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# 2009 3-Year Business Plan

**New Long-term Vision-oriented Growth Strategy Based on Realigned Business Structure** 

February 2010



#### SUMITOMO METAL MINING CO., LTD.

Nobumasa Kemori

President and Representative Director

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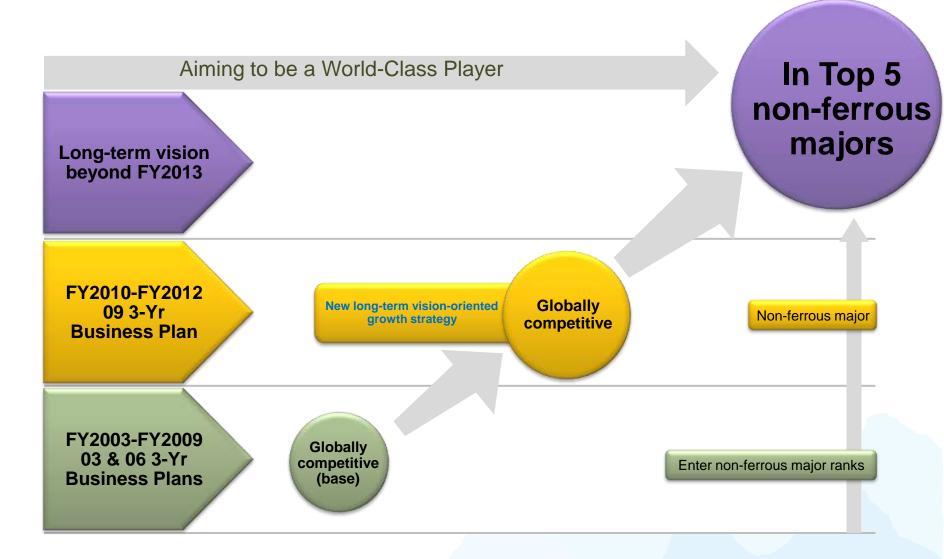
**IV. Financial Strategy & Platform Reinforcement** 

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# I. Long-term Vision (LTV) & 09 3-Yr Business Plan



Hishikari mining engineers



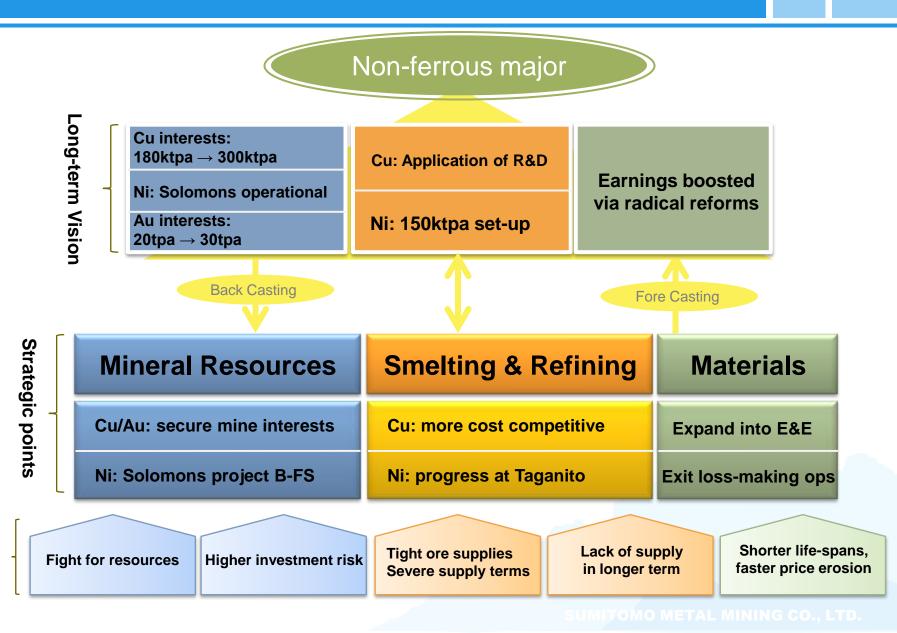
LTV & 09 3-Yr Business Plan

## 2) Basic strategy



## 3) 09 3-Yr Business Plan outline

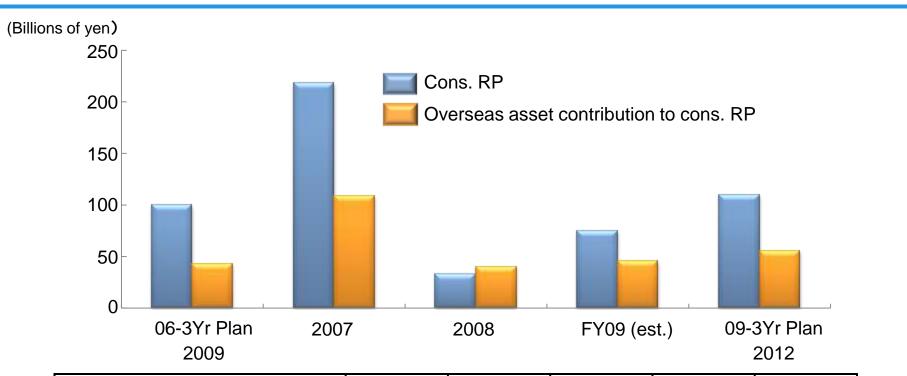
Op. env.



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# 4) Recurring profit (RP)

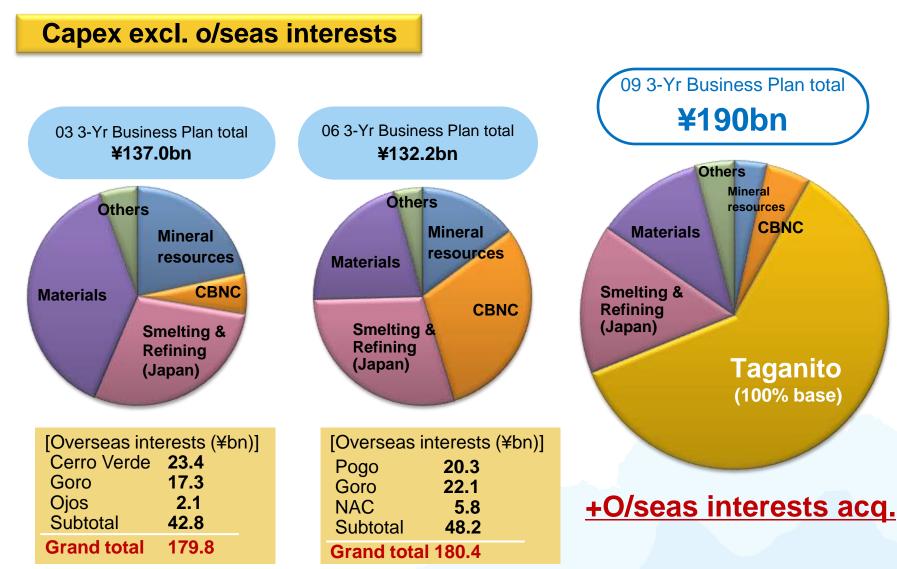
#### - Greater overseas asset contribution -



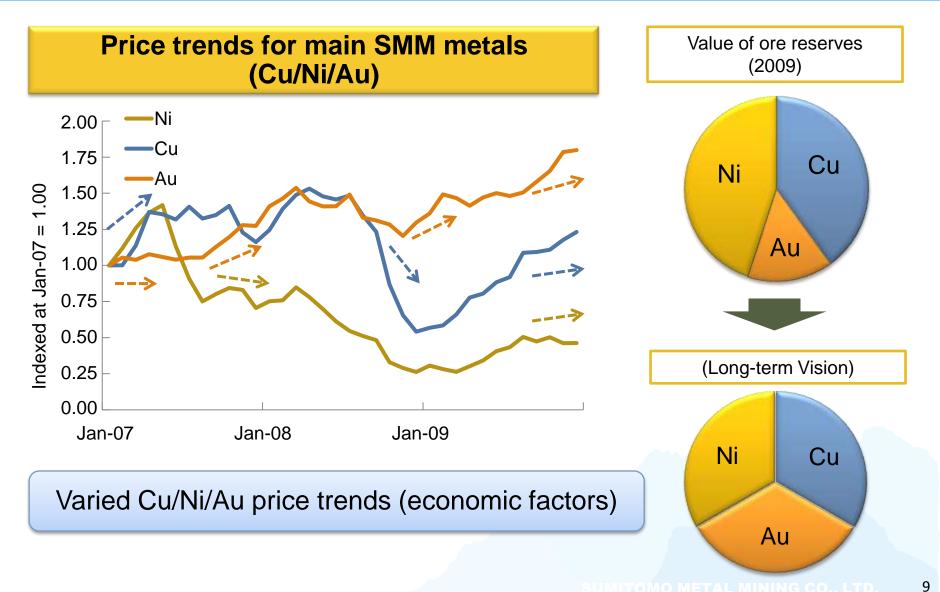
(Billions of yen)	06 3-Yr Plan FY2009	2007	2008	FY09 (est.)	09 3-Yr Plan FY2012
Cons. RP	100.0	217.9	32.6	75.0	110.0
Overseas asset contribution to cons. RP	42.6	108.2	40.2	45.2	55.0
Cu price (\$/T)	4,000	7,584	5,864	6,043	6,000
Ni price (\$/lb)	7.0	15.5	7.5	7.3	8.0
Au price (\$/Toz)	550	766	867	1,021	1,000
Forex (¥/\$)	110.0	114.3	100.5	91.9	90.0

