Energy Management System and Energy Conservation Initiatives
General Motors Experience and Commitment – Road to 2050

GENERAL MOTORS
MERCOSUL

CHEVROLET
FIND NEW ROADS

Sustainable Workplaces
"Creating places you want to be"

General Motors Vision

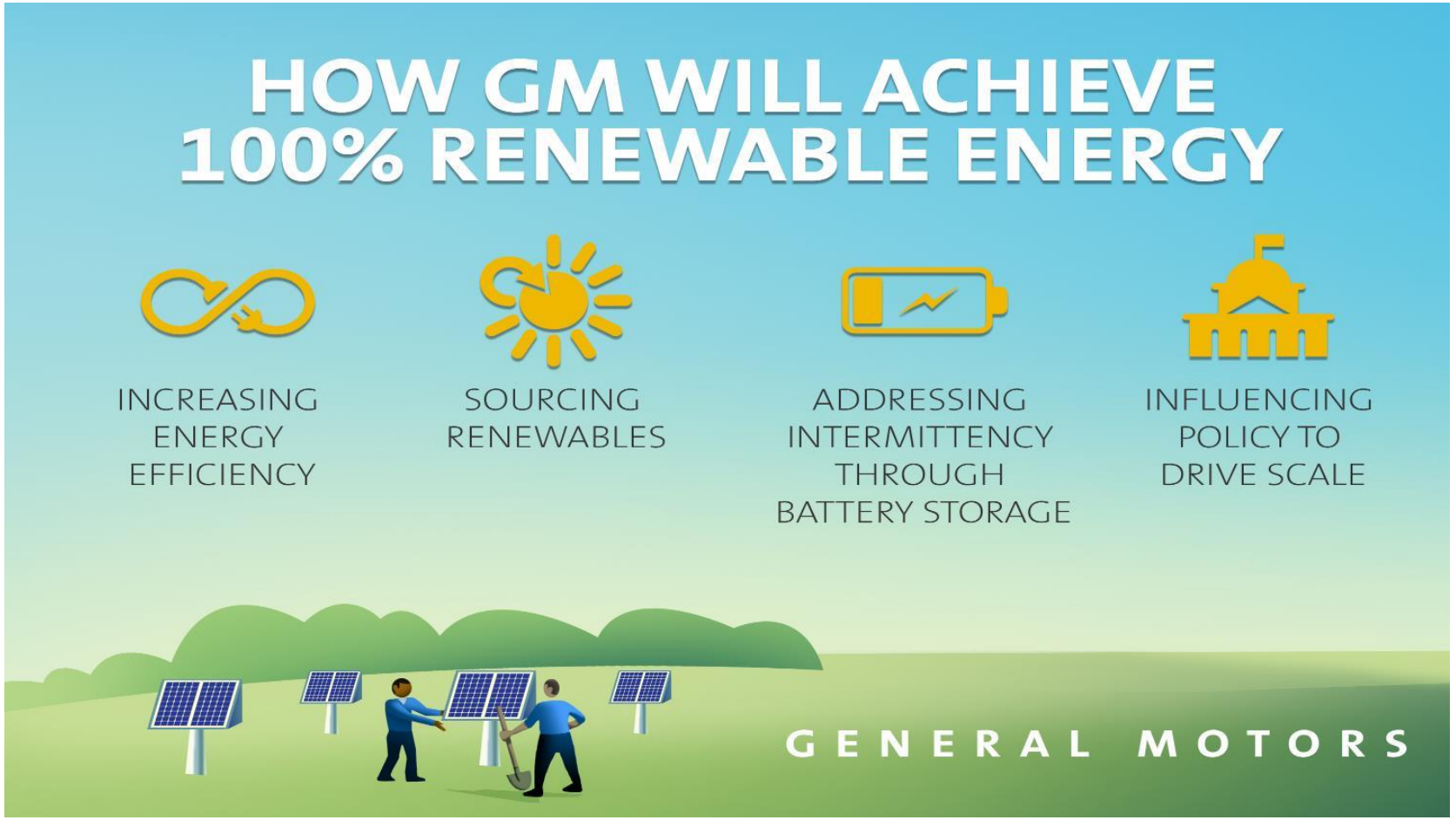
GENERAL MOTORS
MERCOSUL

CHEVROLET
FIND NEW ROADS

Sustainable Workplaces
"Creating places you want to be"

General Motors Vision

Energy Group Vision: Contribute to GM Vision in achieving Zero Emissions
Mission: 100% of GM Energy Matrix provided by Renewable Sources until 2050



ECCJ Cooperation Program

- Since 2003, General Motors has been developing its energy management system at GM S. America, aligned to the global standard and pursuing the reduction of energy and water use per vehicle, as well as the reduction of carbon emissions;

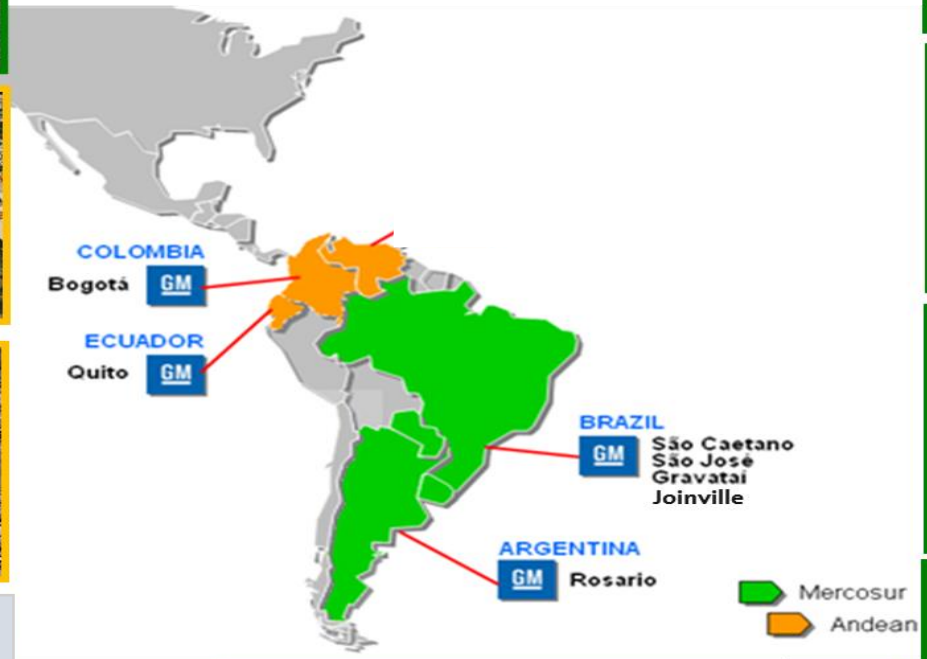
- Through ABRACE, GM participated in every initiative that had a potential to enhance energy efficiency and contribute to the company efforts in sustainability, reducing impact to the environment and to the community around our operations;

- Seeking continuous improvement, GM participated in the Energy Conservation Center Japan initiative with CNI/ABRACE in order to enhance its knowledge regarding energy management system;

