This paper was based on the findings of a study aimed at identifying and evaluating appropriate investment strategies in the area of end of life vehicle management (ELVM), especially against the emerging policy framework, as outlined by the recent EU legislation (2000/53 EG directive). The study was carried out for OMPM SA (Organisation for the Management of Public Material), a Greek organization, with many years’ involvement in the management of ELVs. The departure point of the work was the critical review of available best practices, mostly compiled by means of a considerable number of on the spot visits to diverse ELVM processing facilities in the Northern EU. These experiences and practices were critically adapted to the very different local circumstances, characterized by an underdeveloped market and a low operational sophistication. In this way, the recommendations of the study, also reported in this work, are of a wider relevance to areas where the main priority is rather the development and rationalization of the ELVM business itself, before getting on to the subtler fine tuning and optimization issues that may be on the agenda in more mature environments. Copyright © 2003 John Wiley & Sons, Ltd and ERP Environment.

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INTRODUCTION

The policy developments in the EU with regard to the ELVM issue, especially as reflected in the 2000/53 EG directive, have stirred up an EU-wide discussion, related to the rationale and eventual economic impact of this policy tool as well as the possible range of implementation details, funding mecha-
nisms and management options. Perhaps the most systematic critique has originated from the automotive industry itself, which fears that the new legislative framework will result in unnecessary recycling taxes that will burden the price of the car, lead to a distortion of the market and undermine the competitiveness of the industry. According to this view, these new taxes will be primarily mandated by the ‘excessive’ recycling quotas set by the ELVM Directive, which by themselves are criticized in many instances as downright unrealistic.

This paper aspires to highlight the particularities of an environment of a low technology sophistication, typically encountered in the Southern EU, in order to reveal the possible paths and the priorities that authorities wishing to effectively deal with the ELVM issue should perhaps embark on, address and effectively manage. It has resulted from a study in Greece, contracted by OMPM SA, an organization involved in ELV management and now seeking to make rail investments that would drastically leverage and redefine its role in the emerging environment. We do however believe that it reflects some much wider realities, which may be commonplace in all countries or regions where no real industrial level ELV management has ever been pursued. In the same perspective, we trust that its suggestions are of a wider relevance and may be transferable to other countries that wish to systematically address their ELV problem, for reasons that may exceed a simple requirement to comply with policies, even if this appears to be currently the driving force in the EU.

THE ELV MANAGEMENT
VALUE CHAIN

Around 10 million tonnes of waste is generated every year, by the 12 million vehicles that reach the end of the road each year in the EU (Goodfellow, 2002). Despite the increasing attention ELV related issues have recently received, the ELV management business has been there for a long time. Scrap merchants have always been keen and effective in recovering large quantities of metallic materials. From a certain point of view, steel is the most recycled material, as approximately 44% of the steel part of every new car originates from metallic scrap recycling (Heenan, 2002).

The value chain of ELVMs comprises a number of business entities, involved in one or more aspects of ELVM processing. Figure 1 depicts a representative layout of the business. Shadowed rectangles represent business entities, while non-shadowed rectangles represent specific activities carried out within the ELVM value chain. Obviously, in many cases, business entities might be involved in more than one of the activities shown in Figure 1. For example, dismantling is frequently combined with collecting and exporting of ELVs; also, some, admittedly minor, dismantling may be often carried out at a shredder facility, etc. If we put aside the logistics and the industry consuming the recovered materials, we end up with the following two business entities specific to ELV management: dismantlers and shredders.

