SASKATCHEWAN RESEARCH COUNCIL
RARE EARTH Processing Facility

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SRC Overview

SRC Delivers about $1.3B in economic impacts to SK last year; Jobs, economic growth, innovation

SRC Overview

- SRC Focus: mining, minerals, agriculture and energy sectors in SK
- Increasingly, environmental considerations in each sector.
- Help SK companies solve technology, innovation and commercialization challenges in global markets
- We also work closely with SK Government, supporting key objectives;
- 2030 Growth Plan, Net Zero, ASCP, CLEANS, SMRs and REE

What are Rare Earth Elements?

- Group of 17 elements in the Periodic Table
- They are not particularly “rare”, exist in low concentrations in many places across the world
- Deposits with high concentrations suitable for commercial extraction, are more rare
- These elements have unique properties and are an essential component in many modern technologies
- Their unique and vital importance means that they are deemed “Critical or Strategic” Minerals by Governments, including our own.
- The race is on to secure global access and future market dominance.

REE Essential to Future Economy

- REE form essential components in:
  - Renewables ; Wind and Solar
  - Electric Vehicles ; Motors and Batteries
  - Defense ; Electronics and Defense Systems
  - Communications; Cell Phone Technology
  - Computer Technology & Consumer Electronics
  - “If REE suddenly disappeared, our modern world would simply stop dead”

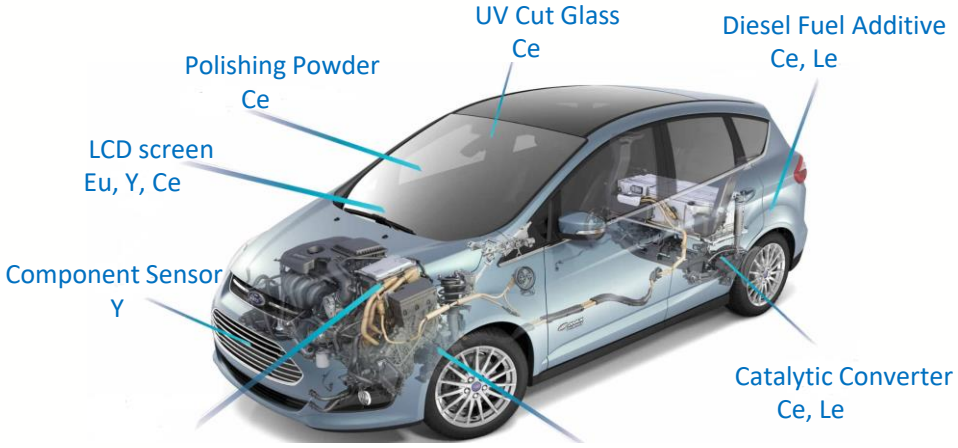
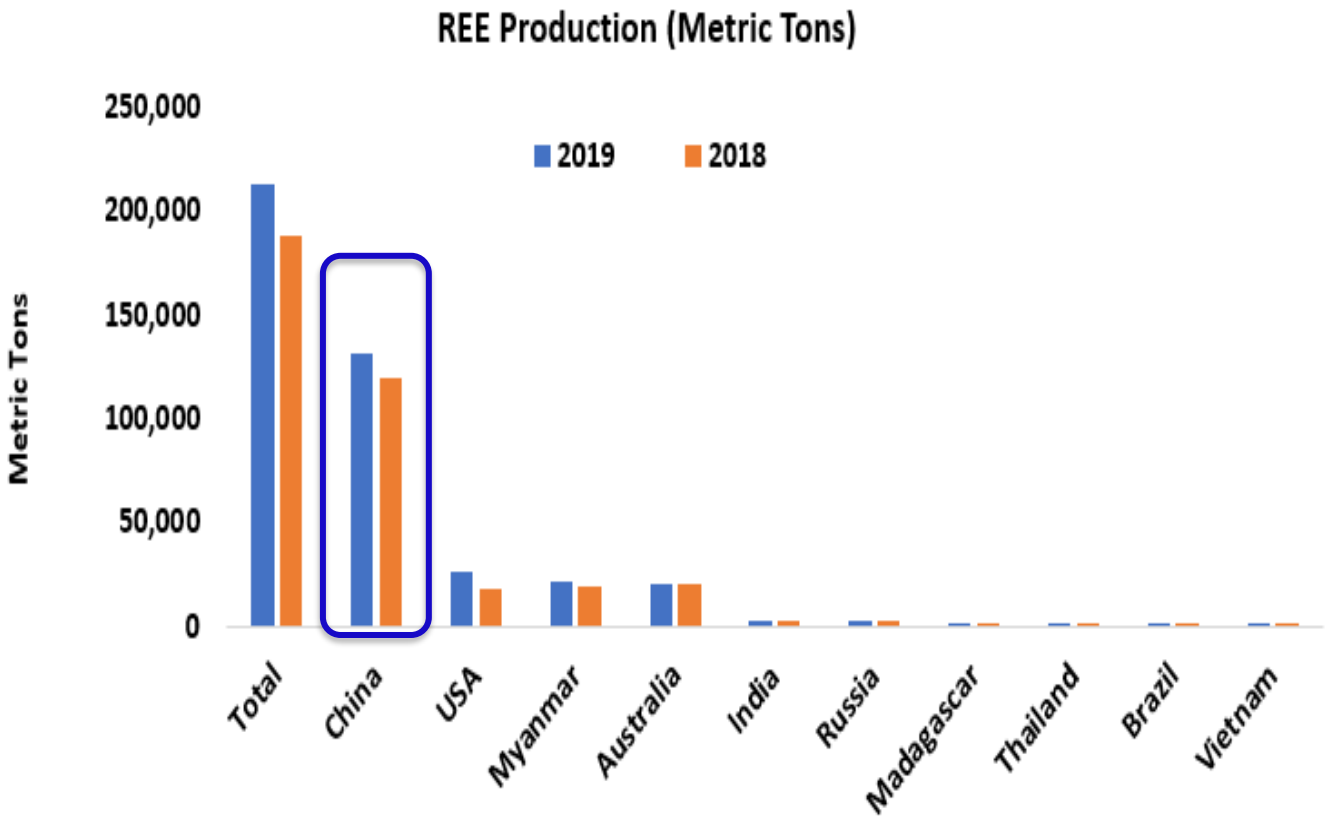


