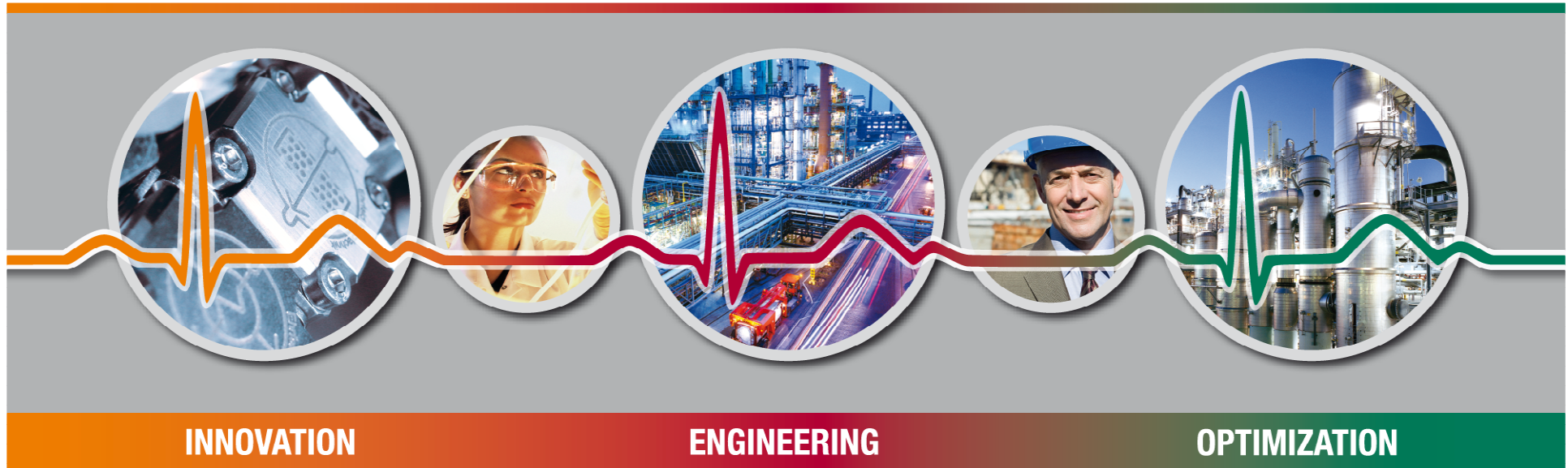


Powering Your Performance



Sustainable Optimization of Energy Efficiency (in the chemical / pharmaceutical industry)

CERAMITEC 2009 – Munich – 22. October 2009

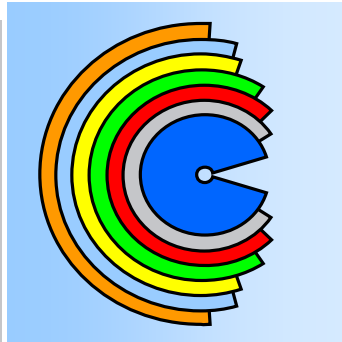
Dr. Philip Bahke



Bayer Technology Services

Agenda

- Introduction
- Energy Efficiency Check
- Climate Footprint[®]
- Energy Efficiency Management



Increasing need to optimize energy efficiency and to reduce greenhouse gas emissions

Energy represents increasing share of operating costs at chemical plants

Percentage of total costs increased from ~3 to ~12 over last ten years due to rising energy prices

Reducing energy costs is key lever to increase profitability



Chemical companies contribute significantly to man-made greenhouse gas emissions

Reduction targets defined by several companies

Reducing greenhouse gas emissions is required for economic and social reasons



Increased expectations of governments in energy and CO₂ efficiency

Regulation started (EEG) and implementation of energy efficiency law (EnEfG) expected

Satisfy increasing regulatory requirements by having a management system in place

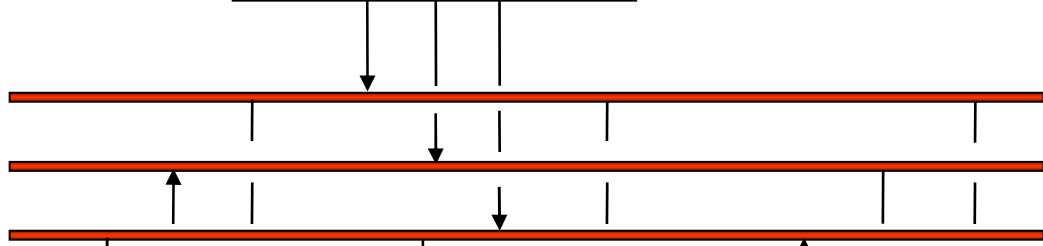


Several levers to improve energy efficiency in the chemical industry

Energy Generation



Site Integration



Production Process



Products



Several levers to improve energy efficiency in the chemical industry

Energy Generation

Co-generation plants – combined heat and power

- Total efficiency incl. heat extraction: ~85%
- Modern power generation efficiency: coal: ~43%, gas: ~55%

Site Integration

Total site integration offers huge potentials

- Energy integration between processes: heat of exothermal processes is used → design of steam pressure levels crucial
- Well balanced material usage, e.g. no by-product flaring (H₂)

Production Process

Best available technology (BAT)

- New type of process technology and equipment design
- Optimized process operation

Products

ICCA study: application of chemical products saves more CO₂ compared to production, e.g.:

- Modern insulation materials for buildings or cooling units
- Plastics to reduce weight of cars

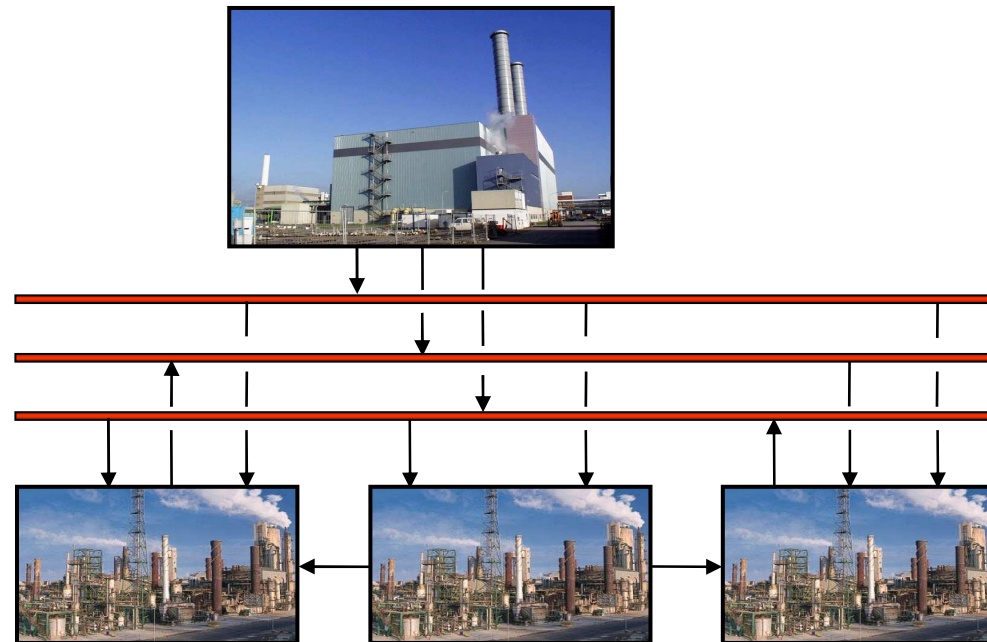
Focus on existing as well as on development of new processes and site networks

Optimization of existing processes and site network

- Potential savings: 5 - 20 %
- Short-term implementation possible
- Low costs

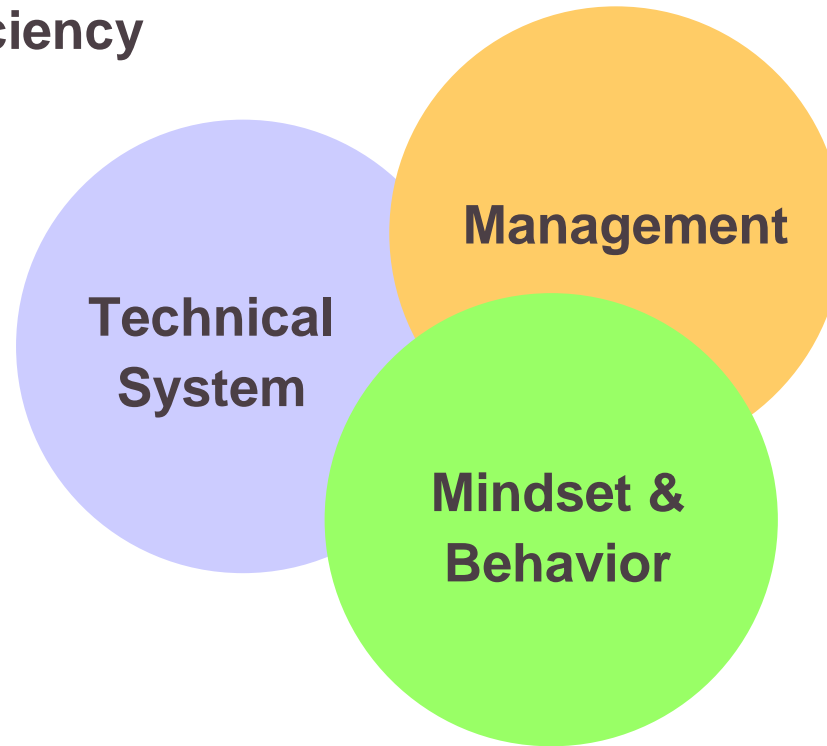
Development of new processes and site network

