BEST-IN-CLASS CAPEX OPTIMIZATION

Service offerings – invest cost & CapEx-associated CO_2e reduction

EFESO
MANAGEMENT CONSULTANTS

OPERATIONS
INSIGHT

How to maximize investment value by stepping-up to best-in-class CapEx optimization

Global organizations say cutting costs is a priority… yet they're failing to use the levers right in front of them

Across all industries and globally, hundreds of billions of Euros are spent each year on new production technologies and facilities.

Entering new product segments, meeting net zero carbon footprint requirements and securing supply chains require significant capital investments (CapEx) in production equipment and facilities, all of which are vitally important to improve the competitiveness and future positioning of firms.

And, with the global economy set for a significant reset while the world grapples with the significant increase in financing costs, embarking on 'cost out' projects has become an essential activity in order to survive.

But how can capital investments be defined using a 'best practice' target-costing approach, while also being achieved in a sustainable manner?

We deliver performance. At speed…

We create opportunity from complexity. Yes, cost optimisation is complicated, but it also offers clear opportunities to increase margins, gain new product insights and unleash innovation.

We deploy our extensive experience and knowledge to help organisations, across many different sectors, understand exactly which levers they need to focus on, in order to be as effective as possible.

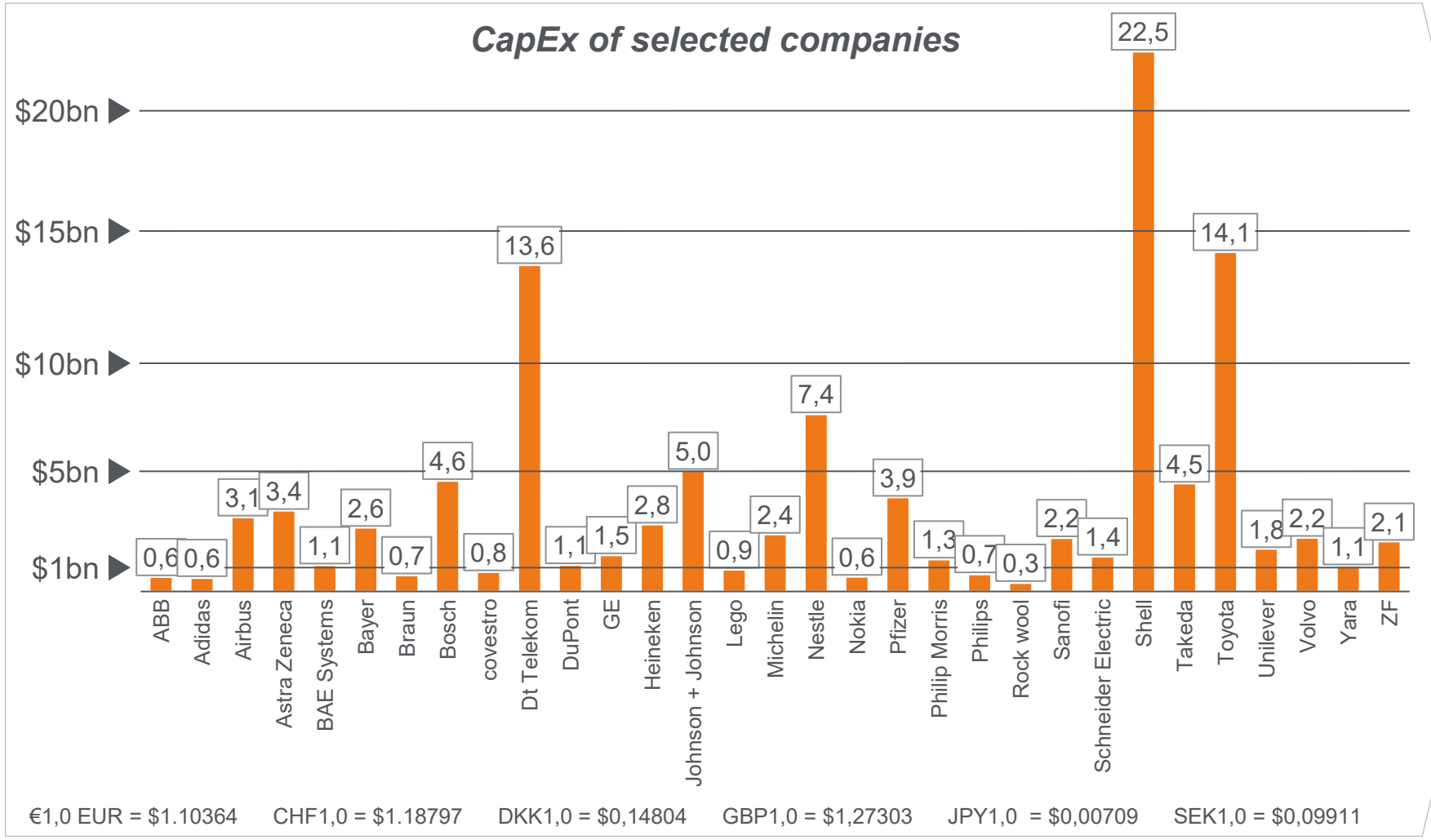
Having completed hundreds of investment cost optimization projects, we know that there's a clear, well-defined formula for success. The following slides illustrate our rigorous approach to optimizing costs of capital goods (CapEx) for production.

If you're looking to make significant savings in your capital goods spending, we can definitely help…

Holger Peterkord
Senior Principal

Roger Ryf
Principal

Increasing capital expenditures for transformational activities, and rising interest rates, are hurting cash flow and profitability



EFESO insight

- **Companies** have to make **significant investments**, driven by **transformations** such as **digitization**, **net zero regulations** and **electrification**
- **Financing costs have increased +185%* and are expected to remain at a high level**

→ **'Money' is becoming scarcer** and the pressure on investment projects is increasing

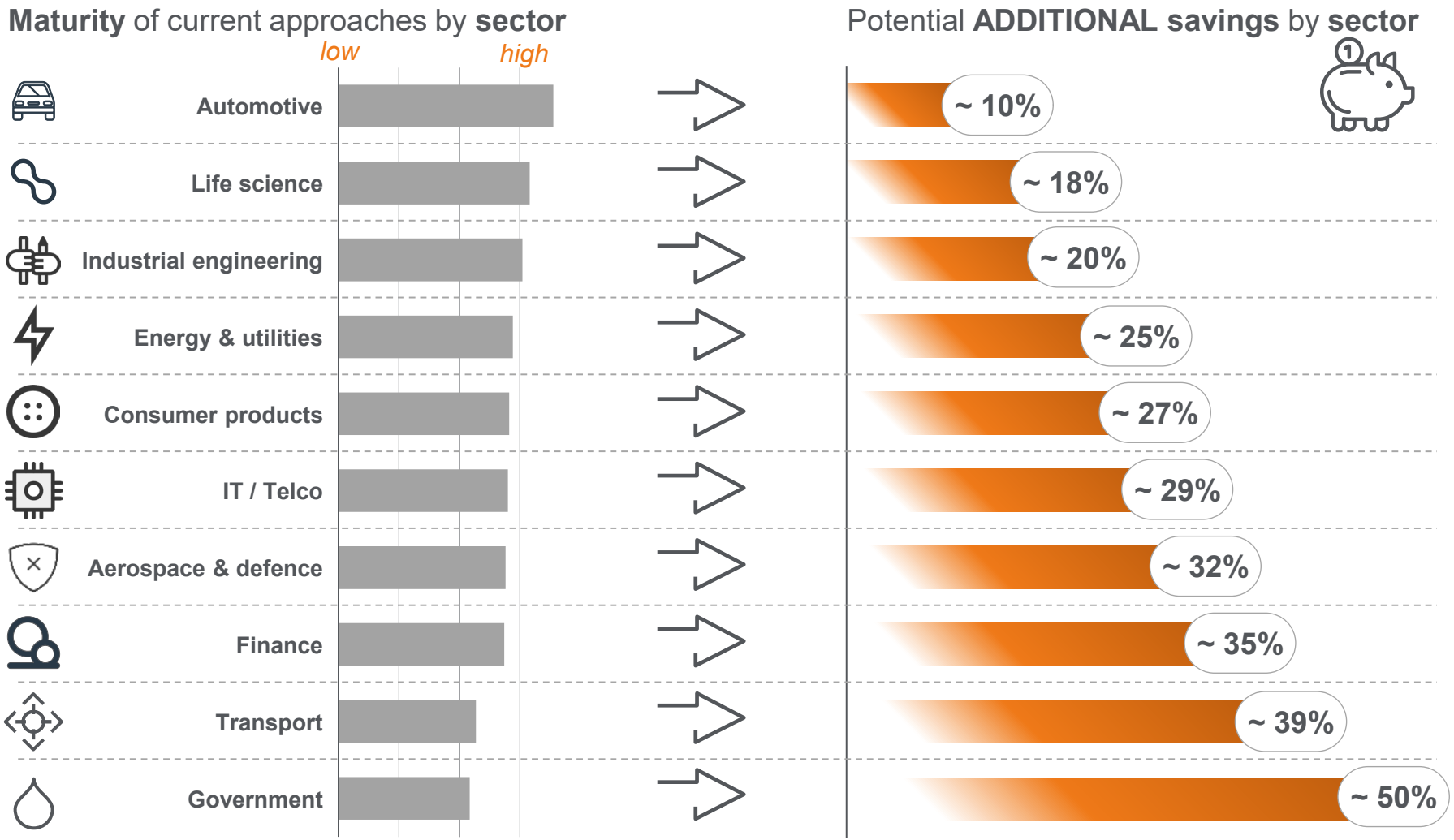
Source: EFESO research, annual reports; *ECB: European Central Bank - cost of borrowing for corporations in Euro area 02/22 vs 12/23: 1.83% to 5.22% p.a.= 185% increase

Our benchmarks show: there are opportunities to reduce CapEx and save cash

Our research shows that there are substantial, unexploited cost savings opportunities in all sectors, with some amounting to as much as 30 to 50 percent of outlay.

