



1

Customizing the Pt Recycling A Future Outlook

A. Semih Sunkar, Dr. Eng.

Pd Pt Rh

Corporate Partners

2



NIPPON PGM
株式会社日本ピージーエム



DOWA

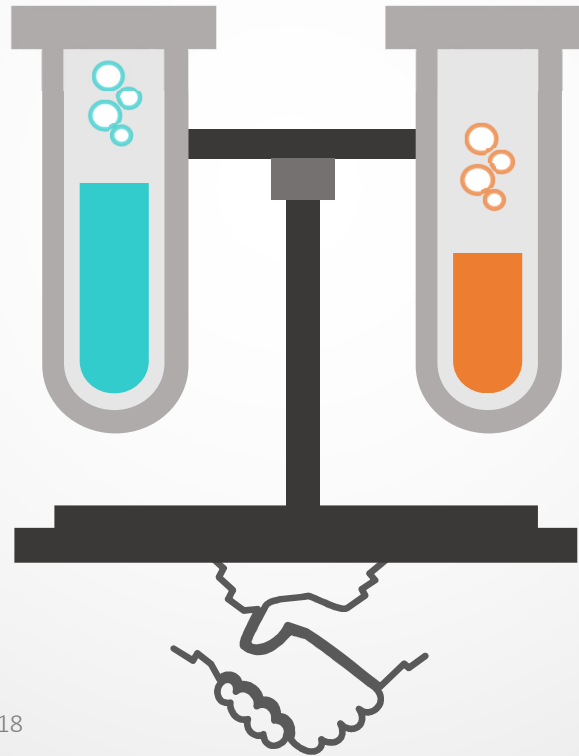
60%

40%



TANAKA

- Smelting
- Base Metals
- Recycling

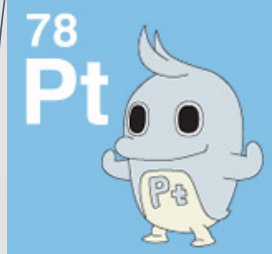


- Refining
- Value Creation
- Sales

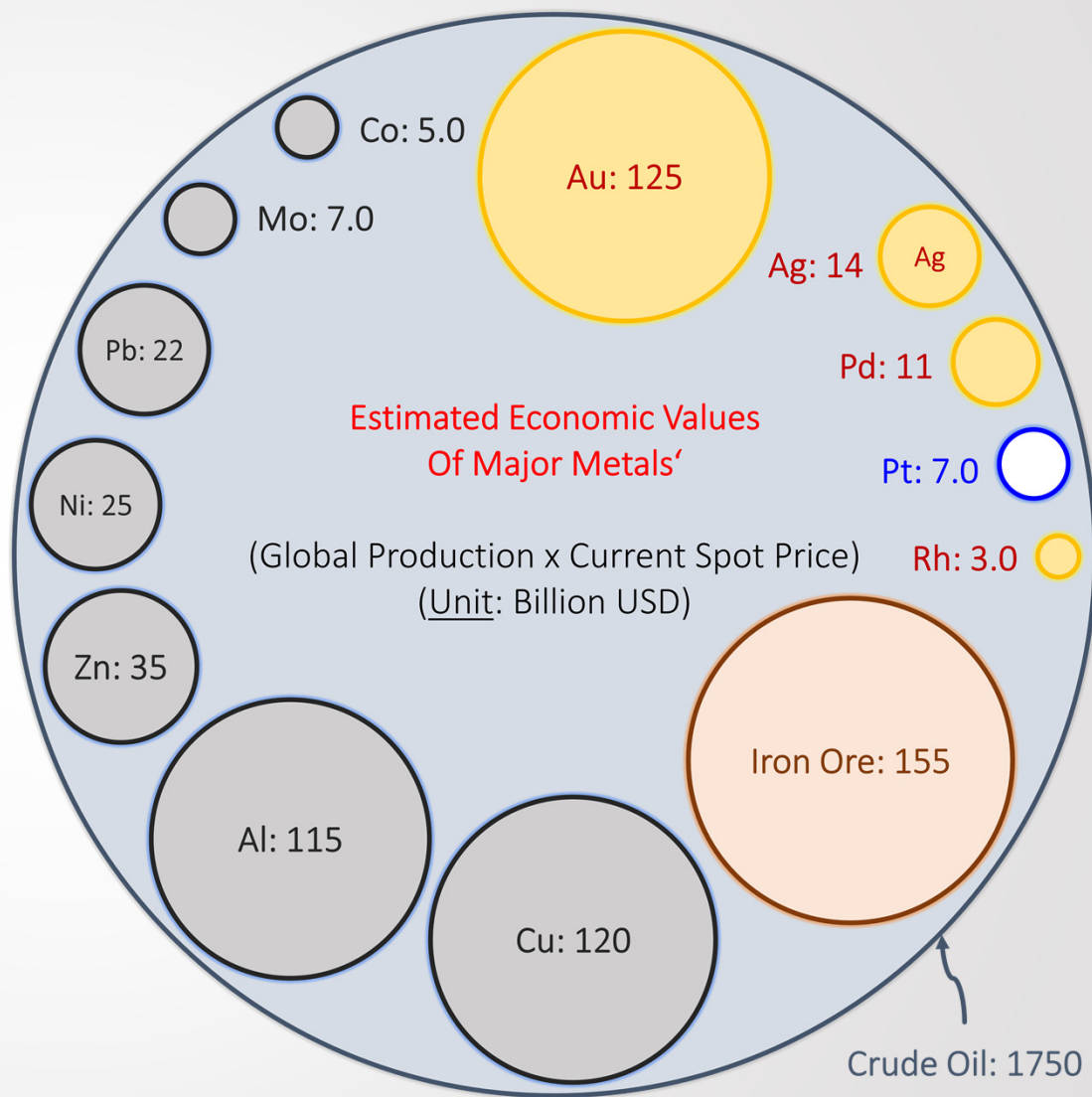


Platinum Facts

3



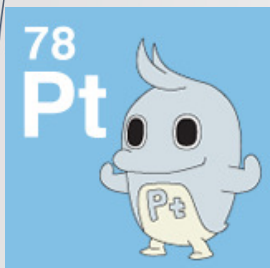
Estimated Economic Value (Billion USD)	
Crude Oil	1750
Metals Total	650
Gold	125
Silver	14
Palladium	11
Platinum	7
Rhodium	3
Iron Ore	155
Copper	120
Aluminum	115
Zinc	35
Nickel	25
Lead	22
Molybdenum	7
Cobalt	5



Platinum Facts

4

Our „Little Silver“



1557

1st Encounter in Europe

1784

1st Pt Crucible

1920

Merensky Reef

1975

1st Autocatalysts

1991

Recycling Starts

2017 SUPPLY

Mining: 192.1 t

Recycling: 62.7 t

Overall: 254.8 t

AUTOMOTIVE

JEWELLERY

INDUSTRIAL

INVESTMENT

41%

28%

25%

5%



Rise of Platinum

5

Evolution of Catalytic Converters

41%

1975
1st Cats in US

Two Way Catalysts

1983
1st Cats in JAPAN

Pellets

Three Way Catalysts

1991
NIPPON PGM JAPAN

EURO 1

Metal-Foil Cats

2003
NIPPON PGM AMERICA

EURO 3

DPF
Cordierite

2010
NIPPON PGM EUROPE

EURO 5

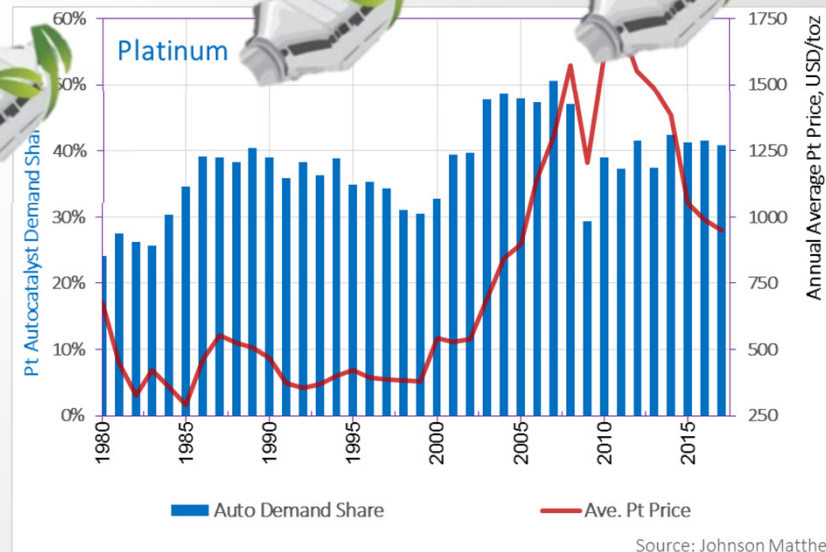
DPF
Silicon Carbide

2018
CAPACITY EXPANSION

EURO 6

DPF
(Sr, Ti)-Aluminates

Share of Automotive Demand for Pt



Pd Pt Rh

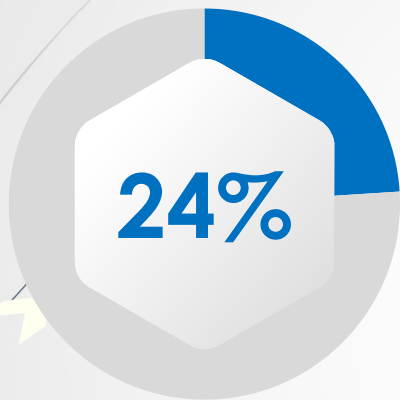
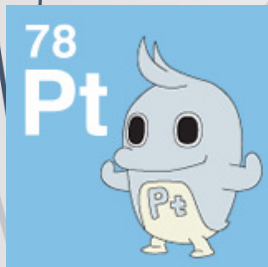
© Copyrighted to Nippon PGM Co. Ltd. - 2018

