



ABB Global Consulting, APW 2011, Orlando

Industrial Energy Efficiency Metals Industry Case Study

Introduction

ABB Global Consulting

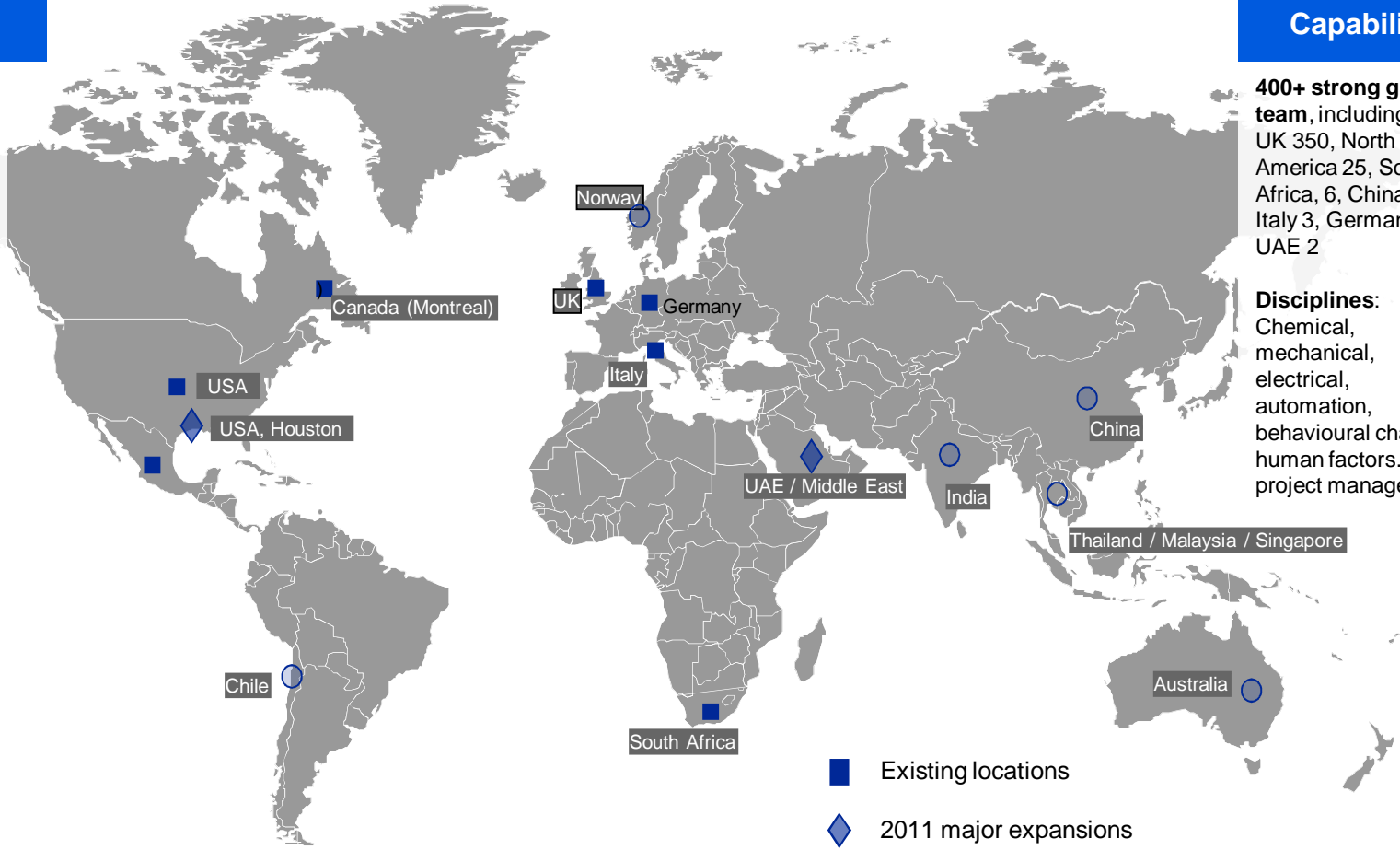
Products

- Industrial Energy Efficiency
- Process Safety Management
- Asset Reliability & Integrity
- Operations Improvement

Capability

400+ strong global team, including:
 UK 350, North America 25, South Africa 6, China 6, Italy 3, Germany 2, UAE 2

Disciplines:
 Chemical, mechanical, electrical, automation, behavioural change, human factors, project management



- Existing locations
- ◆ 2011 major expansions
- 2012 expansions



Industrial Energy Efficiency

Case Study Overview



Integrated Steel Mill,
Southern Europe

Industrial Energy
Efficiency scope:

Opportunity
Identification Study on
electrical systems

Energy Master Plan
to develop Project
Specifications for top
5 projects

- Industrial Energy Efficiency programme
 - Integrated Steel Mill, Southern Europe
- 53 Individual energy saving opportunities identified
 - Estimated electrical savings \$5.5M to \$6.8M/year
 - Additional gas savings of up to \$8.2M per year
- 3 Opportunities agreed for immediate implementation
 - Zero capital investment opportunities
 - Energy saving of \$180K/year, payback <1 year
- 5 Project Specifications developed
 - Energy savings up to \$2.05M/year
 - Averaged payback on portfolio of < 2 years

The Industrial Energy Efficiency programme at the site focussed on key plant areas, including:

- BOF Steelmaking plant
- Blast Furnaces
- Cowper Stoves
- Power Plant
- Sintering Plant
- Hot Rolling Mill

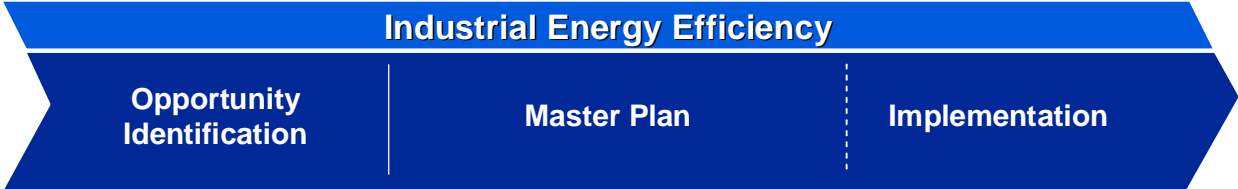
"We are very pleased with the results. ABB have defined very clearly where energy can be saved and how to achieve it. The work is really appreciated. It is better than just an audit"

**European Energy
Manager**

Industrial Energy Efficiency Site Based Program Overview

ABB's proven methodology to help customers reduce energy consumption.

Industrial Energy Efficiency is a 3 phase program, designed to deliver sustainable energy savings:



“Find the Savings”

- On-site Assessment
- Recommendations
- Technology & Control
- Behaviours & Practices
- Monitoring & Targeting

“Develop the Solution”

- Solution Options
- Cost Estimates
- Payback & ROI
- Project Specification

“Gain the Benefits”

- ABB Services
- ABB Technologies
- Solution Implementation
- Measure Success
- Quantify Benefits

5% to 20%

Industrial Energy Efficiency saves between 5% and 20% of our customers energy bill, dependent upon the industry and site specifics.

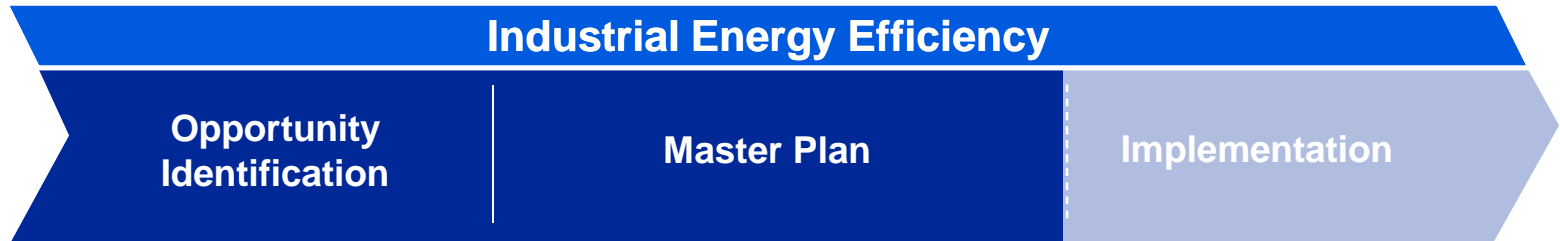
US\$ 75M

Total energy saved per year, every year, via Industrial Energy Efficiency (IEE) across all industrial sectors since 2006.



Industrial Energy Efficiency

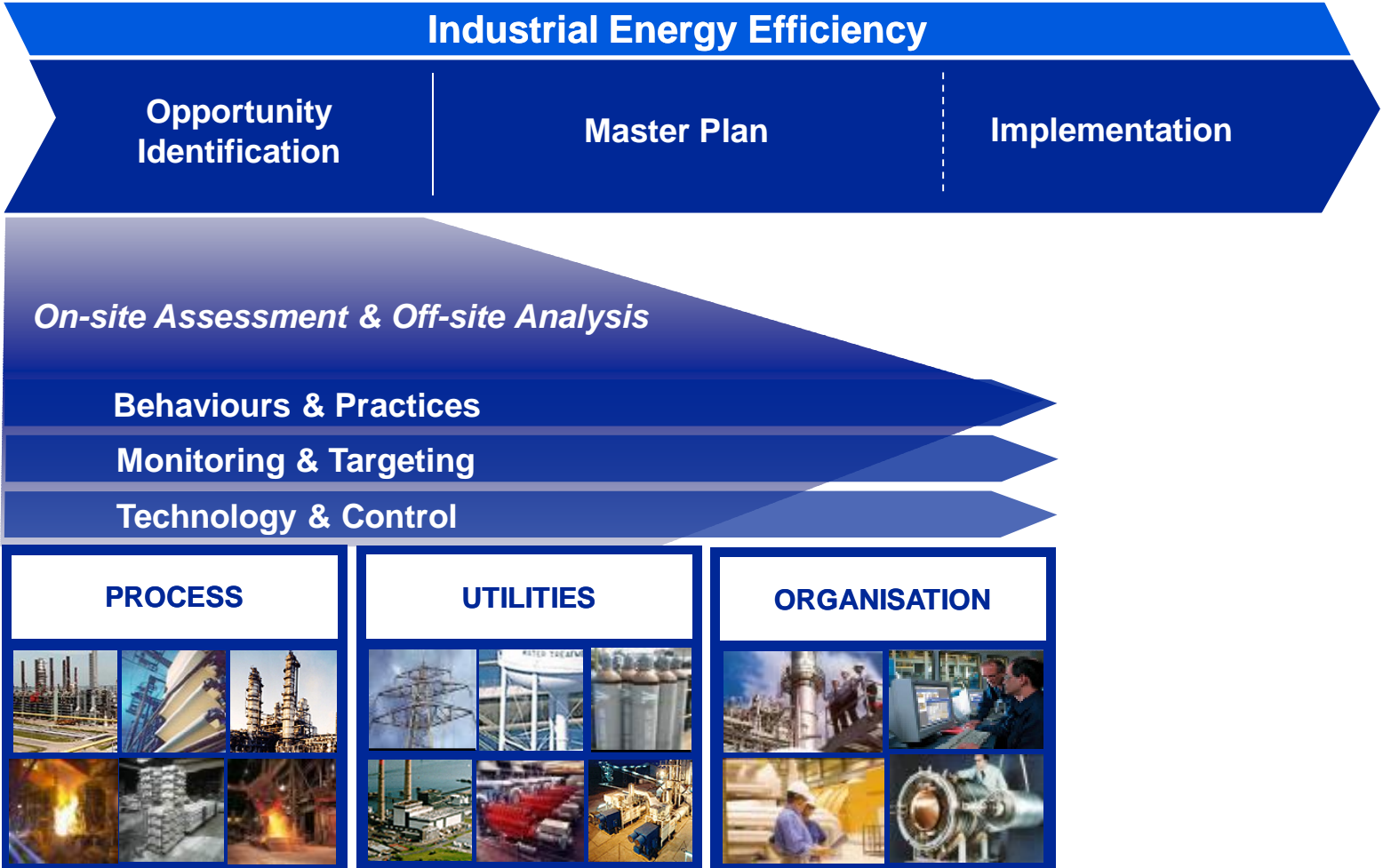
Scope of Supply



- Opportunity Identification Study (Electrical Systems Only)
 - Hot Rolling Mill
 - 13 other major electricity consumer areas
- Energy Master Plan
 - Limited to the 'Top 5' Opportunities
 - Alignment Workshop & Prioritisation Process
 - 5 Project Specifications to be developed

Industrial Energy Efficiency

Opportunity Identification Overview



Opportunity Identification

Plant Areas/Unit Processes Considered



BOS & Sinter Plants

Ventilation systems – 1st, 2nd & 3rd fume catchment drivers. Sinter line combustion air control system and optimisation.



Blast Furnace Plant

Grinding & charging plants, Cowper stove operation, blast furnace auxiliary equipment and drives.



