Module 8: Develop Energy Management measures
Put energy management into practice

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

FABRIC Asia

At the end of this module you will be able to…

Develop energy action plans

Content

- Prioritizing non-product outputs or energy wastages
- Conducting root-cause analysis
- Evaluating alternative solutions
- Developing Action Plans
- Practical Exercise – The Textile Company Evaluating Alternatives

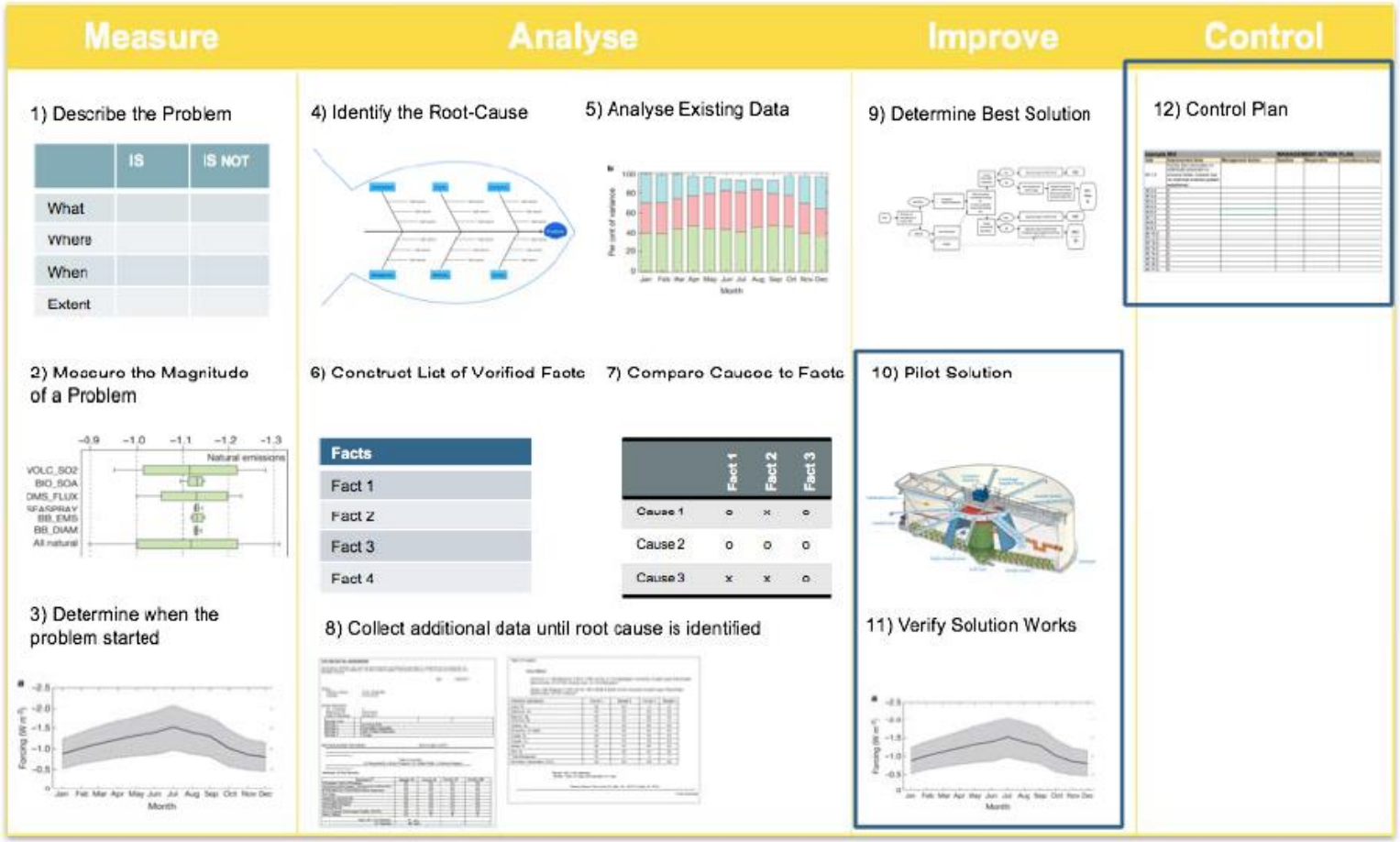
Select energy management measures

ASPECTS TO CONSIDER

- Establish and maintain process for identifying alternative solutions.
- Choose criteria in selection, providing a balanced approach to costs, benefits and risks.
- Obtain complete requirements allocation for each alternative.
- Document the rationale for each alternative.

