Lithium Battery Transport Research Program: lithium batteries market data collection and analysis final report

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Lithium Battery Transport Research Program

Lithium Batteries Market Data Collection and Analysis

Final Report

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Canada

Table of Contents

List of Tables

List of Figures

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Executive Summary

Under a service contract for the Transport of Dangerous Goods Directorate at Transport Canada entitled "Lithium Battery Transport Research Program", the National Research Council of Canada (NRC) carried out Task 1.1 "Conduct Lithium Batteries Market Data Collection and Analysis" in order to support Transport Canada's efforts to better understand the supply chain and commodity flows of lithium batteries and equipment containing lithium batteries in Canada and to help inform their risk analysis efforts. This research will enable Transport Canada to better understand and respond to the public on the hazards involved with the transportation of lithium battery shipments, especially products travelling by air. This final report is comprised of a global trade data analysis of lithium batteries and products containing batteries, an investigation of developments and trends in the global lithium battery market, a Canadian trade data analysis of lithium batteries and products containing batteries, and a survey on lithium battery transportation of new and used lithium batteries within various organizations in the Canadian lithium battery supply chain.

Information is needed about shipments of lithium batteries and products containing them, in order to understand the volume of freight movement into and out of Canada and around the world. This report includes analysis of a subset of data collected from 71 product classifications from various categories identified by NRC. Harmonized System (HS) product codes were used to retrieve statistics for Canadian trade in lithium batteries and/or finished products containing lithium batteries. The four classifications that were included in our detailed analysis are HS 847130 (portable devices and computers), HS 850650 (lithium primary cells and batteries), HS 850760 (Li-ion electric accumulators), and HS 852580 (electronic cameras).

Nearly 440 million portable devices and computers worth $147B USD were imported globally in 2014. The value of global imports has essentially remained flat from 2011 to 2014. The total quantity of imports are on the rise, up 52% overall since 2011. With 9.4 million imports worth $4.1B USD, Canada was ranked 8th globally for imports of portable devices and computers in 2014. 2014 saw more than 470 million global exports of portable devices and computers worth in excess of $150B USD. The value of global exports has essentially remained flat from 2011 to 2014. With 815 thousand exports worth $354M USD, Canada was ranked 22nd globally for exports of portable devices and computers in 2014.

More than 2.9 billion lithium primary cells and batteries worth nearly $2.5B USD were imported globally in 2014. The value of global imports has been rising in recent years, up about 11% from 2011 to 2014. The total quantity of imports is on a downward trend, down overall about 13% since 2011. With 28 million imports worth $63M USD, Canada was ranked 12th globally for imports of lithium primary cells and batteries in 2014. More than 2.4 billion lithium primary cells and batteries worth nearly $2.5B USD were exported globally in 2014. The value of global exports has been rising in recent years, up about 33% from 2011 to 2014. The total quantity of exports is on an upward trend, overall up about 15% since 2011. With 1.5 million exports worth almost $105M USD, Canada was ranked 9th globally for exports/re-exports of lithium primary cells and batteries in 2014.

More than 2.8 billion Li-ion electric accumulators worth over $12.8B USD were imported globally in 2014. The value of global imports has been rising in recent years, up overall about 27% from 2012 to 2014. The total quantity of imports is on a downward trend, down overall about 3% since 2012. With 5.7 million imports worth $95M USD, Canada was ranked 19th globally for imports of Li-ion electric accumulators in 2014. Nearly 2.2 billion Li-ion electric accumulators worth over $14.2B USD were exported globally in 2014. The value of global exports has been rising in recent years, up overall about 24% from 2012 to 2014. The total quantity of exports has fluctuated in recent years but is up overall about 22% since 2012. With 5.7 million exports worth nearly $43M USD, Canada was ranked 19th globally for exports of Li-ion electric accumulators in 2014.

More than one billion electronic cameras worth over $41B USD were imported globally in 2014. The value of global imports has been dropping in recent years, overall down by 11% since 2011. The total quantity of imports is on a slight upward trend, up overall about 3% since 2011. With 7.4 million imports worth $727M USD, Canada was ranked 12th globally for imports of electronic cameras in 2014. Nearly 900 million electronic cameras worth over $35B USD were exported globally in 2014. The value of global exports has been dropping in recent years, overall down by 15% since 2011. The total quantity of exports is on a downward trend, down more than 21% overall since 2011. With 1.4 million exports worth $444M USD, Canada was ranked 13th globally for exports of electronic cameras in 2014.

NRC acquired a research report from Navigant Research entitled "Advanced Battery Tracker 4Q15: 2014 Global Shipments of Advanced Batteries by Application Sector: Automotive, Stationary Energy Storage, and Consumer Electronics." The report tracks global shipments of advanced batteries utilized in automotive electrification, stationary energy storage, and consumer electronics.

Navigant Research found that total global shipments of advanced batteries in 2014 were 53.3 GWh. Consumer electronics comprised the bulk of shipments, followed by Automotive and Stationary Energy Storage. 2014 saw continued growth with increased demand for consumer electronics, electric vehicles and systems for storing grid energy at commercial and industrial locations. Globally, 67.1 GW of batteries were purchased, most of which utilized in electrified vehicles of varying type. Automotive consumed greatest market share of batteries in 2014, representing a 112% increase from 2013.

2014 saw shipments of more than 7 billion individual battery cells, up slightly from 2013. Due to heavy demand in the automotive sector, 2014 saw advanced battery shipments worth in excess of $14.1B USD in revenue, up 7.1% over 2013. 2014 saw little change from 2013 regarding the top ten countries manufacturing advanced batteries. China remained the leader in energy capacity market share in 2014, but was down somewhat from 2013. This was followed by production output from both Japan and South Korea. The Asia Pacific region was responsible for 96% of global advanced battery production in 2014.

The report investigated shipments within three industry sectors – automotive, stationary energy storage, and consumer electronics. Navigant Research targeted battery shipments for light duty consumer classes of battery electric vehicles, plug-in hybrid vehicles, and hybrid electric vehicles. In 2014, close to 8.2 GWh of advanced batteries worth $2.7 billion were produced for automotive

applications, considerably surpassing 2013 production of 4.9 GWh worth $2.2 billion. Navigant Research targeted distributed energy storage, including residential, commercial and industrial, community storage projects, and utility-scale grid energy storage installations. In 2014, 300.6 MWh of advanced batteries worth $114.9M USD were produced for stationary energy storage installations, considerably surpassing 2013 production of 148.2 MWh worth $86.7M USD. 2014 saw continued growth in the consumer electronics sector although public preferences for form factors shifted. Production of advanced batteries for consumer electronics increased to 44.8 GWh in 2014, an increase of 8.7% over the 41.2 GWh sold in 2013.

More than 99% of the energy capacity of the advanced batteries represented in the report consisted of Li-ion chemistries. With nearly 85% of market share, advanced Li-ion batteries of lithium cobalt oxide chemistry continued market dominance in 2014.

Information is needed about shipments of lithium batteries and products containing them, in order to understand the volume of freight movement in and out of Canada. We carried out a detailed analysis of the same four classifications as was done for the global trade analysis.

There was no export or re-export data available for portable devices & computers. A total of 9.4 million portable devices and computers worth $4.5B were imported into Canada in 2014. The value of global imports has essentially remained flat from 2011 to 2014. The total quantity of units received has been steadily growing from 2011 to 2014. Canada imported the highest value of portable devices and computers from China than any other country in 2014.

A total of 28 million lithium primary cells and batteries worth $70M were imported into Canada in 2014. The value of global imports has been steadily increasing from 2011 to 2014. The total quantity of units imported is rising up nearly 50% since 2011. 2014 saw about one million domestic exports of lithium primary cells and batteries worth $110M. There were about half as many re-exports of lithium primary cells and batteries from Canada as compared to domestic exports in 2014 but these units accounted for far less value, $5.4M or about 5% of exports. Total quantity of units shipped showed an upward trend from 2011 to 2014. Total value of re-exports is trending up, increasing by more than 46% from 2011 to 2014.

A total of $105M worth of Li-ion electric accumulators was imported into Canada in 2014. The value of global imports has been steadily increasing from 2012 to 2014. 2014 saw just under one million domestic exports of Li-ion electric accumulators worth nearly $18M. The total quantity of units shipped increased sharply from 2012 to 2013 and went down only slightly in 2014. The total value of Canadian domestic exports is on a significant upward trend increasing nearly 400% from 2012 to 2014. There were about 4.8M re-exports of Li-ion electric accumulators from Canada in 2014. Total quantity and value of re-exports showed minor downward trends from 2011 to 2014.

A total of 7.4 million electronic cameras worth $804M were imported into Canada in 2014. The value of global imports is down 22% overall from 2011. 2014 saw slightly more than 908,000 domestic exports of electronic cameras worth $360M. The total quantity of units shipped is steadily increasing, up more

than 92% since 2011. The same can be said about the total value of exports, rising nearly 80% in that time frame. There were about half a million re-exports of electronic cameras worth more than $130M from Canada in 2014. Total quantity of re-exports is on a minor downward trend, losing about 14% since 2011. The total value of re-exports is rising, up 22% overall since 2011.

New portable and electronic devices, as well as utility scale energy storage, are increasingly being powered by lithium batteries. Over the years, the use and transportation of lithium batteries has grown dramatically. The safe transportation of lithium batteries is of paramount importance for Canadian industry and consumers at large, and has an impact on many organizations across the country. NRC prepared a survey on lithium battery transportation asking questions regarding shipping and receiving of new and used lithium batteries within various organizations in the lithium battery supply chain.

To ensure that current safety regulations keep pace with the growing applications for lithium batteries, NRC requested industry participation in a market data survey, to better understand the current battery transportation environment. Of the 173 industry representatives contacted, 38 individuals initiated the survey and 31 completed the survey in full. A thorough analysis was completed after all the results were received and compiled.

The majority of companies are involved in the following lithium battery supply chains: retailing/distribution; equipment/system manufacture; wholesale; and shipping/carrier. Most companies produce, use, ship or receive original (new) products in these sectors: equipment/system manufacture; retailing/distribution; shipping/carrier & lithium battery end user – corporate; and battery manufacture & wholesale.

The bulk of companies have 5 to 9 years of experience developing or integrating lithium cells or batteries. The most common applications were off-grid or grid energy storage, laptops, personal electronic devices (PED) (e.g., smartphones and tablets), and handheld instrumentation. The most common trade activity was importing products into Canada.

The majority of companies ship and receive products containing lithium batteries. Companies had essentially equal experience shipping as they did receiving products. By far, ground transportation is the most common mode used to ship and receive lithium cells, batteries or equipment containing Li batteries. Most companies ship less than 25% of their products by air. However, there is an unequal distribution in the percentage of products received by air. Only one company ships more than 100 shipments per year. Similarly, only one company receives more than 100 shipments per year. The majority of companies do, in fact, ship and receive Li cells, batteries or equipment containing Li batteries on a regular schedule. The most common products shipped are batteries, equipment containing batteries, equipment packaged with batteries, and cells. The most common products received are batteries, cells, equipment containing batteries, and equipment packaged with batteries. About 2/3 of the cells and batteries shipped and received are lithium ion, 19-22% are lithium metal, and 9-10% are other chemistries. By far, the majority of companies ship and receive lithium ion cells or batteries.

Most companies report having shipped all or almost all products with a brand name or trademark. Fewer companies report having received all or almost all products with a brand name or trademark. The vast majority of companies report having shipped and received batteries classified as Class 9 dangerous goods. One company reported that they receive batteries that are not classified as Class 9 dangerous goods. One company reported being exempt for both shipping and receiving.

More companies reported having shipped only 1 to 2 cell/batteries per shipment and having received 50 to 499 cell/batteries per shipment. The majority of companies ship and receive between 10 and 1,000kg of cells/batteries per shipment. All companies reported having shipped an average of 1 to 24 pieces of equipment containing batteries per shipment. Most reported having received similar numbers of equipment.

Products are being shipped and received in varying average states of charge with slightly more reporting having shipped and received products 50-100%SOC. Somewhat troubling is that seven companies reported that they do not know the average state of charge for each shipment sent and/or received. Products of varying capacities are being shipped and received. The majority of the products shipped and received have an energy content >100Wh.

Companies reported shipping the bulk of their products containing lithium batteries within Canada, with the US being the next most popular destination and China a distant 3rd. Companies reported receiving the bulk of their products containing lithium batteries from the US, with Canada and China tying for the 2nd most popular source country, and South Korea a distant 3rd. Companies reported that they ship products to all 10 Canadian provinces and three territories. Ontario sees products from the most companies, followed by Quebec, and then BC and Alberta (tied for 3rd). Ontario is the source of product for the most companies, followed by Quebec, and then BC. No companies reported sourcing products from New Brunswick, Nova Scotia, Prince Edward Island, or any of the three territories.

1. Introduction

In FY 2014-2015, NRC reviewed codes and standards for general lithium battery safety, as well as specific reports, regulations and protocols for air transport of batteries for Transport Canada. That project generated a request for an in-depth study of the safety risks associated with the air transport of lithium batteries. The study is comprised of global trade data analysis to understand the world commodity flows of lithium batteries and products containing batteries, an investigation of developments and trends in the global lithium battery market, Canadian trade data analysis to understand the commodity flows of lithium batteries and products containing batteries into and out of Canada, and a survey on lithium battery transportation asking specific questions regarding shipping and receiving of new and used lithium batteries within various organizations in the Canadian lithium battery supply chain.

2. 2011-2014 Global Trade Analysis of Lithium Batteries, Battery Packs and Products Containing Lithium Batteries

2.1 Purpose

Information is needed about shipments of lithium batteries and products containing them, in order to understand the volume of freight movement into and out of Canada and around the world, which could pose risks and therefore require special regulation. This report includes analysis of a subset of data collected from 71 product classifications from various categories identified by NRC (Appendix A – 71 HS Codes Identified).

2.2 Key Questions

- What information is available about the total number of lithium battery packs and cells imported by other countries, and how does this compare with commodity flows into Canada?
- What information is available about the number of lithium battery packs and cells exported/re-exported by other countries, and how does this compare with commodity flows out of Canada?
- What information is available about the total number of products which may contain lithium batteries imported by other countries, and how does this compare with commodity flows into Canada? Products include items such as personal electronic devices, power tools, land vehicles, marine vehicles, aerial vehicles, household devices, and hand held instruments.

- What information is available about the number of products which may contain lithium batteries exported/re-exported by other countries, and how does this compare with commodity flows out of Canada? Products include items such as personal electronic devices, power tools, land vehicles, marine vehicles, aerial vehicles, household devices, and hand held instruments.

2.3 Methodology

Harmonized System (HS) product codes were used to retrieve statistics for Canadian trade in lithium batteries and/or finished products containing lithium batteries as follows:

- Imports - goods that have entered the country by crossing territorial (customs) boundaries, whether for immediate domestic consumption (following the payment of any duty) or for storage in customs (bonded) warehouses.
- Domestic Exports - goods grown, produced, extracted or manufactured in Canada leaving the country, through customs, for a foreign destination.
- Re-exports - goods that have previously entered Canada that are leaving in the same condition as when first imported.

2.4 Sources Consulted

United Nations (UN) - Comtrade Database

comtrade.un.org/data

2.5 Summary of Results

The goods are classified according to the HS nomenclature, based on HS2012, in accordance with the World Customs Organization. The system provides a good level of specificity for the identification of products, but the reader should be aware that it does not indicate whether or not battery-operated products contain installed batteries at the time of shipment. It is also important to be aware that the information applies to classes of products; in certain cases, information for specific products is aggregated in larger categories. While the information does not provide a breakdown of the mode of transport, it does provide a sense of the volume of commodity flows around the world.

There were a total of 71 different classifications originally identified (Appendix A – 71 HS Codes Identified) and the detailed datasets are available upon request. Two classifications related directly to lithium cells, batteries and accumulators and the remainder were seen as having the potential for

containing lithium batteries. Table 1 outlines the four classifications that were included in our detailed analysis.

Table 1 HS Code Product Classifications included in detailed analysis

HS Code	Description
847130	Portable automatic data processing machines, wt <= 10 kg, with cpu, keyboard and display
850650	Lithium primary cells and batteries
850760	Lithium-ion electric accumulators, including separators therefor, whether or not rectangular (including square)
852580	Television cameras, digital cameras and video camera recorders

Data for 2015 was available in some cases but incomplete and inaccurate. Therefore, 2014 was chosen as the most current baseline of complete and accurate data. There were significant gaps and inconsistencies observed with the data for re-exports from the UN Comtrade Database so no analysis was performed on any re-exports. In some cases, it was determined that re-exports were lumped together with exports.

Data is sorted by the top ten countries in the world for imports and exports and ranked by value in US dollars in 2014, Value (USD) 2014. As such, in many cases, you will notice the quantity data, Quantity (NMB - number), is not necessarily in order. Furthermore, we decided to maintain this order for data from previous years (as far back as 2011, if available) in order to illustrate historical trends of growth and/or recession of trade with these same 10 countries. In many cases, these top ten countries represent the vast majority (95%+) of trade values and quantities. In other cases, they represent significantly less. The latter is more likely with the quantity data since the top ten ranking is based on value and not quantity. Also, the top ten countries ranked by value vary from year to year, i.e. for years prior to 2014, there will be a high probability that other countries will displace those in the top ten for 2014. Unfortunately, there are several gaps in the quantity data as some countries either did not report or chose only to report shipments in kilograms, which is not readily comparable at this time. Finally, it is unclear as to whether the quantity unit refers to a singular item (cell, battery pack, equipment) or the package being shipped (consignment).

2.5.1 HS 847130: Portable automatic data processing machines, wt <= 10kg, with cpu, keyboard and display

For simplicity, we will refer to this classification as “portable devices & computers”. It is assumed that a large proportion of these products would incorporate secondary (rechargeable) lithium ion batteries.

2.5.1.1 Imports

Figure 1 and Figure 2 show the data from 2011-2014. Nearly 440 million portable devices and computers worth $147B USD were imported globally in 2014. The value of global imports has essentially remained flat, up only 3% from 2011 to 2014. The total quantity of imports are on the rise, climbing 22% in 2012 and 26% in 2013, then remaining flat in 2014 but up 52% overall since 2011. The US imported portable devices and computers of highest value in 2014, accounting for 29% of total value and 22% of total quantities reported. With 9.4 million imports worth $4.1B USD, Canada was ranked 8th globally for imports of portable devices and computers in 2014 with 2.78% of total value and 2.15% of total quantities reported.

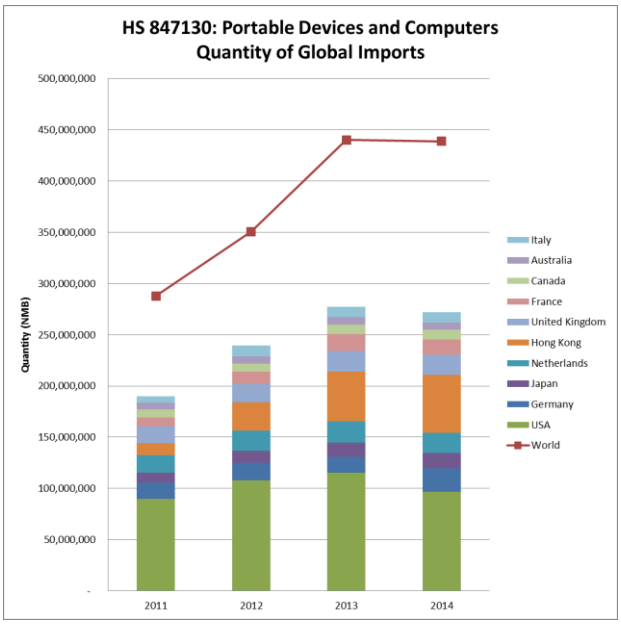

Figure 1 HS 847130: Portable Devices and Computers, Quantity of Global Imports

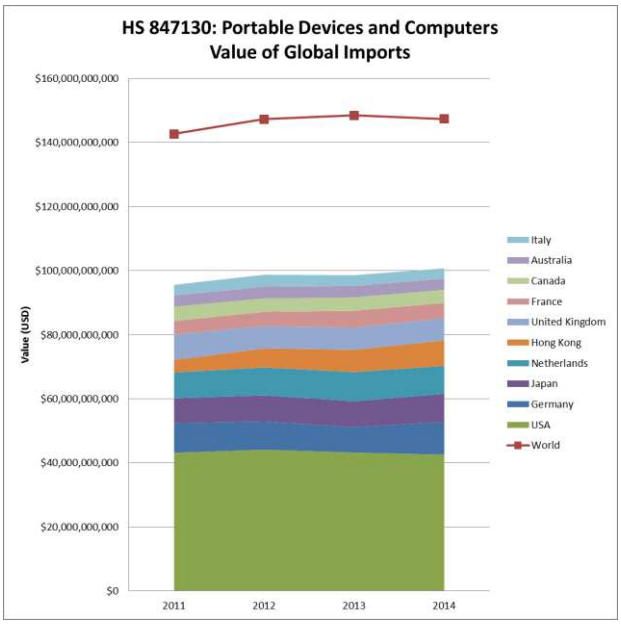

Figure 2 HS 847130: Portable Devices and Computers, Value of Global Imports

2.5.1.2 Exports

Figure 3 and Figure 4 show the data from 2011-2014. 2014 saw more than 470 million global exports of portable devices and computers worth in excess of $150B USD. The value of global exports has essentially remained flat, up only 5% from 2011 to 2014. The total quantity of exports is steadily climbing, rising 17% in 2012, 11% in 2013, 7% in 2014 and up 40% overall since 2011. China exported the overwhelming majority of portable devices and computers worth the highest value in 2014, accounting for 72% of total value and 71% of total quantities reported. With 815 thousand exports worth $354M USD, Canada was ranked 22nd globally for exports of portable devices and computers in 2014 with 0.23% of total value and 0.17% of total quantities reported.

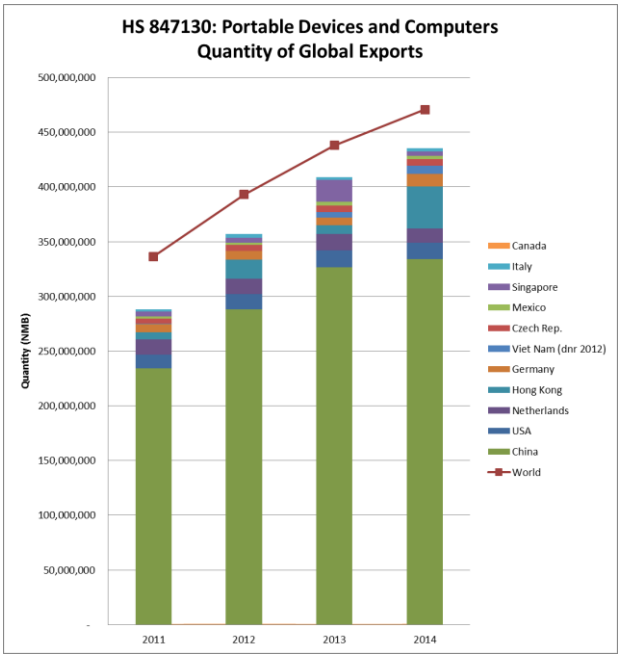

Figure 3 HS 847130: Portable Devices and Computers, Quantity of Global Exports

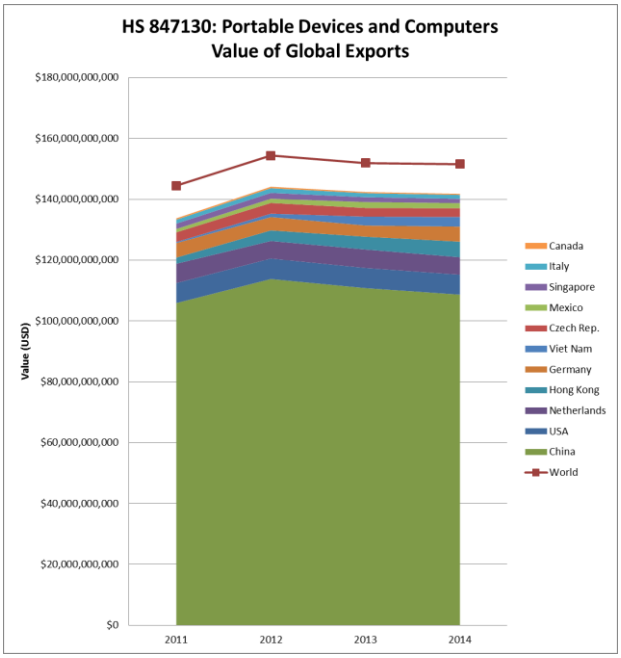

Figure 4 HS 847130: Portable Devices and Computers, Value of Global Exports

2.5.2 HS 850650 (UN 3090): Lithium primary cells and batteries

2.5.2.1 Imports

Figure 5 and Figure 6 show the data from 2011-2014. More than 2.9 billion lithium primary cells and batteries worth nearly $2.5B USD were imported globally in 2014. The value of global imports has been rising in recent years, with a slight dip in 2013, but overall up about 11% from 2011 to 2014. The total quantity of imports is on a downward trend, rising 6% in 2012 but dropping 8% in 2013 and a further 10% in 2014, down overall about 13% since 2011. The US imported lithium primary cells and batteries of highest value in 2014, accounting for 13% of total value. Unfortunately, the US did not report total quantity for 2014 imports. However, it is evident that China and Hong Kong have been the leaders in terms of total quantities, together representing nearly 56% of total quantities reported in 2014. With 28 million imports worth $63M USD, Canada was ranked 12th globally for imports of lithium primary cells and batteries in 2014 with 2.56% of total value and 0.97% of total quantities reported.

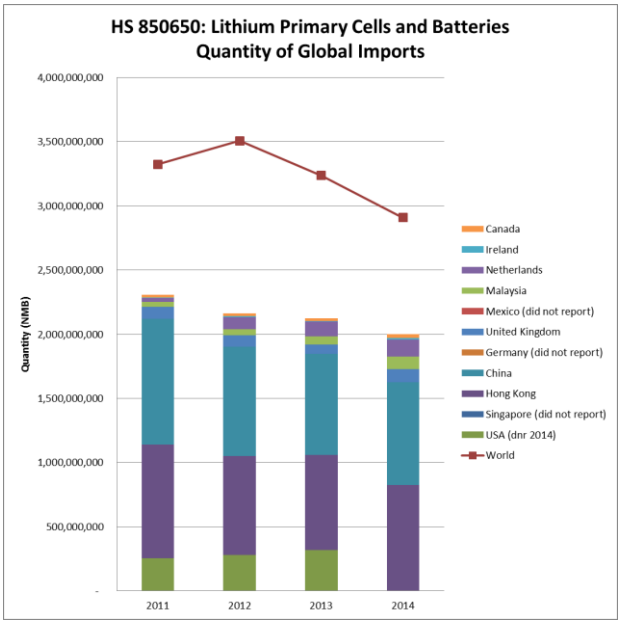

Figure 5 HS 850650: Lithium Primary Cells and Batteries, Quantity of Global Imports

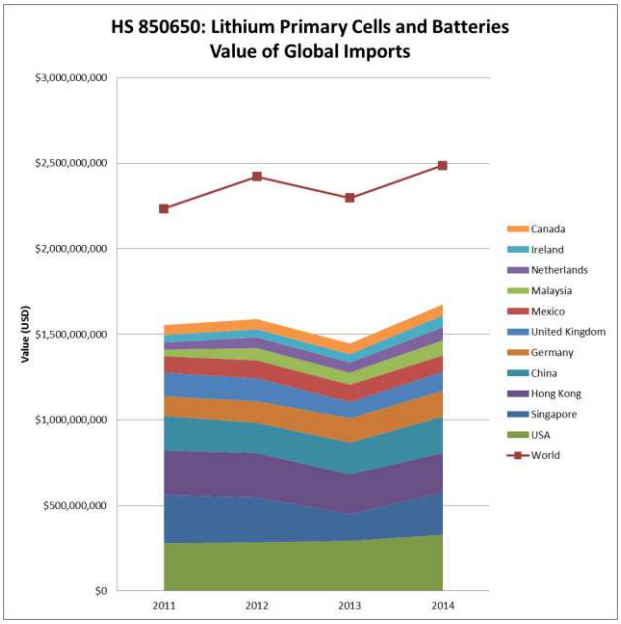

Figure 6 HS 850650: Lithium Primary Cells and Batteries, Value of Global Imports

2.5.2.2 Exports

It appears as though the UN Comtrade Database combined Canadian re-exports with exports. Furthermore, it is obvious that the UN Comtrade Database double counted Re-exports for 2011, since they were already included in Exports. See Table 2 for clarification. More detailed Canadian data was gathered from the Canadian International Merchandise Trade (CIMT) database at Statistics Canada (Refer to Section 4).