Photo Courtesy by Ford Motor Company

REE Global Market Overview & REE Reserves

- China dominates REE Market (over 70% global production)
- Until recently China was a net exporter of REE
- Now a net importer, currently trying to secure REE sources globally
- China's stance on REE of increasing concern, REE now deemed Strategic Minerals
- Current global production around 200,000 MT, demand set to double by early 2030's
- REE ore prices increased by 250% from June 2020 to March 2021.



Source: U.S. Geological Survey, Reston, Virginia: 2020

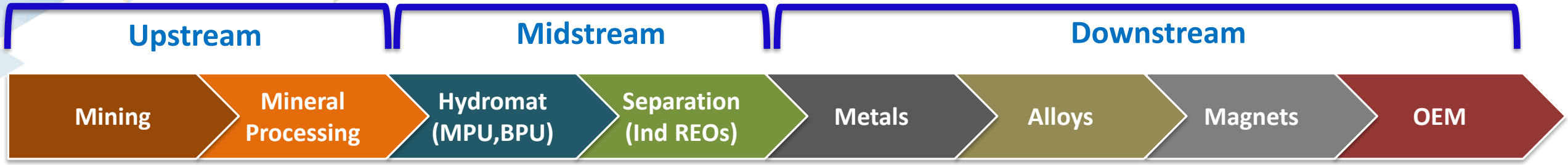
REE Global Market Overview & REE Reserves

Country	Reserves (MT)[1]	Resources(MT)[2]
China	44,000,000	164,000,000
Brazil	22,000,000	55,000,000
Vietnam	22,000,000	14,300,000
Russia	12,000,000	47,800,000
India	6,900,000	
Australia	3,300,000	49,000,000
Greenland	1,500,000	43,000,000
United States	1,400,000	14,300,000
Canada	830,000	33,460,000
South Africa	790,000	-
Other countries	1,200,000	57,360,000

- ✓ Reserves by US Geological Survey 2020
- ✓ Resources by review paper 2017
- ✓ China stands at 1st place
- ✓ Canada is 10th place by reserve and **6th place measured by resources**
- ✓ In REE: Canada currently has 7% of world resources of REE

1: pubs.usgs.gov/periodicals/mcs2020/mcs2020.pdf
2: https://www.mdpi.com/2075-163X/7/11/203/pdf

Existing REE Supply Chain – Canada (Saskatchewan)



