Sokolov : Steam Consumption Reduction

Team Members:	Martin Behunek, Tibor Otta (Maintenance) Jiri Knir, Rudolf Kovac (Utility Plant) Milan Panzer (Monomers) Miroslav Masek, Stanislav Cizek (Dispersions) Jindrich Kotrba (Engineering)
Finance Rep:	Tomas Farsky
Champion:	Alois Zach
Process Owner:	Alois Zach
Black Belt::	Tomas Franc
Mentor/(M)BB:	John C, Dawson
SBU:	EPCD
Date:	December 11th, 2013

Project Background

Sokolov : Steam Consumption Reduction

- Sokolov is a large MDP site located in the Czech Republic producing acrylic acid at two plants and dispersions. Steam costs influence significantly the overall Sokolov site costs and are seen as a potential opportunity for considerable savings taking into consideration the size of the site and annual steam spend about 5,1 mil.$ (own utility site).

- There has been several measures taken in the past to optimize steam consumption especially at acrylic acid plants that are the main consumers however no overall effort has been so far taken to focus on the site as a whole.

- There is a BOS planned to take place in May 2013 that will focus on steam consumption, the ideas arised at BOS will be included in project.

- There is a detailed measurement system available that allows the consumption to be further analyzed.

Project Definition

Sokolov : Steam Consumption Reduction

- **Problem Statement**: Steam costs represent a significant portion of the total Sokolov site costs, annually 491.427 GJ is consumed (2012 consumption). There is a big variation of steam consumed between maximum 60.373 GJ and minimum 21.400 GJ which indicates potential opportunity for steam consumption reduction.

- **Objective**: Analyze the steam consumption, define the opportunity areas and major consumers to reduce the total site steam consumption by 5% from existing annual consumption 491.427 GJ (2012) to 466.855 GJ by Jan 1st, 2014 (consumption to be decreased from Jan 1st, 2014 on). Focus on both optimization without capex required and capex proposals.

- **Background**: Utility costs influence significantly the overall Sokolov site costs and are seen as a potential opportunity for considerable savings. There has been several measures taken in the past to optimize steam consumption especially at acrylic acid plants that are the main consumers however no overall effort has been so far taken to focus on the site as a whole. There is a BOS planned to take place in May 2013 that will focus on site steam costs and consumption, the ideas arised at BOS will be included in project.

- **Metric**: Primary : Monthly site steam consumption in GJ
  Secondary : Monthly site steam costs in CZK

- **Annualized Stake**: 4,20 mil. CZK (211 k$)
  24.571 GJ (5% of 2012) x 171 CZK/GJ (variable costs) = 4.201.700 CZK x 0,0504 CZK/$ = 211 k$

- **Business**: EPCD - MDP

- **Location**: Sokolov, Czech Republic.

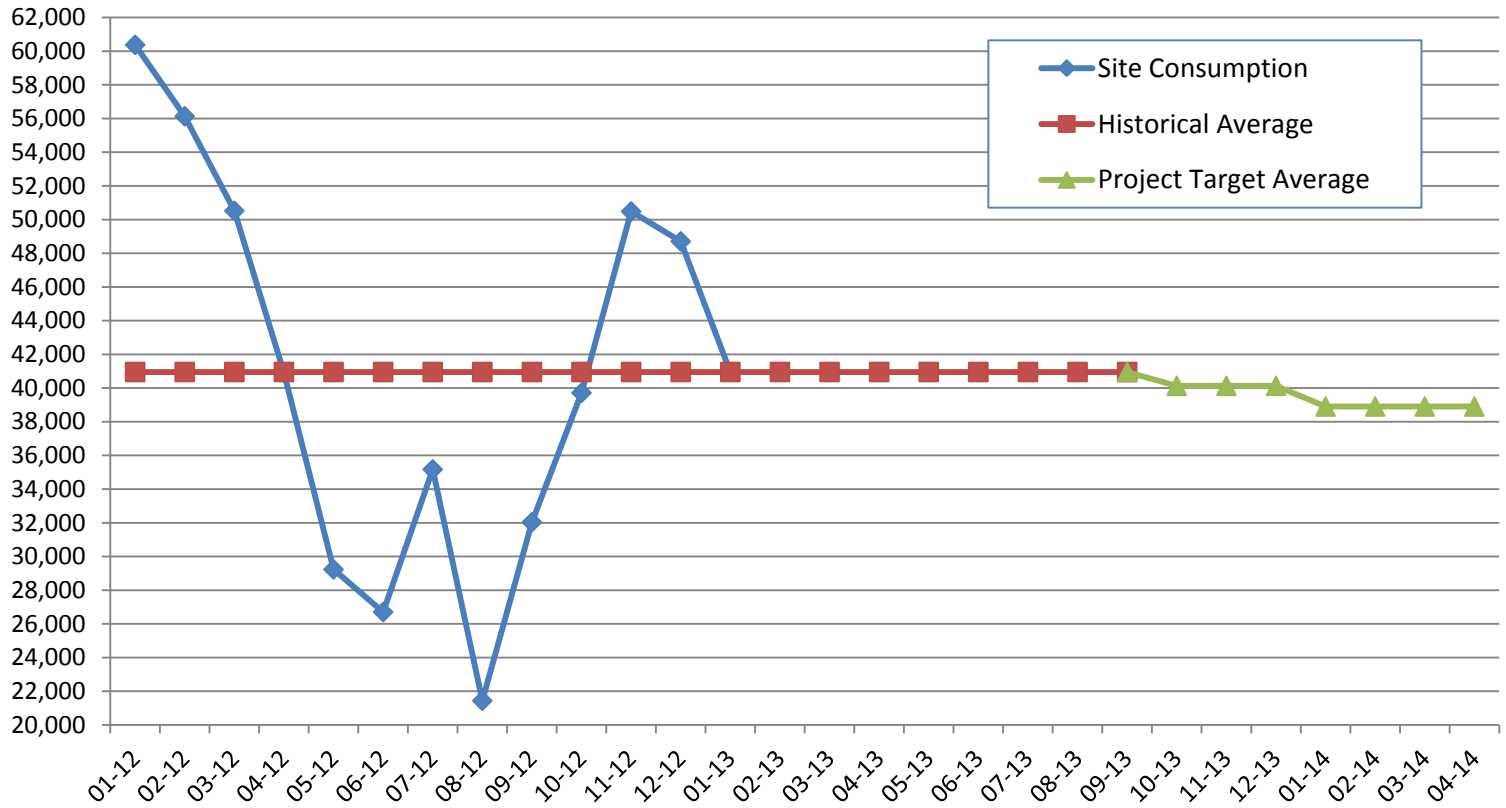
- **Project Type** : Process

- **Approval**:
  - MBB: John C Dawson
  - Process Owner: Alois Zach

Metric Graph

Sokolov : Steam Consumption Reduction

Monthly Sokolov Site Consumption, GJ



Month		01-12	02-12	03-12	04-12	05-12	06-12	07-12	08-12	09-12	10-12	11-12	12-12
Average temperature	°C	0,24	-0,49	4,99	11,65	14,35	17,65	16,89	18,60	15,22	8,90	3,79	3,23