Our graphic shows how the various sectors are performing.

The potential savings that can be achieved by installing a best-in-class approach are easily demonstrated in our client case studies.



Source: EFESO research & analysis

Increasing innovation, along with growing technological breadth and complexity, represent both an enormous challenge for procurement, and a key success factor

Drivers

- Globalization
- New markets
- Innovation
- Production at 'low cost' locations
- R&D in 'best cost countries'
- Productivity
- Economic efficiency
- New technologies
- Sustainability (ESG)
- Energy efficiency
- Transportation costs

CAPITAL GOODS

Challenges

- Worldwide procurement
- Specific local requirements
- Legal requirements
- Trade impediments (pandemic, war, etc.)
- Complexity & range of technologies to be covered
- Knowledge of the procurement market
- Creation of the necessary cost transparency
- Limited financial possibilities (rising costs of credit financing)

We cover all capital expenditures on the balance sheet: property, plant & equipment (PPE)

Buildings

- Civil engineering
- Land development
- Site preparation
- Foundations
- Roads
- Parking areas
- Buildings
- etc.

Technical building services

- Heating, ventilation & air conditioning
- Fire protection
- Low voltage system
- Communication and IT networks
- Building automation
- etc.

Material handling

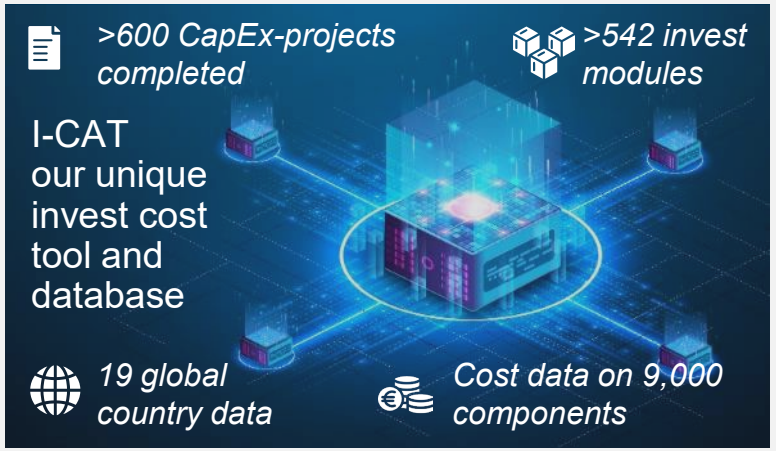
- Overhead conveyors (EMS, P&F)
- Floor conveyors (chain, roller, slat, skillet, etc.)
- Automatic guided vehicles
- Automatic storage & retrieval systems
- etc.

Machinery & equipment

- Machine tools
- Assembly lines
- Heat and surface treatment facilities
- Test benches
- Tooling
- Process equipment (piping, columns, tanks, pumps, etc.)
- etc.

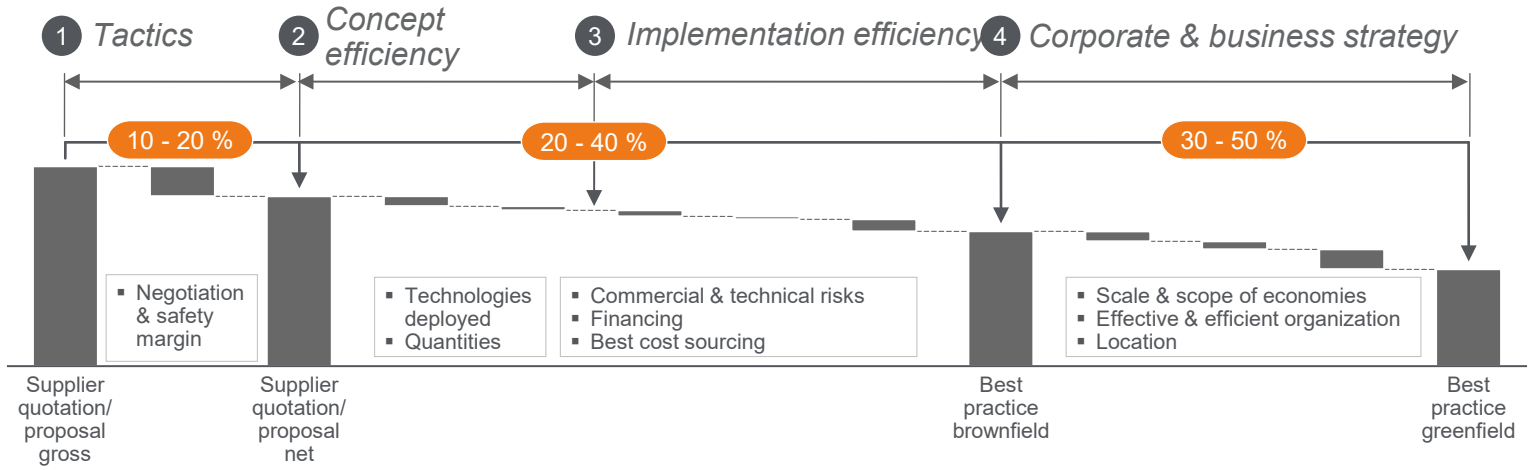
Using our unique ‘invest cost’ tool, database and approach can help significantly reduce CapEx outlay

What makes us unique?



- The world’s largest CapEx database, covering key industry sectors
- Analysis and optimization of work breakdown E2E, based on specifications and/or supplier quotes
- Our technical cost-analysis capability can address a single invest item, a production line, or entire factory sites

Outlining saving opportunities



A prime candidate for optimization…

PROJECT EXAMPLE

New unique 30 MW test bench for gearboxes, to simulate torque and non-torque loads:

- Deep understanding of technical & commercial cost drivers
- Structured and detailed workshops with suppliers and manufacturing engineering
- Total Cost evaluation, based on simulation and comparison of water & energy consumption over the life cycle, to compare different supplier concepts
- Collaboration between purchasing, manufacturing engineering and EFESO team

-10% CapEx cost reduction
-12% reduced power & water consumption over lifetime

CapEx: Capital Expenditure; E2E: End-to-End

Totally integrated procurement of machinery & equipment provides lowest cost for both the buyer and to the environment

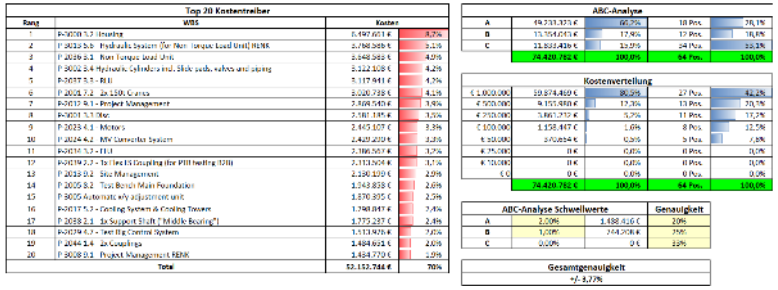
Sustainable approach to balance CapEx and OpEx

CapEx (Capital expenditures)

EFESO's

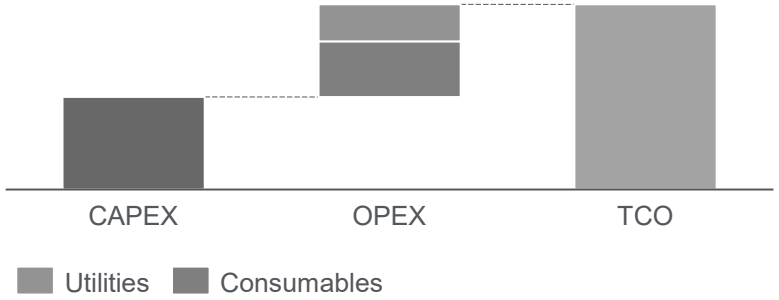
Invest costing & analysis tool (I-CAT) advanced edition

I-CAT ADV R2.41



TCO (total cost of ownership)

- Concept as well as processes and technologies, determine cost, utilities and consumables as well as CO_2e emissions
- As a result, these interdependencies must be balanced so as to minimize cost for both buyer and to the environment

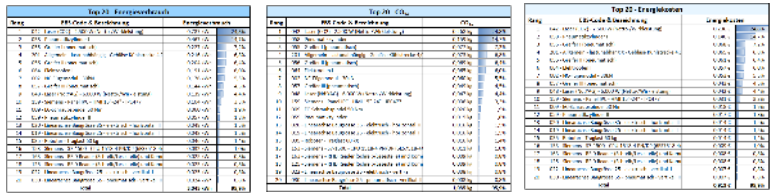


OpEx (operating expenses)

EFESO's

CO_2e calculation & analysis tool (C-CAT) advanced edition

C-CAT ADV R1.00



I-CAT and C-CAT enable and facilitate sustainable procurement of machinery & equipment, minimizing the cost of ownership and externalities.