Table 2 UN Comtrade Database reporting of exports and re-exports for HS 850650

Quantity (NMB)	2011	2012	2013	2014
UN - Exports	**1,262,949**	**598,799**	**1,196,326**	**1,504,994**
CIMT - Exports	1,092,901	468,204	437,567	991,151
UN - Re-exports	**168,582**	-	-	-
CIMT - Re-exports	168,582	130,595	758,737	513,841
CIMT Exports + Re-exports	**1,261,483**	**598,799**	**1,196,304**	**1,504,992**

Figure 7 and Figure 8 show the data from 2011-2014. More than 2.4 billion lithium primary cells and batteries worth nearly $2.5B USD were exported globally in 2014. The value of global exports has been rising in recent years, up about 33% from 2011 to 2014. The total quantity of exports remained essentially flat from 2011 to 2012, dropped nearly 14% in 2013, and then climbed again by 32% in 2014, overall up about 15% since 2011. Singapore exported lithium primary cells and batteries of highest

value in 2014, worth 18% of total value and just beating out the US. Unfortunately, Singapore has not reported total export quantities from 2011 to 2014. However, it is evident that China and Hong Kong have been the leaders in terms of total quantities, together representing nearly 62% of total quantities reported in 2014. With 1.5 million exports worth almost $105M USD, Canada was ranked 9th globally for exports/re-exports of lithium primary cells and batteries in 2014 with 4.23% of total value and 0.06% of total quantities reported.

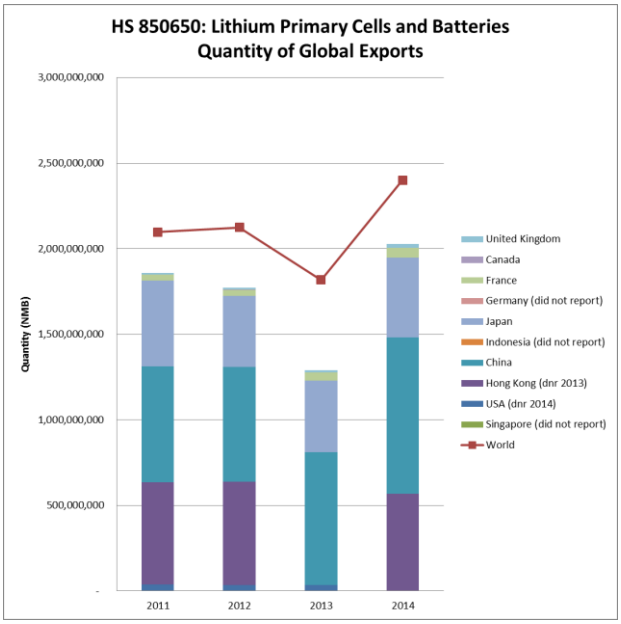

Figure 7 HS 850650: Lithium Primary Cells and Batteries, Quantity of Global Exports

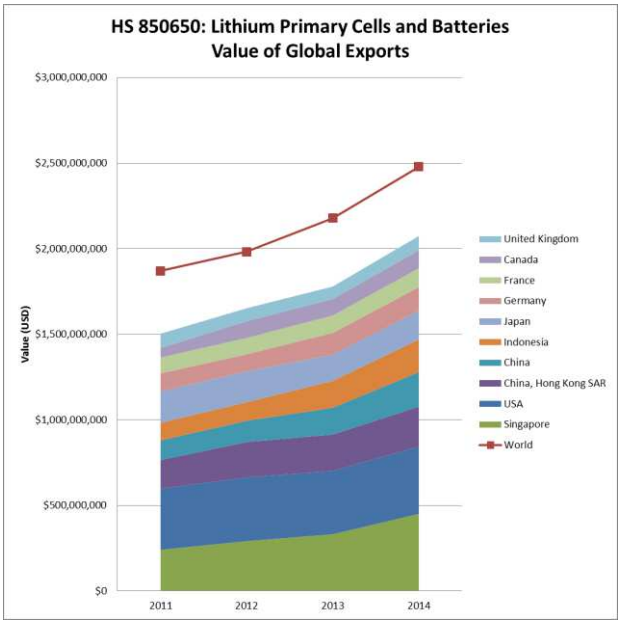

Figure 8 HS 850650: Lithium Primary Cells and Batteries, Value of Global Exports

2.5.3 HS 850760 (UN 3480): Lithium-ion electric accumulators, including separators therefor, whether or not rectangular (including square)

There was no data available for 2011 for this classification since countries only started recording data for Li-ion batteries in 2012.

2.5.3.1 Imports

Figure 9 and Figure 10 show the data from 2012-2014. More than 2.8 billion Li-ion electric accumulators worth over $12.8B USD were imported globally in 2014. The value of global imports has been rising in recent years, rising about 12% in each of 2013 and 2014, and up overall about 27% from 2012 to 2014. The total quantity of imports is on a downward trend, dropping very slightly in 2012 and a further 2% in 2013, down overall about 3% since 2012. China imported the most Li-ion electric accumulators worth the highest value in 2014, accounting for 27% of total value and 62% of total quantity. If you include

Hong Kong, then this represents 38% of total value and 85% of total quantities reported in 2014. With 5.7 million imports worth $95M USD, Canada was ranked 19th globally for imports of Li-ion electric accumulators in 2014 with 0.74% of total value and 0.20% of total quantities reported.

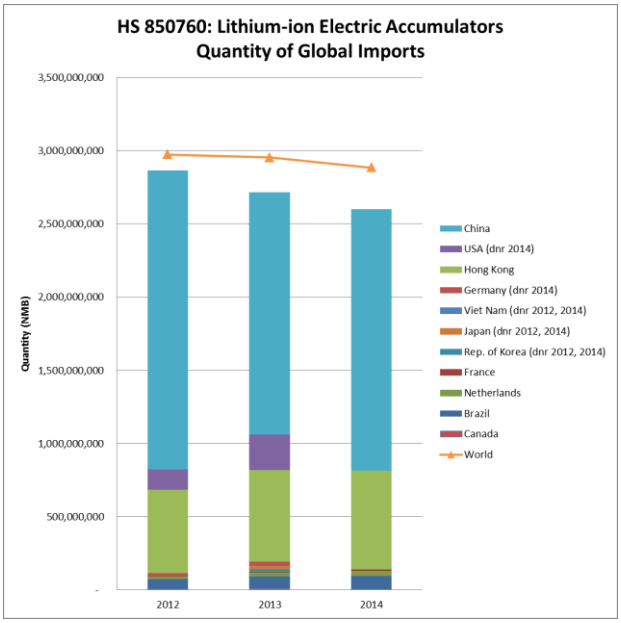

Figure 9 HS 850760: Lithium-ion Electric Accumulators, Quantity of Global Imports

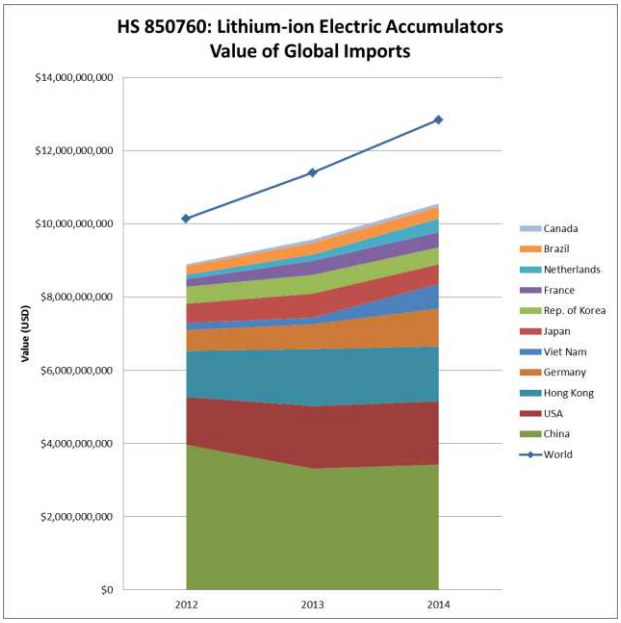

Figure 10 HS 850760: Lithium-ion Electric Accumulators, Value of Global Imports

2.5.3.2 Exports

It appears as though the UN Comtrade Database combined Canadian re-exports with exports (Table 3).

Table 3 UN Comtrade Database reporting of exports and re-exports for HS 850760

Quantity (NMB)	2011	2012	2013	2014
UN - Exports	-	**6,024,170**	**5,774,620**	**5,739,649**
CIMT - Exports	-	56,859	1,000,562	961,548
UN - Re-exports	-	-	-	-
CIMT - Re-exports	-	5,967,311	4,774,058	4,778,101
CIMT Exports + Re-exports	-	**6,024,170**	**5,774,620**	**5,739,649**

Figure 11 and Figure 12 show the data from 2012-2014. Nearly 2.2 billion Li-ion electric accumulators worth over $14.2B USD were exported globally in 2014. The value of global exports has been rising in recent years, climbing 14% in 2013 and 9% in 2014, and up overall about 24% from 2012 to 2014. The total quantity of exports has fluctuated in recent years, dropping nearly 17% in 2012 and then jumping 46% in 2013, up overall about 22% since 2012. China exported the majority of Li-ion electric accumulators worth the highest value in 2014, accounting for 39% of total value and 61% of total

quantities reported. With 5.7 million exports worth nearly $43M USD, Canada was ranked 19th globally for exports of Li-ion electric accumulators in 2014 with 0.30% of total value and 0.26% of total quantities reported.

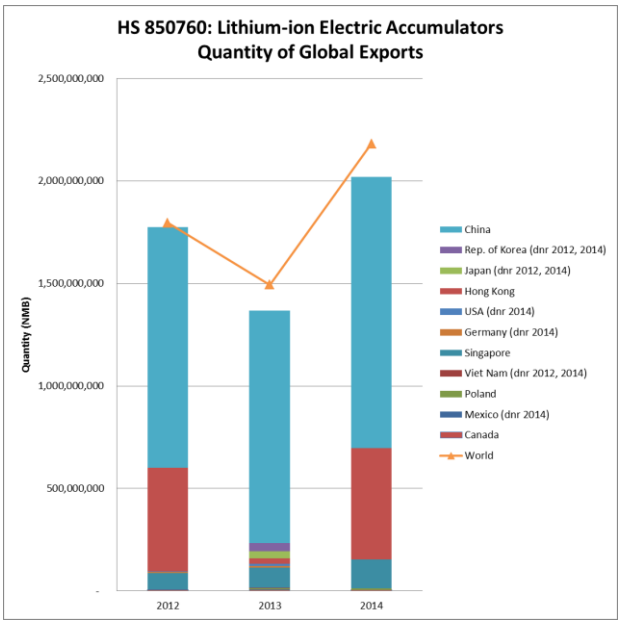

Figure 11 HS 850760: Lithium-ion Electric Accumulators, Quantity of Global Exports

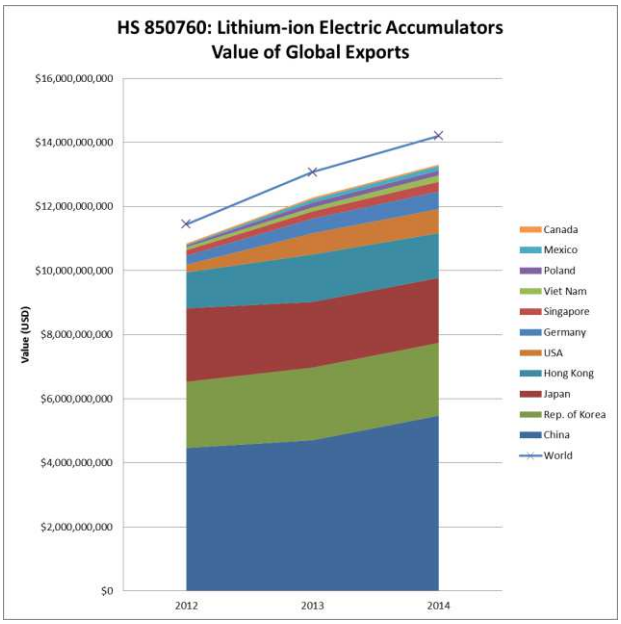

Figure 12 HS 850760: Lithium-ion Electric Accumulators, Value of Global Exports

2.5.4 HS 852580: Television cameras, digital cameras and video camera recorders

For simplicity, we will refer to this classification as “electronic cameras”. It is assumed that a large proportion of these products would incorporate secondary (rechargeable) lithium ion batteries.

2.5.4.1 Imports

Figure 13 and Figure 14 show the data from 2011-2014. More than one billion electronic cameras worth over $41B USD were imported globally in 2014. The value of global imports rose in 2012 by 9% but has been dropping in recent years, down 3% in 2013 and 16% in 2014, overall down by 11% since 2011. The total quantity of imports is on a slight upward trend, dropping 7% in 2012, then rebounding nearly 15% in 2013, but again slipping almost 3% in 2014, but up overall about 3% since 2011. China imported by far the most electronic cameras worth the highest value in 2014, accounting for 25% of total value and 73% of total quantities reported. With 7.4 million imports worth $727M USD, Canada was ranked 12th globally for imports of electronic cameras in 2014 with 1.76% of total value and 0.68% of total quantities reported.

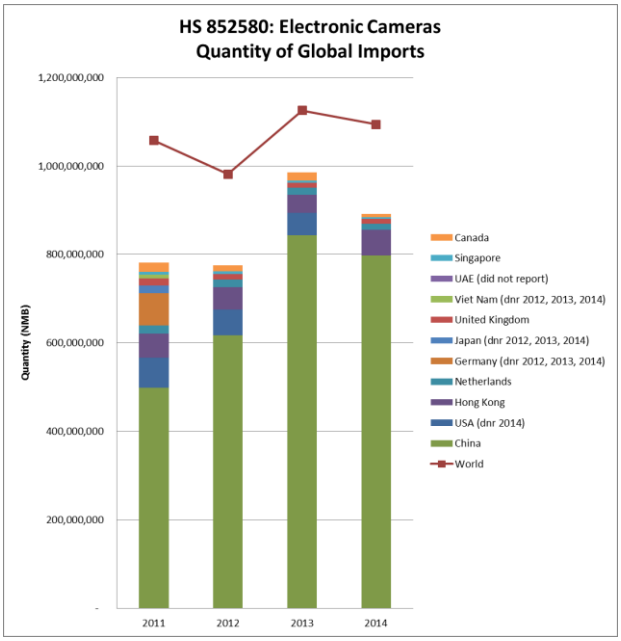

Figure 13 HS 852580: Electronic Cameras, Quantity of Global Imports

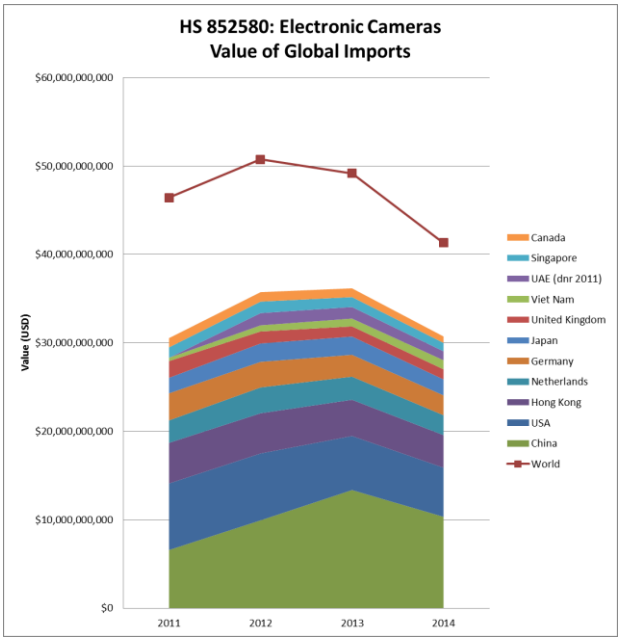

Figure 14 HS 852580: Electronic Cameras, Value of Global Imports

2.5.4.2 Exports

It appears as though the UN Comtrade Database combined Canadian re-exports with exports. Furthermore, it is obvious that the UN Comtrade Database double counted Re-exports for 2011, since they were already included in Exports. Refer to Table 4 below.

Table 4 UN Comtrade Database reporting of exports and re-exports for HS 852580

Quantity (NMB)	2011	2012	2013	2014
UN - Exports	**1,072,063**	**1,179,247**	**1,401,403**	**1,424,403**
CIMT - Exports	471,858	617,201	867,425	908,123
UN - Re-exports	**600,212**	-	-	-
CIMT - Re-exports	600,193	562,046	533,978	516,280
CIMT Exports + Re-exports	**1,072,051**	**1,179,247**	**1,401,403**	**1,424,403**

Figure 15 and Figure 16 show the data from 2011-2014. Nearly 900 million electronic cameras worth over $35B USD were exported globally in 2014. The value of global exports rose in 2012 by 8% but has been dropping in recent years, down 4% in 2013 and 18% in 2014, overall down by 15% since 2011. The total quantity of exports is on a downward trend, dropping 12% in 2012, then rebounding 13% in 2013, but again slipping more than 20% in 2014, down more than 21% overall since 2011. China exported the overwhelming majority of electronic cameras worth the highest value in 2014, accounting for 33% of total value and 89% of total quantities reported. With 1.4 million exports worth $444M USD, Canada

was ranked 13th globally for exports of electronic cameras in 2014 with 1.26% of total value and 0.16% of total quantities reported.

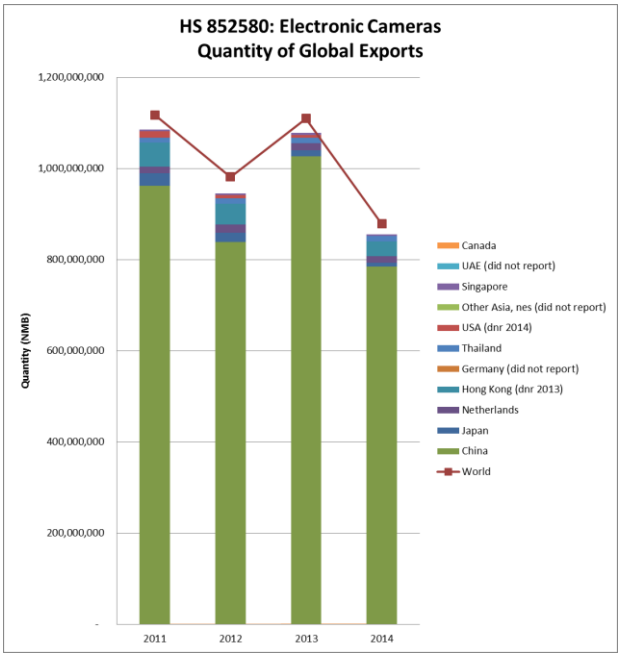

Figure 15 HS 852580: Electronic Cameras, Quantity of Global Exports

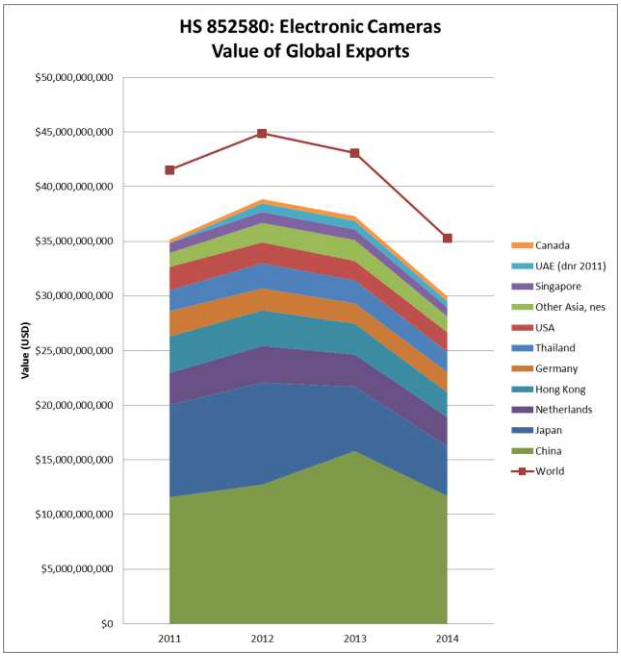

Figure 16 HS 852580: Electronic Cameras, Value of Global Exports

3. 2014 Global Shipments of Advanced Batteries for Automotive, Stationary Energy Storage, and Consumer Electronics Applications

3.1 Introduction

NRC acquired a research report from Navigant Research entitled "Advanced Battery Tracker 4Q15: 2014 Global Shipments of Advanced Batteries by Application Sector: Automotive, Stationary Energy Storage, and Consumer Electronics." The report tracks global shipments of advanced batteries in order to glean information about technology progress and market trends. Navigant Research has shifted its focus from the medical and defense advanced battery sectors to the growing sectors of automotive electrification, stationary energy storage, and consumer electronics (including power tools). All comparisons with previous year's performance are based on information from earlier editions of the report.

The market for advanced batteries is continuing to grow in large part to increases in demand for consumer electronics such as smartphones, electric vehicles (battery electric, plug-in hybrid electric, and hybrid electric), and stationary grid energy storage systems.

The report defines advanced batteries as rechargeable batteries consisting of chemistries that began being mass-produced within the last 20 years. It excludes all chemistries still in research and development phases. In addition to all lithium ion chemistries, they also include advanced lead-carbon, aqueous sodium ion, all flow battery chemistries, sodium-metal halide, and sodium sulphur.

3.2 Global Shipments in 2014

Navigant Research found that total global shipments of advanced batteries in 2014 were 53.3 GWh, representing an increase of 12.8% in energy capacity as compared to 2013. Consumer electronics comprised the bulk of shipments, followed by Automotive and Stationary Energy Storage (Figure 17).

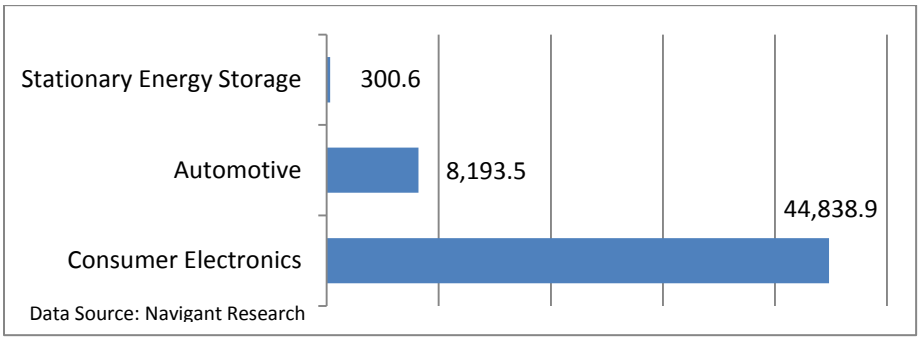

Figure 17 2014 Global Energy Capacity (MWh) of Advanced Batteries by Application Sector

3.3 The Market Position in 2014

2014 saw continued growth with increased demand for consumer electronics, electric vehicles and systems for storing grid energy at commercial and industrial locations. Globally, 67.1 GW of batteries were purchased, most of which utilized in electrified vehicles of varying type. This is represents a 68% increase from 2013. Automotive consumed the greatest market share of batteries in 2014 (Figure 18), representing a 112% increase from 2013.

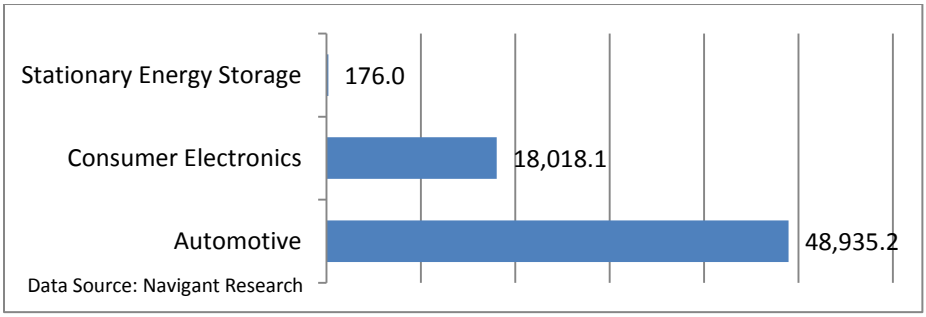

Figure 18 2014 Global Power Capacity (MW) of Advanced Batteries by Application Sector

2014 saw shipments of more than 7 billion individual battery cells, up slightly from 2013 (Figure 19). Automotive cell shipments are relatively low compared to the proportion of power and energy capacity that the sector accounts for.

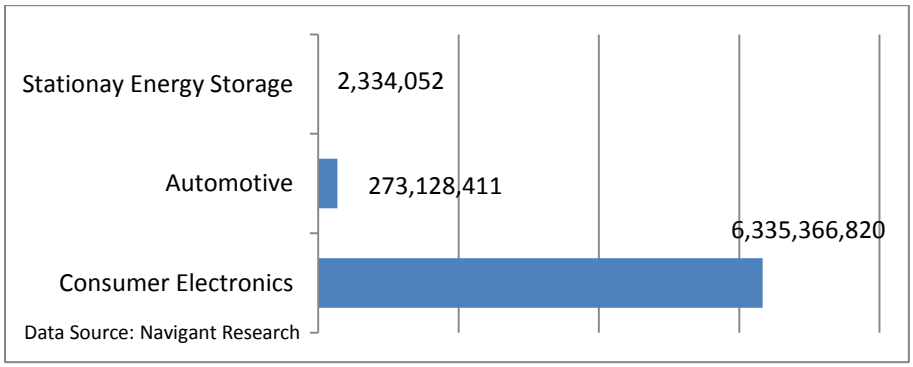

Figure 19 2014 Global Cell Shipments of Advanced Batteries by Application Sector

Due to heavy demand in the automotive sector, 2014 saw advanced battery shipments worth in excess of $14.1B USD in revenue, up 7.1% over 2013 (Figure 20). As costs go down and performance and safety improve, batteries become more attractive and sales improve, resulting in year-over-year revenue growth in the industry.

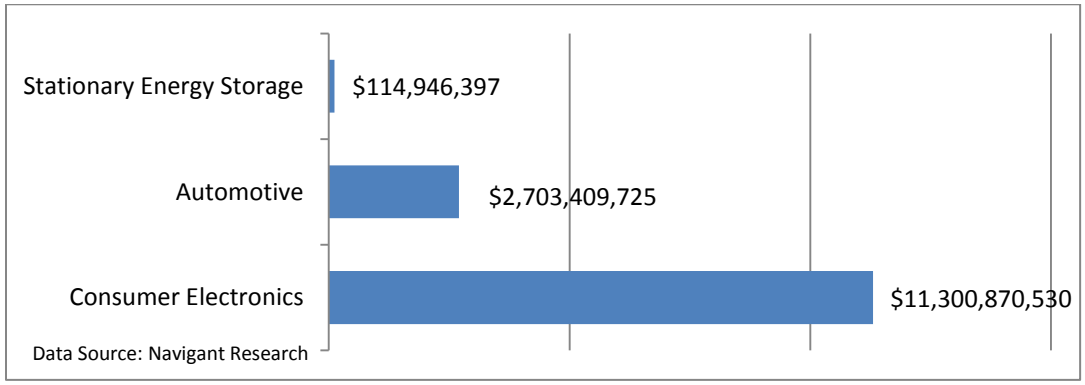

Figure 20 2014 Global Revenue of Advanced Batteries by Application Sector

3.3.1 2014 Shipments by Country of Origin

Little changed between 2013 and 2014 regarding the top ten countries manufacturing advanced batteries. China remained the leader in energy capacity market share in 2014, but was down somewhat from 2013. This was followed by production output from both Japan and South Korea (Figure 21). The Asia Pacific region was responsible for 96% of global advanced battery production in 2014.

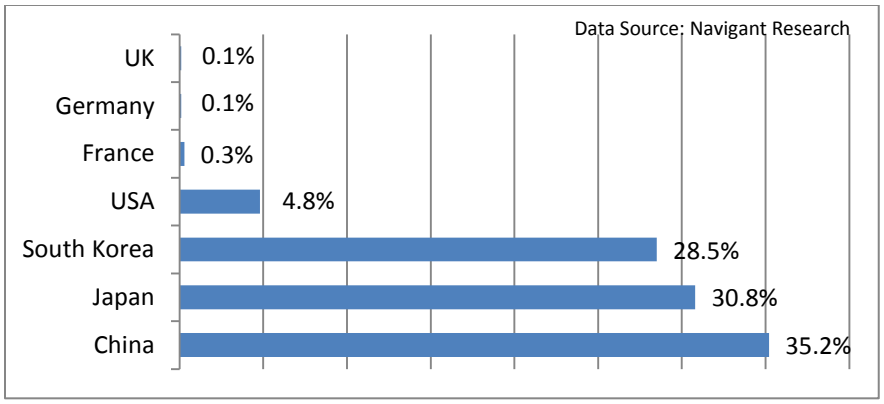

Figure 21 2014 Global Energy Capacity Market Share by Country of Origin

3.3.2 2014 Shipments by Application Sector

The report investigated shipments within three industry sectors – automotive, stationary energy storage, and consumer electronics.