### 5) Capex – Focus resources/aggressive capex –

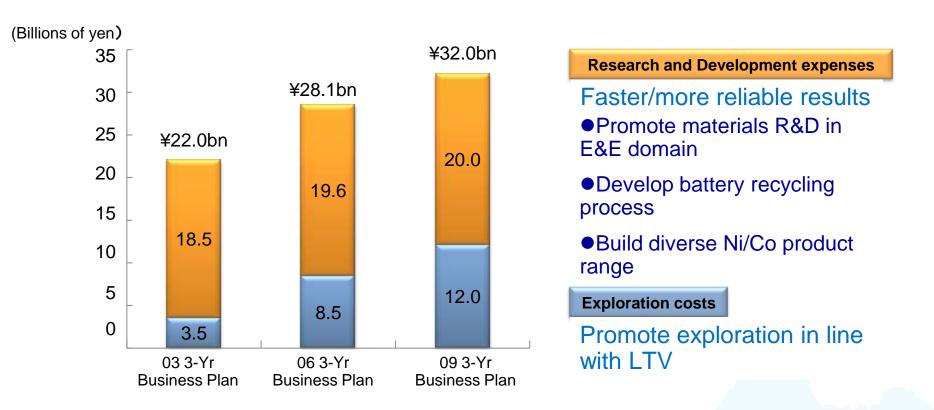




### 6) Metals portfolio (Cu/Ni/Au) - Earnings stabilization -

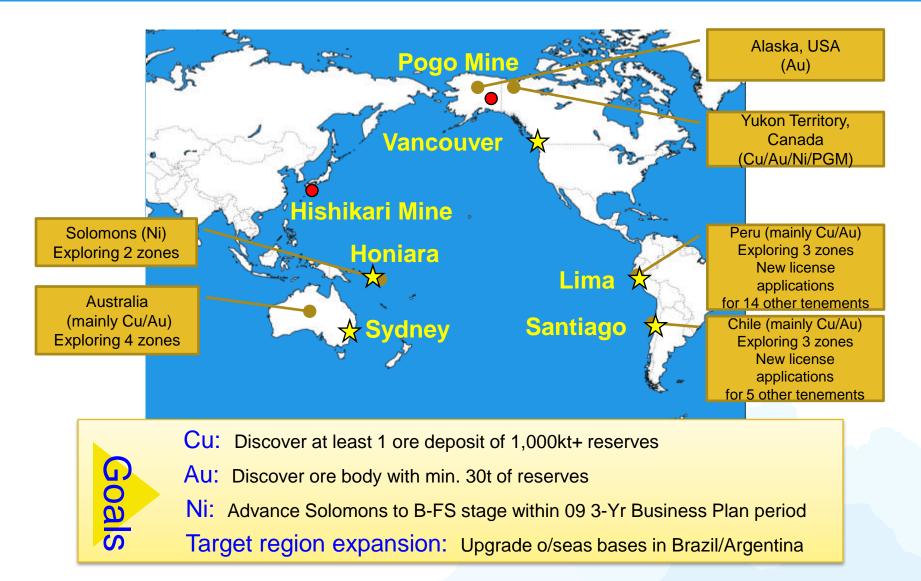


#### 7) Exploration/R&D costs – Proactive stance –



#### Accelerate; budget more if promising

## 8) Overseas mine development







#### (1) E&E-related materials development

#### Until FY2012

[Battery anodes] [Pastes/substitution of sintered magnets] [High-performance coated substrates] Until FY2015

[Solar cell materials] [LED materials] [High-capacity battery materials]

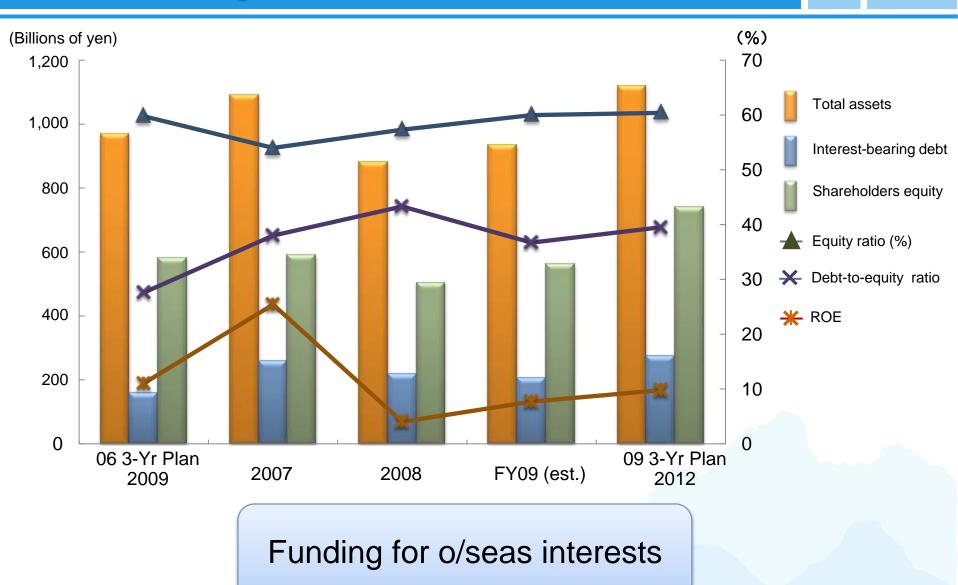
#### (2) Inter-divisional core research

Battery recycling project New ore dressing technology research

#### (3) R&D targeting elevation to Ni major status

Development of new Ni/Co products (powders, briquettes) Maximizing utilization of low-grade Ni oxide ores

#### 10) Financial indicators – Maintaining solid finances –

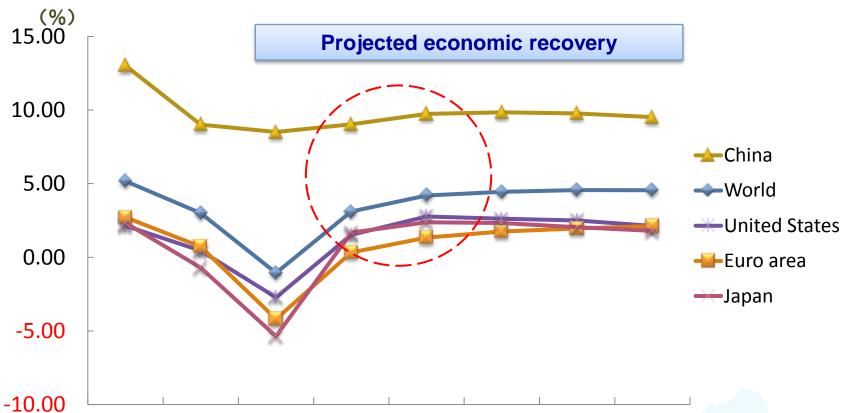


# **II. An Altered Business Environment**



#### **Coral Bay Nickel**

# 1) Global GDP growth comparison



2007

2008 2009E 2010E 201

2011E 2012E 2013E 2014E

(Source: IMF)

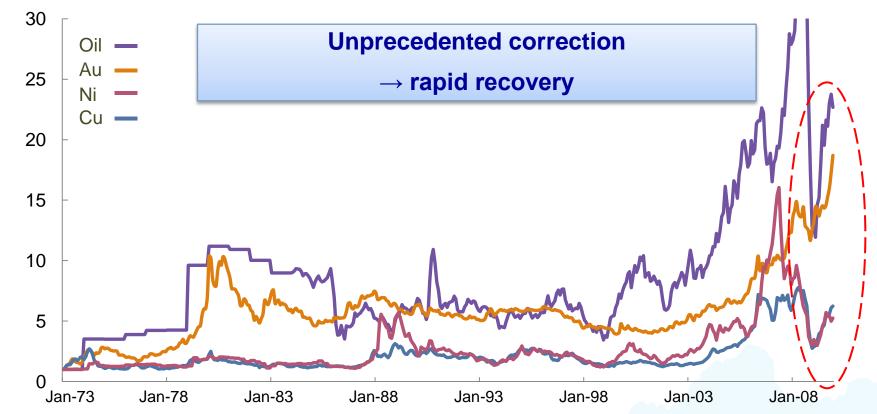
Country Group Name	2007	2008	2009E	2010E	2011E	2012E	2013E	2014E
World	5.17	3.00	-1.06	3.10	4.19	4.44	4.56	4.54
Euro area	2.72	0.72	-4.19	0.33	1.34	1.75	1.96	2.12
China	13.01	9.01	8.50	9.03	9.73	9.84	9.77	9.51
Japan	2.34	-0.71	-5.37	1.68	2.38	2.32	2.04	1.79
United States	2.14	0.44	-2.73	1.52	2.77	2.62	2.49	2.13

An Altered Business Environment

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## 2) Prices of metals and crude oil

Indexed at Jan-73 = 1.00



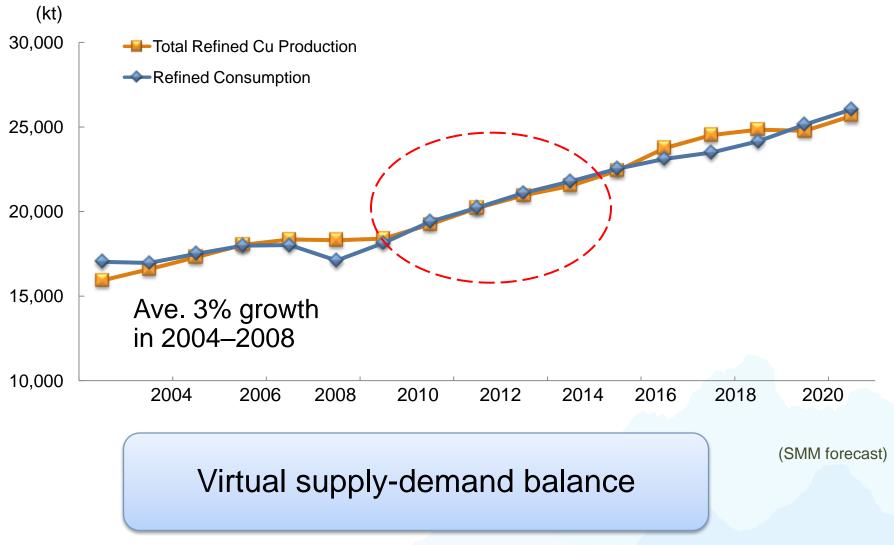
(Source: SMM)

**An Altered** 

Business Environment

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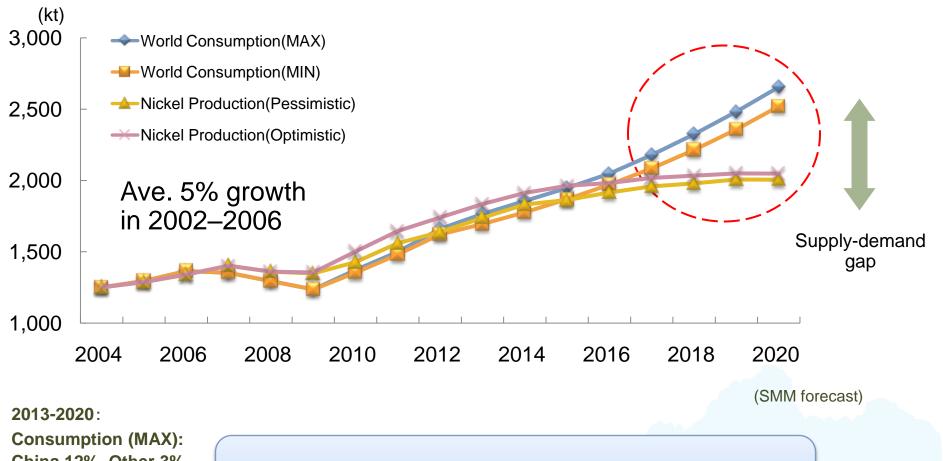
# 3) Long-term forecast (electrolytic Cu)



