May 9, 2013

Underground Mine Energy Audits
A Case Study

by Andy Mork, PG CHG

Objectives

- Outline energy audit process
- Summarize case study
- Show example Energy Conservation Measures (ECMs)

Why Perform Energy Audit?

Organizational Benefits

- Identify energy use patterns/relationship to production
- Baseline information
  - Carbon footprint
  - Greenhouse Gas (GHG) tracking
- Consolidation of operator knowledge

Why Perform Energy Audit?

Economic Benefits

- Energy conservation measures (ECMs)
- Optimize mining and milling operations

= *Lower Production Costs*

Why Perform Energy Audit?

Establish Key Metric for Your Mine:

Energy density for mining processes

kWHr/Ton or mJ/Ton

Energy Audit Process
Phase I

Phase I – Broad analysis of energy use

- Identify major energy-consuming systems
- Quantify energy use by system
- Compare systems to rank energy consumption

Phase I Energy Audit

Owner Responsibility

- Provide at least one years utility bills
- Provide production data for same year
- Schedule key mine personnel
- Arrange site walk-through logistics

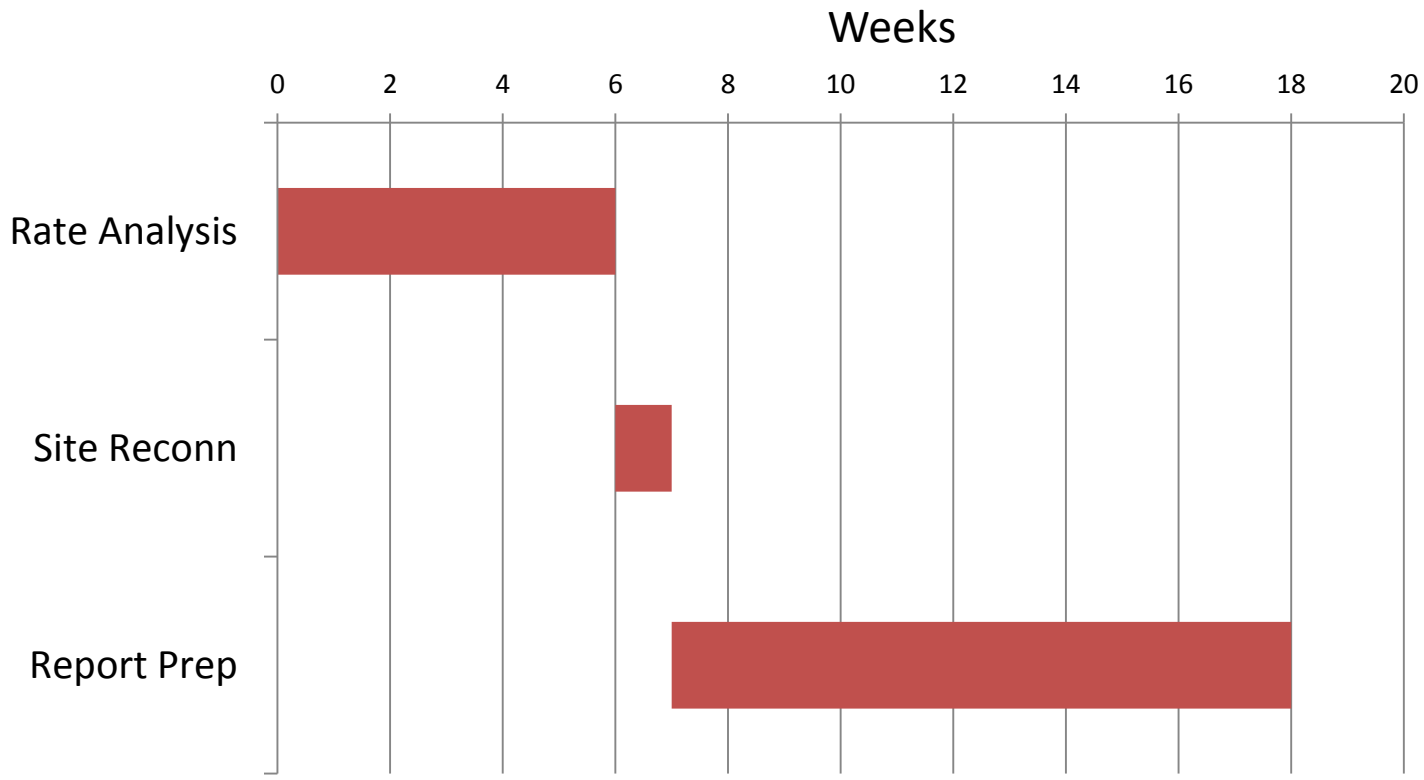
Phase I Energy Audit

Consultant Responsibilities

- Assemble qualified, MSHA safety-trained team
- Team members:
  - Utility rate analyst
  - Electrical engineer with mining experience
  - Electrical system studies engineer
  - Project Manager
- Respect Miners time, obey safety regulations

Phase I Energy Audit

Typical Scope and Schedule



