MACKENZIE Investments | CONFIDENCE IN A CHANGING WORLD

From Oil to Lithium

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Executive Summary:

Climate change is forcing leading economies to make big decisions that could have a historic impact on resource sectors. Many forces are at work. Human ingenuity, innovation, and society's desire to advance are creating demand from all nations for a cleaner and more convenient world. These changing social and economic tides will likely influence profound changes in consumption patterns. We examine the roles of Electric Vehicles (EV) and renewable energy and the likely outcome for consumption over the next decade. The probability of a rapid petroleum obsolescence remains low. However, a step change in transport convenience (autonomy, or speed) would substantially increase the odds of that obsolescence, but also lead to an accelerating global energy demand.

In any case, resource investors can benefit from society's shift away from the inefficient, polluting, and unsustainable to the clean, electrical and efficient. We suggest a valuation framework that can be applied by flexible resource investors. The framework works through the lens of sustainability–from which all stakeholders and shareholders stand to benefit for the decades to come.

One hundred and fifty years ago, apart from coal and firewood, the energy business substantially consisted of harvesting waxy oil from the heads of whales. This substance, called spermaceti, burned both brighter and cleaner than candles. Whale oil sold like hotcakes, lighting parlour rooms and streetlamps all over the world in the mid-nineteenth century. The whaling towns of Nantucket and New Bedford, Massachusetts were boomtowns, the Houston and Calgary of their day. A natural resource fund at the time would have owned large stakes in whaling fleets.

These whaling operations were horribly inefficient. Most of the whale carcass was left for waste. Labour conditions were harsh, even characterized as “satanic.” Fleets of whaling ships culled the cetaceans at a far greater clip than they could reproduce. History has shown that shares in whaling fleets weren’t buy-and-hold propositions.

Let’s compare whale oil with solar energy. Sun-baked panels not only light your parlour room but also power your car. Zero labour, zero emissions, zero waste. Solar energy also offers healthy margins and it is endlessly and effortlessly replenished. Solar could clearly be a cleaner business for everyone.

We are excited about the path to fully renewable energy. But make no mistake, there are many challenges that society must navigate to achieve that goal. Many of the portrayals we see today are utopian. We all want a quick fix to the environmental problems plaguing our planet. But the road from non-renewable to renewable energy will not be straight. There is no quick fix, but there is a way forward.

Consider what happened the last time there was a sea change in fuel. Why did the whale oil industry die out and the petroleum industry emerge in its place? In 1860, a Canadian geologist named Abraham Pineo Gesner invented a method to distil bitumen into “kerosene,” a term that he coined. Kerosene burned both brightly and cleanly yet was more efficient to produce than whale oil. At the same time, hunting whales had become more difficult, expensive and dangerous as fleets chased dwindling stocks. It became less efficient to produce fuel from whales.

But that wasn’t the whole story. A tax on an alternative fuel called camphene may have acted as a subsidy on the emerging petroleum business. Technological disruption, market forces and government policies all contributed to the substitution of whale oil for kerosene. Navigating a transition in the energy sector was complicated the last time it happened. But what followed was better living standards and accelerated energy use for many people. We expect this time to be no different. We see investment opportunities in natural resources benefitting from the unfolding energy transition. Our metric, Sustainable Free Cash Flow, helps to account for the many complexities inherent in this transition and helps us navigate this changing sector. (See Sidebar #1).

SIDEBAR 1

Resource Investing with a Focus on the Sustainability of Future Earnings:

Let’s compare these three metrics for a hypothetical whaling business in the nineteenth century

1. **Earnings:** You build a whaling boat for $100 and the accountants figure that this boat will last for 100 whales. After all, that’s how long the previous boat lasted. Let’s also assume that it costs you $1/whale in operating costs (labour, etc.). And let’s say you get $5/whale in revenue. The math is thus $5 in revenue minus $1 in operating costs minus $1 in boat depreciation. ($100 spread out over 100 whales =equals $1/whale.). That works out to earnings of $3/whale. Not bad!
2. **Operating earnings:** With this metric, you forget about the boat depreciation. Your operating earnings are thus $5-$1=$4/whale.
3. **Sustainable Free Cash Flow:** You put down $100 for the boat. At first, you catch whales at about the same rate you did in the past. But as you exhaust your resource, they’re tougher and tougher to catch. Maybe you go a month to catch a whale. A thorough analysis will suggest that at this rate, your boat will not last for 100 whales. You’d be lucky for it to last about 25 whales. In this way, the forward-looking depreciation rate goes from $1/whale to $4/whale. Add operating costs and you see that, on a forward looking basis, the company isn’t making any money. Maybe we should stop hunting whales and get into something else?