- **Major Objectives:**
  - Share experiences and knowledge related to energy management and efficiency;
  - Be part and contribute to the development of Energy Efficiency Policies for Industry

General Motors South America

General Motors South America – Manufacturing Plants



10 Plants:

6 Assembly
1 Stamping
3 Powertrain
6 ISO 50.001 certified

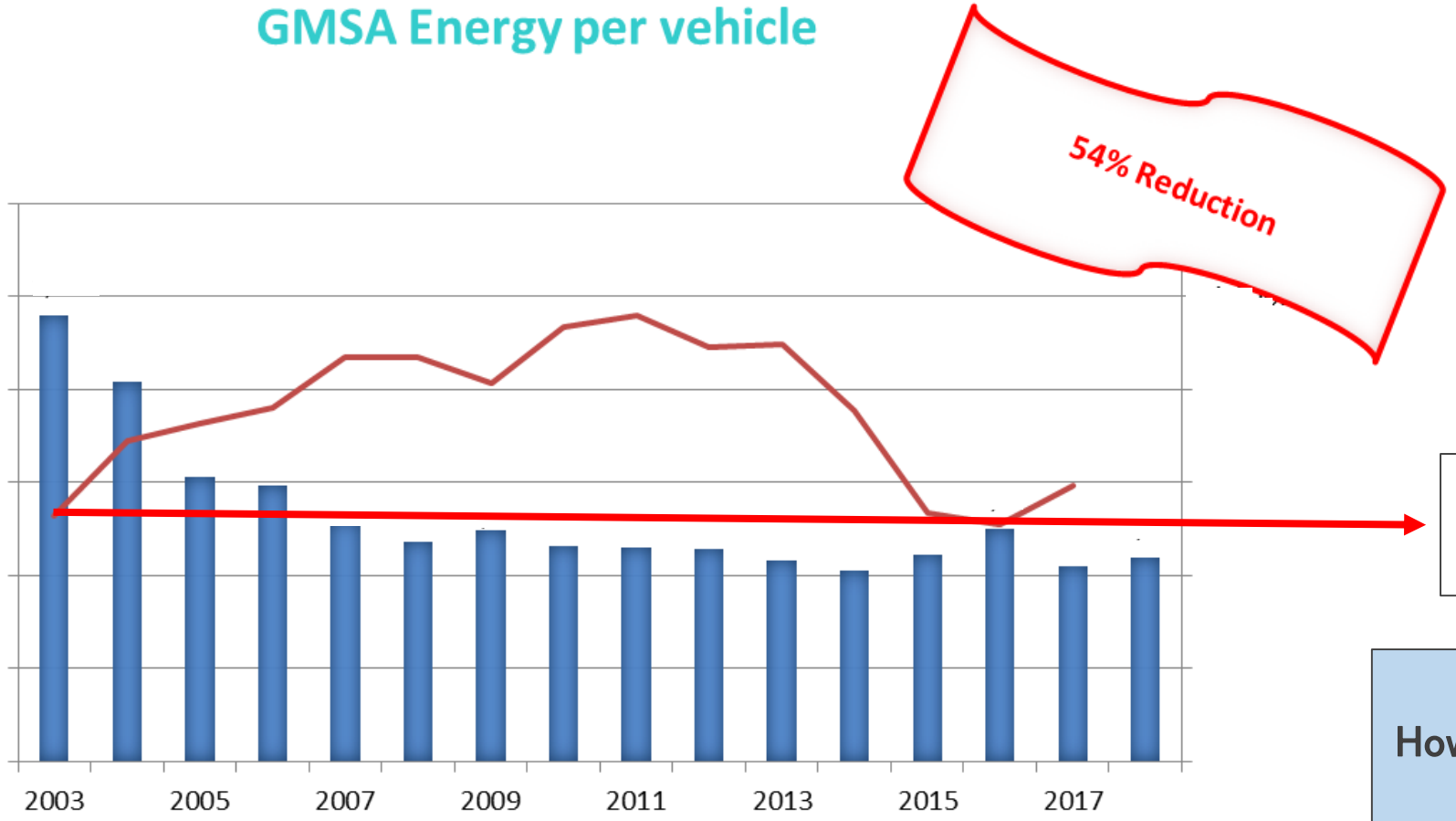
GENERAL MOTORS
MERCOSUL

CHEVROLET
FIND NEW ROADS

Sustainable Workplaces
"Creating places you want to be"

General Motors South America

- General Motors South America – Energy Control since 2003:



- At the same level of production (2003;2016) the reduction was of 48%

CHALLENGE
How can we perform better in a more difficult environment?
No more "hanging fruits"

Workshop ECCJ – Japan 2016

- Great opportunity to understand the Japanese culture and experiences regarding energy consumption and efficiency;

