Industrial Process And Energy Optimization
Industry Workshop

Energy Savings Assessment Methodology – Cost Effective Ways of Establishing the Action Plan

By

Dr. Curt Björk

Curt Björk Fastighet & Konsult AB
curt.bjork@telia.com

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **25 FEB 2004**	2. REPORT TYPE **N/A**	3. DATES COVERED **-**

4. TITLE AND SUBTITLE **Energy Savings Assessment Methodology Cost Effective Ways of Establishing the Action Plan**	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Curt Björk Fastighet & Konsult AB**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM001865, Industrial Process and Energy Optimization. Proceedings of the Industry Workshop Held in Gettysburg, PA, 25-27 February 2004., The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**UU**	**28**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

Driving Forces (in random order)

*Need for modernization (old junk with poor function needs to be replaced)
*Saving (energy) money
*Reduced maintenance costs
*Better - quality of products
- productivity
- indoor climate => health and well-being
*Environmentally sound to reduce energy related emissions

”The critical Eye” and ”The questioning Mind”

These are important tools to detect the defects.

*Why do you have all these technical systems?
*What is the purpose of having this ventilation system?
*Why heat, ventilate and illuminate 100´ sqft 24 hrs per day when you only use 20 % of the space, between 7 a.m. and 5 p.m?
*How does one system affect other systems?

Six Sigma as base for Systematic Energy Systems Analysis

Define the Defect

Measure Costs of Defect

Analyse and Suggest Solution

Implement suggested Measures

Control that you Achieve the resulting change

How do you define the DEFECT?

The Defect is:

Unnecessary Energy Use, i e

Energy that you use without you being aware of it or you just don´t give a damn about it.

At least, it does not contribute to your output.

System defects occur

In the swamp between Technical Systems, Organisation, Responsibility and Motivation

Age of equipment
Lack of routines
Lack of maintenance
Lack of responsibility

It cannot be lack of knowledge or skills !?

System Defects, examples

Simultaneous cooling and heating / moisturising and dehumidification

Lighting at day-time with maximum cooling loads

Cooling loads without external sun protection (external blindfolds or sun protection film on windows)

Separate and independent cooling units for every machine (electronics). Causing massive cooling loads for central cooling system

Aerotempers heating air inside open doors / air locks

Examples of Defects, discovered by ”The critical Eye” and ”The questioning Mind”

1. The timer that seemed to be wrong by 12 hours. That was the case but it also only had the possibility to turn equipment on, never off. This meant 8760 hrs/year.
2. The ground heating system that tried to heat the Swedish ground to +20 ^{o}C. The staff thought that the thermostat setting was for an aerotemper.
3. The compressed air duct that went under the concrete floor in a factory and ended with an open end. It was discovered when the durability of the floor was checked. 5 m^3/min for 10 years cost a lot of money. One year earlier the company bought a new compressor since they were short of capacity….

Methodology for Success in Industrial Plants

Standardized Qestionnaire
Preparation before inventory
Inventory of plant and facilities
20 Points Check List
Measurements of loads of interest
Analysis and Tools to Establish Status Report and Suggested Measures
Profitability and Financing. **Point of Decision**
Implementation under Supervision
Recurrent Staff Training to Achieve Long-Lasting Top Performance
Follow-Up and Operational Phase
Changing Conditions – Continuous Improvements

Methodology

Target: Reduce energy use/ costs/ environmental emissions by at least xx %

Contracts

Prices, base for profitability!
New supplier ?

Statistics

Technical data

Measurements

Inventory

Status report

Possible measures

Action plan

Performance

Follow-up

Tools for analysis and calculations:

- Ventilation calculation program
- TeknoSim
- Energy Balance
- Environment/ Energy/ Cost follow-up spread-sheet
- Life-Cycle Cost analysis tools
- MILP tools

Tools for continuity:

- Check lists
- Follow-up, key figures
- Action plan at deviation from target

Continuous improvements !!

