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Hybrid Logistic Curves And Contradictions Based Approach For Long-Term Technology Forecasting

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Forecasting III : Stream: Forecasting & Time Series Prediction

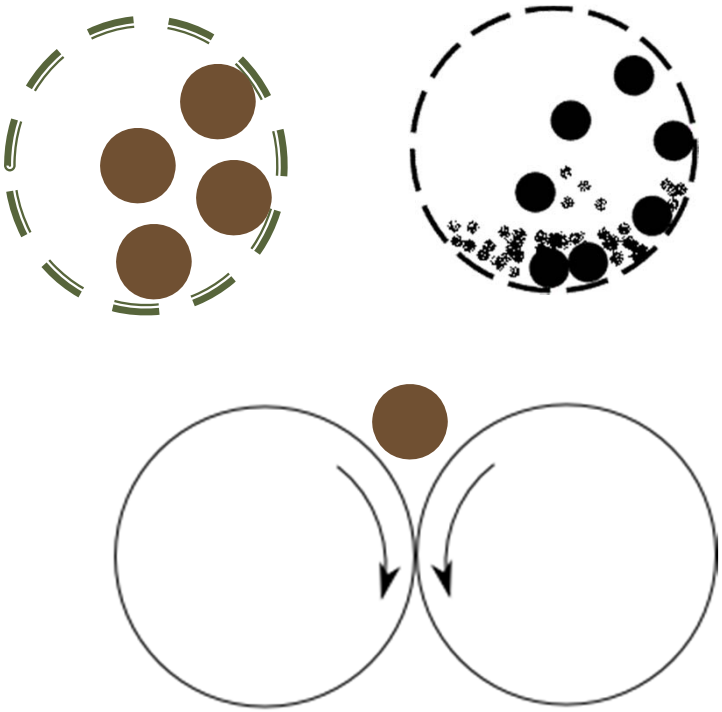
Introduction

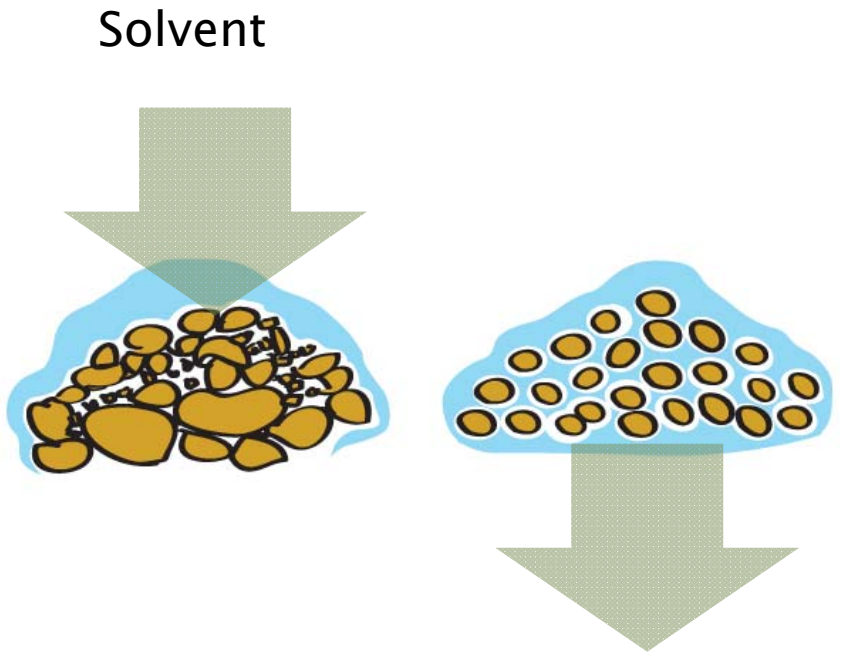
- Context of example
- Outline

Outline

1. Forecasting with S-curves
2. Contradiction analysis
3. Combining the analysis

Available technologies





Mechanical

Chemical (leaching)

Forecasting problem

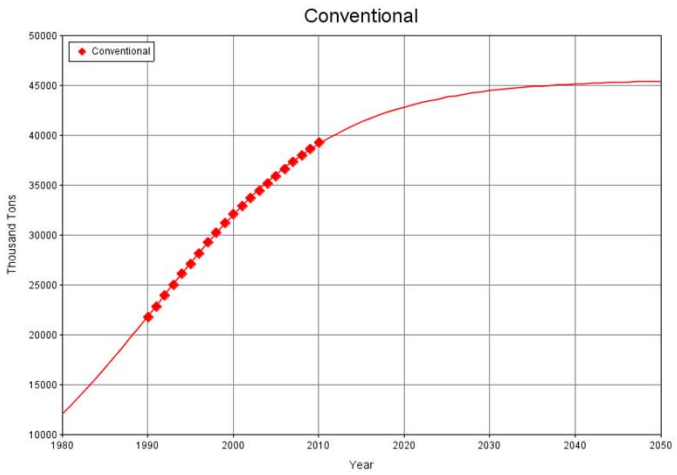
Copper Ore Size-Reduction Process technology substitution (until 2045, in Chile)

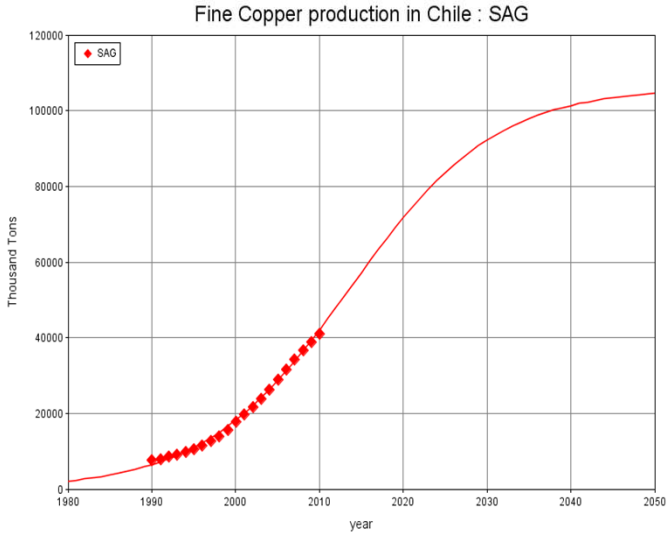
1. Size-reduction technologies life-cycles?
2. neXt technology after crushing and grinding?
3. Gaps of Knowledge and path today→neXt?

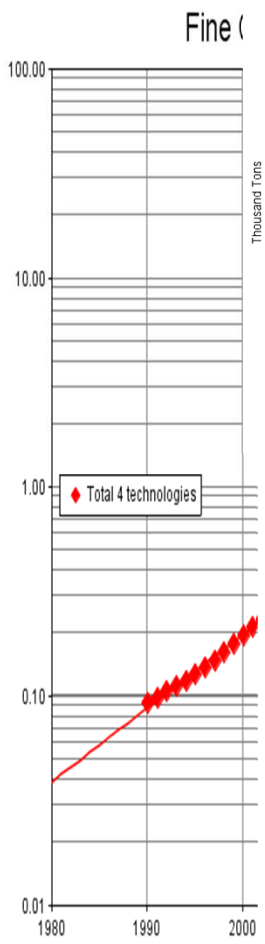
Forecasting with S-curves

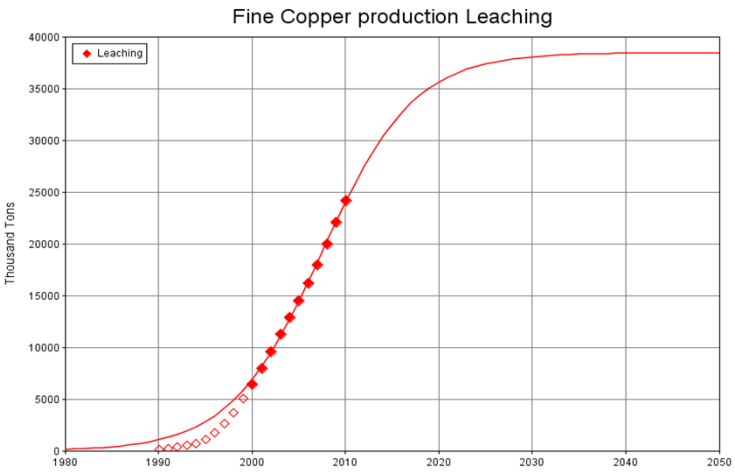
- Simple logistic
- LSM
- Questions about future

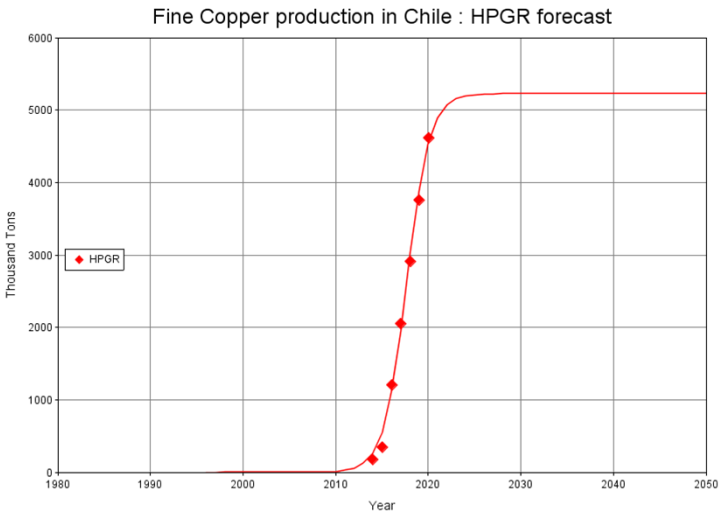
Simple logistics



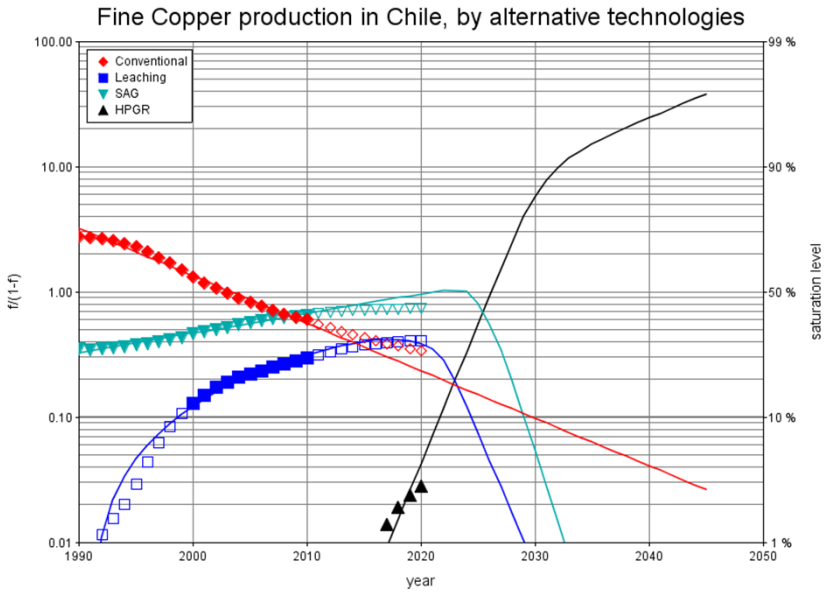




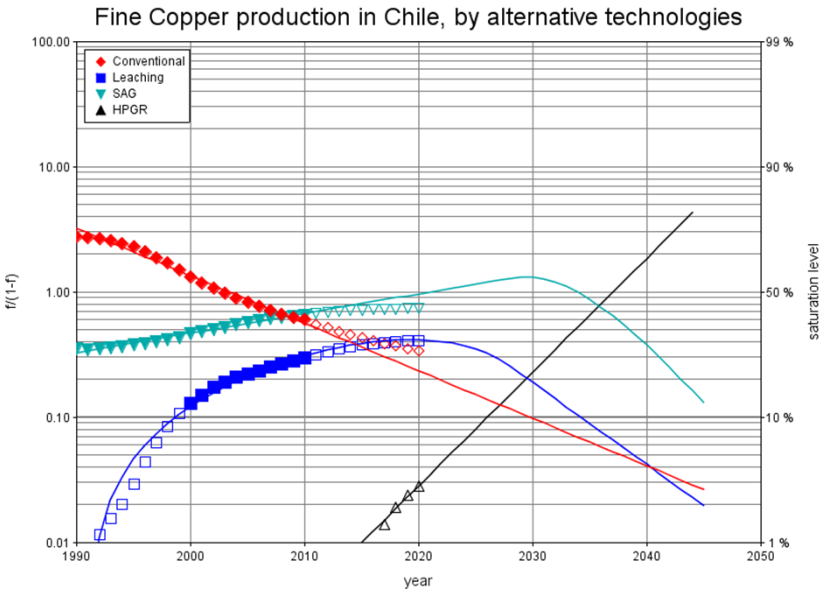




LSM data/scenario

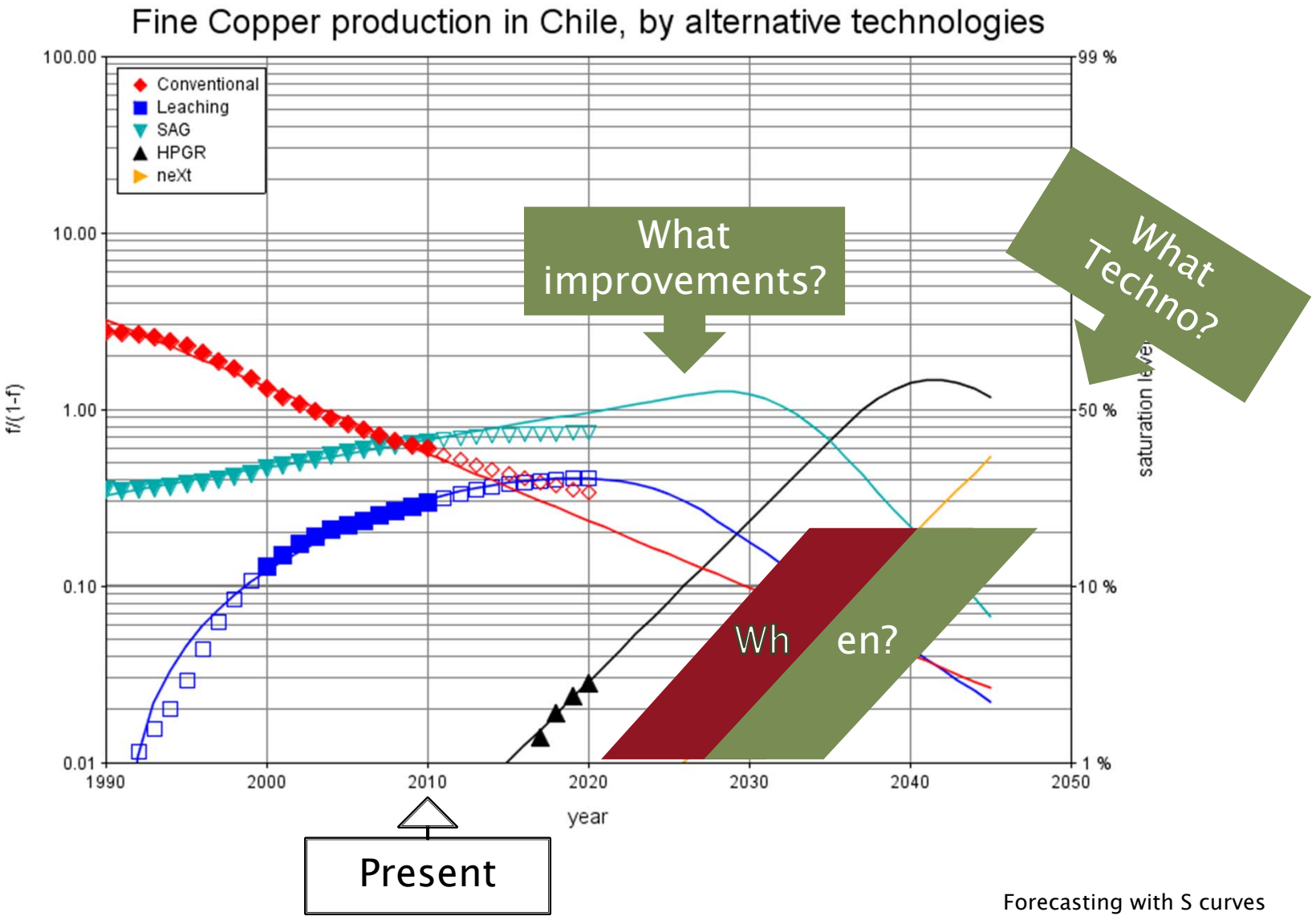


Present



Present

LSM scenario-neXt



Forecasting with contradiction network

- Developping features and challenges for the future of competing technologies

Forecasting the WWW

- Underlying competition among elements of a system (population) under limited resources
- Links system and components

Essence of TRIZ:

- Recognition that **technical systems evolve** towards the increase of ideality
  - by overcoming contradictions
  - mostly with minimal introduction of resources.
- .....

Adapted from
Toru Nakagawa (Osaka Gakuin Univ., Japan)
May 16, 2001

List of problems

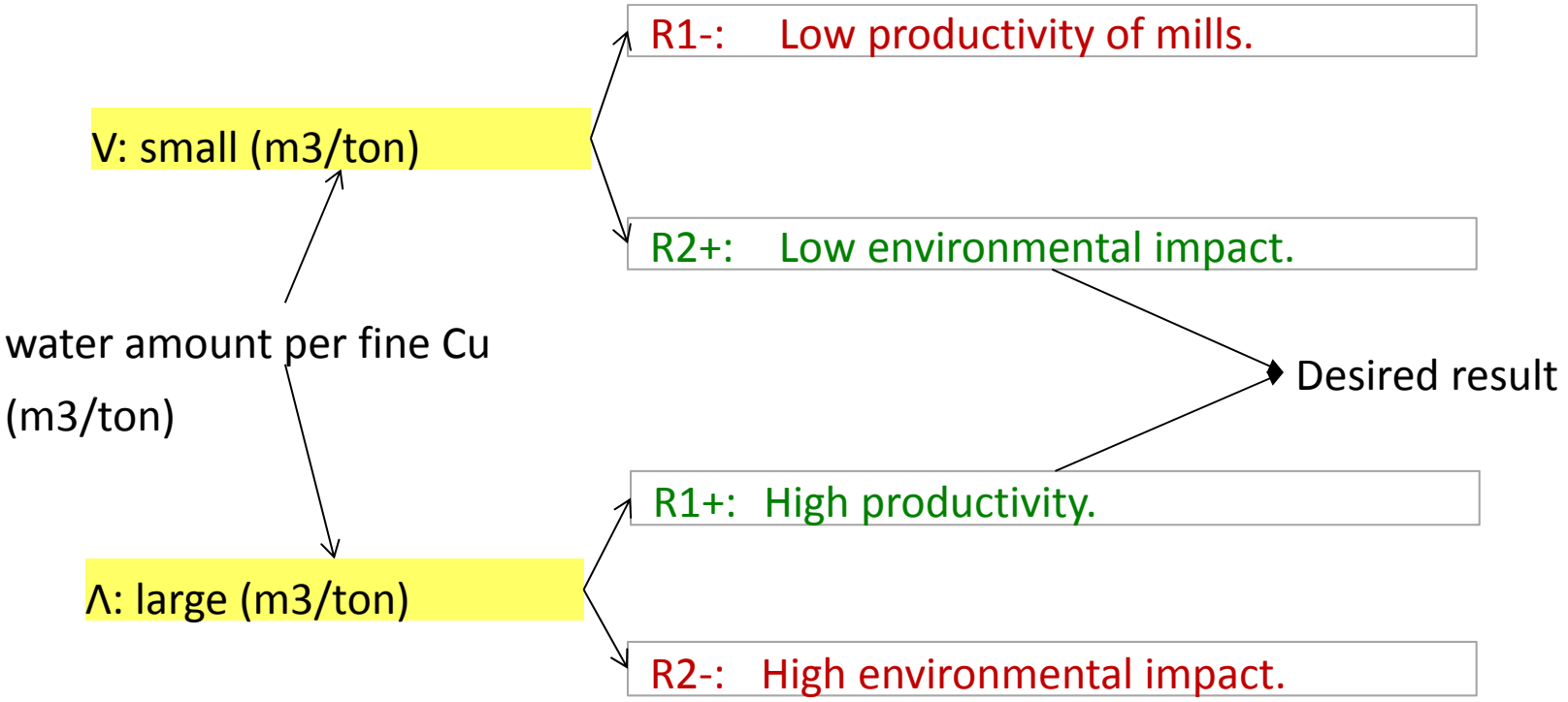
#	Conventional	SAG	HPGR	LEACHING
1	High energy consumption and number of equipment generates a high carbon footprint.	Highest energy consumption generates de highest carbon footprint.	No problem with water.	Not well controlled process.
2	Lack of energy efficiency because of high number of electric equipment with low efficiency electric motors and distribution systems.	Lowest energy efficiency because of high energy consumption of SAG mills.	No problem with financial resources .	Need of a large surface available.
3	There is a lot of water losses during the process.	There is a lot of water losses during the process.	Lack of experience in Copper application.	Low Copper recovery.
4	High number of equipment and interconnection systems makes very complex engineering facilities.	High operational costs because of complex control systems and maintenance costs for SAG mills.	No problem with maintenance costs	Poor safety conditions for operators.
5	Energy consumption and higher number of operators due to higher number of equipment and less automation control makes operational costs the highest of four technologies.	High impact in plant performance of availability and productivity of SAG mills.	Higher probabilities of failures in operation because of higher human intervention.	Not a good option for ores with high percentage of Cu.
6	Needs of a large operational period because of high investment costs for pay back.	Not a good option for ores with low percentage of Cu.	Reduced availability of specialized technicians in Chile for HPGR.	Restrictions of special temperature conditions for bacterial leaching.
7	Large footprint because of high number of equipment and large process net.	Concentrated industry of SAG mills manufacturers.	Concentrated industry of HPGR manufacturers.	Largest processing time.
8	Higher probabilities of failures in operation because of higher human intervention.	Highly specialized technicians for maintenance assistance.	Preventive maintenance of HPGR has a high impact in plant production.	
9	Higher maintenance costs because of high number and different kinds of equipment.	Preventive maintenance of SAG mills has a high impact in plant production.		
10		Need of the highest financial resources of the four technologies.		

Contradiction model

SAG

3. Contradiction for Water amount (partial)

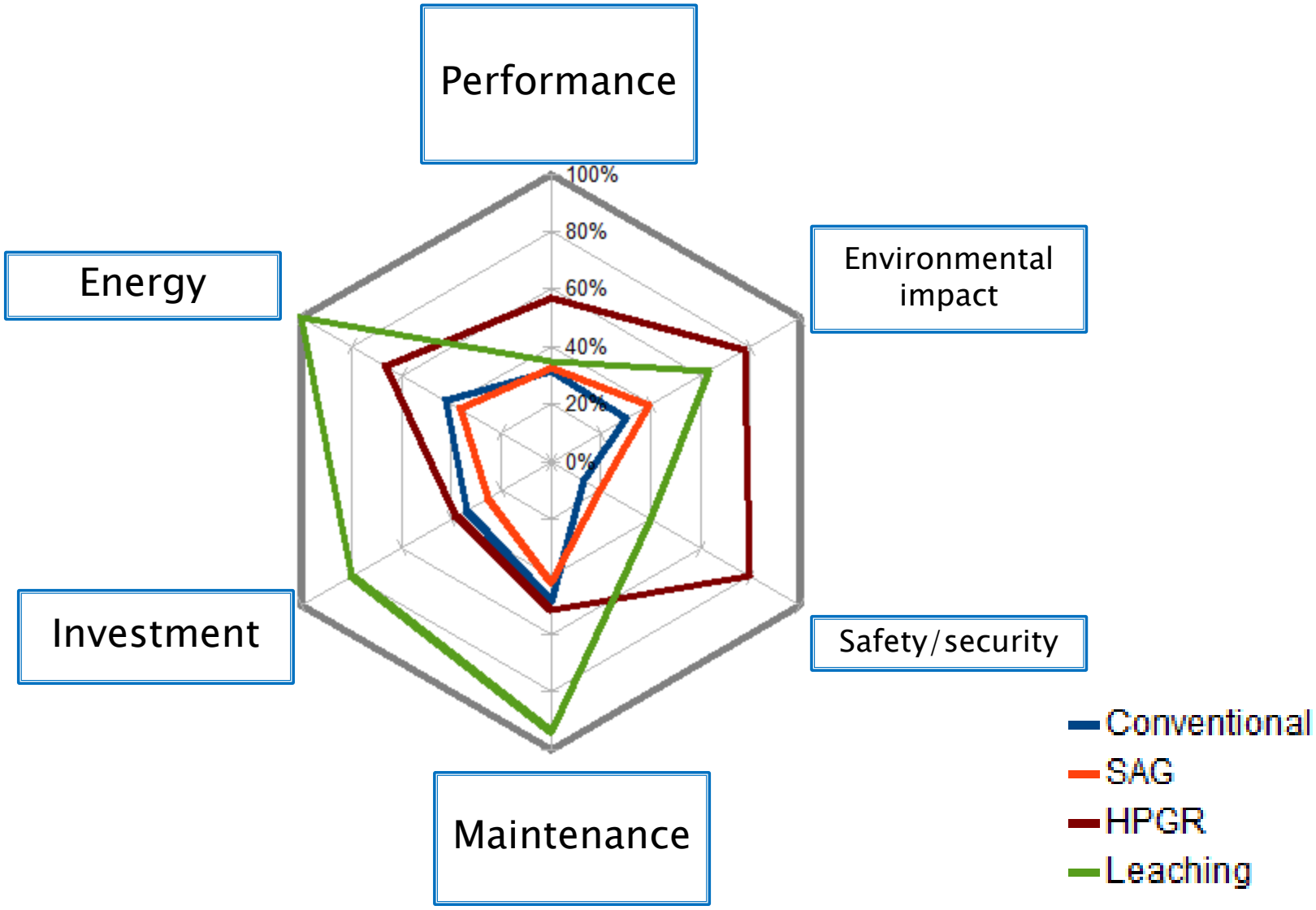
SAG technology needs large amount of water, a resource that is scarce



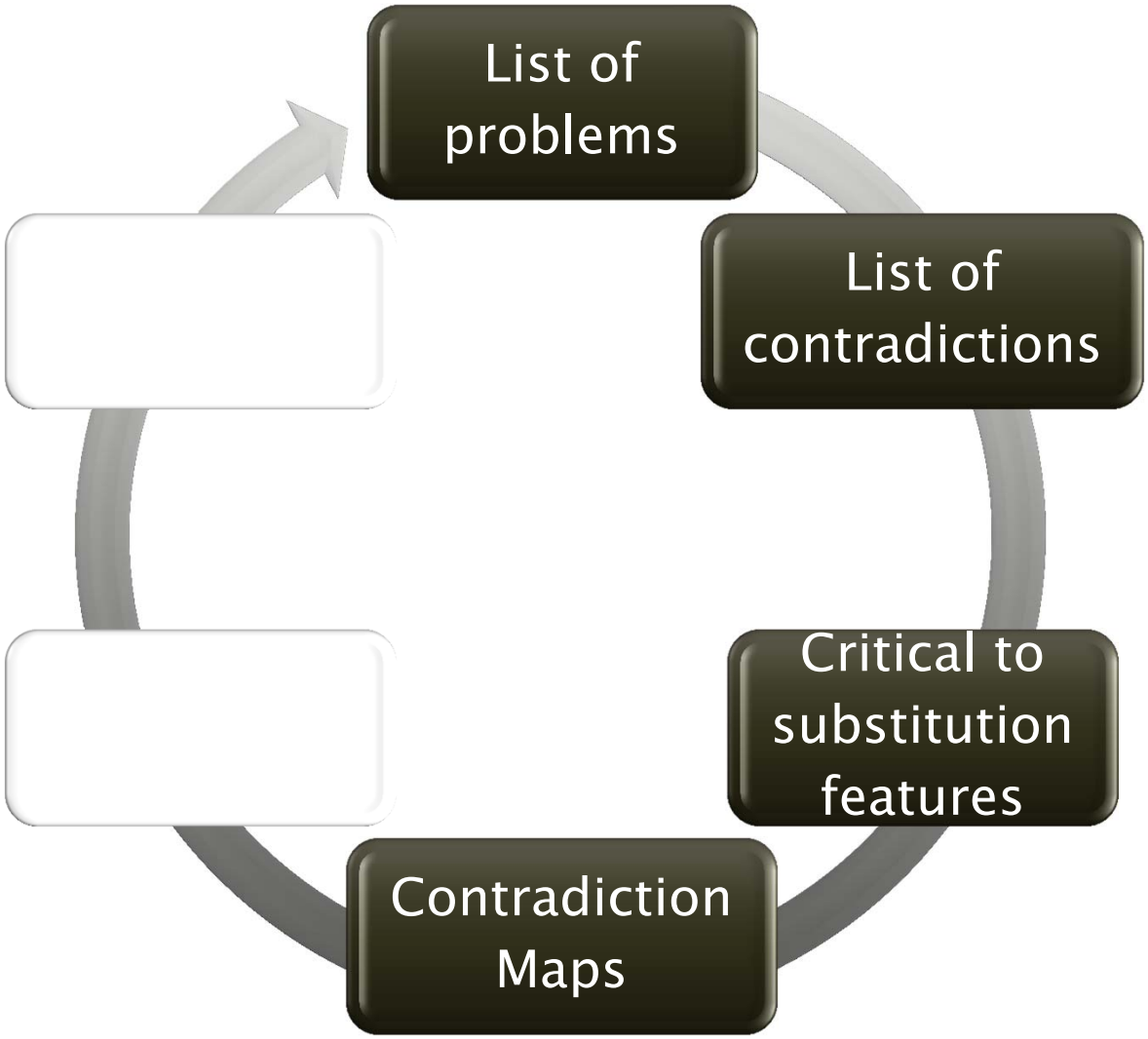
Critical-to-Substitution Features & values

Group	Indicators	Unit	Best	Actual Value				Better Future Value
				Conventional	SAG	HPGR	Leaching	
	Productivity	ton/year	high	50	70	100	20	100

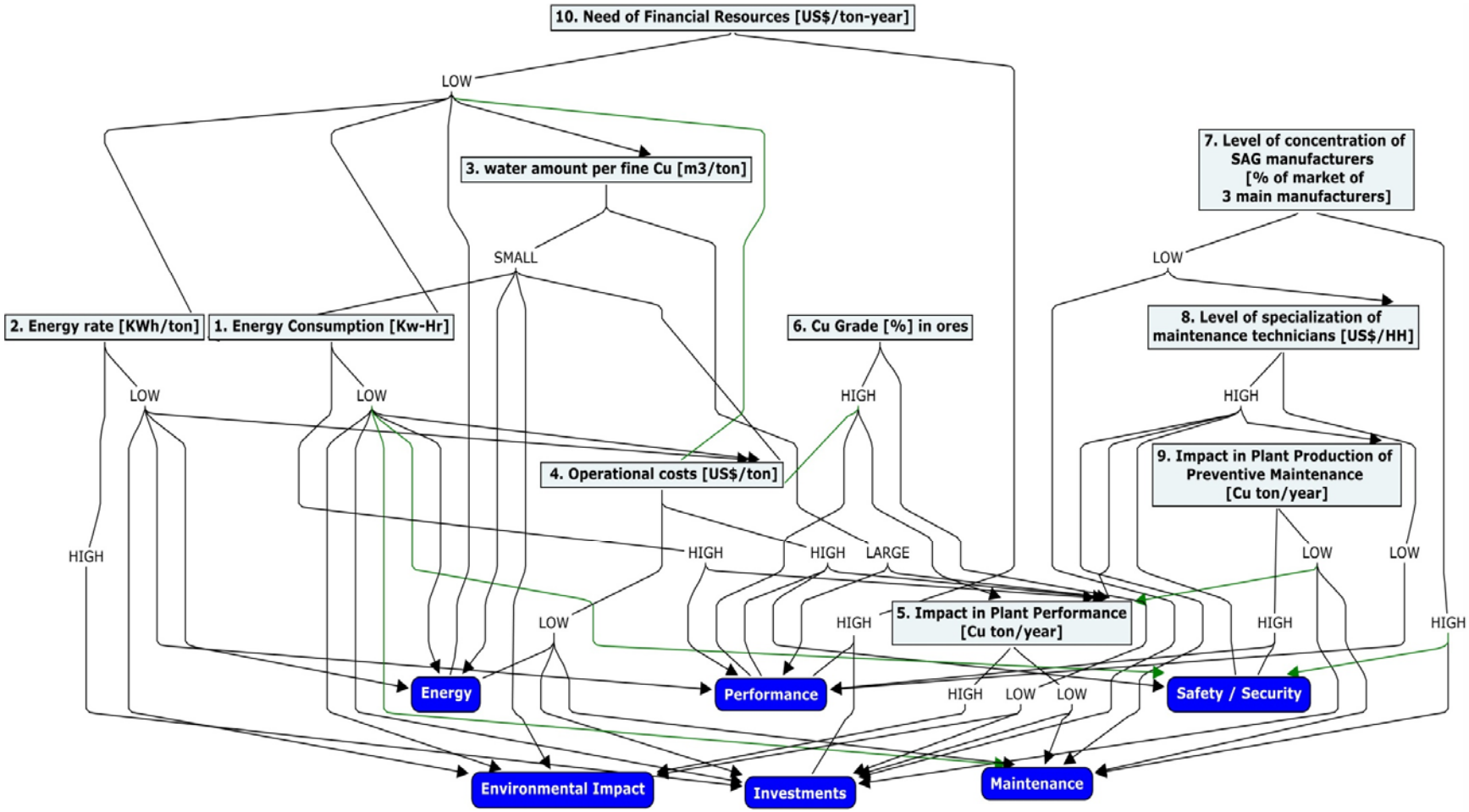
Gaps from Present to Future Technologies



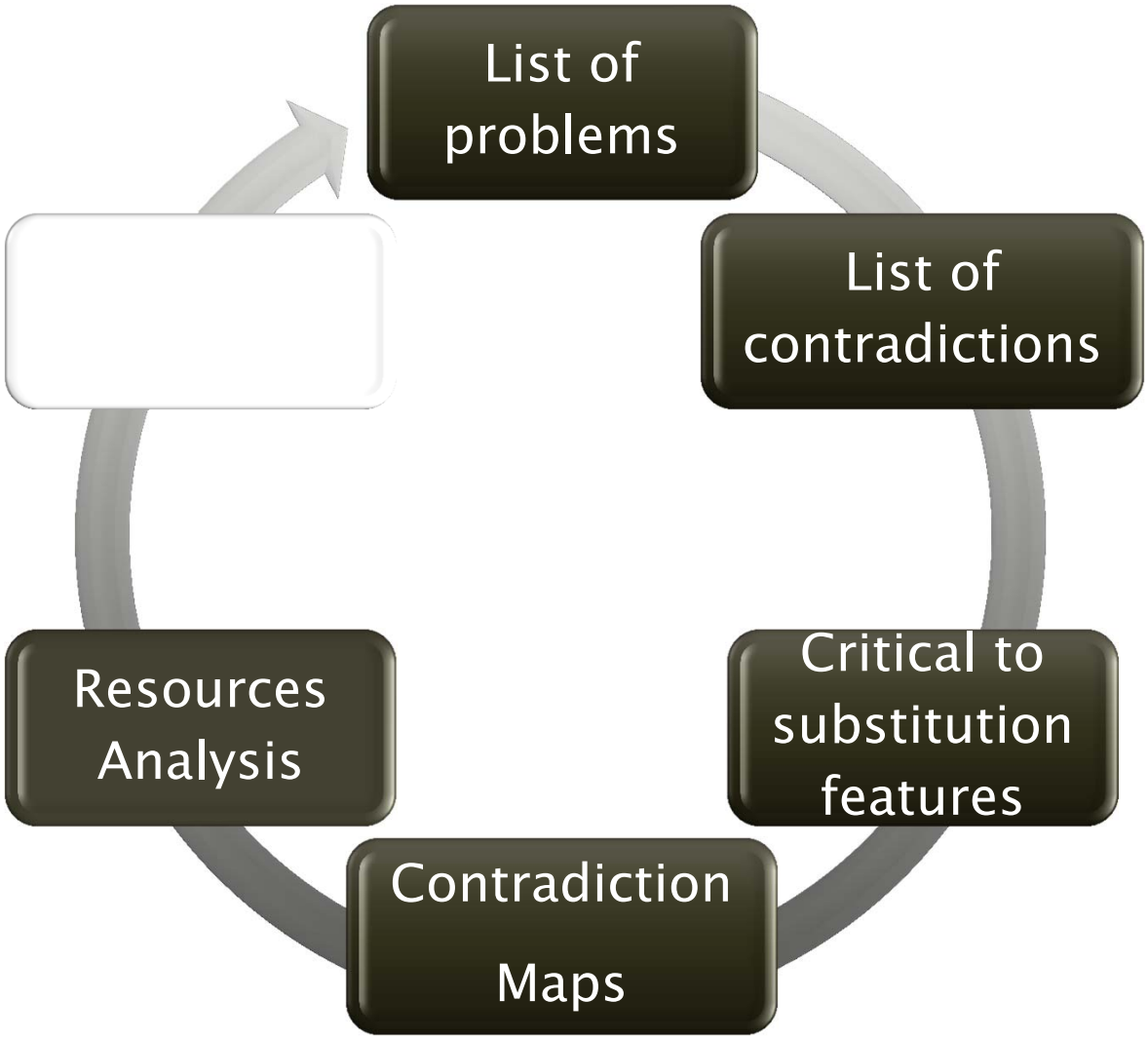
Methodology flow chart (contradiction analysis)



Map of contradictions [SAG]



Resource Analysis



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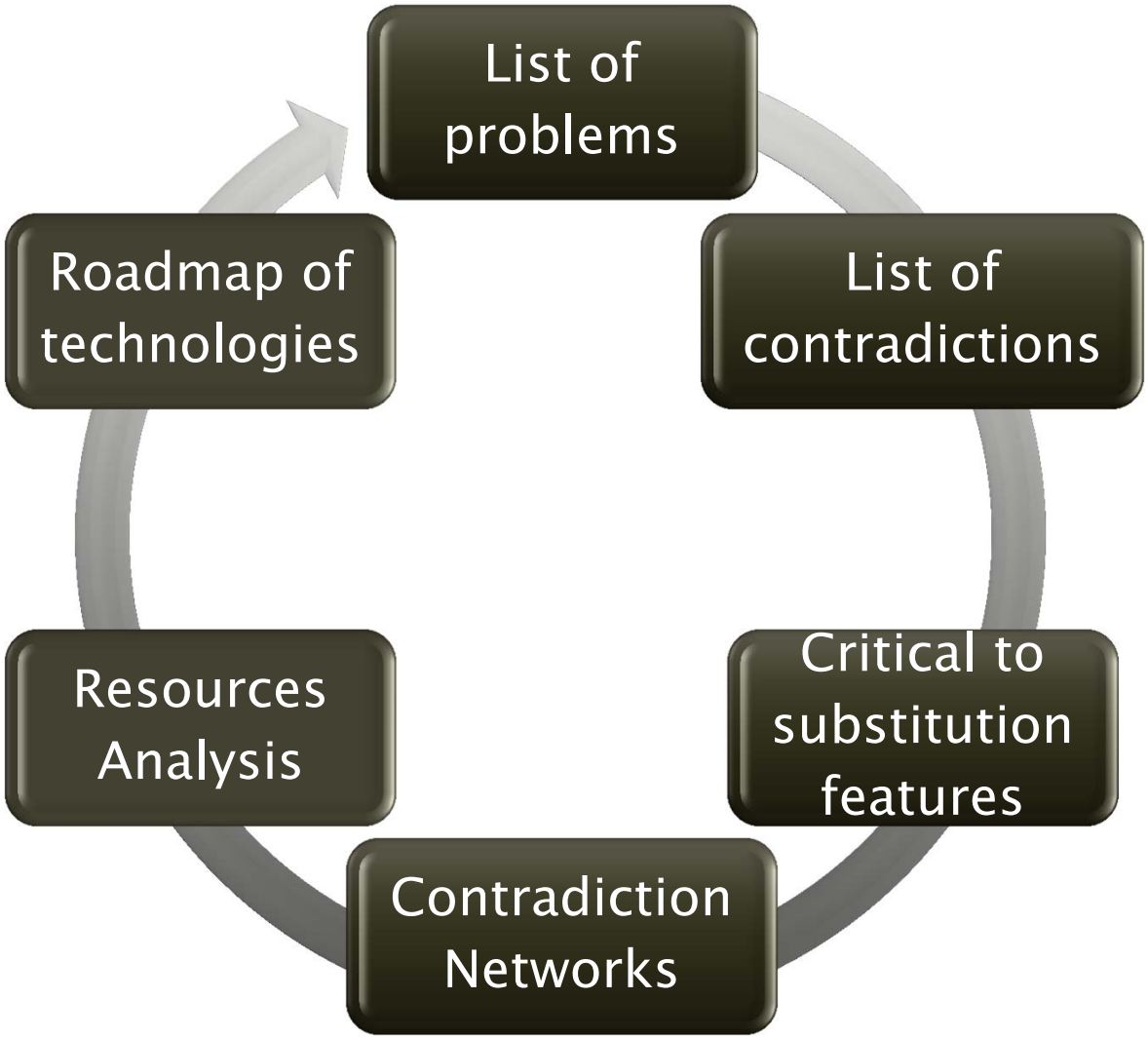
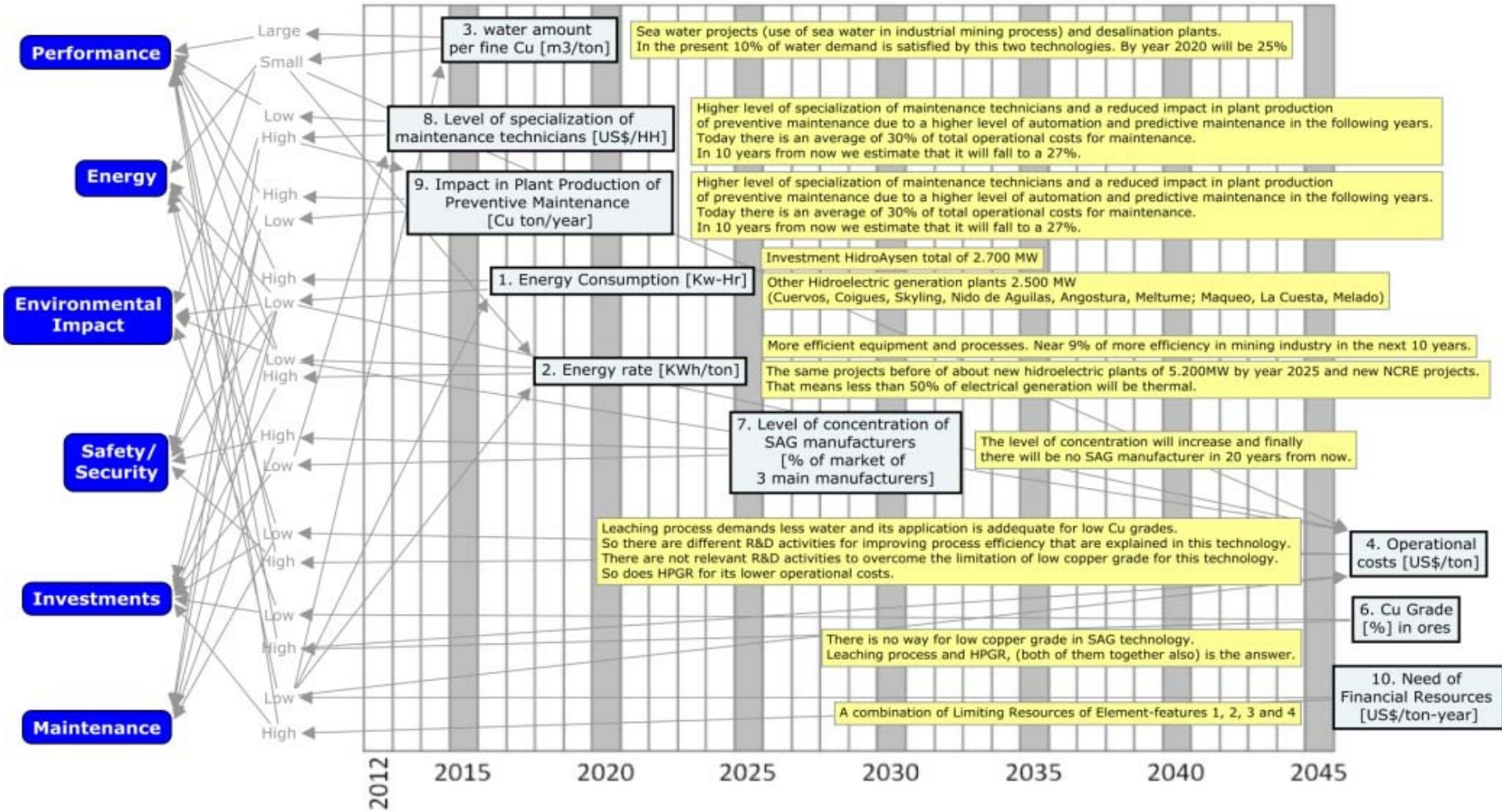
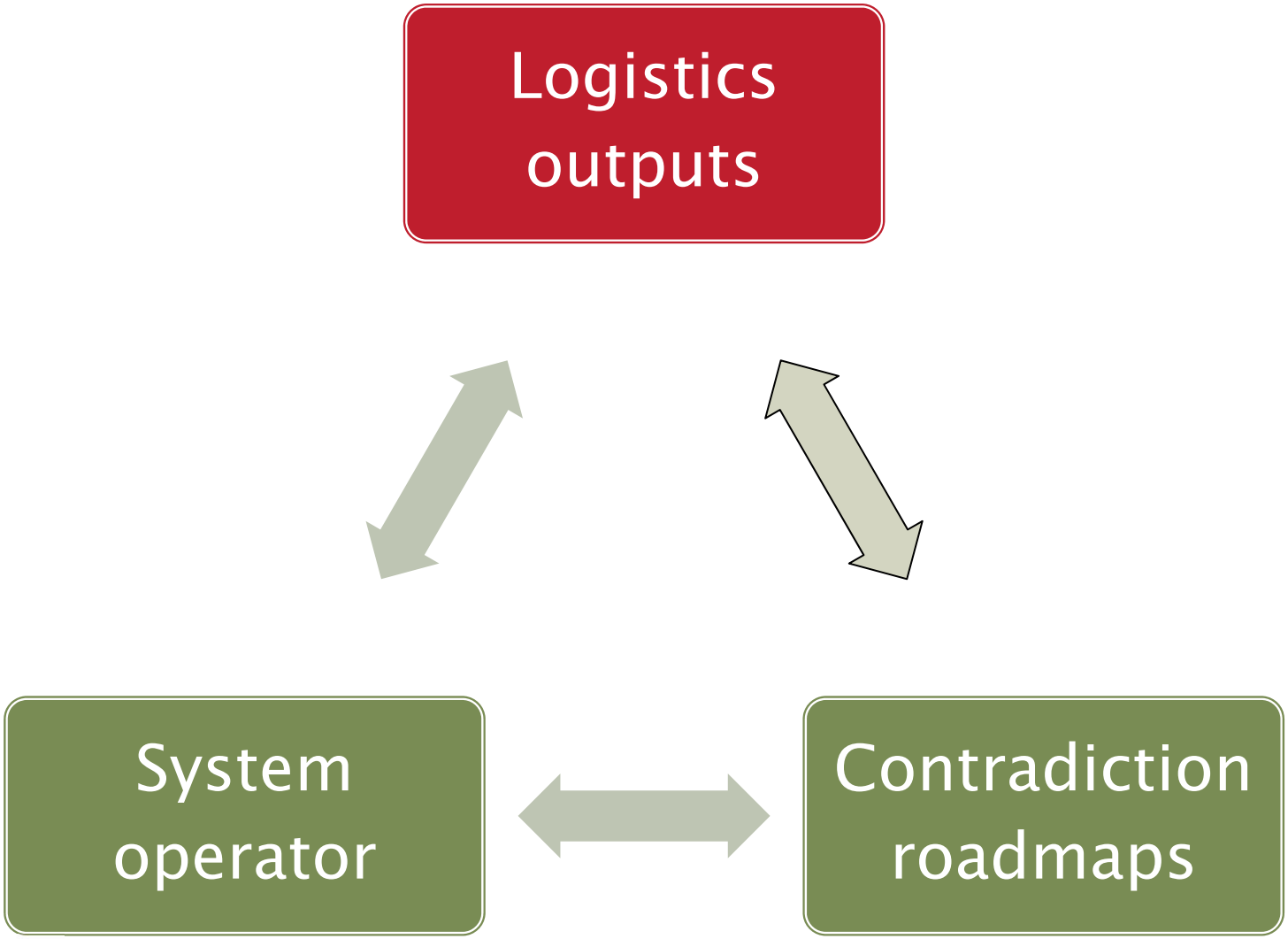


What are the gaps and path between the present states of knowledge and implementation of new technologies?



Forecasting Tuning

Harmonization and 4W



Conclusion

Summary

- Combined use of logistic models and TRIZ based qualitative models
  - Simple logistic – LSM
  - Systems operators–Contradiction
- Similar philosophical evolution assumptions
- Qualitative framework can be used for monitoring and updating forecast
- Identified problems can become inputs in R&D context

It would be a pleasure exchanging with you

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