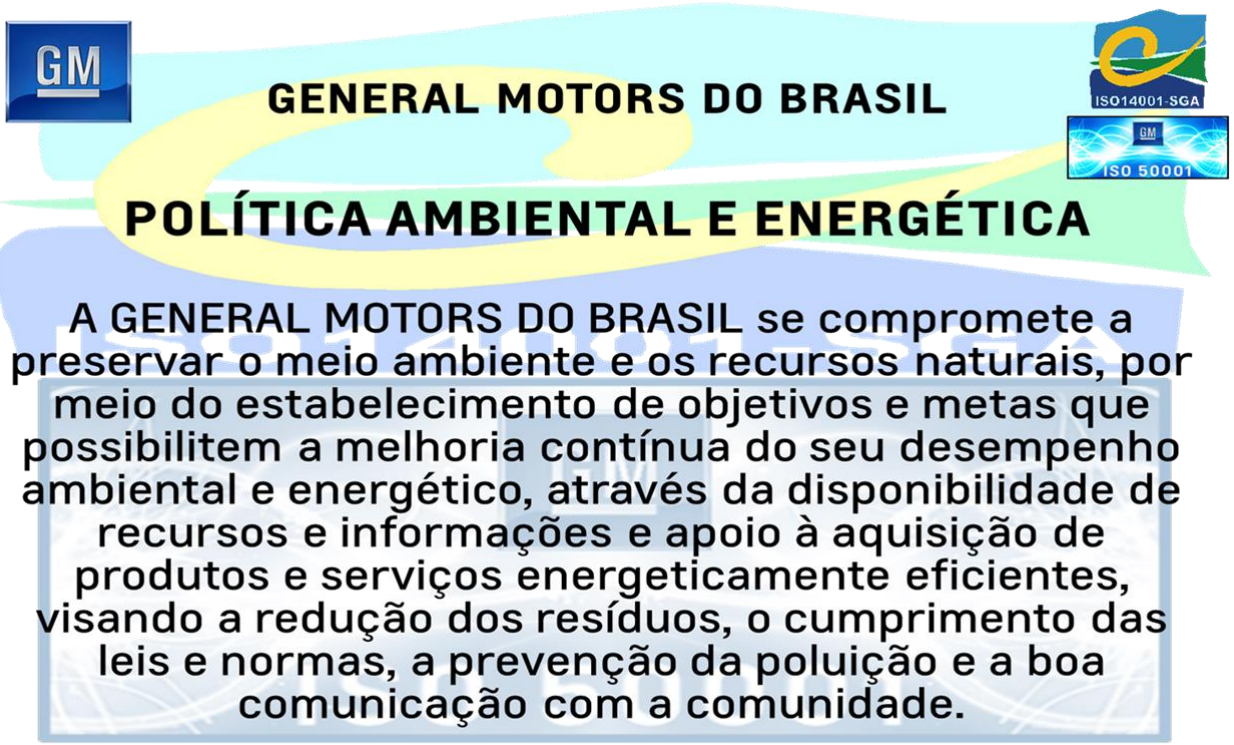
ECCJ Cooperation Program

- Based on the experience exchange between GM and ECCJ during visits to GM Brazil headquarters and Workshop held in Japan, some actions related to Energy Management improvement were identified:
  - Most of the gaps had already been identified before but the interactions with Japanese Experts have reinforced those requirements

1. Energy Policy thorough implementation at the region;
2. Metering automation;
3. Energy KPI deployment to individual shops;
4. Alignment between KPI's and annual budget;
5. Enhance Regional Energy Group;
6. Analysis through process losses;

Energy Policy

- The Energy Policy reflects the company leadership commitment to approve and support initiatives that results in efficient use of energy and natural resources;
- Most significant requirement to achieve the ISO 50.001 certification;



The policy is being implemented for all GMSA Plants according to ISO 50.001 master plan.

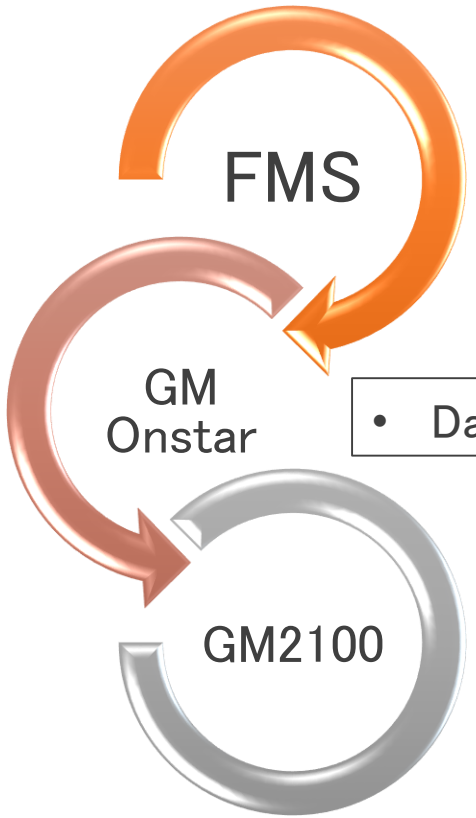
<u>During GM and ECCJ partnership there were 5 plants that received ISO 50.001 certification:</u>

SCS Plant
ROS Assembly Plant
ROS Powertrain Plant
Gravatai Plant
Ecuador Plant

Metering Automation

- GM understands that a comprehensive metering system is essential to leverage its current Energy Management System;
- Key Factors:
  - Eliminate human errors;
  - Identify hidden opportunities;
  - Enables individual shops analysis;

