ENGINES OF ENERGY INNOVATION:
The Role of Smaller Manufacturers of Efficient Lighting Products

Fred Davis
President, Fred Davis Corp. Energy-Lighting Specialists
USA

Abstract
Of the many factors which contribute to improving the energy efficiency of lighting systems, an essential ingredient is the availability of new products. Without improvement in technology, the changing needs of the marketplace can not be met. While technology developments and introductions of new products from well-known, major manufacturers are very important, the lesser-known contributions made by new, smaller manufacturers have been providing a disproportionate share of the momentum for energy improvement in the U.S. Such contributions exemplify the best in American free enterprise. This paper presents case studies of the role smaller manufacturers played in introducing three innovative products to the American market: fluorescents adapted to retrofit a screw-in socket, low-harmonics electronic ballasts, and remotely-ballasted compact fluorescents. In each case, the introduction spawned further development, not only in new product lines, but in whole new markets, previously unknown and untapped.

INTRODUCTION

In the United States, new and small companies have provided many of the most important innovations in energy-efficient lighting in the past decade and a half. These developments have been both technical and market-orientated. Actually, the true test of success has been not so much whether a new product sells in the existing marketplace as whether it helps to create a new market all together.

A century after the introduction[1] of the first light bulb, the American lighting industry is heavily influenced by large, old manufacturers operating within a relatively rigid distribution network. Lamp and ballast manufacturers, especially, comprise very concentrated industries. Indeed, the history of the American lighting industry through much of the twentieth century is strewn with anti-trust suits.[2] Layers of protection insulating against change exist at virtually every level in this "mature" industry. Such inertia eventually demands change, especially given the dramatic impetus provided by energy crises and opportunities.[3]

The stories of many energy efficiency improvements in the lighting field consist of individuals and companies effecting change while working outside of, against, and around, the bulk of the existing lighting industry. Ultimately, such efforts that are successful work their way back into the industry that originally rejected them.

What follows are a few case studies of how individuals made a difference by bringing to bear the right combination of insight, foresight, capital, technical know-how, marketplace knowledge, bravery, and foolishness. They seem to exemplify the best that can be attained in a truly competitive and free market economy.

ENERGY CONSERVATION PRODUCTS (ECP):
"TWIST-OF-THE-WRIST" SCREW-IN CIRCULAR FLUORESCENTS

In 1978, the Zelin family began Energy Conservation Products, in New York City. ECP was one of the first of the smaller manufacturers of energy-efficient lighting products. The late 1970s was a time of great activity in energy conservation, but relatively little of that activity was occurring in the lighting field. The Zelins saw opportunity to extend energy conservation to lighting.

True compact fluorescents were not going to be introduced from Europe for a few years and ECP made use of

the next best thing, the circular fluorescents,.Up until that time, circular fluorescent lamps had been used mostly in surface-mounted ceiling fixtures. While these fixtures could, in many cases, adequately substitute one-for-one for incandescent fixtures, the market conditions were not ripe for massive replacement, considering the substantial cost of electrical work and the considerable sales work needed.

The whole concept of simply retrofitting existing incandescent fixtures got its start with screw-in circular fluorescents. In 1980, ECP developed its line of "twist-of-the-wrist" conversion units to retrofit a broad range of recessed incandescent fixtures. The higher-efficiency fluorescents came in a variety of stylish housings.