The business of shredder residue processors is relatively new, with many still pre-competitive features. It is possible however that the new legislative framework may act as an important driving force for its future development. It is interesting to note that the economic aspects of the dismantlers and the shredders are significantly different. Table 1 presents some related data with regard to the

<table>
<thead>
<tr>
<th>Table 1. Typical size metrics of shredders and dismantlers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dismantler</td>
</tr>
<tr>
<td>Average number of employees</td>
</tr>
<tr>
<td>Average turnover per employee</td>
</tr>
<tr>
<td>ELVM business/total revenues</td>
</tr>
<tr>
<td>Average number ELVs processed</td>
</tr>
</tbody>
</table>
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Equipment and related financial costs as well as energy and maintenance. Shredding necessarily involves impressive equipment investments, high-energy bills and significant maintenance costs. Even if mobile shearing units are in widespread use and may significantly help in reducing the hulk transportation and delivery costs, shredding remains a costly investment. Because of the inherent economies of scale, small shredder plants, below the equivalent of 25000 cars a year, are a rare exception. Dismantling, in contrast, is often pursued at a very small level, of even less than a hundred wrecks a year. However, this by itself cannot automatically exclude the pos-

Table 2. Typical cost profiles of dismantlers in the EU

<table>
<thead>
<tr>
<th>Cost Component</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor cost/total cost</td>
<td>65%</td>
</tr>
<tr>
<td>External expenses/total cost</td>
<td>21%</td>
</tr>
<tr>
<td>(wreck purchase, etc.)</td>
<td></td>
</tr>
<tr>
<td>Depreciation/total cost</td>
<td>15%</td>
</tr>
</tbody>
</table>

Table 3. Typical cost profiles of shredders in the EU

<table>
<thead>
<tr>
<th>Cost Component</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor cost/total cost</td>
<td>15%</td>
</tr>
<tr>
<td>Financial expenses/total cost</td>
<td>15%</td>
</tr>
<tr>
<td>Depreciation/total cost</td>
<td>25%</td>
</tr>
<tr>
<td>Maintenance costs/total cost</td>
<td>45%</td>
</tr>
</tbody>
</table>

situation in France (La Loupe Financiere, 2001). Some better insight into the economics of the two operations can be also provided by considering data, illustrating the cost structure of the two operations. Such are the data of Tables 2 and 3, based on a Peugeot-Citroen study (Feillard, 2002).

Clearly, the economics of the two businesses are fundamentally different. Dismantling is a much more labour-intensive operation as, typically, it appears difficult to introduce any advanced mechanization and automation in a dismantling plant. In contrast, shredding is a much leaner operation in terms of labour, however not at all equally so in terms of capital equipment and related financial costs as well as energy and maintenance. Shredding necessarily involves impressive equipment investments, high-energy bills and significant maintenance costs. Even if mobile shearing units are in widespread use and may significantly help in reducing the hulk transportation and delivery costs, shredding remains a costly investment. Because of the inherent economies of scale, small shredder plants, below the equivalent of 25000 cars a year, are a rare exception. Dismantling, in contrast, is often pursued at a very small level, of even less than a hundred wrecks a year. However, this by itself cannot automatically exclude the pos-

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sibility of scale economies in the case of dismantling. Based on the analysis of the extensive ‘Peugeot-Citroen’ data-set mentioned above, its authors suggest that an optimum plant size exists for dismantling, in the area between 4000 and 6000 cars a year, although such conclusions depend a lot on the underlying technology and a technology shift may drastically reshape the economies of any operation. There have been in fact efforts that we are aware of to introduce production-line equipment in dismantling plants across Europe, in order to achieve scale economies. During our study, we visited a 10,000 car per year dismantling plant near Dulden, in the south Netherlands. This plant was equipped with a novel and freshly patented extensive-dismantling line (Car Recycling Systems B.V., http://home.planet.nl/~crseurop/e-p1.htm), which according to the local management enabled it to raise productivity and production (material recovery) throughput. A number of similar plants are now under installation elsewhere in the EU. Though it may be still early to say, it might eventually be that dismantling can be set up in a more ‘scale prone’ fashion than what is currently considered appropriate. Such a development could lead to a major shift in the ELVM processing modalities in the EU and beyond.

As a last note, it is very rare that either dismantling or shredding relies exclusively on its ELVM processing activities. Shredders, as Table 1 suggests, may recover steel from a great number of other end of life devices, especially white products. Dismantlers are also frequently involved in the trade of used spare parts or in the trading of ELVs themselves, in countries where they may still have a market value as automobiles with still a way to go (usually Eastern European, African and Asian states).