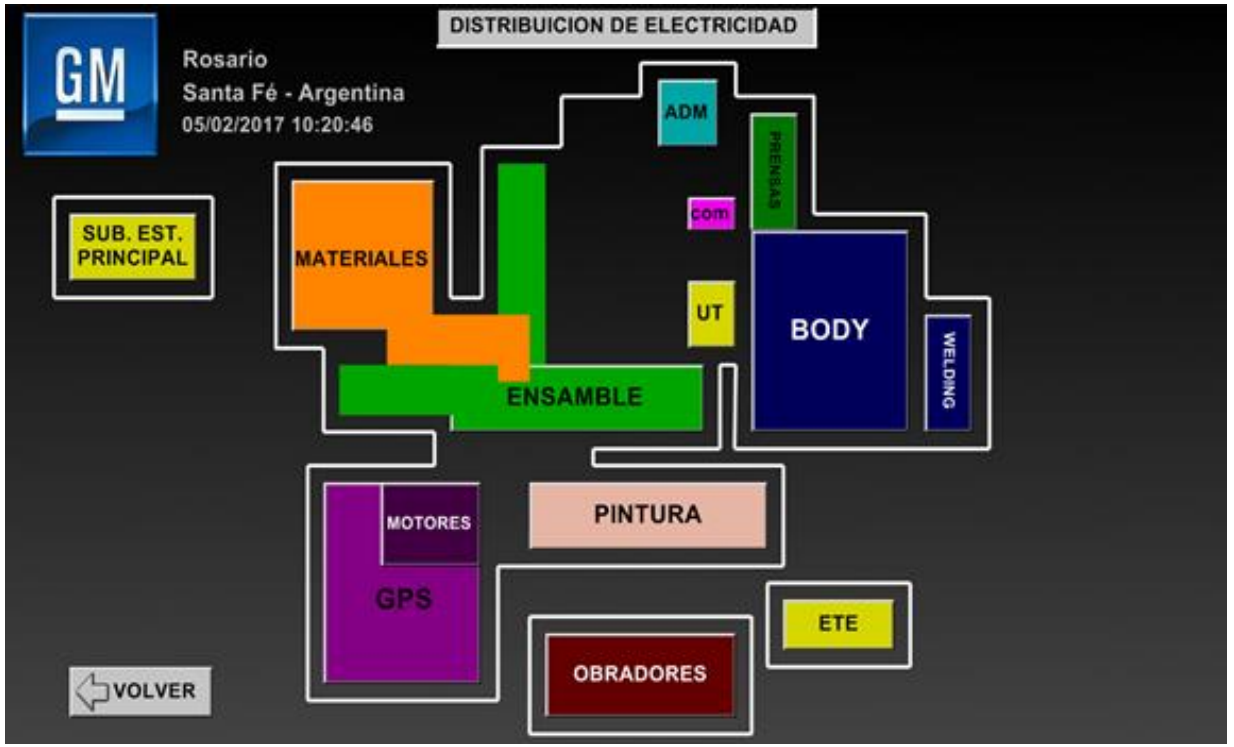
Current GM Data Management Structure



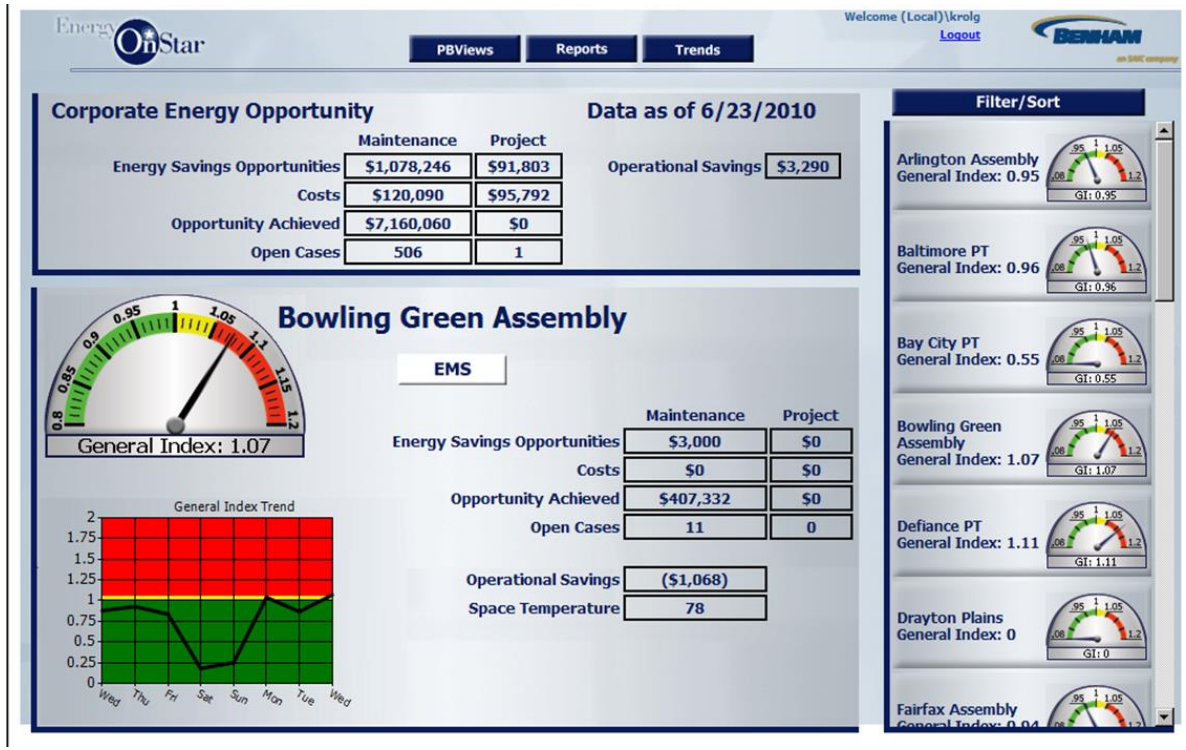
- GM Supervisory System.
- Data Consolidation and analysis.
- Data Library and source for Energy KPIs.

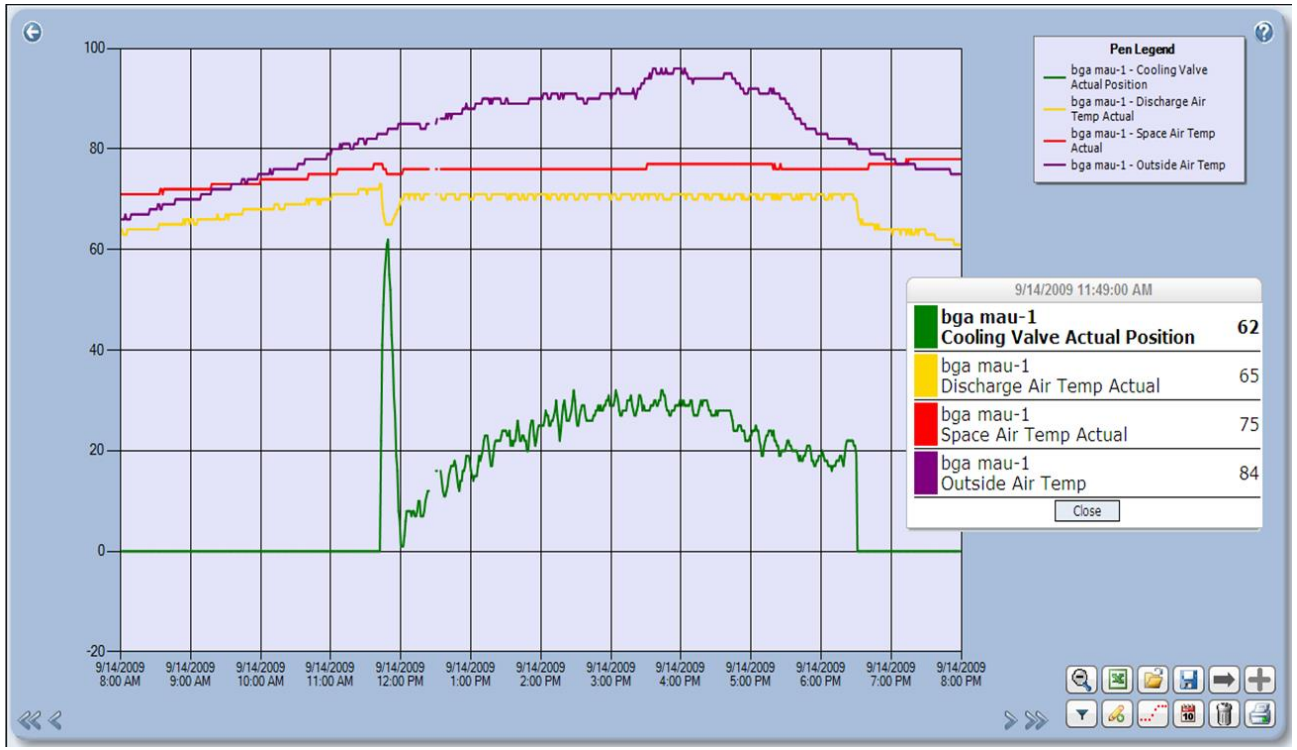
- **FMS**:


GM
Rosario
Santa Fé - Argentina
05/03/2017 09:57:37
Facilities Management System
Vehiculos Producidos Turno: 1
STAGE 80
41
SGE Contadores Turno: 1
Ensamble
Motores
Head Sub
89
81
Mecanizado
Block
Head Line
41
6
Salir
Air
ELETRIC
GAS
WATER


GM
Rosario
Santa Fé - Argentina
05/02/2017 10:20:46
DISTRIBUICION DE ELECTRICIDAD
SUB. EST. PRINCIPAL
MATERIALES
ADM
PRENSAS
com
UT
BODY
WELDING
ENSAMBLE
MOTORES
GPS
PINTURA
ETE
OBRADORES
VOLVER