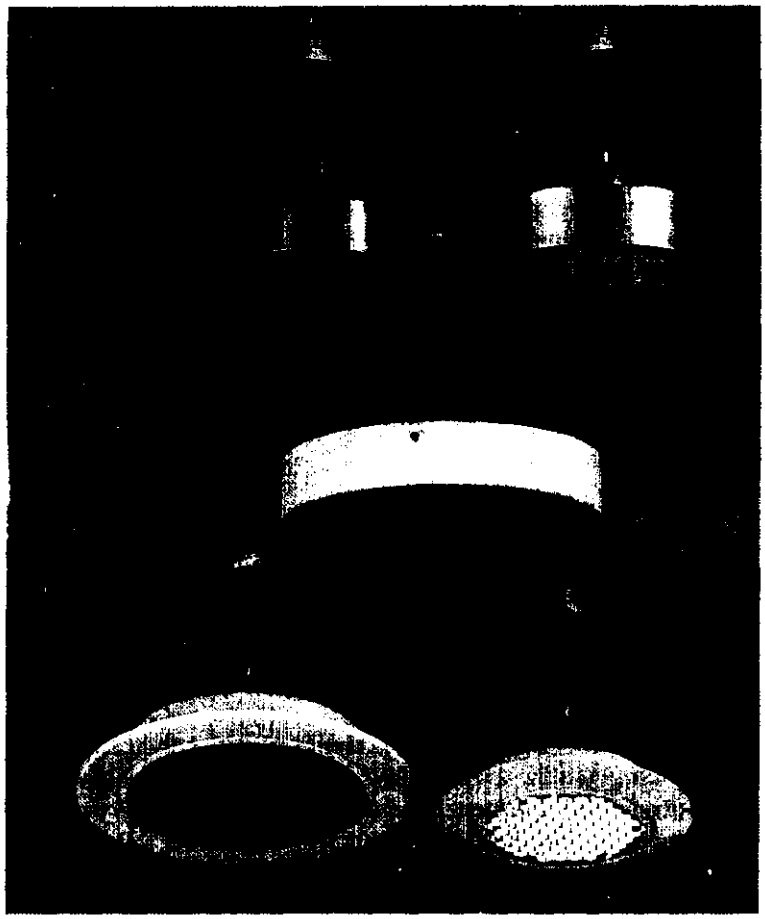

Figure 1: Various types of ECP "Twist of the Wrist" Screw-in Retrofits.

The ECP products screwed into a recessed medium or mogul socket with an appropriate base. The base connected to two telescoping sleeves of plastic pipe with a spring inside. At the opposite (bottom) end of the pipe would be the replacement fixture assembly, consisting of a metal pan holding the circular fluorescent lamp(s), ballast, and diffuser.

The user would have to measure the fixture in advance and order the appropriate length of pipe, diameter, lamp wattage(s) and style. Installation was as simple as a "twist of the wrist"--the unit would screw in to the existing socket, and, with a twist, the spring would engage, pulling the unit up in the ceiling (Figure 2). The finished installation would look either like a recessed fixture, or like a surface-mounted fixture, depending on the style chosen. (Figure 3.)

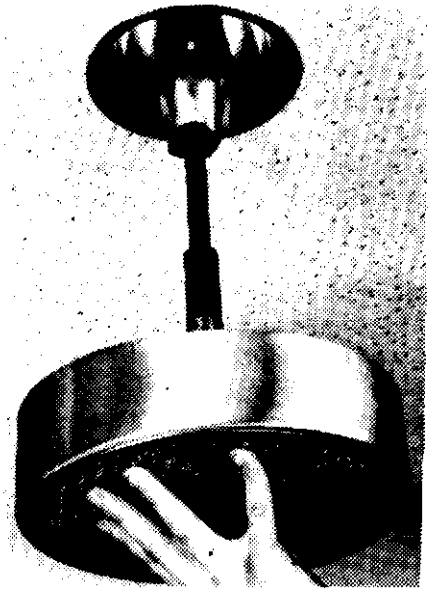

Figure 2: ECP's easy installation.

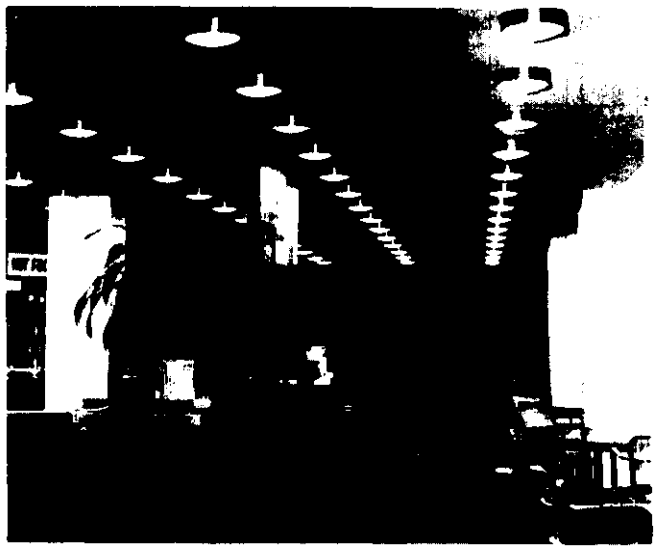

Figure 3: ECP's retrofit of recessed fixtures in a Manhattan restaurant.

