Injection Molding Machine Industry Standard Practice Study

prepared for

The California Public Utilities Commission

energy & resource solutions

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Industry Standard Practice for Injection Molding Machines in California

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1 EXECUTIVE SUMMARY

In recent years, California electric utilities, including Southern California Edison, have provided incentives to promote the purchase of energy-efficient injection molding machines (IMMs) and to speed the transition of the market to IMMs incorporating energy-efficient technology. There is evidence that this market transformation is largely complete. This report details the findings of a study undertaken by ERS[1] to collect and evaluate data and establish the industry standard practice (ISP) for the purchase of new IMMs in California.

1.1 Study Approach

This ISP study was completed in two phases. The initial phase included a review of available literature, identification of key market actors, and preliminary interviews with individuals known to be familiar with the technology and the current IMM markets within California. The data collected during the first phase of this effort informed the development of a survey delivered to key market actors during the second phase of this study.

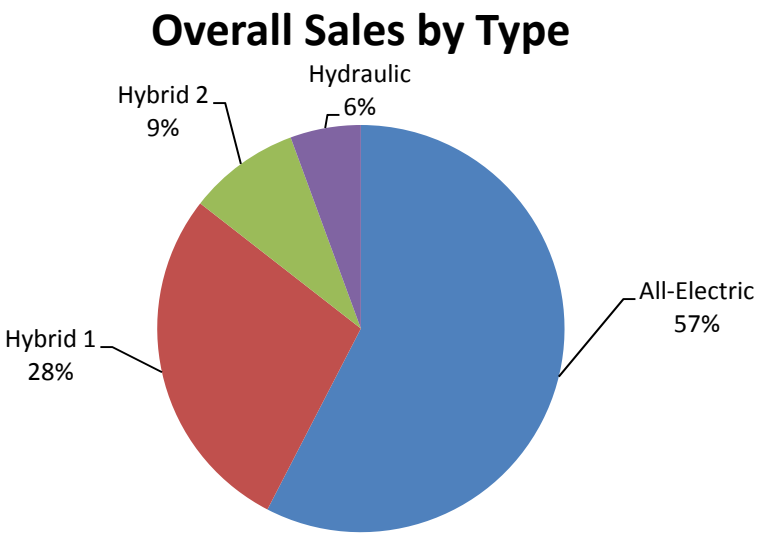
The second phase included refinement and delivery of the survey tool to the targeted respondents, compilation and analysis of the survey responses to characterize the ISP, and presentation of the findings in this report.

1.2 Summary of Survey Data

The survey targeted fifteen major manufacturers serving the California IMM market. ERS successfully implemented surveys with eleven of the fifteen manufacturers' representatives between October 29 and November 19, 2012. The respondents estimated total cumulative sales of 237 IMMs in California during the previous 12 months. Figure 1 provides a breakout of these sales by machine type and indicates that traditional hydraulic models, which have historically represented the baseline IMMs for reporting energy savings associated with IMM incentives, represent only 6% of the overall reported sales during the past year.

[1] The study was authorized by the Energy Division of the CPUC and supported by its consultants.

Figure 1. Overall Sales by Machine Type



The survey did reveal some differentiation in market share based on end-use market and machine size, but there was no significant market identified where fully hydraulic models represented dominant market share. Section 3 of this report provides detailed results differentiated by market segment. Descriptions of the machine types and the distinction between the hybrid 1 and hybrid 2 models reflected in Figure 1 are provided in section 2.1of this report.

2 PHASE 1 RESULTS – SECONDARY RESEARCH FINDINGS

Goals of the secondary research conducted in the first phase of this study included:

- Understand the current state of the technology
- Gain insight into factors that influence purchase decisions within the market
- Segment the market based on factors likely to differentiate purchase decisions
- Identify key market actors
- Develop a draft survey tool

2.1 Current State of the Technology

The injection molding process involves several distinct steps, including clamping (closing the mold), injection of the molten material, holding force on the mold until the product has solidified, opening the mold, and ejecting the product. For several decades, all of these functions were carried out using hydraulics, with a constant speed hydraulic pump powering the machine. This type of machine is still manufactured and generally accepted as the "baseline" by most California programs offering incentives to support the purchase of new machines.

Japanese manufacturers developed the first all-electric IMMs in the early 1980s, and Milacron introduced the technology to the US market in 1985.[2] The technology eliminated the hydraulic operations and replaced them with direct-acting mechanical functions powered by servo-electric motors. These all-electric machines offered much better energy efficiency and additional benefits including better repeatability, cleaner operation (no hydraulic oils), and lower noise levels. The first all-electric machines were of relatively small size (measured in tons of clamping force), and were significantly more expensive than comparable hydraulic models.

As all-electric models were adapted for use in more applications, some manufacturers recognized that hydraulic technology still offered advantages for specific machine operations in some applications (including those requiring high clamping force and long hold times). These manufacturers developed hybrid models that retained the hydraulics for some machine functions, (generally closing and holding the mold), and provided the direct-acting electric servo-driven functions for other machine operations. These models are referred to in this study as hybrid 1 machines.

A few manufacturers elected to offer machines that retained all of the hydraulic machine functions but adopted the servo-electric motor technology to drive the hydraulic pump. This allows for input power to the hydraulic pump to be limited in response to variations in the requirements of each machine function, producing significant savings in comparison to fully hydraulic machines with constant speed hydraulic pumps. This study classified these models as hybrid 2 machines

Phase 1 literature review findings did not produce market share data specific to California, but they did provide evidence that all-electric models have become increasingly prevalent in the overall US market during recent years. Sources cited overall market share of all-electric IMMs at 33% for 2005,[3] 47% for 2007,[4] and 50.5% for 2009.[5]

2.2 Factors Influencing Purchase Decisions

During the initial phase of the study, ERS conducted telephone interviews with consultants, program evaluators, educators, and manufacturers' representatives recognized as being familiar with the California market. These conversations provided insights into factors influencing purchase decisions, and data to support differentiation of the market based on the end use of the machines.

Primary factors influencing purchase decisions include the following:

- Initial purchase cost
- Life-cycle cost per unit of production

[2] Injection Molding Machine Efficiency, Babu Joseph, Southern California Edison Company, April 17, 2003.

[3] M. Knights, "Electric, Hydraulic, or Hybrid? What's the Right Injection Press for You?", *Plastics Technology*, May 2007, http://www.ptonline.com/articles/electric-hydraulic-or-hybrid-what's-the-rightinjection-press-for-you, (accessed December 1, 2012).

[4] A. Kanungo and E. Swan, "All-Electric Injection Molding Machines: How Much Energy Can You Save?", Thirtieth Industrial Energy Technology Conference, New Orleans, 2008.

[5] Plastics Today, "Report highlights recovery of injection molding machine sales," October 17, 2011, http://www.plasticstoday.com/articles/report-highlights-recovery-injection-molding-machine-sales, (accessed December 12, 2012).

- Functionality and speed
- Energy efficiency
- Ease of operation
- Ongoing maintenance cost
- Cleanliness of operation
- Noise levels

Our initial research suggested that the relative importance of these factors could vary significantly with the specific machine and application.