THE 2000/53 DIRECTIVE

On 21 October 2000 Directive 2000/53/EC was published, highlighting the EU strategy with regard to ELV management and presenting a number of obligations for all member states, destined to reach and affect the various operators along the ELV treatment chain. This extensive piece of legislation adheres to the ‘producer responsibility’ principle, by demanding that the ‘take back’ process of ELVs should occur at no charge for the car owner. The car owner should therefore be entitled to a free disposal of his vehicle to predefined authorized stations, where he will obtain his certificate of destruction, a prerequisite for a lawful deregistration of his car. The directive also sets clear material recovery and recycling targets. Overall material recovery should by the year 2006 reach an 85% level, of which thermal recovery should not exceed 5%, the rest being achieved through material recycling. These figures are increased by the year 2016 to 95 and 10% respectively. Other important clauses of the directive relate to the restriction and eventual prohibition of use of Pb, Cd, Hg and CrVI in new products.

The ELVM directive has created quite a tension, especially among car manufacturers. The overall approach of setting high recycling targets is strongly criticized from a technical, financial but also, and maybe paradoxically, also from an ecological perspective. Through this latter point of view, the car industry suggests that lightweight cars, built on new materials, may have less recycling chances when compared to steel, but will nevertheless, because of their low relative fuel consumption, have a much lower environmental impact during their lifecycle. The directive therefore fails to set targets that consider a life cycle impact, along which true environmental progress could be monitored. Along these lines of thought, Volkswagen AG (Goldman, 2002) suggests ‘the ecology related goal of the automotive industry is to reduce energy consumption and CO₂ emissions. From a recycling perspective, a vehicle as the good old Beetle, with its high content of steel and metal, can achieve a higher recovery quota than its contemporary light-weight counter-
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parts, despite its much higher level of fuel consumption. In the background of this statement lies the fact that the composition of a car has drastically changed in the last 30 years. This is especially valid when the plastic content is considered. Plastics in 1965 were only 2% of a car’s weight. This figure has risen today to 15–17% with a high possibility of continuing to grow. Moreover, plastics create many difficulties when it comes to recycling. Although thermoplastic materials are highly recyclable (often on a par with metals), thermosets still pose problems. In addition, it is well known that to recycle plastics you more or less have to separate their various types (PP, PE, ABS, PU etc.), otherwise no real reuse is possible. Despite the many efforts for an automatic separation of plastics, this appears to still be impossible to achieve at an industrial scale (Hooper et al., 2001; Stolberg, 2002; Hooper, 2002).

Therefore, the core problem behind the disputes with regard to the ELVM directive is the high cost of the extra recycling required to reach the targets it sets. Sheer shredding may recover the metal (steel, aluminium and copper) part of the car, which is about 75%, but how do you reach the further 5 and 10% required by the year 2006 and 2016 targets, respectively? Although there is obviously some merit in the life-cycle approach proposed by key auto manufacturers, we believe protests chiefly result from what they consider to be the introduction of unrealistic and financially unviable practices, such as plastic part dismantling and recycling, and from the fact that the price for this is very likely to burden the car industry itself, in particular as long as the ELVM directive dictates that car manufacturers should be financially responsible for all, or a significant part, of the take back systems.

Realistically, if the core of the ELVM directive is to remain in place, which against all evidence appears to be the case, there are two possible directions in leveraging the recycling rates from the current figure of about 75% to the required 80 and 85% by the year 2006 and 2016 respectively: first, to find a way for the automotive shredder residue (ASR) to be put in productive re-use; second, to achieve the additional recycling targets by extensive dismantling that will remove many more materials from ELVMs than appears to be the current practice.

The first approach seems to be the favourite of the automotive industry. This is quite obvious given the good relationships between the industry and the shredder companies, established over many decades of close cooperation. Significant research, sponsored by the auto industry, is currently under way in order to reach some stable and financially sound ASR recycling results (Stahlberg, 2002; Schaub, 2002; Bruggler, 2002). The second, dismantling favouring, approach has found its most advanced implementation in the Netherlands, by means of the system put forward by ARN (Auto Recycling Netherlands) even since 1995, long ahead of the enforcement of the EU legislation.

