennessee Technology Park in Oak Ridge, TN. AMS is currently planning and soliciting technology vendors for a phase III verification test of mercury CEMs at a coal-fired power plant.

In addition to the testing of mercury CEMs, AMS and other ETV centers have conducted or are planning to conduct multiple rounds of verifications for 12 technology categories across

### ASDWA Survey Results

ASDWA reports that of the 37 responding states, 26 states use the ETV DWS Center protocols and test plans for verification of drinking water treatment equipment performance for surface water, and 24 states use them for groundwater. ASDWA also notes that states have used the ETV verification reports in a variety of ways for surface water system applications:

- 24 states use ETV reports to reduce frequency/length of site-specific pilot testing;
- 13 states use ETV reports as prerequisite to consideration of the technology; and
- 15 states use ETV data as the primary source of information for decision-making.

Similar use levels were reported for groundwater systems. ASDWA notes that “[The] ETV drinking water initiative . . . is an effective and useful tool to attain a more streamlined approach to technology applications” and “in a relatively short time frame, state programs have significantly increased their awareness and use of protocols and test plans.”<sup>12</sup>

the program, indicating continued vendor demand for and perceived value of verification. Table 4 highlights verification testing categories for which multiple rounds of testing have been conducted by the different centers and pilot programs.

**Homeland Security Water Monitoring Technologies.** AMS has been conducting verification activities for technologies applicable to meeting U.S. homeland security needs for protecting drinking water supplies. The center has verified the performance of portable cyanide analyzers and rapid toxicity testing systems, both with water security applications. These were the first two rounds of verifications for homeland security to be conducted by the ETV program, and the verifications were completed within an unusually fast six-month time frame. The AMS stakeholders have prioritized immunoassay and rapid polymerase chain reaction screening methods for biotoxins, pathogens, and/or weaponized agents as the next technology categories for verification.<sup>5</sup>

**Building Decontamination**

In 2002, ETV further expanded its role in the innovative technology verification arena by establishing a new center, the ETV Building Decontamination Technology (BDT) Center.

**Table 4.** Technology categories with multiple rounds of ETV testing.

Center/Pilot	Technology Category
Advanced Monitoring Systems Center	Mercury continuous emission monitors (CEMs)
	Nitric oxide/nitrogen oxides (NO/NO <sub>x</sub> ) portable analyzers
	Optical open-path monitors
	Portable multigas emissions analyzers
	Turbidimeters
	Arsenic test kits
	Multiparameter water quality probes
	Groundwater sampling devices
	Lead-in-dust detection technologies
	Explosives detection devices
Air Pollution Control Technology Center	Baghouse filtration products
P2 Coatings and Coating Equipment Pilot	Paint overspray arrestors
	Innovative liquid coatings

This center, which is operated by Battelle under EPA's direction, focuses exclusively on verifying the performance of technologies designed to decontaminate public buildings that have been



contaminated with biological or chemical warfare agents. The goal of this effort is to generate objective performance data so facility managers, first responders, and other technology buyers and users can make informed, and sometimes critical, purchase and application decisions. Currently, three verifications are expected to be completed by this center in 2004. These technologies use gaseous hydrogen peroxide, formaldehyde, and chloride dioxide gas to decontaminate building surfaces. The target agents include *Bacillus anthracis* (spores), nerve agent VX, nerve agent GD (soman), and sulfur mustard agent HD.<sup>5</sup>

### Pollution Prevention (P2)

One of three pilot programs in P2 technology verification, originally initiated under the ETV program, continues to operate. The P2 Coatings and Coating Equipment Pilot (CCEP), operated by Concurrent Technologies Corporation (CTC), verifies commercial-ready coatings and coating equipment that have the potential to prevent pollution. Innovative coatings are environmentally friendly by virtue of their composition or their curing processes. P2 CCEP is currently developing protocols for testing of UV fluorescent coatings and UV curable coatings. Innovative equipment generates less pollution by expanding the use of innovative coatings or by applying coatings more efficiently. Powder coatings processes, high transfer efficiency paint spray guns, high-volume/low-pressure paint spray guns, laser-targeted paint application devices, and surface pretreatment technologies are only some of the technology types that have been prioritized for verification by this pilot program.<sup>12</sup>

### CONCLUSION

The ETV program has produced an expansive record of accomplishment by partnering with public and private sector individuals and organizations to generate objective information that is responsive to the needs of the environmental technology marketplace. The program's collaborative nature and successes have also allowed it to quickly fill an important role in homeland security verification, that is, to obtain and provide critical information to end users on the performance of technologies for protecting water resources and buildings. It has also allowed the program to continue to verify a large number of technologies that address important environmental issues at a cost that is affordable for vendors, many of them small businesses. In fact, ETV verification organizations report that approximately 65% of the vendors with verified technologies are small businesses.

To date, ETV has verified 261 innovative technologies and developed 78 testing protocols. Vendor demand for verification continues to remain strong and ETV is on track to complete 90 protocols and 300 verifications by 2005. As of the end of 2003, more than 100 technologies were in the process of being verified and another 100 applications for verification

were pending. ETV vendors report that they are using ETV information in marketing their verified products; 40 vendors have had multiple technologies verified by the ETV program; and 75% of the technology vendors surveyed during the program's pilot period (1995–2000) indicated that they would submit another technology for ETV verification.<sup>4</sup> As the 2003 ASDWA survey and other results indicate, ETV's products are being used by state and other government agencies to reduce pilot testing, support permit decisions, and obtain air emission reduction credits for state implementation plans. Both the ETV program and the protocols it produces serve as standards for verifying technology performance, both nationally and internationally. The past nine years have been a successful and prolific period for the program. ETV's current focus promises to further elevate the program's role as the international leader in innovative technology verification. ☉

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