Power Plant

Power plant optimisation and control. Optimum boiler combustion air and draught pressure control.

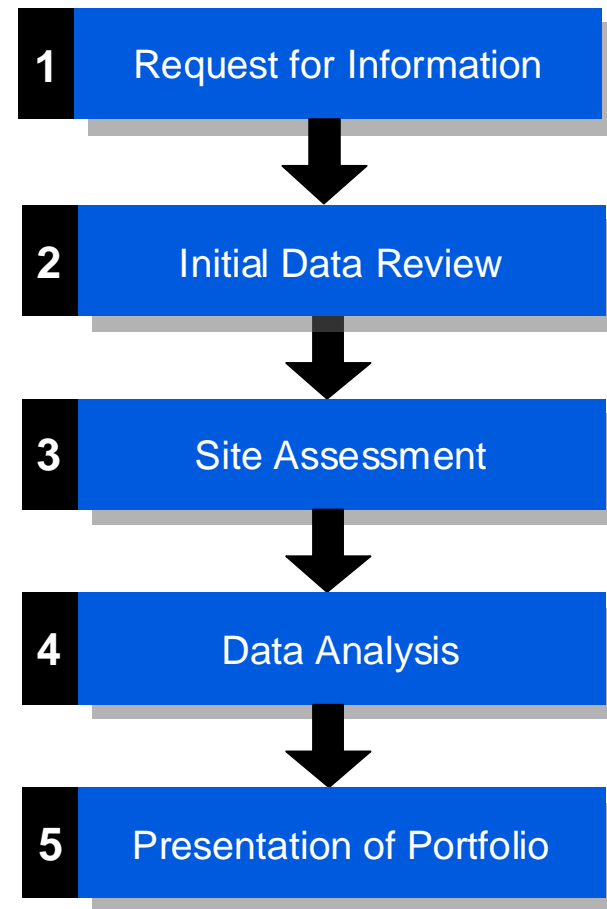


Hot Rolling Mill

Cooling water systems, rolling mill drives, pumps, fans etc. Compressed air system overview.

Opportunity Identification Engagement Process

- 1st Phase completed Dec 2008
- Completed within 8 weeks
- Conducted by:
 - ABB Energy Consultants
 - ABB Specialist Engineers
- Supported by:
 - Site Operations Personnel
 - Energy Manager
- Staged Approach
- On Site Assessment
- Remote Analysis



OPPORTUNITY IDENTIFICATION PORTFOLIO



Date: 06/12/2010

Revision: 0

Plant Area	Opp. ID.	Opportunity Title	Energy Savings (kWh or k€ diesel)		kg CO ₂ Reduction		Energy Savings (R '000s)		Opp'	Energy Type	M&T Requirement		Order of Cost	Comments	
			Low	High	Low	High	Low	High			Type	Criticality			Priority
Co-disposal	ID-29	Replace trucked haulage with conveyors	39	131	38	125	300	900	T&C	Electricity	-	-	High		
Co-disposal	ID-28	Reduce water haulage from discard silo	5	10	13	26	34	68	T&C	Diesel	-	-	Medium		
Co-disposal	ID-30	Establish active co-ordination between control room and co-disposal area	5	10	13	26	34	68	B&P	Diesel	-	-	Low		
Co-disposal	ID-31	Optimise dump truck loading	2	5	7	13	17	34	B&P	Diesel	-	-	Low		
Co-disposal (extra)	ID-27	Generate own power utilising discarded product material	2,800	6,000	2,682	5,746	7,000	15,000	T&C	Electricity	-	-	Very High		
Compressed Air System	ID-03	Fix air leaks	39	78	37	75	100	200	B&P	Electricity	-	-	Medium		
Compressed Air System	ID-06	VSD on process flotation compressor	7	21	7	20	17	55	T&C	Electricity	-	-	Low		
Compressed Air System	ID-07	Reduce delivery pressure on plant instrument air	6	12	6	11	15	30	T&C	Electricity	-	-	Low		
Compressed Air System	ID-08	Measure air flow & kWhrs to compressors (in general)	4	8	4	8	10	20	M&T	Electricity	Essential	Low	Low		
Electrical Systems	ID-10	Power factor correction	240	300	230	267	600	750	T&C	Electricity	-	-	Medium		
Electrical Systems	ID-11	Motor replacement policy	100	300	96	267	250	750	B&P	Electricity	-	-	Low		
Electrical Systems	ID-12	Motor replacement policy - rewinds vs high efficiency							B&P	Electricity	-	-	Low	Combined with ID-11	
Flotation Plant	ID-01	Switch off 18 Bar compressor feeding filter presses	120	200	115	192	300	500	T&C	Electricity	-	-	Low	Only applicable when running both filter presses	
Flotation Plant	ID-02	VSD - 18 Bar compressor feeding filter presses	36	108	34	103	90	810	T&C	Electricity	-	-	Medium		
Flotation Plant	ID-04	Reduce flotation process air delivery from 6 Bar to 3 Bar	10	30	10	29	25	75	T&C	Electricity	-	-	Low		
Flotation Plant	ID-14	Eliminate spill-back from head tank: VSD on flotation feed pump	14	29	14	28	36	72	T&C	Electricity	-	-	Medium		
Flotation Plant	ID-05	Feed compressors with cooler external air	12	24	11	23	30	60	T&C	Electricity	-	-	Medium		
Main Plant	ID-20	Establish effective switch-off policy	57	300	55	267	150	750	B&P	Diesel	Beneficial	High	Low	Establish active co-ordination between Control Room and Stockyard. M&T requirement is to establish reliable continuous monitoring of overall plant consumption.	
Main Plant	ID-26	Prevent sump pumps running dry	40	108	38	103	100	270	T&C	Electricity	Beneficial	Low	Low		
Main Plant	ID-17	Optimise frequency and / or amplitude of vibrating screen operation	0	80	0	77	0	200	T&C	Electricity	Beneficial	Low	Low		
Main Plant	ID-15	VSDs on correct medium pumps	30	60	29	57	75	150	T&C	Electricity	-	-	Medium	Study already completed. Report available.	
Main Plant	ID-18	Optimise water usage	32	60	31	57	80	150	T&C	Electricity	Beneficial	High	Medium	M&T requirement is to establish reliable continuous monitoring of overall plant consumption and use this to measure impact of this improvement.	
Main Plant	ID-16	Reduce water leakage to reduce recycle costs	4	12	4	11	10	30	B&P	Electricity	Beneficial	Low	Low		
Main Plant	ID-19	Monitoring & Targeting on correct medium pump K52	2	5	2	5	6	12	M&T	Electricity	Essential	Low	Low	Pick up early warning of deterioration of pumps	
Overland Conveyors	ID-24	Extend the benefit of the DSM project by including the morning slot	132	180	126	172	330	450	B&P	Electricity	Essential	High	Low	M&T capability is only "Essential" to realise the savings potential of this opportunity as the benefits must be demonstrated but it is noted that the necessary elements already exist.	
Overland Conveyors	ID-22	Reduce weight of water transported overland in FTP coal	6	131	5	125	14	327	B&P	Electricity	-	-	Low		
Overland Conveyors	ID-23	Control overland conveyor speeds to optimise conveyor loading (conveyors WITH installed VSDs)	10	50	10	48	25	125	B&P	Electricity	Essential	High	Low	Much of the M&T infrastructure is already in place. Load cells are installed and working and the installed VSDs should have the capability to monitor power draw, speed, etc.	
Overland Conveyors	ID-21	Control overland conveyor speeds to optimise conveyor loading (conveyors WITHOUT installed VSDs)	8	40	8	38	20	100	T&C	Electricity	Essential	High	High	Much of the M&T infrastructure will be in place if this opportunity is implemented as VSDs will be installed and it is understood that load cells are already installed and working.	
Stockyards	ID-25	Improved ROM stockyard management	100	600	268	1,608	250	1,500	B&P	Electricity	Beneficial	High	Low	Enhancing the M&T infrastructure for the RoM stockyard, to match that in place for the Plant, will make it possible to actively monitor and sustain this improvement.	
Stockyards	ID-13	Replace FELs in product emergency stockpile with mobile conveyor and back-hoe	7	14	19	38	50	100	T&C	Diesel	-	-	Medium		
			Energy Savings (kWh)	3,792	6,566	3,904	9,503	9,954	23,229						
			Energy Savings (k€)	76	339										

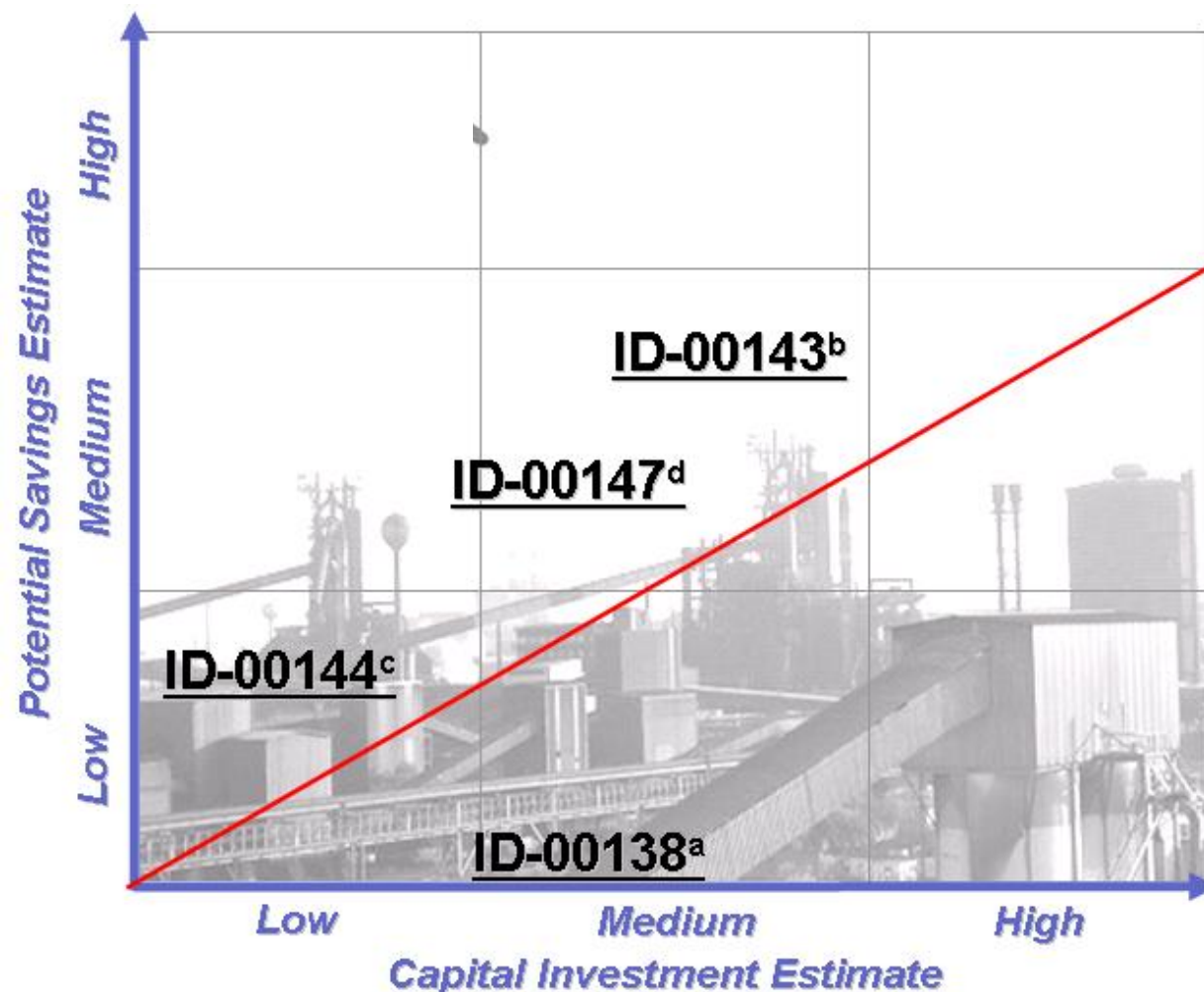
Legend

- Energy saving opportunity proposed for next phase Alignment Workshop
- N/A Not applicable at this stage of the IEE Opportunity Identification process
- T&C Technology and Control
- B&P Behaviours and Practices
- M&T Measurement and Verification



