Reliability Centered Asset Management (RCAM)

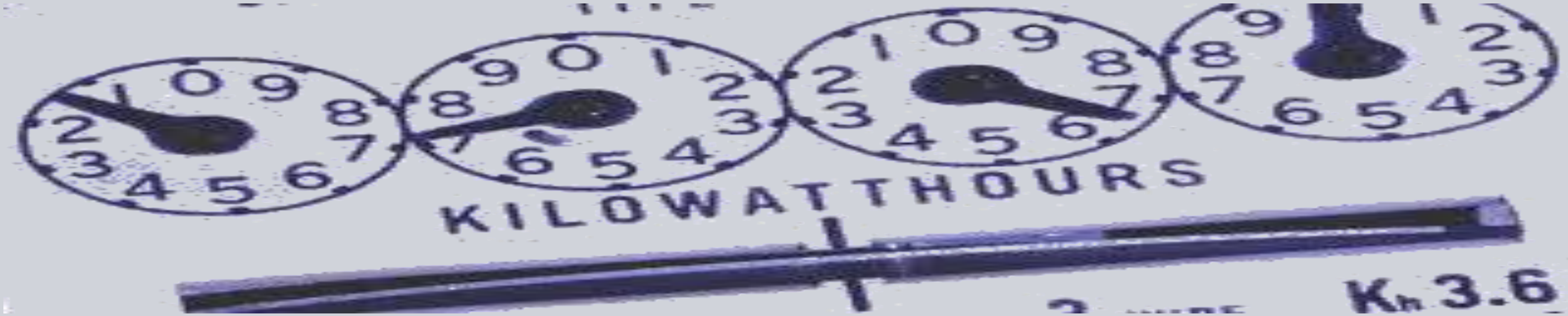
Aiming at Energy Efficient Transmission & Distribution System

IRFAN AHMAD (FIEEEP)

Energy Management & Energy Audit
Electrical Utilities

Energy Management:

Optimization of energy systems and procedures to increase energy efficiency and reliability.



Energy Audit:

A systematic approach in the area of Energy Management to verify, monitor and analyze the energy streams in a Utility. This includes recommendations to improve energy efficiency and action plan to reduce energy losses.

(Source: Bureau of Energy Efficiency, India)

Energy Audit

The main aim is to improve energy efficiency

Energy audit involves the following 3 elements of a T&D System:

1) Processes:

GoP is looking at the bigger picture;
Deregulate, Privatize

2) Manpower:

Fire before hire is the new guideline.
Take care of pounds, the pennies will..

3) T&D System: (Paradigm shift required)

Outdated, weak and un-reliable

Privatisation of electricity firms

By Ashfak Bokhari

THE federal government's decision to privatise power generation and distribution companies will open up lucrative business opportunities for the private sector. But at the same time, it will face a litmus test of its competence to play a lead role in overcoming the country's most serious crisis.

Leading business groups will be vying for the prize units in which they expect a windfall from the government's move. Even if they may be unable to make big profits, for being under the regulator's watch, they will still be able to make good money for themselves.

It is quite likely that electricity in the post-privatisation period will become costlier, with the average consumer finding it difficult to afford, and the low-income groups being the worst hit.

Those who depend on stolen power may have to do without it, for the private operator would not tolerate these losses. Many consumers would, however, be willing to compromise on the cost if the outages are done away with or become rare.

But it is not the common man whose interest is at the heart of the new energy policy. The water and power minister, Khawaja Asif, has been quite unambiguous in making it clear that privatisation was being pursued primarily to meet the terms of the International Monetary Fund (IMF), with whom the country is going to enter into an agreement for financial support, and the World Bank, which is going to provide financing for hydro projects under the new energy policy.

Since 1990, the price of electricity, according to one estimate, has gone up approximately 530 per cent for the average consumer, as the energy mix of the country gradually turned from cheaper hydropower to thermal power. Global oil price fluctuations also took their toll. By 2011, load-shedding of power had become a daily affair, with its duration always on the rise, upsetting the routine of economic activities and industrial production.

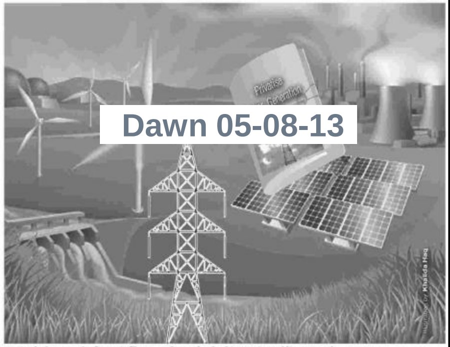
"The whole thing is a nightmare," says Asif, while describing the current state of the power sector. "We are going for a surgery. A lot of discomfort. But once the patient is up and about and running, then he will say that the pain was worthwhile." His team, he claims, would reduce Pakistan's reliance on expensive oil imports, build new (hydro) power plants, and pay off a chain of debt.

The decision is part of an elaborate programme of privatisation under which 64 public sector units are targeted to be sold. These include four power distribution companies, a generation company, three insurance companies and four oil and gas companies, besides divestment of additional government shares in privatised units. The privatisation commission has been asked to prepare a list of units that could be privatised immediately.

Privatisation, it is said, is the cure of mismanagement of state-run units. It became fashionable in the 1980s and 1990s, coinciding with the wave of neo-liberalism. The refrain was that it is not the business of the state to do business. When Britain's Margaret Thatcher sold off inefficient state enterprises, after their financial rehabilitation, to the private sector, her step was widely hailed by international financial institutions such as the World Bank and the IMF, and some economists. Another protagonist of this philosophy was former US President Ronald Reagan.

Nawaz Sharif, it seems, was also impressed by this neo-liberal philosophy. In his earlier two terms as prime minister, he was known for his penchant for privatising state enterprises. And now in his third term, he wants to unleash another wave of privatisation and deregulation, which still remain one of the priorities of his government.

In 1992, at the insistence of the IMF and the World Bank, the PML-N government's special committee on privatisation had approved a Strategic Plan for Restructuring of Wapda, which meant 'unbundling' of Wapda's power wing. It was aimed at shifting the burden of generation and distribution to the private sector.



In its second stint, the PML-N approved the unbundling of Wapda into 13 units: eight distribution companies, three generation companies and the National Transmission and Dispatch Company (NTDC). The entire exercise was conceived to bring the power sector under a market-driven system. But the actual motive was to prepare the sector for privatisation. The PML-N's original plan in the first term was to privatise smaller units first, as it was easy to do. Now that it has returned to power in 2013, the party would like to finish the unfinished business.

Finance Minister Ishaq Dar is eager to vigorously pursue the privatisation programme, and wants the privatisation commission to cut the processing time from 18 months to a year to speed up the work of taking major public sector enterprises to the sale counter. Although no formal decision about units to be privatised has been made, Mr Dar has hinted at divesting more government shares in major banks like the United Bank, Allied Bank and Habib Bank.

The question arises whether the solution to the power crisis lies in promoting public sector investment or inviting the private sector to take over the public sector. The PML-N's election manifesto favours both actions, and says that the party's government, in a bid to turn around the loss-making state enterprises, will appoint independent and professional boards, who in turn will appoint competent CEOs of state enterprises.

Their immediate task will be to plug the losses and manage these corporations effectively. The party will resist every kind of political interference in the affairs of these enterprises, and undertake urgent reforms in the relevant sub-sectors.

However, the PML-N government will identify enterprises that need to be privatised and assign targets to the privatisation commission to ensure the completion of the process within the assigned time frame. The manifesto says that PIA shall be transformed into a profitable and reputed airline of the region.

The Pakistan Energy Outlook, launched in 2011, stated that state-owned thermal power plants suffer from inefficiency, and are also expensive to maintain and operate.

Privatisation will help them operate in a competitive market, with no government support.

