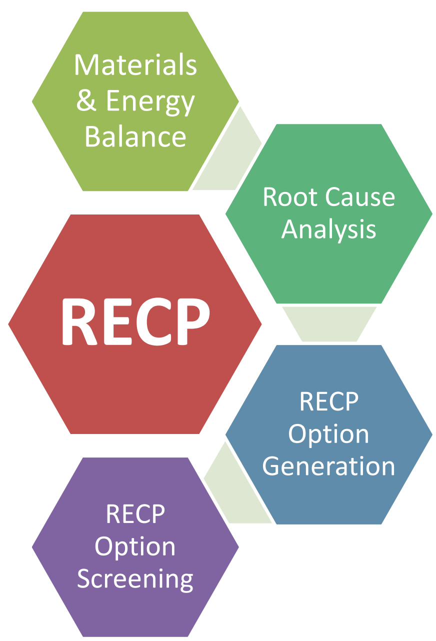
RECP Training

1. RECP Concept & Practice
2. RECP Assessment
3. Motivation, Commitment & Team
4. RECP Indicators
5. Initial Assessment
6. Detailed Assessment

Module 6

Detailed Assessment



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Detailed Assessment

Initial Assessment Completed

DETAILED ASSESSMENT

1. Develop material and energy balances
2. Assess root causes of inefficiencies and wastes
3. Generate RECP options
4. Screen RECP options

1. Process-based quantification of wastes & inefficiencies
2. Set of potential solutions

Detailed Assessment

- Process improvement requires knowledge of major inputs and outputs
- Understanding key factors and root causses is critical
- RECP experts cannot be specialists in every facet, but they can question key assumptions in everyday operations
- Checklists and tips with options are available for most factory operations
- Use materials and energy flow assessments and standard mass and energy balance methods to understand what goes (*missing*) where – and why!
- Data gathering is critical and quality of data is important
- Reproducibility of data is important, but cost of data collection could also be a factor – be prepared to compromise and approximate
- Estimate where data is not available and use benchmarks

Material & Energy Balance

Detailed assessment requires quantification of resource utilization and environmental emissions at the process level for which process data need to be compiled into material and energy balance.

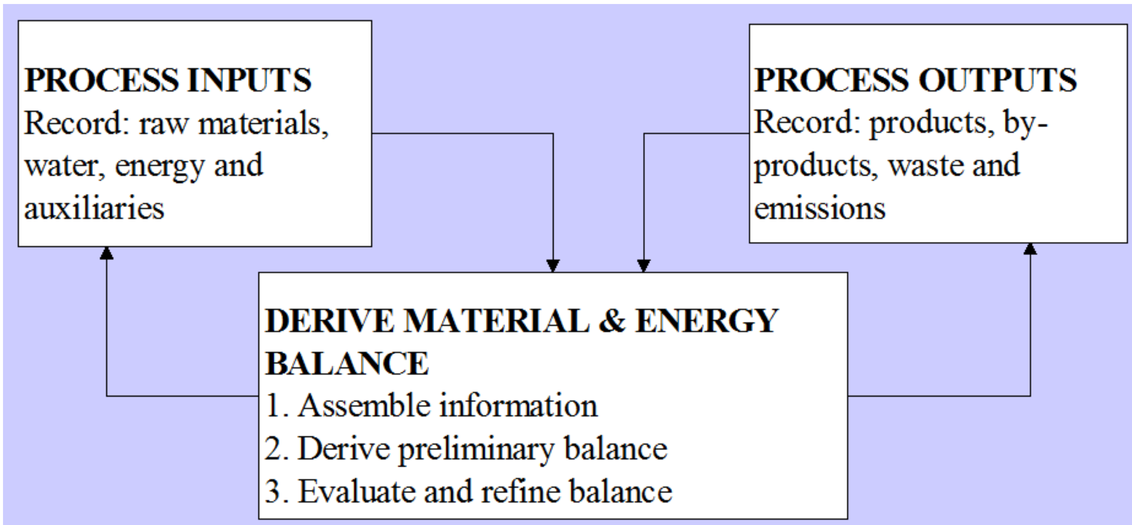
3.1 Materials & Energy Balance

How does a balance work?

Input mass =
Output mass
+ Storage

(Without chemical reaction)

3.1 Develop Material & Energy Balances



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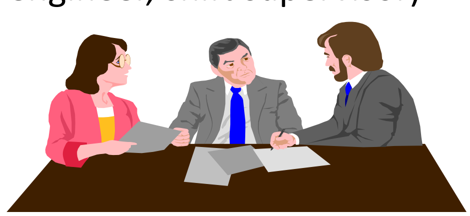
3.1 Develop Material & Energy Balances

- Possible data sources
  - Accounting (invoices)
  - Warehousing
  - Process records
  - Actual usage data
  - Personal information (e.g. engineer, shift supervisor)
  - Estimates
  - Measurements
  - Design or supplier data
  - …



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3.1 Materials & Energy Balance