Overall framework

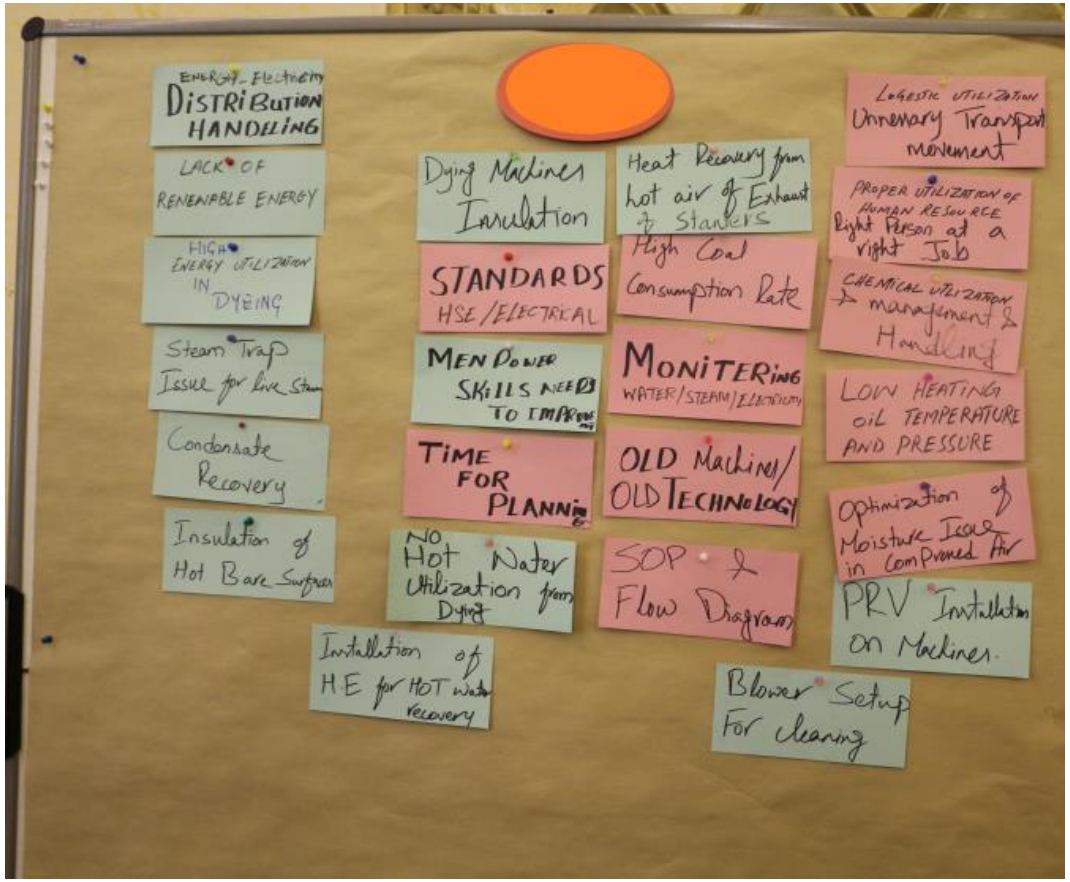
DMAIC/MAIC METHODOLOGY



Understanding the situation

Prioritizing NPOs

Compile list of all energy NPOs and energy saving opportunities



Understanding the situation

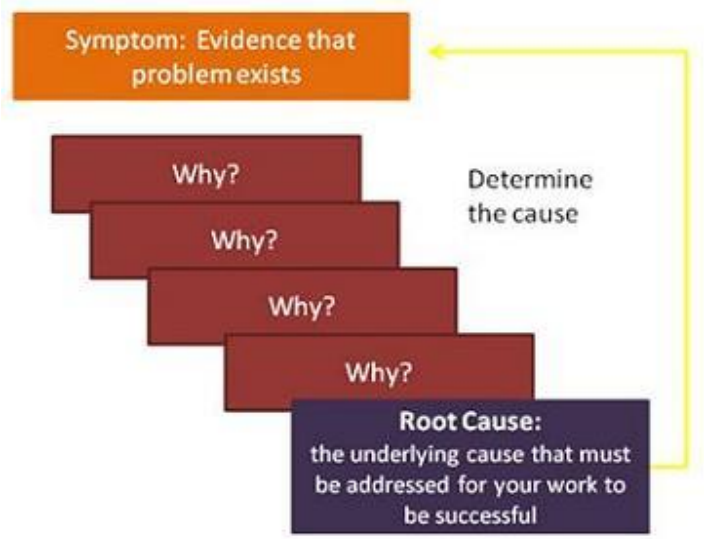
Prioritizing NPOs

- It is important to assess impacts of the energy NPOs /losses /aspects
- Impact assessment can be used for prioritization of NPOs
- Consider evaluating against multiple impact areas and variables

Aspects	**Identification of Impacts** (High=3, Medium=2, Low=1, N/A=0)											
	Results in monetary loss	Causes air Emissions (PM, Sox, NOx, CO…)	Contributes to global Warming, Ozone depletion	Increases fossil fuel use	Effects health of staff/ worker	Contributes to emergencies (fire/,explosion)	Effects relationship with customers	Lead to legal consequences or public reactions	Affects quality/ productivity	Affects working conditions and environment	Increases use of natural resources	Total Impact
Very low condensate recovery	3	0	2	2	0	0	1	0	0	0	3	**11**
Low combustion efficiency of coal fired boiler	3	2	3	3	1	0	2	2	0	1	0	**17**

Understanding the situation

Addressing the roots causes



Examples of common tools for root cause analysis

- 5-Why Analysis
- Failure Mode and Effects Analysis (FMEA)
- Fault/Problem Tree Analysis
- Fishbone or Ishikawa or Cause-and-Effect Diagrams

Understanding the situation

Consider the following situation in the factory

What action do you suggest?

You see leakages of compressed air from various joints, valves and pipes. This may result in enormous energy loss.

Understanding the situation

Addressing the roots causes

Consider the following situation in the factory

What action do you suggest?

You see leakages of compressed air from various joints, valves and pipes. This may result in enormous energy loss.

The immediate solution may be to repair all leakages.

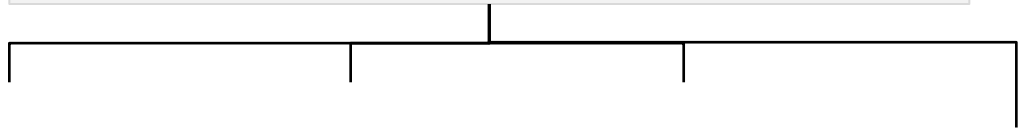
But did you ask yourself why did the leakages start?

Understanding the situation

Plenary exercise

You see leakages of compressed air from various joints, valves and pipes. This may result in enormous energy loss.

Why?



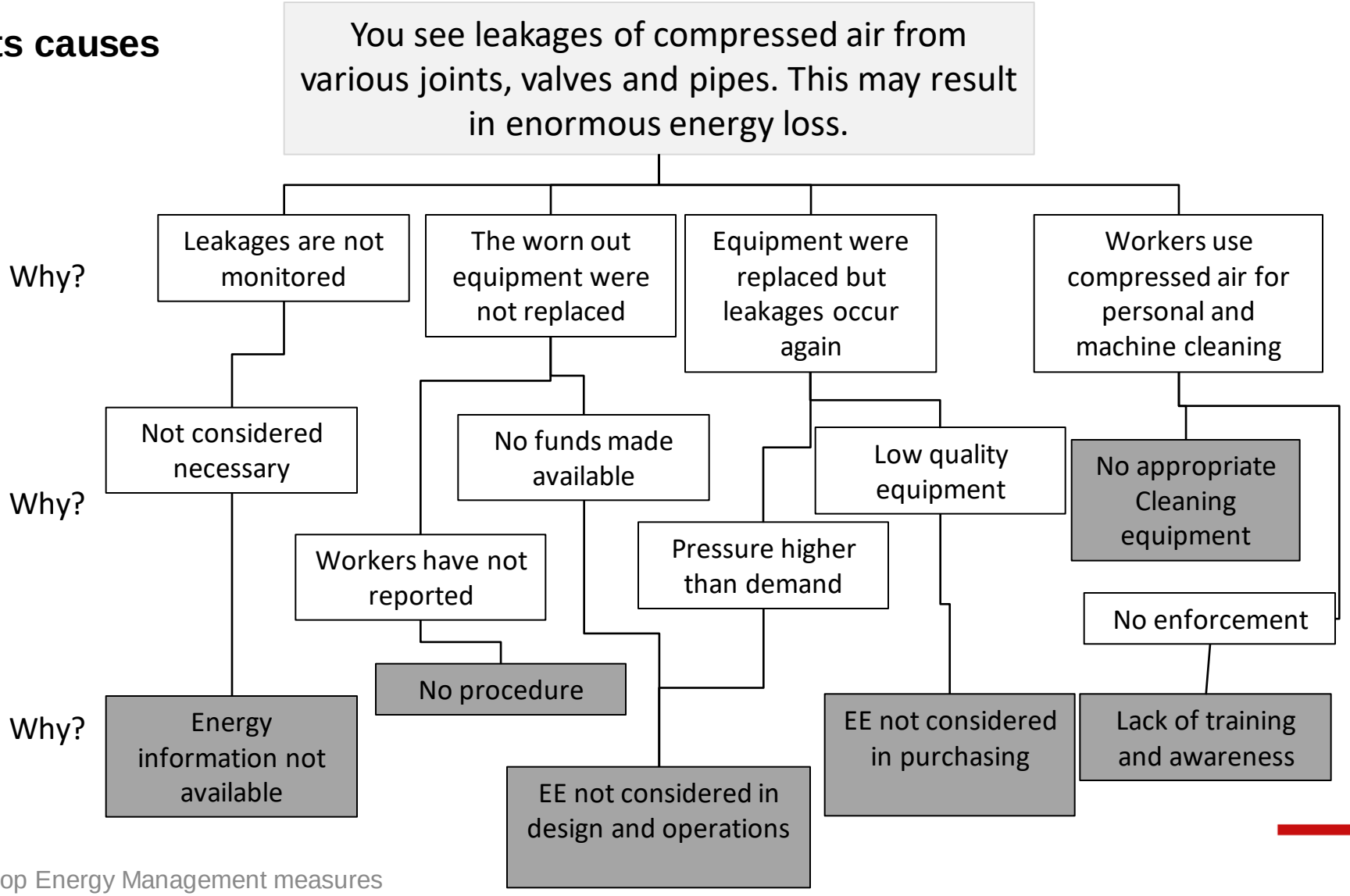
Your task in groups**:**

- Look beyond the situation and try identifying the possible root causes why the leakages occur.
- Visualise your finding and present to the other groups

