Pacific NorthWest Economic Region

The Pacific Northwest Economic Region Presents:

Under the Hood: The Critical Minerals Driving our World

Tuesday, August 17th | 3pm-4pm

Photo Courtesy of Montana Office of Tourism & Business Development

THANK YOU TO OUR SESSION SPONSOR

Moderated by Mining Co-Chairs:

Sen. Keith Regier
Montana State Legislature

Tammy Johnson
Executive Director
Montana Mining Association

Session Speakers

Gary Stanley
Director, Office of Materials Industries
U.S. Dept. of Commerce

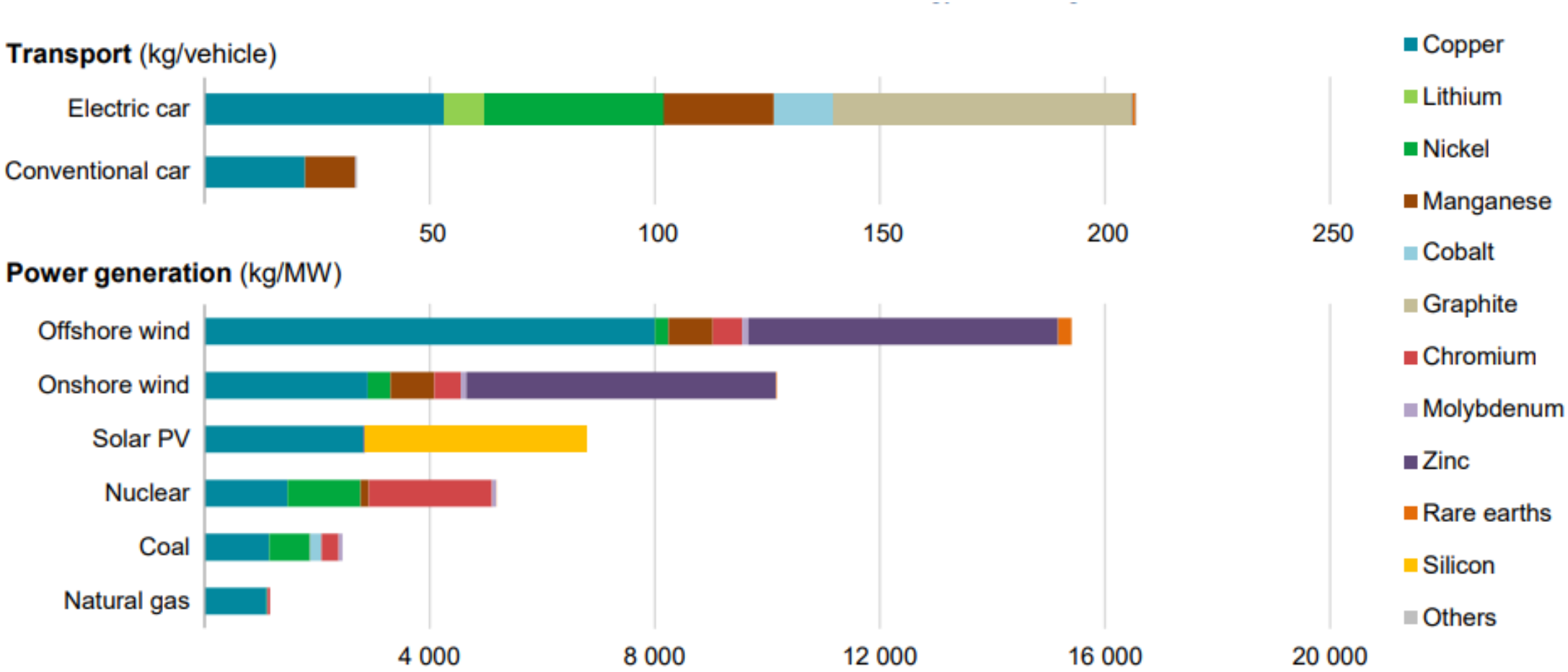
Kimberly Lavoie
General of the Policy & Economics Branch, Lands & Minerals Sector,
Natural Resources Canada

Rich Hammen
CEO
Neodymia

Photo Courtesy of Montana Office of Tourism & Business Development


Natural Resources Canada
Ressources naturelles Canada
Critical Minerals
Canada-U.S. collaboration and roadmap commitments
Presentation to PNWER 30th Annual Summit
August 17, 2021
Canada

The energy transition: a mining and critical minerals story



The Joint Action Plan and Roadmap commitments

Joint Action Plan on Critical Minerals

- June 2019: PM Trudeau and President Trump commit to developing a Joint Action Plan on Critical Minerals Collaboration.
- January 9, 2020: Finalization of Joint Action Plan.
- Areas of collaboration include:
  - Industry engagement
  - Joint R&D
  - Defense supply chains
  - Data exchange
  - Multilateral cooperation
- Multiple federal agencies in both countries involved in implementation.

Roadmap for a Renewed U.S.-Canada Partnership

President Joe Biden
Prime Minister Justin Trudeau
February 23, 2021

"…leaders agreed to **strengthen the Canada-U.S. Critical Minerals Action Plan** to target a net-zero industrial transformation, batteries for zero-emissions vehicles, and renewable energy storage."

