How Well Do Voluntary Agreements and Programs Perform At Improving Industrial Energy Efficiency?

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ABSTRACT

This paper examines evaluation studies of different voluntary agreements and programs and discusses the collective findings on observed performance outcomes. Evidence is drawn from actual evaluations of individual programs implemented in the U.S. and other OECD countries. Performance of voluntary agreements and programs is assessed in terms of the manner and extent to which they can, produce short-run direct effects, as well as soft effects, dynamic effects, wider economic and environmental effects, cost effects, and benefits to policy learning. What is meant by effective implementation of voluntary approaches depends on how these different aspects of performance are accounted for in the policy evaluation.

Introduction

Voluntary programs based on agreements or partnerships between Government and industry are relatively new but widely used policy mechanisms for improving energy efficiency and achieving carbon reductions. During the past five years, many studies evaluating voluntary approaches (VAs) have been completed. They provide important policy insights about how effective VAs are at improving energy efficiency and reducing emissions. There is now an opportunity to address the questions – (1) *"How well do voluntary approaches perform at improving industrial energy efficiency?"* (see Section 3) and (2) *"What lessons about performance can be considered when formulating the next generation of voluntary agreements and programs?"* (Section 4).

This paper summarizes the results of available performance assessments of VAs. Evidence is drawn from actual evaluations of individual programs in the U.S. and other OECD countries. The VAs reviewed in this paper reflect the range of different voluntary schemes used in OECD countries.[2]

The paper does not examine the cost-efficiency, nor compare the effectiveness of VAs to that of alternative policies and measures, such as regulations, taxes, or emission trading. Also,

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[1] The views and opinions of the authors expressed herein do not necessarily state or reflect those of the U.S. Department of Energy or Argonne National Laboratory.

[2] Nine VAs are examined -- The Netherlands Long Term Agreements (LTAs), Declaration by German Industry and Trade on Global Warming Prevention (DGWP, 1995&96 versions), Denmark CO2 Agreements, Australian Greenhouse Challenge, and U.S. Motor Challenge, Energy Star, Voluntary Greenhouse Gas Reporting Program (1605b), and Partnership for a New Generation of Vehicles (PNGV) and Industries of the Future (IOF) programs.

evaluating the techniques for performance assessment employed in the VA studies fall outside the scope of this paper.

Approach Used to Assess VA Performance

The VAs reviewed in this paper have used a variety of evaluation methods to analyze program effectiveness.[3] From a methodological perspective assessing the effectiveness of VAs is a complex and challenging process. This is because of data limitations, difficulties in determining the counterfactual, and problems with isolating the separate effects of the VA policy intervention from other policies in the national policy mix. Box 1 describes six key dimensions of VA performance assessment.

Box 1. Dimensions of VA Performance Assessment[4]

Direct Energy & Environmental effects concern the achievement of short-term (e.g., up to five yrs) direct energy savings or emission reductions.

Soft effects relate to the impact on changes in attitude and awareness of managerial and technical staff and in corporate culture. Do VAs motivate behavioral and attitudinal changes that conserve energy and favor increased energy efficiency and emission reductions? Do VAs lead to organizational changes that institutionalize energy-efficiency decisionmaking? Soft effects are closely related to the dynamic aspects because they prepare the ground for future innovation.

Dynamic effects relate to the impact on market and technology innovation, technical progress, and technology transfer and learning. This includes:

- addressing market, institutional, regulatory or other barriers to technology adoption and innovation
- creating desirable and effective market transformation in targeted end-use markets to establish greater potential for sustainable energy-efficiency investments
- promoting positive dynamic interaction between different actors involved in technology R&D, deployment and market development
- facilitating cooperative arrangements that provide learning mechanisms within a sector or industry to combine knowledge and develop new competencies in industry[5]

Wider economic and environmental effects comprise side effects resulting from strategic investment opportunities, such as those that bring overall productivity improvements, dollar savings and other strategic benefits.

Cost effects result from actions that diminish the costs of implementation (e.g., transaction and operational costs), including addressing opportunistic behaviors of firms and restraining free-riders that could increase transaction costs.

Policy learning is manifested as continuous adaptation and development of policy instruments. Learning associated with design and implementation of VAs is closely related to the evolution of administrative capacities and continuous policy evaluation and modification. If policy learning is low (i.e., opportunities for improvements are not observed or adopted) then VAs are less likely to perform well in a dynamic sense.

Using the criteria in Box 1, we examined the outcomes of individual evaluation studies and identified examples where VAs illustrate the six performance dimensions.

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[3] Techniques include -- analysis of program records of information provided by participants as part of progress reporting obligations; direct monitoring of outcomes at firms; review of audited energy savings; case studies; statistical surveys and semi-structured interviews of participating and nonparticipating firms, surveys of industry experts, market surveys of venders, consultants, industry organizations, and other agents; regression analysis of survey data; analysis of historical trends; and modeling simulation of investment behavior.