Source: Johnson Matthey

Start of Recycling

6

SECONDARY PT SUPPLY (2017)



SUPPLY vs DEMAND (2017)

Mining Supply: 192.1 t
Recycling Supply: 62.7 t
Overall Supply: 254.8 t

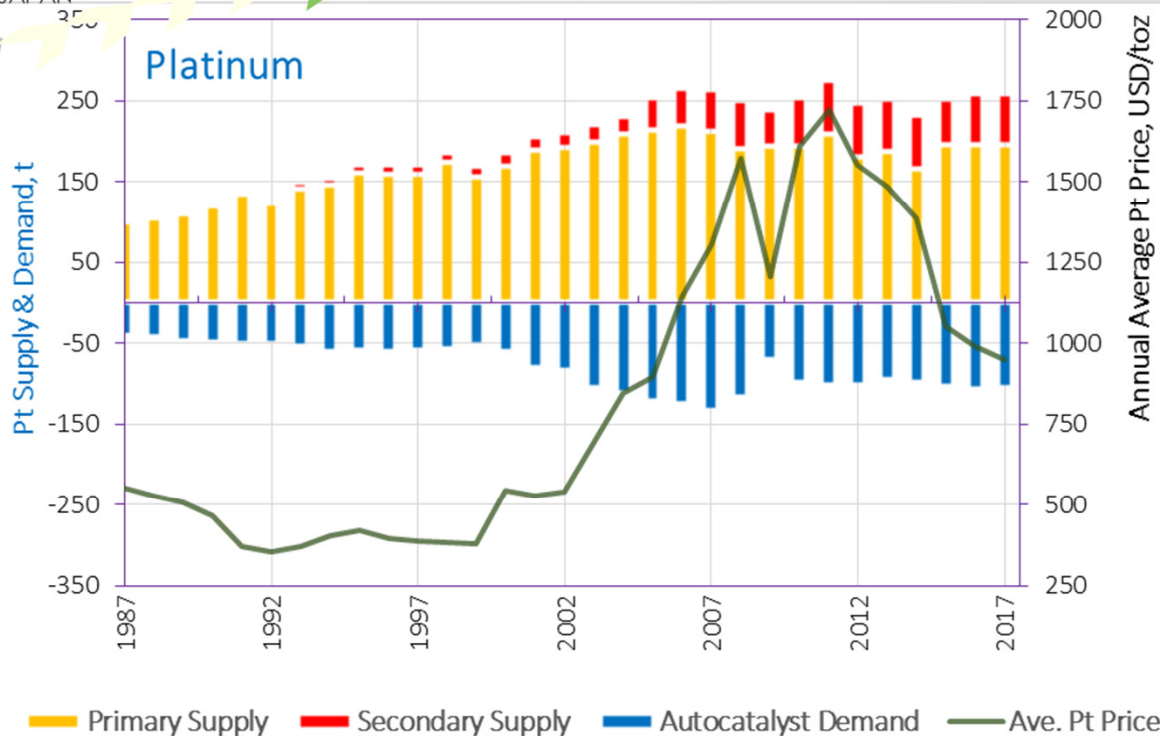
Automotive Demand: 105.8 t

1991
NIPPON PGM JAPAN

2003
NIPPON PGM AMERICA

2010
NIPPON PGM EUROPE

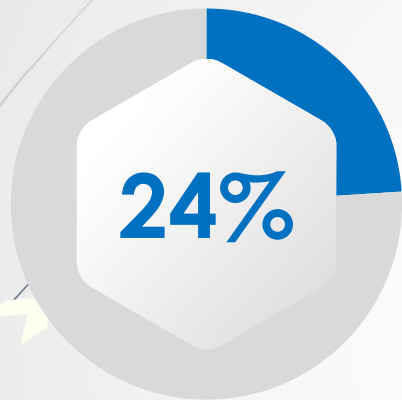
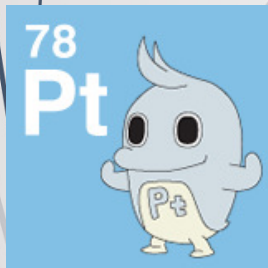
2018
CAPACITY EXPANSION



Success of Autocatalyst Recycling

7

SECONDARY PT SUPPLY (2017)



SUPPLY vs DEMAND
(2017)

Mining Supply: 192.1 t
Recycling Supply: 62.7 t
Overall Supply: 254.8 t

Automotive Demand: 105.8 t

1991
NIPPON PGM JAPAN

2003
NIPPON PGM AMERICA

2010
NIPPON PGM EUROPE

2018
CAPACITY EXPANSION

Reasons of Success in Autocatalyst Recycling

- ✓ **Established** recycling scheme
- ✓ **Competitive** and Innovative collection
- ✓ **Simple** Design
- ✓ **Available Dedicated** Processing Infrastructure

Pd Pt Rh

© Copyrighted to Nippon PGM Co. Ltd. - 2018

Autocatalyst Recycling Business Model

8

European "Food Chain"



Pd Pt Rh

© Copyrighted to Nippon PGM Co. Ltd. - 2018

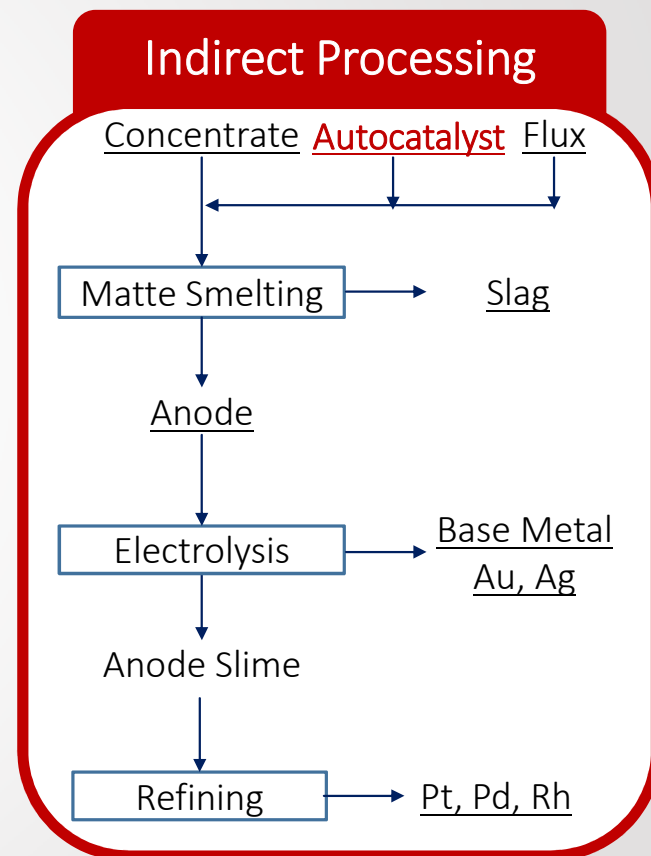
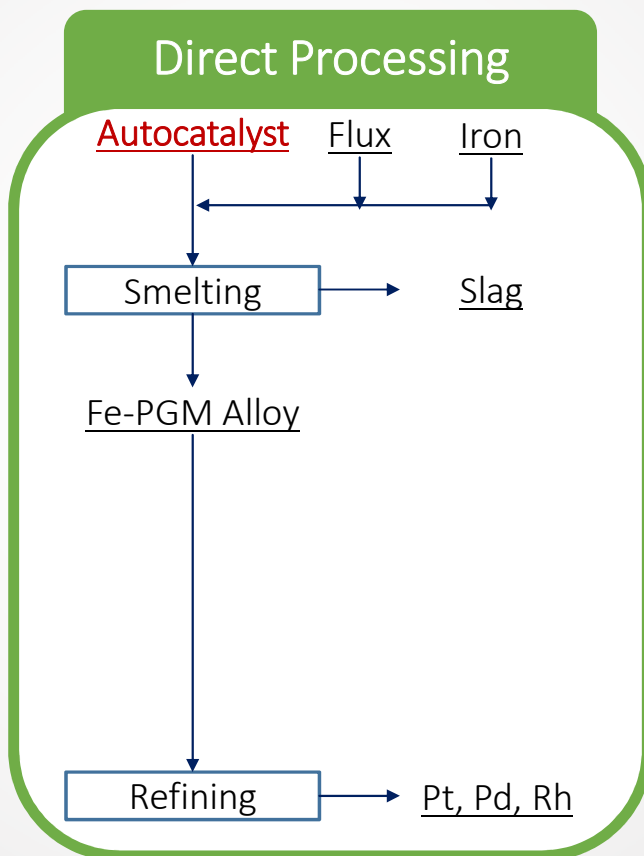
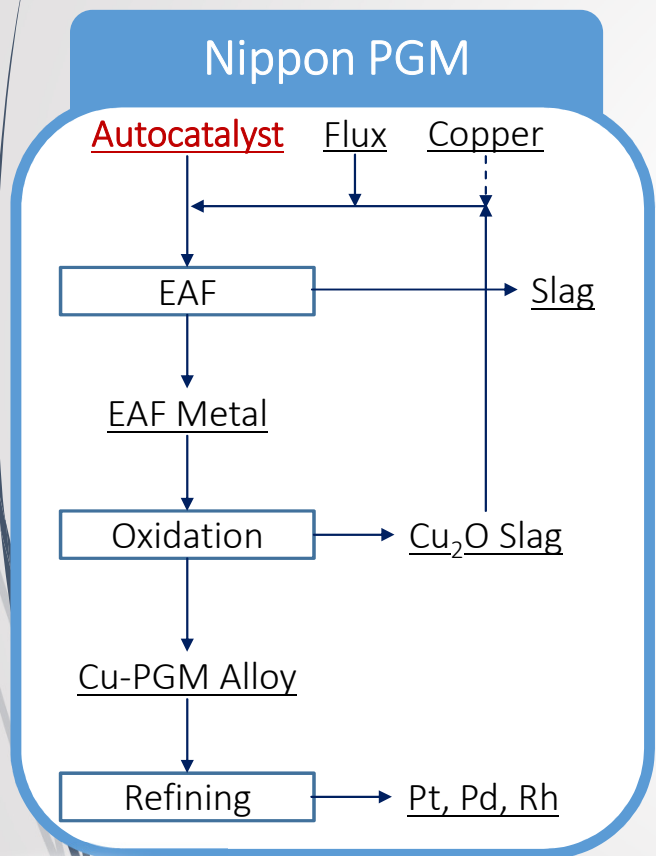


Methods of Autocatalyst Recycling



9

Pyrometallurgical Processing Practices for Autocatalysts



Specialization in Recycling

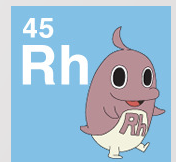
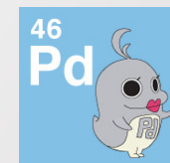
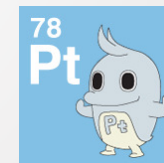
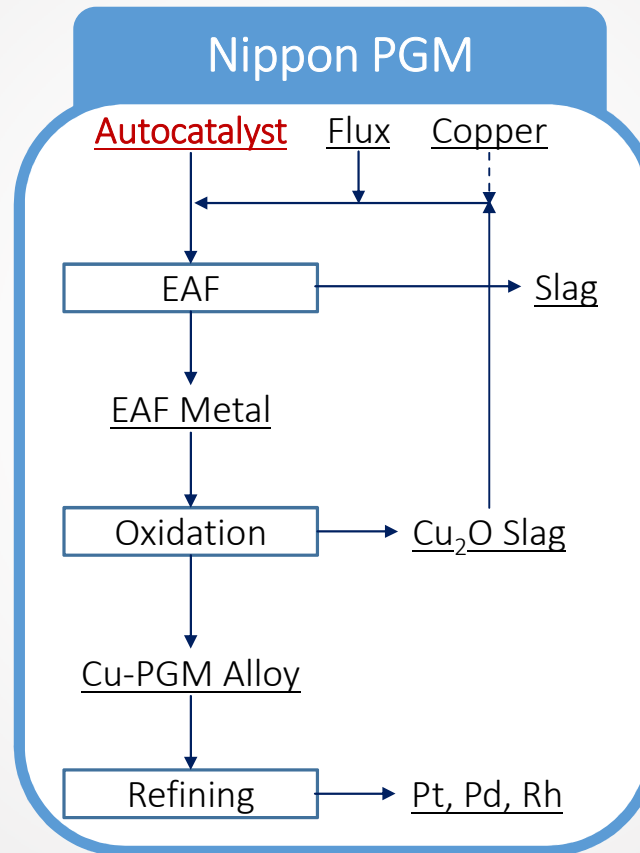
10

Dedicated - Direct Processing



Customized PGM Recycler

- ✓ **Dedicated** to PGMs only
- ✓ **Patented** Technology
- ✓ **Low** Running Cost
- ✓ **High** Metal Recovery
- ✓ **Zero** Hazardous Waste
- ✓ **Low** Carbon Footprint



Pd Pt Rh

Specialization in Recycling

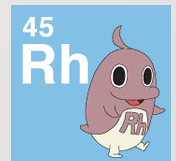
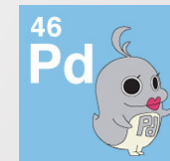
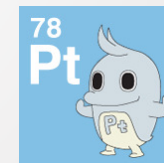
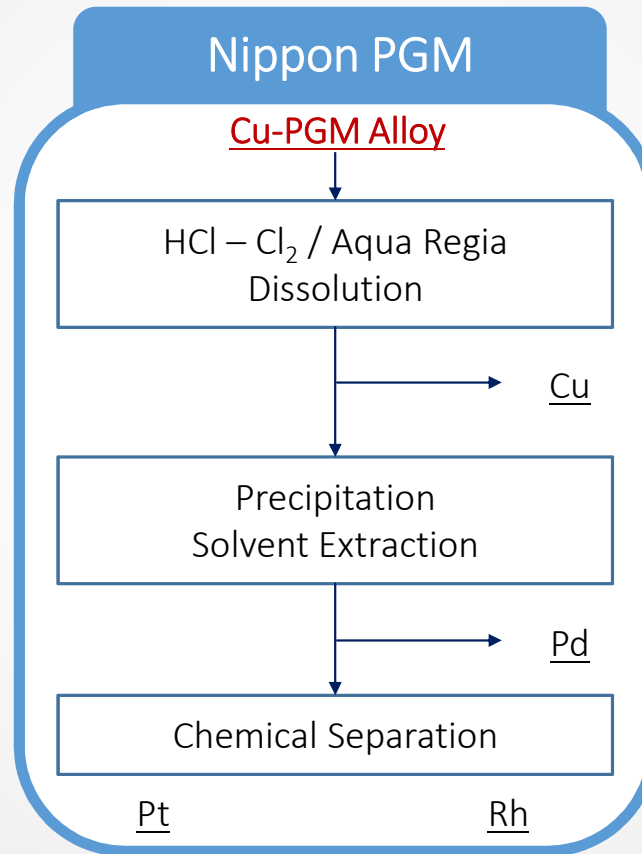
11

Combination of Smelting & Refining



Customized PGM Recycler

- ✓ Automated Process
- ✓ Short Lead Time
- ✓ High Safety
- ✓ High Yield

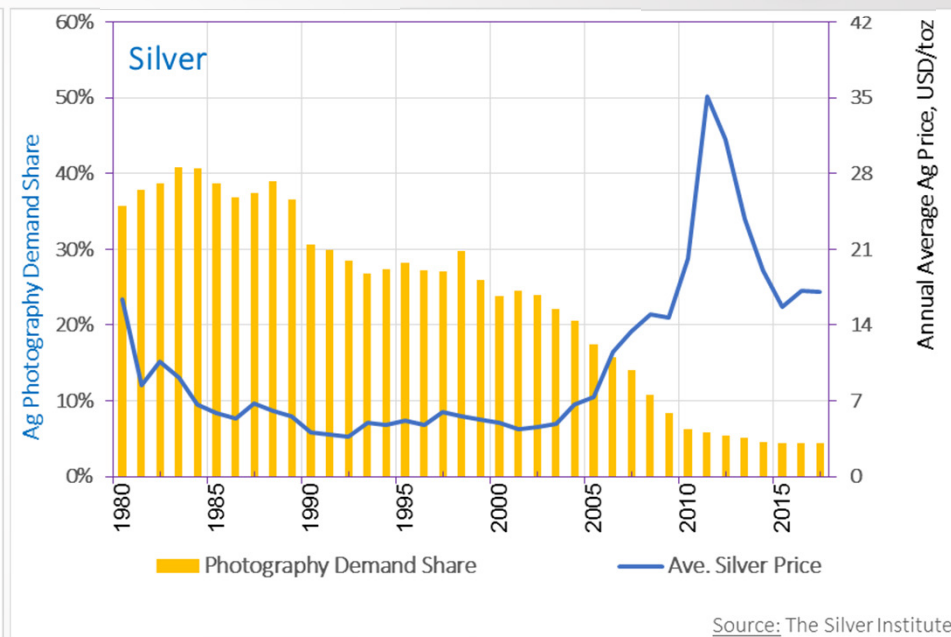
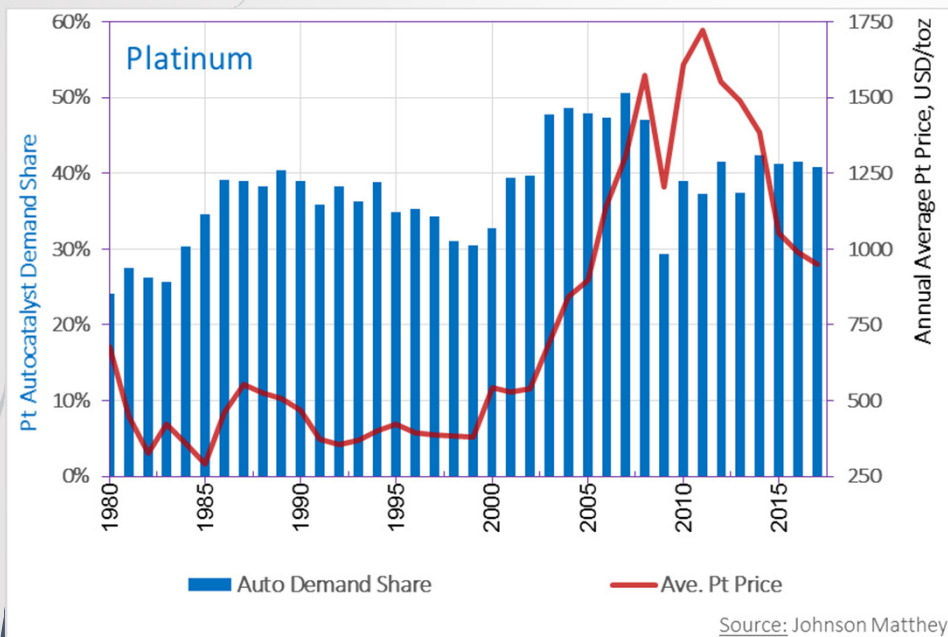
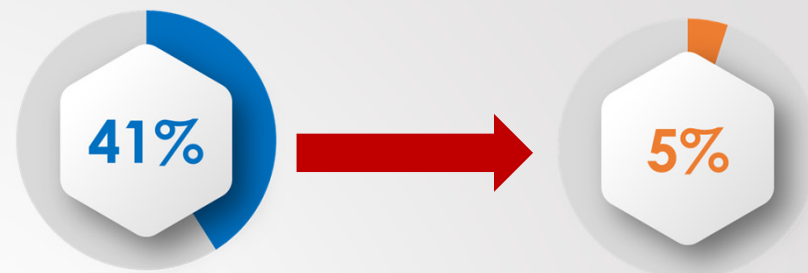