For example, several sources indicated that end users producing parts for the medical industry were more likely to purchase all-electric machines in order to avoid hydraulic oils and the potential contamination in relatively sterile environments where these parts are often produced.

Other sources indicated that end users in the automotive industry, where parts tend to be larger, thus requiring high clamping force and longer hold times, are more likely to select hydraulic machines perceived to be better suited to these operations.

For larger-tonnage machines, the initial cost differential was reported to be more significant than for smaller machines, potentially creating a barrier to adoption of all-electric machines in this size category.

2.3 Market Segmentation

Based on information gained in the first phase of the study, the survey tool was designed to obtain market share data based on the following differentiating factors.

- Industry type the parts are manufactured for:
  - Automotive
  - Medical
  - Packaging
  - Consumer products
  - Other
- Machine size in tons of clamping force:
  - Small – 0 to 200 tons force
  - Medium – 200 to 500 tons force
  - Large – Above 500 tons force

Additional survey questions were developed to identify specific machine characteristics that influenced purchase decision for specific end uses, and to highlight any geographic differentiation of ISP.

2.4 Key Market Actors – Targeted Survey Respondents

During the initial phase of the study, it was decided to limit the targeted survey respondents to key manufacturers and manufacturers' representatives. This decision allowed for a large portion of overall machine sales to be represented by relatively few survey respondents, and it led to survey questions focused toward this specific audience.

The initial research led to a list of fourteen manufacturers representing a significant share of the IMMs sold in California. These major manufacturers were identified as:

- Sumitomo/Van Dorn – Demag
- Nissei
- JSW
- Arburg
- Mitsubishi
- Engel
- Negri Bossi
- Husky
- Toshiba
- Woojin Plaimn
- Milacron
- BOY Machines
- UBE
- Toyo

2.5 Survey Tool

Secondary research findings from the initial phase of the study provided information that enabled ERS to draft structure and content for the survey tool. The draft survey instrument was reviewed and refined with input from Energy Division consultants.[6] The resulting survey tool was comprised of eleven focused ISP inquiries and supplementary questions. The first nine ISP questions were designed to solicit quantitative responses, and they established the distribution of machines sold in California over the last year by type, end-use industry, size, and general area of the state.

Question 10 provided each respondent an opportunity to describe machine type preferences of customers for each industry type they served, and then attempted to uncover the customer motivations behind these preferences. Question 11 asked respondents if additional market actors, beyond the original list of fourteen, should be contacted for information.

A copy of the survey tool is provided as Appendix A to this report.

[6] Nikhil Gandhi, consultant to CPUC, and Kris Bradley of Itron

3 PHASE 2 RESULTS – MARKET SURVEY FINDINGS

ERS successfully delivered the survey tool to eleven of the fifteen targeted manufacturers of IMMs that were identified as key market actors in the California market. Respondents were assured that confidentiality of responses to the survey would be observed. The results of these eleven interviews were tabulated to characterize the ISP for new IMM installations in California, and they are reported in this section.

3.1 Refinement of Survey Tool and Targeted Respondents

Question 11 of the survey tool resulted in only one more manufacturer (Niigata) being added to the initial targeted survey respondents listed in section 2.4 of this report. A large majority of respondents confirmed that our initial list included all major participants in the IMM market and did not offer names of additional market actors, providing confidence that key market actors were adequately identified in the Phase 1 research. The responses obtained from the eleven respondents reflect a representative share of the entire California market.

Very early in the survey implementation process it became apparent that a single definition of hybrid machines was not universally accepted. Therefore, the hybrid 1 and hybrid 2 distinction discussed in section 2.1 of this report was adopted.

3.2 Survey Results

ERS aggregated the individual survey responses to quantify the market characteristics and industry practices. The data in this aggregate analysis included quantitative and qualitative responses to survey questions. The result of this aggregation was the characterization of the current market for IMMs in California. Tables providing aggregate summaries of the survey results are provided in Appendix B.

3.2.1 Analysis by Survey Respondent

ERS observed that annual reported sales per respondent ranged from a low of eight machines per year to a high of forty-five machines per year, with nine of the eleven respondents reporting annual sales of between fifteen and thirty machines. This data indicates that market share is more evenly distributed among the manufacturers than initially anticipated, with no single manufacturer accounting for more than 20% of total reported sales.

It should be noted that while nine of the eleven respondents readily provided estimates of annual units sold during the past 12 months, two respondents declined to provide a specific estimate. Both of these did provide a relatively narrow range of typical annual sales. ERS used the midpoint of these ranges to represent estimated sales for these two respondents.

The types of IMMs offered to the California market by the eleven survey respondents is summarized in Table 1.

Table 1. IMM Type Offered by Survey Respondent

	Type of Machine Offered											
	All-Electric			Hybrid 1 (Electric machine functions)			Hybrid 2 (Servo pump motor)			Hydraulic		
Respondent	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
1	✓	✓	✓									
2			✓						✓			✓
3	✓	✓		✓	✓	✓				✓	✓	✓
4	✓	✓	✓									
5							✓			✓		
6	✓	✓		✓	✓	✓				✓	✓	✓
7	✓			✓	✓	✓					✓	✓
8	✓	✓			✓	✓				✓	✓	✓
9	✓	✓		✓	✓	✓						
10	✓	✓		✓	✓	✓						
11	✓	✓	✓									✓

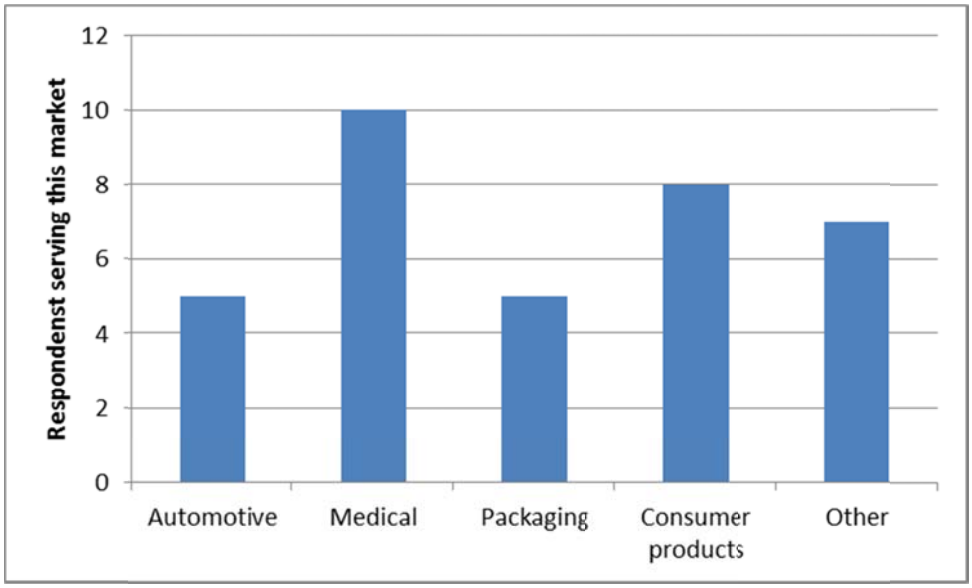
Ten respondents offered an all-electric model in some size range; eight of the eleven offered some version of hybrid machines; and seven respondents offered hydraulic machines.