Areas of Improvement, examples

Energy Contracts

- Electricity
- Fuels or heat
- Compressed air
- PFC contracts

Production / Processes

- Machines/equipment
- Coolant systems
- Washing processes
- Process ventilation
- Use of compressed air
- Combustion of solvents

Building and Supply systems

- Building envelope
- Heating system
- Cooling system
- Ventilation
- Lighting
- Compressed air
- Tap water system
- HVAC control and regulation
- Moisturising / dehumidification

Organization, Routines, Responsibility, Motivation

20 Points Check List
For Industrial Plants and Comm. bldgs

To be used on-site, at Inventory phase

Gives you 80 % of profitable possible savings

Singularities stand for the remaining 20 %. These are new ones at every single plant

For commercial buildings the ratio is 90 / 10

Covers all areas of production, organization, technical systems performance and efficiency

20 Points Check List, Examples (11 Points)

Production hours, divided on departments
Operating hours, ventilation, lighting….
Temperature set values, heating system, ventilation, cooling system
Temperatures in premises, different parts
Doors, gates, air locks, heaters in air locks
Cooling machines (process and general), COP, status, tempeartures
Max Peak Demand, time of day, year. Annual energy use
Compressed air: 5 step action program
Process interaction with each other and with supply systems
Night Time Walkabout
Benchmarking, key figures.

Night Time Walkabouts

”The Crocodile Dundee method”

Unsurpassed efficiency in detecting defects

Night or Weekend

No advertising

Bring one of the bosses, with economical responsibility and enough power to make changes

Document your findings — written report, photographs

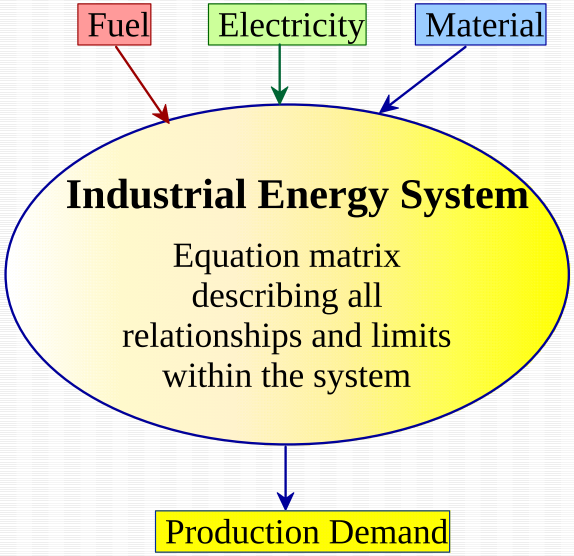
Use results for improvements, not for accusations

Analysis tools, part of the tool-box

- Energy balance programs, for buildings
- Ventilation system calculations, heat and electricity
- Check lists, energy system reviews
- Measurements
- Cause and effect analysis
- LCC analysis tool kits
- Pinch analysis
- Optimization models, LP or MILP
- PLC recordings in manufacturing processes
- Check list / guidelines for new equipment, new processes, purchasing routines
- Environmental and cost follow-up tools, spread-sheets
- Energy coordination (for new buildings and industrial plants)
- Simulation programs (CFD, Teknosim…)

Energy Systems Simulator/Optimizer

- … is a software product for cost-optimizing the energy system. The objective is to minimize the system cost, consisting of investment costs, energy costs and raw material costs. The structure of the energy system is represented as a network of nodes and branches. A MILP model of the energy system is generated.



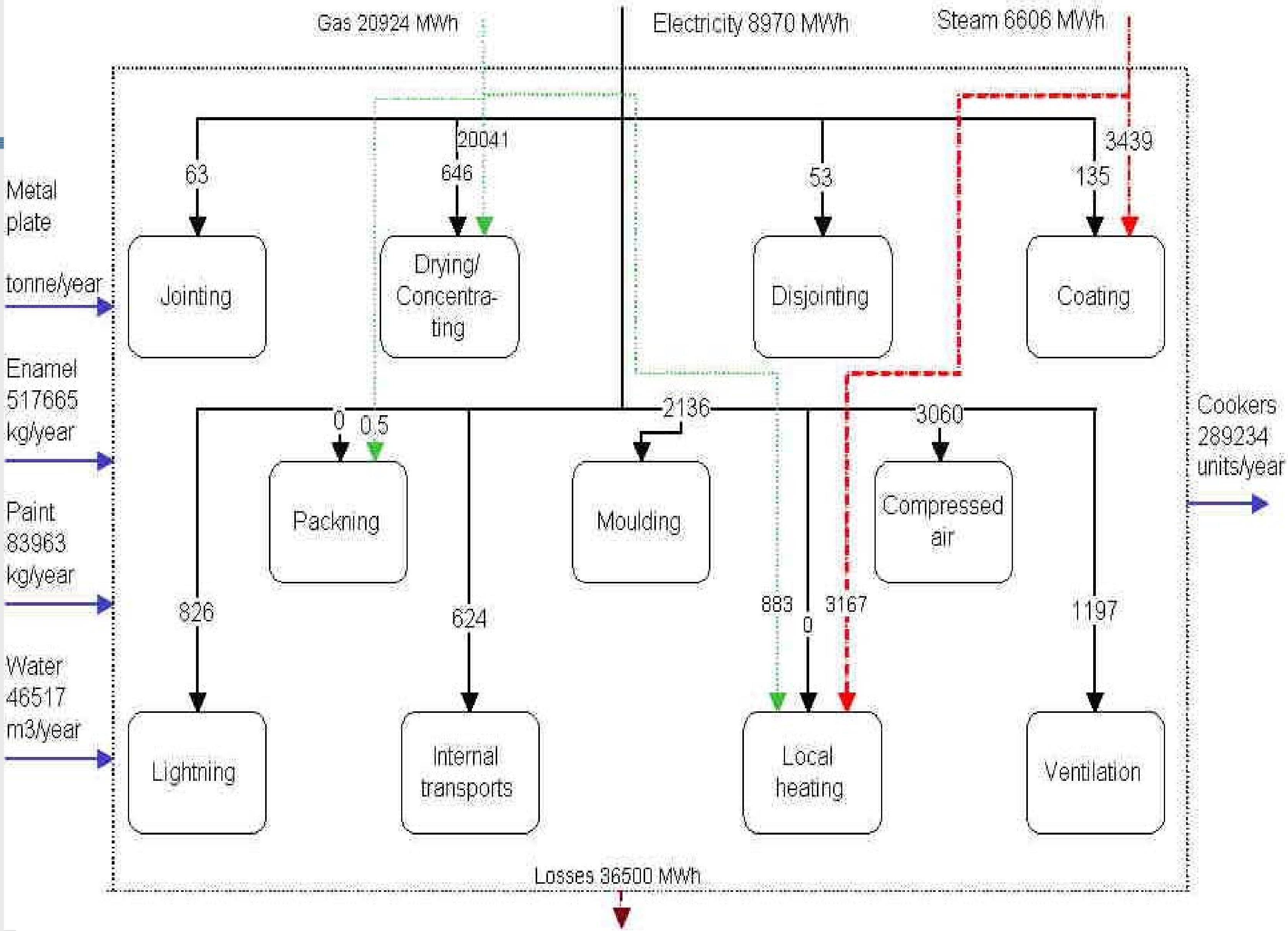
In co-operation with Linköping University, Div. Energy Systems

Energy Systems Simulator/Optimizer

Forecast the energy need; days, weeks or years ahead

- The effect on energy costs when investing in new process technology or new equipment
- Analyse the cost when converting to other energy carrier
- Analyse the effect on higher electricity costs, taxes on **CO_2**
- Simulations to study the impact of changed boundary conditions on the total system
- Increased awareness. Perform systematic analyses and avoid suboptimization. Simplifies continuous optimization
- Optimization of production strategy

STRUCTURE PICTURE UNIT PROCESSES



Six Sigma as base for systematic Energy Systems Analysis

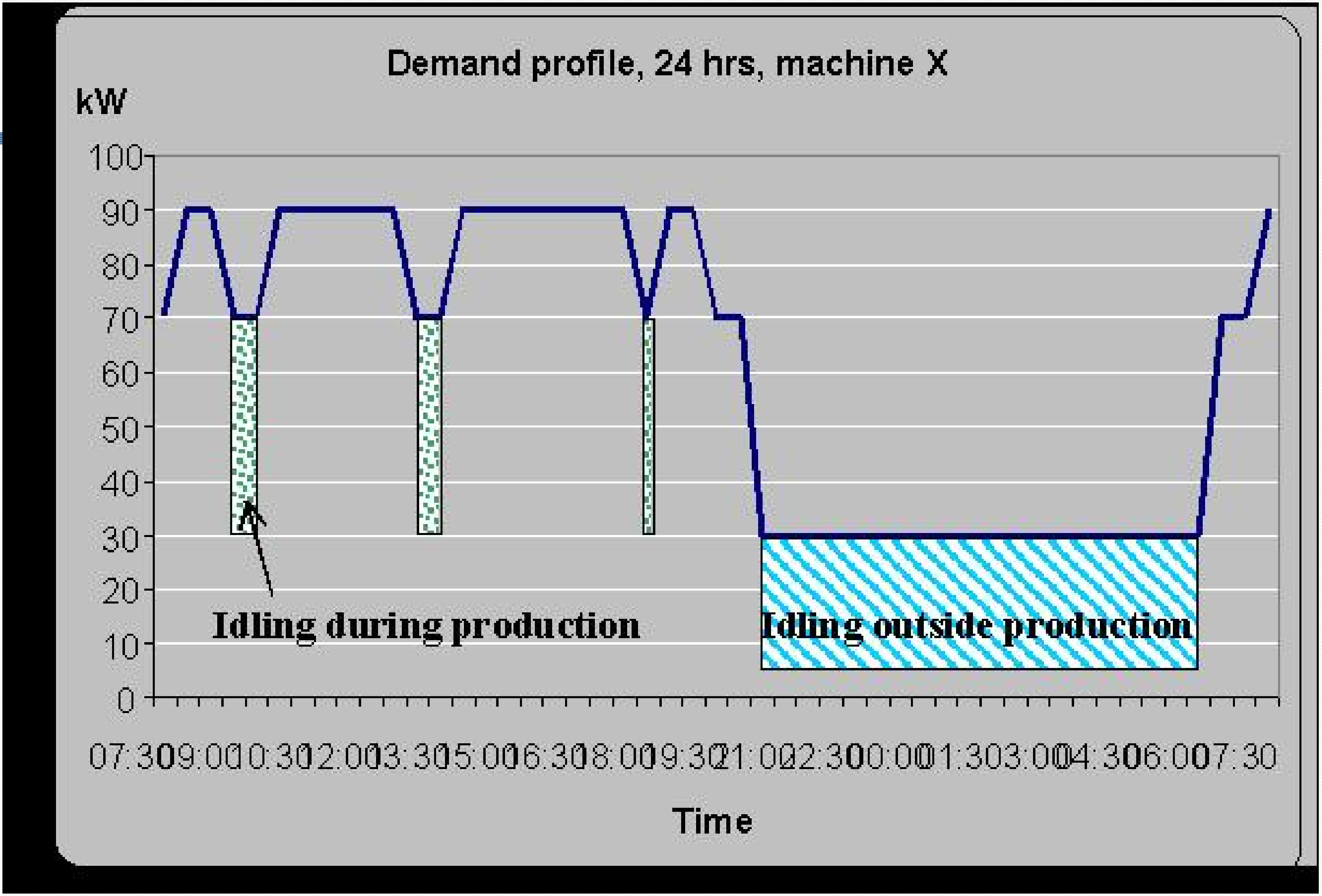
Define the Defect

Measure Costs of Defect

Analyse and Suggest Solution

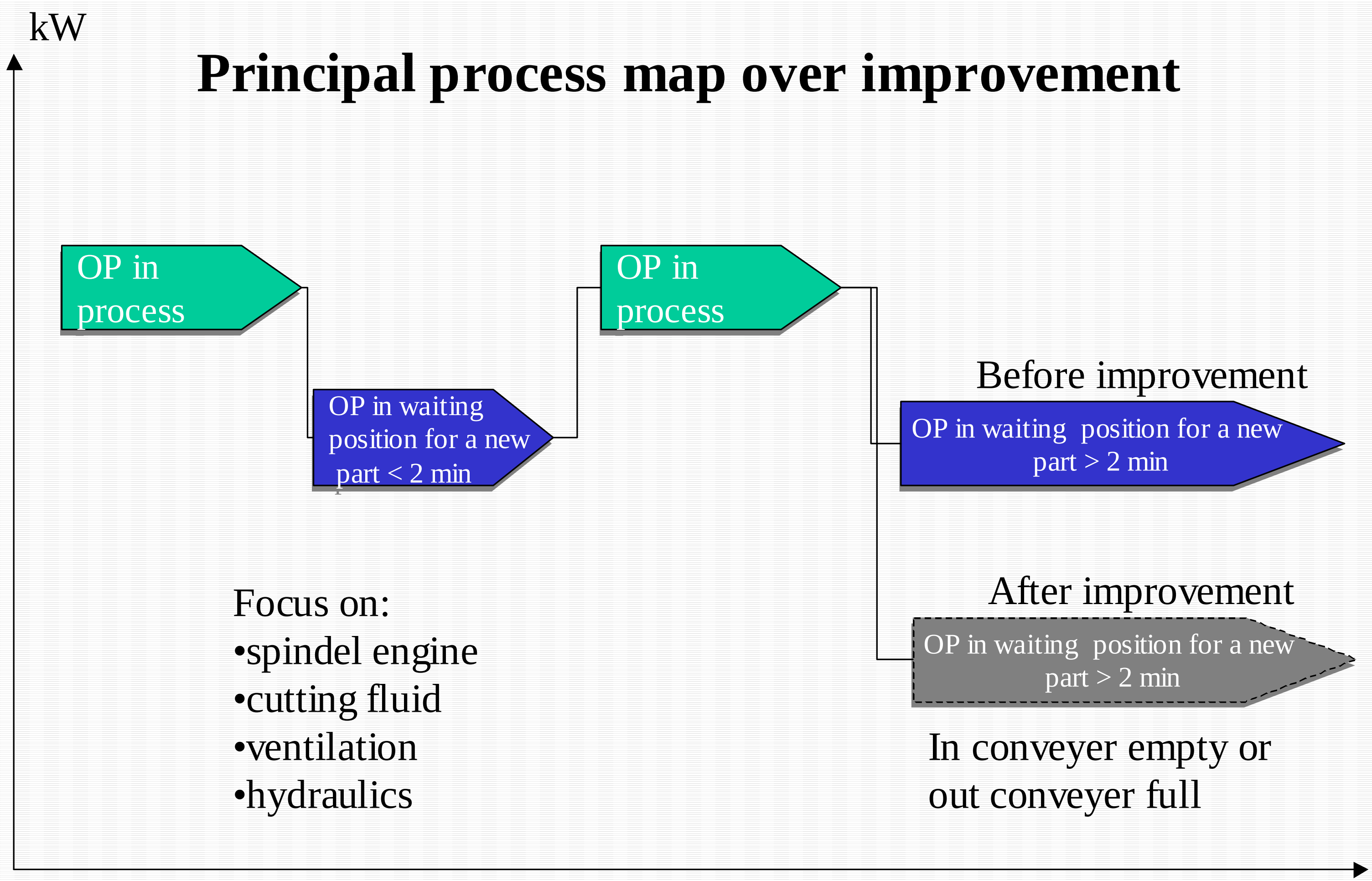
Implement suggested Measures

Control that you Achieve the resulting change

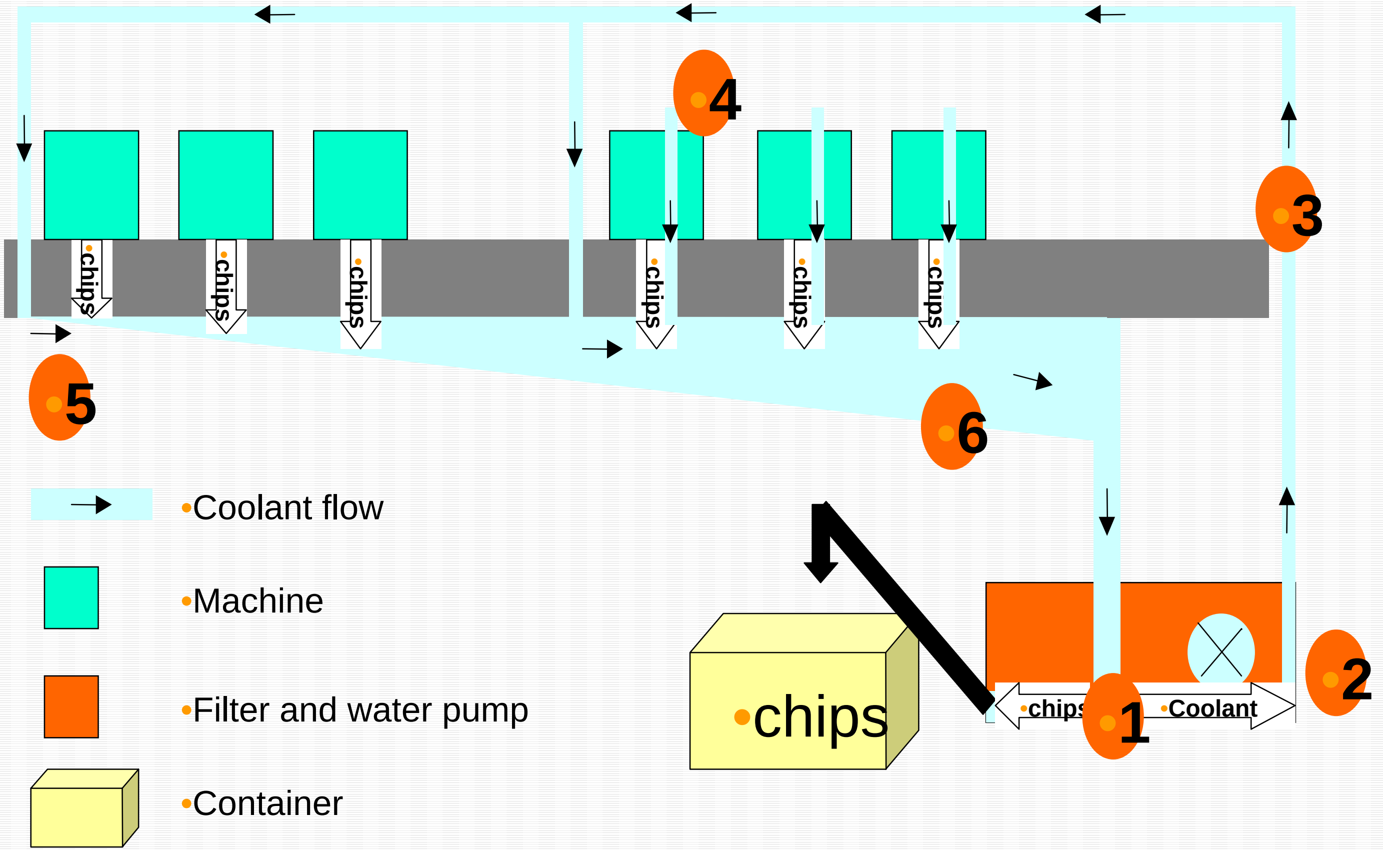


Demand profile, 24 hrs, machine X
kW
100
90
80
70
60
50
40
30
20
10
0
Idling during production
Idling outside production
Time

Transfer Machine, changed operation

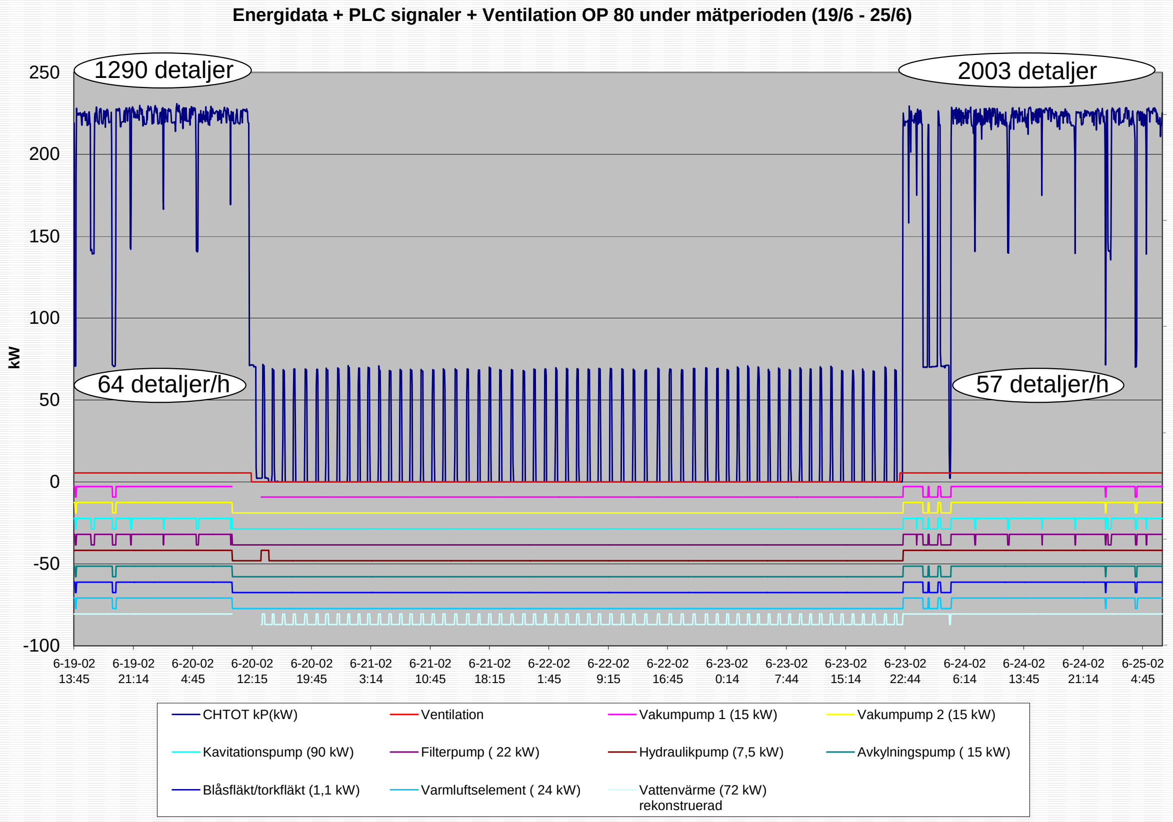


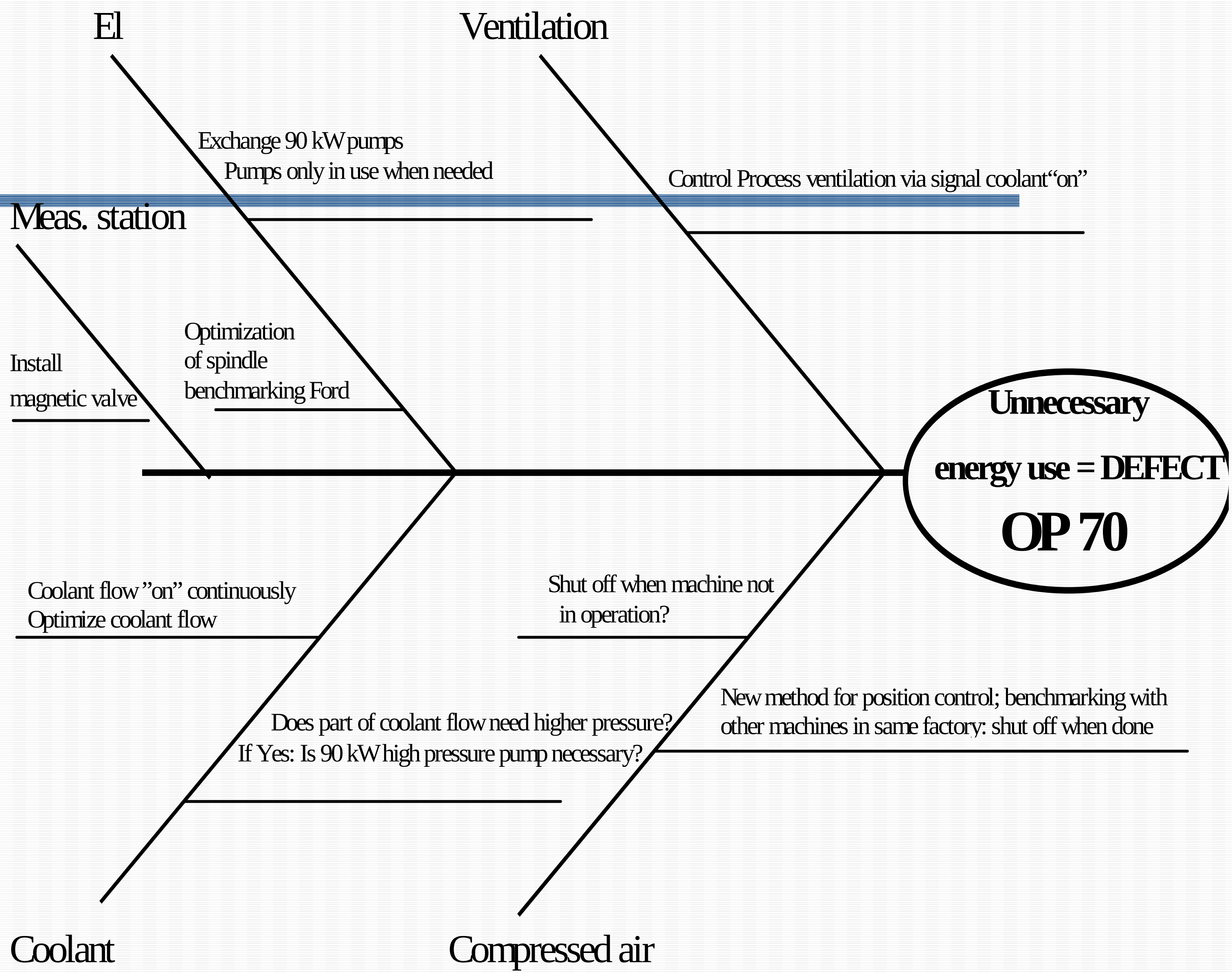
Coolant System at Engine Factory



Coolant flow and Chip Transport in channel under machines

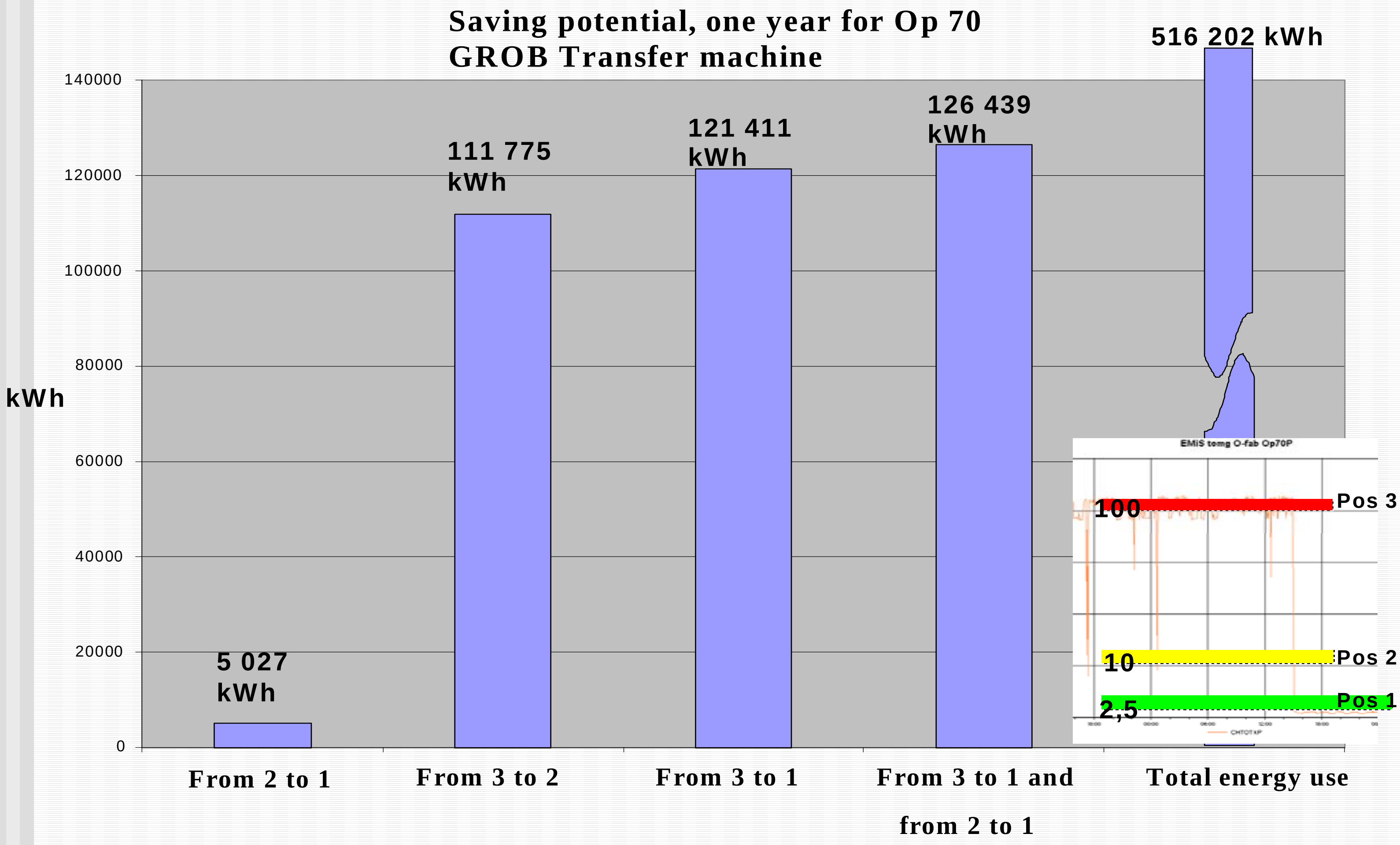
Logging PLC signals and Energy





Fish bone diagram, OP 70. Brainstorming result

Calculated savings, based on measured data



Transfer Machine Savings by minimized idling time. Achieved results.

Machine operation, electricity	99 MWh/year
Process ventilation, electricity	7 MWh/year
Process ventilation, heat	40 MWh/year
Coolant pumping, electricity	20 MWh/year
Total	**166 MWh/year (-19 %)**

In addition: Compressed air (not measured)
Handling of coolant, cleaning, cooling...
More to be done (pumps, pressure......)

All of this easily achieved by re-programming PLC

And finally…………

Some hard examples on complex relations from reality…….

The old-fashioned way; Could we please start the overhead projector now?