Time: 30 minutes

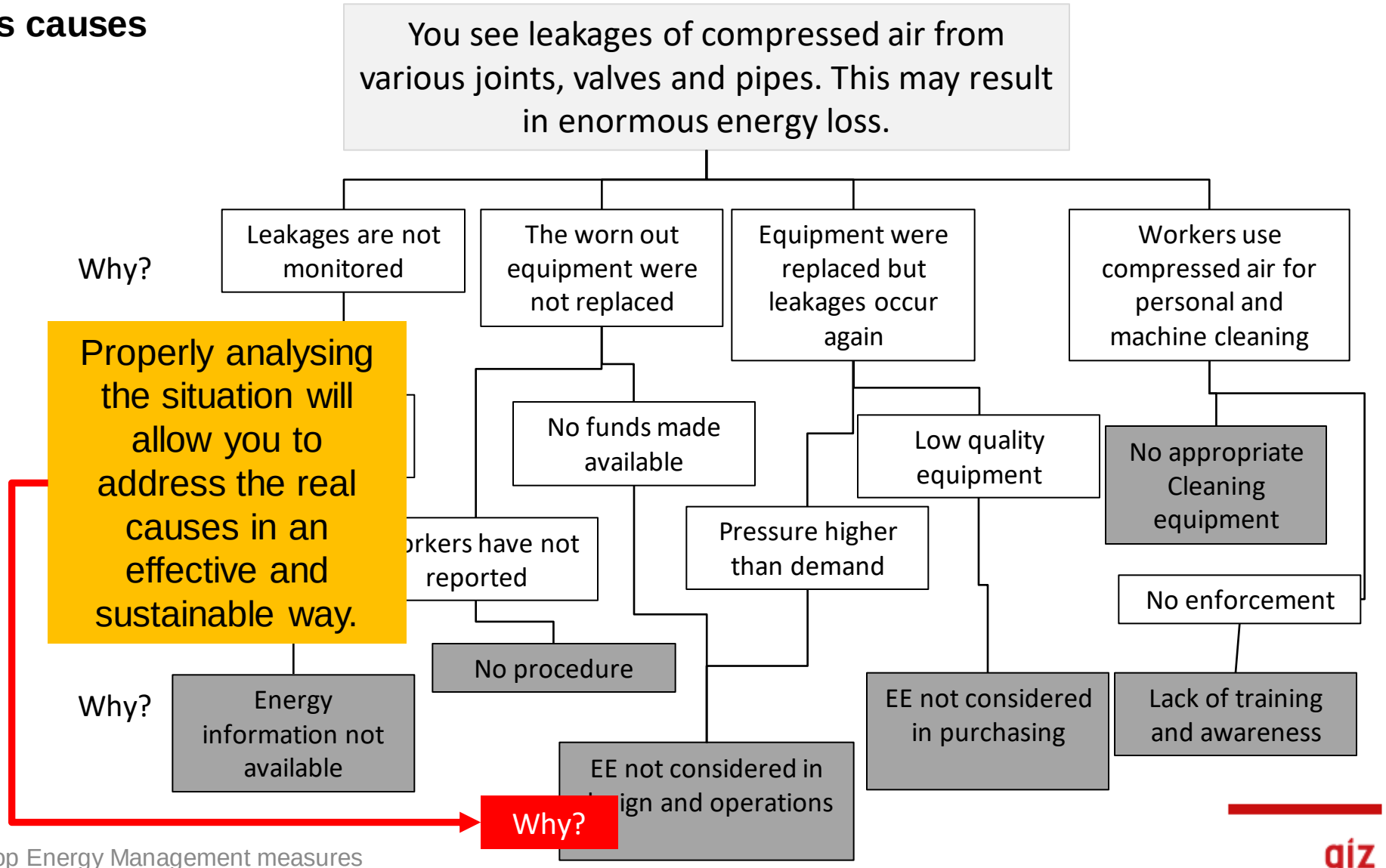
Understanding the situation

Addressing the roots causes



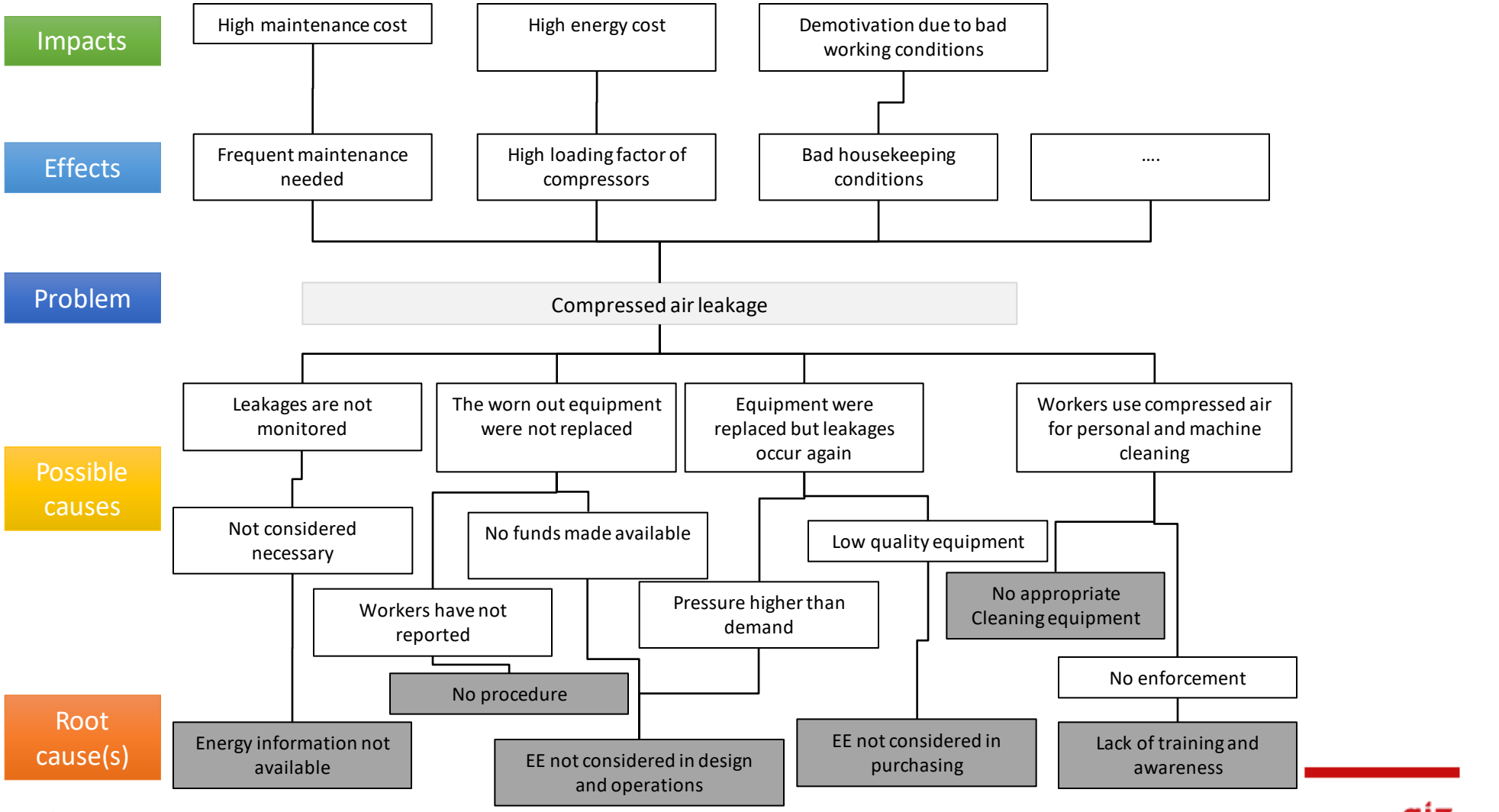
Understanding the situation

Addressing the roots causes



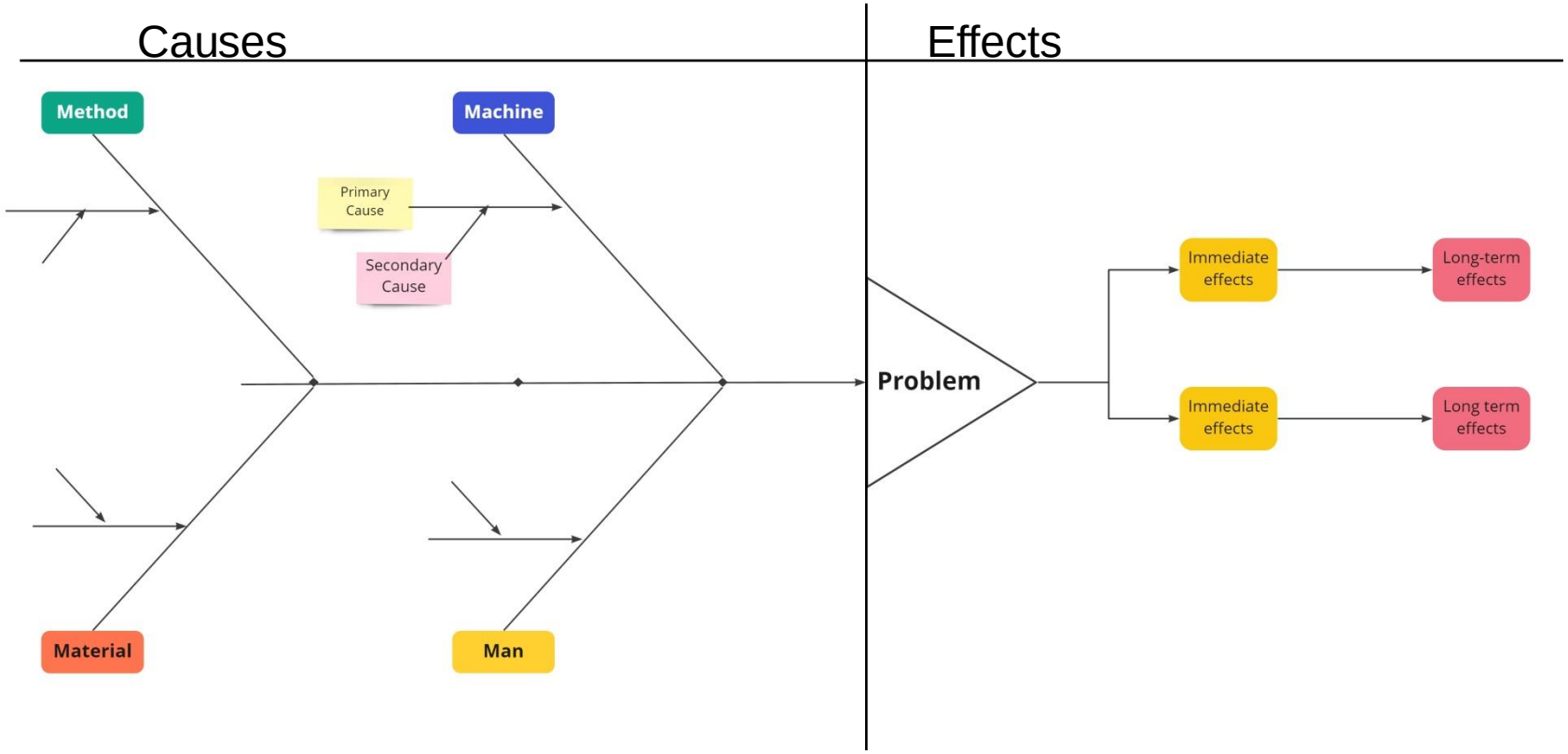
Understanding the situation

Addressing the roots causes and effects



Understanding the situation

Addressing the roots causes and effects



Fishbone or Ishikawa diagram

Select energy management measures -

Methods

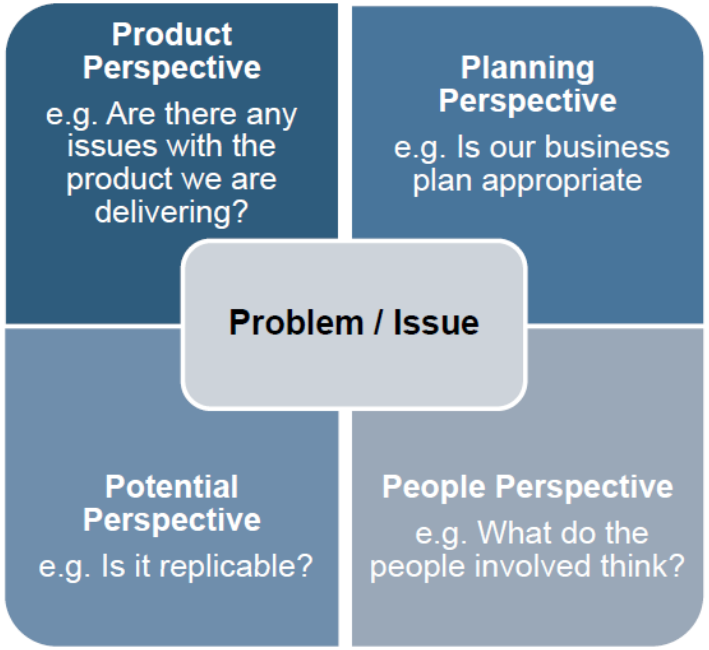
RE-FRAMING MATRIX