3.3.2.1 Shipments of Automotive Batteries

Navigant Research targeted battery shipments for light duty consumer classes of battery electric vehicles, plug-in hybrid vehicles, and hybrid electric vehicles.

In 2014, close to 8.2 GWh of advanced batteries worth $2.7 billion were produced for automotive applications, considerably surpassing 2013 production of 4.9 GWh worth $2.2 billion. This represents an increase in production of 67% and in value of 23%, with the lower average cell cost reflecting cost reductions occurring in the industry.

Panasonic continued to lead global market share of automotive advanced batteries in 2014, followed by AESC and LG Chem (Table 5).

Table 5 2014 Global Energy Capacity Market Share of Advanced Batteries by Top 10 Manufacturers within Automotive Sector

Company	Market Share
Panasonic	38.3%
AESC	18.8%
LG Chem	13.9%
LEJ	5.7%
Samsung SDI	5.0%
BYD	4.6%
Tianneng Group	2.8%
A123 Systems	2.2%
Blue Energy	2.0%
Beijing Pride Power Company	1.5%
Others	5.2%

Data Source: Navigant Research

3.3.2.2 Shipments of Stationary Energy Storage Batteries

Navigant Research targeted distributed energy storage, including residential, commercial and industrial, community storage projects, and utility-scale grid energy storage installations.

In 2014, 300.6 MWh of advanced batteries worth $114.9M USD were produced for stationary energy storage installations, considerably surpassing 2013 production of 148.2 MWh worth $86.7M USD. This represents an increase in production of 103% and in value of 33%. LG Chem led the market in 2014, followed by Saft and both Panasonic and Samsung with slightly more than 10% share (Table 6).

Table 6 2014 Global Energy Capacity Market Share of Advanced Batteries by Top 10 Manufacturers within Stationary Energy Storage Sector

Company	Market Share
LG Chem	31.3%
Saft	20.0%
Panasonic	10.7%
Samsung SDI	10.2%
Gildemeister	4.5%
Ashlawn Energy	2.9%
NEC Energy Solutions	2.7%
BYD	1.7%
UniEnergy Technologies	1.3%
Toshiba	1.2%
Others	13.4%

Data Source: Navigant Research

3.3.2.3 Shipments of Consumer Electronics Batteries

2014 saw continued growth in the consumer electronics sector although public preferences for form factors shifted. Laptop computers and, to a lesser extent, tablet sales continued to show a slowing trend but smartphones sales continued to climb.

In the face of these changes in consumer demand and the ensuing effects on market share, production of advanced batteries for consumer electronics increased to 44.8 GWh in 2014, an increase of 8.7% over the 41.2 GWh sold in 2013. Total earnings increased from $10.9B USD to $11.3B USD and total shipments increased from 6.5 billion to 6.7 billion. Samsung SDI continued to lead the market in 2014, followed by LG Chem and BYD each with around 11%, and Amperex Tech Ltd (Table 7).

Table 7 2014 Global Energy Capacity Market Share of Advanced Batteries by Top 10 Manufacturers within Consumer Electronics Sector

Company	Market Share
Others	24.3%
Samsung SDI	17.7%
BYD	11.0%
LG Chem	11.2%
Amprex Tech Ltd	9.7%
Panasonic	8.6%
Sony	7.1%
Lishen	6.4%
Hitachi	3.9%

Data Source: Navigant Research

3.3.3 2014 Shipments by Battery Chemistry

More than 99% of the energy capacity of the advanced batteries represented in the report consisted of Li-ion chemistries, which is favoured by makers of EVs and consumer electronics. The stationary energy storage market was the only application sector that used other chemistries in significant quantities, where flow batteries, sodium-metal halide and advanced lead-acid batteries were deployed in 2014.

With nearly 85% of market share, advanced Li-ion batteries of lithium cobalt oxide chemistry continued market dominance in 2014, due to continued high demand from the consumer electronics industry (Table 8). Other Li-ion subchemistries that utilize cobalt also increased market presence. The report also highlighted that the manganese spinel subchemistries are expected to continue to be blended with nickel manganese cobalt with the push for increased energy density.

Table 8 2014 Global Energy Capacity Market Share of Advanced Batteries by Li-ion Subchemistry

Subchemistry	Market Share
Li Cobalt Oxide	84.7%
Li Manganese Spinel	7.1%
Li Nickel Cobalt Aluminum	5.9%
Li Iron Phosphate	1.7%
Li Polymer	0.3%
Li Nickel Manganese Cobalt	0.2%
Li Titanate	0.0%

Data Source: Navigant Research

4. 2011-2014 Canadian Trade Analysis for Lithium Batteries, Battery Packs and Products Containing Lithium Batteries

4.1 Purpose

Information is needed about shipments of lithium batteries and products containing them, in order to understand the volume of freight movement in and out of Canada which could pose risks and therefore require special regulation. This report includes analysis of a subset of data collected from 71 product classifications from various categories identified by NRC (Appendix A – 71 HS Codes Identified).

4.2 Key Questions

- What information is available about the number of lithium battery packs and cells, imported into Canada?
- What information is available about the number of lithium battery packs and cells exported from Canada as domestic exports and re-exported from Canada to other countries?
- What information is available about the number of products which may contain lithium batteries imported into Canada? Products include items such as personal electronic devices, power tools, land vehicles, marine vehicles, aerial vehicles, household devices, and hand held instruments.
- What information is available about the number of products which may contain lithium batteries exported from Canada as domestic exports and re-exported from Canada to other countries? Products include items such as personal electronic devices, power tools, land vehicles, marine vehicles, aerial vehicles, household devices, and hand held instruments.

4.3 Methodology

Harmonized System (HS) product codes were used to retrieve statistics for Canadian trade in lithium batteries and/or finished products containing lithium batteries as follows:

- Imports - goods that have entered the country by crossing territorial (customs) boundaries, whether for immediate domestic consumption (following the payment of any duty) or for storage in customs (bonded) warehouses.
- Domestic Exports - all goods grown, produced, extracted or manufactured in Canada leaving the country, through customs, for a foreign destination.
- Re-exports - goods that have previously entered Canada that are leaving in the same condition as when first imported.

4.4 Sources Consulted

Statistics Canada - Canadian International Merchandise Trade (CIMT)

http://www5.statcan.gc.ca/cimt-cicm

4.5 Summary of Results

The goods are classified according to the HS nomenclature, based on HS2012, in accordance with the World Customs Organization. The system provides a good level of specificity for the identification of products, but the reader should be aware that it does not indicate whether or not battery-operated products contain installed batteries at the time of shipment. It is also important to be aware that the information applies to classes of products; in certain cases, information for specific products is aggregated in larger categories. While the information does not provide a breakdown of the mode of transport, it does provide a sense of the volume of goods that enter and exit Canada.

There were a total of 71 different classifications originally identified (Appendix A – 71 HS Codes Identified) and the detailed datasets are available upon request. Two classifications related directly to lithium cells, batteries and accumulators and the remainder were seen as having the potential for containing lithium batteries. We carried out a detailed analysis of the same four classifications as was previous mentioned in Section 2.

Data for 2015 was available in some cases but incomplete and inaccurate. Therefore, 2014 was chosen as the most current baseline of complete and accurate data. Data is sorted by the top ten countries that

Canada imported from, exported and re-exported to, and ranked by value in Canadian dollars in 2014, Value (CAD) 2014. As such, in many cases, you will notice the quantity data, Quantity (NMB - number), is not necessarily in order. Furthermore, we decided to maintain this order for data from previous years (as far back as 2011, if available) in order to illustrate historical trends of growth and/or recession of trade with these same 10 countries. In many cases, these top ten countries represent the vast majority (95%+) of trade values and quantities. In other cases, they represent significantly less. The latter is more likely with the quantity data since the top ten ranking is based on value and not quantity. Also, the top ten countries ranked by value vary from year to year, i.e. for years prior to 2014, there will be a high probability that other countries will displace those in the top ten for 2014. Finally, it is unclear as to whether the quantity unit refers to a singular item (cell, battery pack, equipment) or the package being shipped (consignment).

4.5.1 HS 847130: Portable automatic data processing machines, wt <= 10kg, with cpu, keyboard and display

There was no export or re-export data available for this classification. For simplicity, we will refer to this classification as “portable devices & computers”. It is assumed that a large proportion of these products would incorporate secondary (rechargeable) lithium ion batteries.

4.5.1.1 Imports

Figure 22 and Figure 23 show the data from 2011-2014.

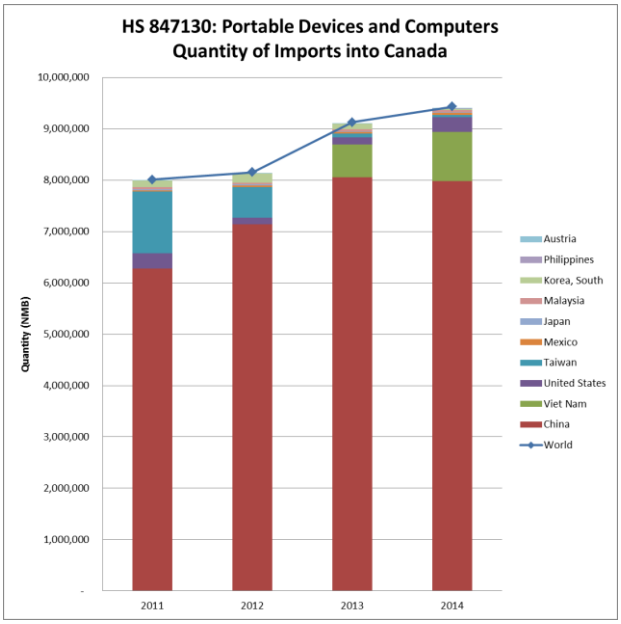

Figure 22 HS 847130: Portable Devices and Computers, Quantity of Imports into Canada

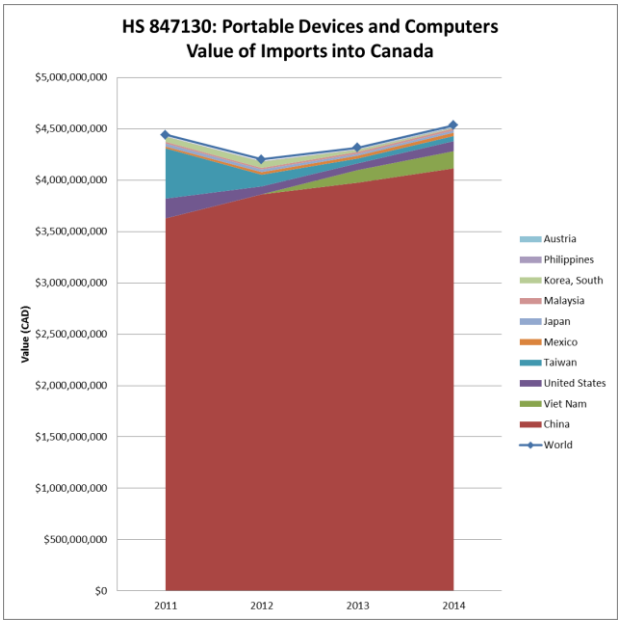

Figure 23 HS 847130: Portable Devices and Computers, Value of Imports into Canada

A total of 9.4 million portable devices and computers worth $4.5B were imported into Canada in 2014. The value of global imports has essentially remained flat, up only 2% from 2011 to 2014. The total quantity of units received has been steadily growing, rising 2% from 2011 to 2012, 12% in 2013, and 3% in 2014. Canada imported the highest value of portable devices and computers from China than any other country in 2014, about 85% of total units received worth more than 90% of total value. This was followed by Vietnam and the US. Imports from China have been increasing from 2011 to 2014, climbing 27% in quantity and 13% in value. Interestingly, Vietnam exported very few portable devices and computers to Canada in 2011 and 2012 but the value skyrocketed in 2013 nearly 500-fold, followed by a 36% increase in 2014. The quantity of these imports rose even more, jumping 1485-fold in 2013 and by 50% in 2014. Imports from Taiwan have gone down dramatically since 2011, dropping more than 25-fold in quantity and nearly 10-fold in value.

4.5.2 HS 850650 (UN 3090): Lithium primary cells and batteries

4.5.2.1 Imports

Figure 24 and Figure 25 show the data from 2011-2014. A total of 28 million lithium primary cells and batteries worth $70M were imported into Canada in 2014. The value of global imports has been steadily increasing with a 23% increase from 2011 to 2014. Although the total quantity of units received dipped slightly in 2013, it appears as though the rising trend is continuing in 2014 with an increase of 32% over the previous year and nearly 50% since 2011. Canada imported more lithium primary cells and batteries

from Indonesia than any other country in 2014. Although 3rd after Indonesia and China for quantity of units shipped, the US provided lithium primary cells and batteries with the highest value in 2014, more than 45% of global imports.

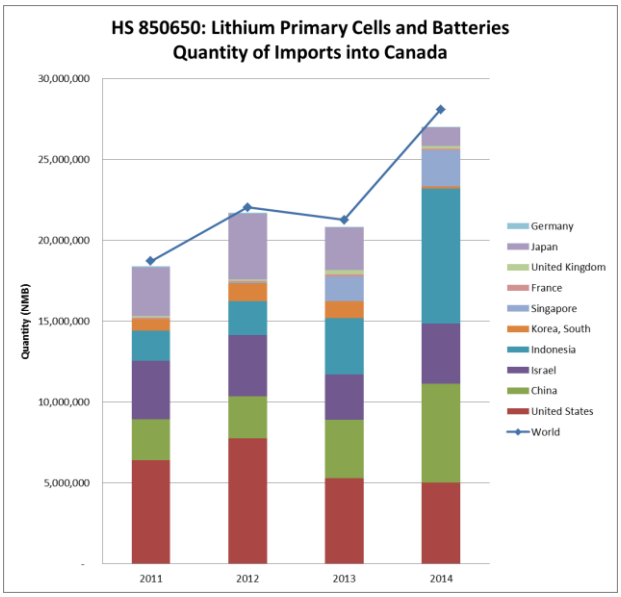

Figure 24 HS 850650: Lithium Primary Cells and Batteries, Quantity of Imports into Canada

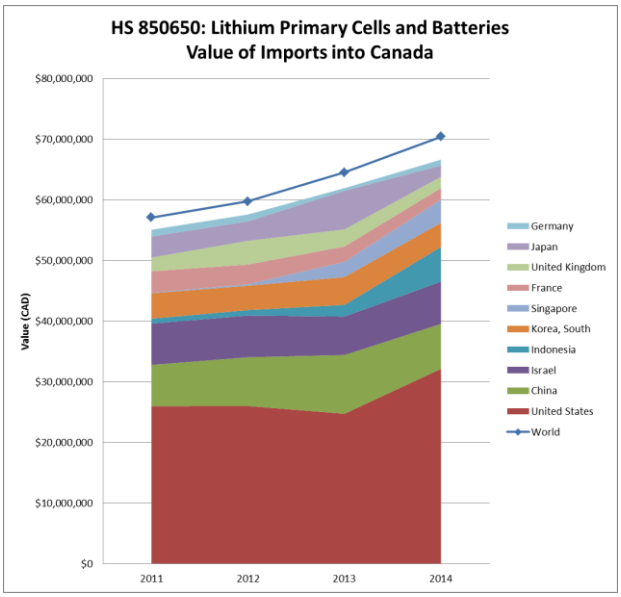

Figure 25 HS 850650: Lithium Primary Cells and Batteries, Value of Imports into Canada

4.5.2.2 Exports

Figure 26 and Figure 27 show the data from 2011-2014. 2014 saw about one million domestic exports of lithium primary cells and batteries worth $110M. The total quantity of units shipped decreased by nearly 60% in 2012, dipped again slightly in 2013 and rebounded by 127% in 2014, down only 9% since 2011. On the positive side, the value of Canadian domestic exports has been increasing steadily, up 115% from 2011 to 2014. There was an 85% increase in value from 2011 to 2012, followed by a flat 2013, and then a 16% increase in 2014. Even though total units exported were only 3.5% of imports, total value was 57% more. Units destined for the US dominated global export quantities until 2014, when units to Hong Kong skyrocketed 1,450-fold from 2013, accompanied by a 32-fold increase in value. On the other hand, the highest value of units shipped in 2014 went to France, which accounted for nearly 50% of export value with the US close behind at nearly 40%. France surged past the US in export value in 2012 and has led ever since. The remaining eight countries accounted for only 8% of total export value.

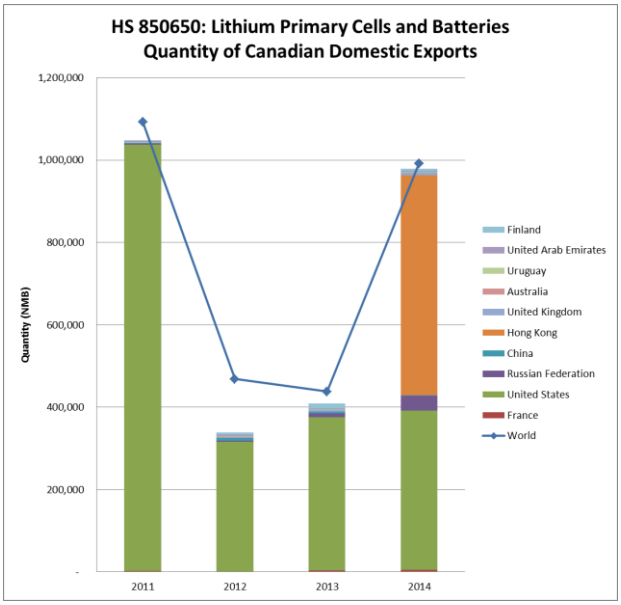

Figure 26 HS 850650: Lithium Primary Cells and Batteries, Quantity of Canadian Domestic Exports

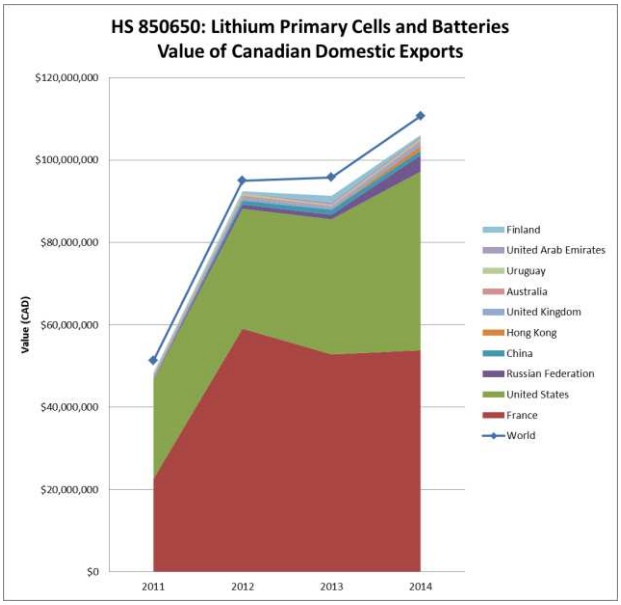

Figure 27 HS 850650: Lithium Primary Cells and Batteries, Value of Canadian Domestic Exports

4.5.2.3 Re-exports

Figure 28 and Figure 29 show the data from 2011-2014. There were about half as many re-exports of lithium primary cells and batteries from Canada as compared to domestic exports in 2014 but these units accounted for far less value, $5.4M or about 5% of exports. Total quantity of units shipped went down by about 23% in 2012 but increased nearly 6-fold in 2013. This was followed by a 32% drop in 2014. After a significant dip in 2012, total value of re-exports is trending up, increasing by more than 46% from 2011 to 2014. 63% of re-export units went to Israel in 2014, although the US was the dominant destination country in past years. The US alone accounted for more than 95% of all re-exports in 2013, which was about 40% more than total global units shipped in 2014. These units represented about 50% of the value of re-exports in 2013. There were no reported re-exports to Israel in 2011, followed by an 833% increase from 2012 to 2013, and an incredible 1,160-fold increase in 2014. Total units destined for the US have fluctuated, dropping 25% from 2011 to 2012, shooting up 650% in 2013, and then dropping more than 75% in 2014. Total value was dominated in 2014 by Israel and the US, who accounted for 55% of the value of total value. Mexico has recently become an attractive market, with re-exports rising 136-fold in value in 2014, representing over 18% of total value.

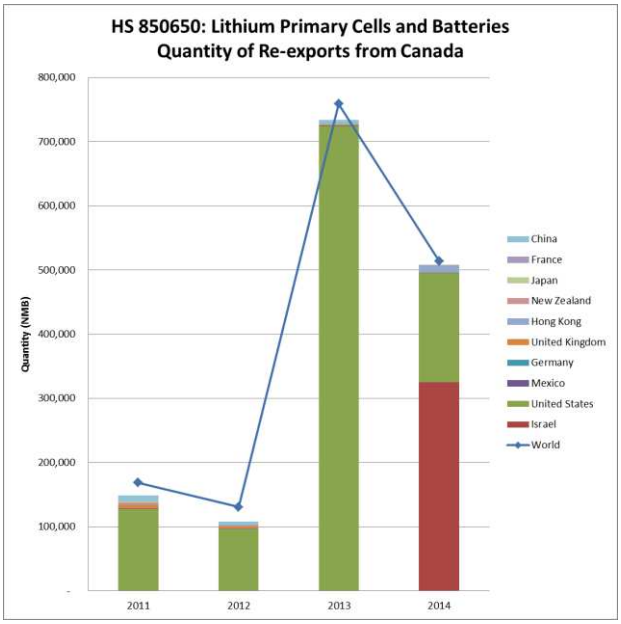

Figure 28 HS 850650: Lithium Primary Cells and Batteries, Quantity of Re-exports from Canada

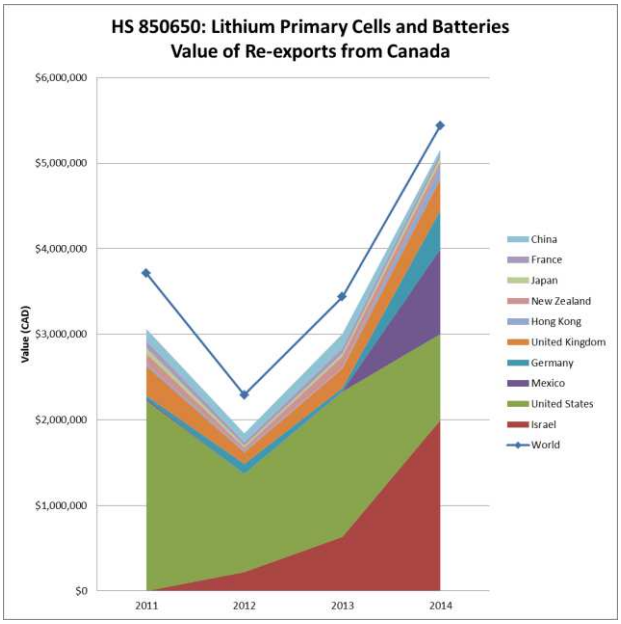

Figure 29 HS 850650: Lithium Primary Cells and Batteries, Value of Re-exports from Canada

4.5.3 HS 850760 (UN 3480): Lithium-ion electric accumulators, including separators therefor, whether or not rectangular (including square)

There was no data available for 2011 for this classification again because countries only started recording data for Li-ion batteries in 2012.

4.5.3.1 Imports

Figure 30 and Figure 31 show the data from 2011-2014. A total of $105M worth of Li-ion electric accumulators was imported into Canada in 2014. The value of global imports has been steadily increasing with a doubling from 2012 to 2013, thanks to a 74% increase in quantity, followed by a modest 9% increase in 2014, even though 37% fewer units were shipped. Canada imported roughly 6 times more units than it exported in 2014. The average unit value of imports and exports was essentially the same for 2014, meaning Canada spent about 6 times more on imports than it earned from exports. Canada imported more electric accumulators from China than any other country in 2013 and 2014. China and Taiwan accounted for 87% of units imported in 2014. However, Taiwan is losing ground to China in terms of total quantities shipped to Canada, having been on top in 2012 with 46% of all imports. China provided electric accumulators with the highest value, representing more than 48% of global imports. The US provided units with the 2nd highest value, even though total units shipped were

only 17% of those of Taiwanese origin. Japan is proving to be an important source country for valuable imports, representing 11% of total value in 2014.

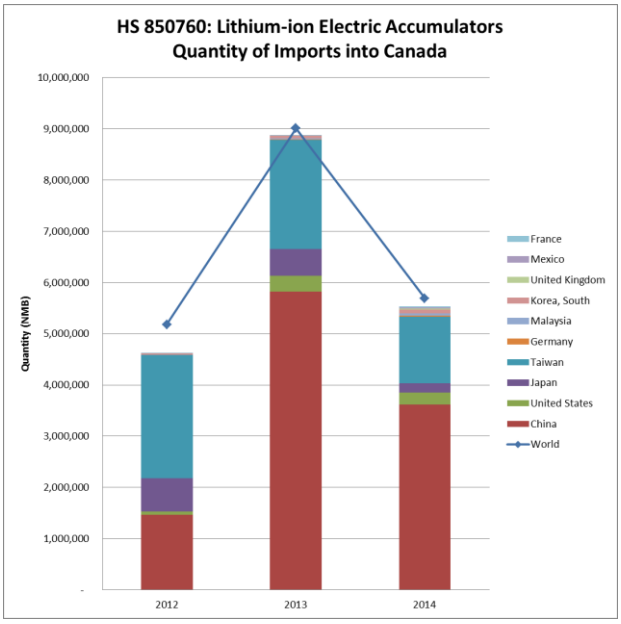

Figure 30 HS 850760: Lithium-ion Electric Accumulators, Quantity of Imports into Canada

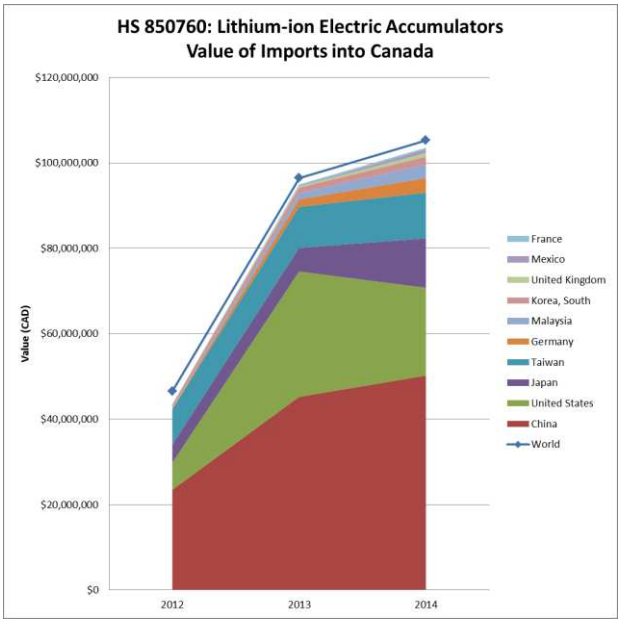

Figure 31 HS 850760: Lithium-ion Electric Accumulators, Value of Imports into Canada

4.5.3.2 Exports

Figure 32 and Figure 33 show the data from 2012-2014. 2014 saw just under one million domestic exports of Li-ion electric accumulators worth nearly $18M. The total quantity of units shipped increased nearly 18-fold from 2012 to 2013 and went down only slightly in 2014. The total value of Canadian domestic exports is on a significant upward trend increasing nearly 400% from 2012 to 2014. There was a dramatic 367% increase in value from 2012 to 2013, followed by a modest 6% increase in 2014. Units destined for the US have dominated global exports in terms of quantity, representing nearly 97% of all units shipped in 2012 and around 99% in 2013 and 2014. The highest value of units shipped went to the US from 2012 to 2014, although Germany, Denmark and Norway are catching up. Exports to the US accounted for more than 30% of export value in 2014 with Germany, Denmark, Norway and the Netherlands close behind, together representing about 60% of value. The remaining five countries accounted for only 7% of total export value.