**An Altered** 

Business Environment

# 4) Long-term forecast (Ni)



China 12%, Other 3% Consumption (MIN): China 7.5%, Other 0.5%

# Future rise in supply uncertainty

**An Altered** 

Business Environment

# **III. Core Business Growth Strategy**

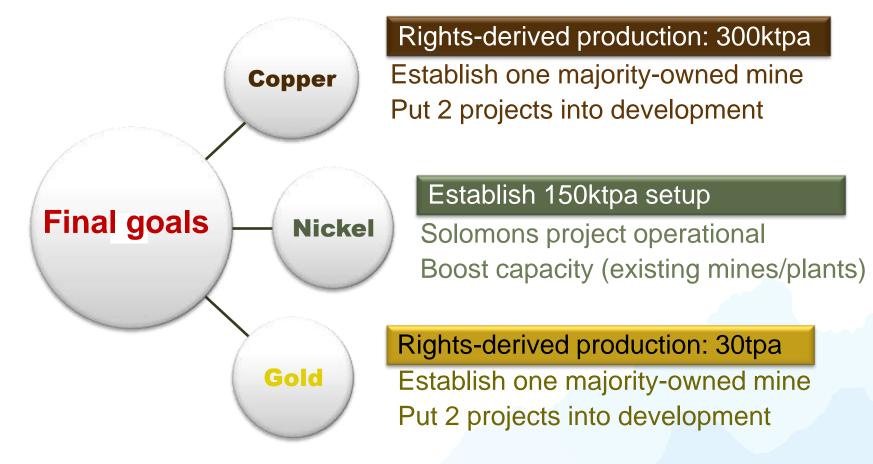


Pogo mine

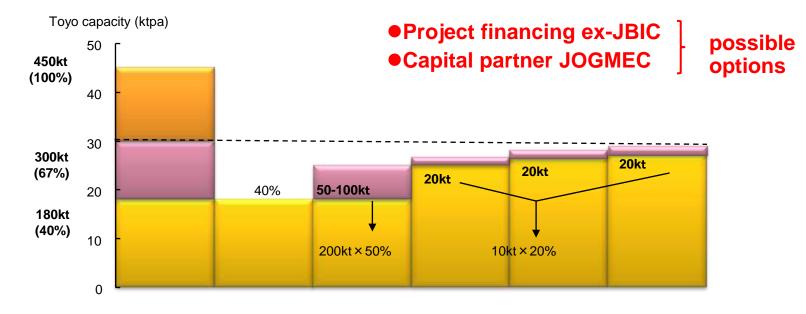
### 1) Mineral resources business [1] Long-term vision goals

Core Business Growth Strategy

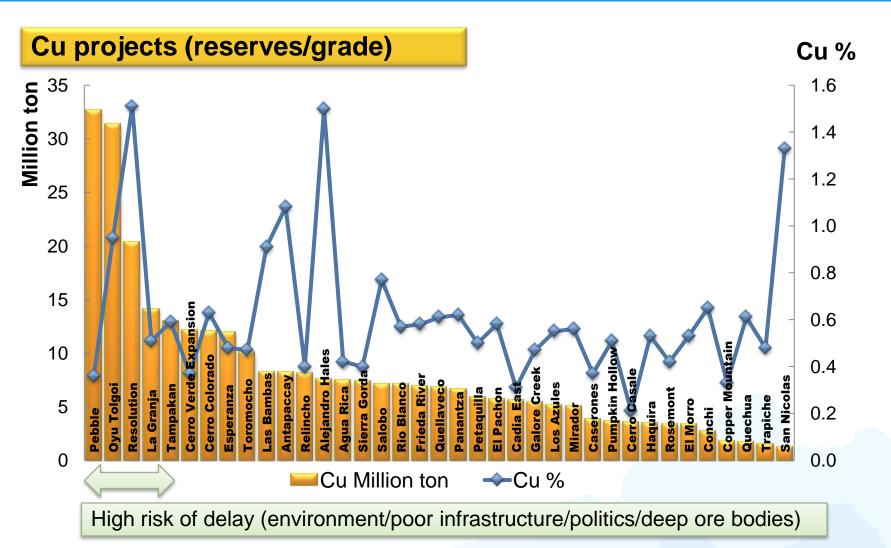
LTV-oriented long-term strategy starts with 09 3-Yr Business Plan



# 1) Mineral resources business [2] Cu: Overseas mine development Raising proprietary ore ratio to 67%



1) Develop in-house	2) External project partnering	3) Boost existing output		
From exploration	(a) JV partner retains interest	Cooperation with JV		
to development	(b) Junior partner	partner essential		
Majority interest:	Minority interest (20-49%):	Equity-stake interest:		
Keep know-how	Keep know-how	Keep know-how		
Low price	Medium/high price	Low price		
High risk	Medium/high risk	Low risk		
Long-term	Short/medium-term	Short-term		



(Source: Metals Economics Group)

Core Business

Growth

Strategy

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# Mineral resources business Ni: Solomons development

#### Core Business Growth Strategy



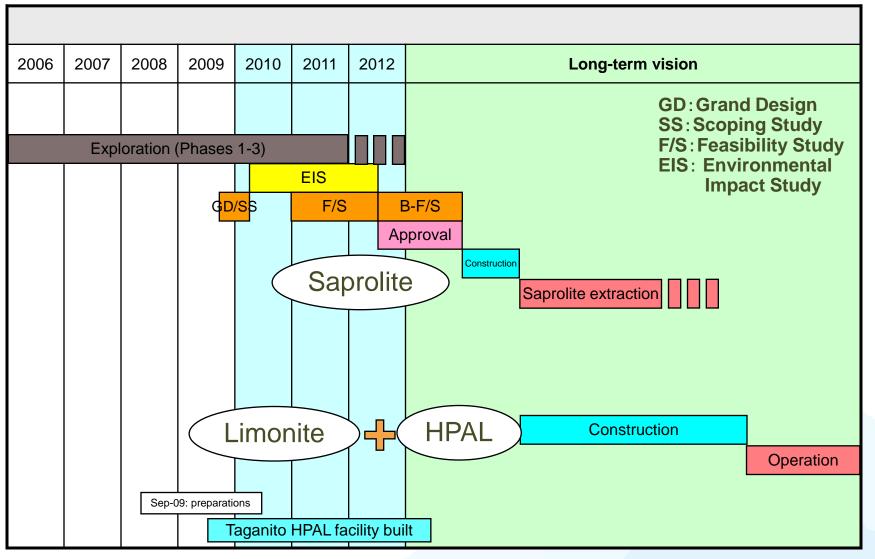
#### **Solomon Islands**

 Area: ~30,000km<sup>2</sup> (2x Iwate Prefecture)
 Population: ~470,000 Six main islands in 1,000+ archipelago







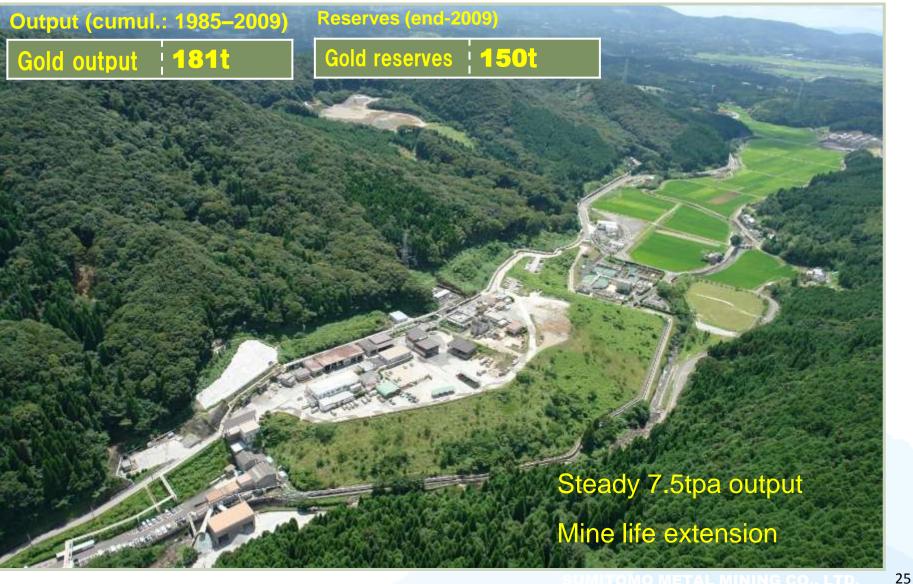


Core Business Growth

### 1) Mineral resources business [4] Au: Hishikari mine

**Core Business** Growth Strategy

П



#### 1) Mineral resources business [4] Au: Pogo mine

Securing new ore via local exploration

Reserves (end-2008): 118t

Colville BROOKS RANGE Kobuk Koyv<sup>ikuk</sup> A L A S K A

Core Business Growth

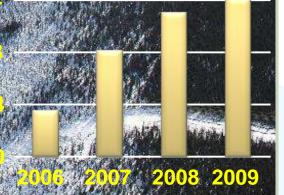
Strategy

2009: approx. 35t\* discovered → extended mine life

\* Reserves: 10t (extractable), potentially 25 on economic viability evaluation (further exploration)

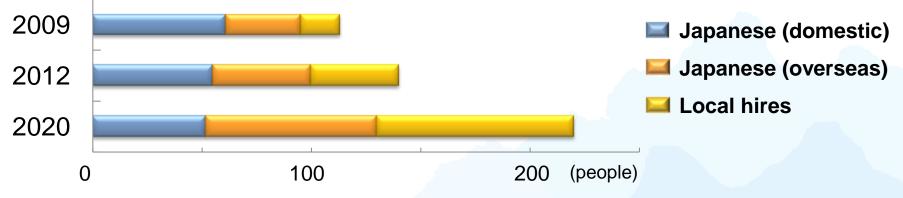


Gold output



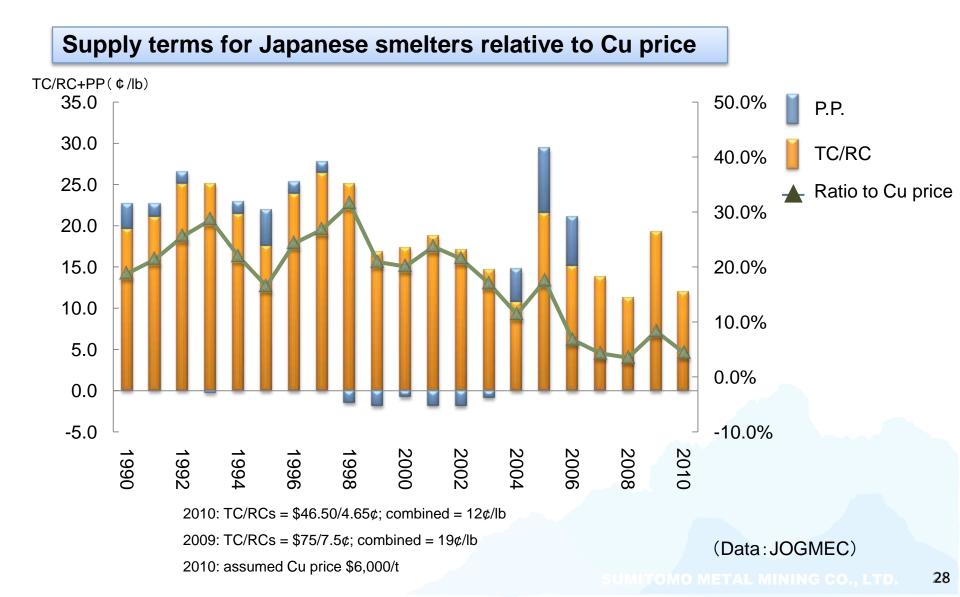
A. Utilization of SMM-operated mines (Hishikari/Pogo) B. Sharp growth in engineers/specialist hires (Japan/local) Mining at Join Hishikari Assignment to Hishikari Pogo or Engineering Dept. SMM overseas mine o/seas site Year 3–4 Year 4–6 Years 5/6-10 Year 10 onward