Phase I Energy Audit Case Study Organization/Rate Analysis

Step 1. Organization – ***Owners Tasks***

- Collect utility bills and production data

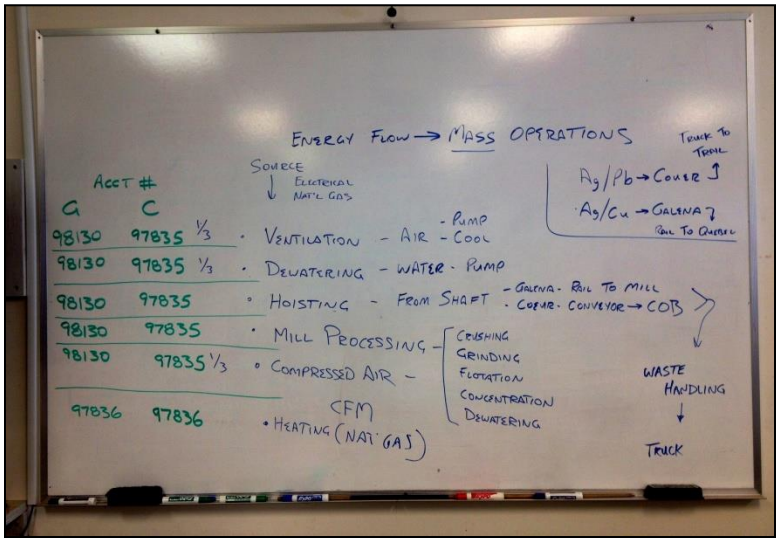
  Consultant performs rate analysis

- Schedule mine staff
  - Technical Leads; electrical and operations
  - Mine Safety rep for Safety Briefing
  - Identify Mine/Mill Tour Guides
- Collect One-Lines and Long Sections

Phase I Energy Audit Case Study
On-Site Activities

Step 2a. Initial On-Site Meeting

- Process Overview
- Rate Analysis Results
- Mine Safety briefing
- Q and A



Phase I Energy Audit Case Study
On-Site Activities

Step 2b. Site Reconnaissance
Mine and Mill Tour

Hoists

Phase I Energy Audit Case Study
On-Site Activities

Step 2b. Site Reconnaissance
Mine and Mill Tour

Dewatering Systems

Phase I Energy Audit Case Study
On-Site Activities

Step 2b. Site Reconnaissance
Mine and Mill Tour

Air Compression and Distribution

Phase I Energy Audit Case Study
On-Site Activities

Step 2b. Site Reconnaissance
Mine and Mill Tour

Ventilation

Phase I Energy Audit Case Study
On-Site Activities

Step 2b. Site Reconnaissance
Mine and Mill Tour

Mill Processes

Phase I Energy Audit Case Study
On-Site Activities

Step 2b. Site Reconnaissance
Mine and Mill Tour

Power Supply

Phase I Energy Audit Case Study
On-Site Activities

Step 2c. Site Reconn – Close-Out Meeting

- Mine Staff
  - Technical Leads
  - Management
- Present Preliminary Findings
  - Energy Systems Overview
  - ECMs
- Q and A