The scope and benefits of EFESO's tools & database, as well as our process know-how

Tool & database

I-CAT

- Proprietary cost calculation tool
- Calculation tool incl.
  - › RBS-Analysis
  - › WBS-Analysis
  - › CSP-Analysis
  - › Per diem-rate calculation
  - › Machine-rate calculation
  - › Fabrication-cost calculation
  - › etc.

No. of data sets

- 542 pcs. complete data sets incl. material & labor
- With these data sets, machinery & equipment can easily be configured, rather than calculated
- Includes 1.700 pcs. single component cost data
- Cost data inquired every 3 years (adjusted for annual inflation)

No. of single comp. cost data

- 9.113 pcs. single component cost data
- These include cost for machine tools, robots, mechanical, pneumatic and electrical components as well as complete systems
- Cost data inflated annually, based on a composite index
- Random sample of price level for selected items

Country Data

- 19 pcs. country data (hourly rates)
- This data includes hourly rates for 18 different qualifications, i.e., 342 pcs. hourly rates in total for the calculation of the value added
- Labor cost data researched every 3 years (adjusted for annual inflation)

Process

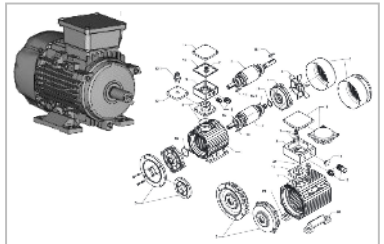
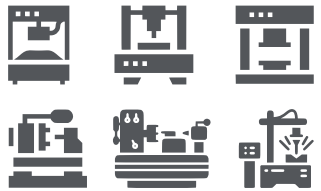
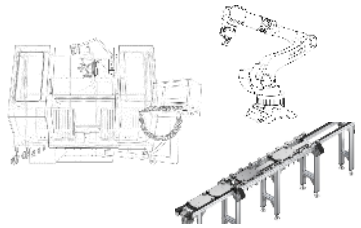
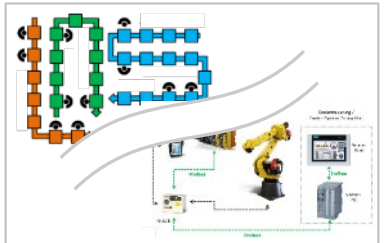
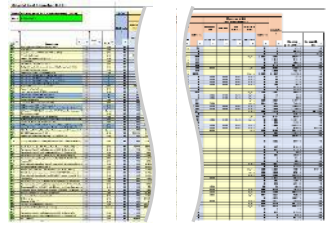
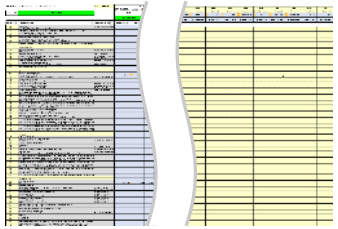
EFESO provides end-to-end processes for both business and CapEx procurement processes:

Business process	Initial investment kick-off	Develop / define technical documentation	Verification of specification	Request for quotation	Conduct CE evaluation	Alignment with prod. plann-ing and purchase	Cost workshop	Negotiation	Appro-val
CapEx procurement process	Demand management	Technical concept optimization	Specification & RFQ optimization	Cost calculation	Cost savings potential analysis	Cost workshop	Negotiation		
	▪ Minimized capital intensity ▪ Maximized capacity utilization	▪ Optimized degree of automation ▪ Best practice processes ▪ OpEx and CapEx balance	▪ Overengineering avoided ▪ Requirements facilitate broad supplier base ▪ KPI-based requirements	▪ Best practice cost estimate ▪ Optimized sourcing concept	▪ Gaps between supplier quotation and best prac-tice estimate identified ▪ Cost reduction measures and levers identified	▪ Validation and verification of best practice process & estimate ▪ Supplier aware of potentials	▪ Story & play book as well as tactics prepared ▪ Prices and terms & conditions negotiated		

RBS: Resource Breakdown Structure; WBS: Work Breakdown Structure; M&E: Machinery & Equipment; CSP: Cost Savings Potential; I-CAT: Invest Costing and Analysis Tool; RFQ: Request for Quotation

Our six-step approach to developing an effective & efficient manufacturing line to achieve best total cost

MANUFACTURING ENGINEERING | COST ENGINEERING

	Product	Process	Equipment	Manufacturing line design	Costing of special equipment	Costing of manufacturing line
Activities						
	▪ The product is stripped down to component level ▪ A Bill of Materials (BoM) is built up	The manufacturing process for each component is defined, including: ▪ Material handling ▪ Tool handling ▪ Manufacturing process & tools	The required equipment for each process is determined & specified, including: ▪ Material handling ▪ Tool handling ▪ Manufacturing process ▪ Transfer system ▪ Controls system	▪ The manufacturing line is designed, based on the major equipment list, as well as the process requirements ▪ The controls architecture is designed, based on the line design and SCADA requirements	▪ The major equipment list is screened for special equipment that is not readily available in database ▪ Special & auxiliary equipment is calculated in detail, using I-CAT	▪ Project overheads, freight, training, documentation, plus project financing, are calculated using I-CAT ▪ Definition of commercial boundary conditions ▪ Unit cost data is merged with equipment quantities in I-CAT
Output	▪ A Bill of Materials (BoM) is generated	▪ Specifications of all processes required to manufacture each component are defined ▪ The cycle time for each process is estimated/ calculated	▪ Major equipment list for entire manufacturing line is available ▪ Major equipment is specified, with design specifications & performance requirements	▪ Manufacturing line designed and equipment defined ▪ Controls architecture is designed and required equipment defined ▪ Tact time calculated/ defined & line balanced	▪ Cost data for each item on the major equipment list, as well as for auxiliary equipment, is established	▪ Total cost for manufacturing line and implementation project is established

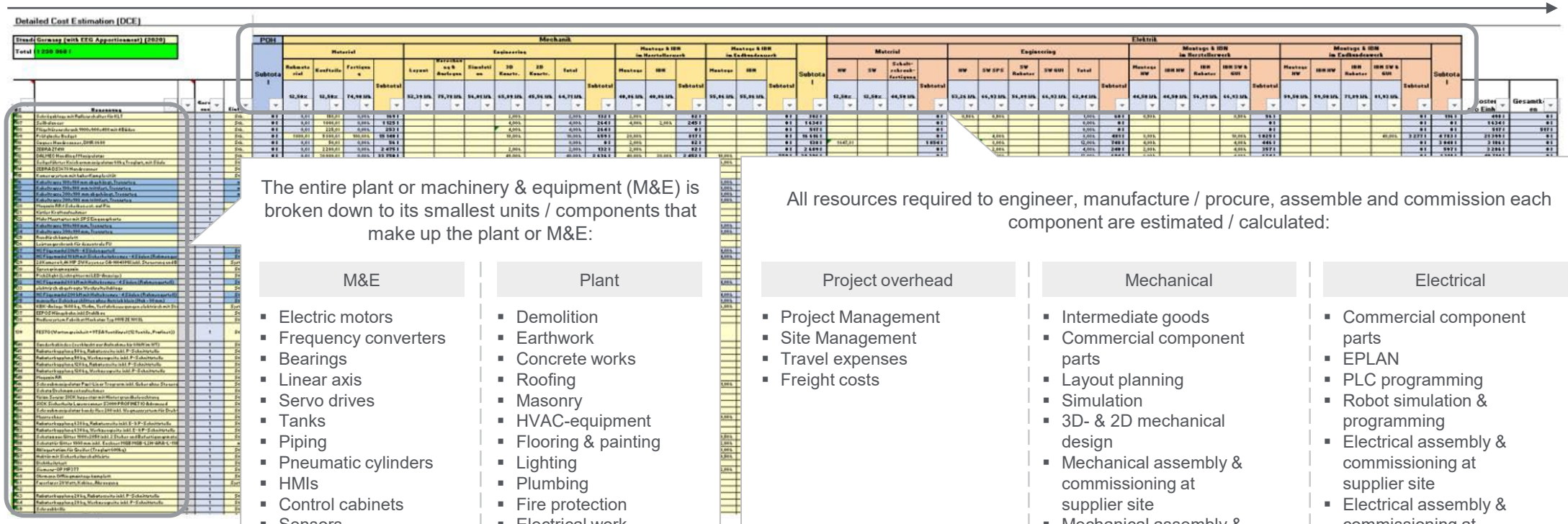
I-CAT: Invest Costing & Analysis Tool; SCADA: Supervisory Control and Data Acquisition

Cost estimation & calculation of deliverables – resources* required are estimated / calculated in the resource breakdown structure (RBS)

WBS – RBS matrix to estimate / calculate required material & labor

Resource breakdown structure (RBS) – resources required to manufacture / render products / services

Work breakdown structure (WBS) – project deliverables (products & services)



The entire plant or machinery & equipment (M&E) is broken down to its smallest units / components that make up the plant or M&E:

M&E

- Electric motors
- Frequency converters
- Bearings
- Linear axis
- Servo drives
- Tanks
- Piping
- Pneumatic cylinders
- HMIs
- Control cabinets
- Sensors
- Structural steelwork
- Base frames
- etc.