Simple technique to look at organisational problems from a number of different viewpoints

Step 1: Draw the grid

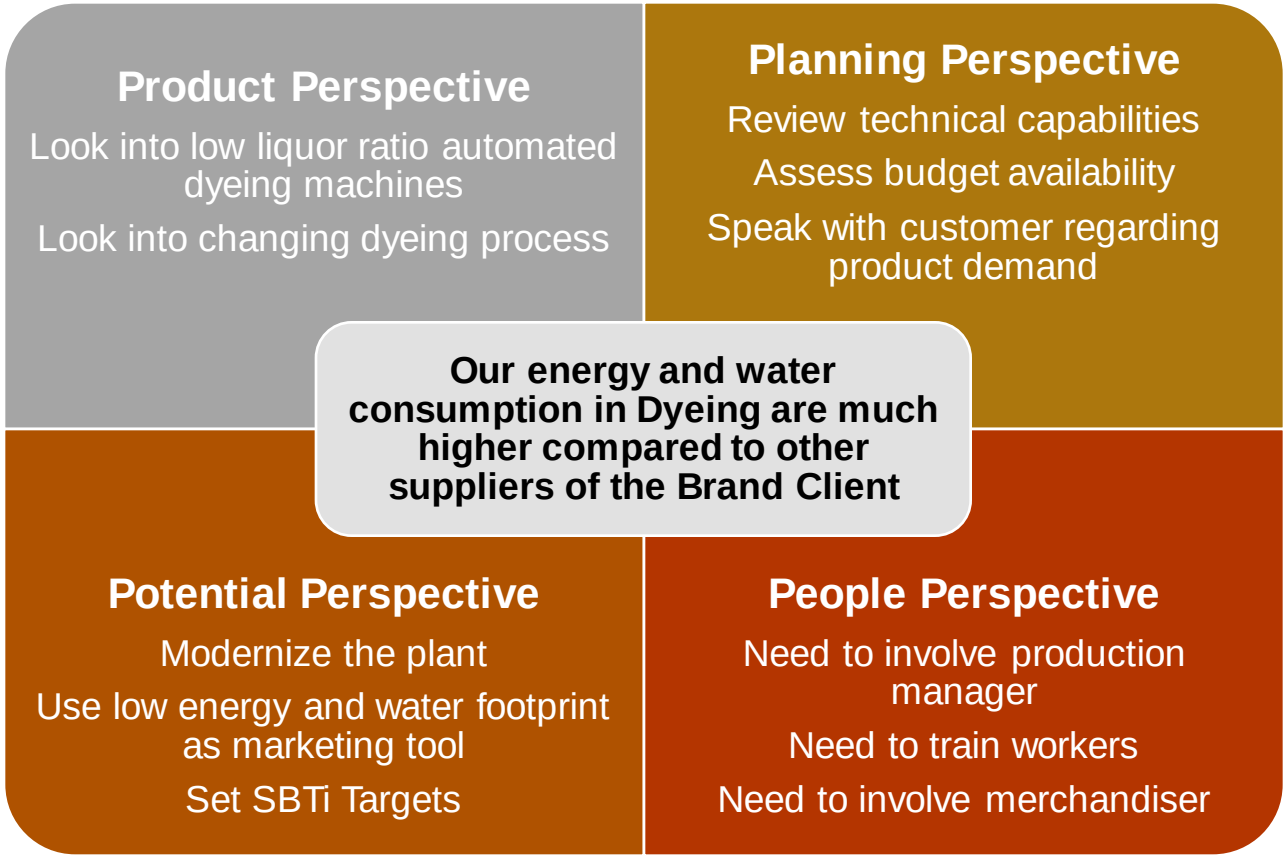
Step 2: Decide on the four perspectives

Step 3: Brainstorm factors related to each perspective



Developing and Evaluating Alternative Solutions - Methods

Example



Developing and Evaluating Alternative Solutions

Basic financial evaluation

- Payback period (months) = Investment ÷ Annual Saving x 12

  e.g. Investment = 1,000 USD, Annual Saving = 750 USD, Payback = 1000 ÷750x12= 16 months

- Return on Investment (RoI) = (Gain from Investment - Investment) ÷ Investment

  e.g. Investment = 1,000 USD, Total gain over lifetime= 5,000 USD, RoI= (5,000-1000)÷1,000= 400%

RoI only presents overall gain disregarding the length of investment and time value of money

Developing and Evaluating Alternative Solutions

Advanced financial evaluation

Net Present Value (NPV)

- NPV is the value of all future cash flows (positive and negative) over the entire life of an investment discounted to the present.
- NPV analysis is a form of intrinsic valuation used extensively for determining the value of a business, investment security, capital project, new venture, cost reduction program, and anything that involves cash flow
- An investor should choose the one with the higher NPV.
- Doing it in Excel
  - ✓ Arrange net cash flow data in excel
  - ✓ Estimate a Rate/discounting factor (e.g. 10%)
  - ✓ Formula =NPV(rate,value1,[value2],...)
  - ✓ Example: =NPV(10%,B2:B6) = 1,096.92

n	Alternate 1	Alternate 2
0	-2000	-3000
1	800	1600
2	1000	1500
3	1200	1500
4	1100	1500
NPV	1096.92	1677.92

Developing and Evaluating Alternative Solutions

Advanced financial evaluation

Internal Rate of Return (IRR)

- The IRR is the discount rate that makes the NPV of a project zero i.e. No-Profit, No-Loss basis
- Any investment at IRR brings Zero financial benefits
- Any investment below IRR causes a financial loss
- Companies usually decide a lowest IRR value below which they are not interested to invest in → a point to check with client
- An investor should choose the one with the higher IRR.
- Doing it in Excel
  - Arrange net cash flow data in excel
  - Formula =IRR(values, guess)
  - Example: =IRR(B2:B6,30%) = 33.82%

n	Alternate 1	Alternate 2
0	-2000	-3000
1	800	1600
2	1000	1500
3	1200	1500
4	1100	1500
NPV	1096.92	1677.92
IRR	33.82%	36.48%

Developing and Evaluating Alternative Solutions

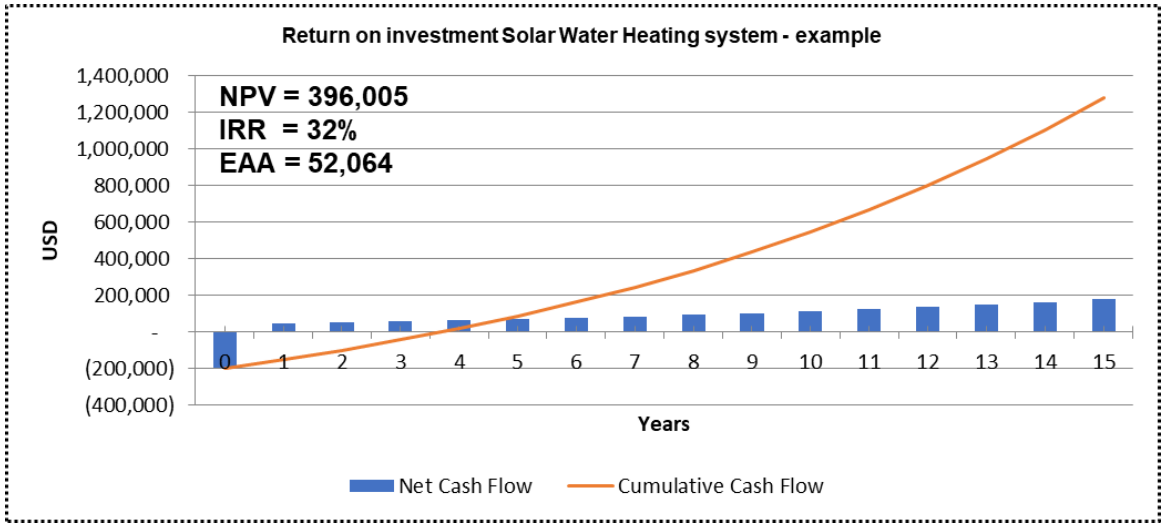
Advanced financial evaluation

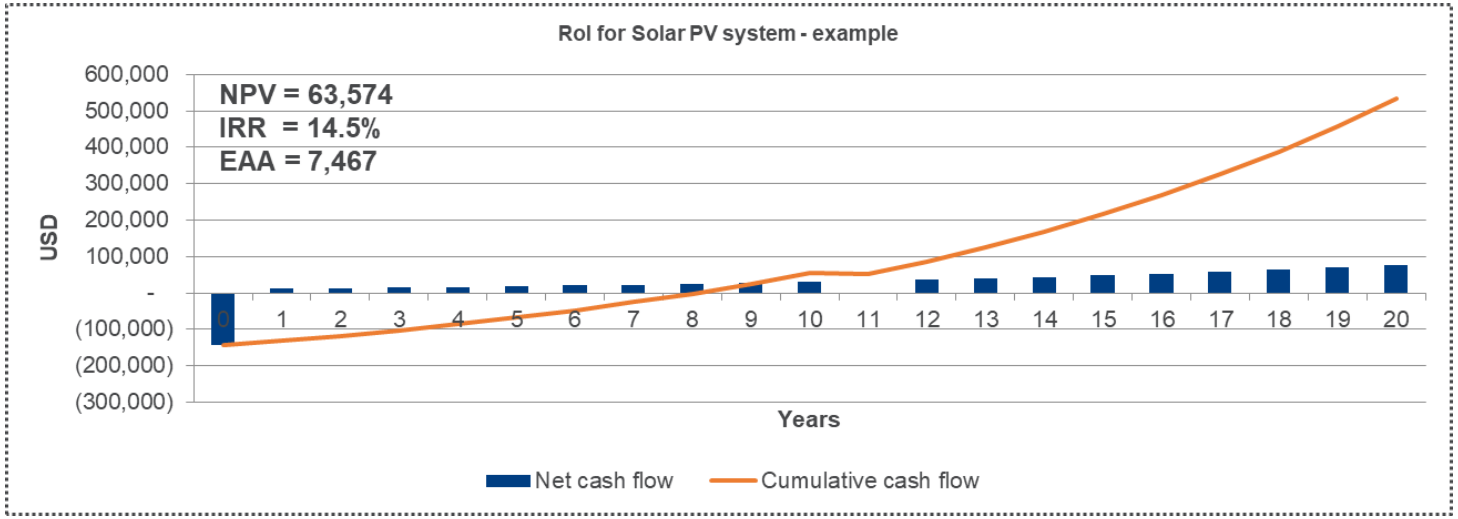
Equivalent Annual Annuity (EAA)

- Used to compare mutually exclusive projects with unequal lives
- Calculates the constant annual cash flow generated by a project over its lifespan if it was an annuity
- When used to compare projects with unequal lives, an investor should choose the one with the higher EAA.
- Doing it in Excel
  - Arrange net cash flow data in excel
  - Calculate NPV
  - Manually apply formula
    $EAA = (r \times NPV) \div (1 - (1 + r)^{-n})$
    - r=discount factor, n=number of periods
  - Example: =(0.1*B9) ÷ (1-(1+0.1)^-4) = 346.05

n	Alternate 1	Alternate 2
0	-2000	-3000
1	800	800
2	1000	1000
3	1200	1200
4	1100	1000
5		1000
6		1000
NPV	1096.92	1203.37
IRR	34%	24%
EAA	346.05	379.63