Ore
$4000/MT

Mixed REO
$10,000/MT

Ind. REO
$40,000/MT

Metal Alloys
$100,000/MT

Development of Midstream Processing Facilities are critical To Canadian Value-Added Production

Saskatchewan is taking the lead

Junior Mining CO,s

SRC REE Facility

Opportunity

SRC Rare Earth Processing Facility

- In August 2020, the Government of Saskatchewan announced $31M for a large scale, fully commercial demonstration Rare Earth Processing Facility
- Facility will be operated by SRC, is ~80,000 square feet and located in Saskatoon at SRC's 51st location
- Intermediate Rare Earth Oxides will be produced from the Monazite processing unit, feed is ~3000 tpy and product is ~1500 tpy
- The product from MPU is fed to Solvent Extraction Unit (SXU) to produce separated Rare earth oxides, namely Nd/Pr Oxides
- These individual Oxides are fed to Metal Processing Unit to produce Didymium metal alloys

SRC Rare Earth Processing Facility

Monazite Processing Unit (MPU) – Process Flow

Step 1& 2
Bag Unloading & Milling System

Step 3 Cracking
NaOH based

Step 4 Dilution
Mixing Tanks

Step 5 Filteration
Washing

Step 6 Leaching
HCL Addition

Step 7 Th/Ur
Precipitation

Step 8 Tailing
Removal Filtre Press

Step 9 Purification
H2SO4 Addition

Step 10 Radium
Removal Filter Press

Step 11 REE
Precipitation
NaHCO3 Add

Step 12 Carbonate
Filteration

Step 13
Carbonate Drying

TSP & Alkaline
Recovery

Water Treatment

Monazite Processing Unit (MPU) – Unit Operations

Equipment Type	~ Quantity	Expected RFQ
Grinding System	1 Package	Out in Sep 2021
TSP Crystallizers	2 Packages	Dec 2021
Effluent Treatment	1 Package	Dec 2021
Steam Generation	1 Package	March 2022
Compressed Air	1 Package	May 2022
Scrubbers	2	Jan 2022
SL Separation	9	Already Out
Heat Exchangers	7	Jan 2022
Pumps	28	Feb 2022
Tanks	50	Feb 2022
Cranes	2	Feb 2021

Services	Specifics	Expected RFQ
Engineering	Electrical	-
	Instrumentation	-
	Piping	-
	HVAC	-
Construction	Civil/Architect	April 2022
	Structure	June 2022
	Equipment Install	Starting from July 2022
	Piping, Electrical, Instrumentation, HVAC	Starting from Sep 2022
Commissioning	Dry	Feb 2022
	Wet	March 2023
Start Up	First Feed	May 2023

Monazite Processing Unit (MPU) – Waste Handling

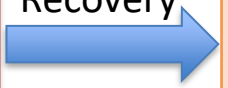
- We will be producing radioactive waste – Uranium , Thorium and Radium
- Produce ~15 tpy of Radium tailings and ~700 tpy Thorium tailings
- Produce 3000 to 4000 tpy of non radioactive waste – Salt, NaCl
- We will require assistance in disposing off the waste

Monazite Feed – 3000 Tonns/year - ~53% TREO

Monazite
3,000 MT

	MPU	SXU
Rare Earth	**MT/Year**	**MT/Year**
Lanthanum Oxide (Le_2O_3)	312	265
Cerium Oxide (CeO_2)	687	585
Praseodymium Oxide (Pr_6O_{11})	77.7	66.1
Neodymium Oxide (Nd_2O_3)	294	251
Samarium Oxide (Sm_2O_3)	47.1	74.5
Europium Oxide (Eu_2O_3)	2.40	
Gadolinium Oxide (Gd_2O_3)	38.1	
Terbium Oxide (Tb_4O_7)	5.10	122
Dysprosium Oxide (Dy_2O_3)	21.6	
Holmuin Oxide (Ho_2O_3)	3.30	
Erbium Oxide (Er_2O_3)	10.2	
Thulium Oxide (Tm_2O_3)	1.20	
Ytterbium Oxide (Yb_2O_3)	5.70	
Lutetium Oxide (Lu_2O_3)	0.90	
Yttrium Oxide (Y_2O_3)	95.7	
TREO	1602	1364

95% Recovery



Metals

Metal – MT/Year	
Didymium (NdPr)	256

Solvent Extraction Unit (SXU)