- Potential savings: 20 - 80 %
- Long-term implementation
- High costs (R&D and investment)



Existing processes: energy efficiency optimization need to consider three elements

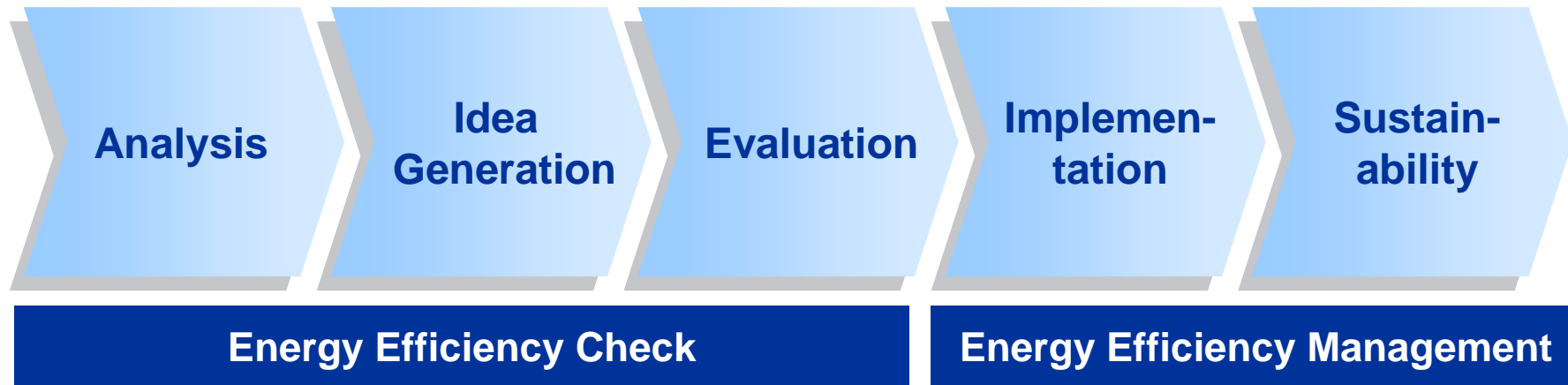
Sustainable energy efficiency optimization of existing processes needs to consider three elements...



and requires an efficient workflow.

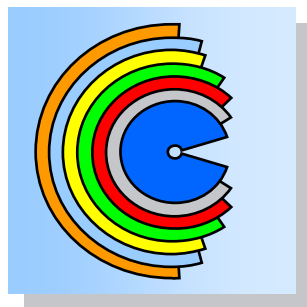


Sustainable energy efficiency is divided in two parts



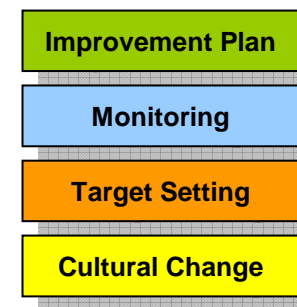
Energy Efficiency Check

- is a systematic screening
- identifies measures for energy & CO₂ emission reduction
- results in improvement suggestions



Energy Efficiency Management

- ensures sustainable implementation of improvement measures
- sustains a high awareness level






The Bayer Climate Check is a lighthouse project of the Bayer Climate Program



Ambitious targets

The subgroups have set themselves new ambitious emissions targets for 2020:





- Bayer MaterialScience
 - Reduction of specific greenhouse gas emissions for every metric ton of product sold by 25 percent
- Bayer CropScience:
 - Reduction of absolute greenhouse gas emissions by 15 percent
- Bayer HealthCare:
 - Reduction of absolute greenhouse gas emissions by 5 percent

Bayer Climate Program

7

Our lighthouse projects

We develop specific solutions within the scope of the Bayer Climate Program:

- Bayer MaterialScience: EcoCommercial Building 
- Bayer CropScience: Stress-tolerance of plants 
- Bayer CropScience: Plants as energy sources 
- **Bayer Technology Services: Bayer Climate Check** 

Bayer Climate Program

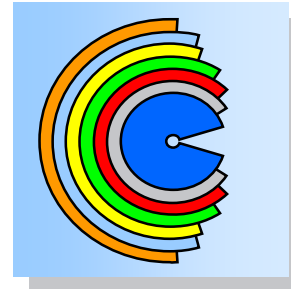
8

The Bayer Climate Check will be applied to all relevant Bayer production units worldwide

The Bayer Climate Check...

- will be applied to all relevant Bayer production units worldwide
- supports achievement of targeted climate goals of Bayer subgroups
- consists of the two elements:

- Energy Efficiency Check



- Climate Footprint[®]

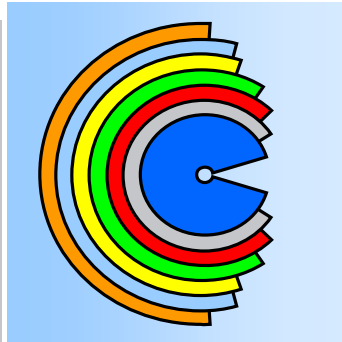


Scope:

- App. 100 Bayer production plants on 40 sites worldwide will be analyzed by the end of 2009.

Agenda

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Analysis Phase determines main levers for energy reduction

Analysis

Idea
Generation

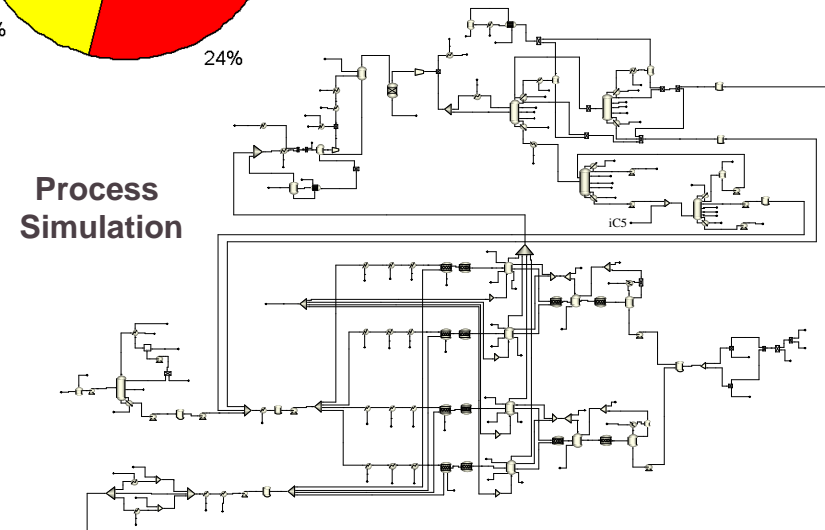
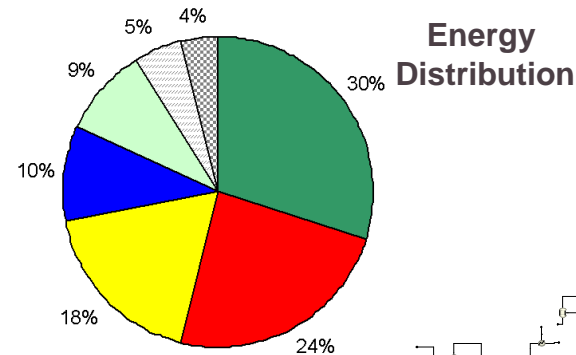
Evaluation

