Superior Energy Performance®
U.S. DEPARTMENT OF ENERGY

SEP Measurement & Verification Case Study Webinar

Detroit Diesel, Detroit MI

July 14, 2016

Paul Scheihing: U.S. DOE Advanced Manufacturing Office
Carlo Caltagirone and Chris Long: Detroit Diesel
Randy Green: Georgia Institute of Technology

U.S. DEPARTMENT OF ENERGY

Webinar and Case Study Purpose

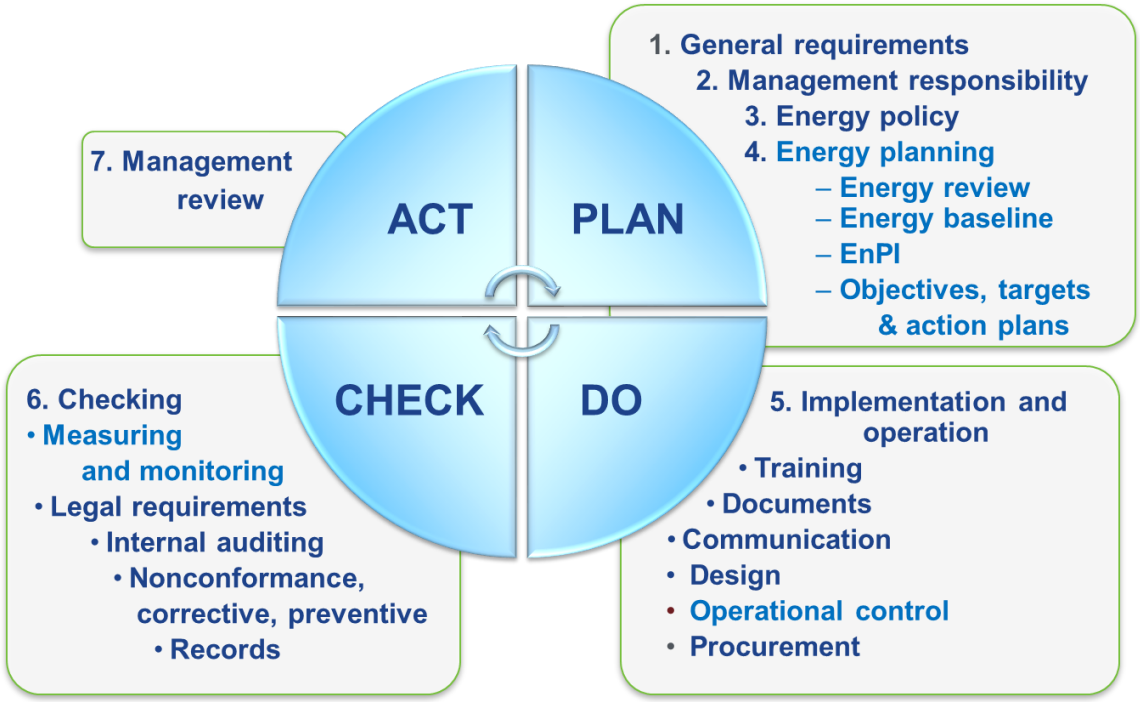
- Communicate the business value of SEP
- Share learnings from SEP pilots; especially on measurement & verification (M&V)
- Demonstrate rigor and robustness of SEP verification
- Develop reference case studies
- Hear from SEP community on their M&V experiences

ISO 50001–Energy Management Systems (EnMS)

International standard that draws from **best practices around the world**. Developed with input from 56 countries, many countries now adopting it as a national standard.

ISO 50001 specifies requirements for establishing, implementing, maintaining and improving an EnMS.

It does not prescribe specific energy performance improvement criteria.



ISO 50001 & Superior Energy Performance®

ISO 50001

- Proven, **internationally recognized**, best practice in energy management **building upon other ISO standards**
- Requires energy performance improvement with **energy data & metrics**
- **Relevance** for global corporation deploying energy management & sustainability programs

- Builds on ISO 50001 with **specific energy performance improvement criteria**
- National program **accommodating diverse facilities**: sector, size, program maturity, etc.
- **Transparency: Rigorous 3rd party verification** that market can reward: supply chains, utilities, carbon trading

Superior Energy Performance® Certified Facilities
15 companies with 41 certified facilities

Superior Energy Performance® Certified Facilities
15 companies with 41 certified facilities