- The major equipment includes the solvent extraction cells, precipitation reactors, set of centrifuges and dryers, and rotary kiln
- A total of ~150 SX cells will be required, with the volume of each cell ranging between 1000 Litres to 1800 Litres
- The cells are comprised of a mixer and settler sections to achieve the two stages of the separation
- We plan to start the procurement process for SXU from July of 2022
- The major equipment and services required for SXU are:
  - SX cell fabrication
  - Centrifuges
  - Dryers
  - Kiln
  - Packers
  - HVAC
  - Pipes
  - I&C and Electrical
  - Civil & Architect
  - Construction
  - Commissioning

Metal Processing Unit

- The major equipment include the electrolytic furnaces and scrubbers
- Depending on the capacity of the furnace the NO of units can vary between 4 to 8
- We plan to start the procurement process for Metal Processing Unit from Sep 2022

REE Facility Current Status

Completed:

- MPU Building Shell
- Pre-Feasibility
- FEED

In progress:

- Procurement
- Construction

MPU Operational – Q1 2023

SXU and Metal Operational – Q2 2024

Chemical Requirements

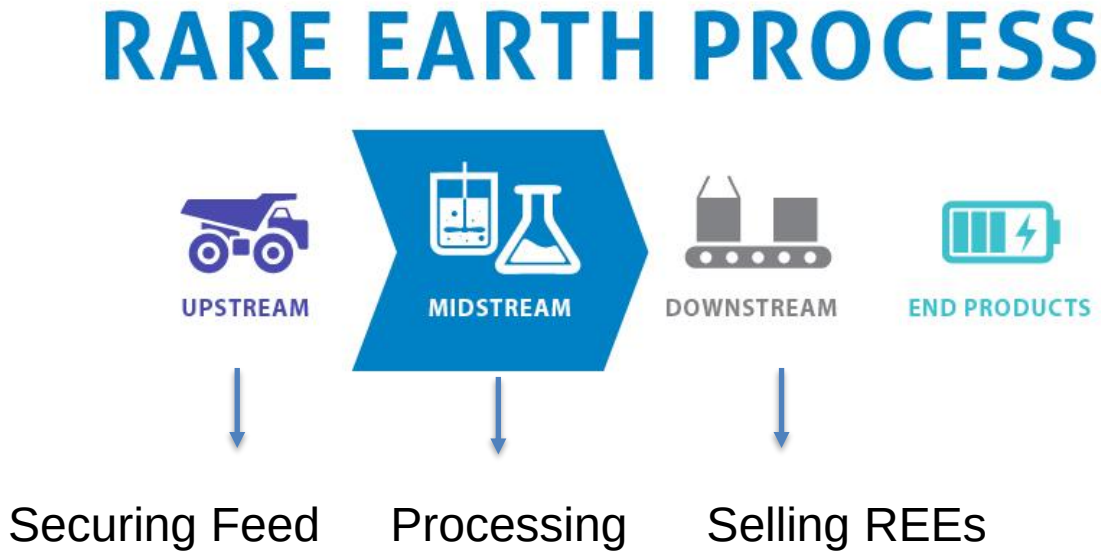
- NaOH (50%) – 8,000 to 10,000 tpy
- HCl (32%) – 10,000 to 15,000 tpy
- NaHCO3 – 3,000 to 4,000 tpy
- H2SO4 – 30 tpy

Plan to Issue RFQs – end of Q1 2022

- Extractant – 10 to 15 m3/year, 200 to 250 m3 for first fill
- Kerosene – 10 to 15 m3/year, 200 to 250 m3 for first fill
- Li Fluoride – 1 Ton for first fill
- Nd Fluoride – 3 Ton for first fill
- Pr Fluoride – 1 Ton for first fill

Rare Earth Element Supply Chain Establishment

- Facility is first step in establishing a Rare Earth Element hub in Saskatchewan and supply chain, outside of China
- This early-stage supply chain is needed to generate cash-flow, investment to stimulate the broader growth of the sector in Saskatchewan and Canada
- Overall goal is to boost domestic supply of key ingredients for renewables, electric vehicles and smartphones and move away from reliance on China
- It will operate to the highest environmental standards



Summary

- SRC will need to work closely with the industry and potential investors as it expands it capabilities throughout the supply chain
- For further questions around SRC REE facility, our up coming needs and requirements, please feel free to contact

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