Plant

- Demolition
- Earthwork
- Concrete works
- Roofing
- Masonry
- HVAC-equipment
- Flooring & painting
- Lighting
- Plumbing
- Fire protection
- Electrical work
- Paving
- Fencing
- etc.

All resources required to engineer, manufacture / procure, assemble and commission each component are estimated / calculated:

Project overhead

- Project Management
- Site Management
- Travel expenses
- Freight costs

Mechanical

- Intermediate goods
- Commercial component parts
- Layout planning
- Simulation
- 3D- & 2D mechanical design
- Mechanical assembly & commissioning at supplier site
- Mechanical assembly & commissioning at customer site
- Production ramp-up

Electrical

- Commercial component parts
- EPLAN
- PLC programming
- Robot simulation & programming
- Electrical assembly & commissioning at supplier site
- Electrical assembly & commissioning at customer site
- Production ramp-up

*Resources include labor and material for both mechanical & electrical engineering, manufacturing, assembly, and commissioning as well as project overhead

With cost structure analysis, the primary cost drivers, in terms of both resources and deliverables, can be clearly identified

Resource breakdown structure (RBS)

			Zukauf	Leistung	Rate	Kosten					
POH	POH	Zukauf	[illegible]		12,90%	[illegible]	[illegible]	216 352 €	17,6%	216 352 €	17,6%
		PL		1 298 h	88,44 €/h	[illegible]	9,3%				
		PI		294 h	77,45 €/h	[illegible]	1,9%				
Mechanik	Material	Rohmaterial	8 940 €		12,90%	10 102 €	0,8%	528 160 €	42,9%	623 985 €	50,7%
		Kaufteile	444 950 €		12,90%	502 568 €	40,7%				
		Fertigung		234 h	74,90 €/h	17 490 €	1,4%				
	Engineering	Layout		0 h	52,39 €/h	0 €	0,0%	60 306 €	4,9%		
		Berechnung & Auslegung		48 h	75,76 €/h	3 637 €	0,3%				
		Simulation		160 h	56,01 €/h	8 962 €	0,7%				
		3D Konstr.		724 h	65,89 €/h	47 707 €	3,9%				
		2D Konstr.		0 h	45,55 €/h	0 €	0,0%				
	Montage & IBN im Herstellerwerk	Montage		572 h	40,86 €/h	23 372 €	1,9%	28 480 €	2,3%		
		IBN		125 h	40,86 €/h	5 108 €	0,4%				
	Montage & IBN im Endkundenwerk	Montage		90 h	55,86 €/h	5 027 €	0,4%	7 038 €	0,6%		
		IBN		36 h	55,86 €/h	2 011 €	0,2%				
Elektrik	Material	HW	154 457 €		12,90%	175 764 €	14,1%	205 764 €	16,6%	390 524 €	31,7%
		SW	20 180 €		12,90%	22 708 €	1,8%				
		Schaltschrankfertigung		164 h	44,50 €/h	7 298 €	0,6%				
	Engineering	HW		269 h	58,76 €/h	[illegible]	1,3%	82 808 €	6,7%		
		SW SPS		788 h	66,44 €/h	52 348 €	4,3%				
		SW Roboter		256 h	56,49 €/h	14 561 €	1,2%				
		SW GUI		0 h	66,93 €/h	0 €	0,0%				
	Montage & IBN im Herstellerwerk	Montage HW		619 h	44,50 €/h	27 546 €	2,2%	90 380 €	7,3%		
		IBN HW		66 h	44,50 €/h	2 937 €	0,2%				
		IBN Roboter		324 h	56,89 €/h	18 433 €	1,5%				
		IBN SW & GUI		620 h	66,93 €/h	41 465 €	3,4%				
	Montage & IBN im Endkundenwerk	Montage HW		40 h	59,50 €/h	2 380 €	0,2%	[illegible]	1,1%		
		IBN HW		0 h	59,50 €/h	0 €	0,0%				
		IBN Roboter		64 h	71,89 €/h	4 601 €	0,4%				
		IBN SW & GUI		83 h	81,95 €/h	6 800 €	0,6%				
Total			698 967 €	6 887 h	64,96 €/h	1 230 960 €	100,0%	1 230 960 €	100,0%	1 230 960 €	100,0%

Funktion	Kosten	
PM	216 352 €	17,6%
Engineering	[illegible]	11,6%
Material	[illegible]	[illegible]
Montage & IBN im HSW	118 860 €	9,7%
Montage & IBN im EKW	20 820 €	1,7%
Total	1 230 960 €	100,0%

Disziplin	Kosten	
PM	216 352 €	17,6%
Mechanik	623 985 €	50,7%
Elektrik	390 524 €	31,7%
Total	1 230 960 €	100,0%

Value Added	
Verkaufspreis/Vollkosten	1 230 960 €
Zukaufkosten	698 967 €
	531 993 €
	43,2%

RBS analysis

- Validation & verification of project cost
- Identification of cost drivers, in terms of resources, functions, and disciplines
- Sensitivity analysis, pertaining to hourly rates & markups

Work breakdown structure (WBS)

Top 20 Kostentreiber			
Rang	WBS	Kosten	
1	POH1 Projektmanagement & Bauleitung	206 085 €	16,7%
2	328 Schraubspindel Bosch BG2, Gerade 1,2-10 Nm, inkl. Haltekonsole und Einzel	125 768 €	10,2%
3	Roboter 5 Stäubli - TX2-90 mit Steuerung CS9, ESD, 6 Achsen	111 869 €	9,1%
4	006 Projektmodul Automatikmodul	95 334 €	7,7%
5	040 Bosch Transfersystem TS2	90 523 €	7,4%
6	007 Schaltschrank für Voll- & Halbautomatik - Stationen	84 983 €	6,9%
7	320 NC Fügemodul 20kN - C Pressengestell	77 329 €	6,3%
8	Roboter 2 Fanuc - SR3IA-30P-C-PN/3 - Scara	64 282 €	5,2%
9	281 Stöger Zange / Schraubenaufnahme bei Direkzuführung	59 789 €	4,9%
10	008 Bedienpult	46 975 €	3,8%
11	282 Stöger Zuführung 4- bzw. 5-fach	40 474 €	3,3%
12	260 Traystapler (Stapeleingabe Abstapeln Palette andienen leere Paetten stapeln	40 071 €	3,3%
13	294 3d Kamerasstem Fa. iDS	32 721 €	2,7%
14	286 2d Cognex Kamera 7802	22 011 €	1,8%
15	189 NC-Achse geführt mittel (Hub = 500 mm)	17 845 €	1,4%
16	188 NC-Achse geführt klein (Hub = 250 mm)	17 293 €	1,4%
17	253 stationärer DMC-Scanner, SR-2000 Keyence	15 601 €	1,3%
18	129 2d Kamera 0,46 MP SW Keyence CA H048MX inkl. Steuerung und Beleuchtu	14 355 €	1,2%
19	307 Kugelzuführung Schwerkraft	12 422 €	1,0%
20	POH2 Fracht & Verpackung	10 267 €	0,8%
Total		1 185 995 €	96%

ABC-Analyse				
A	856 172 €	69,6%	8 Pos.	26,7%
B	220 030 €	17,9%	5 Pos.	16,7%
C	154 758 €	12,6%	17 Pos.	56,7%
	1 230 960 €	100,0%	30 Pos.	100,0%

Kostenverteilung				
€ 1 000 000	0 €	0,0%	0 Pos.	0,0%
€ 500 000	0 €	0,0%	0 Pos.	0,0%
€ 250 000	0 €	0,0%	0 Pos.	0,0%
€ 100 000	443 722 €	36,0%	3 Pos.	10,0%
€ 50 000	472 239 €	38,4%	6 Pos.	20,0%
€ 25 000	160 241 €	13,0%	4 Pos.	13,3%
€ 10 000	109 793 €	8,9%	7 Pos.	23,3%
€ 0	44 965 €	3,7%	10 Pos.	33,3%
	1 230 960 €	100,0%	30 Pos.	100,0%

ABC-Analyse Schwellwerte			Genauigkeit
A	5,00%	61 548 €	10%
B	2,50%	30 774 €	25%
C	0,00%	0 €	50%

Gesamtgenauigkeit
4%

WBS analysis

- Identification of cost drivers
- Pareto-analysis to assess accuracy of total project cost
- Validation of costing approach

Our potential cost-savings calculations & competitiveness analysis allow the root causes of a lack of competitiveness to be easily identified

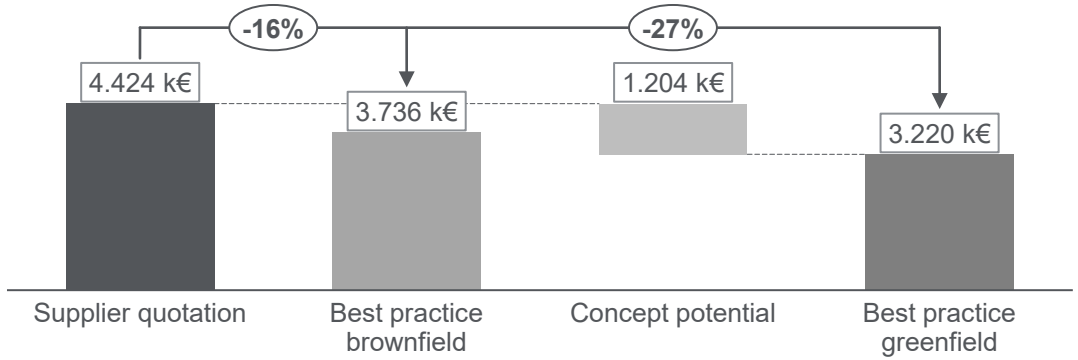
Deliverables that are not competitively priced

Cluster	Bezeichnung	Lieferant	TC	CSP	CSP	CSP-Rang
Total (EUR)		5.395.900	3.840.716	1.555.184	28,8%	
Main Line	CE-E Station 10 - VM Kühlerbaugruppe	162.500	50.508	111.992	68,9%	7
Main Line	CE-E Station 20 - Schrauben Kühlerbaugruppe	361.500	177.162	184.338	51,0%	2
Main Line	Station 10 - VM Deckel groß/ IO Verpackung	224.000	67.251	156.749	70,0%	4
Main Line	Station 16 - Back up Schraubplatz	0	34.104	-34.104	0,0%	98
Main Line	Station 30 - Schrauben Deckel groß	310.500	185.083	125.417	40,4%	5
Main Line	Station 50 - HAP Montage Flexfolien	117.000	46.675	70.325	60,1%	9
Main Line	Station 55 - Back up Schraubplatz Flexfolien	0	35.611	-35.611	0,0%	99
Main Line	Station 60 - Schrauben Stecker Flexfolien	198.000	147.591	50.409	25,5%	15
Main Line	Station 70 - Kolbenlöten Flexfolien	152.000	134.791	17.209	11,3%	20
Main Line	Station 90 - AOI	152.500	163.184	-10.684	-7,0%	91
Main Line	Station 100 - Auftragen Berührschutz	194.500	162.768	31.732	16,3%	19
Main Line	Station 120 - Dichtprüfung	96.667	38.477	58.190	60,2%	12
Main Line	Station 130 - Funktionsprüfung 1	96.667	46.335	50.332	52,1%	16
Main Line	Transfersystem & WT	484.000	471.355	12.645	2,6%	23
Main Line	Kommunikation	0	22.971	-22.971	0,0%	96

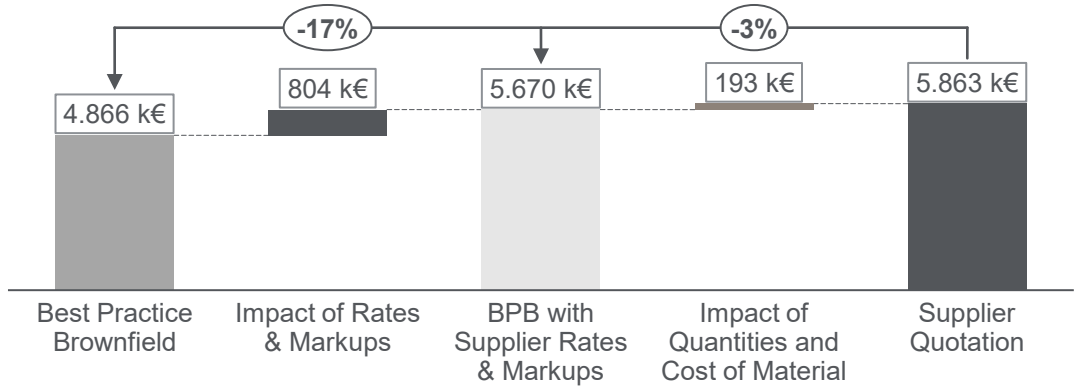
Result of the analysis

- Assessment of the competitiveness of the supplier in terms of company cost-level
- Assessment of the cost efficiency of the supplier's concept
- Identification of individual deliverables that are not competitively priced

Supplier concept not competitive / efficient



Company cost-level not competitive



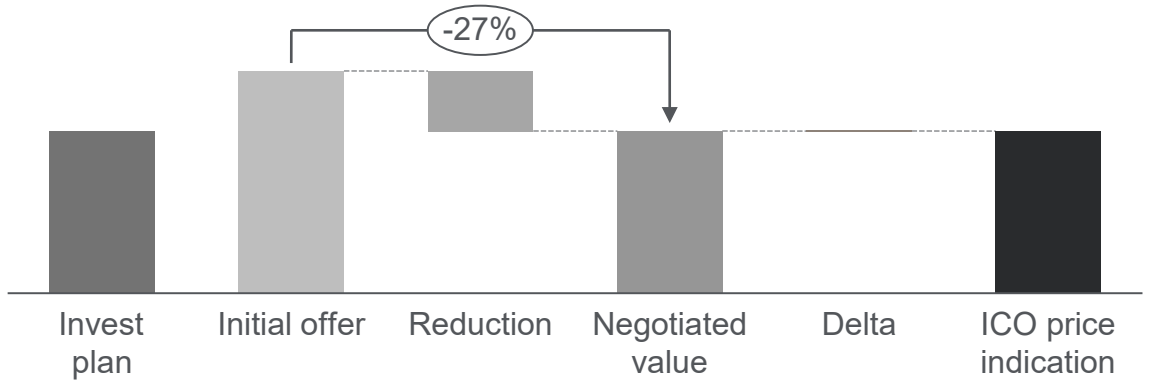
CSP: Cost Savings Potential; BPB: Best Practice Brownfield

Our ‘design-for-value’ approach led to savings of 27% for a cigarette packing line that needed to match a competitors’ price level

Description of Investment

- Description of CapEx project:
  - Cigarette packing line consisting of packer, wrapper and cartoner / over wrapper for 500 - 600 parts per minute
- Technologies deployed:
  - Controls & safety technology
  - Servo drives
  - Tooling
  - Material handling

Results (cost situation, in €m)



Approach

Demand management | **Specification & RFQ optimization** | **CSA invest** | **Quote & cost driver analysis** | Negotiation support | Claim manage-ment

- Lever details:
  - In-depth costing of commercial components, manufacturing, assembly, installation and commissioning, based on man-hour estimates for each task and hourly rates based on BCBM and BCCS
- CE Invest assessment methods applied:
  - Detailed calculation and bottom-up calculation at BOM level
  - Design & cost workshops, with purchasing, production and engineering

Success factors

- Success factors in the project:
  - Deep understanding of technical & commercial cost drivers and interrelationships
  - Detailed, intensive workshops
- Collaboration of all parties involved:
  - Purchasing
  - Manufacturing, Engineering and Production
  - Engineering

Source: EFESO; ICO: Invest Cost Optimization; CE: Cost Engineering; BCCS: Best-Cost Country Sourcing; BCBM: Best-Cost Business Model; BOM: Bill of Material

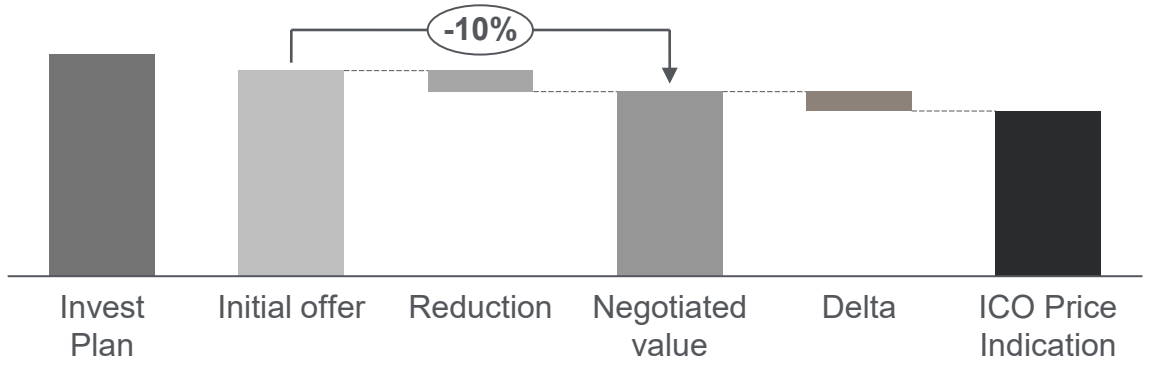
EXAMPLE

Our ‘best-cost’ concept for carbon-fiber materials filling equipment led to savings of 10% with a single source supplier

Description of investment

- Description of CapEx project:
  - Cigarette packing line consisting of packer, wrapper and cartoner / over wrapper for 500 - 600 parts per minute
- Technologies deployed:
  - Controls & safety technology
  - Servo drives
  - Tooling
  - Material handling

Results (cost situation in €m)



Approach

Demand management → **Specification & RFQ optimization** → **CSA invest** → **Quote & cost driver analysis** → **Negotiation support** → Claim manage-ment

- Lever details:
  - In-depth estimating manufacturing, assembly, installation and commissioning cost based on man-hour estimates for each task and hourly rates based on BCBM and BCCS
- CE Invest assessment methods applied:
  - Detailed calculation and bottom-up calculation
  - Cost workshops with suppliers and negotiation support

Success factors

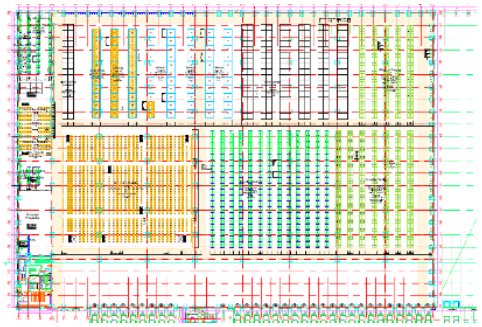
- Success factors in the project:
  - Deep understanding of technical & commercial cost drivers and interrelationships incl. supplier cost structure & level analysis
  - Detailed, intensive workshops with supplier
- Collaboration of involved parties:
  - Purchasing
  - Production planning / manufacturing engineering
  - Cost engineering

Source: EFESO; ICO: Invest Cost Optimization; CE: Cost Engineering; BCCS: Best-Cost Country Sourcing; BCBM: Best-Cost Business Model; BOM: Bill of Material

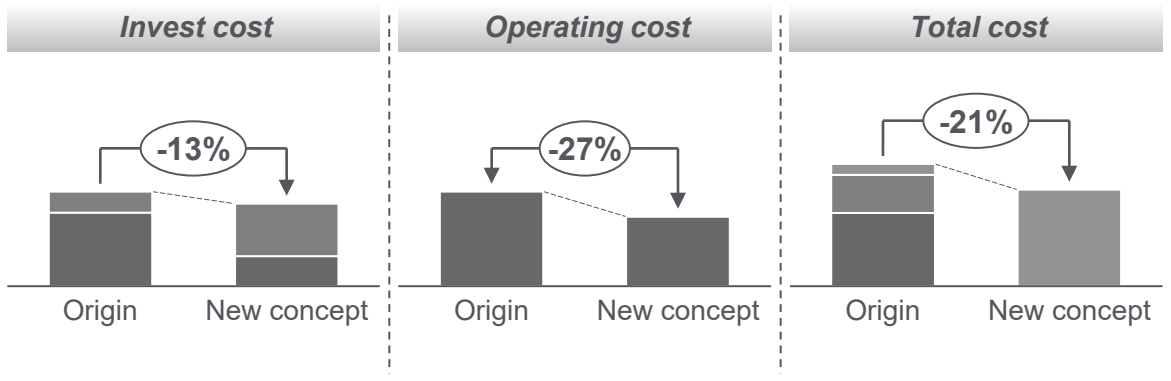
Our ‘total cost of ownership’ approach led to savings of 13% in CapEx, 27% in OpEx and 21% in total, respectively, for a spare-parts logistics center

Description of investment

- New logistics center for worldwide spare-parts supply
- Change from manual handling to semi-automated commissioning system *(from 'man to part' to 'part to man')*



Results (cost scenario in €m over a lifetime of 7 years)



Approach

Demand management | **Specification & RFQ optimization** | **CSA invest** | **Quote & cost driver analysis** | Negotiation support | Claim manage-ment

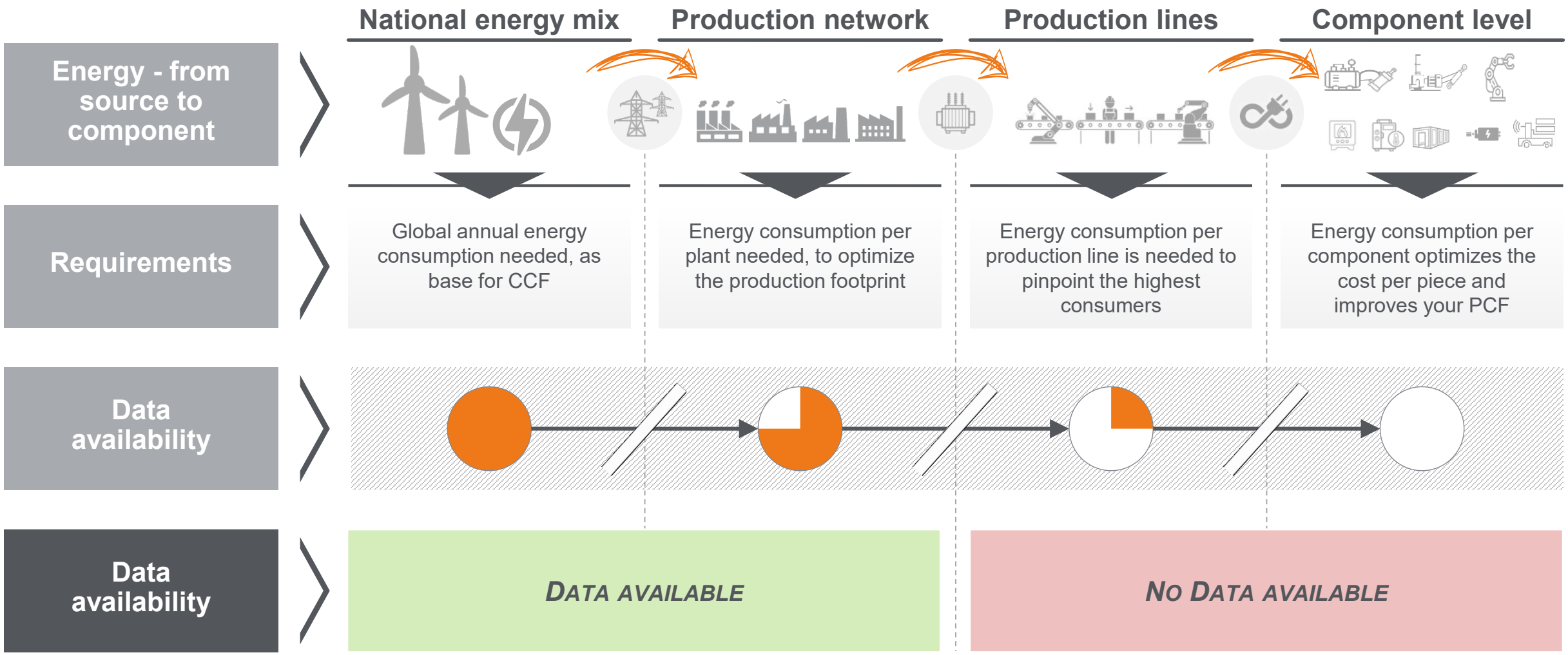
- Redesign of a complete warehouse system including total cost analysis:
  - › New automatic pallet system
  - › New box system for small parts
  - › Transport system for boxes and pallets
  - › Commissioning

Success factors

- Success factors in the project:
  - › Rationalization ideas developed by EFESO to optimize labor intensity and, finally, the total cost
  - › Market research on technical equipment
  - › EFESO’s special expertise
  - › Transparency on current cost situation

Source: EFESO

EFESO's analysis shows that transparency on energy consumption usually stops at plant level, missing out invaluable data from millions of production lines globally



CCF: Corporate-Carbon Footprint; PCF: Product-Carbon Footprint

We help our clients create transparency, and show the way forward to accurately establish footprints, from a single consumer all the way up to global production

EFESO capabilities

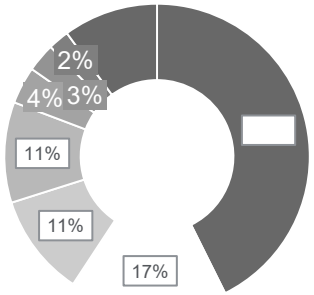
- **C-CAT tool & database**
- **28 emission factors**
- **167 consumption modules**
- **40 global country data**
- **600 completed ICO projects**
- **Direct linkage to cos-ting & performance**

Our approach to creating transparency

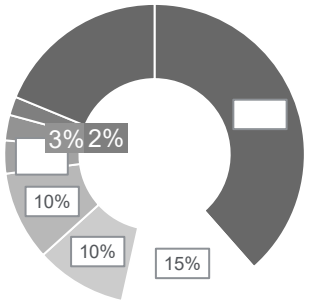
- We calculate the energy & power consumption of machines & equipment from process requirements
- We calculate energy consumption, based on basic laws of physics (electrical, fluid, mechanical, thermal)
- We derive scope 1 & 2 emissions for machines & equipment on actuator level
- We identify the major drivers of energy consumption and cost, as well as CO_2e

Project example – a powertrain assembly line

Energy consumption ***[kWh/piece]***



CO_2e ***[kg/piece]***

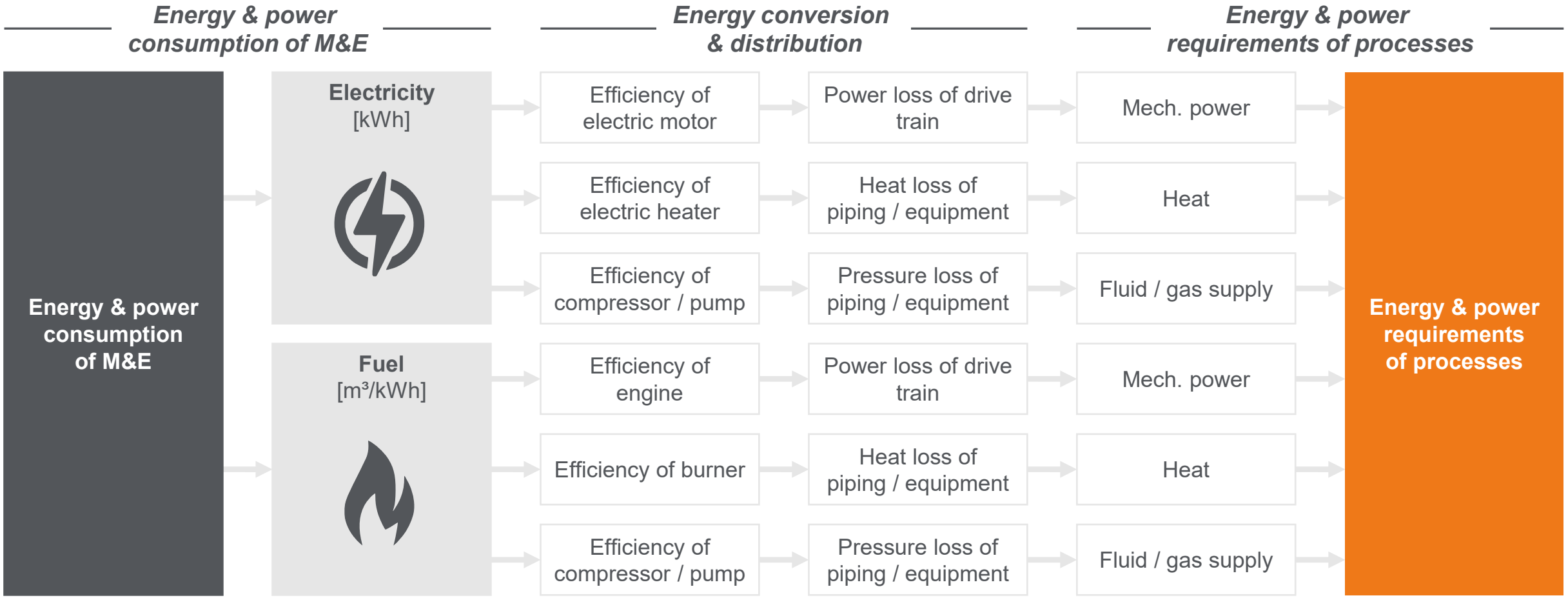


- El. Ofen
- Gripper PN
- Robot I
- Robot II
- Vibration feeder
- linear axle 25 V
- linear axle 30 V
- others

El: Electrical; PN: Pneumatic; ICO: Invest Cost Optimization; C-CAT: CO2e Calculation & Analysis Tool

The energy & power consumption of Machines & Equipment (M&E) is derived from the process requirements, taking efficiencies into account

Calculation methodology of energy & power consumption of M&E



M&E: Machines & Equipment

It’s all about effectiveness & efficiency… from power generation to consumption

Our ‘4R’ approach to reducing energy consumption and CO_2e emissions

✕ REMOVE

Remove energy requirements by…

- **powering-down** idle machines and equipment
- **avoiding automation** where manual processes yield a lower TCO (incl. externalities)

Requirements reduced

⇆ REPLACE

Replace…

- **inefficient processes & equipment** with more efficient ones
- **fossil fuels** with alternative, sustainable energy sources

Consumption reduced

REDUCE

Reduce power, heat, and pressure losses by…

- **minimising friction, increasing insulation, and reducing connections,** as well as transmission distance
- **reducing weight, velocity, force, and flow rate,** via a lowest TCO (incl. externalities) based design

Requirements & consumption reduced

↻ REUSE

Reuse…

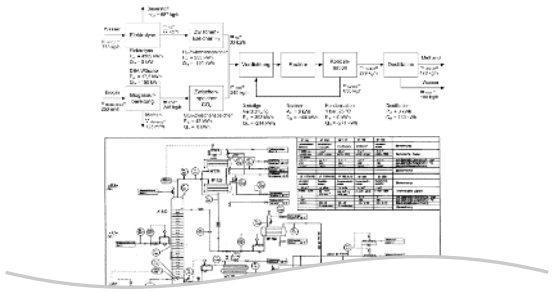
- **braking energy and waste heat** through recuperation
- **kinetic & potential energy** by using non-powered equipment

Requirements & consumption reduced

Our EBS analysis identifies both energy consumption and CO2e emission savings potentials

Equipment breakdown structure (EBS) analysis for process plants

P&ID energy & mass balance



P&I diagram as well as process energy & mass balance define the baseline for the energy consumption of the plant

Equipment list

Item No	Description	Area	Length/ Height	Dia	Arrgt Drg No
1071-B	Stack	18	165	0.5	B0108 B 001
1021-C	H P Heat Exchanger	18	12	2	C1021 C 001
1022-C	H P Condenser	18	20	1.5	C1022 C 001
1023-C	H P Scrubber	18	7	1	C1023 C 001
1024-C	Abs. Circ. Cooler	18	6	0.5	
1031-C	Heater Recirculation	18	7	1	C1031 C 001
1032-C	L P Carb. Condenser	18	6.5	1.3	C1032 C 001
1033-C	L P Scrubber Circ Cooler	18	1 x 1	0.5	C1033 C 001
1041-C	1st Evaporator	18	5.2	1	C1014 C 001
1042-C	2nd Evaporator	18	3	0.7	C1024 C 001
1071-C	Flash Tank Condenser	18	6	0.75	C1017 C 001
1072-C	1st Evaporator Condenser	18	7	1.3	C0172 C 001
1073-C	1st Cond. 2nd Evaporator	18	7	1.5	C1073 C 001
1074-C	2nd Cond. 2nd Evaporator	18	5	0.5	C1074 C 001
1075-C	After Condenser	18			
1077-C	Desorb. Heat Exchanger	18	1 x 1	0.5	C1077 C 001
1078-C	Waste Water Cooler	18	1.5 x 2	0.7	C1078 C 001
1080-C	Hydrolyser Heat Exchanger		9	0.75	C1080 C 004
1091-C	Flash Steam Cond.	18	4	0.8	C1091 C 001
1092-C	Circ. W. Cooler H P Scrubber	18			
1093-C	Circ. W. Cool. H P Cond.				

All energy consuming and distributing equipment is taken off the equipment list, which is based on the P&ID

Greenfield energy consumption

Top 20 - Energieverbrauch

Rang	EBS-Code & Bezeichnung	Energieverbrauch
1	042 - Laser (CO2) - 2.500 W (Netto-/Wirkleistung)	0,787 kWh 24,8%
2	058 - Pneumatikzylinder I	0,467 kWh 14,7%
3	055 - Greifer I (pneumatisch)	0,227 kWh 7,2%
4	201 - Allgemein - lastunabhängig - Gebläse Kühlstrecke 4,0	0,216 kWh 6,8%
5	056 - Greifer II (pneumatisch)	0,204 kWh 6,4%
6	064 - Elektroofen I	0,191 kWh 6,0%
7	002 - NC-Fügemodul - 30kN	0,176 kWh 5,5%
8	057 - Greifer III (pneumatisch)	0,144 kWh 4,5%
9	048 - Laser (Nd:YAG) - 6.000 W (Netto-/Wirkleistung)	0,139 kWh 4,4%
10	159 - Siemens - Panel IPC - HMI 15"-24" - IPC477	0,104 kWh 3,3%
11	009 - EC-Schraubspindel 50 Nm	0,060 kWh 1,9%
12	059 - Pneumatikzylinder II	0,057 kWh 1,8%
13	020 - Linearachse Baugrösse 35 - elektrisch - horizontal	
14	019 - Linearachse Baugrösse 25 - el	