With a minimum of effort, incandescent lamps could be efficiently and stylishly replaced. Dramatic energy savings, on the order of 80%, would accrue to the owner with a quick return on investment. While the photometrics of the space would necessarily change, the finished installation could easily yield lighting characteristics deemed satisfactory by the client. Retrofitting could actually provide improvements in some lighting parameters, such as by increasing light levels and improving evenness of distribution.

ECP, a brand new company, took advantage of a true market niche that the existing lighting industry had so far overlooked. The company's innovations took advantage of a number of opportunities in the marketplace at the time:

- the fluorescent replacement for incandescents was a logical reaction to recent increases in the cost of electricity.
- the screw-in approach avoided the significant costs and hassle factors associated with electrical contractors.
- the spring-engagement stem provided a flexibility of design which overcame the obstacles of the diversity of fixture and lamp types, which had kept retrofit from being an obvious option.
- the unit was available in a variety of attractive, finished styles.
- surface-mounted installations avoided the problem of trying to fit circular fluorescents into narrow openings.

ECP's entry as an independent company into a mature lighting industry, as many other companies would find out in the 1980s, was to have its advantages and disadvantages. Its independence allowed it to approach the market in fresh ways, working with marketers who also were new and independent, to distribute its product. Indeed, new lines of distribution were necessary--existing representatives and distributors could not take the time and effort to educate themselves and the marketplace in the virtues of energy efficiency and quick payback times. On the other hand, breaking into the rigid distribution network would ultimately be necessary to bring such messages to the general marketplace.

Unfortunately, ECP's early innovations could not keep up over the years as many other companies came in to follow in their footsteps. In the late 1980s, the company had annual sales in the range of $3 million (1.7 million ECU[4]) and 25 employees. As recessionary times hit, in early 1991, ECP was forced to close its doors.[5]

ELECTRONIC BALLAST TECHNOLOGY (EBT): LOW-HARMONIC ELECTRONIC BALLASTS

EBT is also an independent, closely-held company. It was started by Peter Shen in 1982 in Torrance, California. As with other companies who were in the business of manufacturing electronic ballasts in the mid-1980s, the company experienced its share of problems with quality control and complications in the field. Product problems plagued the industry and led to the demise of some of EBT's competitors. EBT, however, was able to learn from the mistakes and survive. By 1987, it was emerging as one of the few leading manufacturers of electronic ballasts in the U.S. Up until this point, electronic ballasts had been sold primarily on a job-by-job

basis. Major distributors, as a rule, were not stocking them for replacement and they were not available in new fixtures except by special arrangement. It was an assortment of a few independent salespeople, manufacturers' representatives, and end-users, all vast minorities in their professions, who formed the leading edge marketing electronic ballasts. A mixture of faith and free enterprise was at work to fill this niche of energy conservation opportunity, bit by bit. Each sale required a substantial educational effort and lots of hand holding, as energy savings of 20-30% had to be proven and weighed against the up-front labor and materials costs.

The strongest opportunities for the electronic ballast industry came when utility companies began to call for these products in their commercial and industrial programs. One of the largest utilities in the Northeast, New England Electric System (NEES), took an active and close look at the products it was starting to seriously promote and pay for through generous rebate programs. After evaluating electronic ballasts, NEES made a surprising determination: that electronic ballasts had the capacity to send disruptive harmonic currents backwards through electrical distribution equipment. NEES was concerned that, when installed in sufficient density, electronic ballasts could create harmonics sufficient to harm transmission equipment and, potentially, neighboring facilities. While NEES made no legal moves to prevent their installation, it did preclude the possibility of spending its money for rebates for such products.