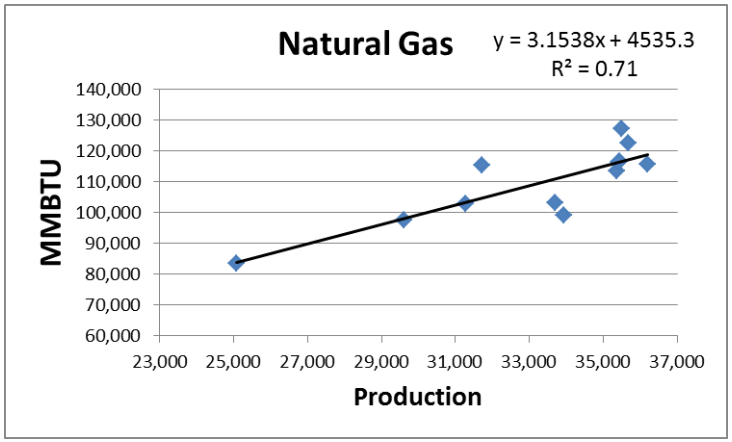
SEP Measurement & Verification

SEP energy performance is demonstrated by,

1. Top-down, whole facility EnPI ("SEnPI")

$$SEnPI = \frac{BTU_{Tot\ actual}}{BTU_{Tot\ predicted}}$$

Where $BTU_{Tot\ predicted} = f(X1, X2, \ldots Xn)$



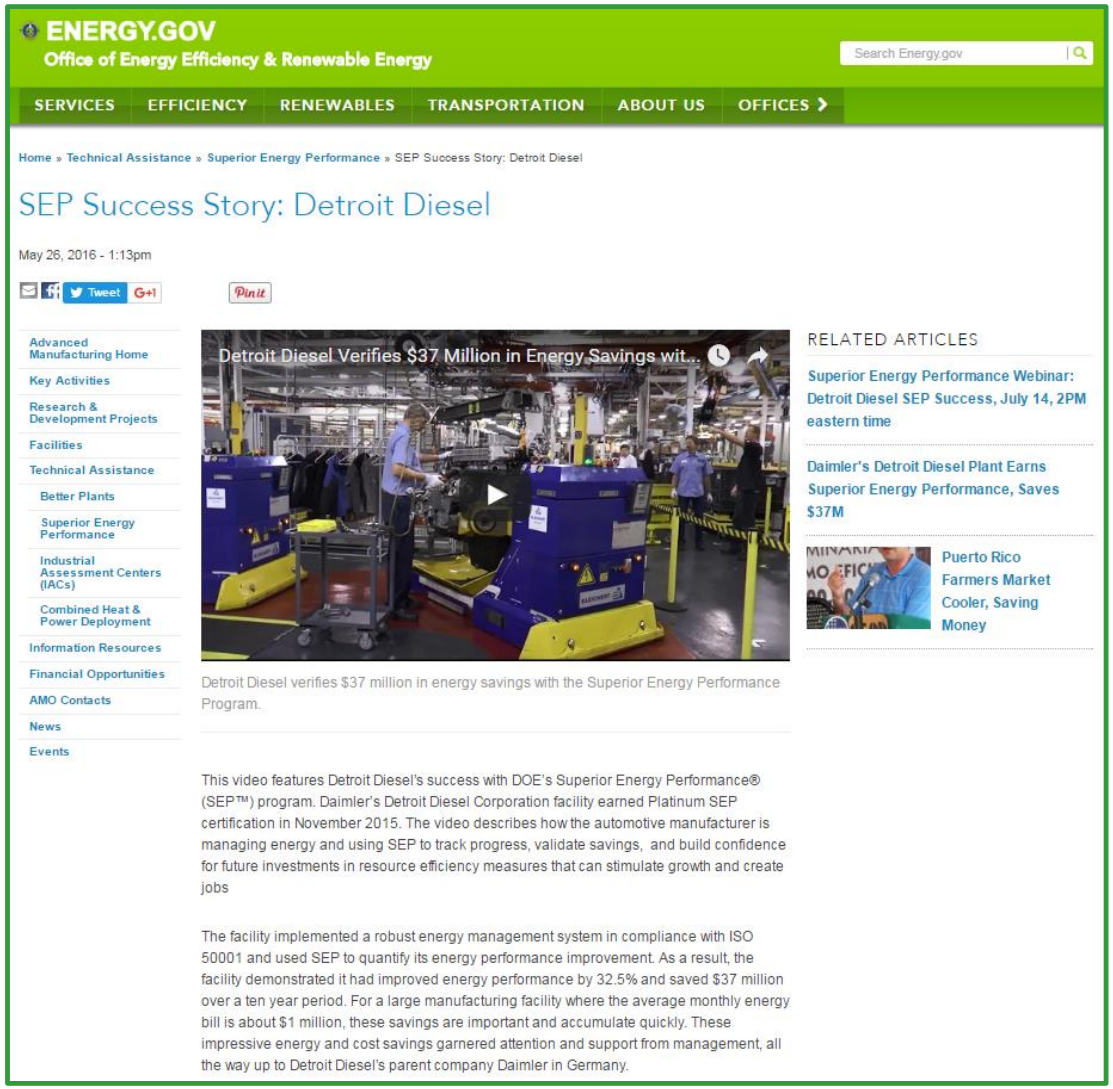
2. Bottom-up sanity check

   list of projects and their approximate energy savings that reasonably sum up to the calculated savings from the top-down performance improvement

SEP Success Story Video: Detroit Diesel

Detroit Diesel's SEP success story captured in a short video

http://energy.gov/eere/amo/articles/sep-success-story-detroit-diesel



Daimler / Detroit Diesel Energy Goals

DETROIT

Energy Policy

Detroit Diesel Corporation has adopted the Daimler Operations Powertrain Truck Energy Policy. This policy provides the framework to utilize energy, in whatever form, in an ecological, economical, sensible and efficient manner and ensures that the ambitious goal of continuous improvement of energy performance will be achieved. The site is committed to:

- Provide all necessary information and resources for energy management.
- Ensure compliance with all relevant legal and other requirements.
- Define and pursue strategic and operational goals using key performance indicators.
- Systematically evaluate energy consumption by recording energy flows.

Operations Powertrain Trucks undertakes to increase its energy efficiency by 2% annually up to the year 2020. The initial basis of evaluation is the energy-related performance for the reference year 2010.The reference parameter for the Corporation is the defined and

products and services.

We will address energy efficiency improvement at all the levels of our business units:

- by delegating responsibility and specifying clear reporting procedures
- by promoting ongoing development of specialized knowledge concerning energy
- by incorporating energy efficiency requirements in the procurement of equipment and services when calculating TCO (Total Cost Ownership)
- by creating energy requirements for new projects and modernization work
- by setting up an energy controlling system at departmental level
- by setting up and maintaining continuous internal communication.

Operations Powertrain Trucks undertakes to increase its energy efficiency by 2% annually up to the year 2020. The initial basis of evaluation is the energy-related performance for the reference year 2010.The reference parameter for the Corporation is the defined and approved operational energy indicator. If new goals are defined and specified by the parent group in the future, they are also binding on Operations Powertrain Trucks.