Implementation

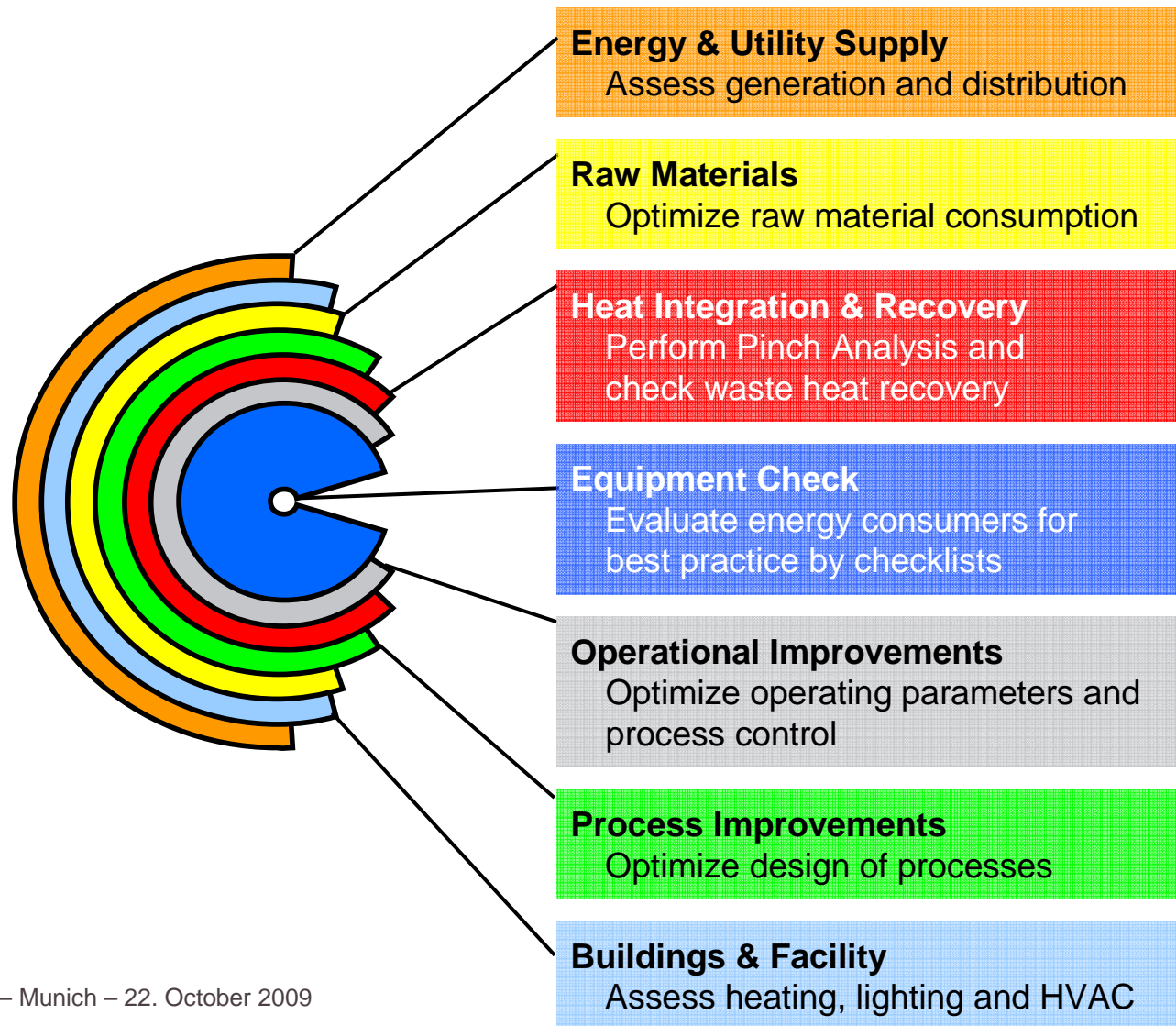
Sustainability

Analysis & Data Collection

- Identify **main energy consumers**
- Determine **consumption data** by measurement, balance or process simulation
- Perform **plausibility check**: comparison of measurement vs. theory
- Determine **degree of completeness**
- Collect **energy relevant data**:
 - Operational process data (e.g. power, temperature, flows)
 - Technical equipment data
- **Result: consistent data base**
e.g. consistent balance of heat sinks and sources by process simulation
incl. energy relevant operating parameters



The Energy Efficiency Check considers a wide range of optimization levels



Idea generation phase determines suggestions for energy & CO₂ emission reduction



Sources for improvement suggestions:

- Checklists & best practices
- Process experts
- Discipline experts of required competences
- Brainstorming sessions & Interviews to incorporate improvement ideas from plant management and operating employees



Checklist Centrifugal Pump

	A	B	C	D	E	F																																																																																																																								
1	Bayer Technology Services Energy-Efficiency-Analysis																																																																																																																													
4																																																																																																																														
5	Centrifugal / Radial Pumps																																																																																																																													
7	Author	Herr Stob (BTS-PT-PP-PA)	Tel (+49) (0)24 30 3551																																																																																																																											
8	Expert	Herr Janssen (BTS-ENGS-PLP-FE)	Tel (+49) (0)24 30 2927																																																																																																																											
9	Where	Centrifugal / Radial pumps																																																																																																																												
12	Background:	A significant amount of electricity costs is caused by operating a large number of pumps in a plant with power inputs varying from a few kW up to several 100 kW. Most of them are over-dimensioned. Assuming that energy savings of 15% over 8400h save costs of roughly 70 Euro/LEU (2006, only consumption price) and have a good rate. About 50% of the total energy consumption of a pump can be saved (requiring investments of a few 10'000), then a detailed consideration of a pump only makes sense for power inputs starting from 30 kW.																																																																																																																												
13		Optimization possibilities depend on the system. In static systems (constant flow rate needed), the desired flow rate can be adjusted by valves (reducing the flow rate to the desired level - mostly at the expense of the pump's efficiency) but reducing the overall power input, or by changing the static. In dynamic systems, the control mode has a large impact on energy consumption.																																																																																																																												
16	Source:	Ausschuss/Regelung von Pumpen und Pumpensystemen.pdf Energieeffizienz in Pumpensystemen.pdf																																																																																																																												
18	Demark:	Pumps with smaller input than 30 kW are not worth detailed investigation.																																																																																																																												
21	Questions:	<table border="1"> <tr> <td>21</td> <td>Basic</td> <td></td> </tr> <tr> <td>22</td> <td>Pump Type (e.g. GPK, G, ...)</td> <td></td> </tr> <tr> <td>23</td> <td>Flowing speed (l/min, m³/min or m³/h)</td> <td></td> </tr> <tr> <td>24</td> <td>Flow diameter (mm)</td> <td></td> </tr> <tr> <td>25</td> <td>Pump Curve available</td> <td></td> </tr> <tr> <td>26</td> <td>Design Flow rate (full load mode) (m³/h)</td> <td></td> </tr> <tr> <td>27</td> <td>Design System Head (m)</td> <td></td> </tr> <tr> <td>28</td> <td>Design Flow rate (load mode) (m³/h)</td> <td></td> </tr> <tr> <td>29</td> <td>Pressure inlet (bar)</td> <td></td> </tr> <tr> <td>30</td> <td>Pressure outlet (bar)</td> <td></td> </tr> <tr> <td>31</td> <td>Operating hours (hour/year)</td> <td></td> </tr> <tr> <td>32</td> <td></td> <td></td> </tr> <tr> <td>33</td> <td></td> <td></td> </tr> <tr> <td>34</td> <td></td> <td></td> </tr> <tr> <td>35</td> <td></td> <td></td> </tr> <tr> <td>36</td> <td></td> <td></td> </tr> <tr> <td>37</td> <td></td> <td></td> </tr> <tr> <td>38</td> <td>Is the system closed? (e.g. tank, ...)</td> <td></td> </tr> <tr> <td>39</td> <td>Control mode</td> <td></td> </tr> <tr> <td>40</td> <td>Control mode</td> <td></td> </tr> <tr> <td>41</td> <td>Control mode</td> <td></td> </tr> <tr> <td>42</td> <td>Is the pump controlled</td> <td></td> </tr> <tr> <td>43</td> <td>How often and for what</td> <td></td> </tr> <tr> <td>44</td> <td>Is the pump</td> <td></td> </tr> <tr> <td>45</td> <td></td> <td></td> </tr> <tr> <td>46</td> <td></td> <td></td> </tr> <tr> <td>47</td> <td>What is the actual / optimal</td> <td></td> </tr> <tr> <td>48</td> <td>Is it</td> <td></td> </tr> <tr> <td>49</td> <td>optimal dimension</td> <td></td> </tr> <tr> <td>50</td> <td>by checking</td> <td></td> </tr> <tr> <td>51</td> <td></td> <td></td> </tr> <tr> <td>52</td> <td></td> <td></td> </tr> <tr> <td>53</td> <td></td> <td></td> </tr> <tr> <td>54</td> <td></td> <td></td> </tr> <tr> <td>55</td> <td></td> <td></td> </tr> <tr> <td>56</td> <td>Do you have ideas for energy</td> <td></td> </tr> <tr> <td>57</td> <td>efficiency improvements</td> <td></td> </tr> <tr> <td>58</td> <td></td> <td></td> </tr> <tr> <td>59</td> <td></td> <td></td> </tr> <tr> <td>60</td> <td></td> <td></td> </tr> </table>					21	Basic		22	Pump Type (e.g. GPK, G, ...)		23	Flowing speed (l/min, m ³ /min or m ³ /h)		24	Flow diameter (mm)		25	Pump Curve available		26	Design Flow rate (full load mode) (m ³ /h)		27	Design System Head (m)		28	Design Flow rate (load mode) (m ³ /h)		29	Pressure inlet (bar)		30	Pressure outlet (bar)		31	Operating hours (hour/year)		32			33			34			35			36			37			38	Is the system closed? (e.g. tank, ...)		39	Control mode		40	Control mode		41	Control mode		42	Is the pump controlled		43	How often and for what		44	Is the pump		45			46			47	What is the actual / optimal		48	Is it		49	optimal dimension		50	by checking		51			52			53			54			55			56	Do you have ideas for energy		57	efficiency improvements		58			59			60		
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Pumps

Equipment check: evaluation of large energy consumers

Analysis

Idea
Generation

Evaluation

Implementation

Sustainability

Equipment Check

- Evaluate larger single energy consumers
- Several checklists for main equipment developed, e.g. centrifugal pump: operating point and control strategy
- What we often see:
 - **Pumps:** up to 50 % of pressure increase is consumed in control valve
→ implement frequency drive
 - **Heat exchanger for cooling:** cooling media flow is not controlled
 - **Heat exchanger for heating:** steam pressure level is too high
 - **Distillation columns:** replace trays by packing
 - Equipment is always running