However, NEES did not prohibit electronic ballasts per se. Instead, it set a strict upper limit on the level of harmonics allowable in products for which it would provide rebates. Such a restriction had the effect of excluding virtually all available electronic ballasts from being considered. Consultants, distributors, contractors, and end-users would have to leave electronic ballasts out of the packages of energy-efficient measures they were assembling.

What made the NEES exclusion especially frustrating was the fact that its rebate program was so extremely attractive: instead of simply offering rebates to end-users, the NEES rebate would go to the vendor or contractor supplying the product or labor. Such a formula produced an enormous upswing of demand for energy-efficient lighting products.

Electronic ballast manufacturers, it seemed, were going to be left out of this market. Attempting to make the appropriate product modifications was deemed too expensive and/or too difficult. In addition, the larger manufacturers felt that making such a product for only one utility company was not worthwhile.

Figure 4: EBT's low-harmonics electronic ballasts.

EBT, upon the urging of salespeople in the field, decided to try to modify its products with the appropriate filters. After significant trial and error, and after submitting samples for tests, EBT determined that it would provide a few of its models in "low-harmonics" versions, thus meeting the NEES criteria. In October of 1989, they succeeded in being the first manufacturer with significant production of low-harmonics electronic ballasts in the U.S.

By filling this niche, EBT had an immediate competitive advantage in the active NEES territory. There was an unheard-of, pre-educated, pre-sold, pent-up demand for electronic ballasts in the NEES territory, and it was theirs for the taking.

What makes EBT's development even more interesting is that, after only a short time, EBT abandoned its original high-harmonics line. In other words, all of its basic products are now of the low-harmonics type. In the last two years, other manufacturers have followed suit to offer low-harmonic versions of electronic ballasts. However, it took a new, independent company to forge this new path. Indeed, such a product might not exist were it not for the innovations of EBT.

EBT had annual sales in the vicinity of $20 million (14.5 million ECU) in 1990 and will be doubling that in 1991. EBT has recently reached a strategic partnership with Toshiba of Japan and is structuring a similar arrangement with a major European company. Such serious growth has not yet diminished their interest in new products. Before the end of 1991, EBT expects to introduce an affordable, low-harmonics, electronic ballast for compact fluorescents. In 1992, they expect to introduce a new affordable dimming ballast, and also expect to enter the European market.

PROGRESSIVE TECHNOLOGY IN LIGHTING (PTL): REMOTELY-BALLASTED COMPACT FLUORESCENT RETROFIT

PTL is a Michigan-based company which began in 1983. Boyd Berends, who was the founder and who still holds the controlling interest, had worked for North American Philips for a number of years prior.

North American Philips was the first to introduce the "PL" or twin, compact fluorescent lamps to the American marketplace in the early 1980s, after it was successfully launched in Europe. Originally, N. A. Philips' intention was to market the lamps only through to fixture manufacturers. The very first lamp holders (sockets) for these lamps were designed by Boyd Berends while he was still at Philips. Within 12 months, a few small, innovative companies were offering retrofit PL units. I took three years for Philips to develop their own screw-in ballast adaptor to allow the lamp to retrofit incandescent sockets. However, it was somewhat bulky and asymmetrical and came in only one size. These limitations prevented this unit from fitting in a significant percentage of existing fixtures. In addition, the ballast could fall off, and eventually the unit was removed from the market. However, the situation provided the impetus for others to try to find a "better mouse trap."

Since these first compact fluorescent lamps became available, a mini-industry has developed to find ways to get compact fluorescent lamps into incandescent sockets. PTL is now one of a number of these American companies which manufacture a variety of screw-in adaptor ballasts for twin- and quad-tube compact fluorescent lamps. These companies exemplify the term "niche-filler:" the many varieties of screw-in products which they make exist to retrofit as many sockets as possible. Through continuous feedback from the field, a wide variety of modular screw-in units has developed: some are longer, some shorter, wider at the base, skinnier at the base, symmetrical or offset, black or white, higher lumen or lower lumen, reflectorized or not, etc. No one of them can retrofit all incandescent sockets.

PTL's particular corporate style has encouraged a fairly continuous stream of innovation and product development. Some would even claim that such constant product development is excessive; over the years, many, many variations have been produced by PTL. Many of PTL's product introductions were first of their kind in this highly competitive field, others followed introductions by other manufacturers. As of spring, 1991, PTL offers almost 400 different product varieties.