We believe that the Sustainable Free Cash Flow metric is superior in identifying companies that can sustain their future cash flows, to the benefit of stakeholders and shareholders[1]. Moreover, Sustainable Free Cash Flow is superior in assessing depleting assets (such as primary reserves of energy and metals) and in identifying key turning points in a company’s evolution. This financial metric provides a signal for capital markets to starve unsustainable businesses and reward sustainable businesses.

[1] B. Gervais, O. Rutten, A. Marrat, M. Mathers “Sustainable Free Cash Flow Analysis: A better measure for resource equities.” Mackenzie Investments (September 2015)

The Emerging Landscape:

The public loves EVs because they don't give off emissions. Electric engines don't even have an exhaust pipe- Internal combustion engines (ICEs) emit nitrous oxides (which contribute to acid rain), particulates (which contribute to smog) and carbon dioxide (a greenhouse gas). Even more impressive is a lesser-known fact about EVs: they use energy far more efficiently than ICE vehicles. About 60% of the energy provided to EVs is used to propel the vehicle down the road—that's three times the amount from ICEs. Feel the hood of your ICE car after a road trip. It will be warm. That is waste.

But EVs are not miracle vehicles. They use energy more efficiently, but still need energy to get around. For now, this energy is drawn from the electrical grid. In most countries, that grid is fuelled by coal, the dirtiest of fuels. China, for example, may be the world's biggest supporter of the electric car to clean the air in its growing cities. But while the cars themselves will be emission-free, for the foreseeable future their power source won't be as China cannot phase out its coal dependency yet. We all want renewable power generation. End-to-end efficient, emission-free energy. Wind and solar. It's an intoxicating vision. With political will and technological advances, we may get there in the coming decades—but along the way we will use fossil fuels.

Why can't we go all-in on renewables overnight? In Chile or Saudi Arabia, given the solar intensity of these two places, the economics of renewables are attractive. But in the UK, where the solar intensity is famously lacking, the economics are decidedly more challenging. One study suggests that for the UK to go 100% renewable you would need to ring the island with windmills three-deep or cover an area the size of Wales with solar panels. More of the world's current electricity markets are like the UK than not; In other words, the countries where renewable energy will be cheap and easy to harness are not where renewables will be needed the most.

This raises another question: energy portability. If you want to transport energy in its chemical form (e.g. natural gas) from Alberta to Ontario, you send it down a pipeline. Or if you want to send oil from the Middle East to China, you put it in a tanker. Energy generated from renewables is not so easily moved around. Nor can it be used in a timely fashion. How do you "transport" energy from a wind farm during the day to heat a home during the night? Batteries could potentially bridge day to night, but the technology has not yet advanced to do that cheaply and efficiently. Until the portability issue is resolved, renewables will likely remain only locally viable, impeding the network effects required for widespread adoption. A cheaper and cleaner facilitator to renewables for the next decade could be natural gas, which is cleaner than coal, abundant, and can be turned off quickly when adequately renewable energy is available.

Governments understand the importance of network effects and the need for a tipping point: without many EVs, it's hard to justify large charging networks but without large public charging networks, there will not be mass adoption. Hence, many countries are enacting legislation that encourages EV ownership. Automakers are responding belatedly. Legislation will continue to play a major role in the development of the sector, and not always in expected ways. For example, Norway might put into place laws governing the weight of EVs and this might limit sales of the world's most high-profile electric luxury models.

EVs are heavy because they contain a lot of metal, particularly in the batteries. Mass adoption will also depend on the availability of these metals, some of which are now only produced in small quantities in difficult environments. The markets for these metals are immature. They should see dramatic change in coming years.