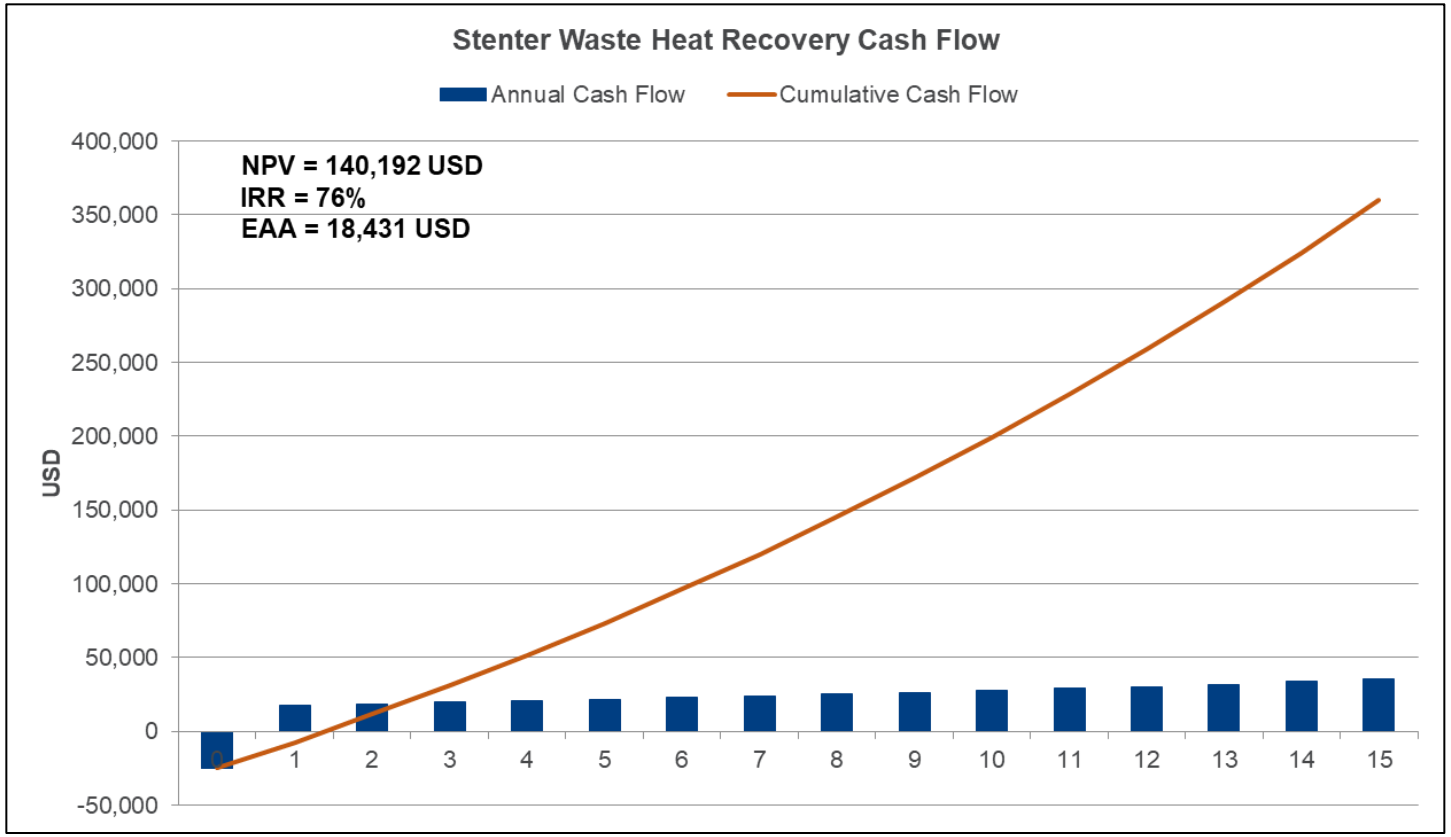
Financial Evaluation - Example





Financial Evaluation - Example

- Do we really need to calculate IRR and EAA here?



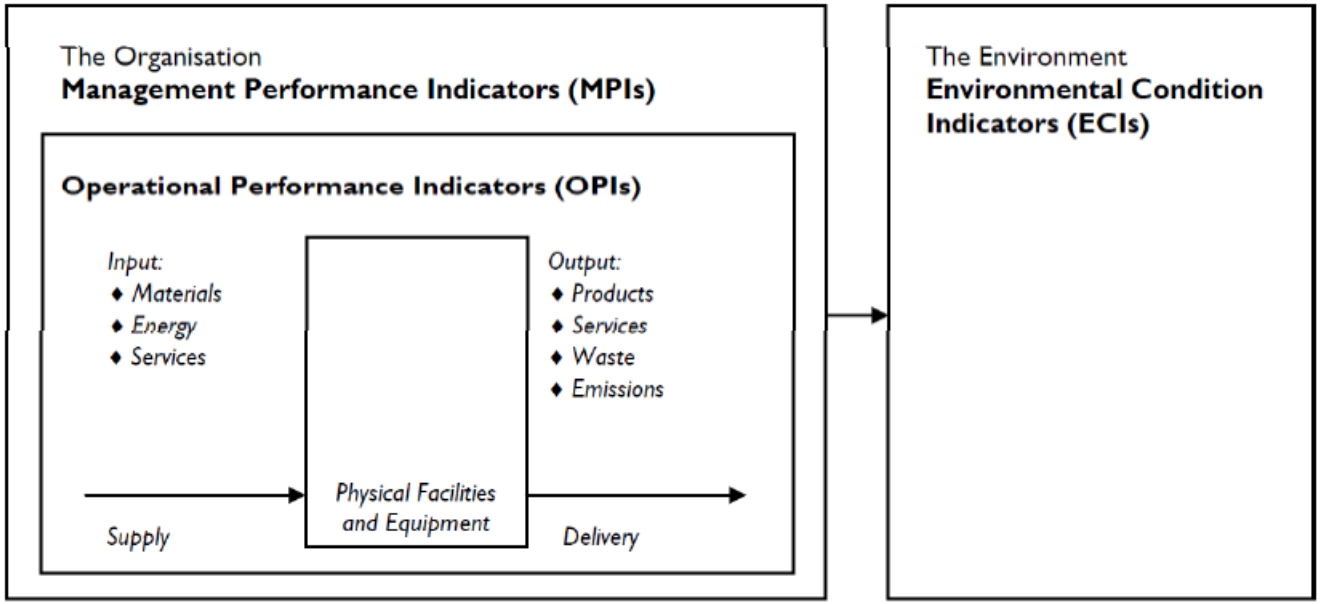
Although the payback is obvious, IRR or EAA might still be needed if bank financing is required.