"…leaders also agreed to strengthen cooperation under the **Energy Resource Governance Initiative (ERGI)**, a multinational effort to foster international cooperation on the minerals and metals that make the energy transition possible."

Advancing Canada-U.S. critical mineral objectives

Critical Minerals Mapping Initiative online portal: Contains the world's largest dataset of critical minerals in and around ore deposits

Energy Resource Governance Initiative (ERGI): Promoting sound mining sector governance and resilient energy mineral supply chains worldwide

Convening industry stakeholders through trade and investment seminars

Collaboration on standards through ISO standards committees

Budget 2021

- **$36.8 million:** targeted R&D for upstream critical minerals processing and battery precursors and related materials engineering.
- **$9.6 million:** Critical Minerals Centre of Excellence to coordinate federal policy and programs, and work with provincial/territorial governments, Canadian industry, and with allied foreign governments to stimulate the development of Canadian critical mineral value chains

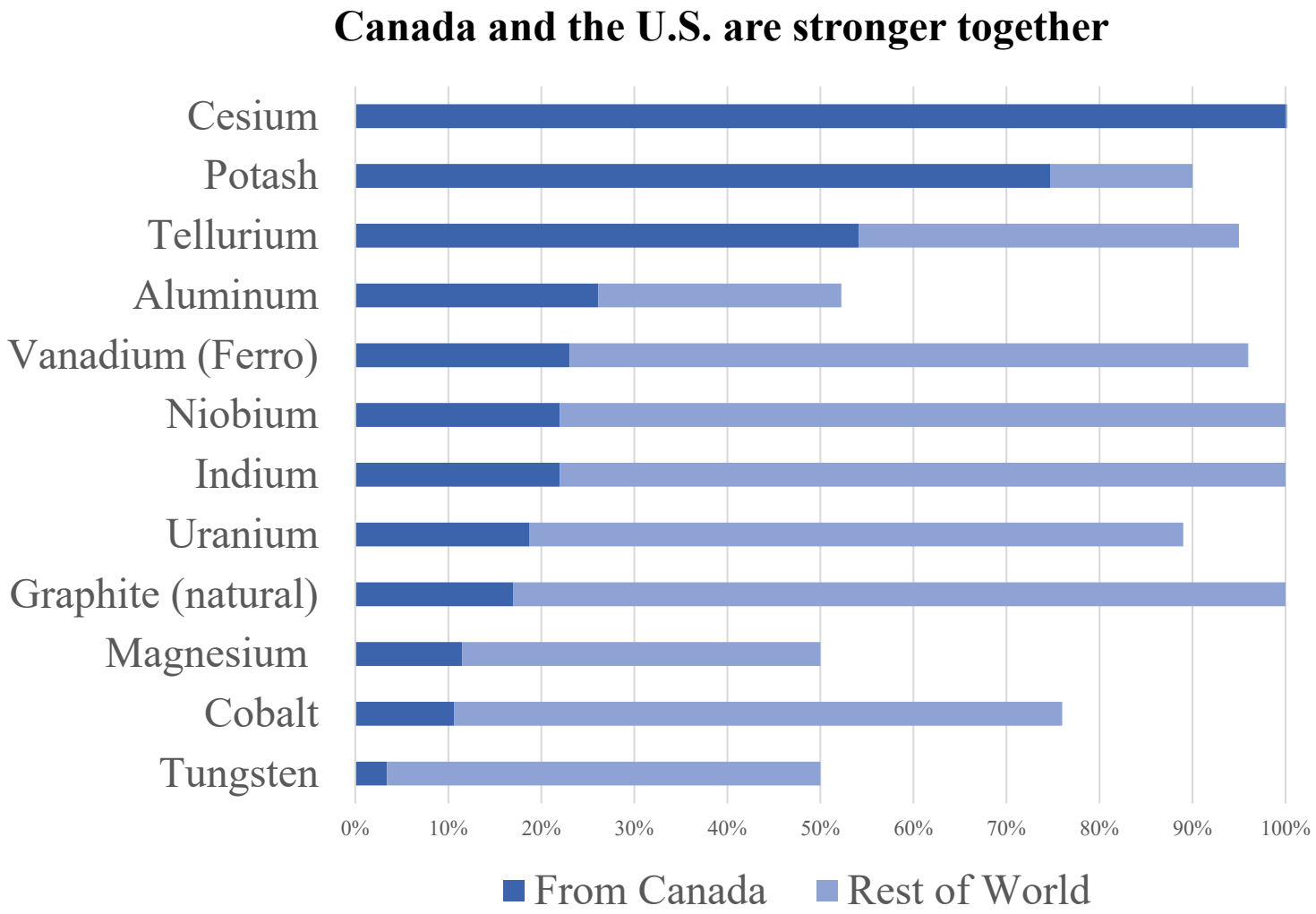
Canada's Critical Minerals List 2021

Federal-Provincial-Territorial Task Team on Critical Minerals and Battery Value Chains

8

Moving forward

- Trade and investment (mechanisms for joint strategic projects; formalizing industry engagements)
- Enhancing transparency and ESG standards within critical mineral value chains
- Innovation and R&D partnerships (circular economy; mining value from waste; critical mineral processing; environmental technologies and GHG reduction)



Source: USGS and US Energy Information Administration

Thank you

America's Supply Chains: 100-Day Report on Critical Minerals

Response to Executive Order 14017

June 8, 2021

EO 14017 - Executive Order on America's Supply Chains
February 24, 2021

Sec. 3. 100-Day Supply Chain Review

- "The **Secretary of Defense** (as the National Defense Stockpile Manager), in consultation with the heads of appropriate agencies, **shall submit a report identifying risks** in the supply chain for critical minerals and other identified strategic materials, including rare earth elements (as determined by the Secretary of Defense), and **policy recommendations to address these risks**."

