IBAAS 2023
TECHNICAL LECTURE SERIES

# ALUMINIUM'S SUSTAINABILITY DILEMMA: THE RED BEHIND YOUR GREEN ALUMINIUM

Dr. Subodh Das

# Aluminium (Al)

- An abundant metal in the earth's crust but exists in its oxidized form in bauxite ore
- Bauxite mining →Alumina refining(Bayer process) → Aluminium smelting (Hall-Héroult)
- 4t Bauxite →2t Alumina→1t Aluminium
- 13,000 to 18,000 kWh/t of electric energy consumption
- An average GHG emission of 12 t $CO2_{2eq}$ / t Al
- Capable of recycling 100% at the end-of-life for most products
- Undesirable by-products:
  - **Bauxite Tailings**
  - **Bauxite Residue**
  - **Spent Pot Lining (SPL)**
  - **Dross**

# Bauxite Residue and Sustainability

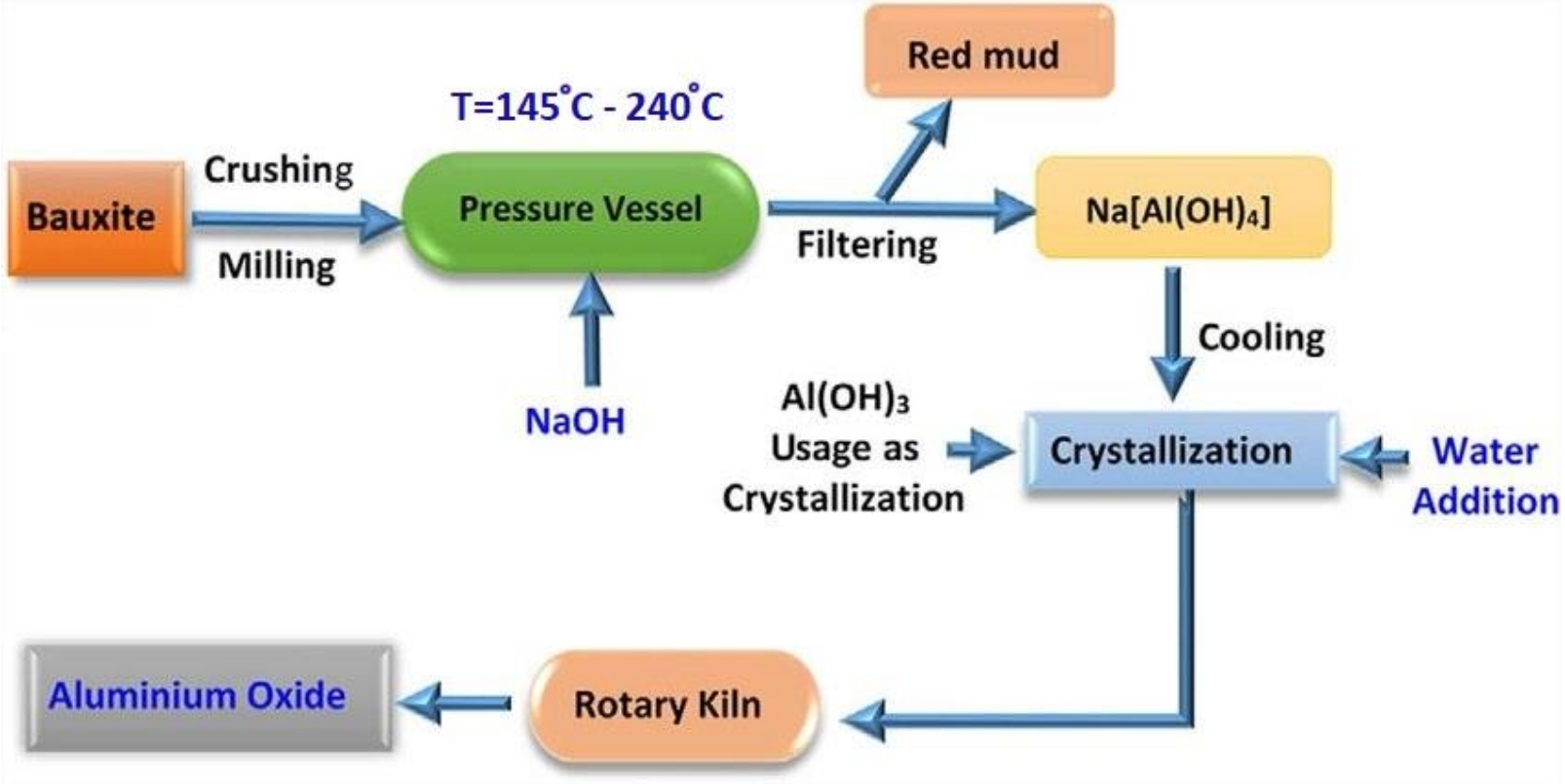
We proudly and justifiably say that 75% of all Aluminum **EVER** produced globally is still in **USE**.