Motors



Pumps



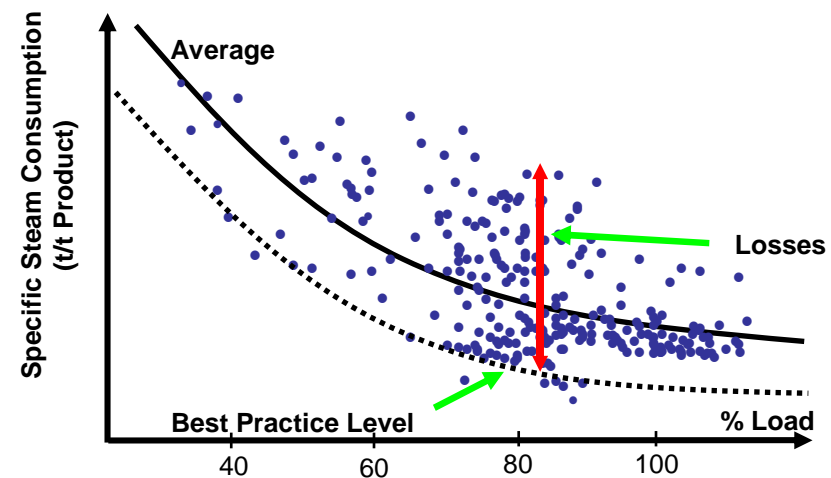
Heat Exchanger

Optimize operating parameters and process control



Operational Improvements & Process Control

- Improve process operation and process control
- What we often see:
 - **Distillation columns** are operated at too high reflux flows → improve process control
 - **Reactors** are operated with excess of solvent or reactant leading to large circulation flows → improve operation by e.g. online monitoring of process control (APC)
 - **Batch plants:** high peak demands of utilities → improve production planning
 - Specific energy consumption shows fluctuations
 - Operating parameters are not challenged
 - After failure processes remain in a “save” operating point
 - Processes are operated in a “comfort zone”



Improve heat integration & heat recovery by pinch analysis and novel technical solutions

Analysis

Idea
Generation

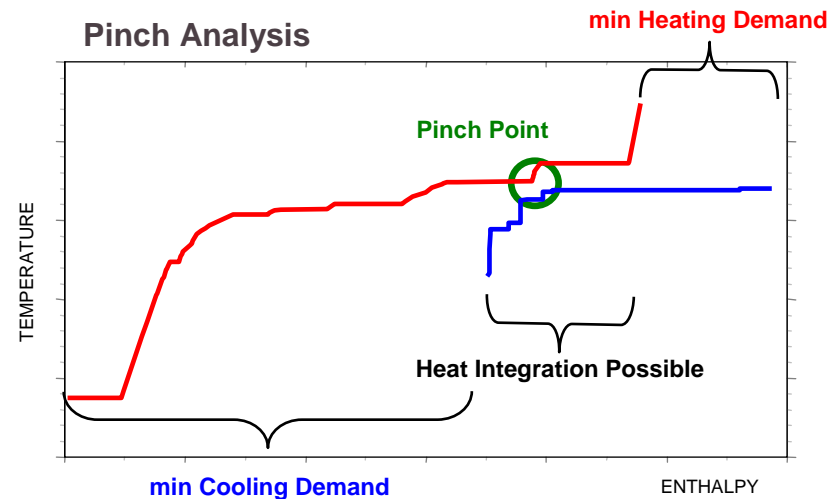
Evaluation

Implementation

Sustainability

Heat Integration & Heat Recovery

- **Optimize heat integration by applying Pinch Analysis**
 - Consideration of process modification essential, e.g. increased pressure in distillation leads to increased condensation temperature
- What we often see:
 - waste heat is “destroyed” with cooling water
- **Recover waste heat by:**
 - **Pre-heating** of feed streams
 - Generation of **low pressure steam**
 - **Absorption chiller** to produce chilled water
 - Applying **vapor recompression** or **heat pumps** to produce “valuable” heat



Optimize processes design



Process Improvements

- **Improve design of process steps / unit operations and complete process**
- **Examples:**
 - **Evaporation or distillation:** replace single step by multi-effect with heat integration
 - **Product concentration:** replace evaporation steps by membrane
 - **Solvent selection:** replace solvent by component with lower evaporation enthalpy or better separation factor
 - **Reaction:** check for application of innovative technologies like micro technology, process intensification, best catalyst etc.
 - **Spray dryer:** optimize atomization and heat recovery
 - **Waste water stripper:** implement vapor recompression by steam jet pump and feed preheating



Redesign of production process leads to significantly increased energy efficiency

Analysis

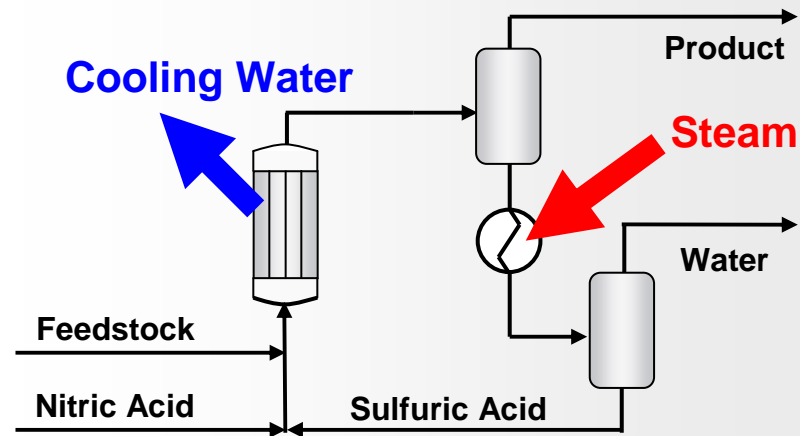
Idea
Generation

Evaluation

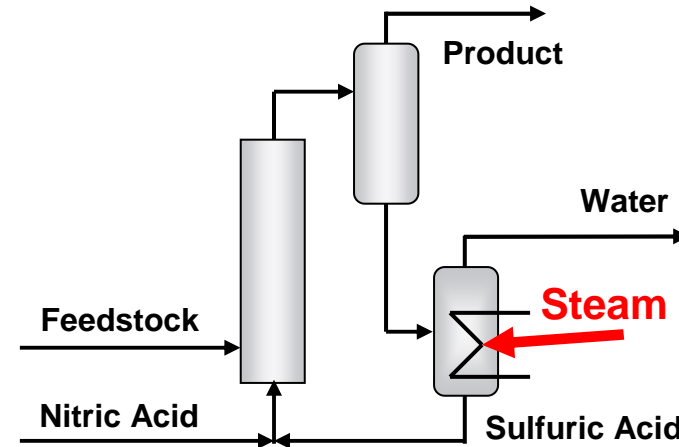
Implementation

Sustainability

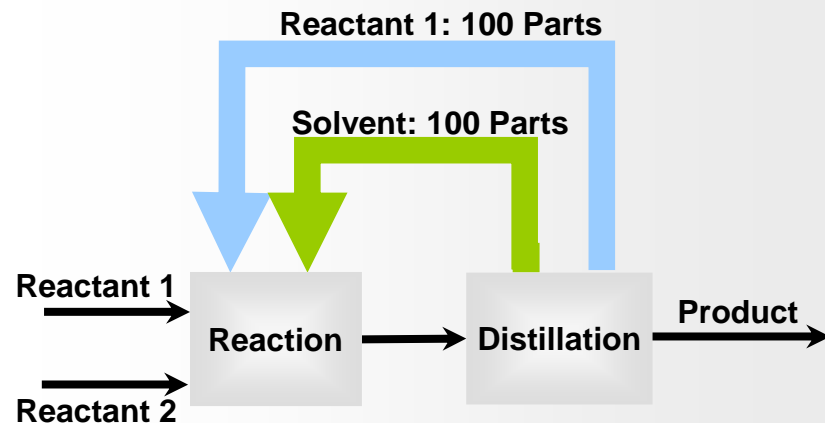
Isothermal nitration



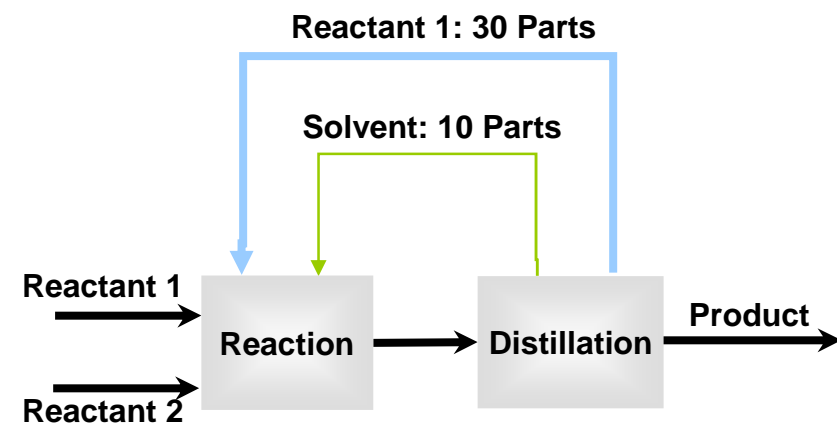
Adiabatic nitration



Liquid phase reaction



Gas phase reaction



Check buildings and facility

Analysis

Idea
Generation

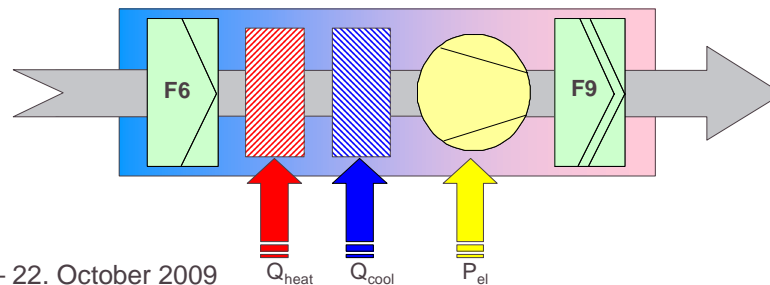
Evaluation

Implementation

Sustainability

Buildings & Facility

- Check illumination, insulation and leakages
- Assess specific energy consumption of buildings by benchmarks or balancing
- Assess heating, ventilating and air conditioning (HVAC)
- What we often see:
 - **Insulation** often inefficiencies
→ use IR camera to detect inefficiencies
 - Outdoor **lighting** is always on
 - **HVAC**: air exchange rates and humidity are higher than required; no heat recovery



Assess generation and distribution of energies & utilities

Analysis

Idea
Generation

Evaluation

Implementation

Sustainability

Energy & Utility Systems

- Improve energy and utility generation and distribution
- What we often see:
 - Low overall **boiler** efficiency, e.g. due to no pre-heating or inefficient degassing of water → increase heat recovery
 - **Let-down of high pressure steam** to low pressures steam leads to enthalpy losses → implement steam turbine
 - Low level of **condensate return** / reuse
 - Low temperature difference in **circulation systems** → decrease circulation flow
 - No regular **steam-trap maintenance**
 - **Heat tracing** not turned off in summer
 - High **peak loads** → peak demand reduction



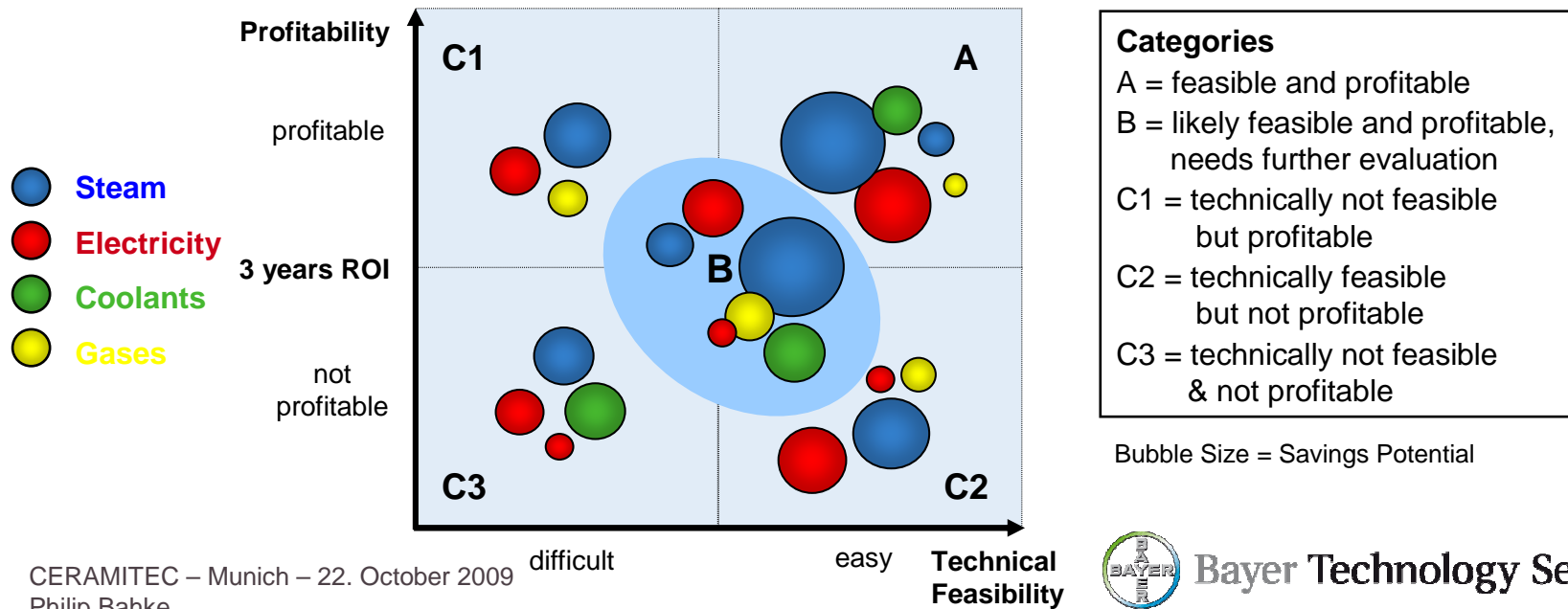
All improvement ideas are evaluated



All improvement ideas are evaluated with regard to

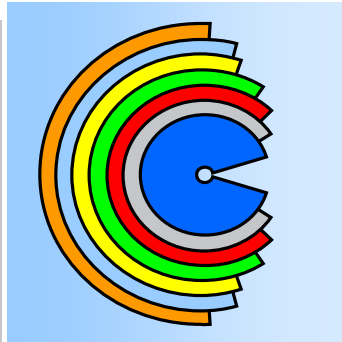
- Technical feasibility
- Savings potential (CO₂e and costs)
- Costs for implementation (rough estimate)
- Profitability (rough estimate)

and displayed in a portfolio:

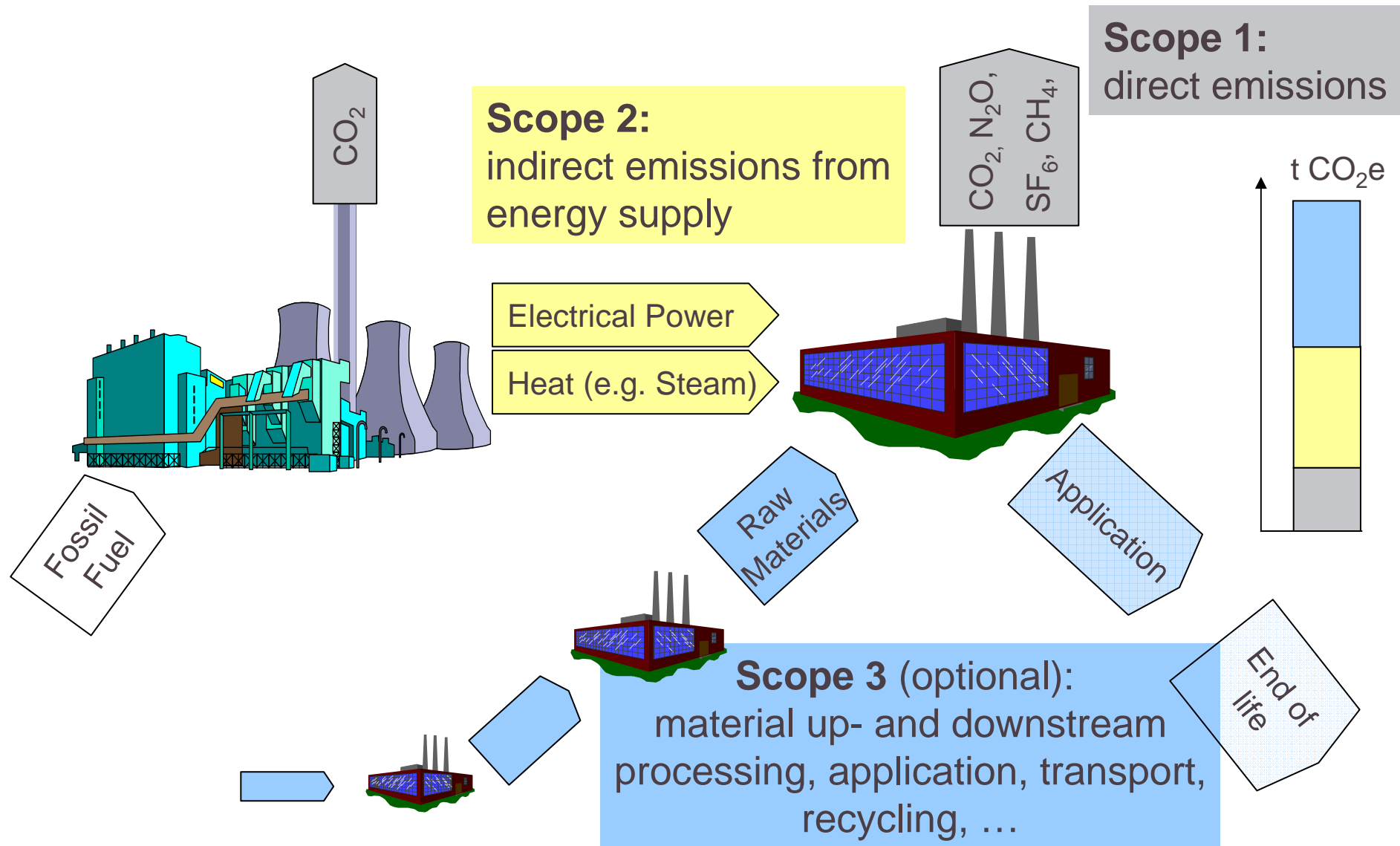


Agenda

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- Energy Efficiency Management