As retrofit products were able to fit more and more sockets, retrofitters in the field became more clearly aware that certain types of fixtures tended to be "retrofit resistant." These included certain "portable" fixture types:

- "Arm" lamps and drafting lamps: a screw-in unit would invariably stick out and its weight would tip the arm over.
- "Piano" lamps or "portrait" fixtures which typically require a tubular incandescent (T-shape).
- Table lamps which are especially small or have odd configurations or require a small (A-15) incandescent.

No amount of shrinkage of compact fluorescent lamps and/or ballast adaptors could retrofit these types of sockets.

In the meantime, a market-oriented need was arising. Until this point, marketing of compact fluorescents had primarily been by commercial retrofitters in the field, including: energy management companies, independent salespeople, energy auditors, contractors, and commercial end-users. However, another whole marketplace had been developing since 1989, in the residential sector. Residential demand was being stimulated by catalog operations, utility company distribution programs, utility company rebates, and, since 1990, a new wave of eco-entrepreneurs buoyed by Earth Day 1990. Common to all of these was the need to sell compact fluorescents "sight-unseen." That is, no professional was available to test or measure sockets within a home. Since no one product could fit all sockets, products which would fit the most applications would have significant market advantages. Also, as the portable fixture types mentioned above tend to be popular in homes, there was a significant opportunity in getting products to fit these fixtures.

In 1988, a new compact fluorescent kit to retrofit portable fixtures was shown by PTL. It makes use of an isolated, or remote, ballast. While PTL may not have been the first to have such a product on the market (Janmar and Teron also introduced versions around the same time in 1990), theirs is eminently easy to apply. First, the existing fixture is unplugged, and the existing lamp is unscrewed. Next, a new "plug-in" ballast-in-a-box is plugged into the wall outlet, and the fixture cord in turn is plugged into the ballast box. Since the ballast provides the proper voltage and current through the fixture's existing wires, all that is needed is a small screw shell adaptor to hold the compact fluorescent twin or quad lamp in the existing lamp socket.

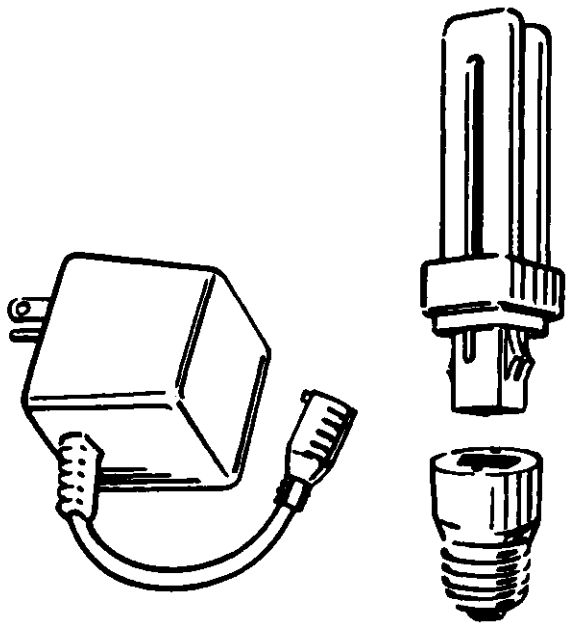

Figure 5: PTL's remote ballast kit with lamp and screw-shell adaptor.

The unit is so short, especially with quad tubes, that almost any portable lamp can be retrofitted. This is especially valuable for typical residential-style table lamp fixtures.