Daimler Energy and Environmental Certification Approach

- All production locations worldwide are certified to ISO 14001
- A total of 22 locations in Germany — including Daimler's major plants already have energy management systems that are certified in accordance with ISO 50001.
- Detroit Diesel – is the 1st Daimler facility in the U.S. to implement ISO 50001 and achieve SEP certification.
  - ISO 50001 was seamlessly blended with the existing ISO 14001 Environmental Management System.

>98%

of our global workforce at production locations works within the framework of a certified environmental management system.

Daimler Sustainability Report, 2015
https://www.daimler.com/images/sustainability/daimler-sustainability-report-2015.pdf

Detroit Diesel Facility Background

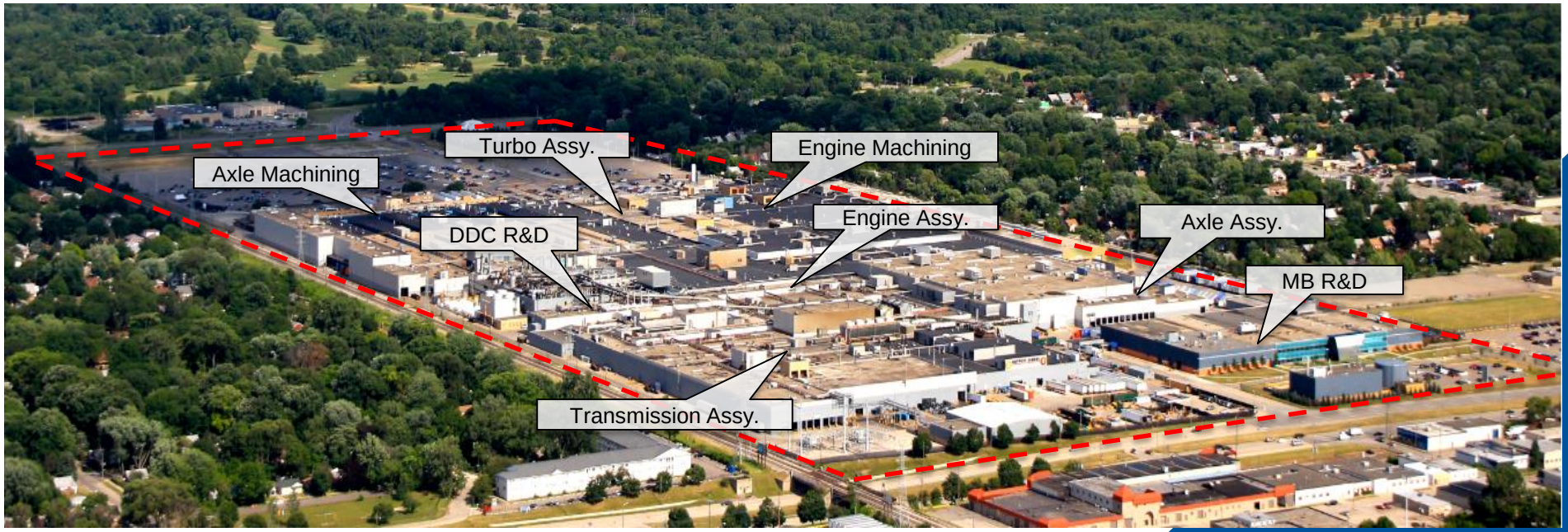
Project Summary	
Industry	Diesel Engines, Axles, Transmissions & Components
Facility location	Detroit, MI, USA
Operations	Machining, Assembly, and Test
Employment	2,800
Production Schedule	3 shifts, 7 days per week
SEP certification level	Platinum – 32.5%
Energy management system	ISO 50001

2015–18 | PLATINUM

Superior Energy Performance®
U.S. DEPARTMENT OF ENERGY

EnMS Scope and Boundary

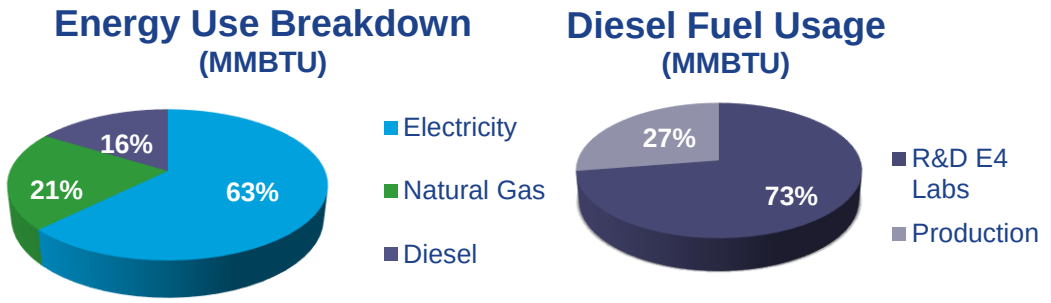
- Detroit Diesel is a 3.2M Sq. Ft. Facility
- Boundary includes entire campus (131 acres)
- Second largest Daimler facility in North America
- Scope includes R&D, Machining, Assembly (engines, axles, automatic transmission for trucks) and Engine Test

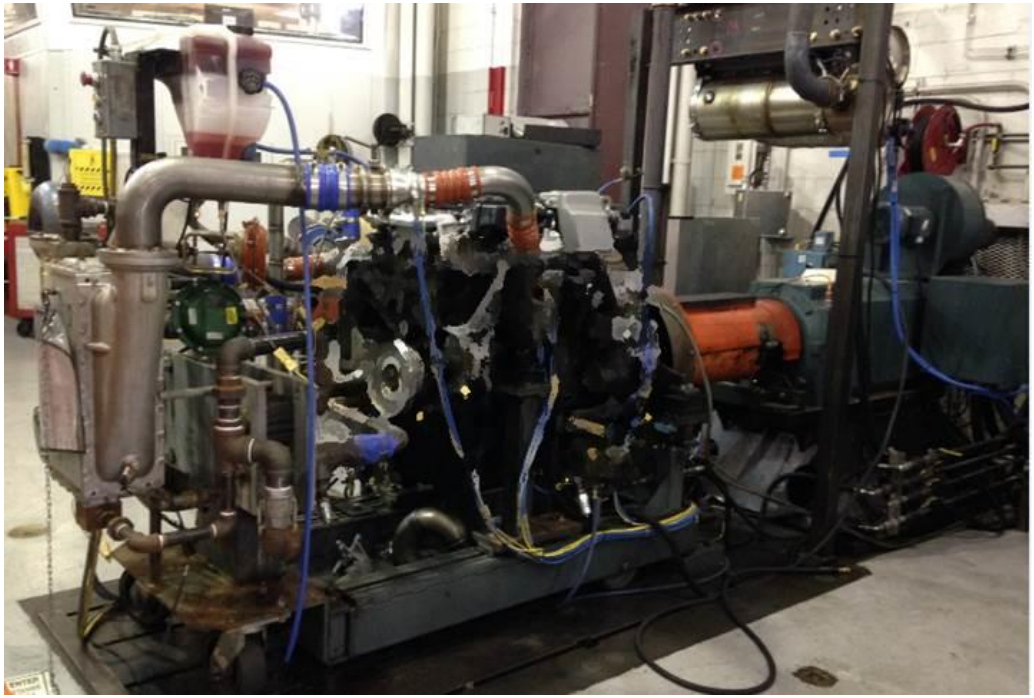


Superior Energy Performance
U.S. DEPARTMENT OF ENERGY

Detroit Diesel Energy Profile

- SEUs selected were the **Boiler Room and Engineering (E4) Lab**
- ISO 50001 and SEP Certified "**Platinum**" with 32.5% improvement
- Baseline Period is Apr 2004 to Mar 2005
- Model Period is Apr 2012 to Mar 2013
- Reporting Period is Apr 2014 to Mar 2015
- Certification date: Nov 2015
- ISO 50001 Certification Body was DEKRA
- SEP Verification Body was DEKRA