[4] These include many of the policy evaluation criteria identified by the OECD (OECD 1997).

[5] Delmas and Terlaak note the development of new competencies includes new environmental management methods, procedures, product designs, and product delivery mechanisms (Delmas & Terlaak 2000).

Characterization of Energy/Environmental Voluntary Approaches

There is considerable diversity among VAs, but patterns do exist. As indicated in Table 1, three types of VA that involve public authorities can be distinguished -- Negotiated Agreements (NAs), Public Voluntary Programs (PVPs), and Emission Trading Hybrids.[6]

These VAs differ in terms of their procedural arrangements and requirements, type and degree of specificity of commitments, reporting/verification mechanisms, accompanying policy support measures, participating parties/stakeholders, institutional context, and industry characteristics. Differentiating VAs is important because variations in underlying characteristics influence performance and determine the factors relevant to their successful application.

In NAs, regulatory or tax relief is granted to participants who meet agreed goals. For example, regulatory relief incentives could include a simplified or accelerated permit application process, waiving government review if facility energy or emission reduction goals are within prescribed limits, tax rebates could be applied, or the government may promise to not impose more stringent or new regulations on industry in future years. In general, NAs are structured so that it is more costly not to volunteer. NAs typically provide fewer support mechanisms than PVPs.

On the other hand, PVPs offer a mix of support mechanisms and are structured so incentives and market motivations encourage industries' voluntary action. PVPs typically have a strong market- or technology-innovation orientation.

Evidence from Individual Program Evaluations

Direct Effects of VAs

Direct effects (e.g., energy savings) are based on (1) goal/target attainment and (2) understanding the actual contribution the VA makes to goal/target attainment. Table 2 summarizes direct effects for selected VAs. Surveys and other analyses provide a rough idea of the magnitude of direct effects. Direct effects are measured by the contribution VAs make to energy-efficiency improvement and emission reduction over the short term (e.g., five years).

Attribution refers to the extent to which (i) the VA is able to either contribute to achievement of an established own target or goal, (ii) directly influence abatement or efficient-technology investment decisions, or (iii) create desirable changes in targeted end-use markets. Attribution is the appropriate measure of policy effectiveness, because autonomous effects and the influence of other policies need to be accounted for. In addition, target or goal attainment by itself can be misleading. In some cases, the quality of targets established by the VA has been heavily criticized (Jochem & Eichhammer 1996; Ramesohl & Kristof 1999).

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[6] NAs, PVPs, and another type, "Unilateral" approaches (e.g., Chemical Industry Responsible Care program), have been identified as distinct forms of VAs (Borkey & Glachant 1998; OECD 1999). Unilateral VAs will not be discussed further in this paper. Emission Trading Hybrids are relatively new formulations; they will not be further considered in this paper.

Table 1. Examples of Voluntary Approaches

VA Types	Description	Examples
Negotiated Agreements (NAs) *-- Serve as alternatives to Command & Control* (This form of NA could be legally-binding or non-binding.)	Several defining characteristics of NAs are: (1) they provide some form of regulatory relief through a direct link to regulatory or tax policies, or explicit threats of regulation, (2) targets are elaborated through a multi-round negotiation (bargaining) process, and (3) they employ punitive sanctions if commitments under the agreements are not met. Two sub-categories of NAs can be distinguished.	Legally-binding -- Netherlands LTAs; Dutch Benchmarking Covenants Non-binding -- Declaration by German Industry and Trade on Global Warming Prevention (DGWP, 1995 & 1996 versions); Finnish Agreement on Industrial Conservation Measures
Negotiated Agreements *-- Grant flexibility in complying with existing regulations or taxes*		Legally-binding – Danish CO2 Agreements[7]; Project XL
Public Voluntary Programs (PVPs) *-- Market Innovation programs*	In PVPs, the Government establishes the participation framework and basic rules, without engaging in extensive bargaining negotiation with industry. Firms are then invited to participate. PVPs are legally non-binding. They typically offer a menu of positive incentives to motivate industry, such as informational measures, targeted subsidies, technical assistance, recognition, etc. Participating firms often set their own targets/goals. Within PVPs three distinctions can be made.	U.S. Green Lights; Motor Challenge; Energy Star
Public Voluntary Programs *-- Public Disclosure, Promotional, and Registry-based programs*		1605b reporting program; Canadian Volunteer Challenge & Registry; Climate Challenge; Climate Wise; Waste Wise; Australian Greenhouse Challenge; Eco-management & Auditing Scheme (EMAS); and the 33/50 program
Public Voluntary Programs *-- Technology Innovation programs*		PNGV; IOF program, Design for the Environment (DfE)
Emission Trading Hybrids	These are "purely" voluntary emission trading schemes or voluntary trading alternatives to taxation/regulation (e.g., U.K.)	U.K. Climate Change Levy scheme; Canadian Greenhouse Gas Emission Reduction Trading Pilot (GERT)

[7] Some analysts believe the Danish Agreements are based more on "rule following" rather than "negotiated bargaining." They consider the Danish scheme to be more like a PVP (Johannsen 2000).