Evaluation Criteria

Sokolov : Steam Consumption Reduction

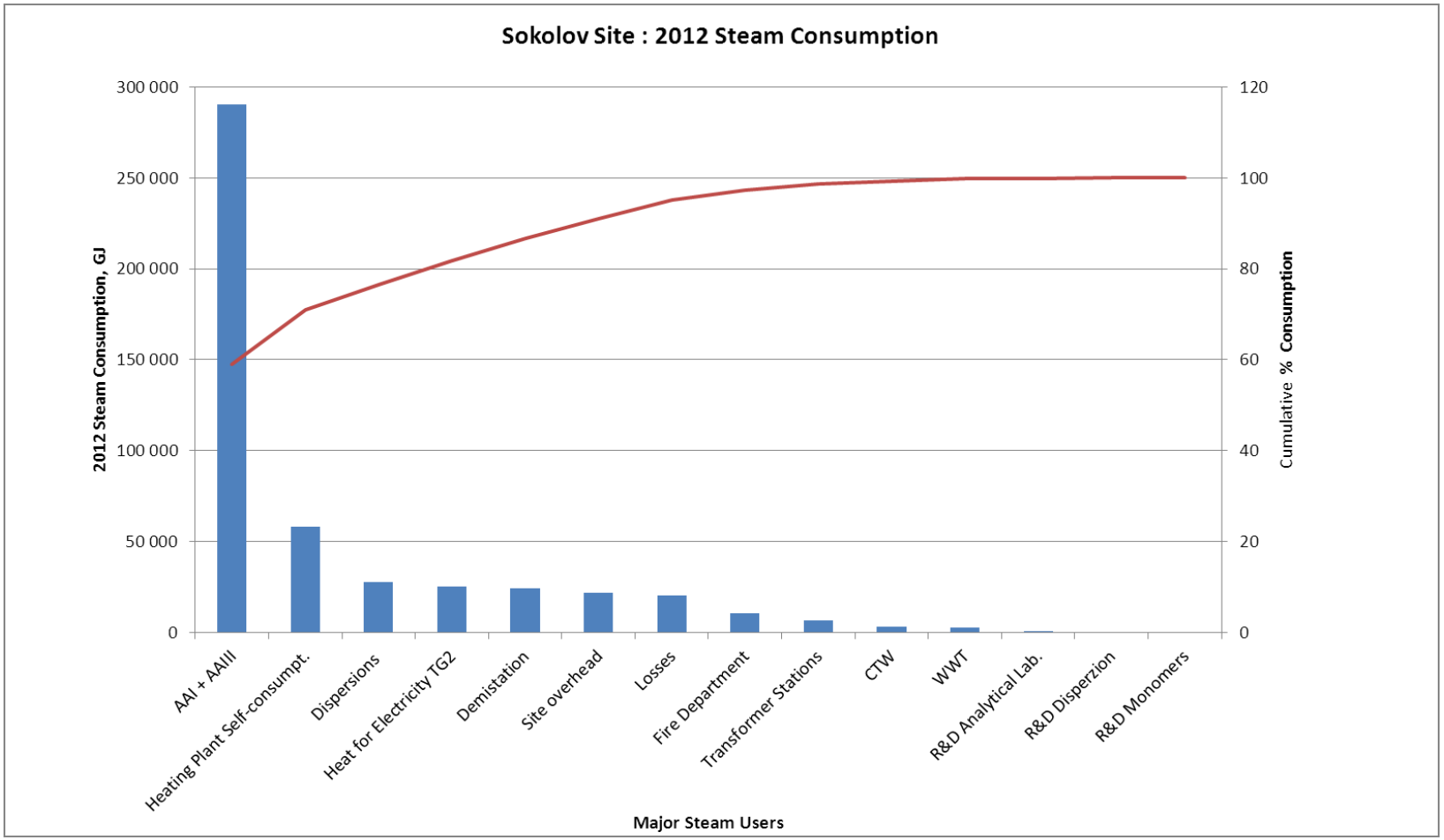
Financial Impact	Very Low (1)	Low (2)	Medium (3)	High (4)
Net savings, or Working Capital				
Leverage ability	**Very Low (1)**	**Low (2)**	**Medium (3)**	**High (4)**
Ability to transfer the accomplishments from the project to other locations				
Estimated Time to Completion	**Very Low (1)**	**Low (2)**	**Medium (3)**	**High (4)**
Number of months to complete Project				
Probability of Success	**Very Low (1)**	**Low (2)**	**Medium (3)**	**High (4)**
Probability that the Project will achieve the desired results				

Item	Impact Weight	Rating	**Total Score:**	**2,35**
Financial Impact	50%	2		
Leverage ability	20%	3	**Double-click table, then fill in ratings based on above criteria**	
Estimated Time to Completion	15%	2		
Probability of Success	15%	3		

Metric Graph

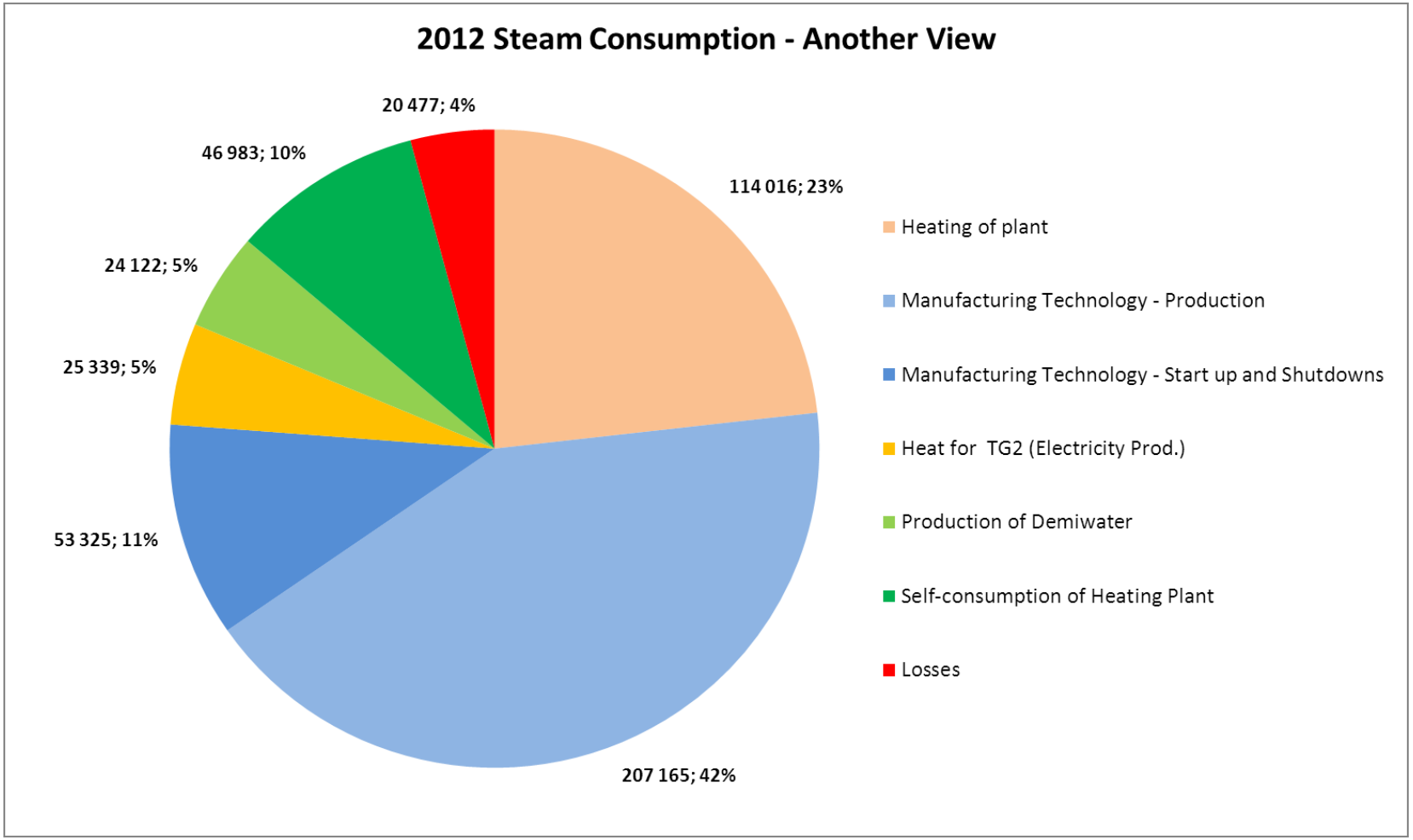
Sokolov : Steam Consumption Reduction

Pareto Chart : Sokolov Site Consumption, GJ



Metric Graph

Sokolov : Steam Consumption Reduction



Project Definition

Sokolov : Steam Consumption Reduction

- **Problem Statement**: Annual Sokolov site steam consumption is 491.427 GJ (2012). There is a big variation of steam consumed between maximum 60.373 GJ and minimum 21.400 GJ which indicates potential opportunity for steam consumption reduction.
- **Objective**: Reduce the total site steam consumption by 5% from existing annual consumption 491.427 GJ (2012) to 466.855 GJ, as measured by steam volume produced&purchased, by Jan 1st, 2014.
- **Background**: Utility costs influence significantly the overall Sokolov site costs and are seen as a potential opportunity for considerable savings. There has been several measures taken in the past to optimize steam consumption especially at acrylic acid plants that are the main consumers however no overall effort has been so far taken to focus on the site as a whole. There is a BOS planned to take place in May 2013 that will focus on site steam costs and consumption, the ideas arised at BOS will be included in project.
- **Metric**: Primary : Monthly site steam consumption in GJ
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- **Annualized Stake**: 4,20 mil. CZK (211 k$)
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- **Business**: EPCD - MDP
- **Location**: Sokolov, Czech Republic.
- **Project Type** : Process
- **Approval**:
  - MBB: John C Dawson
  - Process Owner: Alois Zach

Validated by Tom Farsky, Finance Controller

D2 – Document the Scope of the Opportunity

Project alignment with business strategy

Customer Needs : CTQ

- **Assure energy is spent efficiently both in manufacturing and at the site as a whole**
- **Avoid inefficiency and losses of energy (steam, condensate, HW)**
- **Propose solutions without capex needed or with reasonable payback**

Business Strategy :

- **Increase EBITDA**
- **Run the site efficiently**
- **Reduce utility costs – BOS Steam will take place in Sokolov in May 2013**

Utility costs reduction is within Business Strategy
-> Reduce Steam Consumption by 5 %

D1 – Establish the Customer's Needs
Thought Map

What we know ?