The report asked the government to allow all power distribution and marketing companies to operate in a competitive power market. But the success in achieving efficiency is seen doubtful, since inefficient managements and workforce remain part of the problem.

An important 4th element outside the T&D System, whose participation is necessary in improving energy efficiency, is the Consumer.
A Consumer in Pakistan requires urgent awareness about his role.

Resolving the energy crisis

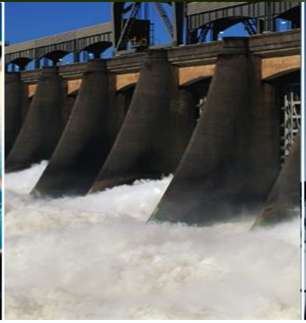
1) Energy Conservation
- Hybridisation
- Smart grids

2) Energy Efficiency
- Loss reduction
- Asset Management

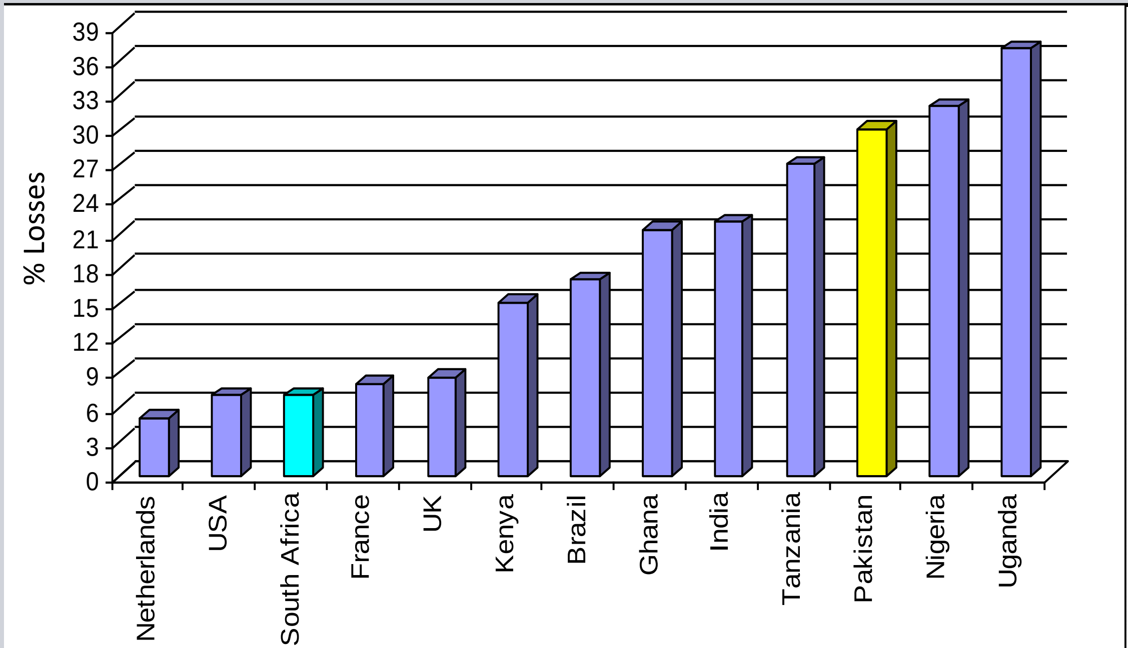
(We need to know where we stand)

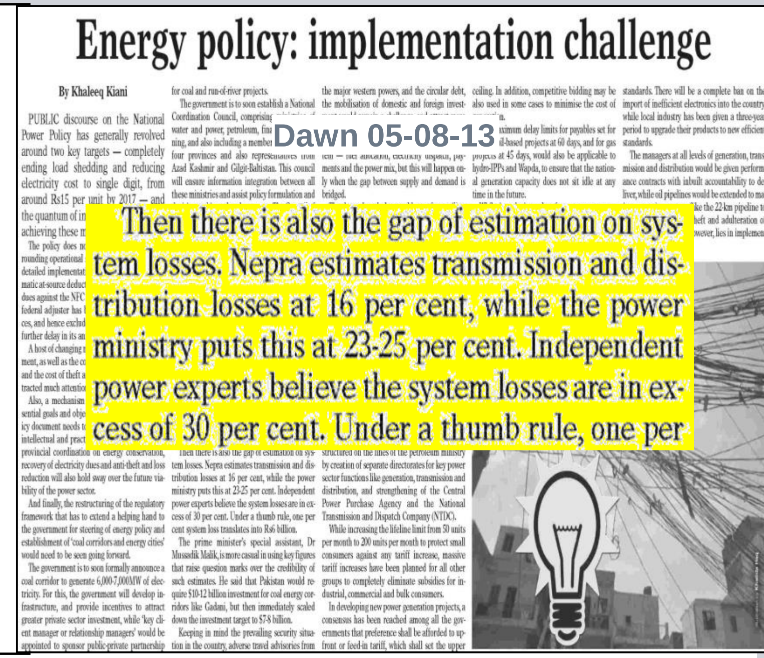
3) Energy Generation
- Renewables
- Alternative
- Conversion




Total Electrical Losses of some typical countries





Energy policy: implementation challenge

By Khaleeq Kiani

Then there is also the gap of estimation on system losses. Nepra estimates transmission and distribution losses at 16 per cent, while the power ministry puts this at 23-25 per cent. Independent power experts believe the system losses are in excess of 30 per cent. Under a thumb rule, one per

The main issue with our utilities are the energy losses on constant increase.

<u>Losses vary from DISCO to DISCO. On the average the total losses are around 30%</u>

Example:

KESC: **Total Average Energy Losses > 40% - (as declared by KESC)**

FESCO: **Total Average Energy Losses = 14% - (as declared by FESCO)**

How big are the utility losses in Pakistan

Total units sold in 2012 *	= 79 x 10^9 Units
Average tariff	= Rs. 15 per Unit
Total revenue / year	= Rs. 15 x 85 x 10^9
	= **Rs. 1185 Billion**
Total loss (>30%) / year	= **Rs. 360 Billion**
Technical losses / year	= **Rs. 100 Billion**

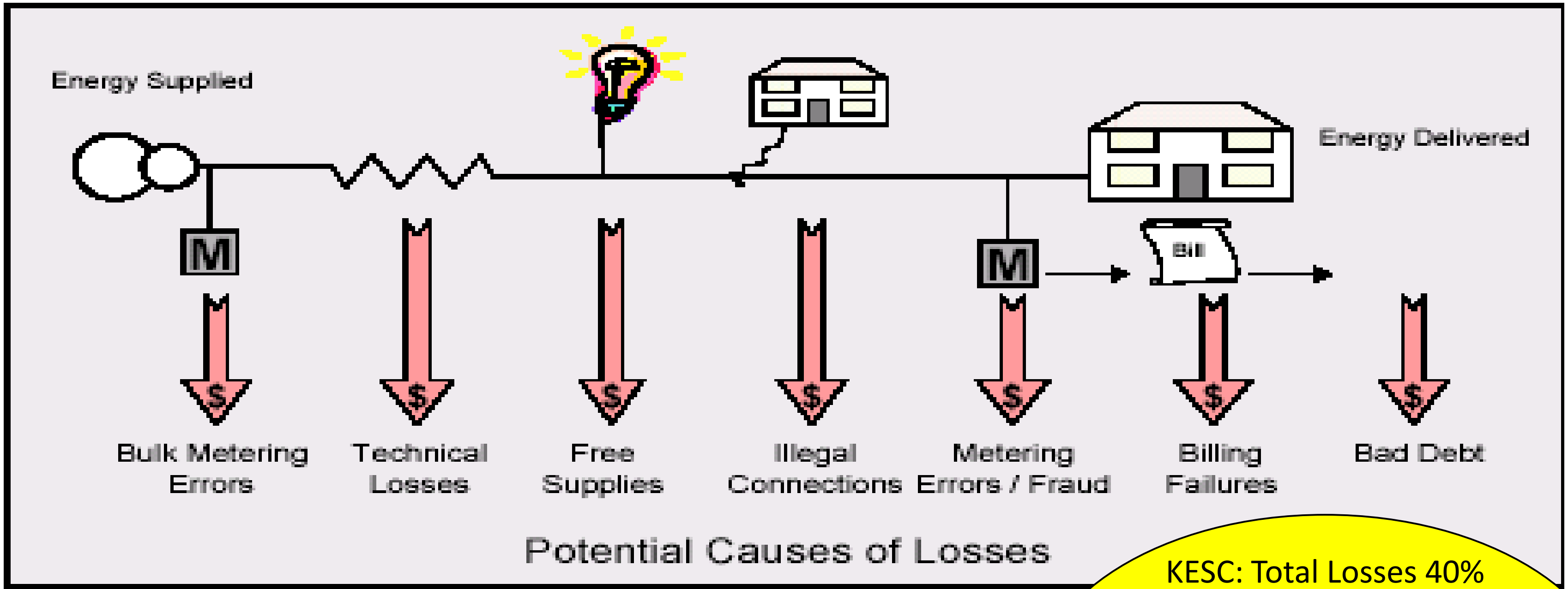
Possible recovery of revenue loss (over 3 years) by simple methods of loss reduction is > 15% which is equivalent to **Rs. 180 Billion / year.**

* Key World Energy Statistics 2012, IEA

Various Types of Losses

Only approximate total losses for Pakistani utilities are known

None of the utilities know the exact amount of technical & non-technical losses



KESC: Total Losses 40%
Technical Losses 20%
Non-Technical 20%

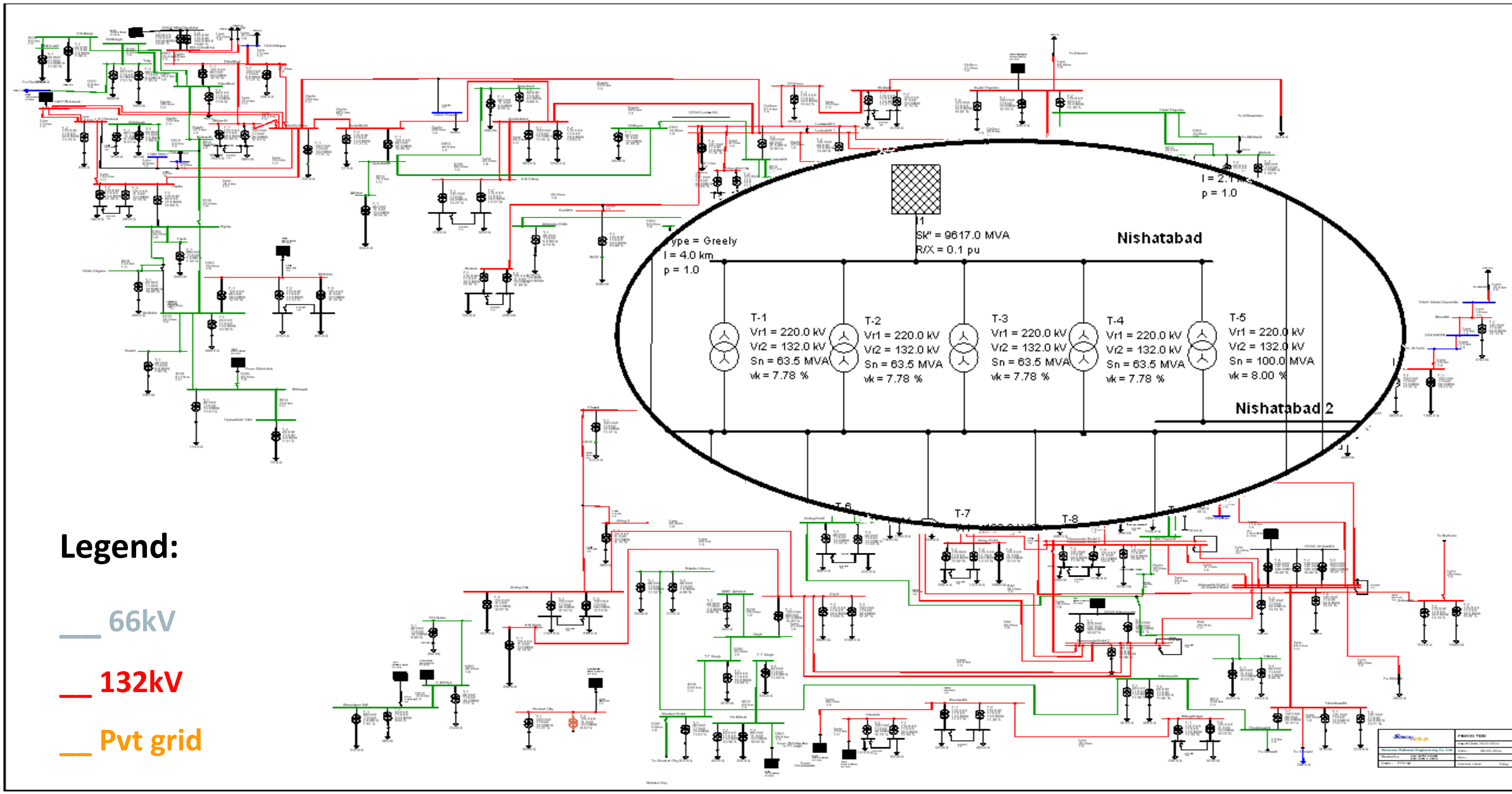
FESCO: Total Losses 14%
Technical Losses 7%
Non-Technical 7%

Two different type of losses:

- Technical Losses such as I^2R Losses
- All other losses are Non-Technical Losses where
  Illegal connections (theft) constitute a major portion

Case 1: Load Flow Study of HV System

Determining Technical Power Losses using Simulation Software



Determination of Losses by Load Flow Studies

Power (kW) Losses are determined and converted into Energy (kWh) Losses by using following formula:

Power Losses x (0.5 to 0.7) = Energy Losses

Factor for Pakistani Utilities Eg. KESC=0.68

Major advantage

Both technical & non-technical losses can be determined.

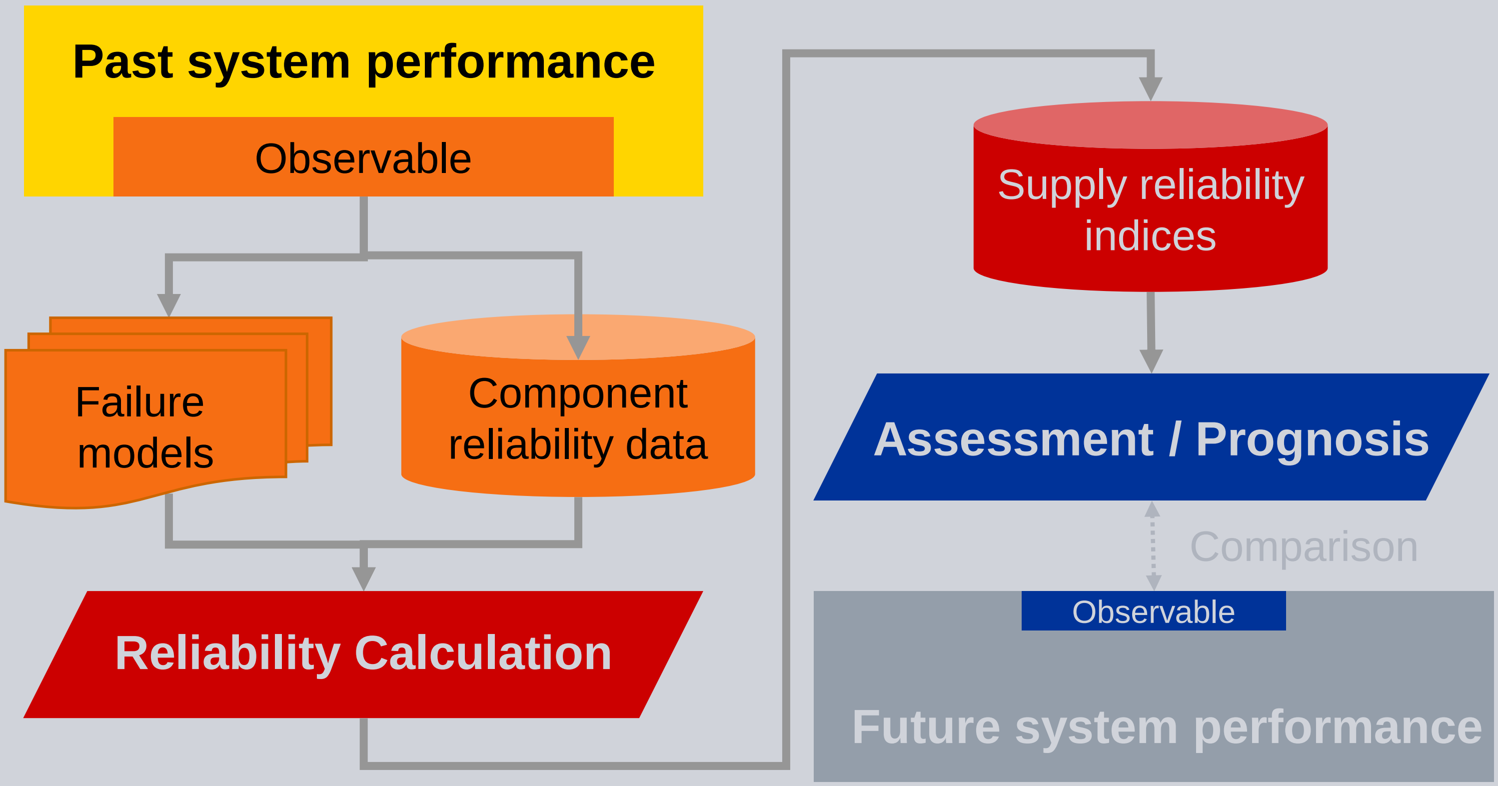
Case 2: Load Flow Study of MV Feeders of a Utility

Result Summary: Technical Losses at MV Level

Feeder Name	No. of Consumer	Tech. Losses	Non-Tech. Losses	Loss perYear PKR	Investm. for Tech. loss reductn by 2% in PKR	Revenue Saving PKR	Return/ Investm. Ratio	Investm. non Tech. loss reduction by 20% in PKR	Revenue Saving PKR	Return/ Investm. Ratio
1	3582	7%	37%	51 M	15.0 M	3 M	**0.20**	20 M	30 M	**1.48**
2	5748	6%	51%	71 M	13 M	3 M	**0.22**	32 M	28 M	**0.86**
3	5450	4%	39%	50 M	20 M	2 M	**0.13**	31 M	26 M	**0.84**
4	10753	6%	30%	41 M	14 M	3 M	**0.18**	61 M	27 M	**0.44**

RCAM
Probabilistic reliability analysis – Overview

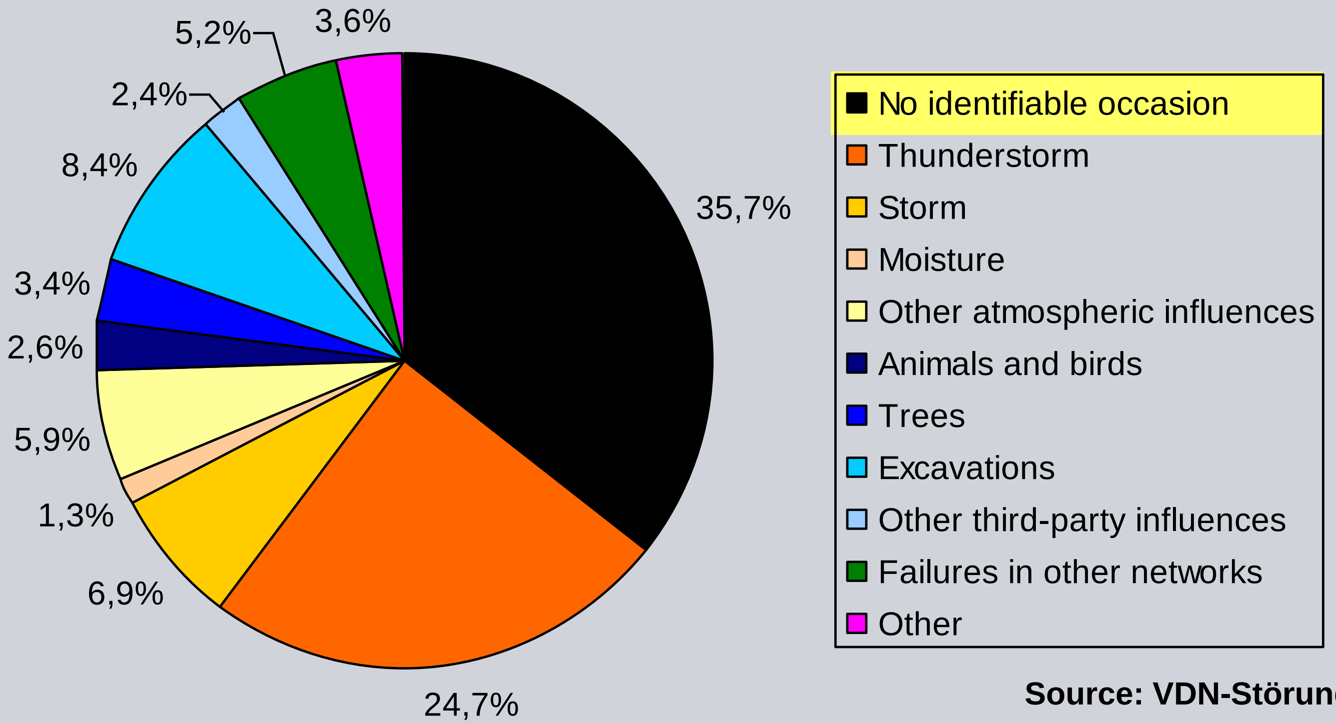
Schematic sequence of probabilistic reliability analysis



Asset Management -
Basic characteristics

Share of the outage performance with possible relation to external influence in electrical power supply networks

Example: Share of outage events per outage occasion in MV (nominal voltage above 1 kV up to 36 kV, ∅ 1994-2003)

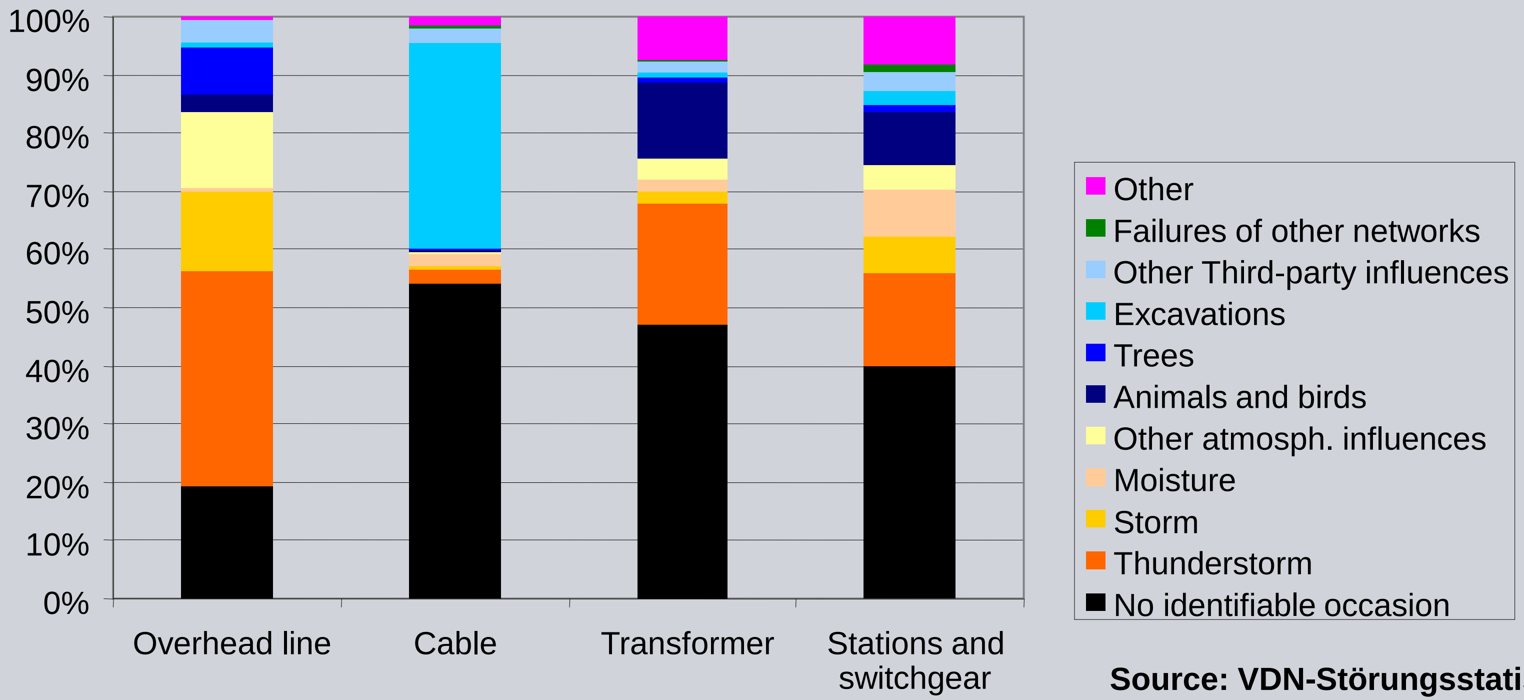


Source: VDN-Störungsstatistik

Asset Management – Basic characteristics

Share of the outage performance with possible relation to external influence on individual components in electrical power supply networks

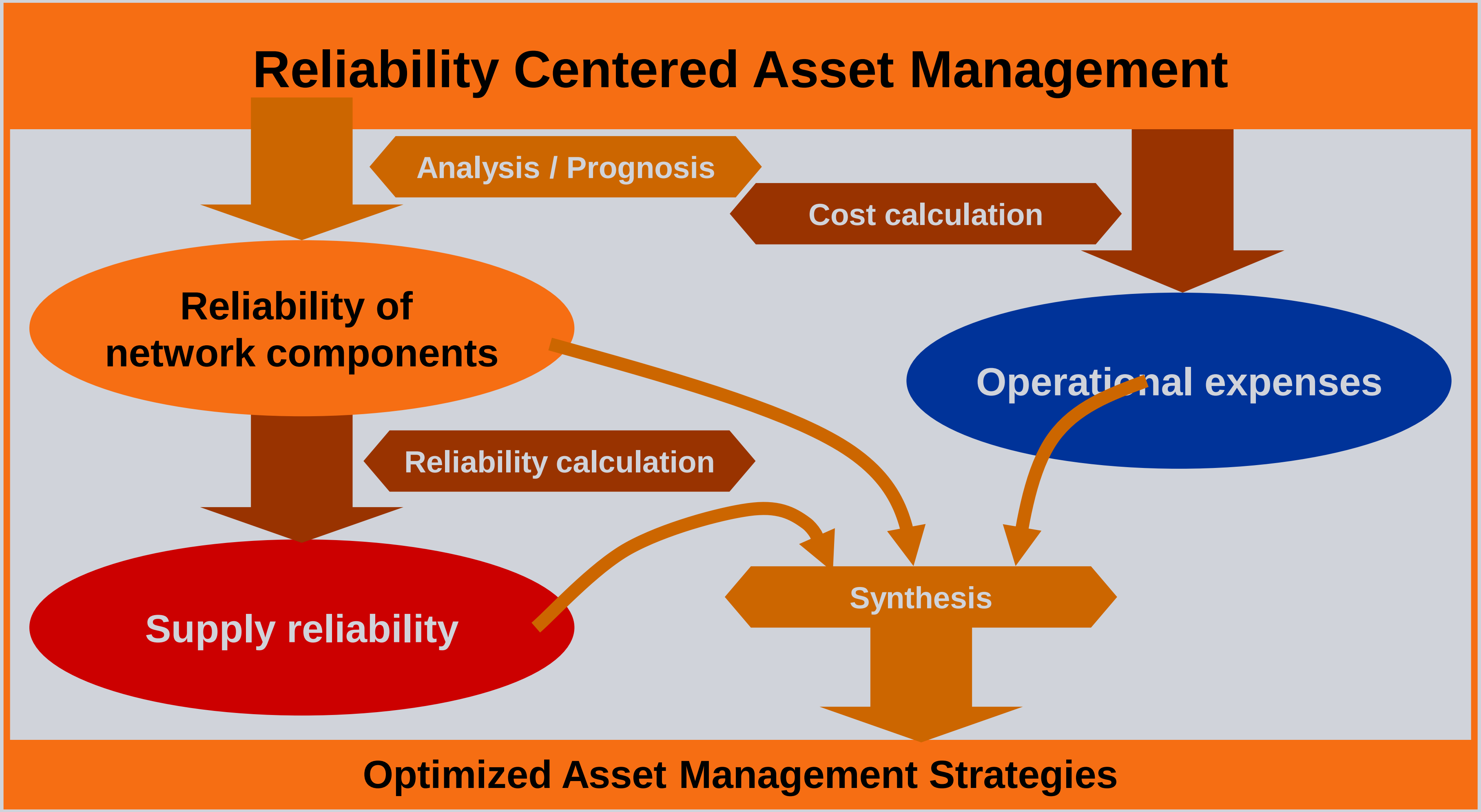
Example: Share of outage events per outage occasion in MV (nominal voltage above 1 kV up to 36 kV, ∅ 1994-2003)



Source: VDN-Störungsstatistik

Reliability Centered Asset Management (RCAM)

Key Challenge: Balance Cost Efficiency & System Efficiency



Reliability Centered Asset Management - Overview

Objective

- Securing Cost Efficiency, reliability and power quality in electrical power supply networks (System Efficiency)

Method

- Analysis of current asset management methods
  - Description of the current situation
  - Identification of cost-saving capabilities
- Systematic analysis of the network
  - Prioritization of network components
- Synthesis of optimized asset management strategies
  - Analysis of effects of cost-saving measures
  - Assessment of different asset management strategies

Result

- Determination of optimized asset management strategies

Example – Component Condition Assessment

Scheme for component condition assessment

Importance Attribute		Quality		Weight
Description	Detail	Description	Value	factor
Age (related to std. service life)		0 - 50 %	0	30
		50 - 75 %	5	
		75 - 90 %	12	
		90 - 100 %	21	
		> 100 %	30	
Serviceability	Spare parts availability	Very Good	0	15
		Good	1	
		Fair	3	
		Poor	5	
	Availability of skilled staff	Very Good	0	
		Good	1	
		Fair	3	
		Poor	5	
	Cost level	Low	0	
		Normal	1	
		High	3	
		Very High	5	

Importance Attribute		Quality		Weight
Description	Detail	Description	Value	factor
Ambient Cond	Indoor/Outdoor	Indoor	0	10
		Outdoor	5	
	Environmental stresses	Low	0	
		Normal	1	
		High	3	
		Very High	5	
Peak Loading (related to th. capacity)		0-75 %	0	15
		75 - 85 %	3	
		85 - 95 %	10	
		> 95 %	15	
Operational experience		Very Good	0	10
		Good	3	
		Fair	10	
		Poor	15	
Condition assessment		Details: Next Slide		20

Example – Component Condition Assessment
Scheme for assessment of physical condition

Importance Attribute: Description	Component class	Detail	Quality: Description	Value	Weight factor
	Overhead lines	Poles	Very Good	0	20
			Good	1	
			Fair	3	
			Poor	7	
		Cross arms	Very Good	0	
			Good	1	
			Fair	3	
			Poor	7	
		Conductor	Very Good	0	
			Good	1	
			Fair	3	
			Poor	7	
		Leakages	Very Good	0	
			Good	1	
			Fair	2	
			Poor		
	Transformers	Painting	Very Good	[illegible]	
			Good	1	
			Fair	2	
			Poor	4	
		Bushings	Very Good	0	
			Good	1	
			Fair	2	
			Poor	4	
		Tap changer	Very Good	0	
			Good		
			Fair		

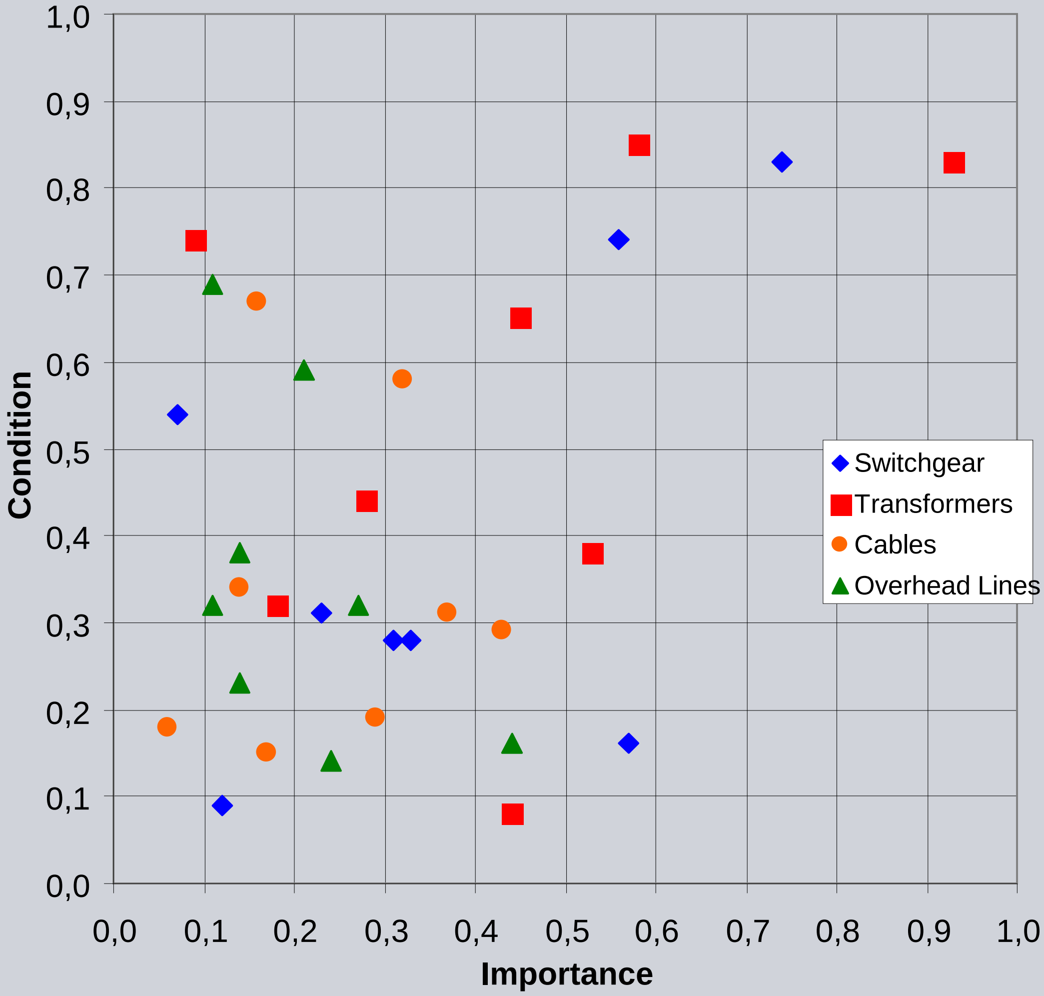
Importance Attribute: Description	Component class	Detail	Quality: Description	Value	Weight factor
	Cables	Cable termination	Very Good	0	20
			Good	3	
			Fair	6	
			Poor	10	
		Leakages	Very Good	0	
			Good	3	
			Fair	6	
			Poor	10	
		Serving test	Good	0	2
			Normal	2	
			Poor	5	
		Leakages	Very Good	0	20
			Good	1	
			Fair	2	
			Poor	4	
		Corrosion	Very Good	0	
			Good	1	
			Fair	2	
			Poor	4	
		Connections	Very Good	0	
			Good	1	
			Fair	2	
			Poor	4	
		Painting	Very Good	0	
			Good	1	
			Fair	2	
			Poor	4	
		Secondary Equipment	Very Good	0	
			Good	1	
			Fair	2	
			Poor	4	
		Enclosure / Building	Very Good	0	
			Good	1	
			Fair	2	
			Poor	4	
		Sealing / Pressure (GIS only)	Good	0	2
			Normal	2	
			Poor	5	
		Partial Discharge	Good	0	2
			Normal	2	
			Poor	5	

Example – Component Importance Assessment

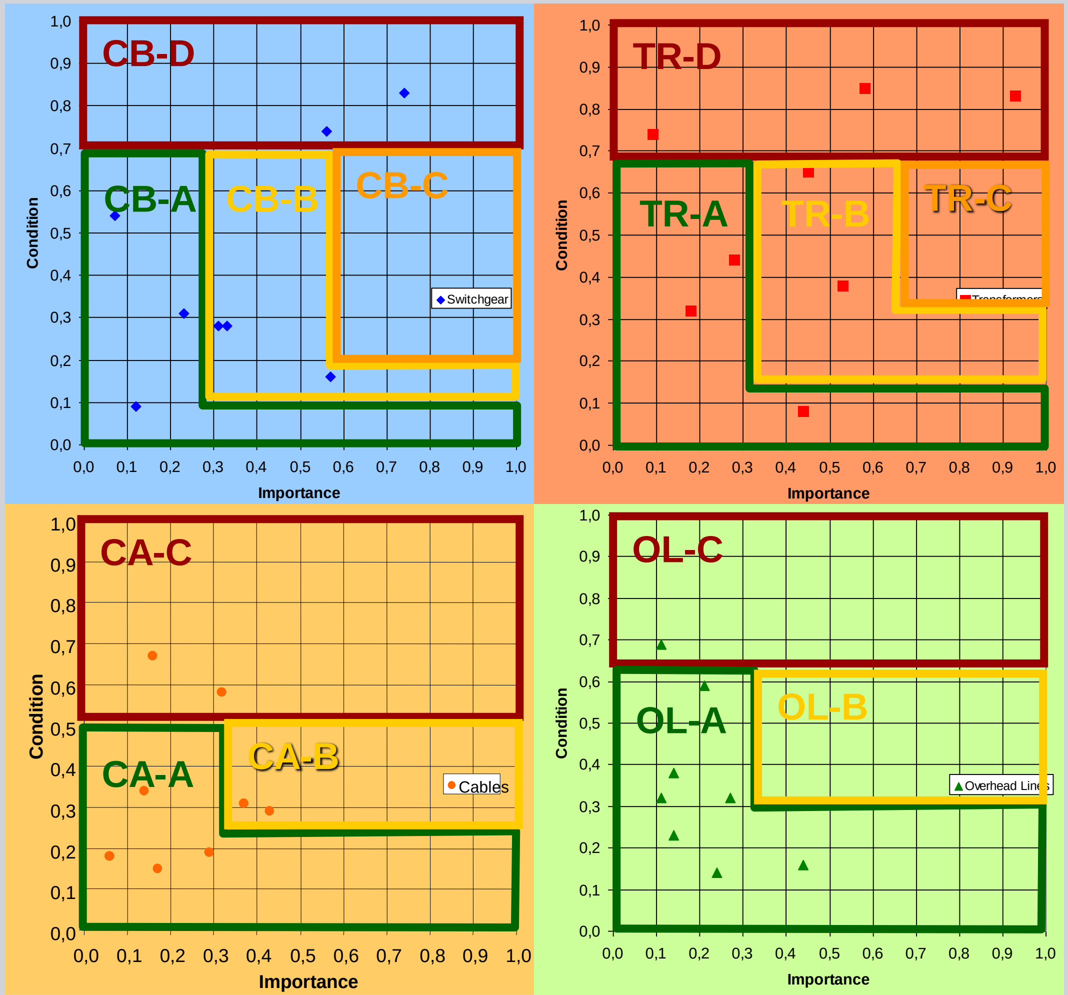
Scheme for component importance assessment

Importance Attribute		Weight factor	Quality	
Identifier	Description		Description	Value
EENS	Share of system EENS	50	Individual results	0 - 50
CustNo	No. of customers disconnected on failure	25	< 50	0
			51 - 150	2
			151 - 400	6
			401 - 1000	12
			> 1000	25
CustCrit	Criticality of customers	15	Rural	0
			Residential	3
			Large Industrial	7
			Commercial	11
			City Center	15
AssetCrit	Criticality of component	10	Low	0
			Normal	10
			High	14
			Very High	20

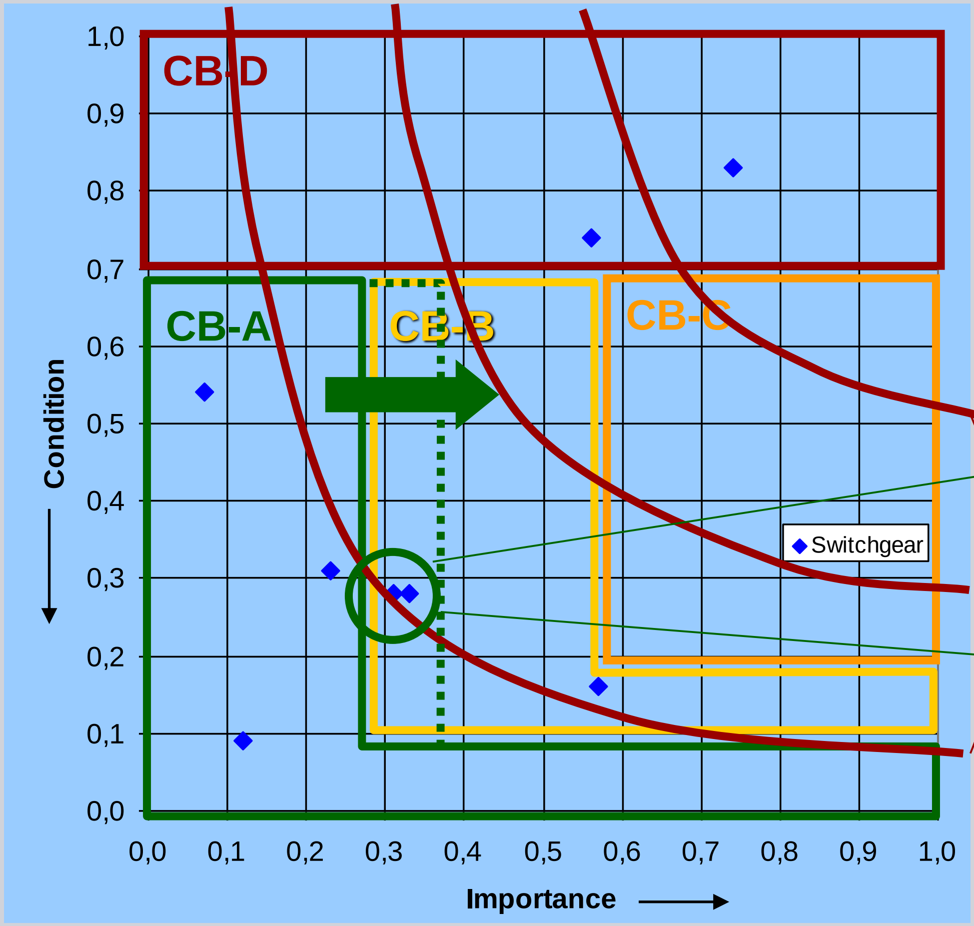
Prioritization of network components



Optimized asset management strategies



Optimized asset management strategies



Risk =
Occurrence probability x effect

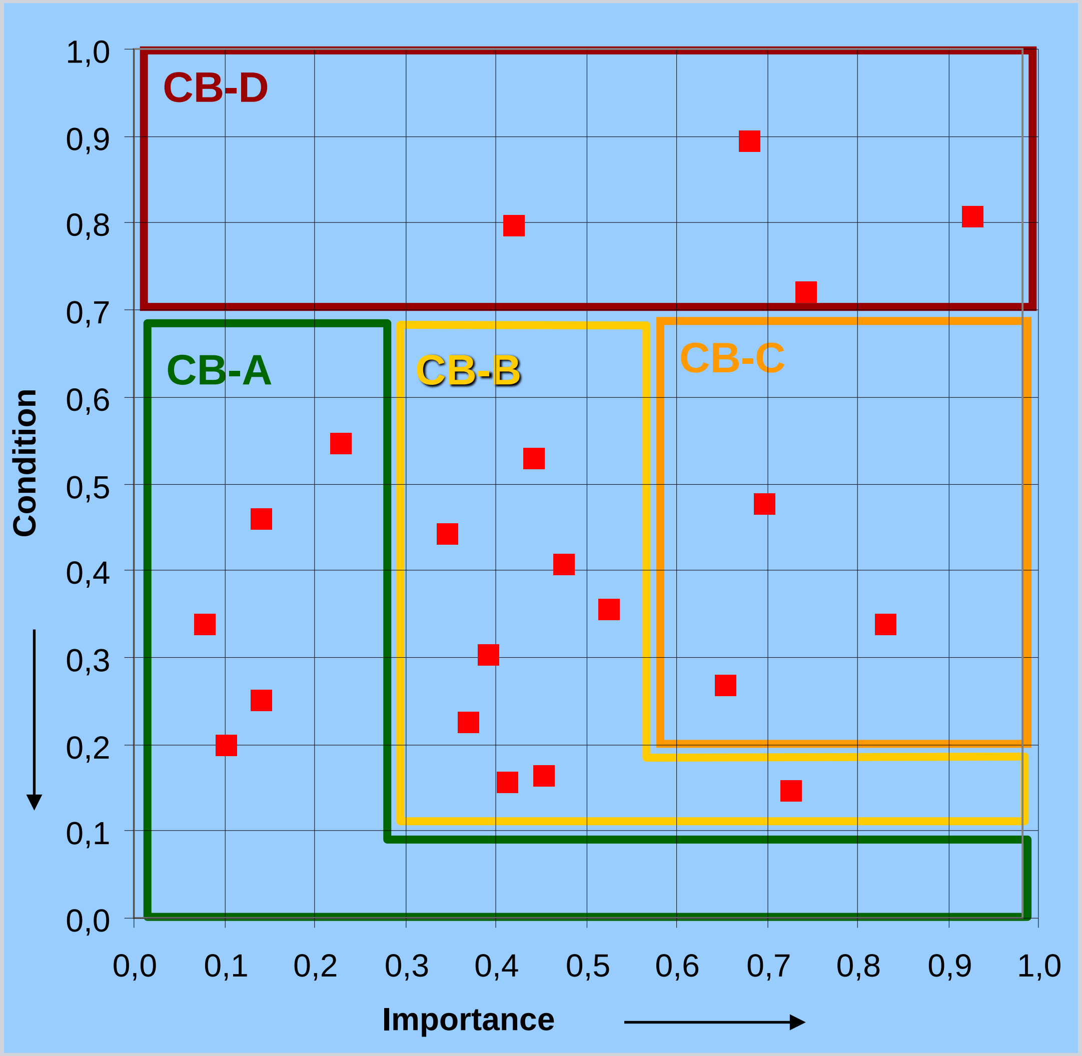
Condition **Importance**

Cost reduction

Curves of constant risk

Reliability reduction

Case 3: Prioritization of Components
Expediting Transformers' Service to increase Reliability



Importance Criteria

- In-laws in the vicinity

:

- Risk of Law and Order Situation

Condition Criteria

- Missing Protection Elements
- History of Stresses
- Oil Leakages
- Visual Appearance
- Condition of Transformer Oil
- Test Data Availability

Cost models

Asset Management Strategies

- Definition of preventive maintenance tasks
- Definition of service life

Influence on cost types

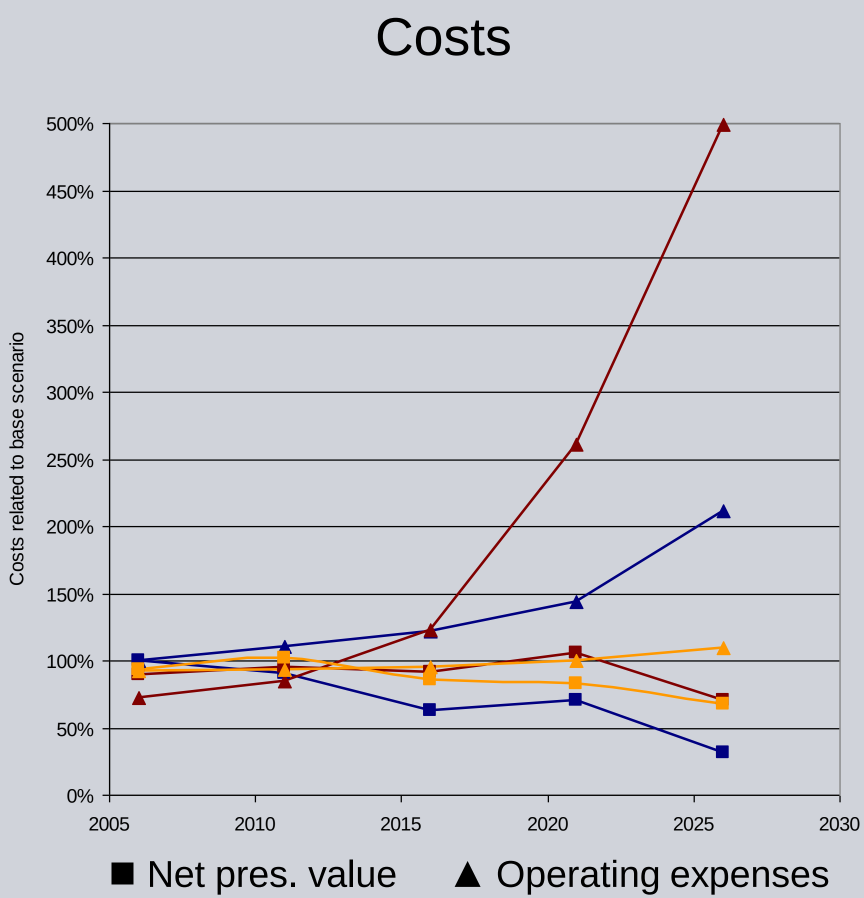
- Investment costs / net present value
- Costs for preventive maintenance
- Fault clearing costs
- Repair costs
- Interruption costs

Cost models

- Simple models for approx. relevant effects
- Based on expected values of e.g. investment

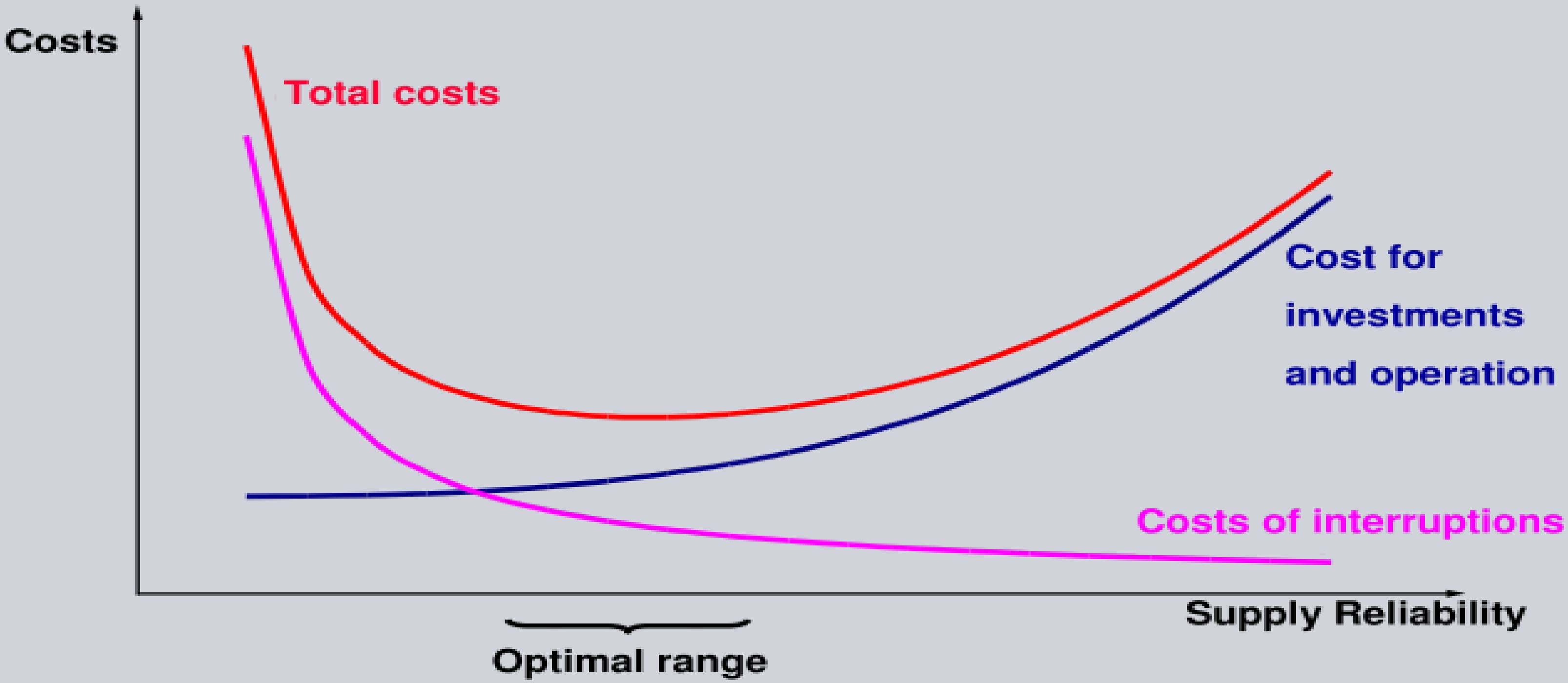
Case 4: Results of parameter studies

Maintenance Costs of an HV Substation



0 Base **1 No replacement** **2 (Partly) No maint.** **3 (Partly) reduced maint.**

Conclusion



RCAM ≡ Optimal Balance b/w Cost and System Efficiency

Thank you for your attention!