Nine of the eleven respondents offered at least two types of machines, with the other two offering only all-electric models. Two others offered only all-electric and hybrid 1 models. One respondent offered only hydraulic and hybrid 2 models.

One respondent offered only small machines of less than 200 tons of clamping force, and one respondent offered only large machines in excess of 500 tons of clamping force. The other nine respondents offered some type of machine in all size categories.

Figure 2 provides a breakdown of the respondents serving customers in each of the identified end-use markets. Several of the respondents commented that new machine sales to end users supplying parts to the automotive industry have sharply diminished in recent years as a result of the relocation of several automotive manufacturing facilities.

Figure 2. Respondents Serving Identified Markets



All survey respondents reported that they market machines throughout California. The reported percentage of total machines sold by these manufacturers in the Southern California market ranged from a low of 50% to a high of 90%. On average, 73% of all reported sales were to Southern California companies. None of the eleven respondents reported any geographic differentiation in terms of machine type preference.

3.2.2 Analysis by End-Use Industry

Figure 3 illustrates the total estimated number of machines sold to each end-use market during the past 12 months.

Figure 3. Annual Sales by Industry

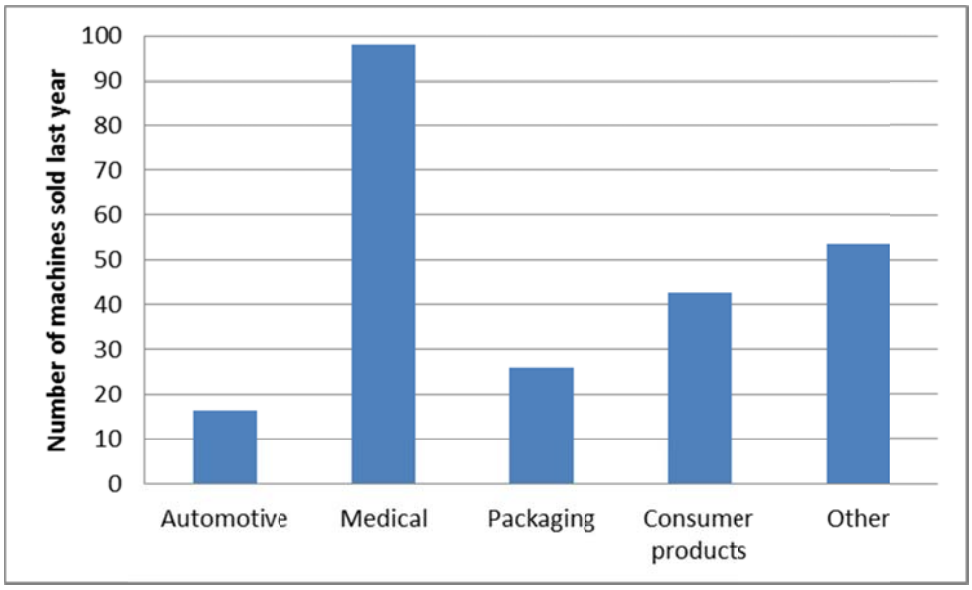
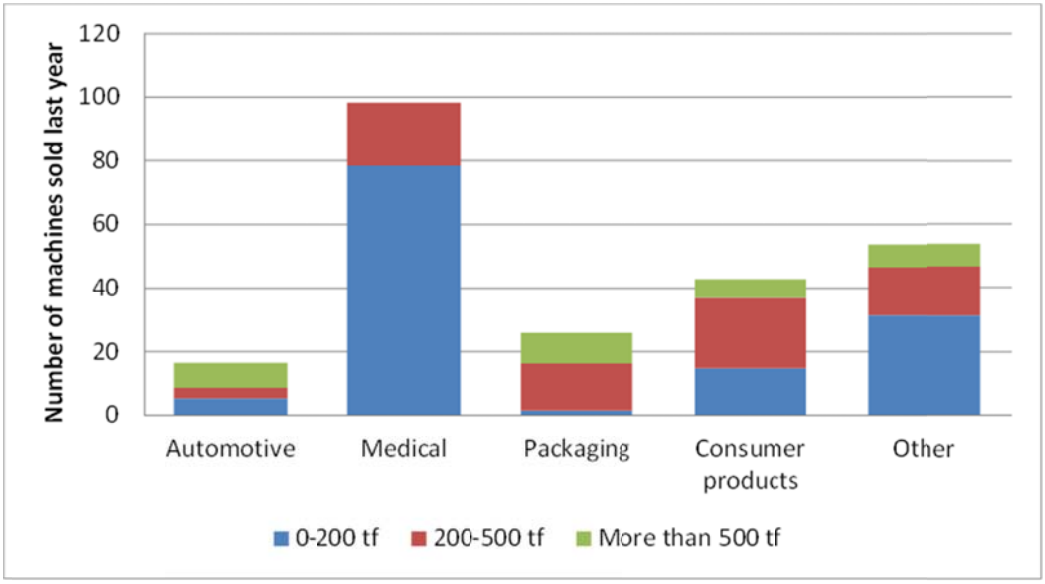


Figure 3 demonstrates that the medical industry represents the largest portion of the reported market. The automotive industry represented only 16 of the 237 total reported sales during the past year, supporting manufacturers' reports that activity in this market segment is slow. It is worthy to note that 31 of the 54 machine sales listed in the "other" category were to "custom molders" who manufacture parts on a contract basis for third parties and could represent several industries simultaneously.

Figure 4 shows how sales to each industry group are differentiated by size, and it clearly demonstrates the predominance of small tonnage machines in the medical industry, where relatively small parts are typically produced.

Figure 4. Annual Sales by Industry and Size



Conversely, the automotive, packaging, and consumer products industries have a higher percentage of medium and large machines, indicative of the larger parts that are typically manufactured for these industries.

Across all industry types, small IMMs account for 55% of the total unit sales compared to 32% for medium-sized machines and 13% for large machines.

Figure 5 and Table 2 illustrate the distribution of sales by machine type in each industry.