51 % of condensate returned to utilitiy site, some condensate reused at AA plant

Older energy audit and its conclusions

Buildings state re. energy requirements, insulation

Age of heat exchange stations more than 30 years

Utilization of buildings, in some buildings few people only, in total some 60 buildings on site, HWW B - some buildings heated 12 months

Payback of insulation project of build. 118 was already calculated

Steam balance in AA plant

Steam traps diagnosed annually, inspection costs cca 120.000 CZK

All main steam users are measured incl. external parties and incl. the total heat consumption for buildings

In the summer the boilers are operated close to the minimal capacity (8-10 T/h depends on the coal)

Dispersions - 85% of consumption in GJ is for heating (mainly build. 004), 15% is for steam - technology

Dispersions - heating of buildings 004 a 005 is closed from May till September, implemented some 2 years ago

Electrical heating cables have higher energy consumption compared to steam heating used for pipes heating, that is however more costly re. maintanance

Annual maint. costs for insulation repair cca 7 mil. CZK incl. scaffolding, sometimes pipe replacement…, system for insulation maint. in place

HWS Temperature of water difficult to regulate from T>5°C outside, the return stream is heated by water from boilers

Possibility to reuse vapour steam at utility plant - payback 6 years

In the past realized project to define what should be closed during production breaks

Payback for insulation upgrade for steam distribution pipes was calculated already for HP, LP, MP - needs to be checked

Heat integration exists (AA), vapours recompression does not give payback - reuse of heat from columns heads

What we assume ?

Opportunities at AA plants are either small or will require large investment

Reflux on the columns were optimized, further decrease will lead to risk of polymerization - AA plants

Current steam consumption to produce AA close to physical minimum, it is however not possible to calculate the minimum exactly, assuming no further big opportunities

What we don´t know ?

Would it make sence to recover heat from dispersions buildings ?

Exact consumption of all individual buildings at the site ?

Which buildings can be closed without heating, risk of damage of build. ?

Heat consumption of fire brigade building - assumed high because of old regulation ?

What would be real payback for insulation of building that is measured (GJ) - administration building and 004

What are m2 heated in buildings and m2 heated per associate ?

Benefits

Lower utilities costs

Reduced site impact to enviroment

Are we able to decrease heat consumption for buildings - leave some buildings, find external users or insulate with a good payback or decrease via better regulation ?

What is measured, what is estimated ?

Can we reduce winter steam&heat consumption - reduce seasonal variation ?

Where is steam & heat used inefficient (GJ/m3 compare for buildings)… ?

Whay is 51% of condensate returned only ?

Is it realistic to find real new opportunities at AA plants after these being subject of many projects and permanent focus of Process Engineering group ?

What are the known ideas to reduce steam consumption - at ideas storage ?

Challenges

There has been so far many optimization efforts realized in the past, strong focus of PE group on AA plants

Several years ago audit focused on energy efficiency was carried out in Sokolov that showed mostly opportunities like insulation with payback issue

Large size of the site and the project

Customers

Site Leader of Sokolov Site

MDP BMT

Sokolov Site Associates

Enviroment, Aithorities

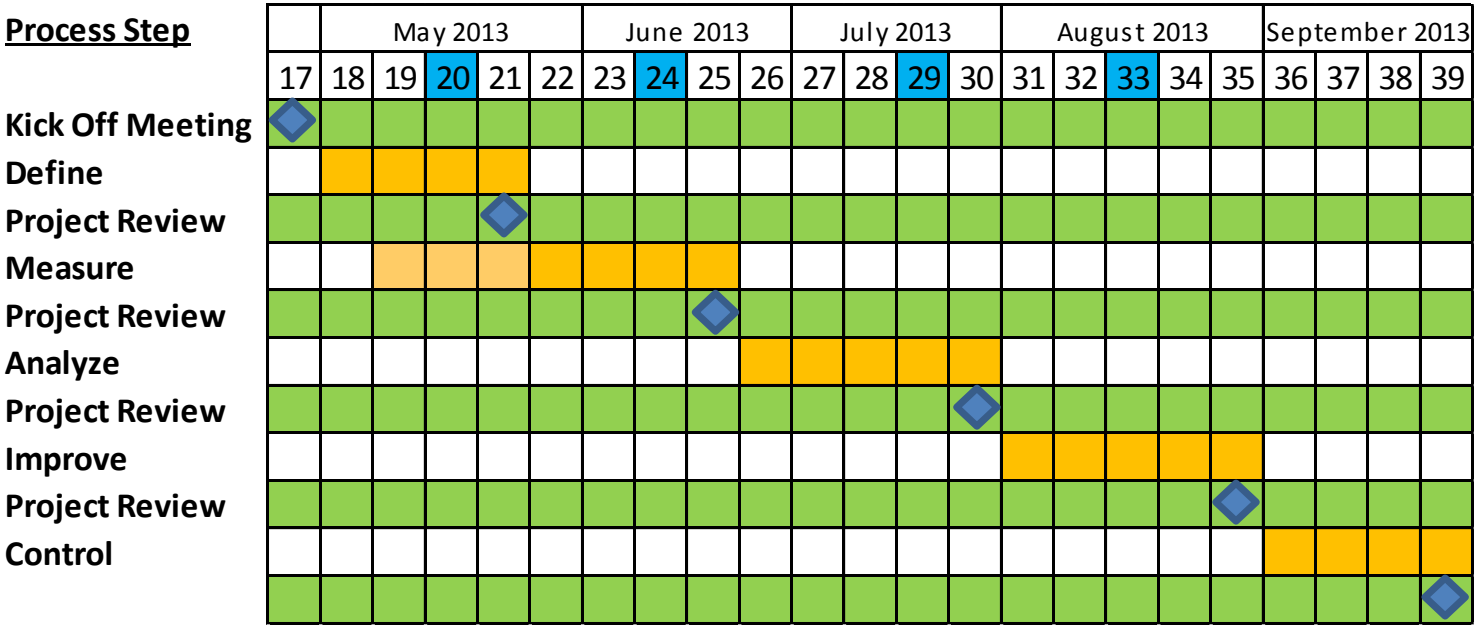
D2 – Document the Scope of the Opportunity

Project Timeline

Kick off Meeting : April 23rd
Team Meeting : May 6th – Define phase

Project : **Sokolov : Steam Consumption Reduction**

Project Plan *agreed on May 6th team meeting*



D2 – Document the Scope of the Opportunity
SIPOC

SIPOC updated to reflect project development

Sokolov : Steam Consumption Reduction

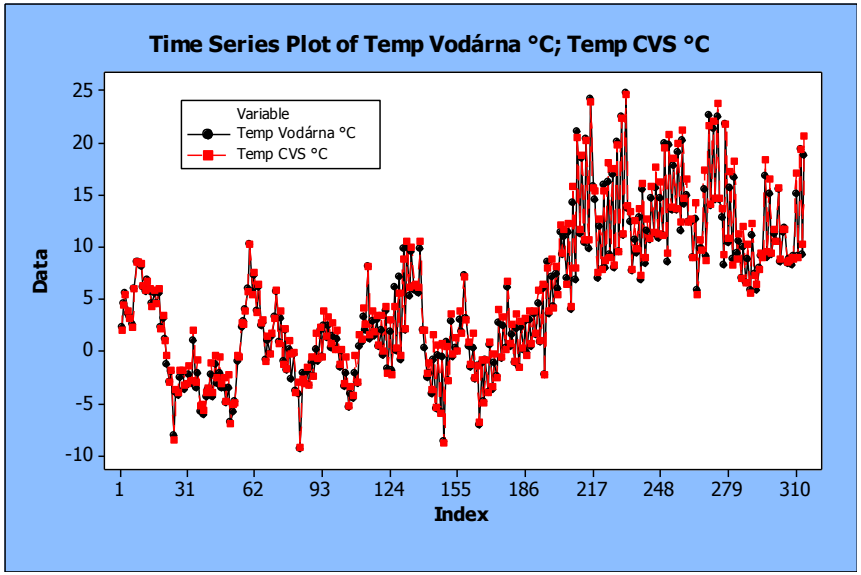
Process: Steam Consumption at Sokolov Site **Process Owner:** Alois Zach, Site Leader

Suppliers (7) (Providers of the Required Resources)	**Inputs** (6) (Resources required by the process)		**Process** (Top level description of the activity)	**Output** (3) (Deliverables from the process)	**Customers** (4) (Anyone who receives a deliverable from the process)	
		Requirements (8)			**Requirements (5)**	
Momentive Utility Plant	LP Steam	Volume, T, p, stable parameters, reliable and flexible supply	2 LP Steam Production 1	Low utility unit costs, reliable supply and operation, EHS results	Efficient operation	Momentive Management, BMT MDP
Site Operation	Personnel : Incl. Leaders to Operators	Effective operation and use of steam/HWS	HWS Operation → HWS Distribution & Usage → HWS Return to Utility Plant	HWS	Volume, T, stable supply according to needs	Sokolov Site, Momentive Overhead
Site Maintanance	Equipment, Distribution, Measurement	Reliable equipment, required automation/regulation, callibrated meters		Steam, HWS	Volume, T, p, stable supply according to needs	External Customers at the Site
Site Engineering	Infrastructure, Distribution, Buildings	Proper design, dimension, insulation, upgrade when needed (acc. to payback)		HWS	Volume, T, stable supply according to needs	Momentive Associates
			Utility Plant 2	Limited impact of process to enviroment	Efficient usage, reduced losses, reduced impact to enviroment	Enviroment, Authorities