- Practical Tips
  1. Define the objectives and parameters to be monitored
  2. Limit the balance scope
  3. Limit the balance period
  4. Identify and define the process steps
  5. Draw the flow diagrams: materials and energy inputs and quality
  6. Draw up the balances: materials and energy
  7. Interpret the results and draw conclusions

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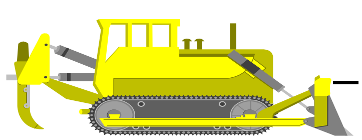
3.1 Materials & Energy Balance



- Example: machine paint shop
  - Parameters:
    - Paints, solvents, energy, water and other input materials
  - Scope
    - Paint booth and drying
  - Timeframe
    - 1 year

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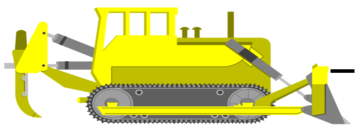
3.1 Materials & Energy Balance



- Example: machine paint shop
  - Process steps
    - Pre-treatment/cleaning
    - Priming and painting
    - Drying
  - Auxiliary operations
    - Steam generator
    - Compressor
    - Exhaust air filter
    - Cleaning booth (spray gun, equipment)

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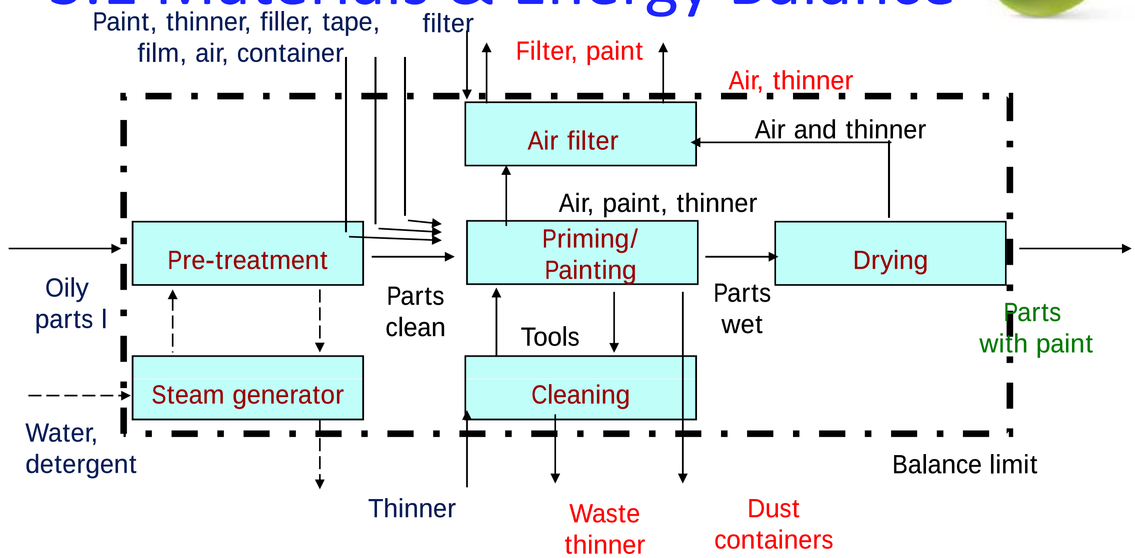
3.1 Materials & Energy Balance



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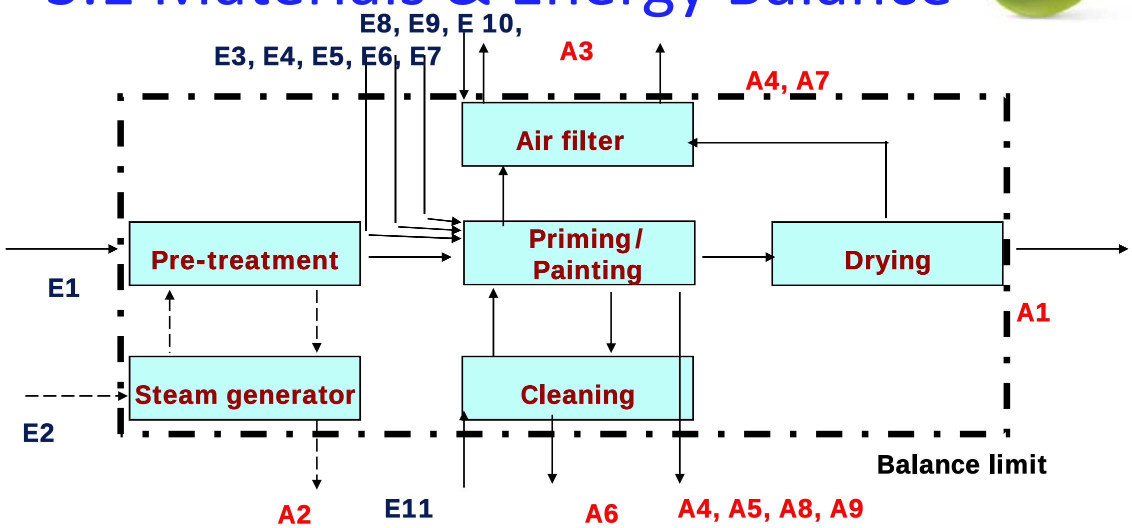
3.1 Materials & Energy Balance