Nos. of engineers/specialists



Core Business Growth

#### 2) Smelting & Refining business [1] Cu (1) Issues in smelting & refining operations



Core Business Growth

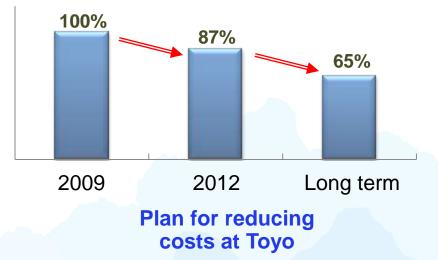
#### 1. More cost competitive (higher productivity)

Rank		Furnace/s	Capa (kt)	Estimated '09 output	
1	Guixi	2	770	765	
2	Onsan	2	525	515	
3	Hamburg East	2	425	405	
4	Тоуо	1	450	401	
5	Saganoseki	1	470	400	

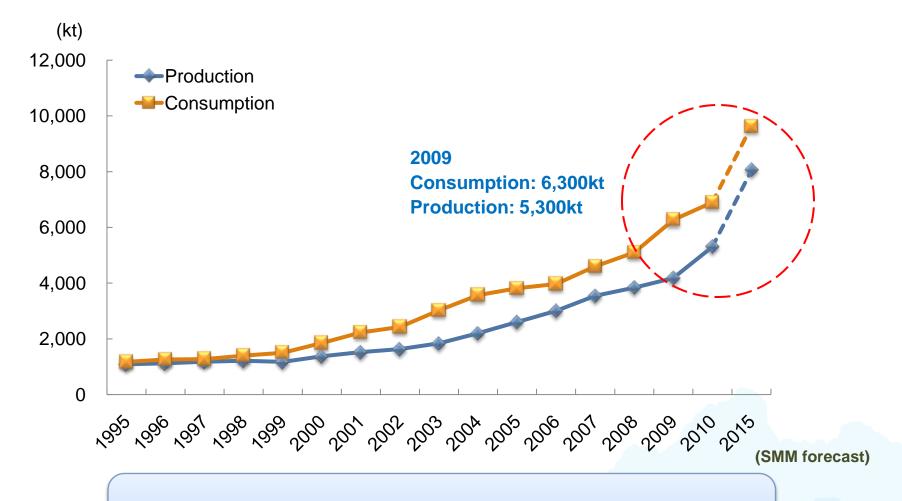
⇒ Minimum cost operation

Core Business Growth

- 2. Technical development
- [1] Ore burner, cont. converter furnace
- [2] Dressing (boost concentrate grade)
- 3. Expand earnings
- [1] Raise prod. margins (cut losses)
- [2] Improve sales premium



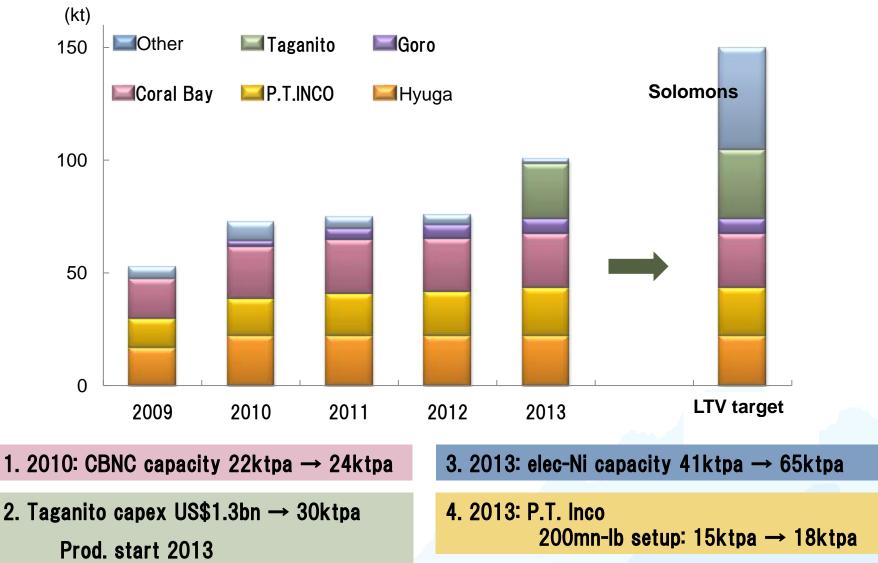
## 2) Smelting & Refining business [1] Cu (3) China projection (electrolytic Cu)



#### **Ongoing Chinese demand growth**

Core Business Growth

# 2) Smelting & Refining business[2] Ni (1) Toward a 150ktpa setup



Core Business Growth

Strategy

# 2) Smelting & Refining business[2] Ni (2) Join Top 5 non-ferrous majors



(Capacity)	End-2009	2013	Long-term vision
Electrolytic Ni	41	65	65
Ferronickel	22	22	22
Refined Ni products	6	10	10
Nickel oxide sinter (Goro)	0	7	7
New Ni products	-	-	50
Total	69	Over 100	Over 150

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Core Business Growth

# 2) Smelting & Refining business[2] Ni (3) New Ni projects

Core Business Growth Strategy

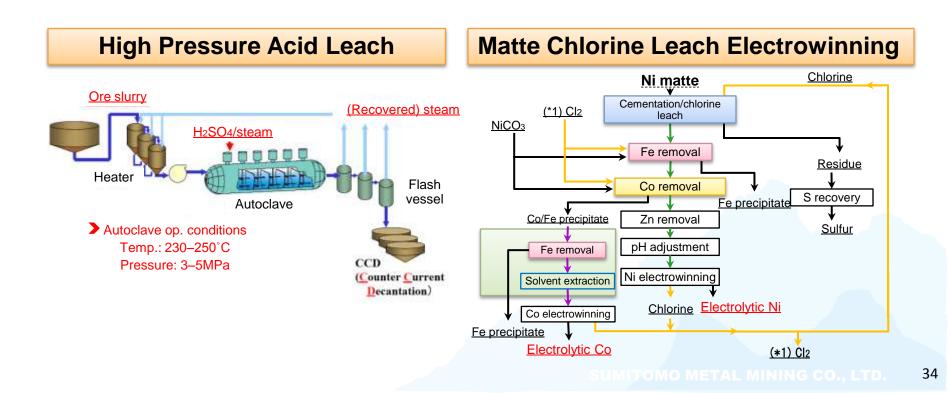


#### **Mainly HPAL-based projects**

Walling HPAL-based projects								(kt)		
Project	Coral Bay	Taganito	Goro	Gladstone	La Sampala	Ramu	Vermelho	Ambatovy	Weda Bey	Total
Company	SMM	SMM	Vale	Gladstone	Rio Tinto	Highland Pacific	Vale	Sherritt	Eramet	
Country	Philippines	Philippines	New Caledonia	Australia	Indonesia	P.New Guinea	Brazil	Madagascar	Indonesia	
Сара	22	30	60	64	46	33	46	60	60	421
Timing	2009	2012	2010	tbd	tbd	2010	Suspended	2010	2014	
Process		HPAL							AS	

# **Technical superiority**

"HPAL+MCLE" process enables the production of high-grade elec. Ni-Co from low-grade Ni oxide ores

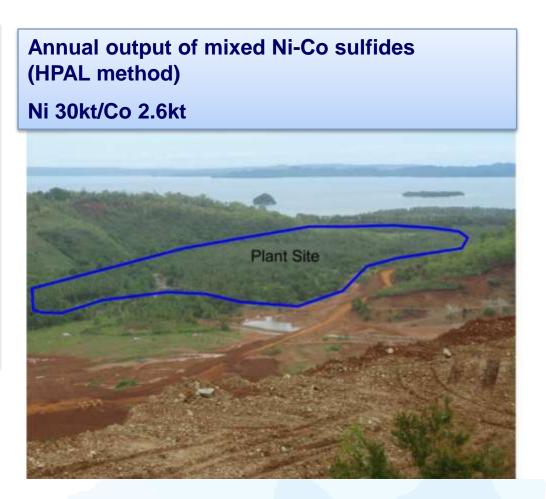


## 2) Smelting & Refining business [2] Ni (5) Taganito

Investment US\$1.3bn

- SMM to retain majority interest NAC investment expected
- Proj. operating life: 30 yrs

Schedule
 Sep. 2009: Project announced
 Mar. 2010: Construction start
 2013: Plant completion
 Pilot operations
 Commercial prod.

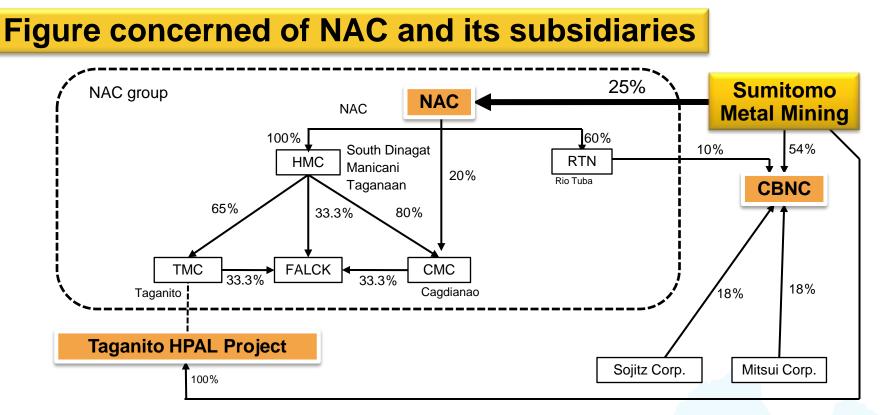


Core Business Growth

# 2) Smelting & Refining business[2] Ni (6) Coral Bay Nickel (CBNC)

Core Business Growth Strategy





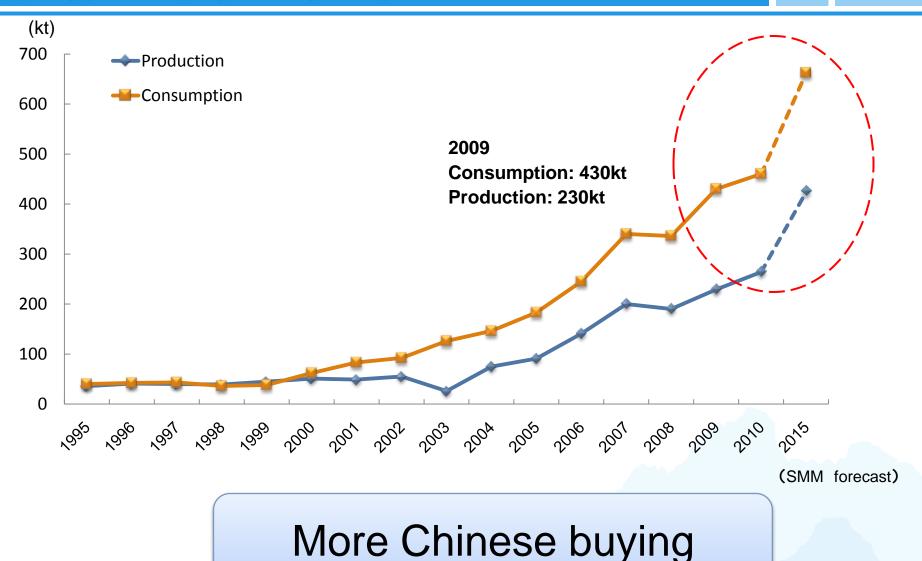
HMC: Hinatuan Mining Corporation RTN: Rio Tuba Nickel Mining Corporation TMC: Taganito Mining Corporation FALCK: Exploration company CMC: Cagdianao Mining Corporation CBNC: Coral Bay Nickel Corporation