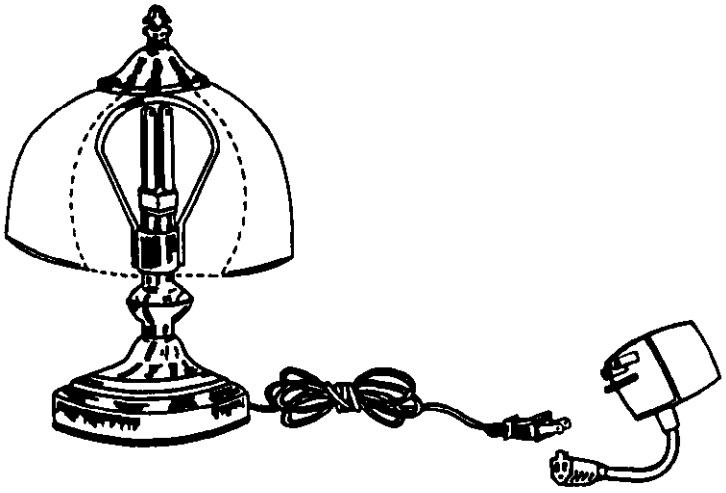

Figure 6: PTL's remote ballast kit installed.

In addition, T-shaped incandescents can be replaced very nicely by twin tubes in many situations. The exceptions (that is, still retrofit-resistant) would include "arm" fixtures from which they might still protrude, and table lamps with clip-on shades. However, new fixtures are available to replace these with compact fluorescents built in. In addition, PTL expects to introduce retrofit units for these applications in mid-1992.

As of 1991, PTL is projecting annual sales in the vicinity of $8 million (5.8 million ECU), and they expect sales to double in 1992.

RESULTS

The new and smaller companies discussed here share certain characteristics which tend to challenge the "mature" lighting industry. Such characteristics could provide the larger industry with some directions for regained economic health. These smaller manufacturers are:

-- More in tune with market conditions and opportunities
-- More inclined to take risks
-- Quicker to change; more nimble
-- Their main focus is on energy-efficiency.

These small manufacturers have succeeded in introducing a huge array of innovation in the American energy-efficient lighting field in the last decade and a half. The quantity and impact of their contributions have certainly been disproportionate to the sizes of the companies. These companies have fueled the drive for energy-efficient lighting by constantly providing new tools to fill existing niches. These new tools, in turn, allow for further new directions in market development. Whole new markets for energy-efficient lighting products exist now as a result of the initiative and leadership of these previously unknown companies.

DISCUSSION

The hypothesis of this paper is that a disproportionate share of innovation in energy-efficient lighting has come from new and smaller manufacturers in the U.S. in the last decade and a half. This could perhaps be empirically tested by some analysis of quantity of types made available versus size of manufacturer. It is not the purpose of this paper to do so. However, looking at the industry by product categories, the superficial evidence seems sufficient to show that this hypothesis has been more the rule than the exception. The field of lamp manufacturing provides the clear exception: while a few non-major manufacturers, most notably Duro-Test, have

manufacturers such as GTE Sylvania, North American Philips, and General Electric. Add to this the introductions made to the U.S. market by Osram and Panasonic which have been largely in energy-saving products. In the realm of compact fluorescent screw-ins, kits, and fixtures, the overwhelming preponderance of products have been introduced by smaller manufacturers. With regard to electronic ballasts, the determination is a little more complicated. Companies such as EBT, Triad-Utrad, XO, Luminoptics, etc., were certainly part of a pioneering brigade. However, many of them did not survive, and the major manufacturers such as Advance and Universal and General Electric eventually got involved. Now, Universal and Triad-Utrad are owned by Magnetek, General Electric Ballast Division was sold to Valmont, and there is a certain amount of private labeling, so the distinctions between "old-large" and "new-small" are blurring. Still, the major introductions of the electronic ballasts which have been on the market the longest were certainly made by companies which were new and small at the time.

Many other companies' stories in addition to the case studies shown here could be put forward to provide similarly illustrative case studies. Examples of other small innovative companies include American Scientific, Lumatech, Electronic Advanced Systems, Tek-tron, Scientific Component Systems, and others who have introduced a wide variety of products, especially in the realm of compact fluorescents. The story of Enertron, Inc., and its development of a line of high-power-factor ballast adaptors for compact fluorescents has significant importance. These products began production around May, 1991. In addition, small new companies have led the way with other energy-saving lighting technologies, including retrofit reflectors and occupancy sensors.

The fact that these smaller manufacturers have made contributions disproportionate to their size in no way minimizes the substantial and essential contributions, including basic research and technology improvements, of the older and larger manufacturers in the lighting industry. Indeed, most of the innovation coming from the smaller manufacturers uses the larger manufacturers' products as essential components. In the U.S., this de facto synergy has been an important ingredient in the development of energy-efficient lighting.