3.1 Materials & Energy Balance

Material flow analysis – flow data

Stream		Quantity	Unit	Stream		Quantity	Unit
E1	Oily workpiece	20400	kg	A1	Workpiece With paint	20000 800	Kg Kg
E2	Steam, water	9500	M³	A2	Waste water With oil, sludge	50000 400	Kg Kg
E3	Detergent	60	L	A3	Air solvent	101 mi. 3600	M³ Kg
E4	Filler	120	Kg	A4	Dust	100	Kg
E5	Hardening agent	24	Kg	A5	Container	n. q.	
E6	Films	150	M²	A6	Spent solvent	1400	kg
E7	Tape	450	Roll	A7	Spent filter	2700	kg
E8	Pressurized air	39000	M³	A8	Sludge	393	Kg
E9	Air	59 million	M³	A9	Covering material	n. q.	
E10	Paint Solvent	4000 2000	Kg kg				
E11	Solvent	3000	Kg				
E12	Air	42 million	M³				
E13	Filter	100	kg				

3.1 Materials & Energy Balance

Balance for solvents

Input			
E10	Solvent in paint	2000	Kg
E11	Solvent	3000	Kg
Total		5000	kg

Output			
A2	Solvent in exhaust air	2700	Kg ???
A6	Spent cleaning solvent	1400	Kg
A8	Paint sludge	393	kg
	Losses	*507*	*kg ???*
Total		5000	kg

3.1 Materials & Energy Balance

- Application efficiency =

$$\frac{\text{dry surface film mass}}{\text{paint input mass}}$$

- In example
  - 800/40000 kg = 20%
- Connect with financial data
  - What is the input value lost with the paint waste?

Conventional	35-50%
HVLP	50-70%
Airless	40-75%
Electrostatic	50-85%
Rotating disc	75-90%
Dipping	90%
Pouring	95%
Rolling	98%

3.1 Materials & Energy Balance

- Combine material balance with energy analysis:
  - Energy is often single most important cost saver from RECP
  - Energy is expensive, not easily seen, often ignored and taken for granted
  - Energy is under increasing scrutiny as a GHG producer
  - Energy savings can often be discovered easily and can be the basis for low hanging fruit motivation to carry on RECP work

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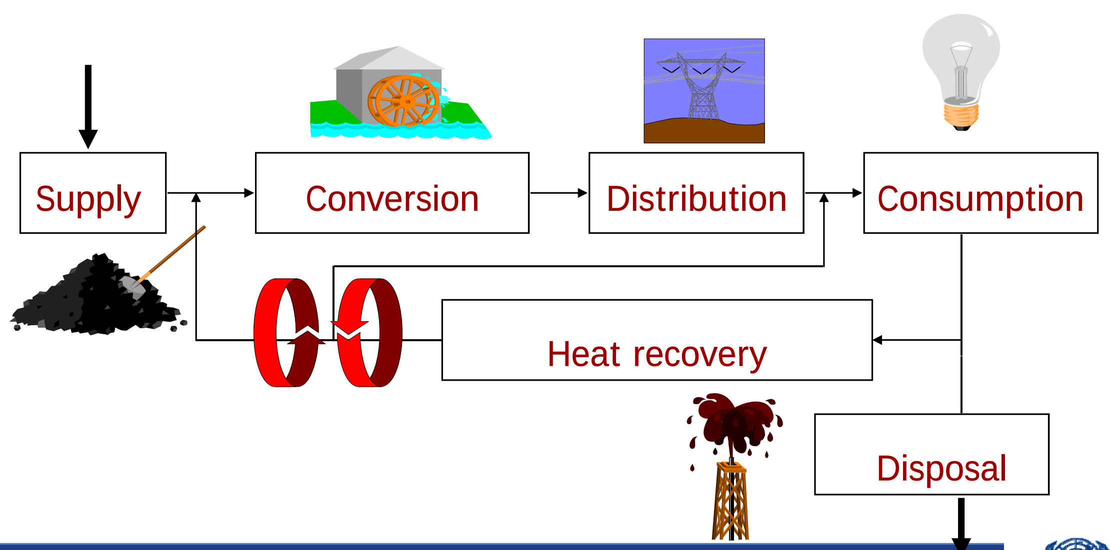
3.1 Materials & Energy Balance



3.1 Materials & Energy Balance

- Key energy users
  - Cooling and refrigeration
  - Heating and steam generation
  - Compressed air
  - Lighting, and room heating, ventilation and cooling (HVAC)
  - Pumping and materials movement
  - Processes, in particular operations at high/low temperature and pressure
  - Waste water treatment
  - Energy can be saved in generation, distribution and use of energy carriers!!