Group Task – The Textile Company

- The Textile Company is planning Installation of a waste heat recovery system at a stenter and has two options;
  - ✓ Option-1: Locally made system with investment of USD 30,000. This may result in annual savings of USD 20,000 with an annual O&M cost of USD 2,162. The equipment life is estimated to be 15 years.
  - ✓ Option-2: Imported system with investment of USD 75,000 resulting in annual savings of USD 25,000 and O&M USD 1,500. Equipment life is estimated to be 20 years
- Company uses 10% discounting factor in all calculations and does not invest in IRR below 15%.
- Your tasks
  - ✓ Create a cash flow for the options in excel
  - ✓ Calculate NPV, IRR and EAA
  - ✓ Suggest which option should company opt for and why

Total time: 30 minutes

Selecting and setting performance indicators and goals



For example:
As per ISO 14031: Guidelines for Environmental Performance Evaluation

Selecting and setting performance indicators and goals

SMART or ACCURATE

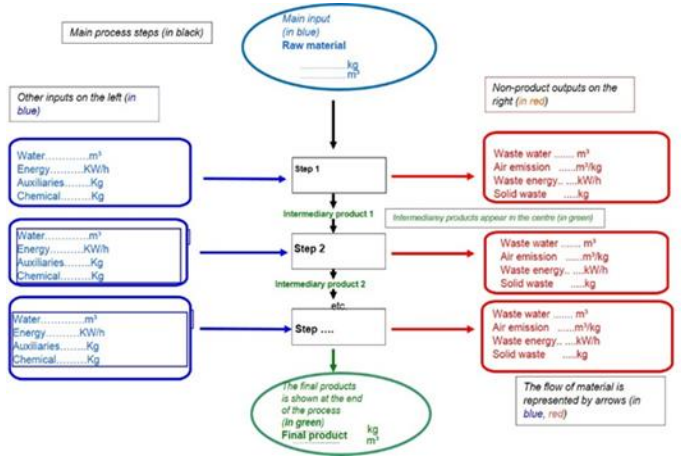
- Assessable or measurable.
- Controllable - able to be changed by what you do in chemical management.
- Central and relevant to what you are trying to achieve.
- Understandable and clear.
- Reliable - providing the same measures when assessed by different people.
- Acceptable to the users as true indicators of performance.
- Timely and
- Efficient to monitor.

Using available information

(1) Energy flow related indicators

- Absolute indicators inputs, outputs, NPOs
  - ✓ e.g. GJ energy used, production volume per year, GHG emissions
- Productivity ratios
  - ✓ e.g. GJ energy per ton of product
- Intensity ratios
  - ✓ e.g. Tonne-CO2/tonne-product

Refer back to your process flow charts



Example of Energy related performance indicators

Performance areas	Possible performance indicators
Energy Inputs	• Share of fossil energy in energy mix • Increase in share of renewable energy in energy mix • Total GHG emissions • Energy consumption per production unit
Demand side	• Individual SEUs energy performances • % of total waste heat recovered • Maintenance cost related to energy use (e.g. leakages, electronics failures…) • Number of health/safety incidents involving energy (e.g. electric shock, hot surfaces, direct exposure to high pressure…) • Number of physical damages involving energy (e.g. electric fire, pressure vessel explosions, gas release…)

Example of Energy related performance indicators

Performance areas	Possible performance indicators
Energy Management	• % of total energy use monitored using meters • Number of internal awareness campaigns • Number of trainings conducted • Number of workers attending training / awareness sessions • Number of workers showing improvement in behaviours after trainings • Number of non-conformances identified during internal EnMS audit • ….

Using energy performance indicators (EnPIs)

- ✓ Compare Energy efficiency, resource productivity and environmental/safety/health performance over time.
- ✓ Highlight improvement and optimization potentials.
- ✓ Identify and follow up on targets.
- ✓ Discover market opportunities and cost-reduction potentials.
- ✓ Involve, educate and motivate staff.
- ✓ Promote organizational learning.
- ✓ Support decision-making by providing concise information about current status and trends with regard to resource use and performance.
- ✓ Implement EnMS or EMS and/or generate information needed for your current EnMS/EMS.
- ✓ Communicate your results to your stakeholders.

Relating performance and management action plans - Example

Energy losses/ critical situation/ identified gap	Proposed measure	Results of proposed measures (Energy, GHG, USD, RoI..)	Necessary action/ activities for implementing measure	Person(s) Responsible	Deadline for completion	Targets/ EnPIs to be monitored
Hot water drained from rope dyeing machine	Install wastewater heat recovery system	Coal Reduction xx T/y Energy reduction at ETP xx kWh Investment xx USD Saving xx USD IRR xx %	Develop technical requirements Hire contractor Install system and conduct first trials Commission the system	Mgr Maintenance Mgr Prcurement Mgr Prooduction	dd/mm/yyyy	Total GHG emissions Energy consumption per production unit

Issues to be addressed; ref. Eco-map, energy balance, energy audit…

Mutually agreed and technically correct measures

Measurable results of the interventions

Work breakdown, division of measure into tasks /milestones

Selected performance indicators

Relating performance and management action plans - Example

Example Energy Management Action Plan	
Objective: Reduce natural gas use by 5% compared to baseline FY 2006	**Original Issue Date:** 12/22/11
Target: Reduce boiler natural gas use 2.5% compared to baseline FY 2006	**Revision Date:**
Energy Management Project: Preheat boiler combustion air from 90°F to 110°F	

Project Planning

Action Items	Person Responsible	Due Date	Required Resources/Comments
Assign project team	Management Rep.	2/14/11	Design, maintenance and procurement representatives
Collect data	Joe Mechanic	3/1/11	Assistance from maintenance
Design heat exchanger	Ima Engineer	5/8/11	Autocad access
Install system	Acme Contracting	6/14/11	Overhaul boiler during installation (See boiler plan)
Test and commissioning	Joe Mechanic and Ima Engineer	6/28/11	
Savings validation	Ima Engineer	7/1/11 – 6/30/12	Maintenance to collect data daily See Project Verification Plan

Target Verification Plan

Item	Information/Resource Requirements
Calculate EnPI in Btu/lb of product each month for baseline year	Boiler gas meter data and production and temperature data for FY 2006
Calculate EnPI in Btu/lb of product each month for 12 months after installation	Boiler gas meter, production and temperature data for 12 months after installation
Calculate average annual EnPI for each 12 month period	
Calculate percentage difference in average annual EnPI for baseline year and 12 months after installation	
Calculate average monthly savings for bottom up analysis	M&V requirements, documented savings

Actual Results/Comments: Based on production records and meter readings the project resulted in an energy savings of 300 Btu/lb based on production and a 1,570,000 Btu/hr (25.4 CFM) savings of natural gas.

Prepared by: Earnest Brown	**Date: 12/22/2011**
Approved by:	**Date:**

Source: 2011 Georgia Tech Research Corporation and U.S. Department of Energy

Relating performance and management action plans

Figure 55. Relationship between Yarn Count and Specific Energy Consumption (100% Cotton Yarn)