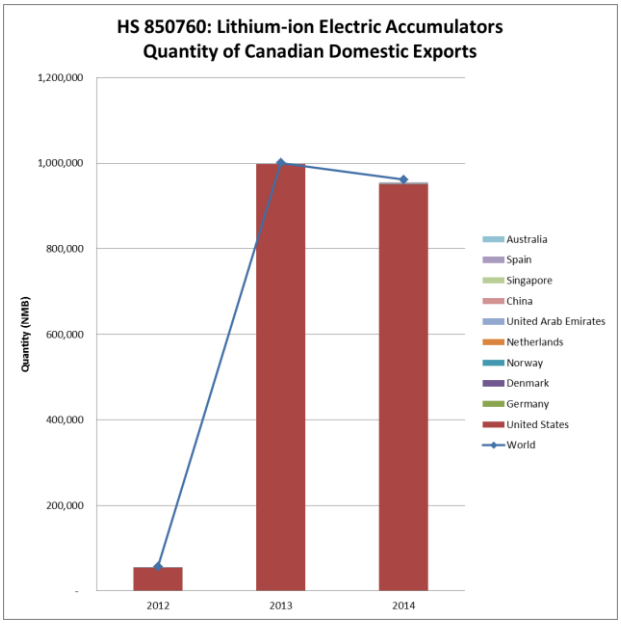

Figure 32 HS 850760: Lithium-ion Electric Accumulators, Quantity of Canadian Domestic Exports

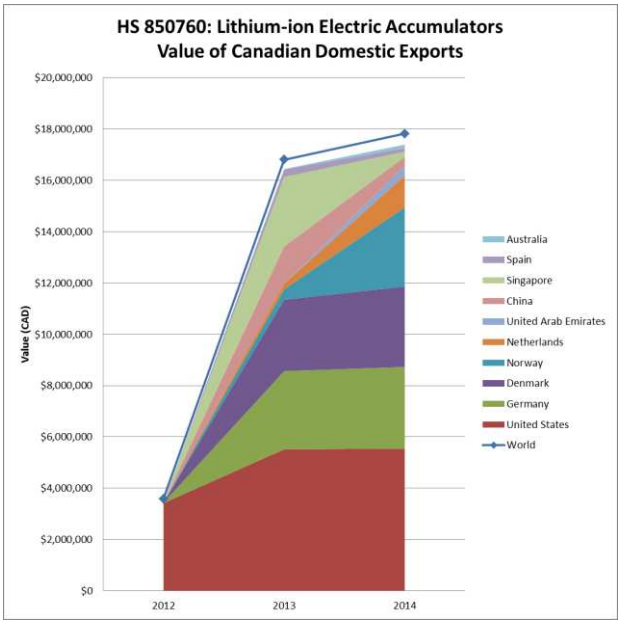

Figure 33 HS 850760: Lithium-ion Electric Accumulators, Value of Canadian Domestic Exports

4.5.3.3 Re-exports

Figure 34 and Figure 35 show the data from 2012-2014. There were about 4.8M re-exports of Li-ion electric accumulators from Canada in 2014, representing nearly five times the quantity of domestic exports. However, at about $30M, they only accounted for about 65% more value. Total quantity of re-exports is on a minor downward trend, dropping about 20% from 2012 to 2013 and then remaining flat in 2014. Total value went up slightly from 2012 to 2013 and then decreased 17% in 2014. The US has been the dominant destination country for re-exports in past years, representing more than 75% of Canada's re-export units worth about 70% of total value in 2014.

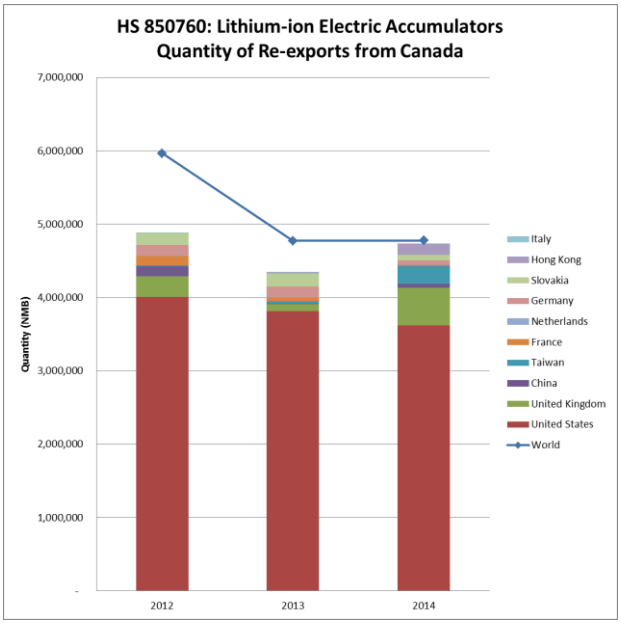

Figure 34 HS 850760: Lithium-ion Electric Accumulators, Quantity of Re-exports from Canada

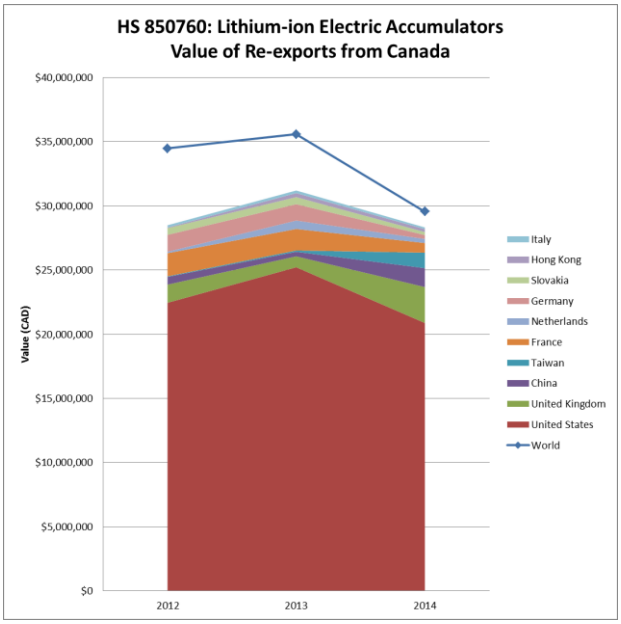

Figure 35 HS 850760: Lithium-ion Electric Accumulators, Value of Re-exports from Canada

4.5.4 HS 852580: Television cameras, digital cameras and video camera recorders

For simplicity, we will refer to this classification as “electronic cameras”. It is assumed that a large proportion of these products would incorporate secondary (rechargeable) lithium ion batteries.

4.5.4.1 Imports

Figure 36 and Figure 37 show the data from 2011-2014. A total of 7.4 million electronic cameras worth $804M were imported into Canada in 2014. The value of global imports rose 3% in 2012, but then dropped nearly 5% in 2013 and a further 21% in 2014, down 22% overall from 2011. Canada imported roughly 8 times more units than it exported in 2014. Canada imported more electronic cameras from China than any other country from 2011 to 2014. Although all imports are down, Japan appears to be losing the most ground in terms of total value shipped to Canada, having lost nearly half the value it saw 2011. China provided electric accumulators with the highest value, representing more than 34% of global imports. Japan provided units with the 2nd highest value, even though total units shipped were only about 10% of those of Chinese origin.

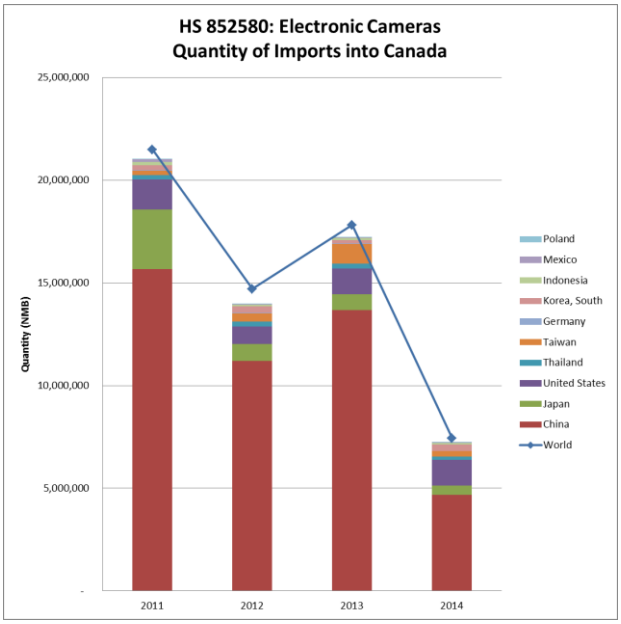

Figure 36 HS 852580: Electronic Cameras, Quantity of Imports into Canada

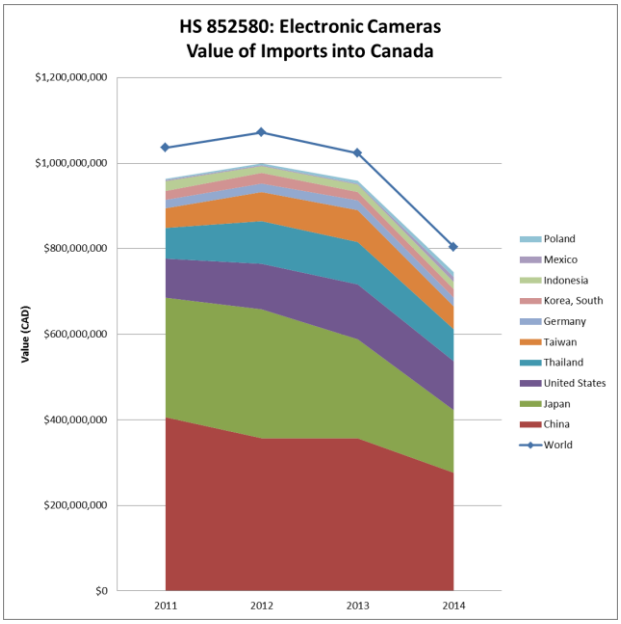

Figure 37 HS 852580: Electronic Cameras, Value of Imports into Canada

4.5.4.2 Exports

Figure 38 and Figure 39 show the data from 2011-2014. 2014 saw slightly more than 908,000 domestic exports of electronic cameras worth $360M. The total quantity of units shipped is steadily increasing, up more than 92% since 2011. The same can be said about the total value of exports, rising nearly 80% in that time frame. There was a 25% increase in value in each of 2012 and 2013, followed by a 14% increase in 2014. Units destined for the US have dominated global exports in recent years, representing nearly 75% of units shipped worth more than 50% of the value in 2014. Exports to the US have risen more than 130% in quantity and about 84% in value since 2011.

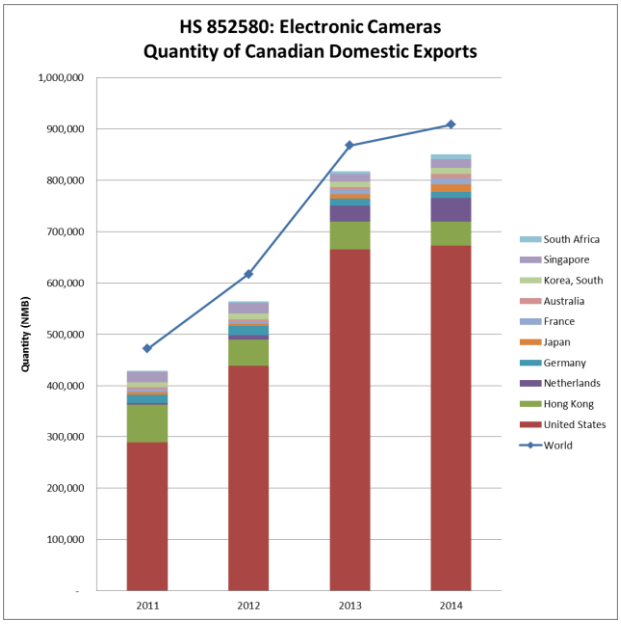

Figure 38 HS 852580: Electronic Cameras, Quantity of Canadian Domestic Exports

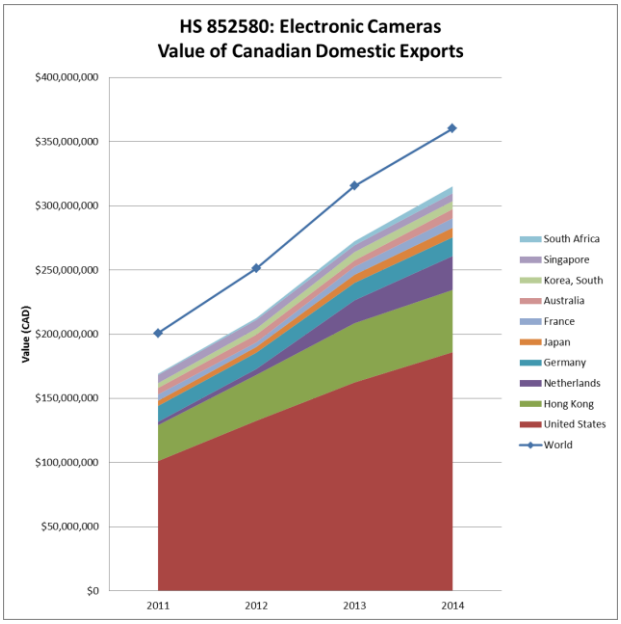

Figure 39 HS 852580: Electronic Cameras, Value of Canadian Domestic Exports

4.5.4.3 Re-exports

Figure 40 and Figure 41 show the data from 2011-2014. There were about half a million re-exports of electronic cameras worth more than $130M from Canada in 2014. Total quantity of re-exports is on a minor downward trend, losing about 14% since 2011. The total value of re-exports is rising, up 21% in 2012, nearly 4% in 2013, but then slipping 3% in 2014, but up 22% overall since 2011. The US has been the dominant destination country for re-exports in past years, representing almost 90% of Canada's re-export units worth about 83% of total value in 2014.

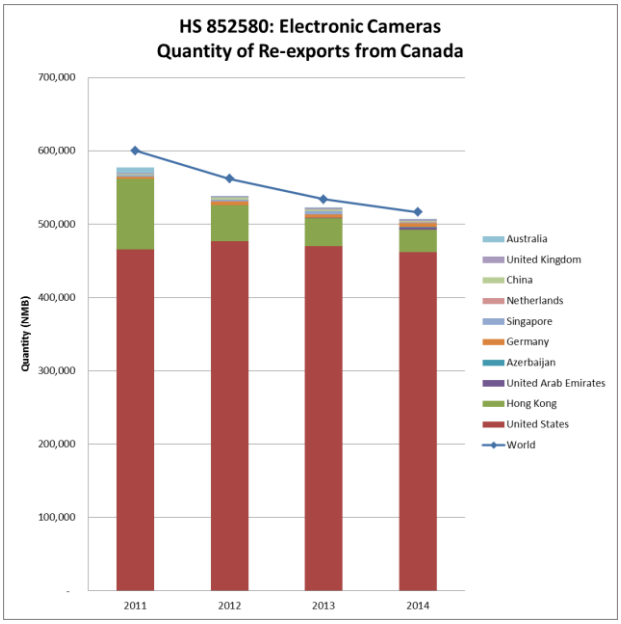

Figure 40 HS 852580: Electronic Cameras, Quantity of Re-exports from Canada

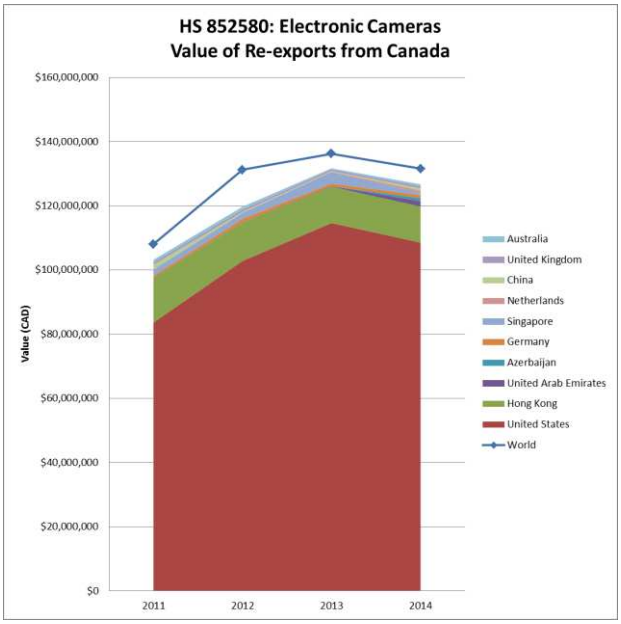

Figure 41 HS 852580: Electronic Cameras, Value of Re-exports from Canada

5. Lithium Battery Transportation Survey

5.1 Purpose

New portable and electronic devices, from laptops to mobile phones and power tools, as well as utility scale energy storage, are increasingly being powered by lithium batteries. Over the years, the use and transportation of lithium batteries has grown dramatically. The safe transportation of lithium batteries is of paramount importance for Canadian industry and consumers at large, and has an impact on many organizations across the country.

NRC prepared a survey on lithium battery transportation asking questions regarding shipping and receiving of new and used lithium batteries within various organizations in the lithium battery supply chain. The complete survey that was made available online is included in Appendix B – Lithium Battery Survey.

5.2 Methodology

To ensure that current safety regulations keep pace with the growing applications for lithium batteries, NRC requested industry participation in a market data survey, to better understand the current battery transportation environment. The survey asked questions regarding shipping and receiving of new and

used lithium batteries within various organizations. Responses were aggregated and analyzed to help Canadian industry and government identify and address gaps and refine applicable codes, standards, and regulations.

5.3 Sources Consulted

Using various resources, such as the Canadian Company Capabilities website from Industry Canada (now Innovation, Science and Economic Development Canada) and other internal means, NRC compiled a contact list of 173 individuals. An online version of the survey was created and each contact was emailed a link for access.

5.4 Summary of Results

Of the 173 industry representatives contacted, 38 individuals initiated the survey, resulting in a 22% overall response rate. 31 of these contacts (18%) completed the survey in full, with the remaining 7 contacts completing some portions and providing partial data. A thorough analysis was completed after all the results were received and compiled.

[Q1&2] What lithium battery supply chain sector(s) are you in?

Figure 42 shows the distribution of results. The majority of companies are involved in Retailing/Distribution, Equipment/System manufacture, Wholesale, and Shipping/Carrier. Four companies selected "Other", three of which were reported as follows:

1. Lithium Ion battery Energy storage
2. Supplier of grid interactive storage balance of system - power controls and conversion
3. Lithium battery end user residential

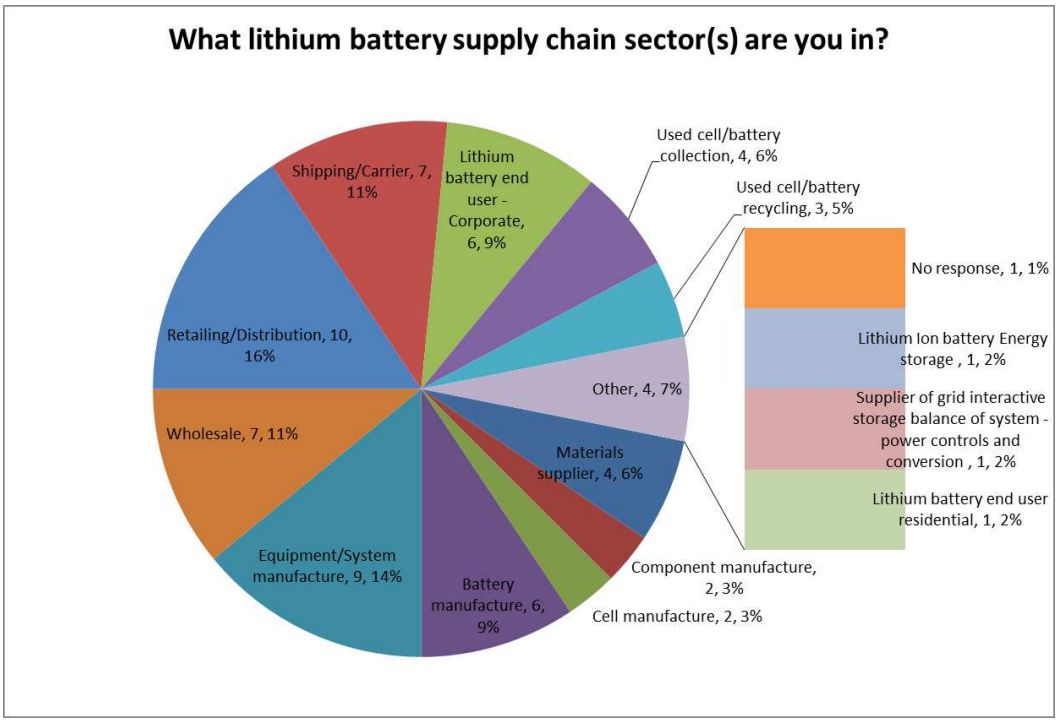

Figure 42 What lithium battery supply chain sector(s) are you in?

[Q3] For each sector, what category of lithium battery products do you produce, use, ship or receive?

Figure 43 shows the distribution of results. Most companies produce, use, ship or receive original (new) products in these sectors:

- Equipment/System manufacture
- Retailing/Distribution
- Shipping/Carrier & Lithium battery end user - Corporate
- Battery manufacture & Wholesale

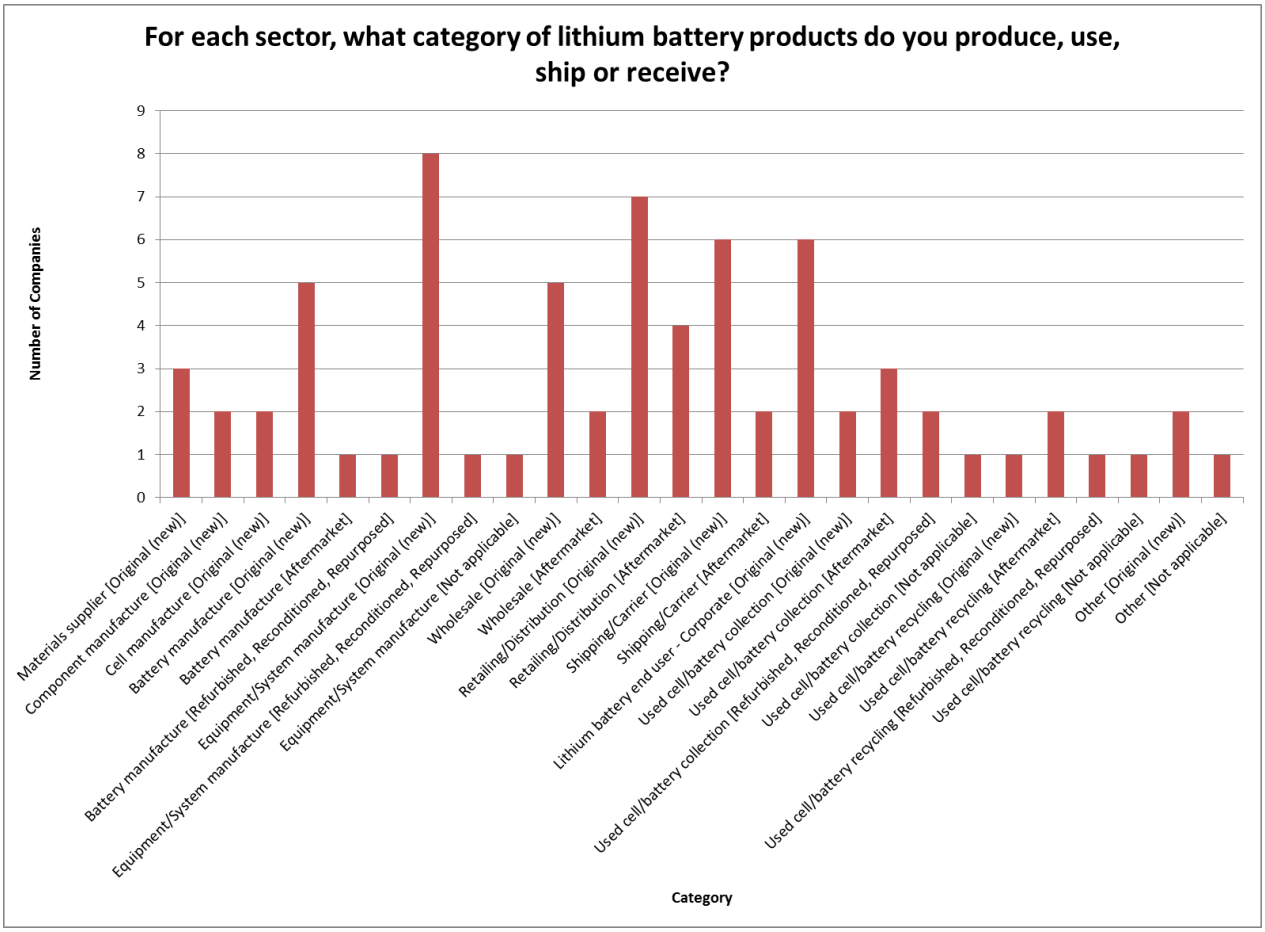

Figure 43 For each sector, what category of lithium battery products do you produce, use, ship or receive?

[Q4] What is your experience developing or integrating lithium cells or batteries?

Figure 44 shows the distribution of results. The bulk of companies (31%) have 5 to 9 years of experience developing or integrating lithium cells or batteries. There were an equal number of companies (21%) having 0 to 4 years of experience as there were companies having 20 or more years of experience.

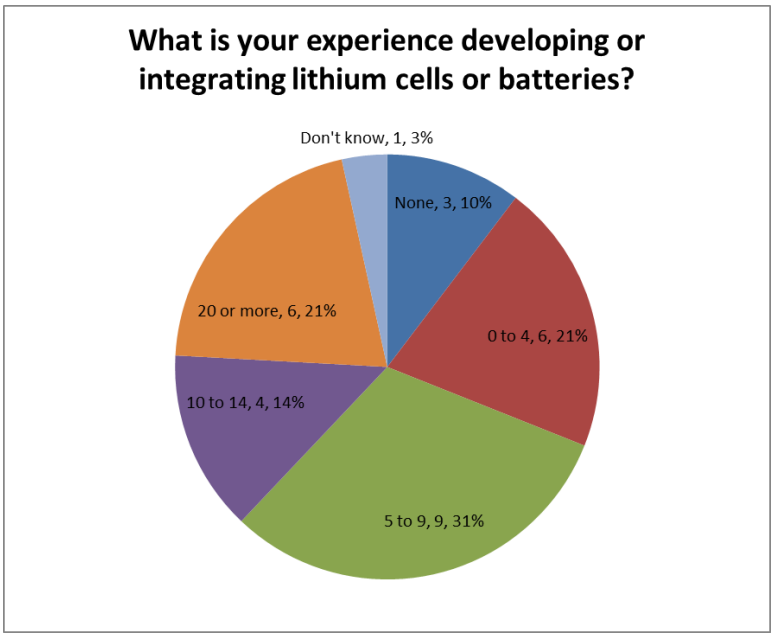

Figure 44 What is your experience developing or integrating lithium cells or batteries?

[Q5] What is the application of the cells, batteries or equipment containing Li batteries that you produce, use, ship or receive?

Figure 45 shows the distribution of results. The most common applications were off-grid or grid energy storage, laptops, personal electronic devices (PED) (e.g., smartphones and tablets), and handheld instrumentation. There were also 10 other applications identified:

- electric-assist bicycles
- small vehicles powered by lithium batteries
- military
- security equipment
- security systems
- individual batteries for flashlights
- implantable medical devices
- ocean monitoring equipment
- remote data recording instruments
- jump starters

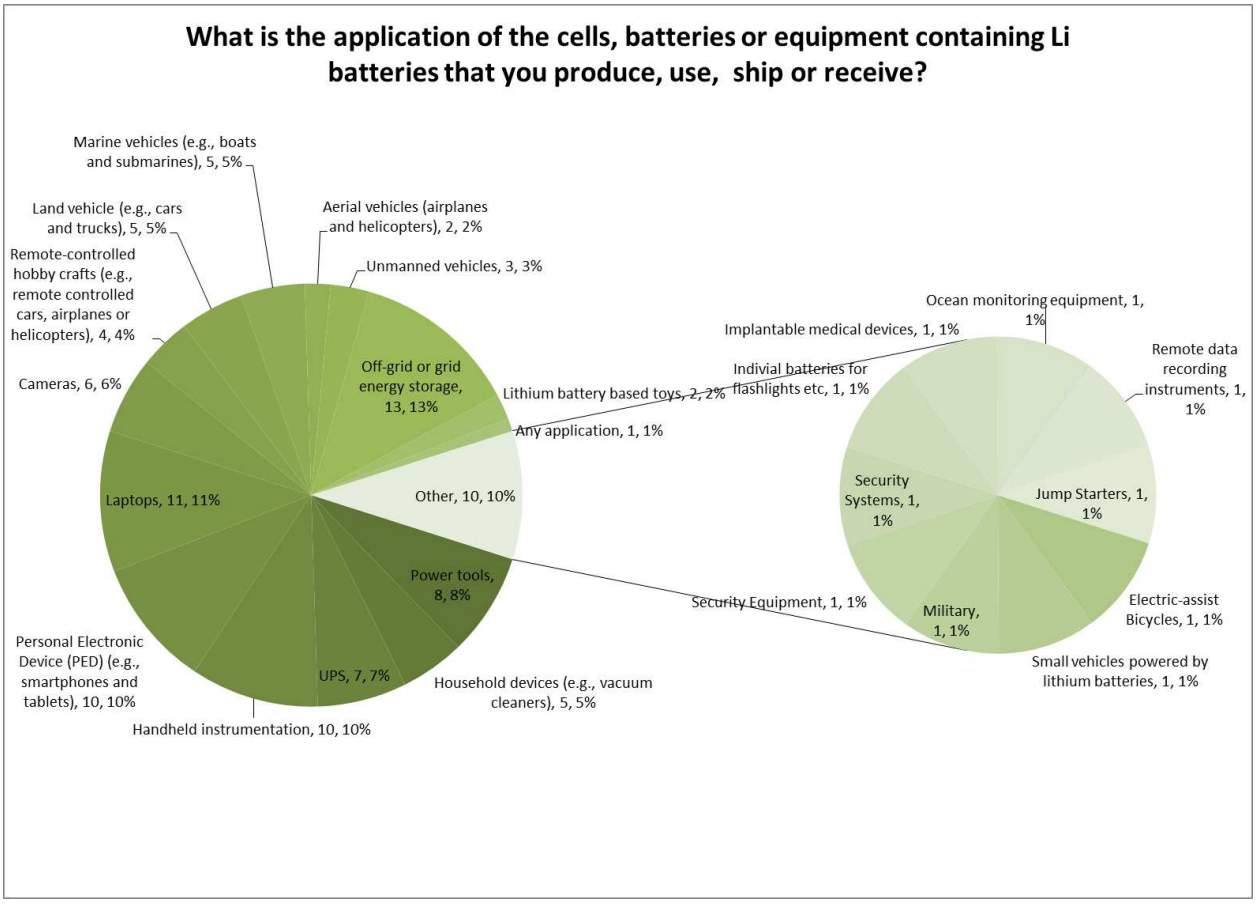

Figure 45 What is the application of the cells, batteries or equipment containing Li batteries that you produce, use, ship or receive?