Opportunity Identification

Payback Chart – Blast Furnace Area



^a Includes ID-00139, 140, 141, 142, 148 & 150

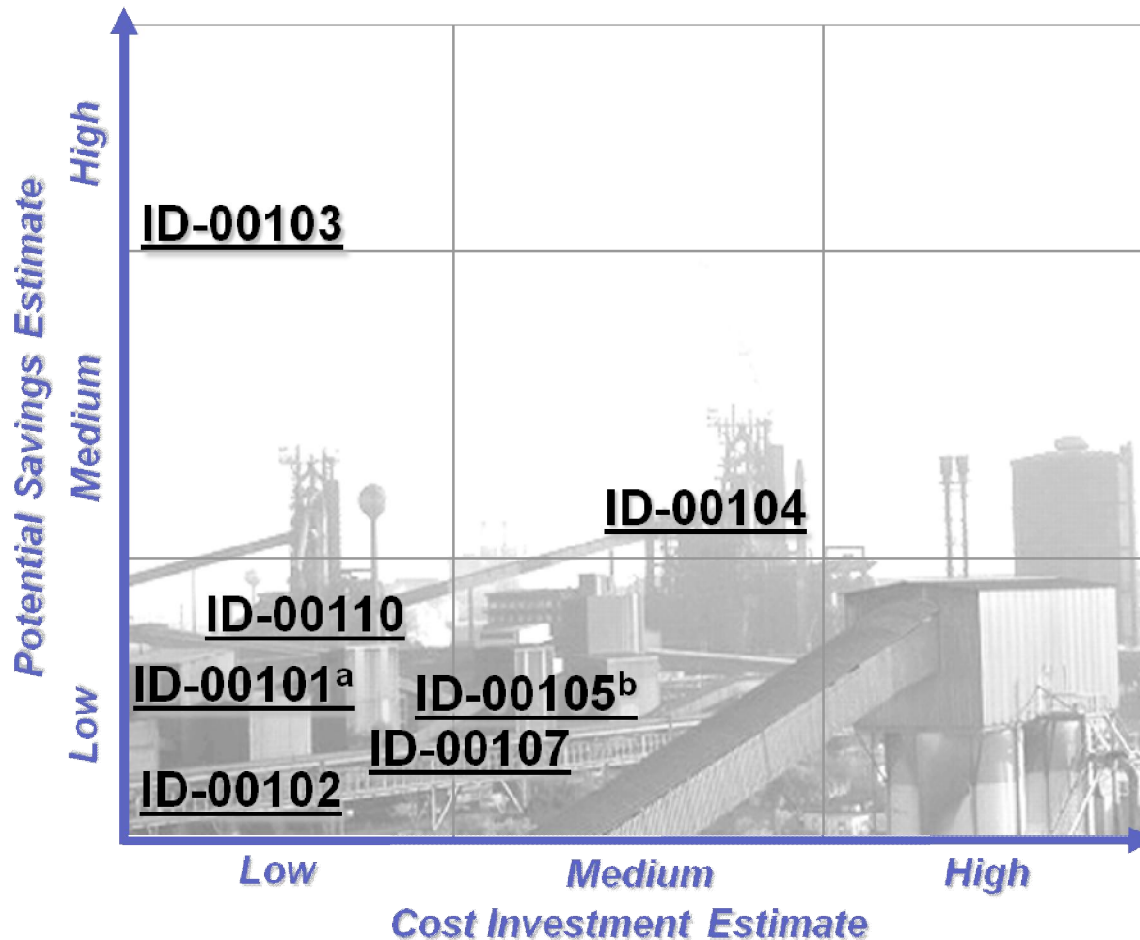
^b Includes ID-00145 ^c Includes ID-00146

^d Includes ID-00149

Project Considered	
ID138	BF Raw Material Prep
ID139	Charging & Grinding
ID140	Plant de-dusting
ID141	extraction Fan VSD
ID142	Installation
4.4	
ID143	BF Combustion Air Fan
ID145	BF1 & BF2 Cowper
4.3	Stove FD Fan VSD
	Installation
ID144	BF Comb Air Header
ID146	BF1 & BF2 Cowper
4.3	Stove Combustion Air
	Header Pressure Control
ID147	BF Lurgi Fans
ID149	BF1 & BF2 Tapping
	Fume Extraction Fan
	VSD Installation
ID148	BF Intensiv Fans
ID150	BF1 & BF2 Torpedo
	Fume Extraction Fan
	VSD Installation

Opportunity Identification

Payback Chart – Hot Rolling Mill



Project Considered	
ID101 3.2.1	PXXQ (Dys Chassess) VSD Installation on 1 x Pump
ID102 3.2.1	PXXW (Dys Agitation) VSD Installation on 1 x Pump
ID103 3.2.1	PXX Pressure Control Pumping System Pressure
ID104 3.2.1	PXX Pumping System VSD Installation on 1 x Pump
ID105 ID106 ID108 3.2.1	PXX, PXY, PXZ Pumps VSD Installation on 1 x Pump in each above pumping system
ID107 3.2.1	PXX Pumping System VSD Installation on 1 x Pump
ID109 3.2.1	SX Cooling Tower Reduce 'overcooling' – elevate CW temperature
ID110 3.2.1	SX Cooling Tower VSD Installation on Fans

Opportunity Identification

Quick Win Example

PLANT AREA

- Blast Furnace Cowper Stoves

OPPORTUNITY IDENTIFIED

- Optimum combustion air header control
- IGV controlled combustion air fan operating at less than optimum performance for system demand

SOLUTION

- Eliminate opportunity for variable speed drive
- Downgrade to redundant lower sized fan & motor

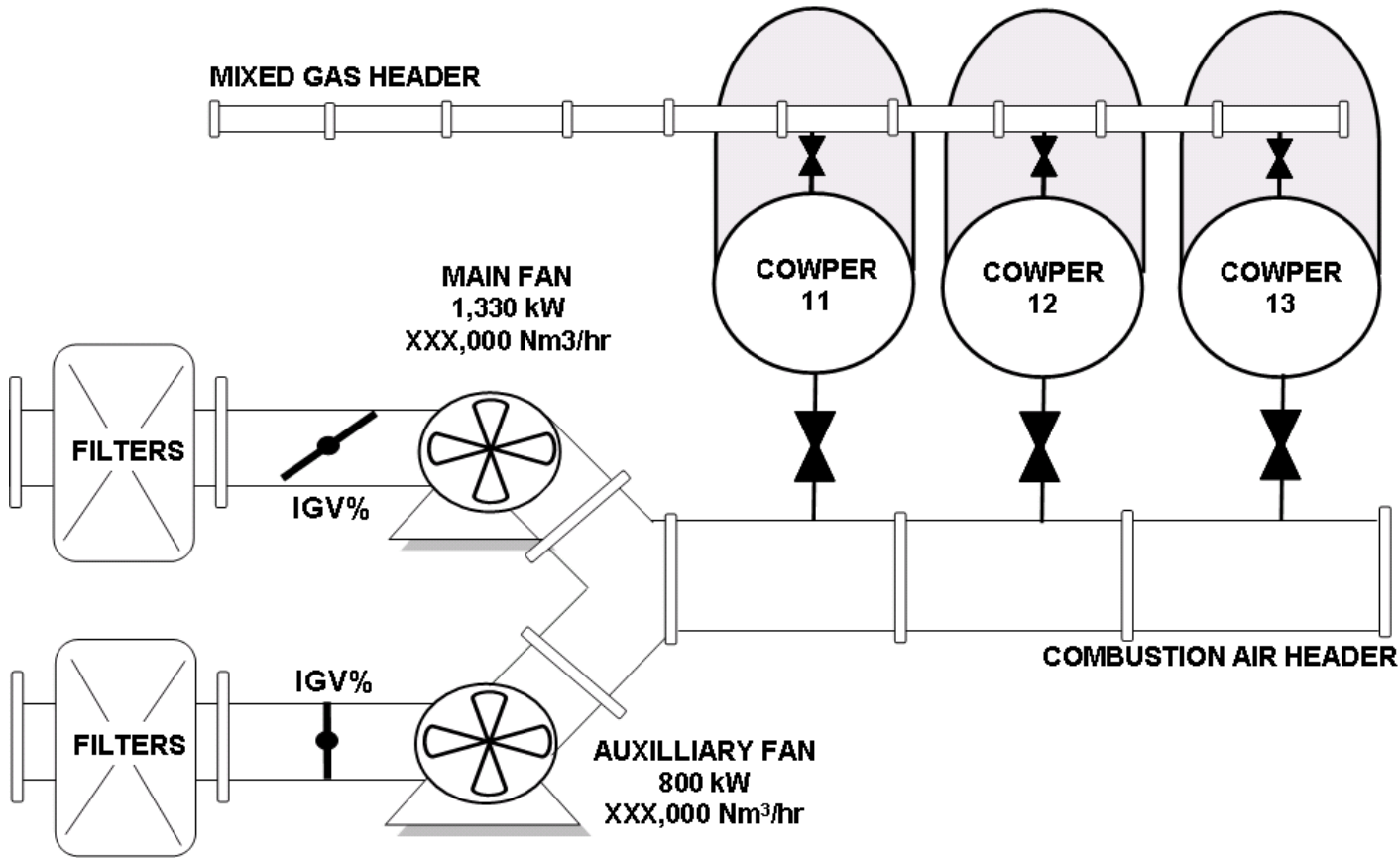
VALUE

- \$50K per year electricity savings
- Less than 1 year payback (including verification)



Opportunity Identification

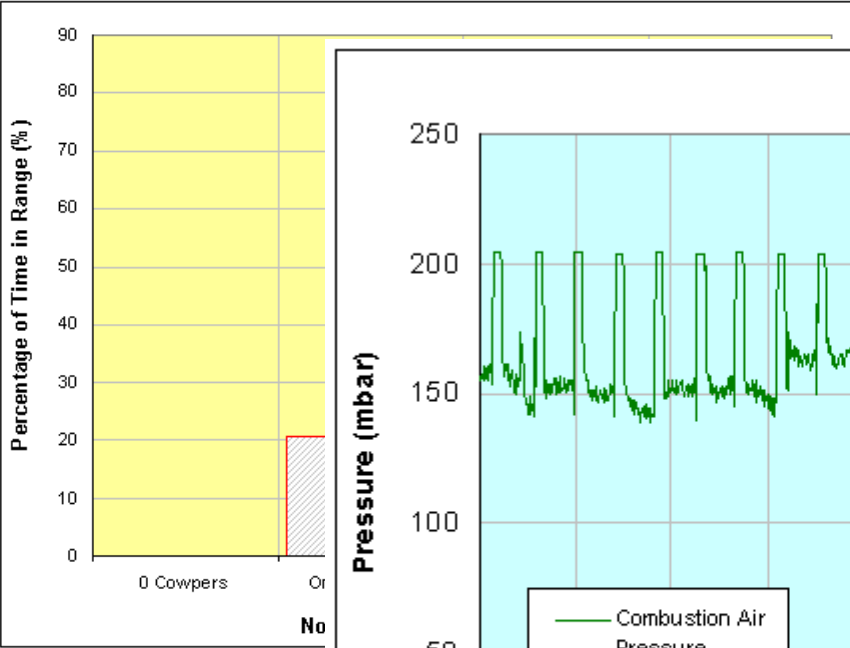
Quick Win Example



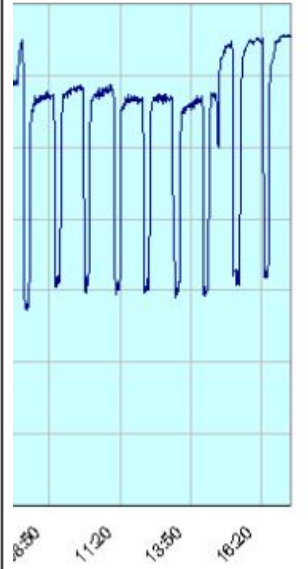
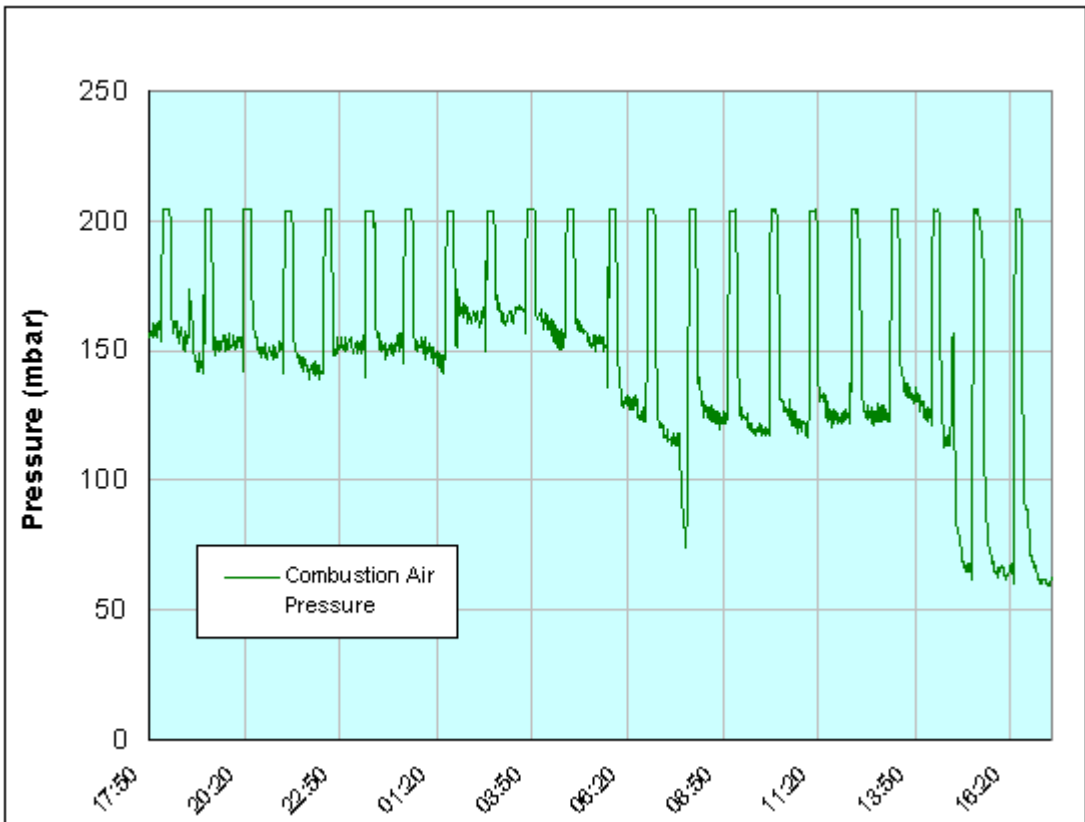
Opportunity Identification