Closer ties for Taganito projectExpand to Cu/Au mining

are affiliated companies of Sumitomo Metal Mining

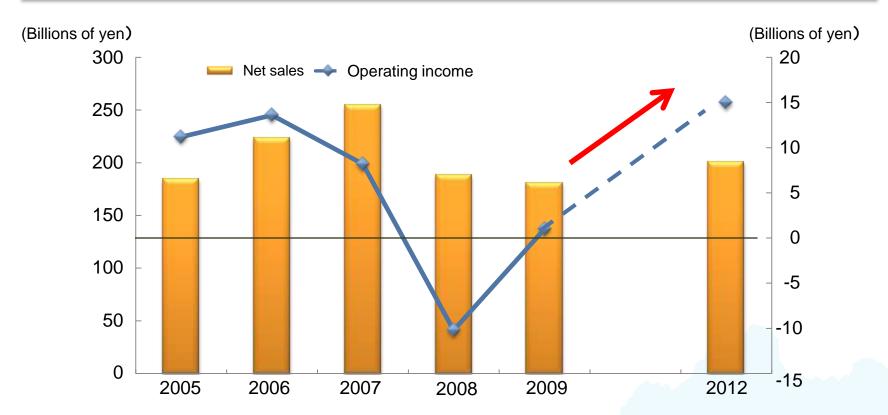
Core Business Growth

# 2) Smelting & Refining Business [2] Ni (8) China projection (nickel)

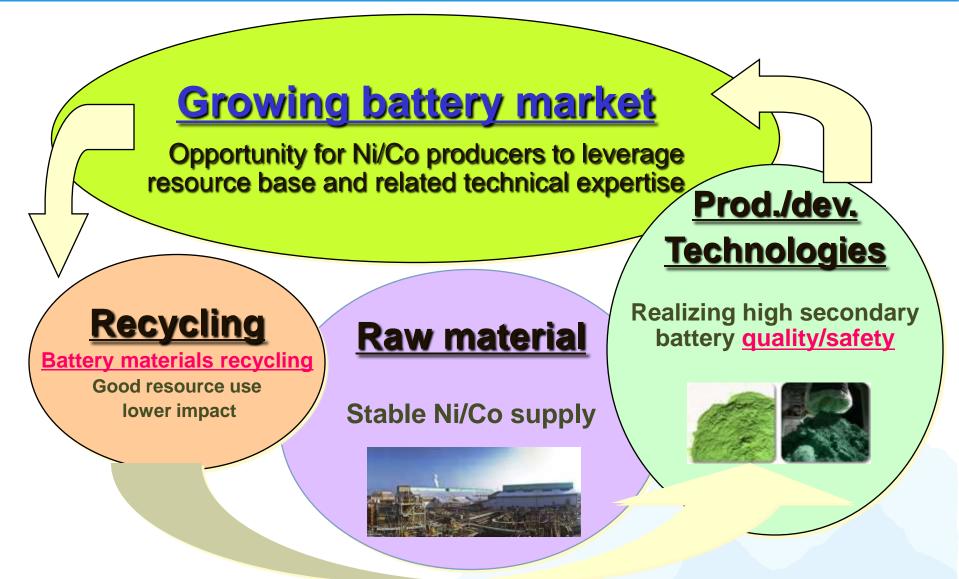


Core Business Growth

### Materials (Electronics/adv. Materials) business sales/operating income



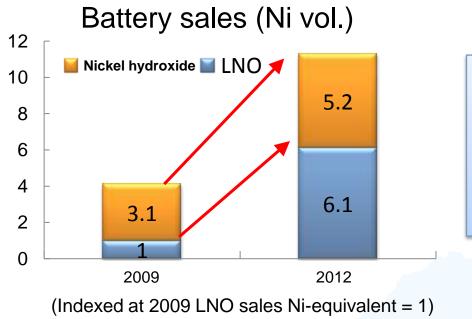
Advanced materials – E&E domain(1) Batteries: supply chain benefits



Core Business Growth



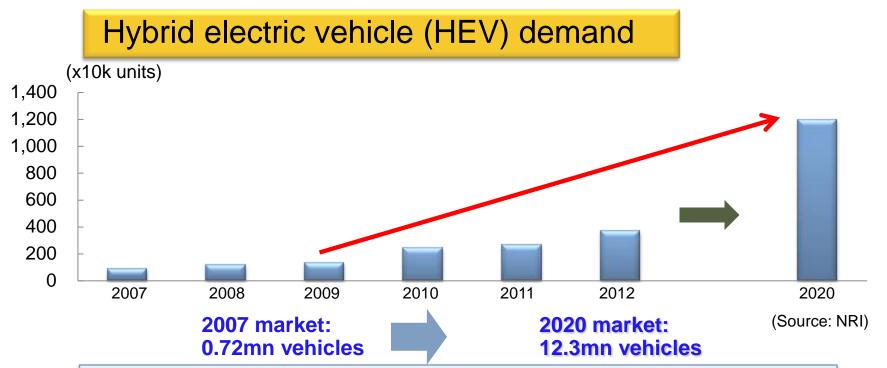
 Anode material for Li-ion consumer batteries: <u>lithium nickel oxide (LNO)</u> Top share in high-performance batteries Supplying Panasonic



Nickel hydroxide Lithium nickel oxide Major growth forecast for both

**Core Business** 

Growth



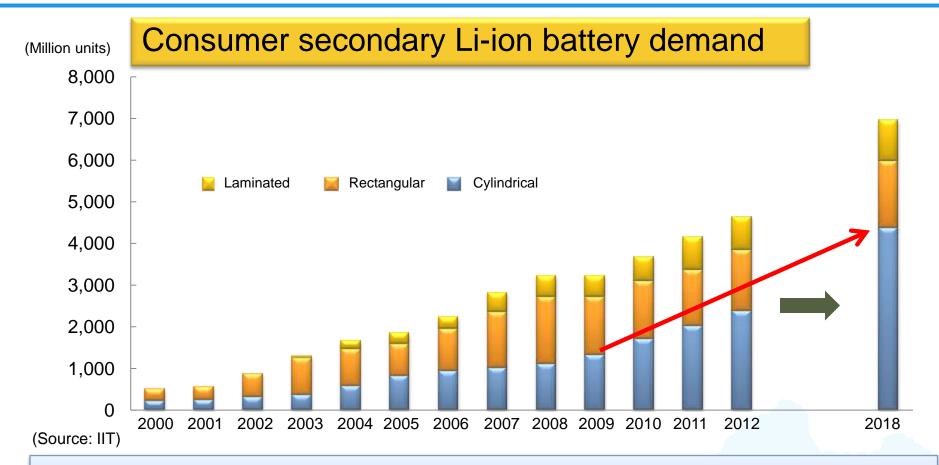
# SMM aims to keep dominant share of anode materials supplied to Toyota for HEV batteries

### Now: Nickel hydroxide

(Toyota HEV prod. capacity: 0.8mn (2009)  $\rightarrow$  1.1mn (2010)) Future: range of anode materials Core Business Growth

Advanced materials – E&E domain (1) Batteries: consumer applications

3) Materials business



### Major growth in (cylindrical) high-performance notebook PC batteries/E&E applications → Growing use of LNO as anode material

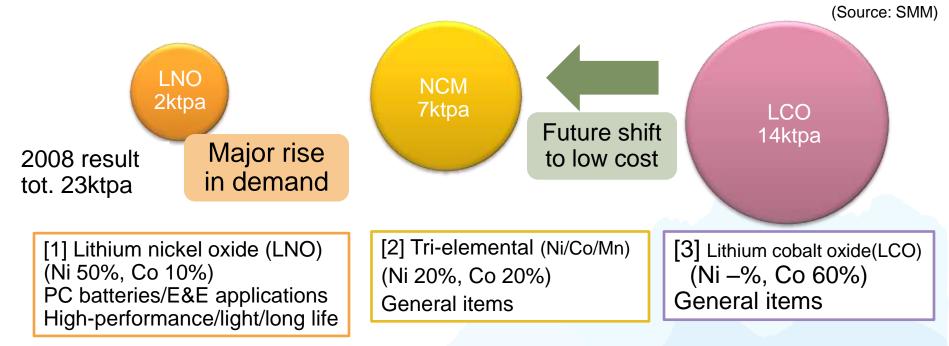
(Laminated) Multiple applications for batteries in thin sheet form (Rectangular) Mobile phone segment peak from 2010

Core Business Growth

Consumer Li-ion battery anode materials

# -Strategy

Higher LNO sales from rising output of Panasonic PC batteries/E&E items
 Execute shift from Co-type to tri-elemental



([1]–[3])

#### 3) Materials business Core Business Growth Advanced materials - E&E domain (2) Global LED market outlook Strategy (Billions of dollar) 15 Other Mean CAGR: 20% Lighting 10 Cars Displays Large-screen LCD F 5 backlighting Mobile handsets 0 2008 2009 2010 2011 2012 2013

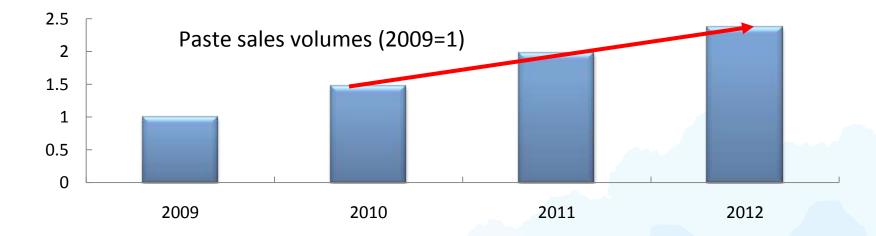
(Displaybank report, May 2009)

Sapphire substrates:

Targeting top share of large substrate market based on integrated large crystal fabrication/finishing processes

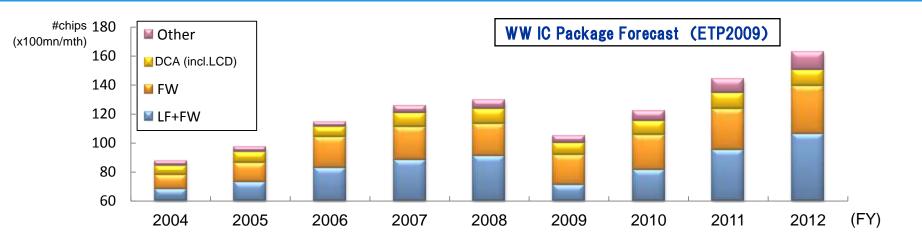


\* Shanghai Sumiko Electronic Paste Co., Ltd.



Core Business Growth

### 3) Materials business Semiconductor materials (1) Reinforce business base

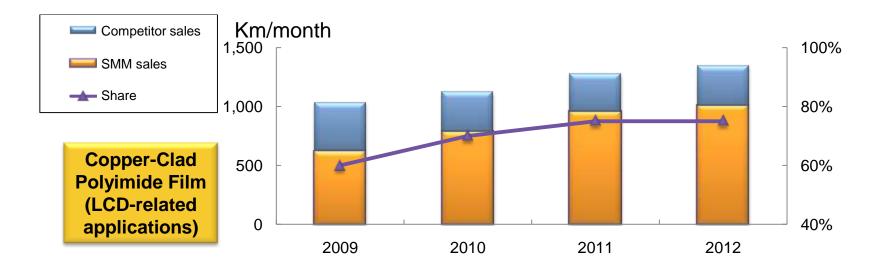


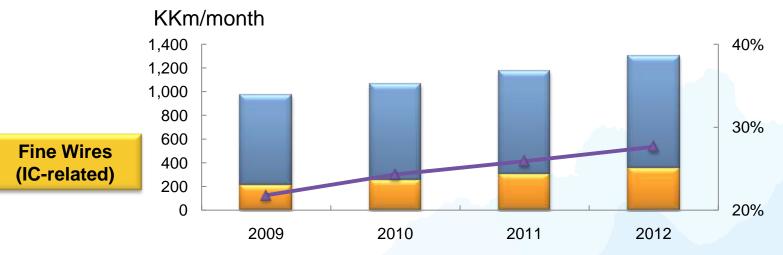
◆Build platform to be profitable under any conditions

Cost reductions across product range (targeted campaign)

Fine wire	Lead frames
Higher share from (1) better Au wire quality (2) Cu wire entry	Supply new lead frames for growth sectors
Copper-clad polyimide film	COF
Film insolubility: (1) world-class quality (2) higher share	Target global leadership within fine-line sector

Core Business Growth





**Core Business** 

Growth

"Target growth sectors offering operational synergies"
"Strategy:"

- Rebuild manufacturing capabilities (technology/facilities)
- Faster improvement in quality/cost competitiveness
- More highly skilled engineers

"Enter new, high-potential product sectors in peripheral areas"

< Restructure/exit businesses lacking growth potential > (1) Ajimu Electronics (IC package plating): to cease Dec-10 (announced Sep-09)

- (2) Shinko (CSP business): operations ceased Sep-09
- (3) Sumiko Tec: consolidation of production/distribution Shutdowns of Gotemba factory (Sep-09), Mie w/house (Oct-09)

Core Business Growth

# **IV. Financial Strategy & Platform Reinforcement**



**Exploration in the Solomons** 

### Maintaining sound finances

- Minimum equity ratio of 50%
- Low debt-equity ratio
- Invest to generate new growth
- Fund o/seas rights acquisitions and other projects (Utilize internal cash flow, project finance)

### Shareholder returns (dividend policy)

- Performance-linked shareholder returns
- Maintain consolidated dividend payout ratio of 20%+

### (1) Ongoing development of support systems

- 1. Entrench safety culture;
  - upgrade risk management/compliance approach
- 2. Environmental/social CSR activities for sustainable co-existence

(2) HR development/training/usage

- 1. Develop managerial corps (core operations)
- 2. Make operations more international
- 3. Establish/use HR development bases (Besshi/Kanto)

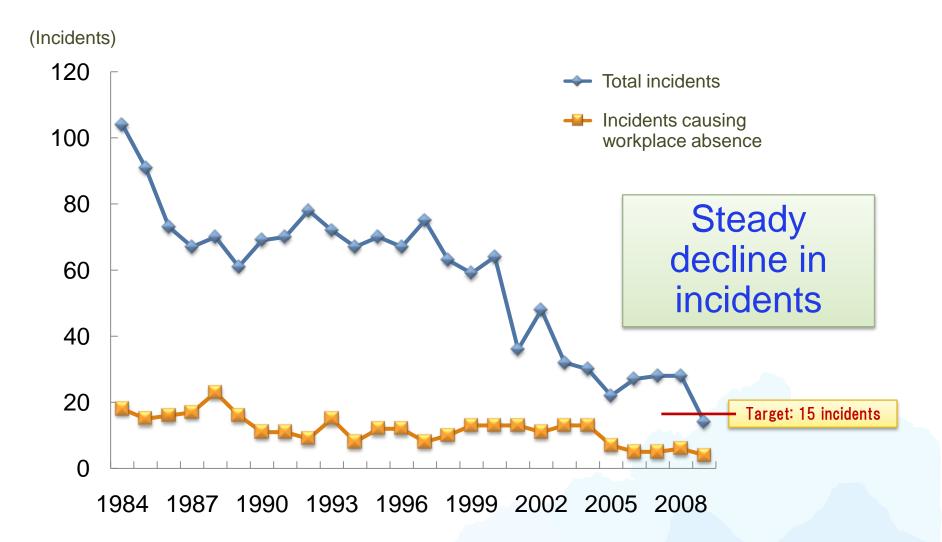
(3) Corporate governance, takeover defenses renewal

1. Pursue greater management transparency/efficiency

Build trust with shareholders and other stakeholders

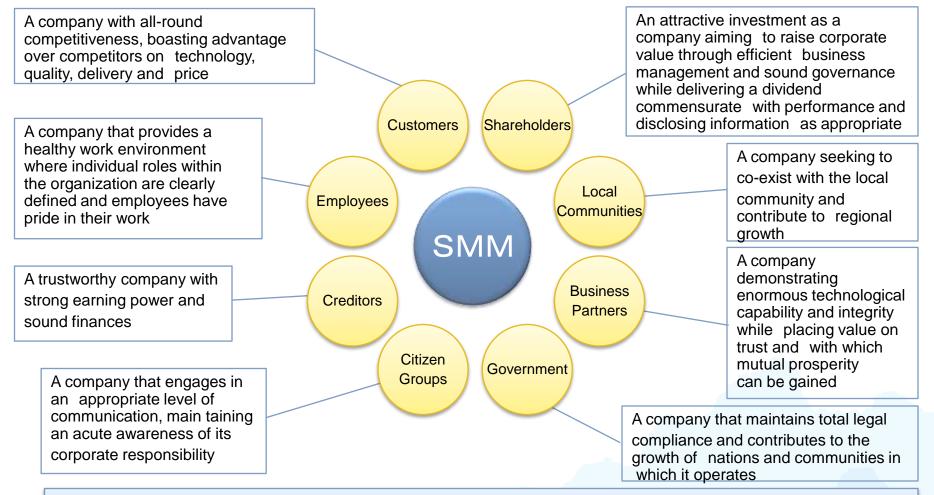
2. Defend shareholder interests from opportunistic acquisition

### 2) Further reinforce business base [1] Entrench safety culture



Financial Strategy &

### 2) Further reinforce business base [2] Each stakeholder category's ideal company



Socially responsible program delegated to line management

Financial Strategy &

Platform

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### 2) Further reinforce business base [3] Solid CSR activities (environmental/social)

Financial Strategy & Platform

# Outline of environmental preservation activities for realizing the CSR Vision for 2020

Key Area	Environmental Preservation Reducing CO2 emissions (energy savings); Biodiversity
Vision for 2020	<ul> <li>"A company that meets international anti- global warming standards by using advanced technologies"</li> <li>Zero waste emissions</li> <li>50% of new products with low environmental impact (e.g. fuel cells, solar cells)</li> </ul>
CSR Vision for 2020	<ul> <li>Reduce the unit energy consumption by 1% in each year to FY2012</li> <li>Zero landfill waste (FY2006: 145kt ⇒ FY2020: 18kt)</li> <li>Provide low cost materials which contribute to reducing environmental impact in products through the use of superior technology</li> <li>Suitable biodiversity preservation initiatives</li> <li>Materials stewardship initiatives</li> </ul>



Peru: surveying with cooperation of local groups



Ancient Roman heritage exhibition sponsor

Financial Strategy & Platform

### Niihama training facility set up to cultivate the next generation

### ▼ HR development center (Oji)

Hazard awareness/facility engineering





▲ HR development center (Hoshigoe) Besshi Sumitomo Club converted to training facility

## 2) Further reinforce business base [5] Takeover defenses – Renewal plus plan revisions –

### Financial Strategy & Platform

### **Operating environment**

- Resource oligopoly by super majors
- Fiercer competition amid government moves to secure resources (notably by China)
- SMM's unique qualities(world-class technologies such as HPAL, plus o/seas asset portfolio)

### Relevant external changes

- Related guidelines published by METI and Tokyo Stock Exchange
- Stricter policies on exercising voting rights by institutional investors worldwide (defenses design/governance setup)

Takeover defenses still essential (renewal at June 2010 s/holder AGM) Revise content to reflect investor opinion [5] Takeover defenses (renewal b/grd) M&A threat shifts from majors to China

(US\$9.2bn)



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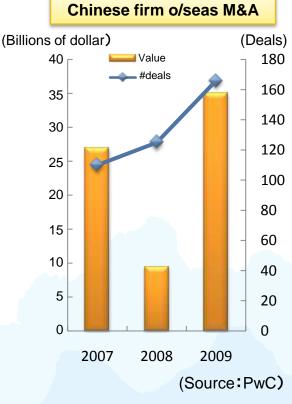
### (1) 2005–7: large M&A deals **Super majors emerge**

- (Cu) Mar-07: FreeportMcMoran buys Phelps Dodge (US\$25.9bn)
- (Ni) Jul-06: Xstrata acquires Falconbridge (US\$16.2bn)
  - Oct-06: Vale acquires Inco (US\$17.9bn)
- (Au) Nov-05: Barrick Gold buys Placer Dome