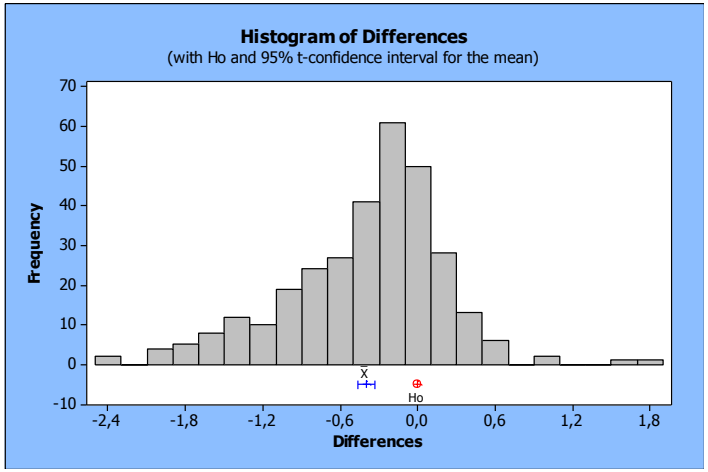
M4 – Validate Measurement of the Process

MSA Parallel Measurement of Outside Temperature (x1)

2013 Datas : Daily readings at 12:00 and 24:00



Two Parallel Thermometers :
- "Vodarna" and "CVS"
- Not covered – influence of the sun during the day etc.
- Informative measurement



- **Descriptive Statistics: Temp Vodárna °C; Temp CVS °C; Diff, C**
- Variable Mean StDev Variance MSSD
- Temp Vodárna °C 4,945 7,098 50,384 12,656
- Temp CVS °C 5,346 7,169 51,395 14,264
- Diff, C -0,4012 0,6116 0,3740 0,4292

Pooled StDev = sqrt ((50,384+51,395)/2) = 7,133

Measur. Variability = StDev diff/ sqrt (2) = 0,6116 / sqrt (2) = 0,432

%Study Var = Measurement Variability/Total Variab * 100%

= (0,432/7,133)*100% = 6,1 %

MSA showing a difference between 2 Thermometers especially at above 15 °C (CVS) - check other thermometers to be used

M4 – Data Collection Plan

Sokolov : Steam Consumption Reduction

Data Collection Plan							
Data Collection Objective:	**Define datas needed on Heating HWS Project Y, most of the datas collected already**						
WHAT to Measure			**HOW to Measure**				**WHO is Measuring**
Measure Operational Definition	**Type of Measure Output(Y) or Input(X) or Process(X) Stratification(X)**	**Type of Data Continuous or Discrete**	**Measurement Tool**	**Measurement Resolution**	**Sampling Scheme Systematic/Random/Stratified Random**	**Sampling Frequency**	**Who is collecting the data?**
LP HWS Steam Cons. in GJ	Output Y	Continuous	viral flowmeter, sensor T,p	g/h, 0,1 °C, kPa	stratified	monthly total	J. Knir
LP HWS Steam Cons. in tonnes, p, T	Output Y	Continuous	viral flowmeter, sensor T,p	g/h, 0,1 °C, kPa	systematic	on-line 5 sec, 60 sec.	J. Knir
LP HWS Condensate returned to Utility Plant	Part of Output Y	Continuous	waterflow meter, temp. sensor	litres, 0,1 °C	systematic	on-line 5 sec, 60 sec.	J. Knir
Outside Temp.	Input X1	Continuous	resistance thermometer PT100 (vodarna)	0,1 °C	systematic	on-line 5 sec, 60 sec.	J. Knir
Buildings GJ Consumption (24 pcs)	Stratification X2 - X25	Continous (but monthly records only)	various types	kg, 0,1 °C, GJ	stratified	monthly total	J. Knir
Fire Brigade Building GJ Cons. *	Stratification X26	Continous* (but monthly records only)	will be installed	kg, 0,1 °C, GJ	stratified	monthly total	J. Knir, * measurement to be installed
Buildings GJ Consumption (41 pcs)	x	x	x	x	x	x	calculation from m2 of building

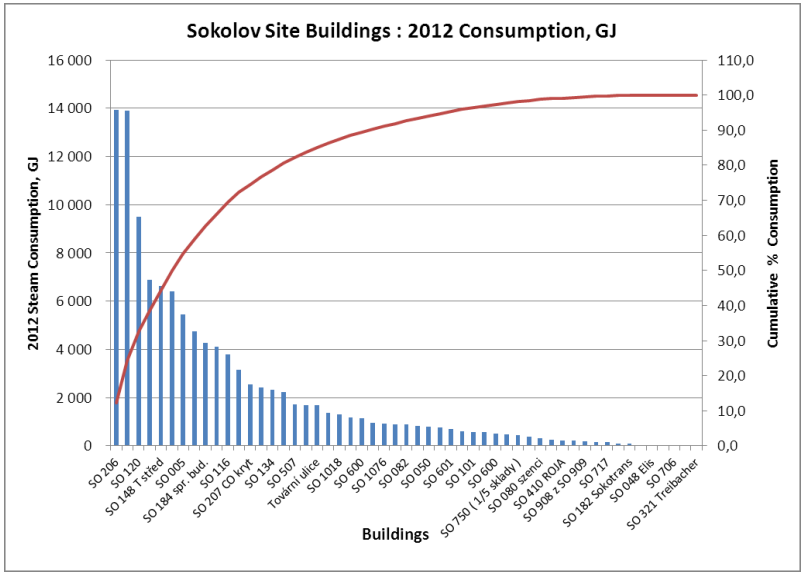
Data Collection Plan Implemented and Fully Operational

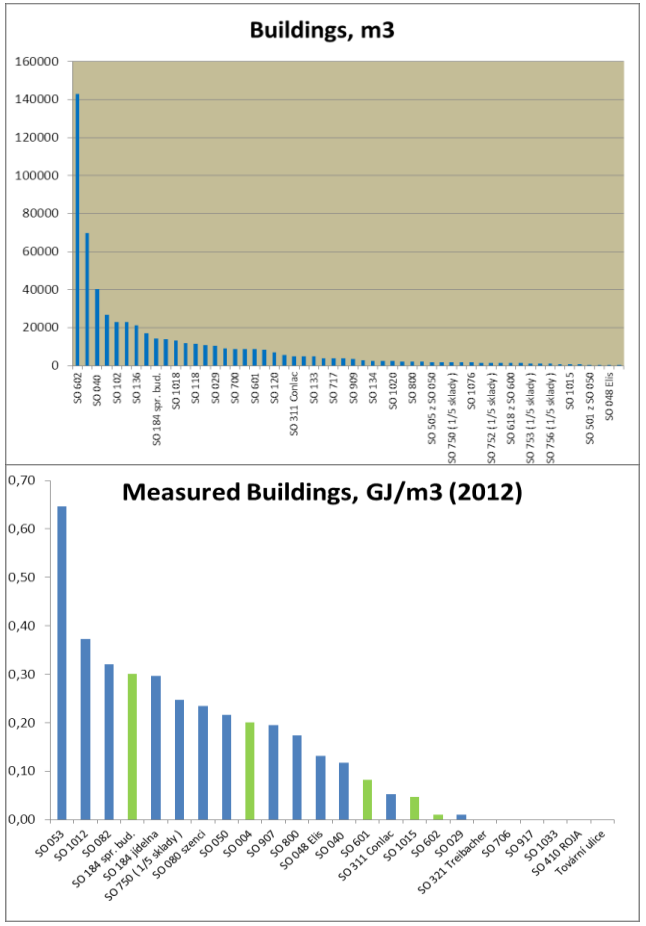
M5 – Graphical Analysis of Y

Sokolov : Steam Consumption Reduction

HWS Used for 67 buildings, 24 of it measured (12 Momentive/Shared, 12 Cust.)

- 15 Buildings = 80% of Consumption
- **The main users are Momentive buildings however not measured - *allocated***





Interesting Pareto Graph but No real usable information :

- **68 % of cons. is allocated to buildings**
- **32 % of cons. is measured – building individual measurement**