Based on the small sample assembled in this paper, many of the VAs appear to have an attribution with respect to energy-efficiency improvement or emission reduction of about 50%.[8]

Beyond direct effects, other measures of performance (see Box 1) point to important medium to long-run impacts. When one looks beyond the short-run outcomes that characterize direct effects, VAs appear to be having some positive medium to long-run impacts in the form of *soft, dynamic, wider economic and environmental, cost minimization,* and *policy learning effects.*

"Soft" Effects of VAs

Table 3 summarizes soft effects. As indicated in the table, both NAs and PVPs show some success in rasing awareness and influencing corporate investment behavior.

Energy auditing is typically a part of VAs -- either expected of participants (e.g., LTAs, Denmark CO2 Agreements, Green Lights, Australian Greenhouse Challenge) or provided as a support service (e.g., Motor Challenge). VAs can have an influence on inducing new management attitudes, depending on the degree of integration with audits or audit support services.

The presence of an auditing component in a VA has the potential to spur a broader mobilization of management attitudes, because the search for savings opportunities can change energy and strategic investment decision-making habits. For example, some changes in management attitudes have been observed in Denmark associated, in part, with the audit component of the agreements (Krarup & Ramesohl 2000).

As a second example, we use the U.S. Industrial Assessment Center (IAC) program experience to illustrate the potential that audits could bring to effective implementation of VAs. The IAC program is a standalone program, but for the purposes of this paper it provides useful

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[8] The ***50%*** figure is determined by the following sample of VA attribution:

- an observed 0.6%-1.0% per year energy-efficiency improvement associated with the LTAs, corresponding to a ***33-100%*** energy-efficiency improvement increase beyond BAU compared to a situation absent LTAs (Rietbergen, Farla & Blok 2001),
- over ***50%*** of Greenhouse Challenge participants surveyed indicated the program stimulated their abatement action (Australian Greenhouse Office 2000)
- about ***30-50%*** of consumer product purchase decisions have been influenced by the Energy Star program (the low end applies when the influence of utility rebate incentives is accounted for, although a full analysis of policy synergy has not been conducted) (CEE 2001),
- more than ***40 %*** of public recognition of Energy Star product labels is attributed to the program's promotional emphasis on market innovation,
- about ***10%*** of available national motor system savings potential has been captured by the Motor Challenge program; among the program's MotorMaster users, some ***18%*** indicate their motor system design, purchase and maintenance practices would not have been made without influence of the program (Xenergy 2000),
- ***56-100%*** of the 50 percent reduction goal of the 33/50 program was attained, depending on whether the 1988 or a 1991 baseline is used to calculate the program's final results (a 1991 baseline may be appropriate if one believes substantial reductions occurred prior to 33/50's implementation) (Mazurek 1998, 22-25).
- although it is reported that, under the 1995&96 versions of the DGWP, Germany industries will likely achieve target attainment, some analysts believe attribution cannot be 100%, but instead will be less than ***70%*** (because many energy efficiency improvements had occurred prior to establishment of the DGWP and some fuel consumption was not included in the early declaration) (Ramesohl & Kristof 1999).

Table 2. Direct Effects

Voluntary Approaches	"Direct effects"
LTAs	- target attainment is achieved: an average 20% energy efficiency improvement by 2000 with respect to 1989 levels of specific energy consumption is realized (van Luyt 2001); annual energy efficiency improvement of 2.1% is observed (Krarup & Ramesohl 2000, Rietbergen & Blok 1999) - overall, about 30-50% of energy efficiency improvement can be attributed to LTAs, about 0.6-1.0% energy efficiency improvement per annum over period 1989-98 (Rietbergen & Blok 1999) - energy efficiency improvement attributed to LTAs in 1996 is calculated to be 31-48% (expert opinion method), 29-44% (firm opinion survey), and 16-47% (comparison of monitored data to model estimates) (Rietbergen & Blok 1999)
DGWP	- target attainment is likely to be achieved, with the degree of target achievement ranging from 60% to 160% in 1997 (Krarup & Ramesohl 2000) - the level of ambition of the targets has been questioned (Jochem & Eichhammer 1996; Ramesohl & Kristof 1999)
Denmark CO2 Agreements	- investments for "pure" energy-efficiency projects (e.g., for service equipment) are usually made, in part, due to supporting mix with subsidies and agreement-mandated audit requirements (Johannsen 2000; Krarup & Ramesohl 2000); however, strategic investments do not appear to be influenced by the agreements (Johannsen 2000)
Motor Challenge	in the sixth year, reduction in electricity consumption by 520Mwh per year attributed to the program; 6% of all premium-efficiency motors sold in 1998 attributed to program; the program has helped companies capture 9% of potential annual savings available for efficiency upgrades and 1.5% of available systems-level savings potential; 24% of ASD-trained users and 48% of pump-system trainees attribute their recent investments in energy efficiency to the program (Xenergy 2000)
Energy Star	specific product purchase decisions are being influenced
Australian Greenhouse Challenge	attribution of 10 MTCO2e of abatement against BAU seems plausible, based on quantitative and survey assessment (Australian Greenhouse Office 2000)
PNGV	technology diffusion is already observed, associated with spillover technologies that have already been adopted by manufacturers to improve fuel economy and manufacturing energy intensity [9]