Quick Win Example

Cowper stove firing range:
Percentage of time Cowper stoves are fired



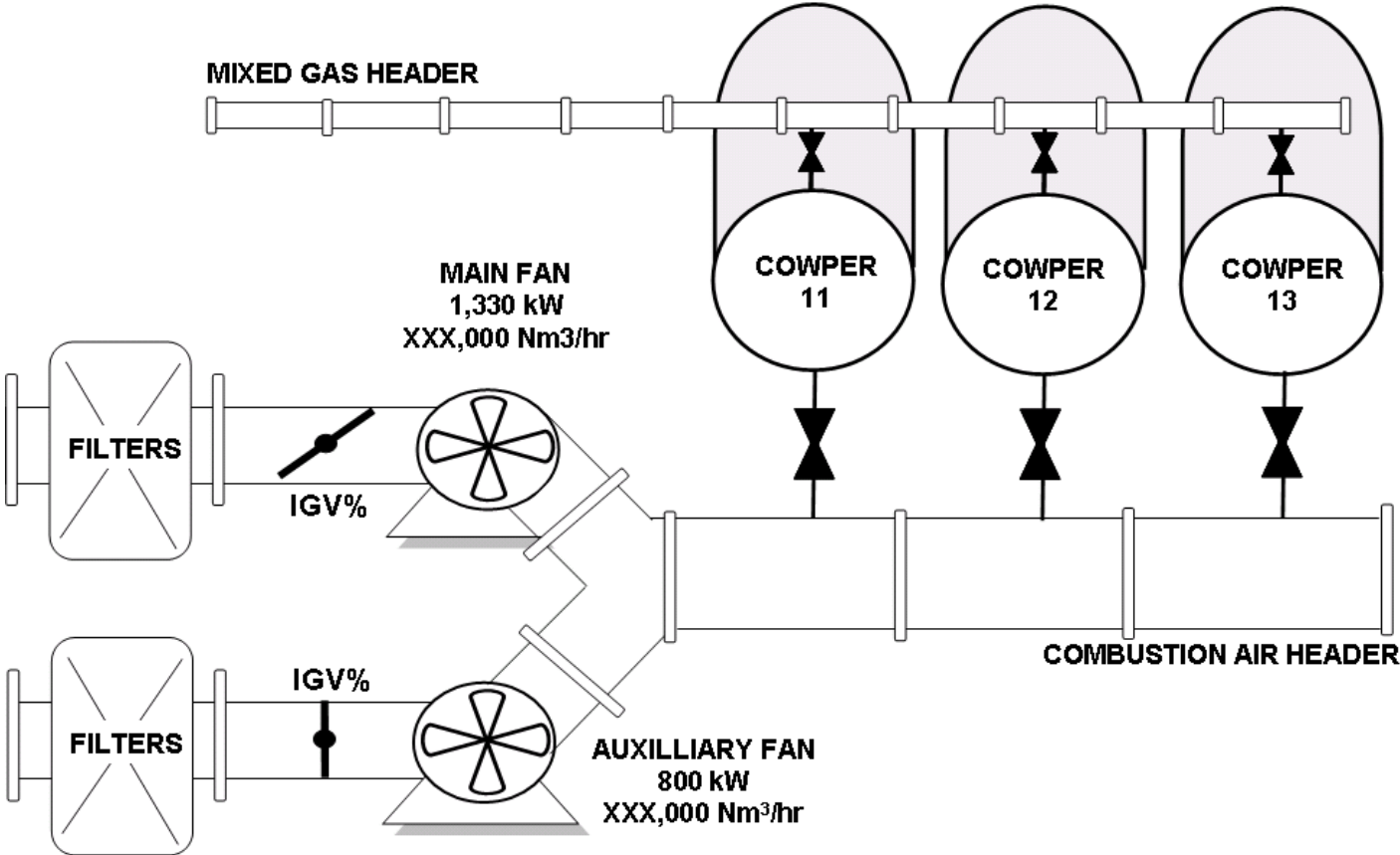
Cowper stove header flow rate:
Combustion air flow rates over time



Cowper stove header pressure:
Combustion air header pressure over time





Opportunity Identification

Quick Win Example



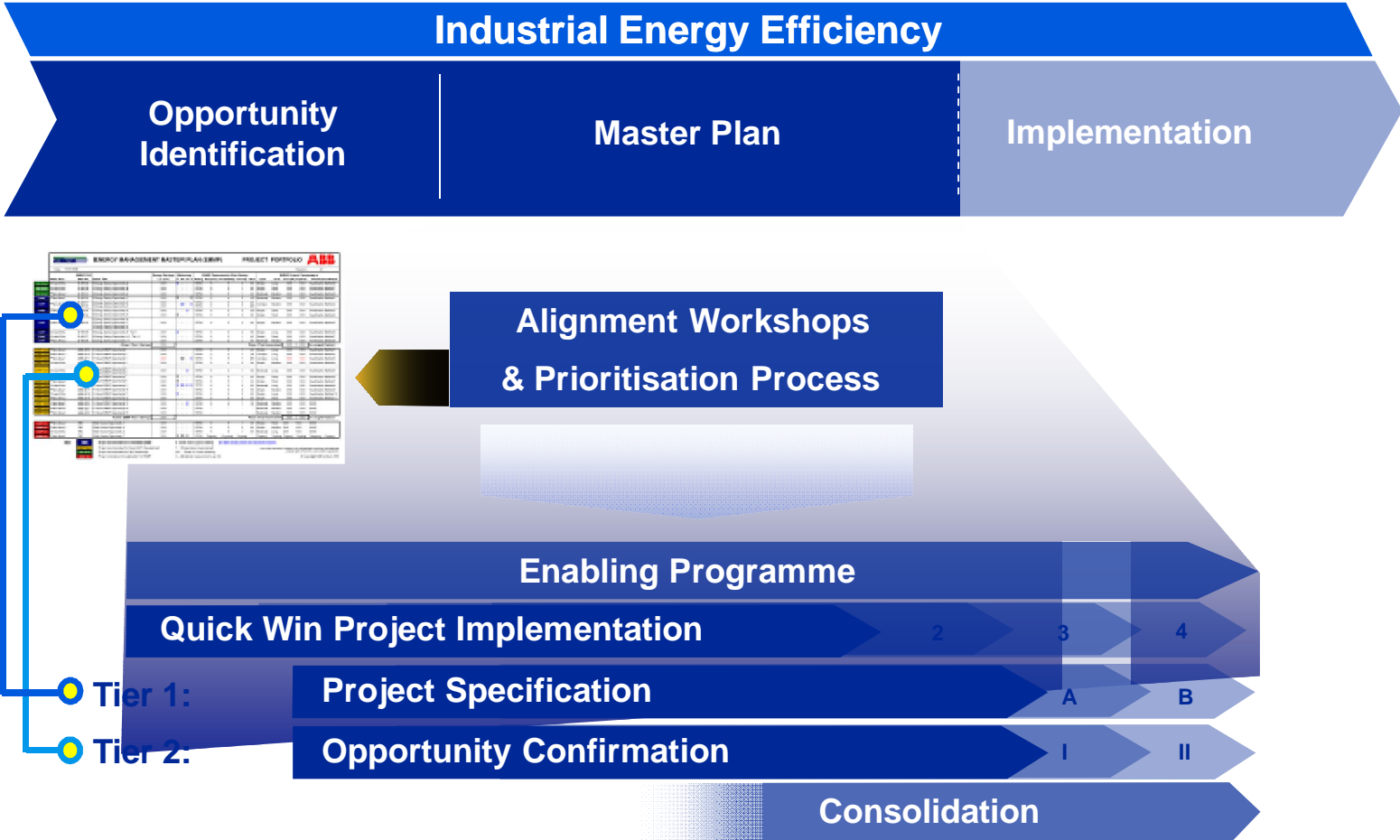
Industrial Energy Efficiency

Opportunity Identification - Activities & Resources

	Schedule (Week No)	ABB Activities	Client Activities	Client Resources
1 Request for Information 	1 - 2	Mobilise, tailor RFI as needed, issue & provide guidance	Mobilise, gather data, drawings etc.	Site Energy Champion + support (part-time)
2 Initial Data Review 	3	Review data & produce initial energy maps	Availability to answer basic queries.	Site Energy Champion as needed (occasional)
3 Site Assessment 	4	2 Lead consultants split into 2 teams	Coordination, liaison, Q&A, support additional data acquisition	Plant area (10) personnel & Site Energy Champion (part-time)
4 Data Analysis 	5 - 7	ABB energy team with mix of resources	Availability to answer further questions	Site Energy Champion (part-time)
5 Presentation of Portfolio	8	Present & finalise Portfolio	Portfolio review & feedback	Site Energy Champion + selected site management team (1/2 day)

Industrial Energy Efficiency

Master Plan Overview



Industrial Energy Efficiency Prioritisation Process

- Opportunity Identification Portfolio
 - Energy saving opportunities by plant area or system
 - Prioritised by estimated simple payback times
- Master Plan Portfolio
 - Energy saving projects by development and implementation priority
 - Projects prioritised by ranking process and payback

OPPORTUNITY IDENTIFICATION PORTFOLIO													
Area	System	Opportunity Title	Area of Impact (kW)	Area of Impact (%)	Area of Impact (kWh)	Area of Impact (kWh)	Area of Impact (kWh)	Area of Impact (kWh)	Area of Impact (kWh)	Area of Impact (kWh)	Area of Impact (kWh)	Area of Impact (kWh)	Area of Impact (kWh)
Area 1	System 1	Opportunity 1.1	100	100	100	100	100	100	100	100	100	100	100
Area 2	System 2	Opportunity 2.1	200	200	200	200	200	200	200	200	200	200	200
Area 3	System 3	Opportunity 3.1	300	300	300	300	300	300	300	300	300	300	300
Area 4	System 4	Opportunity 4.1	400	400	400	400	400	400	400	400	400	400	400
Area 5	System 5	Opportunity 5.1	500	500	500	500	500	500	500	500	500	500	500
Area 6	System 6	Opportunity 6.1	600	600	600	600	600	600	600	600	600	600	600
Area 7	System 7	Opportunity 7.1	700	700	700	700	700	700	700	700	700	700	700
Area 8	System 8	Opportunity 8.1	800	800	800	800	800	800	800	800	800	800	800
Area 9	System 9	Opportunity 9.1	900	900	900	900	900	900	900	900	900	900	900
Area 10	System 10	Opportunity 10.1	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