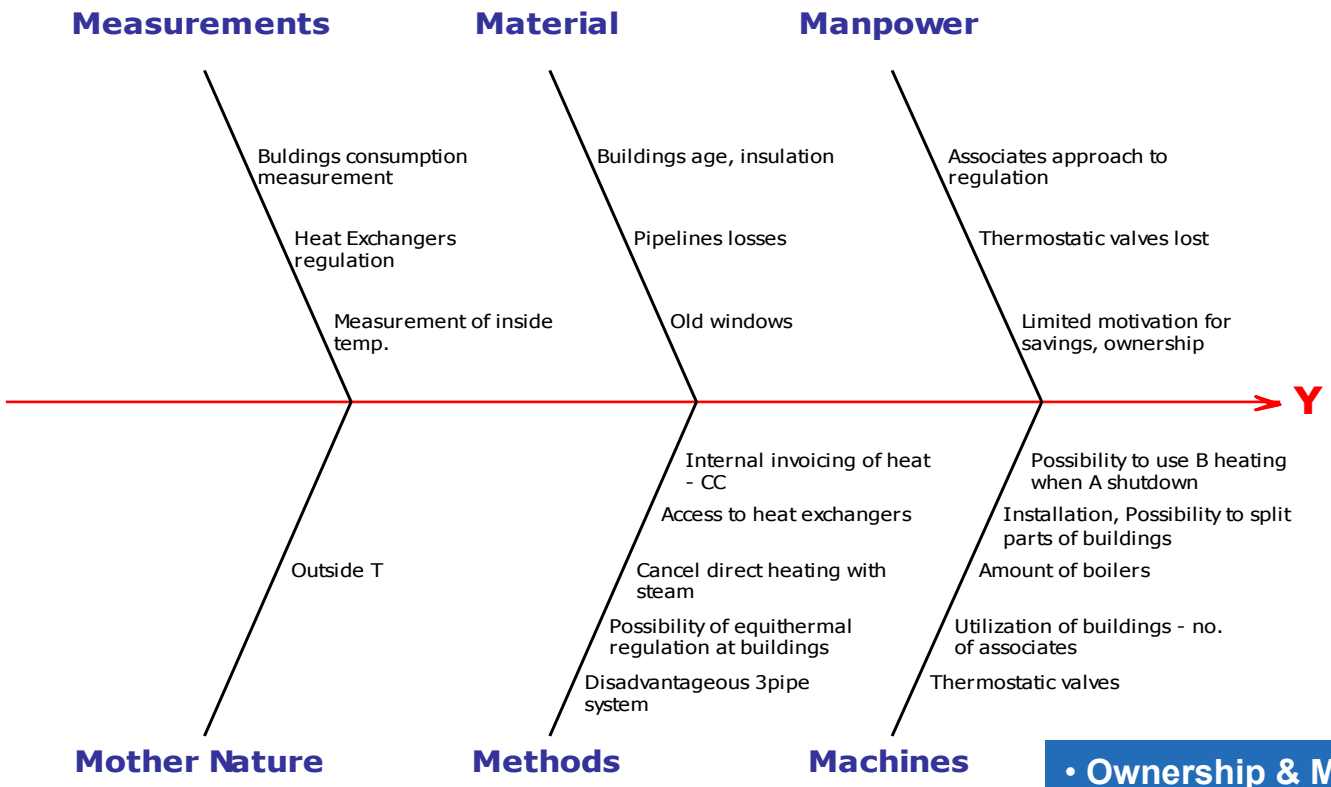
A6 – Prioritize the Xs, Cause and Effects Diagram (Fishbone)

Sokolov : Steam Consumption Reduction

C&E Diagram

Established at the team meeting, June 25th

HWS Energy Consumption (Steam - Condensate)



- **Ownership & Motivation !**
- **No. of Buildings & m3 heated !**
- **Measurement & Regulation !**

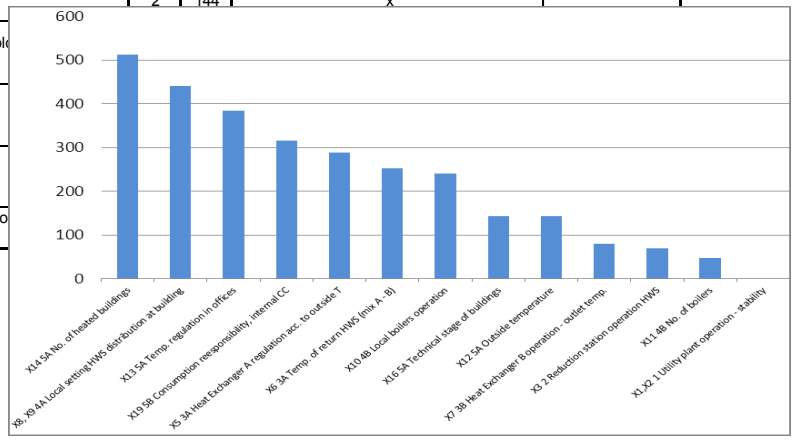
25.6.2013

A6 – Prioritize the Xs, FMEA

Sokolov : Steam Consumption Reduction

Established at the team meetings, July 11th and 31st

Process Function	Potential Failure Mode	Potential Effects of Failure	SEV	Potential Cause(s)/ Mechanism(s) of Failure	OCC	Current Process Controls	DET	RPN	Recommended Action(s)	Responsibility and Completion Date
X14 5A No. of heated buildings	neefektivní využití budov	zbytečná spotřeba tepla	8		8		8	512	zvážit uzavření budov, posoudit využití a možnost odstavení vytápění	6S Projekt - Improve
X8, X9 4A Local setting HWS distribution at building	nastavení přívodu v budově naplno, rozdělení větví		7	5 měsíců v roce, přechodové období	9		7	441	lokální či centrální ekvitermní regulace	6S Projekt - Improve
X13 5A Temp. regulation in offices	lidský faktor, nastavení termostatického ventilu, větrání, rozbití ventilu	vyšší spotřeba energie, vysoká teplota v kanceláři	8	nepoužívání termostatického ventilu nebo porucha	8	není kontrola provozovatelské kázně, není standard osazení ventilů ve všech prostorech	6	384	zaměstnanecká osvěta (ředitel), osazení ventilů a hlavic na žádost uživatele, nepoužívané kanceláře nevytápět, kontrolní měření, měření spotřeby všech budov	A. Zach, Vedoucí úseku (hlavice)
X19 5B Consumption reesponsibility, internal CC	spotřeba nejde na střediska	malá motivace	5	topné období	9		7	315	instalace měřidel na všechny budovy	6S Projekt - Improve
X5 3A Heat Exchanger A regulation acc. to outside T	příliš vysoká výstupní teplota - ruční ventil nastavení	vyšší spotřeba energie	8	5 měsíců v roce, přechodové období	9	teploměr zavedený DCS	4	288	Výměna stávající regulace za automatickou	Capex project
X6 3A Temp. of return HWS (mix A - B)	technické omezení snížení teploty	vyšší ztráty rozvodu a přetápění budov	7	5 měsíců v roce, přechodové období	9	detekce ano, ale není plně automatické	4	252	Změna třítrubkového systému na 4-trubkový, omezeně i dopad bodu X7 - spočítat návratnost vs. ekvitermní regulace	JK, MB
X10 4B Local boilers operation	teplota v boilerech dle normy s provozní rezervou	ztráty boileru a rozvodu topné vody a zvýšení T vratné vody CVS B	6	celoroční	10		4	240	snížení výstupní teploty CVS B	JK
X16 5A Technical stage of buildings	staré budovy se zastaralou koncepcí - střechy, okna, fasády, dveře	vysoké energetické ztráty	8	topné období	9	známý technický stav budov	2	144	investice do zateplení budov a zlepšení technického stavu vs. návratnost je dlouhá - obecně 10 let, nesplňuje požadavky firmy 2 roky návratnost	údržba - obměna oken dle havarijního stavu
X12 5A Outside temperature	chladnější rok		8		9		2	144	x	
X7 3B Heat Exchanger B operation - outlet temp.	příliš vysoká výstupní teplota - ruční ventil nastavení	vyšší spotřeba energie	5	riziko při změně odběru tepla, může dojít k výkyvu od nastavené hodnoty	4	tepl				
X3 2 Reduction station operation HWS	rozhození redukce, vysoký tlak LP		5		2					
X11 4B No. of boilers	zbytečné boilery ?		4		2					
X1,X2 1 Utility plant operation - stability	nestabilní parametry páry z kotelny	vyřeší X3	2		1	auto				



✓ **Process Inputs classified by RPN**

A7 – Financial Opportunity

Sokolov : Steam Consumption Reduction

MOMENTIVE

- **Initial Project Benefit :**
  - Reduce the Site Steam Consumption by **5%** against 2012 **= 24.571 GJ**
  - Recently working on **HWS (Heating)** only : to be reduced by **21,5%** to save **24.571 GJ**

- **Initial Project Benefit *Updated* :**

Established at the team meeting, July 31st

No.	Name	Action	Actual Consumption (2012)	Annual Savings		Note
			GJ	GJ	kCZK	
1	SO 207	Bunker - Close the heating	2651	2651	453	
2	SO 206	Fire Brigade -Decrease the temp. to 15C	14877	2000	342	
3	SO 206	Fire Brigade - Insulation and temp. regulation		4000	684	Capex Costs ?
4	HWS	HWS Automation		5000	855	Capex Costs ?
5	Regulation &Control	Installation of thermostatic valves (where missing), People Involvement		1500	257	
6	Equithermal Reg.	Equithermal Regulation installation for large buildings : 102, 118, 184, 148, 206, 004	27580	2500	428	Capex Costs ?
7	SO 1015	Garage - Close the heating	200	200	34	
8	Other	Revise other buildings usage	.....			
	TOTAL		**114016**	**17851**	**3053**	
	%			**16**		

Estimates!

PR. no. 6794

➢ **Revised Target : Reduce HWS Steam Consumption by 16 %, 17.850 GJ, 154 k$**

10	SO 750-758	Close the connecting pipe to 750-758 - Avoid the loss	400	400	68	
11	SO 907	Close the connecting pipe to 907 (Direct Steam), Avoid the loss	3500	3500	599	Alocation : 1113 GJ only

RTA no. 10151

A7 – Project Charter updated with Process Owner

Sokolov : Steam Consumption Reduction

- **Problem Statement**: Annual Sokolov steam consumption ifor HWS is 114.016 GJ (2012). It makes 23 % of site steam consumption which indicates potential opportunity for steam consumption reduction.
- **Objective**: Reduce the steam consumption for HWS by 16**%** from existing annual consumption 114.016 GJ (2012) to 96.165 GJ, as measured by LP steam volume for HWS no. 109, by Jan 1st, 2014.
- **Background**: Utility costs influence significantly the overall Sokolov site costs and are seen as a potential opportunity for considerable savings. There has been several measures taken in the past to optimize steam consumption especially at acrylic acid plants that are the main consumers however no overall effort has been so far taken to focus on the site as a whole. There is a BOS planned to take place in May 2013 that will focus on site steam costs and consumption, the ideas arised at BOS will be included in project.
- **Metric**: Primary : Monthly Steam consumption in GJ for HWS
  Secondary : Monthly Steam costs in CZK for HWS
- **Annualized Stake**: **3 mil. CZK (154 k$)**
  17.851 GJ x 171 CZK/GJ (variable costs) = 3.052.521 CZK x 0,0504 CZK/$ = 154 k$
- **Location**: Sokolov, Czech Republic.
- **Project Type** : Process
- **Approval**:
  - MBB: John C Dawson
  - Process Owner: Alois Zach

✓ **Project Charter updated after Analyze phase :**
- Reviewed with Alois Zach and Tom Farsky, Aug 7th
- Updated Project Charter Approved by the Champion

I8 – Identify Solutions : Improvement Strategy

Sokolov : Steam Consumption Reduction

MOMENTIVE

Improvement Strategy :

DOE Strategy or Trial Experiments ?

- **Vital Few Xs from Analyze Phase :**

Process Input X	Description	Category	Rsq	C&E Matrix Score	RPN Score
X6	Temp. of return HWS (mix A - B)	N	22	162	252
X13	Temp. regulation in offices	C/N	no data	160	384
X5	Heat Exchanger A regulation acc. to outside T	C/N	40	160	288
X4, X12	Outside temperature	N	82	160	144
X7	Heat Exchanger B operation - outlet temp.	C	40	144	80
X14, X15	No./m3 of heated buildings	C	no data, obvious	140	512
X19	Consumption responsibility, internal CC	C	no data	136	315
X8, X9	Local setting HWS distribution at building	C	no data	44	441
X10	Local boilers operation	C	no data	20	240
X16	Technical stage of buildings	N	no data	126	144

- **Solution may require several actions :**
  - Closing heating of some buildings or their parts
  - Regulation & measurement upgrade …more solutions versions, Capex needed
  - Associates involvement ……. ***independent alternative solutions.***

-> Trial Experiments

- **HWS Operation Optimization :**
  - Optimize HWS A (heating) and B (boilers, air conditioning) temperatures against outside temp. and GJ consumption (and inside T in the buildings)
  - Manual optimization as a temporary option → Target is Automation (Capex)

I8 – Identify Solutions : Generate Alternatives

Sokolov : Steam Consumption Reduction

MOMENTIVE

Team Meeting Sept. 4th, 2013

- **The Alternative Solutions were generated through Analyze phase :**
  - **FMEA** was the most helpful, already includes actions proposal
  - Team agreed to work with these proposals, there are no other potential solutions expected to be generated :

1 Change to 4 pipe CVS (Capex)
2 CVS Automation (Capex)
3 Local Equitherm Regulation for Large Buildings (Capex)
4 Local Actions at Buildings, Inside Meas. (°C)
5 Associates Involvement
6 Building Owner Responsibility, All Buildings Meas. (GJ), (Capex)
7 Combinations of any of the solutions 1-6

-> Screen Alternatives

- **Must Criteria :**
  - Consulted with local HS&E Specialist, Inside temperatures in the buildings
  - Administration type of work requires min. 20 C (20-26) as defined by NV 361/2007 Sb
  - Manufacturing & Workshop : depends on physical character of the work
  - Social rooms : 20 C (change clothe), 22 (bathroom), 25 (shower)

I8 – Identify Solutions : Screen Alternatives

Sokolov : Steam Consumption Reduction

MOMENTIVE

Team Meeting Sept. 10th, 2013

Criteria Based Decision Matrix used :

Criteria	Importance Rating	(Baseline Design)	Options						
			1 Change to 4 pipe CVS	2 CVS Automation	3 Local Equitherm Regulation for Large Buildings	4 Local Actions at Buildings, Inside Meas. (°C)	5 Associates Involvement	6 Building Owner Responsibility, All Buildings Meas. (GJ)	7 Combination : .....
1 Impact Level to CVS consumption in GJ	10	maximal impact	9	3	3	9	3	3	
2 Capex Payback (Maint. Costs) related with the Option	10	No Capex, < 2 years		3	3	9	9	3	
3 Resources requirement (personal)	4	involve associates		3		3	9	3	
4 Time requirement to realize the Option	2	< 6 months	1	3	3	9	9	3	
5 Sustainability of the Option	8	longterm	9	9	9	3		9	
Relative Ranking		0	164	150	138	234	174	150	0

- **Highest rank. Opt. 4 Local Actions & 5 Associates Involvement :**
  - Limited costs, Fast Implementation
  - Involves associates

- **However lower Sustainability :**
  - Prepare also longterm solution (Automation...), **Options Combination**
  - Consider options 2,3,6 – 2nd phase

I8 – Identify Solutions : Define your Objective

Sokolov : Steam Consumption Reduction

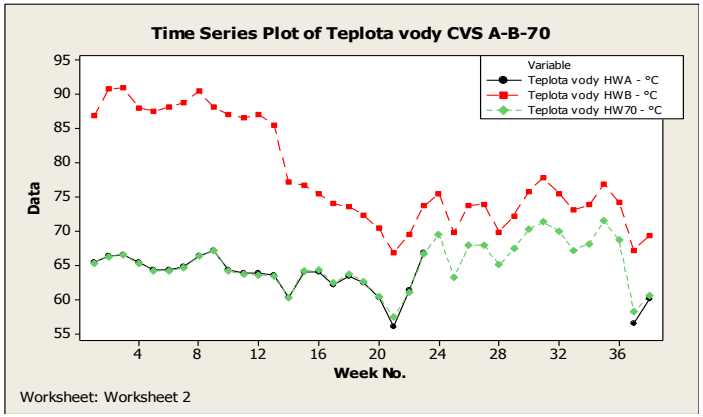
Team Meeting Sept. 10th, 2013

Combining Options from CBDM, Two steps planned :

- **(1) Take actions to arrange incremental steam consumption reduction for HWS through :**
  - **Manual HWS Optimization at Utility Plant**
  - **Associates Involvement :**
    - Update Communication Plan, 10-13
    - Prepare Associates Communication, 10-13
    - Town Hall Meeting, Q4 '13
  - **Local Actions at Larger Buildings** (most buildings)
    - Consider need for Inside T measurement, Consumption meas. (GJ)
    - Consider ability to regulate heating, propose changes, modifications

Objekt	Úsek	jméno	druh vytápěn	GJ	měřen	Prode	m2	GJ/m2	m3	GJ/m	Projekt	Spravi	Zajisti
													Priprava navrhu opatreni
SO 004	P6	sklad surovin a výrobků	HW - východ	13 907	ano		7580	1,83	69559	0,20	Ano	MM	MM
SO 005	P6	výrobní objekt dispersí	HW - východ	5 462			9140	0,60	26712	0,20	Ano	MM	MM
SO 029		doprava paliva a věž V1	HW - východ	100	ano	ano	220	0,45	10450	0,01	Ano		JK
SO 040	ONS	dílny údržby - provozov	HW - východ	4 733	ano	ano	9976	0,47	40300	0,12	Ne		
SO 041 z SO 040	ONS	soc. budova dílen PMCH	HW - východ								Ne		
SO 042 z SO 040	ONS	sklad - zakladač	HW - východ								Ano	JV (AWT)	TF
SO 048 Elis	Log	servis malé mechanizac	HW - západ	40	ano	ano	112	0,36	306	0,13	Ne		
SO 050	ONS	laboratoř P3 a soc. budo	HW - západ	797	ano		612	1,30	3681	0,22	Ne		
SO 053	NMS	sklad hořlavin	HW - západ	1 178			900	1,31	1824	0,65	Ano	JV (AWT)	TF
SO 060	PE	čistírna odpadních vod	HW - východ	841			408	2,06			Ano		JK
SO 069	PE	provozní budova ČOV	HW - východ	944			520	1,82	594	1,59	Ano		JK
SO 080 sezeni			HW - východ	330	ano	ano	78	4,23	1410	0,23	Ne		
SO 081 z SO 040	ONS	dílny dopravy	HW - východ						5436	0,00	Ano		MB, JK
SO 082	Log	garáže - staré	HW - východ	884			550	1,61	2756	0,32	Ano	JV (AWT)	TF, MB
SO 1002	P5	velín, rozvodna	HW - východ	566	ano		2295	0,25	9084	0,06	Ano		MP
SO 101	P5	HVO – KA1	HW - východ	578							Ne		
SO 1012	P5	velín stáčení	HW - východ	151			120	1,26	405	0,37	Ne		
SO 1015	Log	garáže - nové	HW - východ	41			225	0,18	872	0,05	Ano	RL	TF
SO 1018	ONS	budova OPV a OŽP, šat	HW - východ	1 299	ano		4455	0,29	13246	0,10	Ano		x

- **(2) Prepare Sustainable Solution (Capex) :**
  - **Automation, Regulation** to follow step (1)
  - At present HWS Manual Control – shift to Automatic
  - Mistake proofing
  - Expected to influence 2014/2015 heating season



Project Objective :

- Shift the mean in Y, HWS(GJ)=f(Outside T), reduce by 16%
- Improve Process Capability – Reduce Variability, Step (2 ?)

I8 – Identify Solutions : Risk Assessment

Sokolov : Steam Consumption Reduction

MOMENTIVE

Team Meeting Oct 3rd, 2013

Changes may effect mainly Associates, Compliance and Business :

Risk Assessment Tool

Last Revision : Oct 3rd, 2013

Team members :

Risk Issue	Prob	Imp	Initial Score	R/O/Y/G	Abatement Action	Red Prob	Red Imp	Rev Score	Rev R/O/Y/G	Owner	Measure of Success	Est. Comp. Date
Associates												
Reduced work comfort, Change not bought-in	5	1	5	Y	Education, ProjectAwareness							
Compliance												
Not meeting hygienic limits (temporary)	1	3	3	G	Education, ProjectAwareness, Installation of inside thermometers							
Business												
Increased costs due to damaged property, frozen pipes, condensation in buildings etc.	3	3	9	Y	Winter program : zvýšený dohled (6S team projít znovu), zimní opatření - komunikace projít topení, zavřít okna, zimní technická příprava údržby (nastavení vent., klim. Klapky…)							
			Red	0				Red				
			Orange	0				Orange				
			Yellow	2				Yellow				
			Green	1				Green				
			Total	3				Total				

-> Proceed with Caution : Focus on freezing – Winter program

I9 – Confirmation of Propoased Solution

Sokolov : Steam Consumption Reduction

- **Design the Trial Experiments :**
  - No Simulation nor Small Scale Experiments feasible
  - **1 Full Scale Experiment** : Associates Involvement & Local Actions at Buildings
    - Local actions at Buildings : Complete the actions list, Implementation
    - Launch the communication to associates, November

- **No Pilot Trial possible just 1 Full Scale Trial** – currently ongoing

- **Confirmation of Proposed Solution :**
  - **Mean** changed to – 478 GJ against the Fitted Value
  - **Variability** has not changed statistically : it is given by the design and manual control, it can be partly improved via planned 2nd phase solution HWS Automation&Regulation and Equitherm Regulation

- **Evaluate the trial by Dec 2013** – the results can differ during the freezing
- **Prepare 2nd phase Solution**

I9 – List of Critical Xs with levels or configuration

Sokolov : Steam Consumption Reduction

Objekt	Úse	jméno	druh vytápění	GJ	měřen	Prode	Opatření porada 25.9	Odp.	porada 3.10	porada 6.11
SO 004	P6	sklad surovin a výrobků	HW - východ	13 907	ano		ověření nákladů na zateplení vrat, sledování teplot v jednotlivých místnostech	MM		stacirna se vytapi cela v mezidobi kvuli socialnim mistnostem, umoznit odpojeni, na 1 vetvi, seznam na upravy predlozi MM - realizace 2014
SO 005	P6	výrobní objekt dispersí	HW - východ	5 462			přestavení klimatizace na 18C, chodby bez topení nyní	MM		
SO 029	**PE**	**doprava paliva a věž**	HW - východ	100	ano	ano	sahary, topí se naplno, vedro, disciplína a organizace!	JK		
SO 042 z SO 040	**ONS**	**sklad - zakladač**	HW - východ				osazeni mereni spotreby tepla, fakturace, nova smlouva od 01.2014, overit provozni podminky T pro zakladac, vrata zaves, obsluha v kanc., mereni vnitrni	JV		dle jednani 31.10 odhadne p. Vojacek naklady na bunku vs. upravy kancelari a prinos - uspory, mereni spotreby tepla ?
SO 050	ONS	laboratoř P3 a soc. budo	HW - západ	797	ano		odstavit 1 ks boiler - v provozu byl jen 1 ks	MB		
SO 053	**NMS**	**sklad hořlavin**	HW - západ	1 178			ukoncit vytapeni (cil) nebo osazeni mereni tepla a fakturace, nova smlouva od 01.2014, lze zavřít topení v některých místnostech ?	JV		dle jednani 31.10 ukonceni vytapeni mistnosti sklad ND a sklad barev, schvalit JV a AWT
SO 060	***PE***	**čistírna odpadních vod**	HW - východ	841						
SO 069	***PE***	**provozní budova ČOV**	HW - východ	944			velín 3 velké radiátory - chybí termostatické hlavice, pozavírat kamrlíky	JK, MB		
SO 081 z SO 040	ONS	dílny dopravy	HW - východ				mycka aut - uspora topeni a udrzba			
SO 082	**Log**	**garáže - staré**	HW - východ	884			AWT plus udrzba - moznost presunu (?) JV	JV		dle jednani 31.10 neni vyznamne, pouze opravy osvetleni
SO 1002	P5	velín, rozvodna	HW - východ	566	ano		dílny opraveny ventily, kanceláře v pohodě, rozvodny nemají topení, ok - hotovo	MB	hotovo	
SO 1012	P5	velín stáčení	HW - východ	151			oživení ekvitermní regulace	MP		
SO 1015	Log	garáže - nové	HW - východ	41			uzavřít přívod topné vody, přestat vytápět	TF, RL		
SO 1018	ONS	budova OPV a OŽP, šat	HW - východ	1 299	ano		zjistit, zda je osazena ekvitermni regulace, pokud ne, kandidát na osazení	JK		
SO 102	P5	velín, trafo, rozvodna	HW - východ	6 415			odpojit teplou vodu velín, je nové topení/klima el.	MP		
SO 1020	P5	kompresor. stanice vzd	HW - východ	477	ano		seškrtit přívod topné vody u topných těles	MP	hotovo	zavrit - behem odstavky se topilo, kontrola (MP)
SO 907	OUS	dílny OÚS (bývalé elekt	pára Západ	1 702			ZPA, Framac, nase rozvodna		dle review s AZ navrhnout vyu6it9 SO700	
SO 908 z SO 909	ONS	budova výstavby	HW - jih	176	ano		projít prázdné kanceláře, dát ventily na hvězdičku	J		
SO 909	ONS	budova projekce	HW - jih				projít prázdné kanceláře, dát ventily na hvězdičku	J		
SO 910	**PE**	**sklady, dílny**	pára PE	210			patří odborům, topeno párou, hlídá energetika			

✓ **Local Actions :**
- 47 Buildings Included
- Defined Actions

C10 – Control Plan

Sokolov : Steam Consumption Reduction

MOMENTIVE

Team Meeting, Nov 26th, 2013

DMAIC Control Plan

Project:	**Sokolov : Steam Consumption Reduction**	Date (Orig):	26.11.2013	
Key Contact:	Tomas Franc	Date (Rev):		
Core Team :	J. Kotrba, M. Behunek, J. Knir, M. Masek, S. Cizek, R. Kovac, T. Otta, M. Panzer	Authorized By:		Date:
Sponsor:	A. Zach	Signature:		

Department/ Individual	What must be controlled?	Project Y,X,or other?	Require-ments (specs)	Ongoing Control Mechanisms	Measurement Plan				Response Plan		
					Meas'ment Technique	Sample Size	Fre-quency	Who Measures?	Action	Timing	Owner
Utility Plant	HWS (GJ) = f(outside T)	Y	Reaching the project target -16% against 2012	control chart	GJ steam, cond., outside T	continuous m.	weekly	technologist	1. check CVS regulation	when out of spec. limits	Utility Plant
									2. analysis of all data - consumption of all measured buildings, individual flows	when out of spec. limits	Utility Plant
									3. physical control of all heat exchanger/distribution station - check the setting	when out of spec. limits	Utility Plant
Utility Plant	HWS A, B	X6-X7-X8	values according to equitherm curve	T (HWS A/B) = f(outside T)	T HW 90A, 90B, HW70	continuous m.	daily	technologist UP	change temp. setting, inform operator	deviation of average temp. from eq. curve >3C	technologist UP
Utility Plant	steam cons. (GJ) of ind. building	X19	YTD Consumption not exceeding the previous YTD consumption or a target	YTD GJ spent against the last year (and against the target)	GJ consumption - ind. build.	monthly reading of meters	monthly	technologist UP	monthl information for dept. leaders when above targ, physical checking of the heating system	monthly	dept. leader
Dept. Leaders	inside temp., C	X13	according to hygienic limits and type of use of building/room	local temp. measurement as needed	thermometer	as required	continuous	department	change the heating setting	immediately	dept. leader
Dept. Leaders, Building Owner, Utility Plant	winter measures - start and end of the winter	X13	no freezing of pipes/equipment in the winter, no overheating in the autumn/spring	physical inspection and setting the heating prior to and after the winter (freezing)	physical inspection and setting the system	N/A	twice a year	department (setting the heating)	N/A - preventive measure taken	N/A	N/A

