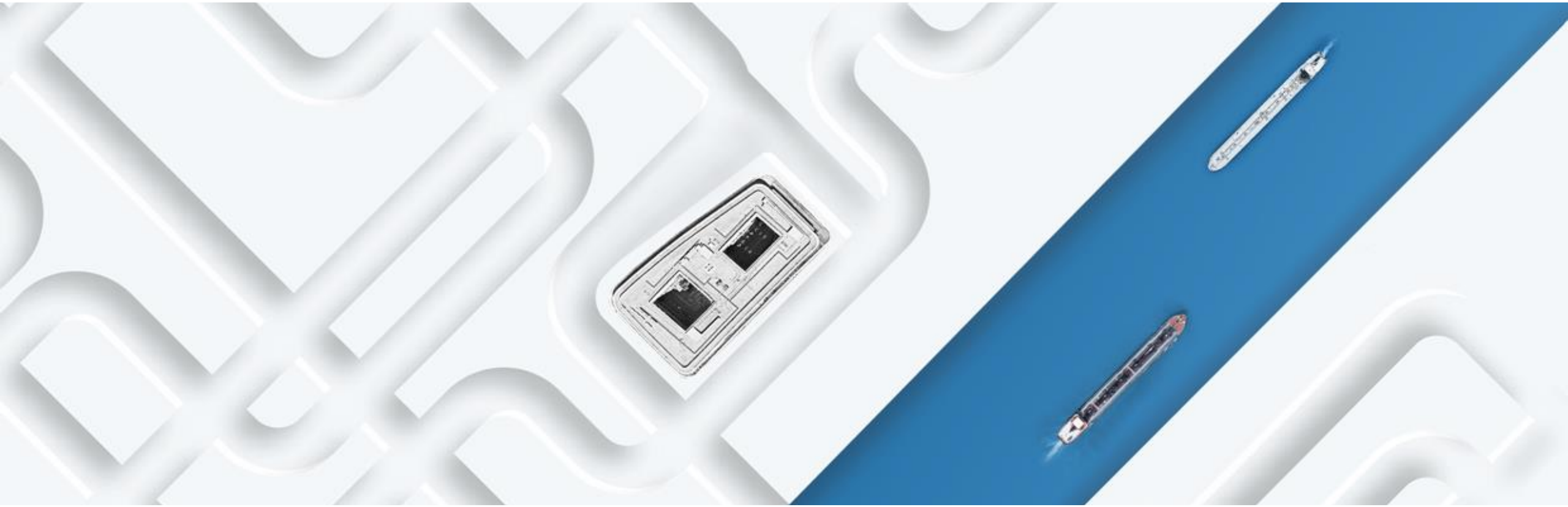
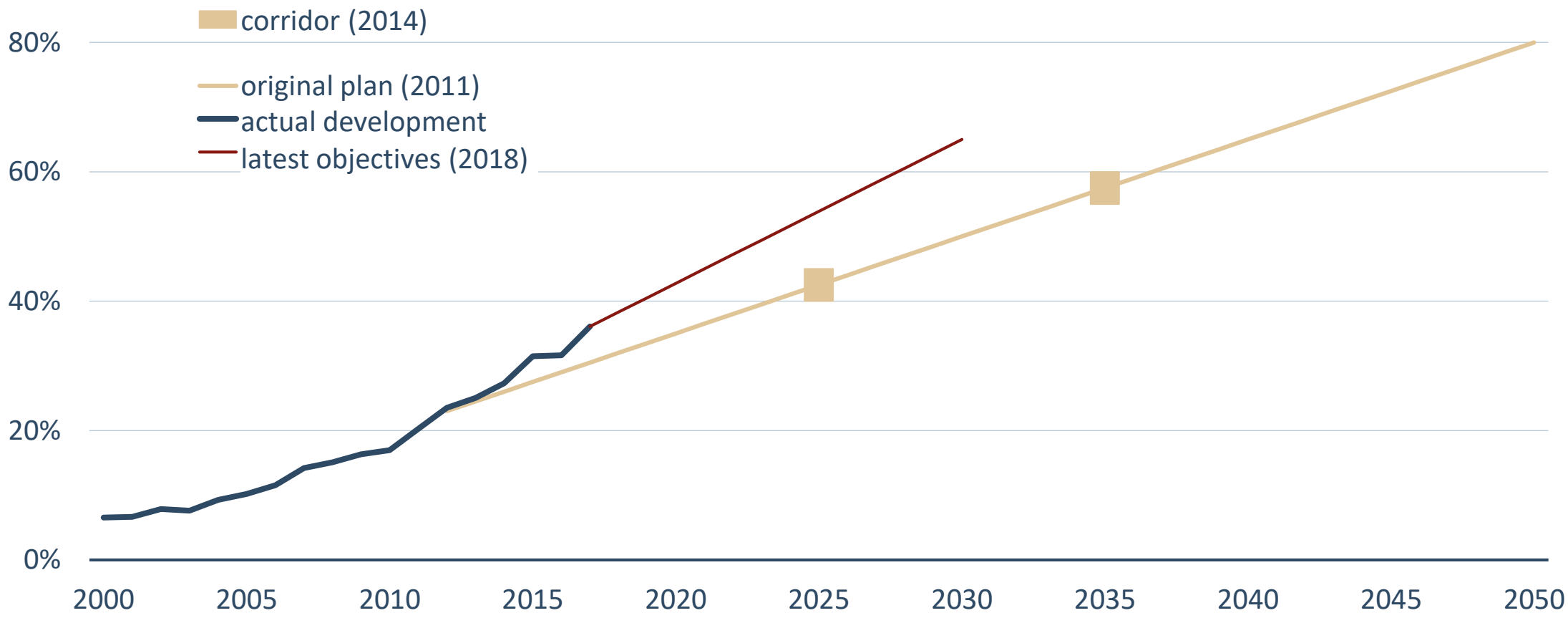
Resource Risks associated with Raw Materials for the Energy Transition



E-Mobility 1899 – Lohner Porsche

Objectives: Expansion of Renewable Energies



Sources: AG Energiebilanzen, 2015; EEG, linear update

Elements with high additional demand caused by new energy technologies

potential additional demand untill 2035 as share of 2013 mining production (high demand scenarios)

Technology	Element	Additional demand up to…
solar-thermal power plant	Magnesium	12 %
Stationery fuel cell (SOFC)	Scandium	122 %
Lithium-Ion batteries for passenger cars	Cobalt	84 %
	Nickel	7 %
	Lithium	368 %
Vanadium-Redox batteries	Vanadium	37 %
Micro harvesting	Dysprosium	9 %
	Neodymium	4 %
Windmills	Molybdenum	6 %
	Tin	6 %
	Neodymium / Praseodymium (Light Rare Earths)	48 %
	Dysprosium / Terbium (Heavy Rare Earths)	50 %

Source: based on Marscheider-Weidemann et al, 2016

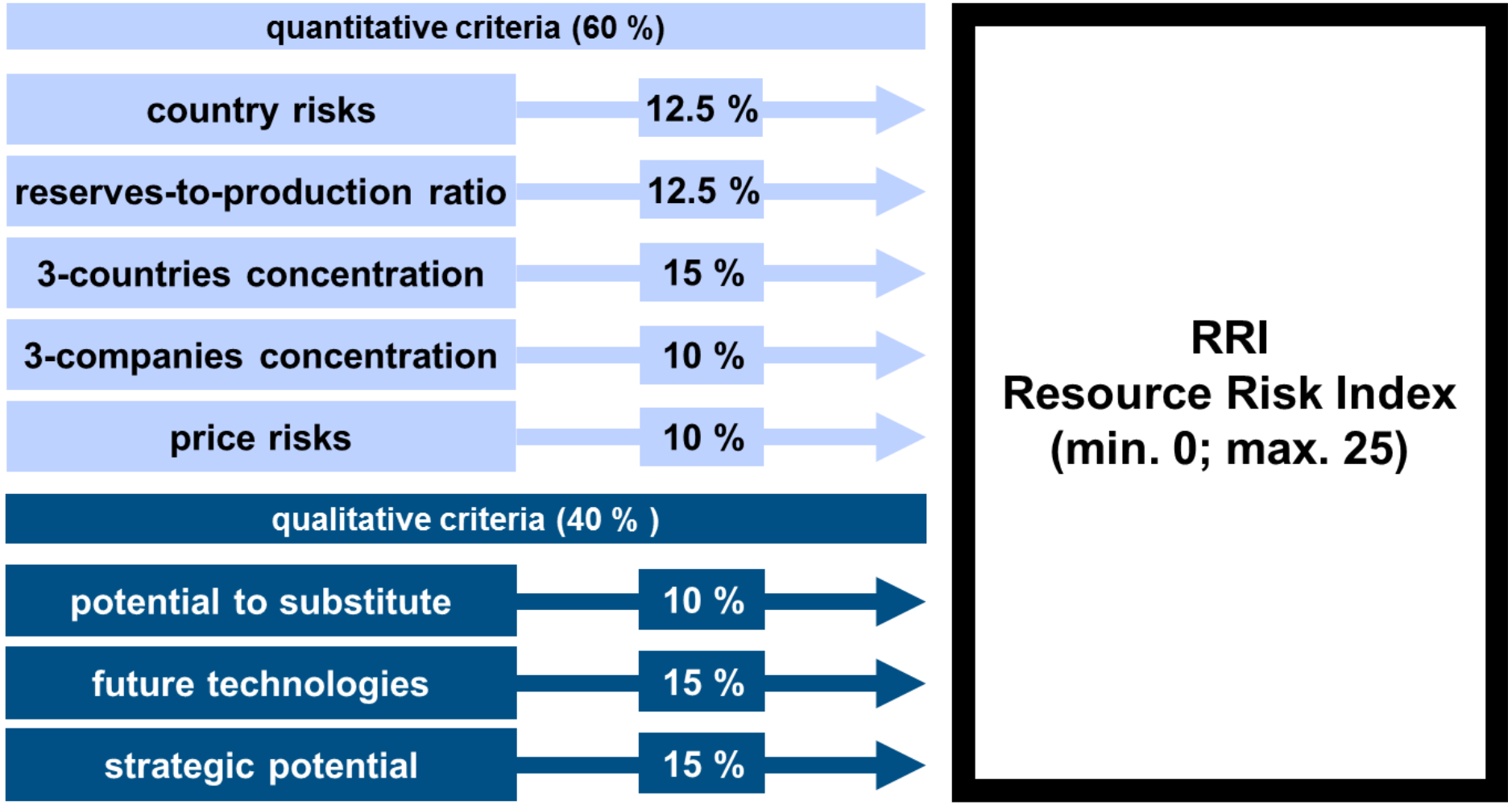
Supply Risks for Metals

Answers from companies on a scale from 1 (very little risk) to 6 (very high risk)

	Total
Price rise	4.3
Price volatility	4.2
Short-term loss of supply	2.9
Insufficient supply	2.7
Discrimination compared to competitors	2.6
Political risks	2.5
Bureaucracy	2.5
Trade barriers	2.4
Transport risks	2.3

Source: Bardt / Kempermann / Lichtblau, 2013

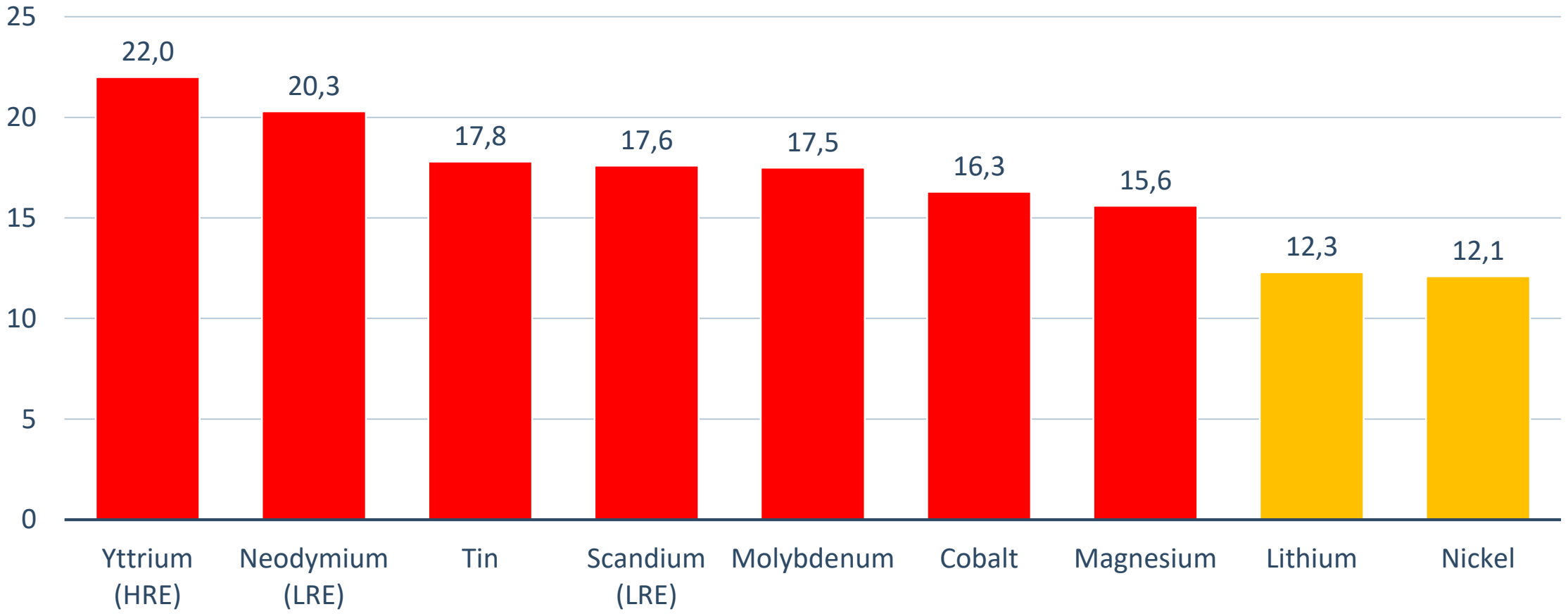
Composition of the Resource Risk Index (RRI)



Source: vbw / IW Consult, 2017

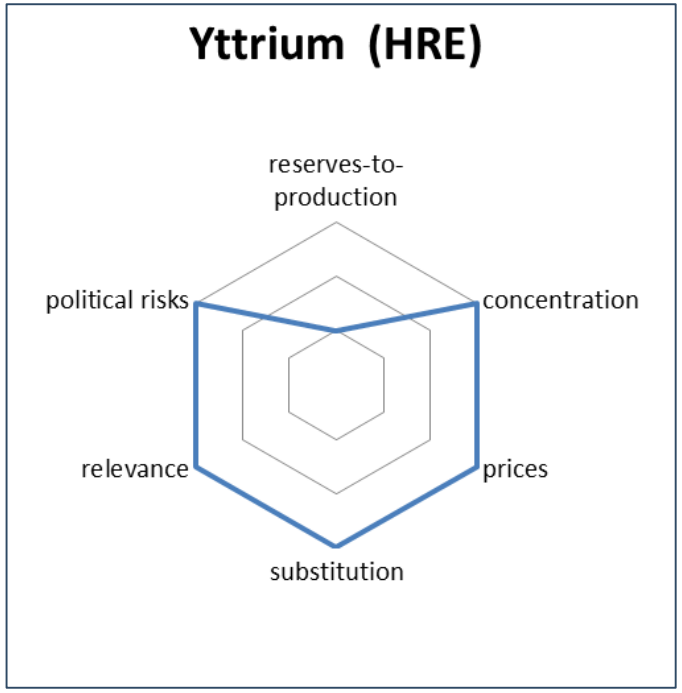
Resource Risk Index (RRI) of Energy Technology Resources

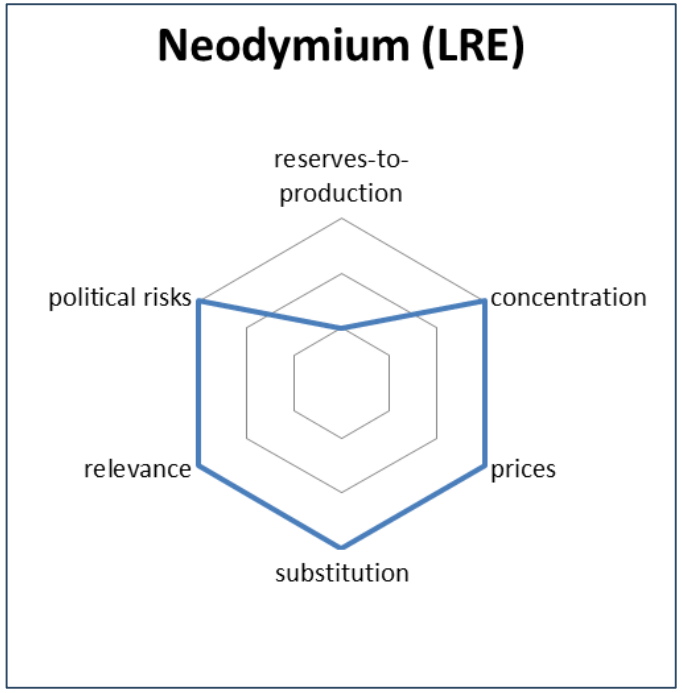
RRI-scale from 0 (no risks) to 25 (maximum risks)

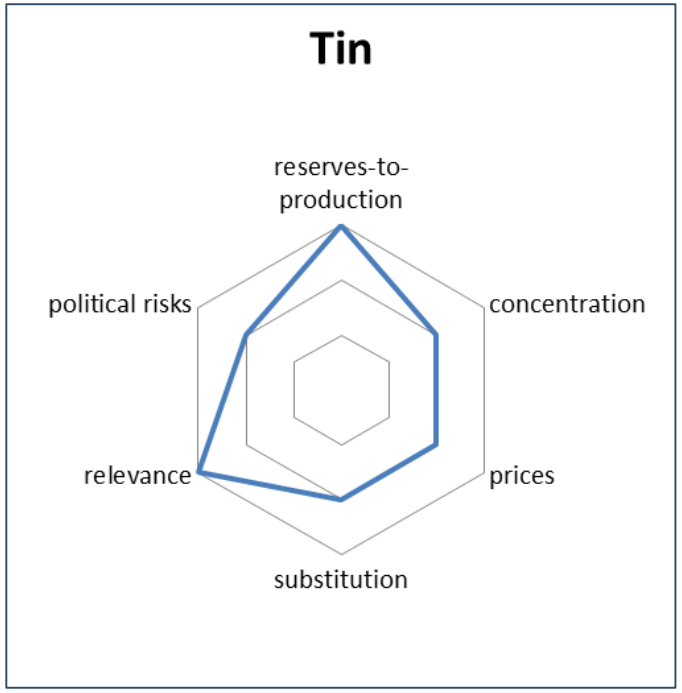


Source: vbw / IW Consult, 2017

Risk Profiles of Energy Technology Resources (1/3)

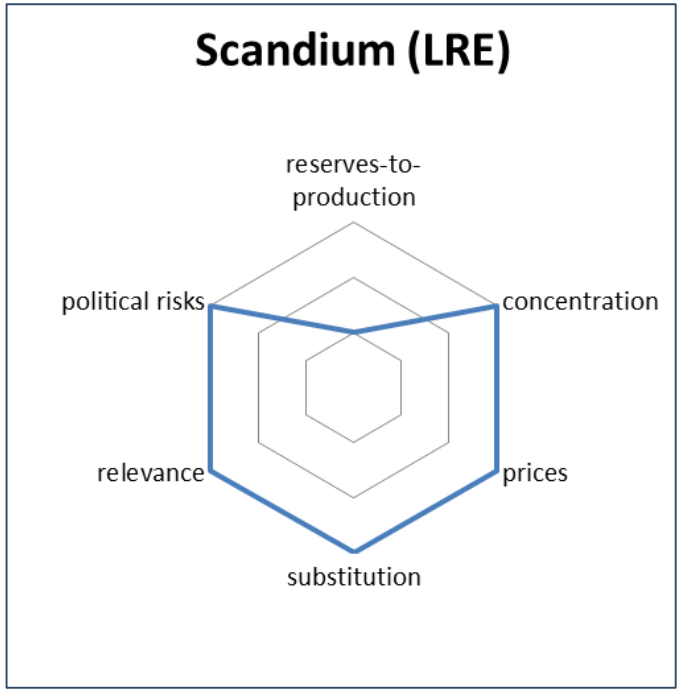


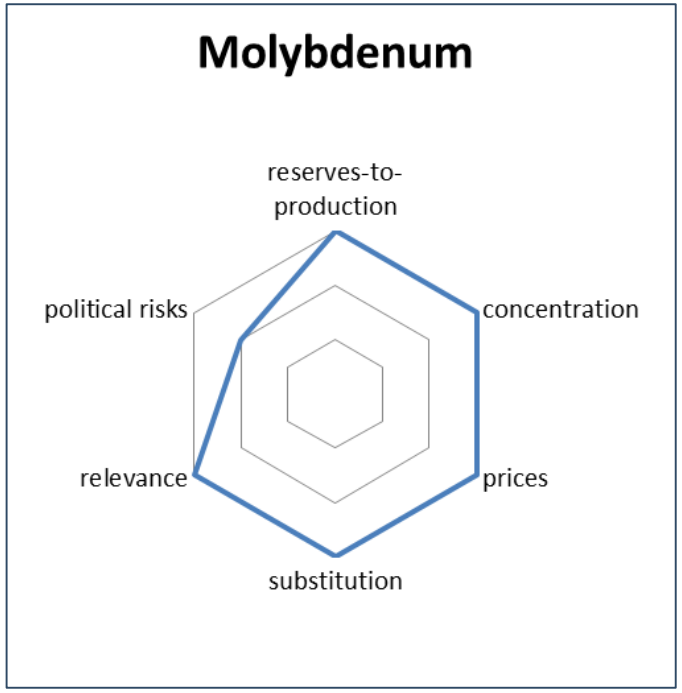


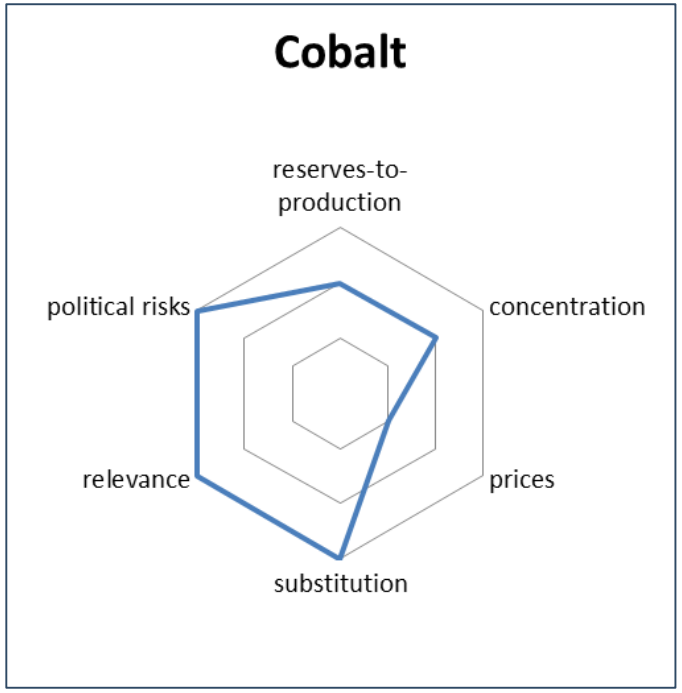


inside: lower risk, outside: higher risk
Source: based on vbw / IW Consult, 2017

Risk Profiles of Energy Technology Resources (2/3)

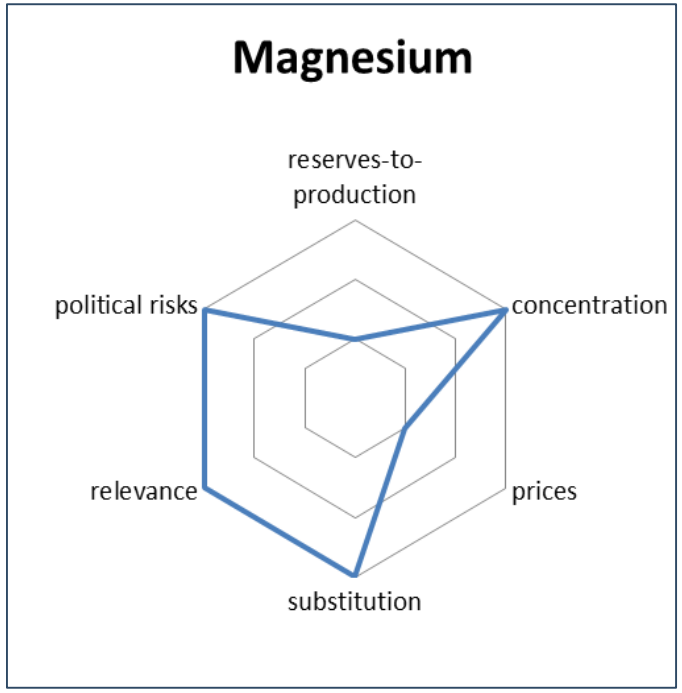


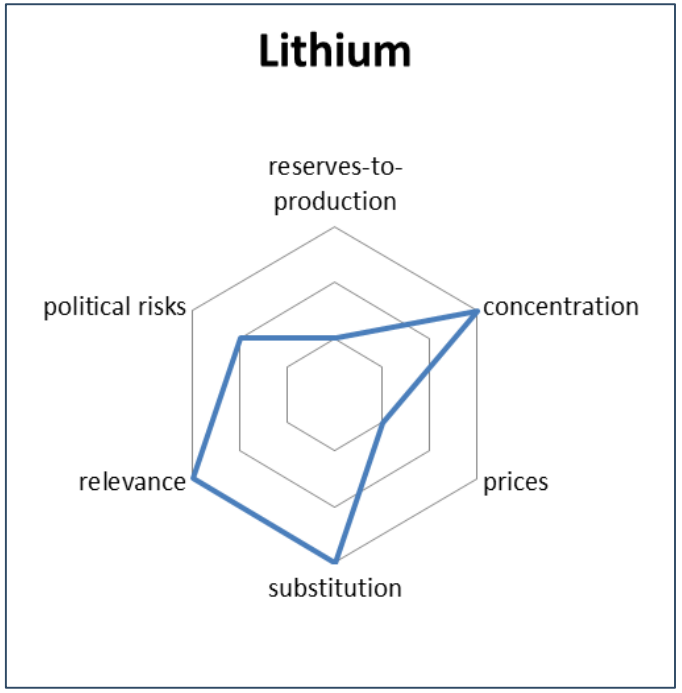


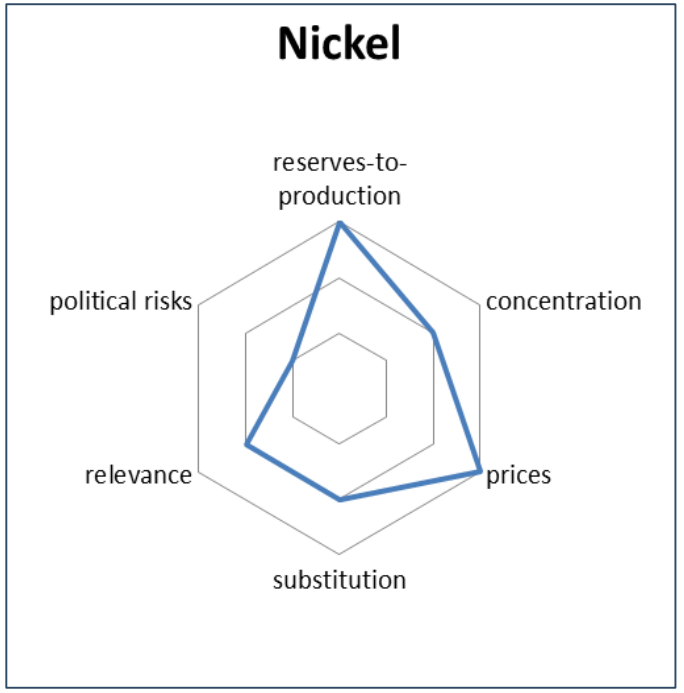


inside: lower risk, outside: higher risk
Source: based on vbw / IW Consult, 2017

Risk Profiles of Energy Technology Resources (3/3)

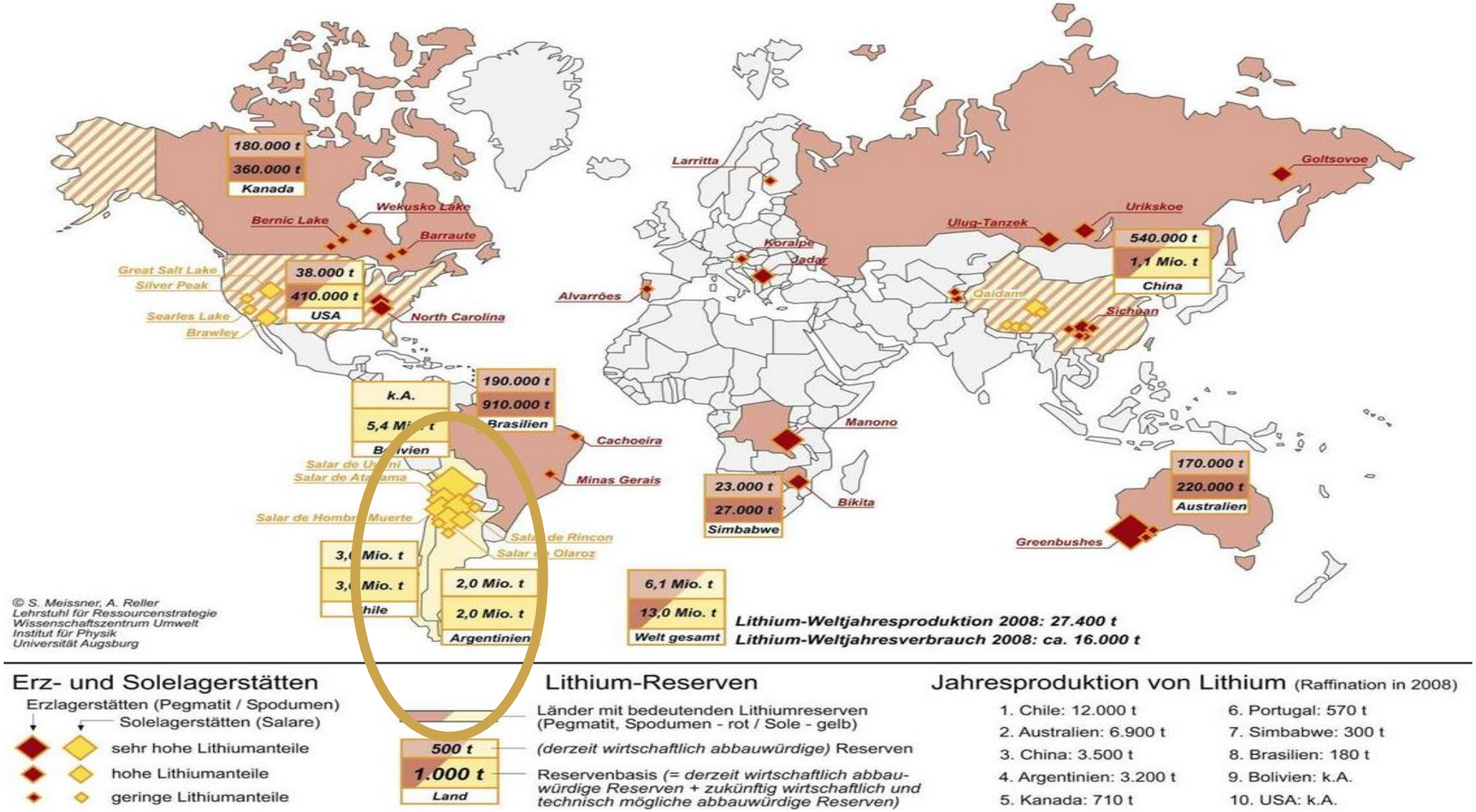






inside: lower risk, outside: higher risk
Source: based on vbw / IW Consult, 2017

Global Distribution of Lithium



Measures to Cope with Supply Risks

Answers from companies, in percent

	Small company	Medium company	Large company	Total
Long-term supply contracts	31.9	59.1	69.2	59.5
Diversification of supply	38.4	48.4	57.0	49.9
Increase in resource efficiency	31.5	42.7	40.4	41.0
Price hedging	9.5	28.7	47.7	32.3
Research and development	8.6	18.6	28.0	20.3
Substitution and secondary resources	6.4	13.0	18.6	14.0
Recycling	11.0	12.5	17.1	13.7
Pooling of demand to increase market power	8.3	10.9	16.7	12.3
Nothing	24.7	9.5	6.1	10.0
Investment in resource-rich countries	0.7	1.5	3.1	1.9
Investment in mining companies	0.4	0.7	1.4	0.9

Small companies: less than 1-million-euro turnover; medium companies: 1 to 50 million euro turnover; large companies: more than 50 million euro turnover
Source: Bardt / Kempermann / Lichtblau, 2013

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