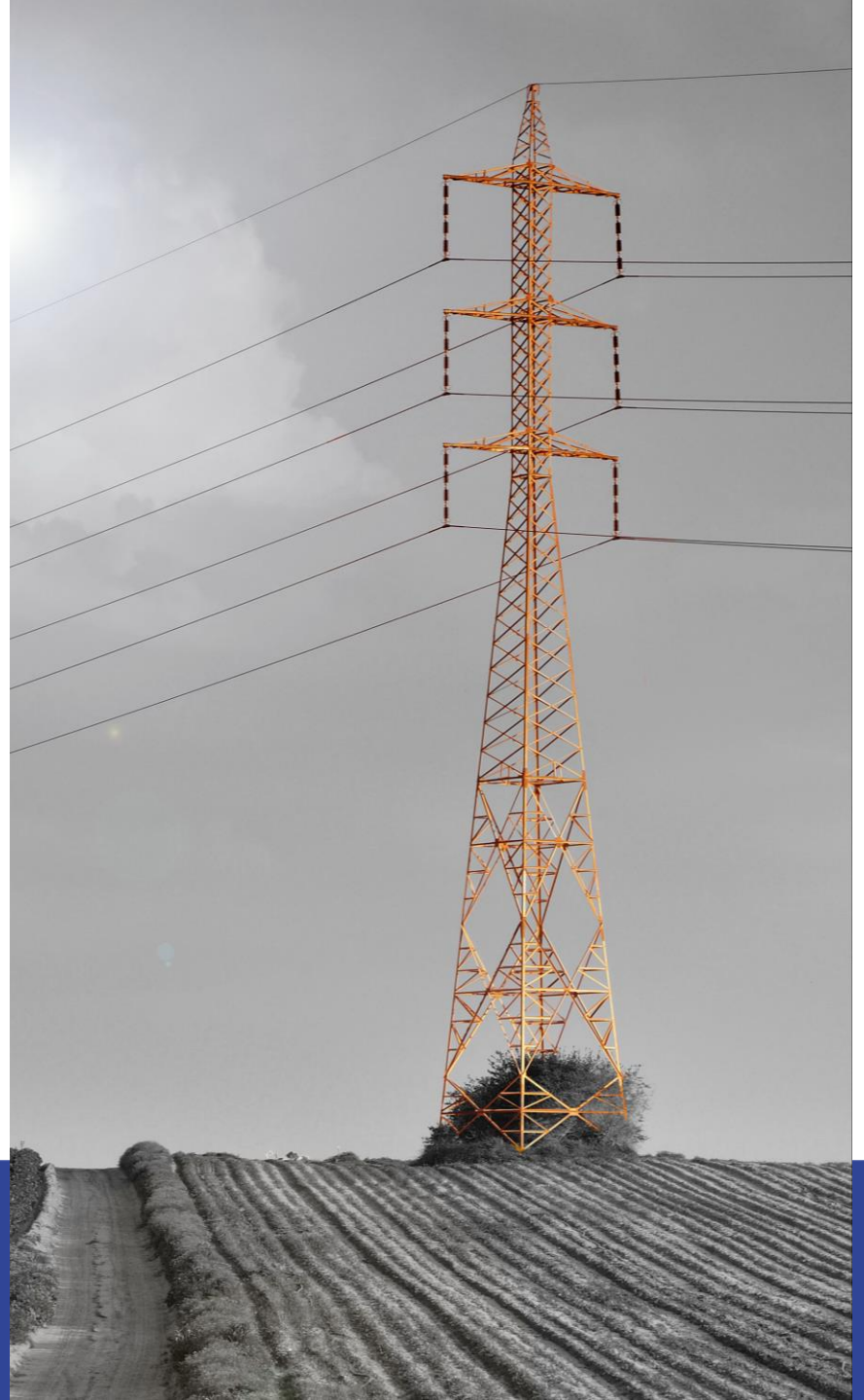
Project Portfolio Optimization

Boudewijn Neijens

2 July 2020



ST-TALKS: ASSET MANAGEMENT SERIES

IN ASSOCIATION WITH

AGENDA

- Who is Copperleaf
- What have we learned so far
- Life cycles and economics
  - Capex, Opex and Totex
  - From long term plans to budgetary cycles
- Asset plans vs. Investment portfolios
- The concept of Value
- Asset Investment Planning & Management
- Prioritization vs. Optimization
- Conclusions

KEY COPPERLEAF CLIENTS

Over **$1 trillion** assets managed worldwide

WHAT WE HEARD SO FAR…

- You need a management system
- A SAMP should be dynamic & express what's best for the company
- Risk and Levels of Service drive AMPs & Lifecycle Plans
- Every organization is different
- It's about "What, When and If"
- Reasons to (re-)invest include:
  - Reliability (Lowest Economic Cost)
  - Cost savings
  - Safety / Regulatory
  - Strategic
- Include quantitative and qualitative factors in evaluations & prioritisation
- Projects that have the highest Benefit/Cost ratio must be prioritised
- Where should you invest your last R1000

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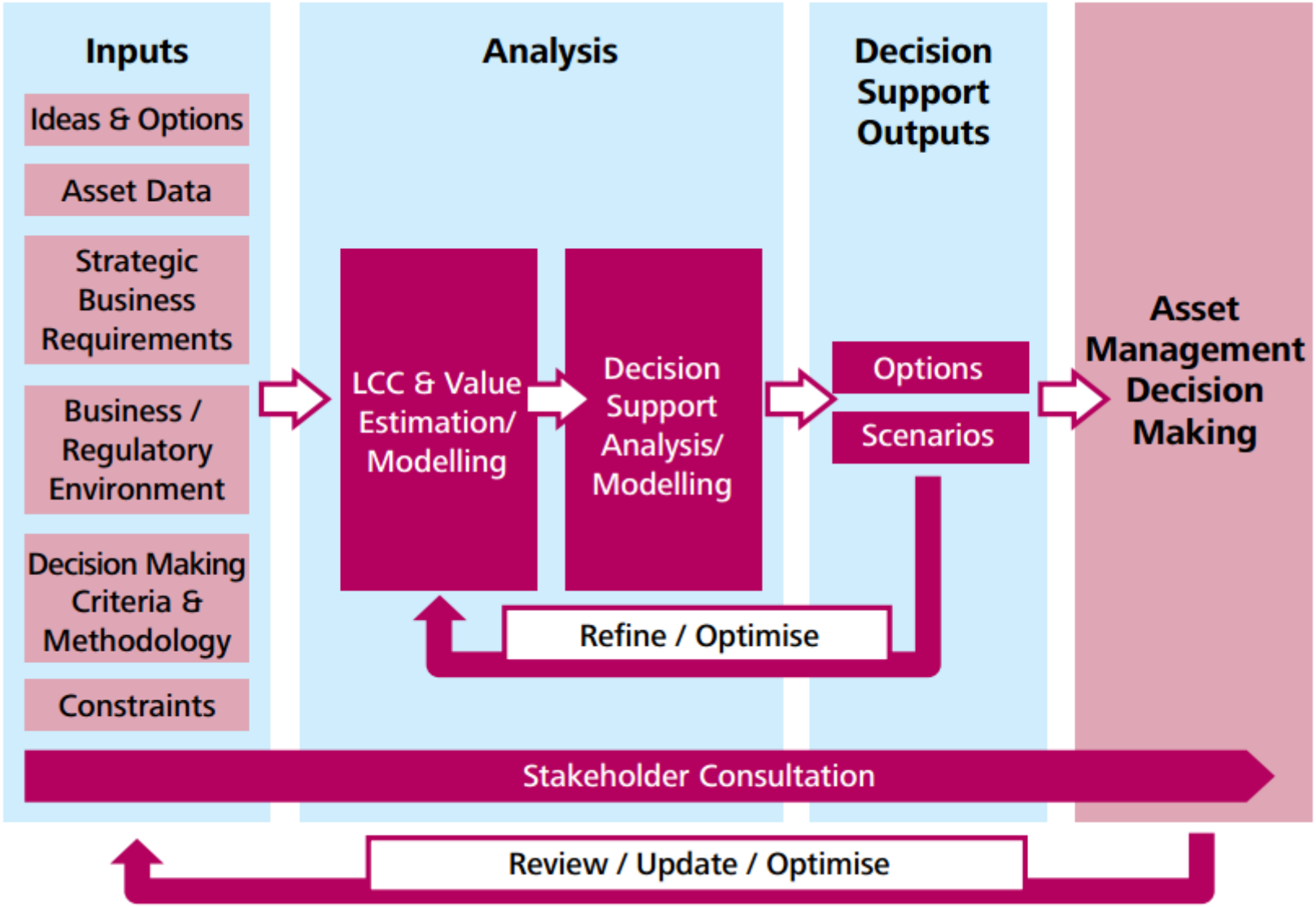
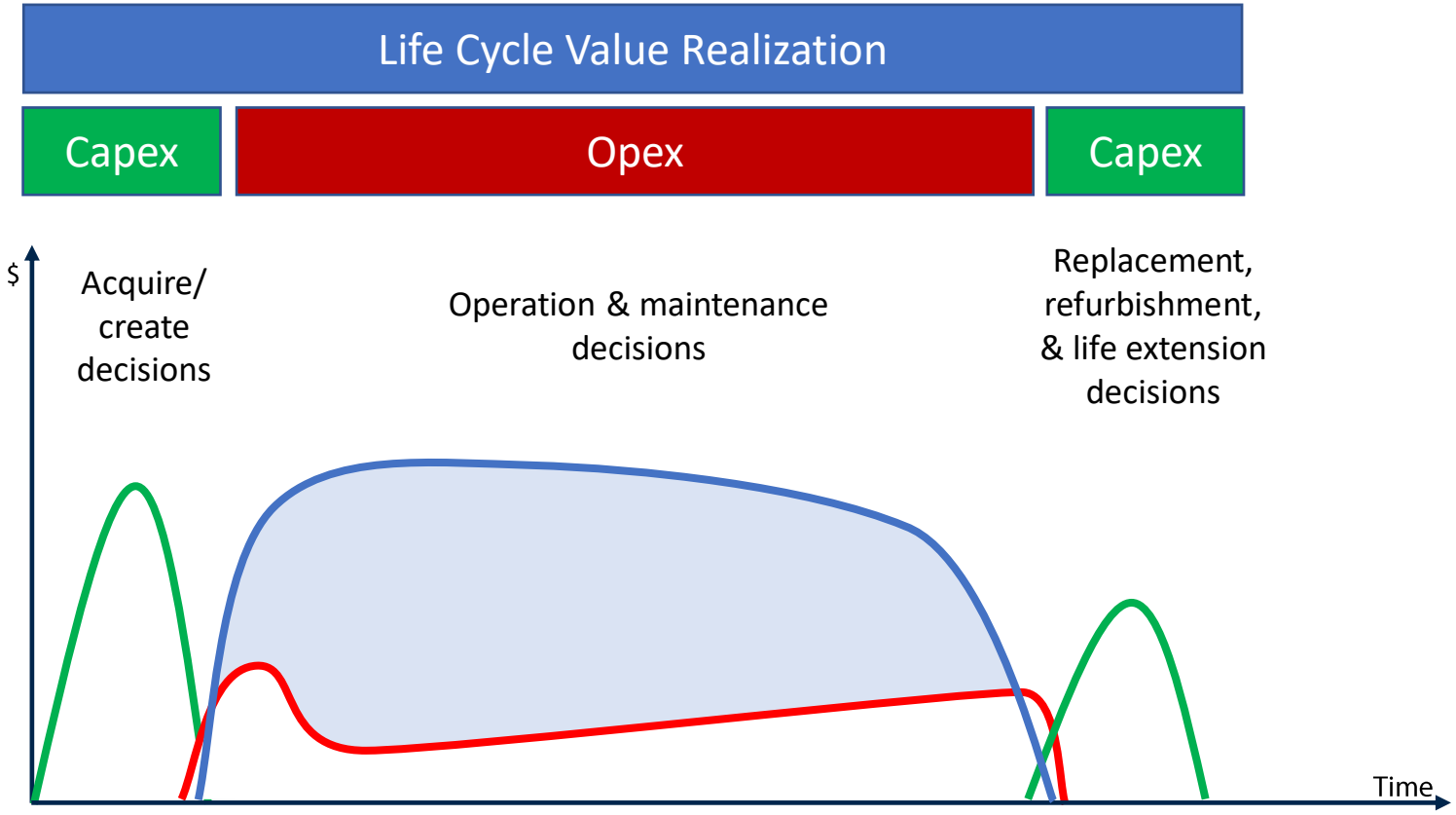
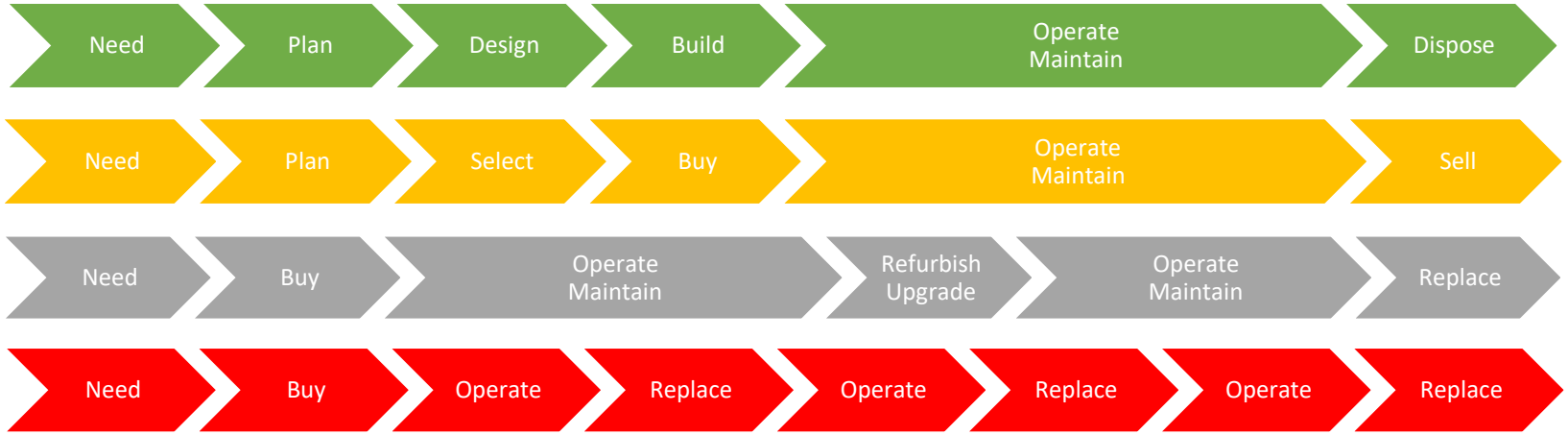
LIFE CYCLE COSTING & VALUE OPTIMIZATION



LIFE CYCLE PHASES

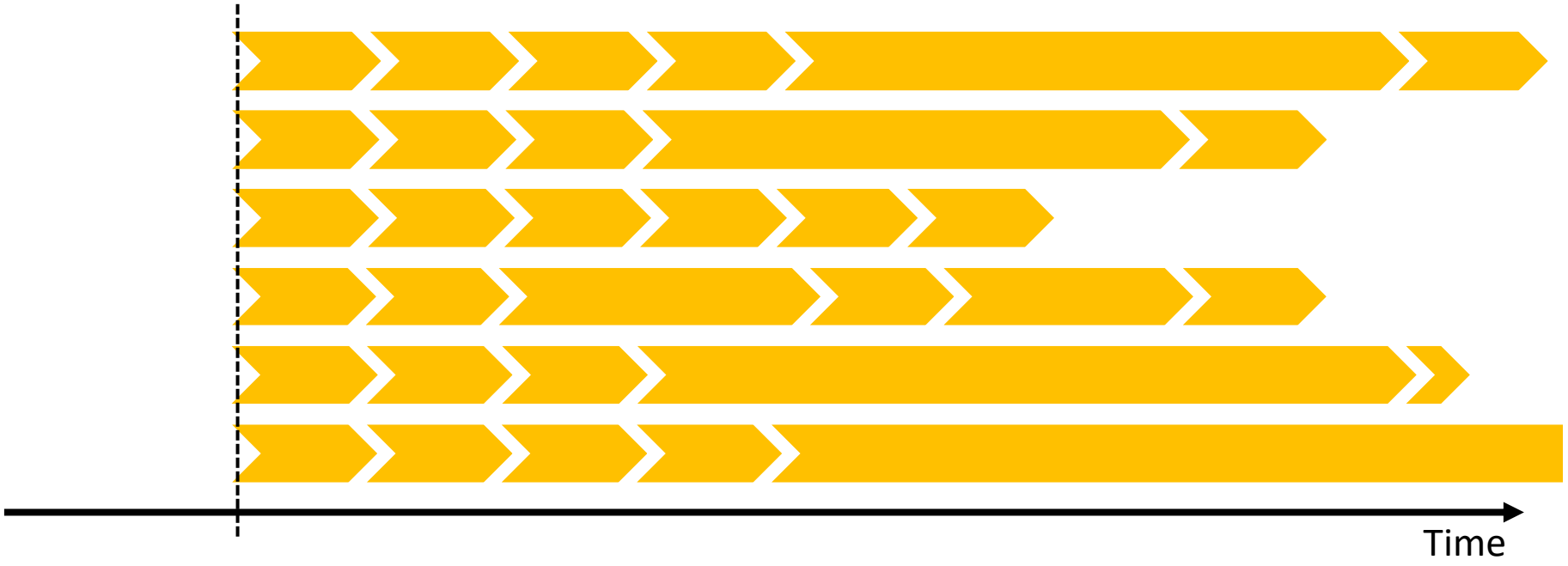


LIFE CYCLE ACTIVITIES



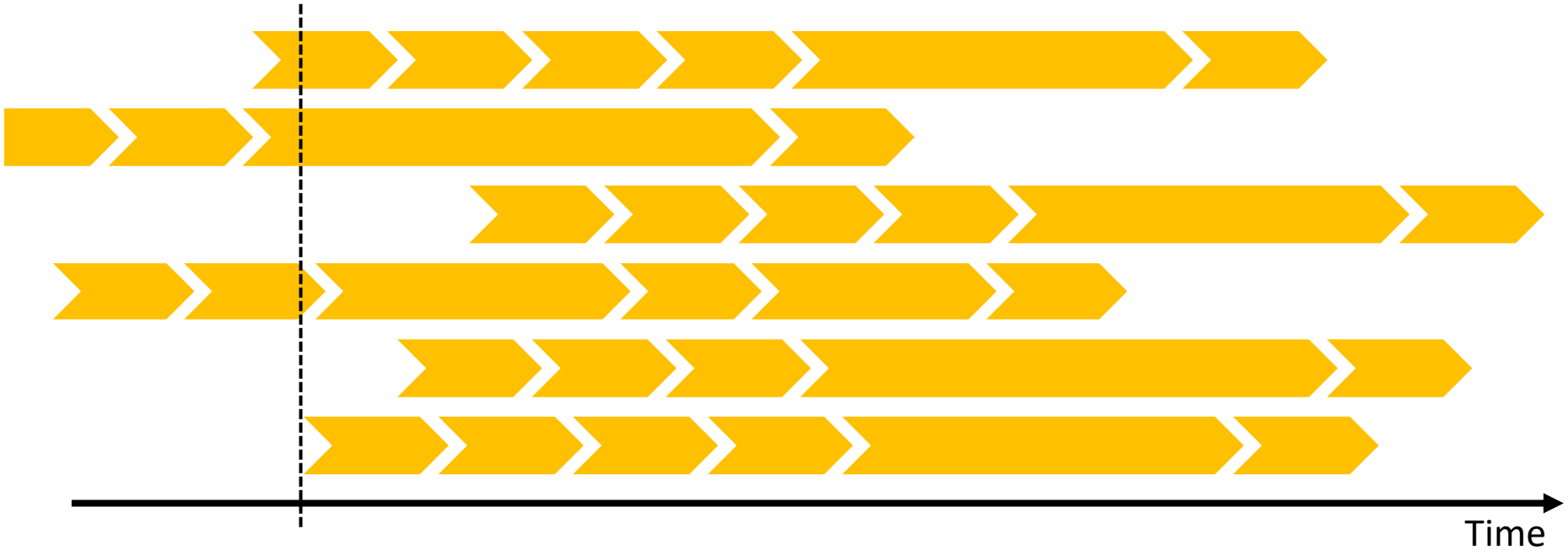
ASSET LIFE CYCLES

- A greenfield project
  - Decisions driven by future needs
  - Value-based
  - Cost of not doing = missed opportunity



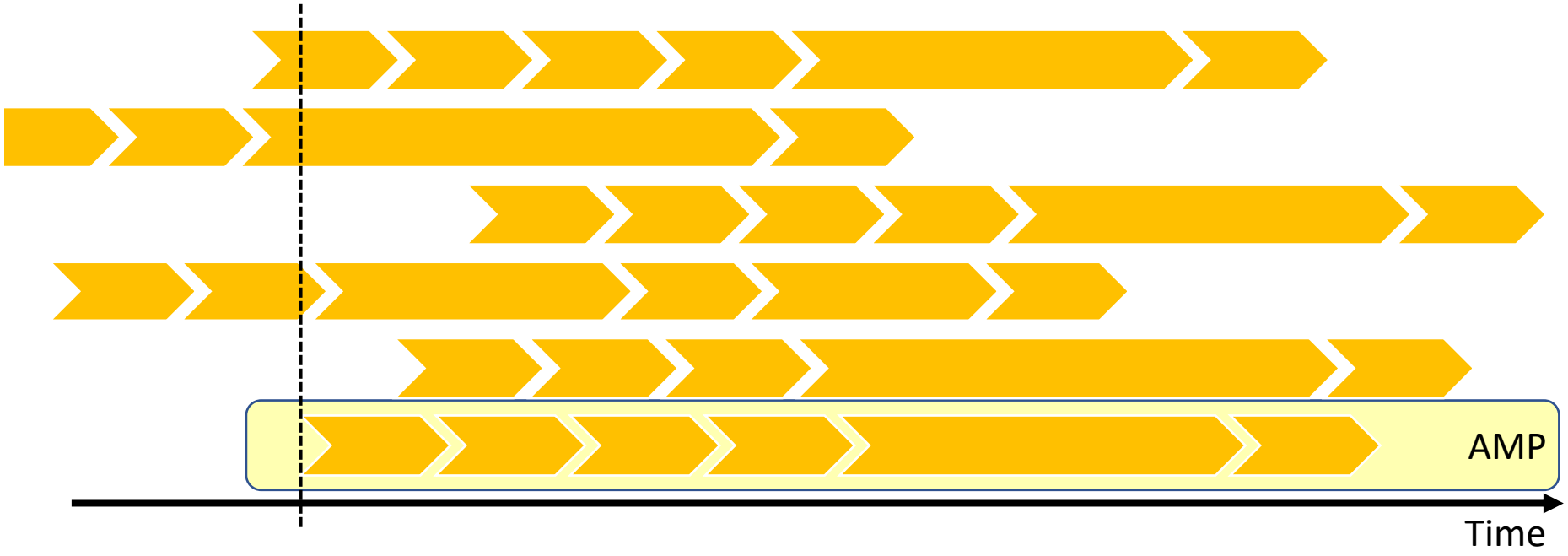
ASSET LIFE CYCLES

- Ongoing operations and life cycle management
  - Many decisions are driven by existing assets & sustainment needs
  - Value-based and risk-informed
  - Cost of not doing = missed opportunity + asset liability

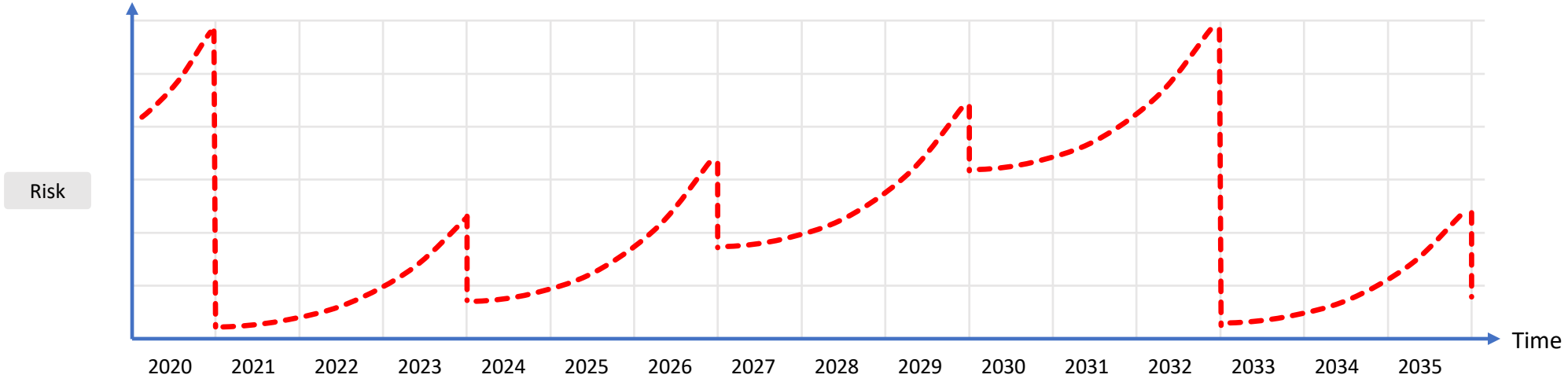


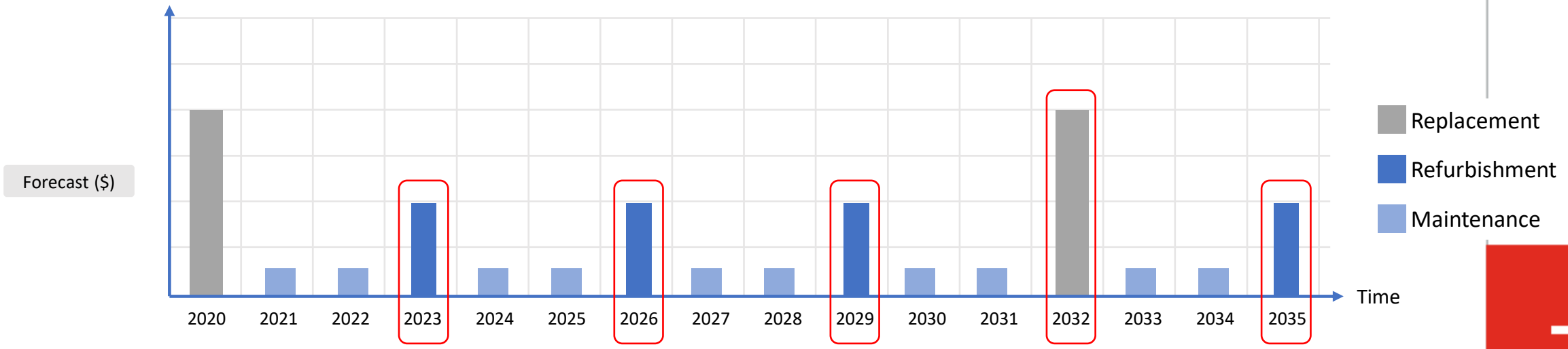
ASSET PLANS

- Asset Management Plan
  - Describes activities, resources, timescales
  - Often a mostly static view
  - Optimal per asset class

