

ZULIANI
Mg Technology



Recent Developments

in

Gossan Resources Magnesium Project

Presented at the International Magnesium Conference
San Francisco May 2012

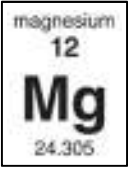
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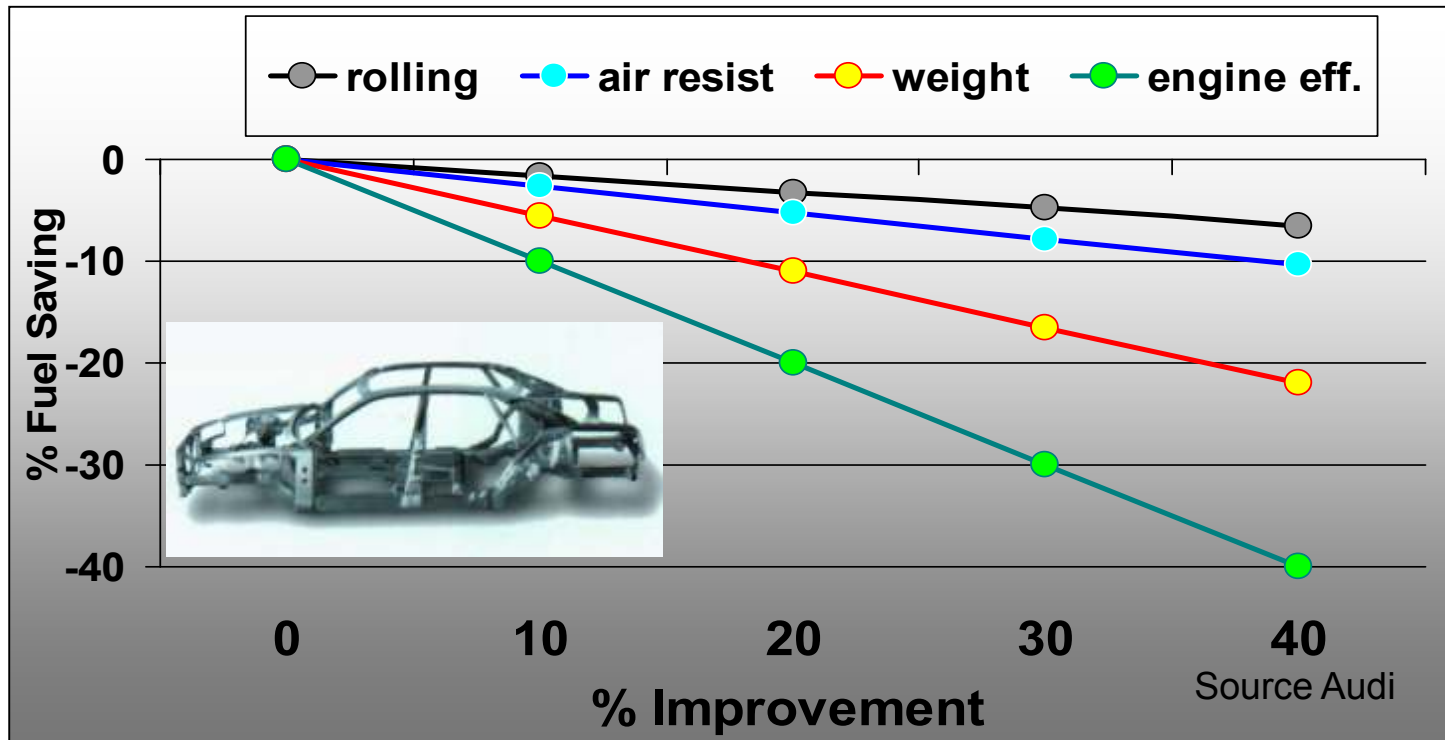


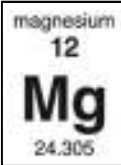
Weight Savings...increasingly a key part of automotive strategy going forward



Light Materials... play increasingly important role in transportation

- Tighter Fuel Standards... USA: 6.5 liters /100 km by 2014 decreasing to 4.3 by 2025
- Electric Vehicles... need light weight for improved range & performance





Magnesium... largely single part substitution

**USAMP
2004 Study**

Exhibit 3.2.2.
Magnesium Components Used in Vehicles (lb.)



CHASSIS

INTERIOR

POWER TRAIN

BODY STRUCTURE

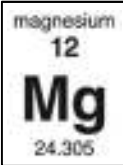
	Original Weight	Original Material	Mg Weight	Weight Saved
CHASSIS				
4 Wheels	65	Al	33	26
IA Frame Cross Member	20	steel	10	10
Engine Cradle	34.8	Al	23.7	11.1
Fuel Tank Barrier	8.7	steel	5	3.7
Brackets - Adjustable Pedal	2	steel	1	1
Brake/Accelerator	2.5	steel	2	0.5
Steering - Wheel	2.5	Al	1.5	1
Columns	4	Al	3	1
Column Brackets	2	steel	1.5	0.5
ABS Mounting Bracket	1.2	iron	0.9	0.4
INTERIOR				
Seats - Frames	44	steel	16	28
Stanchions (2)	24	steel	13	11
IP - X-car beam		steel	15	10
Knee Bolster			6	4
Console	8		5	3
Brackets	1			0.5
Glove Box Door	1	steel		0.3
POWERTRAIN				
Engine Block I 6	56			
Engine Block I 4	42			
Automatic Transmission	42			
Intake Manifold	22			
Transfer Case	25			
Clutch Housing	14			
Oil Pan	9			
Engine Mounting Brackets	6			
Alternator Bracket	5			
Cam Cover (2)	7			
Cylinder Head Cover	7			
Air Intake Housings	6			
Oil Pump Housing	3			
Power Steering Pump Bracket	1.5			
BODY STRUCTURE				
Door Inner Panels (4)	86			
Radiator Support/GOR	32			
Front of Dash Structure	40			
Lift gate Inner	22			
Windshield Surround (frame)	22			
Targa Roof Frame Opening	11			
Wiper Motor/support Assembly	3.5			
Mirror Housing	3			
Headlight Retainer	1.5			
TOTAL	6			

* Rounded to 2 significant figures



Magnesium
 ~ 50 different parts
 ~ 155 major platforms
 ~ Totaling 380 lbs (173 kg)
 ~ Ave. car only 5-6 kg Mg

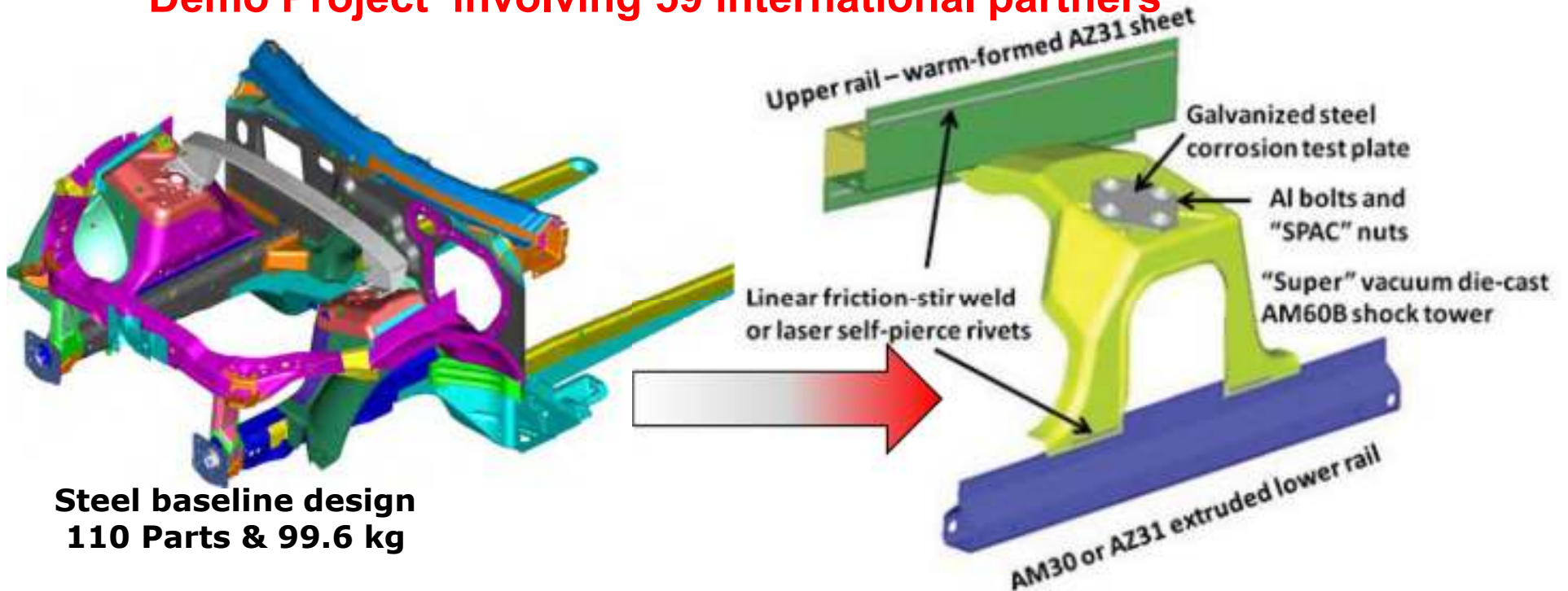
“Single Part Substitution”...
 limited impact on
 “Big Picture” Weight Saving
 Needed in Future (> ~ 100 kg)



USAMP... Big Picture ~155kg Mg parts save 222 kg weight (~15% Wt Reduction)

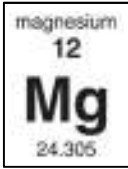


✓ **USAMP undertook 5 year, \$9.2M multi-material Demo Project involving 59 international partners**



"Big Picture" Mg Wt Saving... requires Multi Material Assemblies

- ✓ ~ 45% weight saving compared to high performance steel baseline
- ✓ ~ 60% reduction in number of component parts
- ✓ ~ 25% weight saving compared to similar Al structure



MAGNESIUM... KEY SUCCESS FACTORS to Seize Auto Opportunity

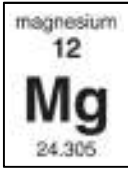


- ✓ **USAMP Study PROVEN TECHNICAL CAPABILITY...** Mg Multi-Material assemblies (castings, sheet & extrusions) satisfy auto performance requirements for
 - ✓ Crashworthiness
 - ✓ Noise, Vibration & Harshness
 - ✓ Fatigue
 - ✓ Durability & Corrosion
 - ✓ Joining & Fabrication
- ✓ **Mg provides SIGNIFICANT WEIGHT SAVINGS...** Mg structural assemblies provided ~45 - 50% weight savings over Steel & ~25% over Aluminum
- ✓ **Mg provides DESIGN SIMPLICITY...** significant reduction in number of parts

TO SEIZE AUTO OPPORTUNITY ... Mg NOT in competition with ITSELF!!!!!!

Mg MUST BE COMPETITIVE with Other Light Weight options particularly Al

- **Price ...** Price Competitiveness requires Operating Cost Competitiveness
- **Environmental...** Life Cycle Competitiveness

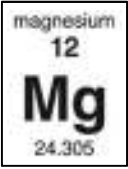


Magnesium... undergone TWO Major Paradigm Shifts in last 20 years



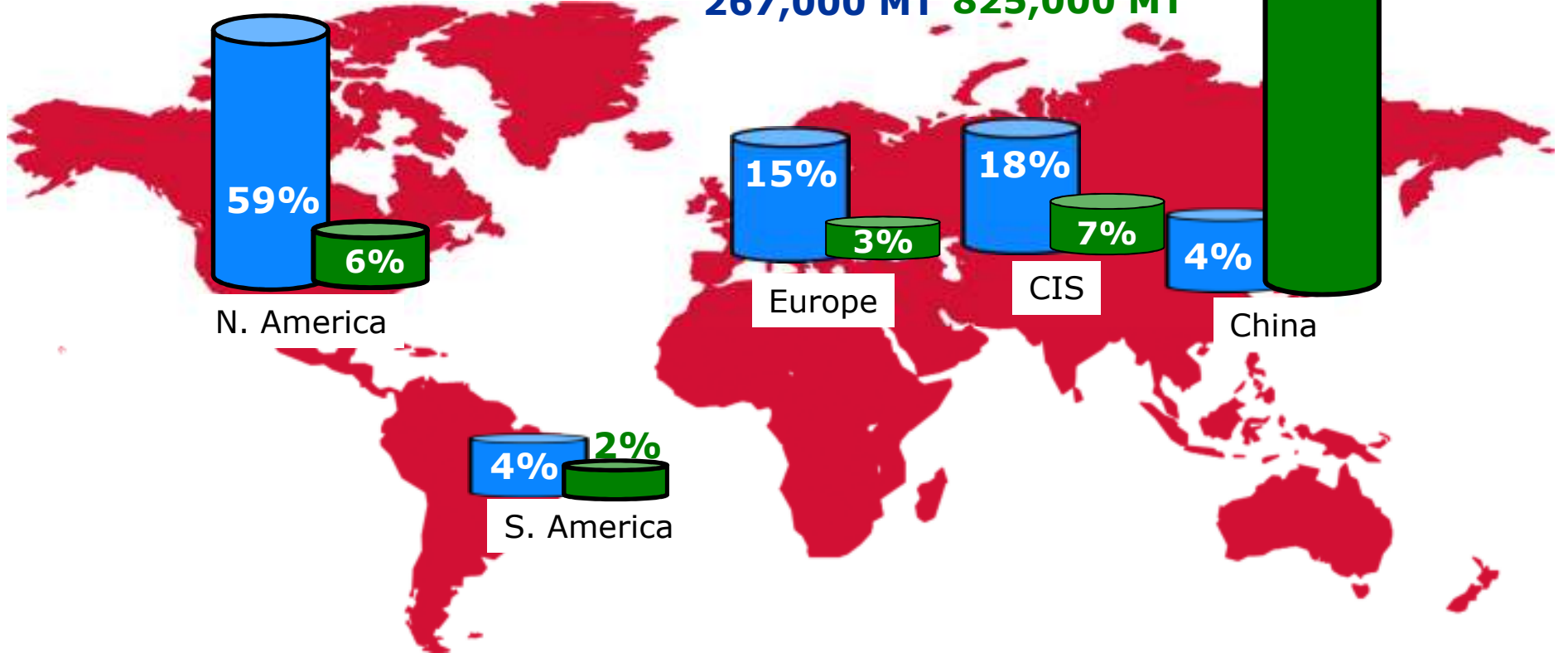
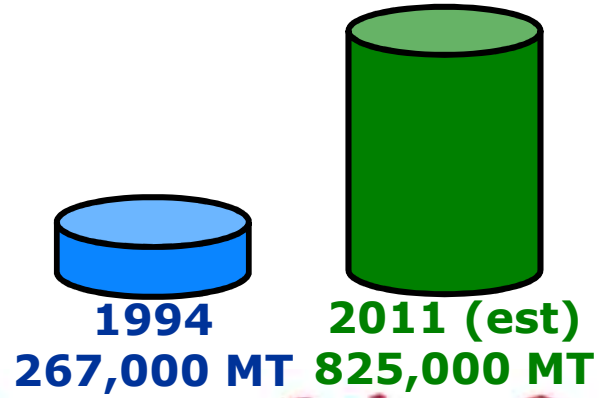
Magnesium industry undergone TWO major paradigm shifts...

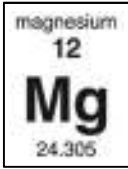
- **Before ~ 1990 China Produced No Magnesium...** Dow Chemical, Norsk Hydro, US Mag, Northwest Alloys (Alcoa) & Pechiney dominated production with other minor producers in Canada, Brazil, & CIS
 - Price Mg \geq 1.50 times Price Al
- **“First Paradigm Shift” began in ~ 1990...** led by lower labor costs in China. Resulted in rapidly declining prices & a transformation in production base from the West to China
 - Price Mg \leq Price Al
- **Today China is producing $>$ ~80% of world’s Mg...** Dow & Norsk exited the business, most others have now permanently shut down. Dead Sea (Israel), US Mag, RIMA (Brazil) & few former Soviet based plants are only remaining western producers



Magnesium Production...

USGS Data +6.9% CAGR (1994 – 2011)





Magnesium's Second Paradigm Shift... began ~ 2005



- **China shifted to a deregulated free market economy...**
resulted fundamental upwards shift in energy, materials & labor costs

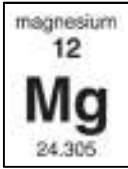
Commodity	% Increase (2005 - 2011)
Thermal Coal	~ 450%
Electricity	~100%
Ferrosilicon	~ 60%
Labor Hourly Rate	> 250 – 350%

**Chinese
Energy, Fuel
Labor Costs
ALL Up
Significantly**

Based on Published Data

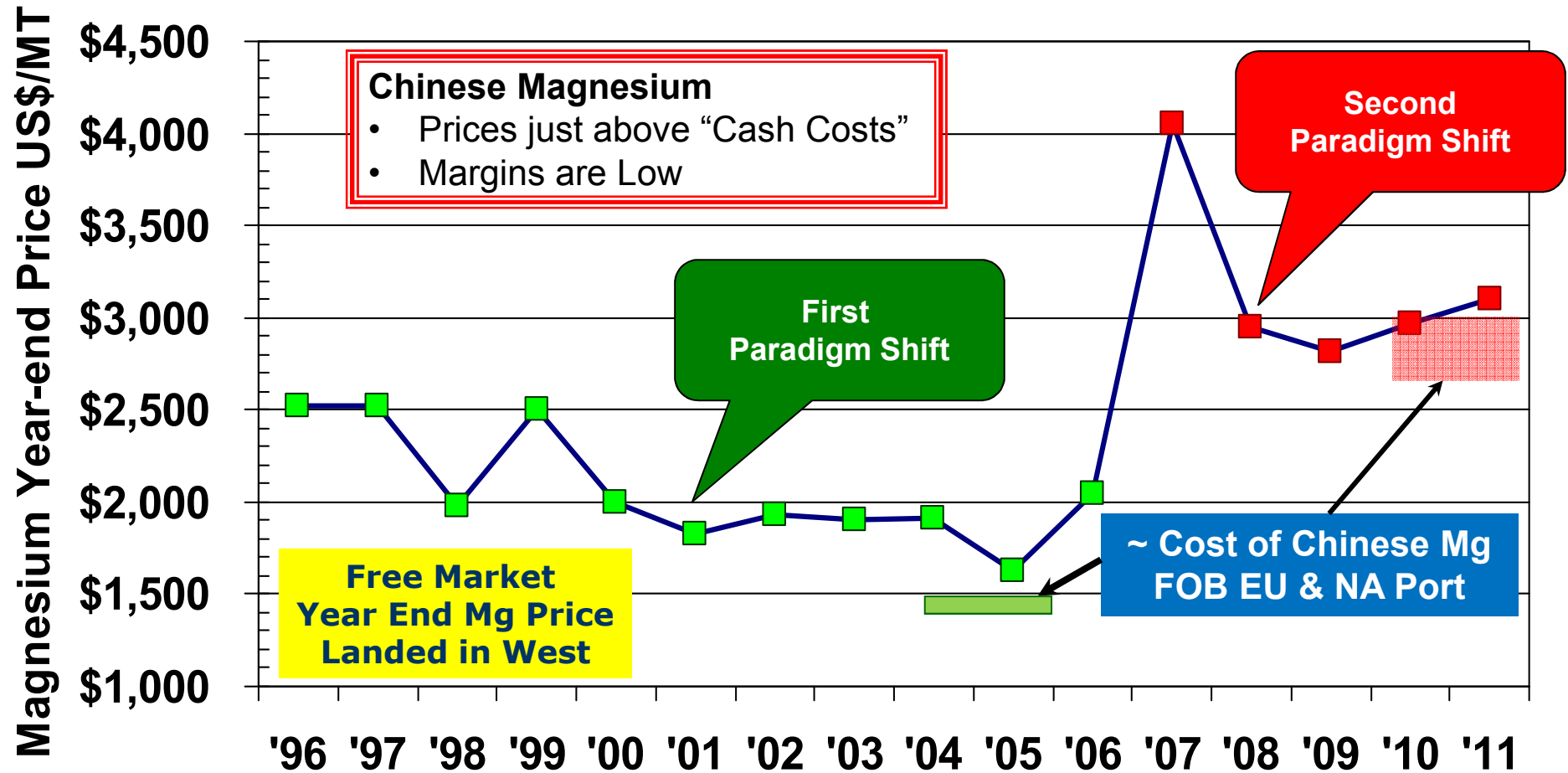
- ☒ **Chinese Mg Production Costs ... have risen sharply since 2005**

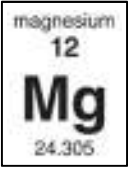
**Between 2005 to 2011
Cost of Mg Ingot “Delivered” to EU & NA Markets
Has Essentially Doubled**



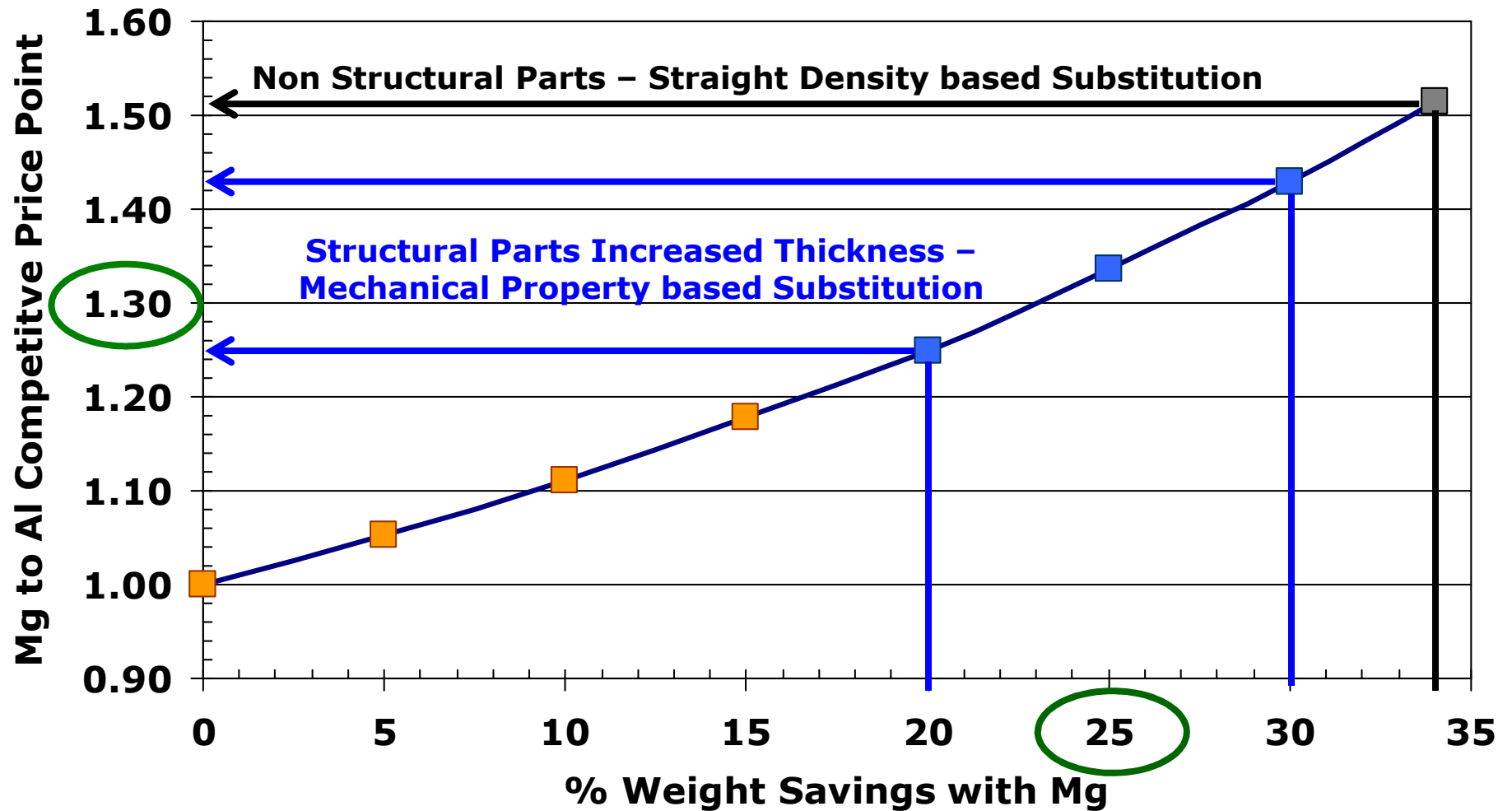
Today's Higher Magnesium Prices

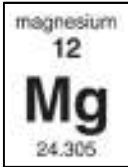
... reflect fundamentally higher Chinese production & transportation costs





Magnesium's Competitive Position *vis-à-vis* Aluminum

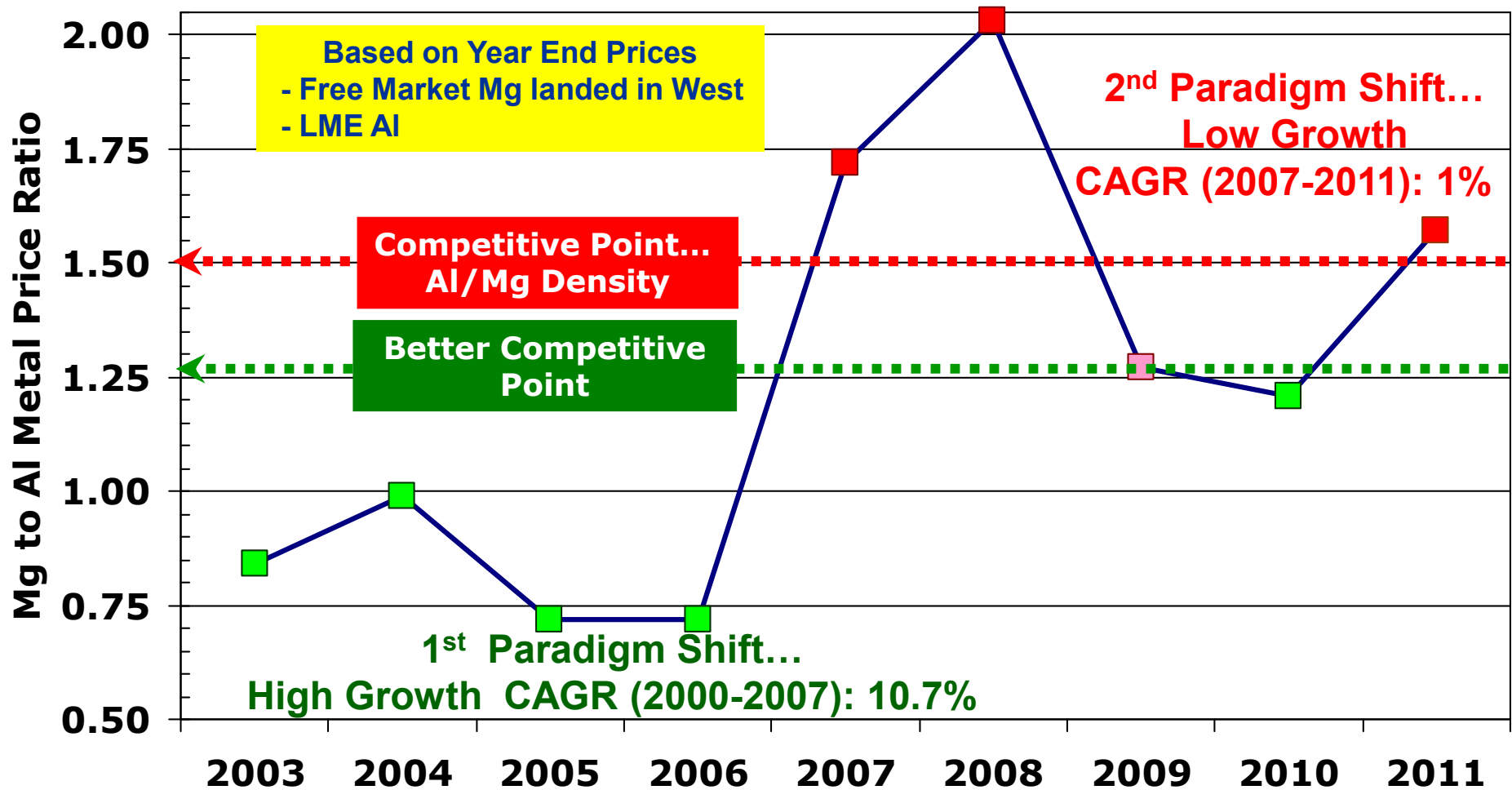


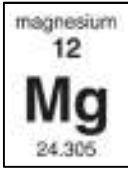


Free Market Mg Competitive Position



... deteriorated compared to aluminum & growth has suffered





What Can Mg Free Markets Expect Going Forward?



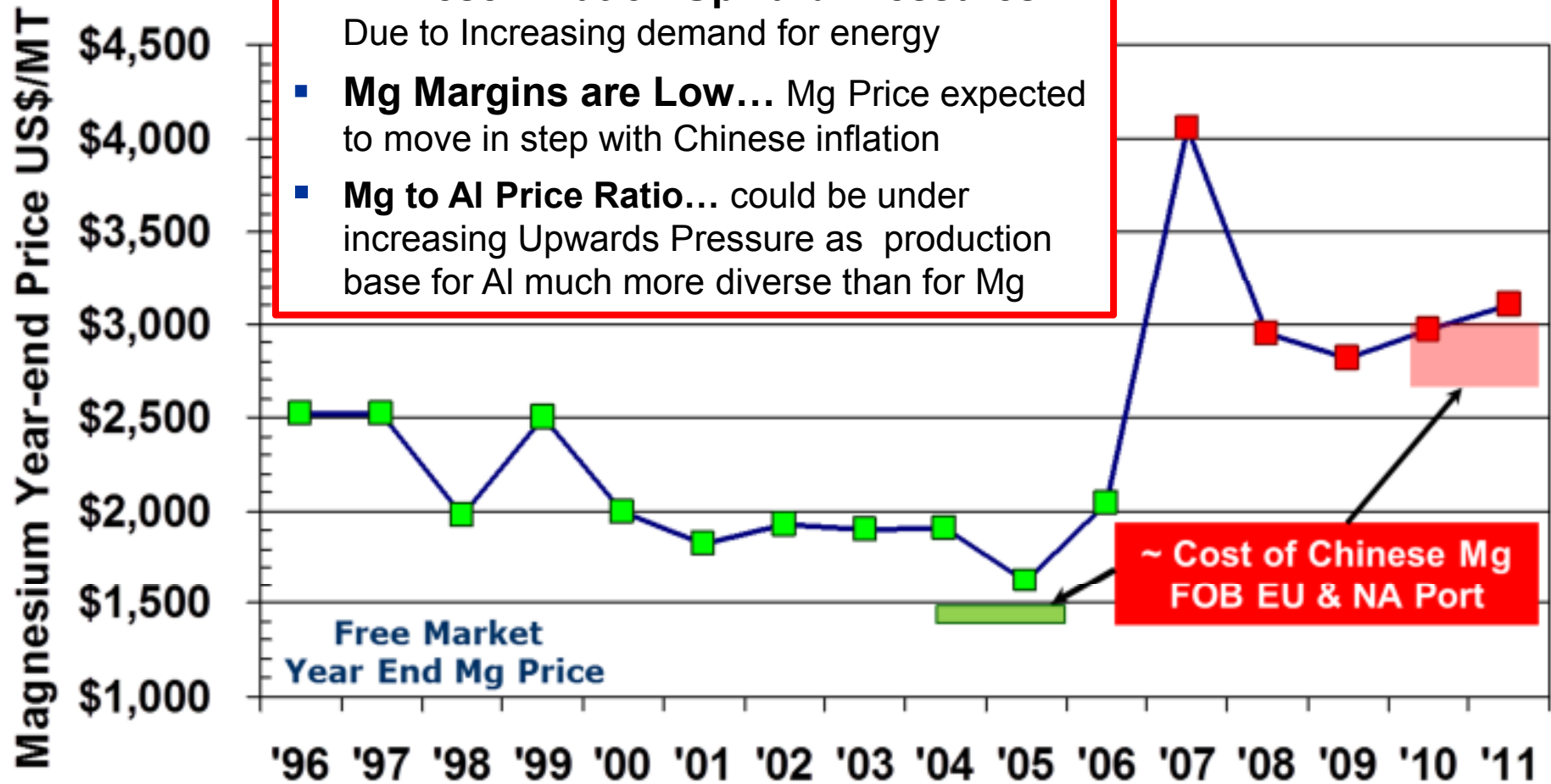
Chinese Magnesium Production Costs largely impacted by

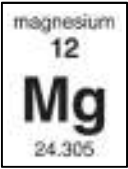
- **GDP...** has slowed somewhat but still growing @ very healthy 8 – 10% pa
- **Price of FeSi...** FeSi represents ~ 50% of Chinese Mg production cost
 - **Demand for Steel ...** determines demand & pricing of FeSi.
CRU (Feb 2012) projects Chinese steel production to recover by mid 2012 & continue to grow @ GDP levels
- **Electricity...** Major determinant in FeSi production cost
EU Policy Commission (May 2010) Chinese Electricity demand will grow @ 1.1 x GDP
- **Coal...** used extensively in Chinese Mg production & in Electricity generation
EU Policy Commission (May 2010) Chinese Coal demand will TRIPLE by 2025
- **Price of Oil...** affects Chinese inflation & overseas transportation costs
Chinese Fuel prices increase 6 - 7% TWICE in first 4 months of 2012
- **Inflation...** will put upward pressure on cost of labor
Chinese inflation target officially 4%; Actually running ~ 4 to 6.5%

What Can Mg Free Markets Expect? Given Concentrated Chinese Production

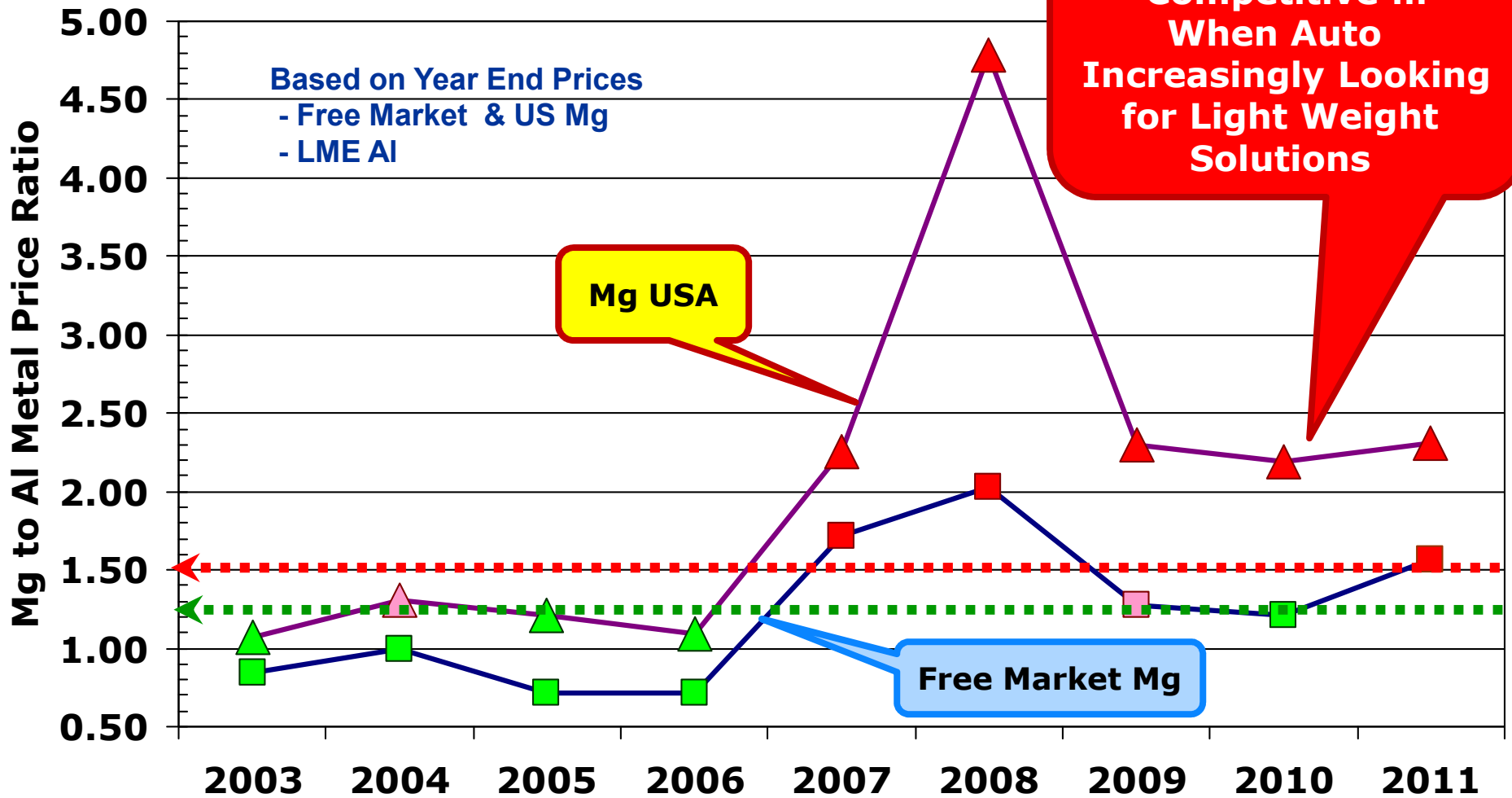
Future Magnesium Pricing???

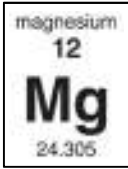
- **Chinese Inflation Upward Pressures....**
Due to Increasing demand for energy
- **Mg Margins are Low...** Mg Price expected to move in step with Chinese inflation
- **Mg to Al Price Ratio...** could be under increasing Upwards Pressure as production base for Al much more diverse than for Mg





USA Magnesium's Competitive Position... even worse *vis-à-vis* aluminum





MAGNESIUM...

Environmental Competitiveness

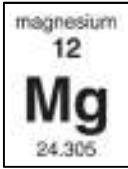


Mg Environmental Competitiveness...

- China ~ 80% world's Magnesium.... 1940 vintage Pidgeon Process
- Chinese Pidgeon Process is Energy intensive...
 - FeSi (50% of Mg Cost)... electricity generated from coal
 - Mg Production... uses coal or coal gas

Production Process (Location)		GWP Kg CO2/kg
Magnesium	China - Coal	43.3
	China -COG (IMA)	26.2
Aluminum	Average	12.7
	North America	9.8
	Europe	11.0
	China	24.7





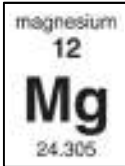
MAGNESIUM KEY SUCCESS FACTORS...to Seize Auto Opportunity



- ✓ **PROVEN TECHNICAL CAPABILITY...** as verified by USAMP study, Magnesium assemblies satisfy automotive performance requirements for
 - ✓ Crashworthiness
 - ✓ Noise, Vibration & Harshness
 - ✓ Fatigue
 - ✓ Durability & Corrosion
 - ✓ Joining & Fabrication
- ✓ **SIGNIFICANT WEIGHT SAVINGS...** Mg structural assemblies provide significant weight savings over Steel (~50%) & Aluminum (~25%)
- ✓ **DESIGN SIMPLICITY...** significant reduction in number of parts

REMAINING SUCCESS FACTORS... require new production technology that is competitive with other Light Weight Materials particularly with Aluminum

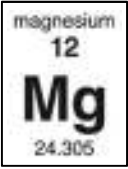
- ? Price ... Impacts on Price of increasing operating costs
- ? Environmental... Life Cycle Competitiveness



Gossan Resources Magnesium Project... 1st Advantage is Location & High Quality Ore Reserves

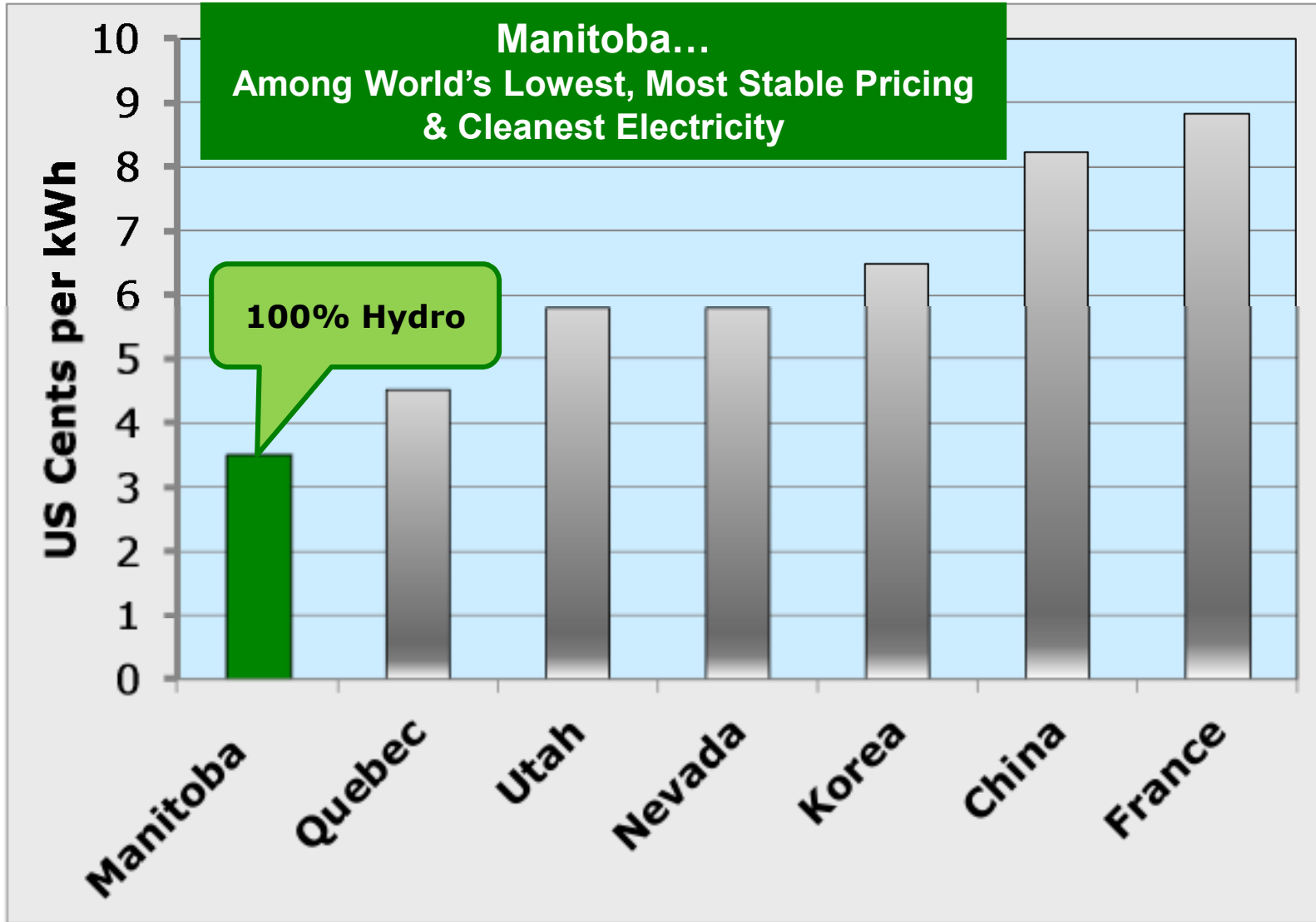


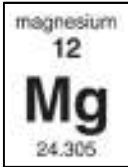
- ▶ **Strategic Manitoba Location...** mid-continent trade corridor with excellent access to NAFTA & EU
- ▶ **Extensive high purity Dolomite & Quartz reserves...** for Mg & FeSi Production
- ▶ **Measured Dolomite resource...** ~100,000 MT Mg metal per year for 30 years



Gossan's Magnesium Project...

2nd Advantage is Electricity





Gossan's Magnesium Project...

3rd Advantage Breakthrough Technology



EXECUTION PLAN

Develop Breakthrough Process Concept

- Increase raw materials utilization efficiency
- Reduce energy consumption
- Minimize labor & process complexities
- Increase %yield & recoveries
- Continuous Process
- Competitive cost & environmentally with Al



Confirm Process Fundamentals Correct

- Thermodynamics
- Kinetics



Experimental Confirmation

- Bench Scale Testing... confirm modeling
- Larger Scale Testing... material flow



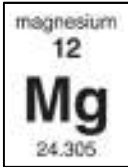
Pilot Scale Demonstration

STATUS

- ☑ Breakthrough process conceived... signed contracted Gossan 2007
- ☑ Detailed Cost Modeling indicated
 - ✓ 25 – 30% advantage... over Chinese Mg cost
 - ✓ Cost... within 1.3 Mg to Al “Competitive Cost Ratio Target”
- ☑ FactSage Thermodynamic Modeling... Prof Pelton Ecole Polytechnique Montreal
- ☑ Confirmed fundamentally sound
- ☑ Bench Scale Trials... Process Research ORTECH
- ☑ Test & Modeling results agree
- ☑ Larger Scale Tests underway



Planning 5,000 MT semi-commercial facility



Experiment & Model Comparison... Exceptional Agreement

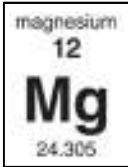


Reduction of Calcined Dolomite to Produce Magnesium Vapor

Agreement ...
Experiment & Model
Exceptional

Parameter	Measure	Experimental Mass Balance	Thermodynamic Model	Delta %
FeSi Balance	Weight Consumed by reaction	25.0	25.3	1.2%
By-Product Balance	Weight Produced by reaction	131.3	130.1	0.9%
	Molar CaO/ SiO2	1.98	2.04	2.9%
Mg Balance	Weight Produced by reaction	34.0	33.8	0.6%
Efficiency Factors	Mg Produced per Si Consumed	1.63	1.63	0.0%
	% Si Efficiency	94.4%	94.2%	0.2%
	% Mg Recovery	92.9%	92.3%	0.6%

Method Patent Filed... 1st US Provisional patent filed June 2011
2nd US Provisional patent filed April 2012



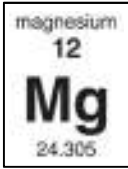
Comparison of Mg Processes



Process Comparison to produce 1 kg Mg ingot	Pidgeon Process CHINA	GOSSAN CANADA
World Magnesium Production	~ 80%	NA
Process Dynamics	Solid State	Molten State
Reduction Reactor Pressure	Vacuum	Atmospheric
Mg Recovery – from calcined ore	~ 74.0%	90.4%
Silicon Efficiency	~ 64.8%	91.9%
Production Cost Ratio	1.00	0.70 – 0.75
GHG – kg CO2 per kg Mg	26.2 ** - 43.3 *	9.1 **
LCA – breakeven ,thousand km	171.6 – 275.6 ***	69.5***

* Thanumarajah et al, Journal of Cleaner Production, Vol. 15, 2007
 ** IMA with COG (2012)
 *** Based on 222 kg weight saving from 154 kg Mg following method of F.D'Errico et al. JOM, Vol. 61, No.4, 2009

**Magnesium
Very Competitive
with Aluminum**



Summary



USAMP Study ... Mg assemblies can be significant player in lightweight auto

- ✓ Confirms Technical Capabilities
- ✓ Confirms Significant Reduction Number of Parts
- ✓ Confirms Significant Weight & Fuel Savings

Mg production dominated by China (~80%) & US Tariffs

- ? Rising Production Costs
- ? Mg Prices Ongoing Upward Pressure
- ? “Mg to Al” Price Ratio Upward Pressure
- ? Environmental GWP & LCA

Gossan’s Breakthrough Magnesium Technology

- ✓ **Significantly Improved Process Efficiencies...** production cost 25 - 30% less than China & within target 1.3 Mg/Al competitive production cost ratio
- ✓ **Environmentally Competitive...** favorable GWP & LCA
- ✓ **Gossan Resources Mg Project...** favorable western location, high quality dolomite resource & exceptionally low and stable electricity rates