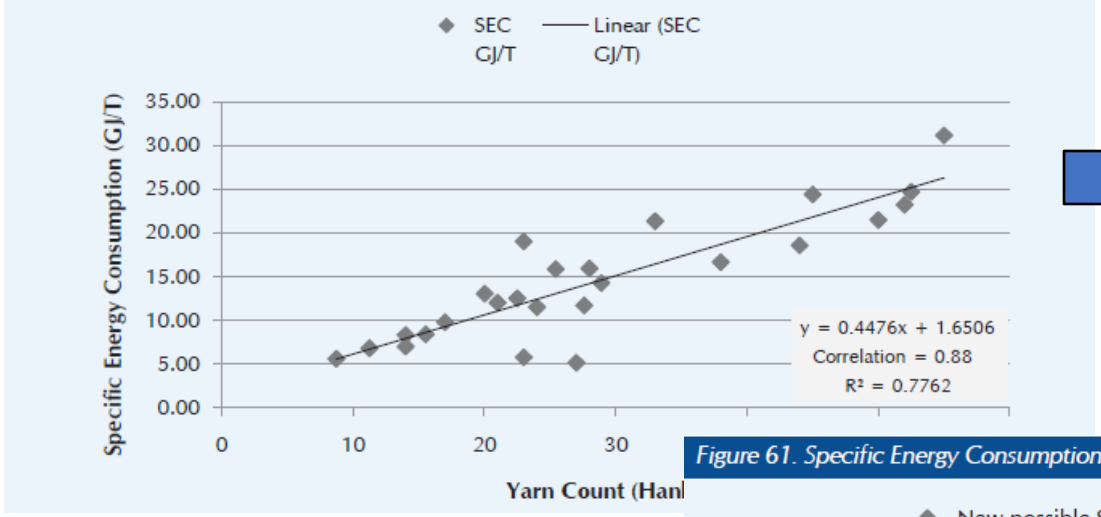
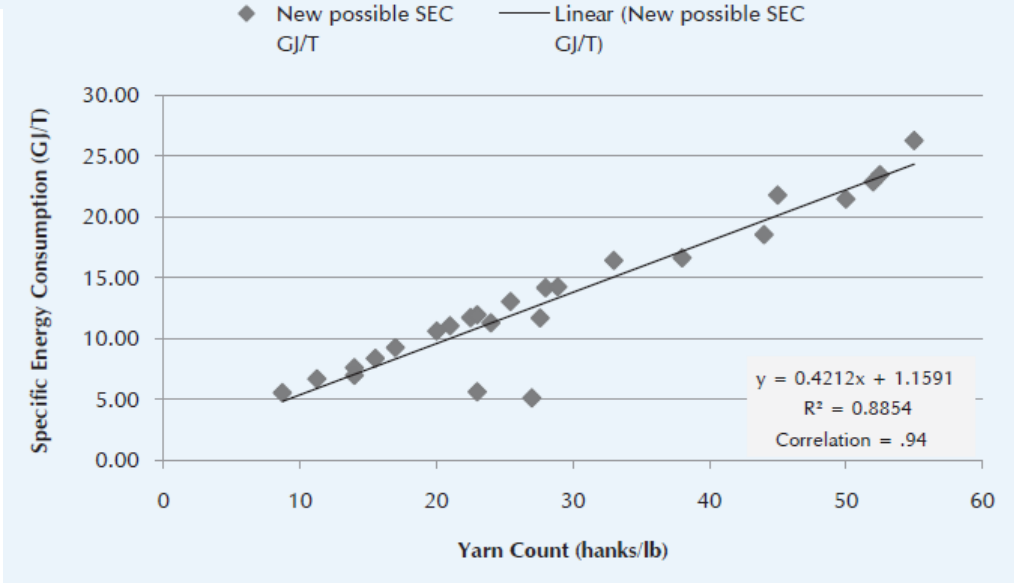


Figure 61. Specific Energy Consumption Trend line based on Possible Savings (100% Cotton Yarn)



Source: Sectoral Analysis on Renewable Energy and Energy Efficiency in 5 sectors of Pakistan - UNIDO

Relating performance and management action plans

Resource	Key performance indicator			Projected Annual Saving	
	Current	Target	% Reduction	Quantity	Monetary (USD/y)
Electricity	1.153	1.145	0.7%	148,133 kWh	11,408
Steam	14.12	14.11	0.05%	131 Tonne	1,568
NG	0.318	0.313	1.8%	111,975 m^3	25,010
Water	86.40	85.2	1.4%	24,015 m^3	2,235
GHG	3.74	3.72	0.4%	310 TonneCO_2	
Total					40,221

Units for KPI: kWh/kg for electricity, kg/kg for steam, m^3/kg for NG, l/kg for water and GHG emission kg/kg

Exercise – The Textile Company

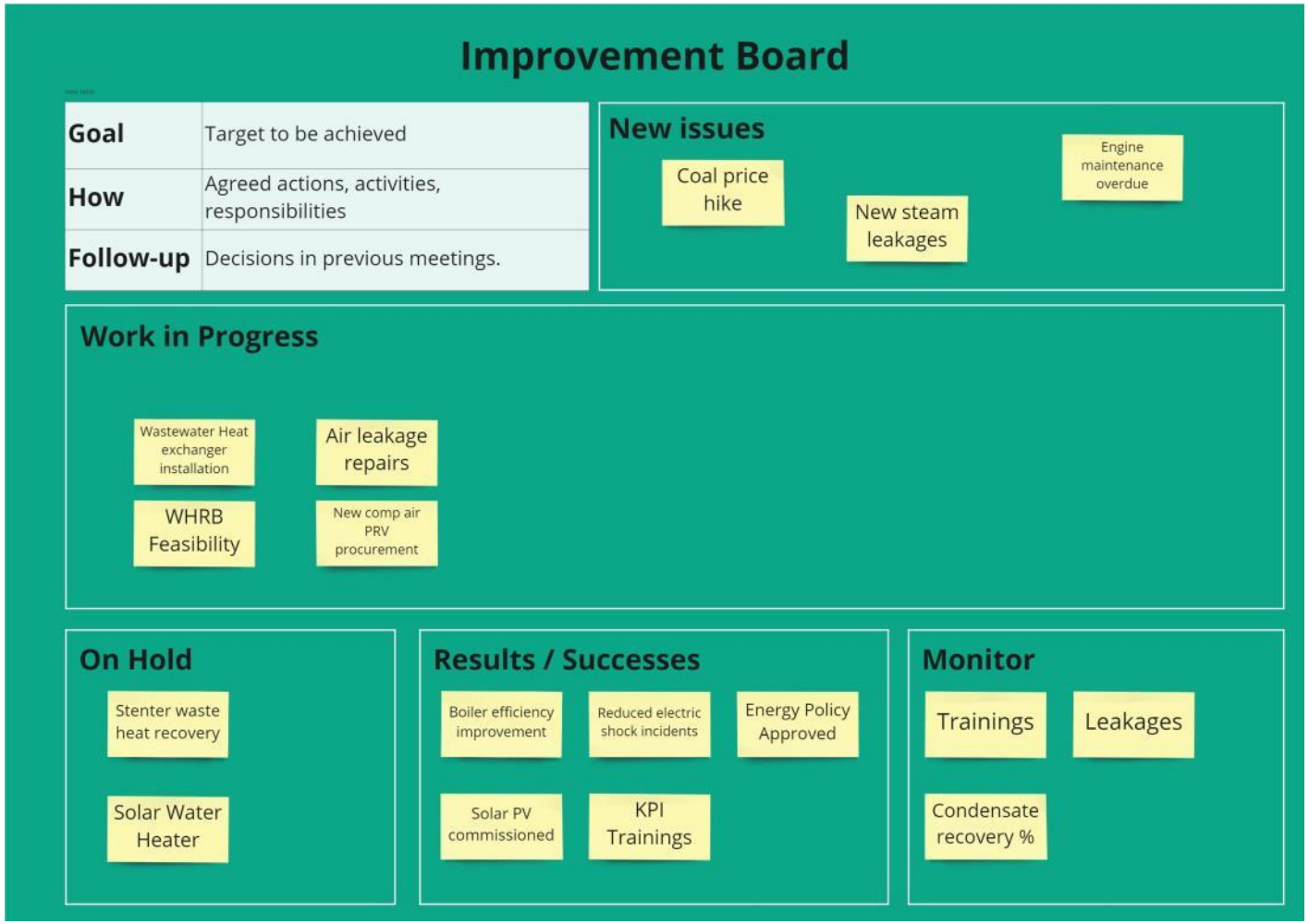
Tasks in your group

1. Refer to earlier identified energy NPOs (eco maps, flow charts, energy balance)
2. Assess impacts of major NPOs and select 3 top priority NPOs
3. Conduct Root-cause analysis for selected NPOs
4. Develop action plans
5. Present your findings in plenary

Total time: 90 minutes

Organizing, monitoring and reporting implementation

Example: Using an implementation board



Key takeaways

- Technical solution is only one aspect while management system and competence development are also important aspects
- The action plans must also include solutions to non-technical problems. This becomes relatively easier if the cause analysis is conducted properly, identifying not only the technical causes of the NPOs but also the causes relating management, administration, and competence

Plan next steps

- Identify suitable solutions to identified energy wastages or energy management issues and develop an action plan.

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn

Friedrich-Ebert-Allee 32 + 36
53113 Bonn, Germany
T +49 228 44 60 - 0
F +49 228 44 60 - 17 66

Dag-Hammarskjöld-Weg 1 - 5
65760 Eschborn, Germany
T +49 61 96 79 - 0
F +49 61 96 79 - 11 15

E info@giz.de
I www.giz.de

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH