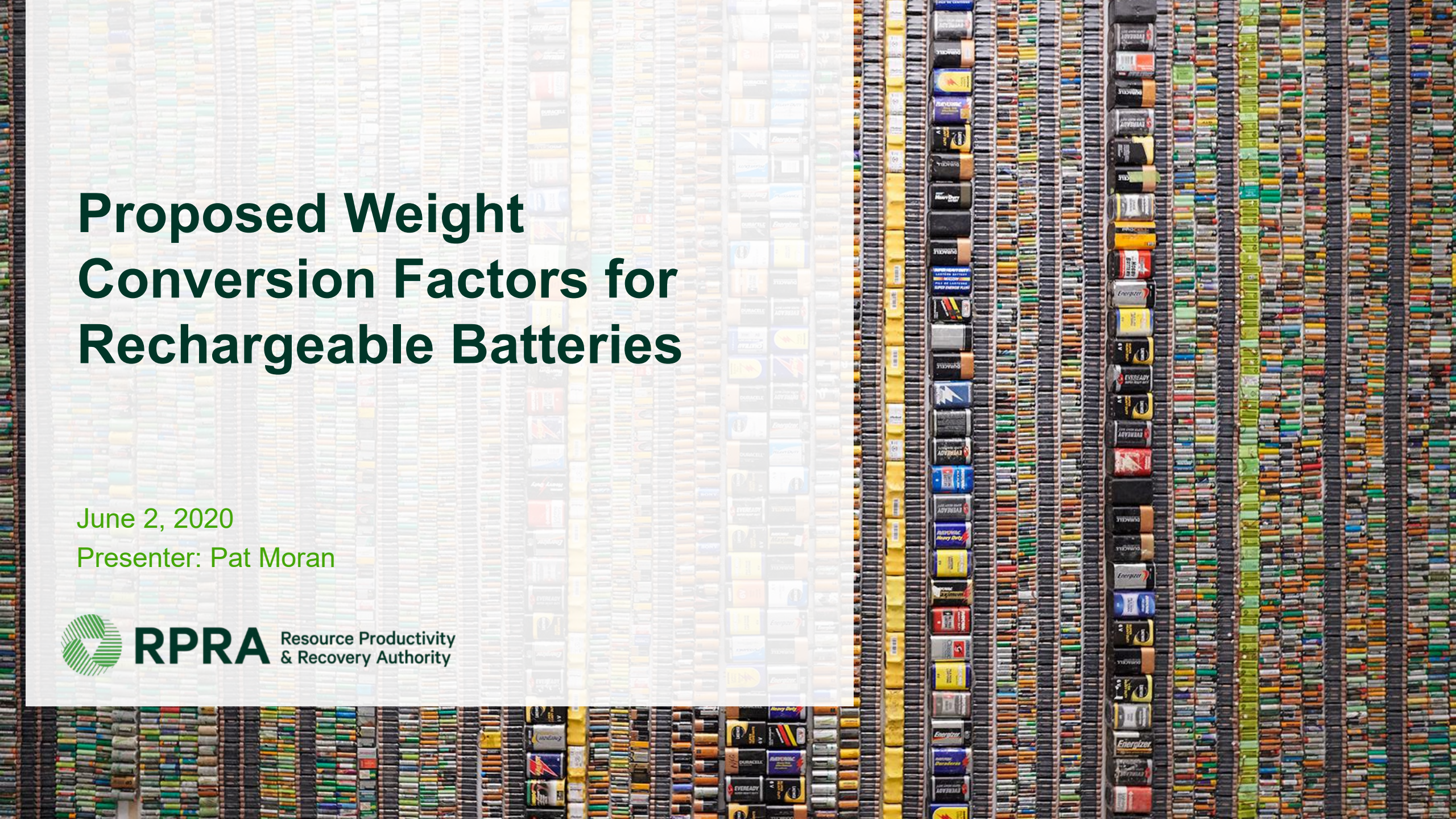
Proposed Weight Conversion Factors for Rechargeable Batteries

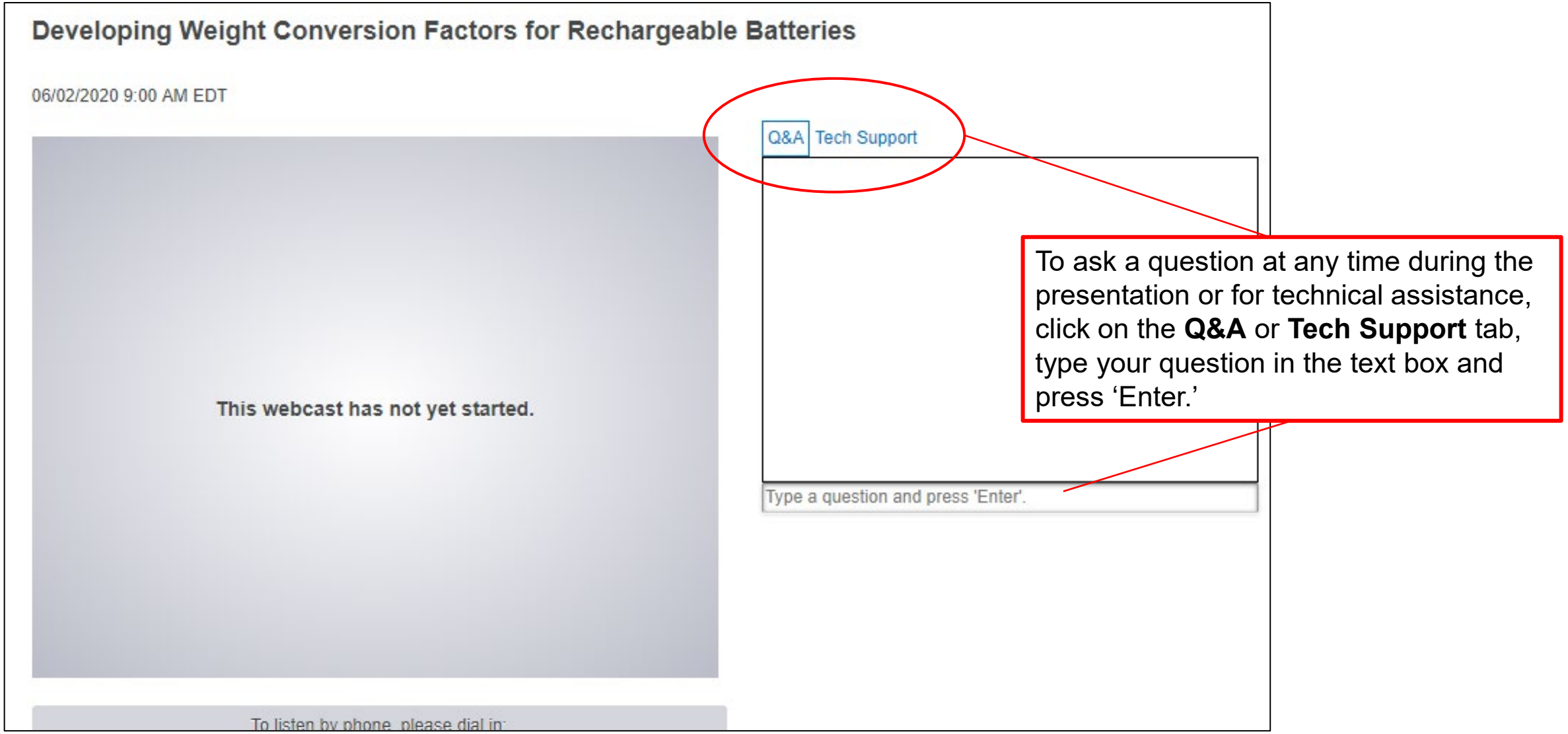
June 2, 2020

Presenter: Pat Moran

RPRA Resource Productivity & Recovery Authority

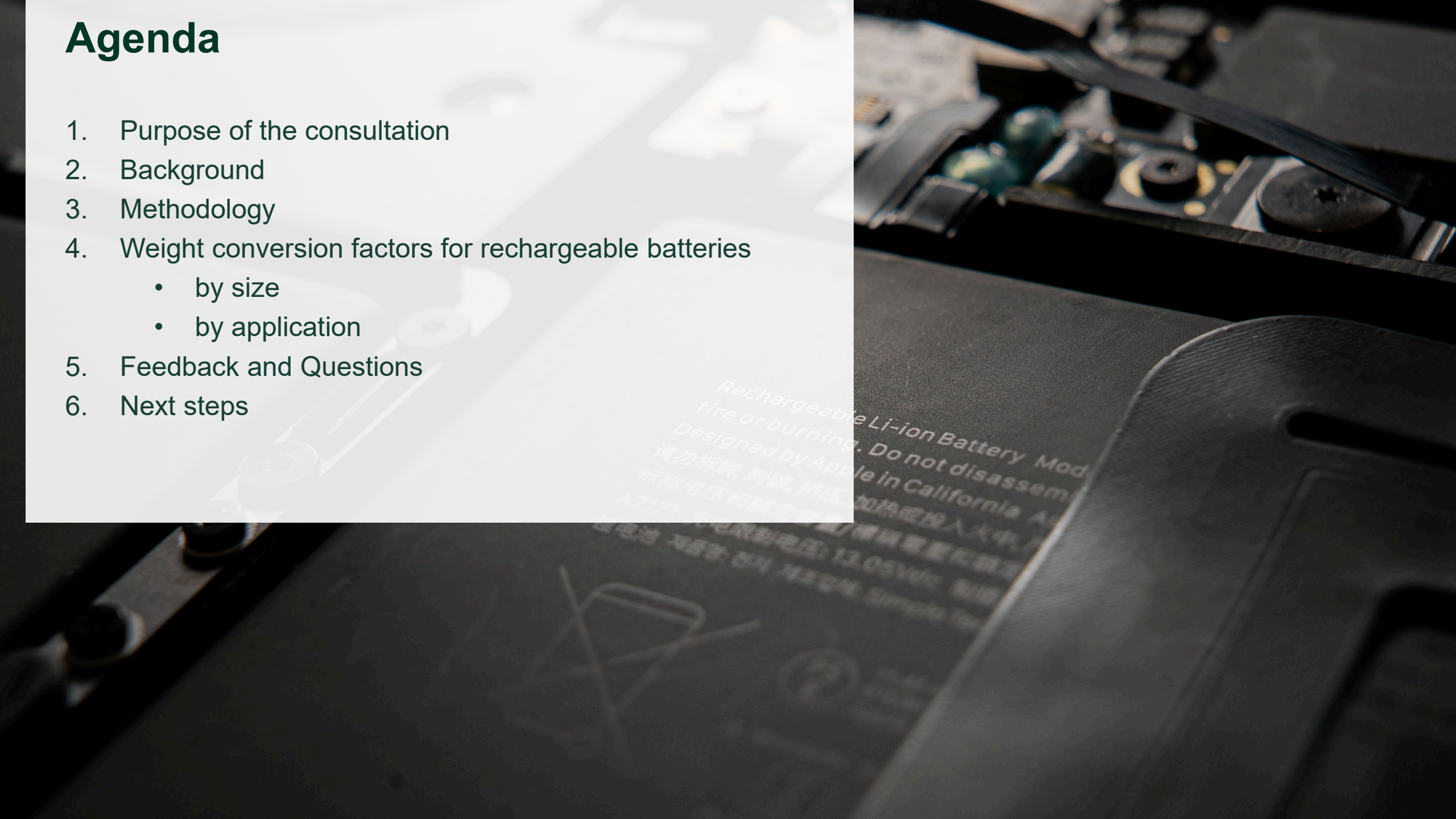


How to ask a question



Agenda

1. Purpose of the consultation
2. Background
3. Methodology
4. Weight conversion factors for rechargeable batteries
    - by size
    - by application
5. Feedback and Questions
6. Next steps



Purpose of this consultation

- The purpose of this consultation is to allow the Registrar to develop conversion factors to calculate the weight of rechargeable batteries, to be included in the Registry Procedure—Verification and Audit for Batteries.
- The Authority is seeking feedback from batteries producers and stakeholders, which we will consider when finalizing the weight conversion factors for rechargeable batteries.

Background

- The Batteries Regulation was released in February
- The regulation requires producers of single-use batteries and rechargeable batteries weighing 5 kg or less to report, by November 30, 2020, the weight of batteries they supplied into Ontario:
    - In the years 2018 and 2019 for single-use batteries
    - In 2018 for rechargeable batteries
- The document entitled Registry Procedure—Verification and Audit, published by the Authority is incorporated by reference into the Batteries Regulation

Background: Registry Procedure – Verification and Audit

- Section 1 of the Registry Procedure establishes two ways to determine battery weight for the purposes of reporting
    - Actual weight; or
    - Calculated weight using weight conversion factors provided by the Registrar
- Weight conversion factors can be used by battery producers to do a unit-to-weight conversion for the purpose of reporting the weight of batteries they supplied into Ontario
- Appendix B to the Registry Procedure provides a weight conversion calculator for single-use batteries
- The Registry Procedure indicates that a weight conversion calculator for rechargeable batteries will be developed in consultation with stakeholders, with the intention of adding it to the Registry Procedure.
- This webinar begins that process

Methodology

The research team

The RPRA contracted researchers from The United Nations Institute for Training and Research (UNITAR), Vanessa Forti and Kees Baldé.

- The UNITAR team has broad expertise in waste statistics and quantifying material flows, battery flows, and closely linked e-waste flows.
- The have done extensive research in this area, including as part of the ProSUM Project (Prospecting Secondary raw materials in the Urban mine and Mining wastes) - in Europe.
- This experience, as well as access to data collected during related projects made them the ideal team to assist in the development of the Authority's weight conversion factors for rechargeable batteries.

How the team developed the weight conversion factors

Goal:

Develop unit-to-weight conversion factors for all sizes, material types and chemistries of rechargeable batteries:

- Sold loose, embedded within or with products
- Sold as standalone or replacement batteries
- Weighing 5 kg or less

The average weights need to include the weight of the casing/housing of the battery cells

Steps:

1. Classification of rechargeable batteries by chemistry, size and application
2. Calculation of average weights by size
3. Calculation of average weights by application

Step 1 – Classification of rechargeable batteries

The first process classified rechargeable batteries by:

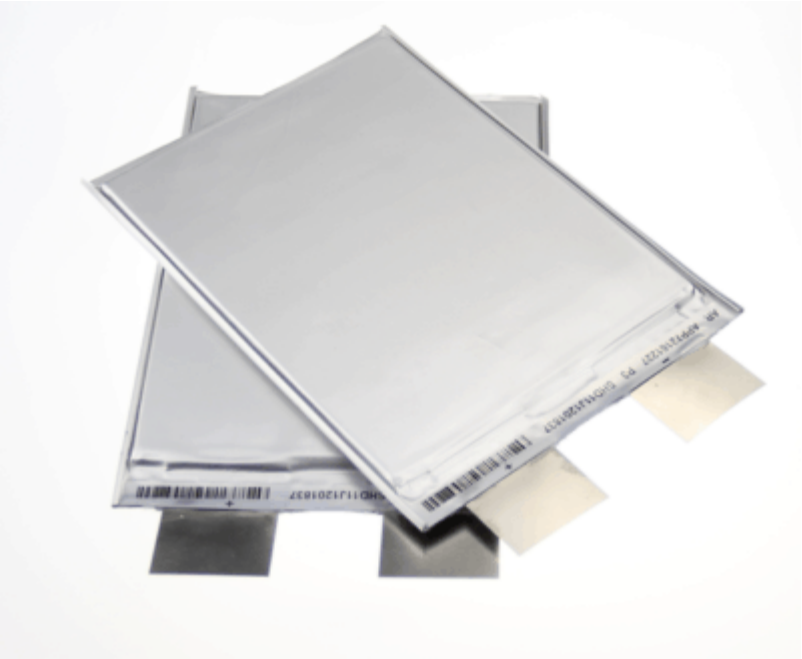
1. Common battery chemistries
2. Common rechargeable battery sizes
3. Typical applications of rechargeable batteries

The classification of batteries was done through:

- Literature review
- Review of product catalogues
- Comparison with similar projects done in the European Union

Step 2 – Calculation of average weights by size

- The researchers conducted desktop research to compile a comprehensive list of average weights by battery size (including the casing or housing).
- For most battery chemistries, standard sizes and average weights from different data sources were found to be comparable and consistent.
- Due to the high level of variability in the lithium ion pouch group, it was necessary to group the cells by capacity in milliamp hours (mAh). The following groups were selected:
    - 55-500 typical nominal mAh
    - 501-1000 typical nominal mAh
    - 1001-2000 typical nominal mAh
    - 2001-5000 typical nominal mAh
    - >5001 typical nominal mAh



RPRA Resource Productivity & Recovery Authority

Step 3 – Calculation of average weights by application

Part one: calculation

- Calculated the average weight of rechargeable batteries by application (g/unit) by dividing the average energy usage per application (Wh/unit) by the average energy flow per grams of battery (Wh/g)
- Calculated the weight of the casing or housing of the battery from the average share of the weight of the casing or housing out of the total weight of the battery cell or pack by chemistry group
    - proposed to be 10% for lead acid batteries
    - proposed to be 25% for all other types of batteries (NiMH, NiCd and Li-ion)
- We would like your feedback on this proposed approach

Step 3 – Calculation of average weights by application

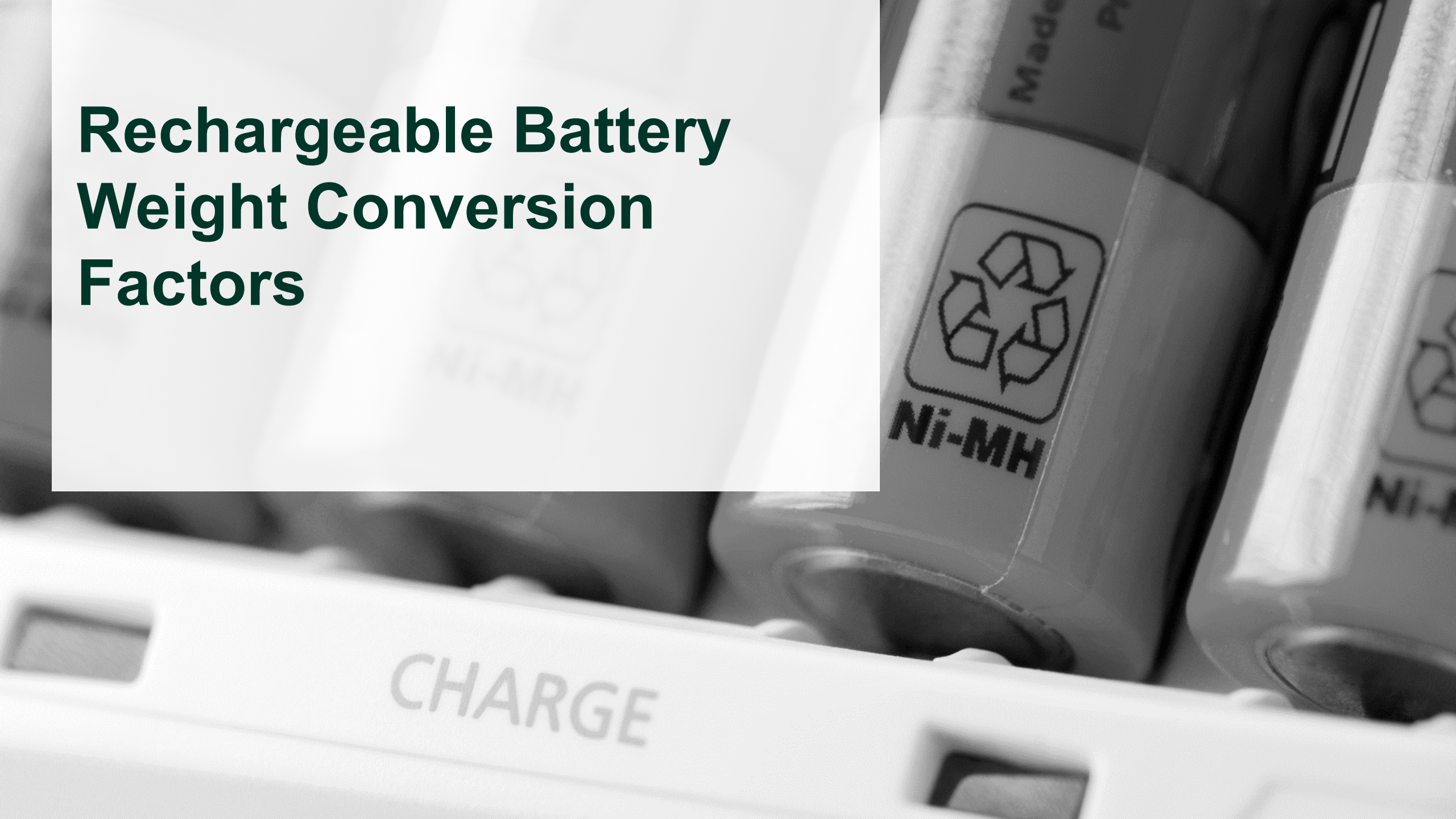
Part two: validation

- Average weights validated by researching actual battery weights per chemistry and application in the marketplace.
- Average weights compared to the average of the weight of at least 10 batteries of the same kind and from a variety of producers and brands.
- The difference between the calculated weights and the weights of products in the marketplace was in the range of ±1–20% for all battery chemistries and applications analyzed.
    - Given the limited sample size and the variety of batteries that exist in the marketplace, this was considered an acceptable difference.

Questions and Comments

- Do you have any questions about the consultation process or the methodology we are using to develop the weight conversion factors?
- Any questions for our researchers about their experience or research background?
- Are you aware of or have you used other methods to calculate the weight of rechargeable batteries?

Rechargeable Battery Weight Conversion Factors



Common battery chemistries

Chemistry group	Chemistry sub-group	Chemistry abbr.	Chemistry
Lead acid	Lead acid	PbA	$PbSO_4$
Nickel	Nickel-Cadmium	NiCd	NiCd
	Nickel-Metal Hydride	NiMH	NiMH
Lithium-ion	Lithium Cobalt Oxide	LCO	$LiCoO_2$
	Lithium Nickel Manganese Cobalt Oxide	NMC	$LiNiMnCoO_2$
	Lithium Nickel Cobalt Aluminium Oxide	NCA	$LiNiCoAlO_2$
	Lithium Manganese Oxide	LMO	$LiMn_2O_4$
	Lithium Iron Phosphate	LFP	$LiFePO_4$
Other	Other (e.g. Alkaline Metal Oxide)	Other	Other

Common Battery Sizes

Group	Sub-group	Chemistry abbr.	Chemistry	Size
Lead acid	Lead acid	PbA	$PbSO_4$	4 V
				6 V
				12 V
Nickel	Nickel-Cadmium, Nickel-Metal Hydride	NiCd, NiMH	NiCd, NiMH	9 V
				A
				AA
				AAA
				C
				D
				F
				N
				Sub C
Lithium-ion	Lithium Cobalt Oxide, Lithium Nickel Manganese Cobalt Oxide, Lithium Manganese Oxide, Lithium Iron Phosphate	LCO, NMC, NCA, LMO, LFP	$LiCoO_2$, $LiNiMnCoO_2$, $LiNiCoAlO_2$, $LiMn_2O_4$, $LiFePO_4$	Cylindrical single cell
				Prismatic single cell
				Pin cell
				Button cell
				Pouch cell (55-500 typical nominal mAh)
				Pouch cell (501-1000 typical nominal mAh)
				Pouch cell (1001-2000 typical nominal mAh)
				Pouch cell (2001-5000 typical nominal mAh)
				Pouch cell (>5001 typical nominal mAh)
Other	Other (e.g. Alkaline Metal Oxide)			AAA
				AA
				C
				D

Weight Conversion Factors by Battery Size – part 1 of 2

Size	Chemistry	Weight (kg)
4 V	Lead acid	0.0013
6 V	Lead acid	0.0016
9 V	Nickel-Cadmium	0.035
	Nickel-Metal Hydride	0.042
12 V	Lead acid	0.002
N	Nickel-Cadmium	0.010
	Nickel-Metal Hydride	0.011
AAA	Nickel-Cadmium	0.0105
	Nickel-Metal Hydride	0.013
	Other	0.011
AA	Nickel-Cadmium	0.0215
	Nickel-Metal Hydride	0.0271
	Other	0.022
A	Nickel-Cadmium	0.032
	Nickel-Metal Hydride	0.040
C	Nickel-Cadmium	0.073
	Nickel-Metal Hydride	0.080
	Other	0.058
Sub C	Nickel-Cadmium	0.0529
	Nickel-Metal Hydride	0.055

Weight Conversion Factors by Battery Size – part 2/2

Size		Chemistry	Weight (kg)
D		Nickel-Cadmium	0.145
		Nickel-Metal Hydride	0.1628
		Other	0.104
F		Nickel-Cadmium	0.231
Pin cell		Nickel-Metal Hydride	0.2613
Button cell		Lithium-ion	0.0025
Prismatic single cell		Lithium-ion	0.0217
Cylindrical single cell		Lithium-ion	0.0418
Pouch cell	55-500 typical nominal mAh	Lithium-ion	0.0052
	501-1000 typical nominal mAh	Lithium-ion	0.0158
	1001-2000 typical nominal mAh	Lithium-ion	0.030
	2001-5000 typical nominal mAh	Lithium-ion	0.055
	>5001 typical nominal mAh	Lithium-ion	0.112

Common Applications for Rechargeable Batteries

- **Camera/games:** camcorders, digital cameras, games, racing cars
- **Other portable:** MP3, cordless phones, shavers, toothbrushes, power banks, drones, hover boards, cordless mice, remote controls etc.
- **Tablets**
- **Laptops/Portable PC:** laptops, portable PCs, net-books, ultra-books
- **Cordless tools:** gardening tools, cordless tools, power tools
- **E-bikes**
- **Industrial excluding mobility:** pallet jacks, forklifts, energy storage for industrial use, other non-portable
- **Lighting:** security lighting, shielded or full cut-off lamps, control and power lines, portable light fixtures
- **Medical:** measuring instruments, medical carts and beds, portable defibrillators, other instruments
- **Uninterruptible Power Supply (UPS)**
- **Telecom:** phone exchanges
- **Personal Mobility Devices/ Light Electric Vehicles:** golf carts, mobility scooters

Weight Conversion Factors by Battery Application - part 1/2

Application	Chemistry	Weight (kg)
Cell phones E.g. cellular phones, smartphones	Lithium Cobalt Oxide (LCO)	0.028
	Lithium Nickel Manganese Cobalt Oxide (NMC)	0.053
Cameras/video games E.g. video game controller	Lithium-ion (Includes: Lithium Cobalt Oxide, Lithium Nickel Manganese Cobalt Oxide, Lithium Manganese Oxide)	0.215
Others - portable E.g. power banks, shavers, toothbrushes, drones, cordless mice, remote controls, MP3, cordless landline phones	Nickel-Metal Hydride (NiMH)	0.042
	Lithium-Ion (Includes: Lithium Nickel Manganese Cobalt Oxide, Lithium Manganese Oxide, Lithium Iron Phosphate)	0.215
	Lead acid (PbA)	1.111
Tablets	Lithium-ion (Includes: Lithium Cobalt Oxide, Lithium Nickel Manganese Cobalt Oxide)	0.246
Laptops/Portable PC	Lithium Nickel Manganese Cobalt Oxide (NMC)	0.438
Cordless tools E.g. gardening tools, cordless tools, power tools	Lithium Nickel Manganese Cobalt Oxide (NMC)	0.495
	Nickel-Metal Hydride (NiMH)	0.923
	Nickel-Cadmium (NiCd)	1.182
	Lead acid (PbA)	1.556

Weight Conversion Factors by Battery Application - part 2/2

Application	Chemistry	Weight (kg)
E-bikes	Lithium Ion (Includes: Lithium Nickel Manganese Cobalt Oxide, Lithium Manganese Oxide, Lithium Cobalt Oxide, Lithium Iron Phosphate)	2.802
Industrial excluding mobility E.g. pallet jacks, forklifts, energy storage for industrial use, other non-portable	Any Nickel (Includes: Nickel-Cadmium Nickel-Metal Hydride)	2.963
	Lithium-ion (Includes: Lithium Manganese Oxide, Lithium Cobalt Oxide, Lithium Nickel Manganese Cobalt Oxide, Lithium Nickel Cobalt Aluminum Oxide, Lithium Iron Phosphate)	2.984
Lighting E.g. security lighting, shielded or full cut-off lamps, control and power lines	Nickel-Cadmium (NiCd)	2.963
Medical E.g. measuring instruments, medical carts and beds, portable defibrillators	Lithium Cobalt Oxide (LCO)	2.984
Uninterruptible Power Supply (UPS)	Lithium Iron Phosphate (LFP)	2.984
Telecom	Lithium Nickel Manganese Cobalt Oxide (NMC)	2.984
Personal Mobility Devices/ Light Electric Vehicles E.g. golf carts, mobility scooters	Lithium Nickel Manganese Cobalt Oxide (NMC)	3.284

Ongoing Review of Weight Conversion Factors

- RPRA will ensure that the weight conversion factors continue to be representative of products in the marketplace.
- The weight conversion factors developed through this consultation will be reviewed regularly.
- The UNITAR researchers will also be providing guidance on how to adapt the methodology they developed for use in future reviews of the weight conversion factors.

Questions and Comments

- Are the presented battery classifications accurate?
- Are there any battery classifications missing?
- Are the weight conversion factors representative of batteries sold into Ontario?
- Are the applications for rechargeable batteries representative?
- Are there applications you want to draw to our attention?
- How could the weight conversion factors be improved?

Next Steps

- A recording of today's presentation and the presentation slides will be emailed to everyone registered for the webinar and will also be posted on our website: https://rpra.ca/consultations/weight-conversion-factor-for-rechargeable-batteries/
- You can contact us to ask a question or provide your feedback at consultations@rpra.ca
- You can also contact us via email to schedule a phone call or meeting to provide your feedback.

All feedback must be received by the Authority by **June 23, 2020.**

For more information about the Batteries Regulation

- Send questions to our Compliance Team at registry@rpra.ca or call us at:
  - (647) 496-0530 or
  - toll free at (833) 600-0530

- Visit our website for more information https://rpra.ca/programs/batteries/

RPRA Resource Productivity & Recovery Authority