### (2) 2007–9: M&A deals ex-China

Vast foreign exchange reserves (\$2.4trn end-09) <u>Sep-07: China Investment Corp (CIC) created</u> (investment funds US\$200bn) Government-led drive to invest in blue-chip assets 1. 2007: Blackstone Group (US\$3bn) Morgan Stanley (US\$5bn) 2. Jul-09: Teck Resources (Canada, US\$1.5bn), 17.2% stake <u>Jul-09: "going global" strategy clarified</u> Go abroad to gain (1) resources (2) techs (3) markets More aggressive foreign investment 2008: Chinalco acquires interest in Rio Tinto (9% stake, valued at US\$14.1bn)





Proj. long-term recovery in resource demand/prices after '08 global recession Promotion of active investment to secure offshore energy and resources (Resource M&A funded by US\$2trn+ in foreign currency reserves)

- ♦ O/seas drive to secure assets/techs/markets
- Targeting high-risk regions such as Africa
- Investments in resource majors and JV projects



### SMM resource strategy: exploit technology

- Exploit mine development/project evaluation/refining technologies
- Target resource regions in Asia-Pacific Rim and South America
- Develop diverse strategy, incl. independent exploration/JVs

Financial Strategy &

Key points of revision

(1) Need to canvass shareholder opinion

No process to gauge shareholder views

→ Create mechanism for convening shareholder AGM

to consider "Independence Committee" (IC) recommendation and Board resolution

(2) Limits on periods to supply/evaluate data

No limit on data provision period  $\rightarrow$  max. 60 days

Evaluation period: Board max. 60 days + IC max. 60 days + unlimited extension

 $\rightarrow$  max. 120 days incl. extension

(3) Mitigation of damage from aborted takeover attempts

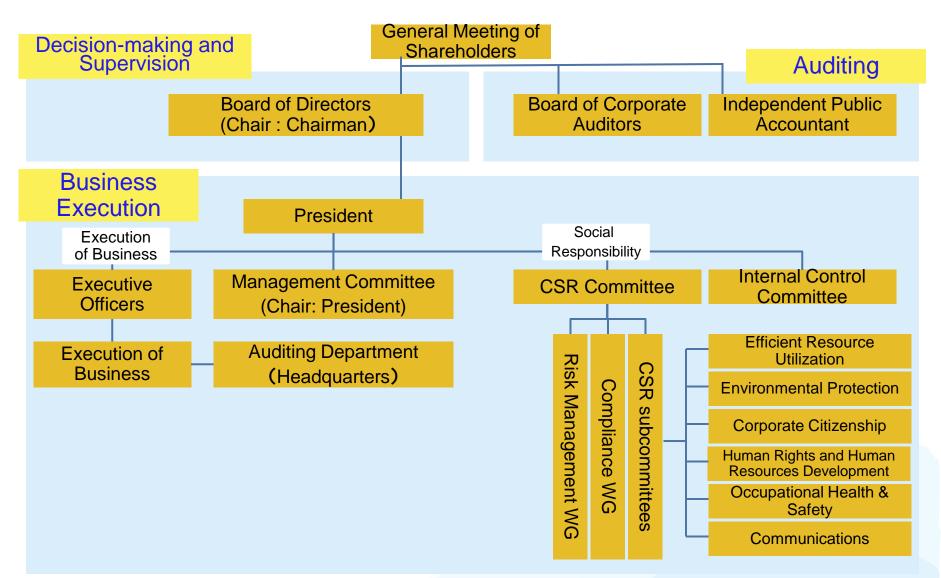
No process for related damage mitigation

→ Ability to exercise subscription warrants

if bidder's shareholding below certain level (on exit)

Financial Strategy &

# 2) Further reinforce business base [6] Corporate governance framework



Financial Strategy &

# V. Supplementary Materials



### **Exploration in Chile**

# 1) 09 3-Yr Business Plan [2012 cons. RP: ¥110bn]

				(Billions of yen)	
		09 3-Yr Plan 2012	FY2009(est.)	Change	
ę	Mineral Resources	30.0	30.0	0	
erat	Smelting & Refining	37.0	25.5	11.5	
ingi	Materials	15.0	1.0	14.0	
Operating income	Others	3.0	▲ 0.2	3.2	
me	Elimination or corporate	0	<b>▲</b> 1.3	1.3	
	Total	85.0	55.0	30.0	
R	ecurring Profit	110.0	75.0	35.0	
Pr	ofit before tax	110.0	70.0	40.0	Net Income
	Net Income	70.0	46.0	24.0	ROA: Total Assets
(Equ	uity Method Profit)	30.0	26.5	3.5	
Av	g. Total Assets	1,120.0	910.0	210.0	ROE: Net Income
	ROA	6%	5%	1%	S/holder equity
	ROE	10%	8%	2%	oquity
C	Copper (\$/T)	6,000	6,043	<b>▲</b> 43	
Ν	Nickel (\$/lb)	8.0	7.3	0.7	
	Gold (\$/Toz)	1,000	1,021	▲ 21	
	Zinc (\$/T)	2,000	1,937	63	
	Forex (¥/\$)	90.0	91.9	<b>▲</b> 1.9	

V

# 2) Balance sheet & cash flow projection

(Billions of ven)

### **Consolidated Balance Sheets**

	FY 2012 end	FY 2009 end	Change
Current Assets	510.0	400.0	110.0
Fixed Assets	640.0	540.0	100.0
Total Assets	1,150.0	940.0	210.0
Interest-bearing Debt	270.0	210.0	60.0
Other Liabilities	140.0	130.0	10.0
Total Liabilities	410.0	340.0	70.0
Total Net Assets	740.0	600.0	140.0
Total Liabilities & Net Assets	1,150.0	940.0	210.0
Equity Ratio	60%	60%	0%
D/E Ratio	40%	37%	3%
Avg. Total Assets	1,120.0	910.0	210.0

### **Consolidated Cash Flow (3 years)**

### (Billions of yen)

Profit before tax	280.0
Depreciation	110.0
Change in Working Capital	-30.0
Equity Method Profit/Loss	-80.0
Equity Method Dividends	60.0
Minority interests	10.0
Minor s/holder divid.	-10.0
Taxes	-110.0
Operating Cash Flow	230.0
Investments	-190.0
Profit Appropriation	-30.0
Net Cash Flow	10.0

(Billions of yen)

	2004	2005	2006	2007	2008	FY09 Estimates	06 3-Yr Plan ('09)	09 3-Yr Plan ('12)
Net Sales	484.6	625.6	966.8	1132.4	793.8		680.0	
Operating Income	47.9	82.8	162.6	155.4	10.5	55.0	76.0	85.0
Recurring Profit	54.5	99.7	205.3	217.9	32.6	75.0	100.0	110.0
Equity Method profit	13.5	21.9	46.7	74.0	31.5	26.5	31.0	30.0
Net Income	37.0	62.8	126.1	137.8	22.0	46.0	64.0	70.0
ROA(%)	6.8	9.3	14.8	13.6	2.2	5	7	6
ROE(%)	13.8	19.1	29.0	25.4	4.0	8	11	10
Dividend Per Share(¥)	8.0	14.0	27.0	30.0	13.0	17.0	N/A	N/A
Copper (\$/T)	3,000	4,097	6,970	7,584	5,864	6,043	4,000	6,000
Nickel (\$/lb)	6.3	6.6	14	15.5	7.5	7.3	7.0	8.0
Gold (\$/Toz)	414	477	629	766	867	1021	550	1,000
Zinc (\$/T)	1,110	1,614	3,579	2,986	1,560	1,937	2,250	2,000
Forex (¥/\$)	107.5	113.3	117.0	114.4	100.7	91.9	110.0	90.0

(Billions of yen)

	2004	2005	2006	2007	2008	FY09 Estimates	<b>06 3-Yr</b> Plan ('09)	<b>09 3-Yr</b> Plan ('12)
Mineral Resources	10.0	17.1	33.5	38.1	17.7	30.0	15.5	30.0
Smelting & Refining	27.7	49.7	109.6	108.8	2.4	25.5	37.0	37.0
Materials	7.3	11.2	13.6	8.2	-10.2	1.0	20.0	15.0
Others	3.6	6.4	6.2	3.7	0.6	-0.2	3.5	3.0
Inter-Segment Eliminations	-0.7	-1.6	-0.3	-3.4	0	-1.3	0	0
Total	47.9	82.8	162.6	155.4	10.5	55.0	76.0	85.0

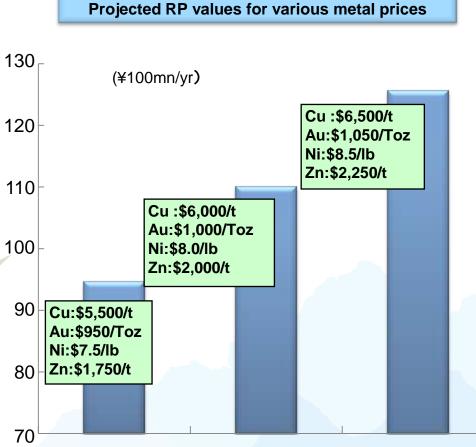
Supplementary Materials

# Impact on RP of metals prices and FX rate

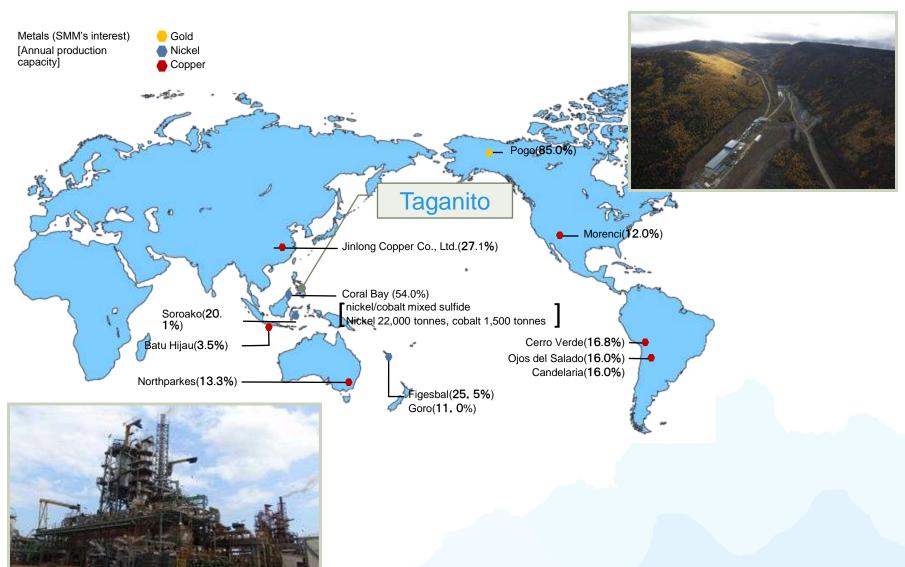
	Cons. RP impact
Cu price sensitivity -±\$100/t	¥1.0bn
Au price sensitivity -±\$10/Toz	¥0.5bn
Ni price -sensitivity ±10¢/lb	¥1.1bn
Zn price sensitivity -±\$100/t	¥0.6bn
Forex sensitivity ±¥1/\$	¥0.8bn