In the next section we will provide some further insight on extensive dismantling and comment on its possible contribution towards the achievement of the ELVM directive targets. This will be of particular relevance when considered against the Southern EU circumstances, and in search of affordable strategies in such weakly developed and poorly experienced, environments.

EXTENSIVE DISMANTLING PRACTICES

As stated above, extensive dismantling has already been practised for many years in the Netherlands, which has thus set an example of taking action before being forced to do so by legal obligations. In year 1995, a private, a not-for-profit company, called ARN (Auto Recycling Netherlands BV) was set up with the participation of key stakeholders (car importers, shredder and dismantler associations etc.) to manage ELVs in the country.
Quality procedures are in place for the registration of any company, along the ELVM value chain, wishing to enter the ARN network. Work is carefully carried out according to instructions provided by ARN. Regular, on the spot, audits guarantee the adherence to the operational guidelines set. The participating companies receive a premium for all agreed dismantling activities they perform. This premium is calculated per kilogram or litre of outgoing product, once all administrative data are transmitted and thoroughly checked. The network is financed by means of a waste disposal tax, raised on every new car registered in the Netherlands. This amounts to a fixed sum of 45 €. It is important to note that since 1995 ARN has managed, besides financing the so-called ‘chain deficit’, to also build a significant reserve fund, amounting to 40 M€, to be used in future circumstances, especially in a downturn of the car market, in which case the number of processed ELVs may significantly exceed the new car registrations. The materials whose removal and recycling is financially supported, at this moment, amount to a maximum of about 106 kg per typical car and include about 18 categories (1999) such as coolants, brake fluids, tyres, glass, batteries, various plastic items, LPG tanks etc. Metal scrap processing is and has always been a financially sustainable activity and is obviously not supported by ARN. The setting of the amount of financial support per kilogram or litre of item reclaimed and handed over to the next in the chain is perhaps the finest element of the overall exercise. This has to be carefully regulated, so that it is neither too low, which would make the operation expensive and therefore meaningless, nor too high, which would lead to market price distortions.

About 300 companies, primarily dismantlers (although also shredders are recently joining in), are active members of the ARN network, processing about 270,000 cars (2000), which amount to about 90% of the total ELV fleet in the country. These figures provide an indication of the importance of the management task carried out by ARN, as it has to continuously monitor and guide a significant number of companies involved in the business. An elaborate IT system automating transactions as much as possible is currently under implementation (ARN, 2000).

ARN reports an 86% recycling rate for its network in year 2000, which makes it fully compatible with the ELVM directive, well in advance of year 2006 (ARN, 2001). Figure 2 demonstrates the overall Netherlands picture (including those companies that have opted not to be part of ARN). Again, this appears to be in fact very close to the satisfaction of the ELVM directive recycling rates. The total achieved recycling amounts to 10.3 + 71.3 + 2.6 = 84.2%. This is very close to the 2006 goal for an 85% recycling rate and, obviously, a bit lower than the ARN reported rate.

Finally, it also deserves note that, according to data we have collected from large plants, in the range of 10,000 cars per year (in Dulden and Amsterdam in the Netherlands), the dismantling and recycling of materials exceeds the 10.3% figure, which, according to this study, corresponds to a national average value. This ARN system received significant criticism for not observing the competition rules by introducing state financing. This however has been recently (21 October 2001) overruled by the
Commission itself, and was judged as a non-valid assertion.

Despite the controversy that ARN has created across the EU, it is nevertheless clear that a 45€ premium is not any significant add-on to the value of a new car (less than 0.25%). This fact, together with the impressive results reported by ARN, and also with the Commission judgement that no violation of competition rules is in place, makes the Dutch practice a world-wide reference model, to which many other countries look seriously as a source of inspiration. For sure, this model does not enable any outright rejection of extensive dismantling on the grounds of financial non-efficiency, as frequently proclaimed by the auto industry. Such a dismantling is rather something that should be considered along other processing options, and within the characteristics of any particular region. The regional effect will be considered in the next section, for the case of the Southern EU.