- "The report shall also describe and **update work done pursuant to Executive Order 13953 of September 30, 2020** (Addressing the Threat to the Domestic Supply Chain From Reliance on Critical Minerals From Foreign Adversaries and Supporting the Domestic Mining and Processing Industries)."

3 Successive Executive Orders

<u>Executive Order 13817</u> – December 20, 2017

"A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals"

- *On June 4, 2019, Commerce Secretary Ross released the Federal Critical Mineral Strategy*

<u>Executive Order 13953</u> – September 30, 2020 (an update of 13817)

"Addressing the Threat to the Domestic Supply Chain from Reliance on Critical Minerals from Foreign Adversaries and Supporting the Domestic Mining and Processing Industries"

<u>Executive Order 14017</u> – February 24, 2021 (an update of 13953)

"*America's Supply Chains*"

INTERNATIONAL TRADE ADMINISTRATION

Figure 2.—2020 U.S. Net Import Reliance[1]

Commodity	Percent	Major import sources (2016–19)[2]
ARSENIC, all forms	100	China, Morocco, Belgium
ASBESTOS	100	Brazil, Russia
CESIUM	100	Canada
FLUORSPAR	100	Mexico, Vietnam, China, South Africa
GALLIUM	100	China, United Kingdom, Germany
GRAPHITE (NATURAL)	100	China, Mexico, Canada, India
INDIUM	100	China, Canada, Republic of Korea
MANGANESE	100	Gabon, South Africa, Australia, Georgia
MICA (NATURAL), sheet	100	China, Brazil, Belgium, India
NEPHELINE SYENITE	100	Canada
NIOBIUM (COLUMBIUM)	100	Brazil, Canada, Germany, Russia
RARE EARTHS,[3] compounds and metal	100	China, Estonia, Japan, Malaysia
RUBIDIUM	100	Canada
SCANDIUM	100	Europe, China, Japan, Russia
STRONTIUM	100	Mexico, Germany, China
TANTALUM	100	China, Germany, Australia, Indonesia
YTTRIUM	100	China, Republic of Korea, Japan
GEMSTONES	99	India, Israel, Belgium, South Africa
VANADIUM	96	Brazil, South Africa, Austria, Canada
TELLURIUM	>95	Canada, China, Germany, Philippines
BISMUTH	94	China, Republic of Korea, Mexico, Belgium
POTASH	90	Canada, Belarus, Russia
TITANIUM MINERAL CONCENTRATES	88	South Africa, Australia, Madagascar, Mozambique
DIAMOND (INDUSTRIAL), stones	84	South Africa, India, Botswana, Congo (Kinshasa)
ZINC, refined	83	Canada, Mexico, Peru, Spain
ANTIMONY, metal and oxide	81	China, Belgium, Thailand, India
SILVER	80	Mexico, Canada, Peru, Poland
PLATINUM	79	South Africa, Germany, Italy, Switzerland
STONE (DIMENSION)	79	China, Brazil, Italy, India
COBALT	76	Norway, Canada, Japan, Finland
PEAT	76	Canada
RHENIUM	76	Chile, Germany, Canada, Kazakh
ABRASIVES, crude fused aluminum oxide	>75	China, France, Canada, Russia
ABRASIVES, crude silicon carbide	>75	China, Netherlands, South Africa
BARITE	>75	China, India, Morocco, Mexico
BAUXITE	>75	Jamaica, Guyana, Australia, Braz
IRON OXIDE PIGMENTS, natural and synthetic	>75	China, Germany, Brazil
CHROMIUM	75	South Africa, Kazakhstan, Mexico
TIN, refined	75	Indonesia, Malaysia, Peru, Bolivia
MAGNESIUM COMPOUNDS	54	China, Israel, Brazil, Netherlands
GOLD	52	Mexico, Canada, Peru, Colombia
GERMANIUM	>50	China, Belgium, Germany, Russia
IODINE	>50	Chile, Japan
LITHIUM	>50	Argentina, Chile, China, Russia
TITANIUM, sponge	>50	Japan, Kazakhstan, Ukraine
TUNGSTEN	>50	China, Bolivia, Germany, Austria
NICKEL	50	Canada, Norway, Finland, Russia
CADMIUM	<50	Australia, China, Canada, Germa
MAGNESIUM METAL	<50	Canada, Israel, Mexico, Russia
SELENIUM	<50	China, Philippines, Mexico, Germ
ALUMINA	49	Brazil, Australia, Jamaica, Canad
GARNET (INDUSTRIAL)	48	South Africa, India, China, Austra
DIAMOND (INDUSTRIAL), dust, grit, and powder	47	China, Ireland, Republic of Korea,
PALLADIUM	40	Russia, South Africa, Germany, U
SILICON, metal and ferrosilicon	38	Brazil, Russia, Canada
COPPER, refined	37	Chile, Canada, Mexico
MICA (NATURAL), scrap and flake	31	Canada, China, India, Finland
PERLITE	28	Greece, China, Mexico, Turkey
SALT	27	Chile, Canada, Mexico, Egypt
BROMINE	<25	Israel, Jordan, China
ZIRCONIUM, ores and concentrates	<25	South Africa, Senegal, Australia, I
LEAD, refined	24	Canada, Republic of Korea, Mexi

INTERNATIONAL TRADE ADMINISTRATION

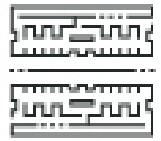
Energy

HAFNIUM

RHENIUM

TANTALUM

URANIUM



Technology

GERMANIUM

INDIUM

GALLIUM

RARE EARTHS

Industrial

BERYLLIUM

ZIRCONIUM

TUNGSTEN

ALUMINUM

PGMs

BARITE

FLUORSPAR

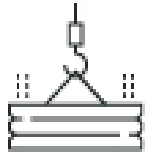
ARSENIC

SCANDIUM

STRONTIUM

TITANIUM

POTASH



Steel

MAGNESIUM

CHROMIUM

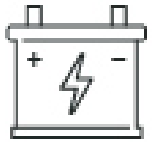
TIN

TELLURIUM

MANGANESE

VANADIUM

NIOBIUM



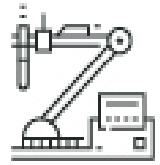
Batteries

LITHIUM

COBALT

ANTIMONY

GRAPHITE



Research

HELIUM

RUBIDIUM

CESIUM

BISMUTH

June 8, 2021 - Supply Chain Review
Critical Minerals Report Recommendations

1. Rebuild our Production and Innovation Capabilities:
   (a) Establish a New Supply Chain Resilience Program (at Commerce, to be authorized by Congress)

2. Support the Development of Markets That Invest in Workers, Value Sustainability, and Drive Quality:
   (a) Create 21st Century Standards for the Extraction and Processing of Critical Minerals

3. Leverage the Government's Role as Purchaser of and Investor in Critical Goods: (a) Use federal procurement to strengthen U.S. supply chains; (b) Strengthen Domestic Production Requirements in Federal Grants for Science and Climate R&D; (c) Reform and Strengthen U.S. Stockpiles.

June 8, 2021 - Supply Chain Review

Critical Minerals Report Recommendations (cont'd)

4. Strengthen International Trade Rules, Including Trade Enforcement Mechanisms:
   (a) Establish a Trade Task Force; (b) Evaluate Whether to Initiate a Section 232 Investigation on Imports of Neodymium Magnets (Commerce/BIS).
5. Work with Allies and Partners to Decrease Vulnerabilities in the Global Supply Chains:
   (a) Expand Multilateral Diplomatic Engagement, Including Hosting a New Presidential Forum (on Supply Chain Resilience)
   (b) Leverage the U.S. Development Finance Corporation and Other Financing Tools to Support Supply Chain Resilience.
6. Monitor Near-Term Supply Chain Disruptions as the Economy Reopens form the COVID-19 Pandemic:
   (a) Establish a Supply Chain Disruptions Task Force (Commerce, Transportation and Agriculture to Chair)
   (b) Create a Data-Hub to Monitor Near-Term Supply Chain Vulnerabilities (Commerce).

Importance of U.S.-Canada Critical Minerals Partnership

- Canadian companies and persons are the only non-U.S. entities and persons who are considered a “domestic source” for the purposes of the Defense Production Act (DPA) (50 U.S.C. 4500 et seq.).

- **Canada**:
  - 2nd-largest import source for strategic and critical materials for which the U.S. has net import reliance greater than 50%

  - Global hub for mining project finance, including the risk finance that supports junior mining companies exploring for strategic and critical materials and developing the next generation of projects.

  - Has substantial resource potential in existing operations and planned projects that could support U.S. needs for cobalt, tantalum, antimony, and twenty additional strategic and critical materials.

U.S.-Canada Critical Minerals Cooperation

- **June 2019** – The Strategy proposes that the Federal Government establish intergovernmental critical mineral agreements with partner countries.
  - October 2019 – First full meeting of the **U.S.-Canada Critical Minerals Working Group.**

- **December 2019** – both parties agree to **Joint Action Plan** which lays out integrated approach to 1) address mutual security concerns; 2) facilitate greater trade and investment; and 3) increase both country's industry competitiveness.
  - **ITA is the USG co-lead on behalf of Commerce for the Sub-Working Group on Industry Engagement.** Examples of activities/engagements – March 2020 PDAC Annual Convention, November 2020 industry webinar.