insights into how VA performance could be affected by inclusion of provisions for auditing. The IAC has produced significant shifts in the corporate culture and philosophy of U.S. companies Preliminary evaluation results for the IAC program show that an auditing instrument can shift the investment habits of small and medium-sized plants over time from a state of "little or no"

[9] Energy-efficient technologies developed as a result of the PNGV's program efforts that have already been adapted by the manufacturers are – (1) intelligent induction hardening of suspension parts allows General Motors to make Saturn suspension parts that are lighter and consume less energy to manufacture; (2) hydroformed aluminum side rails increased chassis and roof stiffness and reduced vehicle mass in some Chevrolets and Cadillacs; (3) composite fenders in Lincoln Town Cars, Grand Marquis and Ford Crown Victorias saved 5 pounds per vehicle; and (4) reduced rolling resistance tires that improve gasoline mileage are now available from Goodyear (U.S. State Department 2000).

Table 3. Soft Effects

Voluntary Approach	"Soft effects"
LTAs	some short term changes in management practice, in part influenced by supporting measures such as subsidies for feasibility and investments and communication efforts
DGWP	little influence on current investment practice; broader mobilization of management attitudes gradually takes place, mainly within the frame of existing energy management schemes; the effect will depend on the quality of sectoral declaration containing the relevant commitment of sector associations but these are still pending (Ramesohl 2001)
Denmark CO2 Agreements	some short-run energy management effects, linked to integration with an audit requirement -- but few firms seem to have energy management systems as per the Agreement; the observed shift in investment practice appears to be due mainly to a mandatory requirement for specific investment; little shift in investment planning is observed, although 74% of energy managers surveyed report a positive impact on the Agreement on energy management; firms tend to focus on energy accounting aspects of energy-management obligations rather than long-term management practice (Johannsen 2000; Krarup & Ramesohl 2000; Togeby, et al. 1999)
Motor Challenge	- some evidence that neglected "systems optimization" of motors is now receiving increased attention in companies and in the marketplace - among its MotorMaster users, some 18% indicate their motor system design, purchase and maintenance practices would not have been made without the program's influence
Energy Star	- there is increased awareness of the benefits of energy-efficient equipment - 80% consumers surveyed were familiar with logo; more than 40% used logo in making purchase decision (Laitner 2001)
1605b	the 1605b program is believed to have helped companies become more focused on energy efficiency and emission reductions, including learning how to estimate greenhouse gas emissions (Hakes 2000)
Australian Greenhouse Challenge	- two-thirds of the organizations report positive management and cultural change attributed to the program (Australian Greenhouse Office 2000) - capability is being built within firms to identify, monitor, manage, and report greenhouse gas emissions (Australian Greenhouse Office 2000)
IOF	some evidence of an improved research focus within industries and their respective firms

energy savings decision-making to more advanced stages of decision-making (e.g., "routinization", "inculturation", or "continual vigilant") (ORNL 1999).[10]

In addition to auditing, other accompanying policy measures such as informational measures and targeted subsidies appear to be positively correlated with observed soft effects. For example, in the aforementioned IAC program, provision of financial information to firms further increases the likelihood of acceptance of specific recommendations. This increase in likelihood of adoption is much greater than would be expected by cost differences alone (Boyd 2001).

Dynamic Effects of VAs

Dynamic effects are reported in Table 4.

[10] Before the audit policy intervention only 5% of IAC client plants in the sample were categorized as actively pursuing energy savings investments. After the audit intervention some 62 percent of client plants in the sample were categorized as having advanced decision-making habits (ORNL 1999).

Table 4. Dynamic Effects

Voluntary Approach	"Dynamic effects"
LTAs	dynamic effects do not seem to have taken place
DGWP	some dynamic effects noted -- e.g., policy committees formed, working groups, top-execs involved, depending on the degree of competition within a sector, increased inter-firm communication and exchange of information are observed (Rampshol & Kristof 2000)
Denmark CO2 Agreements	- low effect on technology innovation, with no observed change in the underlying technology innovation strategies of firms (Johannsen 2000) - a very low impact on networking among firms and diffusion of knowledge
Motor Challenge	- emergence of "system optimization" services is helping to transform motor markets - communication channels established with thousands of end-users - has facilitated networks, disseminated information, and created access to one-stop "best practice" information pools
Energy Star	Energy Star products have become well established in the national market
1605b	dynamic effects do not seem to have taken place
Australian Greenhouse Challenge	dynamic effects do not seem to have taken place
PNGV	- significant changes in underlying technologies and innovation strategies are occurring; the recent breakthroughs made by Ford, General Motors, and Daimler-Chrysler in hybrid vehicle technology design are a direct result of the PNGV program - impact on networking among firms and diffusion of knowledge is very high
IOF	- impact on networking among firms and diffusion of knowledge is high - IOF industries are now taking advantage of technologies developed for industries outside their own sector (e.g., sensors and controls, and oxygen-fuel combustion)

The PNGV program demonstrates how a VA can contribute to technological innovation. Recent technical advances in hybrid vehicle technology design -- by Ford (Prodigy, 80 MPG equivalent), General Motors (Precept, 72 MPG equiv.), and Daimler-Chrysler (ESX3, 72 MPG equiv.) -- have been credited by PNGV industries as a result of the partnership.

VAs have also resulted in observed market-level changes that reflect desirable and effective transformation in targeted end-use markets, aimed at speeding up the diffusion of best practices. Market changes have been stimulated by VAs that make a concerted effort to (i) address market, institutional and regulatory barriers to diffusion of efficient-technologies and best practices, and (ii) promote positive dynamic interaction between different actors involved in technology manufacturing, deployment and market development. Motor Challenge and Energy Star are two good examples of VAs that generate market effects.

Demand-side market effects have been observed in the Motor Challenge program. There has been a steady growth in the demand for "systems optimization" skills, along with an increase in preferred use of contractors and designers who have "system-efficiency" service offerings. In addition, the Motor Challenge program has seen an increase in the number of trade allies (e.g., venders, utilities, industrial organizations) engaged in activities to disseminate information on the "systems"approach. More than 200 Allied Partners have established communication channels to reach over 10,000 motor system end-users (Xenergy 2000).

On the supply-side, there has been an increase in the number of trained system optimization specialists as a result of the Motor Challenge program. Several thousand plant managers and energy service professionals have received motor system optimization training over the past five years. As a second supply-side example, Energy Star has successfully established a clear national label "ENERGY STAR" that identifies energy-efficient products from over 1,200 manufacturers. More than 98% of all office equipment sold meets Energy Star levels of performance, up from nearly zero before the start of the program (U.S. State Department 2000). Energy Star products are now available in more than 4,600 stores (Laitner 2001). Surveys suggest that 80% of consumers surveyed were familiar with the logo and that over 40% used the Energy Star logo in making purchase decisions (ACEEE 1999; Laitner 2001). A recent survey analysis indicates an influence of the Energy Star program on consumer purchase decisions of as much as 50% (CEE 2001).

VAs also facilitate cooperative arrangements that provide learning mechanisms to combine knowledge and develop new competencies in industry. Examples are – (1) the establishment of industry user groups in the Netherlands and Germany; (2) Motor Challenge has facilitated the development of cooperative partnerships between market agents who share the common desire to promote energy efficiency as part of their product differentiation strategy (e.g., the Allied Partners); and (3) IOF industries are now taking advantage of technologies developed for industries outside their own sector (e.g. sensors and controls).

Wider Effects of VAs

In general, program evaluations tend to give little attention to wider economic and environmental effects. Wider economic effects are possible for VAs that encourage audits, where companies search for both energy and strategic investment opportunities. The Motor Challenge program has documented company case studies that show non-energy cost benefits (e.g., increased overall productivity, reduced waste and throughput) can equal or significantly exceed energy-related dollar savings.

Cost Effects of VAs

Transaction costs arise when there are free-riders, high negotiation costs, or firms face high search cost in looking for energy-saving opportunities. Free-riders may impose future costs on other firms in sector-wide VAs that establish collective industry commitments. Transaction costs can be diminished by promotion of information flows – e.g., information channels, informational support tools, experience sharing, publications of results, and knowledge sharing mechanisms (Cabugeria 1999). Costs can also be reduced by designing the VA so that free-rider behavior is discouraged. Table 5 shows the cost effects for selected VAs.

Energy Star programs help diminish transaction costs by addressing informational barriers. In particular, two informational barriers the program has successfully attacked are: (1) lack of objective information and (2) definition of the efficiency and comparability of competing products.

Table 5. Cost Effects

Voluntary program	"Cost effects"
LTAs	formalization of negotiation process seems to result in high transaction costs (Krarup & Ramesohl 2000)
DGWP	free riding occurs with respect to non-member companies of the committed association (sometimes up to 20% of a sector) as well as to (smaller) firms which simply ignore the declaration made by the association (Ramesohl 2001)
Denmark CO2 Agreements	- an auditing requirement in the early Agreement design lead to high transaction costs (Johannsen 2000) - by design, the Danish agreement scheme eliminates free-riders because tax rebated are directly linked to individual firm participation (Johannsen 2000)
Motor Challenge	diminishes transaction cost by addressing informational barriers and increasing market coordination and collective learning
Energy Star	diminishes transaction cost by addressing informational barriers and increasing market coordination and collective learning
Australian Greenhouse Challenge	diminishes transaction cost by providing a database for benchmarking use
PNGV	collective learning processes diminish transaction cost
IOF	collective learning processes diminish transaction cost

Many PVPs deter free-riders by including a rich incentive structure consisting of a mix of different accompanying policy measures aimed at encouraging maximum participation. When participation is maximized, the likelihood of free-ridership is diminished and transaction costs are reduced. Programs such as Motor Challenge and Energy Star may be having this cost effect, although it has not yet been quantified. They have supporting policy measures that facilitate coordination and collaborative arrangements among participating companies, establish user groups, disseminate information, and create access to one-stop "best practice" knowledge pools. The result is to reduce search and contracting costs (Delmas 2000). Innovation-oriented PVPs, such as PNGV and IOF, establish research groups, disseminate technical information, and create access to R&D knowledge pools that enhance collective learning.

Policy Learning Effects

Policy learning occurs when program evaluation is used to make continual improvements in VAs over time. As Table 6 indicates, policy learning has clearly taken place in many countries, based on lessons learned from evaluation of first generation VAs.

Policy learning requires information and data. For example, the Industrial Electric Motor Systems Market Opportunities Assessment provides a detailed statistical profile of the U.S. motor system population (USDOE 1998). In addition, it provides the first-ever profile of motor system practices for motor replacement patterns, rewind vs. replacement decisions, motor system purchases, maintenance, use of system efficiency measures, and motor sizing. A motor system energy "savings opportunity" is also identified and estimated by type of savings measure, motor application, and horsepower. By providing these detailed national profiles, the Market Assessment has established the national baseline conditions for equipment use, practices, and

Table 6. Policy Learning Effects

Voluntary program	"Policy learning effects"
LTAs	The Netherlands Government, upon concluding its Long-Term Agreements (LTAs), decided not to extend them for heavy industry, but chose instead to establish a new form of VA based on benchmarking covenants. Both the Government and industry believe that, for the most part, the LTAs successfully captured the "low-hanging fruit." The new goal is to achieve energy efficiency for different production processes that is benchmarked to the best in the world by 2012.[11] For other industries, LTAs now have an average 2.2% improvement target (up from previous 2%), with standardized and improved monitoring (Krarup & Ramesohl 2000, van Luyt 2001)
DGWP	The DGWP has undergone refinements from DGWP (1995) to undated DGWP (1996), to the newest formal Agreements (2000). In the newest Agreements, the German Government has taken a firmer position to better ensure reductions beyond BAU are achieved. This new position is reflected in increased target levels to 28% for CO2 and 35% for all greenhouse gases.
Denmark CO2 Agreements	- Agreements suffered from high transaction costs associated with a company auditing requirement; auditing is no longer an obligation - increased emphasis on special investigation assessments of energy savings opportunities for production processes - shift from service equipment to greater emphasis on core energy-consuming production processes - improved elaboration and enforcement of energy management systems (Johannsen 2000; Krarup & Ramesohl 2000)
Motor Challenge	- continuously redefines best practice energy efficiency as new information and technology become available - a major national Market Assessment provides detailed information to support the policy learning process
1605b	- experience has been gained through development of an accounting framework for categorizing greenhouse gas emissions, emission reductions, and carbon sequestration activities - entity reports provide a "test" database of approaches to emission reductions that can be used to evaluate future emissions limitation policy instruments - the program has helped to illuminate many of the important emissions accounting issues that must be addressed in designing any future emission limitation policies (Hakes 2000).
Australian Greenhouse Challenge	- new implementation of independent and random verification includes complementing a self-reporting regime with establishment of emissions accounting/reporting procedures for participants - initial self-selecting participation now shifted to proactive targeting of energy-intensive industries - introduced Allies to better facilitate establishment of networks (Australian Greenhouse Office 2000)
PNGV	PNGV is at the forefront of an emerging trend among industrialized countries, and has stimulated the launching of the EuCar effort in the European Community and the ACE project in Japan. Each have goals similar to the PNGV (U.S. State Department 2000).
IOF	industries such as forest products and steel are beginning to examine more ambitious "stretch goals" and are reassessing the ability of the current portfolio of R&D activities and available policy instruments to meet industry needs.

opportunities. Progress with market transformation stimulated by Motor Challenge can now be measured against the national baseline conditions for motor systems.

[11] Best in world means – (1) average energy efficiency of the best region in the world or (2) the top 10% of the most efficient plants in the world (van Luyt 2001).

Lessons About VA Performance

Although there is still no definitive study available on the effectiveness of VAs as a policy tool, several general observations are emerging about lessons to consider when formulating the next generation of voluntary agreements and programs. This section presents five of those observations, based on the sample of VAs examined in this paper. A broader analysis of a larger VA sample is required in order to reach more definitive conclusions.

1. When looking only at short-term direct effects (e.g., energy savings), program evaluations suggest that many VAs have an attribution with respect to energy-efficiency improvement or emission reduction of roughly 50%.

Based on our limited sample of VAs, an attribution of roughly 50% seems plausible for many VAs. Attribution is the appropriate measure of policy effectiveness, because autonomous effects and the influence of other policies need to be accounted for. In addition, target or goal attainment by itself can be misleading.

2. Most target-based schemes are successful in achieving their targets, however target achievement in itself is not measure of overall effectiveness. Sometimes the level of ambition of the targets is criticized.

There are examples of cases where targets have been attained in VAs, but analysts have found targets to be unambitious, ex post. Two examples of VAs where the quality of targets was heavily criticized are – (1) the early DGWP (Jochem & Eichhammer 1996; Ramesohl & Kristof 1999) and (2) the 33/50 program (Mazurek 1998). Where numerical improvement targets are established, they should be clearly-defined and challenging for industry. Knowledge of what is technically and economically feasible is essential to help industry establish its own "stretch goals." Energy savings or emission reductions that occurred prior to program implementation should be made explicit and appropriately accounted for when setting targets.

3. In the long run, heightened industry awareness and changes in management processes and organizational culture within firms could lead to significant future energy savings. It takes longer for these kinds of indirect effects to translate into observed modification in firms' investment criteria and decision outcomes.

Indirect effects should not be overlooked. We find it is necessary to look beyond the narrow performance measures and short-run outcomes that characterize direct effects, to take into account the broader performance perspective. This means looking at soft effects (e.g., changes in attitudes and awareness), dynamic effects (impact on learning, market and technology innovation), wider economic and environmental effects (e.g., productivity and local air-quality improvement), cost effects, and finally benefits to policy learning. Raised awareness, broader mobilization of management attitudes, collective learning and transaction cost reduction – through targeted industry R&D and market facilitation, inter-firm cooperation, and connections between energy and strategic investments – are all very important performance outcomes to consider when evaluating VAs. VAs can influence the long-run behavior and decisions of firms, and help increase market and technology innovation. Significant technical achievements can

occur as a direct result of program efforts to speed up technical improvements and the longer-term innovation.

4. Effective integration of VAs with supporting policy measures may be a key factor that determines the scope and magnitude of indirect effects.

Indirect effects appear to be enhanced when VAs contain a supporting policy mix, such as when inventory/auditing provisions are part of the agreement process or included as a support service, or ISO14000/EMAS is integrated into the agreement. This appears to be also true when the VA contains a mix of incentives, such as informational measures, technical assistance or targeted subsidies.

5. Policy learning is occurring and can contribute to continual adaptation and development of VAs.

Recent efforts in a number of countries to enhance VAs point to rising expectations for participants, with greater benefits provided in return. When it is determined by governments that low-hanging fruit has been sufficiently exploited, VAs tend to shift emphasis to more challenging goals (e.g., more aggressive reduction targets, shift in investment emphasis from service equipment to production processes, etc.). Expectations for clear and more aggressive goal setting and credible monitoring and verification is an emerging trend, along with greater recognition that industry participants must benefit for them to cooperate.

Areas for Further Study

Several areas for further study are noted.

- VAs require distinct evaluation efforts which include qualitative assessments such as expert interviews and consumer and market statistical surveys. More work needs to be done to document the experience by applying qualitative evaluation techniques and combining them with quantitative methods, including cost-benefit analysis.
- Significant analytical work and tool development is necessary to produce improved estimates of the "soft", "dynamic", "wider economic and environmental", and "cost" effects associated with application of VAs.
- Since different forms of VAs are recognized for their unique structures and varied objectives, an important question that needs to be carefully examined is -- *"What should a VA look like when you want to achieve different performance goals, such as sustainable market transformation, technology innovation, or rapid delivery of carbon reductions?"*

References

ACEEE (American Council for an Energy-Efficient Economy) 1999. "Consumers Recognizing and Using Energy Star Label", Press release posted 4/28/99, http://aceee.org/press/estar.htm.

Australian Greenhouse Office. 2000. *Greenhouse Challenge Evaluation Report 1999*, Australia.

Boyd, Gale 2001. "A Probit Model of Energy Efficiency Technology Decision Making", paper prepared for the *ACEEE 2001 Industrial Summer Study*, July.

