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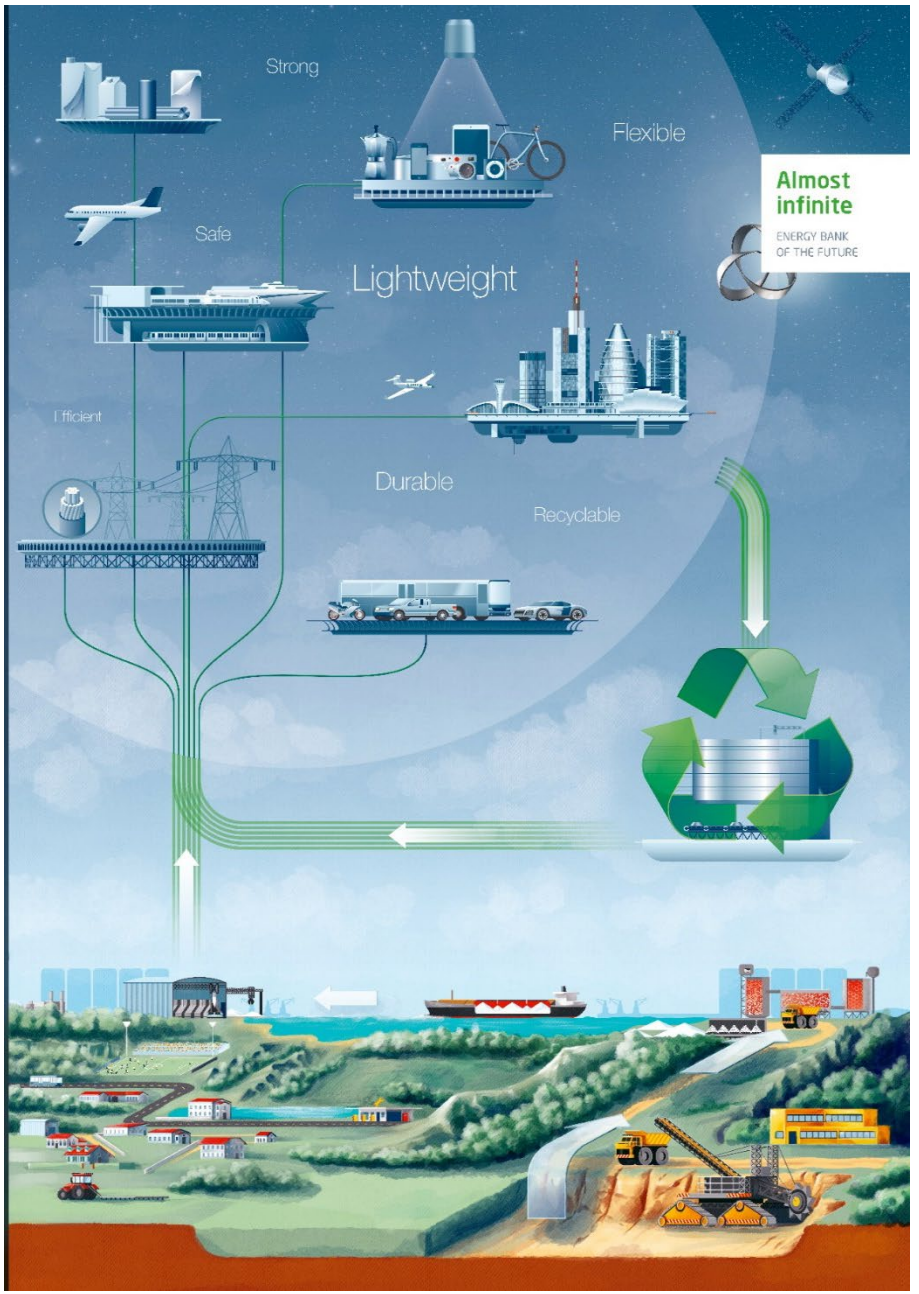
THE ALUMINIUM STORY

www.thealuminiumstory.com

World Aluminium



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Sir Jonathan Ive
Chief Design Officer, *Apple*

"The best design acknowledges that you can't disconnect the form from the material.

The material informs the form."

"The only way to make the *MacBook Pro* unibody was to machine it from a single piece of aluminium."

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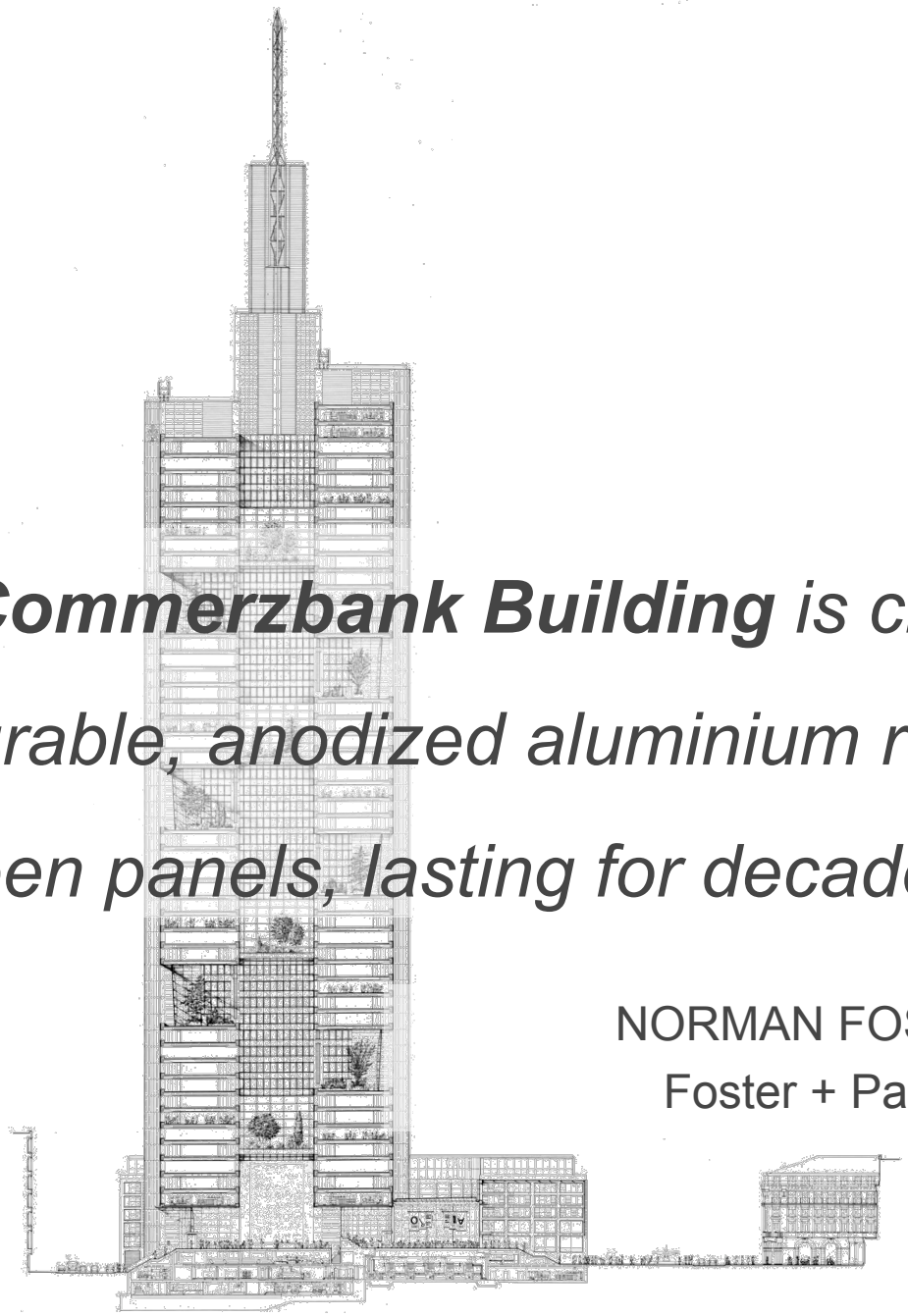

*"The **Commerzbank Building** is clad in durable, anodized aluminium rain screen panels, lasting for decades"*

NORMAN FOSTER
Foster + Partners

World Aluminium

Jaguar

Land Rover

Ford

"The use of aluminium…brings benefits in terms of:

- weight savings,
- improved fuel efficiency,
- lower emissions,
- increased crash safety, and...
- better vehicle dynamics"

"...the material of choice"


“Aluminium allows *Bombardier* to manufacture low weight vehicles and thus reduce environmental impact, with a high quality exterior finish”
Guillaume Rétaux
Director Strategic Sourcing
BOMBARDIER
the evolution of mobility

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The industry must demonstrate that...

1. it produces responsibly, by mitigating environmental impacts and positively impacting the communities in which it operates;
2. its products bring a net benefit to society in terms of reduced environmental impact; improved quality of life, health, safety & wellness and economic growth;
3. at the end of product life, the value of the metal, the energy that went into its production and the resource inputs are retained and realised as another product, through collection and recycling or energy recovery.