[Q6] Which of the following lithium battery trade activities fit your business best?

Figure 46 shows the distribution of results. The most common trade activity was importing products into Canada (29%). 62% of companies that manufacture in Canada, or substantially modify local or imported products, ship these products within Canada; the remaining companies re-export these same products. 70% of companies that import products and do not significantly modify them, ship these products within Canada; the remaining companies re-export these same products.

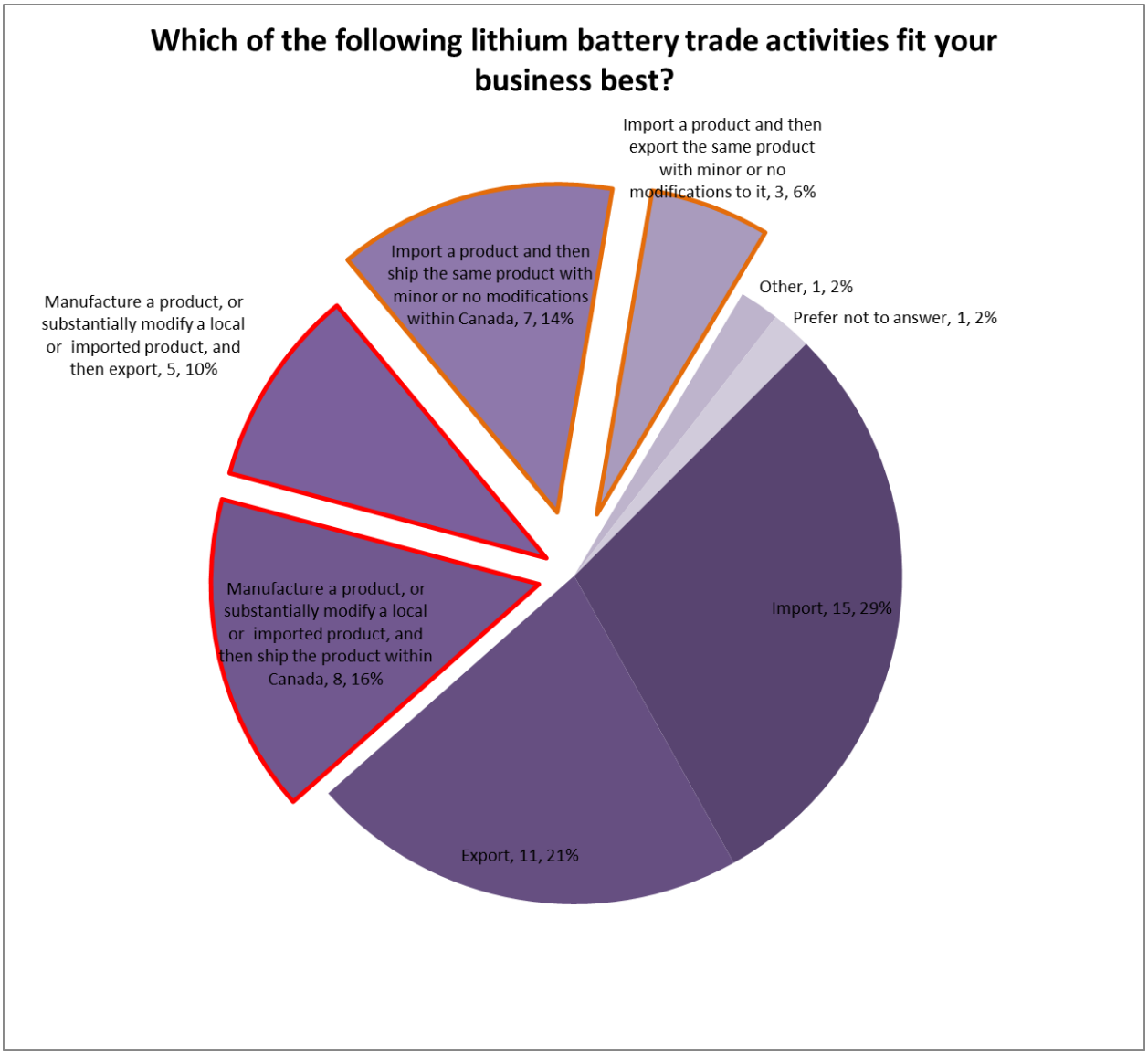

Figure 46 Which of the following lithium battery trade activities fit your business best?

[Q7] Do you ship and/or receive batteries (cells, modules, packs) or products containing batteries?

Figure 47 shows the distribution of results. The majority of companies (82%) ship and receive products containing lithium batteries.

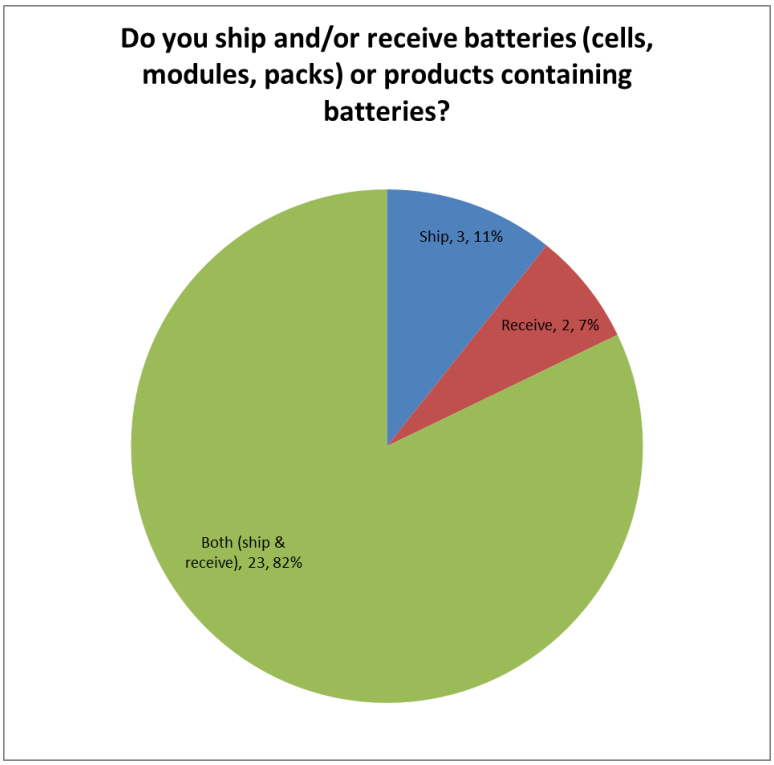

Figure 47 Do you ship and/or receive batteries (cells, modules, packs) or products containing batteries?

If we compare the data from Questions 4 and 7, we can get some insight into the link between the experience companies have in developing or integrating lithium cells or batteries and in shipping and receiving products containing lithium batteries. Figure 48 shows the comparative results between the two questions.

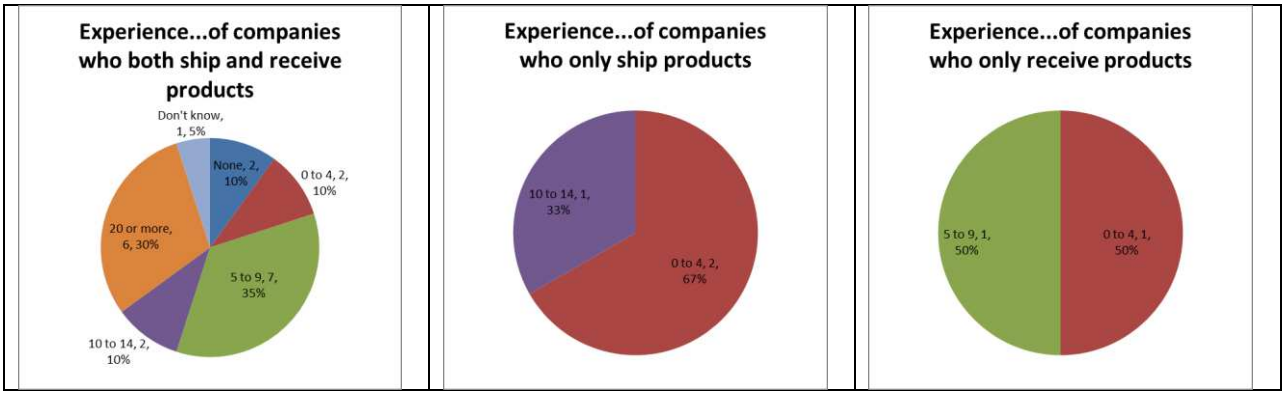

Figure 48 Experience developing or integrating lithium cells or batteries of companies who reported having shipped and received batteries or products containing batteries

[Q8] What is your experience shipping and receiving lithium cells or batteries? (Years)

Figure 49 shows the distribution of results. Companies had essentially equal experience shipping as they did receiving products. With the exception of one company, most companies were relatively equally distributed amongst the following four categories:

- 0 to 4 years
- 5 to 9 years
- 10 to 14 years
- 20 or more years

One company did not know the answer to the question for either shipping or receiving.

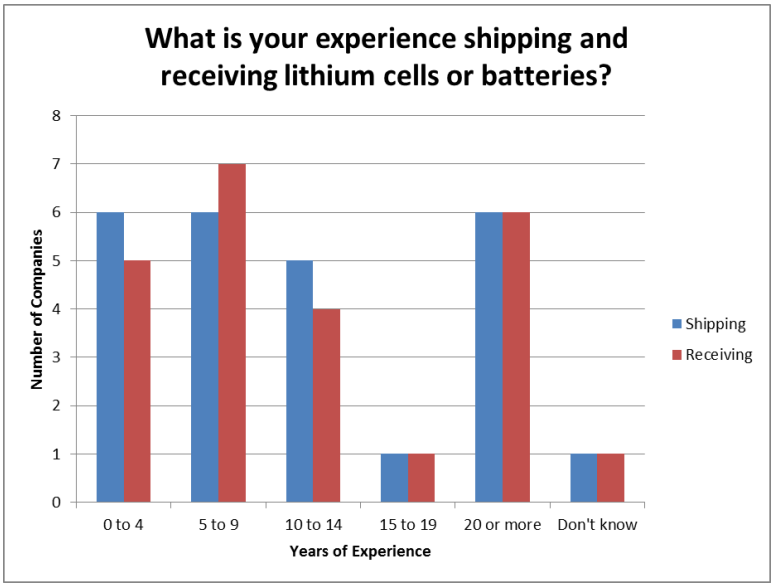

Figure 49 What is your experience shipping and receiving lithium cells or batteries? (Years)

[Q9] Via what transportation modes are lithium cells, batteries or equipment containing Li batteries shipped and received?

Figure 50 shows the distribution of results. By far, ground transportation is the most common mode used to ship and receive lithium cells, batteries or equipment containing Li batteries. The 2nd most common mode for receiving products is via marine transportation while air transport is the 2nd most common mode for shipping products. Rail is the least common mode of transportation, used by only one company. Two companies preferred not to answer and one company did not know the answer to this question.

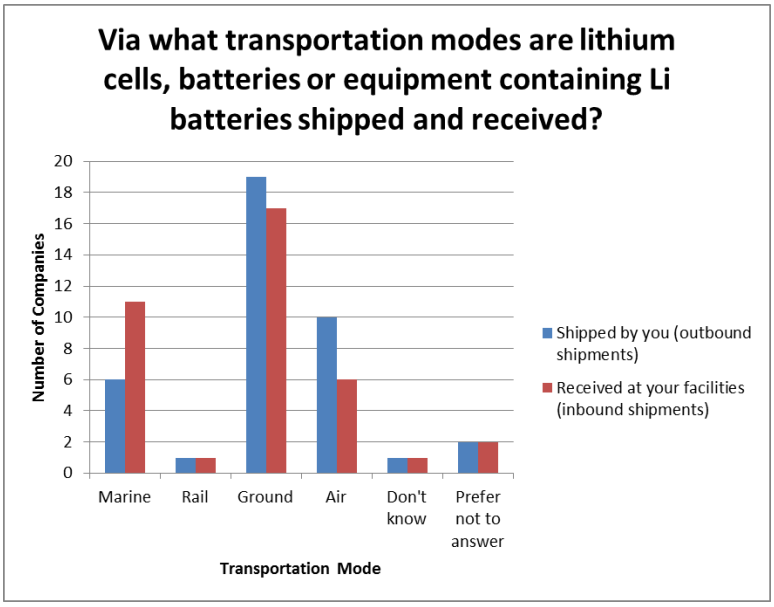

Figure 50 Via what transportation modes are lithium cells, batteries or equipment containing Li batteries shipped and received?

[Q10] Approximately what percentage of shipments do you ship and receive by air?

Figure 51 shows the distribution of results. Most companies ship less than 25% of their products by air. However, there is an unequal distribution in the percentage of products received by air. One company did not know how much they ship or receive products by air.

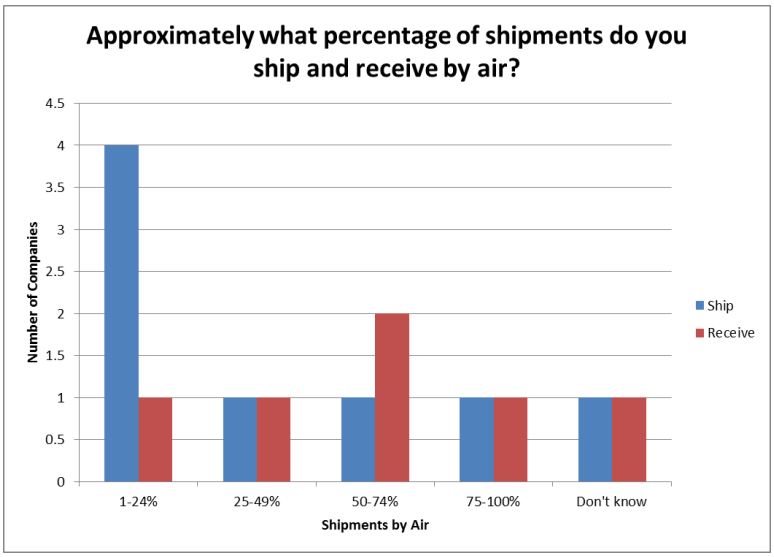

Figure 51 Approximately what percentage of shipments do you ship and receive by air?

[Q11] If you are a carrier, what type of aircraft do you use?

Figure 52 shows the distribution of results. Unfortunately, no respondents answered this question in full. Of the two companies that responded to the question, one stated not applicable and the other preferred not to answer the question.

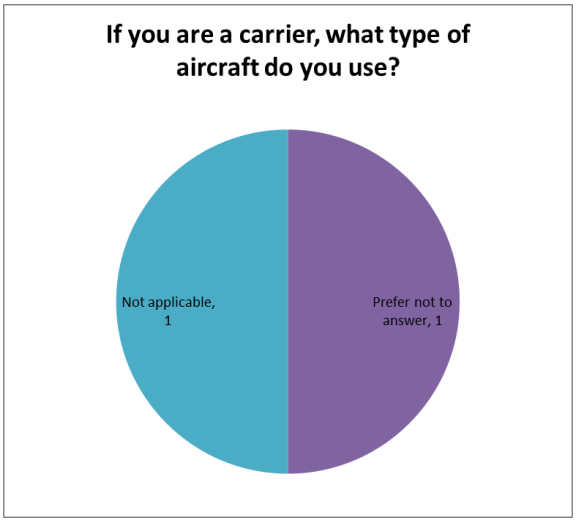

Figure 52 If you are a carrier, what type of aircraft do you use?

[Q12] How many shipments per year of Li cells, batteries or equipment containing Li batteries do you ship and receive?

Figure 53 shows the distribution of results (note the logarithmic scale). Only one company ships more than 100 shipments per year. Similarly, only one company receives more than 100 shipments per year. In the comments section, at the end of the survey, it was revealed that this company recycles ~200,000kg of Li batteries per year. As a result, this company is treated as an outlier since recycling falls under a different regulatory regime. Most companies ship and receive on the order of 10 to 60 shipments per year. Five companies stated that they shipped exactly the same number as they received per year. 29% didn't know and 17% preferred not to answer how many annual consignments they shipped. 22% didn't know and 13% preferred not to answer how many annual consignments they received.

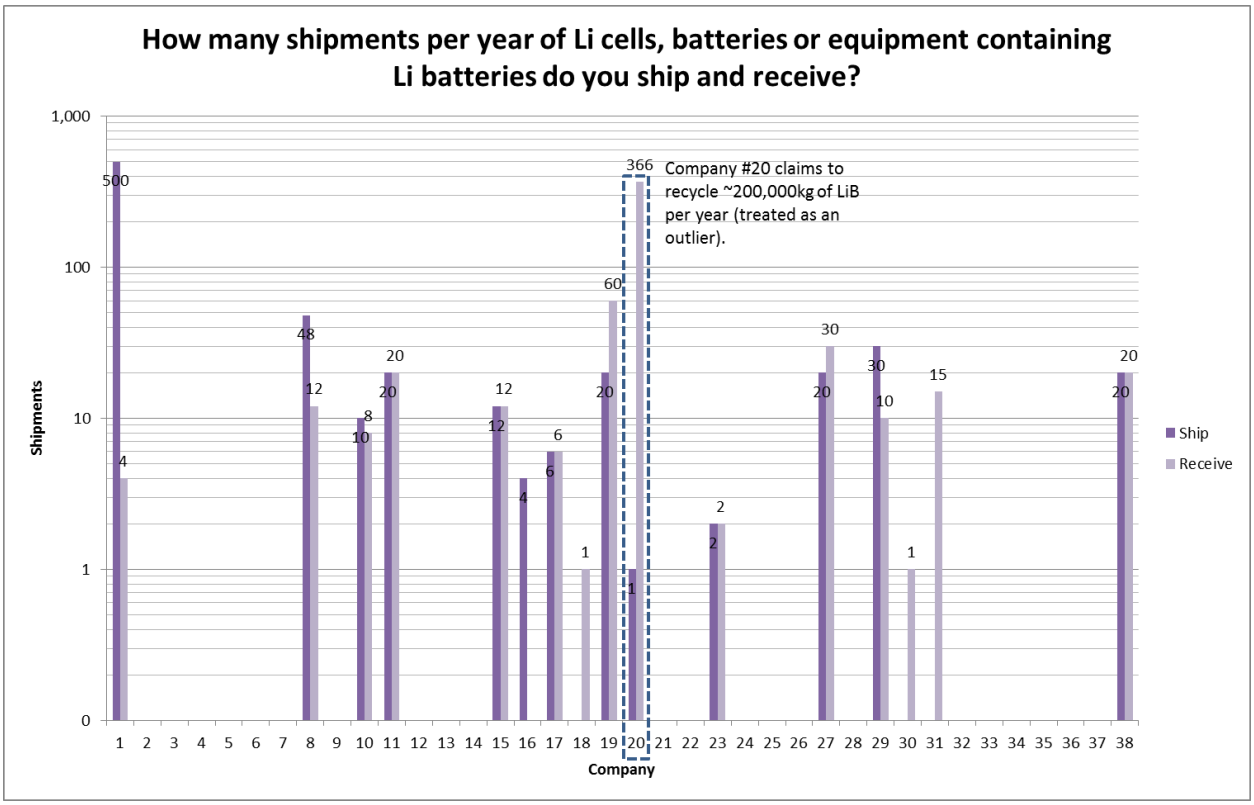

Figure 53 How many shipments per year of Li cells, batteries or equipment containing Li batteries do you ship and receive?

To get a better understanding of what the shipments contain, and the associated risk of these shipments, further details of the companies represented in Question 12 are shown in Table 9.

Table 9 Reported supply chain(s) and application(s) of companies represented in Question 12.

Company ID	Supply Chain	Application
1	• Equipment/System manufacture	• Land vehicle (e.g., cars and trucks)
	• Wholesale	• Other - Electric-assist Bicycles
8	• Battery manufacture	• Personal Electronic Device (PED) (e.g., smartphones and tablets)
	• Equipment/System manufacture	• Land vehicle (e.g., cars and trucks)
		• Marine vehicles (e.g., boats and submarines)
		• Aerial vehicles (airplanes and helicopters)
		• Unmanned vehicles
		• Other - Military
10	• Battery manufacture	• UPS
	• Equipment/System manufacture	• Handheld instrumentation
	• Retailing/Distribution	• Other - Security Equipment
11	• Retailing/Distribution	• Handheld instrumentation
15	• Wholesale	• Off-grid or grid energy storage
	• Retailing/Distribution	
16	• Shipping/Carrier	• Power tools
		• Personal Electronic Device (PED) (e.g., smartphones and tablets)
		• Laptops
17	• Component manufacture	• Land vehicle (e.g., cars and trucks)
	• Battery manufacture	• Off-grid or grid energy storage
	• Equipment/System manufacture	
18	• Lithium battery end user - Corporate	• Off-grid or grid energy storage
19	• Wholesale	• Power tools
	• Retailing/Distribution	• Household devices (e.g., vacuum cleaners)
	• Shipping/Carrier	• Handheld instrumentation
	• Used cell/battery collection	• Personal Electronic Device (PED) (e.g., smartphones and tablets)
		• Laptops
		• Cameras
		• Remote-controlled hobby crafts (e.g., remote controlled cars, airplanes or helicopters)
		• Other - indivial batteries for flashlights etc
20	• Used cell/battery collection	• Any application
	• Used cell/battery recycling	
23	• Equipment/System manufacture	• Off-grid or grid energy storage
27	• Materials supplier	• Other - ocean monitoring equipment
	• Component manufacture	
29	• Equipment/System manufacture	• Handheld instrumentation
	• Lithium battery end user - Corporate	• Other - remote data recording instruments
30	• Other - Lithium Ion battery Energy storage	• Off-grid or grid energy storage
31	• Cell manufacture	• Power tools
		• Household devices (e.g., vacuum cleaners)
		• UPS
		• Handheld instrumentation
		• Personal Electronic Device (PED) (e.g., smartphones and tablets)
		• Laptops
38	• Battery manufacture	• Marine vehicles (e.g., boats and submarines)

If we compare the data from Questions 10 and 12, we can estimate the total number of shipments per year transported by air. Figure 54 shows the comparative results between the two questions.

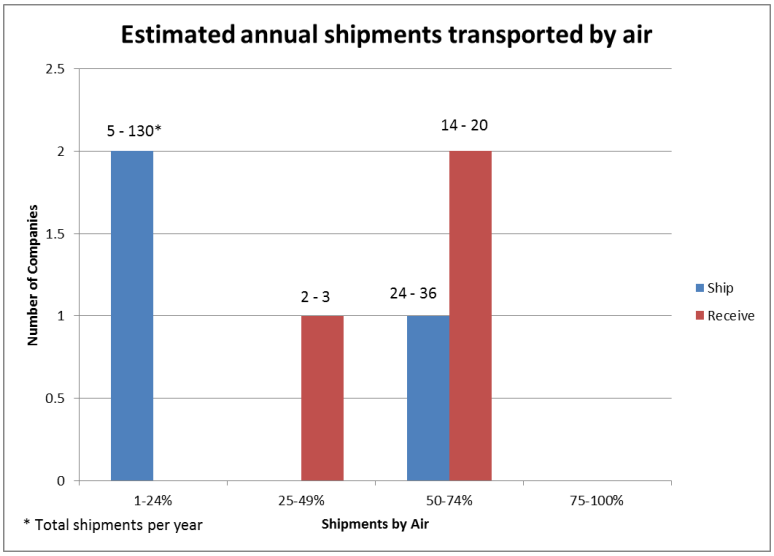

Figure 54 Estimated annual shipments transported by air

[Q13] Do you ship and receive Li cells, batteries or equipment containing Li batteries on a regular schedule?

Figure 55 shows the distribution of results. The majority of companies do, in fact, ship and receive Li cells, batteries or equipment containing Li batteries on a regular schedule.

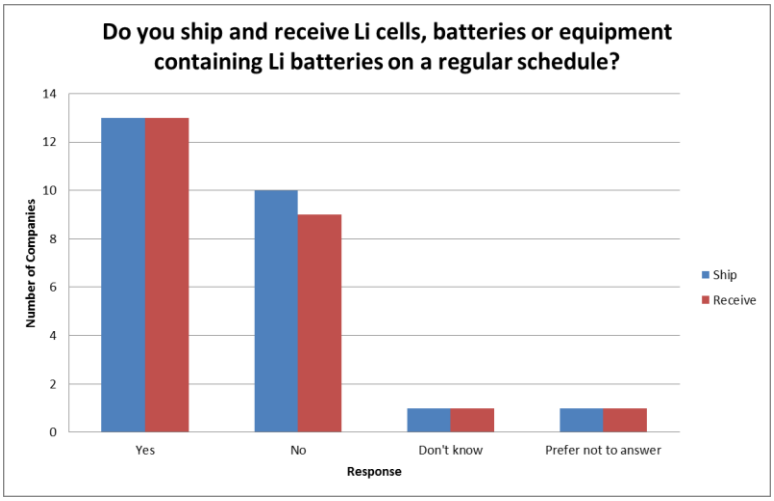

Figure 55 Do you ship and receive Li cells, batteries or equipment containing Li batteries on a regular schedule?

[Q14] What do you ship and receive?

Figure 56 shows the distribution of results.

The most common products shipped are as follows:

1. Batteries
2. Equipment containing batteries
3. Equipment packaged with batteries
4. Cells
5. Other

The most common products received are as follows:

1. Batteries
2. Cells, Equipment containing batteries
3. Equipment packaged with batteries
4. Other

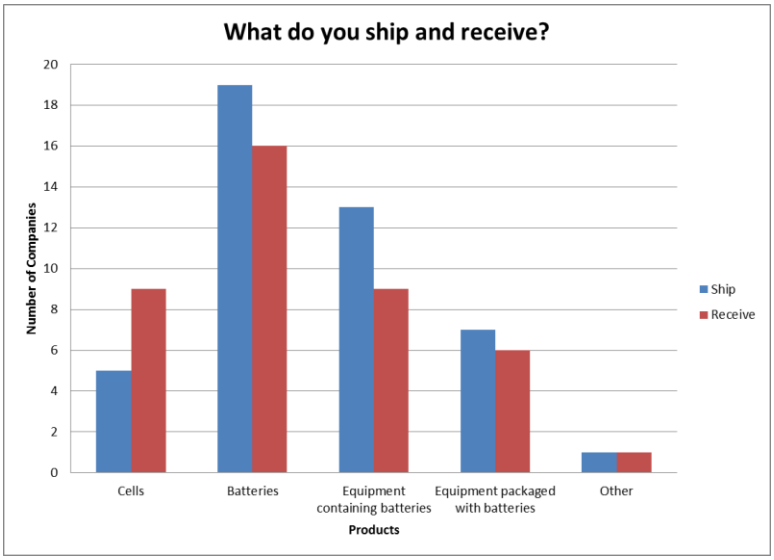

Figure 56 What do you ship and receive?

[Q15] What type of lithium cells or batteries do you ship and receive (by itself or inside a product)?

Figure 57 shows the distribution of results. About 2/3 of the cells and batteries shipped and received are lithium ion, 19-22% are lithium metal, and 9-10% are other chemistries.