(Forex sensitivity only shows impact on metal refining margin)

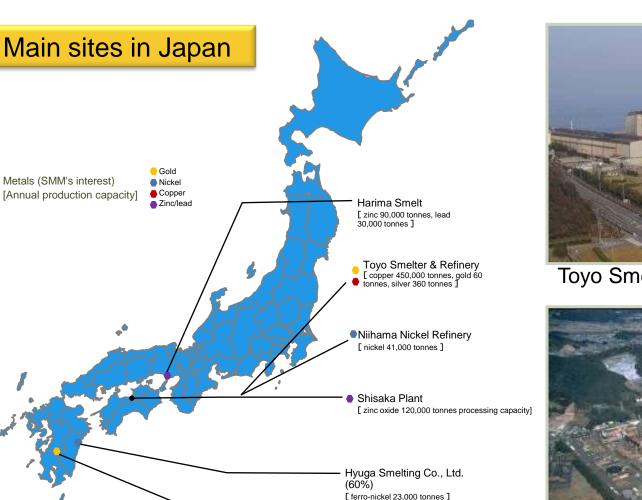
Cu price  $-\pm$ \$500/t Au price  $-\pm$ \$50/Toz Ni price  $\pm$ 50¢/lb Zn price  $-\pm$ \$250/t RP gain for specified fluctuation in given metal price



# 6) SMM's overseas mines



# 7) Domestic facilities



Hishikari Mine

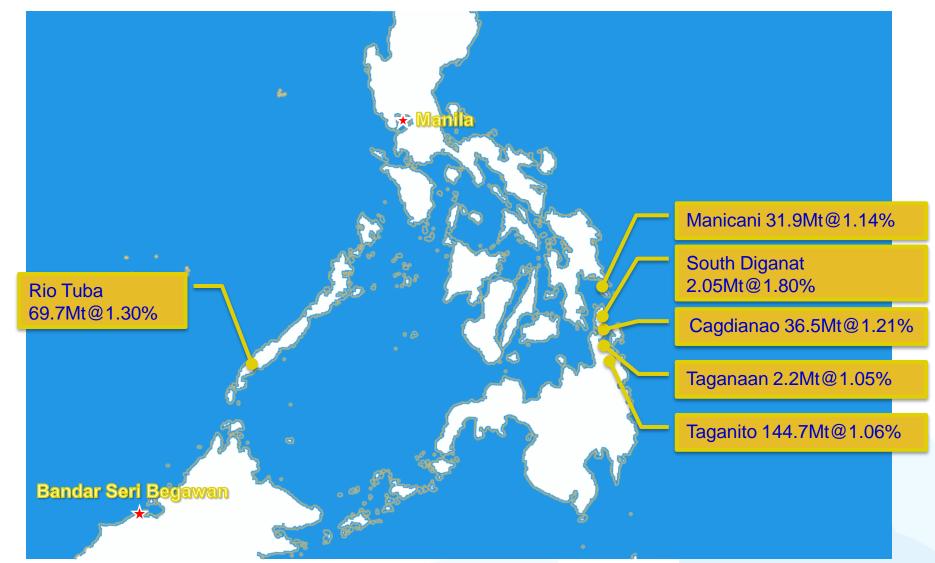


### Toyo Smelter & Refinery (Ehime)



Hyuga Smelting Co., Ltd. (Miyazaki)

# 8) NAC-owned nickel mines







#### Mineral resources and metals 1)Metal trading

#### London Metal Exchange (LME)

The LME specializes in trading of non-ferrous metals such as copper, nickel, aluminum, lead and zinc. The LME trading prices for metals are used as the international pricing benchmarks for sales of refined metal and purchases of refining ores.

#### TC/RC

Treatment Charge (TC) and Refining Charge (RC) are commonly used in the terms of purchase for copper concentrate or nickel ore for refining. They are amounts designed to cover refining costs. For example, copper concentrate contracts may define a purchase price based on the LME price at a certain date, minus the TC or RC being used at the time.

#### London fixing

Gold is not traded on the LME. Its price is determined for each transaction between market participants. The financial institutions in the London Bullion Market Association (LBMA) agree a standard price for gold based on these transactions and publish it on the morning and afternoon of each trading day. This "London fixing" price is the benchmark for trading in gold.

#### Pound (lb)

Part of the imperial system of measures, the pound is the standard unit of weight used in measuring and pricing base metals such as copper and nickel, and in TC/RC calculations. One pound is equal to 453.59 grams; an imperial ton equals 2,204.62lb.

#### Troy ounce (toz)

The troy ounce is the standard unit of weight for precious metals such as gold and silver. It equals approximately 31.1 grams. It is named after Troyes, a city in the Champagne region of central France that was the site of a major market in Europe in medieval times. Originally used as a unit of exchange for valuing goods in terms of gold or silver weights, the troy ounce is still used today in gold trading.

#### 2) Metal refining Smelting and refining

Refining processes extract valuable metals from ores or other raw materials. They fall into two basic types: hydrometallurgical (wet) and pyrometallurgical (dry). At SMM's Toyo facilities in Ehime Prefecture, the copper concentrate pre-processing undertaken at Saijo uses pyrometallurgical processes and the nickel refining at the Niihama site uses hydrometallurgical processes entirely. The term 'smelting' is used for the extraction of metal from ores using melting and heating (pyrometallurgy). The term 'refining' refers to any process that increases the grade or purity of a metal.

#### Pyrometallurgical refining

The precursor ore is melted at high temperature in a furnace, and refining techniques are applied to separate the metal in a molten state. Although large amounts of ore can be processed at one time, the equipment needs periodic maintenance for heat proofing.

#### Hydrometallurgical refining

The ore and impurities are dissolved in a solution, and chemical reactions are used to separate out the metal. This approach allows continuous and stable refining, but incurs additional costs due to the refining chemicals consumed.

#### 3) Metal ores

#### Sulfide ores

These ores contain copper, nickel or other metals chemically bonded to sulfur. Since the application of heat breaks these bonds, releasing the sulfur, such ores are generally refined using pyrometallurgical techniques.

#### Oxide ores

These ores contain metals in oxidized forms. Unlike sulfide ores, oxides need much more energy to achieve melting. For this reason, the hydrometallurgical approach is generally used to refine these ores.

#### Copper concentrates

Used as raw materials in copper smelting, copper concentrates have a copper content of about 30% by weight. The remainder consists mostly of sulfur and iron. Copper concentrates are made mostly from sulfide ores. Ores extracted from overseas mines have a typical grade of about 1%. The ores are then "dressed" at the mine to increase the purity and produce concentrate. Most of the copper ores imported by SMM for smelting in Japan are concentrates.

#### Nickel oxide ores

Whilst the higher-grade sulfide ores are used predominantly in nickel refining, nickel oxide ores are more prevalent than nickel sulfides. The sulfide-oxide ratio in current nickel reserves is believed to be about 3:7. High refining costs and technical issues have limited use of oxide ores in nickel refining to date, but SMM has succeeded in refining nickel from low-grade oxide ores based on HPAL technology.

#### Mixed sulfide (MS) ores

CBNC produces a mixed nickel-cobalt sulfide intermediate containing about 55–56% nickel by weight. This is used as a raw material in electrolytic nickel production.

#### Matte

A matte is another term for metal sulfides. For raw material, electrolytic nickel production at SMM also uses a nickel matte (of about 77–78% purity) sourced from PT Inco.

#### Proprietary ore ratio

This ratio is the proportion by volume of ore procured from overseas mining interests relative to the overall volume of smelting ores used as raw materials. Typically, off-take rights are proportional to the equity interest in a mine. In the case of Cerro Verde, SMM has secured 50% off-take rights for the first ten years of production from 2006, based on a 21% equity interest.



#### 4) Nickel production process Coral Bay Nickel Corporation (CBNC)

Based in the Philippines, this SMM subsidiary produces mixed nickel-cobalt sulfides using HPAL technology and exports the raw materials to the SMM Group's nickel refining facilities in Niihama, Ehime Prefecture.

#### High Pressure Acid Leach (HPAL)

HPAL technology enables the recovery of nickel from nickel oxide ores that traditionally were difficult to process. SMM was the first company in the world to apply it successfully on a commercial scale. The oxide ores are subjected to high temperature and pressure and reacted under stable conditions with sulfuric acid to produce a nickel-rich refining intermediate.

#### Matte Chlorine Leach Electrowinning (MCLE)

MCLE is the technology used in the manufacturing process at SMM's nickel refinery. The matte and mixed sulfide ores are dissolved in chlorine at high pressure to produce high-grade nickel using electrolysis. MCLE is competitive in cost terms, but poses significant operational challenges. Other than SMM, only two companies are producing nickel based on this kind of technology.

#### 5) Main applications for metals

#### Copper

Copper is fabricated into wires, pipes and other forms. Besides power cables, copper is used widely in consumer applications such as wiring in vehicles or houses, and in air conditioning systems.

#### **Electrolytic nickel**

This form of nickel, which has a purity of at least 99.99%, is used in specialty steels, electronics materials and electroplating, among other applications. SMM is the only producer of electrolytic nickel in Japan.

#### Ferronickel

Ferronickel is an alloy containing nickel (about 20%) and iron. Its main use is in the manufacture of stainless steel, which is about 10% nickel by weight. Based in Hyuga, Miyazaki Prefecture, SMM Group firm Hyuga Smelting produces ferronickel.

#### Gold

Gold is in demand worldwide for investment and decorative purposes. Gold is widely used in Japanese industry within the electronics sector because of its high malleability and ductility. Part of SMM's gold production goes to SMM Group companies engaged in fabricating and selling bonding wire.

#### Semiconductor and advanced materials Copper-clad polyimide film (CCPF)

CCPF is a polyimide film that is coated using a copper base. It is used as a material for making COF substrates. SMM commands a global market share of over 70% of the CCPF supplied for use in large liquid crystal displays.

Supplementary

**Materials** 

#### Chip-on-film (COF) substrates

COF substrates are electronic packaging materials used to make integrated circuits for LCD drivers. They connect these circuits to the LCD panel.

#### Lead frames (L/F)

Lead frames are electronic packaging materials used to form connections in semiconductor chips and printed circuit boards. They contain thin strips of a metal alloy containing mostly nickel or copper.

#### Bonding wire

Composed of gold wire that is just a few micrometers thick, bonding wire is used to make electrical connections between lead frames and the electrodes on semiconductor chips.

#### Secondary batteries

Secondary batteries are ones that can be recharged and used again. SMM supplies battery materials that are used in the anodes of nickel metal hydride batteries and lithium-ion rechargeable batteries, which supply power for hybrid vehicles or notebook computers, among other consumer applications.

# Note

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