Pd Pt Rh

Fall of Platinum

12

Automotive Driven „Little Silver“



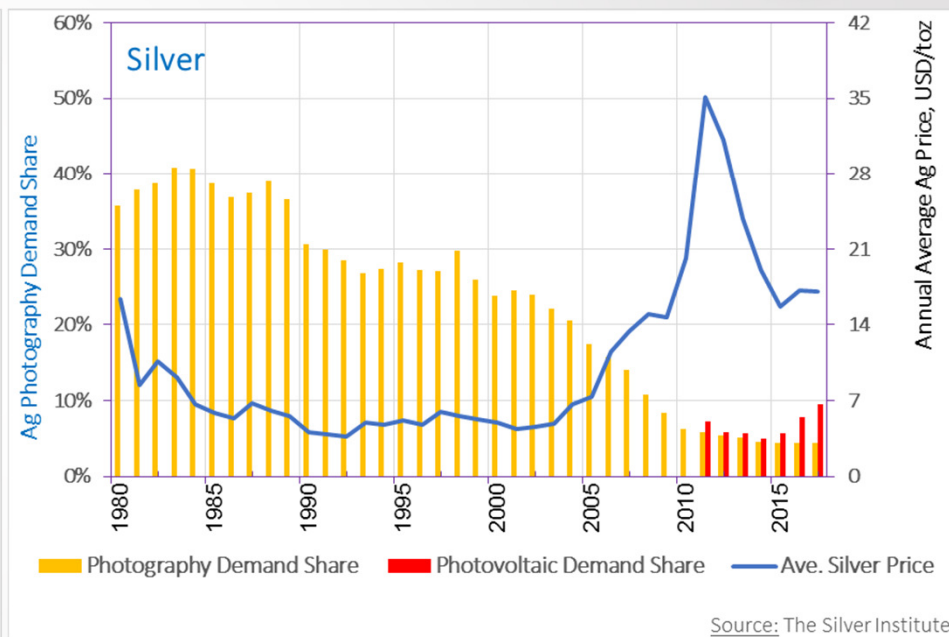
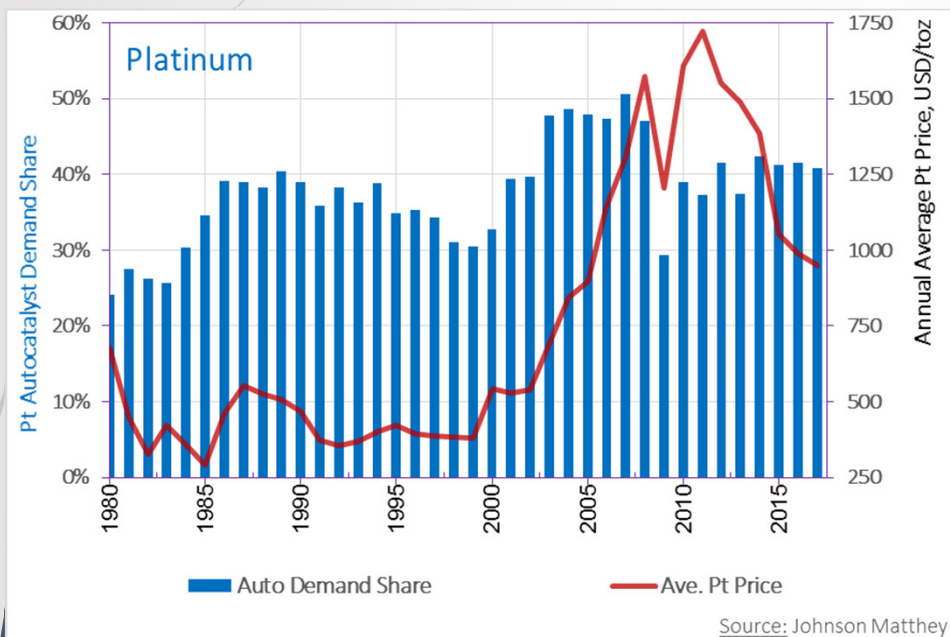
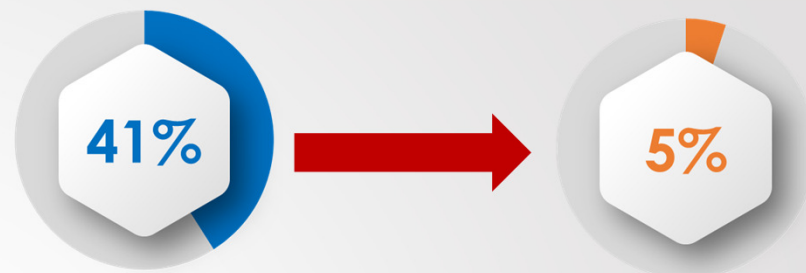
Photography demand was as high as 40% at its peak, but declined to 5%.



Fall of Platinum

13

Automotive Driven „Little Silver“



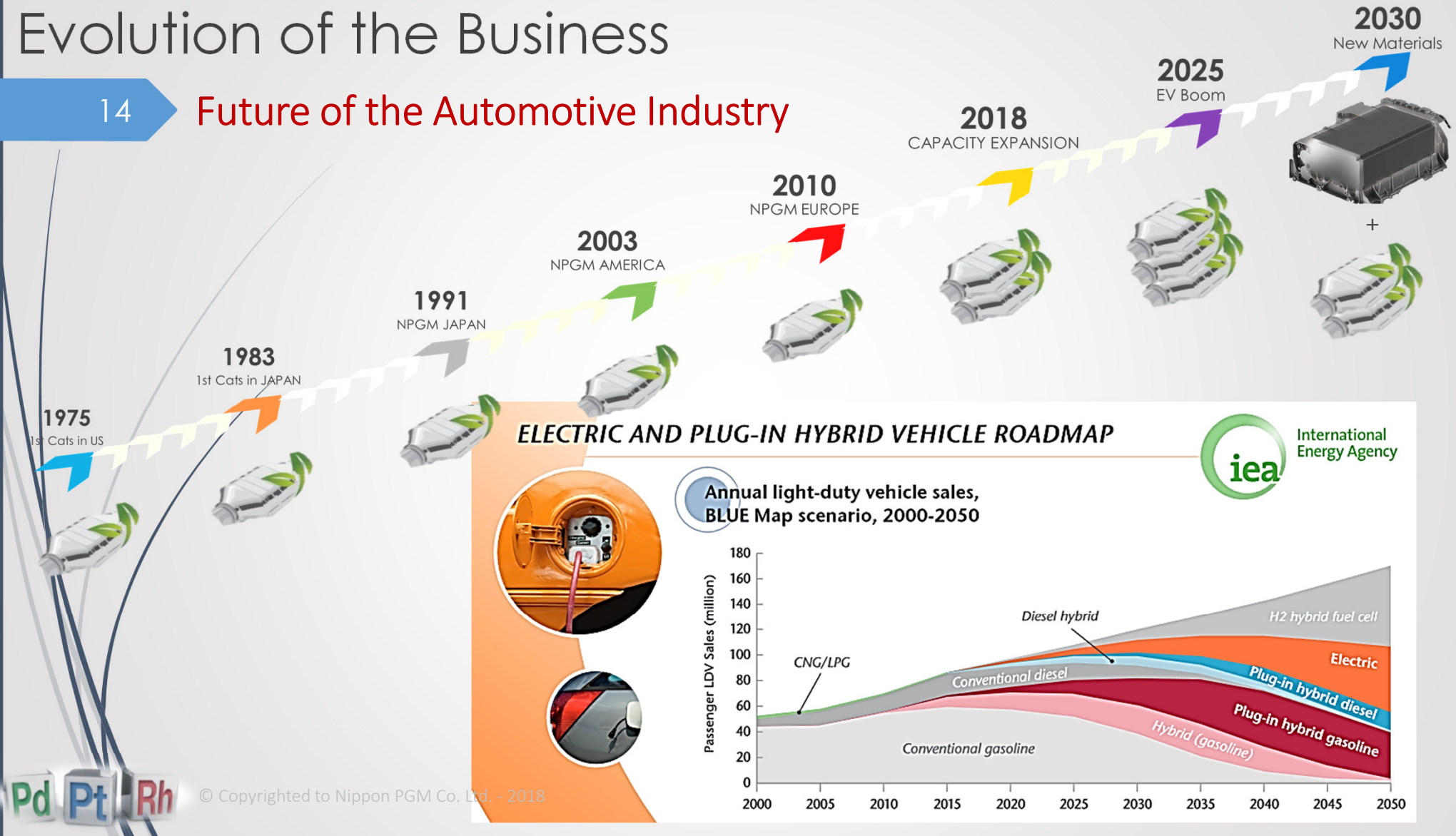
Photovoltaic Solar Panels Demand became the „Ag saviour“.



Evolution of the Business

14

Future of the Automotive Industry



Evolution of the Business

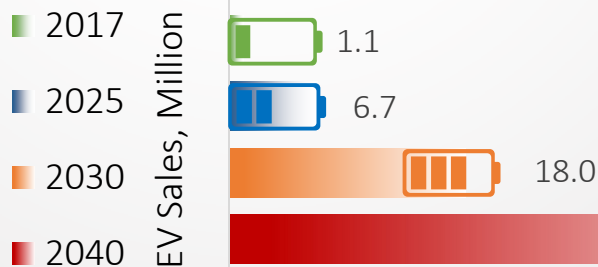
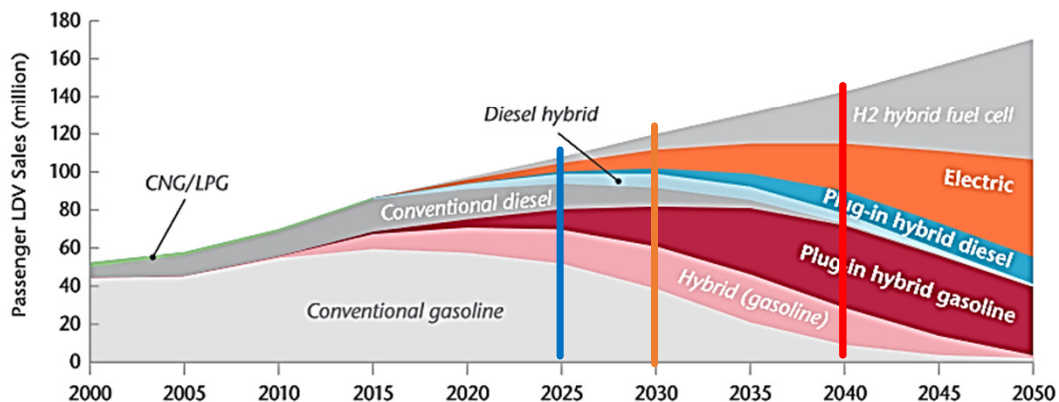
15

Future for Pt in Automotive Industry?

ELECTRIC AND PLUG-IN HYBRID VEHICLE ROADMAP



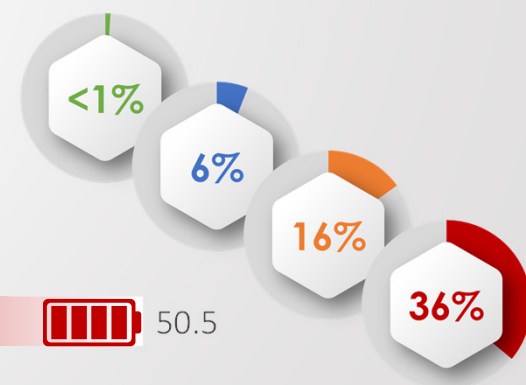
Annual light-duty vehicle sales, BLUE Map scenario, 2000-2050



Vehicle Sales Share Projection

- H₂ Fuel Cell Hybrid
- Battery Electric
- Plug-in Hybrid Electric

Source: IEA

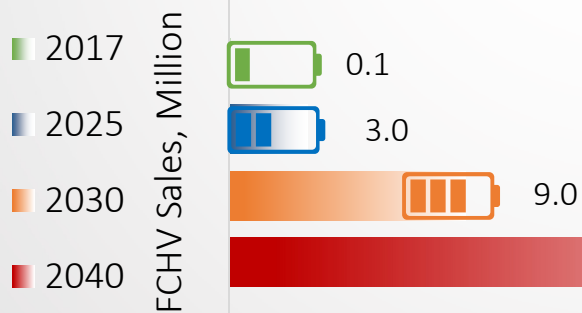
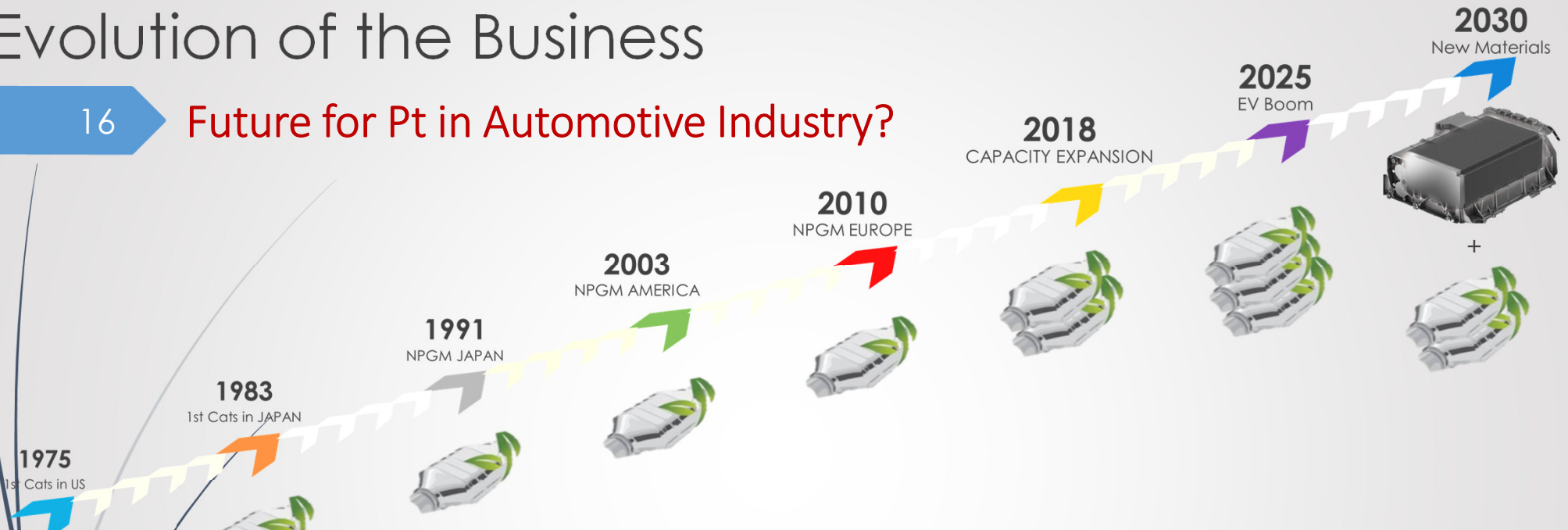


Pd Pt Rh

Evolution of the Business

16

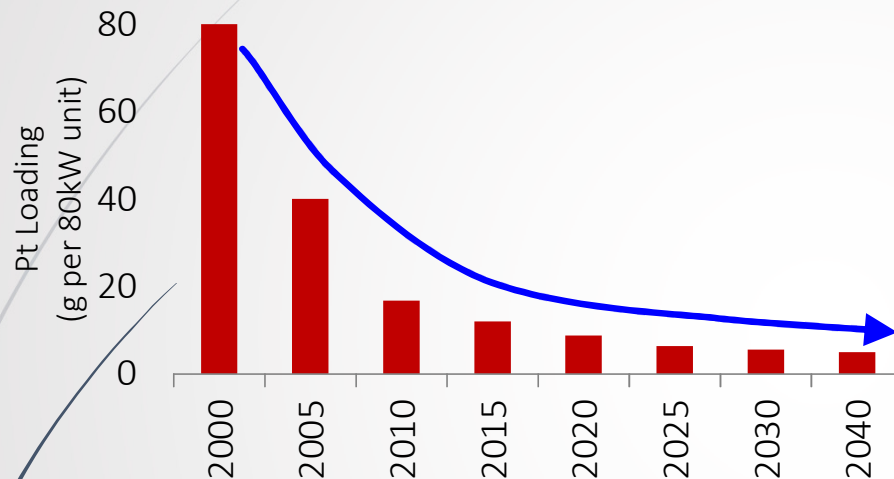
Future for Pt in Automotive Industry?



Fuel Cell Vehicles Future Outlook

17

Will „Fuel Cell“ be our Champion?



Good News for Fuel Cell Technology

- ✓ Getting cheaper and more efficient.
- ✓ Non-Transport applications exist.
- ✓ National policies exist

Issues for FCHV Penetration

- ✓ Cost and Performance
- ✓ Infrastructure for H₂ distribution
- ✓ End-User Acceptance
- ✓ Global Penetration

Bad News for Fuel Cell Technology

- ✓ BEV Battery Technology is leading.
- ✓ PGM loadings are decreasing.
- ✓ Infrastructure is the key issue.



Pd Pt Rh

© Copyrighted to Nippon PGM Co. Ltd. - 2018

Source: A. Månberger et.al, Energy Policy, Vol. 119, Aug. 2018

Fuel Cell Vehicles Future Outlook

18

Will „Fuel Cell“ be our Champion?

Country	2025 National Target	
	H ₂ Refuelling Station (Number of Location)	FCHV Fleet (x1000 Units)
Germany	500	500
Japan	320	200
Korea*	200	200
China	350	50
California"	100	50

*: Estimate: 2020: 100 / 100, 2030: 520 / 630
": Estimate: 2023: 94/37.4

Issues for FCHV Penetration

- ✓ **Cost** and Performance
- ✓ **Infrastructure** for H₂ distribution
- ✓ **End-User** Acceptance
- ✓ **Global** Penetration

Good News for Fuel Cell Technology

- ✓ Getting cheaper and more efficient.
- ✓ Non-Transport applications exist.
- ✓ National policies exist

Bad News for Fuel Cell Technology

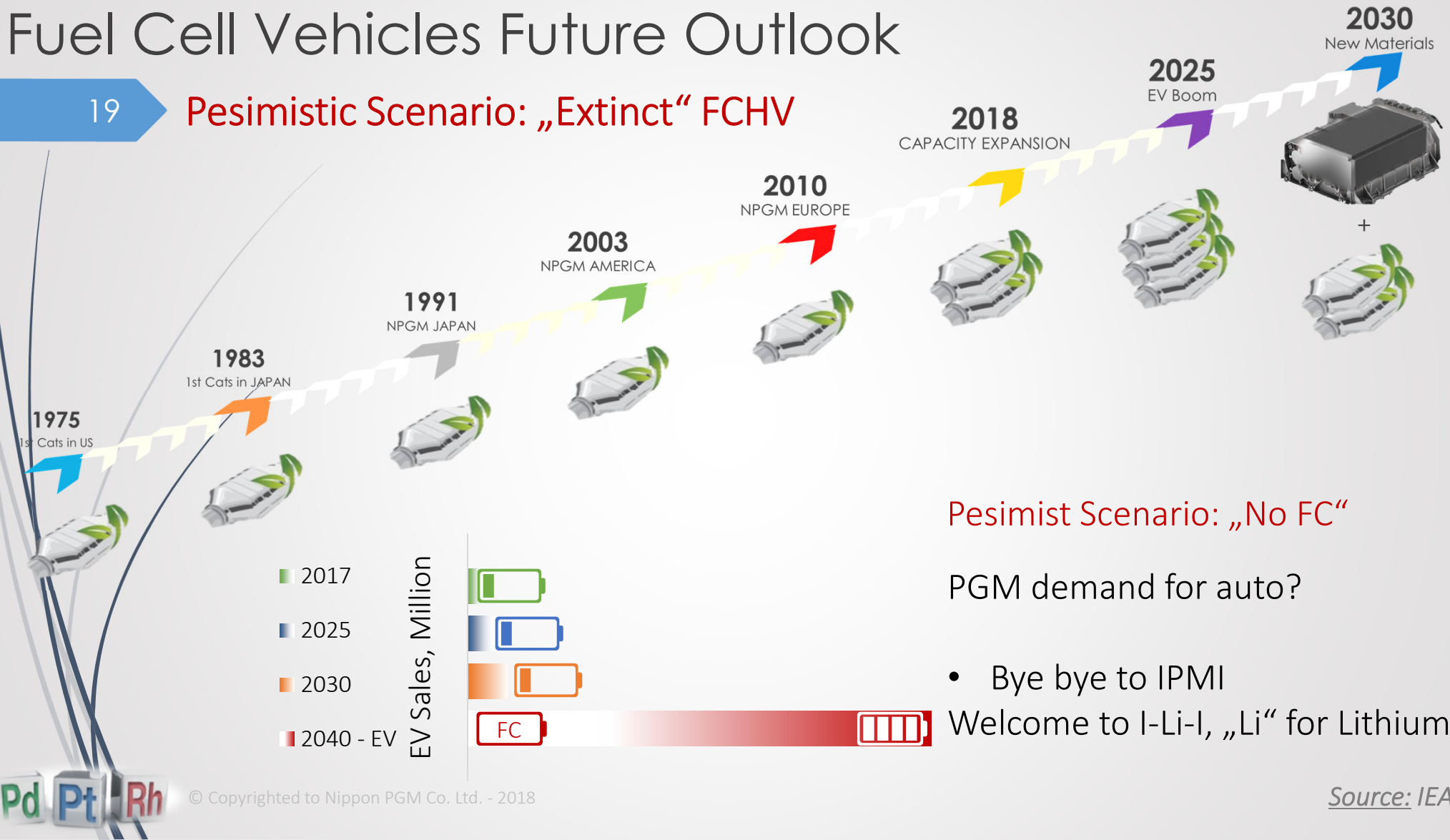
- ✓ BEV Battery Technology is leading.
- ✓ PGM loadings are decreasing.
- ✓ Infrastructure is the key issue.



Fuel Cell Vehicles Future Outlook

19

Pesimistic Scenario: „Extinct“ FCHV



Pesimist Scenario: „No FC“

PGM demand for auto?

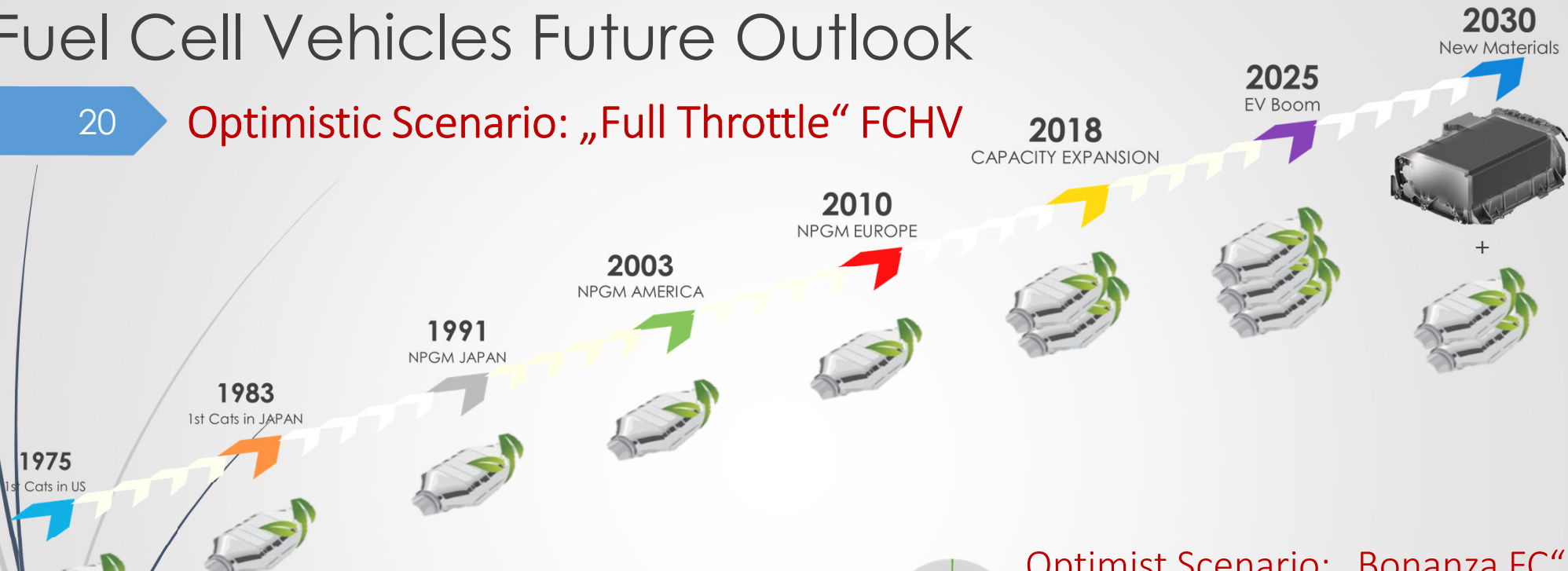
- Bye bye to IPMI
- Welcome to I-Li-I, „Li“ for Lithium

Pd Pt Rh

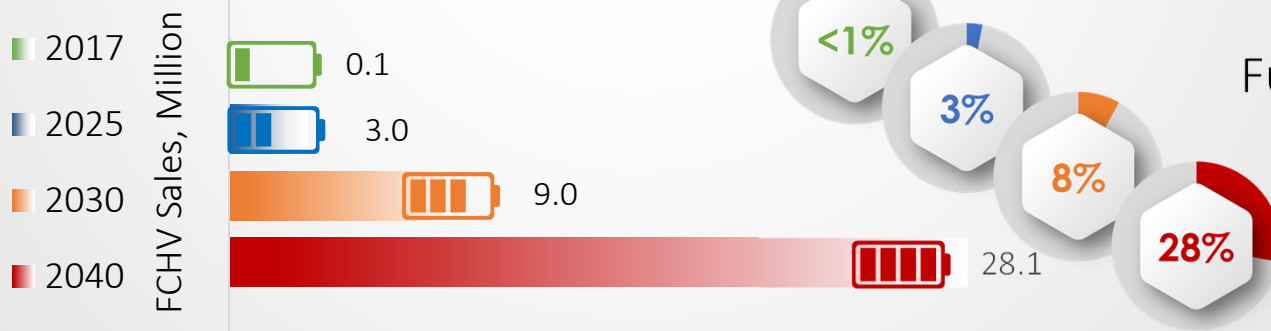
Fuel Cell Vehicles Future Outlook

20

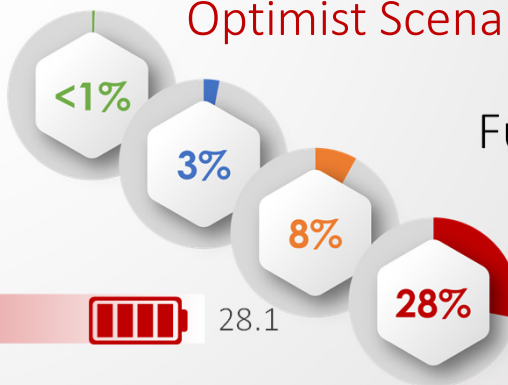
Optimistic Scenario: „Full Throttle“ FCHV



Optimist Scenario: „Bonanza FC“



Fuel Cell HV
Sales Share
Projection



Pd Pt Rh

Fuel Cell Vehicles Future Outlook

21

Super Optimistic Scenario: „Full Throttle“ FCHV

Super Optimistic Scenario

	FCHV Units	Pt Demand	Comparison to Autocat
Units	(Millions)	(t/y)	(% of 2017 auto share)
2010	0.001	0.0	0.0
2015	0.01	0.1	0.1
2020	0.1	0.9	0.8
2025	3.0	19.2	18.1
2030	9.0	50.5	47.7
2040	28.1	134.7	127.3

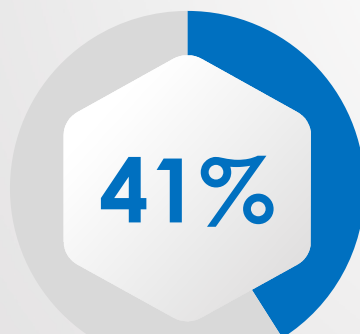
FC Mobility Roadmaps

✓ Road Transport

- ✓ Light Duty Passenger Vehicles
- ✓ Heavy Duty Vehicles (Trucks and Buses)

✓ Ships

✓ Trains

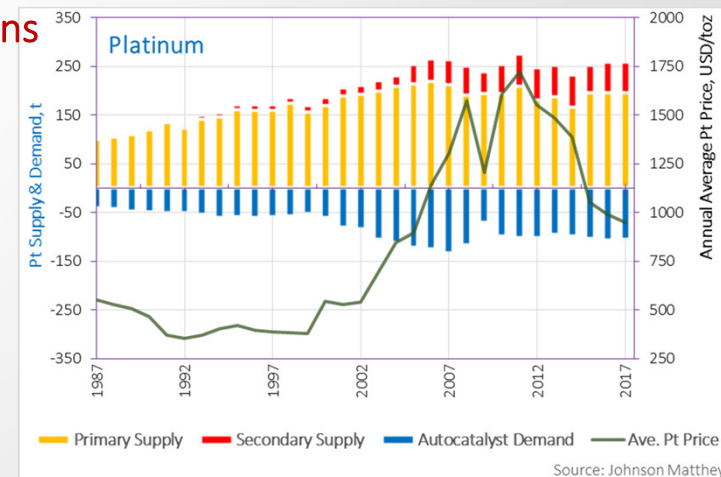


2017 SUPPLY vs DEMAND

Mining Supply: 192.1 t

Recycling Supply: 62.7 t

Automotive Demand: 105.8 t



Pd Pt Rh

© Copyrighted to Nippon PGM Co. Ltd. - 2018

Source: Johnson Matthey

Fuel Cell Vehicles Future Outlook

22

Optimistic Scenario: „Moderate Penetration“ FCHV

Super Optimistic Scenario

	FCHV Units	Pt Demand	Comparison to Autocat
Units	(Millions)	(t/y)	(% of 2017 auto share)
2010	0.001	0.0	0.0
2015	0.01	0.1	0.1
2020	0.1	0.9	0.8
2025	1.0	6.4	6.0
2030	6.0	33.6	31.8
2040	14.2	68.2	64.4

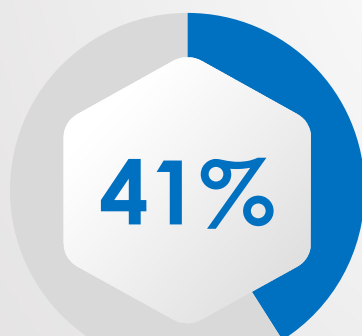
FC Mobility Roadmaps

✓ Road Transport

- ✓ Light Duty Passenger Vehicles
- ✓ Heavy Duty Vehicles (Trucks and Buses)

✓ Ships

✓ Trains

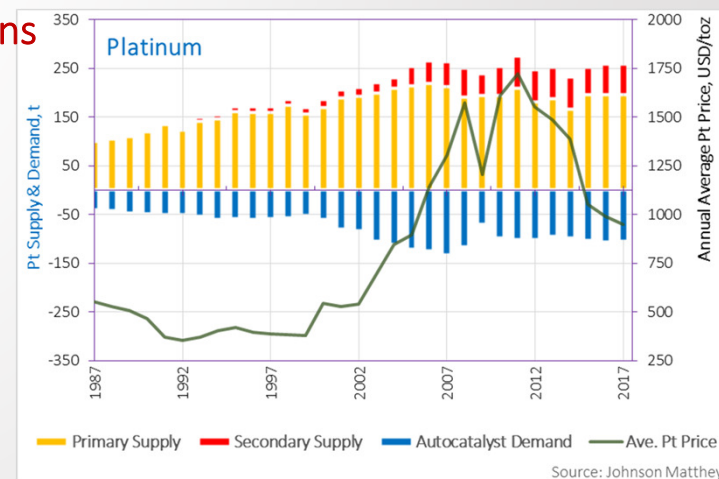


2017 SUPPLY vs DEMAND

Mining Supply: 192.1 t

Recycling Supply: 62.7 t

Automotive Demand: 105.8 t

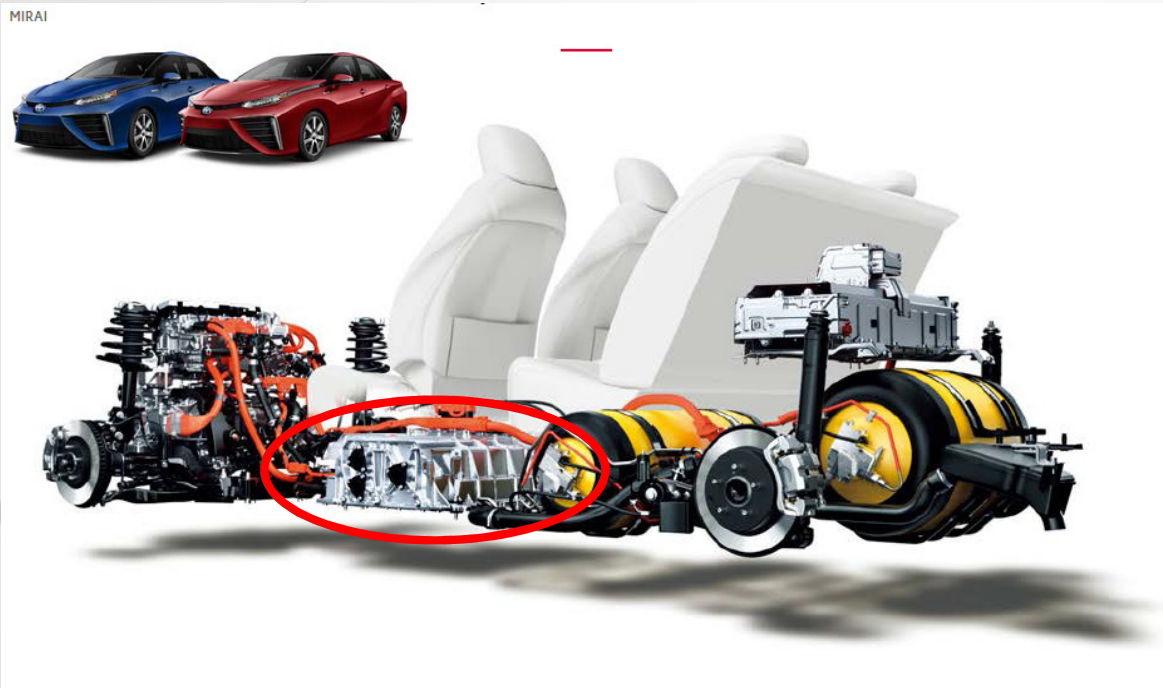


Pd Pt Rh

Fuel Cell Vehicles Future Issues

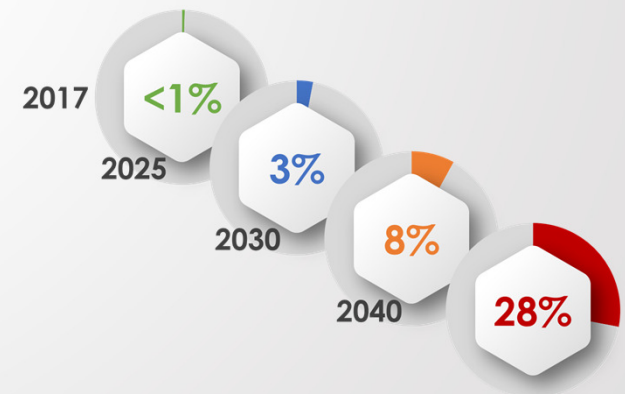
23

Will „Saviour FC“ be our Champion?



Issues for FCHV & Pt Recycling

- ✓ Supply of Platinum
- ✓ Recyclability (Recycle Pt or Reuse FC)
- ✓ Collection Network
- ✓ Technological Readiness



Pd Pt Rh

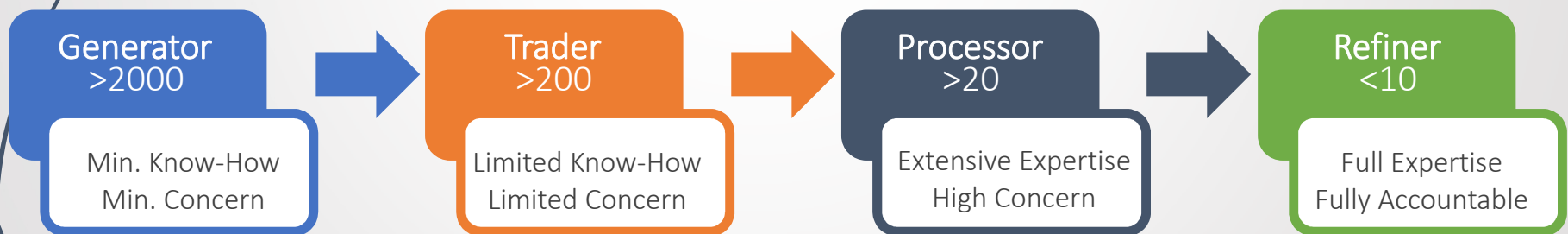
© Copyrighted to Nippon PGM Co. Ltd. - 2018

Shift in Business Structure

24

Will PGM Recycling Sector Be Ready?

	Autocatalysts	Fuel Cells
Unit Weight, kg/unit	<5	>50
PGM Content, g/unit	2-3	10-12
Initial Processing, per unit	Very Fast	Labor Intensive
Initial Evaluation, per unit	Established	Needs special know-how
Purchasing Capital, per unit	Low	High

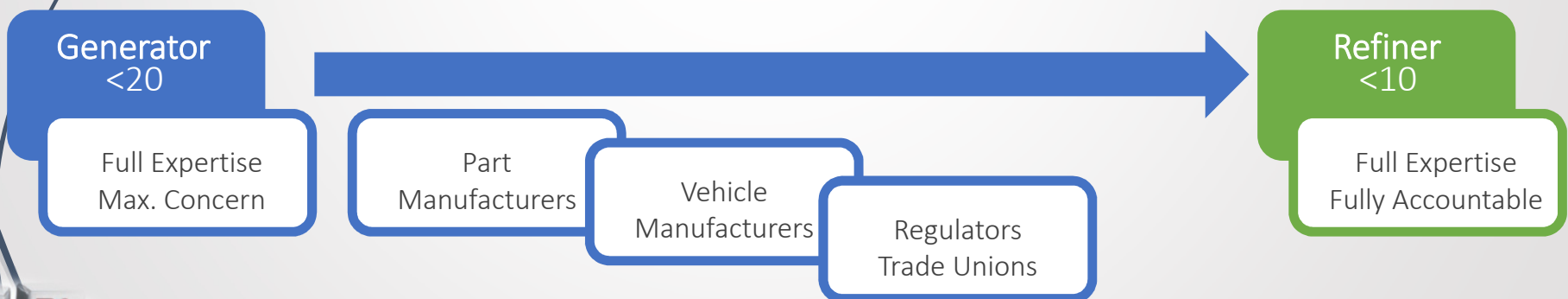


Shift in Business Structure

25

Will PGM Recycling Sector Be Ready?

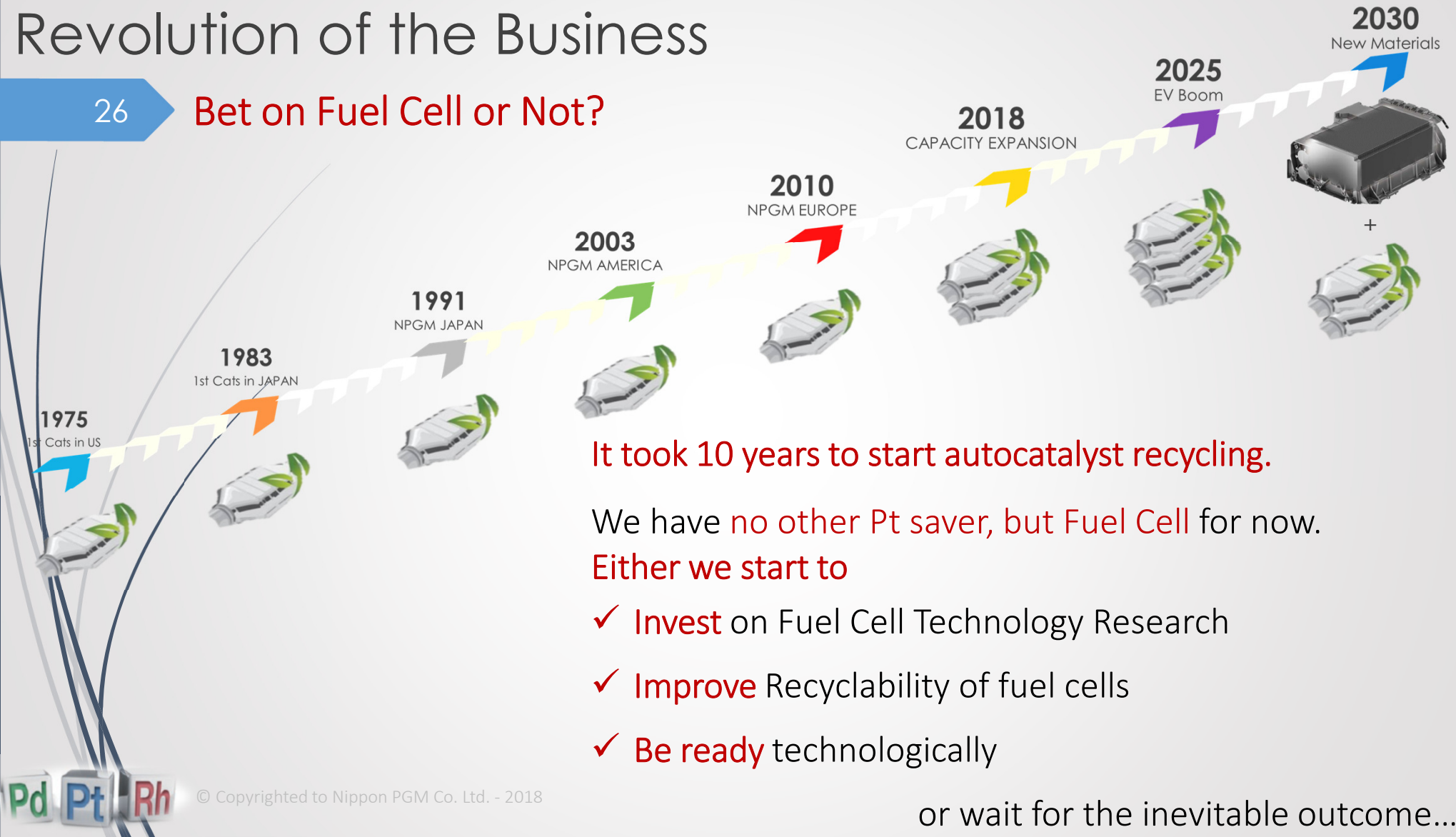
	Autocatalysts	Fuel Cells
Generator Know-How	Basic	Advanced
Sampling Technology	Established	Needs Special Line
Final Processing Technology	Established	Needs Special Line
Safety Concern	Limited	Extensive
Regulations & Control	Basic	Advanced



Revolution of the Business

26

Bet on Fuel Cell or Not?



It took 10 years to start autocatalyst recycling.

We have no other Pt saver, but Fuel Cell for now.

Either we start to

- ✓ Invest on Fuel Cell Technology Research
- ✓ Improve Recyclability of fuel cells
- ✓ Be ready technologically

or wait for the inevitable outcome...



Thank You Very Much

Visit us: <http://nipponpgm.dowa.co.jp/>

E-mail: semih.sunkar@dowa-europe.com

Pd Pt Rh