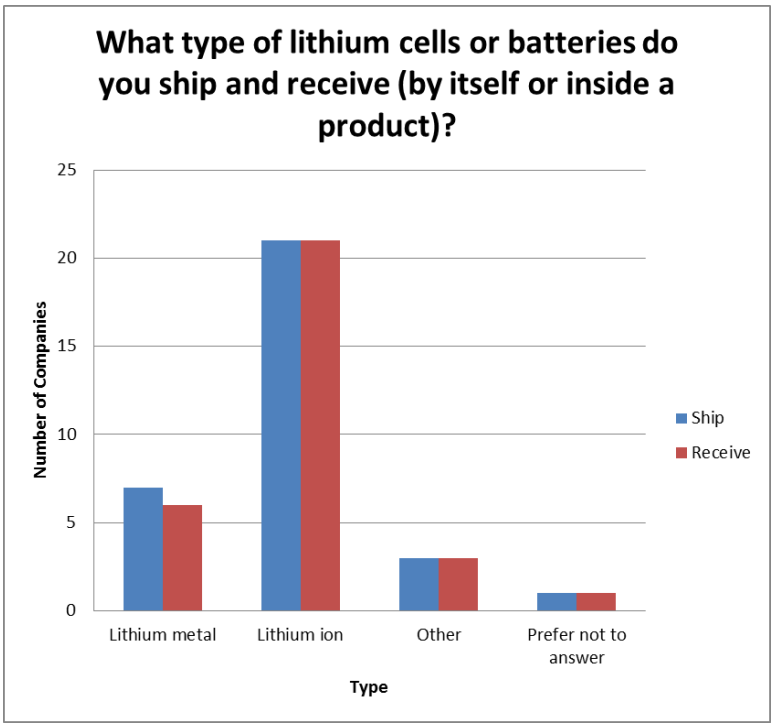

Figure 57 What type of lithium cells or batteries do you ship and receive (by itself or inside a product)?

[Q16] What proportion (%) of lithium cells or batteries do you ship and receive (by itself or inside a product)?

Figure 58 and Figure 59 show the distribution of results. By far, the majority of companies ship and receive lithium ion cells or batteries. All but one company ship and/or receive 100% lithium ion cells or batteries. One company exclusively ships and receives cells or batteries of other chemistries. One company exclusively ships lithium metal cells or batteries and one company exclusively ships and receives lithium metal cells or batteries. 30% didn't know what proportion they shipped or received and one company preferred not to answer what proportion they shipped. Two companies answered having shipped or received 100% each for Li metal and Li ion and, since this adds to 200%, they obviously did not understand the question. One company answered shipping 50% Li metal and receiving 50% Li metal and did not answer what the remaining 50% shipped and received were. These erroneous results are not included.

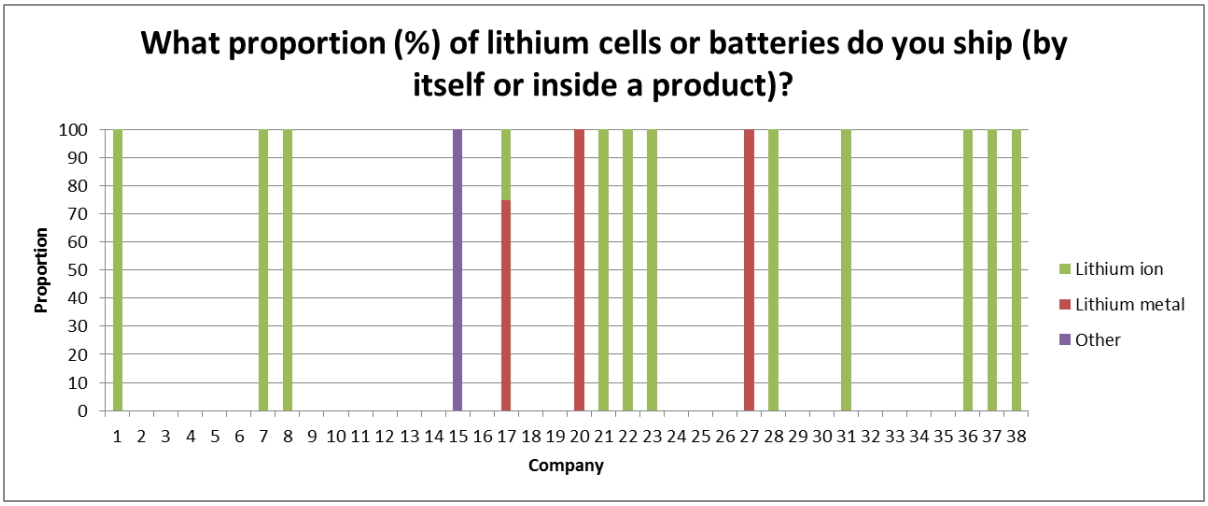

Figure 58 What proportion (%) of lithium cells or batteries do you ship (by itself or inside a product)?

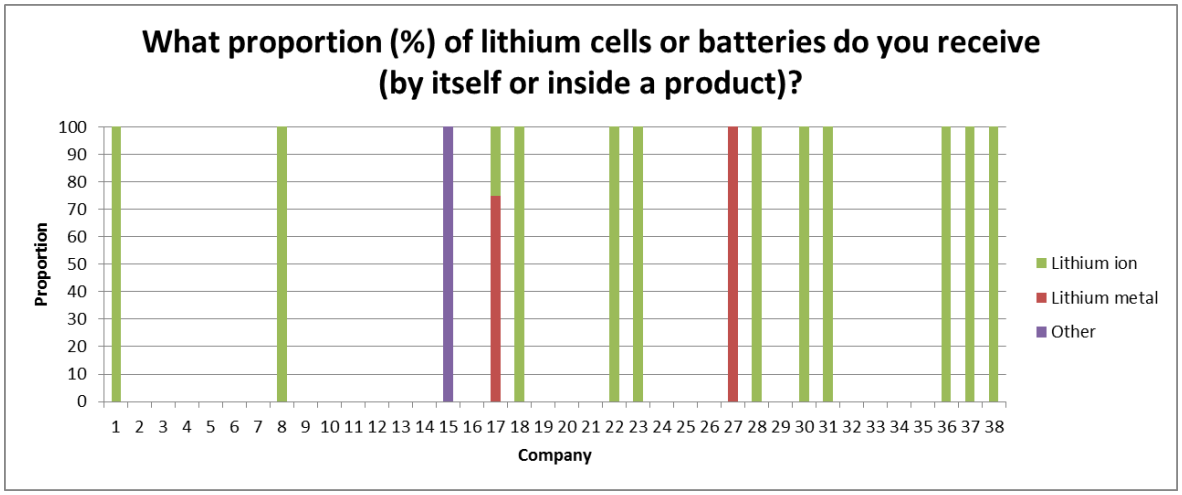

Figure 59 What proportion (%) of lithium cells or batteries do you receive (by itself or inside a product)?

[Q17] What percentage of the lithium cells, batteries or products containing Li batteries that you ship or receive have a brand name or trademark?

Figure 60 shows the distribution of results. Most companies (70%) report having shipped all or almost all products with a brand name or trademark. Fewer companies (57%) report having received all or almost all products with a brand name or trademark. Three companies reported having shipped and received no or almost no products with a brand name or trademark. Two companies preferred not to answer the question.

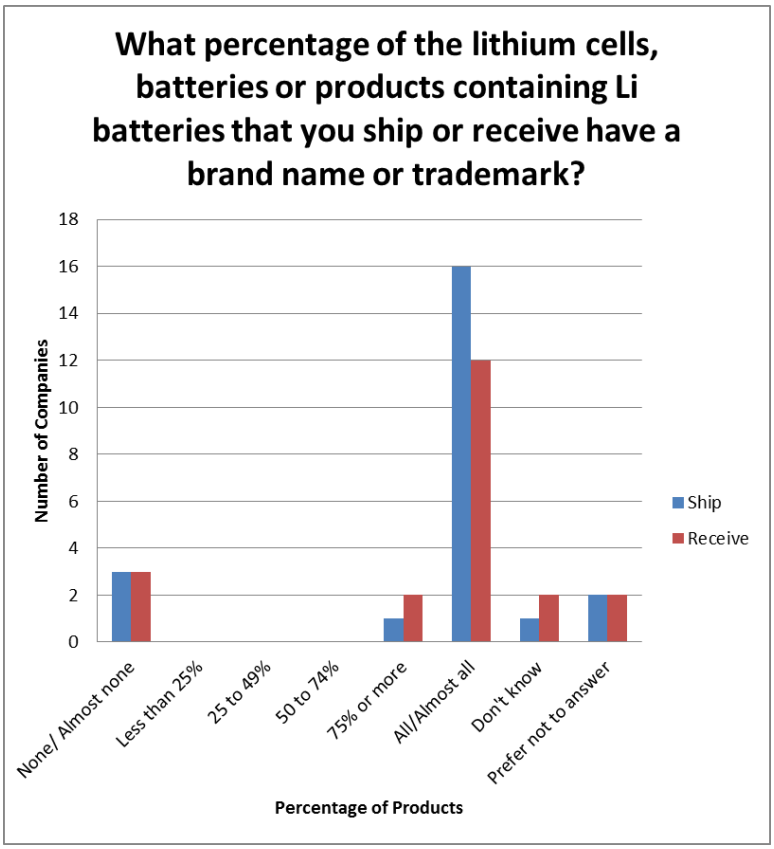

Figure 60 What percentage of the lithium cells, batteries or products containing Li batteries that you ship or receive have a brand name or trademark?

[Q18] Are the batteries that you ship and receive being shipped as Class 9 dangerous goods under UN regulations?

Figure 61 shows the distribution of results. The vast majority of companies report having shipped and received batteries classified as Class 9 dangerous goods. Notably, five companies reported not knowing the answer to the question for both shipping and receiving. One company reported that they receive batteries that are not classified as Class 9 dangerous goods but did not answer the question in regards to shipping. One company reported being exempt for both shipping and receiving and one company preferred not to answer the question.

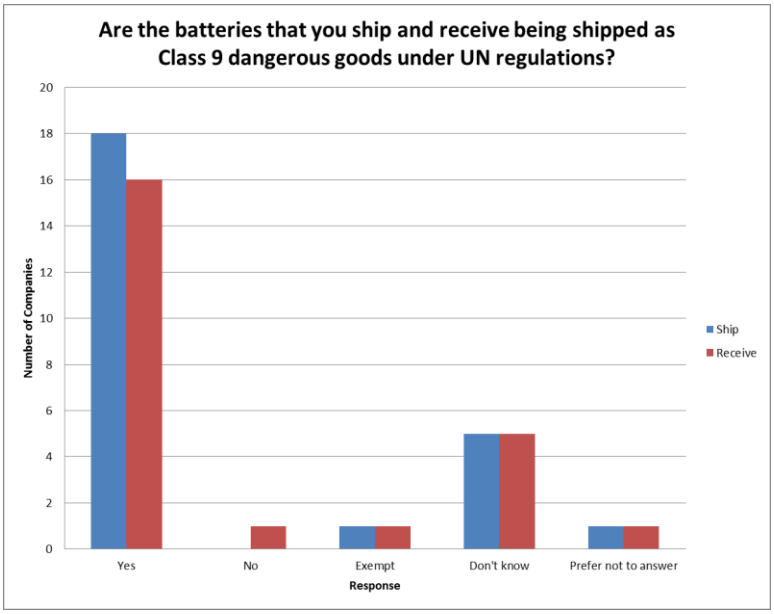

Figure 61 Are the batteries that you ship and receive being shipped as Class 9 dangerous goods under UN regulations?

[Q19] On average, what is the number of cells/batteries that you ship and receive per shipment?

Figure 62 shows the distribution of results. More companies reported having shipped only 1 to 2 cell/batteries per shipment and having received 50 to 499 cell/batteries per shipment. Aside from that, there was a relatively equal distribution of across the range of answers. Only one company ships and receives 50,000 or more and one company receives 50,000 or more. Three companies reported not knowing how many cells/batteries they shipped or received and one reported not knowing how many cells/batteries they received. Two companies preferred not to answer how many cells/batteries they shipped or received and one preferred not to answer how many cells/batteries they shipped and did not answer in regards to receiving.

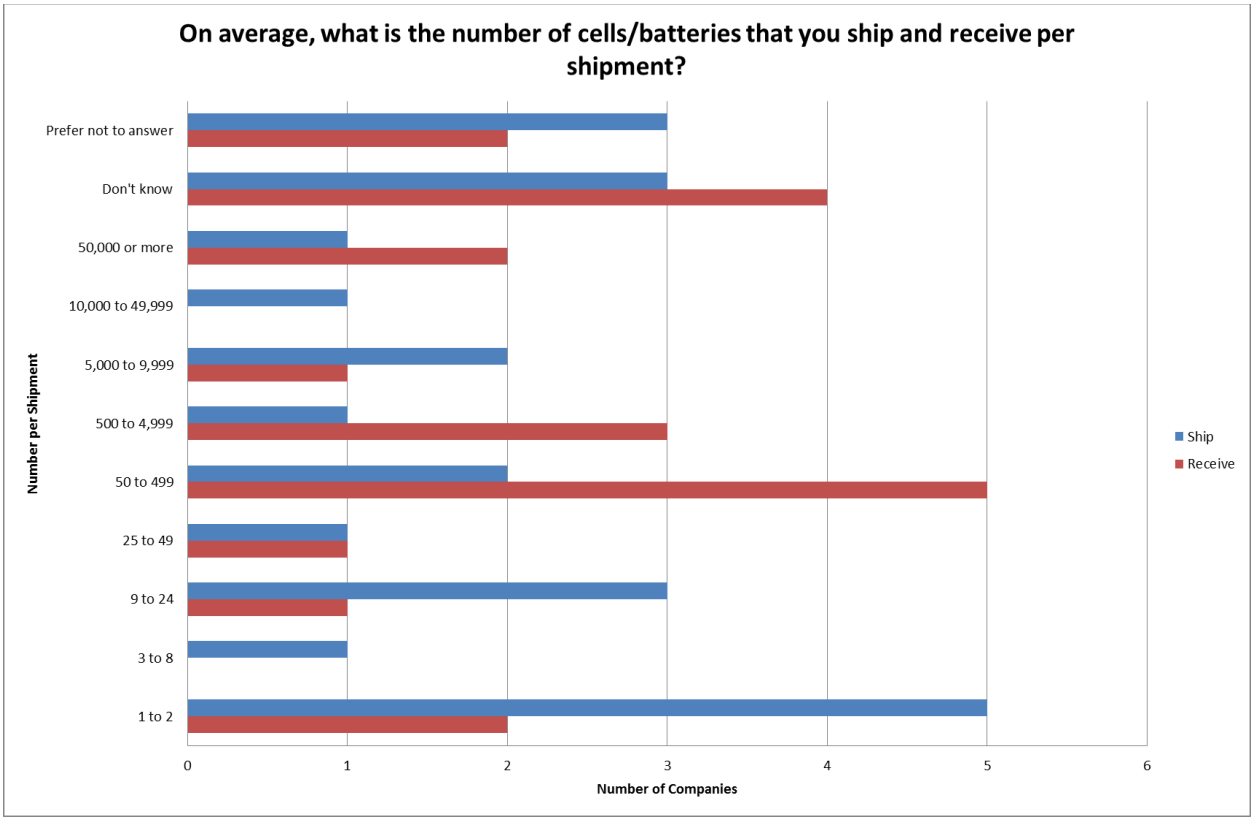

Figure 62 On average, what is the number of cells/batteries that you ship and receive per shipment?

If we compare the data from Questions 9 and 19, we can estimate the average number of products shipped and received via each mode of transportation – marine, rail, ground and air. Figure 63 shows the comparative results between the two questions.

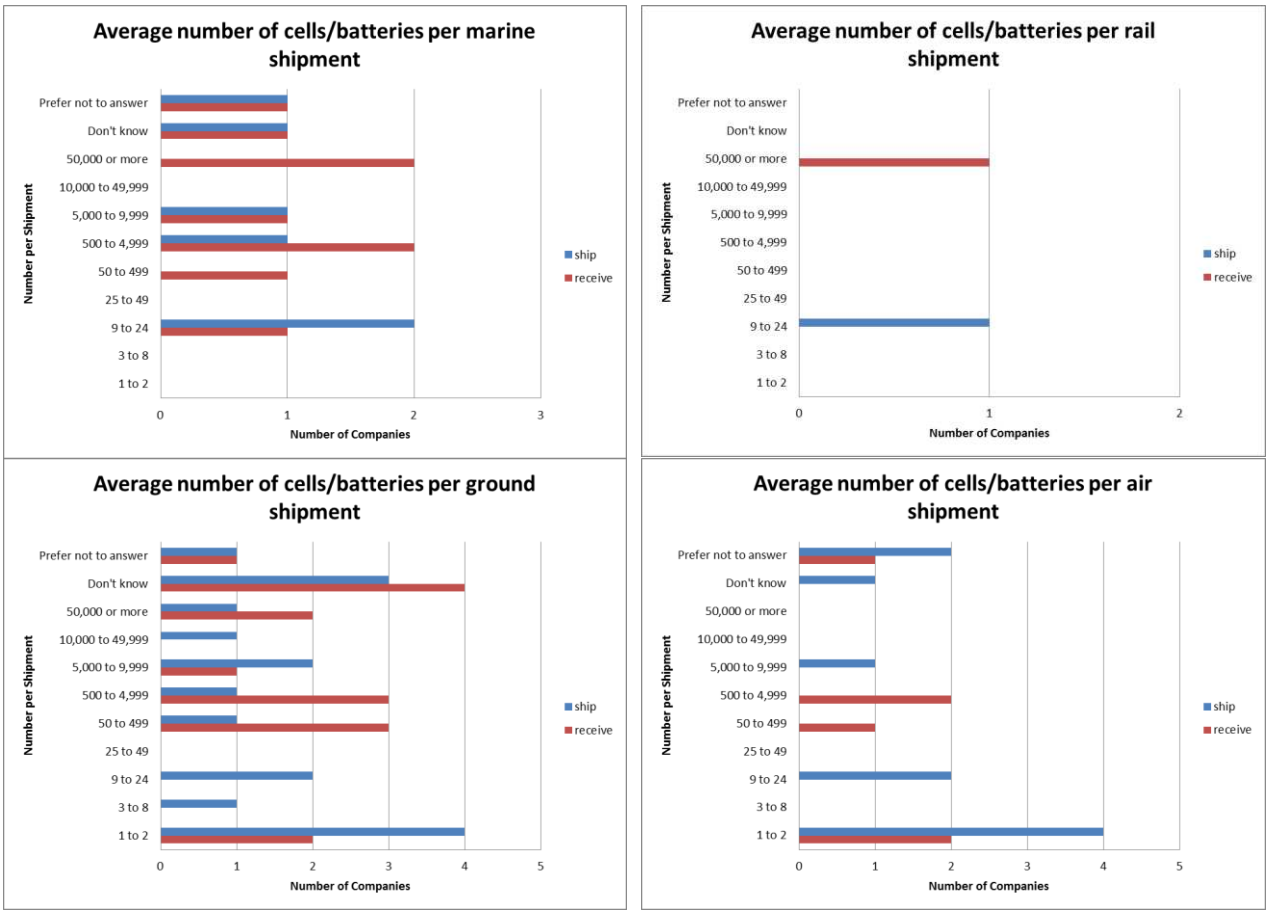

Figure 63 Average number of cells/batteries shipped and received via each mode of transportation.

If we compare the data from Questions 12 and 19, we can estimate the minimum and maximum number of lithium cells, batteries or equipment containing lithium batteries shipped and received per year. The received maximum was not available for Company 20 and the shipped and received maximums were not available for Company 23 as they reported "50,000 or more" cells/batteries per shipment. Figure 64 shows the comparative results between the two questions.

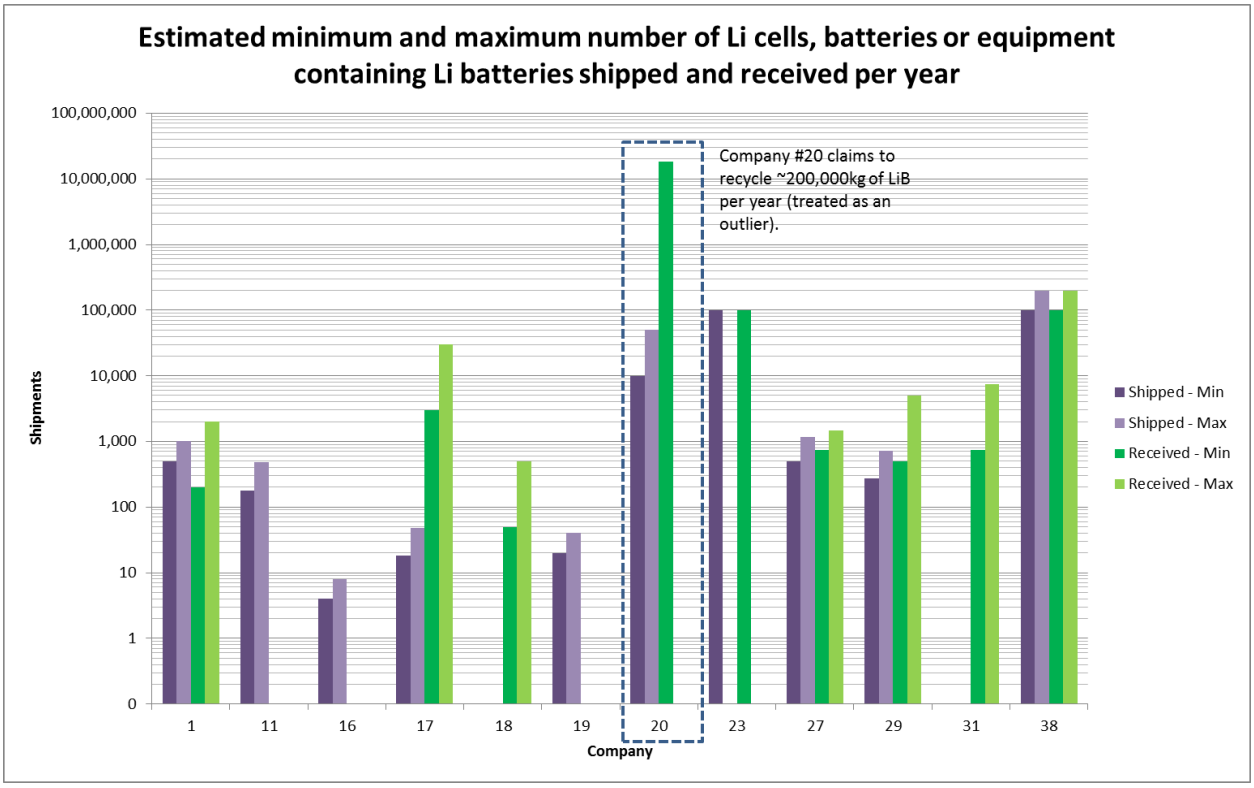

Figure 64 Estimated minimum and maximum number of Li cells, batteries or equipment containing Li batteries shipped and received per year

[Q20] On average, what is the mass of cells/batteries that you ship or receive per shipment?

Figure 65 shows the distribution of results (note the logarithmic scale). Only one company receives more than 10,000kg of cells/batteries per shipment (the same company that recycles ~200,000kg of lithium batteries per year). The majority of companies ship and receive between 10 and 1,000kg of cells/batteries per shipment. Five companies ship and three companies receive between 1,000 and 10,000 kg of cells/batteries per shipment. One company ships and receives only 1kg of cells/batteries per shipment. Two companies receive only 1kg of cells/batteries per shipment. Six companies reported not knowing the mass of cells/batteries they ship or receive per shipment, one company reported not knowing the mass of cells/batteries they ship and two reported not knowing the mass of cells/batteries they receive. Two companies preferred not to answer the mass of cells/batteries they ship or receive and one preferred not to answer the mass of cells/batteries they ship.

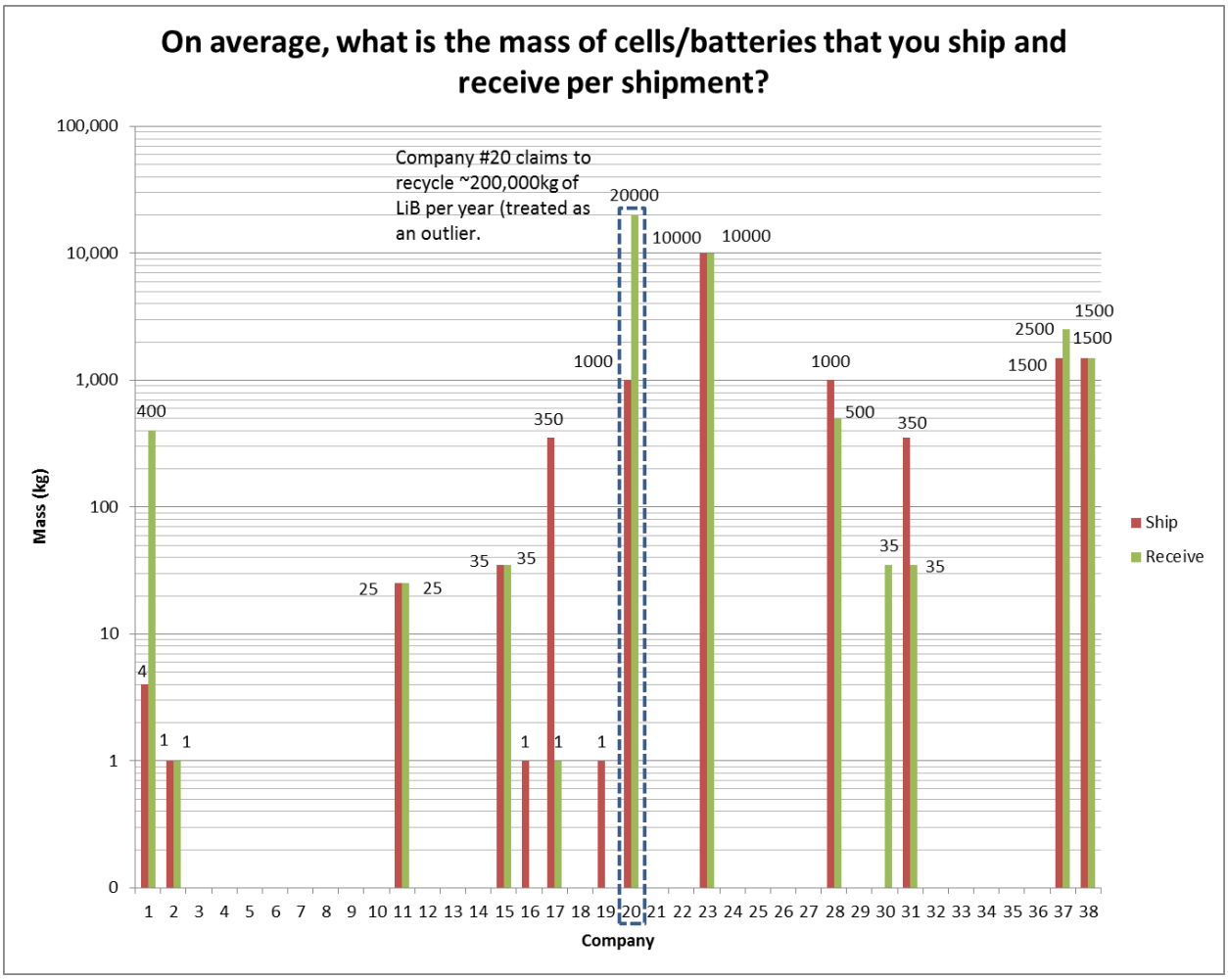

Figure 65 On average, what is the mass of cells/batteries that you ship or receive per shipment?

[Q21] On average, what is the number of equipment containing batteries that you ship or receive per shipment?

Figure 66 shows the distribution of results. All companies reported having shipped an average of 1 to 24 pieces of equipment containing batteries per shipment. Most reported having received similar numbers of equipment with the exception of three companies, one of whom receives 50 to 499 and two who receive 50 to 499. Two companies reported not knowing how many they ship or receive and two companies preferred not to answer the question.