Phase I Energy Audit Case Study Reporting

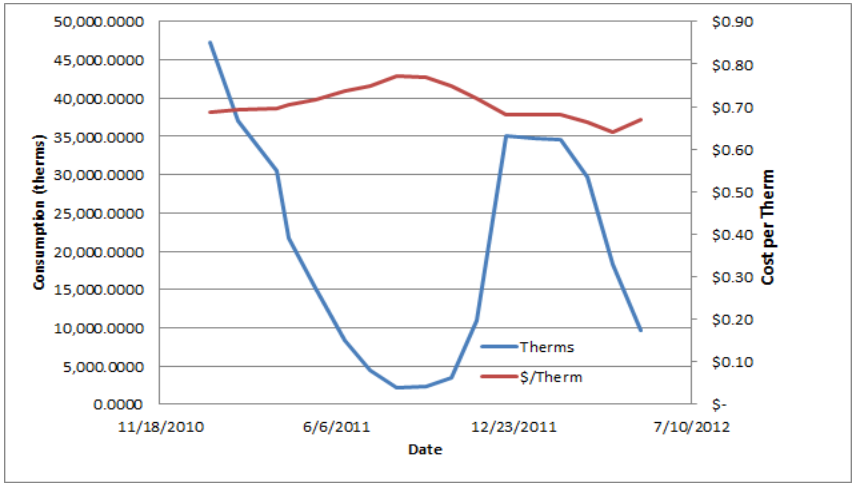
Step 3. Reporting

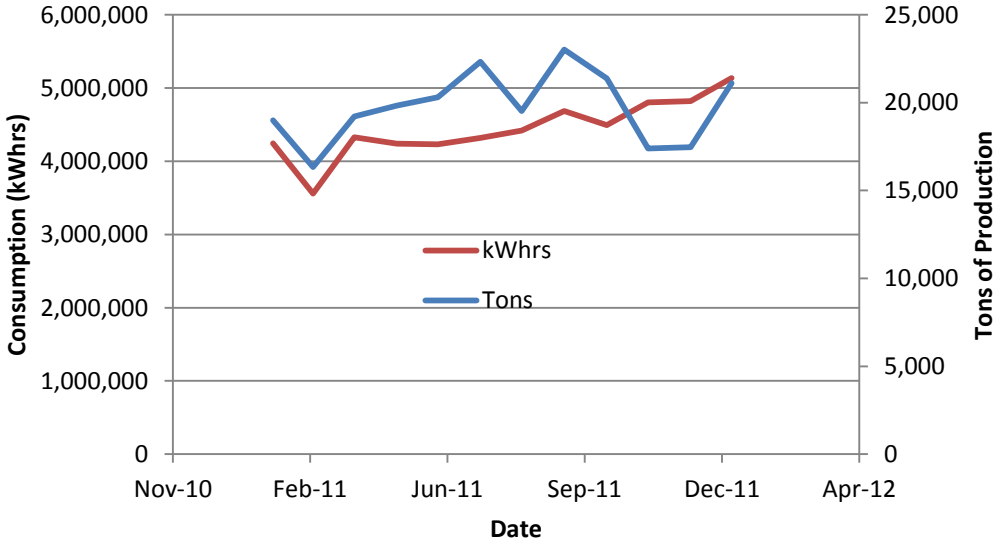
- Rate Analysis
- Energy Distribution by System
- Power Quality Study – if data readily available
- ECMs and Cost Savings Detail
- Recommendations for Phase II Audit

Phase I Energy Audit Case Study Report: Rate Analysis

Step 3. Report – Rate Analysis

- Examine gas and electricity contracts
- Chart usage for period of record
- Compares usage per ton production