Summarizing the discussion to this point, it is clear that, from a technical point of view, shredding and dismantling have historically been the two prime pathways for dealing with ELVs. In fact, these approaches have harmoniously co-existed, as parts of the same value chain in the European north, for quite a few decades. Recently however, especially in light of the ELVM directive, it appears that dismantling is gaining additional business thrust, in that it enables high percentages of material recovery. This, in its turn, has created much scepticism, on the side of the auto industry, and has increased its efforts to achieve compliance by means of an effective re-use of ASR rather than by expensive dismantling schemes.

‘Hot’ and interesting as this discussion may be, it nevertheless reflects only the ELVM realities and set-ups of the European north, where shredding and dismantling are now practised and well established over many years. It bears little relevance to the relatively primitive environment of the Southern EU, where both types of business are notably underdeveloped. Such, low sophistication environments, before any possible steady state, must undergo a painful transient period, whose essential features are very loosely coupled to the current EU debate about the extent of dismantling that should be pursued prior to taking the car to a shredder.

In the next section we will present the framework and the findings of a feasibility study carried out in Greece, on behalf of a public sector organization, OMPM SA, who, among other tasks, has a many year involvement in the ELV business, as an intermediary between wreck production and a significant number of scrap merchants. This case study will reveal the real issues in environments of a similar typology, and will help define priorities and possible management options.

**THE SITUATION IN GREECE: CHARACTERISTICS AND POSSIBLE ACTIONS**

It is estimated that the fleet in Greece amounts to about 2.2 million cars, and that typically about 140–160,000 cars a year reach the end of the road. This latter figure may significantly differ if the state enforces incentives for withdrawing old cars from circulation, as was the case in the early 1990s. The ELV number surged in those years, and significantly decreased in the next years. It has now stabilized again close to the above-mentioned figure.

It is important to note that very little information is available as to the real fate of these decommissioned vehicles. The main reason for this is that the car deregistration process is not at all rationalized, nor closely monitored and controlled. Owners are required to bring their cars to a limited number of places in the cities, managed by the public authorities, in order to obtain a deregistration certificate. Equally, however, they may make a statement that the wreck is kept on private property, hardly ever controlled for its honesty. Given the fact that the ELV disposal places are very few and difficult to reach for the majority of the population,
and also that the overall process may turn out to be tedious and time consuming, it is very common that to get rid of a car it appears far more convenient, though also socially irresponsible, to abandon it at a nearby place and to make a false statement to the authorities about keeping it on private ground. Unfortunately, this appears to be a widespread practice. A careful walk around any city will reveal a great number of such abandoned wrecks, resulting in aesthetical degradation, pollution and reduction of the precious and already limited parking spaces.

Given this background, it is no wonder that no more than 25–35,000 wrecks, i.e., about 25% of the total number, enter the ELVM chain yearly in a controlled and systematic way. OMPM SA, which is a major ‘collection point’ of ELVs in the Athens area, can account only for 12–15,000 wrecks a year. From data collected from 14 municipalities, it appears that all over the country a slightly bigger (13–20,000 wrecks per year) additional number can be collectively accounted for. The fate of the remaining vast majority is difficult to track, and only speculations can be made about what percentage ends up directly in the landfill, or is picked up by scrap and spare part merchants, and put to an even more untraceable ‘processing’ track.

As far as the more observable part is concerned, in the case of the quite typical OMPM SA, the wrecks are auctioned and sold off to spare part and metal scrap traders. The average price the organization receives during these auctions is in the area of 45 € per wreck. The merchants remove the spare parts of interest, and, in some cases, where they have the machinery to do so, they press and shear the wrecks, bale the resulting parts and transfer and sell them off to steel works. All this processing is completely empirical, in poorly organized yards, where operations are carried out with little, if any, environmental concern. All these merchants are marked by their small size, low technical awareness and organizational merit, as well as their frequent inability to seriously abide by quality standards. They are essentially selling off ‘products’ of a low quantity, a low quality and no consistency in delivery time. It is no wonder the prices they manage to agree with the steel makers are far below international steel scrap prices (which are close to 100 € per ton of steel scrap, in year 2002).

By analysing the data provided by two large scale dismantling plants in the Netherlands, one operating in Dulden and one planned for operation soon in Amsterdam, it was possible to estimate how the value of a wreck could reshape if it were subject to dismantling instead of being sold off as-is to intermediary merchants. The figures that resulted are summarized in Table 4.

The ARN funding results from the waste disposal tax institutionalized in the Netherlands. There is no such equivalent currently in Greece nor is there, for the moment, any discussion to proceed along this way. However, we do believe that the 134 € revenue from selling off the more typical and easy-to-market secondary materials can also, to a large extent, be considered a feasible benchmark for other countries, such as Greece. Of course the existence or non-existence of an appropriate, recycLate processing, infrastructure in a particular country may have an effect on market prices. However, building upon experiences from other exercises in recycling, we tend to consider that the main factors determining prices in the secondary product market are quantity, quality

<table>
<thead>
<tr>
<th>Type and place of activity</th>
<th>Revenue per wreck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car wreck sold off directly to intermediary scrap and spare part merchants (OMPM, Greece)</td>
<td>45 €</td>
</tr>
<tr>
<td>Large scale dismantlers in the Netherlands</td>
<td>134 € (from the market)</td>
</tr>
<tr>
<td></td>
<td>85 € (from ARN funding, for extensive dismantling of specified items)</td>
</tr>
</tbody>
</table>
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Table 5. Expected financial results for investment in large scale dismantling and car shredding (NPV = net present value, IRR = internal rate of return, PP = payback, ROI = annual return on investment)

<table>
<thead>
<tr>
<th>Type and size of investment</th>
<th>Investment cost (k€)</th>
<th>NPV (k€)</th>
<th>IRR (%)</th>
<th>PP (years)</th>
<th>ROI (%)</th>
<th>Operational cost (€/wreck)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large scale dismantling (10,000 wrecks per year)</td>
<td>3,061</td>
<td>1,204</td>
<td>16</td>
<td>7.5</td>
<td>11%</td>
<td>50</td>
</tr>
<tr>
<td>Large scale dismantling – economic scenario (10,000 wrecks per year)</td>
<td>1,270</td>
<td>2,440</td>
<td>47</td>
<td>3.5</td>
<td>34%</td>
<td>50</td>
</tr>
<tr>
<td>Shredding (85,000 wrecks per year)</td>
<td>11,748</td>
<td>19,020</td>
<td>43</td>
<td>3.4</td>
<td>23%</td>
<td>30</td>
</tr>
</tbody>
</table>

and delivery consistency. Should these be guaranteed, the price is not expected to differ much across the EU, at least not any more than the price of, let us say, virgin polyethylene differs from the Netherlands to Greece.

The basic result from this analysis is that the main direction for any serious leverage of simplistic practices in ELV management must be based on the ‘quantity–quality–consistency’ triplet of the operations. This can be the only approach that can guarantee the real market prices for any secondary material. Equally important, such a typology is very often also a basic condition for a higher productivity and internal operational efficiency.

Certainly, large scale dismantling is not the only technical path to achieve these three important conditions. Car shredding is also an alternative path. We have elaborated on the fundamentally different economics of this process in previous sections.

As part of our feasibility study, we carried out a techno-economical analysis of an investment in large scale dismantling and also in car shredding. These extensive analyses were based on data from real dismantling plants in the Netherlands and real shredding plants in Switzerland, as well as quotations from respective machinery providers. It was also based on data related to various cost categories in Greece (labour, land, auxiliary machinery etc.). Labour cost is still significantly lower in Greece when compared with Northern Europe, a fact that had to be strongly taken account of in order to set up the appropriate business assumptions. The study took strong account of the existing infrastructure of OMPM SA (primarily the availability of appropriate premises). Last, it took account of the market of secondary materials in Greece and the expected prices for various retrieved materials, for which a market can be already identified. Three scenarios for the prices were set up (high, medium and low). Also, the analysis was carried out for a 10 year lifetime, although some small terminal value of around 15–20% of the purchase price was also considered. The basic results of this study are summarized in Table 5, although only for the medium price scenario.

In the case of large scale dismantling two sub-cases were studied. The first was based on the assumption of a fully covered car park and on the quotations of foreign machinery manufacturers, while the second on the assumption that the car park would be open and not covered (in sunny countries, such as Greece, this seems to be pretty reasonable) and also a part of this machinery would be locally built. This latter, admittedly fine, assumption resulted from a strong awareness of the capacity of the local construction sector, which, for parts of the dismantling line, can guarantee, in our view, more competitive solutions.

The sizes of the alternative plants that were evaluated were specified on several assumptions. As far as the shredder is concerned, it appears that this machinery cannot be sized for small capacities, in a financially wise way. Therefore, the plant that would keep opera-
tional costs under control, while not skyrocketing investment costs, was found to be in the area of 85,000 cars per year. As the ‘production’ of ELVs is, in Greece, around 150,000 per year, there is obviously no place for many shredders of this size in the country. An important finding of our study was that there already exist two or three shredders across the country, operating however at a dramatic undercapacity. This is a very interesting point, as it is clear that there is very little ground for further investments in shredding plants until the existing capacities are fully exploited.

Even if these capacities did not exist, it would, in our view, be a luxury to set up shredders only for ELVs. They should necessarily also process various other types of metal scrap (white products), just as they usually do elsewhere in the EU. Their set-up would require very good planning, so that they could be sited in areas where the ‘raw material’ could be economically and consistently guaranteed, and the metals recovered and channelled in a similarly efficient way.

With regard now to the dismantling plants, we have only considered large scale plants, in the area of 10,000 wrecks per year. It has already been stated that such a plant size is often contested as to its economic efficiency. This important issue has been extensively elaborated in previous parts of the paper. However, two reasons mandated a departure from a possible selection of smaller plants: first, the good impression the large sized plants in the Netherlands created on us, and second, the fact that a network of many medium sized dismantlers, operating under the management and control of a central authority, is not a feasible scenario for countries such as Greece. The ELVM business is very underdeveloped and it is not conceivable that the small yards, scattered across the country, stand any chance of fast modernization. From an institutional point of view, dismantlers in the country have no representative body, making co-ordination a highly improbable event, at least for the near future. A model of many small to medium size dismantlers, centrally controlled, may be a well established practice in the Netherlands and elsewhere; however, for countries in the Southern EU, we hold this as an utterly unrealistic management option. Therefore, economies of scale aside, if dismantling is to stand any chance and to contribute towards the implementation of the ELVM directive, this can only be through a typology of a few, large scale plants, professionally managed and appropriately sited across the country, along similar considerations as in the case of the shredders.

Getting back now to the results of the analysis presented in Table 5, we would point out the two following points, well in line with the broader literature, although, of course, more accurately calculated to reflect the Greek environment.

Effectively sized shredding has about a scale of magnitude higher investment costs when compared with extensive dismantling, although the processing capacity is also about as high. Overall the investment cost per wreck processed seems about the same, at least in the case where the ‘economic dismantling’ scenario is opted for and juxtaposed to the ‘shredder’ one.

A much higher operational cost per wreck must be expected in the case of dismantling. This in fact is the most serious point of concern for extensive dismantling and the spearhead of the auto industry’s loud denouncement of it. Despite the lower labour costs (partially at least offset by a lower competitiveness), even in countries like Greece dismantling still appears a very labour-intensive operation.

More strategically, however, it must be noted that extensive dismantling may more easily benefit from future recycling taxes, in which case, as the Dutch model has shown, it may seriously help towards achieving a compliance with the ELVM directive. Also, extensive and large scale dismantling is a practice that may still be in the early part of its learning curve as a business. Developments of tools, machinery, approaches etc. should be expected in the near future. The IDIS (International Dismantling
Information System), an information system produced and maintained by important auto industry representatives to provide technical details on their products and suggestions on their dismantling, may influence the efficiency of the dismantling practices and enhance their cost performance.

To what does all this discussion boil down, in terms of the technology options available for enabling gradual compliance with the ELVM directive in countries like Greece? Of course there is no suggestion that either of the two ELV processing paths, shredding or dismantling, should be a priori abandoned. In the case of Greece, we have already mentioned that there is significant overcapacity in shredding facilities. This should be best used and integrated in a national scheme, also combining the processing of other wastes. Any investment in shredding prior to exploiting the existing capacities is of course meaningless. Dismantling should be given a chance, a better chance than it currently enjoys in the small and poorly organized dismantler yards. Only large scale dismantling may provide for a serious breakthrough and for the establishment of such dismantlers as credible partners of primarily the steel industry, but also of other industries that would be interested in seriously looking at secondary products, delivered in a consistent fashion, at high quantities, with stable specifications and at an acceptable quality.

CONCLUSIONS AND SUGGESTIONS

There is a long way to go before countries such as Greece can meet the maturity of the ELV markets in the Northern EU and be really involved by the considerations raised and the issues currently hotly debated in the EU, with regard to the ELVM directive. Rather than opting for one or the other possible processing path, the clear priority is to develop and fundamentally rationalize the market itself. At a moment when it is difficult to report even on the fate of ELVs, it is clear that any discussion on recycling percentages is, for the moment, premature.

Though international best practice will never lose its great importance in decision-making, there is also a good degree of local knowledge required when ELV management priorities are to be set in the Southern EU. These environment particularities are epitomized here in four distinct directions of thought and action, relevant to broad parts of the Southern EU, and are presented below.

Redefine ELV deregistration

If we are to offer the citizen a free ELV take back system we are certainly not entitled to require him to travel 50 km or more and to spend a day standing in queues and completing documents. Nor should we silently accept him disposing of his ELV to a supposedly private ground! To build a practical, public friendly and optimized de-registration scheme is a first, key, institutional intervention for ELV traceability, and a milestone for any successful ELVM strategy.

Build industry alliances

Effective steel recycling may be a goal achieved for many years in the Northern EU, but is still in its infancy in Greece and other Southern EU countries. The priority here cannot be how to move from any well established 75% recycling of the ELV (metals) to the 80% required by the Directive in a few years time. It is rather how to first start converging to this 75% that can by no means be claimed, in any acceptable approximation. The ELV deregistration process is clearly linked to this prospect. However many follow-up actions are required to guarantee that at least the easy part, the steel scrap recycling, is put on track. Alliances with major players in the steel industry will be necessary to start a discussion on quantities, qualities, deliveries, prices etc. This will be a long-term discussion, and it is obvious that every time the steel market feels the conditions are met, the
bar (and the prices offered) will be raised. The EU steel leader USINOR reported on how much important it is for the quality of the steel to have the copper, as far as possible, removed from the scrap, before it is committed to the furnace (Russo et al., 2002). Obviously, this is a level of requirement maturity that will take years to reach in Greece, but this is no reason not to start the discussion with the steel industry, perhaps on more trivial and elementary issues, which will however establish on their part the feeling that ‘something sizeable and worth considering and discussing’ is going on.

Give large scale dismantling a chance

Re-organizing the dismantling practices is of paramount importance in order to have a serious and long-term agenda for the ELVM directive. The small yards, operating on no standards and few procedures, will merge into greater units, in order to avoid marginalization or outright extinction. If bigger dismantling units emerge across the country, the current yards may very likely transform into simple collecting stations, just selling off their collected ELVs to the greater units, which will have the processing responsibility. Large scale dismantling (10–12000 wrecks per year) may provide for quantity, quality and consistency in delivery, which are imperative conditions, if the dismantling business is to emerge as a worthy communicator of the industry, aspiring to be granted internationally competitive prices for recycled materials. Lastly, large scale dismantling is a relatively low risk investment, whereas its environmental performance is much better, at least compared to shredders, with all the noise (approximately 90 dB indoors) and transport congestion usually created just out of the shredder door.

Exploit existing shredding capacities

Shredders are costly investments that can only make sense and be seriously considered if already existing capacities are first fully exploited. This is not always the case. More generally, shredders should be carefully integrated in a wider recycling network, involving not only ELVs but also other metal wastes.

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