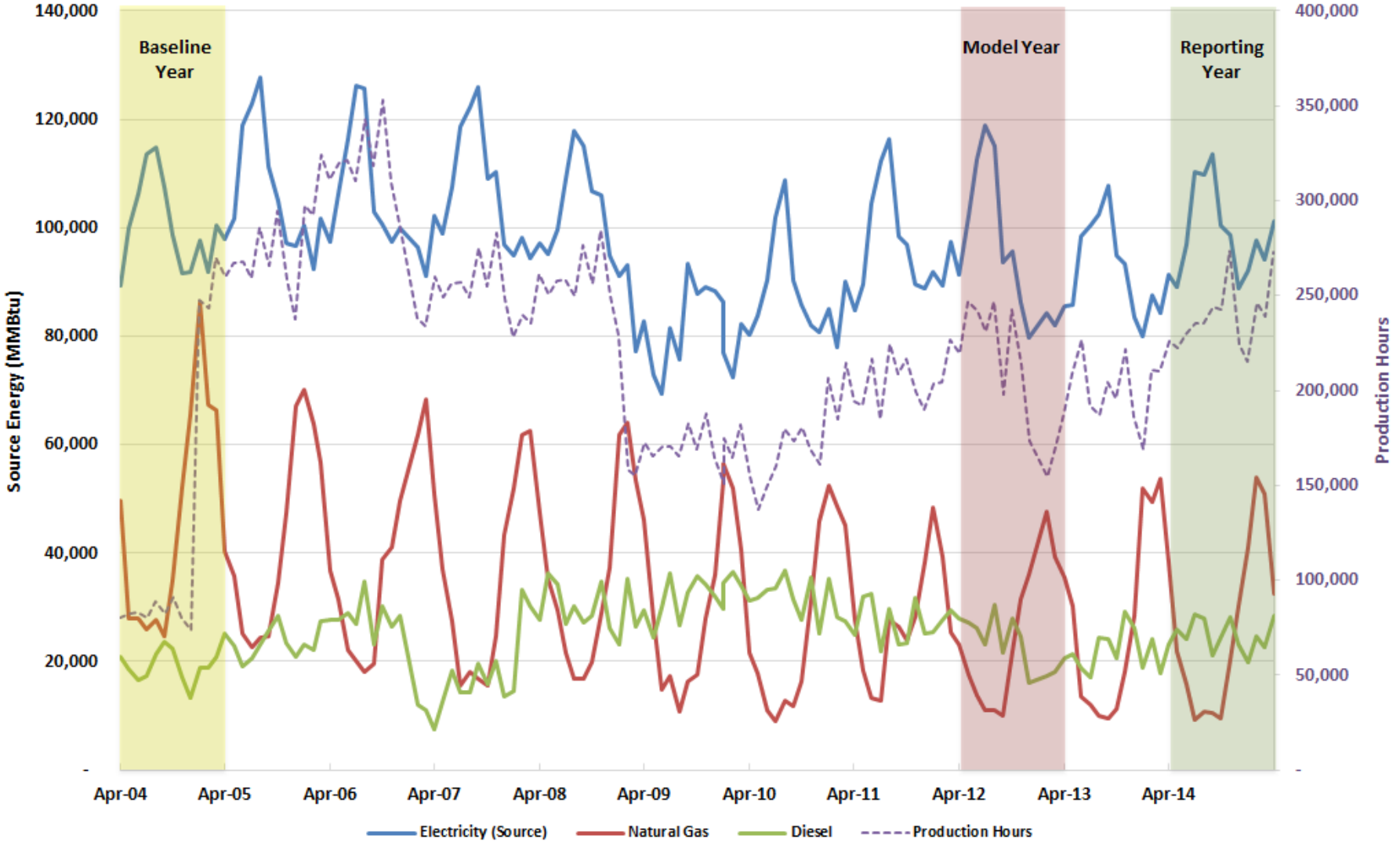




ISO 50001 Implementation

- Daimler has extensive energy management expertise in their German facilities. Carlo Caltagirone, energy management specialist, was sent to Detroit Diesel to implement ISO 50001. To assist with Carlo's assignment, PHI Environmental Consulting was hired as an ISO 50001 subject matter expert.
- Detroit Diesel merged ISO 50001 with the existing ISO 14001 Environmental Management System. Implementation of ISO 50001 was similar to ISO 14001 and assimilated seamlessly.
  - Identified roles and responsibilities
  - Conducted gap analyses SEU (internal audit)
    - Identified what we do now and what we need to do to meet ISO 50001
- Daimler exchanged information and best practices from their German facilities to Detroit Diesel.
- Essentially, ISO 50001 was an enhancement of ISO 14001 rather than a completely new system.

Detroit Diesel Energy Consumption Data



EnPI Model

Variables that most closely affect energy consumption at the plant:
Production Hours, HDD, CDD

- Electricity – Production Hours and CDD
- Natural Gas – HDD
- Diesel – Production Hours

Regression analysis methodology: Chaining

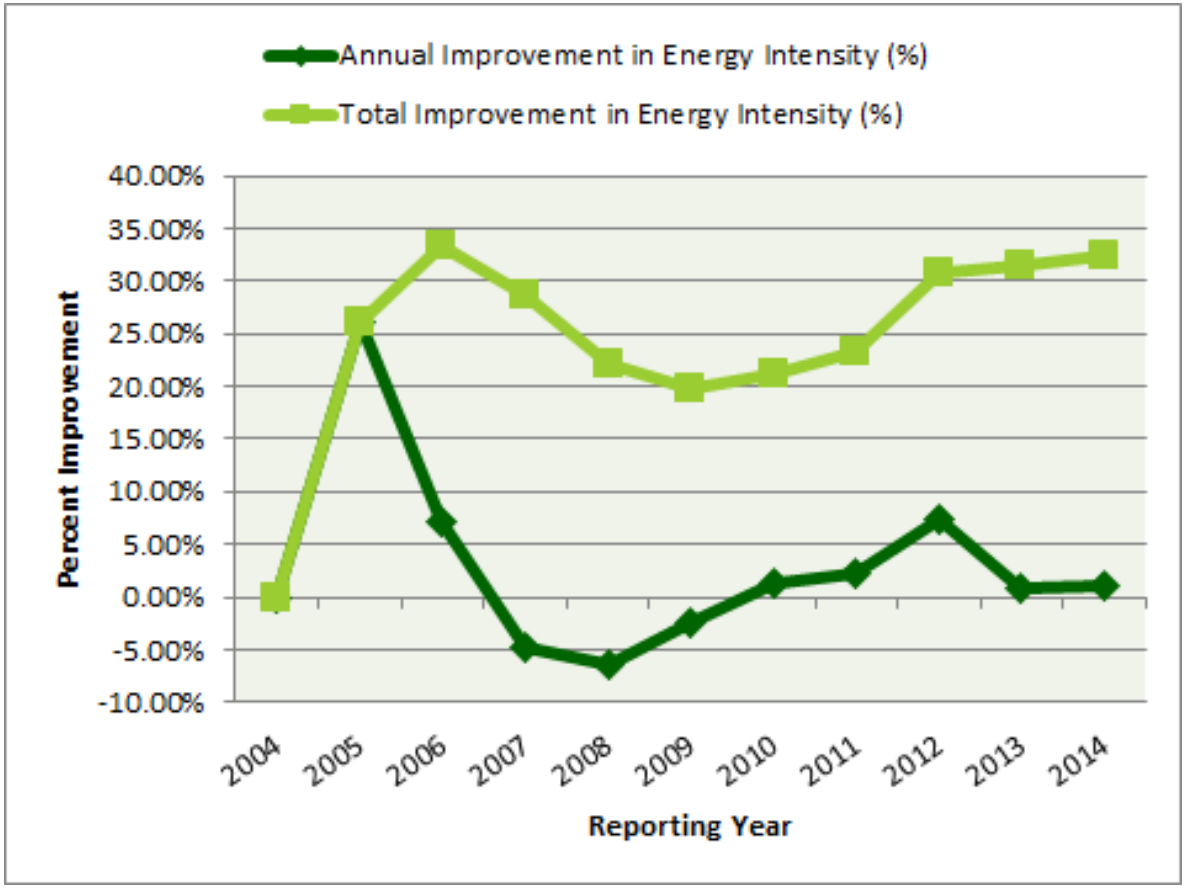
Modeled energy consumption was normalized utilizing actual production hours, HDD and CDD
The "Model Year" was Apr 2012 – Mar 2013, the Achievement Period was Apr 2005 – Mar 2015

All statistical tests were met.
Allowed us to calculate energy savings, which translated into dollar savings.

Model Results

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total Improvement in Energy Intensity (%)	0.00%	26.09%	33.25%	28.58%	22.19%	19.79%	21.10%	23.35%	30.74%	31.46%	32.49%
Annual Improvement in Energy Intensity (%)	0.00%	26.09%	7.16%	-4.68%	-6.39%	-2.40%	1.31%	2.25%	7.39%	0.72%	1.03%
Total Energy Savings since Baseline Year (MMBtu/Year)	0	515,315	661,892	569,634	442,178	421,430	441,832	477,149	611,428	17,809	46,522
New Energy Savings for Current Year (MMBtu/year)	0	515,315	146,577	-92,257	-127,457	-20,747	20,401	35,317	134,279	-593,619	28,714

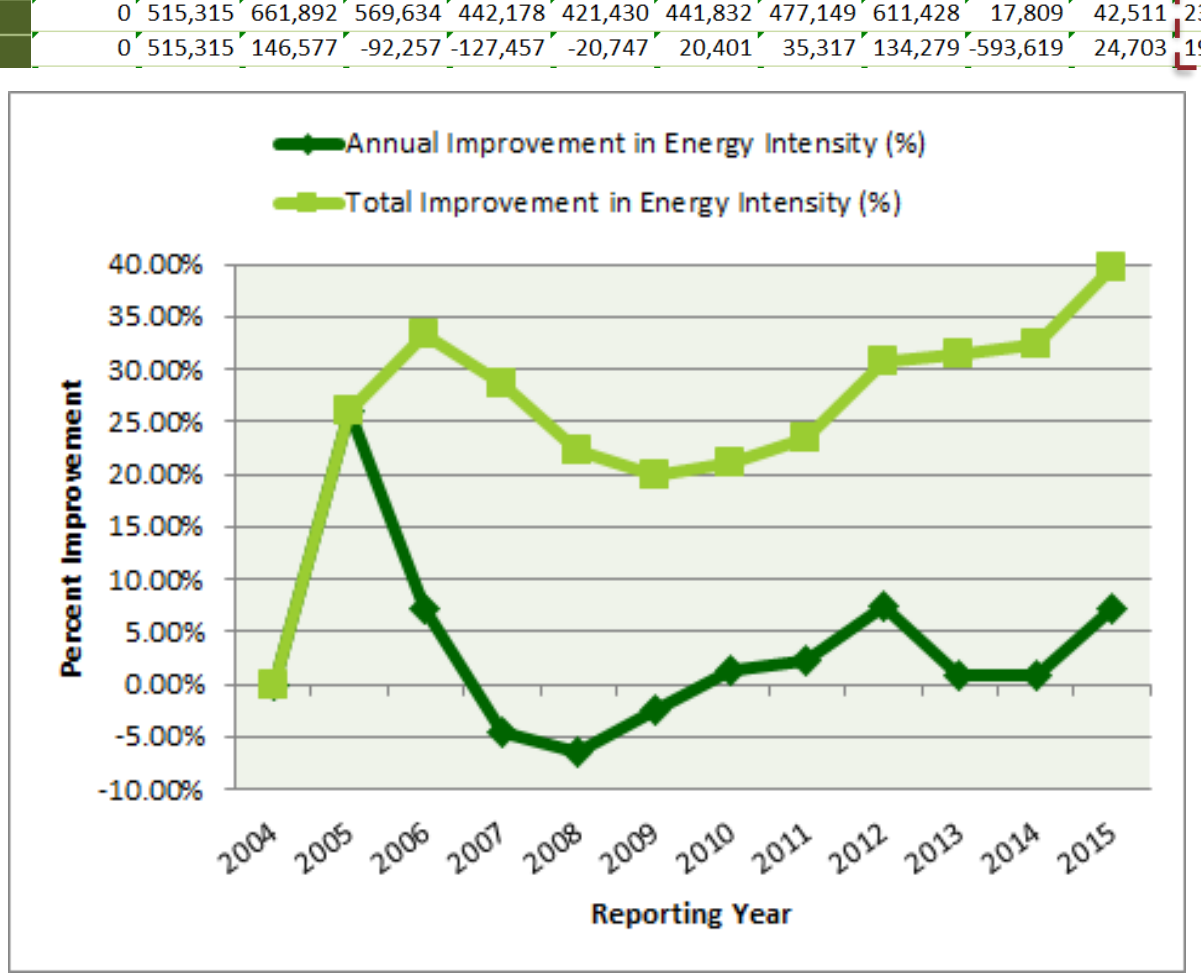
- Large initial savings
- Regression in savings (reduced production years)
- Implemented ISO 50001 EnMS to embed energy savings into business practices
- Energy Performance Improvement: 32.5%
- Saving for the future



Model Results + 1 year

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total Improvement in Energy Intensity (%)	0.00%	26.09%	33.25%	28.58%	22.19%	19.79%	21.10%	23.35%	30.74%	31.46%	32.34%	39.62%
Annual Improvement in Energy Intensity (%)	0.00%	26.09%	7.16%	-4.68%	-6.39%	-2.40%	1.31%	2.25%	7.39%	0.72%	0.88%	7.28%
Total Energy Savings since Baseline Year (MMBtu/Year)	0	515,315	661,892	569,634	442,178	421,430	441,832	477,149	611,428	17,809	42,511	238,714
New Energy Savings for Current Year (MMBtu/year)	0	515,315	146,577	-92,257	-127,457	-20,747	20,401	35,317	134,279	-593,619	24,703	196,203

- Large initial savings
- Regression in savings (reduced production years)
- Implemented ISO 50001 EnMS to embed energy savings into business practices
- Energy Performance Improvement: 32.5%
- Saving for the future