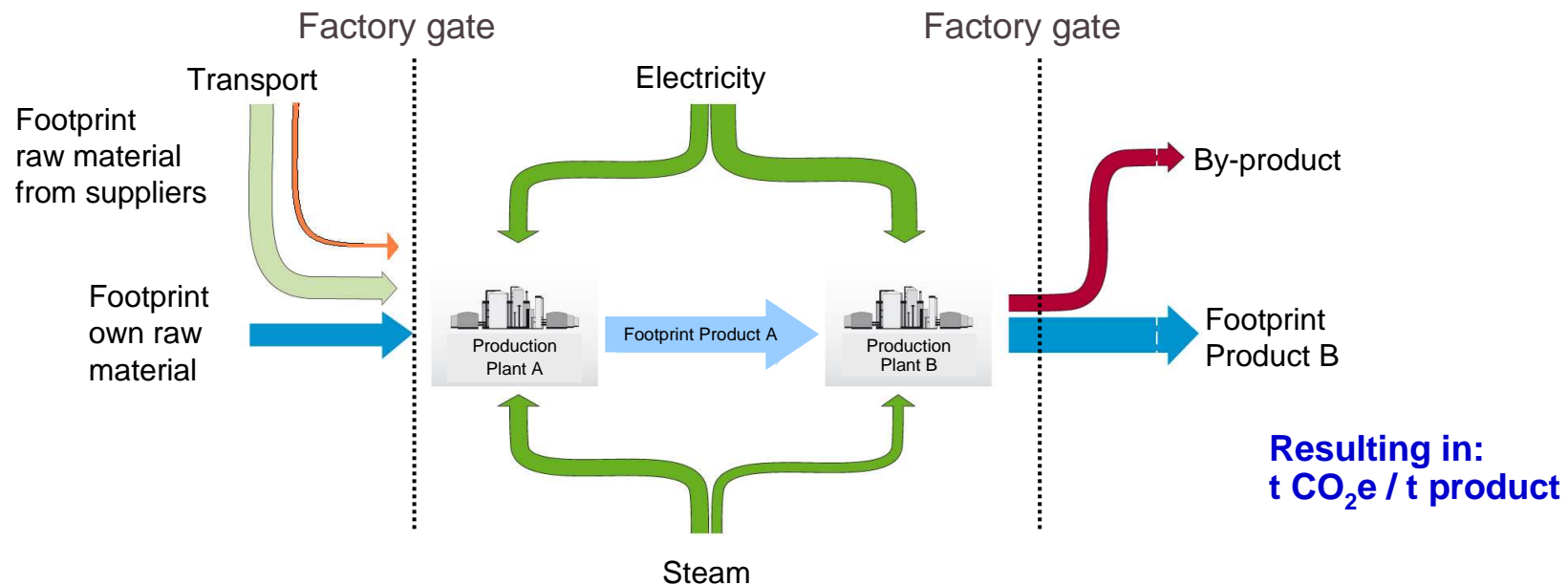
CO₂e emission reporting according to GHG protocol distinguishes 3 scopes



The Climate Footprint[®] is the indicator to assess the total climate impact of production processes

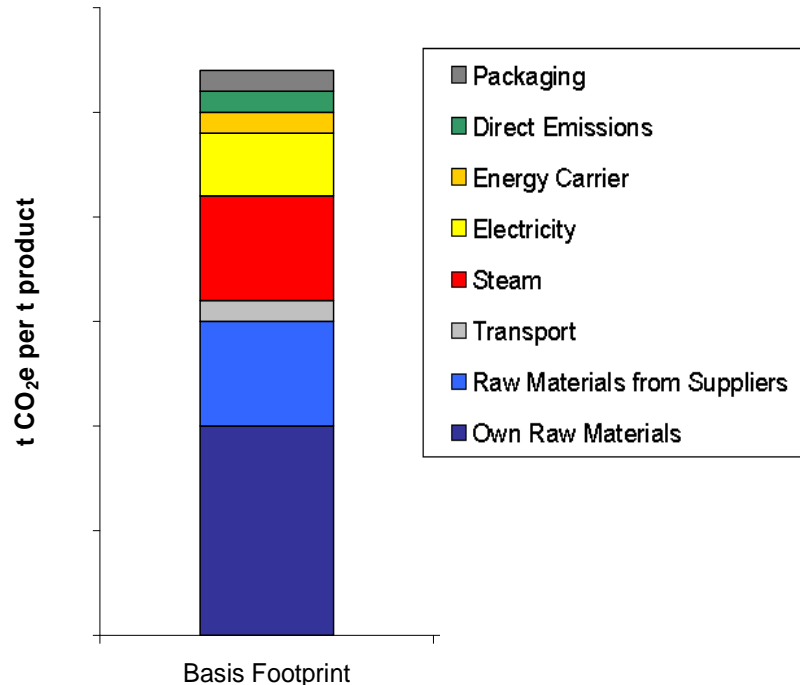
The Climate Footprint[®]

- is based on the Life Cycle Analysis method.
- covers the elements a product supplier could influence.
- summarizes direct emissions and emissions caused by energy consumption, raw materials and transport.



The Climate Footprint[®] visualizes different contributions

The Climate Footprint[®] visualizes individual climate impact and different contributions.



The Climate Footprint[®] is certified by TÜV Süd.

Carbon footprints are in public discussion.



Examples for Carbon Footprints

E. LECLERC WATTELOIS
POINT ACCUEIL
TEL : 03 20 20 99 99
BONJOUR,

Caisse 0464070 le 04/10/2008 17:08
Titre: 13/04/08 0 1547 05000

* BLANC DE POULE	1.54
* SAUCISSES	1.39
* NOUVEAU MARI	2.50
* CACAO	1.43
* MONTARBE	1.32
* POUR LES PROMISES	1.40
* MONTARBE CUIRE	1.20
* COGNAC CHATEAU	11.30
* MONTARBE	1.30

Total 4 articles	24.12
Sur en taxe: 150.22	(1 non-4.5000 taxes)

Expans	24.12
Mont	0

MERCI
DE VOTRE CONFIANCE
A BIEN TOT !

Le bilan CO₂ de mes courses est de :
13,28 kg eq CO₂⁽¹⁾

Plus le chiffre est faible, mieux c'est pour ma planète !!
Pour en savoir plus, rendez-vous sur le site de l'entreprise ou sur www.lesconomistesoplamete.fr

(1) Ce chiffre correspond au total des émissions de gaz à effet de serre en équivalent CO₂ des produits inclus par vos achats. Voir le bilan de vos achats.

*HARICOT VERT EXTRA FIN 440GR

0.440 KG 2.84 €/KG

0,778 kg eq CO₂

3017800048221

↑

1 € 25

CARBON LABELS

These labels will soon be on products to help customers select goods produced in a climate-friendly process. The figure shows the amount of carbon dioxide reduction. The higher the figure, the greater the reduction.

Source: Thailand Greenhouse Gas Management Organisation P&E Graphics

Carino et la planète

Une vraie relation durable

L'Indice Carbone Carino

La démarche L'indice carbone Comprendre les étiquettes Les produits concernés

COMPRENDRE LES ETIQUETTES

Proches à la marque Carino, les indicateurs et l'étiquetage des produits répondent à un souci de transparence et d'optimisation de leur impact sur l'environnement. Nous vous expliquons ici comment bien lire ces étiquettes, afin d'opérer le meilleur choix pour notre planète.

Cliquez sur l'un des éléments pour en découvrir la signification <<<<

Pour le mieux en place de cet étiquetage, Carino s'engage à travailler sur la réduction de l'indice Carbone de ses produits, car des optimisations sont toujours possibles : perfectionnement des procédés de production, modernisation du parc automobile, utilisation d'énergies renouvelables, etc.

Dans les années à venir, Carino continuera donc à travailler sur toutes ces pistes d'optimisation, afin de réduire l'impact environnemental de ses produits de sa marque pour le bien-être de la planète.

Accueil • Nos engagements • L'Indice Carbone Carino • Nos gammes • Les Eco-gamtes • Le glossaire vert eco-citoyennet

INDICE CARBONE

55g de CO₂

voir au dos

L'INDICE CARBONE de ce produit

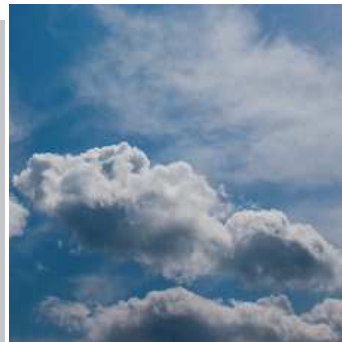
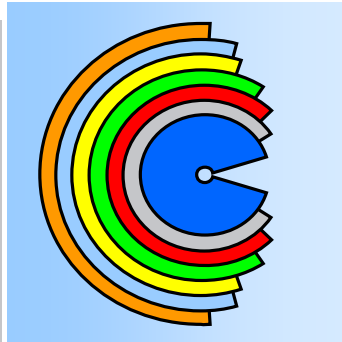
210g