Börkey P, and F. Leveque. 1998. *Voluntary Approaches for Environmental Protection in the European Union*, OECD ENV/EPOC/GEEI(98)29/FINAL, OECD, Paris.

CEE (Consortium for Energy Efficiency) 2001. *CEE Energy Star Household Survey Report (2000)*, prepared by The Cadmus Group, Inc and Xenergy Consulting, Inc., February 9.

Delmas, Magali A. and Ann K. Terlaak. 2000. "Voluntary Agreements for the Environment: Innovation and Transaction Costs", CAVA Working Paper 00/02/13, February.

U.S. State Department. 2000. "U.S. Best Practice Policies and Measures." U.S. Government Submission to the G8. *In Proceedings of the G8 Environmental Futures Forum 2000 on Domestic Best Practices Addressing Climate Change*, February 14-15, Kanagawa, Japan, Government of Japan, Environment Agency (publisher)

Hakes, J. 2000. Testimony of Jay Hakes, Administrator, Energy Information Administration, U.S. Department of Energy, before the U.S. Senate Committee on Energy and Natural Resources on Senate Bills S.882 and S.1776 and Their Impact on EIA's Programs, March 30.

Krarup, S. and S. Ramesohl. 2000. "Voluntary Agreements in Energy Policy", *Final Report from the Project VAIE*'. Kopenhavn, AKF.

Johannsen, K. S., 2000, "Combining Voluntary Agreements and Taxes – An Evaluation of the Danish Agreement Scheme on Energy Efficiency in Industry", AKF, Denmark.

Johannsen, K.S., and M.. Togeby. 1998. Evaluations of the Danish CO2 Agreement Scheme, CAVA paper no. 98/11/7

Jochem. E., and W. Eichhammer. 1996. "Voluntary Agreements as an Instrument to Substitute Regulation and Economic Instruments" Lessons from the German Voluntary Agreement on CO2-Reduction", paper presented at *CERNA and FEEM conference on Economics and Law of Voluntary Approaches in Environmental Policy*, November 18-19, Venice.

Laitner, Skip. 2001. "Voluntary Programs: A Cost-Effective Means for an Innovation-Led Energy Policy", presentation given at the *IEA Workshop on Government-Industry Cooperation To Improve Energy-Efficiency and the Environment Through Voluntary Action*, Washington, DC , 22 February 2001

Mazurek, J. 1998. *The Use of Voluntary Agreements in the United States: An Initial Survey*, report prepared for the OECD Environment Directorate, ENV/EPOC/GEEI(98)27/Final.

Oak Ridge National Laboratory (ORNL). 1999. *Industrial Assessment Center Program Impact Evaluation*, ORNL/CON-473, December.

OECD 1997. *Evaluating Economic Instruments for Environmental Projects and Policies – A Practical Guide*, OECD, Paris

OECD 1999. *Voluntary Approaches for Environmental Policy: An Assessment*, Paris: OECD Environment Directorate

Ramesohl, S. 2001. Personal communication (reviewer comment), April.

Ramesohl, S. and K. Kristof, 1999. "The Declaration of German Industry on Global Warming Prevention" A Model for Effective and Self-improving Climate Policy Processes?", CAVA Working Paper, No. 98/11/6, January.

Ramesohl, S. and K. Kristof, 2000. *Voluntary Agreements – Implementation and Efficiency: The German Country Study*, Wuppertal Institute for Climate, Environment, and Energy, Germany

Rietbergen, Martijn and Kornelis Blok. 1999. *The Environmental Performance of Voluntary Agreements on Industrial Energy Efficiency Improvement*, Task D report of the VAIE project, NW&S report No. 99068, Utrecht University, The Netherlands.

Rietbergen, M., J.C.M. Farla, and K. Blok. 2001. "Do Agreements Enhance Energy Efficiency Improvement? Analysing the Actual Outcome of Long-Term Agreements on Industrial Energy Efficiency Improvement in the Netherlands", paper prepared for the *Journal of Cleaner Production*, March 23.

Togeby, M., K. Johannsen, C. Ingerslev, K. Thingvad, and J. Madsen. 1999. "Evaluation of the Danish Agreement Scheme"

U.S. Department of Energy (USDOE). 1998. *United States Industrial Electric Motor Systems Market Opportunities Assessment*, Office of Energy efficiency and Renewable Energy, December.

van Luyt, Peter. 2001. "LTAs and the Recent Covenant Benchmarking Energy efficiency Agreements in the Netherlands", a program Fact Sheet prepared for the *IEA Workshop on Government-Industry Cooperation to Improve Energy-efficiency and the Environment Through Voluntary Action*, February 22, Washington DC.

Xenergy, Inc. 2000. *Evaluation of the Motor Challenge Program*, prepared for ORNL, 10 May, final report.