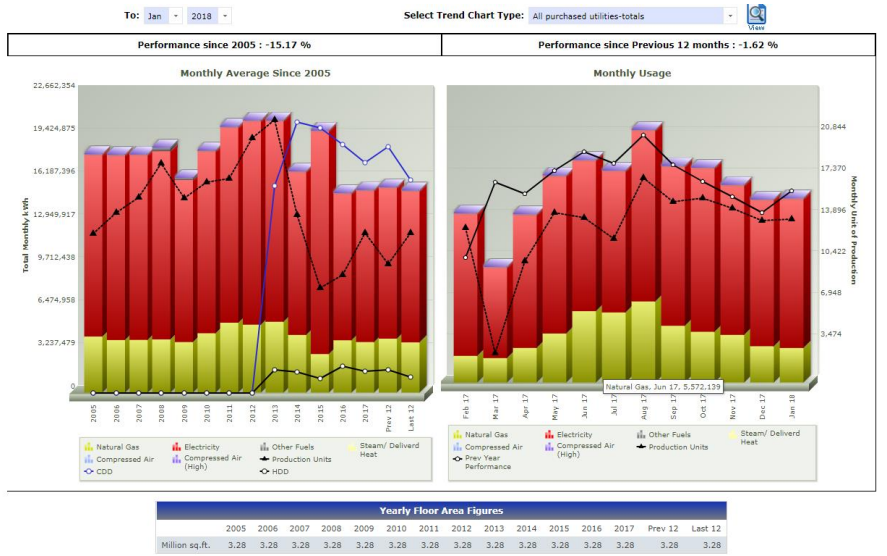
- **GM Energy OnStar:**

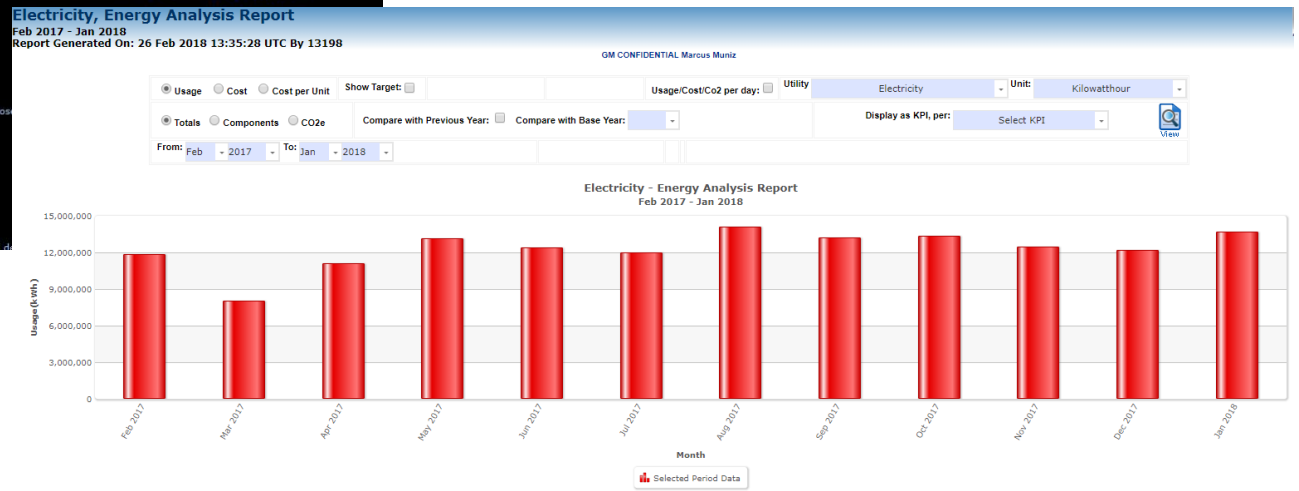




Metering Automation

- GM 2100:





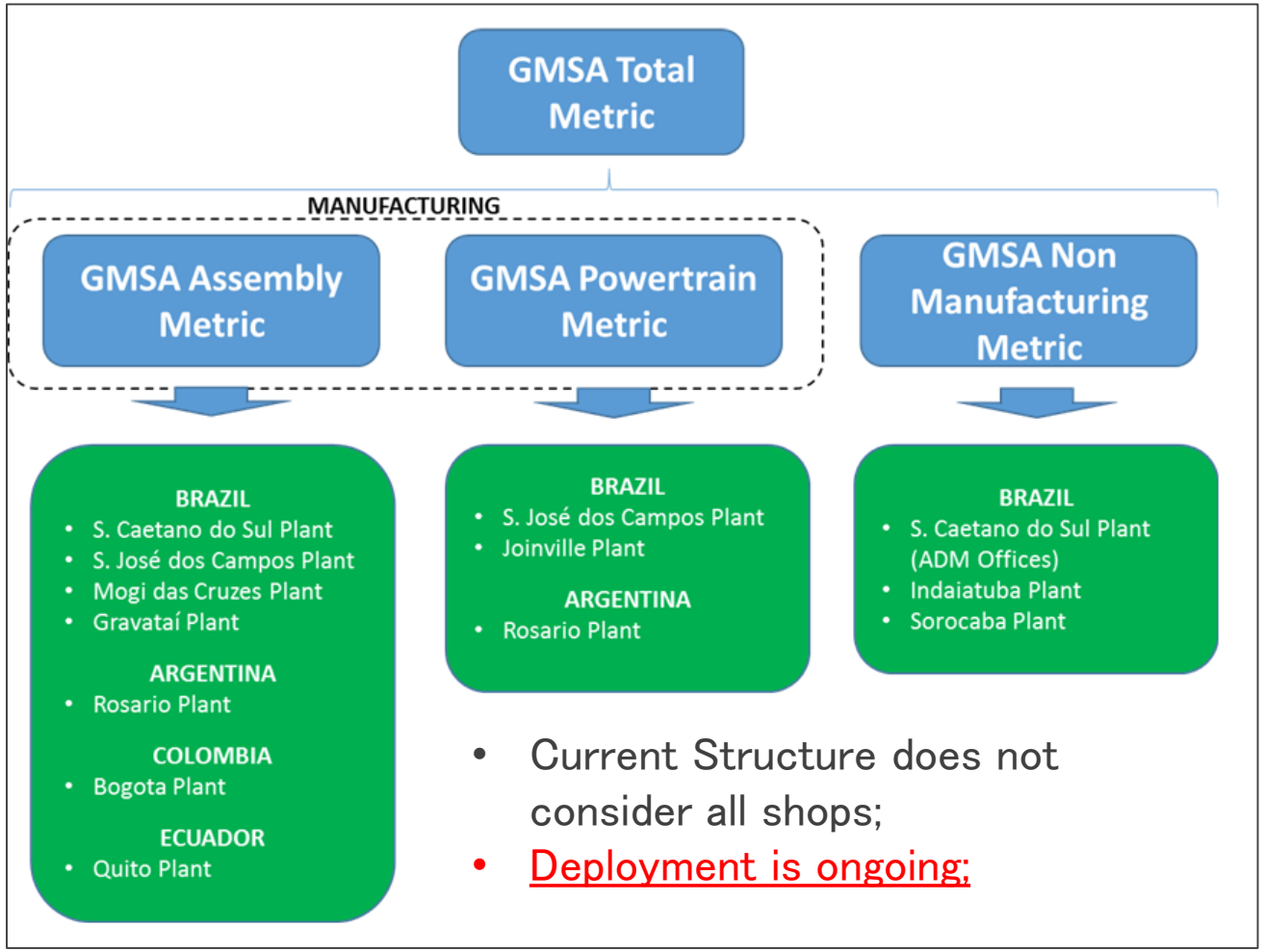
GENERAL MOTORS
MERCOSUL

CHEVROLET
FIND NEW ROADS

Sustainable Workplaces
"Creating places you want to be"

Energy KPI Deployment

- With an automated system – GM can develop current individual performance metric to each shop that composes the vehicle manufacturing complex:
  - Powertrain;
  - Plastic Injection – Bumpers;
  - Press Shop;
  - Body Shop;
  - Paint Shop;
  - General Assembly;
  - Support Areas;
  - Non Manufacturing Operations.



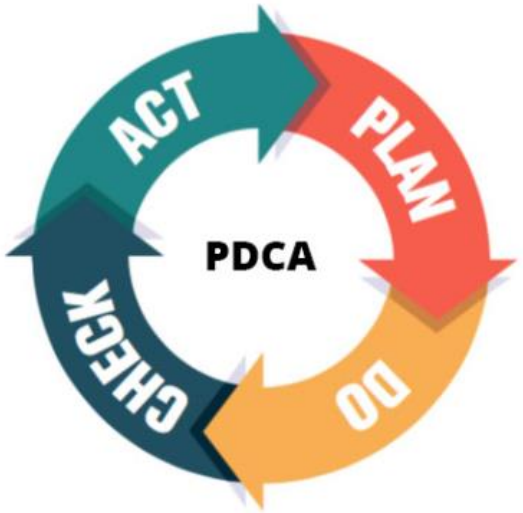
Energy KPI Deployment

- Current KPI Analysis:
  - Target Development – Based on forecasted scenarios and according Production variation features;
  - Monthly Analysis – Through Plant individual performance:

GMSA Manufacturing												
Actual		Total Energy (MWh)	Monthly Energy/vehicle	*Monthly Target*	Total Energy / vehicle	*Target YTD*	Total Water (m^3)	Monthly Water/vehicle	*Monthly Target*	Total Water / vehicle	*Target YTD*	Production (vehicle)	Production (Forecast)
2018	JAN												
	FEB												
	MAR												
	APR												
	MAY												
	JUN												
	JUL												
	AUG												
	SEP												
	OCT												
	NOV												
	DEC												

Energy KPI Deployment

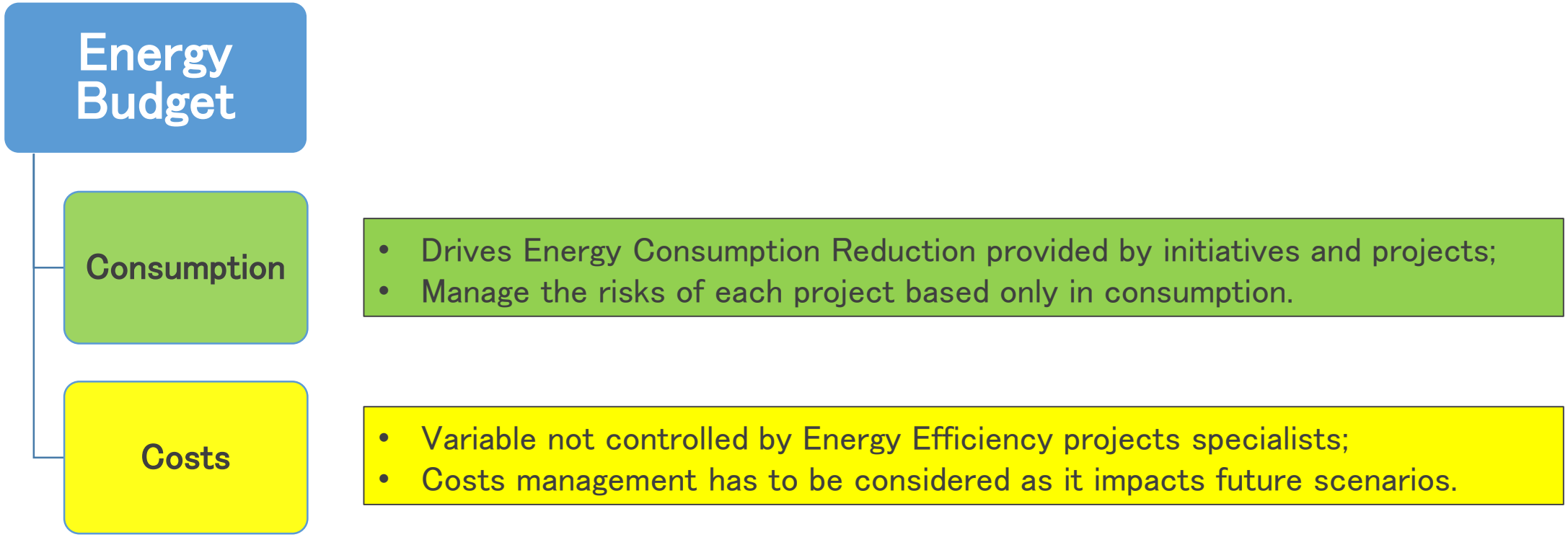
- Current KPI Analysis:
  - PPR (Plan Performance Review) – Action Plans to revert initial bad performance
  - Based on PDCA Cycle (ISO 50.001)



PPR - Plan Performance Review - 2018									October
São Caetano do Sul									
Energy									
Date	**Ref**	**Results**		**Root Cause**	**Action (Countermeasure)**	**Timing**	**Responsible**	**Status**	**Support / Comments**
		Target							
		Actual							
Water									
Date	**Ref**	**Results**		**Root Cause**	**Action (Countermeasure)**	**Timing**	**Responsible**	**Status**	**Support / Comments**
		Target							
		Actual							

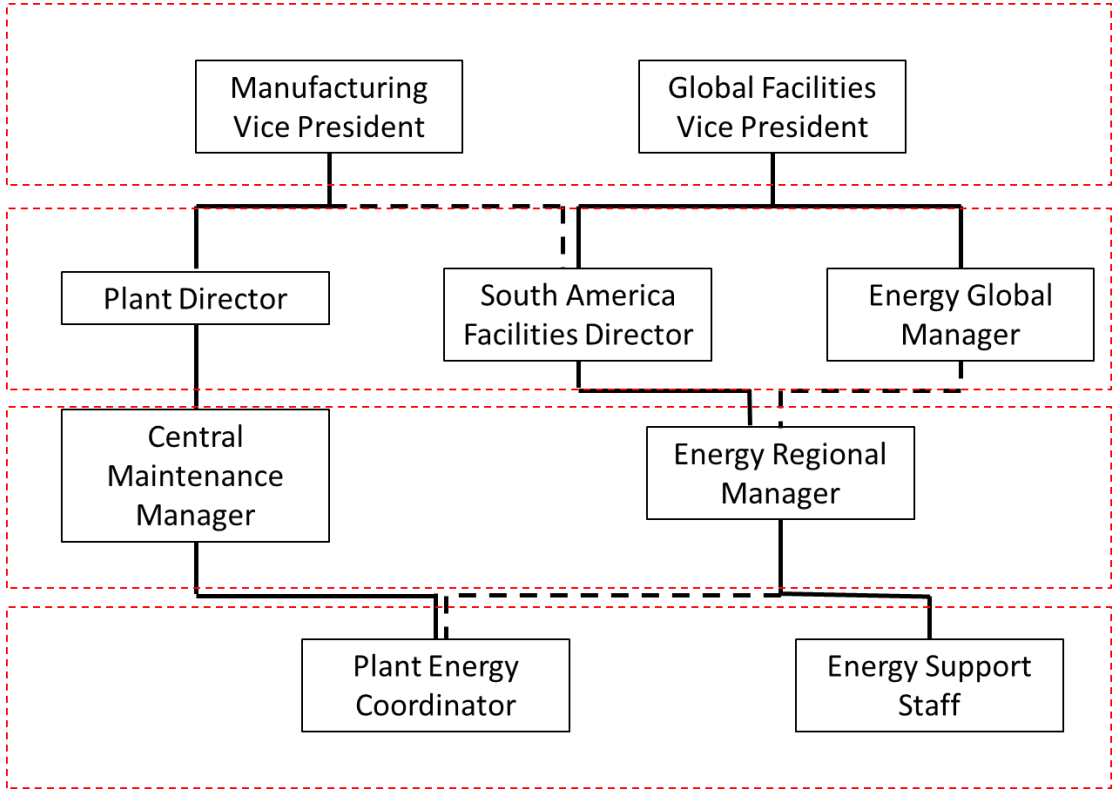
Alignment with Annual Budget

- GMSA Energy Group understands that it has become difficult to approve projects (higher complexity) without identifying exactly the impact on approved budget.



Alignment with Annual Budget

- GMSA Regional Energy Group Mission – Provides guidance, support and knowledge to plant operations with an objective to have them achieve their objectives of energy consumption;

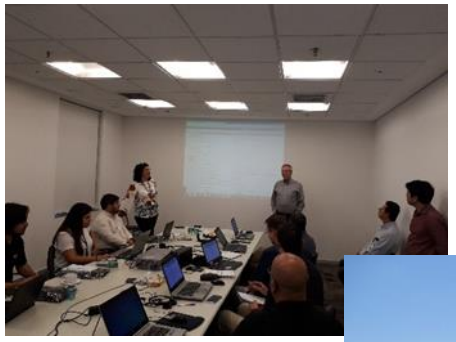


- **Current Structure – Each Plant Director has the role of achieving the target of energy consumption and the responsibility is directed until the Plant Energy Coordinator.**
- **The Energy Regional Manager and its team are responsible for give support to Plant Energy Coordinator in accomplish those targets.**

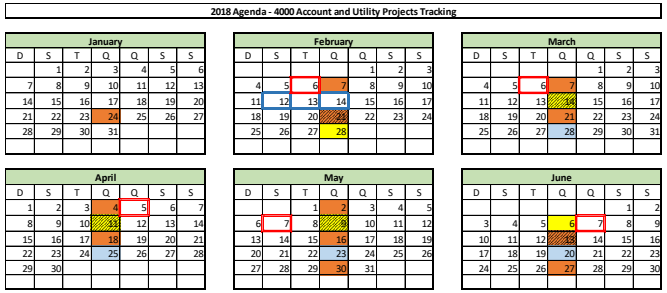
Enhance Regional Energy Group

- Tools to leverage All Energy Group Relationship:

Regional Face to Face Meetings – the last was held in November 2017



Agenda



Utility Efficiency Projects 2018 plan

Plant	São Caetano do Sul	
Project	**Type**	**Development Level**
Replacement of ADM and Tech Center buildings cooling system	Electrical Energy	Medium
Installation of ATLAS compressor management system	Electrical Energy	High
Replacement of motors by high efficiency models (ETE e CF)	Electrical Energy	High
Replacement of common lighting by LED lighting (external lighting)	Electrical Energy	High
Install a drinking water line to maintain supply of the Tech Center through the Main Plant	Water	Low
Install a Reverse Osmosis system + Ultra filtration system in Powerhouse II (Boilers and Cooling Towe	Water	Low
Reverse Osmosis system installation + Ultra filtration system in Paint Shop	Water	Low
Reforming the clarifier tank to store rainwater	Water	Medium

Routine and Standardization process

Enhance Regional Energy Group

- Tools to leverage All Energy Group Relationship:

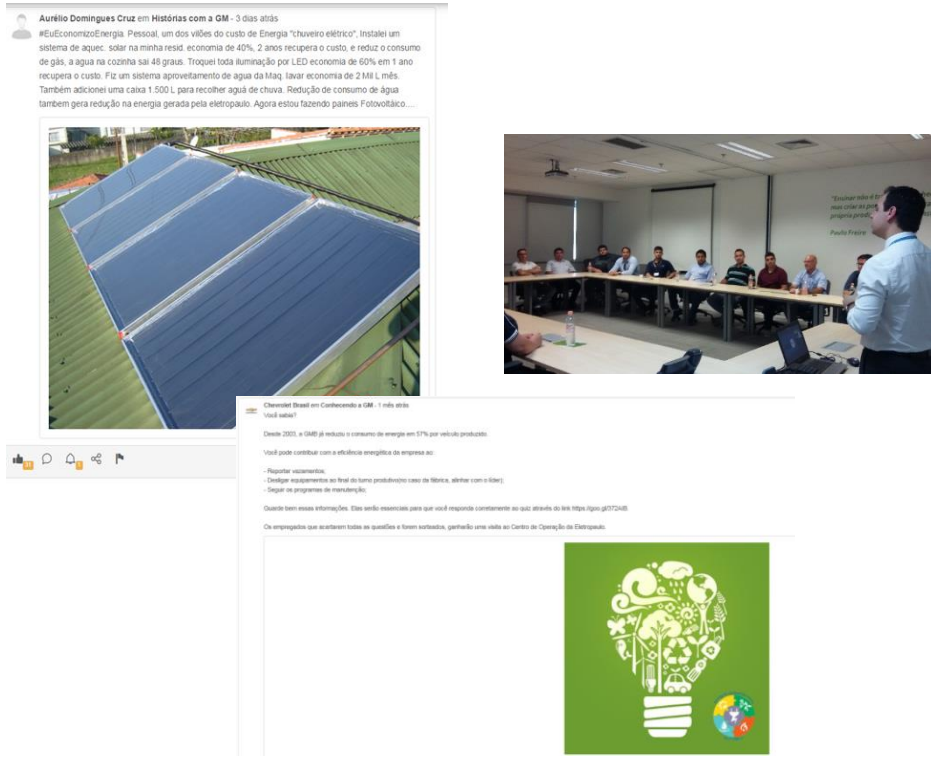
Sharing External Programs to all group

PROGRAMA ALIANÇA

PROGRAMA DE EFICIÊNCIA ENERGÉTICA

ANEEL
AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA

ECCJ
The Energy Conservation Center, Japan



Strong Communication Program

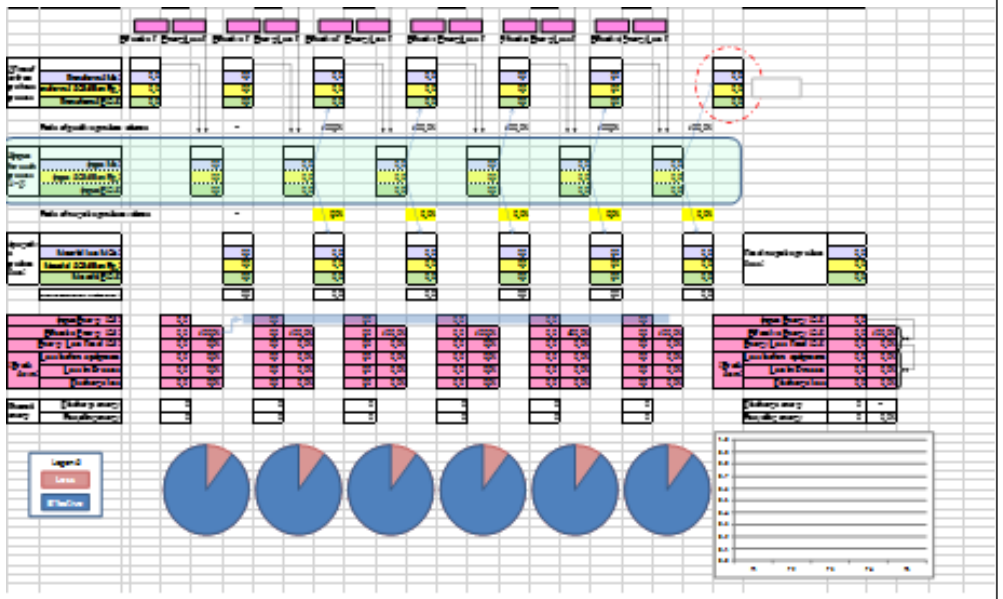
GENERAL MOTORS
MERCOSUL

CHEVROLET
FIND NEW ROADS

Sustainable Workplaces
"Creating places you want to be"

Analysis Through Process Losses

- GM understands that this could be the most significant contribution that ECCJ provided in this partnership.



- ECCJ team has provided General Motors with some analysis that are based not only consumption but through some other factors such as:
  - Raw Material;
  - Losses though the entire process flow;
  - Different production indicators;
- GMSA has considered these features in its vision of energy management and It is already considered as a plan that depends on the initiatives described before:
  - Metering Automation
  - KPI Deployment;

GMSA initiatives – Master Plan

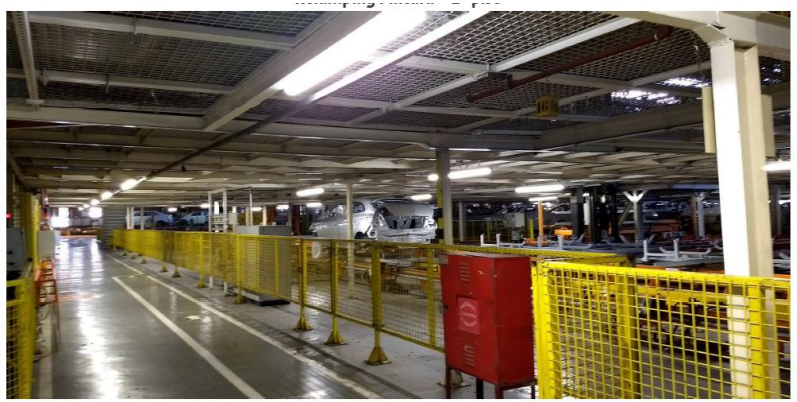
- There is a master plan to have all those initiatives concluded by 2020:

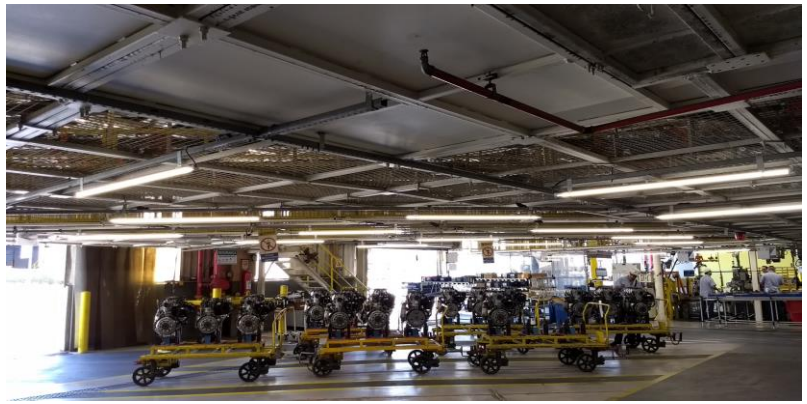
		2018				2019				2020			
Initiative	**Status**	**1Q**	**2Q**	**3Q**	**4Q**	**1Q**	**2Q**	**3Q**	**4Q**	**1Q**	**2Q**	**3Q**	**4Q**
Energy Policy	Concluded												
Metering Automation	On Going												
Energy KPI to Individual Shops	On Going												
Alignment with Annual Budget	On Going												
Enhance Regional Group	On Going												
Analysis through process losses	Not Started												

ECCJ Experience – Major contribution of this partnership (GM view) was not only regarding technical initiatives that could be used in the operations but how the company in South America can look at its energy consumption pattern and change the behavior and culture to be even better in its standards related to energy management.

GMSA Major Achievements – 2016-2018

- Full LED project initiative:
  - Have 100% of manufacturing operation lighting provided by LED technology – until 2020;
    - 2016 – 20% Concluded;
    - 2017 – 45% Concluded;
    - 2018 – 100% Concluded.
  - Estimated Savings of R$1,0 Mi per year;



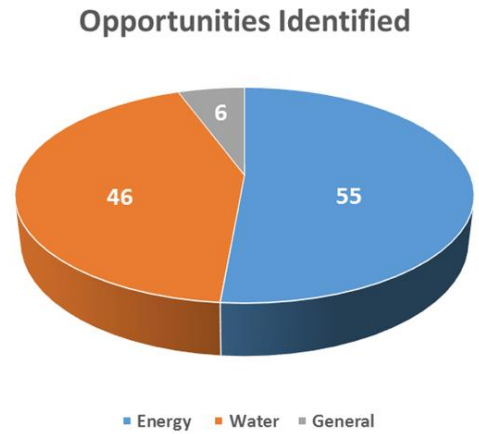


GMSA Major Achievements – 2016-2018

- Energy Efficiency Workshops in each plant:
  - 2016 – Gravatai;
  - 2017 – São José dos Campos;
  - 2017 – São Caetano do Sul – Aliança Program;
  - 2018 – Rosario Plant

  (More than 100 initiatives were raised and at least 20% were implemented – R$ 250.000 / per year);

  (Gravataí has achieved its energy annual target after this workshop);



GENERAL MOTORS
MERCOSUL

CHEVROLET
FIND NEW ROADS

Sustainable Workplaces
"Creating places you want to be"

THANK YOU

Sustainable Workplaces

"Creating places you want to be"