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Greenhouse Gas Emissions

- All sectors:
  - Approx. 50 Gt CO_2e in 2010 *
    - *[likely ~60 Gt CO_2e in 2018]*
- Aluminium industry (cradle to gate):
  - 1 Gt CO_2e in 2018 †

Source: * IPCC 2014, † IAI

Source: IPCC 2014, IAI

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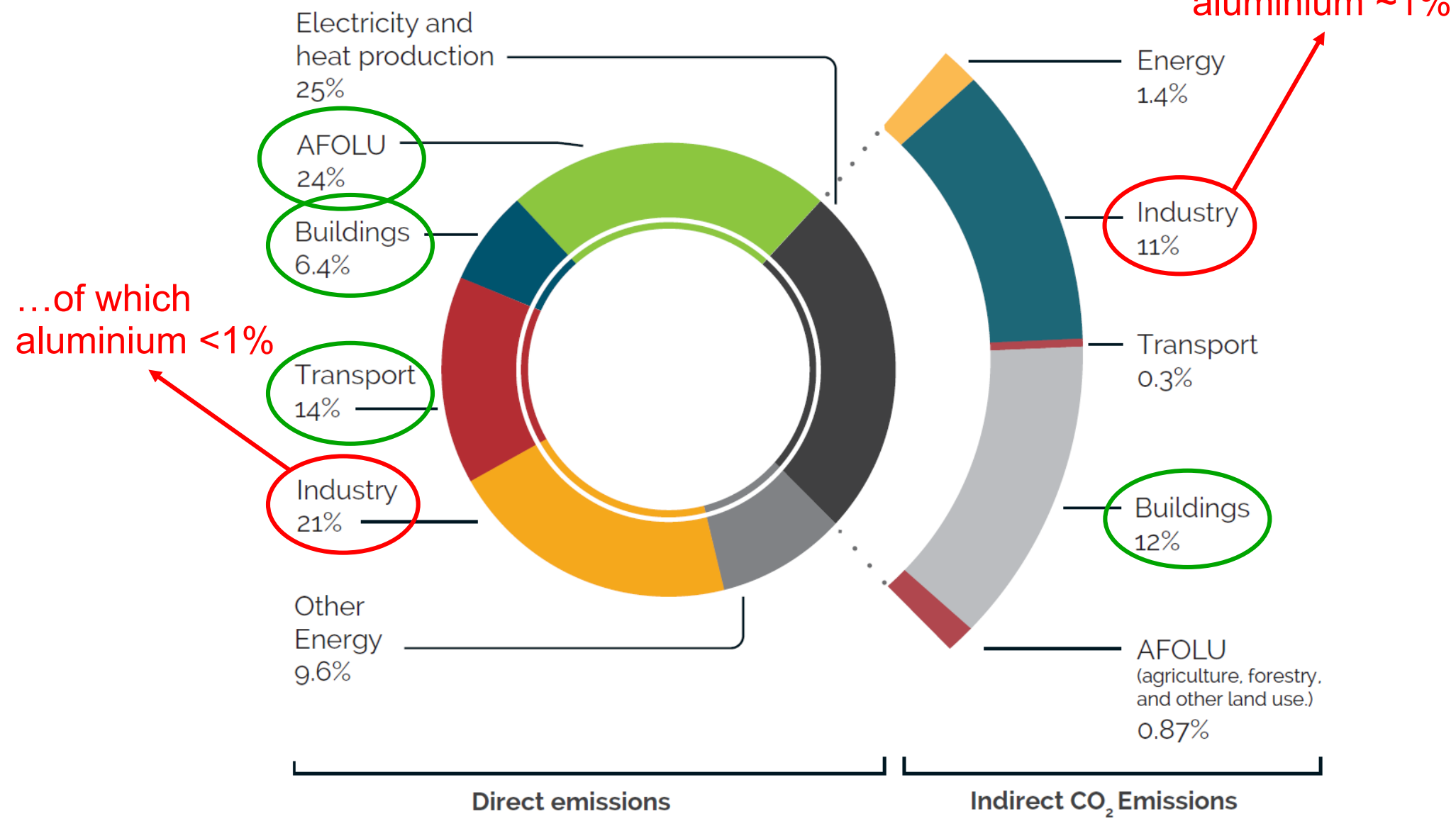

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Vehicle light-weighting

- 1 kg of aluminium, replacing heavier materials in a car or light truck, can save 20 kg of CO_2 over the vehicle life;
- Similar number for electric vehicles in coal-intensive grids such as India and China;
- Up to 80 kg CO_2 per kg aluminium used in trains;
- The 20 million tonnes of aluminium shipped to the transportation sector every year could save half a billion tonnes of CO_2 and over 100 billion litres of crude oil.

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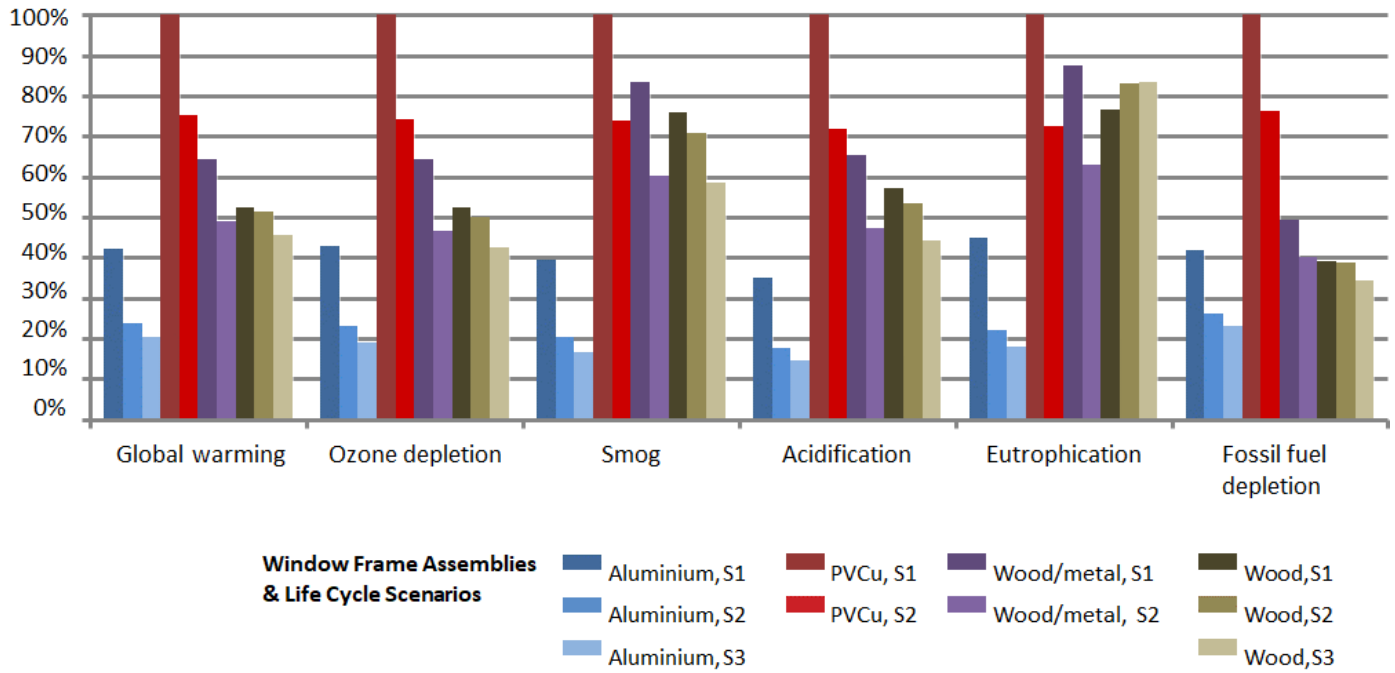
Building applications: durability matters



Source: KieranTimberlake Research Group/IAI

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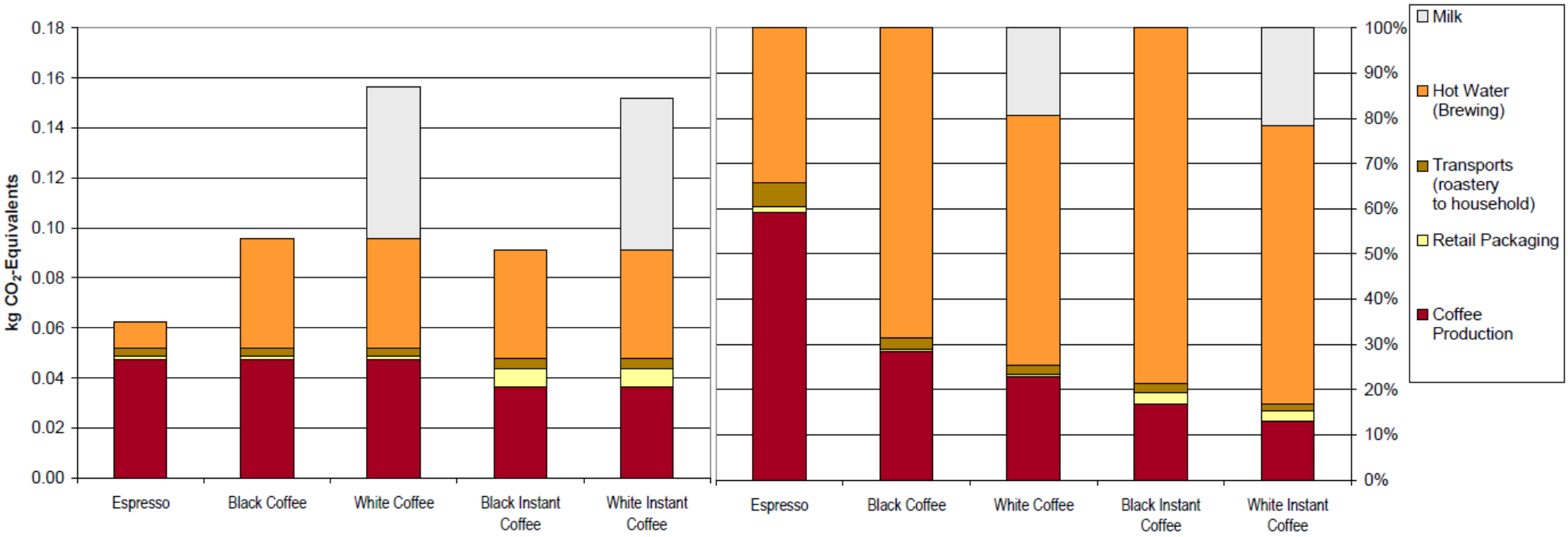
Protective packaging