We should also acknowledge and do something aggressively to mitigate the fact that > 95% of bauxite residue (red mud) EVER produced globally is still **NOT** in **USE**.

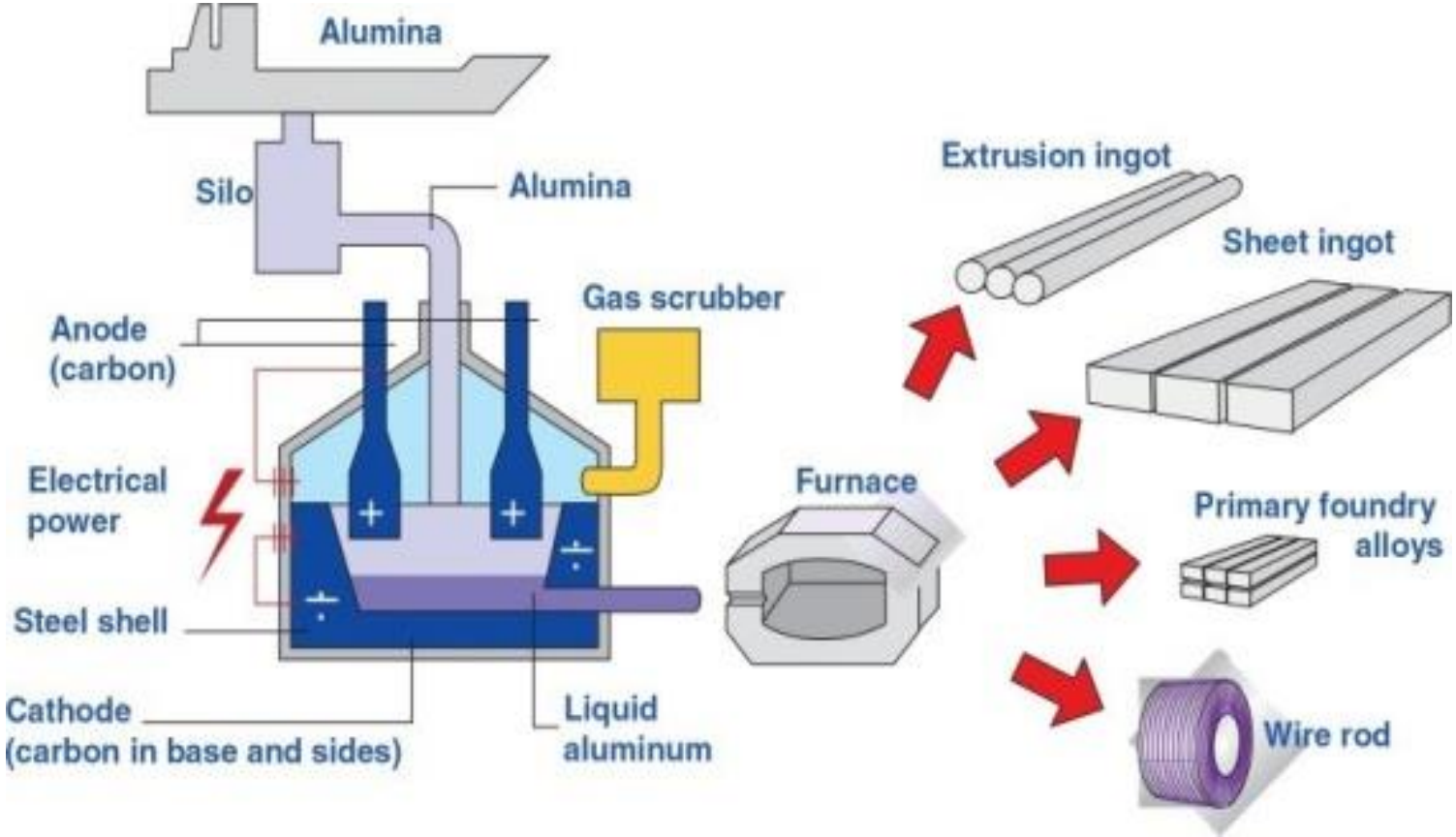
Bauxite residue is **THE MOST IMPORTANT** sustainability challenge facing the global aluminium industry today.