Figure 5. Annual Sales by Industry and Machine Type

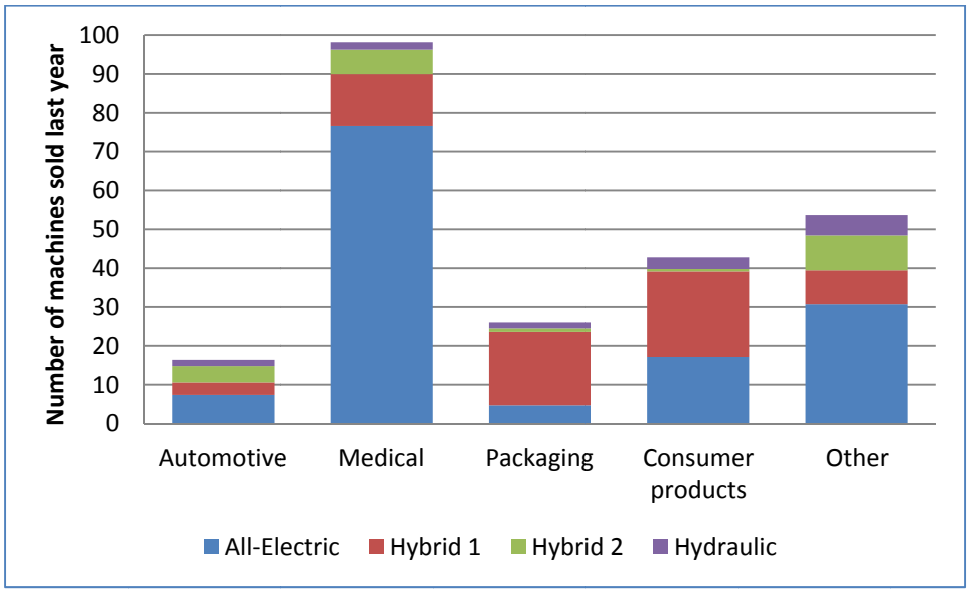


Table 2. Market Share by Industry and Machine Type

Industry	All-Electric	Hybrid 1 Servo Functions	Hybrid 2 Servo Pump	Hydraulic
Automotive	44.9%	19.5%	25.6%	10.0%
Medical	78.0%	13.6%	6.4%	2.0%
Packaging	18.0%	72.8%	3.5%	5.7%
Consumer products	40.0%	51.5%	1.4%	7.1%
Other	57.3%	16.2%	16.8%	9.7%
Combined	57.6%	27.9%	8.9%	5.6%

This data clearly demonstrates the dominance of all-electric machines in the medical market. More importantly, it shows that traditional hydraulic models have very small market share (10% or less) in every industry type.

The predominance of hybrid 1 machines in packaging (72.8% market share) and consumer products (51.5% market share) is noteworthy. Several of the survey respondents reported that hybrid 1 sales were on the rise and the technology had progressed to the point where performance and energy efficiency were comparable to all-electric models. One manufacturer reported that some hybrid models cost more than corresponding all-electric machines but were frequently selected based on the enhanced performance and lower lifetime cost per unit of product produced.

3.2.3 Analysis by Machine Size

Figure 6 depicts the overall reported annual sales by IMM type and size, and Table 3 provides the percent of market share for each machine type differentiated by machine size.

Figure 6. Annual Sales Machine Type and Size

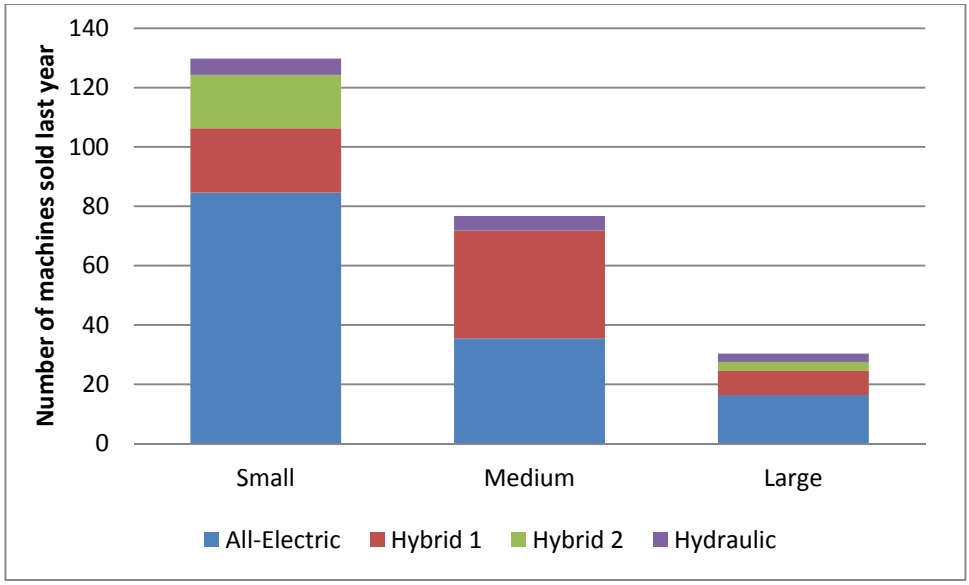


Table 3. Market Share by Machine Size and Type

Industry	All-Electric	Hybrid 1 Servo Functions	Hybrid 2 Servo Pump	Hydraulic
Small	65.2%	16.7%	13.9%	4.2%
Medium	46.3%	47.3%	0.0%	6.4%
Large	53.8%	26.9%	9.9%	9.3%

Market share for all-electric machines represents approximately two-thirds of all machines sold in the small size category and roughly half of those in the medium and large size categories.

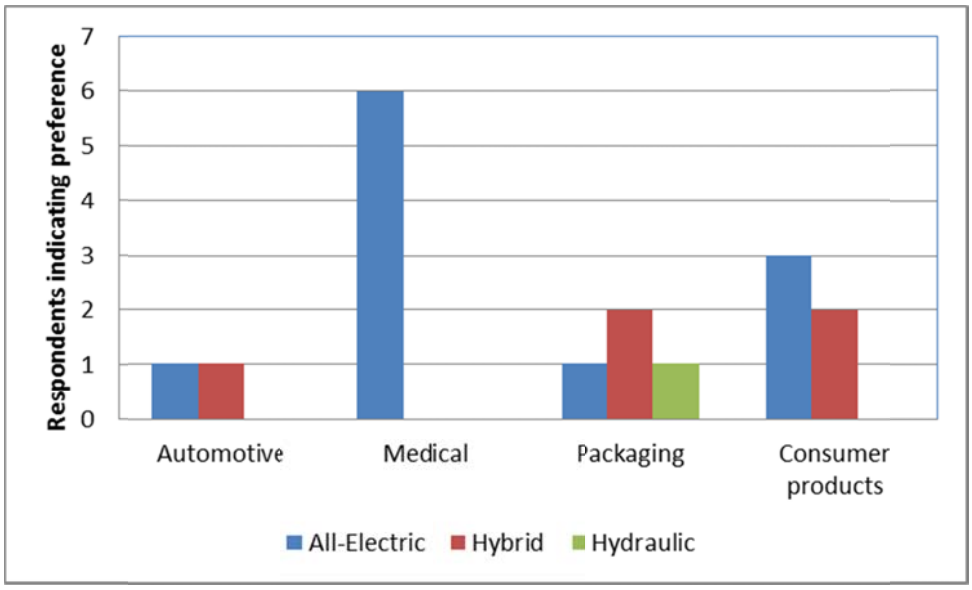
IMMs classified as hybrid 1 account for nearly half of sales in the medium size category. This is in large part due to their popularity in the packaging and consumer products industries, where most machines fall into the medium (200–500 tons of clamping force) range.

The market share for hydraulic machines increases with machine size, as was anticipated based on preliminary research, but even in the category of large machines (over 500 tons of clamping force), the market share is less than 10%.

