

GENERAL MOTORS

ENERGY MANAGEMENT SYSTEMS

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Global Energy Manager

September 22, 2015



GENERAL MOTORS

OVERVIEW OF GM MANUFACTURING

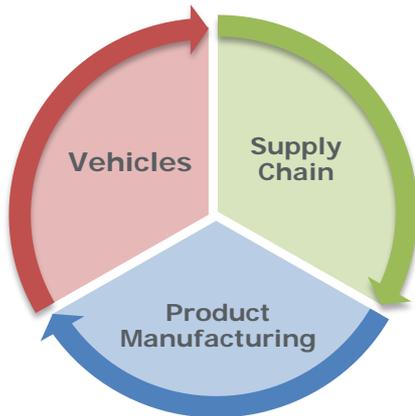
- Design, build and sell the world's best vehicles
- Building 10 million vehicles per year= \$1.2 billion in energy
- Enough electricity to power 1 million homes
- Carbon equivalent of 172 million trees for 10 years
- Enough water to fill 166 billion glasses



GM ENVIRONMENTAL SUSTAINABILITY

*We're continually assessing our **environmental impact** and taking steps to **reduce it***

GM has a commitment to the environment and sustainability that applies to every part of our business – from our **supply chain**, to **product manufacturing**, to the **vehicles** we put on the road.



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Top level support

▼▼ We have a customer-driven sustainability strategy. Customers expect us to help mitigate, if not eliminate, issues like congestion, pollution and traffic accidents, among others. If we expect our industry to continue to thrive, we must provide solutions. This extends to how we build our products and how we engage with the world around us. When it comes to sustainability, we pursue outcomes that create value for both GM and our customers. This has led to expanded use of renewable energy, a 'zero waste' mindset and other initiatives that have sharply reduced our energy intensity, resource consumption and greenhouse gas emissions worldwide.

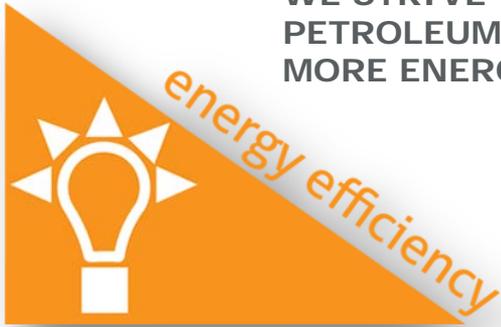
Our CDP ranking shows that we're measuring and pulling insight from our energy and carbon data to capitalize on opportunities for greater efficiency. It reinforces our stewardship and sustainability goals. Responding to CDP helps us communicate to the financial community that we're prepared for changing market demands and emissions regulation. Effectively managing our carbon within our vehicles and facilities and sharing it publicly is good for our customers, shareholders, the planet and our bottom line. ▼▼

Mary T. Barra
Chief Executive Officer
General Motors Company



ENERGY & CARBON INTENSITY – 20% BY 2020

WE STRIVE TO REDUCE EMISSIONS AND PETROLEUM DEPENDENCE BY BEING MORE ENERGY EFFICIENT.



Energy Star® Certified

- ❖ 2 Assembly
- ❖ 5 Warehouses
- ❖ 1 Office



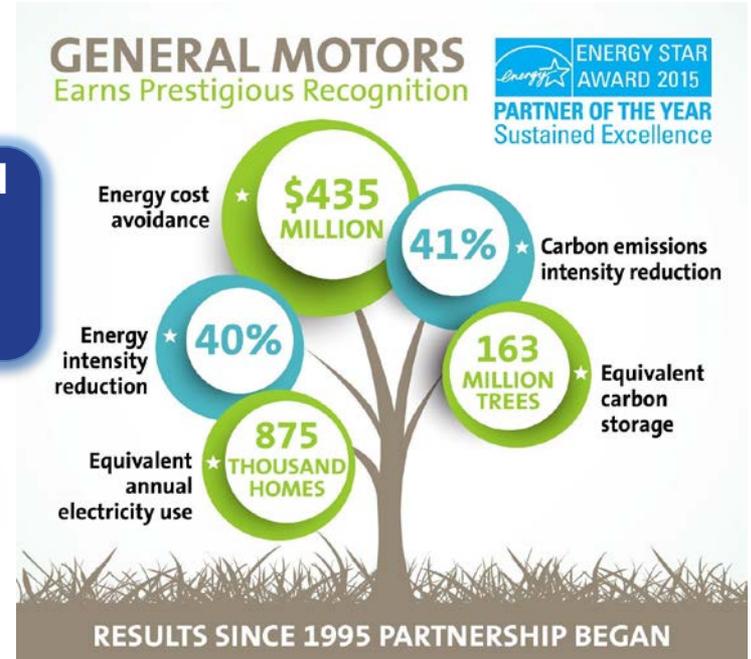
Reduce Use



Renewable Energy

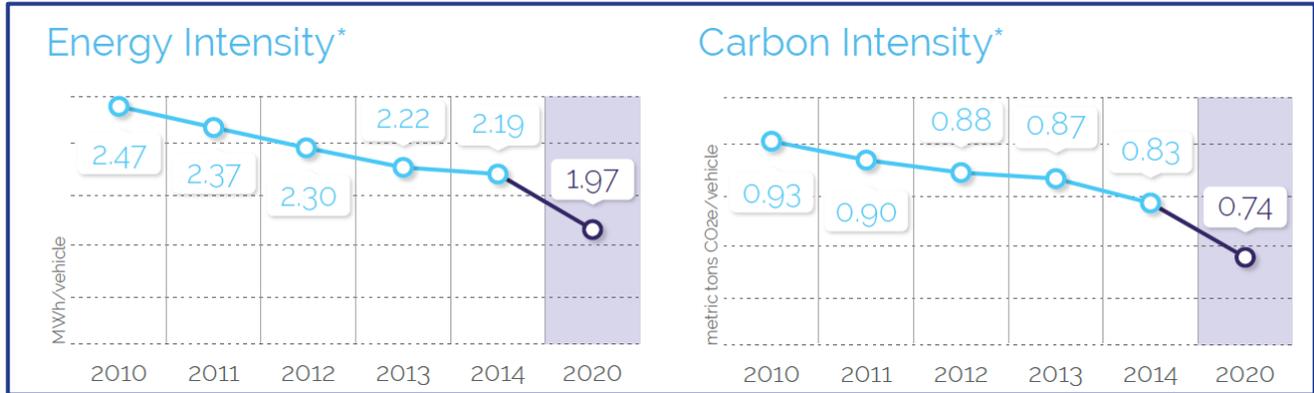


Fuel Switching



2014
11% less energy since 2010

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RENEWABLE ENERGY – 125 MW

RENEWABLE ENERGY

WE BELIEVE IN HARNESSING THE POWER OF RENEWABLE AND ALTERNATIVE ENERGY AND WE'RE ONE OF THE LEADING USERS IN THE MANUFACTURING SECTOR.



Solar

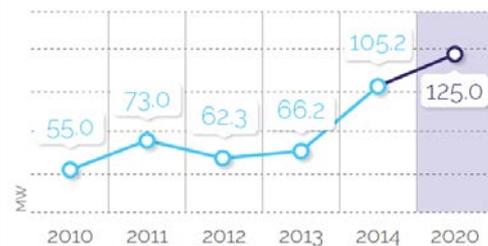


Biomass



Landfill Gas

Installed Renewable Energy Capacity*



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SOLAR POWER – UNITED STATES

- Named "Solar Champion" for promoting renewable energy
- More U.S. solar installations than any other automaker
- Ranked top 25 of all commercial solar energy users in U.S.



SOLAR POWER – ZARAGOZA, SPAIN

- Our Zaragoza assembly plant was the world's largest industrial rooftop solar installation until 2012.



PRESERVE NATURAL RESOURCES



WE PRESERVE NATURAL RESOURCES AND ENHANCE HABITATS SURROUNDING OUR FACILITIES.



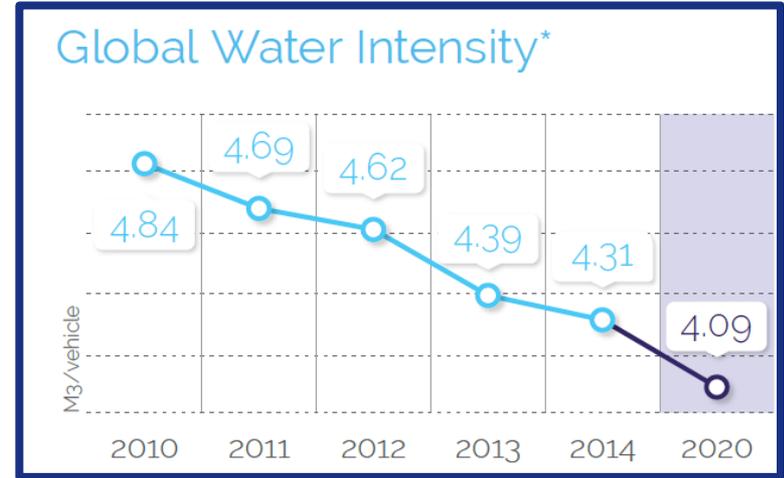
Reduce Water Use



Habitat Enhancement



Watershed Education



GM GREEN WATERSHED EDUCATION - 25 YEARS -



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Habitat Enhancement

40 sites certified by:



WILDLIFE HABITAT COUNCIL™

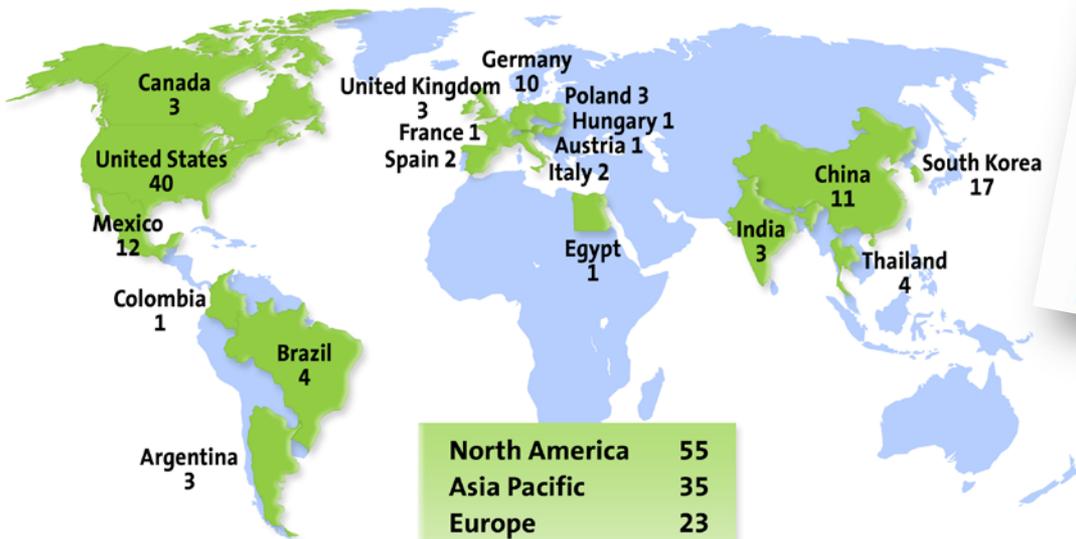


5,000 acres dedicated



WASTE REDUCTION – REDUCE, REUSE, RECYCLE

GM's 122 LANDFILL-FREE FACILITIES



North America	55
Asia Pacific	35
Europe	23
South America	8
Africa	1

Re-Use of Automotive Byproducts

- Buick Verano**
Recycled cardboard used in headliner
- GMC Sierra**
Plastic caps and shipping aids used in radiator shrouds
- Chevrolet Volt**
Old tires used in air and water baffles

85% MANUFACTURING WASTE RECYCLED

- 43% total waste reduction from 2000-2010
- 23% total waste reduced from 2010-2013
- 73% of non-recycled waste reduced since 2000

1 TRASH BAG = 122 GM facilities combined

COMMUNITY ENGAGEMENT

Shipping Crates = Raised Urban Garden Beds

1,200 shipping crates from Orion Assembly turned into raised beds

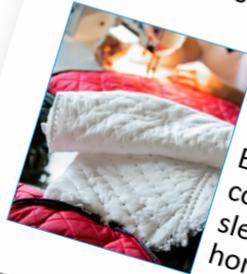


Provides nearby residents and soup kitchens with nutritious, locally grown food



Coats for Homeless with Vehicle Scrap

4,000 yards of sound absorption material donated from production of Malibu and Verano sedans



Insulates 800 Empowerment Plan coats that transform into sleeping bags for the homeless.



CHEVROLET CARBON REDUCTION PROJECT

U.S. 5-Year Clean Energy Projects

GOAL

8 MILLION METRIC TONS CO₂ REDUCTION

=

Emissions from **1.9 M** Chevrolet's sold from 11/18/10 - 12/31/11

INVESTMENT \$40 MILLION



GREENER VEHICLES – FUEL ECONOMY



WE'RE BUILDING FUEL-EFFICIENT VEHICLES THAT FIT OUR CUSTOMERS' NEEDS AND LIFESTYLES.



Research & Development



Fuel Economy



Energy Diversity

Goals to reduce CO₂e from vehicles per mile

- ❖ US – 15% reduction by 2016
- ❖ EU – 27% by 2020

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CHEVROLET VOLT
World's first mass-produced vehicle with extended-range capability

38 Miles
Battery Electric Driving

+

342 Miles
Extended Range Driving

The advertisement features a white Chevrolet Volt driving on a road. The text is overlaid on the image, highlighting the car's dual driving modes.

FUEL EFFICIENCY
Improvement since 1970s

180%
FOR CARS

93%
FOR TRUCKS

The advertisement includes images of a red Chevrolet sedan and a red Chevrolet pickup truck. A fuel efficiency gauge icon is also present. The text emphasizes the percentage improvement in fuel efficiency since the 1970s.

OVERVIEW OF GM'S ENERGY MANAGEMENT PROCESS & GLOBAL MANUFACTURING SYSTEM

Integrating Energy into your business plan will make it a sustainable part of your operations

What is needed to be successful?

- Top leadership support
- Resources (dedicated people and budget)
- Establish Energy as a pillar of business plan

Tool kit for implementation

- Benchmarking*, Goals, and Scorecards
- Meter data, dashboards
- Continuous commissioning
- Budgeting and forecast
- Energy Savings Project Implementation Process
- Recognition



GM has been an Energy Star® partner for 20 years

GM'S GLOBAL MANUFACTURING SYSTEM

Plan, Do, Check, Act aligns with Energy Star® guidelines



GLOBAL MANUFACTURING SYSTEM



Each of the 5 GM-GMS Principles is supported by key elements. There are 29 GM-GMS Elements.

People Involvement

1. Vision, Mission
2. Health & Safety
3. Qualified People
4. Team Concept
5. Engagement
6. Open Communication Process
7. Shop Floor Management

Standardization

8. Workplace Organization
9. Management By Takt Time
10. Standardized Work

Built-In Quality

11. Quality Standards
12. Process & Product Validation
13. In-Process Control & Verification
14. Quality Feedback/Feedforward
15. Quality Management System

Short Lead Time

16. Simple Process Flow
17. Pull Systems
18. Lean Containerization
19. Level Scheduling & Fixed Period Orders
20. Controlled External Transportation
21. Scheduled Shipping / Receiving
22. Temporary Material Storage
23. Supply Chain Management

Continuous Improvement

24. Business Plan Deployment
25. Problem Solving
26. Lean Design
27. Andon Concept/Process
28. Total Productive Maintenance
29. Continuous Improvement Process

Why – Vision & Mission

What – Goals & Objectives

Where – Focus on where value is added

When – Schedule and Control points

How - Methods

Who – Responsible & Support



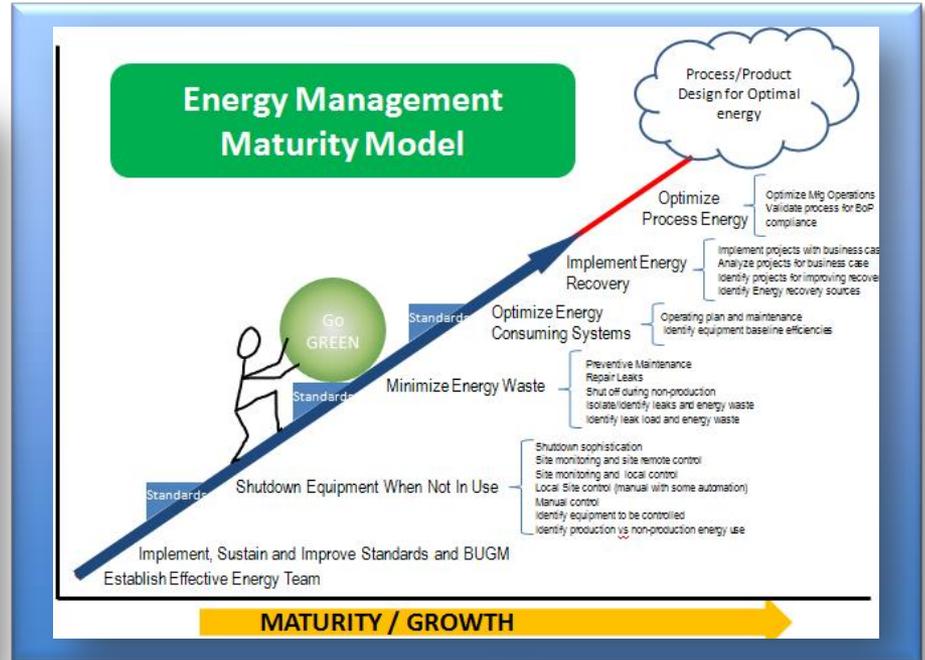
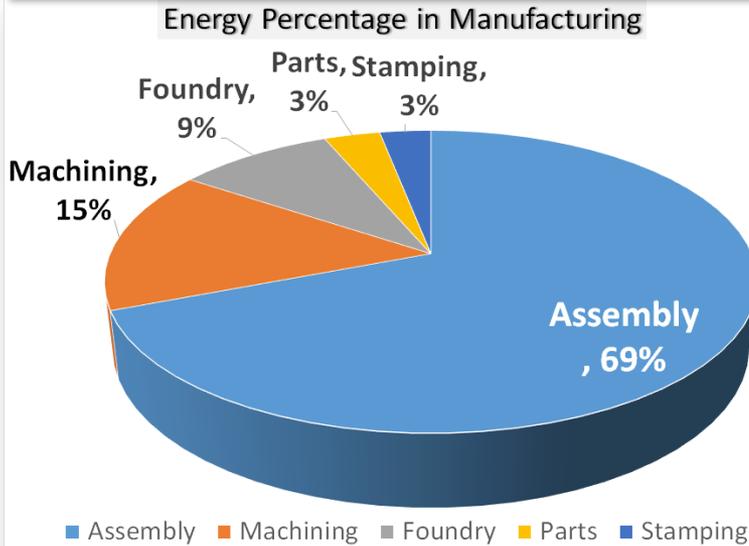
In GMS, E-Metric or Environmental / Energy is managed along with our Business Plan in "Continuous Improvement"

MWh/Unit

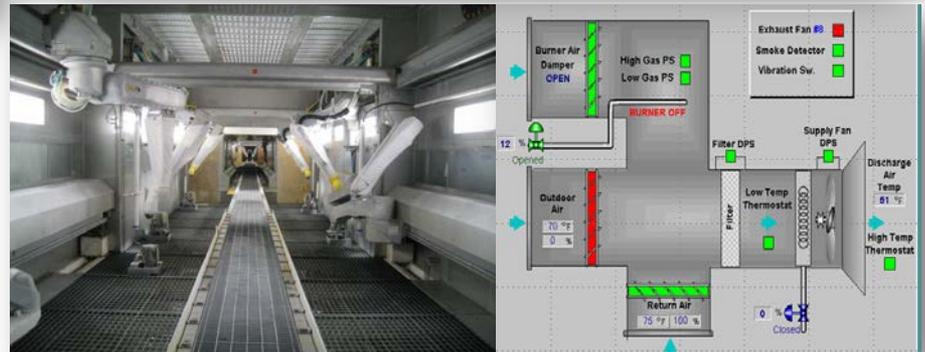
	Goal
S	Continue Safety Leadership
P	Engaged & Qualified Work Force
Q	Segment Leaders by 2012
R	Meet Customer Demand
C	Regain Profitability
E	Industry Leader in Environmental Systems

PRIORITIZE ASSEMBLY & PAINTING OPERATIONS

PAINT OPERATIONS ARE 70% OF ASSEMBLY ENERGY



- Recycle air to automated zones
- Design in efficiency—fans, pumps
- Three-wet paint process
- Automated shutdown



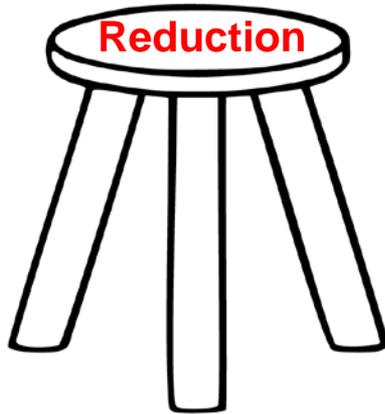
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Painting: 50% of energy & 70% water use

ENERGY & CARBON FACILITY STRATEGY

Renewable Energy

- 125 MW
- Hosting
- PPAs



Energy Efficiency Conservation

Fuel Switching

- ❖ Steam elimination or reduction using direct fired gas
- ❖ Convert boilers to eliminate coal – Wentzville (52,000) tons CO₂e
- ❖ Purchase steam – Hamtramck (57,000) tons CO₂e , (35%) adds 16 MW renewable

Energy – Efficiency/Conservation

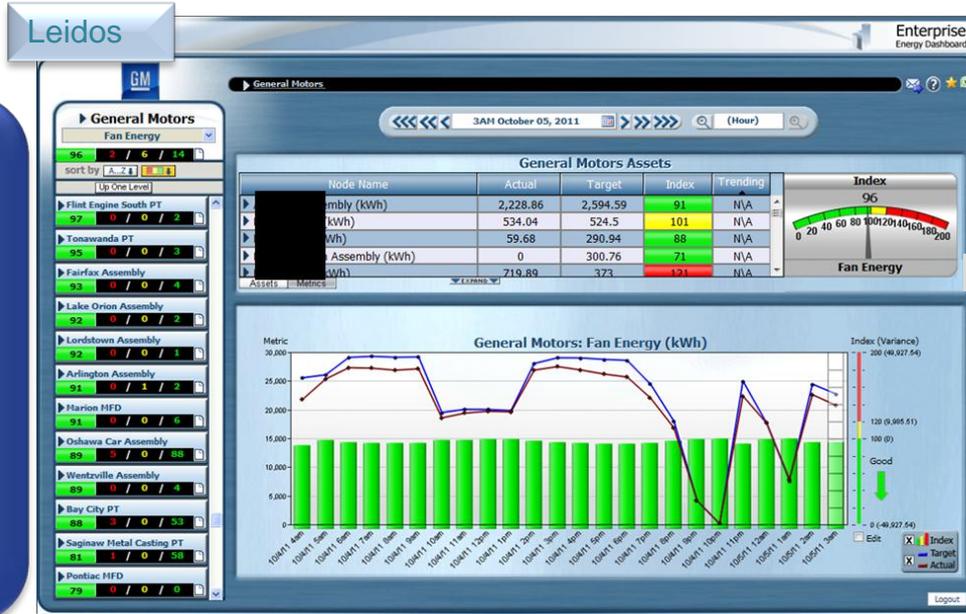
- ❖ Design in efficiency – lean design engineering guidelines
- ❖ SMEs on new project teams
- ❖ LEED principles as guidance
- ❖ Dedicated budget for energy projects and Performance Contracting – \$30M or 5%
- ❖ Targets set for plants to meet public goals, (\$ and MWh/vehicle)
- ❖ Sufficiency plans to meet target
- ❖ Hourly, daily dashboard
- ❖ Monthly scorecards

WEB-ENABLED ENERGY ONSTAR – REAL TIME DASHBOARD



Identified important energy metrics and targets:

- Heat/Cool Energy
- Fan Energy
- Outside Air Index and Rate
- Run Times
- Set Points
- Supply Air Index and Rate
- Energy Metrics



Continuous Commissioning HVAC provides saving \$4M for (6) month payback

Monthly Energy, GHG, & Water Scorecard

GM	Energy per Unit Production (MWh/Unit)			YTD Energy			Water per Unit Production (MT/Unit)			YTD Water		
	Actual	Target	Status	Actual	Target	Status	Actual	Target	Status	Actual	Target	Status
Assembly	1.236	1.282	●	1.517	1.579	●	2.162	2.327	●	2.138	2.212	●
Plant 1	0.912	0.924	●	0.968	1.004	●	1.661	1.819	●	1.671	1.736	●
Plant 2	1.850	1.905	●	2.589	2.687	●	5.192	4.803	●	5.487	5.427	●
Plant 3	0.354	0.443	●	0.563	0.616	●	1.088	1.349	●	1.127	1.305	●
Plant 4	0.095	0.078	●	0.753	0.788	●	1.023	1.743	●	1.051	1.743	●
Plant 5	0.174	1.004	●	1.415	1.488	●	2.115	2.258	●	2.362	2.432	●
Plant 6	0.091	0.655	●	0.896	0.912	●	1.392	1.392	●	1.561	1.435	●
Plant 7	2.877	4.856	●	3.764	4.180	●	10.443	13.847	●	6.574	6.797	●
Plant 8	0.540	0.552	●	0.672	0.685	●	1.265	1.334	●	1.358	1.349	●
Plant 9	1.526	1.215	●	1.816	1.899	●	2.410	1.782	●	2.236	2.060	●
Plant 10	0.621	0.891	●	1.019	1.147	●	1.686	1.783	●	1.819	1.681	●

Roll-up to company-wide data or drill down to air handling unit 2.5 million data points each minute into perspective

Monthly Scorecard

- Too late to react
- Need daily / hourly feedback

Daily e-mail to plants (MWh/unit)

Daily pro-rated information for 07/29/2013:

Resource	Daily Actual	Daily Target	MTD Actual	MTD Target
Electricity	0.46	0.61	0.77	0.61
Heating	0.32	0.83	0.44	0.83
Total	0.78	1.44	1.21	1.44

GM ENERGY PROJECT FUNDING METHOD

Less than 2 year Payback

- Dedicated fund each year
 - **\$15-20M average**
- Net the payback with utility incentives
 - **averaging \$4M**
- Prioritize on quick payback
- Remove savings in next year's budget

Greater than 2 year Payback

- Energy Performance Contracting (shared savings)
 - **\$15-20M per year**
- Life Cycle cost savings on new installations
 - Product programs
 - Asset sustainment

NATURAL CAPITAL- VALUE OF ENERGY SAVINGS PROJECTS

2014 GM GLOBAL INITIATIVES

Activity type	Description of activity	CO2e savings, Tons	Monetary savings, USD	Investment required, USD	PAYBACK
Behavioral change	Reduce pre-start time for plant operations prior to production, repair air leaks, and improve cold shutdown.	24,049	\$ 1,740,905	\$ 5,000	0.0
Process emissions reductions	De-humidification of hot blast air for a cupola to reduce coke use.	6,858	\$ 316,000	\$ 150,000	0.5
Low carbon energy installation	Converted 3 boilers from coal to natural gas, install pipeline to purchase steam from renewable source and decommission coal fired boilers, and install PV system for building.	53,735	\$ 5,003,702	\$ 5,518,810	1.1
Energy efficiency: Processes	Install direct fired gas burners on paint booth air supply units to replace steam, process pump VSD controls, automate process shutdown controls...	86,846	\$ 10,844,417	\$ 14,157,656	1.3
Energy efficiency: Building fabric	Infiltration reduction and increasing R-values in building roof, windows, and walls.	6,298	\$ 664,778	\$ 911,267	1.4
Energy efficiency: Building services	Lighting upgrades to LED with controls, VSDs on motors, HVAC controls, and conversion from steam to natural gas heat.	148,444	\$ 31,993,697	\$ 83,120,992	2.6

Carbon Equivalent Savings

- 45,000 Homes electric
- Hiawatha National Forest, MI

Monetary Savings

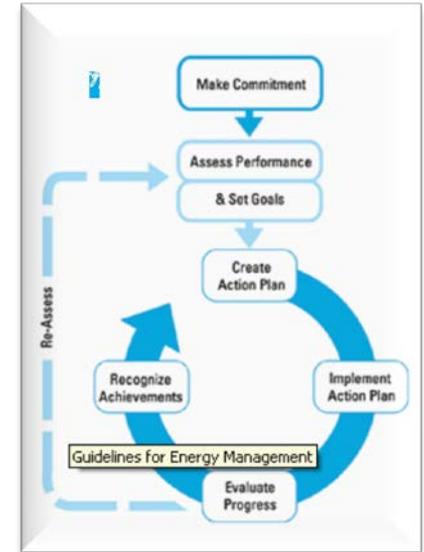
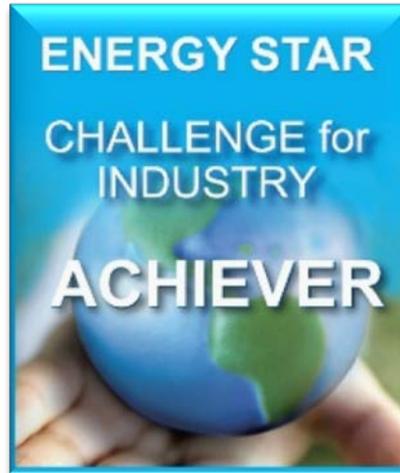
\$104M @ 2 Year payback

BENEFITS OF PARTNERSHIP

RECOGNITION

External Recognition

- Best practice sharing
- Lessons learned
- Industry experts



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- GM - 73 plants met Challenge
- Partner of the Year award – 4 years in a row

QUESTIONS & ANSWERS

Al Hildreth, PE, CEM

Global Energy Manager

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