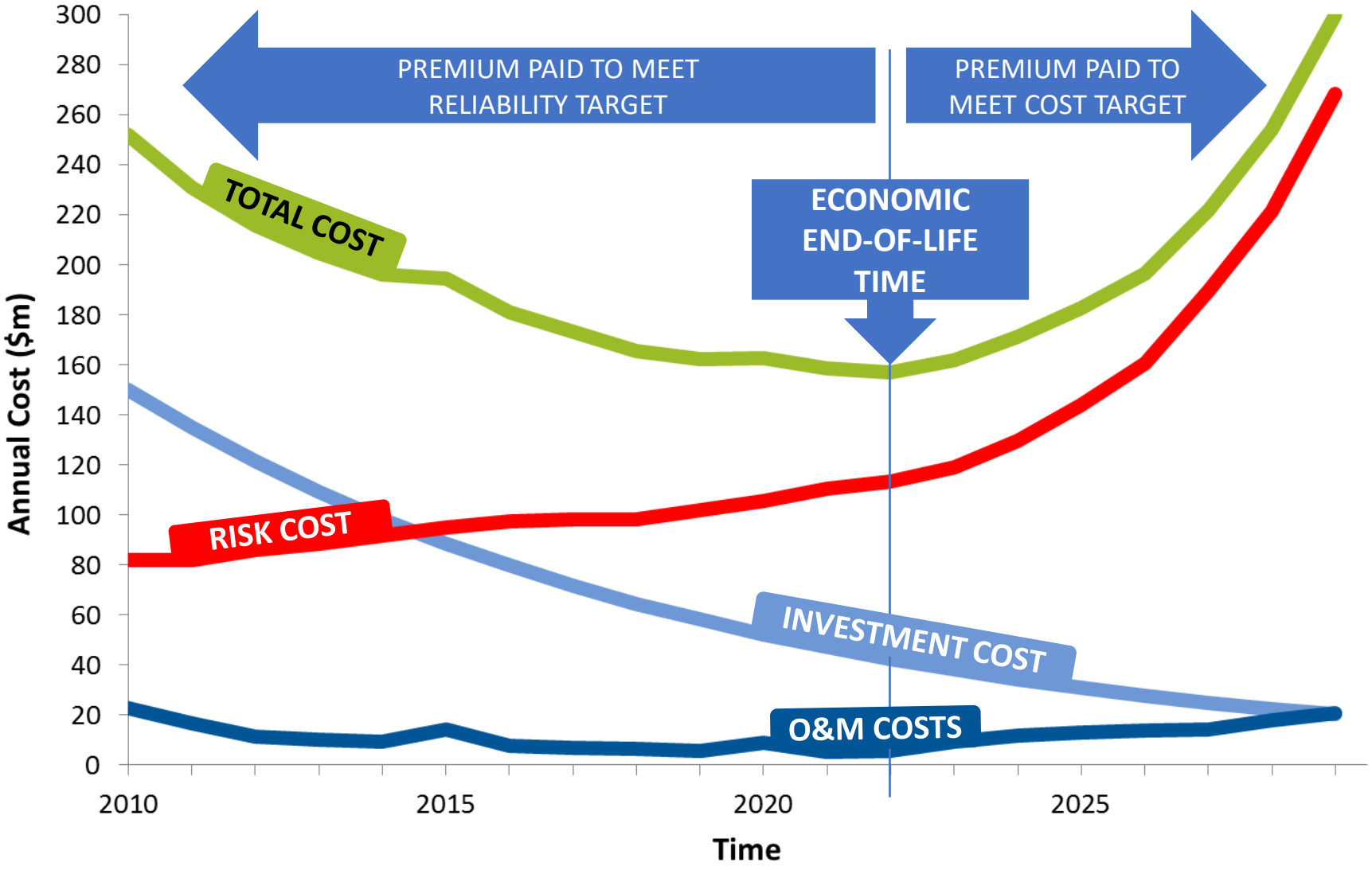


THE RIGHT LIFE CYCLE STRATEGY

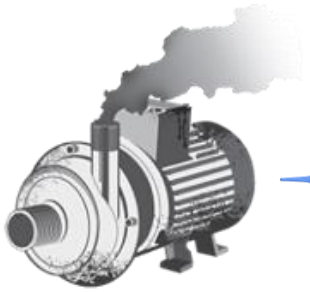




ECONOMIC END-OF-LIFE



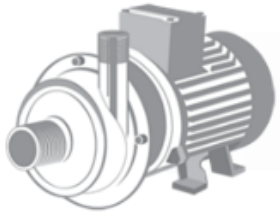
ALTERNATIVES



- Refurbish

- Replace

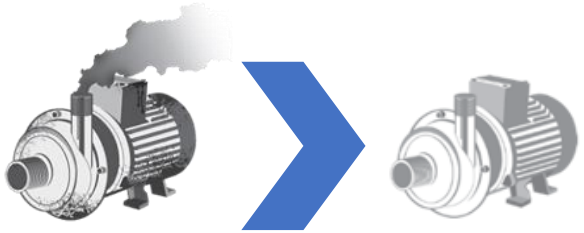
- Upgrade

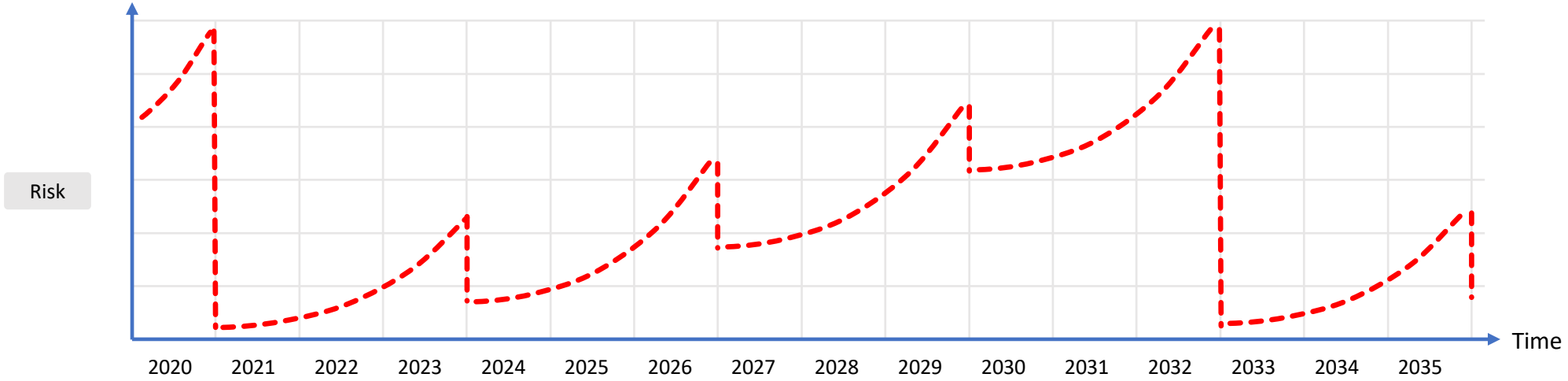


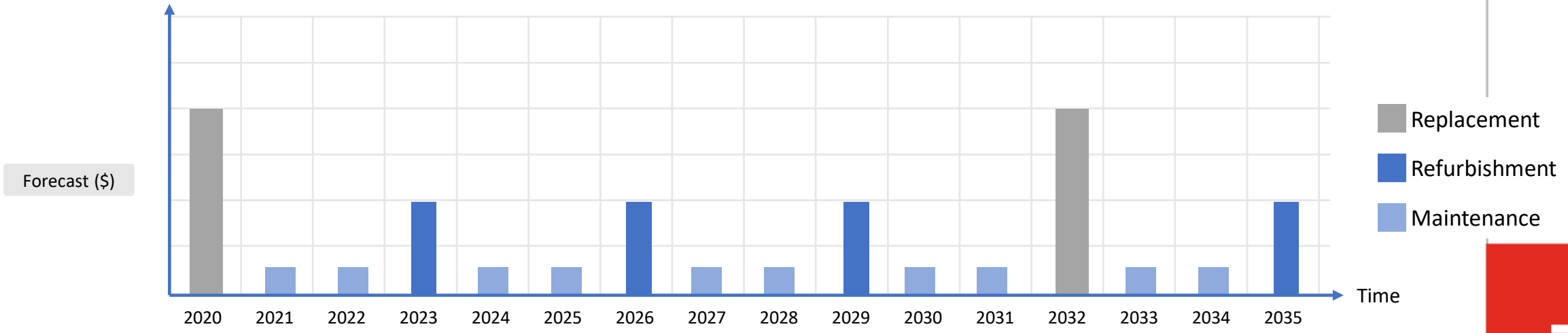
- Increase capacity

- Add redundancy

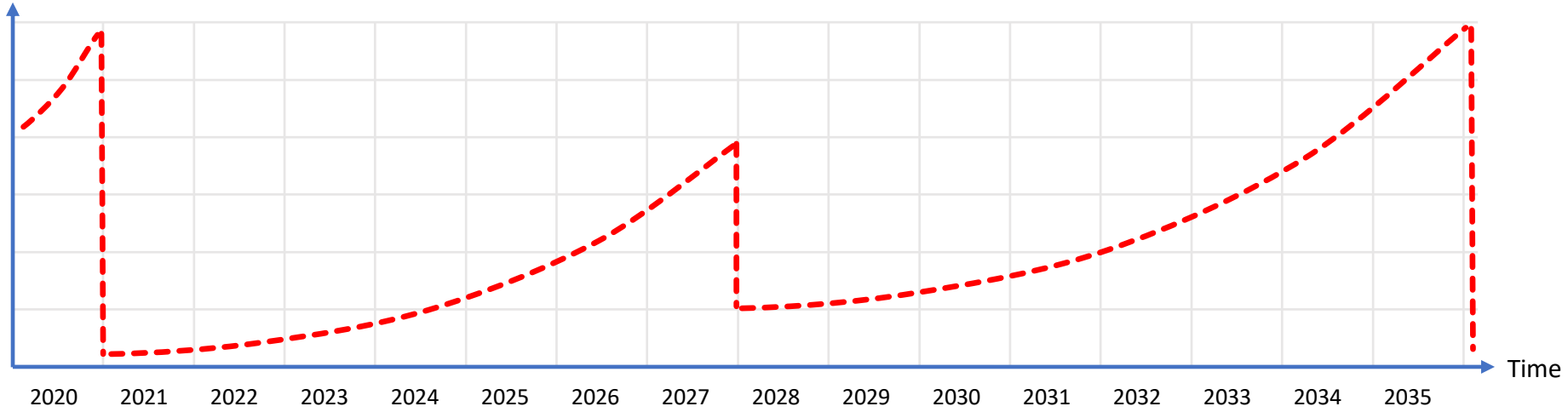
ALTERNATIVE: REPLACE

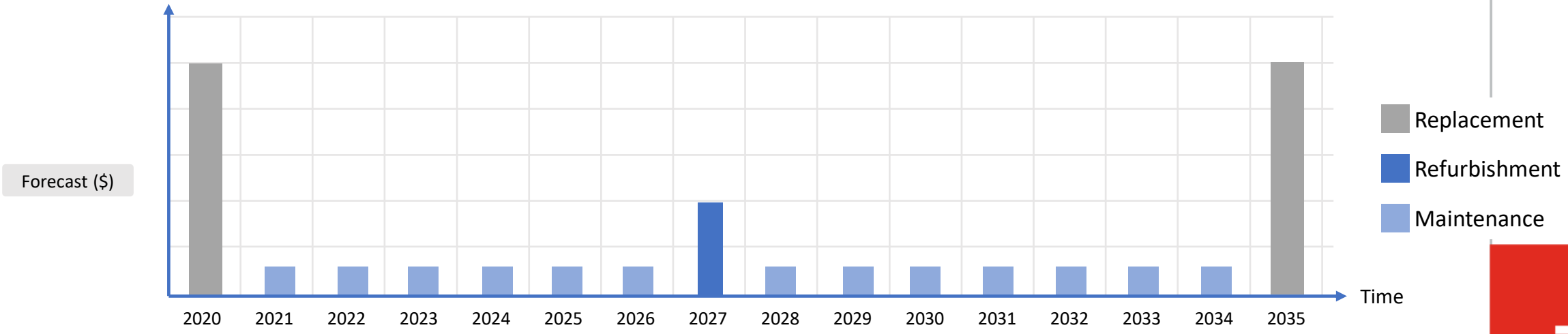






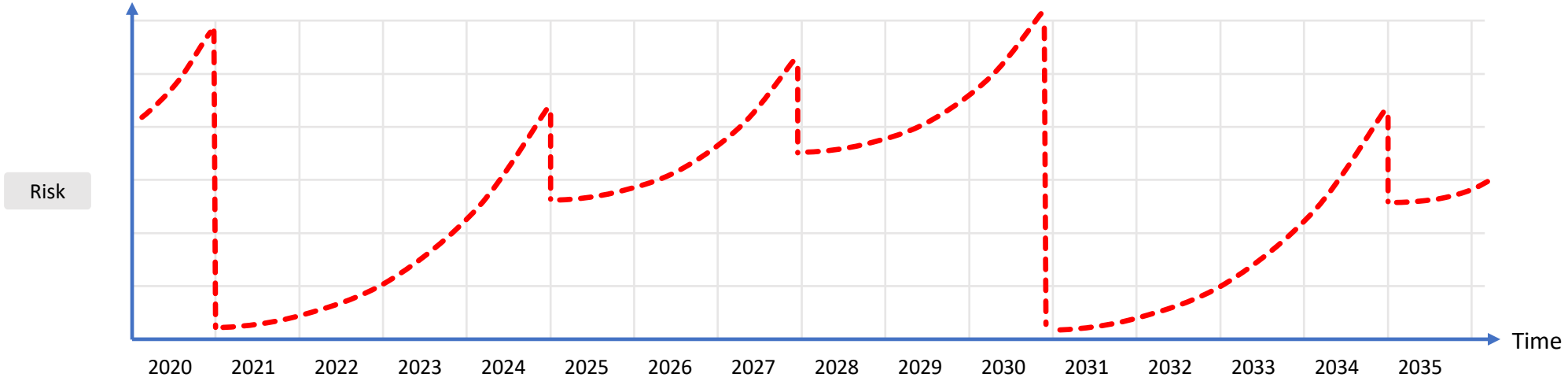
ALTERNATIVE: UPGRADE

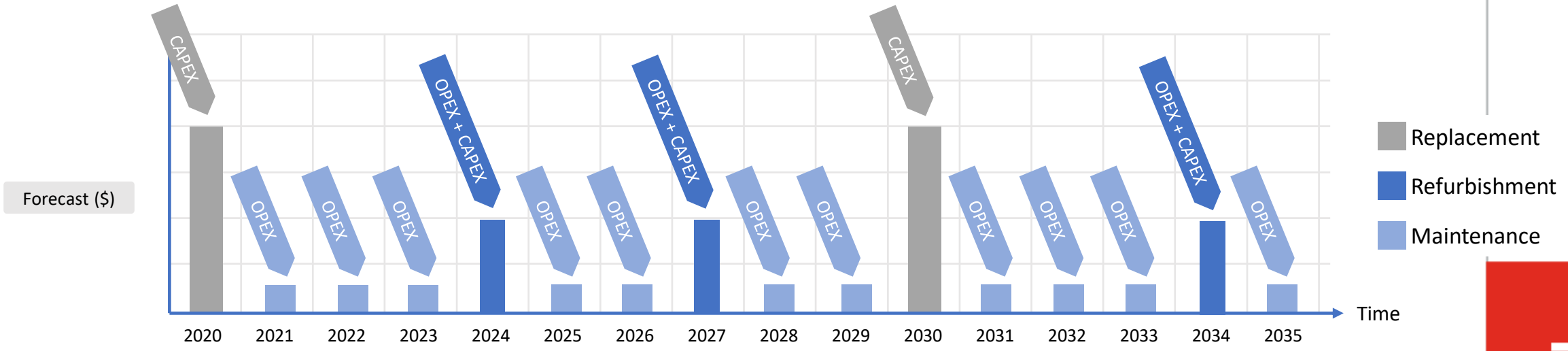




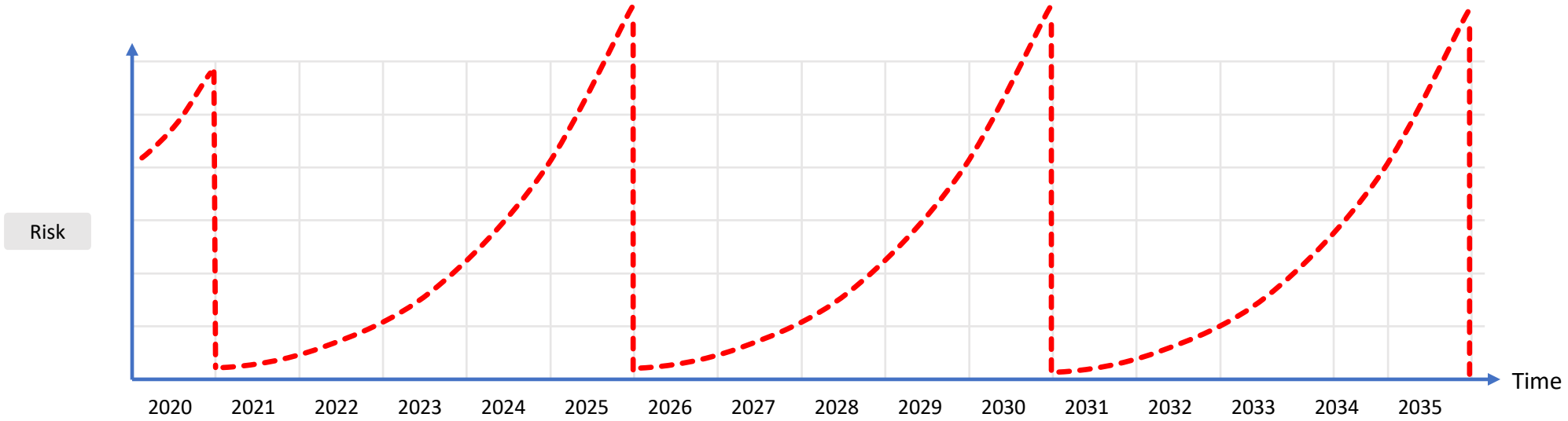
DIFFERENT POTS OF MONEY

- Opex + Capex = Totex





MORE CAPEX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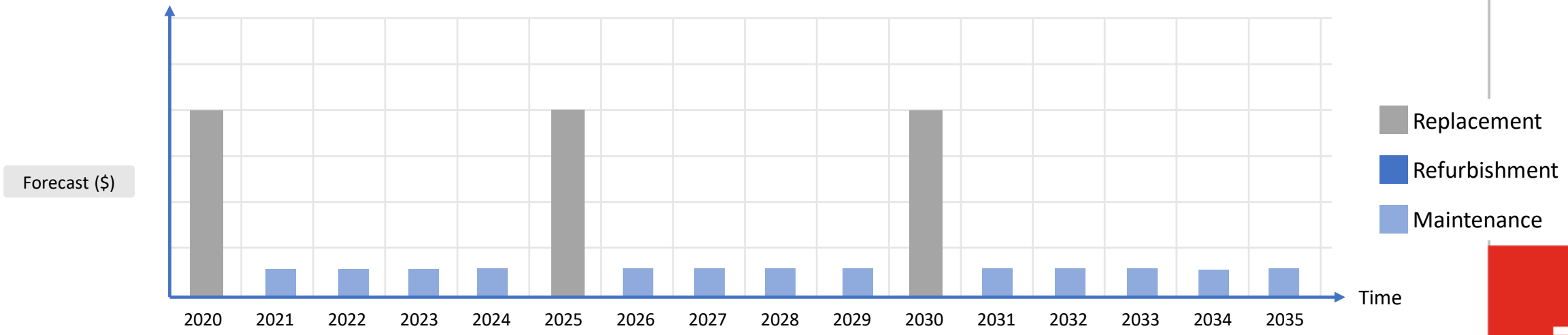
Forecast ($)
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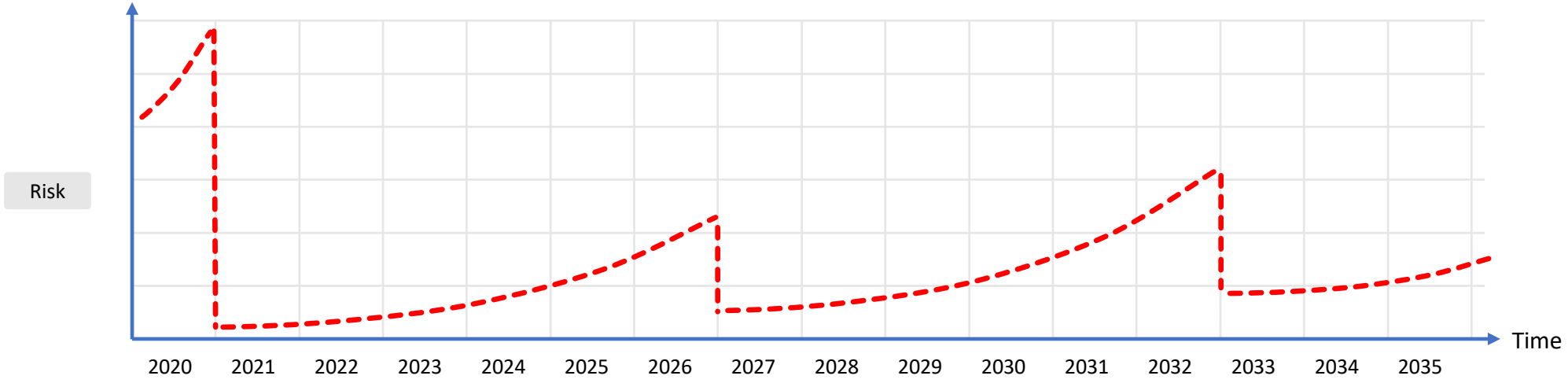
2034
2035
Replacement
Refurbishment
Maintenance

MORE OPEX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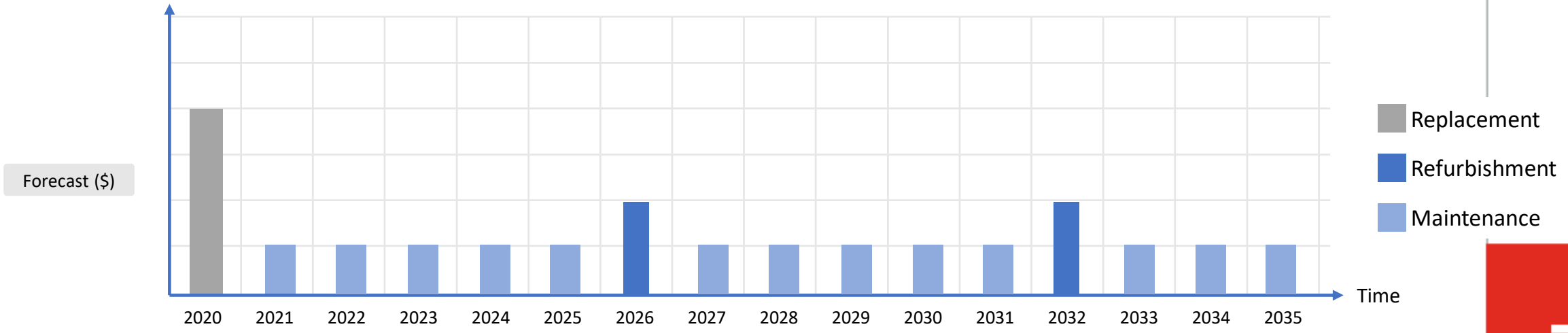
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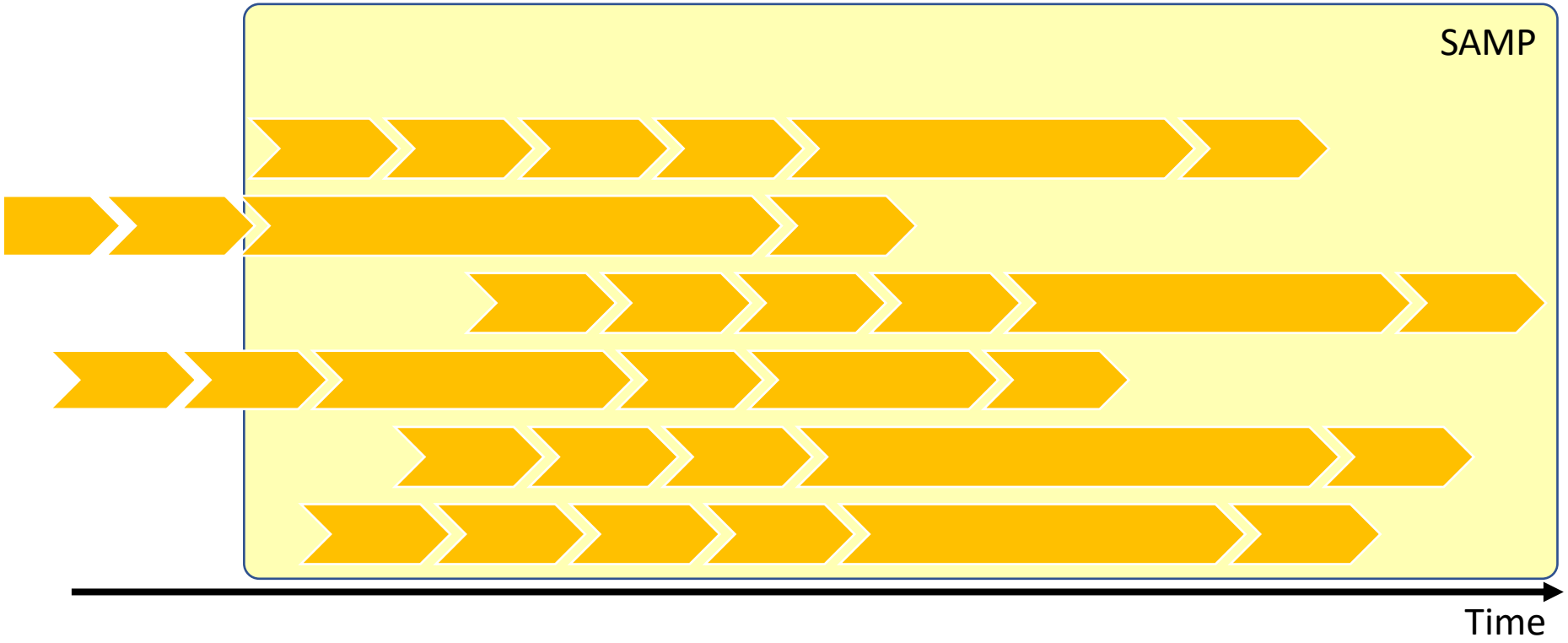
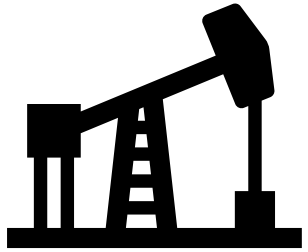
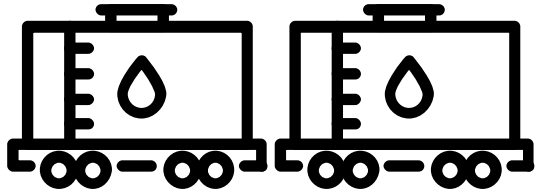
ASSET PLANS

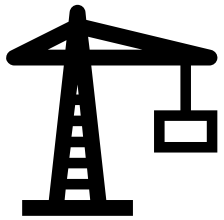
- Strategic Asset Management Plan
  - Guidance for all AMPs
  - The aggregate of all AMPs



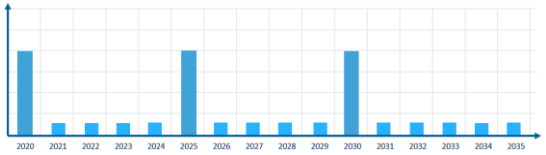
DOES IT ALL ADD UP?

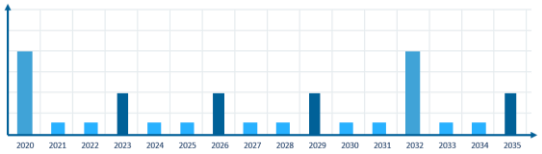






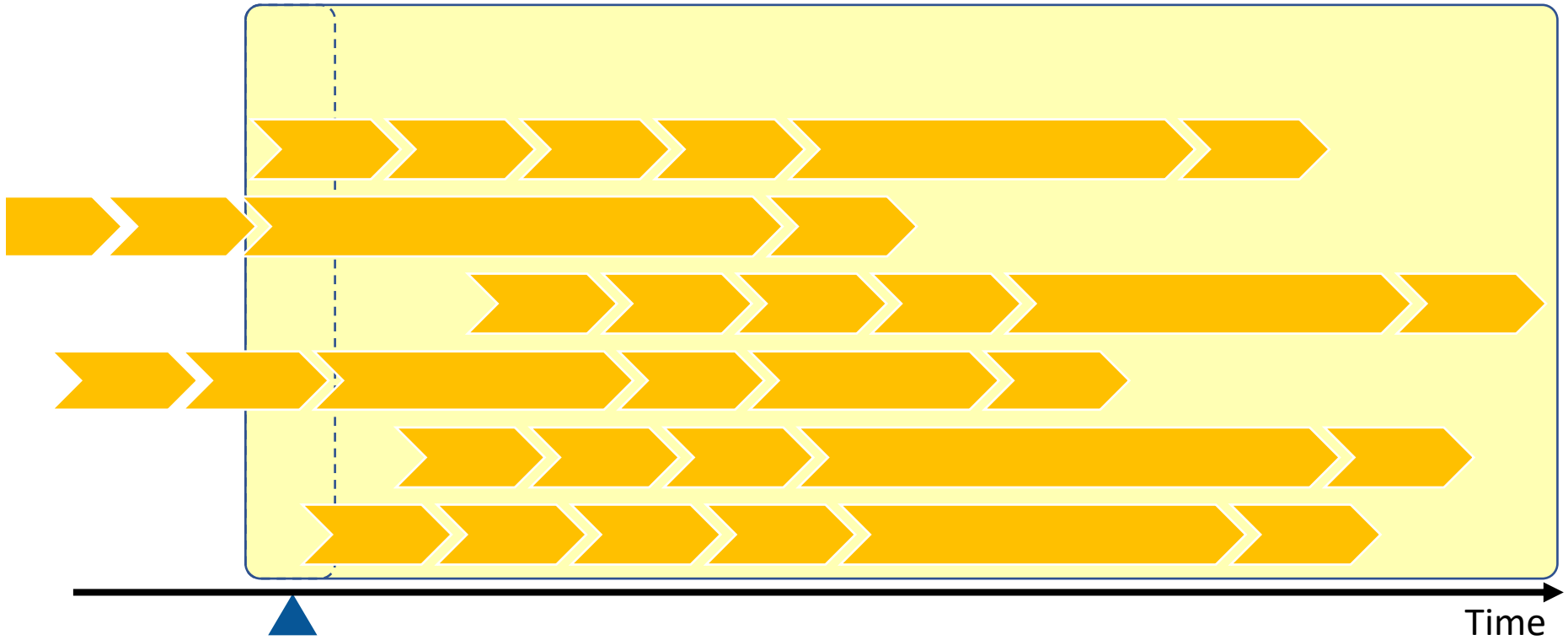
Optimal Life Cycle Plan 1 + Optimal Life Cycle Plan 2 + Optimal Life Cycle Plan 3 = ?





ASSET PLANS VS. INVESTMENT PORTFOLIOS

- Investment Portfolio
  - A real-world, constrained decision-making environment



OPTIMIZE PORTFOLIOS

FINANCIAL

TOTAL RISK

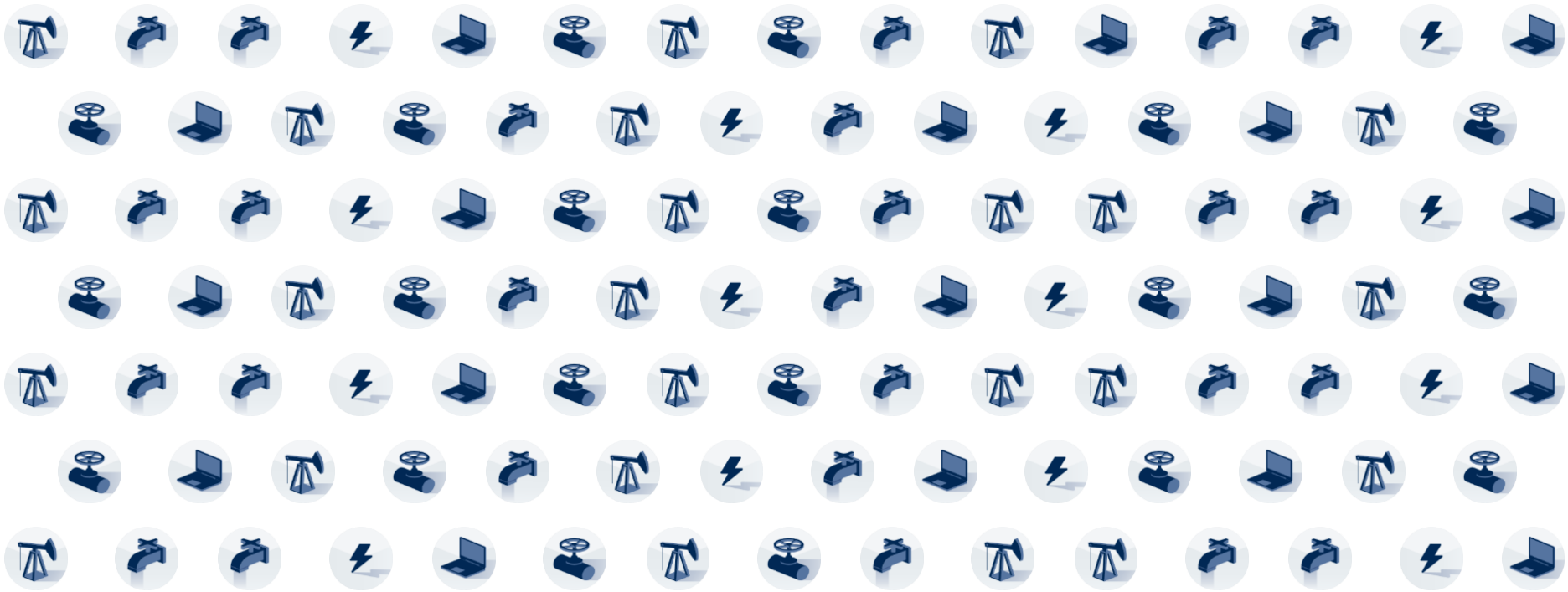
RESOURCES

OUTAGE CONSTRAINTS

RENEWABLE TARGETS

ASSET REPLACEMENT TARGETS

ALL



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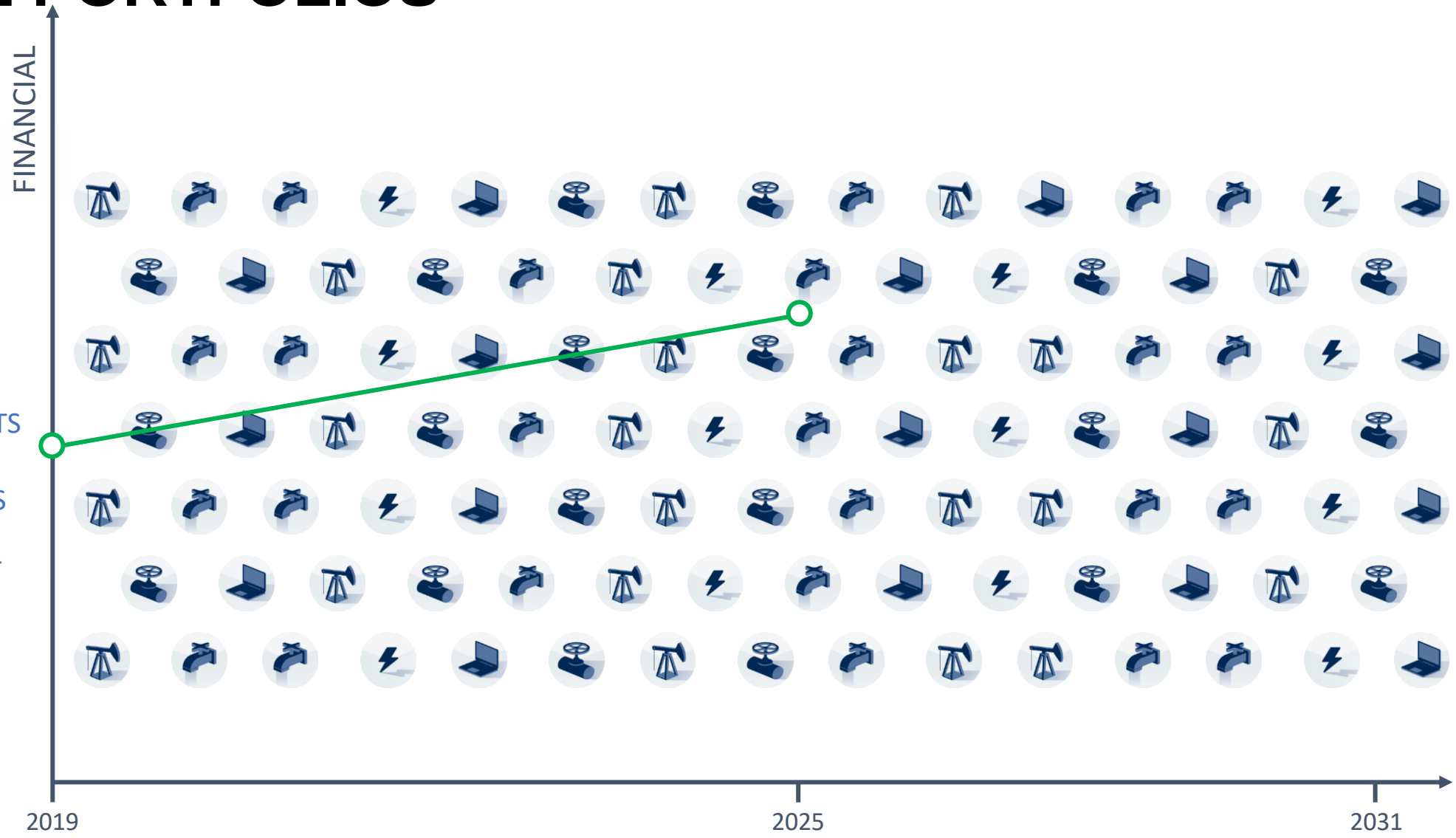

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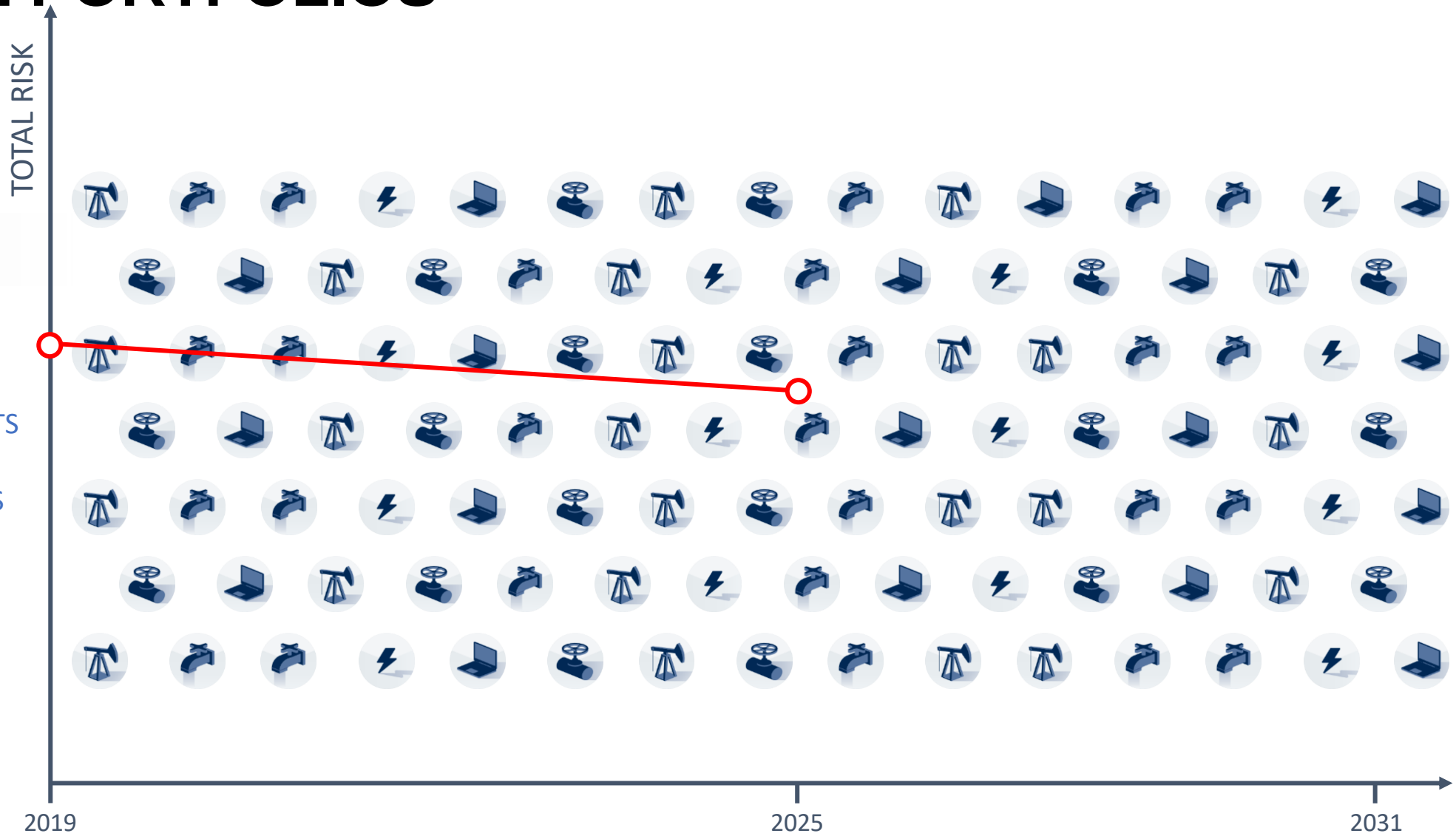

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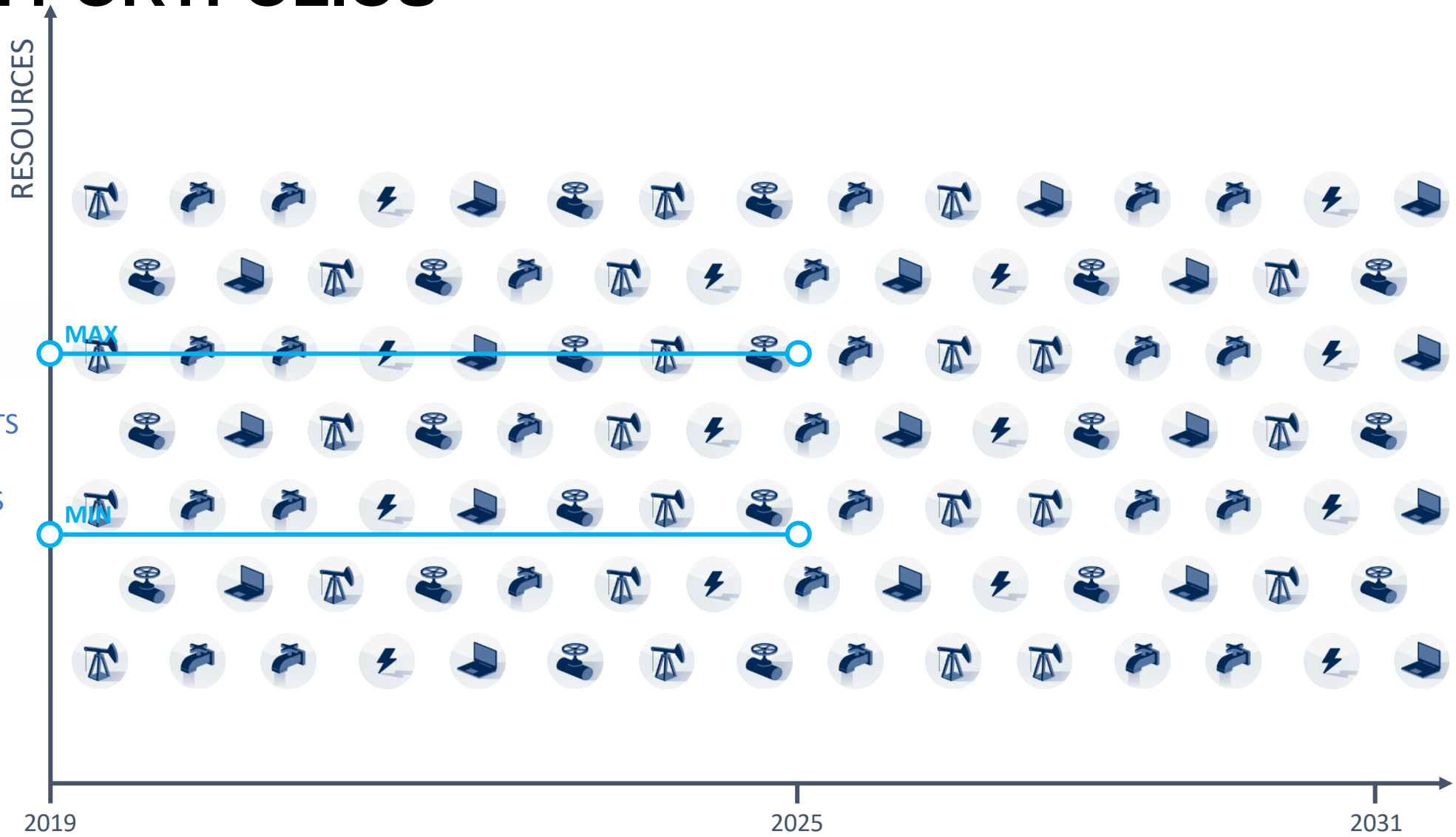
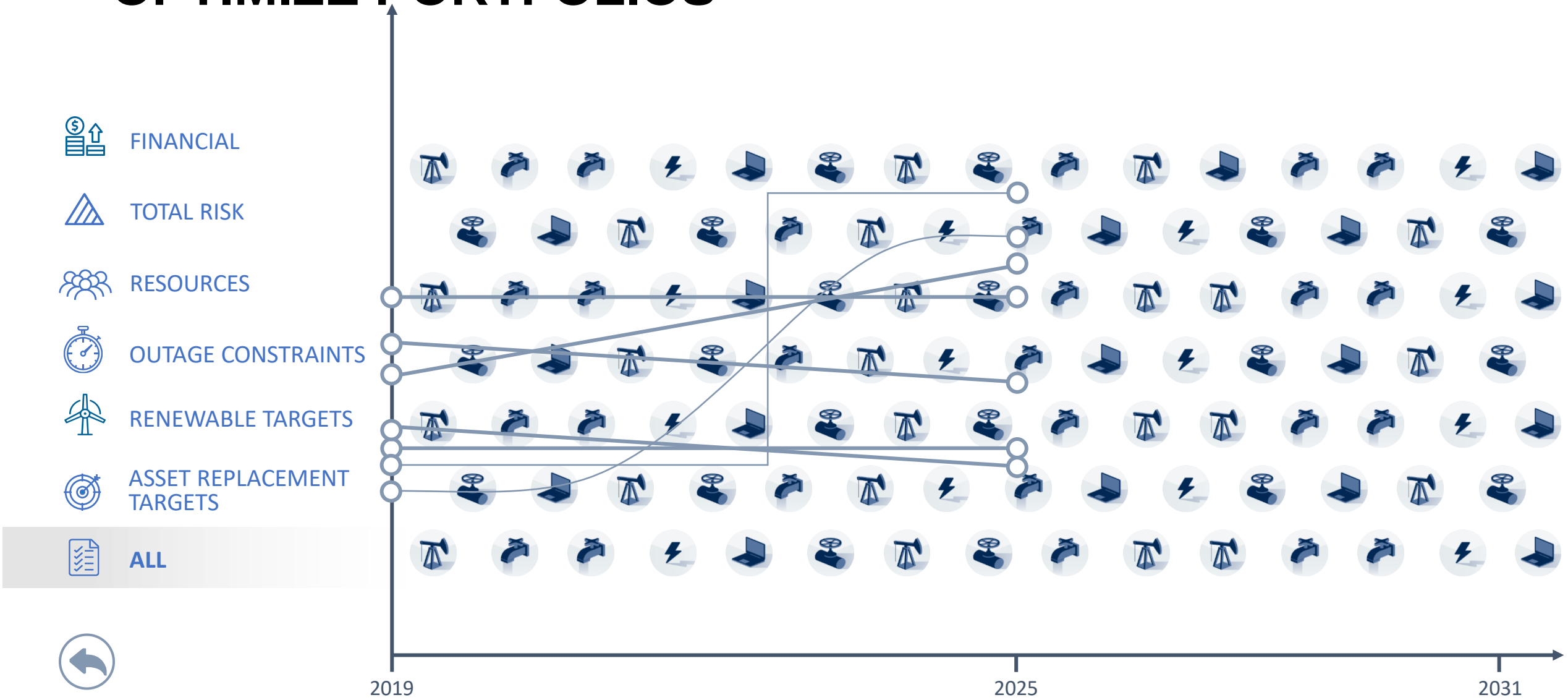
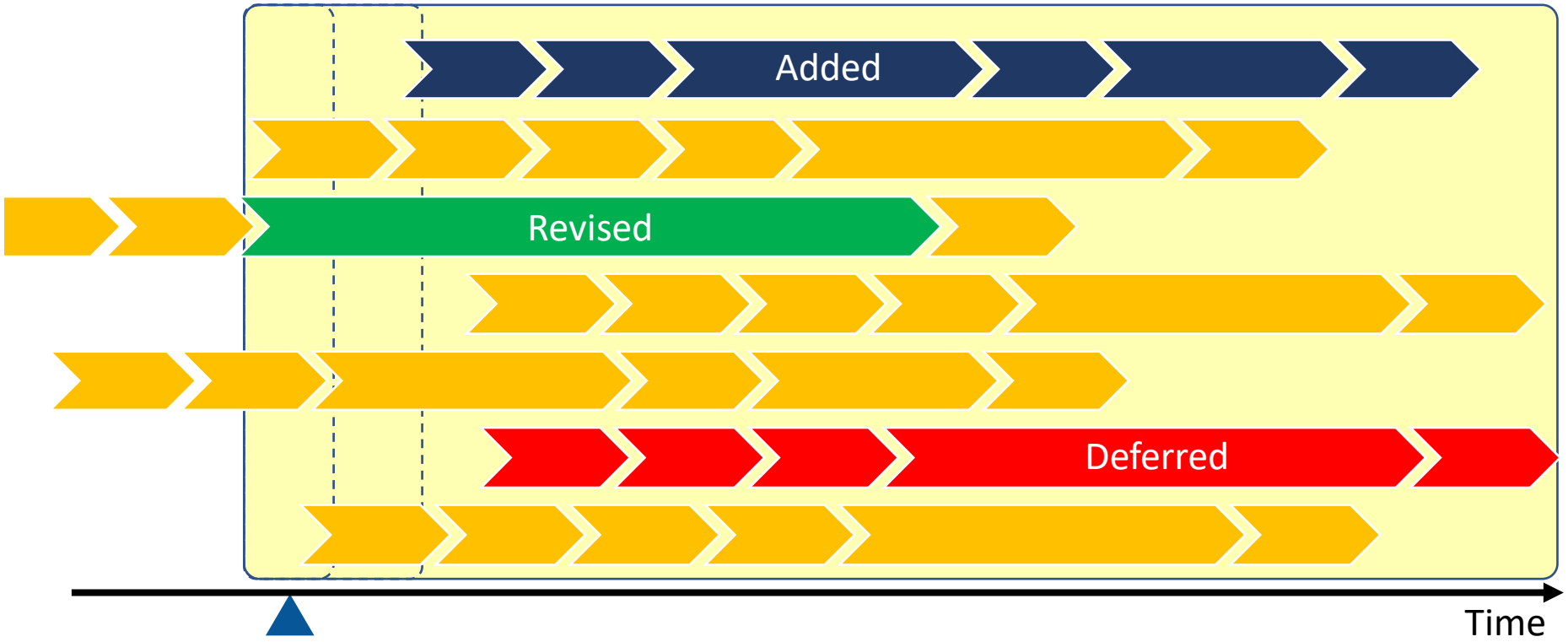


OPTIMIZE PORTFOLIOS

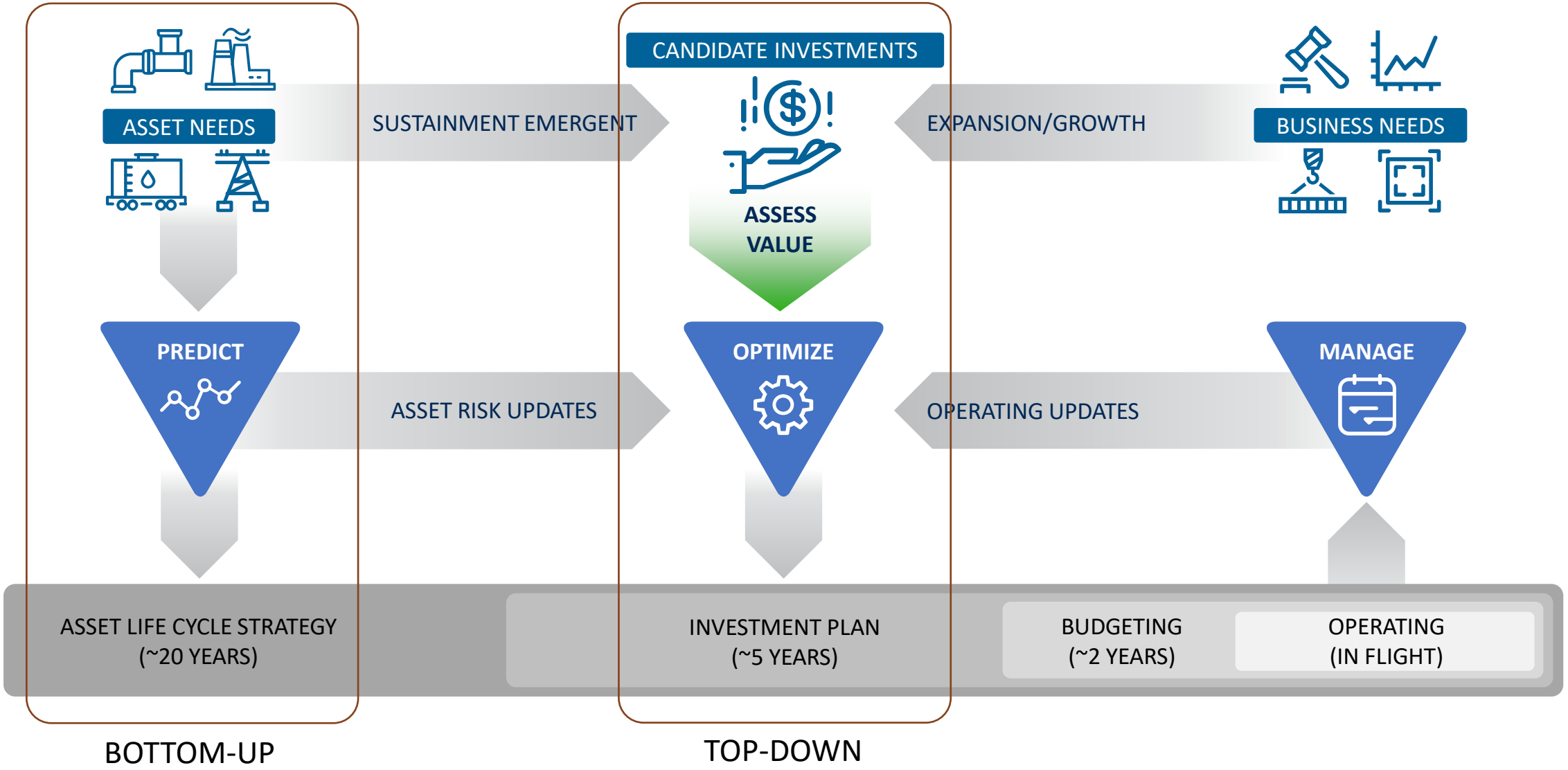


ASSET PLANS VS. INVESTMENT PORTFOLIOS

- Assets and market conditions evolve over time
  - AMPs should be dynamic
  - Every decision should be taken full knowledge of how it affects the AMPs

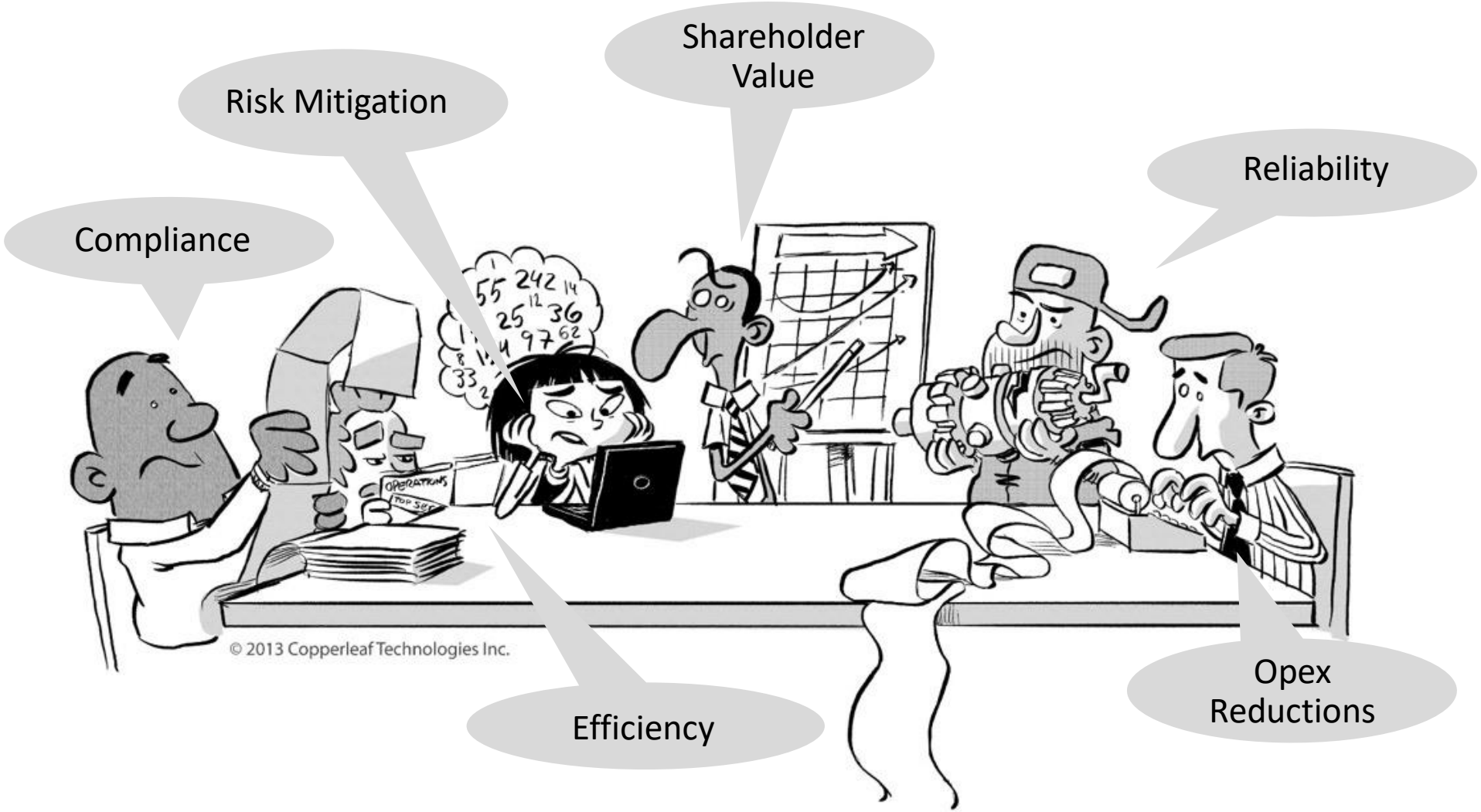


ASSET INVESTMENT PLANNING & MANAGEMENT

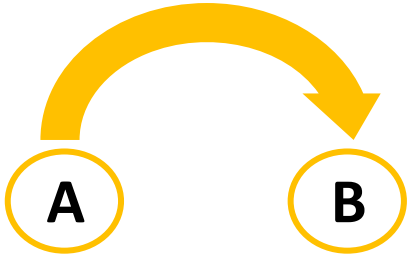


WHAT IS "VALUE"?

- Depends Who You Ask…



AN EXAMPLE…

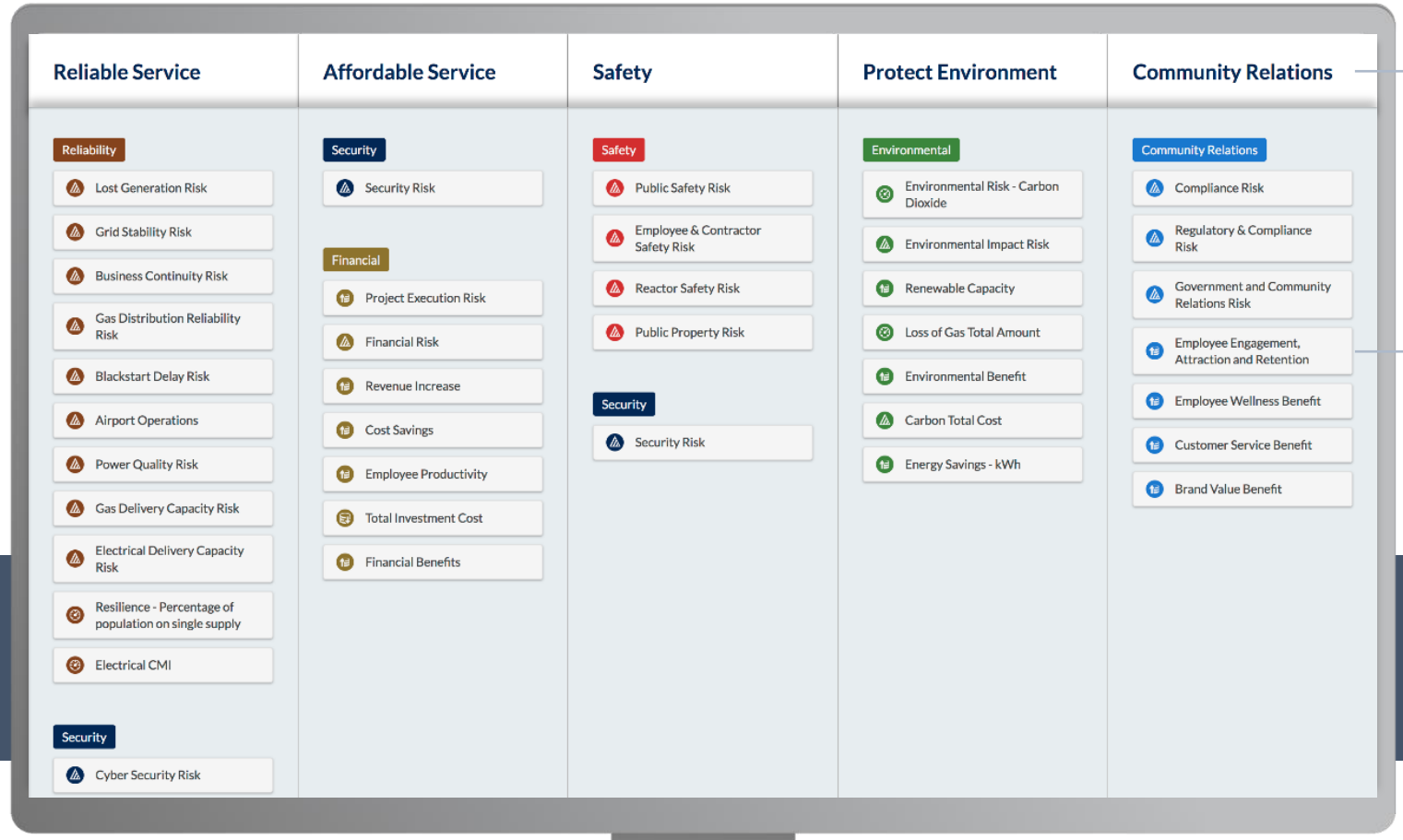







Value	Repair	Replace	Upgrade	Carpool	Limo	Transit
Affordable	$	$ $	$ $ $	$ $	$ $ $ $	$
Look	☆	☆☆	☆☆☆	☆	☆☆☆☆	☆
Speed	⌛⌛	⌛⌛⌛	⌛⌛⌛⌛	⌛⌛	⌛⌛⌛	⌛
Safety	△	△ △ △	△ △	△	△ △ △	△ △
Convenience	💰 💰	💰 💰 💰	💰 💰	💰 💰	💰 💰 💰 💰	💰
Space	🚹 🚹 🚹 🚹 🐎	🚹 🚹 🚹 🚹 🐎	🚹 🚹	🚹 🚹 🐎	🚹	🚹

VALUE-BASED DECISIONS ALIGNED WITH STRATEGY

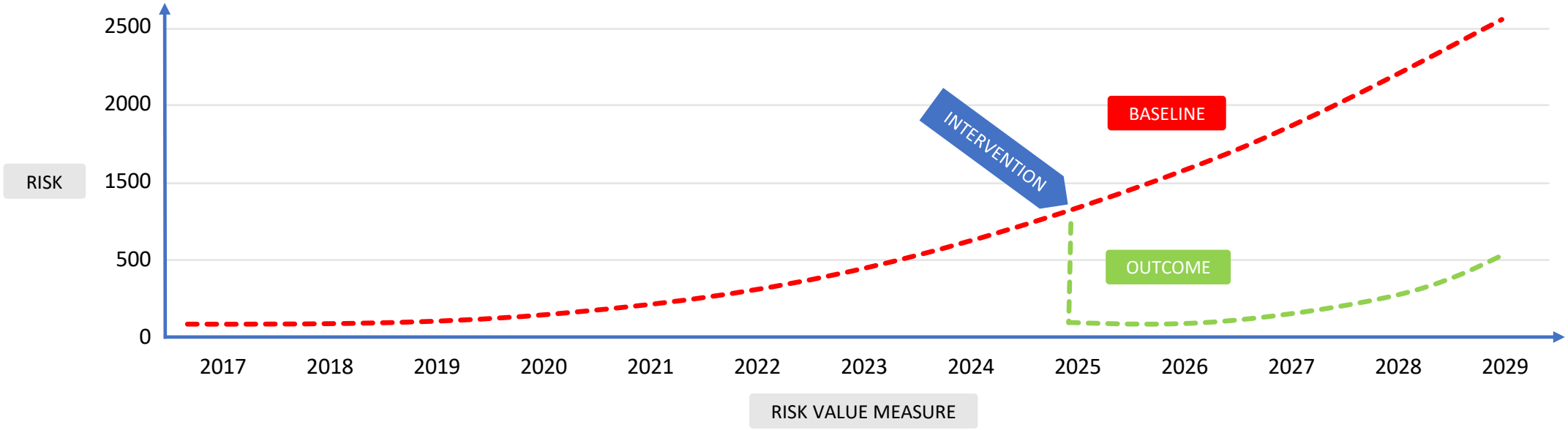


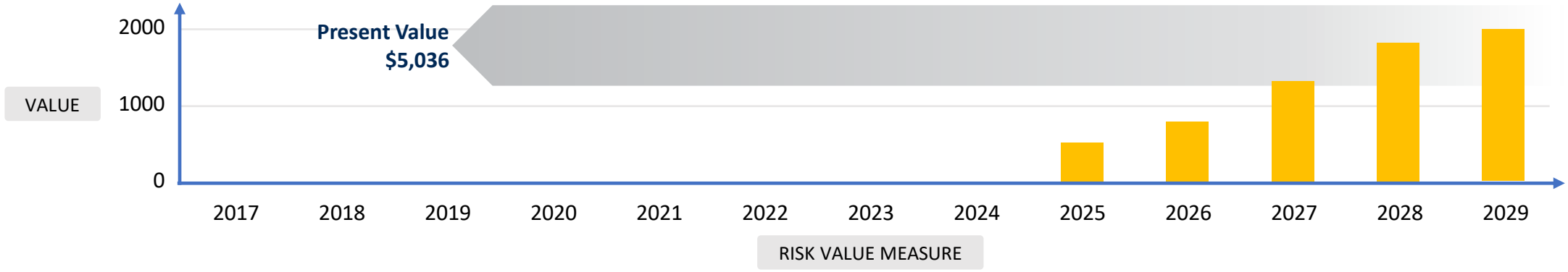
STRATEGIC OBJECTIVES

VALUE MEASURES

Make decisions that drive the organization's strategy

RISK AND VALUE OVER TIME





ALIGNING METRICS

Event Type	Negligible	Small	Minor	Moderate	Major	Extreme
Safety	On-Site first aid injury	Injury requiring medical attention / near miss	Injury requiring medical attention / lost time	Multiple injuries requiring medical attention / lost time	Permanent disability	Fatality / multiple fatalities
Environmental	Minor impact / no remediation required	Minor impact / contained on-site / simple remediation	Minor impact / contained / moderate remediation	Limited impact offsite / contained / moderate impact on site	Detrimental impact / on or offsite / long term remediation	Catastrophic offsite / impossible to mitigate / uncontained
Financial	< $100K	$100K → $500K	$500K → $1M	$1M → $5M	$5M → $10M	>$10M
Dx SAIDI	< 1.5 h	1.5 → 8 h	8 → 16 h	16 → 80 h	80 → 160 h	> 160 h
Tx Frequency of Outages	<17	17 → 85	85 → 168	168 → 830	830 → 1660	> 1660
Lost Generation	< 2 GWh	2 → 11 GWh	11 → 22 GWh	22 → 110 GWh	110 → 220 GWh	> 220 GWh

VALUE-BASED DECISION MAKING

Value-based Decision Making is an approach to making decisions that is focused on delivering the maximum value to an organization

IDENTIFY

Identify the criteria that deliver the greatest value to the organization

ALIGN

Align criteria to a common scale to compare dissimilar investments (i.e. financial and non-financial)

ASSESS

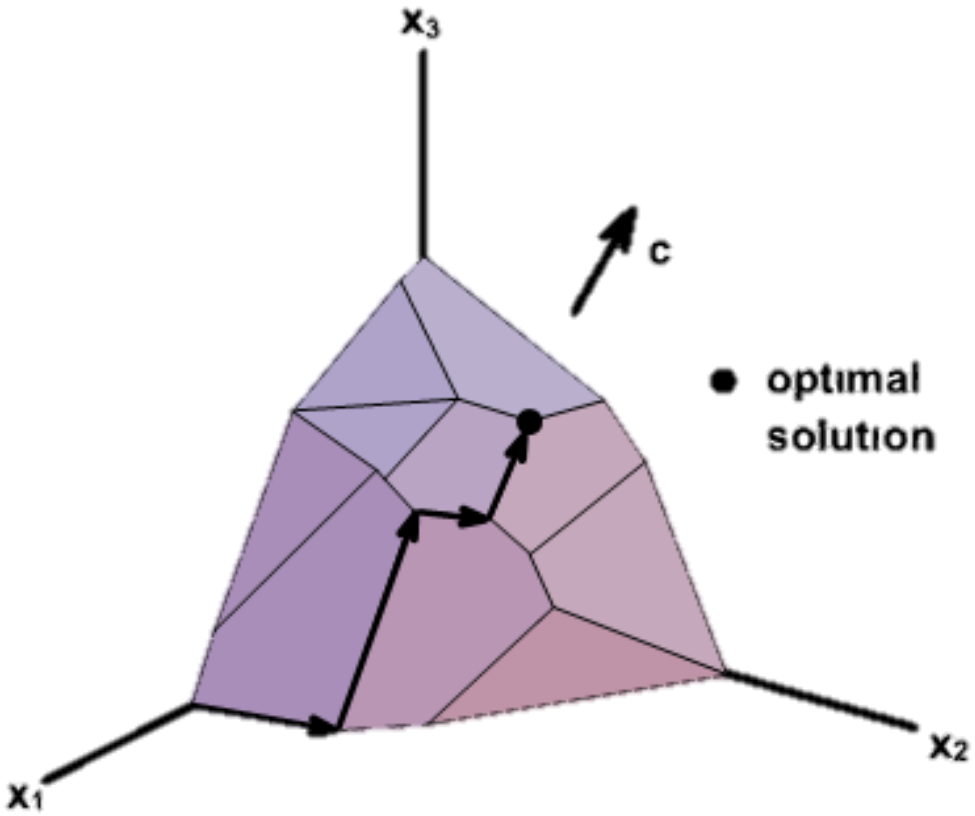
Assess the value of investments using a rational economic approach

OPTIMIZE

Optimize investments across the organization based on value and constraints

OPTIMIZATION

- Simplex algorithm invented in the 40's by G.B. Dantzig
- Large set of simple equations describing objectives & constraints
- Requires serious computing power



PRIORITIZATION VS OPTIMIZATION

PRIORITIZATION

Name	Alt	Score	Cost	2020	2021	2022	2023
Project 1	A	$50	$3				
Project 2	A	$100	$3				
Project 3	A	$75	$4				
Project 4	A	$50	$2				
Project 5	A	$25	$1				
Project 6	A	$100	$2				
Project 7	A	$50	$3				
Project 8	A	$50	$1				
		$250	$10				

Budget Constraint: $10

2020 Budget Process	Max. Value
1. Consider only 2020 projects	**$300**
2. Rank by Value, then Cost	
3. Apply budget constraint	**$225**
4. Manually adjust	**$250**

OPTIMIZATION

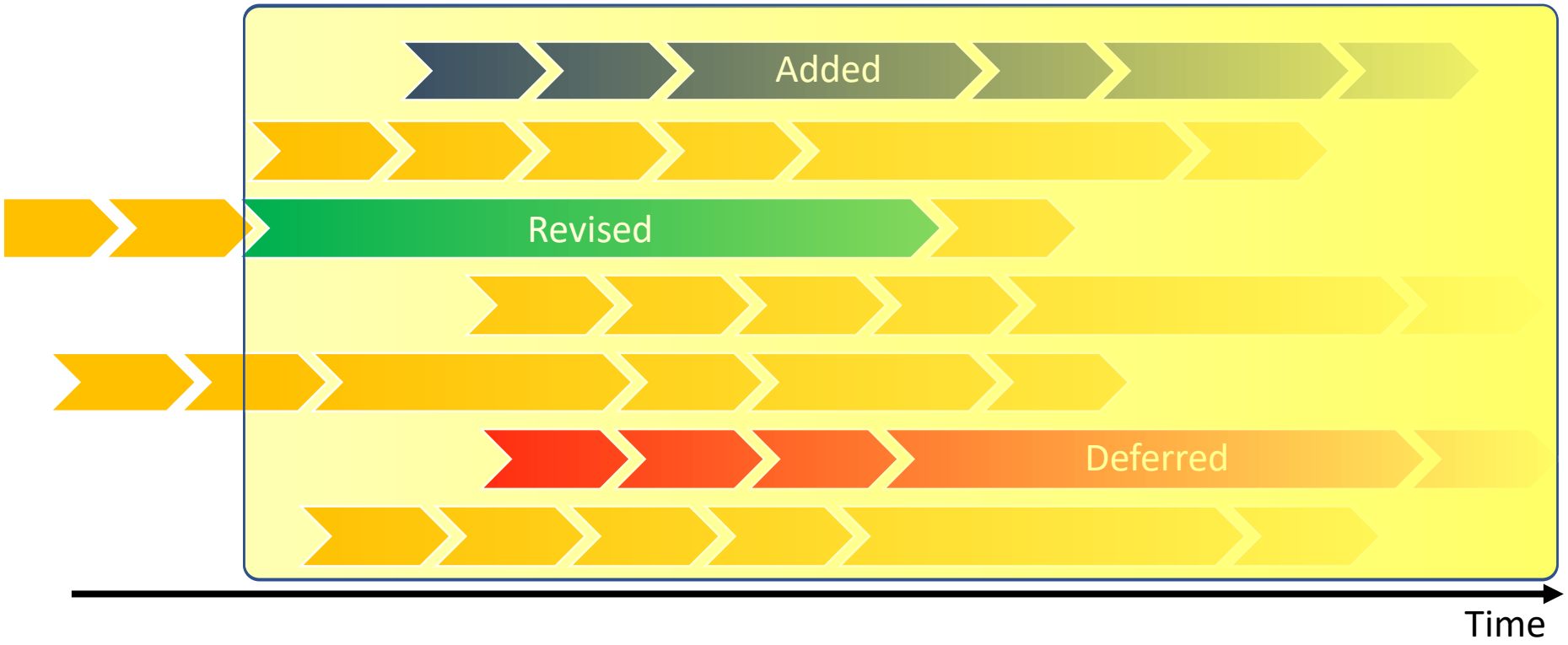
Name	Alt	Value	Cost	2020	2021	2022	2023
Project 1	A	$50	$3				
Project 2	B	$70	$2				
Project 3	A	$70	$4				
Project 4	A	$50	$2				
Project 5	A	$22	$1				
Project 6	A	$103	$2				
Project 7	A	$50	$3				
Project 8	A	$52	$1				
		$325	$10				

Budget Constraint: $10

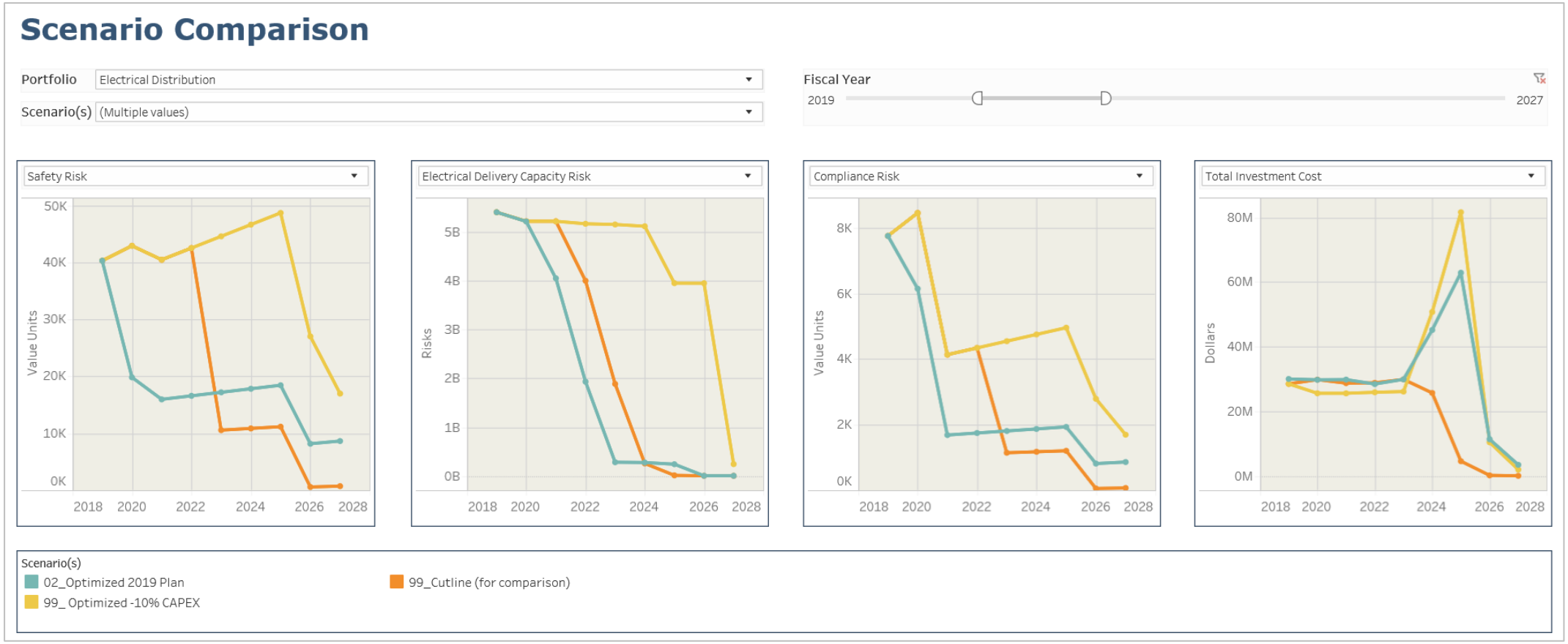
2020 Budget Process	Max. Value
1. Automatically:	
• Defer & advance projects	
• Select project alternatives	
• Iterate to optimum solution	**$325**

OPTIMAL DECISIONS OVER TIME

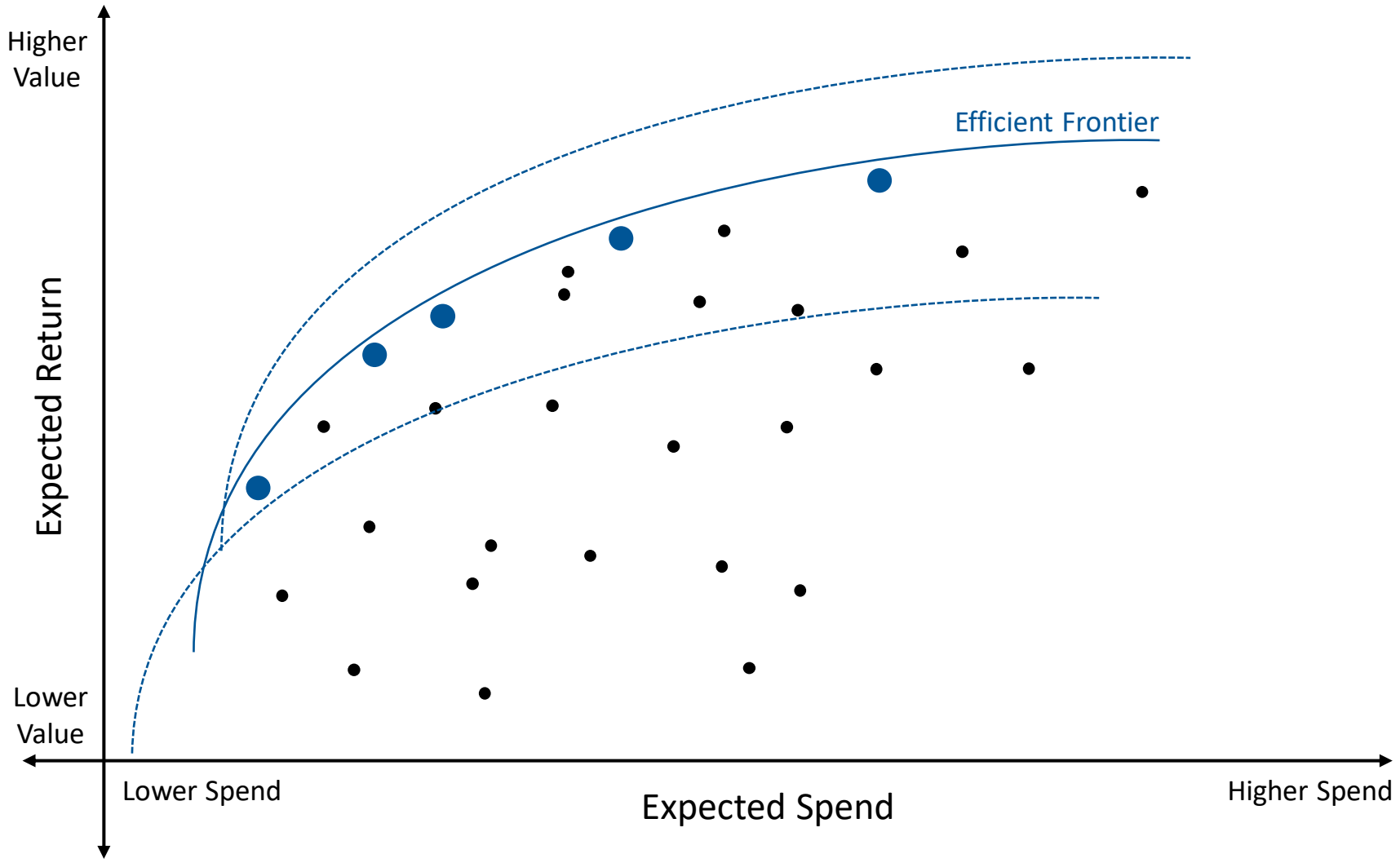
- Uncertainty increases in outer years
  - Both economically and asset behaviour
  - Explore multiple scenarios – “what if”
- Importance of dynamic AMPs



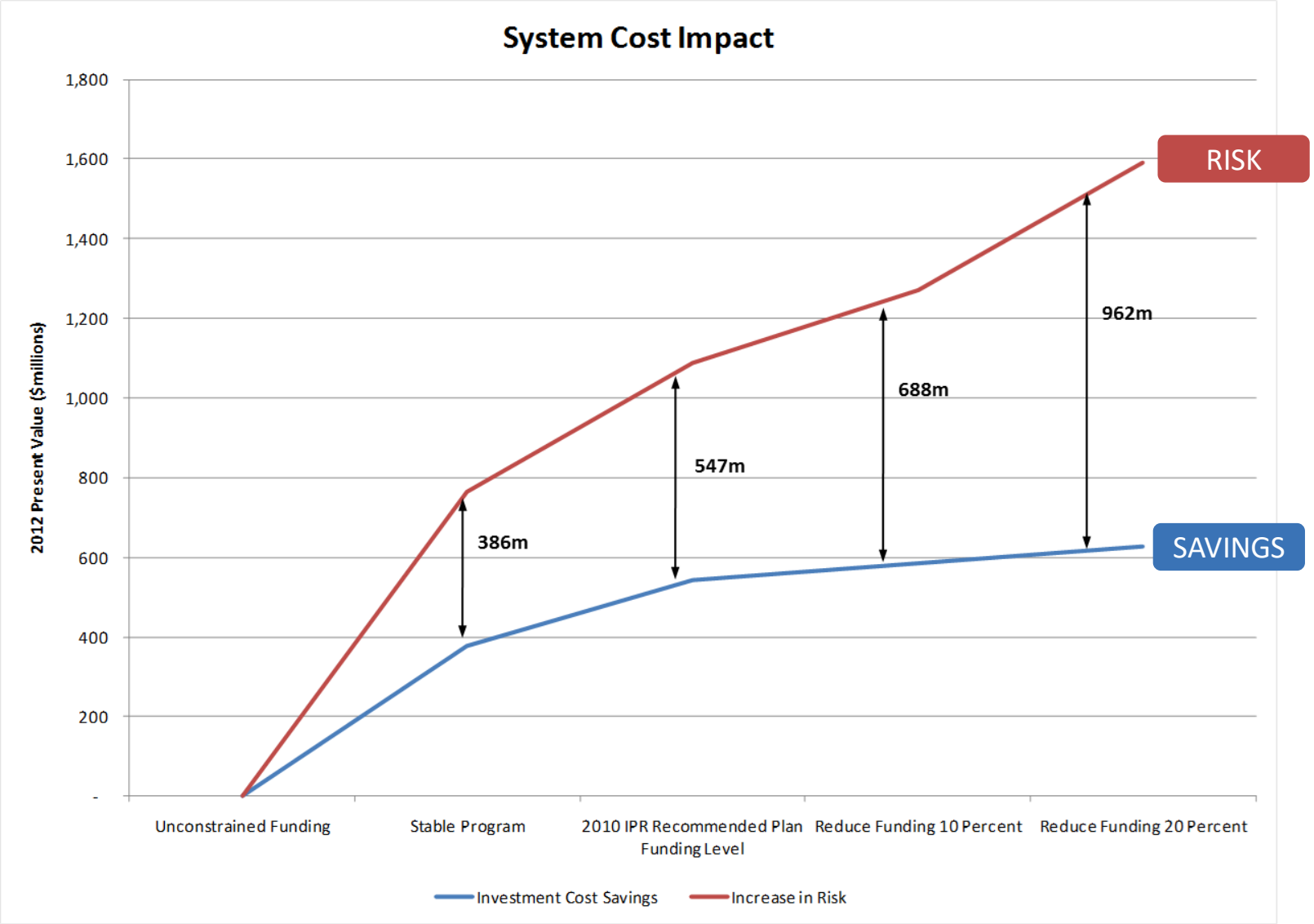
WHAT-IF SCENARIOS

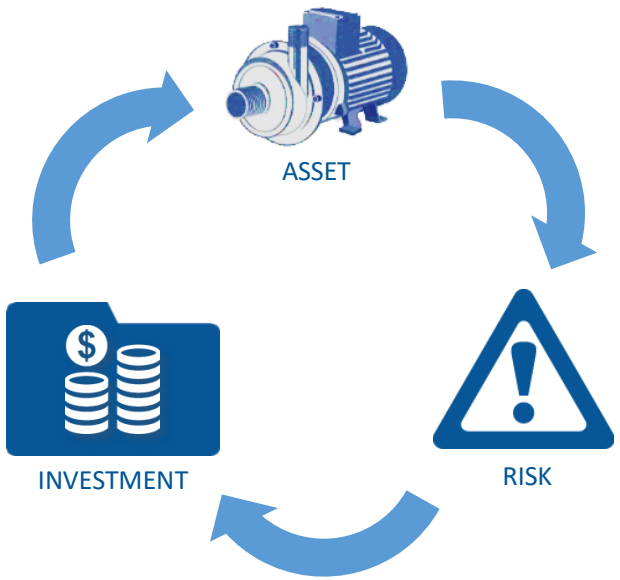


THE EFFICIENT FRONTIER



THE COST OF NOT DOING





CONCLUSIONS

- All previous speakers were right!
- Engineers tend to think bottom-up
- Management tends to think top-down
- Decisions need to consider all objectives and constraints
- Everything changes with time
- Prioritization generally leaves money on the table
- Enter Multi-Criteria Decision Analysis
- Best practices
  - Consider alternatives
  - Make everything time-dependent
  - Develop a common value scale (and monetize)
  - Use proper optimization
  - Explore “what-if” scenarios
  - Close the loop: with long term plans and with project execution
- It’s a journey…

Thank You

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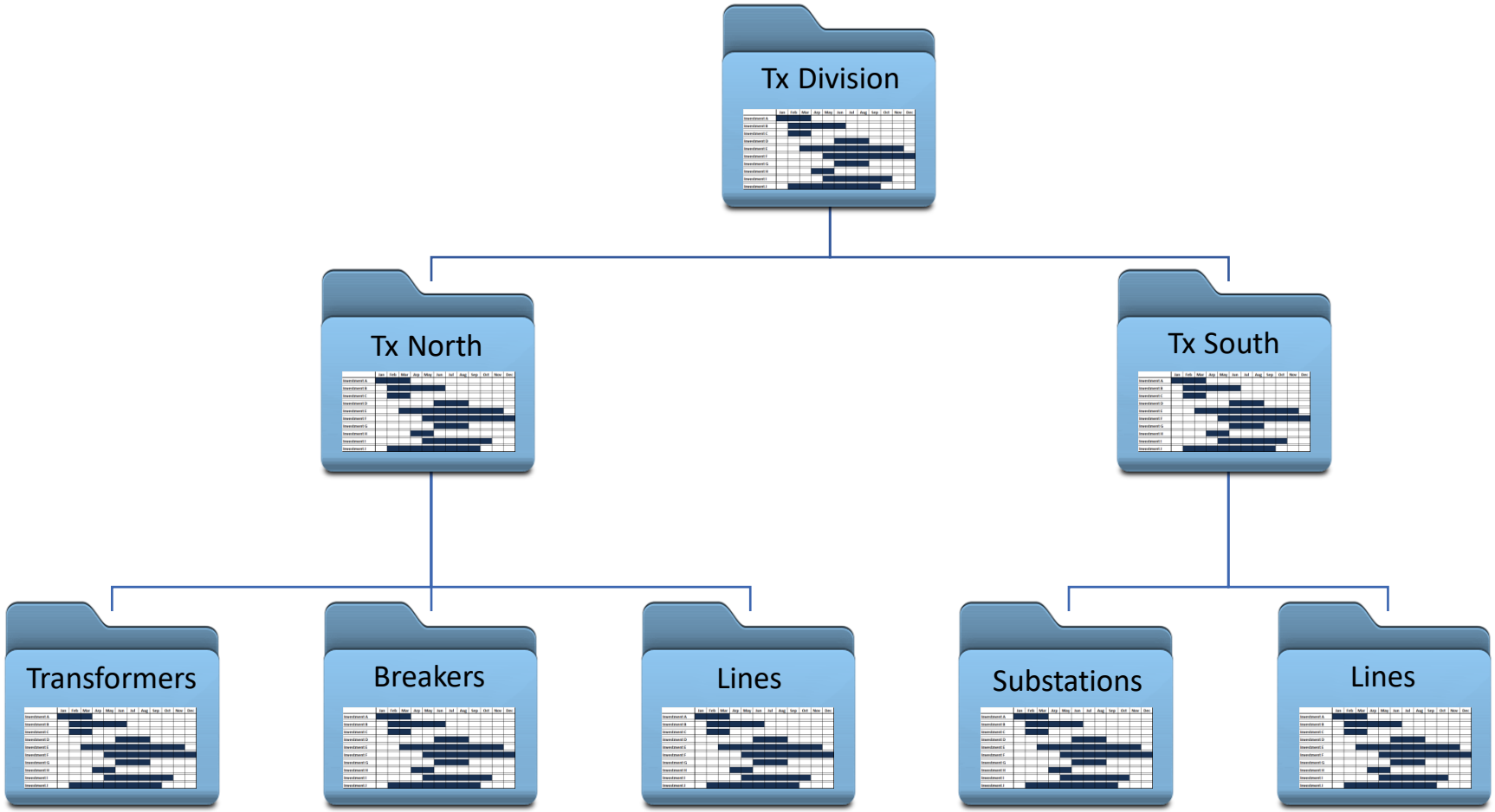
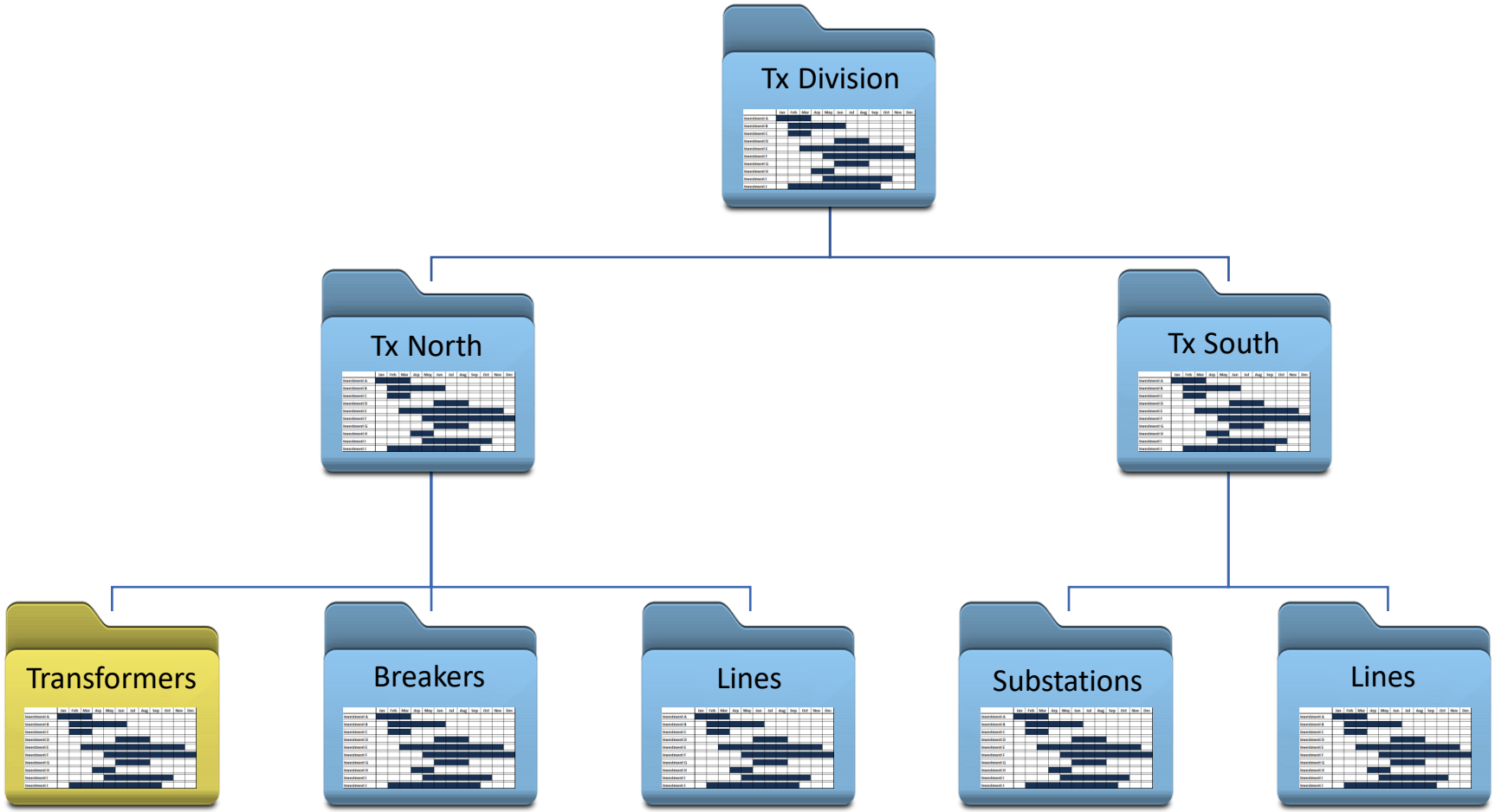
IN ASSOCIATION WITH cigre For power system expertise

WHERE TO START?



PER ASSET CLASS



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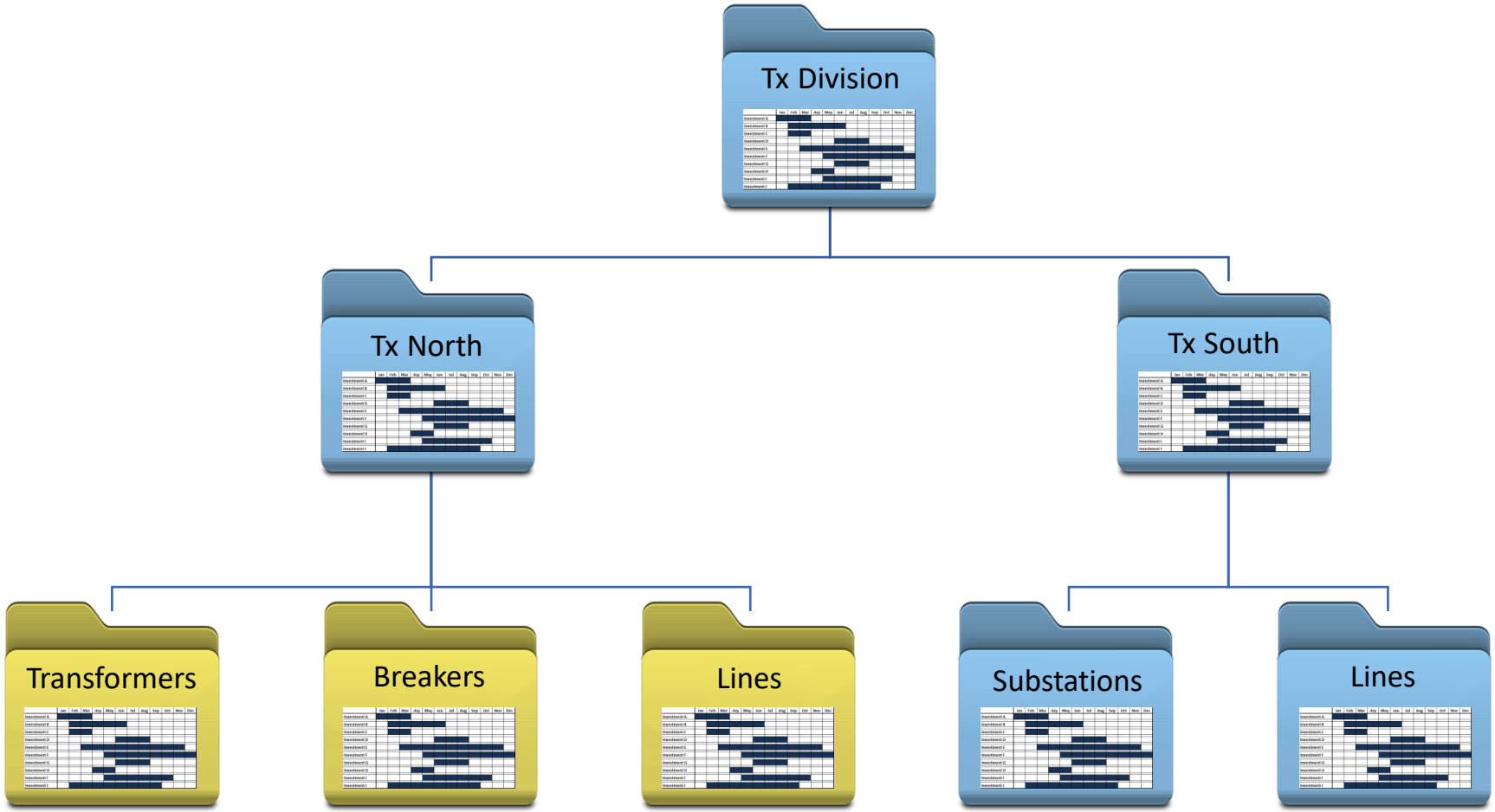
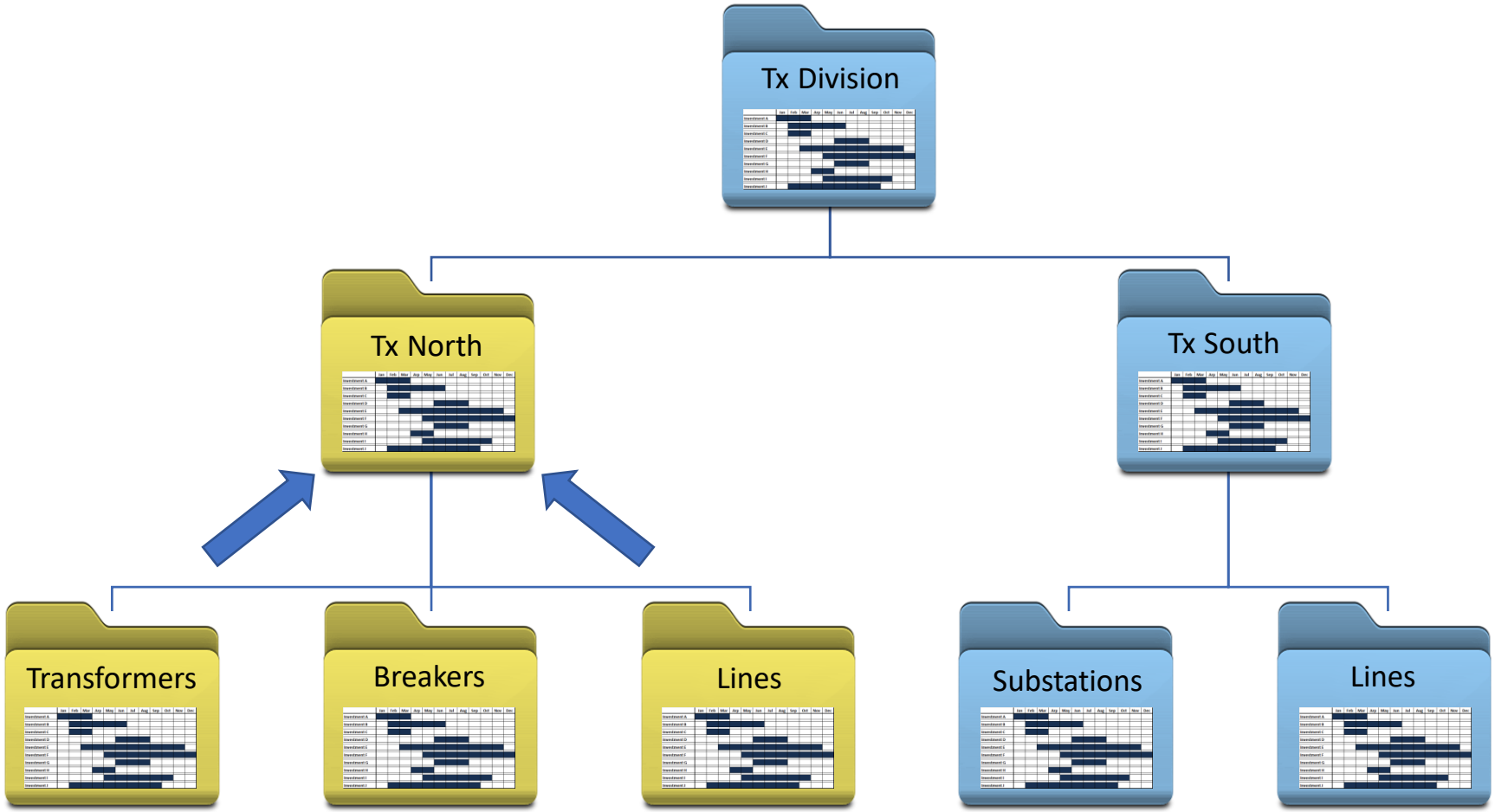
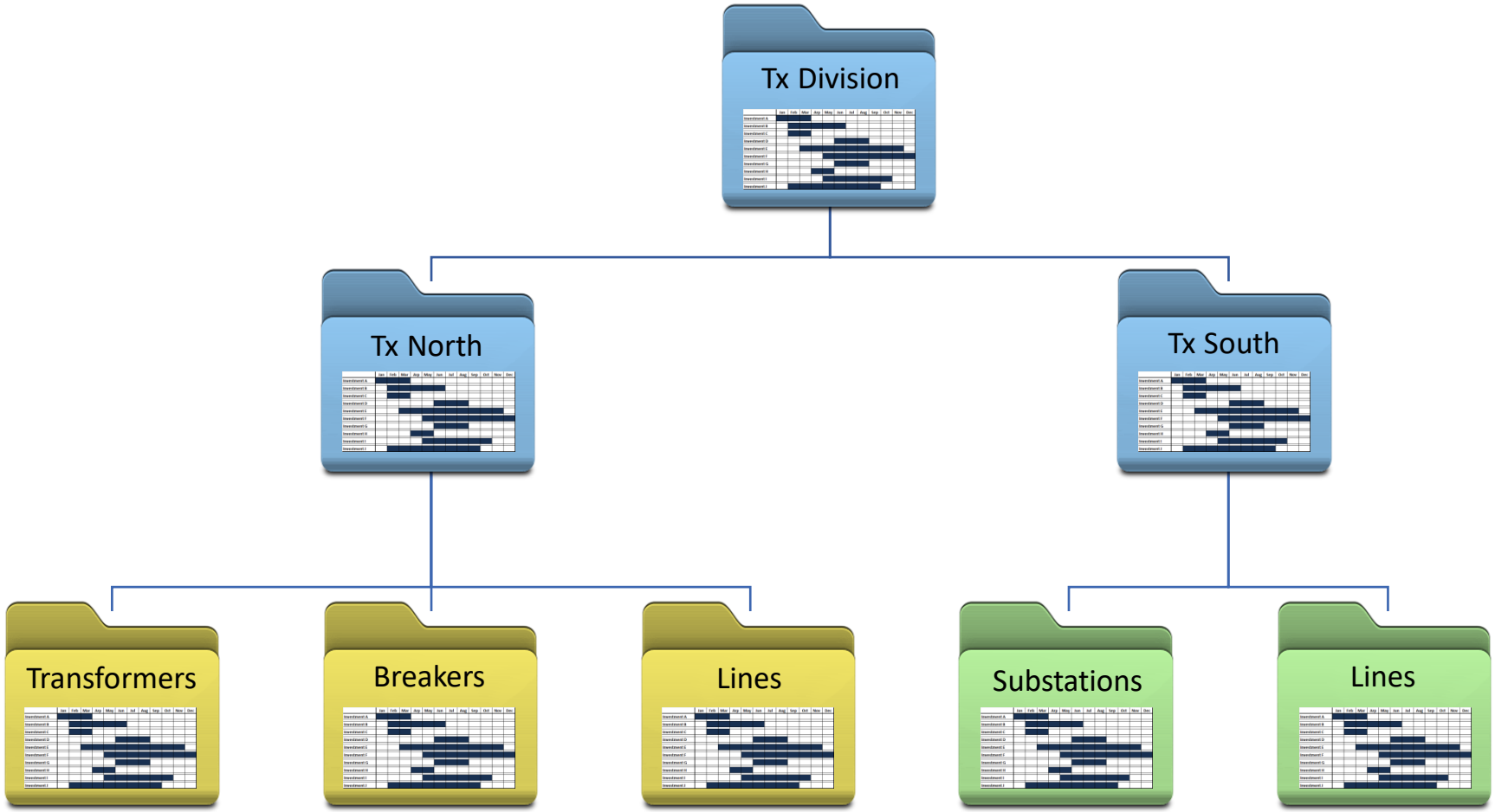


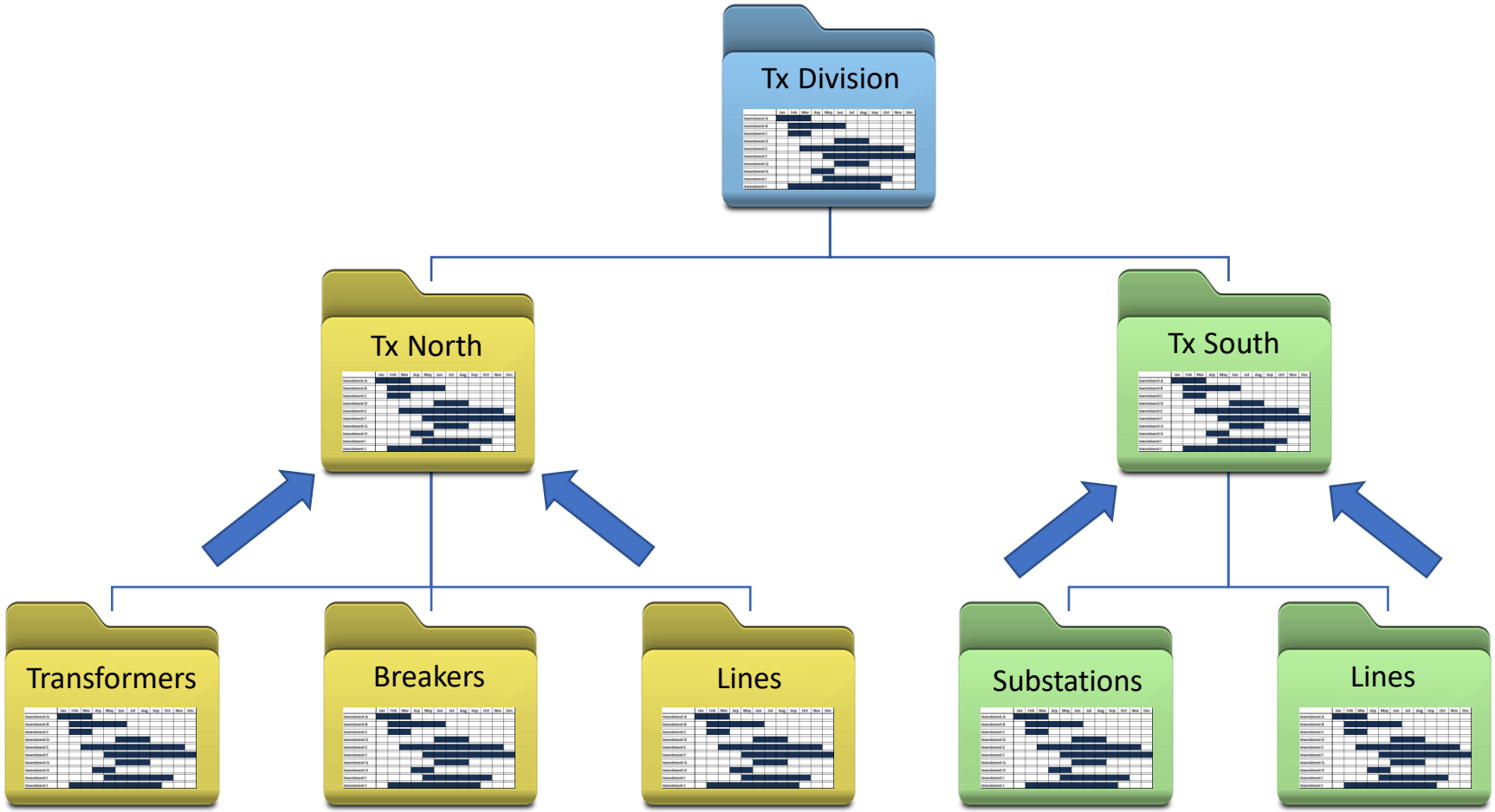
COMPETING ASSET CLASSES



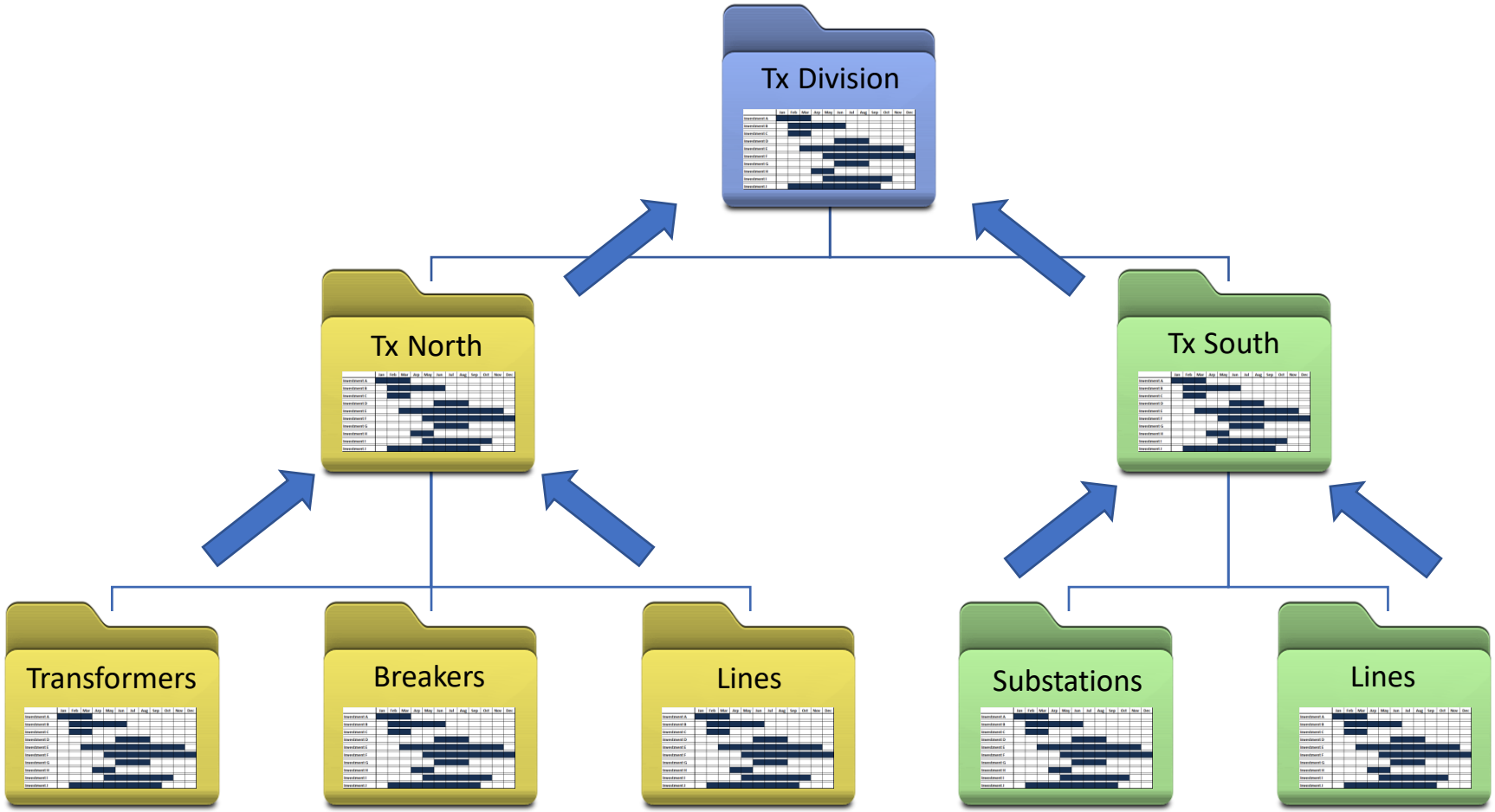
MORE ASSET CLASSES



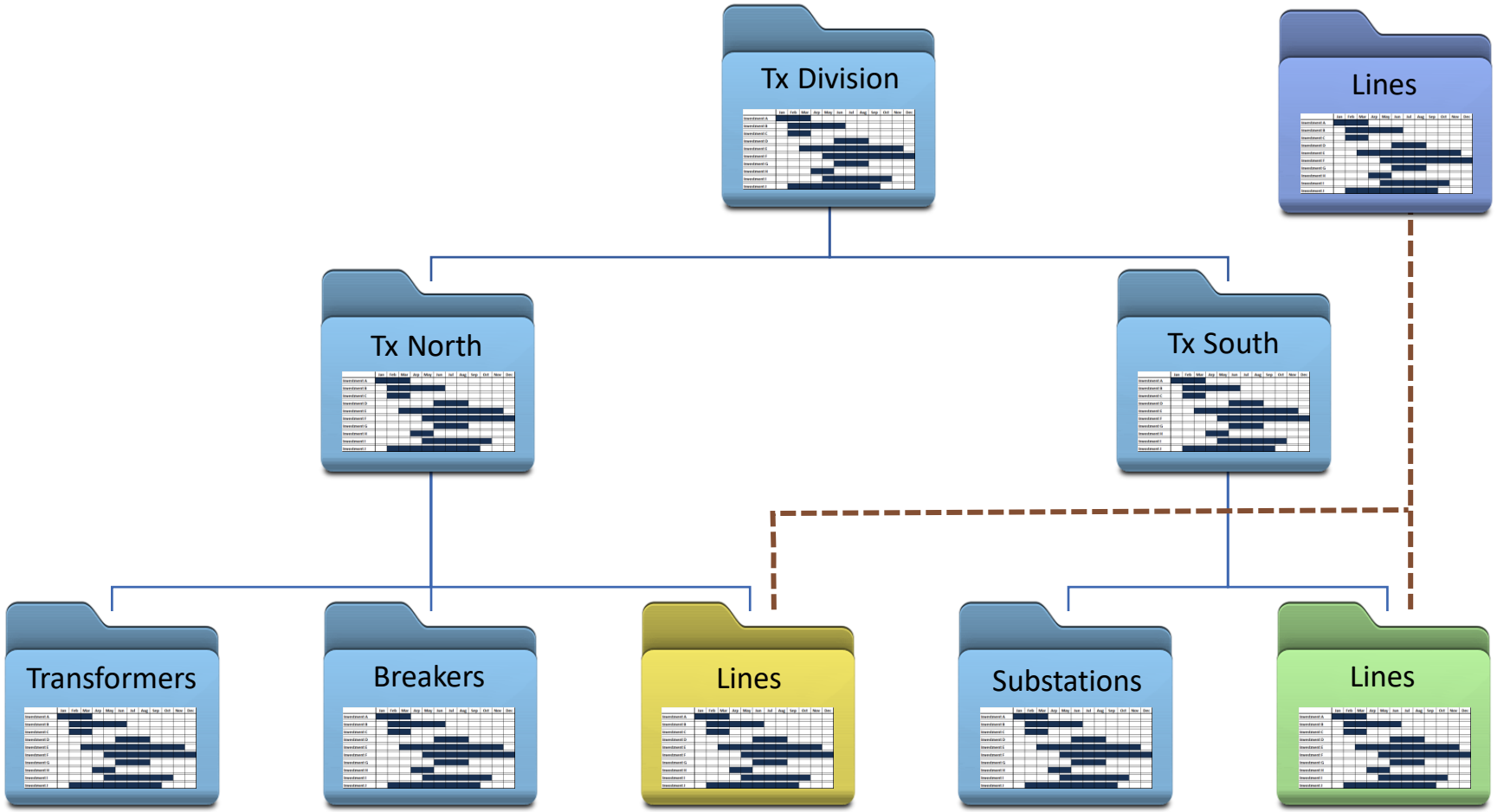
PER DIVISION



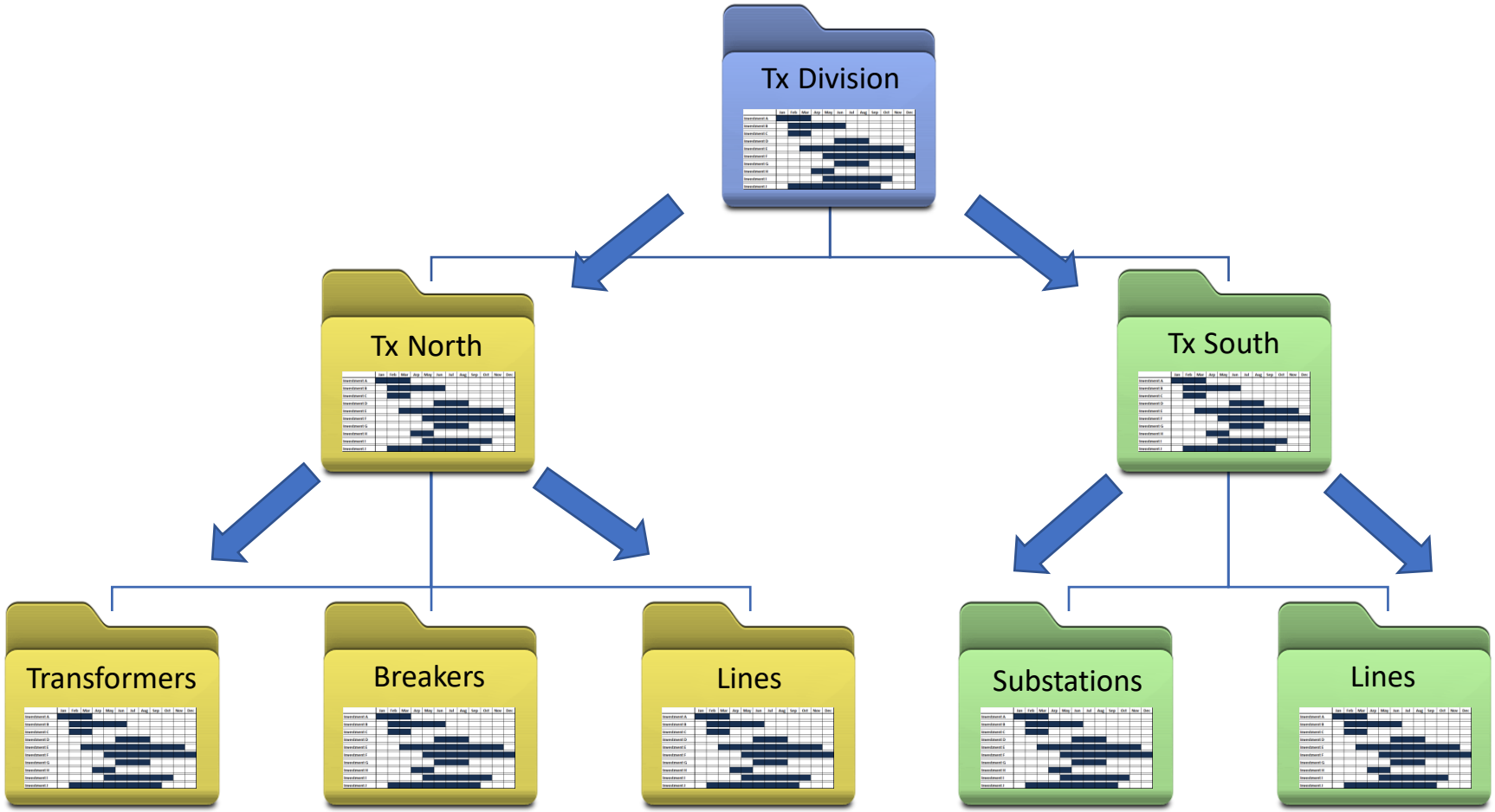
GRADUALLY ESCALATE



PER ASSET CLASS



TOP-DOWN


Tx Division
Tx North
Tx South
Transformers
Breakers
Lines
Substations
Lines