- **February 2021** – In the **Roadmap for a Renewed U.S.-Canada Partnership,** President Biden and Prime Minister Trudeau agreed to strengthen the Canada-U.S. Critical Minerals Action Plan to "target a net-zero industrial transformation, batteries for zero-emissions vehicles, and renewable energy storage."

Future of U.S.-Canada Critical Minerals Cooperation

- **June 2021 - 100-Day Report released under Executive Order 14017** cites the bilateral partnership as a **model example** for international cooperation on strategic and critical materials. It notes that "these efforts should continue and, as appropriate, additional engagements should be undertaken."

- **July 28, 2021** – At the third U.S.-Canada Critical Minerals Working Group meeting, the parties:
  1. Discussed implementation of commitments outlined in the Roadmap for a Renewed U.S.-Canada Partnership;
  2. Shared perspectives on strengthening supply chains that utilize critical minerals; and
  3. Reviewed E.O. 14017 and the 100-day supply chain review of critical minerals and materials and other key sectors issued in June.

INTERNATIONAL TRADE ADMINISTRATION

Thank You

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THE BENEFICIAL REUSE OF COAL FLY ASH WASTES

Richard Hammen Ph.D.: Neodymia, IntelliMet, Metals US
Brad Layton, Ph.D., P.E.: Neodymia
John Hammen: Metals US
Chris Hammen: IntelliMet
www.metalsus.com

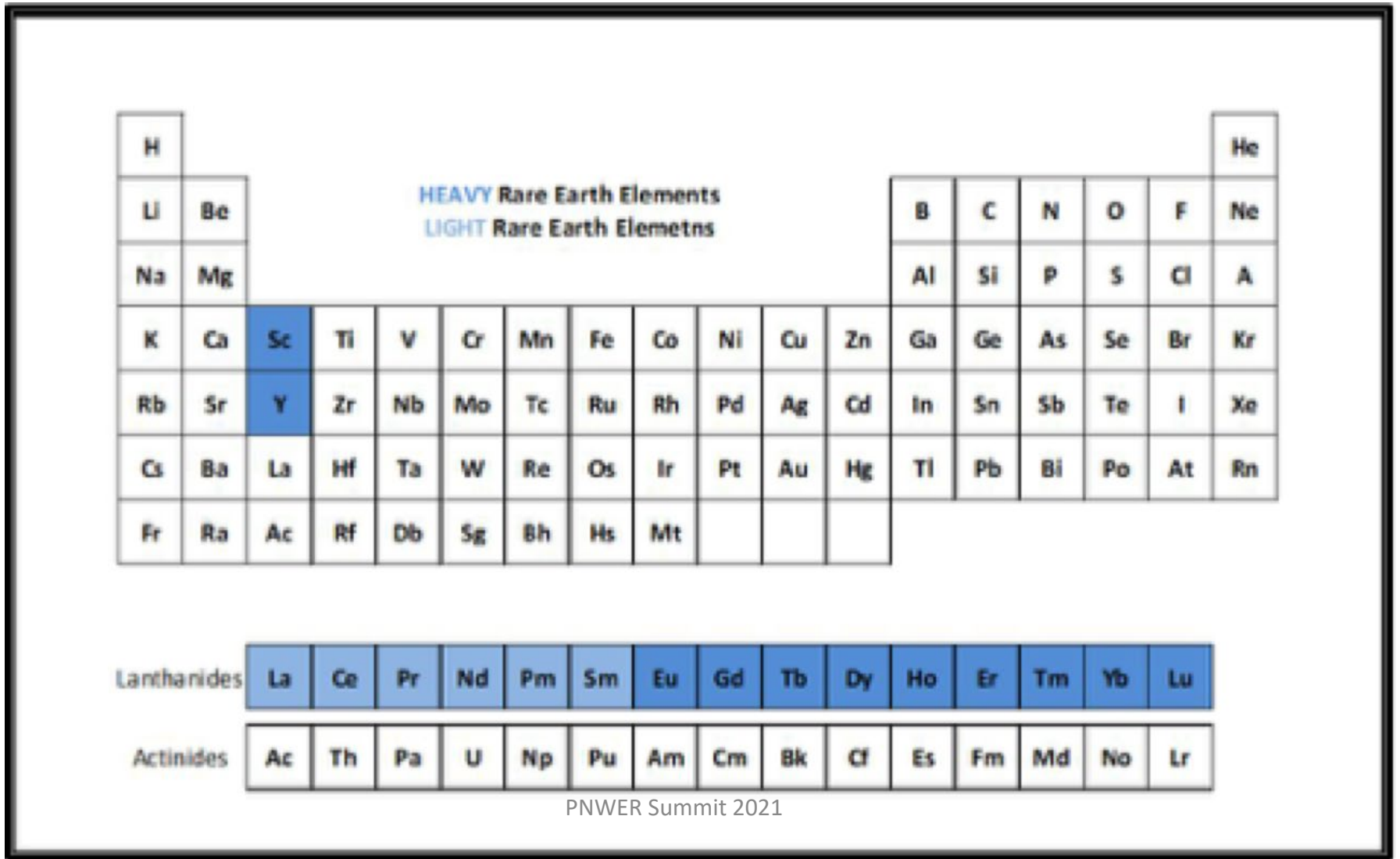
PNWER Annual Summit, Big Sky, MT
August 15-19, 2021

AERIAL VIEW OF COLSTRIP MT POWER FACILITY

THE SITUATION: COAL ASH AND RARE EARTH ELEMENTS (REE)

- Coal combustion has produced much of the electric power that enables us to enjoy today's life style.
- Coal combustion leaves a mineral residue called Coal Fly Ash (CFA).
- REE's have been found in CFA waste piles in quantities that could enable the USA to be independent of world supply issues
- Efforts are underway to have REE "mining" from CFA become an economical source of REE

WHAT ARE REE?


