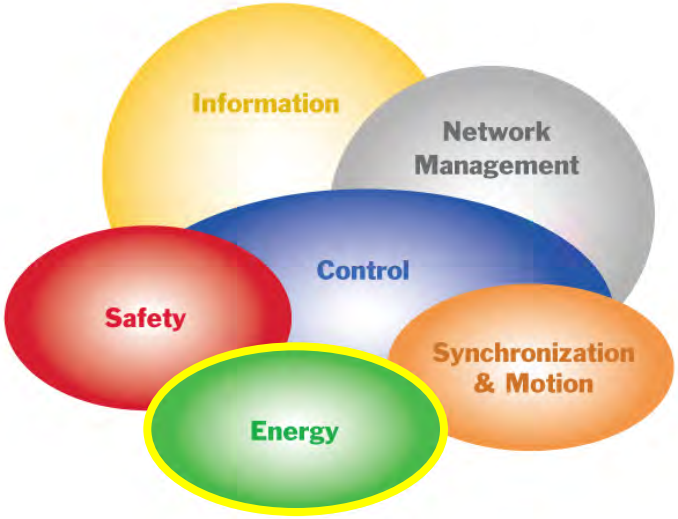
A Technical Approach to Optimization of Energy Usage (OEU™)



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Mock Energy Debate

Before examining a "day in the life of energy", in the spirit of the political season, it might be interesting to hold a MOCK debate about energy. Our presenters stepped out of their roles and portrayed two fictitious opponents debating the relative merits of their energy plans. Here is the transcript!

Speaker #1

We all know that the energy issue has become a top priority worldwide for individuals, companies and governments. World energy prices have soared in the past decade and fears of an environmental disaster have brought how we develop and use energy to the forefront. There is a lot of debate about which energy sources are best, the most cost effective and the least harmful to the environment. There can be no doubt however, that the greenest type of energy initiative is energy efficiency. The energy not used is energy that did not have to be mined or drilled or delivered to the generating station. It is 100% green and has zero negative impact on the ecosystem.

That is why I have developed a three step program for energy efficiency. My program will focus on Industrial Energy, which contributes more than a third of all carbon emissions worldwide. My three step program (called Energy MOM) uses measurement, optimization and maintenance to reduce and sustain significant energy reductions. Energy MOM has been implemented successfully in industrial facilities with rapid return of investment. My plan is proven, effective and improves the competitive position of companies that use it.

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Speaker #2

I would also like to thank Stone Mountain resort and all of you who have come out today to listen. The challenges facing the country and planet today are significant and require a thoughtful approach. I have had a deep interest in energy issues and especially energy efficiency for many years. As a youngster, I was taught to respect the planet, to use no more than I needed and to give back to the ecosystem. That is why I have devised an energy plan that provides big savings to companies that want and need to conserve. We know that energy prices continue to climb - and this increase has hit our industrial sector very hard. To stay competitive, companies need a disciplined approach to energy savings.

My program uses a unique process I call Energy POP, which stands for plan, operate and perform. The Energy POP program uses methods that rely not only on proven energy management techniques, but also in the innovative spirit of businesses to take charge of their energy bill. Energy POP frees up capital so that companies can reinvest money in their operations and become market leaders. My plan encourages companies to take responsibility for their own energy consumption.

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Moderator: Speaker #1, can you describe how your plan differs from your opponent?

Speaker #1

My plan is unique in its approach, because it incentivizes businesses to invest in the technologies that can reduce consumption and emissions. It creates a partnership between groups to help finance improvements. Energy MOM creates a safe haven, so that companies know that if they invest with Energy MOM, they are protected from adverse risk.

My opponent's program does not provide these guarantees; in fact several companies that tried his methods have since gone out of business. I don't think that his program's record of success is one to be proud of. As a matter of fact, my opponent has stated that 47% of industrial facilities don't care about saving energy, they only want energy rebates.

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Speaker #2

That is not true. You may be entitled to your own luxury rental car, but not to your own facts! Those companies you say went out of business actually became more profitable because of the energy savings that Energy POP provided. They became more attractive and were acquired by other companies in part due to low operational costs. In fact independent studies have shown that Energy POP is 27% more effective in reducing operational costs at manufacturing facilities than Energy MOM. Not only better, but POP also provides faster results because companies are highly motivated to achieve results.