3.2.4 Expressed Preferences and Factors Influencing Preference

Question 10 of the survey tool provided respondents with an opportunity to indicate if certain market segments preferred specific machine types, and it solicited qualitative input related to factors influencing these preferences. Figure 7 illustrates the total number of responses provided.

Figure 7. "Yes" Responses to Industry Preference Question



It is noteworthy that only one of the manufacturers indicated that hydraulic machines represented the preferred choice for any industry they serve. This response was from a manufacturer who offered all-electric, hybrid 1, and hydraulic models:

- "Customers we serve in the packaging industry generally require larger machines, and seem to operate on slimmer margins, with a greater focus on initial cost. The cost premium for all-electric or hybrid is greater for larger machines, resulting in hydraulic models representing the preferred choice for this market. It is worth noting that only 5% of our California sales, or 1 machine per year, come from this market segment."

Another survey respondent did not suggest that hydraulic was the preferred choice for any market but did offer the following comment related to the motivation behind the purchase of these machines:

- "When end users select hydraulic, it is often because the machine is available in the distributor's inventory and they need it quickly."

The medical industry was the only market that had entirely consistent responses to question 10, with six of the ten respondents who served this market indicting that all-electric machines represented the preferred choice. Reasons provided for this preference are as follows:

- "Cleanliness (no hydraulic oil), speed, precision, repeatability, and efficiency. Also, needs are mostly for relatively small machines with low price delta between all-electric and hydraulic."

- "Clean, no hydraulic oil. High efficiency, small machines with low initial cost premium compared to hydraulic."
- "Generally smaller machines with less cost differential. Also, end users in the medical industry generally have more focus on long-term planning and life cycle cost."
- "The production of very thin-walled products, (less than 1 mm thick) prevalent in this industry, is better suited to all electric machines."

It is noteworthy that one respondent who provided both all-electric and hybrid 1 type machines indicated that cleanliness was a motivating factor, but he added his opinion that it was frequently a misconception: "The perception of all-electric (machines) being cleaner drives the medical industry to prefer them. However, all-electric machines actually have more internal lubrication than many hybrid models."

This respondent indicated that within the external covering of all-electric machines; there are frequently large quantities of excess lubricants associated with the mechanical actuation of servo-driven machine functions that can contaminate product as easily as hydraulic oils. This contention was not validated or explored further under the scope of this study.

In each of the other three industry types, at least one respondent expressed a belief that all-electric models represented the preferred choice. Reasons provided for these preferences included:

- In the automotive industry, "many parts are painted subsequent to molding, and contamination with hydraulic oils requires cleaning before painting, adding a step to the process and increasing cost. This makes all-electric the preferred choice of this industry."
- In the packaging industry, "the all-electric machines are more precise, programmable, faster and more energy efficient."
- In the consumer products industry, "there are highly competitive markets driven by life cycle per unit production cost. All-electric models offer the best life cycle economic option, especially with the utility incentives. The initial cost premium compared to hydraulic is usually 20%–30%."

One respondent indicated that while all-electric was the preferred choice in the medical industry, hybrid 1 machines represented the preferred choice for the automotive, packaging, and consumer products industries. A second respondent expressed the same observations for the packaging and consumer products industries, but did not participate in the automotive industry and offered no opinion regarding it. Rationales they provided for the hybrid 1 preference are as follows:

- The hybrid machines represent the preferred choice for the packaging and consumer products markets due to their relative ease of use, lower lifetime maintenance, comparable energy efficiency, and better life cycle economics as compared to all-electric machines.
- Hybrid machines represent the preferred choice for end users in the automotive, packaging, and consumer products markets due to the higher speed and increased production as compared to all-electric.

Each of these respondents sold only all-electric and hybrid 1 models, and both expressed opinions that there were no applications where fully hydraulic machines still represented a preferred choice.

Appendix B includes a table listing each preference that was expressed along with the rationale provided.

Most of the respondents expressed a belief that the market was moving toward even more all-electric dominance; however, a minority of the respondents expressed a belief that sales of hybrid models were rapidly growing in market in some market segments and could eventually dominate the entire market. There was consensus that the market share belonging to traditional hydraulic machines would continue to decline in all areas, with the possible exception of some niche applications, including the production of very large parts requiring extreme clamping force and long hold times.

One respondent indicated that manufacturers of proprietary parts with higher margins are more likely to pay the higher initial cost associated with all-electric machines, while contract molders, with fixed prices and lower margins, often selected the lowest initial cost option and frequently participate in the used IMM market.

4 CONCLUSIONS

Data collected and analyzed in this study provides strong evidence that leads to the following conclusions.

4.1 Hydraulic Market Share

Data collected in this study indicates that traditional fixed-speed hydraulic IMM machines accounted for only 13 of 237 new IMMs sold in California during the 12 months preceding survey implementation, representing 5.6% of the overall market sales.

When the market is segmented by industry type the market share for hydraulic machines in the markets targeted in this study is:

- Medical industry – 1.9%
- Packaging industry – 5.8%
- Consumer products – 7.1%
- Automotive – 10.0%

Also, responses to the survey question related to end users machine preference did not indicate that hydraulic machines represented a preferred choice in any of the four defined market segments.[7]

When the market is differentiated by machine size, expressed in tons of clamping force, the market share for hydraulic machines is as follows:

- Small machines (less than 200 tons clamping force) – 4.2%
- Medium machines (200 – 500 tons of clamping force) – 6.4%
- Large machines (more than 500 tons clamping force) – 9.3%

Information obtained in phase one of this study suggested that sales of hydraulic machines would be highest in the automotive industry and for large machines. The data collected in phase two confirmed this information, but even in these areas market share for hydraulic machines was 10% or less.

Based on this information, it is clear that fixed-speed hydraulic machines should no longer be considered an appropriate baseline for the purpose of calculating and reporting energy savings associated with incentives for installation of high efficiency IMMs for capacity expansion or normal replacement (end of life) projects.

4.2 Hybrid 2 Market Share

Machines classified by this survey as hybrid 2 models have all machines functions powered by hydraulics, with a single servo–electric motor powering the hydraulic pump. This type of machine accounted for total sales of twenty-one machines, or 8.9% of the overall market sales, during the 12 months preceding the survey.

[7] One survey respondent believed hydraulic machines were preferred by the packaging industry, but three other respondents indicated a different preference for this industry type.

This style of machine was most successful in the automotive industry, where it accounted for 25.6% of the market. Market share was well under 10% in each of the other markets. The relative success of these machines in the automotive market segment is consistent with information from phase 1 of this study suggesting that many applications in this industry are well suited to hydraulic machine functions. The hybrid 2 models are very similar to fixed-speed hydraulic machines in terms of performance, with significantly reduced energy consumption resulting from the variable flow hydraulic pumps.

Only two of the eleven survey respondents offered machines of this type, and they were not referenced as the preferred model for any industry type.

4.3 Hybrid 1 Market Share

The study indicates that hybrid 1 machines incorporating direct-acting servo-electric motors for some machine functions, with hydraulic functions retained where they are appropriate for the specific applications, represent a 27.9% share of the overall market. The data indicates that these machines have a dominant 72.8% share of the market for the packaging industry and a 51.5% share of the consumer products industry.