- equipment list
- energy / mass balance

Energy / CO_2e savings potential

Cluster	Bezeichnung	Lieferant	TC	CSP	CSP	CSP-Rang
	Total (EUR)	5.395.900	3.840.716	1.555.184	28,8%	
Main Line	CE-E Station 10 - VM Kühlerbaugruppe	162.500	50.508	111.992	68,9%	2
Main Line	CE-E Station 20 - Schrauben Kühlerbaugruppe	361.500	177.162	184.338	51,0%	2
Main Line	Station 10 - VM Deckel groß/ IO Verpackung	224.000	67.251	156.749	70,0%	4
Main Line	Station 16 - Back up Schraubplatz	0	34.104	-34.104	0,0%	98
Main Line	Station 30 - Schrauben Deckel groß	310.500	185.083	125.417	40,4%	5
Main Line	Station 50 - HAP Montage Flexfolien	117.000	46.675	70.325	60,1%	3
Main Line	Station 55 - Back up Schraubplatz Flexfolien	0	35.611	-35.611	0,0%	99
Main Line	Station 60 - Schrauben Stacker Flexfolien	198.000	147.591	50.409	25,5%	15
Main Line	Station 70 - Kolbenlöten Flexfolien	152.000	134.791	17.209	11,3%	20
Main Line	Station 90 - AOI	152.500	163.184	-10.684	-7,0%	91
Main Line	Station 100 - Auftragen Berührschutz	194.500	162.768	31.732	16,3%	19
Main Line	Station 120 - Dichtprüfung	96.667	38.477	58.190	60,2%	12
Main Line	Station 130 - Funktionsprüfung 1	96.667	46.335	50.332	52,1%	16
Main Line	Transfersystem & WT	484.000	471.355	12.645	2,6%	23
Main Line	Kommunikation	0	22.971	-22.971	0,0%	96
Main Line	CE-E Station 10 - VM Kühlerbaugruppe	162.500	50.508	111.992	68,9%	2
Main Line	CE-E Station 20 - Schrauben Kühlerbaugruppe	361.500	177.162	184.338	51,0%	2
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Main Line	Station 60 - Schrauben Stacker Flexfolien	198.000	147.591	50.409	25,5%	15
Main Line	Station 70 - Kolbenlöten Flexfolien	152.000				
Main Line	Station 90 - AOI					
Main Line	Station 100 - Auftragen Berührschutz					

Actual energy consumption is compared to greenfield consumption in order to identify energy / emission-savings potentials

Energy and CO_2e-intensive processes and equipment can effectively & efficiently be identified, and compared to actual consumption and generation, to identify energy / emission-savings potentials.

P&ID: Piping and Instrumentation Diagram; EBS: Equipment Break Down Structure

EFESO's approach, using its unique CO_2e / energy tool & database, significantly reduces operating costs

Overview of EFESO's methodology

C-CAT
unique CO_2e & energy tool and database

69 emission factors

294 consumption modules

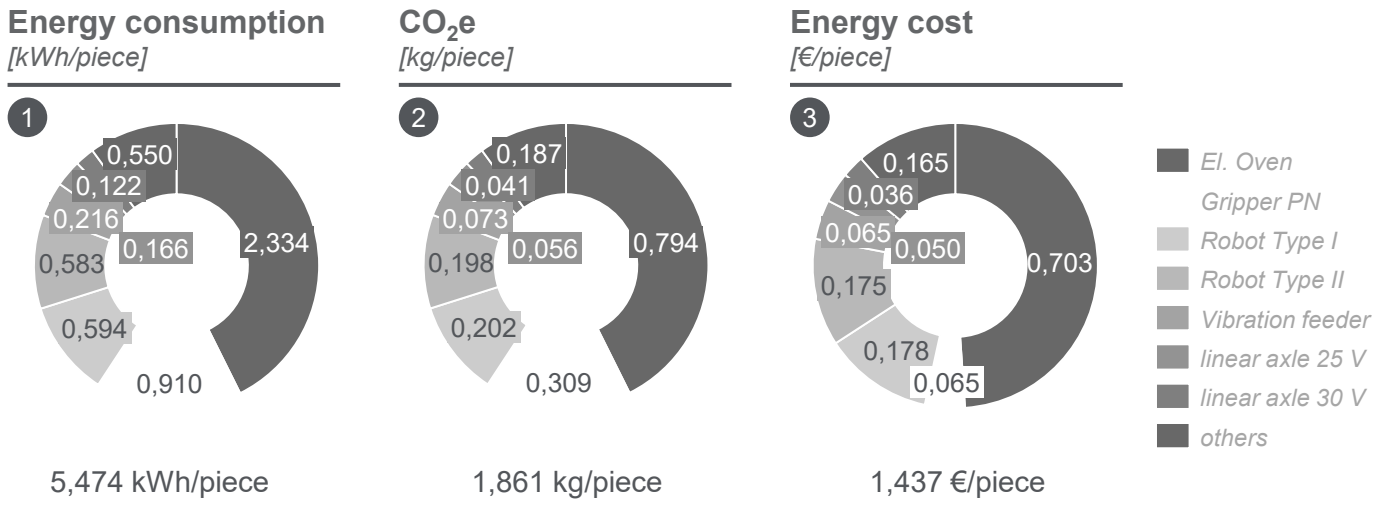
41 global country data

Scope 1 & 2 emissions are primarily calculated based on the basic laws of physics: i.e., independent of supplier-specific products:

Best Practice calculation of energy consumption and CO_2e emissions and costs based on latest status technology

- **Analysis** and **optimization**, based on **equipment breakdown** and related **energy consuming processes**
- **Technical breakdown of machinery & equipment**, down to individual **units & components**
- Preparation of detailed **best practice calculation based on EFESO's unique tools & database**

Project example of a powertrain assembly line



Example of optimization levers

- Deep understanding **of technical & commercial cost-drivers**
- **Removal** of content through more efficient processes & concepts
- **Replacement** of pneumatic actuators with electrically-driven ones
- **Reduction** of number of robots through better material handling concepts
- **Reuse** of energy by regenerative braking

21% energy savings potential

The first step… an on-site appointment to assess the existing situation and identify potential areas for CapEx reduction

I. On-site appointment

to assess the existing situation

Quick check

- Quick assessment of existing invest management and procurement processes
- Talk with clients from production engineering, controlling and procurement
- Identification of areas of improvement and possible pilot projects

1-2 day(s)

II. Piloting

of a 'specific invest project' (bottom-up)

Proof-of-concept

- Project selection based on greatest impact
- Setup of piloting team
- Execution of pilot, impact evaluation and estimate of overall benefit for client

4-6 weeks

III. Project

Holistic CapEx optimization / reduction

Tangible results

- Blended top-down / bottom-up approach
- Top-down: CapEx avoidance, reduction, optimization, and timing
- Bottom-up: detailed cost engineering & negotiation approach including procurement support

12+ weeks

IV. Delivery & rollout

of 'CapEx reduction program' globally

Global leverage

- Setup of global rollout team (factories, countries, regions)
- Execution of global rollout
- Tracking and reporting of deliverables and generated impact
- 'Lessons learned' feedback loops to optimize rollout program on the fly

12+ months

Our cooperative approach is guided by successful, proven principles

Our approaches…

…use processes tailored for our clients' challenging environments.

We have tailored our approaches to work with dynamic teams from different backgrounds.

While ensuring cross-functional collaboration, we will implement a clear and stringent performance management drive, decision-making, as well as ambitious target setting.

...come with a custom-made 'drum beat', to ensure constant progress.

...are a cooperative endeavour, to ensure sustainable project success.

We work as a team on an equal footing. We wield the know-how of renowned teams with proven industry expertise.

We help client team members to further build and improve their capabilities in cost and process optimization.

We focus on identifying and prioritizing cost savings opportunities, to ensure near-term product improvement.

We strive to deliver timely recommendations.

… lead to a fast achievement of the objectives.

EFESO is uniquely positioned to support clients with CapEx projects, thanks to its know-how, toolset, database and training

KEY success factors	In detail…	Ready-to-go
A — We know products, manufacturing processes and technologies	We have worked with OEMs, Tier 1s and other industries for years, consistently delivering best-in-class results	☑
	We have already conceived & deployed Cost Engineering processes successfully at our clients	☑
	Our deep insights into processes & products allow us to swiftly get to grips with new situations and deliver results fast	☑
B — We know how to design machinery & equipment to minimize both CapEx & OpEx	We have relevant industry expertise in buildings, material handling and process technologies	☑
	We know how to balance CapEx & OpEx to minimize Total Cost of Ownership including minimising the CO_2e footprint	☑
	This allows us to easily apply our capabilities to many industries (e.g., food, chemicals, aerospace and defense)	☑
C — We have a proven methodology, tool and database	Our knowledge & experience is based on more than 10.000 consulting days and hundreds of projects	☑
	Our methodology, toolset and database have been used for automotive OEMs, as well as Tier 1s and other industries	☑
	Our proprietary tools (I-CAT & C-CAT) for capital goods are one of a kind, not available from anybody else	☑
D — We have implemented CE-invest methodology with multiple customers	Training & coaching of staff on-the-job: Based on our tools' (I-CAT & C-CAT) methodology	☑
	There are no trial-and-error loops, because we have already developed a tried and tested toolset and database	☑
	End-to-End know-how: Concept → calculation → analysis → cost workshop → negotiation	☑

I-CAT: Invest Costing and Analysis Tool; CapEx: Capital Expenditures; OpEx: Operational Expenditures; ICO: Invest Cost Optimization; C-CAT: CO2e Calculation and Analysis Tool

EFESO
MANAGEMENT CONSULTANTS

REAL RESULTS, TOGETHER

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