HEAVY Rare Earth Elements
LIGHT Rare Earth Elemetns
H
He
Li
Be
B
C
N
O
F
Ne
Na
Mg
Al
Si
P
S
Cl
A
K
Ca
Sc
Ti
V
Cr
Mn
Fe
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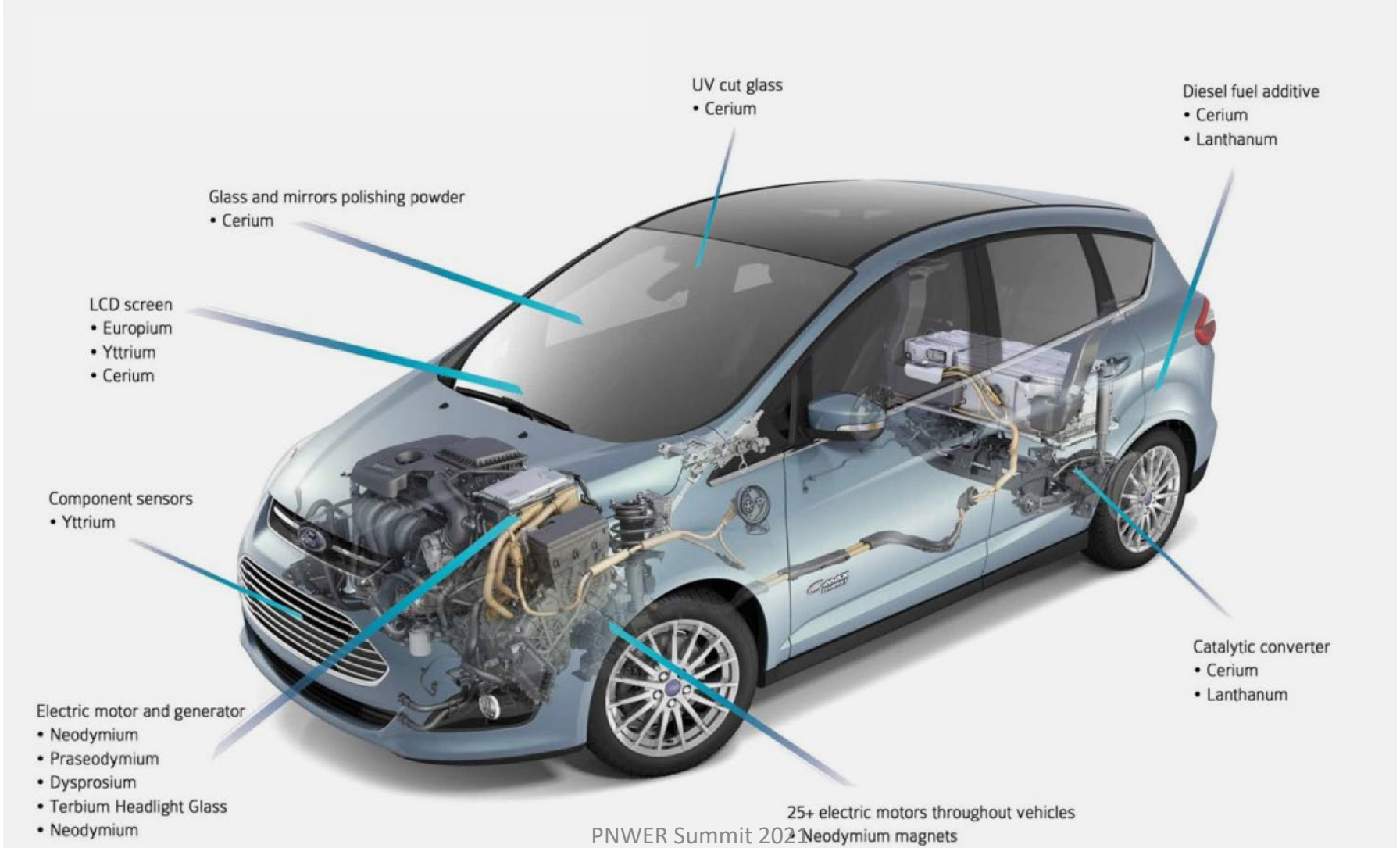
REE IN HYBRID VEHICLES



GROSS REVENUE OF ELEMENT PRODUCTS RECLAIMED FROM MONTANA COAL FLY ASH (CFA)