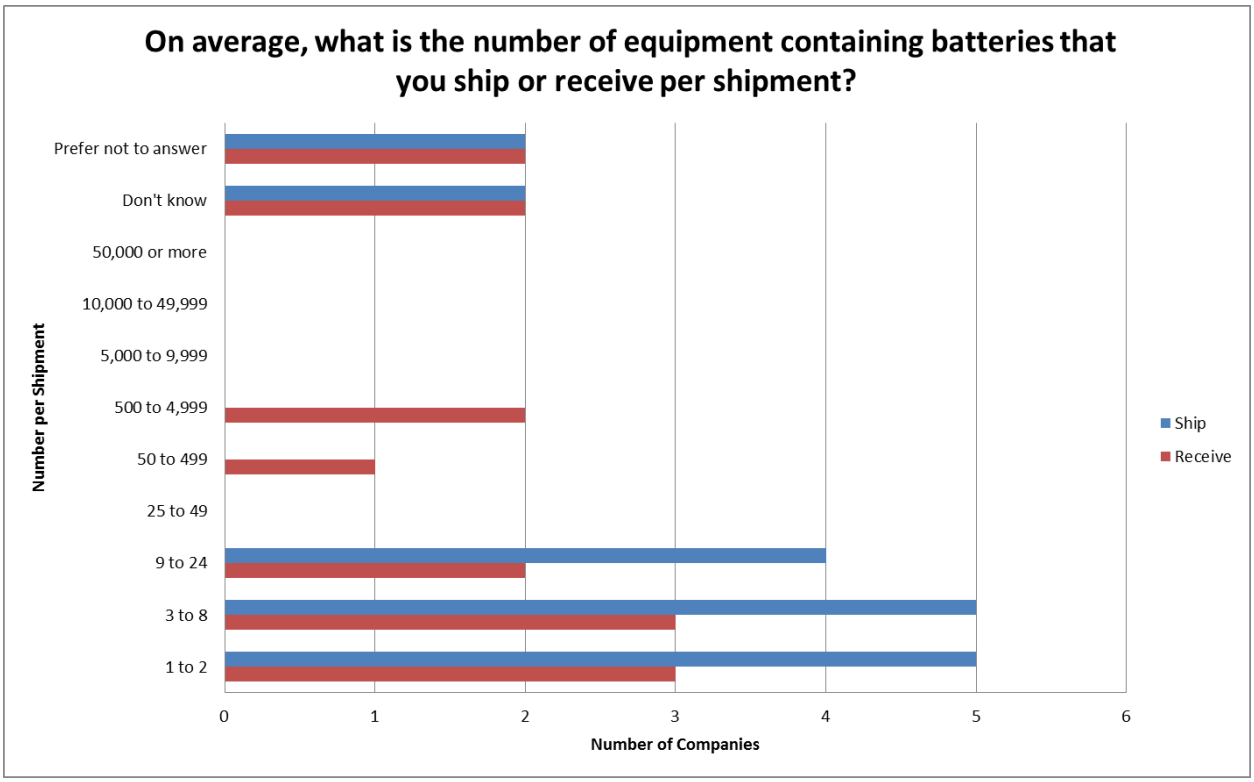

Figure 66 On average, what is the number of equipment containing batteries that you ship or receive per shipment?

[Q22] On average, what is the mass of equipment containing batteries that you ship or receive per shipment?

Figure 67 shows the distribution of results (note the logarithmic scale) and includes data from Question 16 to illustrate the proportions of lithium products shipped and received (if available). Only one company ships and receives more than 10,000kg of equipment containing batteries per shipment. Three companies ship between 1,000 and 1,500kg of equipment containing batteries per shipment. Four companies receive between 10 and 1,000kg of equipment containing batteries per shipment. Two companies ship and receive only 1kg of equipment containing batteries per shipment and one company receives 2kg of equipment containing batteries per shipment. Six companies reported not knowing the mass of equipment containing batteries they ship or receive per shipment, one company reported not knowing the mass of equipment containing batteries they ship and two reported not knowing the mass of equipment containing batteries they receive. Two companies preferred not to answer the mass of equipment containing batteries they ship or receive.

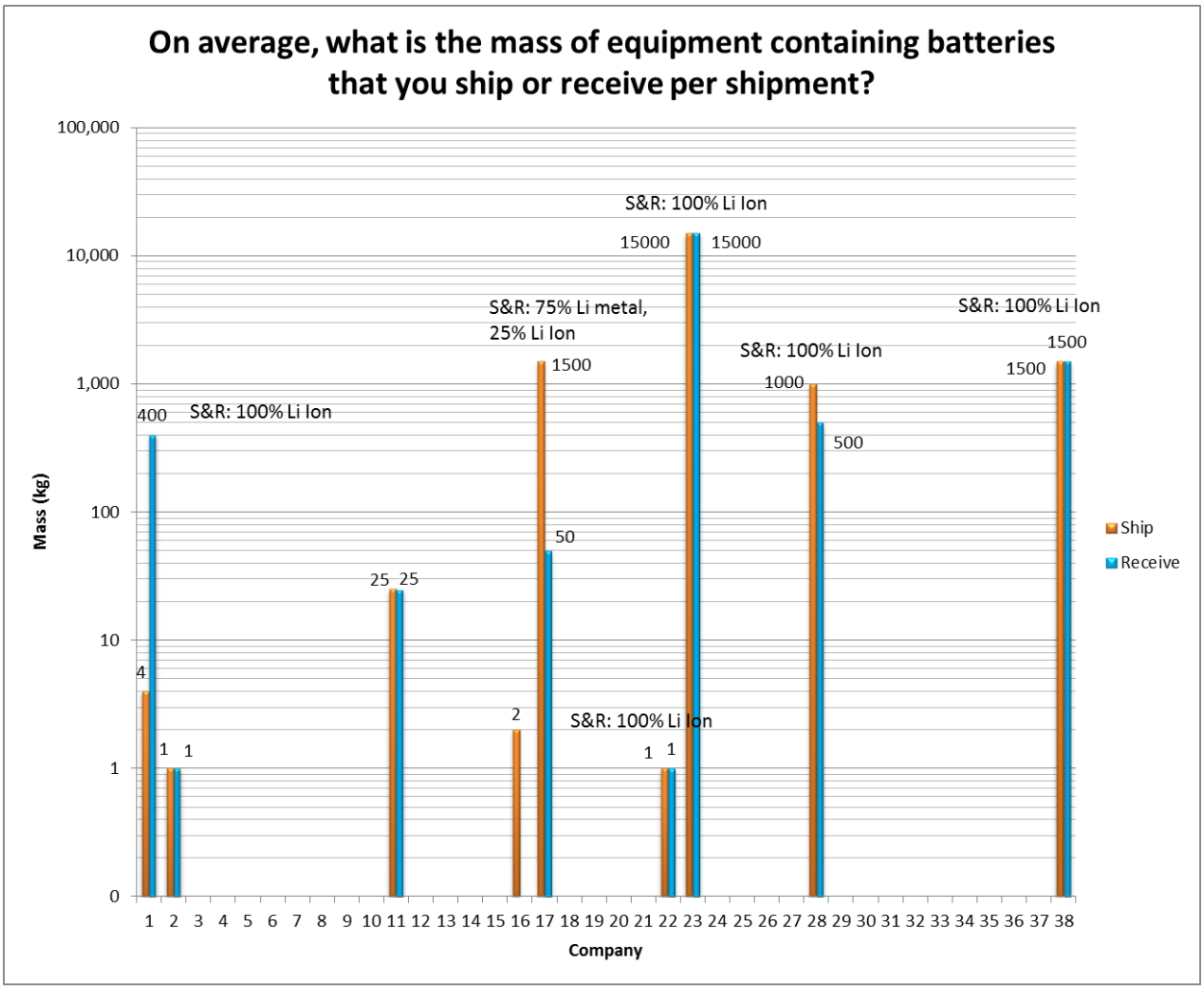

Figure 67 On average, what is the mass of equipment containing batteries that you ship or receive per shipment?

[Q23] What is the average state of charge of the lithium cells, batteries or products containing lithium batteries for each shipment sent or received?

Figure 68 shows the distribution of results. The results indicate that products are being shipped and received in varying average states of charge with slightly more reporting having shipped and received products 50-100%SOC. One company reported in the comments section that they would have preferred to choose a narrower range in the order of 45-55%SOC. Somewhat troubling is the number of companies reporting that they do not know the average state of charge for each shipment sent or received. Four companies report not knowing the SOC of products they ship or receive, one reports not knowing the SOC of what they ship, and two report not knowing the SOC of what they receive. One company preferred not to answer the question.

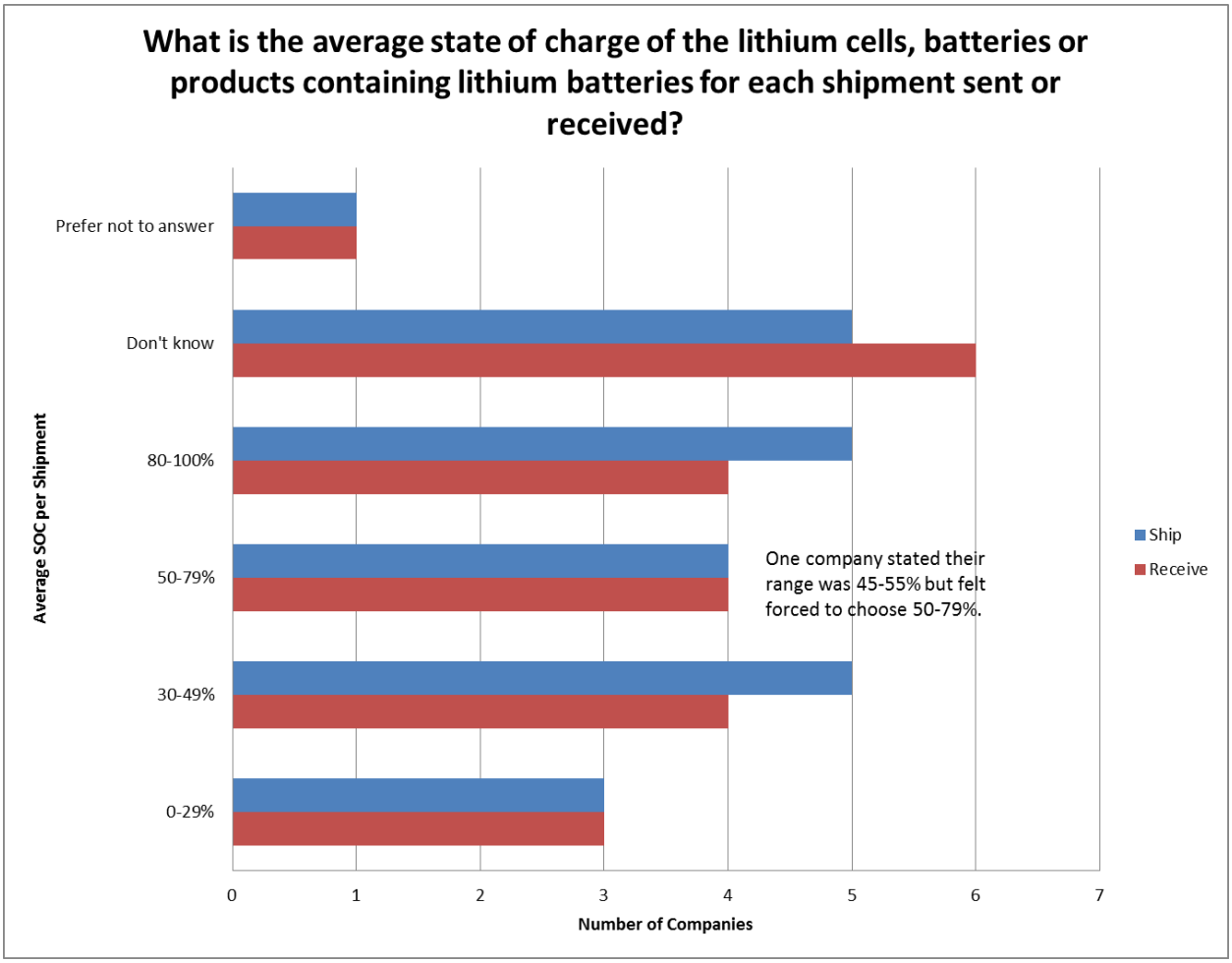

Figure 68 What is the average state of charge of the lithium cells, batteries or products containing lithium batteries for each shipment sent or received?

To get a better understanding of the companies who ship and receive products with only 0-29% SOC, further details of those companies represented in Question 23 are shown in Table 10.

Table 10 Reported supply chain(s) and application(s) of companies referenced in Question 23 who ship and receive products with 0-29% SOC.

Company ID	Supply Chain	Application
2	• Shipping/Carrier	• Handheld instrumentation
	• Lithium battery end user - Corporate	• Personal Electronic Device (PED) (e.g., smartphones and tablets)
		• Laptops
		• Aerial vehicles (airplanes and helicopters)
11	• Retailing/Distribution	• Handheld instrumentation
15	• Wholesale	• Off-grid or grid energy storage
	• Retailing/Distribution	

If we compare the data from Questions 23 and 10, we can estimate the average state of charge of the lithium cells, batteries or products containing lithium batteries for shipments transported via air. Figure 69 shows the comparative results between the two questions.

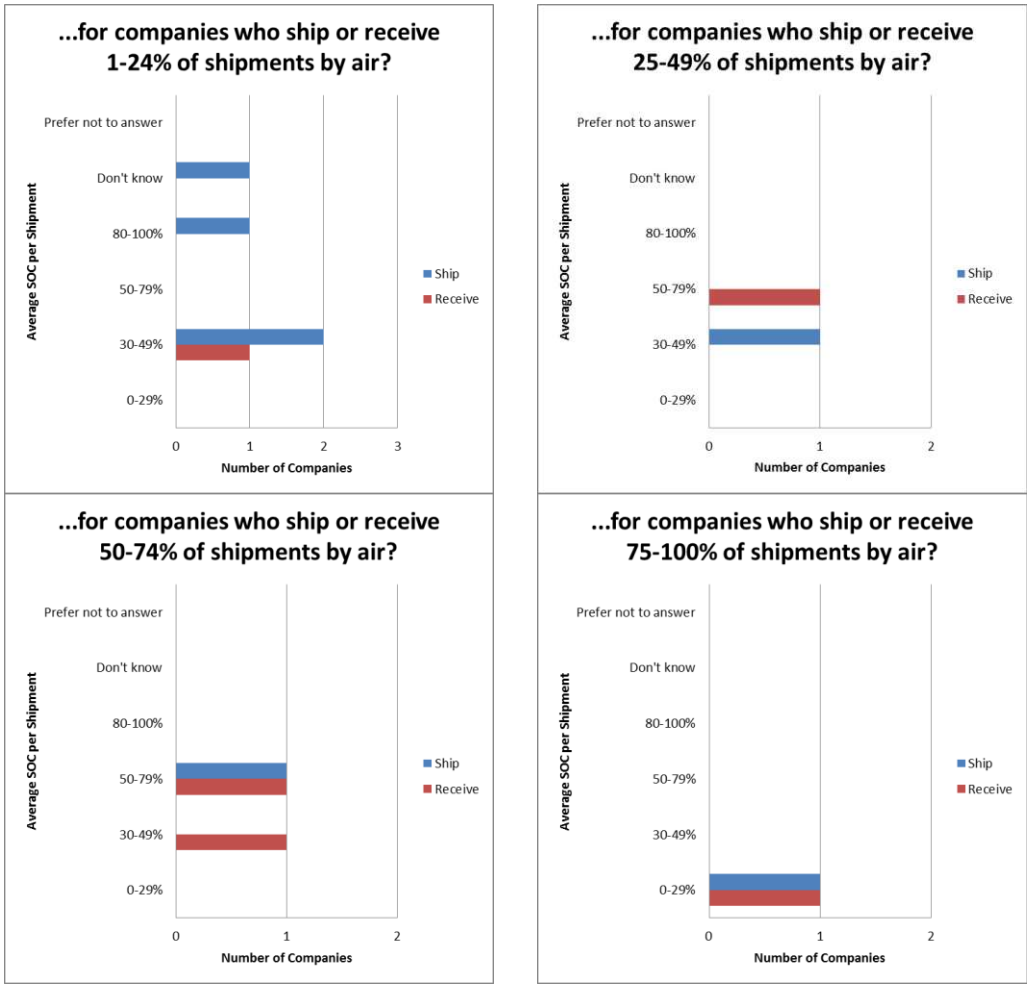

Figure 69 What is the average state of charge of the lithium cells, batteries or products containing lithium batteries for shipments transported via air?

[Q24] What is the capacity of the batteries/cells you ship or receive (Amp-Hour)?

Figure 70 shows the distribution of results. The results indicate that products of varying capacities are being shipped and received. Only one company reported that they ship and receive batteries/cells with a capacity of >5,000Ah, while two report that they ship batteries/cells with a capacity of >5,000Ah. One company reports that they ship and receive batteries/cells with a capacity of <1Ah, while one company reports that they ship batteries/cells with a capacity of <1Ah. Five companies reported that they do not know the capacity of the batteries/cells they ship or receive. One company reported that they do not know the capacity of the batteries/cells they ship and two companies reported that they do not know the capacity of the batteries/cells they receive. One company preferred not to answer the question.

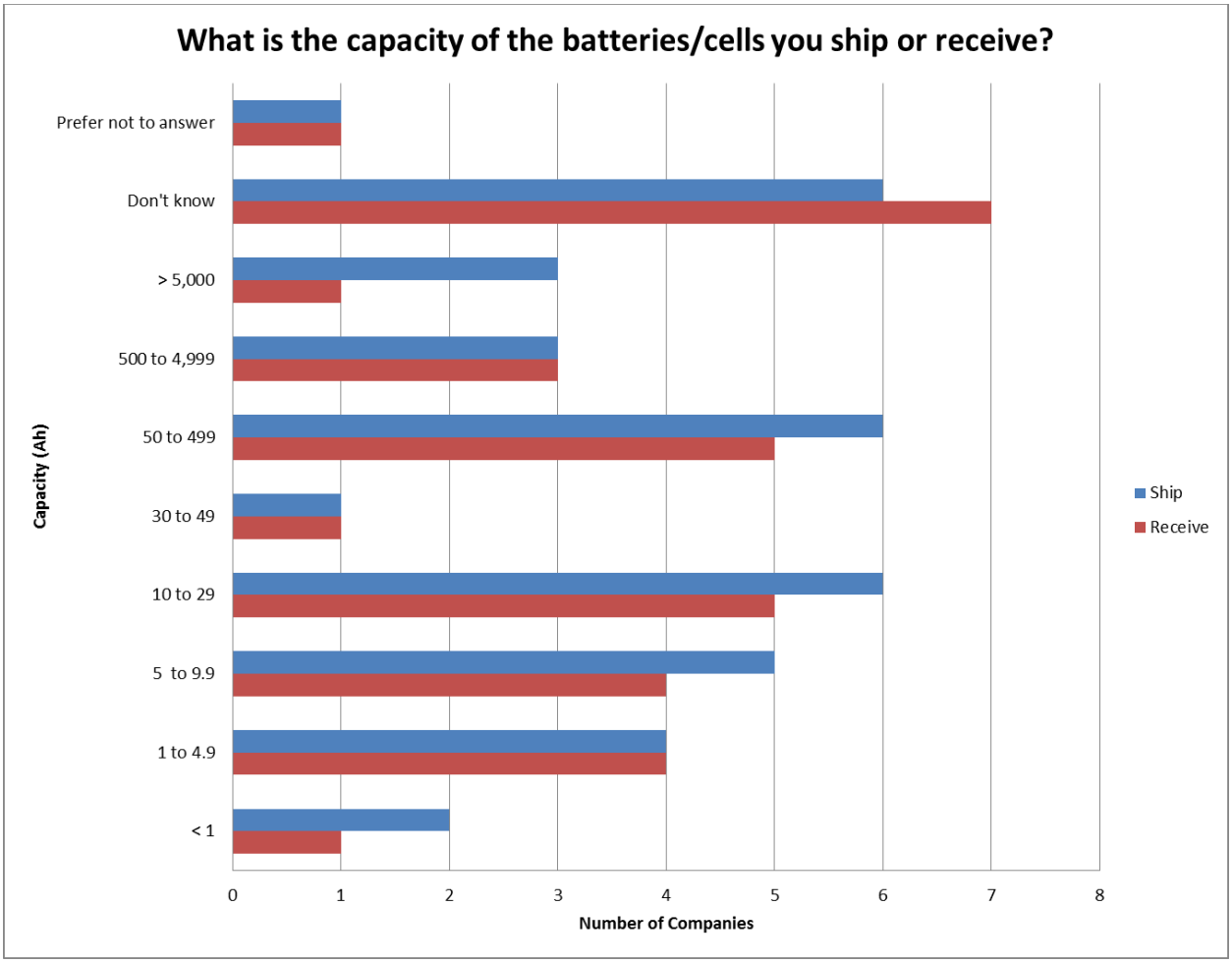

Figure 70 What is the capacity of the batteries/cells you ship or receive (Amp-Hour)?

[Q25] What is the energy content of the batteries/cells you ship or receive (Watt-Hour)?

Figure 71 shows the distribution of results. The majority of the products shipped and received have an energy content >100Wh. Seven companies only ship and receive products with an energy content >100Wh. One company ships and receives products of any energy content. Six companies reported that they do not know the energy content of the batteries/cells they ship or receive. Two companies reported that they do not know the energy content of the batteries/cells they receive. One company preferred not to answer the question.

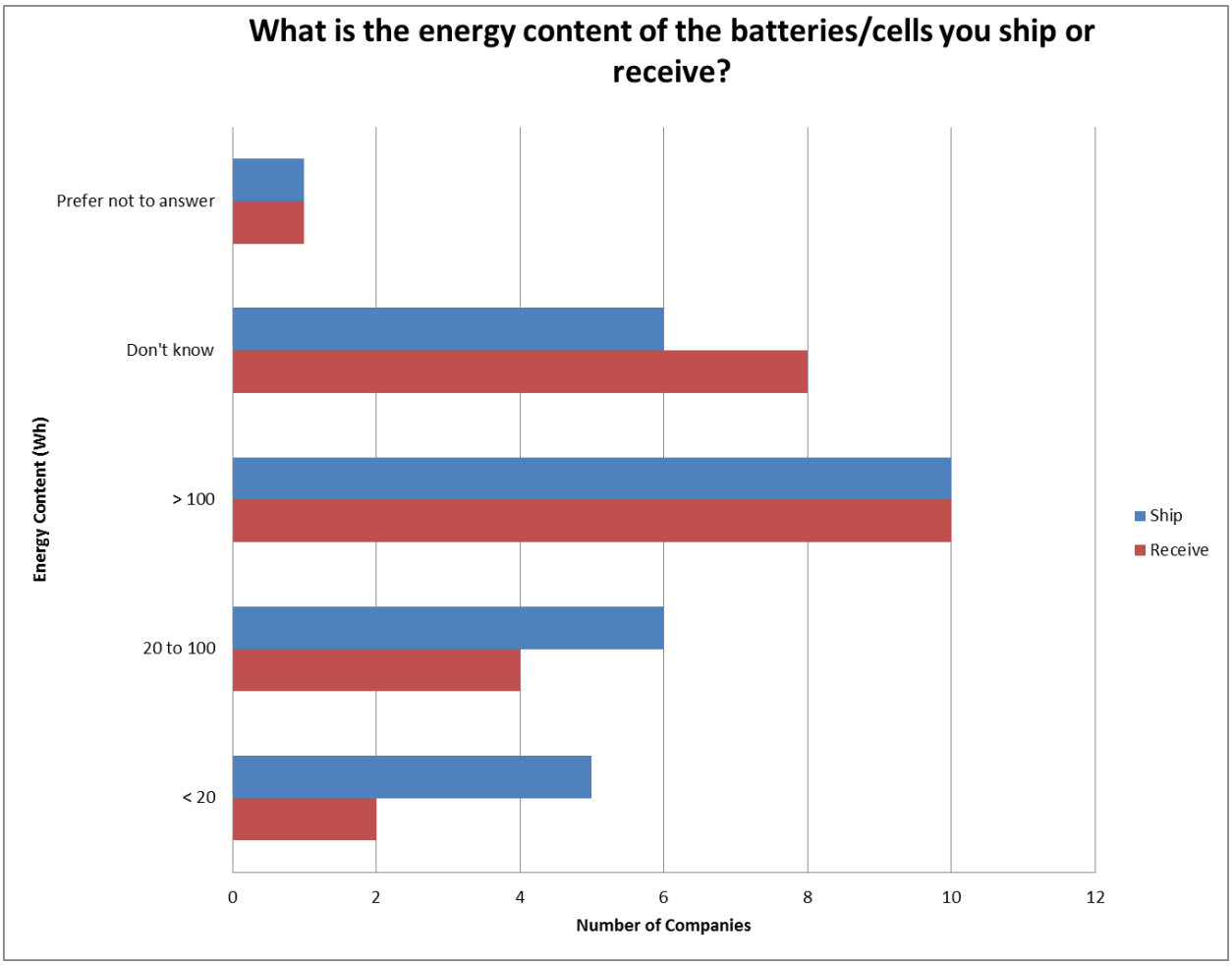

Figure 71 What is the energy content of the batteries/cells you ship or receive (Watt-Hour)?

[Q26] Where do you ship lithium cells, batteries or products containing lithium batteries?

Figure 72 shows the distribution of results. Companies reported shipping the bulk of their products containing lithium batteries within Canada, with the US being the next most popular destination and China a distant 3rd. Some companies reported shipping products to an EU member country, EU country (non-EU member), and a South American country without specifying any further. One company preferred not to answer the question.

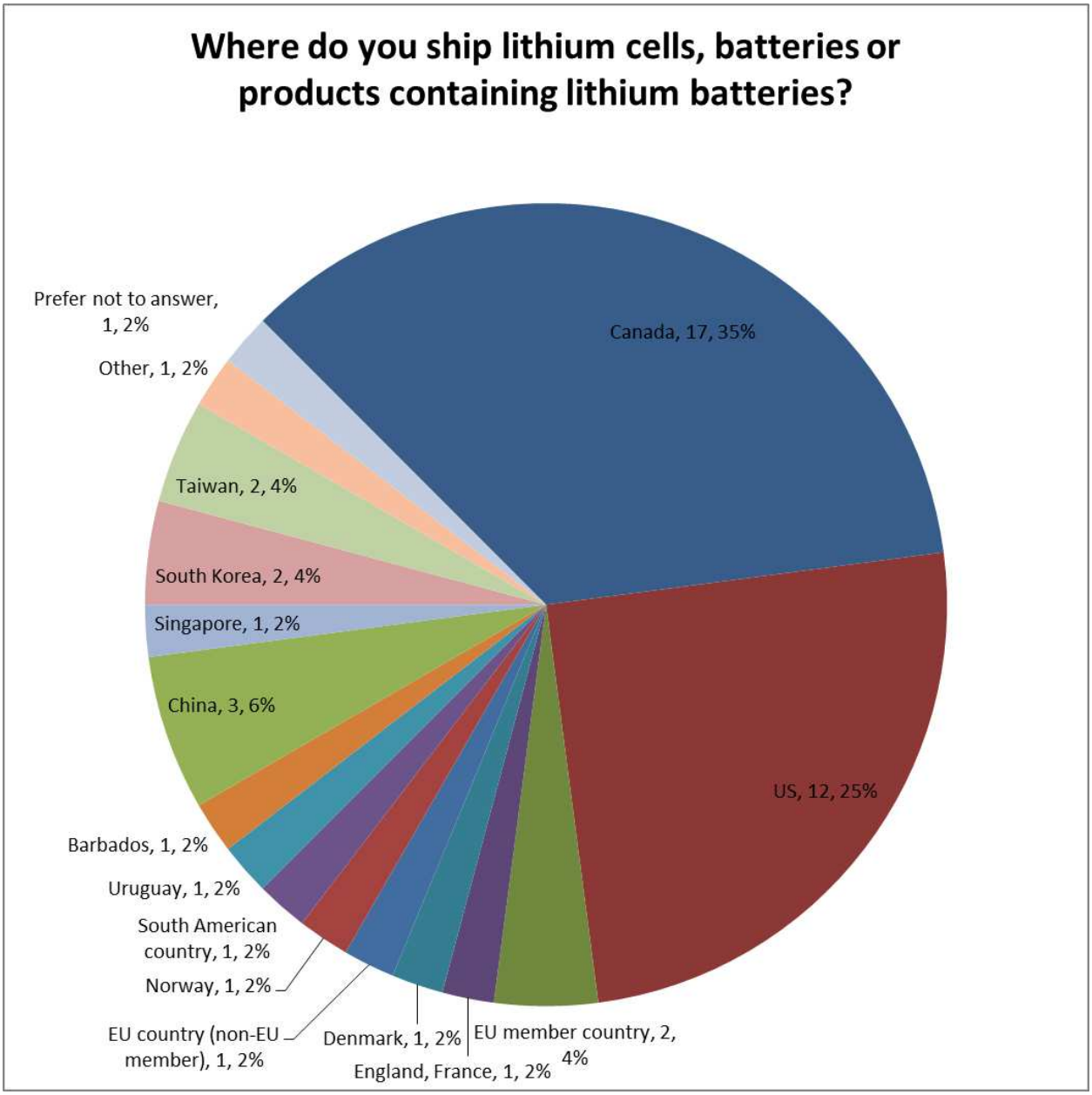

Figure 72 Where do you ship lithium cells, batteries or products containing lithium batteries?

[Q28] What is the origin of the lithium cells, batteries or products containing lithium batteries received in your facilities?