✓ **Control Plan Implemented**

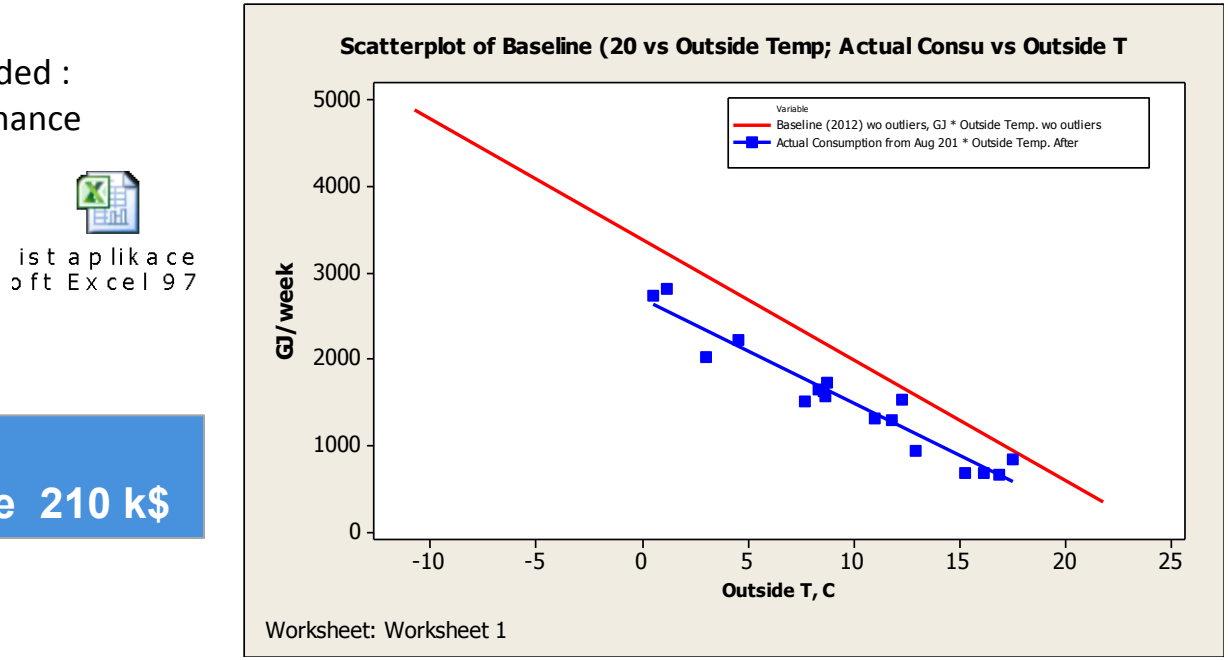
C10 – Final Benefit Calculation

Sokolov : Steam Consumption Reduction

- **Hard Savings :**
  - Based on Weekly CVS Heat Measurement (Steam – Condensate) and Outside Temp., C
  - Comparing actual week heat consumption in GJ against Baseline (2012) consumption for actual temp., Y=f(Outside Temp.)
  - Steam Direct Costs Included : 171 CZK/GJ
  - **Estimated Hard Savings : 229 k$**
  - Calculation : 114.016 GJ (Cons. 2012) * 0,221 (% savings) * 171 CZK/GJ (direct costs) / 18,852 CZK/$
  - 22,1 % Savings considered based on actual savings average roughly 25% (3 months only)

- **Hard Costs :**
  - Actions based on 6S project included :
  - Mostly Regulation valves, Maintenance
  - Maint. Tracking SAP
  - **Estimated Hard Costs : 19 k$**

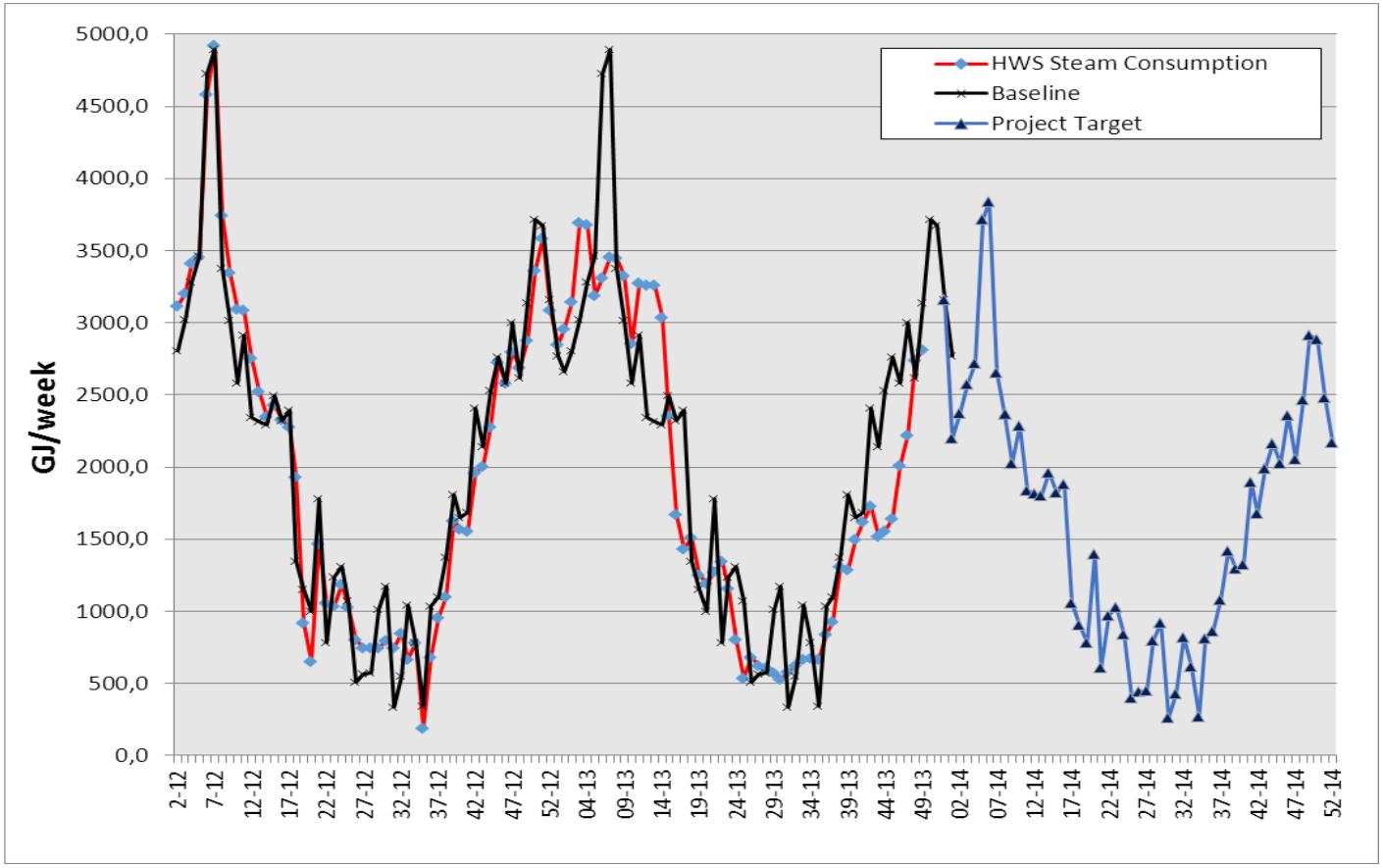
✓ **YTD Benefit 95 k$**
✓ **Annaul Benefit Estimate 210 k$**



Metric Graph Update

Sokolov : Steam Consumption Reduction

- Comparing the Actual with Baseline
- Not considering Actual Outside Temp.
- Faster Implementation of Changes



Leverage Learnings
Sokolov : Steam Consumption Reduction

- **Complex Project with ~ 60 buildings heated, main actions :**
  - Control of HWS A/B temp. according to Equithermal curve
  - SO 207 Bunker: Heating minimized, 08-2013
  - SO 206 Fire Brigade & Archive : Archive heating regulated, Fire Brigade monitored, actions in 03-2014 (venting)
  - SO 004 Dispersions Warehouse : Temperature monitoring, seasonal optimization
  - SO 005 Manufactring Dispersions Lowe setting for Air Conditionning temp.
  - SO 042 Spare parts warehouse : Termostatic valves, temp. regulation (15 C), costs invoiced from 01-2014
  - SO 053 Flammable Liquids Warehouse : Closing heating of 2/3 of building
  - SO 700 Logistic building : emptied, heating minimized to avoid frost
  - Minimizing heating at rooms&buildings that are not used – P5, P6, PE, administration
  - Seasonal regulation of heating : avoid overheating in the spring&autumn
  - Minimizing circulation of HWS water without use, closing by-pass…
  - SO 184 Administration building : Old windows replacement supporting the project
  - SO 116 P5 : Lowering inside temp.
  - Maintenance : Termostatic valves repair&installation

- **Sustain the solution – actions described in the Control Plan :**
  - Seasonal ctions needed to avoid demage (due to frozen pipe) and overheating

- **Start the Control Phase**

➢ **Planning to close the Project in Dec**
➢ **Realization Phase : Monthly Review**

Leverage Learnings
Sokolov : Steam Consumption Reduction

- **Actions :**
  - Control of HWS A/B temp. according to Equithermal curve
  - SO 207 Bunker: Heating minimized, 08-2013

- **Sustain the solution – actions described in the Control Plan :**
  - Seasonal ctions needed to avoid demage (due to frozen pipe) and overheating

- **Start the Control Phase**

- **Planning to close the Project in Dec**
- **Realization Phase : Monthly Review**