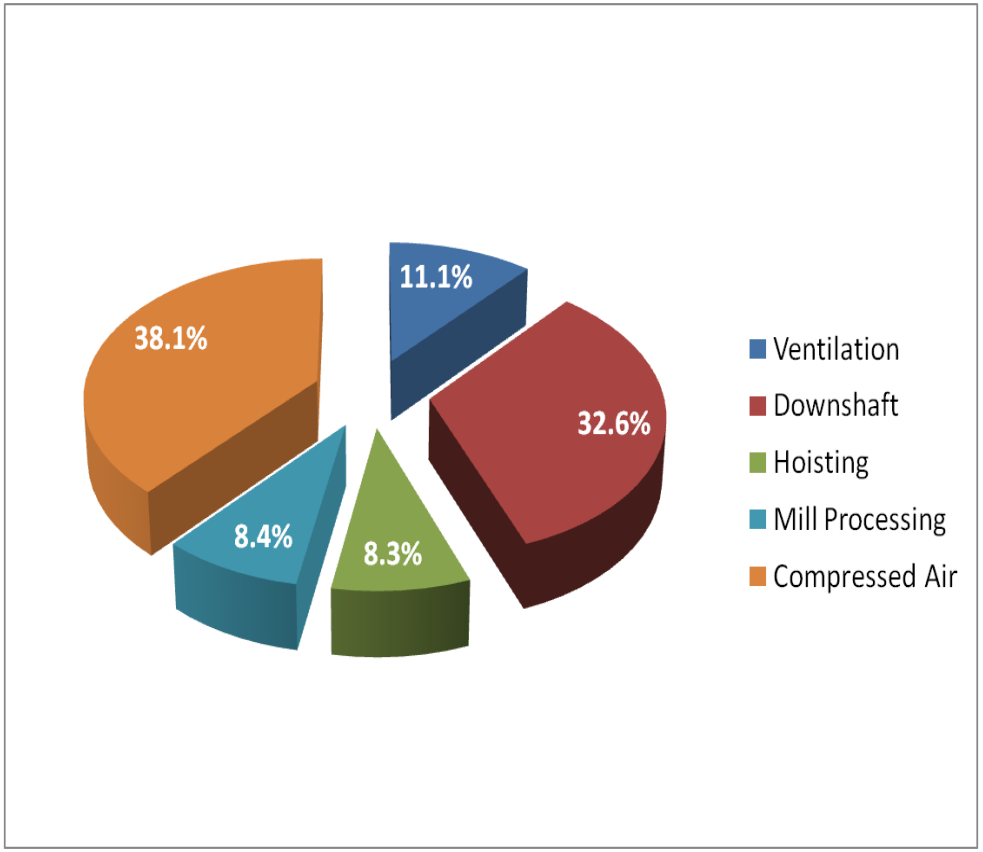


Phase I Energy Audit Case Study Report: Energy Distribution by System

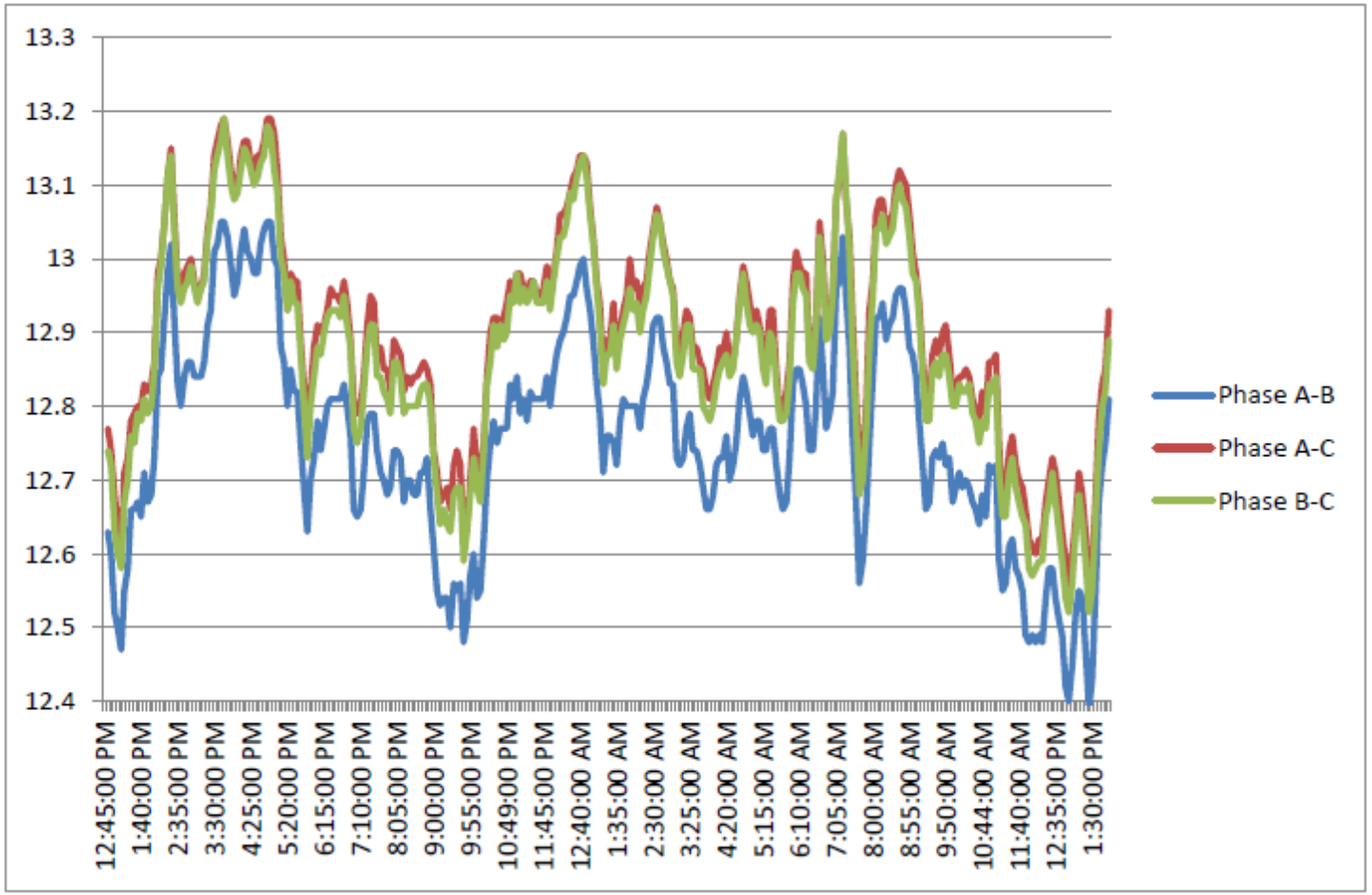
System	% of Total
Air Compression	38.1
Downshaft	32.6
Ventilation	11.1
	81.8
Mill Processes	8.4
Hoisting	8.3
	16.7