Source: European Aluminium Foil Association

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ALUMINIUM DEMAND

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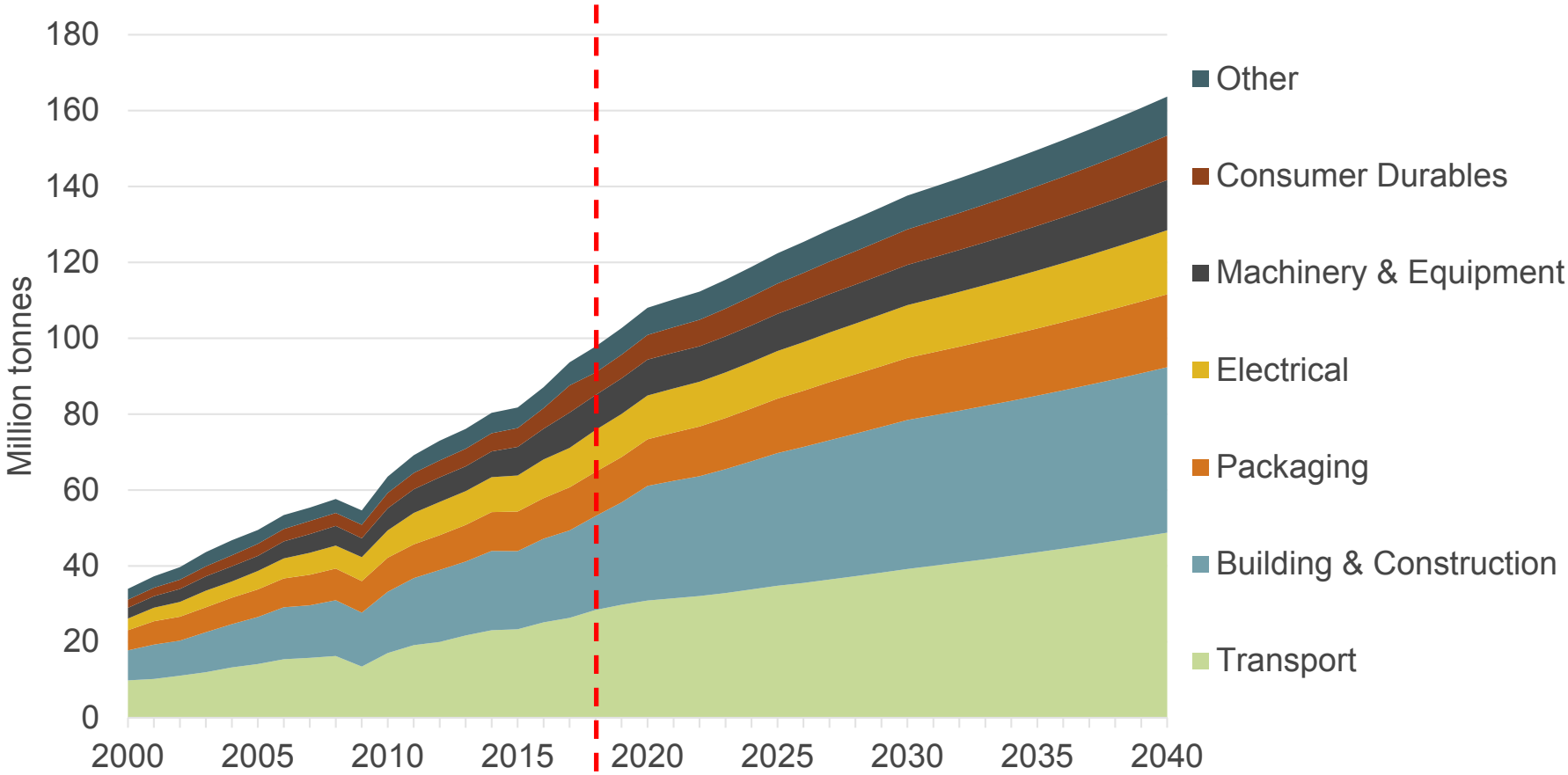
Semis shipments per annum



Source: IAI

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Three quarters of all aluminium ever produced is still in productive use

- 1.3 billion tonnes produced since 1888
- One billion tonnes still in use

- A positive recycling story but…

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…more significantly a story of

- Demand growth
  - For light, strong, conductive, protective products
  - 800 million tonnes produced since 2000

- Durability
  - Long lifetime products not yet reached the end of “First Life”
  - Long lifetime products tend to have high recycling rates (>90%)

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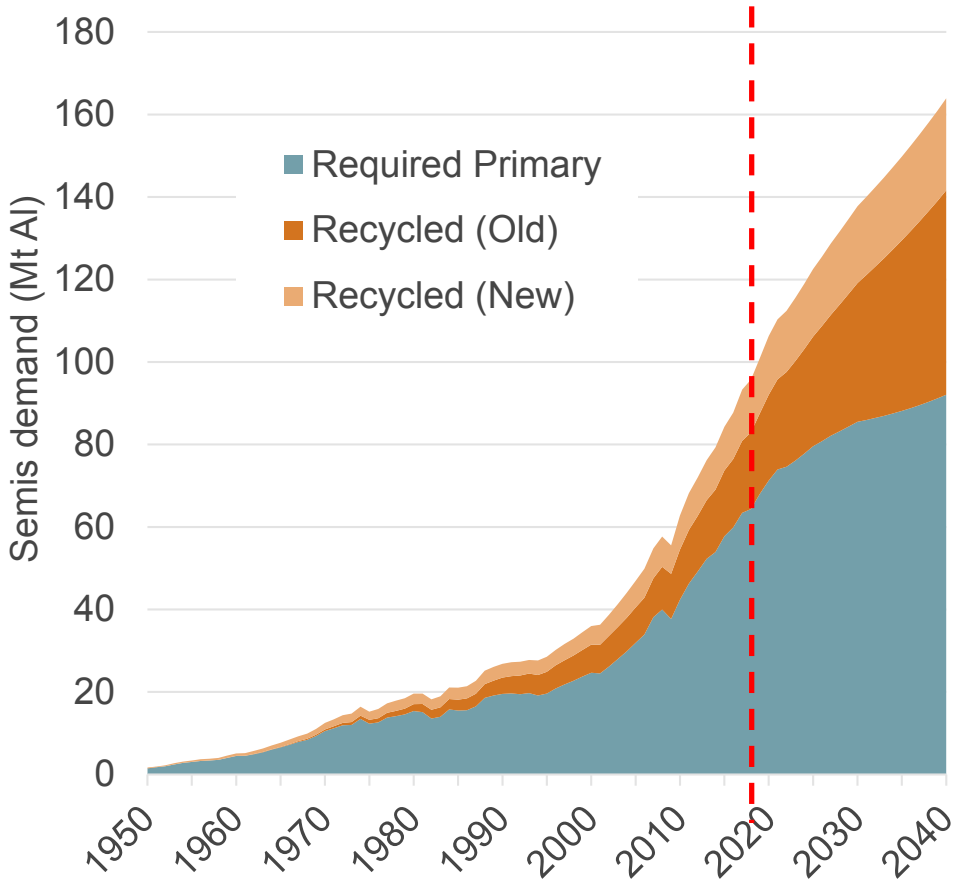
Primary continues to dominate supply



Million tonnes	2000	2018	2040
Semis demand	35	95	160
Final product demand	30	80	140
Recycled aluminium	12	31	70
...of which “old”	7	18	50
...of which “new”	5	13	20
Primary required	25	64	90

Source: IAI

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RAW MATERIALS

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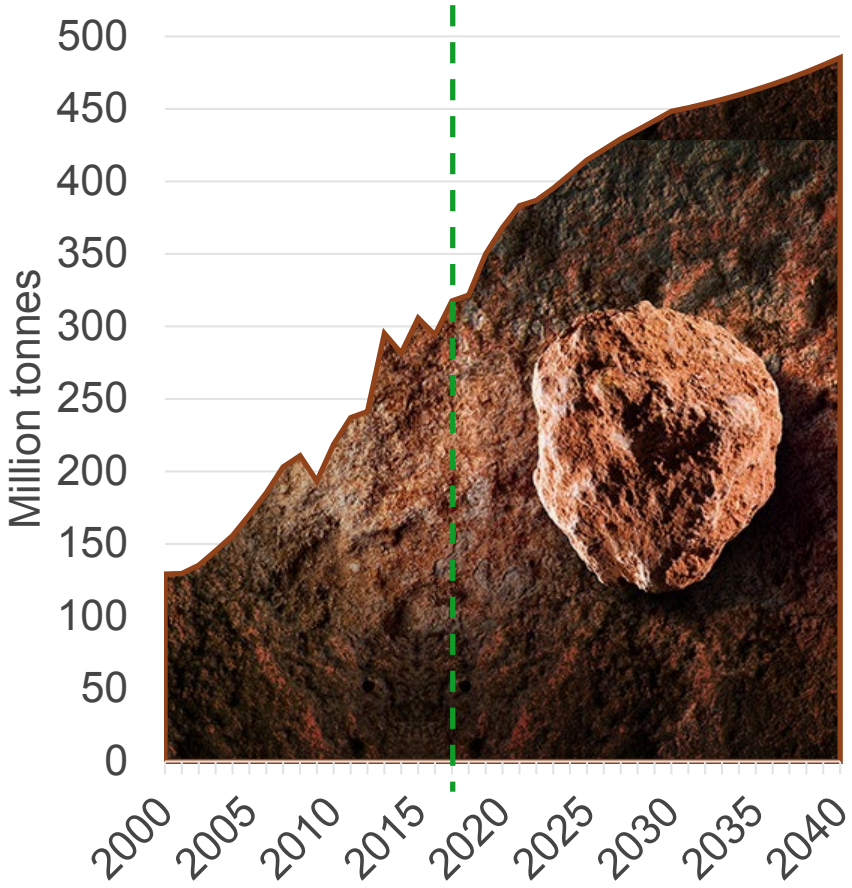
Global bauxite demand



- + 50% by 2040;
- Additional 150 Mtpa;
- China ratio 60:40 domestic to imported to reverse (40:60);
- Fast growing regions of supply bring risks
  - supply,
  - political,
  - environmental,
  - reputational.

Source: IAI

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Sustainable Bauxite Mining Guidelines

可持续铝土矿开采指南

第 1 版

2018 年 5 月

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AUSTRALIAN ALUMINIUM COUNCIL LTD

abal ASSOCIAÇÃO BRASILEIRA DO ALUMÍNIO

Sustainable Bauxite Mining Guidelines

First Edition

May 2018

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AUSTRALIAN ALUMINIUM COUNCIL LTD

abal ASSOCIAÇÃO BRASILEIRA DO ALUMÍNIO

Panduan Penambangan Bauksit Berkelanjutan

Edisi Pertama

Maret 2018

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abal ASSOCIAÇÃO BRASILEIRA DO ALUMÍNIO

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What is included?

Sustainable mining practices

Governance

Community assessment & contribution

Health & safety

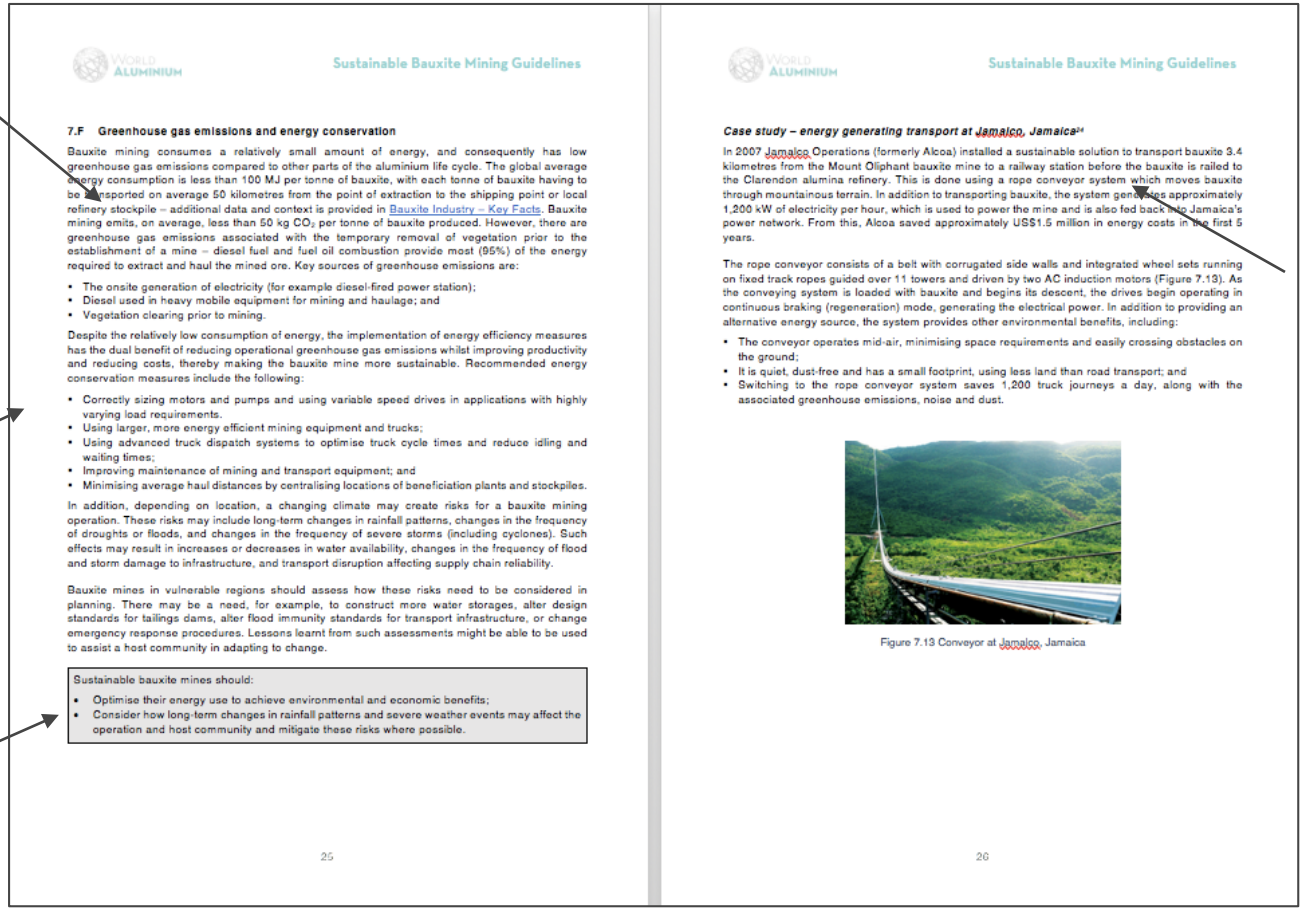
Environmental assessment & performance

Guideline use

Theory and how it applies to bauxite mining

- Do's and don't's
- Key risks
- Mitigations

Bauxite specific guidelines



Sustainable Bauxite Mining Guidelines

7.F Greenhouse gas emissions and energy conservation

Bauxite mining consumes a relatively small amount of energy, and consequently has low greenhouse gas emissions compared to other parts of the aluminium life cycle. The global average energy consumption is less than 100 MJ per tonne of bauxite, with each tonne of bauxite having to be transported on average 50 kilometres from the point of extraction to the shipping point or local refinery stockpile – additional data and context is provided in Bauxite Industry – Key Facts. Bauxite mining emits, on average, less than 50 kg CO_2 per tonne of bauxite produced. However, there are greenhouse gas emissions associated with the temporary removal of vegetation prior to the establishment of a mine – diesel fuel and fuel oil combustion provide most (95%) of the energy required to extract and haul the mined ore. Key sources of greenhouse emissions are:

- The onsite generation of electricity (for example diesel-fired power station);
- Diesel used in heavy mobile equipment for mining and haulage; and
- Vegetation clearing prior to mining.

Despite the relatively low consumption of energy, the implementation of energy efficiency measures has the dual benefit of reducing operational greenhouse gas emissions whilst improving productivity and reducing costs, thereby making the bauxite mine more sustainable. Recommended energy conservation measures include the following:

- Correctly sizing motors and pumps and using variable speed drives in applications with highly varying load requirements.
- Using larger, more energy efficient mining equipment and trucks;
- Using advanced truck dispatch systems to optimise truck cycle times and reduce idling and waiting times;
- Improving maintenance of mining and transport equipment; and
- Minimising average haul distances by centralising locations of beneficiation plants and stockpiles.

In addition, depending on location, a changing climate may create risks for a bauxite mining operation. These risks may include long-term changes in rainfall patterns, changes in the frequency of droughts or floods, and changes in the frequency of severe storms (including cyclones). Such effects may result in increases or decreases in water availability, changes in the frequency of flood and storm damage to infrastructure, and transport disruption affecting supply chain reliability.

Bauxite mines in vulnerable regions should assess how these risks need to be considered in planning. There may be a need, for example, to construct more water storages, alter design standards for tailings dams, alter flood immunity standards for transport infrastructure, or change emergency response procedures. Lessons learnt from such assessments might be able to be used to assist a host community in adapting to change.

Sustainable bauxite mines should:

- Optimise their energy use to achieve environmental and economic benefits;
- Consider how long-term changes in rainfall patterns and severe weather events may affect the operation and host community and mitigate these risks where possible.

25

Sustainable Bauxite Mining Guidelines

Case study – energy generating transport at Jamalco, Jamaica[24]

In 2007 Jamalco Operations (formerly Alcoa) installed a sustainable solution to transport bauxite 3.4 kilometres from the Mount Oliphant bauxite mine to a railway station before the bauxite is railed to the Clarendon alumina refinery. This is done using a rope conveyor system which moves bauxite through mountainous terrain. In addition to transporting bauxite, the system generates approximately 1,200 kW of electricity per hour, which is used to power the mine and is also fed back into Jamaica's power network. From this, Alcoa saved approximately US$1.5 million in energy costs in the first 5 years.

The rope conveyor consists of a belt with corrugated side walls and integrated wheel sets running on fixed track ropes guided over 11 towers and driven by two AC induction motors (Figure 7.13). As the conveying system is loaded with bauxite and begins its descent, the drives begin operating in continuous braking (regeneration) mode, generating the electrical power. In addition to providing an alternative energy source, the system provides other environmental benefits, including:

- The conveyor operates mid-air, minimising space requirements and easily crossing obstacles on the ground;
- It is quiet, dust-free and has a small footprint, using less land than road transport; and
- Switching to the rope conveyor system saves 1,200 truck journeys a day, along with the associated greenhouse emissions, noise and dust.

Figure 7.13 Conveyor at Jamalco, Jamaica

26

One or more case study per section; practical examples

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WASTE MANAGEMENT

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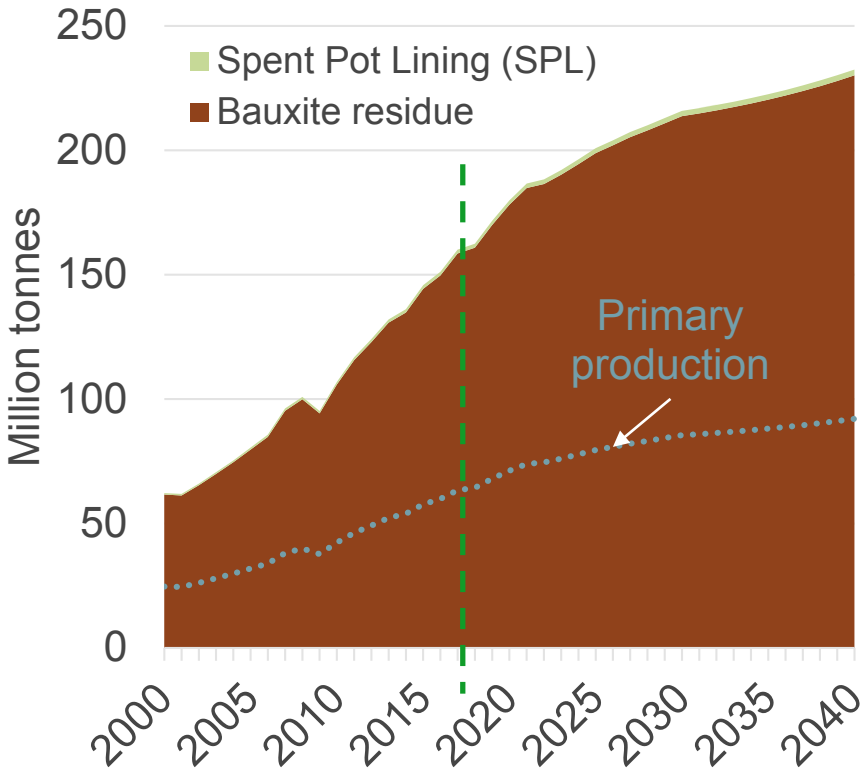
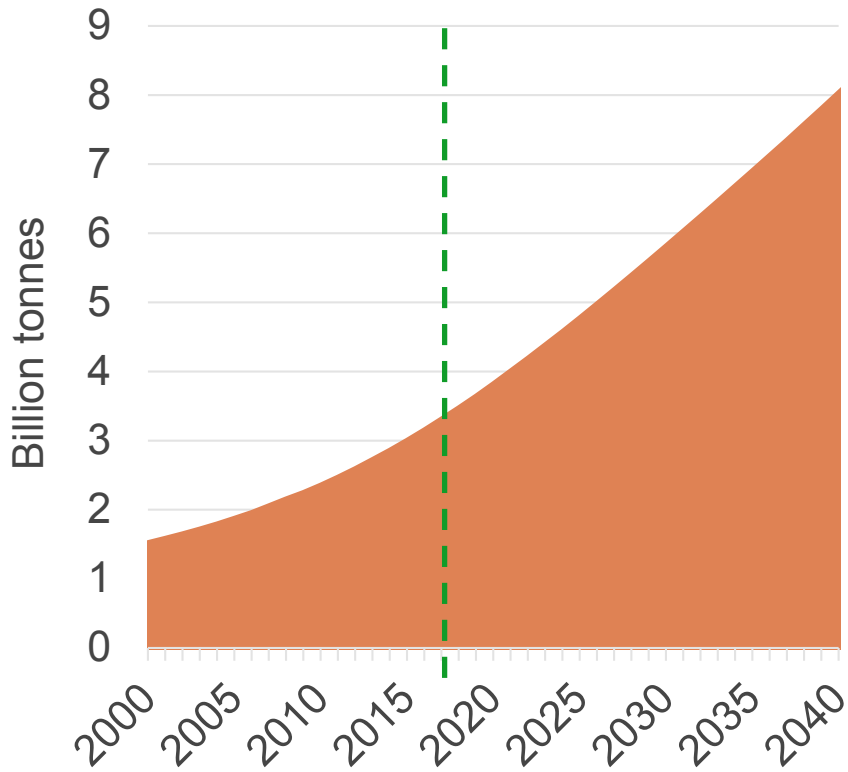
SPL and bauxite residue

Annual generation



Cumulative bauxite residue



Source: IAI

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铝土矿赤泥管理：最佳方案

2015年8月

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Bauxite Residue Management: Best Practice

July 2015

WORLD ALUMINIUM

EUROPEAN ALUMINIUM

Manajemen Residu Bauksit: Pelaksanaan Tindakan Yang Terbaik

2015

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- Optimal strategy for a site at a given time;
- Not “one-size fits all”;
- Approaches evolve to accommodate innovations;
- Best available technology, appropriate to local, national and regional circumstances.

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ENERGY AND GREENHOUSE GASES

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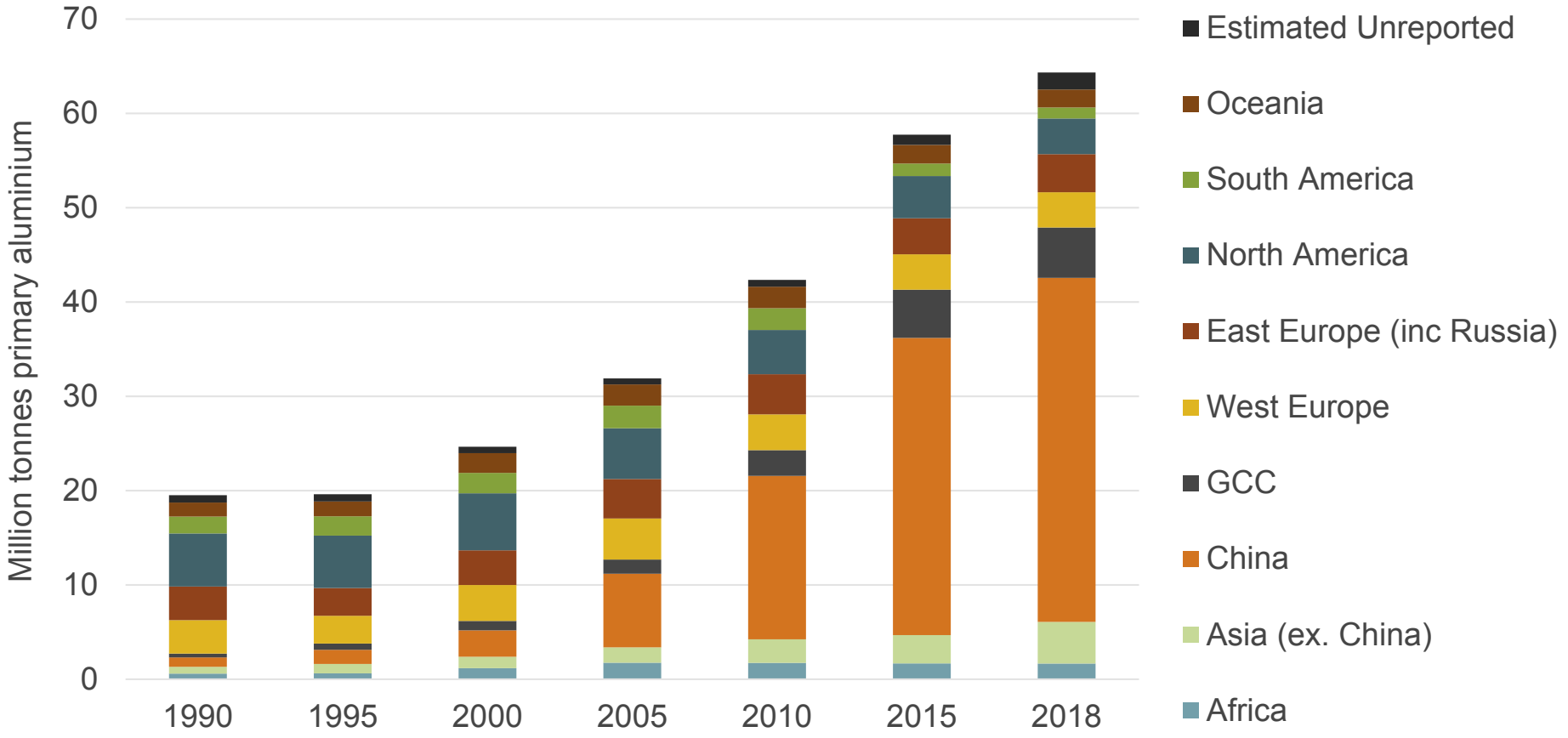
Growth of primary production



Source: IAI

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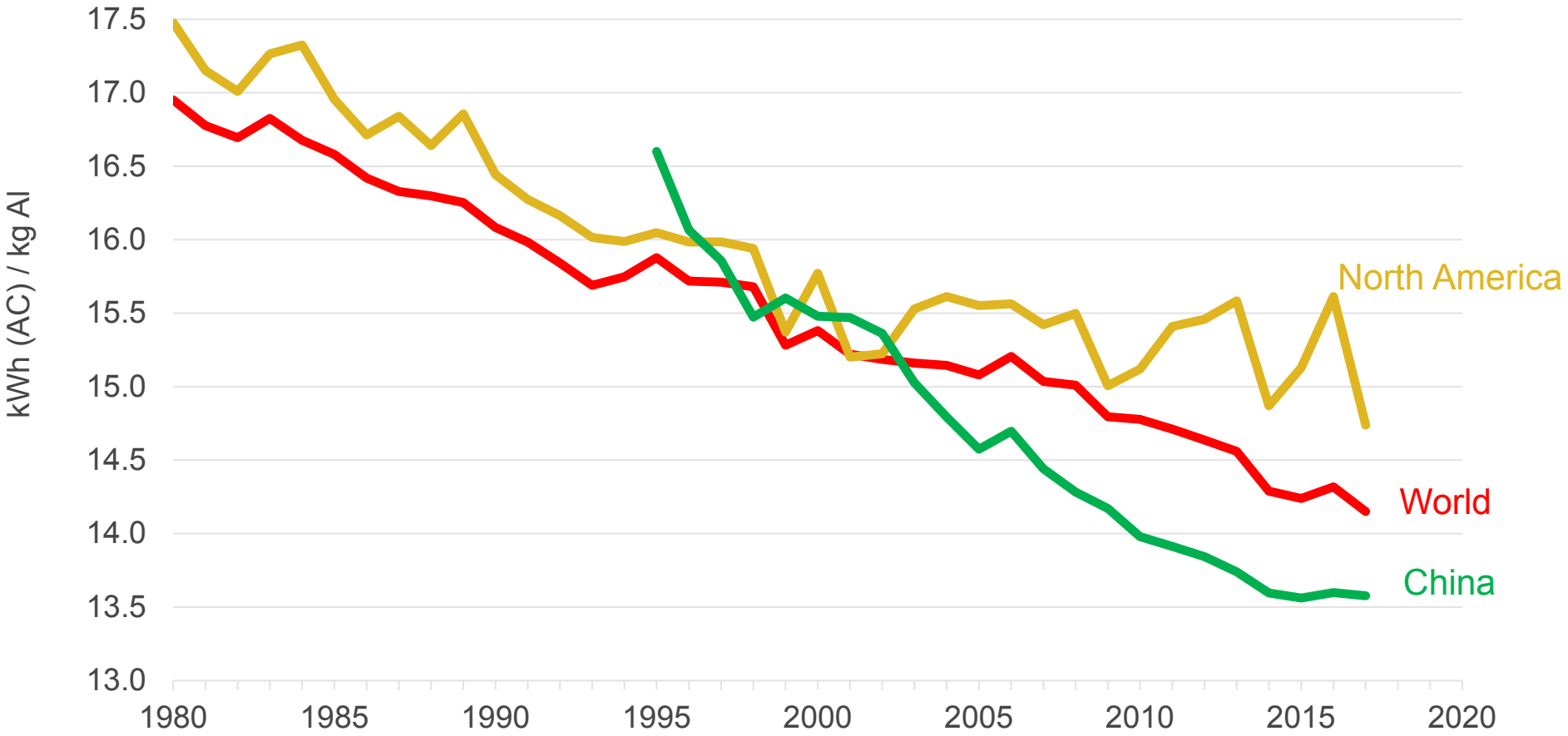
Electrolytic energy intensity reduced by over 15% since 1980



Source: IAI

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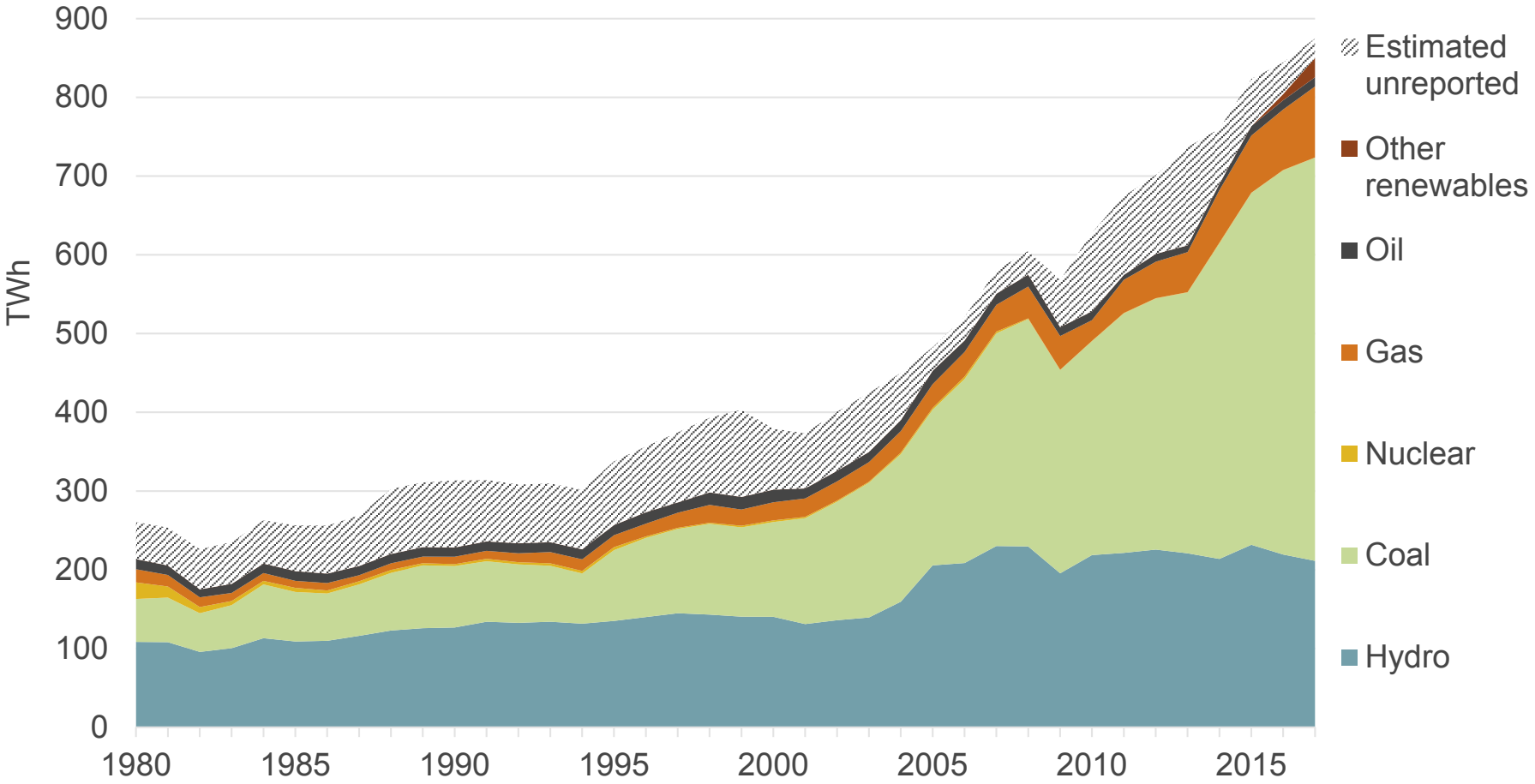
Globally smelter power is now 60% coal-fired



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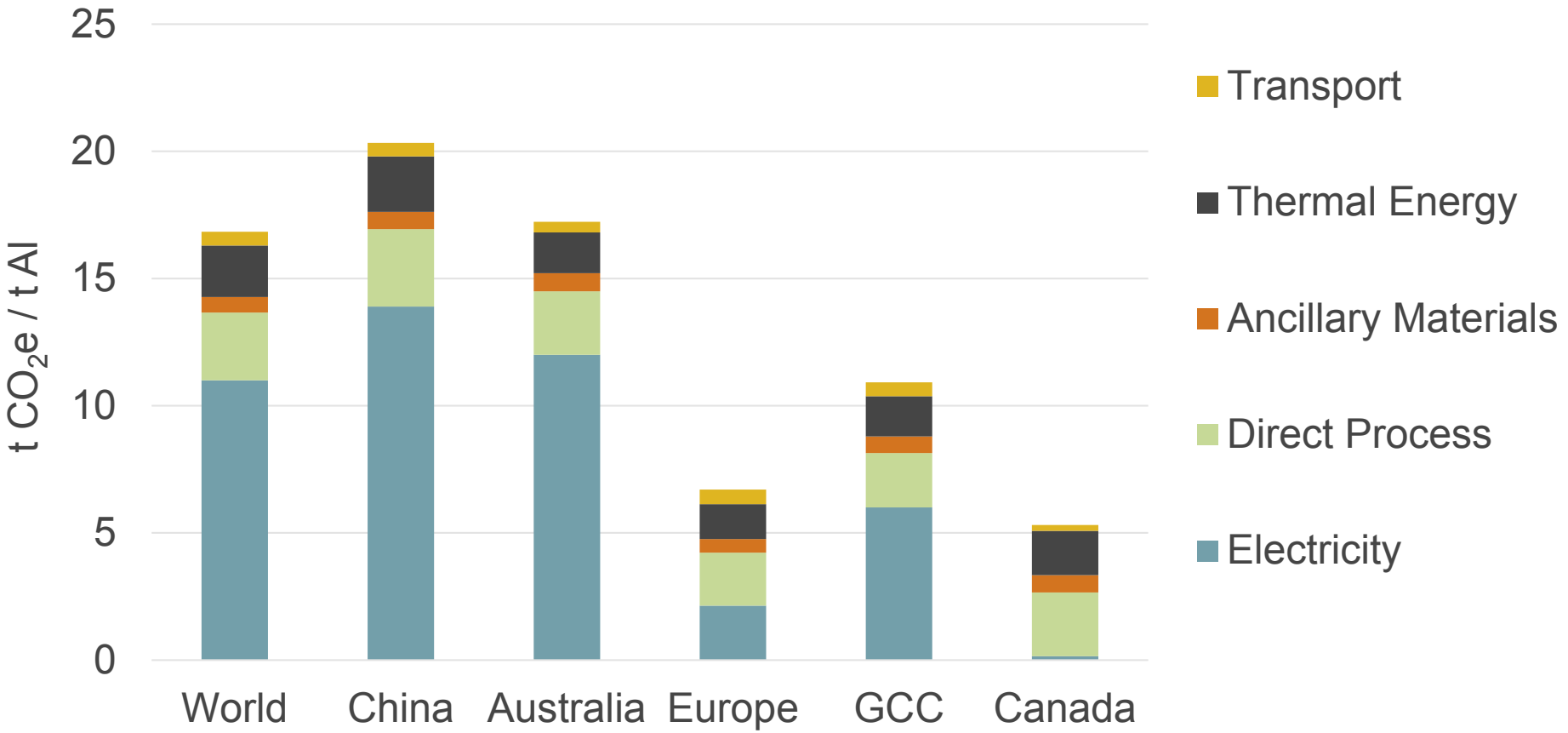
Carbon footprint

primary aluminium cradle-to-gate



Source: IAI, GaBi

IAI Member Company Low CO_2 Market Offerings

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RenewAl™ Low CO_2 Aluminium

Allow

asi Aluminium Stewardship Initiative

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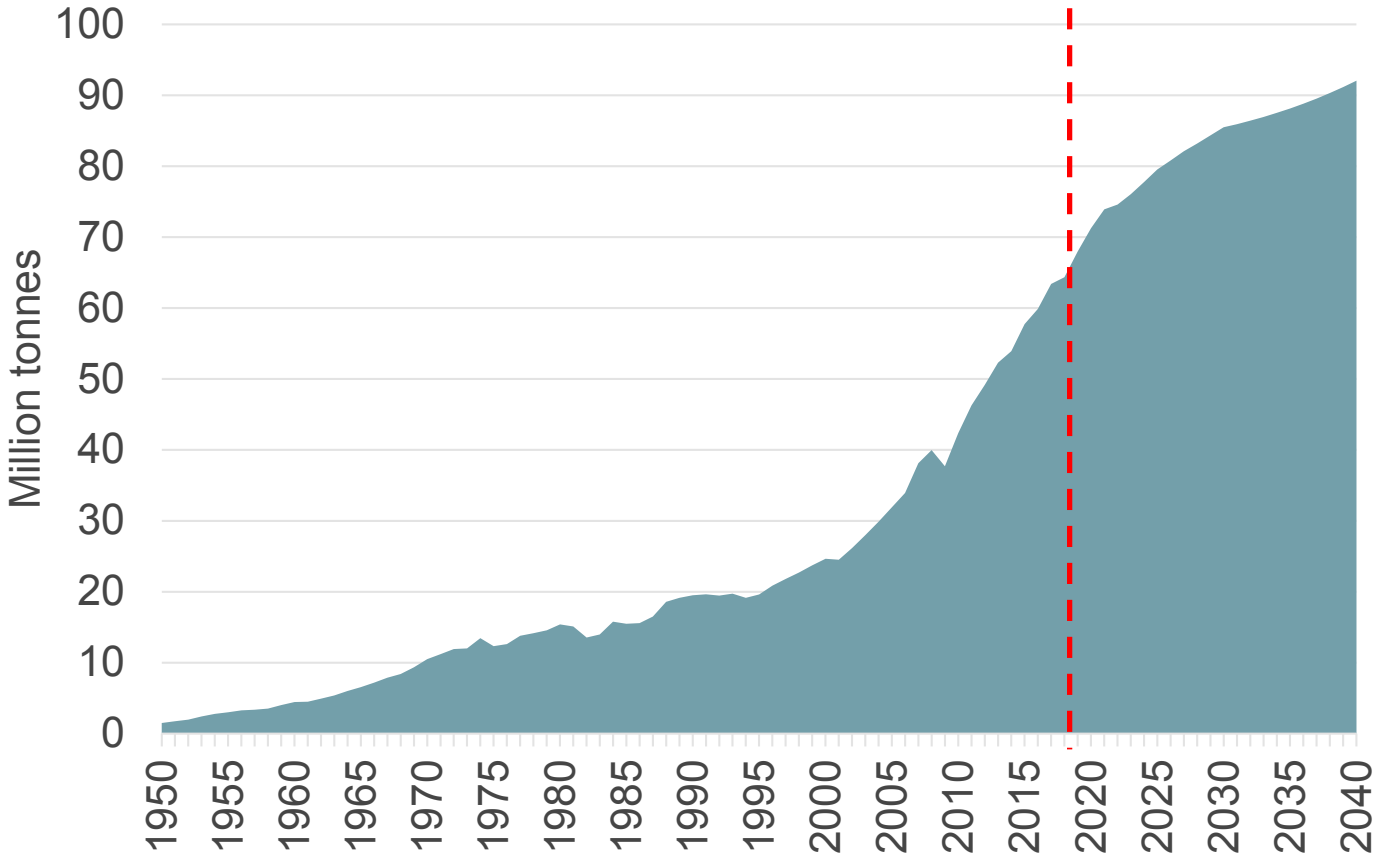
Primary production

2040 scenario



Source: IAI

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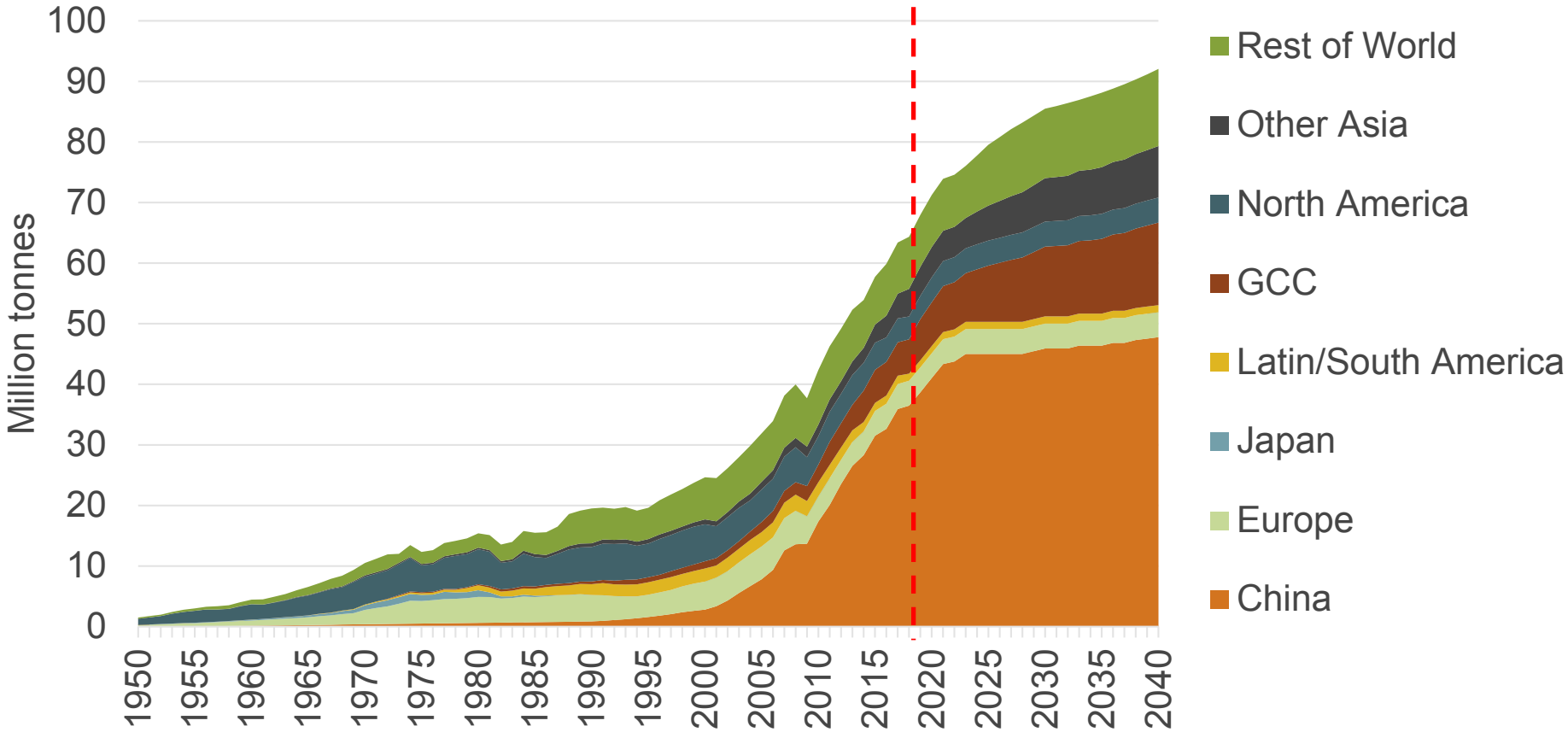
Primary production

2040 scenario



Source: IAI

Source: IAI, GaBi

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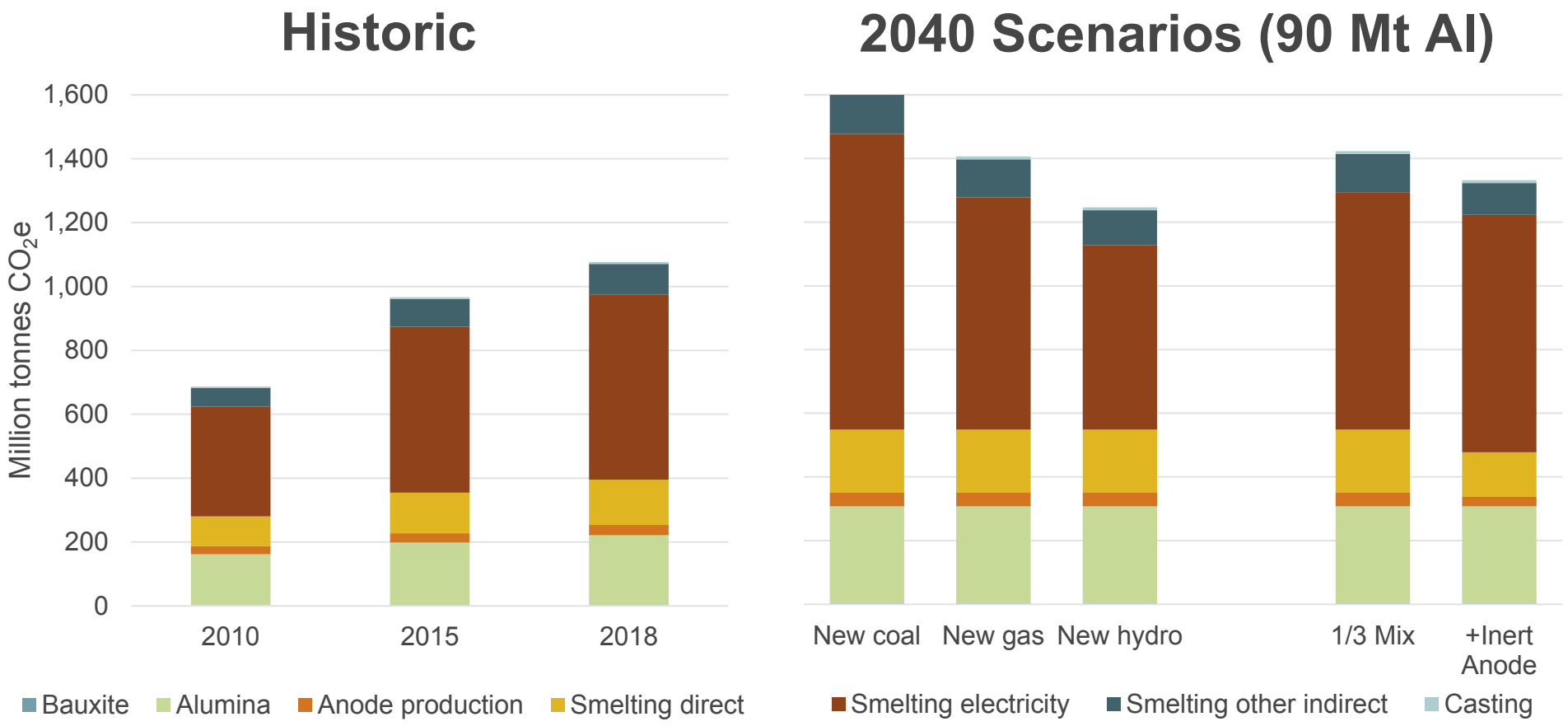
Total GHG emissions



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CONCLUSIONS

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2040 baseline scenario

- 50% increase in semis demand from today;
- Increased recycling rates only offer limited potential, due to long life of products;
- Scrap quality also an issue;
- Primary aluminium will continue to meet the bulk of metal demand, at least until mid-century;
- 90 Mt primary required (65 Mt today).

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Increasing risks

- Raw materials supply and waste management;
- Significant range of greenhouse gas emissions, primarily a function of power mix;
- Location of new smelting capacity uncertain, but likely fossil fuelled power;
- Some companies are already marketing “low impact” aluminium in response to customer demands.

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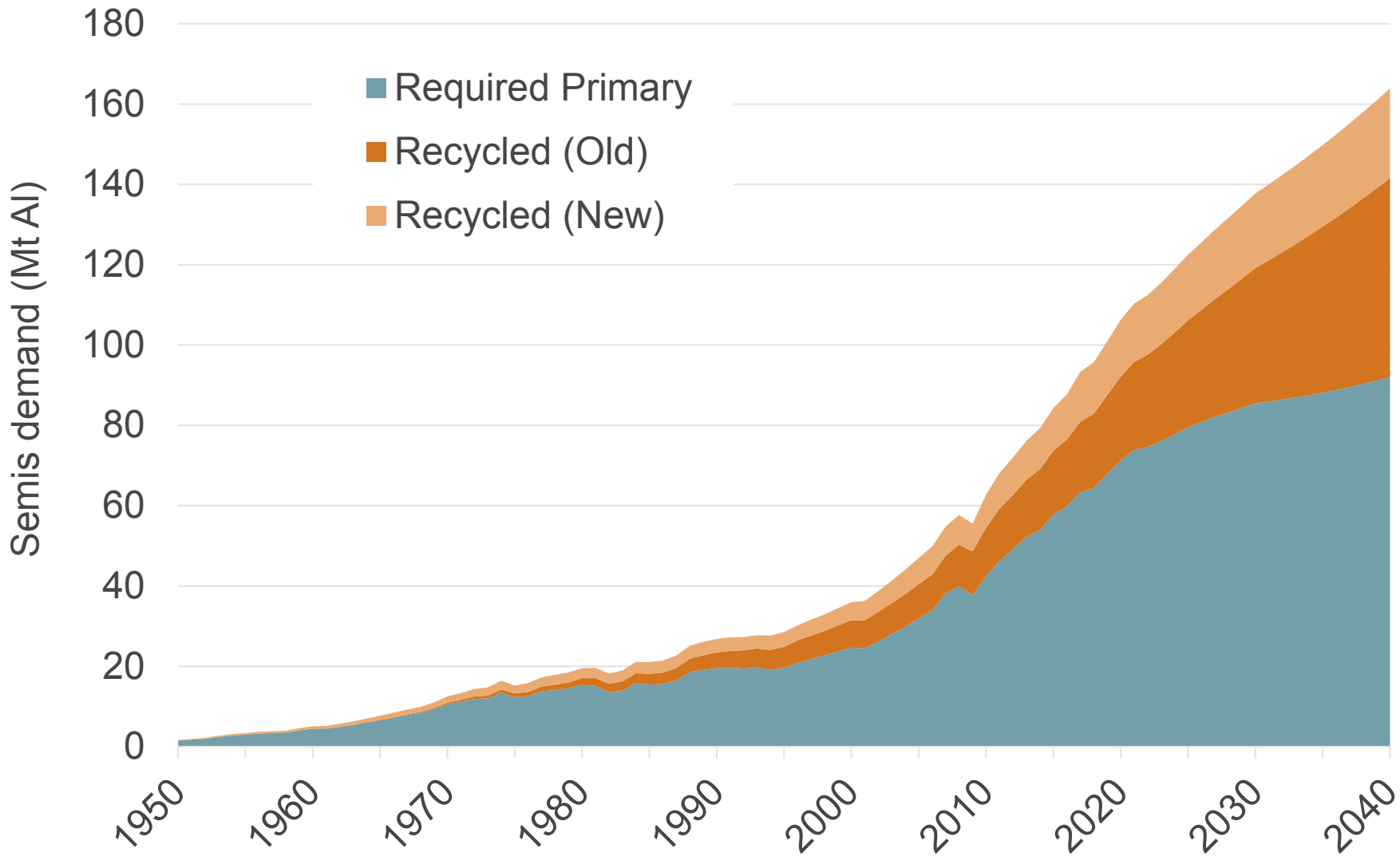

Source: IAI

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