Element	Al	As	B	Ba	Ca	Ce	Cu	Dy	Er	Eu
ppm extracted	39,427	10	288	7	28,256	31	60	7	0	0.50
$/ton of produc	$ 400	$ 2,100	$ 377	$ 180		$ 5,000	$ 6,160	$ 300,000	$ 300,000	$ 300,000
tons/annum	3.94E+05	1.05E+02	2.88E+03	6.70E+01	2.83E+05	3.10E+02	5.98E+02	6.68E+01	0.00E+00	4.97E+00
$/annum	$ 157,709,235	$ 219,888	$ 1,086,754	$ 12,058	$ -	$ 1,551,916	$3,683,752	$ 20,036,861	$ -	$ 1,490,568
$/ton CFA	$ 15.77	$ 0.02	$ 0.11	$ 0.00	$ -	$ 0.16	$ 0.37	$ 2.00	$ -	$ 0.15

Element	Fe	Gd	Ge	Ho	La	Li	Lu	Mg	Mn	Mo
ppm extracted	17,083	14.12	2.48	22.13	15	43	1	12,800	$ 422	$ 18
$/ton of produc	$ 207	$ 50,000	$ 1,240,000	$ 150,000	$ 5,000	$ 10,000	$ 200,000	$ 624	$ 2,200	$ 26,000
tons/annum	1.71E+05	1.41E+02	2.48E+01	2.21E+02	1.48E+02	4.28E+02	5.26E+00	1.28E+05	4.22E+03	1.82E+02
$/annum	$ 35,361,555	$ 7,059,633	$ 30,769,924	$33,188,436	$ 740,493	$ 4,284,055	$1,051,067	$ 79,869,406	$ 9,287,690	$ 4,739,952
$/ton CFA	$ 3.54	$ 0.71	$ 3.08	$ 3.32	$ 0.07	$ 0.43	$ 0.11	$ 7.99	$ 0.93	$ 0.47

Element	Nd	Ni	P	Pb	Pr	Sc	Sm	Sn	Sr	Ta
ppm extracted	$ 19	$ 11	$ 490	$ 15	$ 31	$ 6.1	$ 5	$ 5	$ 484	$ 8.9
$/ton of produc	$ 55,000	$ 14,000	$ 70	$ 2,036	$ 93,000	$ 3,000,000	$ 17,000	$ 17,634	$ 698	$ 182,000
tons/annum	1.90E+02	1.14E+02	4.90E+03	1.51E+02	3.08E+02	6.10E+01	5.04E+01	4.54E+01	4.84E+03	8.90E+01
$/annum	$ 10,436,496	$ 1,591,527	$ 341,214	$ 307,975	$28,658,034	$183,147,220	$ 856,363	$ 801,289	$ 3,375,960	$ 16,190,307
$/ton CFA	$ 1.04	$ 0.16	$ 0.03	$ 0.03	$ 2.87	$ 18.31	$ 0.09	$ 0.08	$ 0.34	$ 1.62

Element	Tb	Ti	Tl	U	V	W	Y	Yb	Zn	Zr
ppm extracted	$ 0.4	$ 785.2	$ 5.9	$ 47.3	$ 61.5	$ 2.5	$ 16.9	$ 1.5	$ 33.0	$ 9.9
$/ton of produc	$ 650,000	$ 9,100	$ 100,000	$ 66,000	$ 66,000	$ 316	$ 35,000	$ 200,000	$ 13,000	$ 13,000
tons/annum	4.30E+00	7.85E+03	5.95E+01	4.73E+02	6.15E+02	2.51E+01	1.69E+02	1.50E+01	3.30E+02	9.91E+01
$/annum	$ 2,793,757	$ 71,449,280	$ 5,945,359	$31,190,176	$40,597,885	$ 7,927	$5,909,452	$ 2,995,272	$ 4,284,625	$ 1,288,241
$/ton CFA	$ 0.28	$ 7.14	$ 0.59	$ 3.12	$ 4.06	$ 0.00	$ 0.59	$ 0.30	$ 0.43	$ 0.13

Total Gross Revenue = $804,311,602 per year, with processing rate of 10 M tons CFA/year

GROSS REVENUE OF TOP 8 ELEMENT PRODUCTS RECLAIMABLE FROM MONTANA COAL FLY ASH (CFA)

Element	Scandium	Aluminum	Magnesium	Vanadium	Iron	Uranium	Germanium	Praseodymium	Totals
ppm extracted	6.1	39,427	12,800	62	17,083	47	2.5	30.8	
tons/annum	61	394,273	127,996	615	170,829	473	25	308	**694,579**
$/ton of product	$ 3,000,000	400	$ 624	$ 66,000	$ 207	$ 66,000	$1,240,000	$ 93,000	
$/annum	183,147,220	157,709,235	79,869,406	40,597,885	35,361,555	31,190,176	30,769,924	28,658,034	**$587,303,435**