Focus Phase II on:

- Air compression
- Downshaft



Phase I Energy Audit Case Study
Report: Power Quality Study



Phase I Energy Audit Case Study
Report: Power Quality Study

Low Power Quality Implications

- Inefficient motor function
- Higher heat loads
- Shorter operational life
- Increased maintenance/replacement costs

Phase I Energy Audit Case Study Report: ECMs & Cost Savings Detail

Typical ECMs - Air Compression Systems

Energy losses due to:

- Leaks
- Lack of valving to isolate unoccupied levels
- Old or inefficient compressors

Phase I Energy Audit Case Study Report: ECMs & Cost Savings Detail

ECM Demonstration: Air Leak Losses

Leak Dia.	CFM Loss	CF/YR Loss
1/64”	0.41	212,809
1/32”	**1.55**	**849,139**
1/16”	**6.5**	**3,401,798**
1/8”	26	13,628,160
1/4”	104	54,628,160
3/8”	234	122,653,440
1/2”	415	217,526,400

Source:
http://www.reliabilityweb.com/excerpts/excerpts/Lets%20Talk%20About%20Compressed%20Air%20Leakage.pdf

Phase I Energy Audit Case Study Report: ECMs & Cost Savings Detail

ECM Demonstration: Air Leak Loss Cost Estimate[1]

- Est. Leak Size 1/32” (1.55 CFM @ 100 psi)
- Cost for one leak = $163/year (@ $0.20/1,000 cfm)
- Annual Cost of 1,000 leaks = $163,000/year
- Cost for one leak 1/16” = $663/year (@ $0.20/1,000 cfm)
- 1,000 Leaks @ 1/16” = $663,000/year

Note: 1. Costs will vary depending on electrical rate

Phase I Energy Audit Case Study Report: ECMs & Cost Savings Detail

ECM Demonstration: Motor Operation

Alternative cost comparisons[1]

- Variable frequency drives

- Soft starters on large induction loads

Note: 1. Could be proposed as part of Phase II scope

Phase I Energy Audit Case Study Report: ECMs & Cost Savings Detail

ECM Demonstration: Lighting

- 75 Watts incandescent vs
- 15 Watts per CFL
- 2,000 bulbs @ 8,760 hrs
- Savings $52,000/year (will vary with electrical rates)
- Incandescent life span 750 – 1,000 hours
- CFL life span 6,000 – 15,000 hours
- Labor costs savings for CFL vs. incandescent replacements—significant!

Phase I Energy Audit Case Study
Closing Thoughts

- Mines on grid: May consider using renewable energy generation sources
- Mines off grid: May consider using more efficient conventional or renewable energy generation sources

Thanks!

Questions?

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