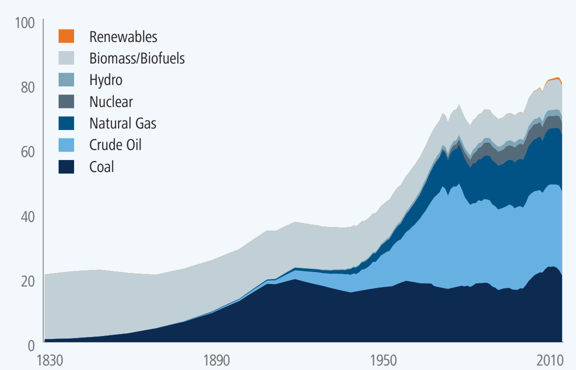
Despite their weight, EV batteries don't contain a lot of energy, relatively speaking. A pound of gasoline will take you much farther than the energy contained in a pound of battery. More innovation will increase energy density of batteries and, hence, open the possibility to expand their adoption beyond urban transportation.

In the coming decades the world's resource demands will look different than they do today. Experienced investors with a background of allocating capital to resource securities should be well-suited to navigate these coming changes.

The Next Electric Age

Cleaner electrical cars. Cleaner power grids. These are just two of many expected outcomes of the upcoming Electrical Age. Another outcome could be higher energy consumption. History offers us insight. The invention of the coal-fired steam engine drove industrialization, higher living standards and a population boom in the late 1800s. Population growth demanded more energy and energy consumption per capita also took off (see chart below)

Global Primary Energy Consumption 1830 - 2015



Sources: V. Smil; UN; BP

The emergence of mass-affordable cars in the USA (e.g. Fords and Chevy) and in Europe (the aptly named Volkswagen), combined with massive postwar fiscal stimulus that created the Interstate Highways led to another explosion in energy demand. When baby boomers expanded, so did their energy use. Average energy consumption per capita in the USA exploded from approximately 205 gigajoules (GJ) to a world-beating 325 GJ. A similar revolution is underway in today's China: From ~25 GJ in 1990 to 90 GJ today and still expanding, mostly through increased oil and electricity consumption. Naturally, the shrinking populations in Japan and Europe, combined with society's increasing willingness to reduce energy waste will moderate energy use. But rapidly growing and urbanizing populations in emerging economies underline the need for society to migrate to cleanly generated electrical energy as fast as possible (see Sidebar #2).

SIDEBAR 2

A Growing World Population That Wants More Energy per Capita

The world population is forecast to grow annually at a pace of 0.8%. While each newcomer needs energy to sustain life, society also wants a better life for all. That often involves urbanization, access to the best healthcare, and increased transport mobility. Imagine China, where the population grew from 1.2 billion to 1.4 billion from 1990 to today and energy consumption per capita expanded from approximately 25 GJ to 90 GJ as apartments were built, fridges and air conditioners installed and bicycles were surpassed by scooters and cars. India and Africa have similar aspirations.

	2015	2015	2015	2040e	2040e	2040e
	energy consumption per capita	population	energy consumption	energy consumption per capita	population	energy consumption
	(GJ/capita)	(mm)	(PJ)	(GJ/capita)	(mm)	(PJ)
USA & Canada	295	355	105,000	202	415	84,000
Japan	150	130	20,000	117	115	13,000
Europe	125	740	93,000	110	730	81,000
China	90	1,400	126,000	110	1,410	155,000
ROW	92	2,375	218,000	104	2,840	295,000
India	20	1,310	26,000	50	1,600	79,000
Africa	10	1,190	12,000	20	2,100	42,000
WORLD	**80**	**7,500**	**600,000**	**81**	**9,210**	**749,000**

Sources: V. Smil; UN; Mackenzie Investments

Global energy needs could thus increase by 25% by 2040. Our simplistic example applies UN population growth forecasts. It also assumes 0.5% to 1.5% annual energy usage declines in the developed world to account for energy savings and new environmental sensitivities. We apply varying rates of growing energy intensity per capita for the main emerging regions, depending on their stage in the development curve.

In North America, energy intensity per capita is currently 2.3 times as high as an in Europe and Japan. In China, energy intensity is accelerating towards the European average; which shows a potential pathway if India were to be able to accelerate is development.

This example ignores the possibility of accelerating energy intensity due to technological breakthroughs such as autonomous cars or the dramatic transport cost reductions often touted. Both potential breakthroughs, in our view, could increase energy use per capita.

In any case, global energy consumption is likely to grow, which underlines the need for cleaner energy, such as solar, wind and hydro.