4.4 All-Electric Market Share

This study indicated that the overall market share for all-electric models is 57.6%, with a dominant share of 78.0% in the medical industry. In the past year, 65.2% of all small machines (less than 200 tons of force), sold were all-electric. All of these values are consistent findings from phase 1 of this study, including published market penetration data for the entire US market.

4.5 All-Electric and Hybrid 1 Combined Market Share

When reported sales of these all-electric and hybrid 1 machines are combined they represent 85.5% of the overall market. Their combined market share by industry type is as follows:

- Medical industry – 91.6%
- Packaging industry – 90.1%
- Consumer products – 91.5%
- Automotive – 64.4%

The combined market share for all-electric and hybrid 1 machines differentiated by machine size, expressed in tons of clamping force, is as follows:

- Small machines (less than 200 tons clamping force) – 81.9%
- Medium machines (200 – 500 tons of clamping force) – 93.6%
- Large machines (more than 500 tons clamping force) – 80.8%

Sixteen of the seventeen survey responses expressing a preferred machine type by some industry segment indicated either all-electric or hybrid 1 machines as the preferred choice.

4.6 Industry Standard Practice Conclusions

Traditional fixed-speed hydraulic IMMs no longer represent ISP for any of the market segments analyzed in this study, and thus should no longer be accepted as the baseline for IMM installations for capacity expansion or normal replacement projects. Our experience indicates that a large majority of IMM purchases fall into one of these project categories, with very few new machines purchased to replace existing operational equipment that is not at or very near end of life.

ISP conclusions for each market segment and machine size addressed in this study are provided in Table 4. These conclusions are based upon analysis of the quantitative data derived from questions 1–9 of the survey tool, customer preference responses provided to question 10 of the survey, and consensus views of overall industry trends obtained from interviews with industry experts and key market actors.

Table 4. Industry Standard Practice by Industry Type and Machine Size

	Machine Size – Tons of Clamping Force		
Industry Type	200 or Less	200 – 500	500 or Greater
Automotive	All-electric	Hybrid 1	Hybrid 1
Medical	All-electric	All-electric	All-electric
Packaging	All-electric	Hybrid 1	Hybrid 1
Consumer products	All-electric	Hybrid 1	Hybrid 1

Because quantitative sales data reported for the automotive industry represented only sixteen units sold over the preceding year, ISP conclusions for this segment are based primarily upon consensus views obtained from interviews with industry experts and customer preference data obtained from the survey.

4.7 Closing Comments and Suggestions

The findings of this study indicate that the market for IMMs in California has undergone a transformation away from fixed-speed fully hydraulic machines. The study provides very strong evidence that traditional fixed-speed hydraulic machines no longer represent a plausible baseline for any of the market segments analyzed in this study.[8] In light of the data presented here, modifications to the methodology used to approve IMM incentives and document associated energy savings are appropriate. New baselines should be represented by machine types that are shown by this study to represent ISP for each market segment.

Actual energy consumption and the differential between consumption for various IMM types varies significantly with the specific application of the machine and the percentage of overall cycle time devoted to each machine function. In general, the differential between fixed-speed hydraulic and all other types is greatest for applications producing smaller parts with shorter cycle times. Documentation of actual consumption for specific machines types or applications was outside the scope of this study.

[8] Fixed-speed hydraulic machines could still represent a plausible baseline for some niche markets not addressed by this study or in cases where existing operable IMM are replaced before end of life.

Manufacturers of both types of hybrid models alluded to overall efficiencies comparable to, or in some cases slightly better than, that of all-electric machines. This study revealed no actual documentation to support these claims. It is certainly reasonable to conclude, based on the principles of operation and general information contained in the literature reviewed as part of phase 1, that overall energy consumption for all-electric models or for either type of hybrid model is likely to be significantly lower than for a traditional hydraulic IMMs with fixed-speed pumps operating in the same application. More effort should be made to quantify actual consumption of the various models over a range of applications, to allow for the derivation of typical energy consumption or per unit of production values for use with an appropriate ISP baseline.

The IMM technology is continuing to evolve with new super-efficient models including features such as regenerative drives and heat reclaim equipment as an integral part of the machine. Identification of these emerging technologies and the associated potential savings was beyond the scope of this study, but they appear to represent an opportunity to refocus incentives and move the market to even higher levels of efficiency.

Appendix A

Survey Tool Template

SURVEY TOOL

DATE:

INTERVIEWER:

COMPANY INTERVIEWED:

PERSON INTERVIEWED:

CONTACT TITLE:

CONTACT PHONE NUMBER:

DATE AND TIME OF CALL:

QUESTIONS FOR VENDORS

ERS is conducting research for the California Public Utilities Commission (The CPUC) related to purchase practices for new injection molding machines (IMMs) in the State of California.

Investor owned utilities in California offer incentives to promote the purchase of energy efficient equipment and drive markets toward the adoption of more energy efficient technologies.

Our initial research has identified you as a representative of _____ and someone who is familiar with the IMM market within California. ERS is hoping you can share some general information that will assist with our effort to better understand the energy efficiency potential of IMMs and further efforts to promote the utilization of energy efficient equipment. All information that you provide will remain confidential and reported only in aggregate form along with that obtained from other manufacturers.

Do you have a few minutes to answer a series of questions?

General Questions

1. Does your company market IMMs for sale within California?
    a. If no: END
    b. If yes, continue with survey.

2. What industries do you serve in California? ***(Check all that apply; do not prompt unless necessary for clarification.)***

   - ❑ Automotive
   - ❑ Medical
   - ❑ Packaging
   - ❑ Consumer products
   - ❑ Other

3. Are your sales concentrated in one geographic area or statewide?

4. What is the approximate % breakdown of sales by region?

   - ❑ Southern California (define)

   - ❑ Northern California (define)

5. What types and sizes of IMMs do you provide to these markets? ***(Check all that apply.)***

- ❑ All-electric
  - ❑ 0–200 tf
  - ❑ 200-500 tf
  - ❑ Over 500 tf
- ❑ Hydraulic
  - ❑ 0–200 tf
  - ❑ 200–500 tf
  - ❑ Over 500 tf
- ❑ Hybrid
  - ❑ 0–200 tf
  - ❑ 200–500 tf
  - ❑ Over 500 tf

Distribution of Machine Sales

6. Over the past 12 months, how many new IMMs has your firm sold in California?

7. What percentage of the total number sold falls into each end use market? ***(Ask only about the markets indicated in Q2.)***

- ❑ Automotive ____%
- ❑ Medical ____%
- ❑ Packaging ____%
- ❑ Consumer products ____%
- ❑ Other ____%

8. For each market you serve, what percentage of machines sold falls into each machine-type category (all-electric, hybrid, hydraulic)?

- ❑ Automotive
  - ❑ All-electric ____%
  - ❑ Hybrid ____%
  - ❑ Hydraulic ____%
- ❑ Medical
  - ❑ All-electric ____%
  - ❑ Hybrid ____%
  - ❑ Hydraulic ____%
- ❑ Packaging
  - ❑ All-electric ____%
  - ❑ Hybrid ____%
  - ❑ Hydraulic ____%
- ❑ Consumer Products
  - ❑ All-electric ____%
  - ❑ Hybrid ____%
  - ❑ Hydraulic ____%
- ❑ Other
  - ❑ All-electric ____%
  - ❑ Hybrid ____%
  - ❑ Hydraulic ____%

9. For each market you serve, what percentage of the machines sold falls into each size category?

- ❑ Automotive
  - ❑ 0–200 tf ____%
  - ❑ 200–500 tf ____%
  - ❑ Over 500 tf ____%

- ❑ Medical
  - ❑ 0–200 tf ____%
  - ❑ 200–500 tf ____%
  - ❑ Over 500 tf ____%

- ❑ Packaging
  - ❑ 0–200 tf ____%
  - ❑ 200–500 tf ____%
  - ❑ Over 500 tf ____%

- ❑ Consumer products
  - ❑ 0–200 tf ____%
  - ❑ 200–500 tf ____%
  - ❑ Over 500 tf ____%

- ❑ Other
  - ❑ 0–200 tf ____%
  - ❑ 200–500 tf ____%
  - ❑ Over 500 tf ____%

For Each Market Served In California, Ask:

10. For IMM end users in the _____ industry, do specific types of IMMs represent a dominant choice?

(If answer to Q10 is yes:)

10.1 Document the preferred type (All Electric, Hybrid, Hydraulic) and description of preference. For example, "essentially all medical products manufacturers specify all electric", or "most auto parts manufacturers specify hydraulic machines due to the requirement for longer hold times".)

10.2 For IMM end users in the _____ industry, is there any difference regionally within California for IMM type preference? (***If yes document details of response)***

(If the answer to Q10 is no:)

10.3 For IMM end users in the _____ industry who do not specify a preferred type of machine, which type do you offer as your base proposal?. (All Electric, Hybrid, or Hydraulic)

10.4 What % of the time does the end user select an alternative to your base proposal that represents a different machine type? (Document details of response.)

10.5 For IMM end users in the _____ industry, is there any difference regionally within California for IMM type preference? (***If yes document details of response)***

10.6 Within the _____ industry is the preferred type of machine or your base proposal likely to change during the next few years?

If so, in what way will it change?

11. For IMM end users in the _____ industry, do specific types of IMMs represent a dominant choice?

(If answer to Q10 is yes:)

11.1 Document the preferred type (All Electric, Hybrid, Hydraulic) and description of preference. For example, "essentially all medical products manufacturers specify all electric", or "most auto parts manufacturers specify hydraulic machines due to the requirement for longer hold times".)

11.2 For IMM end users in the _____ industry, is there any difference regionally within California for IMM type preference? (***If yes document details of response)***

(If the answer to Q10 is no:)

11.3 For IMM end users in the _____ industry who do not specify a preferred type of machine, which type do you offer as your base proposal?. (All Electric, Hybrid, or Hydraulic)

11.4 What % of the time does the end user select an alternative to your base proposal that represents a different machine type? (Document details of response.)

11.5 For IMM end users in the _____ industry, is there any difference regionally within California for IMM type preference? (***If yes document details of response)***

11.6 Within the _____ industry, are there any industry-specific machine performance criteria that lead to an end user preference for machine type?

11.7 Within the _____ industry is the preferred type of machine or your base proposal likely to change during the next few years?

If so, in what way will it change?

Additional Market Players

Who else do you suggest we contact that represents a significant share of the California IMM market?

Appendix B

Tabulated Survey Results

Type of Machine Offered												
	All Electric			Hybrid 1 (electric machine functions)			Hybrid 2 (servo pump motor)			Hydraulic		
Respondent	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
1	✓	✓	✓									
2			✓						✓			✓
3	✓	✓		✓	✓	✓				✓	✓	✓
4	✓	✓	✓									
5							✓			✓		
6	✓	✓		✓	✓	✓				✓	✓	✓
7	✓			✓	✓	✓					✓	✓
8	✓	✓			✓	✓				✓	✓	✓
9	✓	✓		✓	✓	✓						
10	✓	✓		✓	✓	✓						
11	✓	✓	✓									✓

Markets Served					
Respondent	Automotive	Medical	Packaging	Consumer Products	Other
1		✓		✓	
2	✓		✓	✓	
3	✓	✓	✓	✓	✓
4		✓			✓
5	✓	✓			✓
6		✓			✓
7		✓		✓	✓
8		✓	✓	✓	✓
9		✓	✓	✓	
10	✓	✓	✓	✓	✓
11	✓	✓		✓	

Reported Sales By Market Served											
Respondent	Annual	Automotive		Medical		Packaging		Consumer Products		Other	
	(machines)	(%)	(machines)	(%)	(machines)	(%)	(machines)	(%)	(machines)	(%)	(machines)
1	8	0%	-	50%	4	0%	-	50%	4	0%	-
2	15	50%	8	0%	-	30%	4.5	20%	3	0%	-
3	20	10%	2	60%	12	5%	1.0	15%	3	10%	2
4	45	0%	-	50%	23	0%	-	0%	-	50%	23
5	20	15%	3	35%	7	0%	-	0%	-	50%	10
6	11	0%	-	10%	1	0%	-	0%	-	90%	10
7	15	0%	-	25%	4	0%	-	50%	8	25%	4
8	25	0%	-	70%	18	10%	2.5	10%	3	10%	3
9	30		-	30%	9	50%	15.0	20%	6		-
10	30	10%	3	35%	11	10%	3.0	35%	11	10%	3
11	18	5%	1	60%	11		-	35%	6		-
Total Sample	237		16		98		26.0		43		54

Annual Sales by Market and Type																								
Respondent	Annual Sales Units		Automotive				Medical				Packaging				Consumer products				Other					
			All Elec	Hybrid 1	Hybrid 2	Hydraulic	All Elec	Hybrid 1	Hybrid 2	Hydraulic	All Elec	Hybrid 1	Hybrid 2	Hydraulic	All Elec	Hybrid 1	Hybrid 2	Hydraulic	All Elec	Hybrid 1	Hybrid 2	Hydraulic		
1	8	%					100%								100%									
		Units	-	-	-	-	4.0	-	-	-	-	-	-	-	4.0	-	-	-	-	-	-	-		
2	15	%	70%		20%	10%					70%		20%	10%	70%		20%	10%						
		Units	5.3	-	1.5	0.8	-	-	-	-	3.2	-	0.9	0.5	2.1	-	0.6	0.3	-	-	-	-		
3	20	%	50%	25%		25%	60%	30%		10%	10%	10%		80%	60%	20%		20%	50%	20%		30%		
		Units	1.0	0.5	-	0.5	7.2	3.6	-	1.2	0.1	0.1	-	0.8	1.8	0.6	-	0.6	1.0	0.4	-	0.6		
4	45	%					100%												100%					
		Units	-	-	-	-	22.5	-	-	-	-	-	-	-	-	-	-	-	22.5	-	-	-		
5	20	%			90%	10%			90%	10%											90%	10%		
		Units	-	-	2.7	0.3	-	-	6.3	0.7	-	-	-	-	-	-	-	-	-	-	9.0	1.0		
6	11	%					100%												18%	65%		18%		
		Units	-	-	-	-	1.1	-	-	-	-	-	-	-	-	-	-	-	1.7	6.4	-	1.7		
7	15	%					100%								10%	80%		10%	20%	50%		30%		
		Units	-	-	-	-	3.8	-	-	-	-	-	-	-	0.8	6.0	-	0.8	0.8	1.9	-	1.1		
8	25	%					100%				45%	45%		10%	70%			30%	70%			30%		
		Units	-	-	-	-	17.5	-	-	-	1.1	1.1	-	0.3	1.8	-	-	0.8	1.8	-	-	0.8		
9	30	%					50%	50%				100%				100%								
		Units	-	-	-	-	4.5	4.5	-	-	-	15.0	-	-	-	6.0	-	-	-	-	-	-		
10	30	%	10%	90%			50%	50%			10%	90%			10%	90%			100%					
		Units	0.3	2.7	-	-	5.3	5.3	-	-	0.3	2.7	-	-	1.1	9.5	-	-	3.0	-	-	-		
11	18	%	90%			10%	100%								90%			10%						
		Units	0.8	-	-	0.1	10.8	-	-	-	-	-	-	-	5.7	-	-	0.6	-	-	-	-		
Total Sample	237		7.4	3.2	4.2	1.6	76.6	13.4	6.3	1.9	4.7	18.9	0.9	1.5	17.1	22.1	0.6	3.0	30.7	8.7	9.0	5.2		

Annual Sales by Market and Size																		
Respondent	Annual Sales Units		Automotive			Medical			Packaging			Consumer Products			Other			
			Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	
1	8	%				60%	40%					20%	60%	20%				
		Units	0.0	0.0	0.0	2.4	1.6	0.0	0.0	0.0	0.0	0.8	2.4	0.8	0.0	0.0	0.0	
2	15	%			100%						100%			100%				
		Units	0.0	0.0	7.5	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	3.0	0.0	0.0	0.0	
3	20	%	30%	60%	10%	70%	30%			100%		80%	20%		70%	20%	10%	
		Units	0.6	1.2	0.2	8.4	3.6	0.0	0.0	1.0	0.0	2.4	0.6	0.0	1.4	0.4	0.2	
4	45	%				90%	10%								60%	30%	10%	
		Units	0.0	0.0	0.0	20.3	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.5	6.8	2.3	
5	20	%	100%			100%									100%			
		Units	3.0	0.0	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	
6	11	%				100%									33%	33%	33%	
		Units	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	3.3	3.3	
7	15	%				100%						10%	80%	10%		70%	30%	
		Units	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.8	6.0	0.8	0.0	2.6	1.1	
8	25	%				60%	40%			70%	30%	80%	20%		10%	80%	10%	
		Units	0.0	0.0	0.0	10.5	7.0	0.0	0.0	1.8	0.8	2.0	0.5	0.0	0.3	2.0	0.3	
9	30	%				100%				70%	30%		100%					
		Units	0.0	0.0	0.0	9.0	0.0	0.0	0.0	10.5	4.5	0.0	6.0	0.0	0.0	0.0	0.0	
10	30	%	50%	50%		80%	20%		50%	50%		60%	40%		100%			
		Units	1.5	1.5	0.0	8.4	2.1	0.0	1.5	1.5	0.0	6.3	4.2	0.0	3.0	0.0	0.0	
11	18	%	20%	70%	10%	70%	30%					40%	40%	20%				
		Units	0.2	0.6	0.1	7.6	3.2	0.0	0.0	0.0	0.0	2.5	2.5	1.3	0.0	0.0	0.0	
Total Sample	237	0	5.3	3.3	7.8	78.4	19.8	0.0	1.5	14.8	9.8	14.8	22.2	5.8	31.4	15.1	7.1	

Reported Machine Type Preference by Market																				
Respondent	Automotive				Medical				Packaging				Consumer Products				Other			
	All Elec	Hybrid 1	Hybrid 2	Hydraulic	All Elec	Hybrid 1	Hybrid 2	Hydraulic	All Elec	Hybrid 1	Hybrid 2	Hydraulic	All Elec	Hybrid 1	Hybrid 2	Hydraulic	All Elec	Hybrid 1	Hybrid 2	Hydraulic
1					✓	Cleanliness (no hydraulic oil), speed, precision, repeatability, and efficiency														
2	✓	Many parts are painted subsequent to molding and contamination with hydraulic oils requires cleaning before painting							✓	More efficient, precise and programmable. Production Mgrs. like speed and precision: Environmental Mgrs. like energy efficiency			✓	When end users do select hydraulic it is often because the machine is available and they need it quickly. Also, there still is some "fear of the unknown", which drive people to stay with what they know.						
3					✓	Generally smaller machines. More focus on long term planning and life cycle cost.			Generally larger machines and slimmer operating margins, and more focus on initial cost. Delta in initial cost is more for larger machines			✓	✓	Generally smaller machines. More focus on long term planning and life cycle cost.						
4																				
5																				
6																				
7					✓	Cleanliness (no hydraulic oil), speed, precision, repeatability, and efficiency. Also needs are mostly for relatively small machines with low price delta between all electric and hydraulic.														
8					✓	Cleanliness (no hydraulic oil), speed, precision, repeatability, and efficiency.							✓	Highly competitive markets driven by life cycle per unit production cost. All electric offers best economic option, especially with the utility incentives. Initial cost delta is 20-30%.						
9					✓	This respondent indicates that the perception of all electric being cleaner drives this market to prefer them. However they pointed out that all electric machines actually have more internal lubrication oils than many hybrid models.			✓	Faster speed and increased production as compared to all electric.			✓	Faster speed and increased production as compared to all electric.						
10		✓	Lower lifetime maintenance cost comparable to all electric.		✓	Clean, no hydraulic oil. High efficiency. Small machines with low initial cost premium compared to hydraulic. Hybrid is an option.			✓	Lower lifetime maintenance cost comparable to all electric.			✓	Lower lifetime maintenance comparable to all electric.						
11																				

Geographic Information						
Respondent	Annual Sales Units	Sales Area	Southern California		Northern California	
			%	Units	%	Units
1	8	Statewide	85%	6.8	15%	1.2
2	15	LA South & Bay Area	50%	7.5	50%	7.5
3	20	Statewide	70%	14.0	30%	6.0
4	45	Mostly So. Calif.	70%	31.5	30%	13.5
5	20	Mostly So. Calif.	70%	14.0	30%	6.0
6	11	Mostly So. Calif.	90%	9.9	10%	1.1
7	15	Statewide	60%	9.0	40%	6.0
8	25	Statewide	75%	18.8	25%	6.3
9	30	Statewide	75%	22.5	25%	7.5
10	30	Statewide	80%	24.0	20%	6.0
11	18	Mostly So. Calif.	90%	16.2	10%	1.8
Totals	237		73%	174.2	27%	62.9