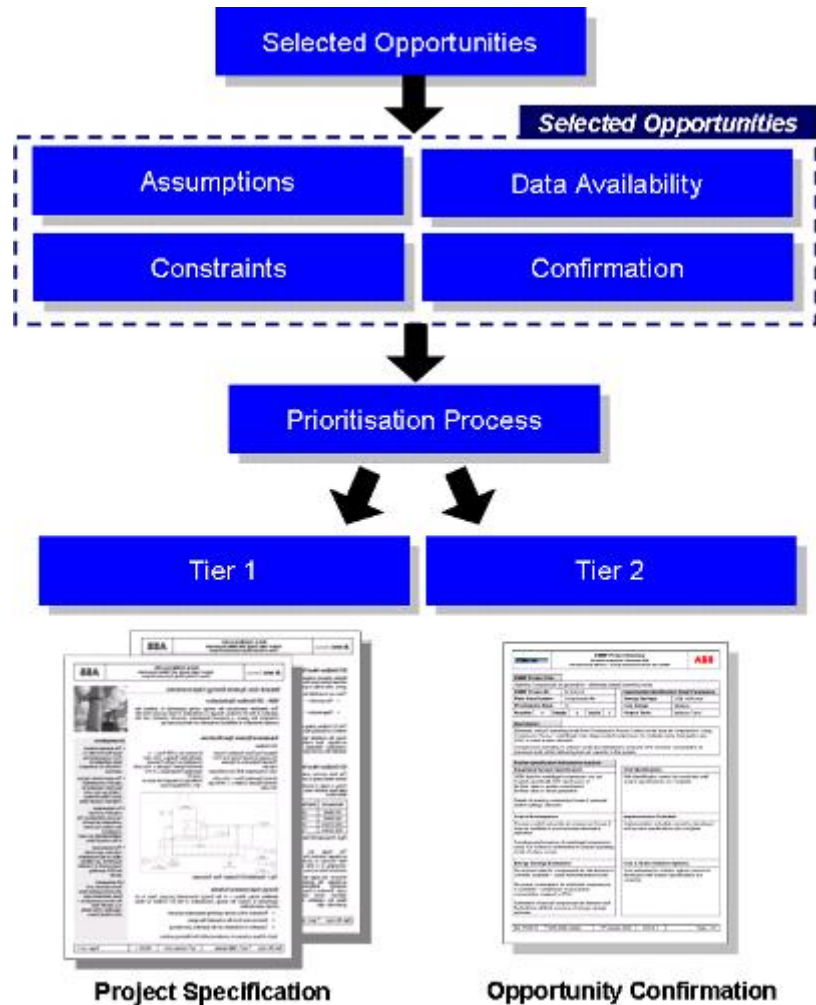


ENERGY PERFORMANCE CONTRACTING PROJECT PORTFOLIO													
Area	System	Project Title	Area of Impact (kW)	Area of Impact (%)	Area of Impact (kWh)	Area of Impact (kWh)	Area of Impact (kWh)	Area of Impact (kWh)	Area of Impact (kWh)	Area of Impact (kWh)	Area of Impact (kWh)	Area of Impact (kWh)	Area of Impact (kWh)
Area 1	System 1	Project 1.1	100	100	100	100	100	100	100	100	100	100	100
Area 2	System 2	Project 2.1	200	200	200	200	200	200	200	200	200	200	200
Area 3	System 3	Project 3.1	300	300	300	300	300	300	300	300	300	300	300
Area 4	System 4	Project 4.1	400	400	400	400	400	400	400	400	400	400	400
Area 5	System 5	Project 5.1	500	500	500	500	500	500	500	500	500	500	500
Area 6	System 6	Project 6.1	600	600	600	600	600	600	600	600	600	600	600
Area 7	System 7	Project 7.1	700	700	700	700	700	700	700	700	700	700	700
Area 8	System 8	Project 8.1	800	800	800	800	800	800	800	800	800	800	800
Area 9	System 9	Project 9.1	900	900	900	900	900	900	900	900	900	900	900
Area 10	System 10	Project 10.1	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000



Industrial Energy Efficiency Master Plan – Alignment Workshop

- Alignment Workshop Goals
 - Confirm opportunities
 - Reduce assumptions
 - Identify constraints
 - Agree potential ROI
- Prioritisation Process
 - Project ranking process
 - FEASIBLE
 - SIMPLE
 - QUICK
- Agreed set of projects for development (Tier 1)



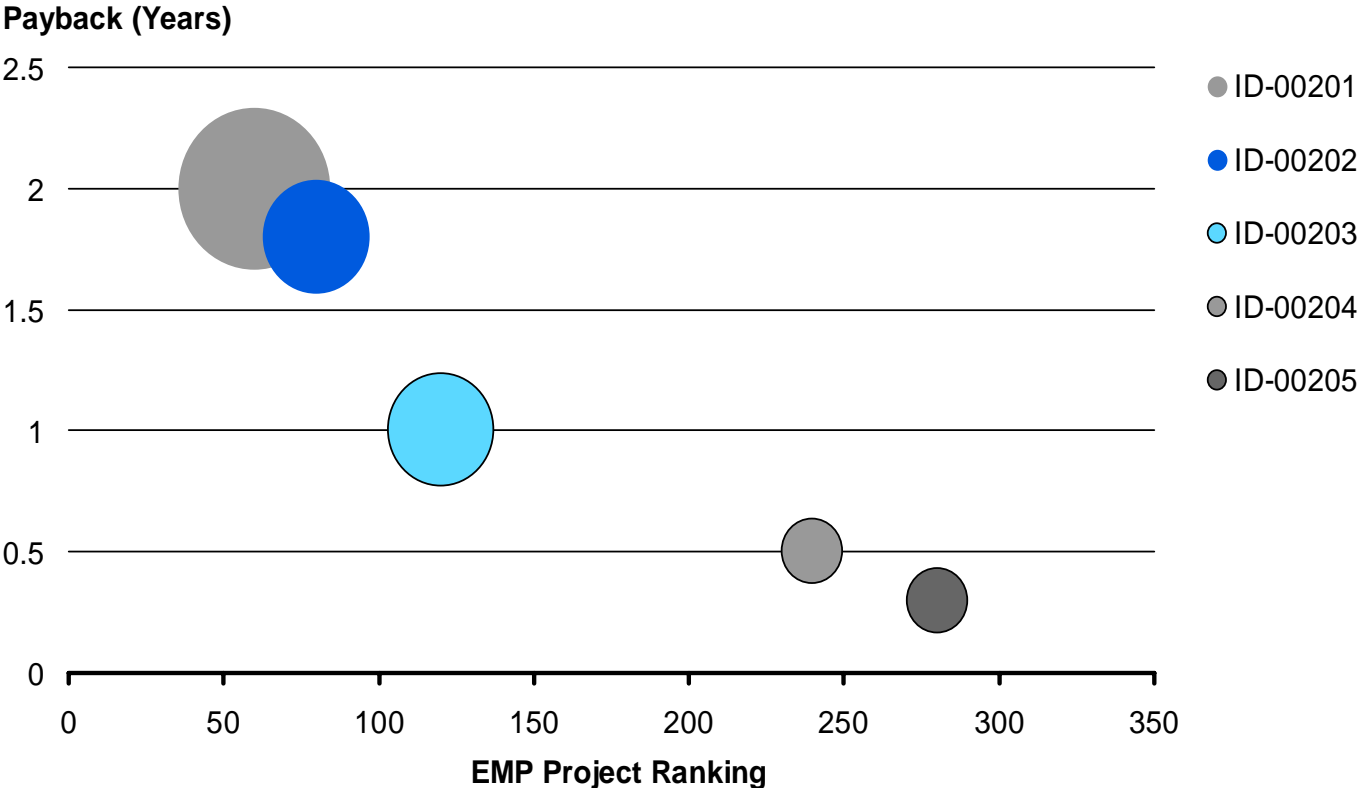
Industrial Energy Efficiency Prioritisation Process

Feasible		
Solution Confidence		Data Confidence
Witnessed technology within industry application, certain of success, 100% review team agreement.	CERTAIN 5	Archived historical data of process parameters confirms opportunity beyond doubt across all normal operating conditions.
Proven technology within application, success is anticipated, < 100% review team agreement.	ALMOST CERTAIN 4	Archived historical data of process parameters confirms opportunity over majority of expected operating conditions.
Documented solution for application, sound & established engineering principles, <100% review team agreement.	EXPECTED 3	Snapshot of historical data confirms opportunity during a period of stable process operation, under normal operating conditions.
Unproven technology within specific application, data suggests success, <75% review team agreement.	THREAT EXISTS 2	Local process parameter readings witnessed at expected levels. Site-based knowledge of typical operating ranges confirmed.
No available technology identified, clear identified threat to success, less than 50% review team agreement that any practical solution is conceivable.	POSSIBLE 1	No data available to confirm opportunity, expected process parameters suggest success, clear requirement to measure and record data.

Industrial Energy Efficiency Prioritisation Chart

Prioritisation Chart

A visual representation of simple payback and project ranking as a combination of 'feasible', 'simple' and 'quick' parameter assessment.



MASTER PLAN PORTFOLIO



Date: 30/12/2005

Electricity Price: 6p / kWhr

Revision: 5.0

Plant Area	Idea No.	Idea Title	Energy Savings (€K)		Rating	IEE Project RISK Parameters				Power (MW)	ABB & Project Parameters			Comment		
			Low Value	High Value		Probability	Severity	Term	Risk		ABB \$	Drive (kW)	Cost (€K)		Payback	
Owned	BOF Plant	ID - 00135	2nd Catchment Induction Fan Optimisation		00	ENERGY	4	5	0	210	1.5	1500	30	0.5	JJ Bertin owned	
Owned	BF Cowper Stoves	ID - 00144	BF1 Combustion Header Pressure Control		00	ENERGY	4	5	0	200	0.0	000	25	0.0	T Loschetter owned	
Owned	BF Cowper Stoves	ID - 00146	BF2 Combustion Header Pressure Control		00	ENERGY	4	5	0	200	0.0	000	25	0.0	T Loschetter owned	
			Total Saving		120					Total Cost			30	0.7	Averaged Payback	
EMMP Top	BOF Plant	ID - 00137	Tertiary Catchment Induction Fan VSD		180	ENERGY	4	3	4	48	1.5	1500	300	1.7	Max Cost / Max Saving	
EMMP Top	Power Plant	ID - 00125	Boiler 1GV Forced Draught Fan VSD		1,520	ENERGY	4	2	6	48	1.7	500	950	0.6	Max Cost / Max Saving	
		ID - 00126	Boiler 1GV Induction Draught Fan VSD													
EMMP Top	ECA (Water) ECHA (Water) CCDF (Water) Pre-coil cooling	ID - 00100 ID - 00113 ID - 00117 ID - 00122	Generic Cooling Tower Overcool Reduction Implementation Scheme		80	100	ENERGY	4	5	8	216	1.8	-	40	0.4	
EMMP Top	Finishing line cooling	ID - 00120	HP1 - 3 Finishing Line Pumps VSD		50	80	ENERGY	1	2	4	8	5.7	950	275	3.1	No system information
			Total Saving		1,810	1,490					Total Cost			1,365	0.9	Averaged Payback
EMMP Future	HRM ECA (Water)	ID - 00101	FO1A (D07 Classes) VSD		20	30	ENERGY	3	5	4	60	0.1	128	35	1.2	VSD on pump
EMMP Future	HRM ECA (Water)	ID - 00102	FO1B (D07 Acilatur) VSD		10	10	ENERGY	3	5	4	60	0.1	128	35	3.5	VSD on pump
EMMP Future	ECA (Water)	ID - 00103	FO2 Pumping System Pressure Control		80	180	ENERGY	1	5	8	54	8.1	-	50	0.3	ΔP Setpoint reduction
EMMP Future	ECA (Water)	ID - 00104	FO2 Pumping System VSD		40	70	ENERGY	2	2	8	24	0.0	1220	300	4.3	VSD on 1 x pump
EMMP Future	ECA (Water)	ID - 00110	G1 Cooling Tower Fan VSD		30	40	ENERGY	3	5	8	90	0.5	180	50	1.3	VSD on 1 x fan
EMMP Future	ECRA (Water)	ID - 00111	FO2 Pumping System VSD		30	50	ENERGY	3	2	4	24	1.8	800	225	4.5	VSD on 1 x pump
EMMP Future	ECRA (Water)	ID - 00114	Cooling Tower Fan Optimisation VSD		30	40	ENERGY	3	5	6	90	0.2	150	50	1.3	VSD on 1 x fan
EMMP Future	ECRF (Water)	ID - 00115	FO2 Pumping System VSD		30	40	ENERGY	3	2	4	24	1.3	425	200	5.0	VSD on 1 x pump
EMMP Future	ECRF (Water)	ID - 00118	Cooling Tower Fan Optimisation VSD		20	30	ENERGY	3	5	8	90	0.5	130	35	1.0	Relay on 1 x 3 fan bank
EMMP Future	Decoaling System	ID - 00119	Change to Euizer + KSD duty pumps		650	1200	ENERGY	1	7	0	42	10.0	1100	50	0.0	Use smaller pumps
EMMP Future	Pre-coil cooling	ID - 00121	CA1-0 Flocculation pumps		20	40	ENERGY	2	2	4	16	2.4	400	200	5.0	No system information
EMMP Future	Pre-coil cooling	ID - 00123	Cooling Tower Fan Optimisation VSD		30	40	ENERGY	3	5	6	90	0.0	150	50	1.3	VSD on 1 x fan
EMMP Future	Reheat Furnace 1	ID - 00124	Combustion Air Pressure Control VSD		80	140	ENERGY	3	5	4	60	1.2	605	225	1.6	VSD on 1 of 2 fans
EMMP Future	Reheat Furnace 2	ID - 00124	Combustion Air Pressure Control VSD		80	140	ENERGY	3	5	4	60	1.2	605	225	1.6	VSD on 1 of 2 fans
EMMP Future	Reheat Furnace 3	ID - 00124	Combustion Air Pressure Control VSD		80	140	ENERGY	3	5	4	60	1.2	605	225	1.6	VSD on 1 of 2 fans
EMMP Future	Power Plant	ID - 00127	Boiler 2GV Forced Draught Fan VSD		120	3,320	ENERGY	4	2	6	48	1.7	500	475	0.1	
EMMP Future	Power Plant	ID - 00128	Boiler 2GV Induction Draught Fan VSD		120	3,320	ENERGY	4	2	6	48	1.7	500	475	0.1	
EMMP Future	Power Plant	ID - 00129	Boiler 3GV Forced Draught Fan VSD		120	3,320	ENERGY	4	2	6	48	1.7	500	475	0.1	
EMMP Future	Power Plant	ID - 00130	Boiler 3GV Induction Draught Fan VSD		120	3,320	ENERGY	4	2	6	48	1.7	500	475	0.1	
EMMP Future	Power Plant	ID - 00131	Boiler 4GV Forced Draught Fan VSD		120	3,320	ENERGY	4	2	6	48	1.7	500	475	0.1	
EMMP Future	Power Plant	ID - 00132	Boiler 4GV Induction Draught Fan VSD		120	3,320	ENERGY	4	2	6	48	1.7	500	475	0.1	
EMMP Future	LD Converter 1	ID - 00134	Primary Catchment Induction Fan VSD		100	170	ENERGY	4	2	2	16	2.8	2600	400	2.6	Confirmed profile
EMMP Future	LD Converter 2	ID - 00136	Primary Catchment Induction Fan VSD		100	170	ENERGY	4	2	2	16	2.8	2600	400	2.6	Confirmed profile
EMMP Future	BF Cowper Stoves	ID - 00143	BF1 Main Combustion Air Header Fan VSD		80	125	ENERGY	4	2	4	32	1.3	1330	300	2.4	Confirmed profile
EMMP Future	BF Cowper Stoves	ID - 00145	BF2 Main Combustion Air Header Fan VSD		80	125	ENERGY	4	2	4	32	1.3	1330	300	2.4	Confirmed profile
EMMP Future	BF Pouring Basin	ID - 00148	BF1 Lurgi (taphole aspiration) Fan VSD		50	80	ENERGY	4	2	4	32	0.8	530	200	2.2	Confirmed profile
EMMP Future	BF Pouring Basin	ID - 00130	BF2 Lurgi (taphole aspiration) Fan VSD		50	80	ENERGY	4	2	4	32	0.8	530	200	2.2	Confirmed profile
			Total Saving		2,055	12,905					Total Cost			2,360	1.1	Averaged Payback
EMMP NA	Sintering Plant	D - 00151	Extraction Fan Control Optimisation		100	140	ENERGY	1	9	6	24	16.0	-	20	0.2	Rejected by Fes-sar-Me
EMMP NA	ECA (Water)	D - 00105	FO4 Pumping System VSD		20	30	ENERGY	3	2	4	24	0.9	300	170	0.8	VSD on 1 x pump
EMMP NA	ECA (Water)	D - 00106	FO3 Pumping System VSD		15	25	ENERGY	3	2	4	24	0.9	300	170	7.0	VSD on 1 x pump
EMMP NA	ECA (Water)	D - 00107	FO3 Pumping System VSD		10	20	ENERGY	3	2	4	24	1.1	210	150	7.5	VSD on 1 x pump
EMMP NA	ECA (Water)	D - 00108	FO1 Pumping System VSD		20	30	ENERGY	1	2	4	24	1.5	300	175	5.8	VSD on 1 x pump
EMMP NA	Charging Plant	D - 00138	BF1 Dust Extraction Fan VSD		5	25	ENERGY	1	2	4	8	0.5	500	200	6.0	Unconfirmed Profile/Spec
EMMP NA	Charging Plant	D - 00139	BF2 Dust Extraction Fan VSD		5	25	ENERGY	1	2	4	8	0.5	500	200	6.0	Unconfirmed Profile/Spec
EMMP NA	Grinding Plant	D - 00140	Horizontal Grind - Principal Extract Fan VSD		5	25	ENERGY	1	2	4	8	0.6	550	200	6.0	Unconfirmed Profile/Spec
EMMP NA	Grinding Plant	D - 00141	Horizontal Grind - Principal Extract Fan VSD		5	25	ENERGY	1	2	4	8	0.6	550	200	6.0	Unconfirmed Profile/Spec
EMMP NA	Grinding Plant	D - 00142	Vertical Grind - Principal Extract Fan VSD		5	25	ENERGY	1	2	4	8	0.5	500	200	6.0	Unconfirmed Profile/Spec
EMMP NA	Pouring Basin	D - 00147	BF1 Intensive (torpedo aspiration) Fan VSD		10	20	ENERGY	4	2	4	32	0.6	600	225	11.3	Confirmed profile