There is **NO** such thing as a sustainable aluminium industry without mitigating the bauxite residue situation.

# Bayer process (Alumina production)



# Aluminium production

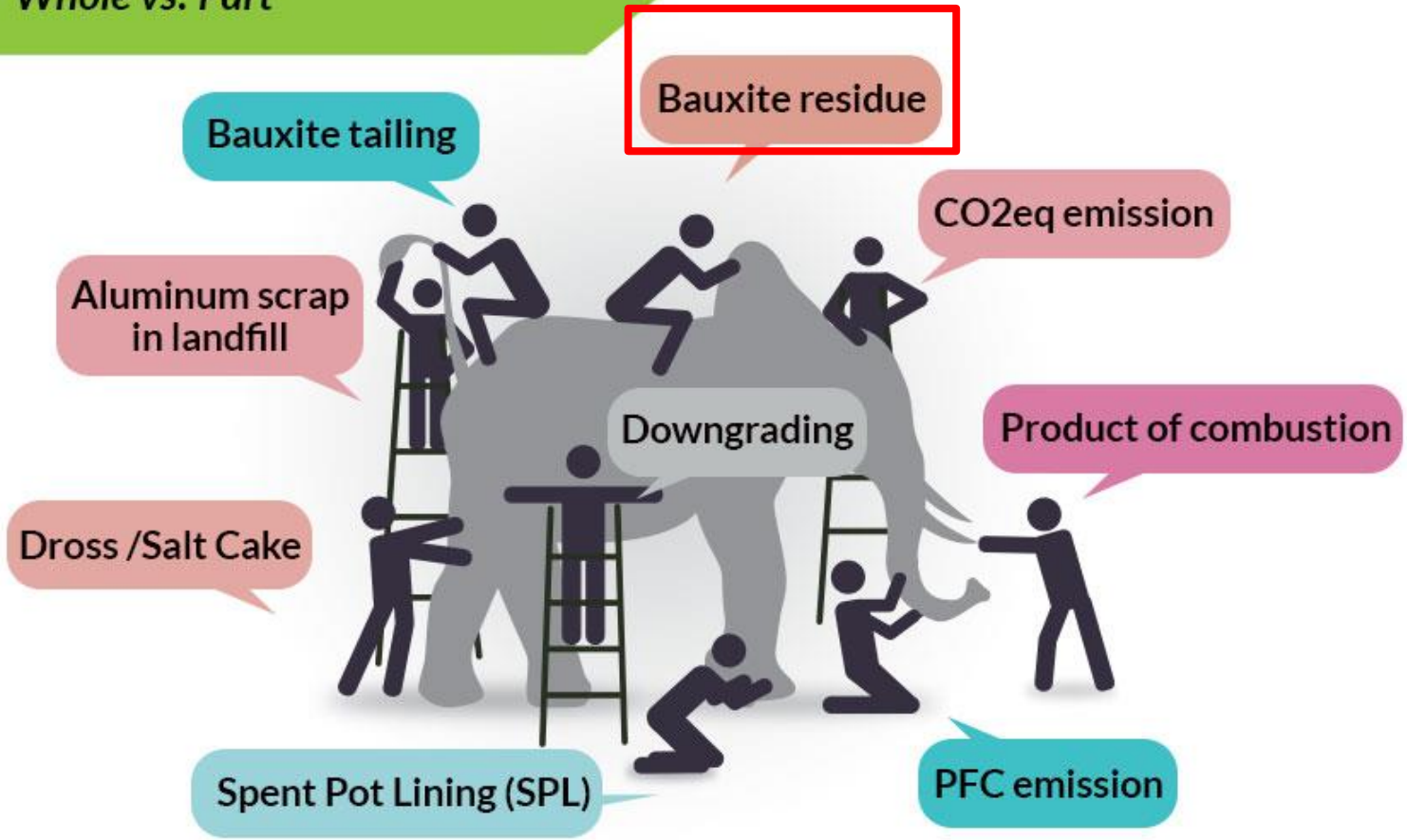


# LMA Article 2011 February 2021

| | |
|---|---|
| Bauxite Mining | •1. Bauxite Tailing |
| Alumina Refining | •2. Bauxite Residue (red mud) |
| Power Generation | •3. CO2eq emission |
| Anode Manufacturing | •4. Product of Combustion (POC) |
| Aluminium Smelting | •5. Per Fluoro Carbon (PFC)<br>•6. $CO_{2eq}$ emission<br>•7. Spent Pot Lining (SPL) |
| Aluminium Melting & Casting | •8. Dross / Salt Cake |
| Aluminium Recycling | •9. Landfill<br>•10. Downgrading |