3.1 Materials & Energy Balance

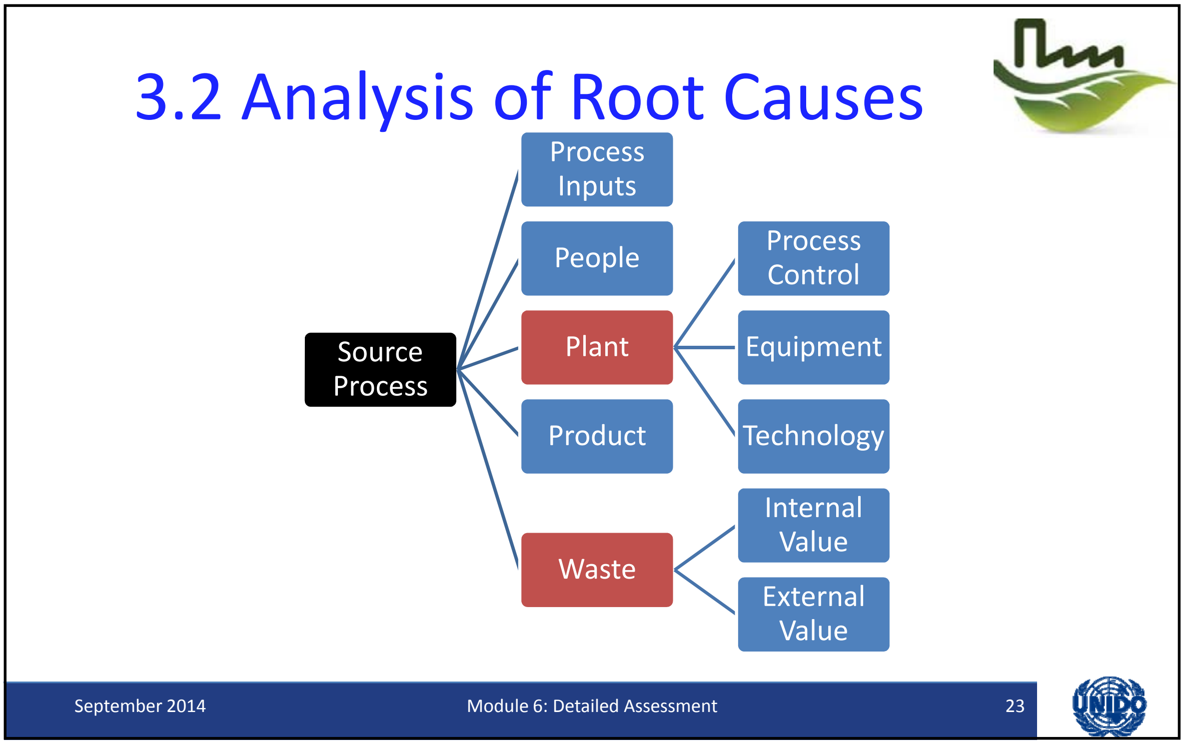
- And water is also a material!
  - Water is used in multiple operations inside and outside plant
  - Water is used for domestic and production needs
  - Water is often misused and forgotten
  - There is a nexus (connection) between water use, energy use and often waste production!
  - Water is critical in many sectors, e.g. food, metal finishing, textiles, chemicals
  - Water use is beginning to be seen as a profit centre and a risk minimisation issue

Root Cause Analysis

The quantified losses (and costs thereof) serve to inform the diagnosis of process areas so that root causes of inefficiencies can be determined.

3.2 Analysis of Root Causes

- Use standard '*cause categories*' to explore their potential impact on process efficiency and waste generation:
  - Product specifications
  - Choice and quality of input materials
  - Selection and design of technology
  - Selection and design of equipment
  - Status of process control/standard operating practices
  - Material handling, operation and maintenance procedures
  - Internal values of - components - of waste streams
  - External values of - components - of waste streams


3.2 Analysis of Root Causes
Source Process
Process Inputs
People
Plant
Product
Waste
Process Control
Equipment
Technology
Internal Value
External Value
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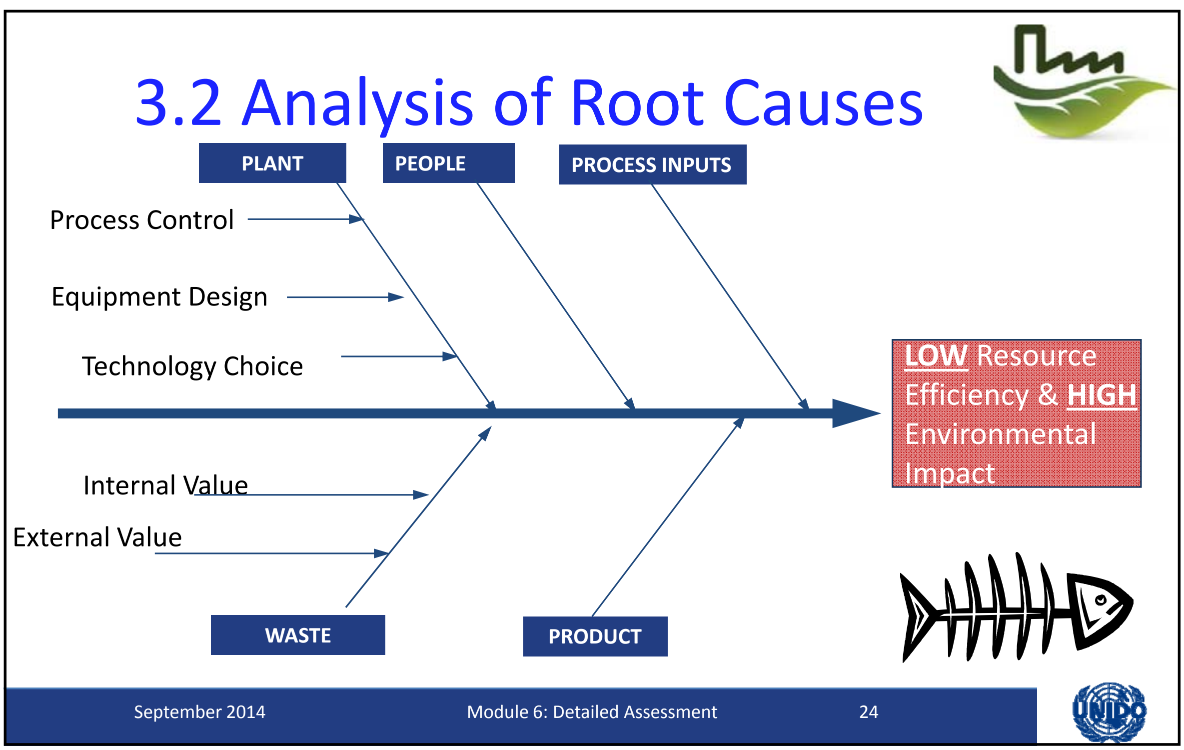
3.2 Analysis of Root Causes
PLANT
PEOPLE
PROCESS INPUTS
Process Control
Equipment Design
Technology Choice
Internal Value
External Value
WASTE
PRODUCT
LOW Resource Efficiency & HIGH Environmental Impact
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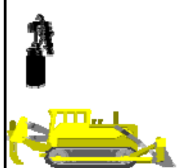
3.2 Analysis of Root Causes

Root Cause Category		Some examples
Process Inputs		• Paint deteriorated due to poor packaging and storage
People		• Poorly trained operators
Plant	Process Control	• Pressure on spray guns variable, on average too high • High rework rates due to inadequate cleaning and pre-treatment
	Equipment	• Spray nozzles worn out • Leaks in steam cleaner
	Technology	• Using traditional spray guns
Product		• Complicated and heavy items, difficult for operator to access properly • High variation in colour and other paint specifications
Waste	Internal Value	• Paint in waste is high cost, yet unrecoverable in present set up
	External Value	• High disposal costs, in principle though high energy content that might be recoverable



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3.2 Analysis of Root Causes

- Ask five times "*why*"
  - Problem: troublesome oil residue burnt onto bakery conveyor belts
    - Why is the residue generated? *(oil bakes on)*
    - Why does oil get there? *(overspray from mixers)*
    - Why is there overspray? *(hard to control sprays)*
    - Why do we use oil? *(to stop dough sticking)*
    - Why does it need to be oil? (*always done that)*
  - Solution: try water!

    (it worked very well!!)

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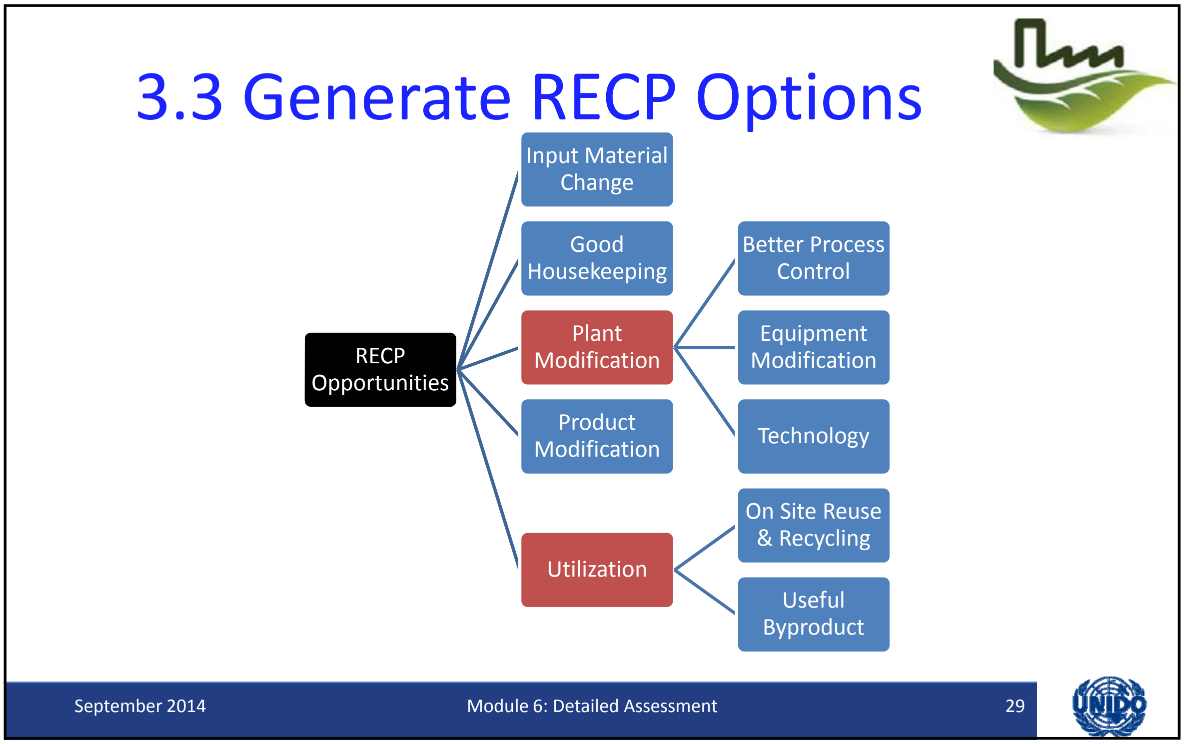
RECP Option Generation

Knowing the root causes, option generation is aimed at finding alternative ways to eliminate or otherwise control the root causes, and thereby improve resource efficiency and/or reduce emissions.

3.3 Generate RECP Options

- Apply standard 'RECP practices' to all waste and emissions causes and process inefficiencies
  - Product Modification
  - Input Material Substitution
  - Technology Change
  - Equipment Modification
  - Better Process Control
  - Good Housekeeping
  - On Site Recycling
  - Useful By-Product


3.3 Generate RECP Options
RECP Opportunities
Input Material Change
Good Housekeeping
Plant Modification
Product Modification
Utilization
Better Process Control
Equipment Modification
Technology
On Site Reuse & Recycling
Useful Byproduct
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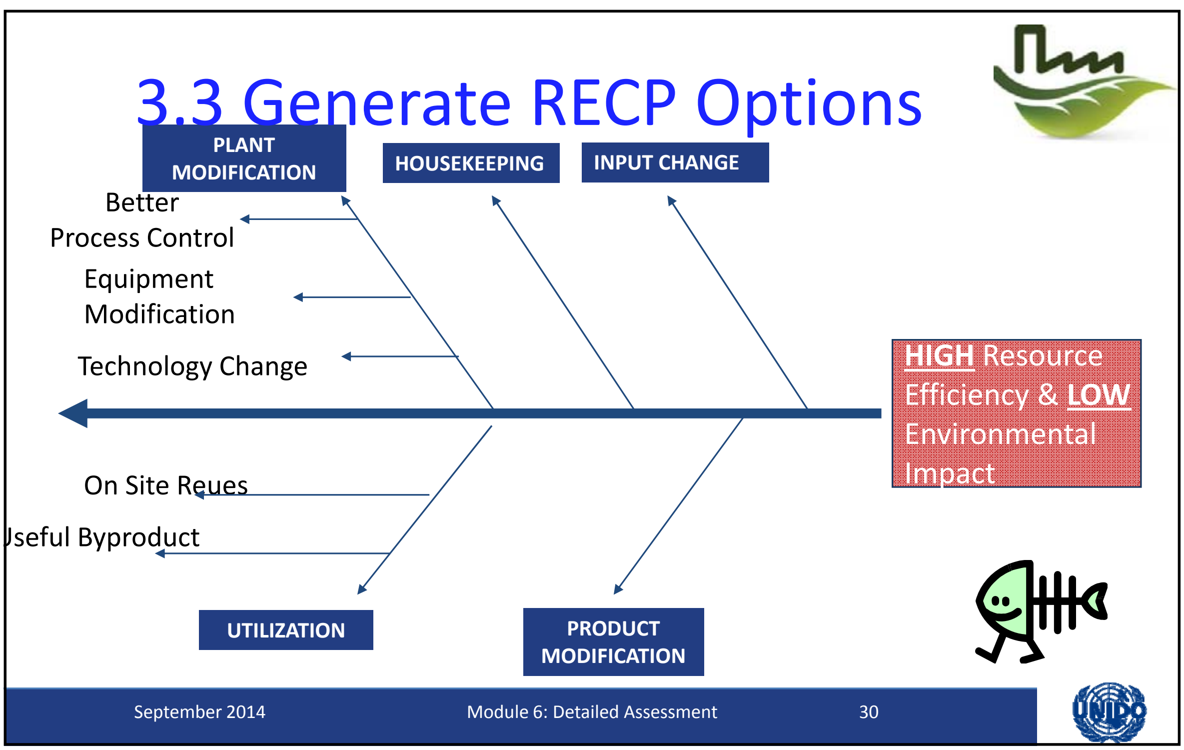
3.3 Generate RECP Options
PLANT MODIFICATION
HOUSEKEEPING
INPUT CHANGE
Better Process Control
Equipment Modification
Technology Change
HIGH Resource Efficiency & LOW Environmental Impact
On Site Reues
Useful Byproduct
UTILIZATION
PRODUCT MODIFICATION
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3.3 Generate RECP Options

- Or in other words brainstorm about:
  - How could we avoid the waste?
  - How could we reduce the waste?
  - How could we reuse the waste?
  - How could we recycle the waste?
  - How can we improve housekeeping?
  - How can we modify our equipment?
  - How can we change the inputs?
  - How can we modify the product or service?

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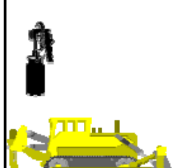
3.3 Generate RECP Options

RECP Practices		Some examples
Input Change		• Purchase paint in proper containers, and in appropriate quantifies • Use right paint for right job
Good Housekeeping		• Operator training and awareness, including monitoring and feed-back on overspray • Clean as you go
Plant Modification	Process Control	• Replace pressure control valves • Improve cleaning process, and check before painting
	Equipment Modification	• Replace nozzles, possibly ceramic, high abrasion resistant nozzles • Replace worn steam hose
	Technology Change	• Replace spray guns with high volume low pressure (HVLP) guns
Product Modification		• Request customer for more standardized product and painting specifications
Reuse	On Site Reuse	• Recover overspray for immediate reuse on same job
	Useful By Product	• Left over paint might be reusable by others for lower specification jobs



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RECP Option Screening

Preliminary screening of options is undertaken to combine options into integrated solutions and prioritize for follow up, either immediate implementation or for further feasibility studies.

3.4 Screen RECP Options

– Organise RECP options in consistent packages
- Organise options per unit operation
  - » Enable integrated evaluation of all changes for each unit operation (e.g. all changes to the paint booth system)
- Evaluate obvious mutual interferences
  - » E.g. change of technology (e.g. powder coating for machine parts), would normally require complementary changes in inputs, operations, etc.
- Implement obviously feasible options
  - » Typically the addition housekeeping options, including e.g. staff training, fixing of leaks etc.
- Remove obviously non-feasible options
  - » Such as changing the product or business

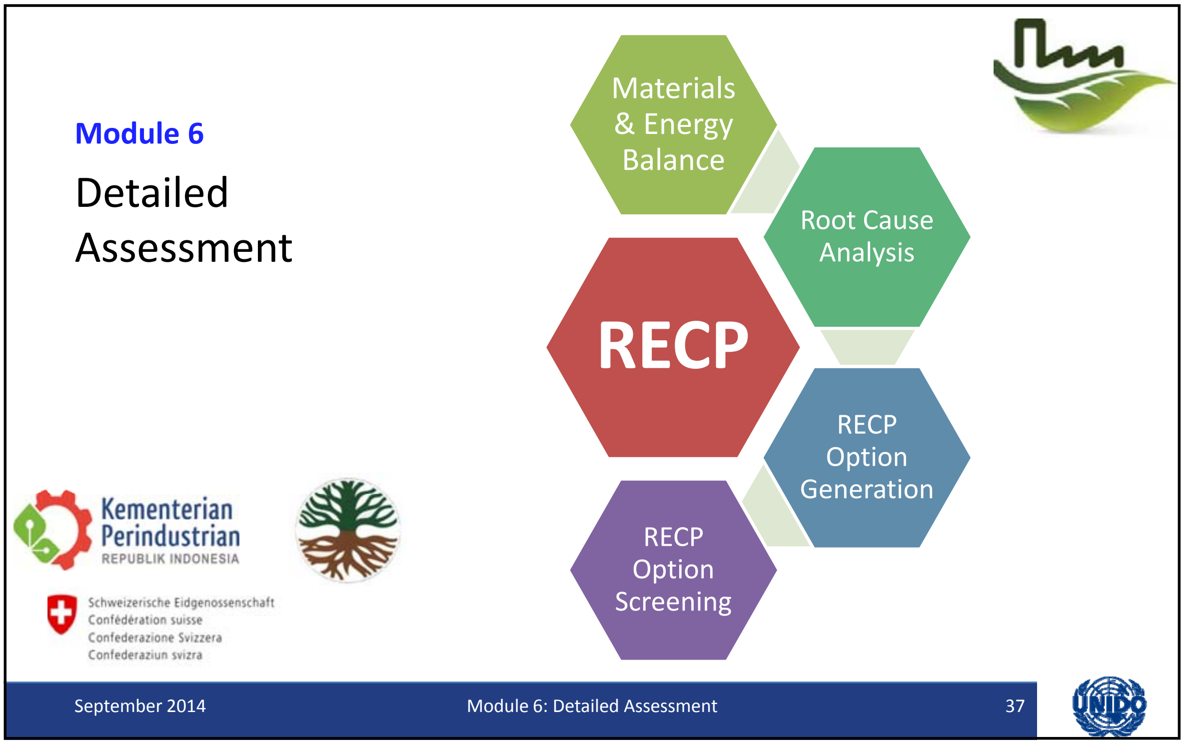
3.4 Screen RECP Options

– Preliminary evaluation of remaining options
  - Impact on product
  - Impact on health and safety
  - Impact on customer satisfaction
  - Impact on environmental performance (resource use and emission generation, toxicity/harm, etc.)
  - Impact on staff, including morale and satisfaction
  - Impact on operability and quality
  - Ease of and resource requirements for implementation?
  - Expected economics – investment , cost savings, productivity improvements, etc.

3.4 Screen RECP Options

– Determine next steps
- RECP options for immediate implementation
  - Prepare and implement action plan and monitor results
- RECP options to be evaluated in detail
  - Feasibility studies to asses technical, economic and environmental aspects
- RECP options to parked
  - Set aside those options that appeared less doable during first screening for later consideration

RECP team to put together findings and report back to management and staff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Detailed Assessment
Materials & Energy Balance
Root Cause Analysis
RECP
RECP Option Generation
RECP Option Screening
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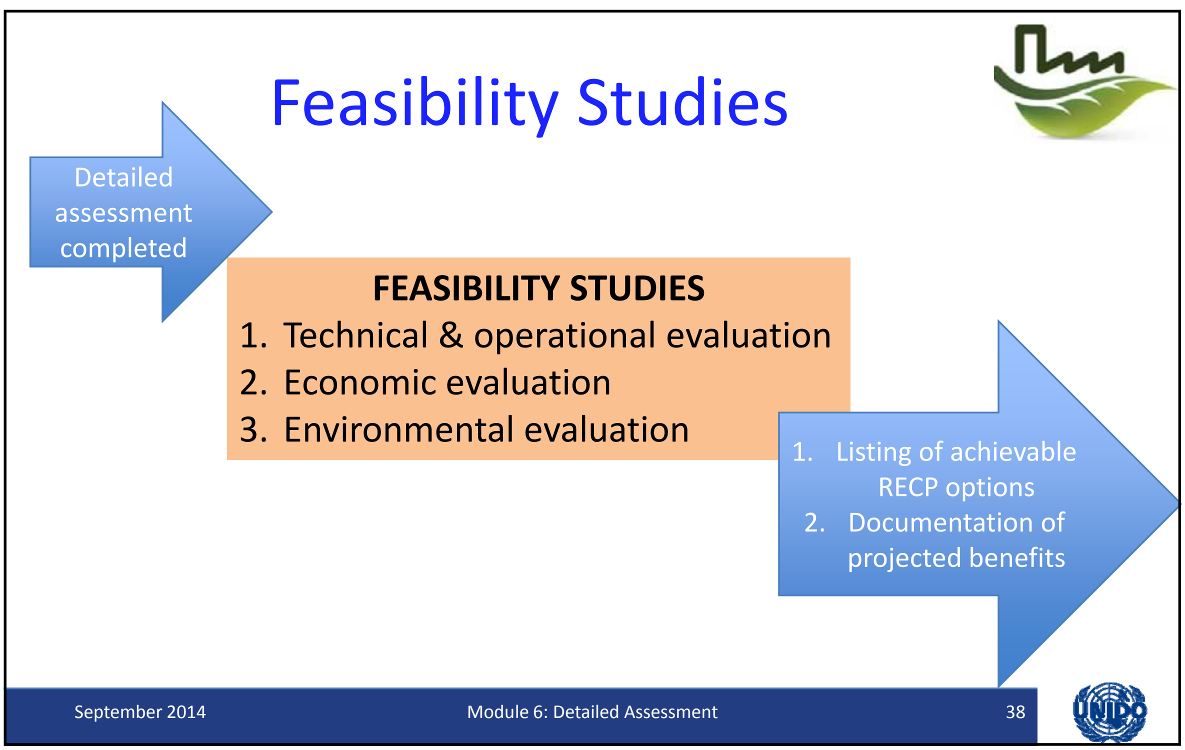
Feasibility Studies
Detailed assessment completed
FEASIBILITY STUDIES
1. Technical & operational evaluation
2. Economic evaluation
3. Environmental evaluation
1. Listing of achievable RECP options
2. Documentation of projected benefits
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Implementation

Feasibility studies completed

IMPLEMENTATION

1. Plan and implement feasible options
2. Monitor RECP benefits
3. Integrate RECP in management

Continued improvements in resource productivity and environmental performance

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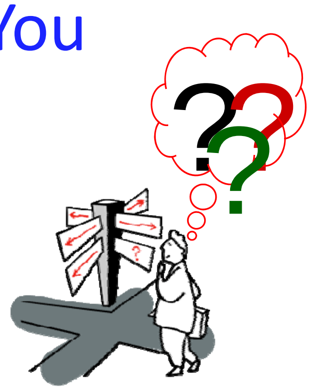
Thank You



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