Master Plan – Tier 1 Project Specifications

A SAMPLE CUSTOMER, USA
Industrial Chemicals - Industrial Energy Efficiency
Phase 2 - Energy Management Master Plan

Fired Equipment Energy Improvement Opportunity

Flue Gas Heat Recovery
Heat credits lost through the exhausting of furnace (and boiler) flue gases to atmosphere is a common feature of energy inefficient operations. Good practice sees flue gas stack emissions temperatures should be no higher than 300°C to 400°C. Stack gas temperatures any higher than this, are generally good opportunities for heat recovery.

Equipment System Specifications

• Inlet Name of Unit	Normal Stack CO	5 %
• Inlet Type of Unit	Flue Gas Flowrate	5,000 kg/s
• Current Stack Temp	Ambient Air Ref Temp	20 °C
• Fired Fuel Type	Gas	
• Output Type System?	Yes	

Assumptions

- The average flue gas flowrate through the fired equipment has been estimated at 5 kg/s for evaluation purposes.
- The average oxygen content in the furnace stack has been estimated at 5% and from recent observations.
- The average stack temperatures observed from the fired equipment is typically 300°C.
- The operation of the fired equipment is only considered during periods of normal gas firing.
- The average ambient temperature of intake air is estimated at 20°C for illustration only.

Energy Improvement Scheme
Recovery of heat from exhaust flue gases is a widely employed technology used commonly to pre-heat the intake combustion air, thereby substantially improving process thermal efficiency of the fired unit.
Fig 1 illustrates a common air pre-heating scheme for a fired heater, using an induction fan to draw flue gases against a forced draught intake combustion air. A pre-heater system is often used to regulate intake temperature.

Fig 1 Typical Simplified Heat Recovery Scheme

Ref: EE-0000 - © 2007, ABB Limited - 00 June 2009 - 000001 - Page 1 of 4

Project Description & Assumptions

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Fired Equipment Heat Recovery - Scheme Overview

The heat recovery potential of the exhaust flue gases has been analysed in further detail using a variety of heat transfer simulations, depicted by Fig 2.

Using a range of possible shell-and-tube heat exchanger sizes, determined by total heat transfer area, a range of heat recovery scenarios is presented in the table below:

EXCHANGER SIZE	INLET AIR T (°C)	INLET AIR F (°C)	EFFICIENCY (%)	SAVINGS (\$/yr)
6 m ²	200	20	80%	1,362
30 m ²	180	20	80%	11,204
60 m ²	150	20	80%	10,926
90 m ²	120	20	80%	15,621

Fig 3 Projected Savings from Heat Recovery Scenarios

The target heat exchanger selected, the most heat recovery is possible - converging to a limit at the maximum heat recovery.

However, the larger the heat exchanger, the greater the expected replacement costs. Therefore a theoretical optimum exists between these two variables, shown graphically below in Fig 4.

Theoretical optimum exchanger size estimated at 182 m²

Fig 4 Projected Savings versus Investment Costs

Energy Savings
For an exchanger area 182 m² shell-and-tube heat exchanger with 80% heat transfer efficiency between streams:
US \$52,412 per year

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Energy Savings & Payback Estimates

- Contains detailed project specific information to enable the implementation of the energy saving opportunity

Master Plan – Tier 1 Project Specifications

A SIMPLE CUSTOMER, USA
Industrial Chemistry - Industrial Energy Efficiency
Phase 2 - Energy Management Master Plan

Fixed Equipment Heat Recovery - Scheme Summary

Scheme Methodology

- Complete PFD for streams of heat exchange equipment to recover heat from the exhaust flue gases - expected hardware is:
 - A heat exchanger - a number of types are available but welded plate and jacketed heat exchangers are most likely to be suitable for this duty. The high temperatures mean that expertise must be considered.
 - New ductwork to carry the exhaust flue.
 - Modifications to the fan as the pressure drop will increase.
- New instrumentation including air flow meters, a meter for the fan motor and temperature measurement in and out of the heat exchanger. All instruments should be linked to the data logger.
- Engage sub-contractor for detailed design and construction.

Risks (Technical/Commercial/Safety & Environment) etc

Technical

- This is a standard technology and is widely used throughout the world. Temperatures are high and so quality design is essential.
- The physical attributes of the existing stack ductwork require detailed analysis to assess the ease of re-using the exhaust flue gas in a heat exchanger and its associated costs.
- There may be some fouling on the flue gas side of the exchanger but this should be minimal with Natural Gas fired equipment.
- It is important that the flue gas retains enough temperature for thermal lift and must remain above dew point to prevent corrosion.

Comments:

- The technology is standard and so it is expected that design performance will be achieved. The furnace system will become more complicated and so it must be expected that maintenance activity will increase.
- This project will be a retrofit so some downtime must be expected and so effort should be made to transfer the modifications into routine shutdown slots.
- The project will be a retrofit which carries some additional risk for timetable and cost and high-quality project engineering is essential.

Safety and Environment:

- The project will have a positive environmental impact but the relevant authorities may need to be consulted. NOx deposits may require checking due to reduced thermal lift.
- The major safety issues will be engineering the project to cope with the high temperatures and the need to do much of the work whilst the existing facility is still operating.

State of Implementation

Complex - this scheme involves civil and engineering and design and modification of the existing fixed equipment together with associated ductwork.

Timeline

Larger Time
± 6 months

Verification of Benefits

Benefits can be assessed through monitoring the site natural gas consumption post implementation. More detailed analysis requires installation of a local natural gas meter.

Interaction with other Energy Schemes

Each of the heat exchanger schemes subserves a process and may affect the overall scheme net savings, however each are complementary areas.

Further Information Required

Further operating data of the equipment - operating load, typical oxygen concentrations etc.

Ref: PFC-XXXX-00-2007-ABB Limited 06 June 2008 01/06/1 Page 2 of 4

Implementation Scheme & Risk Identification

A SIMPLE CUSTOMER, USA
Industrial Chemistry - Industrial Energy Efficiency
Phase 2 - Energy Management Master Plan

Project Estimates

The project cost estimates throughout have been prepared using the well established Long Historical methods together with the Chemical Engineering Plant Cost Index (PCI), using the example of a:

100 MW (1004 BT) heat exchanger.

Total Physical Plant Cost (PPC)

Major Equipment Costs (PCE)	US \$	24,346
Direct Capital Costs Items (Plant, Electrical, Instrumentation, etc.)	US \$	21,727
	SUB	US \$ 46,073

Total In-Scope Project Cost (PC)

Design & Engineering	US \$	11,512
Contractor's Fee	US \$	1,805
Materials	US \$	0
Contingency (10% PC)	US \$	3,174
	SUB	US \$ 16,491

Total Project Cost

	US \$	76,068
--	-------	--------

Project Savings Estimate (per year)

	US \$	82,415
--	-------	--------

Net Payback Period

		11.2 Months
--	--	-------------

Cost of Implementation

The following items will require completion for this scheme:

- ENHANCED Safety
- Change Request
- PPAC change
- Flow Sheet Change
- Operating Procedure Change
- Control System Update
- Isolation for Maintenance

Ref: PFC-XXXX-00-2007-ABB Limited 06 June 2008 01/06/1 Page 4 of 4

Cost Estimate & Benefits Verification

- May be supported with further documentation (e.g. vendor quotations)

Opportunity Identification

Project Specification Example

PLANT AREA

- Power Plant

OPPORTUNITY IDENTIFIED

- Improve boiler efficiencies
- IGV controlled FD/ID fan not operating with optimum control

SOLUTION

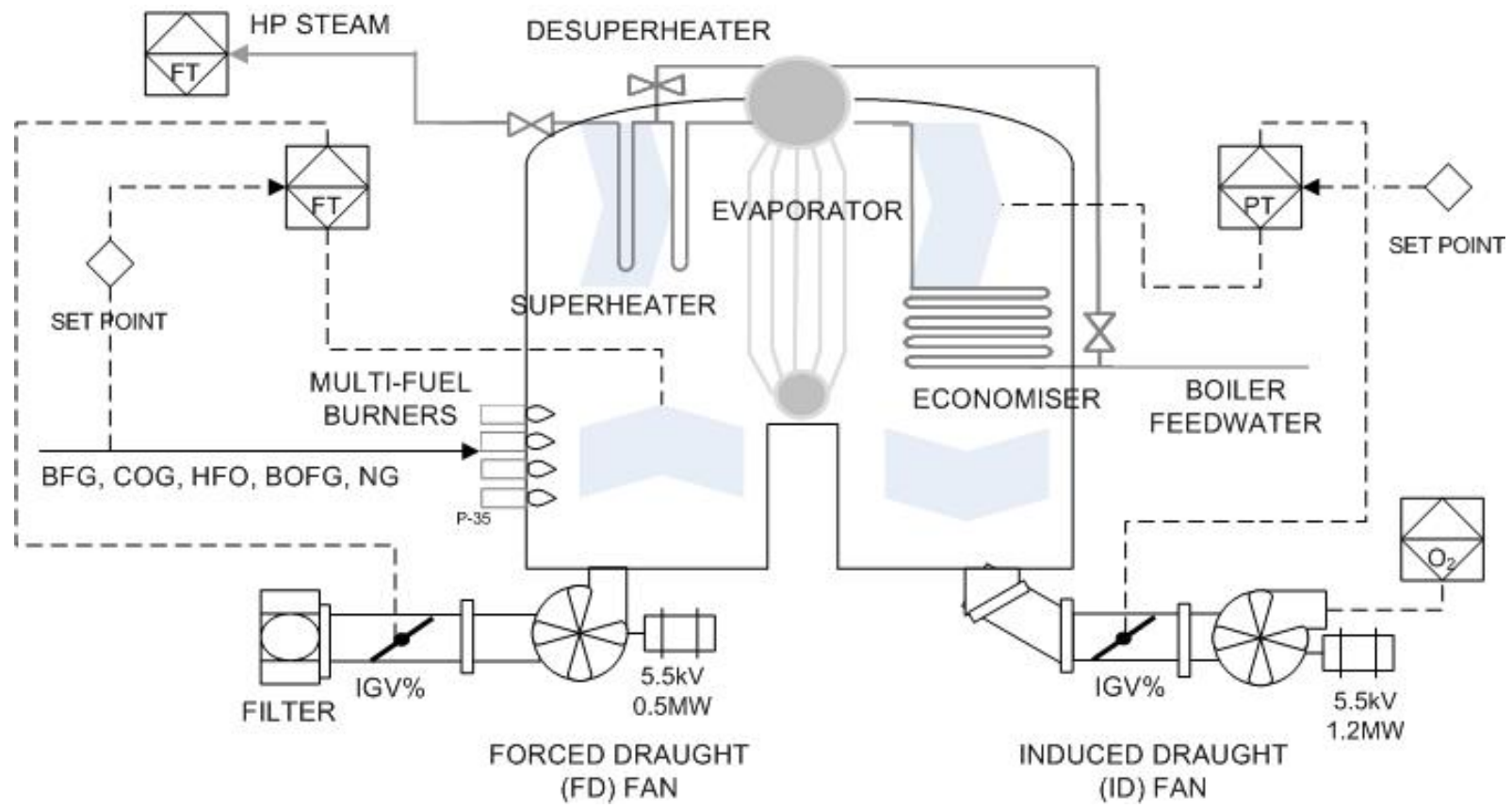
- Install variable speed drives
- Improve control loop to maintain optimum air-to-fuel ratios

VALUE

- \$8.2M per year gas savings (€\$80K electrical savings)
- Less than 2 year payback (including verification)

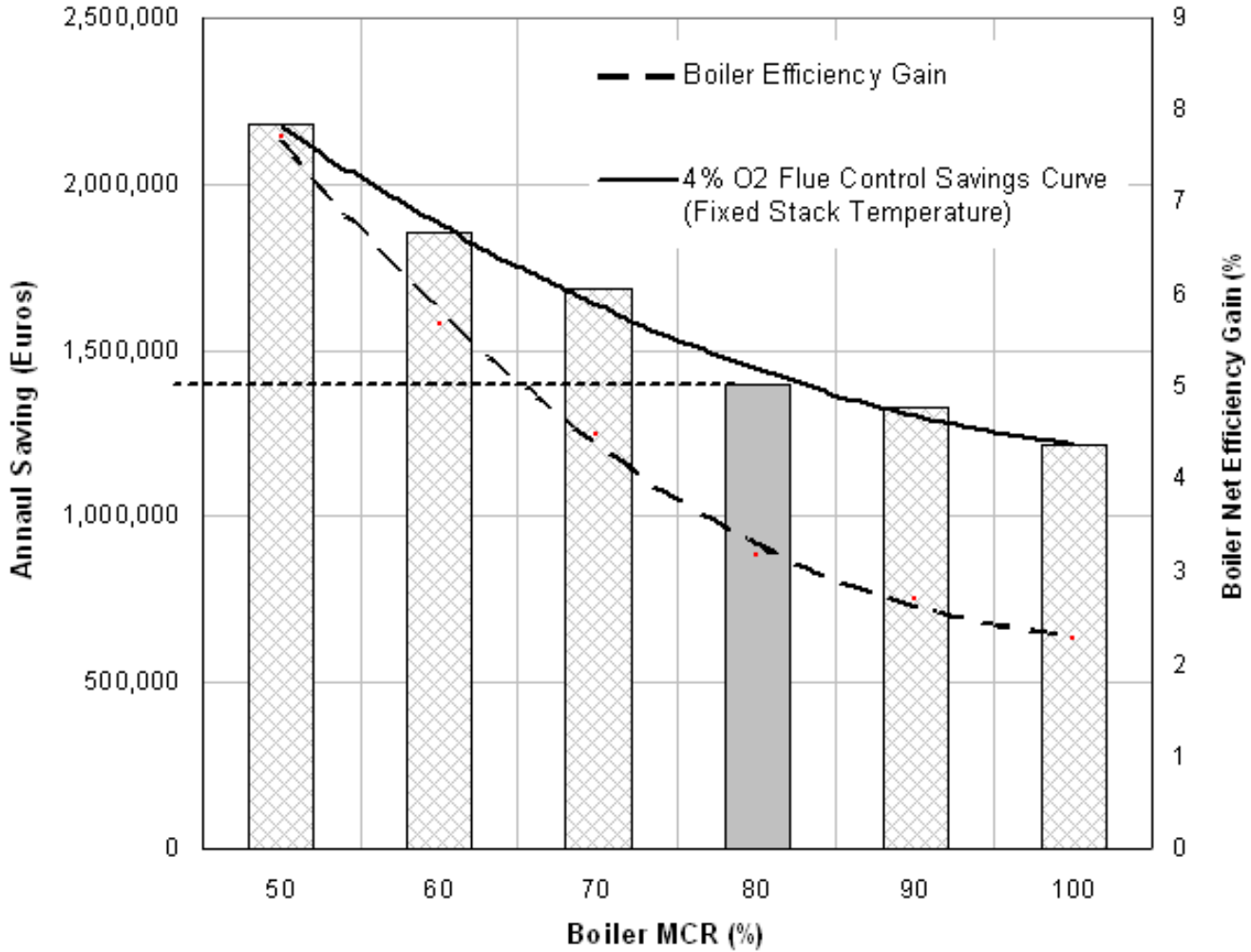


Opportunity Identification Project Specification Example



Opportunity Identification

Project Specification Example



Opportunity Identification Project Specification Example

Industrial Energy Efficiency – Energy Management Masterplan (EMMP)

TRANSFORMER CONVERTOR MOTOR

Integrated Transformer ACS5600 Air-to-Air Cooled HV Drive AMI550 LBA, BAH New 1200kV HV Motor

Fig 8 Simplified Boiler 1GV - ID Fan VSD Option A Solution

Using the existing 5.5kV motors together with an additional step-up transformer is regarded as a technically unattractive solution, from previous experiences with [redacted]

Project Estimates

The project cost estimates have been prepared using the well established engineering methods together with the vendor supplied budgetary costs for the above solution option. Payback estimates are considered for electrical savings only and electrical savings plus gas consumption savings.

Total Physical Plant Cost (PPC)

Major Equipment Costs (PEC)	€ 795 000
Direct Capital Cost Items (Piping, Electrical Instrumentation etc.)	€ 50 000
Sum	€ 845 000

Total Indirect Project Cost (IPC)

Design & Engineering	<i>Vendor engineering staff design included above.</i>
Contractor's Fee	€ 50 000
Miscellaneous	Zero
Contingency (@ 10%)	€ 80 000
Sum	€ 130 000

Total Project Cost

€ 975 000

Further General Consideration

Recently ABE has been made aware of some customers who have re-wound existing motors with a 'star' to a 'delta' wound configuration.

As a result, existing HV motors e.g. a 5.5kV motor can be reduced to approx 3.2kV, in turn reducing the costs of VSD applications.

This could be investigated further by [redacted]

Option A - Project Component Estimates

FD Fan ACS600 LV Drive and HXR 450 Motor: € 210,300

ID Fan ACS500 HV Drive: € 365,300

ID Fan AMI560 HV Motor: € 140,300

Estimated Simple Payback

8 Years (electric only)

8 Months (electric & gas)

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21st December 2008

ISSUE 1

Page 8 of 12

Industrial Energy Efficiency – Energy Management Masterplan (EMMP)

Boiler 1GV Optimisation Summary – VSD Installation

Scheme Methodology

- Evaluate the Boiler 1GV inlet guide vane mechanical problem and quantify likely repair costs;
- Undertake a series of trials to manually control flue gas oxygen concentration:
 - Operators should switch to manual control of the FD Fan IGV position, lowering combustion air intake and allowing the automated ID Fan IGV position to vary to meet the required draught pressure;
 - The trials should be conducted over a sufficient operating period to allow data to be recorded for a range of boiler loads where possible (2-3 hours minimum);
 - The trial should incrementally reduce flue gas oxygen control levels, e.g. trial 1 = 8%, trial 2 = 5%, trial 3 = 4%;
 - Recorded data for oxygen concentration, steam flow rate, FD fan IGV position, ID Fan IGV position and measure air flows should be analysed in conjunction with the combustion control model (Fig 3).
- Re-evaluate likely electrical energy savings through VSD installation using Fig 5 & Fig 6 as approximations;
- Apply for capital funding according to the normal site application process.

Risks (Technical/Commercial/Safety & Environment etc.)

Technical:

- Variable speed drives for boiler combustion fan systems are a standard technology and widely used throughout the world;
- The existing 5.5kV supply for fan electric motors is a non-standard voltage for variable speed drive technology. Care should be taken to ensure that potential vendors can demonstrate case studies and experience of solution implementation at this voltage for fan applications;
- With multiple fuels and variable fuel composition, care should be taken to ensure that incomplete combustion does not occur within the boiler furnaces. This can be monitored using the existing flue analysers, checking for CO (carbon monoxide) concentrations;
- Using oxygen trimming systems, it is also important to be aware of the response time of control loops to ensure adequate air during instantaneous steam generation peaks. With VSD applications, response times are generally quicker than IGV control.
- Lower flue gas oxygen concentration levels will promote higher superheater flue gas temperatures, potentially increasing thermal stresses around superheater tubes and in particular de-superheater thermal shock. Although the temperatures within design specifications of Boiler 1GV it may have been some time since the system was last exposed to higher temperatures. Conversely, current problems achieving desired superheater steam temperatures should be eliminated.

Ease of Implementation

Complex – this scheme involves front end engineering design and modification of the existing boiler 1GV fan system, together with associated downtime.

Timescale

Longer Term
> 6 months

Verification of Benefits

Benefits can be assessed through monitoring the site gas consumption, steam flowrates, ID/FD fan speed and flue gas oxygen levels post implementation.

Interaction with other Energy Schemes

Both of the Boiler 1GV Optimisation scheme sub-categories (air-to-fuel ratio & VSDs) interact and may affect the overall scheme net savings, however each are complimentary overall.

Further Information Suggested for Benchmarking

Further operating data of Boiler 1GV – Steam flow rates, stack temperatures, air flow rates, gas rates, stack oxygen concentrations – over an extended data period (during normal operation) to confirm operating profile.

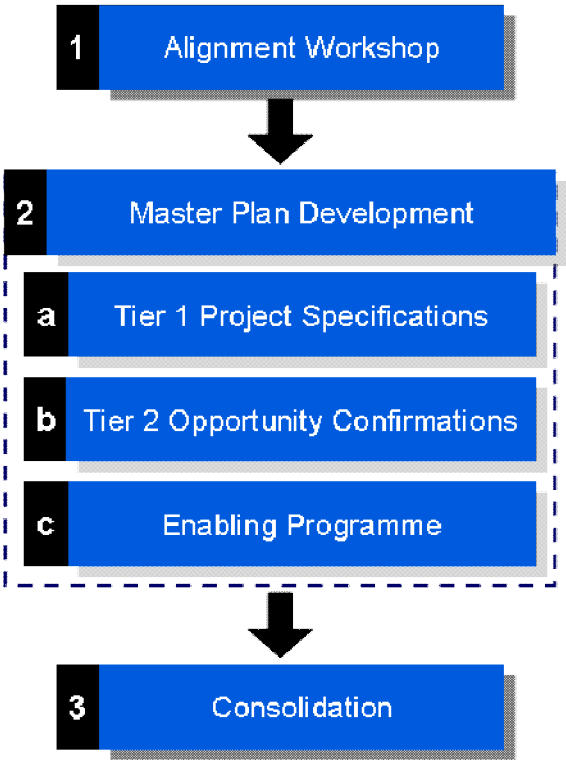
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ISSUE 1

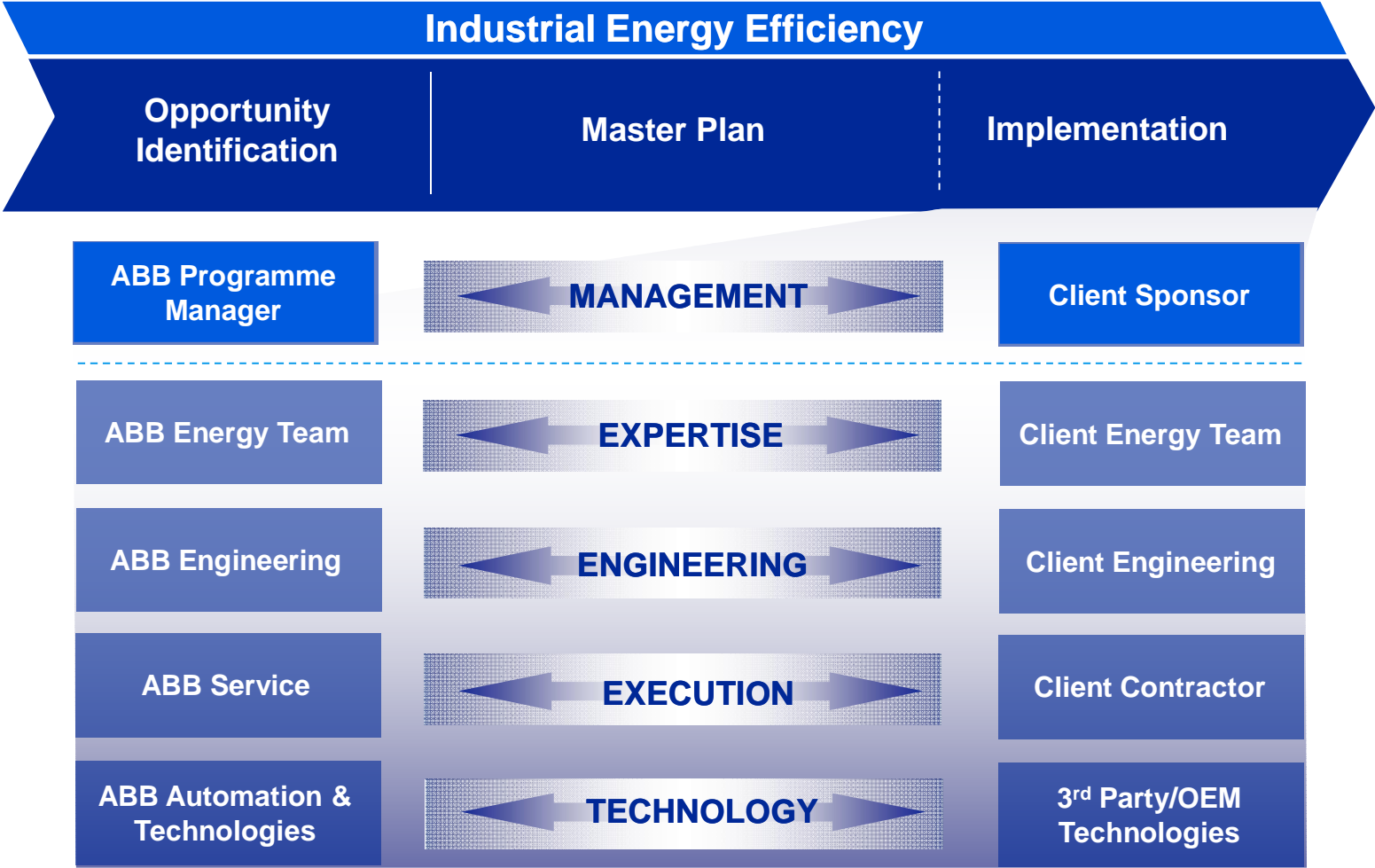
Page 11 of 12

Industrial Energy Efficiency Master Plan - Activities & Resources



Schedule (Week No)	ABB Activities	Client Activities	Client Resources
1 - 2	Prepare Workshop, facilitate, issue draft Master Plan	Attend workshop, confirm & prioritise projects for development	Site Energy Champion + key stakeholders (1 day +)
3 - 8	Develop specs and confirmation sheets, including schemes, estimates, risks, verification method. Programme management.	Provision of site / company specific information; liaison with preferred vendors where necessary	Site Energy Champion + support (especially engineering team) (part-time)
9	Present Master Plan for implementation / progress review / further development	Confirm / review; implement Quick Wins & Tier 1 projects, select Tier 2 projects to advance	Site Energy Champion + selected site management team (1/2 day)

Industrial Energy Efficiency Implementation



Return on Investment?

Estimates indicate < 2 year averaged payback

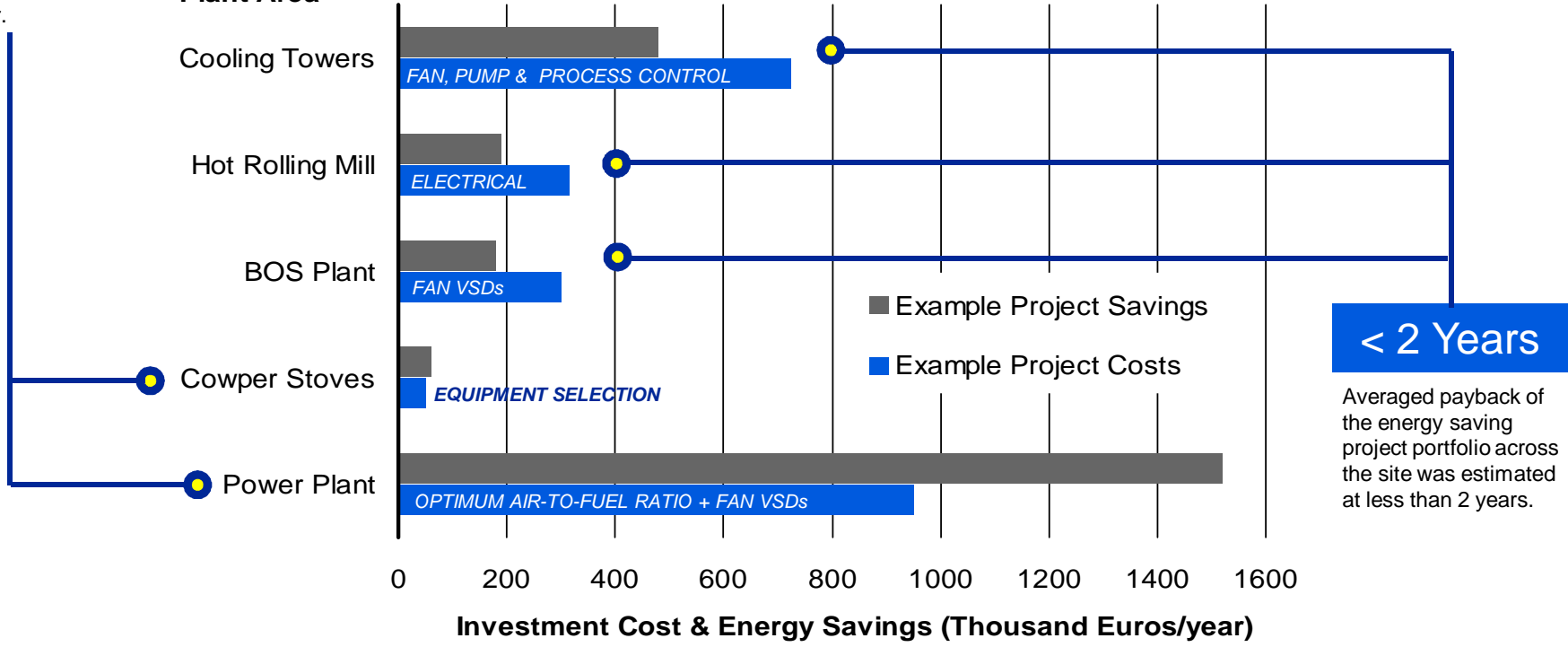
< 1 Year

Industrial Energy Efficiency Projects

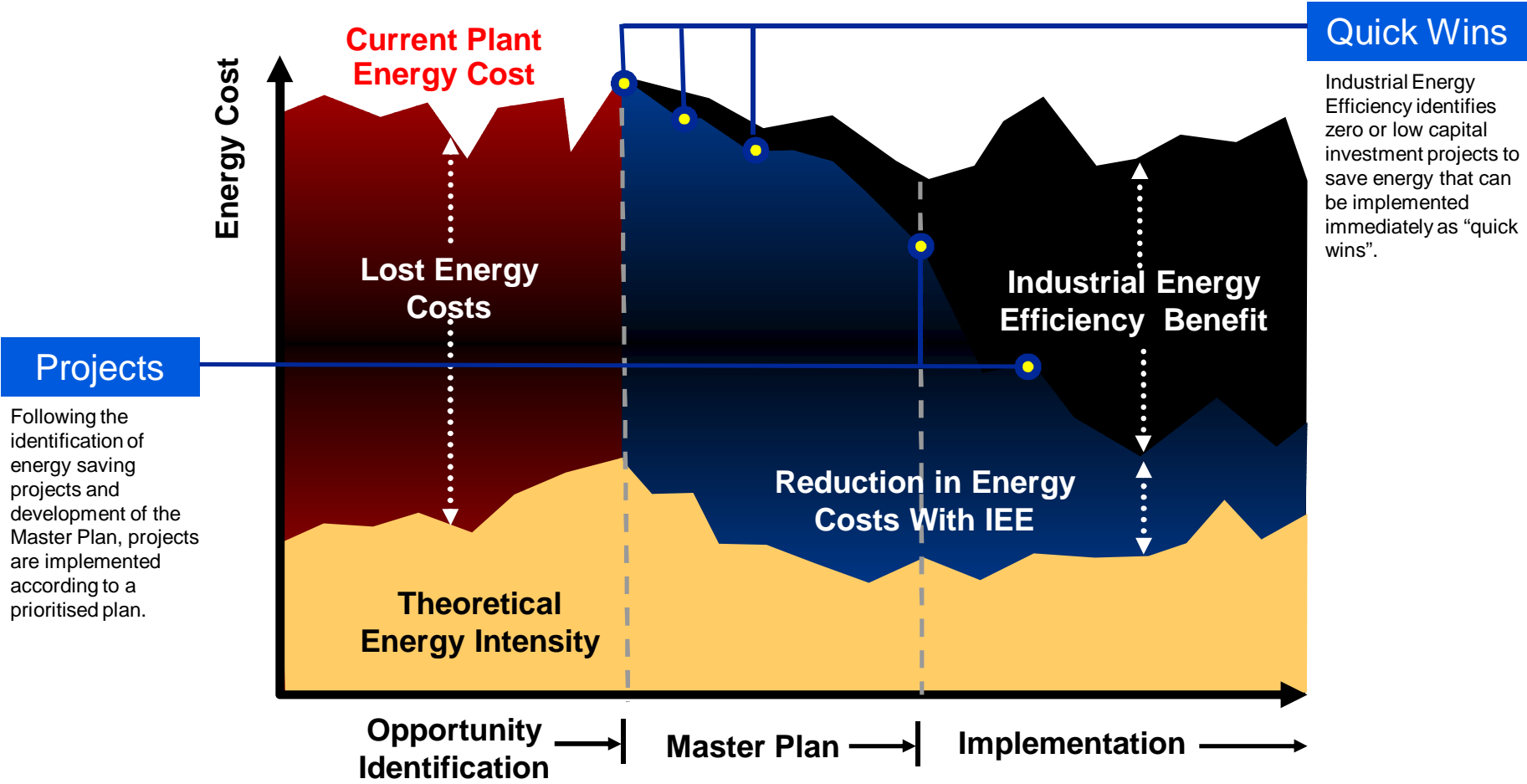
Source: Industrial Energy Efficiency programme conducted at an integrated steel mill in Southern Europe, completed early 2009.

Some exceptional projects were identified with simple payback of less than 1 year.

Plant Area



Industrial Energy Efficiency Programme Value Creation



Following the identification of energy saving projects and development of the Master Plan, projects are implemented according to a prioritised plan.



Lessons from the project

- Quick payback opportunities are often still available
- Identifying the potential requires understanding of technology + operation + constraints
- Need to consider both Thermal and Electrical energy
- Benefits from sharing experiences across industry sectors
- Objective prioritisation of Opportunity Portfolio by joint team yields real benefits



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