# Aluminum Sustainability

*Whole vs. Part*

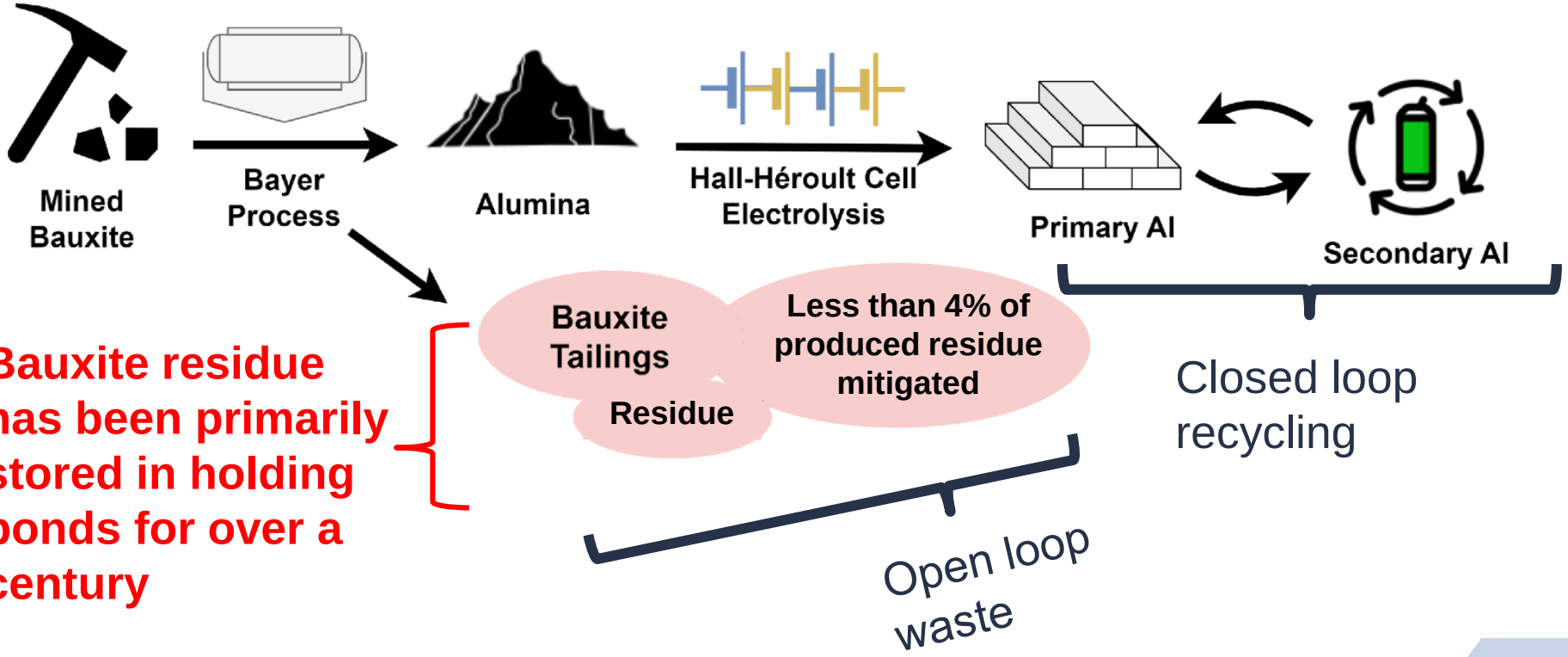


# How Green is our Aluminium?

- World is shifting to green aluminium or low CO2 aluminium
- Focus is on hydropower and inert anode technology-based aluminium
- The industry is also focusing on increased recycling of post-consumer scrap
- Bauxite residue management continues to remain the neglected area of aluminium sustainability
- The alumina that gives us green aluminium is extracted through a process that endangers lives and environment
- Without a viable solution for bauxite residue mitigation, aluminium can never be truly green

# Bauxite Residue (Red Mud) is Historically Unmanaged

>3 billion ton bauxite residue inventory grows by 150 million tons/yr



# Poorly Managed Bauxite Residue Causes Real Harm

Hydro Alunorte (Brazil 2009 & 2018)

Ajka Alumina (Hungary 2014)

Aughinish Alumina – Ireland Growing Concerns 2023

# Successful (Yet Sparse) Mitigation Projects

- Bauxite residue are processed by three aluminium companies in three countries:

| Country | Company | Maximum usage (t/yr) |
|---|---|---|
| Ukraine | Mykolayviv | 250,000 |
| Greece | Mytilineos | 85,000 |
| India | Hindalco | 2,000,000 |