Whale oil displaced beeswax or tallow candles because its light was so much brighter. Petroleum overtook coal as steam engines were too big for cars. For rapid and complete adoption, a technology must be either dramatically cheaper (think of a pdf file versus Xerox paper) or dramatically better (think iPhone versus Motorola flip phone). History should repeat itself, and we predict that the pace of EV adoption will also be driven by affordability and convenience. Both need work. Excluding subsidies and tax breaks, an EV is not yet competitive in most mass markets and an electric car still doesn't get a person from Montreal to Toronto or from Shanghai to Nanjing any faster. Critically, the pace of adoption will drive the rate of obsolescence for, say, offshore oil drilling rigs, just like what happened to those whaling fleets.

We are acutely watching how self-driving/autonomous car technologies develop. They could enable a modern boom in energy consumption. Think of all of those people who do not have a driver's license, adults and children alike, taking a ride door to door. Think of going to the cottage while watching the latest Netflix show. In this world, wouldn't one travel more often and farther? The faster traveling speeds of autonomous pilots, and the higher kilometers traveled per person could easily surpass the energy efficiency brought by EVs (see Sidebar #3).

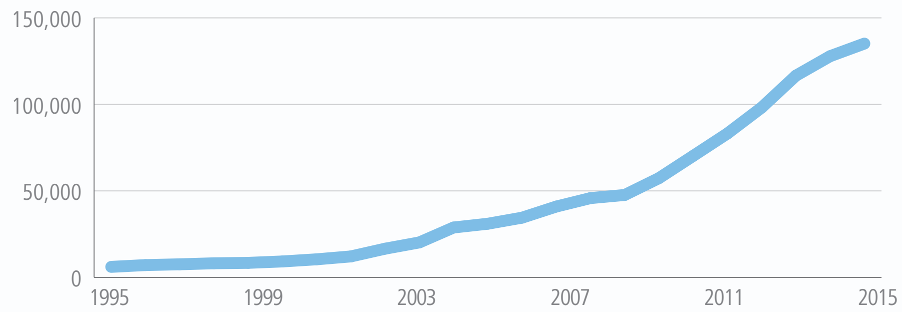
SIDEBAR 3

Energy & Speed

Physics teaches that traveling at greater speeds increases energy consumption exponentially. Take an electric car traveling down the highway at 100 km/h currently; with a perfect robotic driver, perhaps you increase speed to 200 km/h. Accounting for both acceleration and wind resistance at speed, traveling at 200 km/h would increase the rate of energy consumption by six times. With consideration given to time savings (you would arrive at your destination twice as fast), the total energy consumed would be roughly three times higher to travel the same distance.

High-speed, higher-cost travel increases exponentially with rising incomes, as can be seen from the massive growth in air travel by the Chinese (see chart below). Rapidly expanding air travel is a key driver behind growing oil consumption. To date there have been no alternatives found to the use of oil-derived kerosene for air travel. And by going faster via air travel, consumers can go further – along the way consuming approximately eight times more energy per hour traveled.

China Air Travel



Sources: Evercore ISI

Conclusion: Opportunity for Resource Investors

Emerging economies seek a better standard of living for their expanding populations. But we also believe in human ingenuity, innovation, and in society's desire to advance. Emerging and developed nations are demanding a cleaner and more convenient world. Zero-emission electric vehicles, powered by a cleaner electrical grid will gradually be adopted. To accelerate the phase-out of fossil fuel, and accelerate a phase-in of EVs, wind, and solar power, substantial improvements in cost or utility are still necessary. Obsolescence of one type of energy (fossil energy) doesn't equate to declining energy demand. In fact, a technological breakthrough would only accelerate global energy demand. Global energy consumption is likely to expand gradually into the 2020s. Less likely but possible, should travel costs, speed or convenience see a step change, watch for an acceleration of energy demand.

Resource investors can benefit from society's shift from the heavy, polluting sources of industrial energy (coal / oil / pig iron) to the clean, electrical and lightweight (gas / copper / lithium / plastics / carbon fibre). To meet the need for a better environment, sustainability will become more important, as will renewable resources, such as lumber.

Flexible resource investors that can cover this broad suite of energy and materials and that apply a valuation framework that takes into account the sustainability of future earnings have the opportunity to accumulate wealth over the next decades. Anticipating the rate of change will also be a key determinant of resource investment returns. We will present our execution strategy in subsequent paper.

Talk with your financial advisor to learn more about resource investing opportunities with Mackenzie Investments.

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