Total Gross Revenue = $587 M per annum for the Top 8 Elements

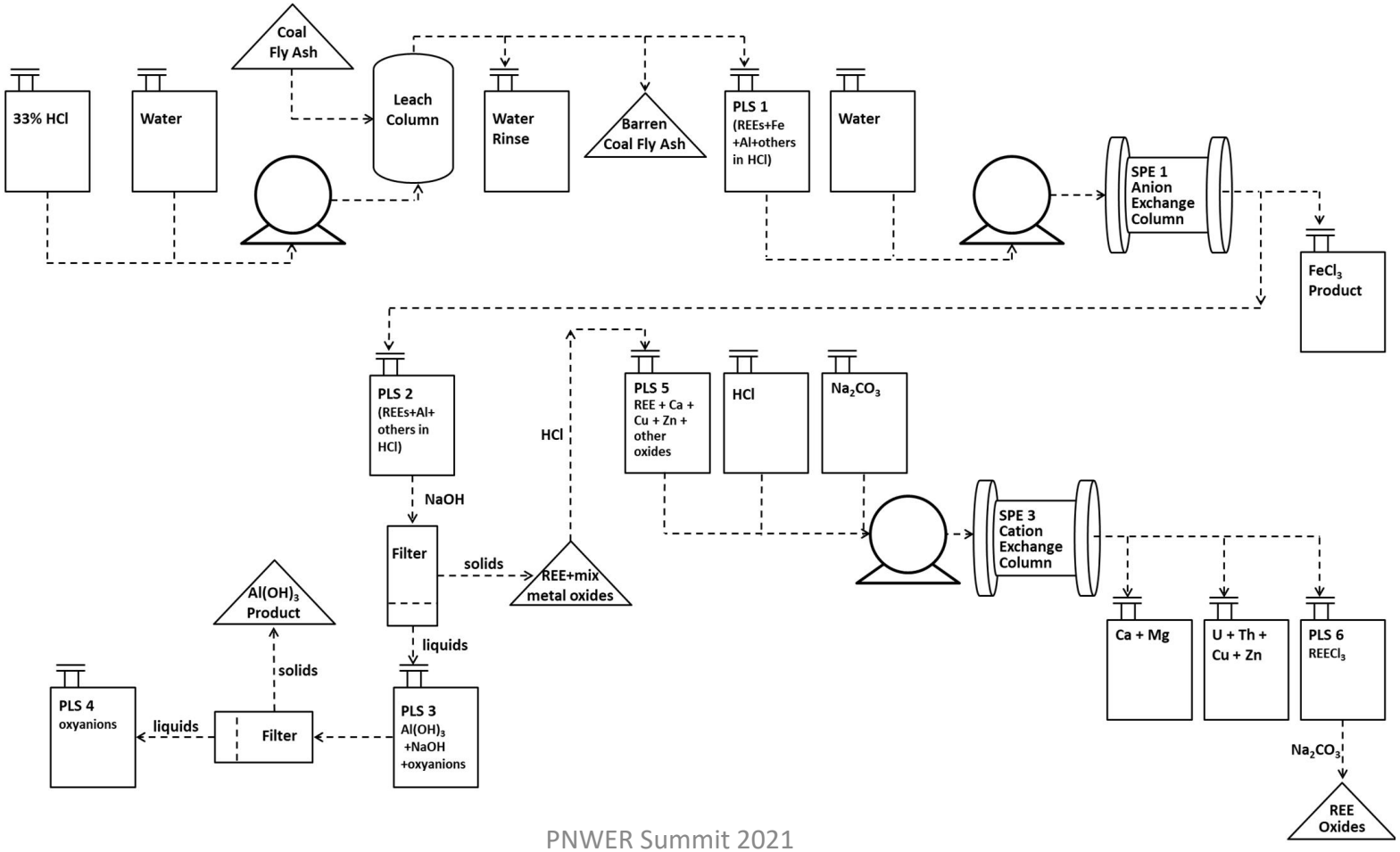
Gross of REE's = $117 M

Conclusion: We must consider all of the element recoveries, rather than only REE production

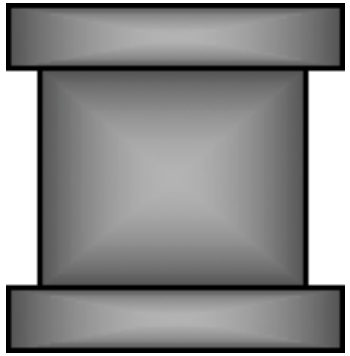
ECONOMIC IMPACT

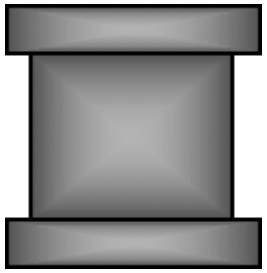
A total gross revenue of $587 M per year will generate over 5780 jobs

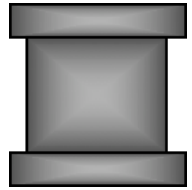
(PARTIAL) PROCESS DIAGRAM FOR METAL RECLAMATION PLANT



PROJECTED SCALE OF PURIFICATION UNITS







Solute Capture from Extraction Fluid

Class separation

REE Element Purification

SUMMARY

- The tremendous value of elements in CFA waste piles can be extracted
- The physical systems for extracting the valuable elements from CFA solids were developed over 100 years ago and are well-known in the mining industry
- The systems for recovery of the REE are known.
- The extraction/purification plant is modular and linearly scalable. This give predictable economics for the overall factory