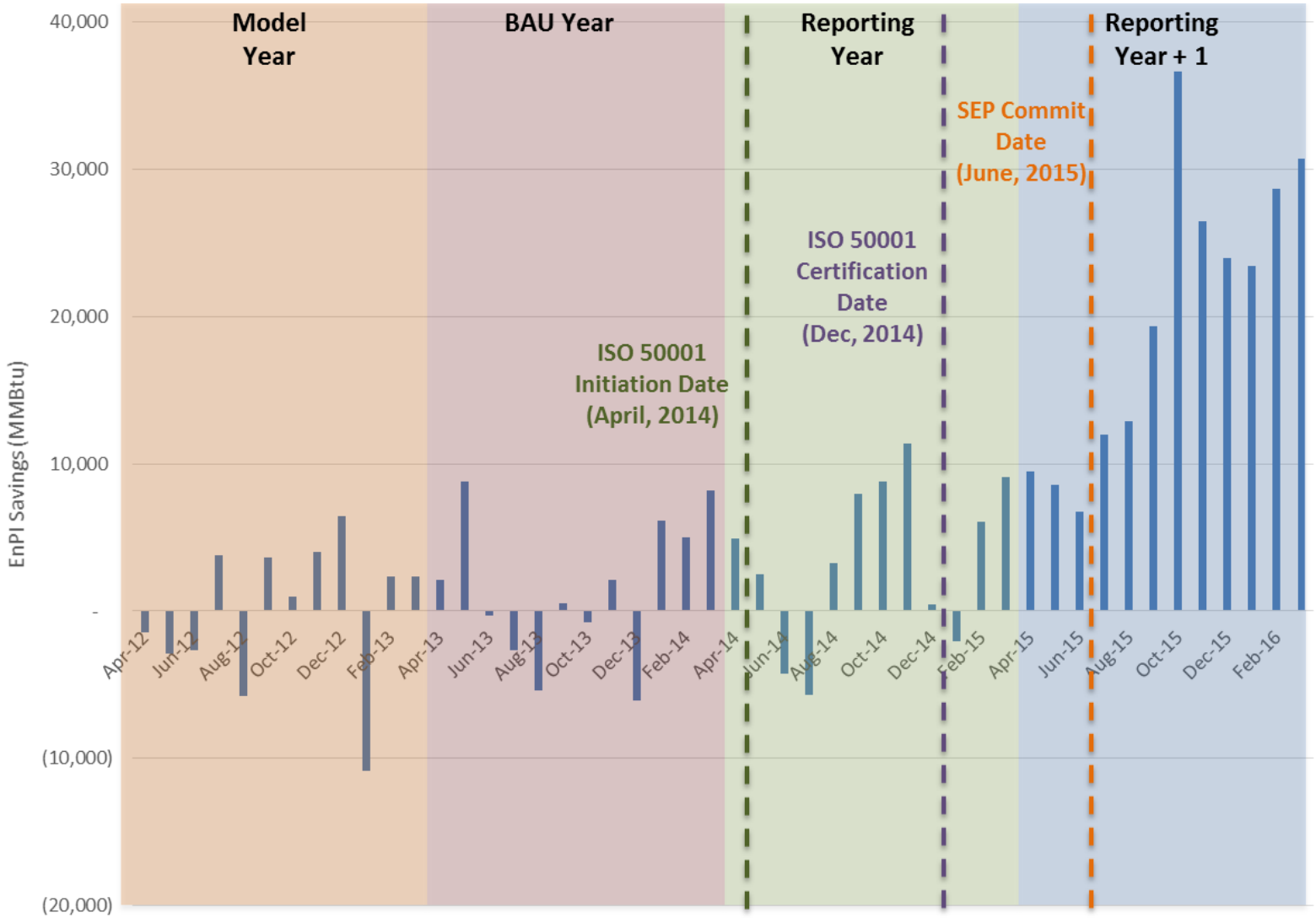
Detroit Diesel SEP Cost Saving

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
Electricity (MMBTU) Annual Savings	270,580.08	315,343.37	214,416.03	246,227.92	317,870.52	273,537.81	237,038.61	264,189.49	6,646.20	(11,528.71)	2,134,321.31
Average $ per MMBTU	4.64	5.12	5.53	5.79	6.34	6.03	6.19	7.61	7.70	7.31	
Total $ of MMBTU	$ 1,256,205.34	$ 1,613,708.52	$ 1,185,069.18	$ 1,426,355.44	$ 2,015,372.42	$ 1,649,148.00	$ 1,467,293.61	$ 2,009,810.98	$ 51,192.43	$ (84,246.39)	$12,589,909.53
Natural Gas (MMBTU) Annual Savings	31,503.91	90,458.63	134,372.41	132,892.86	179,280.56	235,317.56	198,177.11	250,043.35	7,776.86	20,121.87	1,279,945.11
Average $ per MMBTU	9.32	7.80	7.47	9.78	4.97	5.36	4.83	3.69	4.56	6.59	
Total $ of MMBTU	$ 293,514.68	$ 705,197.94	$ 1,003,838.85	$ 1,299,588.04	$ 891,622.16	$ 1,260,350.30	$ 956,369.68	$ 923,076.71	$ 35,478.81	$ 132,697.01	$7,501,734.19
Diesel (MMBTU) Annual Savings	213,230.73	256,089.88	220,846.04	63,057.17	(75,720.60)	(67,023.53)	41,933.15	97,195.09	3,385.66	37,929.33	790,922.92
Average $ per MMBTU	17.17	19.39	20.54	27.43	17.52	21.28	27.69	28.56	28.10	27.61	
Total $ of MMBTU	$ 3,661,784.57	$ 4,965,104.56	$ 4,536,229.37	$ 1,729,743.38	$ (1,326,285.81)	$ (1,426,010.37)	$ 1,161,272.03	$ 2,775,560.34	$ 95,134.76	$ 1,047,381.26	$17,219,914.09
									Total DDC MMBTU Saved		4,205,189.34
									Total DDC Cost Saving		$37,311,557.81

Detroit Diesel Bottom-Up Sanity Check – Project List

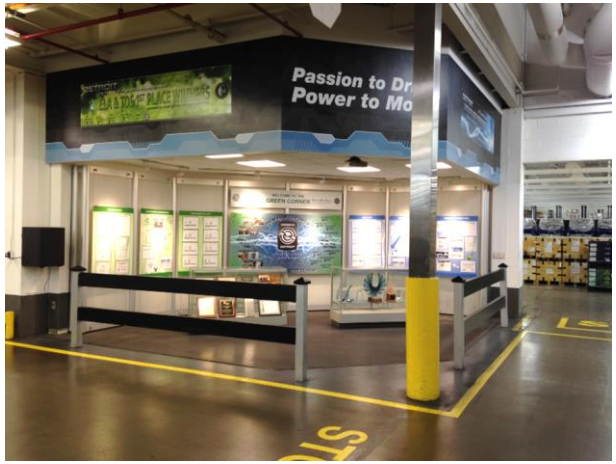
- Replacement of Roofing and Windows
- Boiler Combustion Efficiency Program
- Steam Reduction Program
- Compressed Air Leak Repairs and Compressor Replacement
- Repairs and/ or Upgrades to HVAC Systems
- Chiller Replacement
- Lighting Replacement Program (All LED lighting fixtures by 2020)
- Secure Building Envelope Program
- Replaced engine paint with lower curing temperature paint
- VFD Program
- R & D Engine Test Layering System
- Replacement of old Series 60 Engines Machining & Assembly lines

Monthly EnPI Savings



Challenges

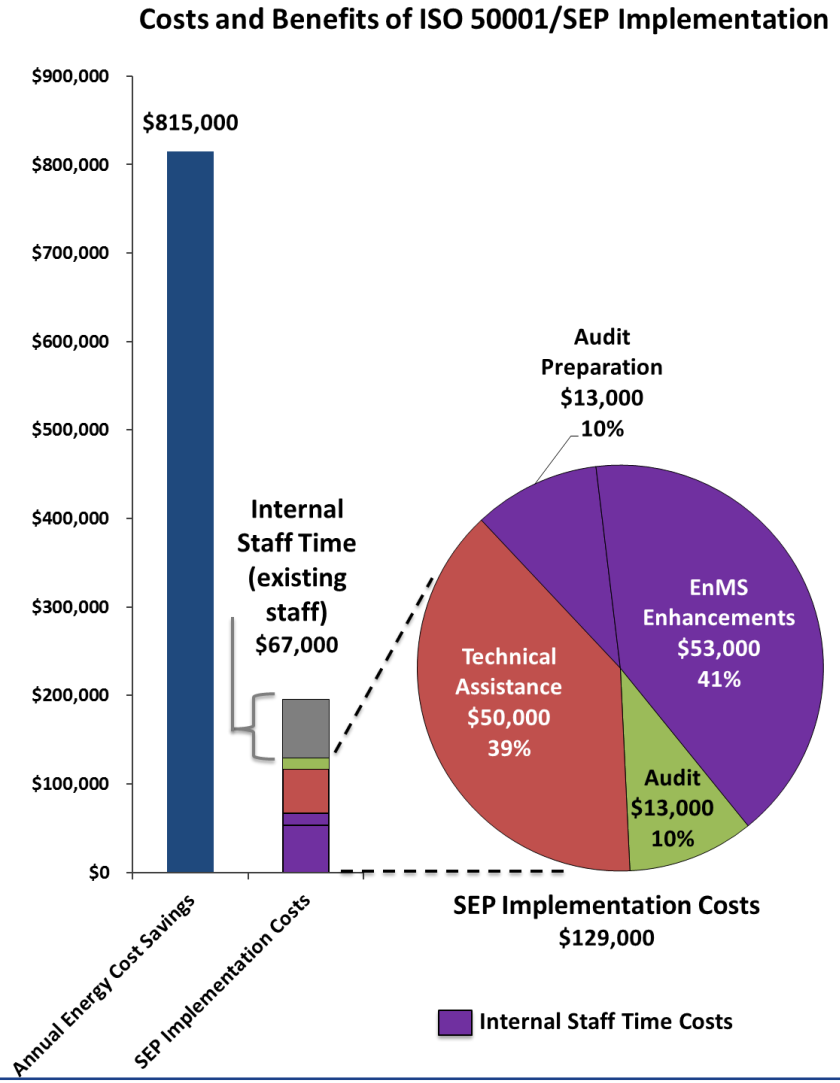
- Management Engagement
- Time Requirement
- Manpower & Expertise
- Budget
- Competing interest (energy efficiency vs. non-energy)
- Communication
- Changing the Plant Culture



Cost-Benefit Analysis

Project Cost / Benefit Analysis	
SEP certification level	Platinum
Energy management system (EnMS)	ISO 50001
Energy performance improvement	32.5% over 10 years
Annual energy cost savings	$815,000
Cost to implement	$129,000
Payback period*	2 months

* SEP marginal payback is based on operational energy cost savings attributable to the SEP program.



Additional Benefits of SEP

- Increased awareness of energy consumption and savings from top management
  - SEP provided the pathway to set energy goals
  - SEP M&V process enable quantifying savings and impacts of energy efficiency efforts.
  - Secure funding/reinvestment in the plant from upper management
- Energy Efficiency considered for all new equipment

"Daimler Plant Managers in Germany were impressed with the energy and costs savings resulting from the Detroit Daimler plant's approach to energy management through the SEP program."

- Carlo Caltagirone, Energy Management Specialist

Closing Comments

Observations

- If top management supports you, your projects will be successful. SEP helps attain management support
- Management values public recognition through awards
- Simple: energy savings = saving money

Next Steps

- 2020 Corporate goal to reduce energy consumption by 20%
- Join the Better Plants Program
- Expand Energy Management to the 9 other Major Daimler Plants

SEP info

- SEP webinar page: http://www.energy.gov/eere/amo/sep-webinars
- Further training on SEP M&V is included in CP EnMS and SEP PV Training

  http://energy.gov/eere/amo/become-energy-management-professional

energy.gov/isosep

Please subscribe on SEP homepage for SEP updates