In the normal cycle of business growth, however, innovators' success can eventually lead to serious competition. In the case of compact fluorescents, global demand has mushroomed in recent years to the point of serious shortages of certain units. At this juncture, many believe the lamp manufacturers can determine where their production capacity will be applied.

In the U.S., modular compact lamps have been supplied in significant quantities to the newer companies. However, there are concerns that limits placed by lamp manufacturers on distribution in the U.S. are impeding further new and innovative compact fluorescent development.[6] This is perhaps of most concern in the competition for introduction of modular electronic compact fluorescent adapters. Up until now, these products have been essentially unknown in the U.S. 120V market, but many manufacturers, large and small, are actively working on such designs.

In Europe, it seems clear that the lamp manufacturers intend to exclude small adapter manufacturers from playing any serious role and thus encroach on the market for their one-piece units.[7] A few adapter manufacturers have surfaced in spite of this, mostly manufacturing modular electronic units. The electronic-magnetic situation is reversed in 220-240V Europe compared to the 120V U.S.: the higher voltage allows a more compact electronic ballast, but a magnetic ballast is quite bulky. Arcotronic of Zurich, Switzerland, a small company of 8-10 people operating for 8 years, is perhaps the best known of these.[8] They manufacture the Mini-tronic unit, which has been described as fairly expensive compared to the popular one-piece units made by the lamp manufacturers directly.[9] Also introduced recently are electronic modular units from the Far East, via Australia ("Auslamp") or Sweden ("Intelec"). These have the advantage of having a high power factor, and at least some of the units have the ability to be multi-lamp. This enables one unit to drive a number of different wattage lamps, which could be useful. However, according to the lamp manufacturers, lamp characteristics such as optimal output and/or life may be more or less sacrificed.[10]

One lamp manufacturer has estimated that the combined sales volume of all European adapter manufacturers is approximately the same as that of Enertron in the U.S. (see above).[11]

A new introduction to this field of 220-240V modular adapters is expected soon (November, 1991) from Newtronics in Australia. This line will move to a low-harmonics version.[12]

The control of patents is another tool that large lamp manufacturers use to maintain control over the marketplace

In the U.S., patents have been used to allow certain manufacturers of one-piece compact fluorescents to operate, but to exclude others. The major lamp manufacturers in Europe have also ensured that patents exist in each European country to dissuade potential competitors.

CONCLUSION

Whether in the U.S. or Europe, it seems the greater the opportunity there is to compete in a free and open marketplace, the greater will be the drive towards energy innovation.

NOTES AND REFERENCES

[1] As often used in business, the term "introduction" in this paper denotes: the bringing into the marketplace of a substantially new product.

[2] See, for example, Robert P. Rogers. 1980. Staff Report on the Development and Structure of the U.S. Electric Lamp Industry, Federal Trade Commission Bureau of Economics, U.S. Government Printing Office, Washington, D.C.

[3] For a critique along these lines, see, for instance, p. 3-5 in Paul W. Hansen. July 31, 1990. "Planned Obsolescence in Lighting: The Cost to the Environment and Economy," in Compact Fluorescent Bulb Conference Report, The California Compact, San Francisco, California.

[4] ECU value computed at rate of 1.734 ECU per $ 1 US as of January 1991.

[5] For each of the three businesses, salient facts such as starting date, name(s) of owner, and current sales volume, were garnered from a business reporting service and subsequently checked with the respective principal via personal communication.

[6] These concerns have been expressed by executives of US adapter manufacturing companies in personal communication.

[7] Personal communication, representative of a major European lamp manufacturer.

[8] Personal communication, Ms. Mohler, Arcotronic, Zurich, Switzerland, October 16, 1991.

[9] Personal communication, Mark Wood-Robinson, South Western Electricity, Bristol, U.K., May 28, 1991.

[10] Op cit, Ref. 7 and 9.

[11] Personal communication, George Lechermann, Osram US, Montgomery, New York, US, May 24, 1991.

[12] Personal communication, Alan Charak, Newtronics, Melbourne, Australia, October 15, 1991.