Figure 73 shows the distribution of results. Companies reported receiving the bulk of their products containing lithium batteries from the US, with Canada and China tying for the 2nd most popular source country, and South Korea a distant 3rd. Some companies reported receiving products from an EU member country, an African country, a South American country, and from the Middle East without specifying any further. One company preferred not to answer the question.

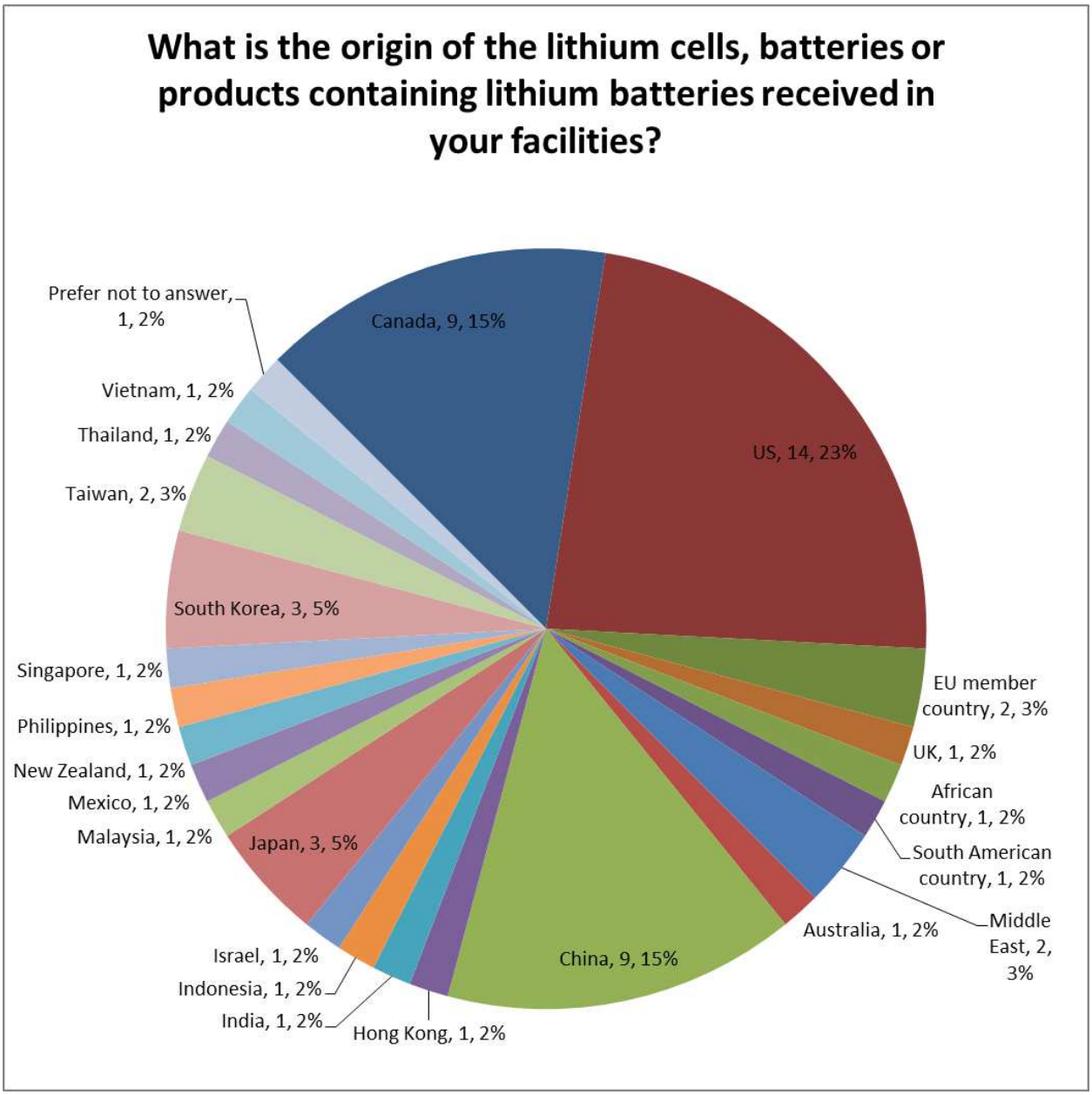

Figure 73 What is the origin of the lithium cells, batteries or products containing lithium batteries received in your facilities?

[Q27&29] Which Canadian provinces/territories do you ship to? From which Canadian provinces/territories do you receive lithium cells, batteries or products containing lithium batteries?

Figure 74 shows the distribution of results. Companies reported that they ship products to all 10 Canadian provinces and three territories. Ontario sees products from the most companies, followed by Quebec, and then BC and Alberta (tied for 3rd). One company reported as not knowing where they ship products to within Canada.

Ontario is the source of product for the most companies, followed by Quebec, and then BC. No companies reported sourcing products from New Brunswick, Nova Scotia, Prince Edward Island, or any of the three territories.

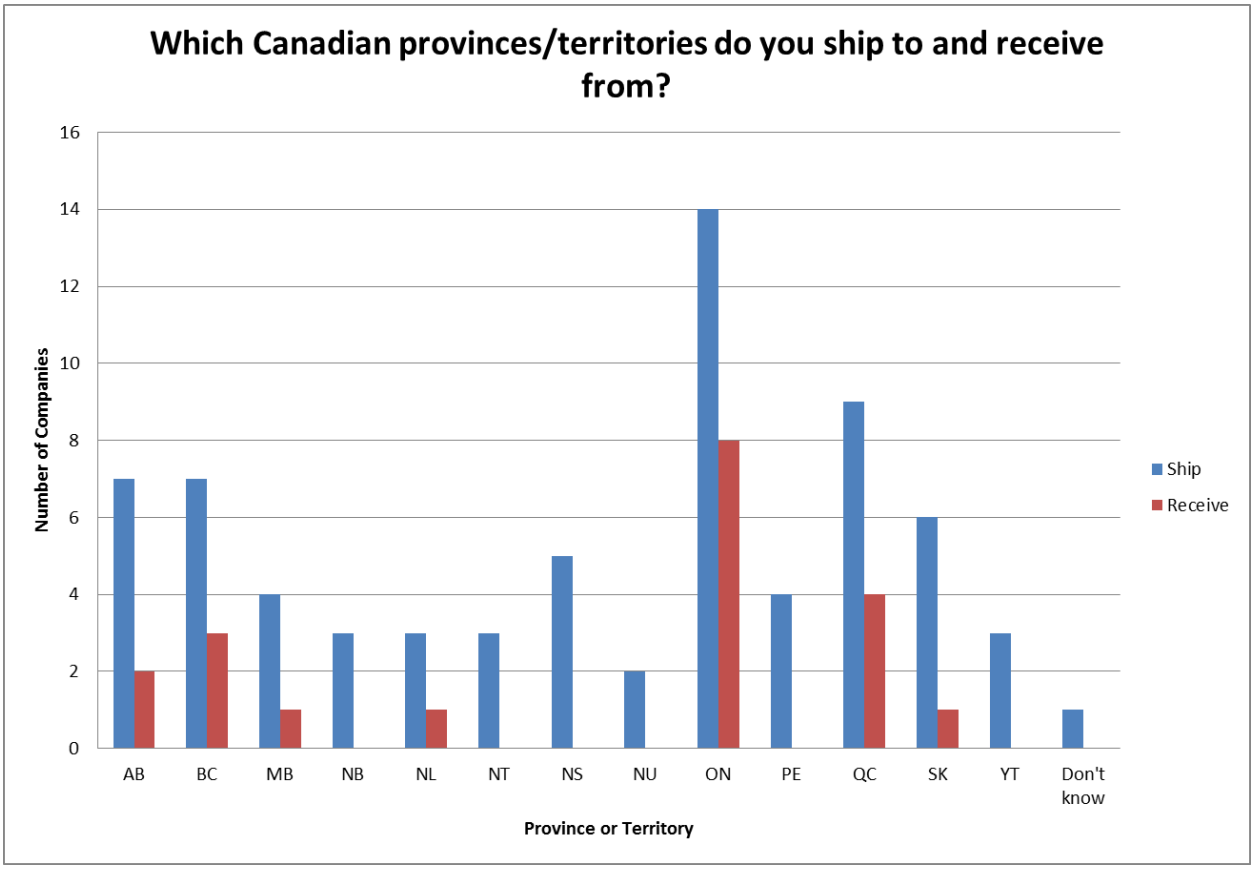

Figure 74 Which Canadian provinces/territories do you ship to? From which Canadian provinces/territories do you receive lithium cells, batteries or products containing lithium batteries?

[Q30] Do you have any final comments?

We received seven responses in total (see Table 11 below).

Table 11 Respondents' final comments.

No.	Response
1	We are the National Airlines Council of Canada. We represent and serve our member airlines and advocate on their behalf but we do not get involved in the day to day operations (example shipping of goods/batteries)
2	Your question on the state of charge for shipping batteries and cells has ranges that are far too large. The industry standard is 50% +/- 5%. But your choices were split right at the 50% mark so I really couldn't answer properly. Our range is 45-55%, but we could only select one range (50-74%[sic] [79%]).
3	Yes when you have a standard plan have something that matches the USA, as it is a pain to have one set of rules here and one set in USA and yet 95% of items come into Canada from the USA. Also don't allow the China product in via CANADA POST. Please have the rules explain very understandable as there are many interpretations of the rules right now. The Canada government should be the only place to offer a course both on line and in ever large city, then it would be more standard. You should have an email data base to send updated information to everyone and not just one or 2 companies.
4	Retriev Technologies is a recycler of both primary and lithium batteries. We process ~200,000 kg of lithium batteries every year.
5	Hello. I am an American rechargeable lithium ion battery importer working closely with a Canadian rechargeable lithium ion battery exporter. We need affordable and accessible ways to import/export our batteries safely and securely across our border. Canada can become a powerhouse lithium ion battery exporter, but it must resolve the dangerous goods' restrictions with the reality behind battery safety. America has its own import/export challenges, which we have to resolve together with Canada and Mexico. We can team up as North Americans and create affluence and wealth from expanding our technical capabilities in energy storage. Thank you.
6	The DG shipping of our Lithium batteries seems to get more complicated every year.
7	There should be questions about what is done with expired batteries. For example are they put into garbage or amen[sic] [taken] to a recycling centre.

[Q31] If you would like to receive additional information on the ES program, or the results of this survey, please add your email below:

We received 11 requests for additional information in total.

6. Appendix A – 71 HS Codes Identified

Count	HS Code	Description
1	840721	Outboard motors, spark-ignition reciprocating or rotary type
2	841451	Fans: table, roof, etc, with a self-cont elec mtr of an output not excdg 125 W
3	842710	Self-propelled works trucks, powered by an electric motor
4	843020	Snow-ploughs and snow-blowers, not self-propelled
5	843311	Mowers, powered, lawn, with horizontal cutting device
6	843319	Mowers, powered, lawn, nes
7	846721	Drills of all kinds, hand-held, with self-contained electric motor
8	846722	Saws, hand-held, with self-contained electric motor
9	846729	Tools, nes, hand-held, with self-contained electric motor
10	846781	Chain saws
11	**847130**	**Portable automatic data processing machines, wt <= 10 kg, with cpu, keyboard and display**
12	**850650**	**Lithium primary cells and batteries**
13	**850760**	**Lithium-ion electric accumulators, including separators therefor, whether or not rectangular (including square)**
14	850811	Dom vacuum cleaner,w self-cntd elec mtr, pwr <= 1,500 W,dust bag/recept <= 20 L
15	850819	Vacuum cleaners, with self-contained electric motor, nes
16	850860	Vacuum cleaners, nes
17	850940	Domestic food grinders and mixers; fruit or vegetable juice extractors
18	850980	Electro-mechanical domestic appliances, with self-contained electric motor,nes
19	851010	Shavers, with self-contained electric motor
20	851020	Hair clippers, with self-contained electric motor
21	851030	Hair-removing electro-mech domestic appl, with self-contained electric motor
22	851310	Portable electric lamps, designed to function by their own source of energy
23	**852580**	**Television cameras, digital cameras and video camera recorders**
24	852712	Pocket-size radio cassette-players, op w/o an external source of power,etc
25	852719	Radio broad rece capable of op w/o an external source of power, nes
26	870110	Pedestrian controlled tractors
27	870190	Wheeled tractors, nes
28	870290	Buses with a seating capacity of more than nine persons, nes
29	870310	Snowmobiles, golf cars and similar vehicles
30	870321	Automobiles with reciprocating piston engine displacing not more than 1,000 cc
31	870322	Automobiles with reciprocating piston engine displacing >1,000 cc but<=1,500 cc
32	870323	Automobiles with reciprocating piston engine displacing >1,500cc but<=3,000 cc
33	870324	Automobiles with reciprocating piston engine displacing > 3,000 cc
34	870331	Automobiles with diesel engine displacing not more than 1,500 cc
35	870332	Automobiles with diesel engine displacing > 1,500 cc but <= 2,500 cc

36	870333	Automobiles with diesel engine displacing more than 2,500 cc
37	870390	Automobiles, nes, including gas turbine powered
38	870410	Dump trucks designed for off-highway use
39	870421	Diesel powered trucks with a GVW not exceeding five tonnes
40	870422	Diesel powered trucks with a GVW exc five tonnes but not exc twenty tonnes
41	870423	Diesel powered trucks with a gvw exceeding twenty tonnes
42	870431	Gas powered trucks with a GVW not exceeding five tonnes
43	870432	Gas powered trucks with a GVW exceeding five tonnes
44	870490	Trucks, nes
45	870540	Mobile concrete mixers
46	870590	Special purpose motor vehicles, nes
47	870911	Work trucks, electrically powered, for use in factories and warehouses
48	871110	Motorcycles with reciprocating piston engine displacing 50 cc or less
49	871120	Motorcycles with reciprocating piston engine displacing >50 cc but<=250 cc
50	871130	Motorcycles with reciprocating piston engine displacing >250 cc but<=500 cc
51	871140	Motorcycles with reciprocating piston engine displacing >500 cc but<=800 cc
52	871150	Motorcycles with reciprocating piston engine displacing more than 800 cc
53	871190	Motorcycles with other than a reciprocating piston engine
54	871390	Carriages for disabled persons, mechanically propelled
55	880211	Helicopters of an unladen weight not exceeding 2,000 kg
56	880212	Helicopters of an unladen weight exceeding 2,000 kg
57	880220	Aircraft, nes, of an unladen weight not exceeding 2,000 kg
58	880230	Aircraft, nes, of an unladen weight > 2,000 kg but not exceeding 15,000 kg
59	880240	Aircraft, nes, of an unladen weight exceeding 15,000 kg
60	890391	Sailboats, with or without auxiliary motor
61	890392	Motorboats, other than outboard motorboats
62	910111	Wrist-watches with mech display, electric & with case of precious metal
63	910119	Wrist-watches, electric, with case of precious metal, nes
64	910191	Pocket-watches & other watches, electric & with case of precious metal
65	910211	Wrist-watches, electric, with mechanical display only, nes
66	910212	Wrist-watches, electric, with opto-electronic display only, nes
67	910310	Clocks with watch movements, electric
68	910511	Alarm clocks, electric
69	910521	Wall clocks, electric
70	910811	Watch movements, assembled, electric, with mechanical display
71	910910	Clock movements, complete and assembled, electrically operated

Note: nes – not elsewhere specified

7. Appendix B – Lithium Battery Survey

The Lithium Battery Survey

New portable and electronic devices, from laptops to mobile phones and power tools, as well as utility scale energy storage, are increasingly being powered by lithium batteries. Over the years, the use and transportation of lithium batteries has grown dramatically.

The safe transportation of lithium batteries is of paramount importance for Canadian industry and consumers at large -- and we believe it has an impact on your business, too.

To ensure that current safety regulations keep pace with the growing applications for lithium batteries, the National Research Council Canada (NRC) requests your participation in a market data survey, to better understand the current battery transportation environment. The survey will ask questions regarding practices around how your organization uses, ships and disposes of lithium batteries. Responses will be aggregated and analyzed to help Canadian industry and government identify and address gaps and refine applicable codes, standards, and regulations.

The National Research Council Canada (NRC) is the Government of Canada's premier research and technology organization. Working with clients and partners, we provide innovation support, strategic research, scientific and technical services.

The Energy Storage for Grid Security and Modernization program works with the entire Canadian energy storage supply chain to reduce costs and decrease the technical risks associated with adopting innovative technologies that will strengthen the electricity grid.

Click "Next" below to begin the survey:

Tell us about your business...

Q1 What lithium battery supply chain sector(s) are you in?

(Please check all that apply)

- ☐ Materials supplier
- ☐ Component manufacture
- ☐ Cell manufacture
- ☐ Battery manufacture
- ☐ Equipment/System manufacture
- ☐ Wholesale
- ☐ Retailing/Distribution
- ☐ Shipping/Carrier
- ☐ Lithium battery end user - Corporate
- ☐ Used cell/battery collection
- ☐ Used cell/battery recycling
- ☐ Other
- ☐ Don't know
- ☐ Prefer not to say
- ☐ Not applicable

Q2 Please list the other sectors of the lithium battery supply chain that you are involved in below:

Sector 1: _____

Sector 2: _____

Sector 3: _____

Sector 4: _____

Sector 5: _____

Q3 For each sector, what category of lithium battery products do you produce, use, ship or receive?

(Please check all that apply)

	Original (new)	Aftermarket	Refurbished, Reconditioned, Repurposed	Don't know	Prefer not to answer	Not applicable
Materials supplier	☐	☐	☐	☐	☐	☐
Component manufacture	☐	☐	☐	☐	☐	☐
Cell manufacture	☐	☐	☐	☐	☐	☐
Battery manufacture	☐	☐	☐	☐	☐	☐
Equipment/System manufacture	☐	☐	☐	☐	☐	☐
Wholesale	☐	☐	☐	☐	☐	☐
Retailing/Distribution	☐	☐	☐	☐	☐	☐
Shipping/Carrier	☐	☐	☐	☐	☐	☐
Lithium battery end user - Corporate	☐	☐	☐	☐	☐	☐
Used cell/battery collection	☐	☐	☐	☐	☐	☐
Used cell/battery recycling	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐

Q4 What is your experience developing or integrating lithium cells or batteries? (Years)

- ○ None
- ○ 0 to 4
- ○ 5 to 9
- ○ 10 to 14
- ○ 15 to 19
- ○ 20 or more
- ○ Don't know
- ○ Prefer not to answer
- ○ Not applicable

Q5 What is the application of the cells, batteries or equipment containing Li batteries that you produce, use, ship or receive?

(Please check all that apply)

- ☐ Power tools
- ☐ Household devices (e.g., vacuum cleaners)
- ☐ UPS
- ☐ Handheld instrumentation
- ☐ Personal Electronic Device (PED) (e.g., smartphones and tablets)
- ☐ Laptops
- ☐ Cameras
- ☐ Remote-controlled hobby crafts (e.g., remote controlled cars, airplanes or helicopters)
- ☐ Land vehicle (e.g., cars and trucks)
- ☐ Marine vehicles (e.g., boats and submarines)
- ☐ Aerial vehicles (airplanes and helicopters)
- ☐ Unmanned vehicles
- ☐ Off-grid or grid energy storage
- ☐ Lithium battery based toys
- ☐ Any application
- ☐ Other (specify:) _____

- ☐ Don't know
- ☐ Prefer not to answer
- ☐ Not applicable

Q6 Which of the following lithium battery trade activities fit your business best.

(Please check all that apply)

- ☐ Import
- ☐ Export
- ☐ Manufacture a product, or substantially modify a local or imported product, and then ship the product within Canada.
- ☐ Manufacture a product, or substantially modify a local or imported product, and then export.
- ☐ Import a product and then ship the same product with minor or no modifications within Canada.
- ☐ Import a product and then export the same product with minor or no modifications to it.
- ☐ Other
- ☐ Don't know
- ☐ Prefer not to answer
- ☐ Not applicable

Tell us about your battery shipping and receiving activities…

Q7 Do you ship and/or receive batteries (cells, modules, packs) or products containing batteries?

- ○ Ship
- ○ Receive
- ○ Both (ship & receive)
- ○ Don't know
- ○ Prefer not to answer
- ○ Not applicable

Q8 What is your experience...? (Years)

	None	0 to 4	5 to 9	10 to 14	15 to 19	20 or more	Don't know	Prefer not to answer	Not applicable
Shipping lithium cells or batteries	○	○	○	○	○	○	○	○	○
Receiving lithium cells or batteries	○	○	○	○	○	○	○	○	○

Q9 Via what transportation modes are lithium cells, batteries or equipment containing Li batteries ... ?

(Please check all that apply)

	Marine	Rail	Ground	Air	Don't know	Prefer not to answer	Not applicable
Shipped by you (outbound shipments)?	☐	☐	☐	☐	☐	☐	☐
Received at your facilities (inbound shipments)?	☐	☐	☐	☐	☐	☐	☐

Q10 Approximately what percentage of shipments do you ... by air?

	1 - 24%	25 - 49%	50 - 74%	75 - 100%	Don't know	Prefer not to answer	Not applicable
Ship?	○	○	○	○	○	○	○
Receive?	○	○	○	○	○	○	○

Q11 If you are a carrier, what type of aircraft do you use?

(Please list all types you use)

	Manufacturer	Model	Don't know	Prefer not to answer	Not applicable
Type 1:			☐	☐	☐
Type 2:			☐	☐	☐

Type 3:			☐	☐	☐
Type 4:			☐	☐	☐
Type 5:			☐	☐	☐

Q12 How many shipments per year of Li cells, batteries or equipment containing Li batteries do you ... ?

	Number of shipments	Don't know	Prefer not to answer	Not applicable
Ship?		☐	☐	☐
Receive?		☐	☐	☐

Q13 Do you ... Li cells, batteries or equipment containing Li batteries on a regular schedule?

	Yes	No	Don't know	Prefer not to answer	Not applicable
Ship?	○	○	○	○	○
Receive?	○	○	○	○	○

Tell us about what you ship and receive…

Q14 What do you...?

(Please check all that apply)

	Cells	Batteries	Equipment containing batteries	Equipment packaged with batteries	Other	Don't know	Prefer not to answer	Not applicable
Ship?	☐	☐	☐	☐	☐	☐	☐	☐
Receive?	☐	☐	☐	☐	☐	☐	☐	☐

Q15 What type of lithium cells or batteries do you ... ? (by itself or inside a product)

(Please check all that apply)

	Lithium metal	Lithium ion	Other	Don't know	Prefer not to answer	Not applicable
Ship?	☐	☐	☐	☐	☐	☐
Receive?	☐	☐	☐	☐	☐	☐

Q16 What proportion (%) of lithium cells or batteries do you ... ? (by itself or inside a product)

	Lithium metal	Lithium ion	Other	Don't know	Prefer not to answer	Not applicable
Ship?				☐	☐	☐
Receive?				☐	☐	☐

Q17 What percentage of the lithium cells, batteries or products containing Li batteries that you ... have a brand name or trademark?

	None/ Almost none	Less than 25%	25 to 49%	50% to 74%	75% or more	All/Almost all	Don't know	Prefer not to answer	Not applicable
Ship?	○	○	○	○	○	○	○	○	○
Receive?	○	○	○	○	○	○	○	○	○

Q18 Are the batteries that you ... being shipped as Class 9 dangerous goods under UN regulations?

	Yes	No	Exempt	Don't know	Prefer not to answer	Not applicable
Ship?	○	○	○	○	○	○
Receive?	○	○	○	○	○	○

Tell us more about the products you ship and receive…

Q19 On average, what is the number ofcells/batteries that you ... per shipment?

(We are defining the shipment as the entire consignment.)

	1 to 2	3 to 8	9 to 24	25 to 49	50 to 499	500 to 4,999	5,000 to 9,999	10,000 to 49,999	50,000 or more	Don't know	Prefer not to answer	Not applicable
Ship?	○	○	○	○	○	○	○	○	○	○	○	○
Receive?	○	○	○	○	○	○	○	○	○	○	○	○

Q20 On average, what is the mass ofcells/batteries that you ... per shipment? (kg)

(We are defining the shipment as the entire consignment.)

	Mass (kg)	Don't know	Prefer not to answer	Not applicable
Ship?		☐	☐	☐
Receive?		☐	☐	☐

Q21 On average, what is the number ofequipment containing batteries that you ... per shipment?

(We are defining the shipment as the entire consignment.)

	1 to 2	3 to 8	9 to 24	25 to 49	50 to 499	500 to 4,999	5,000 to 9,999	10,000 to 49,999	50,000 or more	Don't know	Prefer not to answer	Not applicable
Ship?	○	○	○	○	○	○	○	○	○	○	○	○
Receive?	○	○	○	○	○	○	○	○	○	○	○	○

Q22 On average, what is the mass ofequipment containing batteries that you ... per shipment? (kg)

(We are defining the shipment as the entire consignment.)

	Mass (kg)	Don't know	Prefer not to answer	Not applicable
Ship?		☐	☐	☐

Receive?		☐	☐	☐

Q23 What is the average state of charge of the lithium cells, batteries or products containing lithium batteries for each shipment ...?

(We are defining the shipment as the entire consignment.)

	0 - 29%	30 - 49%	50 - 79%	80 - 100%	Don't know	Prefer not to answer	Not applicable
Sent?	○	○	○	○	○	○	○
Received?	○	○	○	○	○	○	○

Q24 What is the capacity of the batteries/cells you ... ? (Amp-Hour)

(Please check all that apply)

	< 1	1 to 4.9	5 to 9.9	10 to 29	30 to 49	50 to 499	500 to 4,999	> 5,000	Don't know	Prefer not to answer	Not applicable
Ship?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Receive?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q25 What is the energy content of the batteries/cells you ... ? (Watt-Hour)

(Please check all that apply)

	< 20	20 to 100	> 100	Don't know	Prefer not to answer	Not applicable
Ship?	☐	☐	☐	☐	☐	☐
Receive?	☐	☐	☐	☐	☐	☐

Finally, tell us about where you ship and receive….

Q26 Where do you ship lithium cells, batteries or products containing lithium batteries?

(Please check all that apply)

- ☐ Canada
- ☐ US
- ☐ European Union member country (Please specify:) _____
- ☐ European country (non-EU member) (Please specify:) _____
- ☐ African country (Please specify:) _____
- ☐ South American country (Please specify:) _____
- ☐ Middle East (Please specify:) _____
- ☐ Australia
- ☐ China
- ☐ Hong Kong
- ☐ India
- ☐ Indonesia
- ☐ Israel
- ☐ Japan
- ☐ Malaysia
- ☐ Mexico
- ☐ New Zealand
- ☐ Philippines
- ☐ Singapore
- ☐ South Korea
- ☐ Taiwan
- ☐ Thailand
- ☐ Viet Nam
- ☐ Other(s) (specify:) _____
- ☐ Don't know
- ☐ Prefer not to answer

☐ Not applicable

Q27 Which Canadian provinces/territories do you ship to?

(Please check all that apply)

☐ Alberta

☐ British Columbia

☐ Manitoba

☐ New Brunswick

☐ Newfoundland and Labrador

☐ Northwest Territories

☐ Nova Scotia

☐ Nunavut

☐ Ontario

☐ Prince Edward Island

☐ Quebec

☐ Saskatchewan

☐ Yukon

☐ Don't know

☐ Prefer not to answer

☐ Not applicable

Q28 What is the origin of the lithium cells, batteries or products containing lithium batteries received in your facilities?

(Please check all that apply)

- ☐ Canada
- ☐ US
- ☐ European Union member country (Please specify:) _____
- ☐ European country (non-EU member) (Please specify:) _____
- ☐ African country (Please specify:) _____
- ☐ South American country (Please specify:) _____
- ☐ Middle East (Please specify:) _____
- ☐ Australia
- ☐ China
- ☐ Hong Kong
- ☐ India
- ☐ Indonesia
- ☐ Israel
- ☐ Japan
- ☐ Malaysia
- ☐ Mexico
- ☐ New Zealand
- ☐ Philippines
- ☐ Singapore
- ☐ South Korea
- ☐ Taiwan
- ☐ Thailand
- ☐ Viet Nam
- ☐ Other(s) (specify:) _____
- ☐ Don't know
- ☐ Prefer not to answer
- ☐ Not applicable

Q29 From which Canadian provinces/territories do you receive lithium cells, batteries or products containing lithium batteries?

(Please check all that apply)

- ☐ Alberta
- ☐ British Columbia
- ☐ Manitoba
- ☐ New Brunswick
- ☐ Newfoundland and Labrador
- ☐ Northwest Territories
- ☐ Nova Scotia
- ☐ Nunavut
- ☐ Ontario
- ☐ Prince Edward Island
- ☐ Quebec
- ☐ Saskatchewan
- ☐ Yukon
- ☐ Don't know
- ☐ Prefer not to answer
- ☐ Not applicable

Q30 Do you have any final comments?

Q31 If you would like to receive additional information on the ES program, or the results of this survey, please add your email below: