







UNEP



Basel, Rotterdam and Stockholm Conventions



UNITED NATIONS ENVIRONMENT PROGRAMME

Programme des Nations Unies pour l'environnement Programa de las Naciones Unidas para el Medio Ambiente

Программа Организации Объединенных Наций по окружающей среде

برنامج الأمم المتحدة للبيئة

联合国环境规划署



Seminar on the Environmentally Sound Management Of Used Lead Acid Batteries (ULAB) In The ECOWAS Region

Dakar, Senegal

14-16 December 2016









Environmentally Sound Used Lead Acid Battery Recycling: “Risks, Mitigation and Opportunities”

Environmentally Sound Used Lead Acid Battery Recycling: “Risks, Mitigation and Opportunities”

Brian Wilson

International Lead Association





Sustainable with ESM and Profits

Sustainable with ESM and Profits

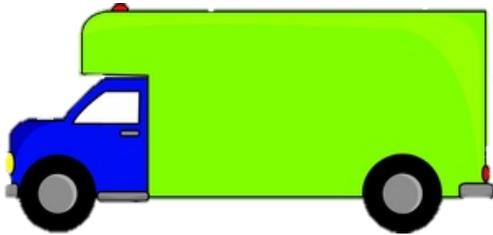
Environmentally Sound Management:

- **Protection of:**
 - ✓ *human health & the environment*
- **Advocates -“integrated Life Cycle Approach”**
 - ✓ *control at every stage of manufacturing – use- recycling or disposal.....*

Closed Loop



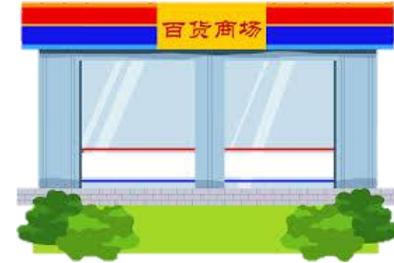
**ULAB are recycled
& components used
to produce LAB**



**ULAB are collected
and delivered to
the recycler**



**Batteries are
delivered to
the retailers**



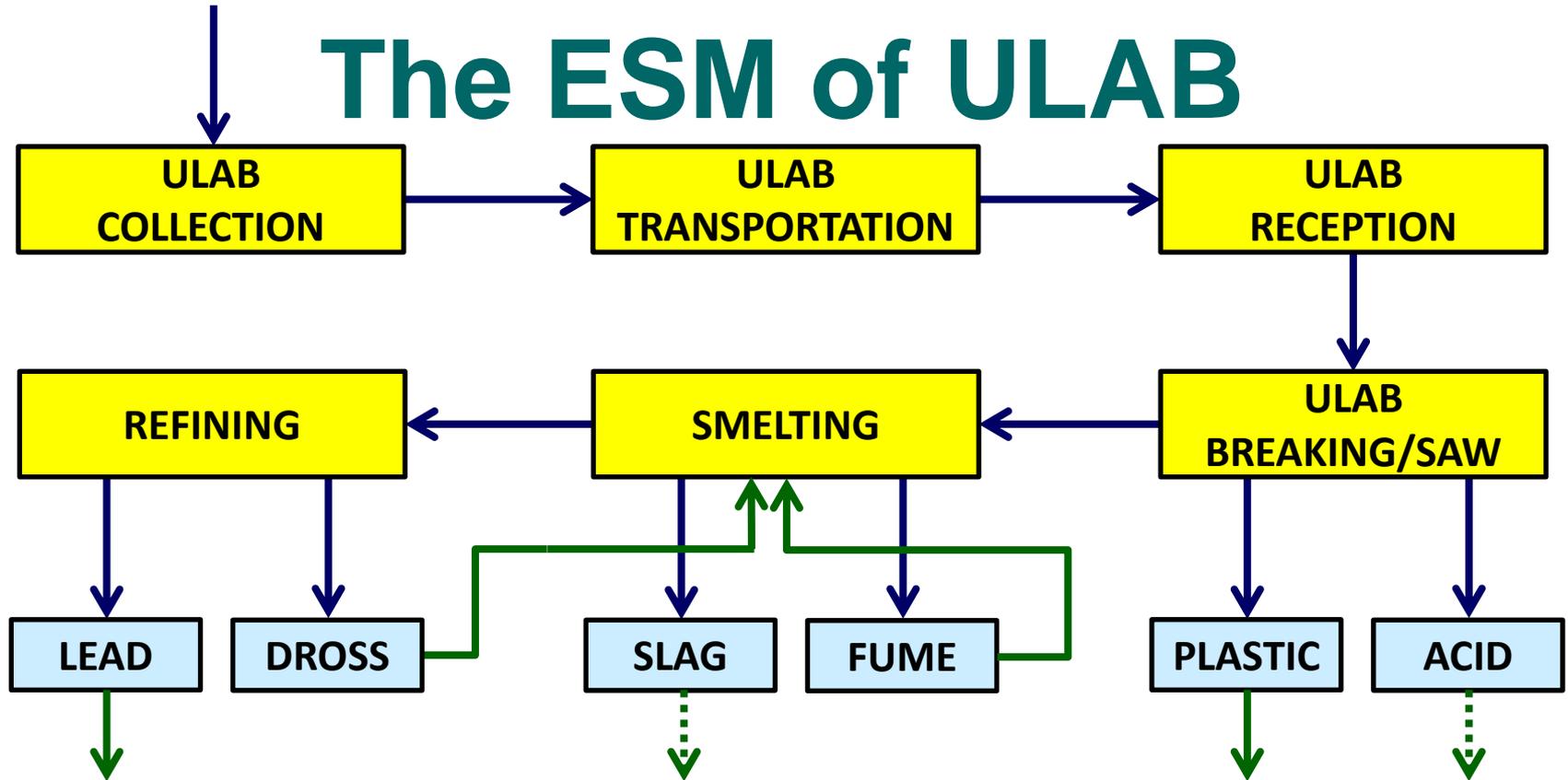
**New batteries
are sold &
ULAB returned**

The ESM of ULAB

Key Steps:

- 1. ULAB Collection, Packaging & Transport***
- 2. Drain the acid and treat it for disposal***
- 3. Separate the organic and non-organics***
- 4. Smelt the Pb grids, terminals and paste***
- 5. Refine the Pb bullion***

The ESM of ULAB



The ESM of ULAB

Current Technologies Used to Recycle ULAB

- ❖ Rotary Furnace
- ❖ Blast Furnace

The ESM of ULAB

Current Technologies Used to Recycle ULAB

- ❖ *Rotary Furnace*
- ❖ *Blast Furnace*
- ❖ *Ausmelt / IsaSmelt*
- ❖ *Bottom Blown*

The ESM of ULAB

Key Steps in ULAB Recovery and Recycling

1. *ULAB Collection, Packaging & Transport*

ULAB Packaging



ULAB Sorted by Size



ULAB Unsorted & No Packaging



Central America



Leaking ULAB



Central America



ULAB Packaging

UN Certified



Plastic Leak Proof Container

ila
International
Lead Association



ULAB Packaging



Shrink Wrapped and Banded

ila
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Lead Association



ULAB Transportation



Dedicated Truck with Decals



The ESM of ULAB

Key Steps in ULAB Recovery and Recycling

- 1. ULAB Collection, Packaging & Transport*
- 2. Drain the acid & treat for disposal/reuse*

Untreated Effluent



Damanganga River

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Electrolyte Containment



Containment and Evaporation



Electrolyte Refurbishment



 IBERIA, S.A.

Refurbished for Re-Use



Electrolyte Refurbishment



Refurbished for Re-Use



Electrolyte Neutralization

Electrolyte Neutralization

Chemical Equations for Acid Neutralization



Electrolyte Neutralization

Chemical Equations for Acid Neutralization



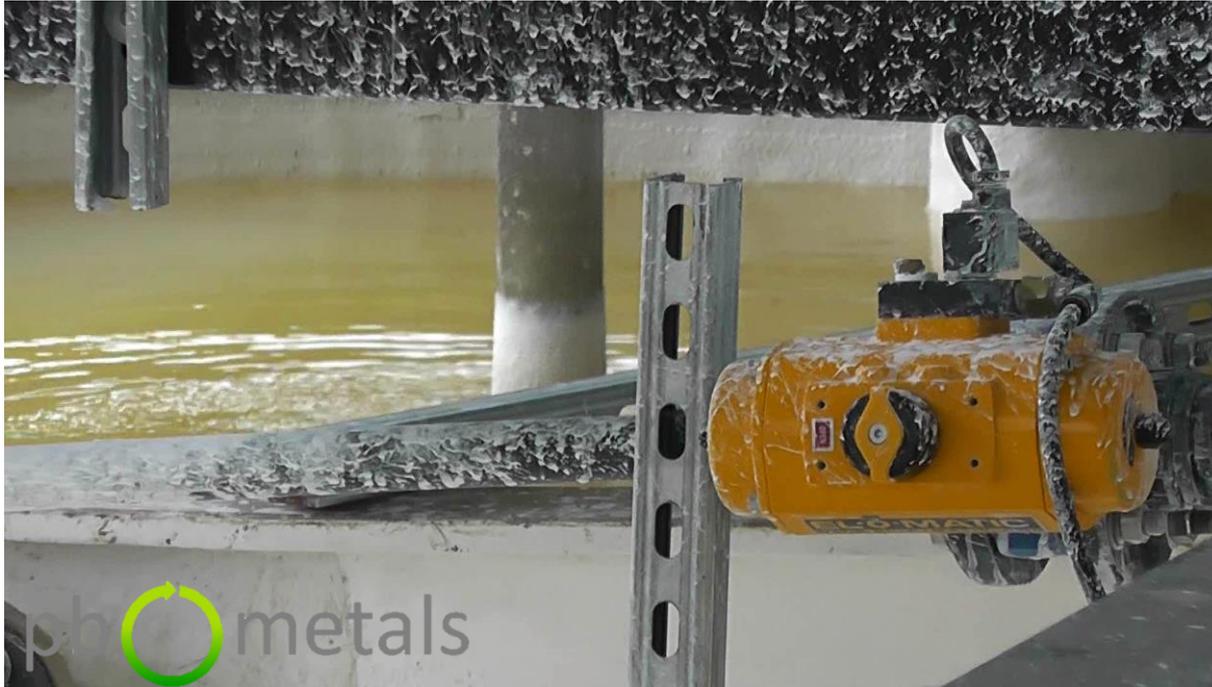
Electrolyte Neutralization

Chemical Equations for Acid Neutralization



Gypsum Production

Gypsum Production



Pb Metals – Costa Rica



Gypsum Production

Gypsum Production



MAC - Colombia



Gypsum Production



Gypsum Wall Boarding

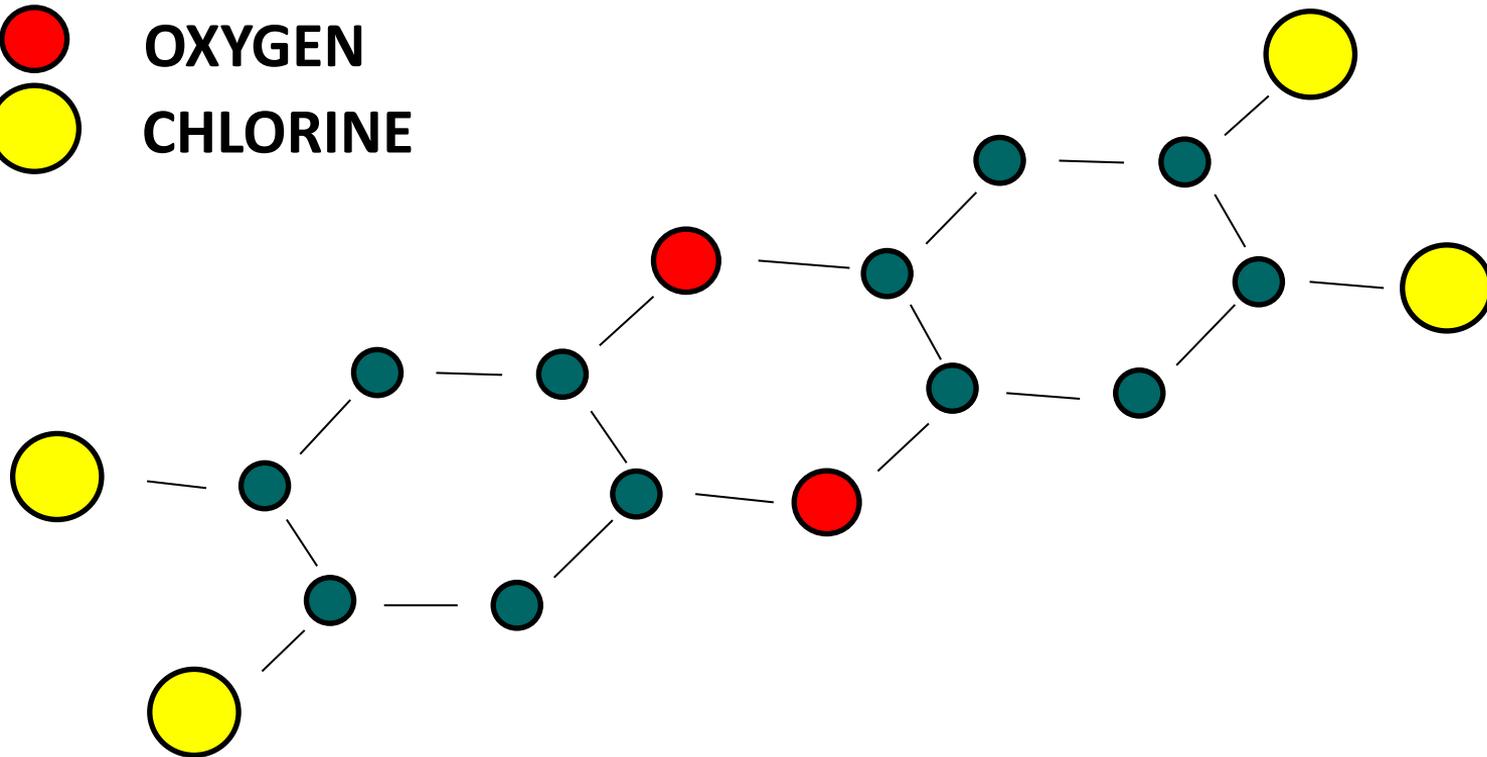
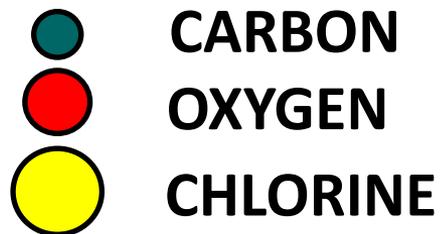


The ESM of ULAB

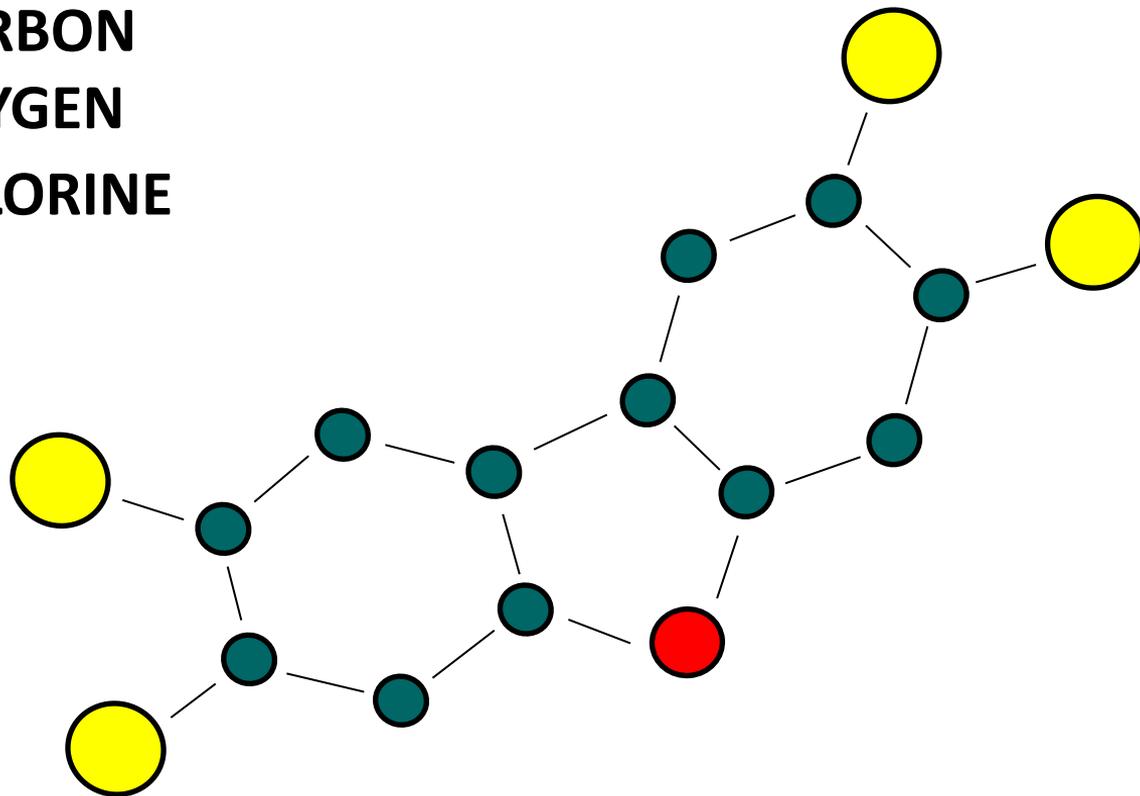
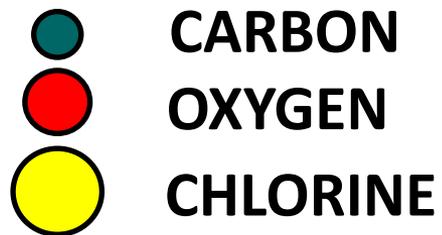
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- 1. ULAB Collection, Packaging & Transport*
- 2. Drain the acid & treat for disposal/reuse*
- 3. Separate the organic and non-organics*

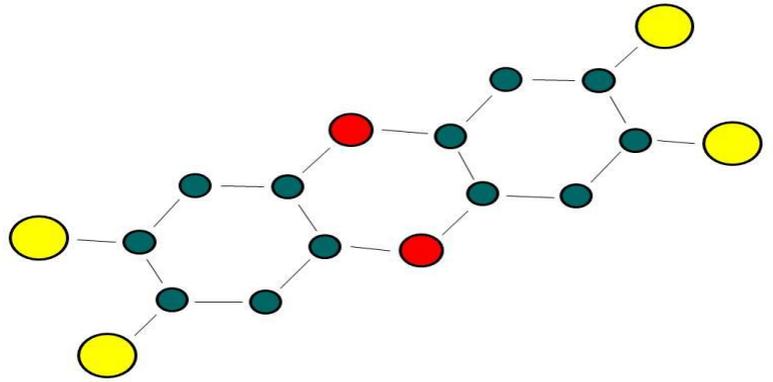
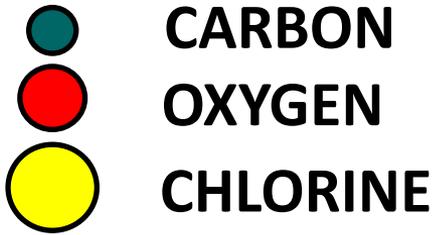
Dioxins and Furans



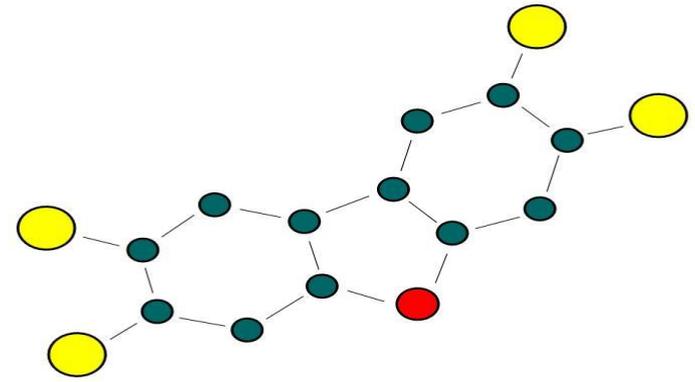
2,3,7,8 –tetrachlorodibenzo-p-dioxin



2,3,7,8 –tetrachlorodibenzofuran



2,3,7,8 –tetrachlorodibenzo-p-dioxin



2,3,7,8 –tetrachlorodibenzofuran

Dioxins and Furans

Battery Breaker

Battery Breaker



Pb Metals – Costa Rica



Battery Breaker

Battery Saw

Battery Saw



EcoGlobal – The Philippines



Battery Saw

Sulfur Dioxide Emissions



SO₂ – Contributes to Acid Rain

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International
Lead Association



De-Sulfurization

Paste De-Sulfurization

Three Options:

- **Before Smelting**
- **During Smelting**
- **After Smelting**

Paste De-Sulfurization

Three Options:

- **Before Smelting**
- **During Smelting**
- **After Smelting**

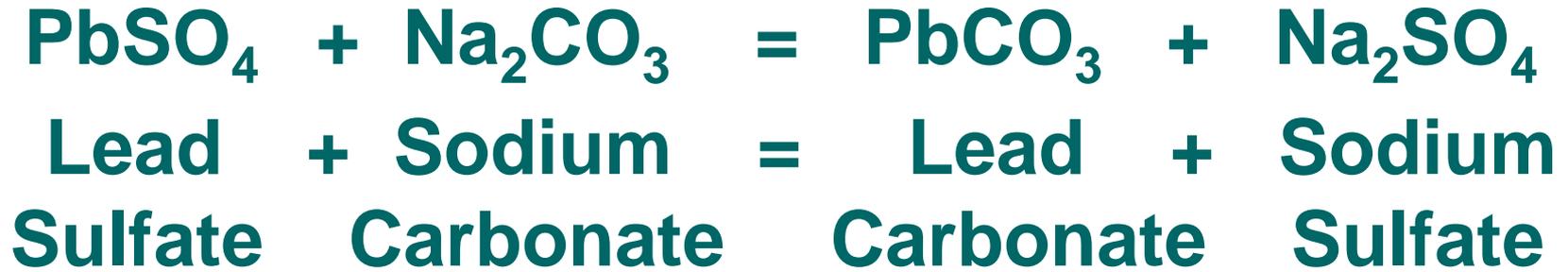
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- **During Smelting**
- **After Smelting**

Paste De-Sulfurization

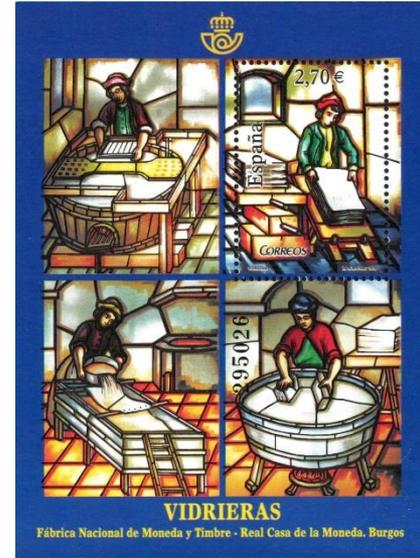
Two Options: 1



Other compounds: $\text{Pb}_3(\text{CO}_3)_2(\text{OH})_2$, $\text{NaPb}_2(\text{CO}_3)_2\text{OH}$

Paste De-Sulfurization

Two Options: 1



Paper Production: 1883 - Carl Dahl - Kraft Process

Paste De-Sulfurization

Kraft Paper Making Process

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Paste De-Sulfurization



Kraft Paper Making Process

ila
International
Lead Association



Paste De-Sulfurization

Kraft Paper Making Process

ila
International
Leaf Association



Paste De-Sulfurization

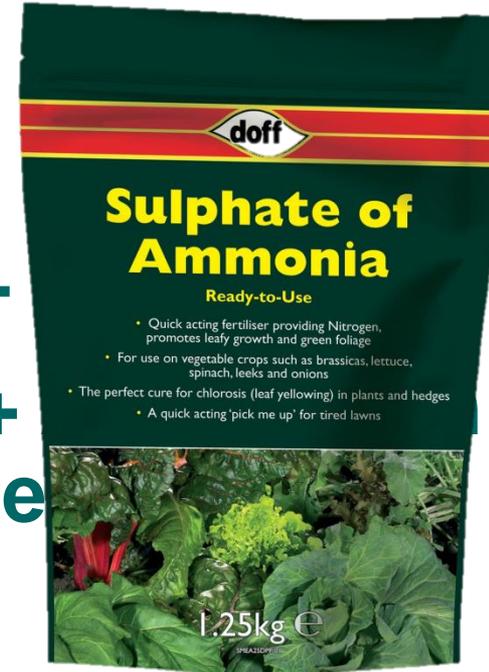
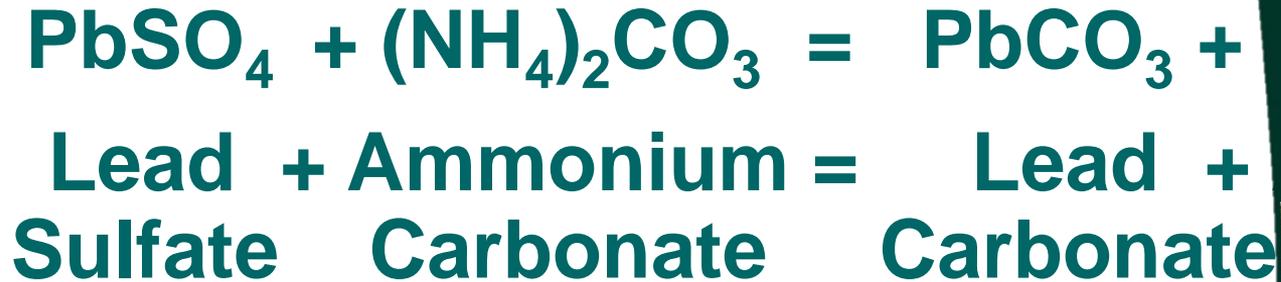
Two Options: 2



Lead + Ammonium = Lead + Ammonium
Sulfate Carbonate Carbonate Sulfate

Paste De-Sulfurization

Two Options: 2



The ESM of ULAB

Key Steps in ULAB Recovery and Recycling

- 1. ULAB Collection, Packaging & Transport*
- 2. Drain the acid & treat for disposal/reuse*
- 3. Separate the organic and non-organics*
- 4. Smelt the Pb grids, terminals and paste*

Rotary Furnace

Rotary Furnace

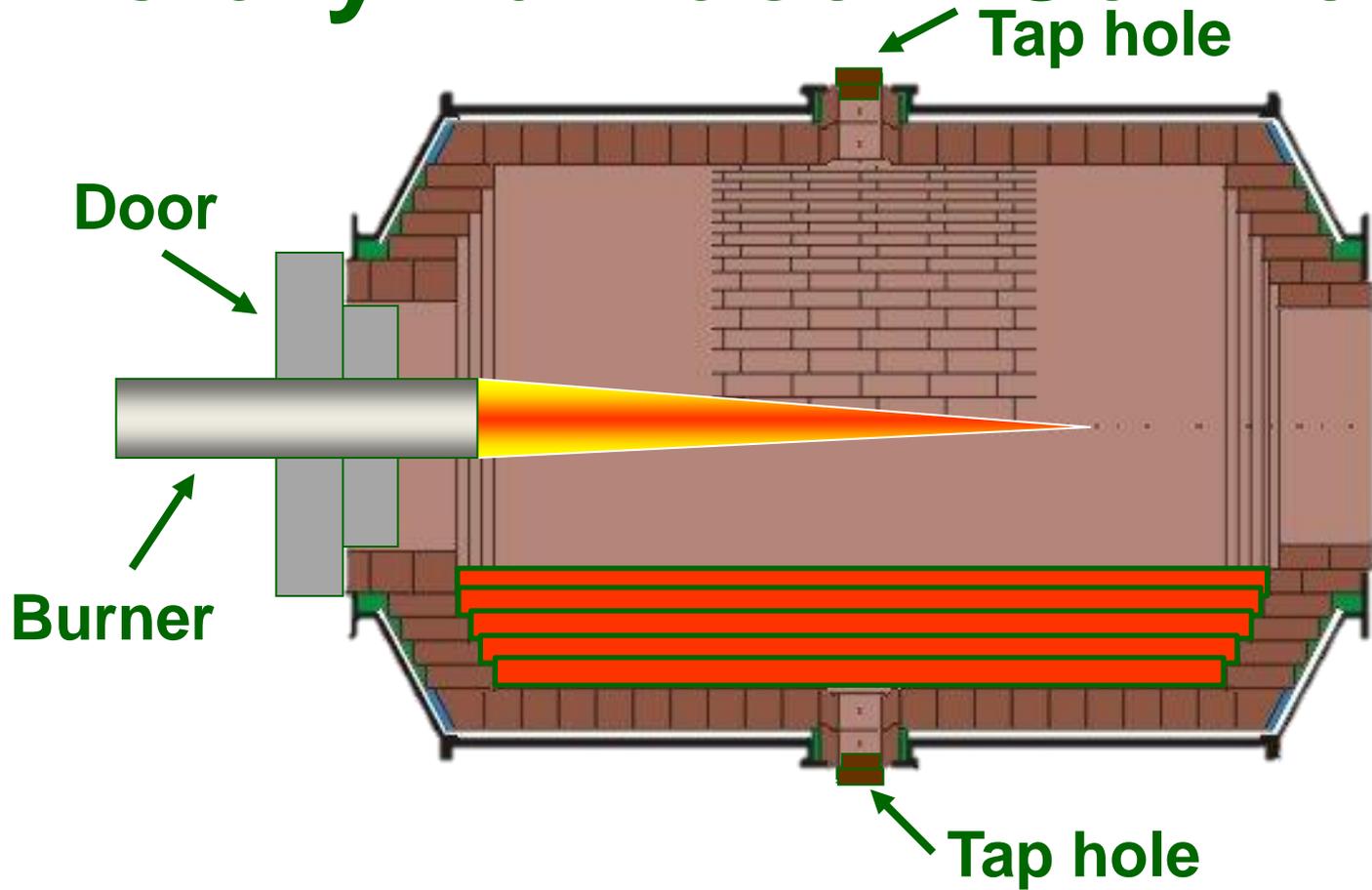


Pb Metals – Costa Rica



Rotary Furnace

Rotary Furnace – Centre Tap



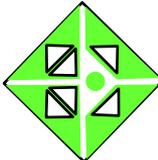
Rotary Furnace – Centre Tap

Rotary Furnace – Centre Tap



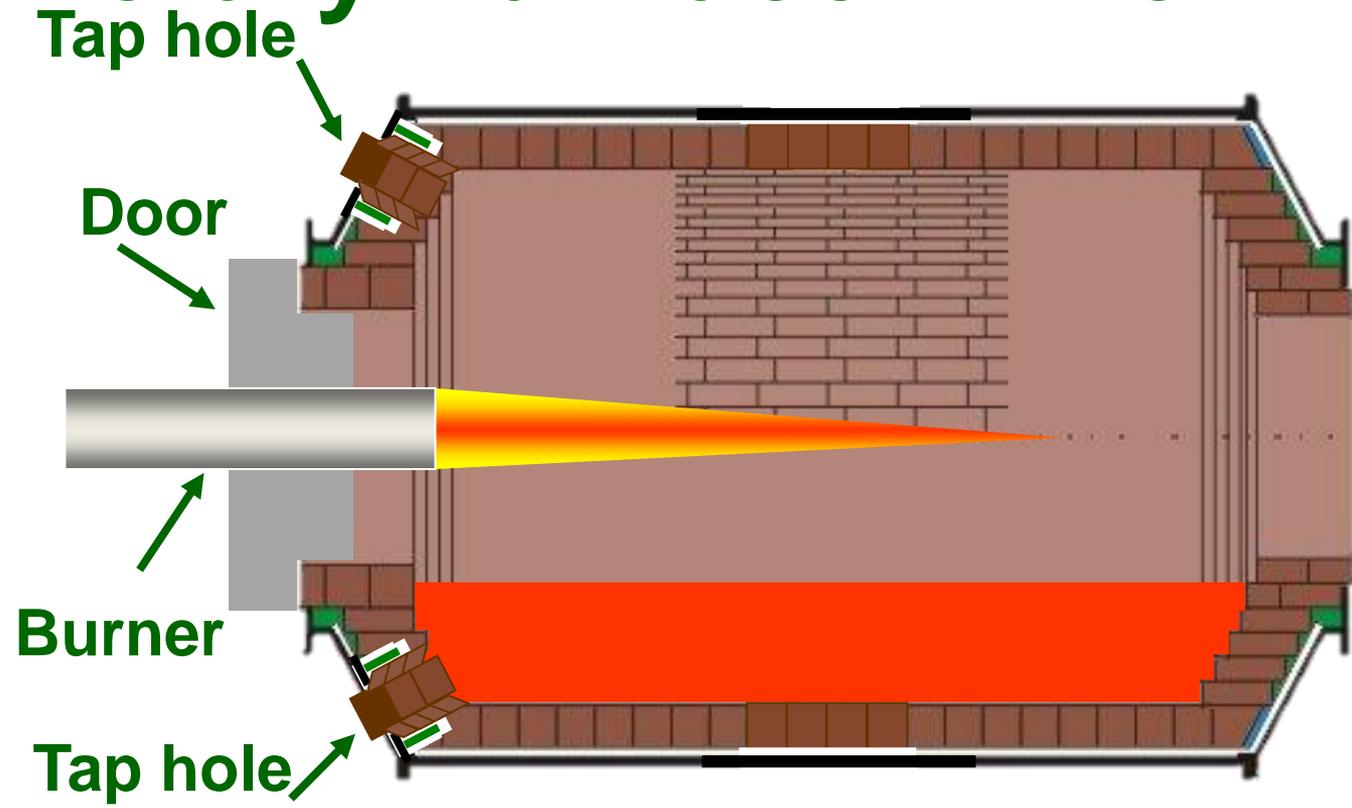
ECOGLOBAL

EcoGlobal – The Philippines



Rotary Furnace – Centre Tap

Rotary Furnace – Front Tap



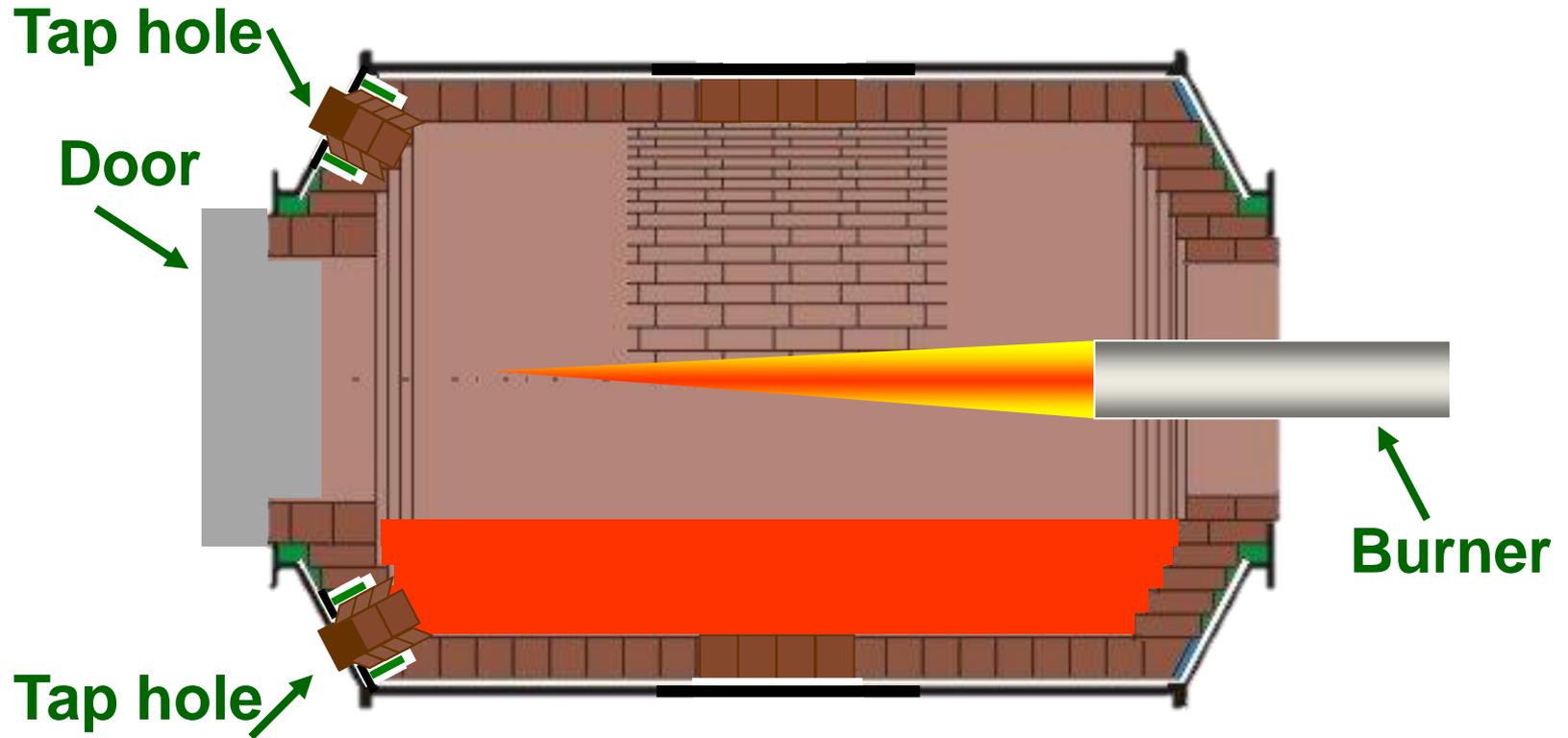
Rotary Furnace – Front Tap

Rotary Furnace – Front Tap

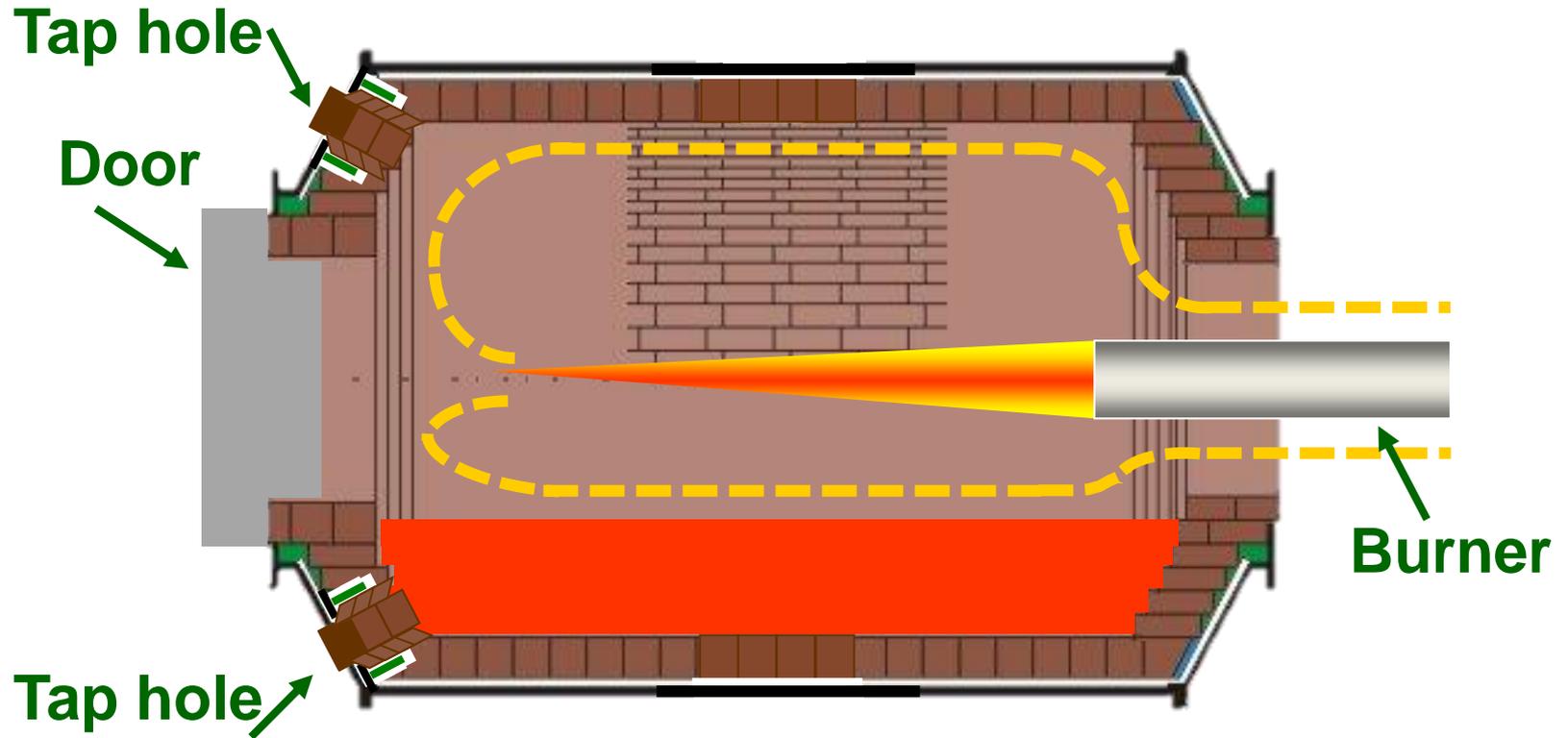


Rotary Furnace – Front Tap

Rotary Furnace – Rear Burner



Rotary Reverberatory – Rear Burner



Tilting Rotary Furnace



Major Engineering Group

ila
International
Lead Association



Tilting Rotary Furnace



Dross Engineering Ltd.



Paste De-Sulfurization

Three Options:

- Before Smelting
- **During Smelting**
- After Smelting

Rotary Furnace

Metallurgical Equations for the capture of Sulfur:



Rotary Furnace

Metallurgical Equations for the capture of Sulfur:



Rotary Furnace

Metallurgical Equations for the capture of Sulfur:



Rotary Furnace

Metallurgical Equations for the capture of Sulfur:



Erdite Slag with the formula NaFeS_2

Rotary Furnace

Metallurgical Equations for the Production of Lead:

Rotary Furnace

Metallurgical Equations for the Production of Lead:



Rotary Furnace

Metallurgical Equations for the Production of Lead:



Rotary Furnace

Metallurgical Equations - Sulfur Dioxide Production



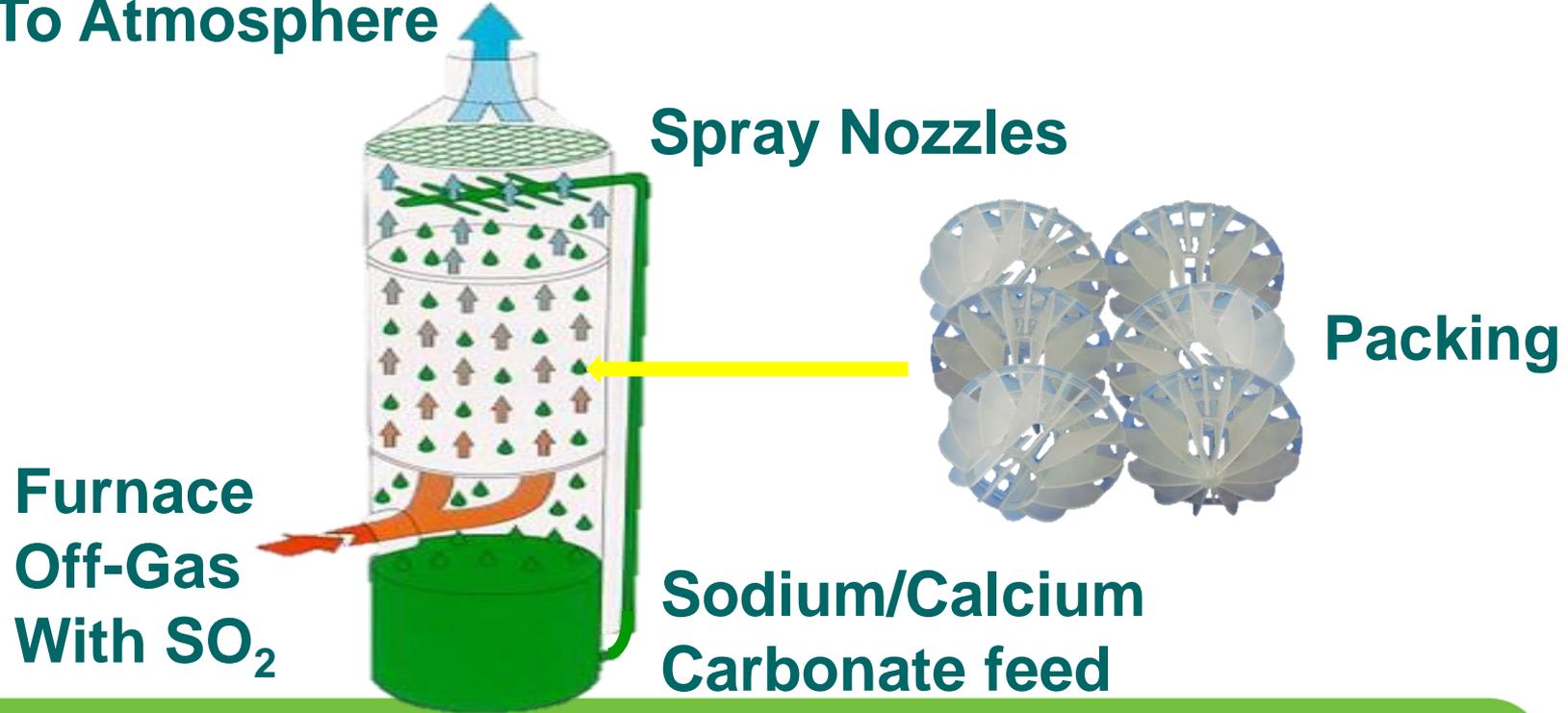
Paste De-Sulfurization

Three Options:

- **Before Smelting**
- **During Smelting**
- **After Smelting**

Paste De-Sulfurization

To Atmosphere



Scrubbing Tower

Flue Gas De-Sulfurization



Scrubbing Tower



Paste De-Sulfurization

Three Options: Preferences

- **Before Smelting**
- **During Smelting**
- **After Smelting**

Paste De-Sulfurization

Three Options: Preferences

- **Before Smelting**
- **During Smelting**
- **After Smelting**

Ventilation and Baghouse

Ventilation and Baghouse

A lack of effective ventilation causes:

- ❖ **High levels of Occupational Exposure**
- ❖ **High levels of Lead dust emissions**
- ❖ **Site and location contamination**
- ❖ **Loss of recycling material**

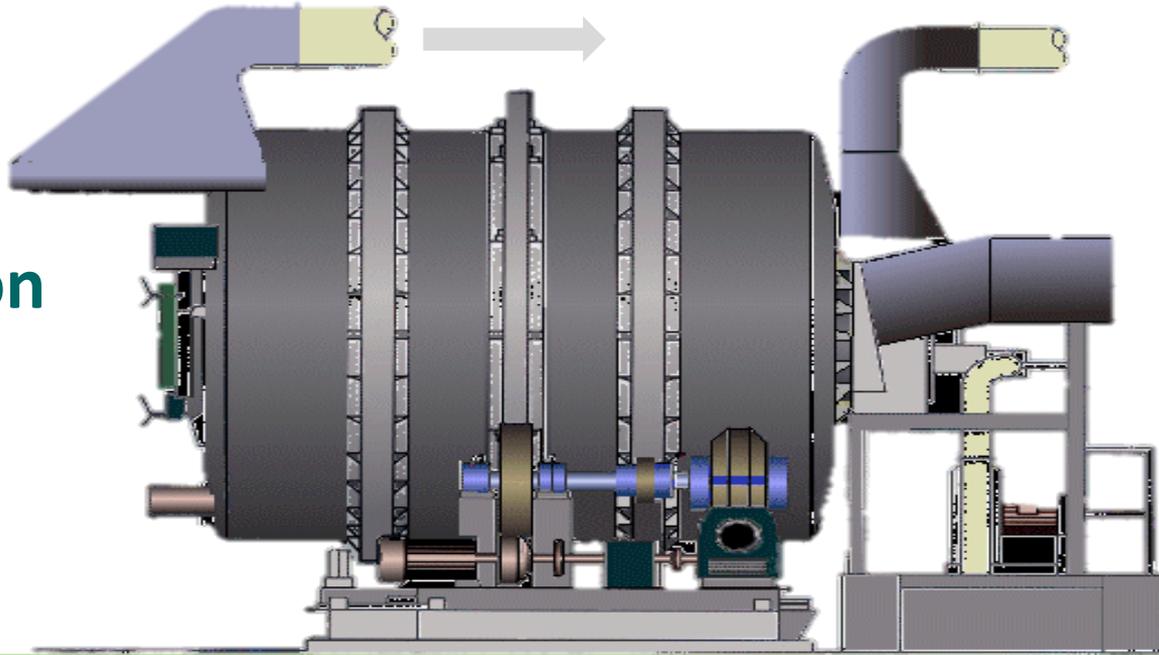
Ventilation and Baghouse



Ventilation and Baghouse

Ventilation and Baghouse

Front
ventilation
hood



Rear
ventilation
hood

Rotary Furnace Ventilation



Ventilation and Baghouse

Rotary Furnace Ventilation



Ventilation and Baghouse

Front
ventilation



Rear
ventilation

pp metals

Rotary Furnace Ventilation



Ventilation and Baghouse

Rotary Furnace Ventilation



Ventilation and Baghouse



Rotary Furnace Boxed Ventilation



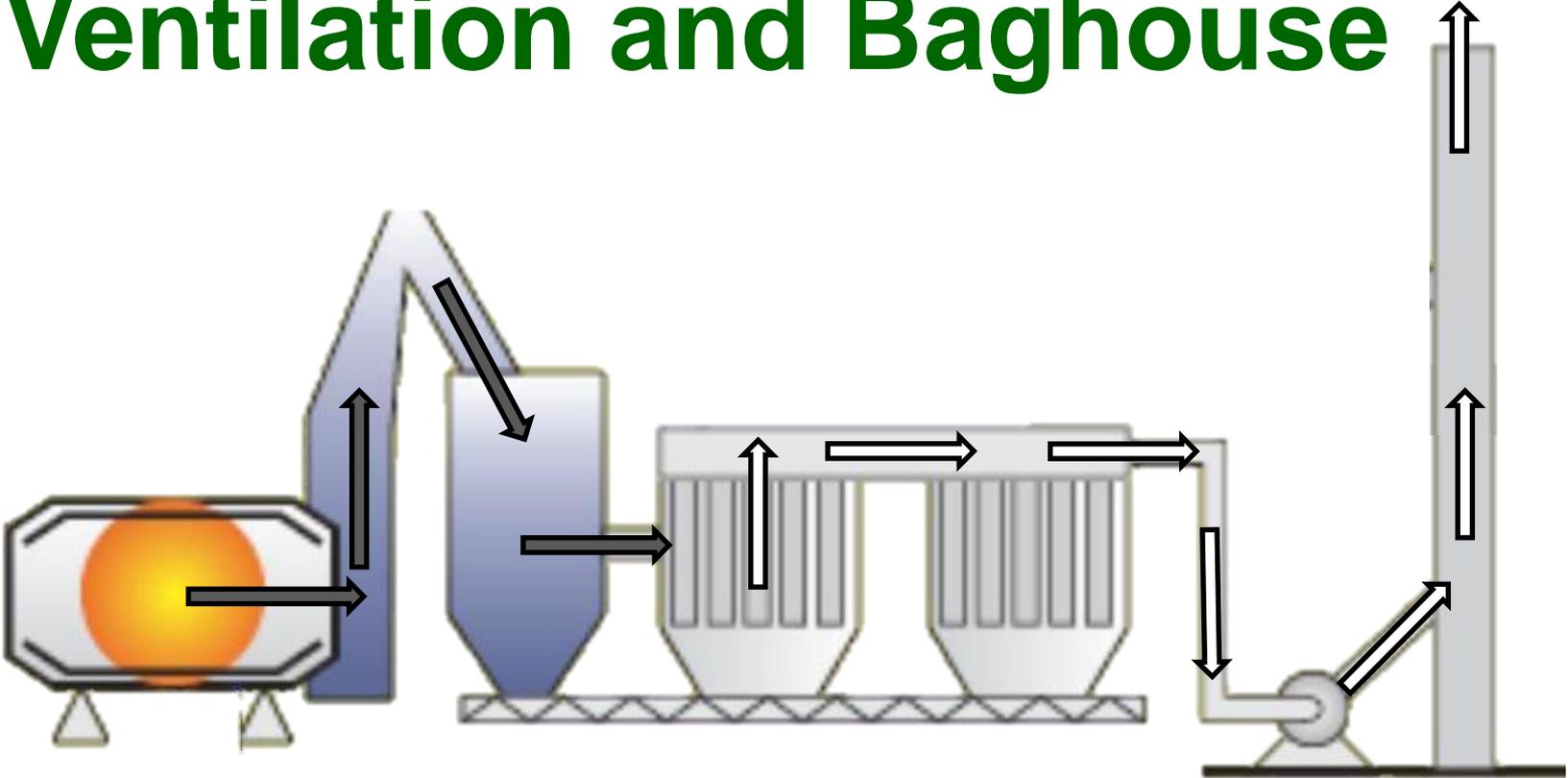
Ventilation and Baghouse

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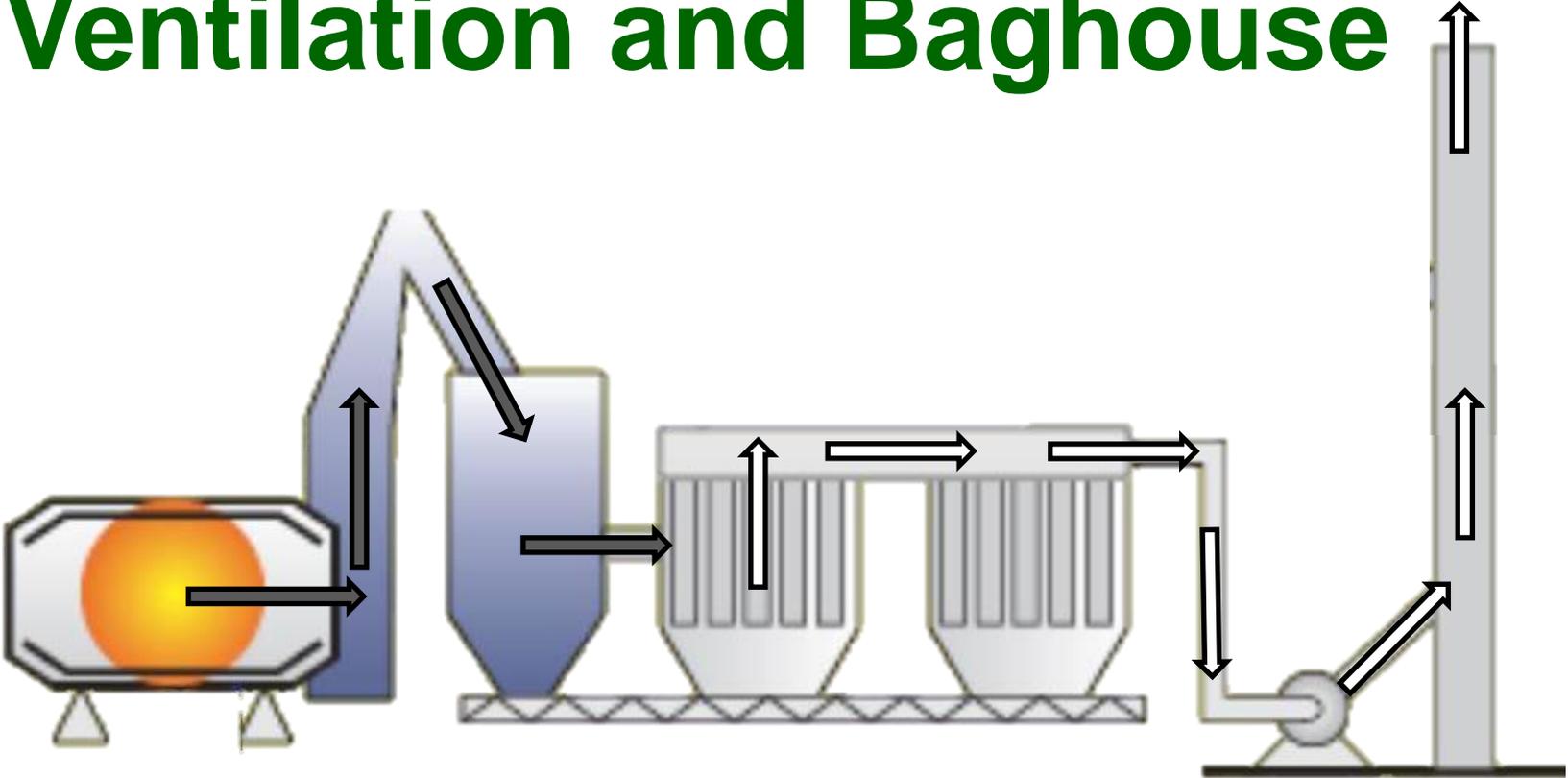


Ventilation and Baghouse

Ventilation and Baghouse



Ventilation and Baghouse



Ventilation and Baghouse



Zhejiang Changxing Jintaiyang Power Co., Ltd



超威
CHILWEE

Furnace Slag



Furnace Slag



MAC – Colombia – Ornamental House Bricks



Tegal Industrial - Indonesia

Slag reclamation - Paving



Tegal Industrial - Indonesia

KONVERSI BENTUK PEMANFAATAN LIMBAH B-3 MENJADI BATAKO / PAVING

1. PASIR	: 15 kg
2. KAPUR	: 8 kg
3. BOTTOM ASH	: 10 kg
4. LIMBAH CAMPURAN	: 10 kg
5. SLAG BESI	: 25 kg

Slag reclamation - Paving



Tegal Industrial - Indonesia

THE CONVERSION AND THE REUSE OF WASTE B-3 INTO BRICKS / PAVING

1. SAND	: 15 kg
2. LIME	: 8 kg
3. LEAD SLAG	: 10 kg
4. MIXED WASTE	: 10 kg
5. IRON SLAG	: 25 kg

Slag reclamation - Paving



Tegal Industrial - Indonesia

**Utilization
of Waste by
Conversion
into Paving**

**Sand, Lime &
Furnace Ash
Mixed Waste
Iron Slag**

Slag reclamation - Paving

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International
Lead Association



Tegal Industrial - Indonesia

Utilization
of Waste by
Conversion
into Paving



Sand, Lime &
Furnace Ash
Mixed Waste
Iron Slag

Slag reclamation - Paving



Tegal Industrial - Indonesia

Slag reclamation - Paving



Housekeeping



Process Controls – Clean & Tidy

ila
International
Lead Association



Housekeeping

Process Controls – Damp Down



Housekeeping



Process Controls – Damp Down

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Lead Association



Housekeeping

Process Controls – Damp Down



Industrial Hygiene

Industrial Hygiene

Personal Protection

1. Personal Protective Equipment (PPE)

Industrial Hygiene



Industrial Hygiene

Respirator and PPE



Industrial Hygiene



Choose
disposable dust
masks with
exhaust valves

Respirators



Industrial Hygiene

Most Important!

Use the metal strip to ensure a good fit around the nose

Respirators



Industrial Hygiene



Most Important!
Use the metal
strip to ensure a
good fit around
the nose

Respirators



Industrial Hygiene

Most Important!

Use the metal strip to ensure a good fit around the nose



Respirators



Industrial Hygiene



Most Important!
Use full mask
and coveralls
when working in
a Baghouse

Respirators - Baghouse

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International
Lead Association



Industrial Hygiene



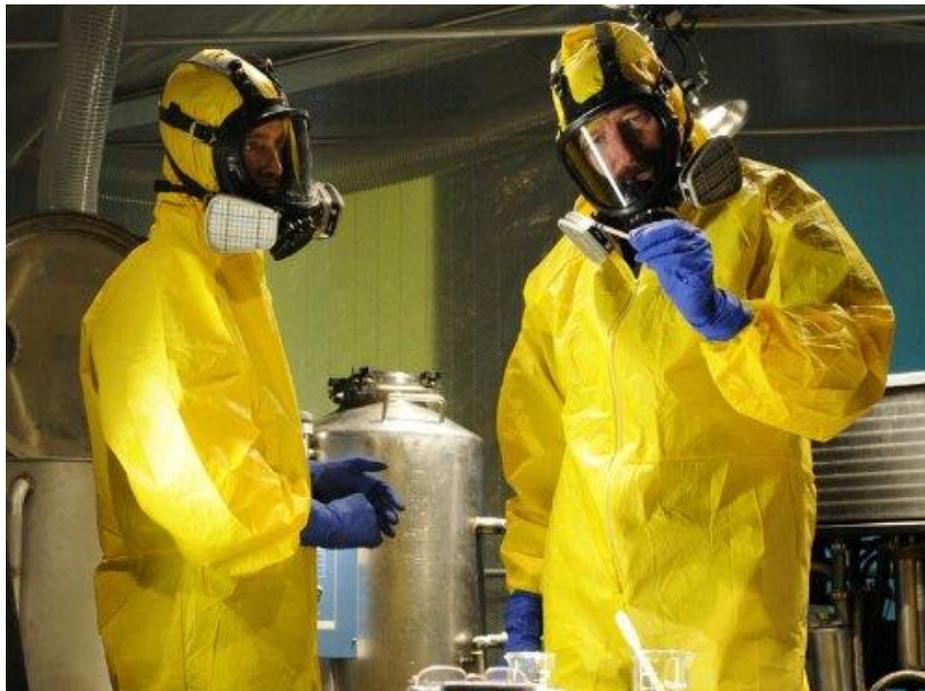
**Most Important!
Use full mask
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a Baghouse**

Respirators - Baghouse

ila
International
Lead Association



Industrial Hygiene



Most Important!
Use full mask
and coveralls
when working in
a Baghouse

Respirators - Baghouse

ila
International
Lead Association



Industrial Hygiene



Most Important!
Work done –
Shower wearing
the Protective Suit
and Respirator to
remove dust –
then remove them

Respirators - Baghouse



Industrial Hygiene

Furnace Operations

Helmet, face visor, boots, respirator, gloves, protective overall or coat



Personal Protective Equipment



Industrial Hygiene



Clean Work Clothes



Industrial Hygiene



Clean Work Clothes



Industrial Hygiene



Changing Rooms



Industrial Hygiene

1. Segregate home and work clothing in a changing room
2. All personnel to shower at the end of the day or shift

Showers



Industrial Hygiene



Showers – Dong Mai



Industrial Hygiene

- 1. Segregate home & work clothing in changing rooms**
- 2. All personnel to shower at the end of the day/shift**
- 3. Only wear home clothes when leaving the plant**

Industrial Hygiene

1. Provide a clean place to eat
2. Air condition the canteen

Canteen



Industrial Hygiene



Canteen - Guatemala





Sustainable ULAB Recycling

Criteria for a Sustainable Secondary Lead Smelter

1. Health and Safety

- ✓ A safe, hygiene and healthy working environment

2. Environmental

- ✓ Efficient resource use: energy, water, land and reagents
- ✓ Controlled atmospheric emissions to International norms
- ✓ No process effluent discharges to water courses
- ✓ No solid hazardous waste disposal
- ✓ Only saleable products to be produced
- ✓ ESM of the ULAB collection system

Sustainable ULAB Recycling

Criteria for a Sustainable Secondary Lead Smelter

3. Financial

- ✓ Low cost SLS design and O&M with regard to 1 and 2.
- ✓ Cost effective, optimising resources to max. results

4. Technical

- ✓ Quality engineered design and equipment
- ✓ Reliable and easy to maintain equipment
- ✓ After sales support and equipment spares

Sustainable ULAB Recycling

Criteria for a Sustainable Secondary Lead Smelter

5. Capacity

- ✓ Capacity tailored to recycle all domestic ULAB
- ✓ Modular: allows expansion for increase in ULAB.

6. Inputs

- ✓ Recycles all types of ULAB generated
- ✓ Recovers 99% of recyclable material in every ULAB

Sustainable ULAB Recycling

Criteria for a Sustainable Secondary Lead Smelter

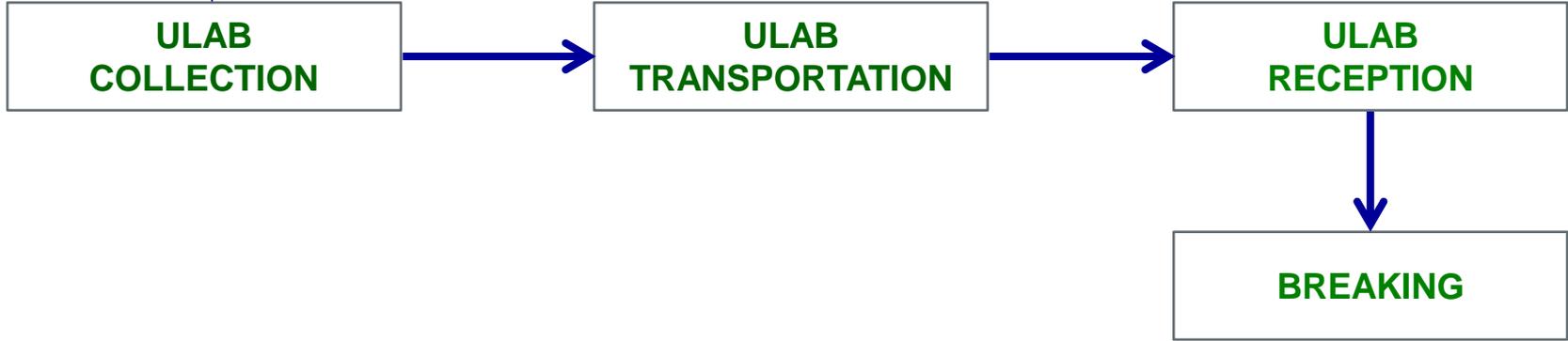
7. Outputs – High Quality Saleable Products

- ✓ Refined Lead ingots of 99.97% – 99.99% purity
- ✓ Refined Lead Alloys for LAB manufacturing
- ✓ Clean Polypropylene Pellets
- ✓ Hexagonal paving slabs to building standards

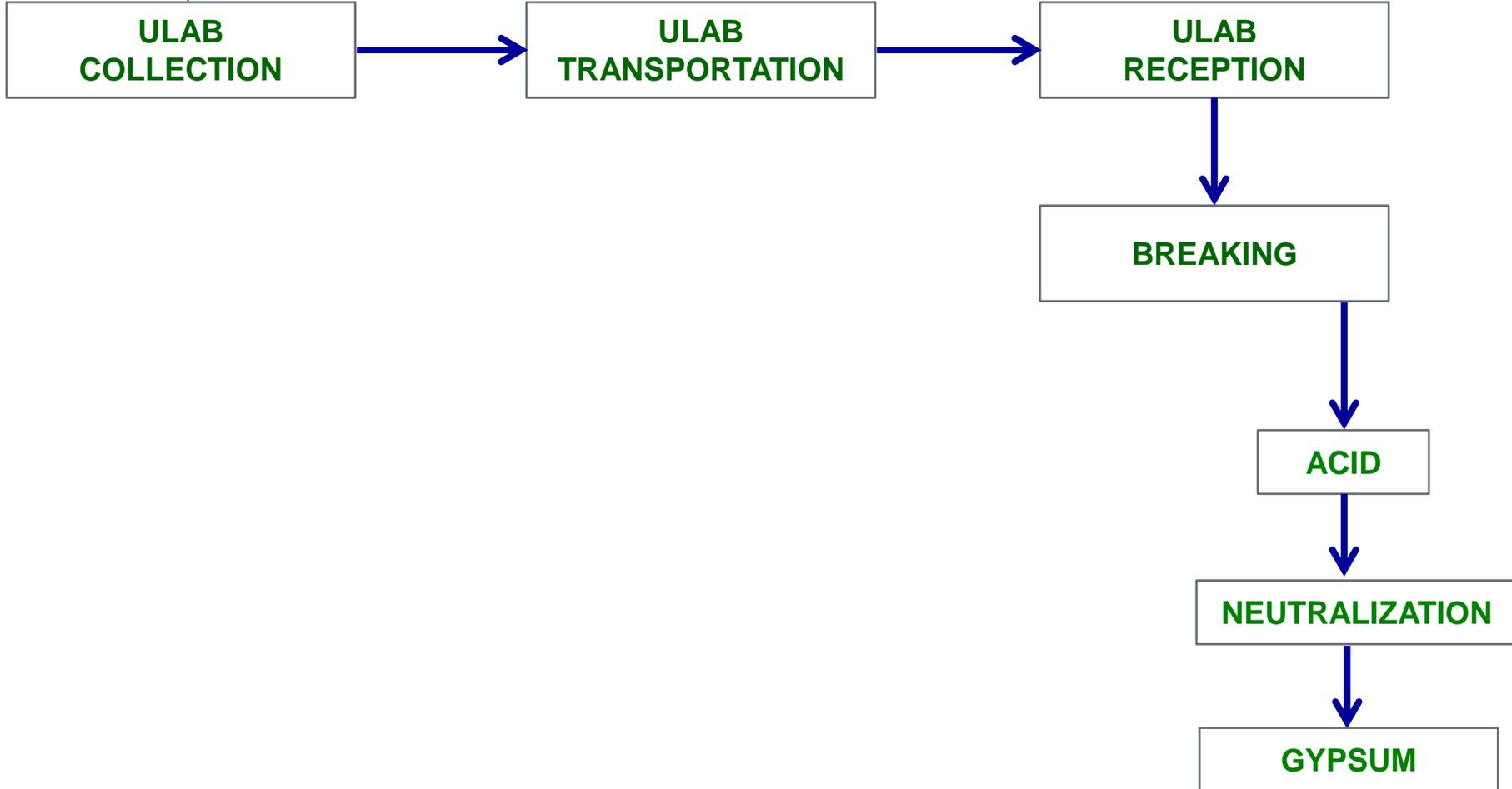
Sustainable ULAB Recycling



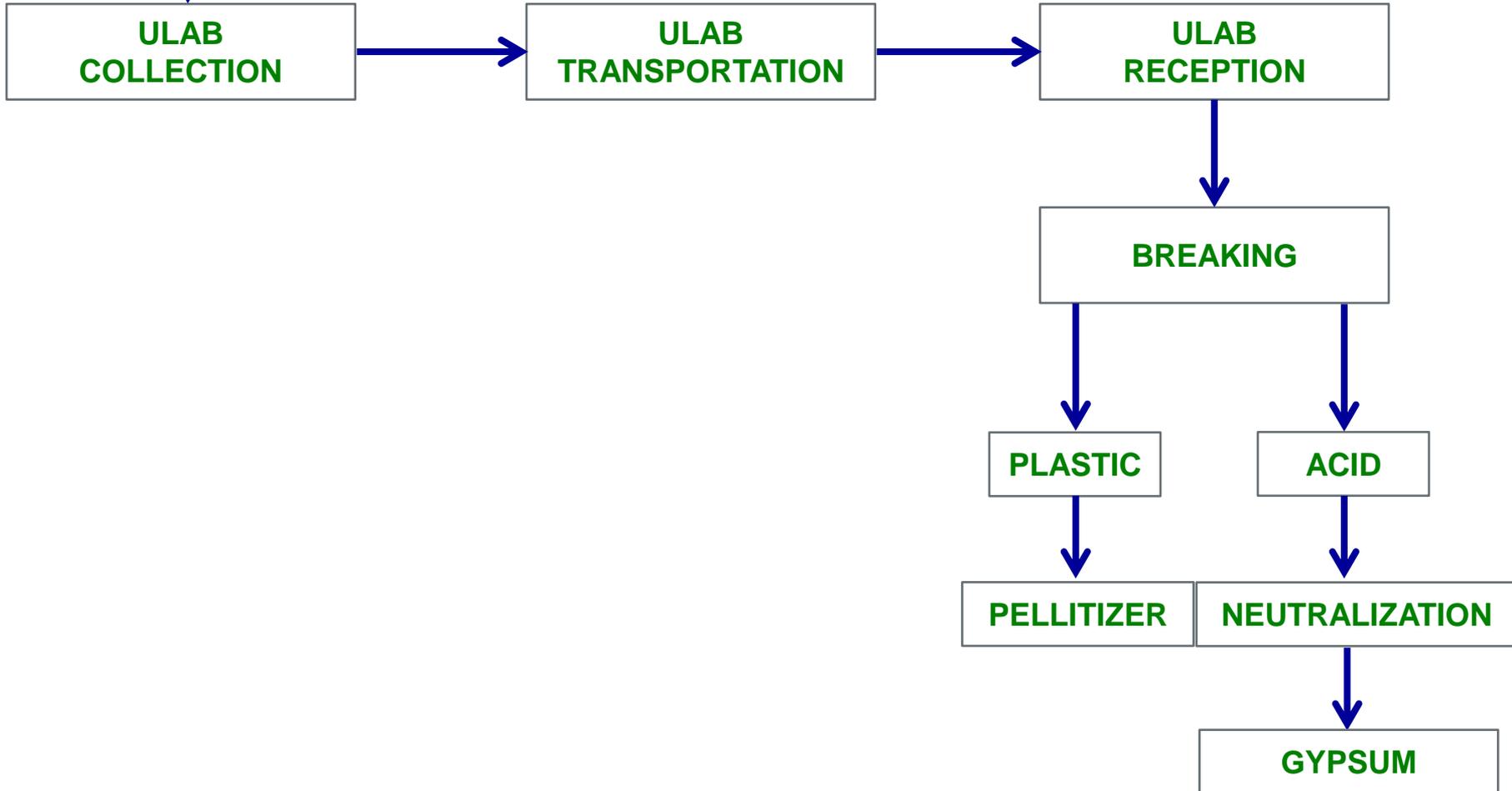
Sustainable ULAB Recycling



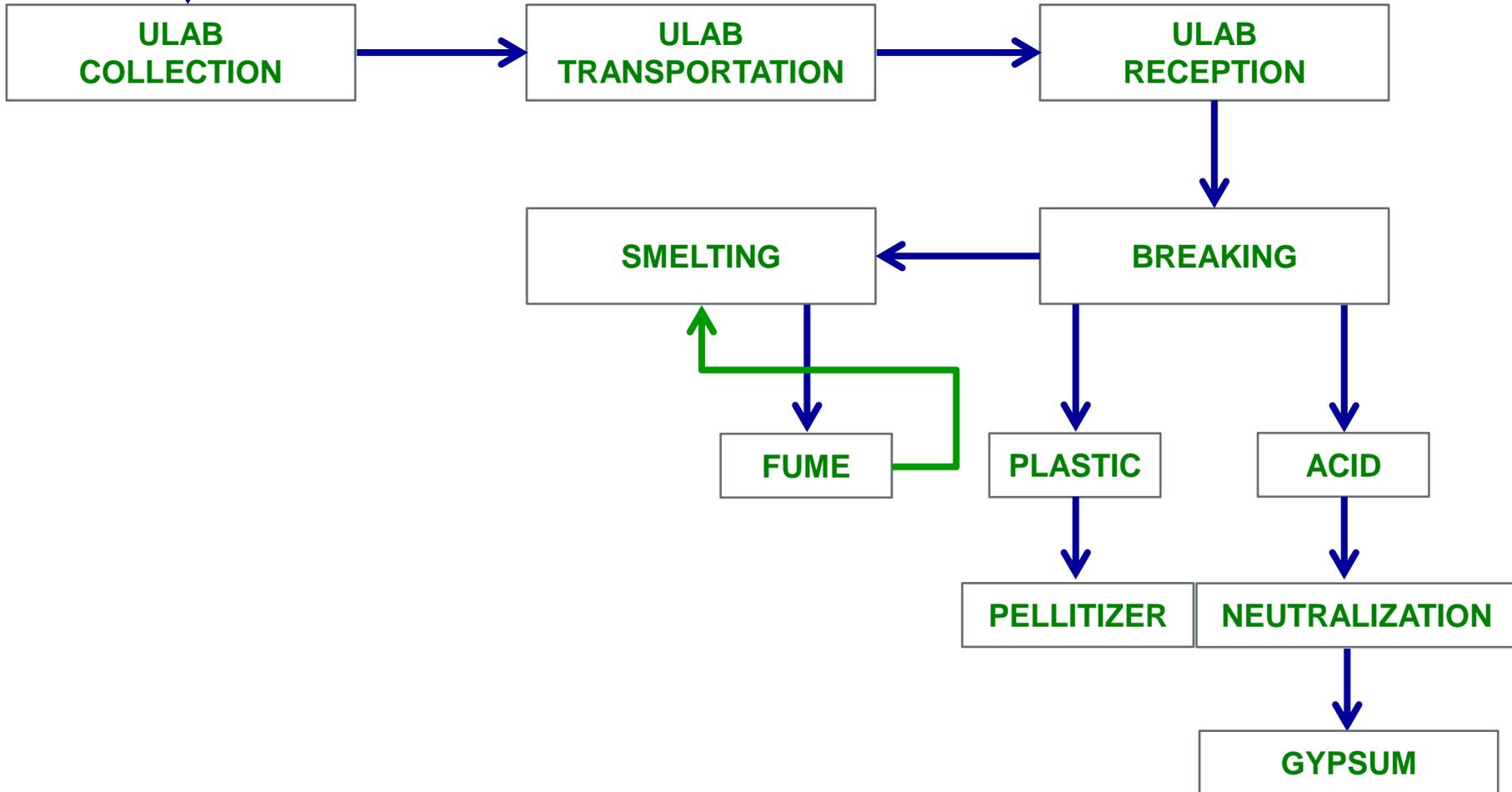
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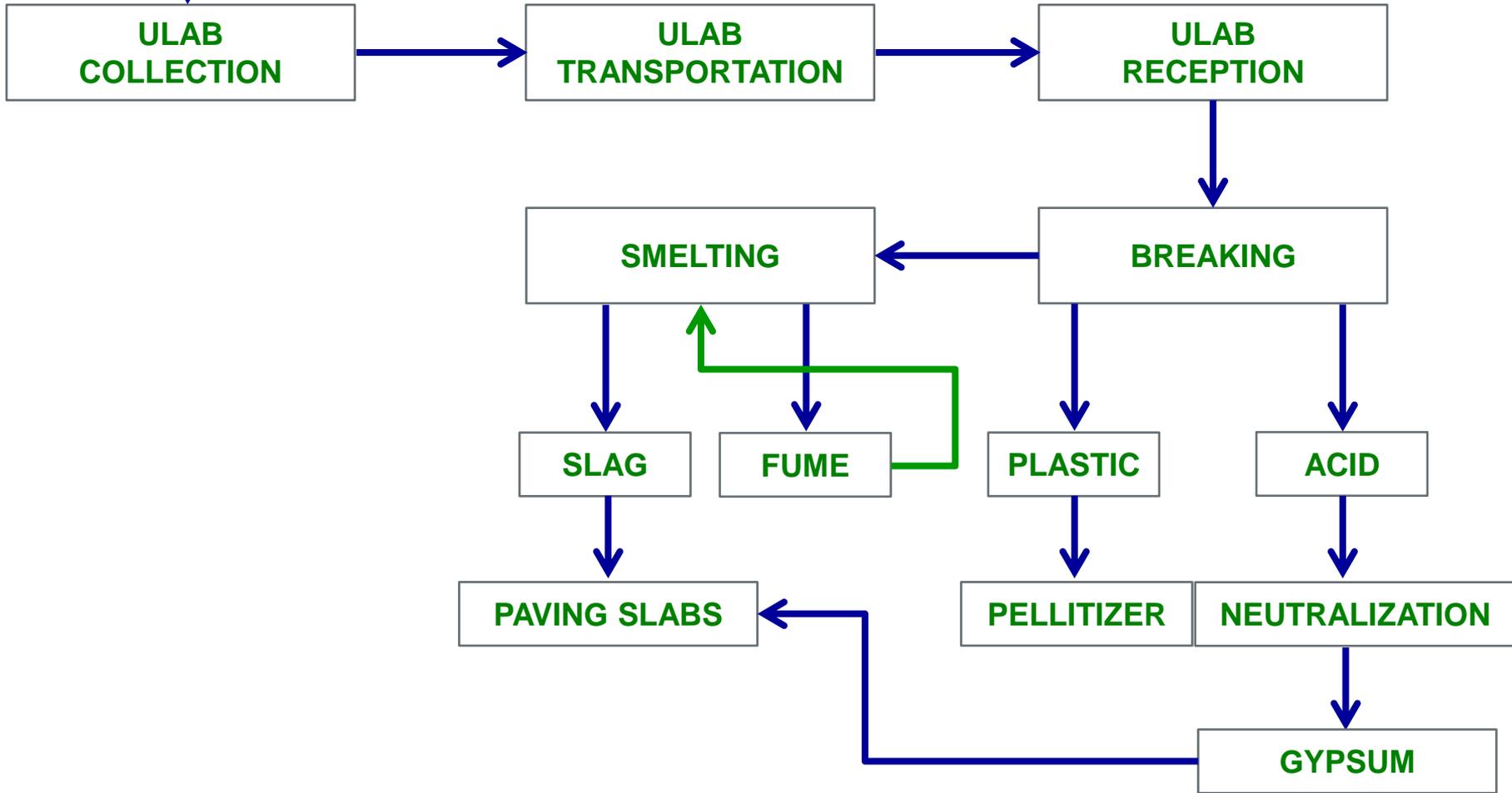
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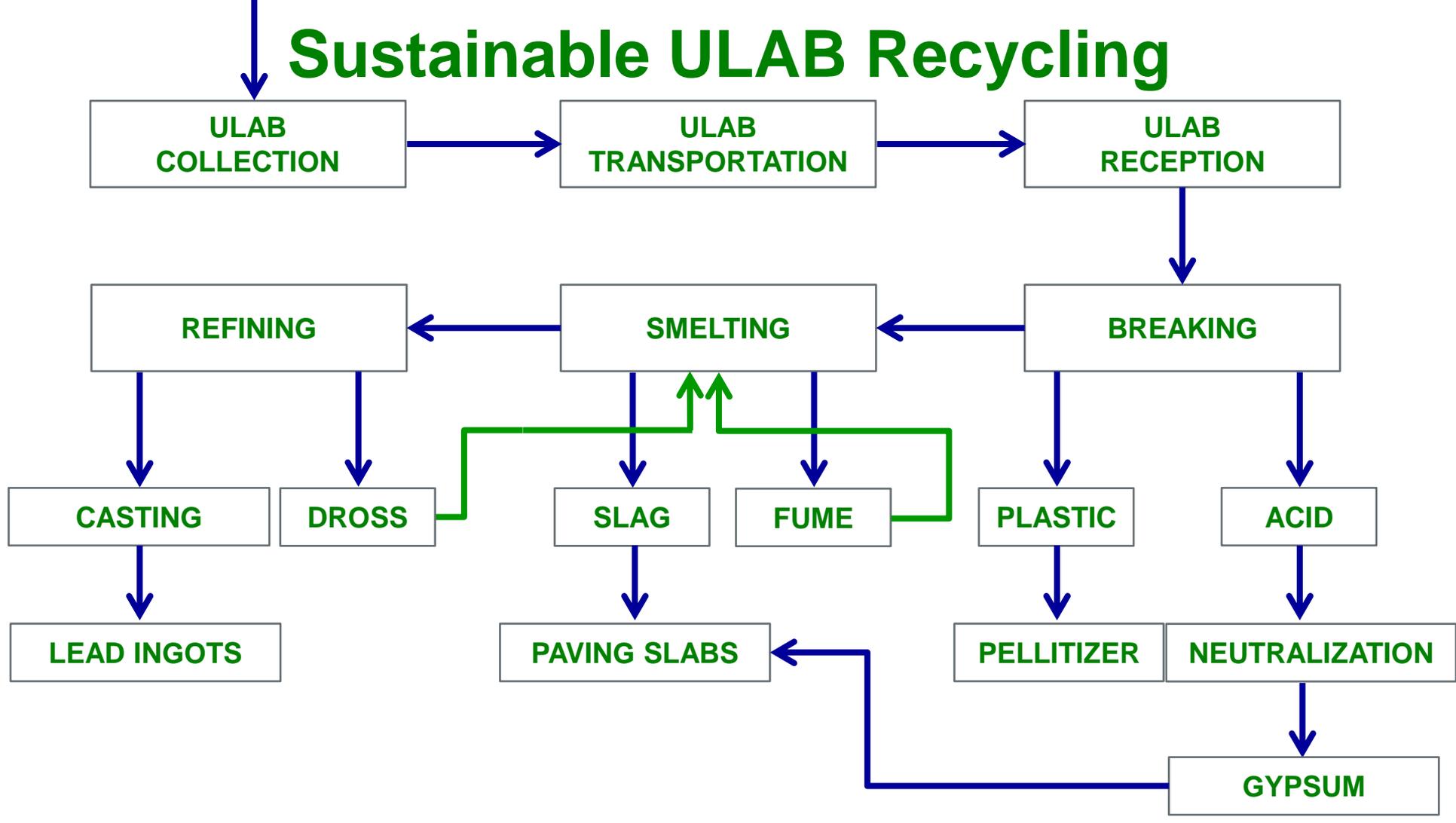
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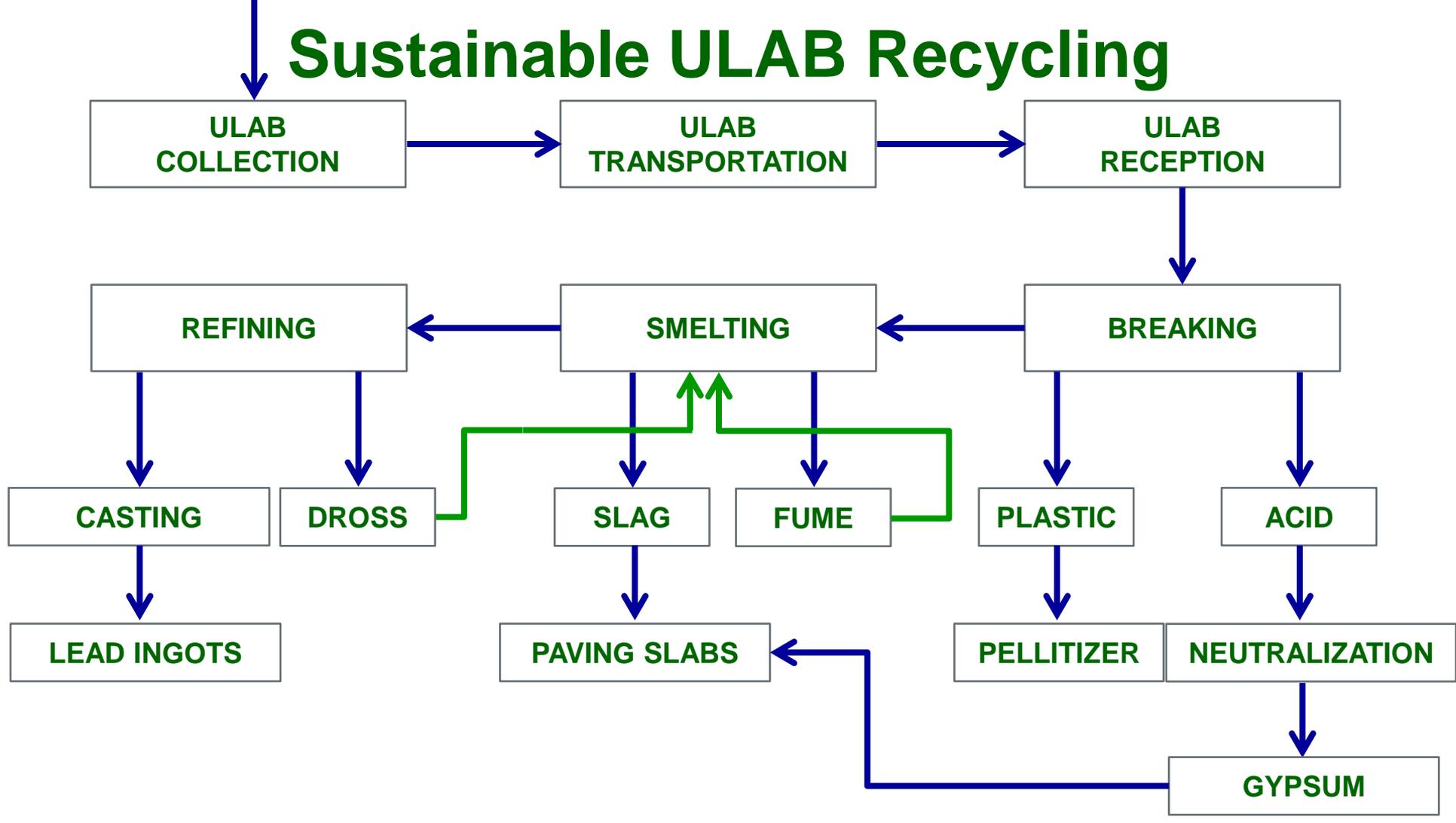
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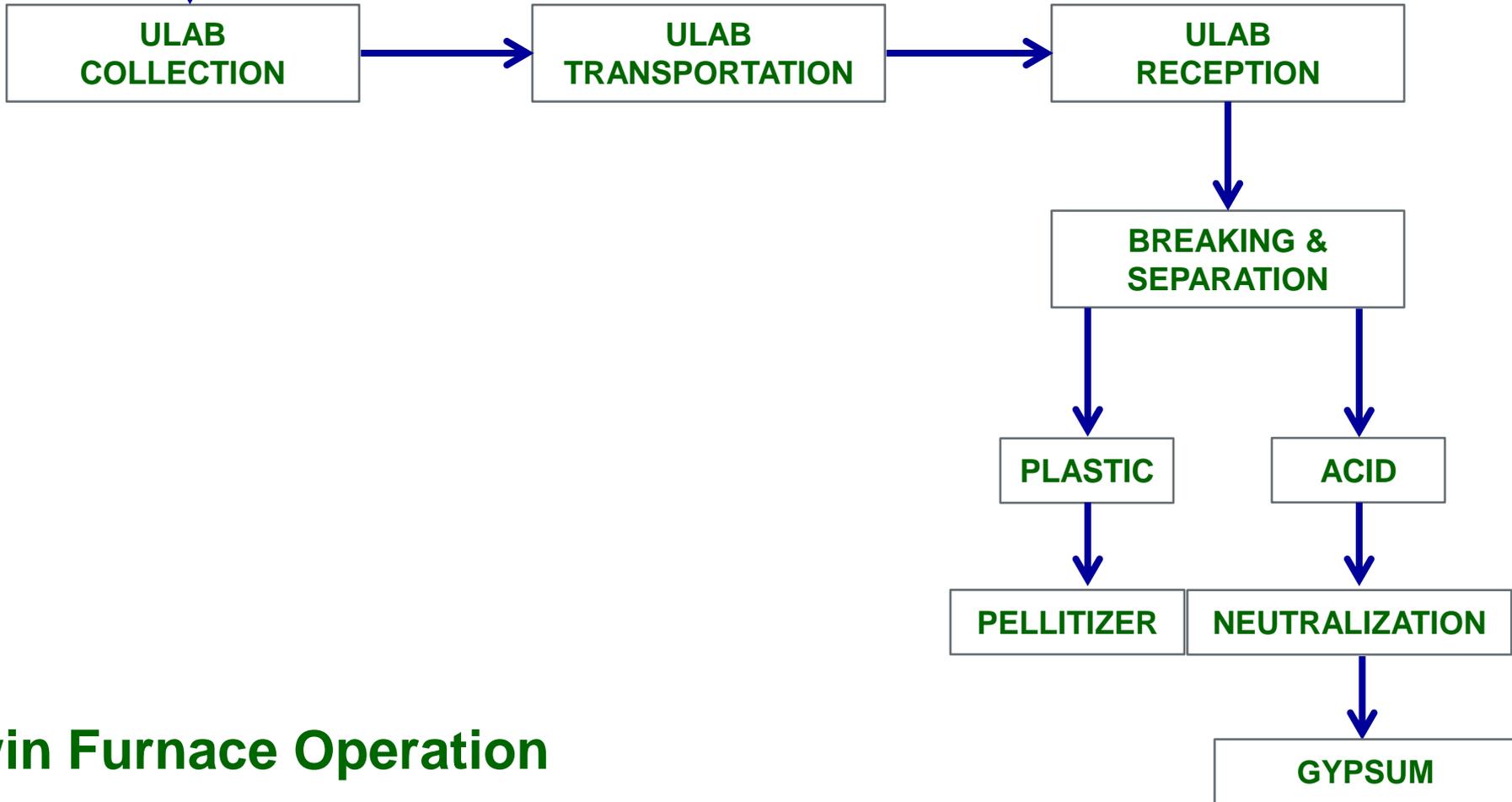
Sustainable ULAB Recycling



Sustainable ULAB Recycling

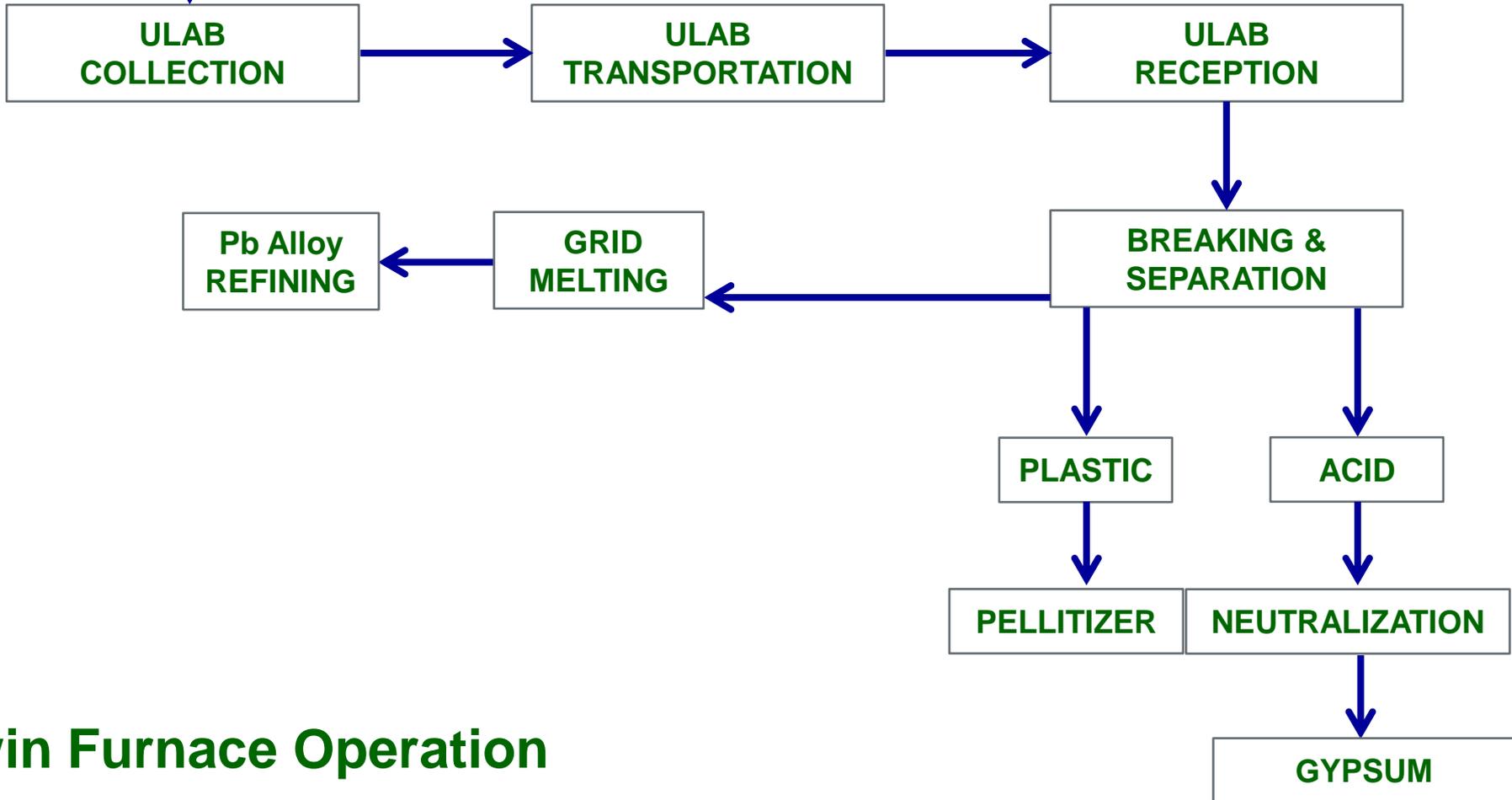


Sustainable ULAB Recycling



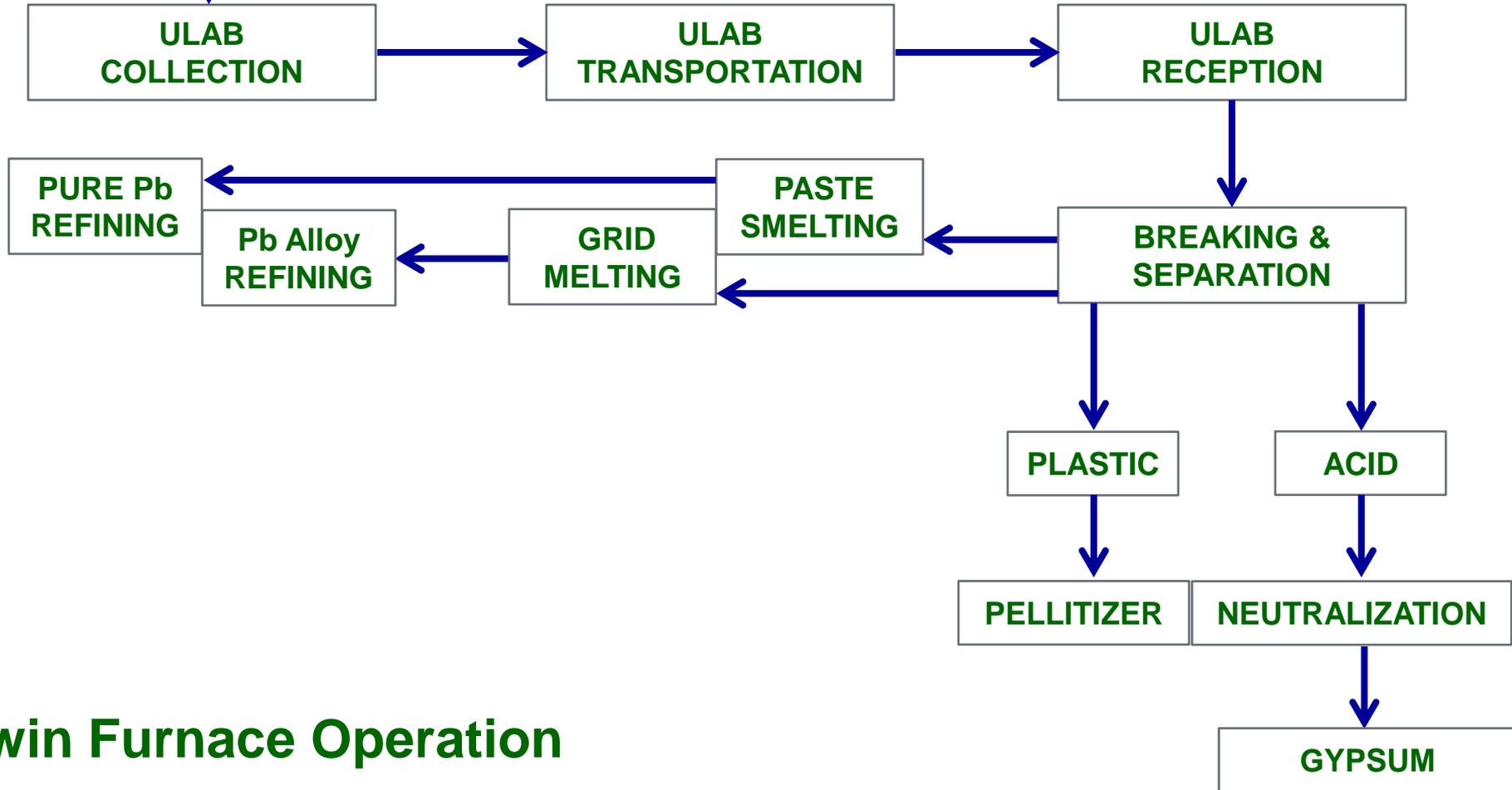
Twin Furnace Operation

Sustainable ULAB Recycling



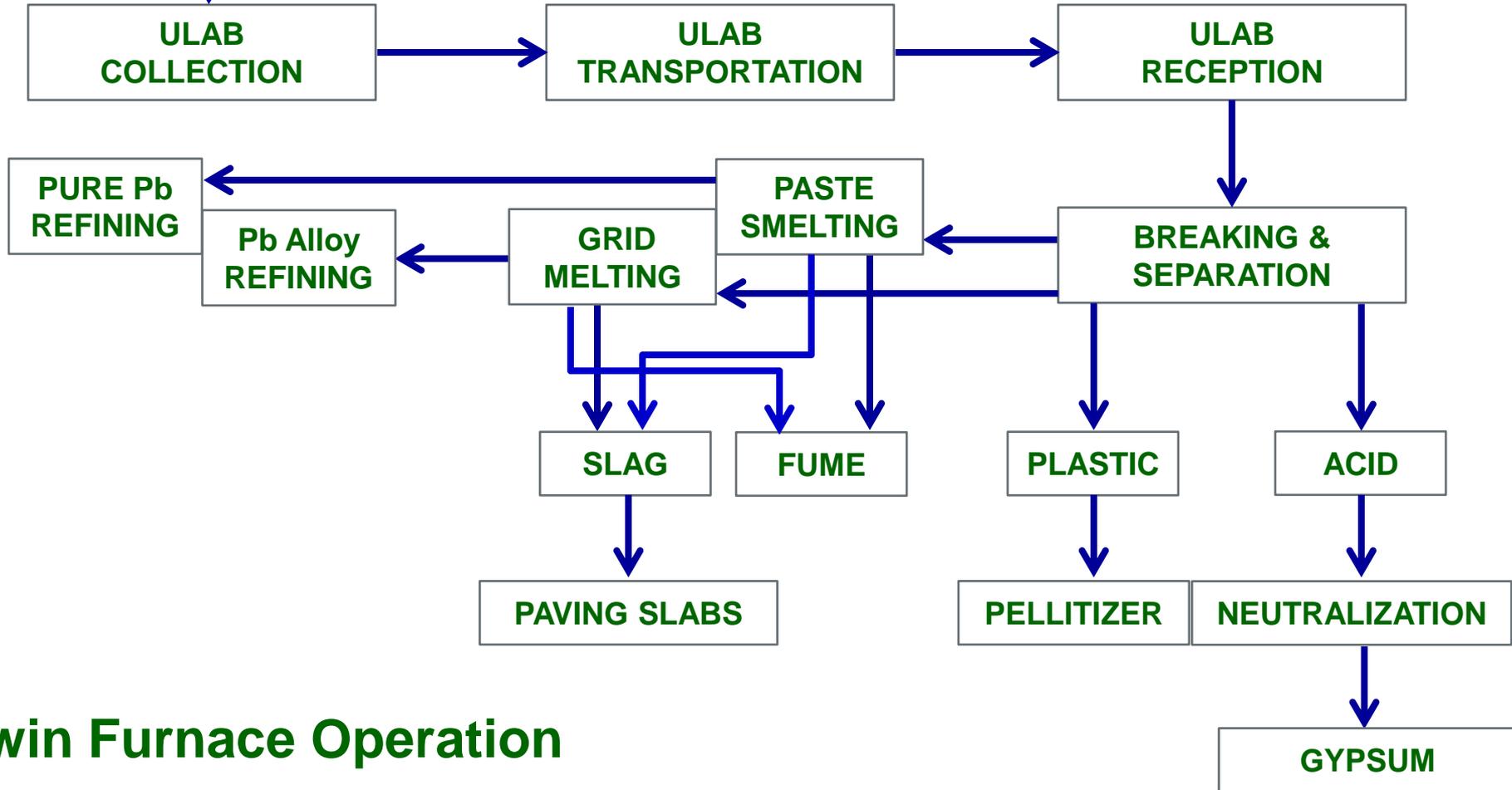
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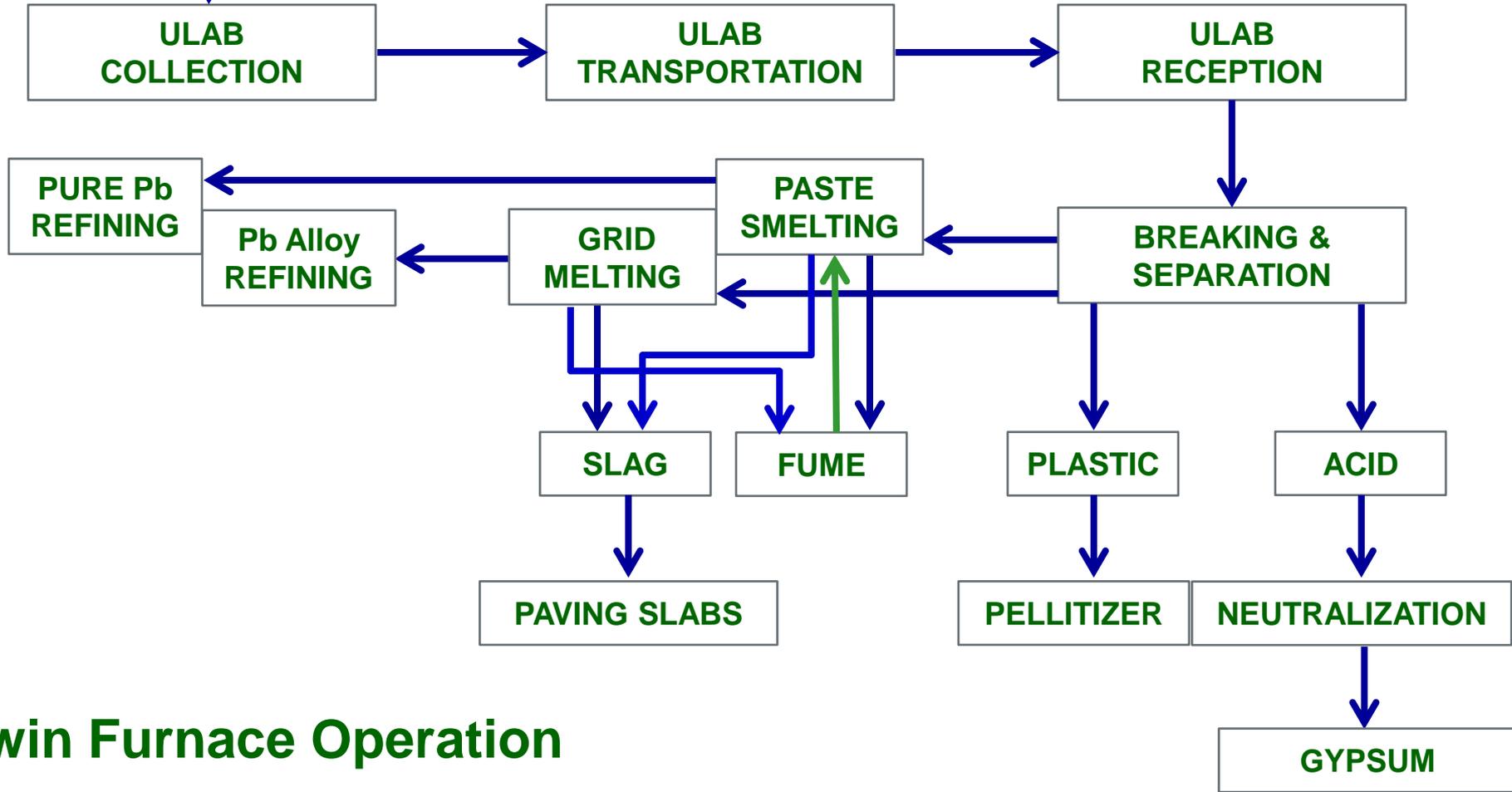
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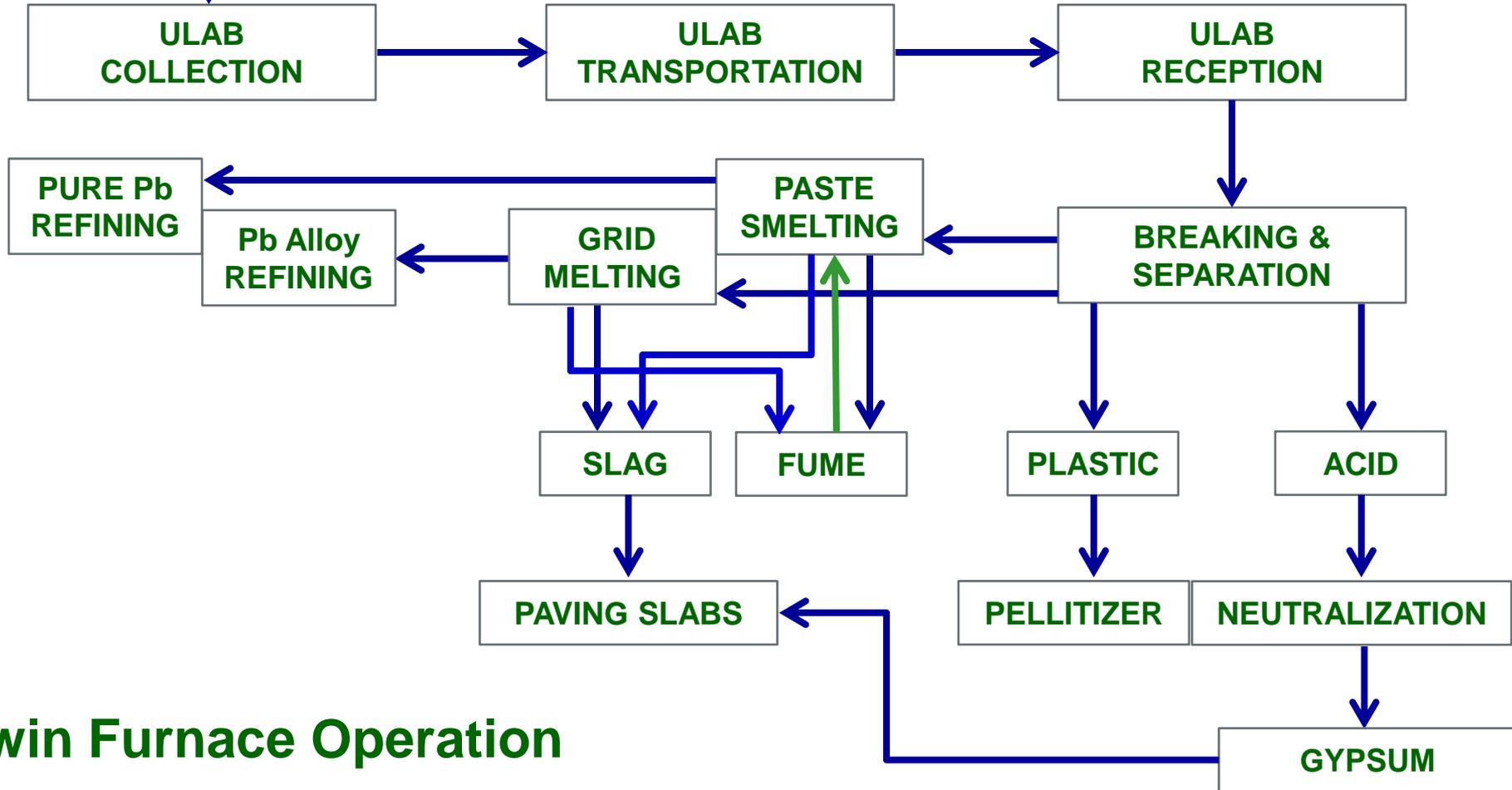
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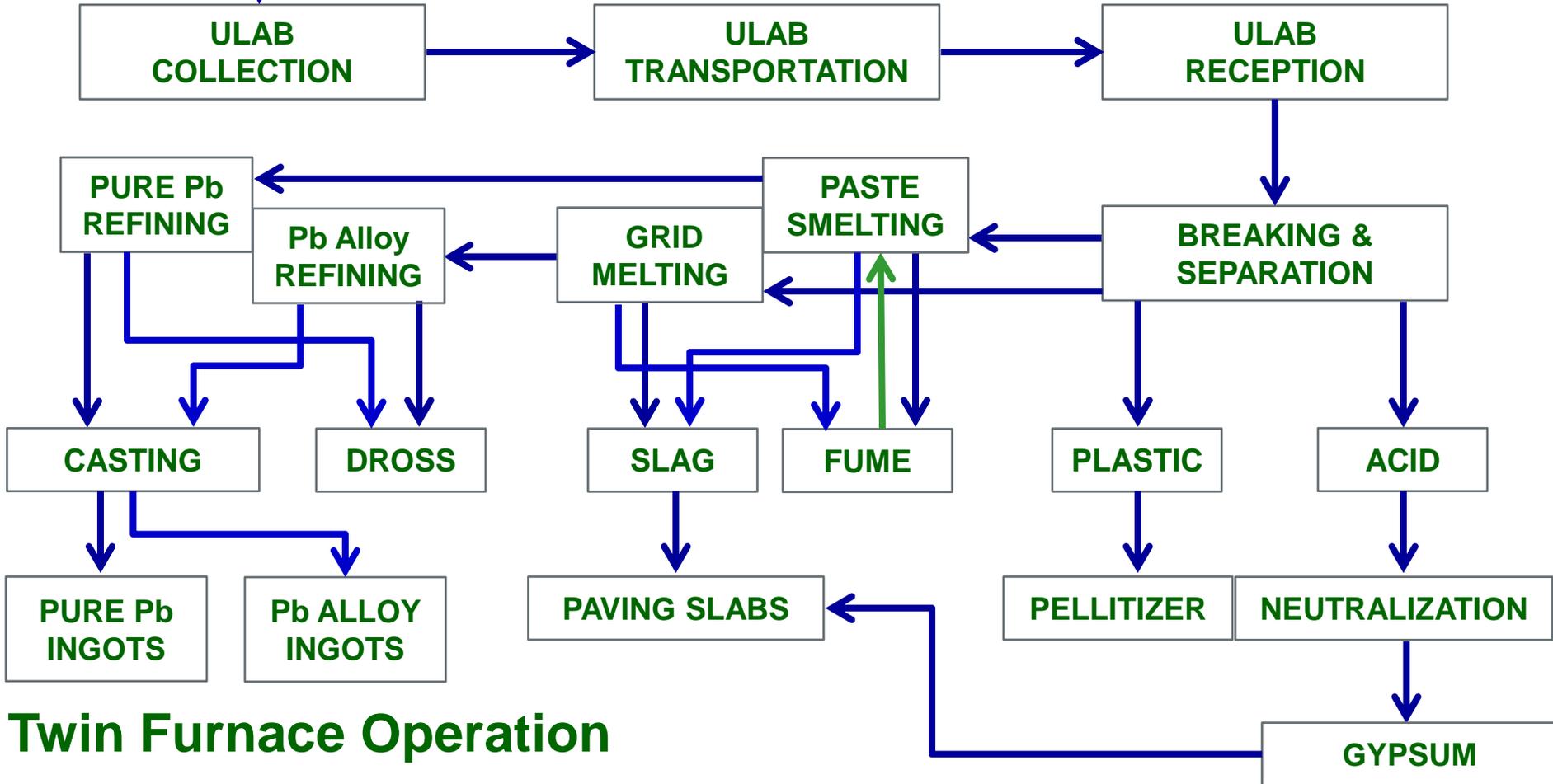
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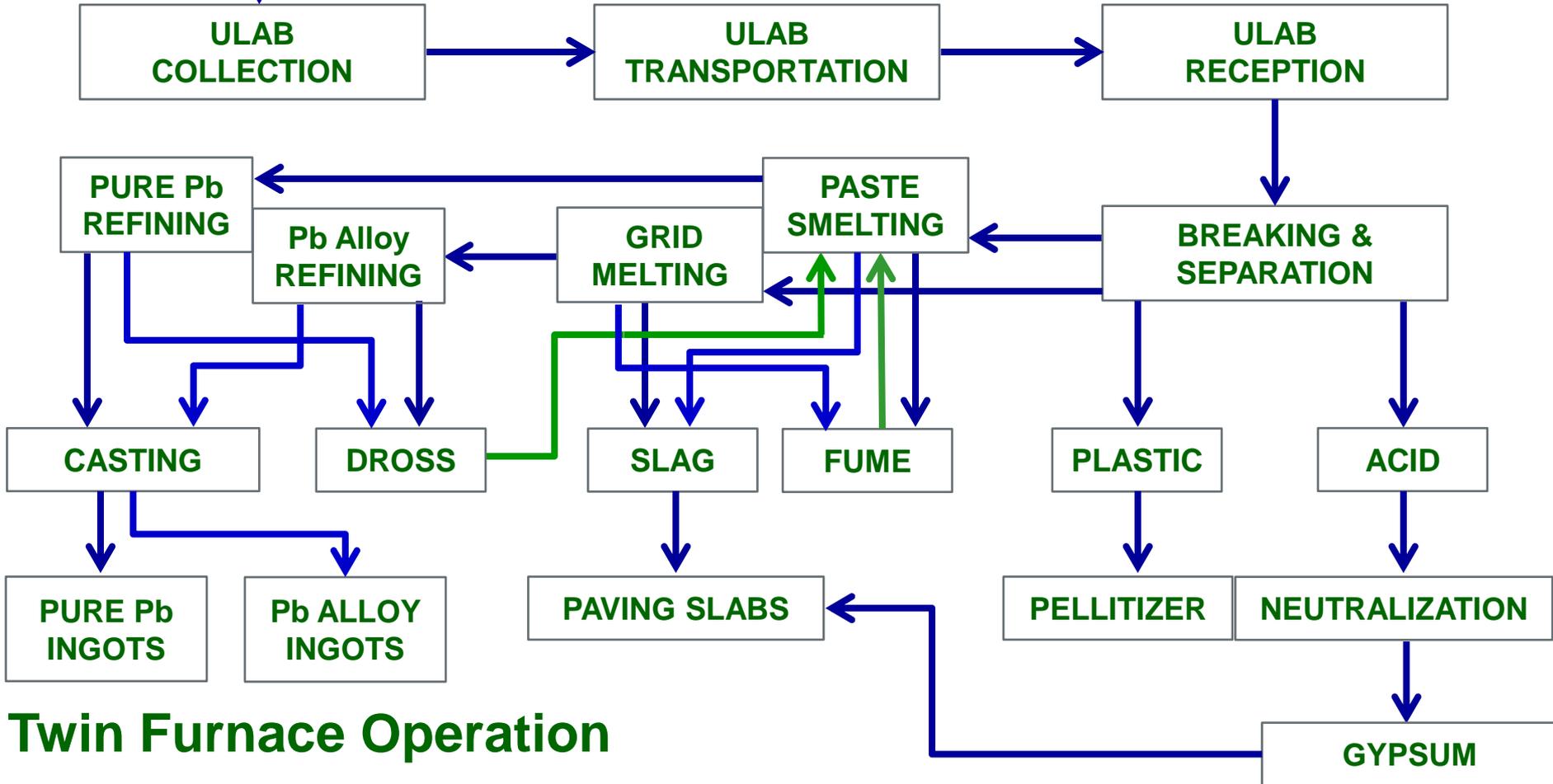
Twin Furnace Operation

Sustainable ULAB Recycling



Twin Furnace Operation

Sustainable ULAB Recycling



Twin Furnace Operation

What Else Can We Do?



Solar Energy – 300 KW



Thank You