Faible Impact environnemental Fort Impact environnemental

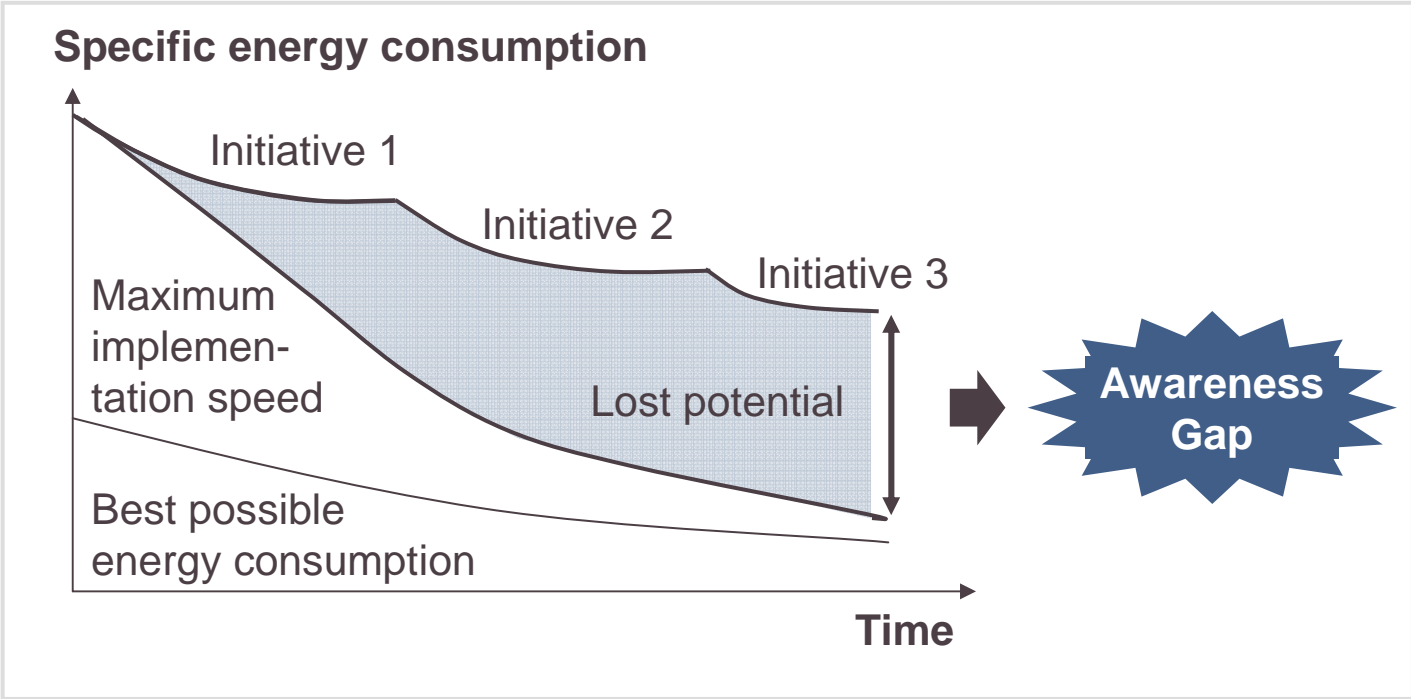
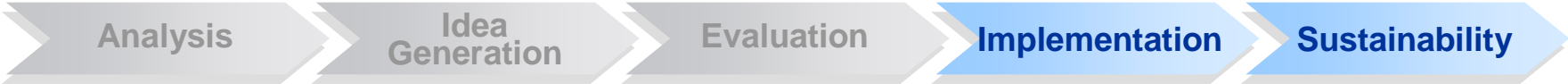
Plus d'informations : www.produits-casino.fr ou SERVICE CONSOMMATEURS

Agenda

- Introduction
- Energy Efficiency Check
- Climate Footprint[®]
- Energy Efficiency Management



Closing the awareness gap is a challenge



Individual energy savings initiatives cannot sustain a high awareness level over time.

Improvement of energy efficiency is achieved by optimized design and optimized operation

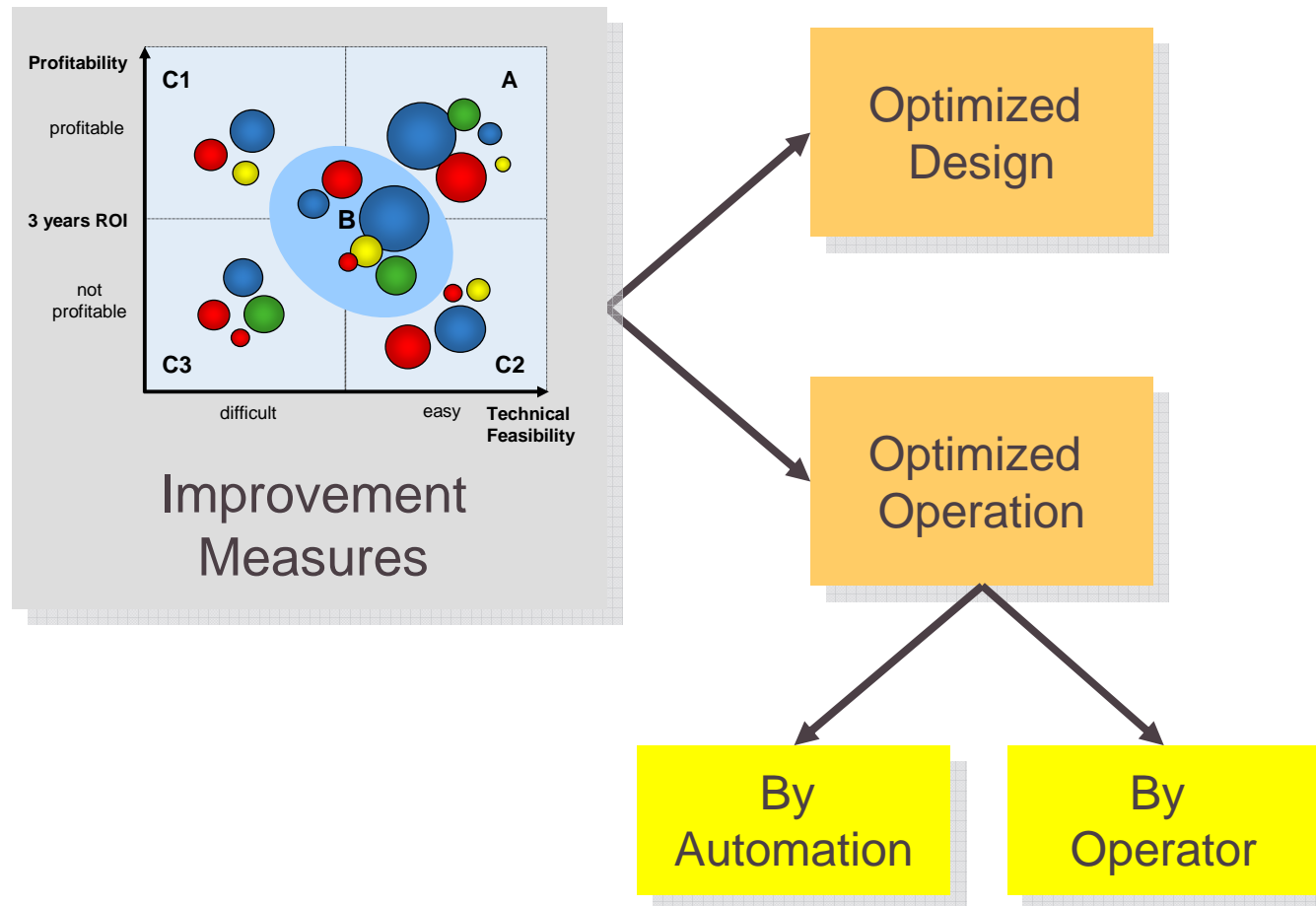
Analysis

Idea
Generation

Evaluation

Implementation

Sustainability



Energy efficiency management comprises four elements



Four elements for sustainable implementation of energy efficiency:

Improvement Plan

Improvement plan to manage implementation of design measures (capex projects).

Monitoring

Monitoring (e.g. online) to visualize the status of a plant.
→ Ability to change

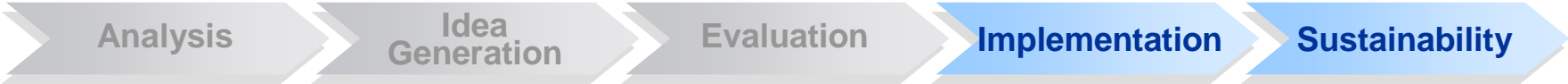
Target Setting

Reporting, target setting and responsibilities to motivate to leave the „comfort zone“. → Motivation to change

Cultural Change

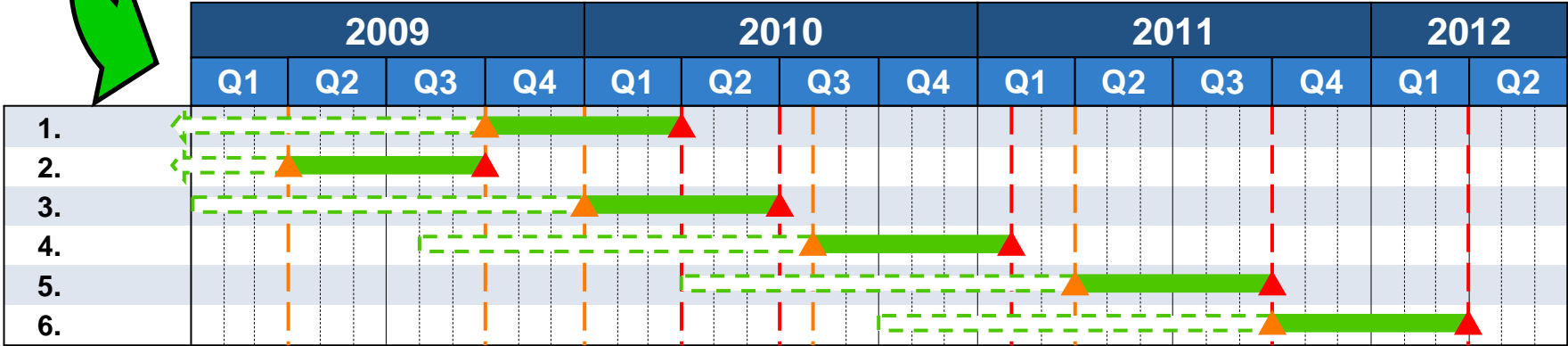
Cultural Change to increase awareness for energy-conscious behavior and mindset. → Awareness to change

To ensure implementation of design measures an improvement plan need to be managed



Elaboration and implementation need to be managed!