- About 250,000t/y bauxite residue from Nikolayev is used in in the manufacture of clinker cement in Ukraine, Russia, Georgia, Moldova and Belarus. The Nikolayev refinery blends the residue produced to give the cement plant a consistent feed. The plant unfortunately remains closed temporarily now due to the Russia-Ukraine war.

- MYTILINEOS AoG (Aluminium of Greece) alumina refinery produces about 750,000t/y of bauxite residue for 830,000t/y alumina. AoG has achieved approximately a 10% annual reuse of bauxite residue in cement plants. Since 2018 the company has recycled more than 400,000t of bauxite residue in four cement plants in Greece and Cyprus.

# Successful (Yet Sparse) Mitigation Projects

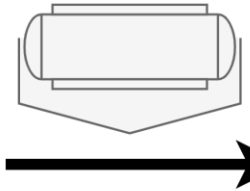
- India’s Hindalco signed an agreement with UltraTech Cement to deliver 1.2 million tons of bauxite residue per year to be used as input materials.
- UAE’s EGA is constructing a pilot plant to convert bauxite residue into soil products in association with the University of Queensland, Australia.
- Hydro Alunorte signed a contract with Wave Aluminum to build a bauxite residue processing plant in Brazil to process 50,000 tons/yr of bauxite residue.

# Incentivize Bauxite Residue Reduction

## We propose the LME introduces an additional class of ‘Low Bauxite Residue Aluminum’ (LBRA) premiums

The premium increases with greater residue processing rates per ton of aluminum

Mined Bauxite



Bayer Process

Global Bauxite Residue Inventory

Storage

Valorization + Utilization

Soil and Cement

Structural and Rare Earth Metals

Chemicals and Catalysis

Higher premium is placed on reduction of existing bauxite residue

# Proposed LME Premiums for LBRA

## We propose the LME introduces an additional class of 'Low Bauxite Residue Aluminium' (LBRA) premiums

| Bauxite Residue (BR) | Suggested LME Premiums for P1020 | |
|---|---|---|
| Residue Processed Per Ton of P1020 Sold | **% of LME Pricing** | **LME Premium @$2,000/MT** |
| NEW BR (1T) | 0.25 | 5 |
| NEW BR (2T) | 0.50 | 10 |
| NEW BR(3T) | 0.75 | 15 |
| NEW BR (4T) | 1.00 | 20 |
| EXISTING BR (1T) | 0.50 | 10 |
| EXISTING BR (2T) | 1.0 | 20 |
| EXISTING BR (3 T) | 1.5 | 30 |
| EXISTING BR (4T) | 2.0 | 40 |

**Increased incentive for increased residue processing rates**

Create economic incentive for producers to **process new residue**

Place **greater incentive on processing existing bauxite residue**

# Challenges & Action Plan

## CHALLENGES

- Low carbon AIuminium drive is currently focused on:
  - Hydro power (limited geographically & no new dams due ecological concerns)
  - High technology not capable of retrofitting existing primary AIuminium smelters

- Bauxite residue is **THE MOST IMPORTANT** sustainability challenge facing the global Aluminium industry today.

- There is **NO** such thing as a sustainable Aluminium industry without mitigating the bauxite residue situation.

## ACTION PLAN

- Global engagement from AIuminium industry & sustainability leaders
- Create a LinkedIn Group on Bauxite Residue to share strategies
- Create a website dedicated to Bauxite Residue mitigation plan
- Create a monthly focus group virtual discussion
- Set-up a Global non-profit organization to educate & develop sustainable practices & technologies
- **YOUR THOUGHTS?**

# References


**LMA** Light Metal Age, ”The Quest for Low Carbon Aluminum: Developing a Sustainability Index”, February 2021)

**TMS** “Current Status and Proposed Economic Incentives for Higher Utilization of Bauxite Residue to Enhance Sustainability of the Aluminum Industry” Light Metals 2023

**LME Sustainability Spotlight - March 2023**

https://link.edgepilot.com/s/be4d0a8f/FQXf0m8Zo0aTdgCz663bow?u=https://www.lme.com/en/about/Responsibility/Sustainability/Sustainability-newsletter/March-2023

**Links for LinkedIn posts on bauxite residue**

https://link.edgepilot.com/s/7daf0c54/lKA5EjsTNUSnlCp9w9r59w?u=https://www.linkedin.com/posts/subodhdas_sustainability-aluminium-aluminium-activity-7043996812415758336-9me_/?utm_source=share%26utm_medium=member_desktop

https://link.edgepilot.com/s/91f6bd13/PVgzbliDIUO8MDc8WISq7A?u=https://www.linkedin.com/posts/subodhdas_enhancing-aluminum-sustainability-activity-7047721030559113216-2yEH/?utm_source=share%26utm_medium=member_desktop

https://link.edgepilot.com/s/426e781e/CoINU38630G2aAhAat98Ag?u=https://www.linkedin.com/posts/subodhdas_bauxite-enhancing-sustainability-of-aluminum-activity-7047744348775473152-TN7P/?utm_source=share%26utm_medium=member_desktop

# THANK YOU

**Dr. Subodh Das**

skdas@phinix.net

www.phinix.net

+1 859 619 8386