Bayer Technology Services									
Update		Jump to selected Sheet		Euro BMS		Change		Improvement Plan	
Compact		Add new Project Sheet		Enumerate		Change			
Active?	Project No.	Title	Unit/AKZ	Rating	Cost Saving Potential AP	Total Investment	Payback Time	Loss Code	Lead Responsible
	1			A	7866,00	not calculated	not calculated	Op Par	Triebeneck
	1b			A	51863,37	not calculated	not calculated	Op Par	de Bruyne
Y	2			C2	1242423,00	5500000	4,43	Eq large	Wuytack
Y	3			C2	166142,59	927500	5,58	Eq large	anden Eynde/Trieben
Y	4			-	0,00	0	not calculated	---	Triebeneck
Y	5			B	35961,60	0	0,00	Op Par	Kahnis
Y	6			-	0,00	not calculated	not calculated	---	-> Project 1
Y	7			A	8035,17	5000	0,62	Op Par	Kahnis/Heylen
Y	8			B	100623,20	10	0,00	Op Par	Kahnis/Braun



- ▲ Start of construction work
- ▲ Completion of project
- Budget decision, detail planning, equipment ordering, work preparation
- █ Construction work in the plant

More efficient operation requires transparency

Analysis

Idea
Generation

Evaluation

Implementation

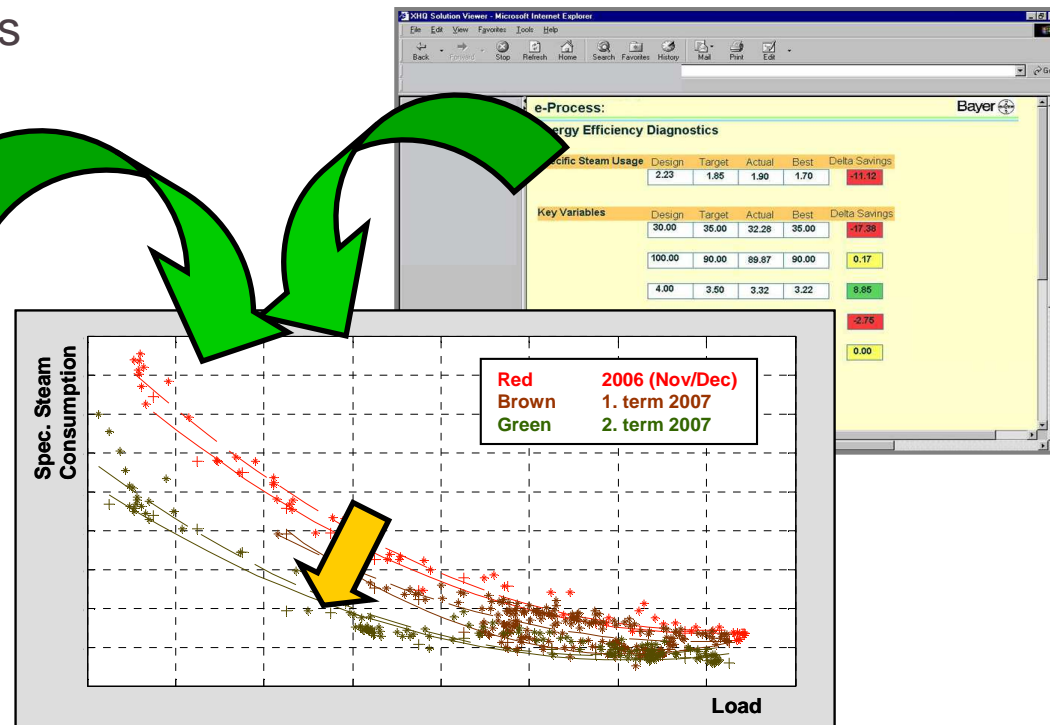
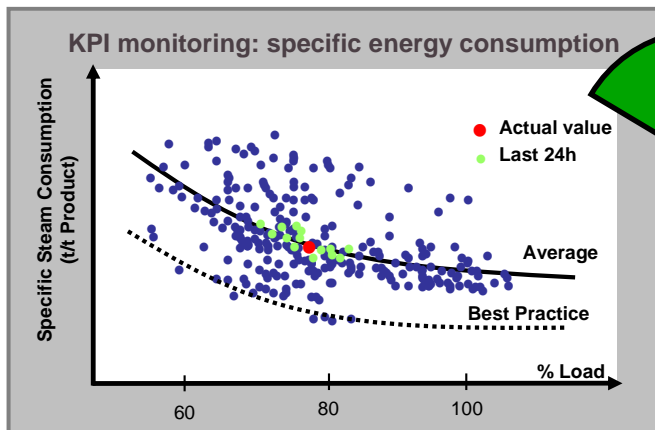
Sustainability

First requirement for more efficient operation is:

Ability to change

- Create Transparency
- Let the operator know in which status the plant is
- Visualize energy influencing operating parameters (target vs. actual)
- Define and visualize KPIs

Monitoring



More efficient operation means motivating the operator to leave the “comfort zone”

Analysis

Idea
Generation

Evaluation

Implementation

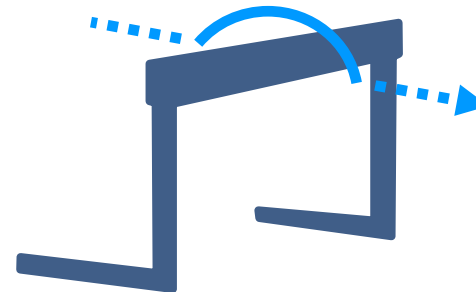
Sustainability

Second requirement for more efficient operation is:

Motivation to change

- Motivate / force the operator to leave the „comfort zone“
- Set targets and track results
- Ensure daily reminding and reporting, e.g. in shift meeting
- Define responsibilities and reporting structure
- Give clear leadership commitment
- Give incentives for targets achievement

Target Setting



Cultural Change increases awareness for energy-conscious behavior and mindset



Third requirement for more efficient operation is:

Motivation to change

Goal: **Stimulate awareness and mindset of employees regarding energy-conscious behavior**

Cultural Change

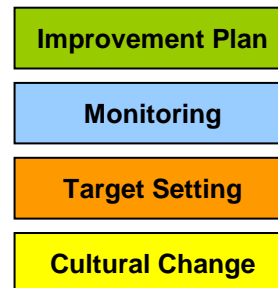
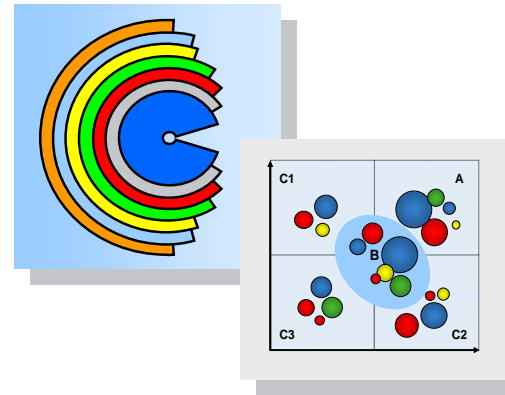
- Give commitment of upper management
- Train employees, e.g. best practice, guidelines, SOPs, maintenance plans
- Give examples for model type behavior, e.g. “turn it off if not needed”
- “Translate” savings into understandable figures
- Improve cost awareness
- Create an internal climate change / energy efficiency award



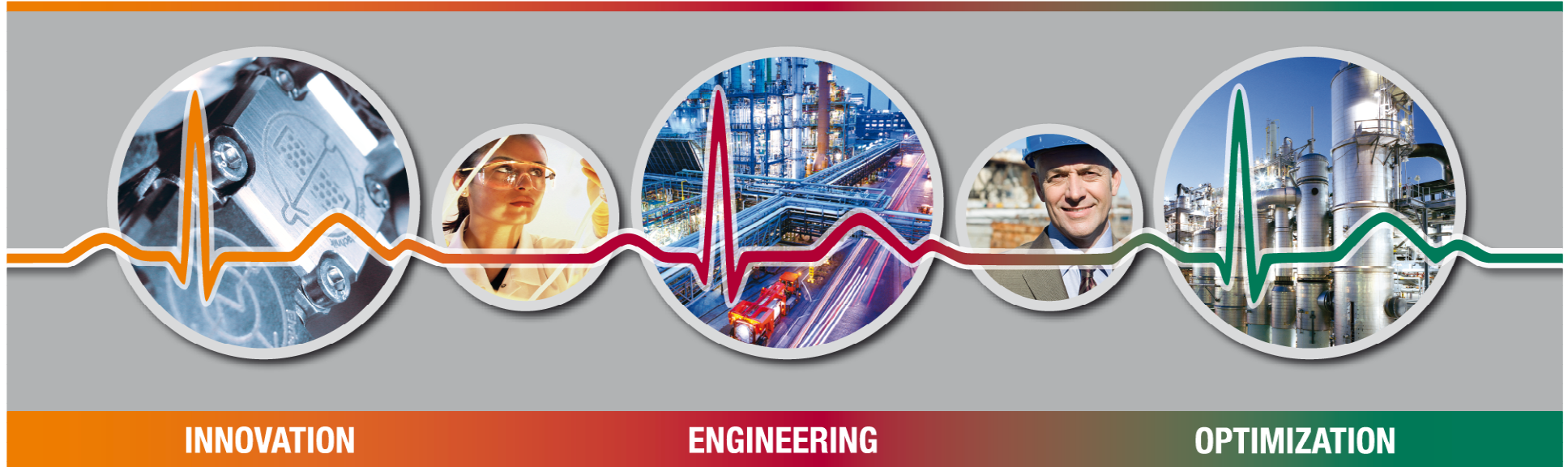
Conclusion

Sustainable energy and climate efficiency requires...

- an indicator to determine the climate impact
- a comprehensive identification of measures for energy & CO₂ emission reduction
- and an integrated energy management approach



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