Look, I want ALL industrial facilities to benefit from energy efficiency. Like the plant manager I met from Dubuque, Iowa, who told me that if only he could save 10% on his energy bill, he could invest in new equipment to make his production line more competitive.

Moderator: Speaker #2, can you describe in one paragraph the philosophical differences between you and your opponent's energy plan?

Speaker #2

My plan relies on the Plan, Operate and Perform methodology. My program also allows companies to reinvest the savings they earn. So all cuts in energy stimulate even more cuts in energy. My opponent's program relies on guarantees, which doesn't stimulate the same performance from individuals and companies.

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Moderator: Speaker #1, critics say that Energy MOM is actually very similar to Energy POP and that lack of bipartisan dialog is actually holding back energy savings. How do you respond?

Speaker #1

Well, there are some similarities in the approach of both programs. Where my program relies on Measure, Optimize and Maintain, my opponent relies on Plan, Operate and Perform. With some work, it might be possible to reconcile the gaps in my opponent's approach to create a unified plan.

Speaker #2

And I think there might be some room to work with my opponent to improve his methods and create an approach that leverages the best ideas so that Industrial Energy consumers can maximize their savings. If we could work together, we could create a standard method for energy efficiency that reduces costs and create benefits for even more companies.

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- Optimization of Energy Usage (OEU™)
- Energy SIG Goals and Objectives
- Energy Consumption 101
- Phase 1 – Energy Awareness
- Phase 2a – Power Management
- Ongoing and Future Activities
- Summary

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OEU's 3 Pronged Approach

Optimization of Energy Usage (OEU™)

- Awareness of energy usage
- Consuming energy more efficiently
- Procuring energy at the lowest cost

Working Hypothesis

- *Energy is essential to produce products but has been an invisible line item on production bills of materials and consequently an unmanaged resource (energy should be a managed resource in the production domain).*
- *Increasing the availability of energy information and visibility of energy consumption will promote awareness by industrial consumers of the need to manage energy as a production resource which, in turn, will lead to best practices in OEU.*

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ODVA Energy SIG Objectives

Specification enhancement phases:

1. Awareness: Standard access to energy information
2. (a) Power Management: Commanding equipment to conservation states
   (b) Energy Management: Controlling energy demand
3. Standardized interface to the Smart Grid

Phase 1 was published in November, 2011

- Included in CIP Networks Library, Volume 1, Edition 3.11

Phase 2a was published in April, 2012

- Included in CIP Networks Library, Volume 1 & 2, Edition 3.12

Phase 2b work is in process, targeted for Fall 2013 publication

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Energy Consumption 101

Energy (W) is a resource that enables work to be done

- Units of measure: Joules, kilowatt-hours, British thermal units, etc.
- Prefix kilo (x1000), mega (x10^6), giga (x10^9), etc.

Power (P) is the rate of converting energy to work per unit of time

- Units of measure: Joules per second, Btu per hour, kilowatts

Electrical energy is a bit weird

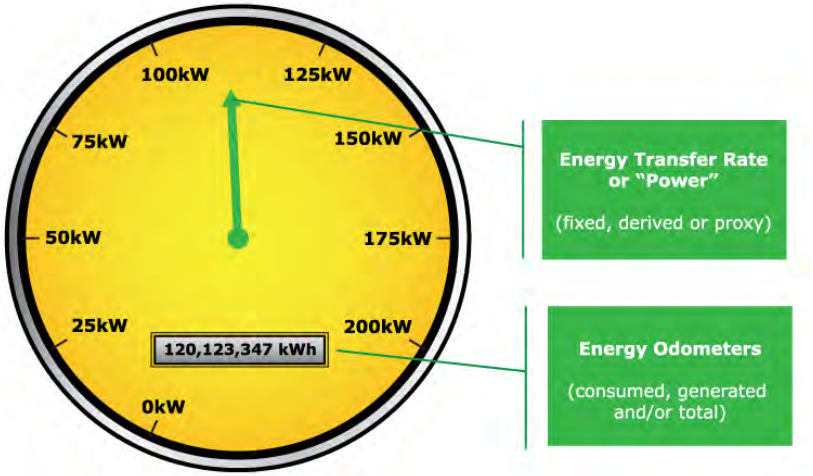
Time is part of the energy unit:

kilowatt-hour

- All other units put time in the power unit: J/s

How to visualize energy and power

Figure 1: Energy Odometer and Power Illustration



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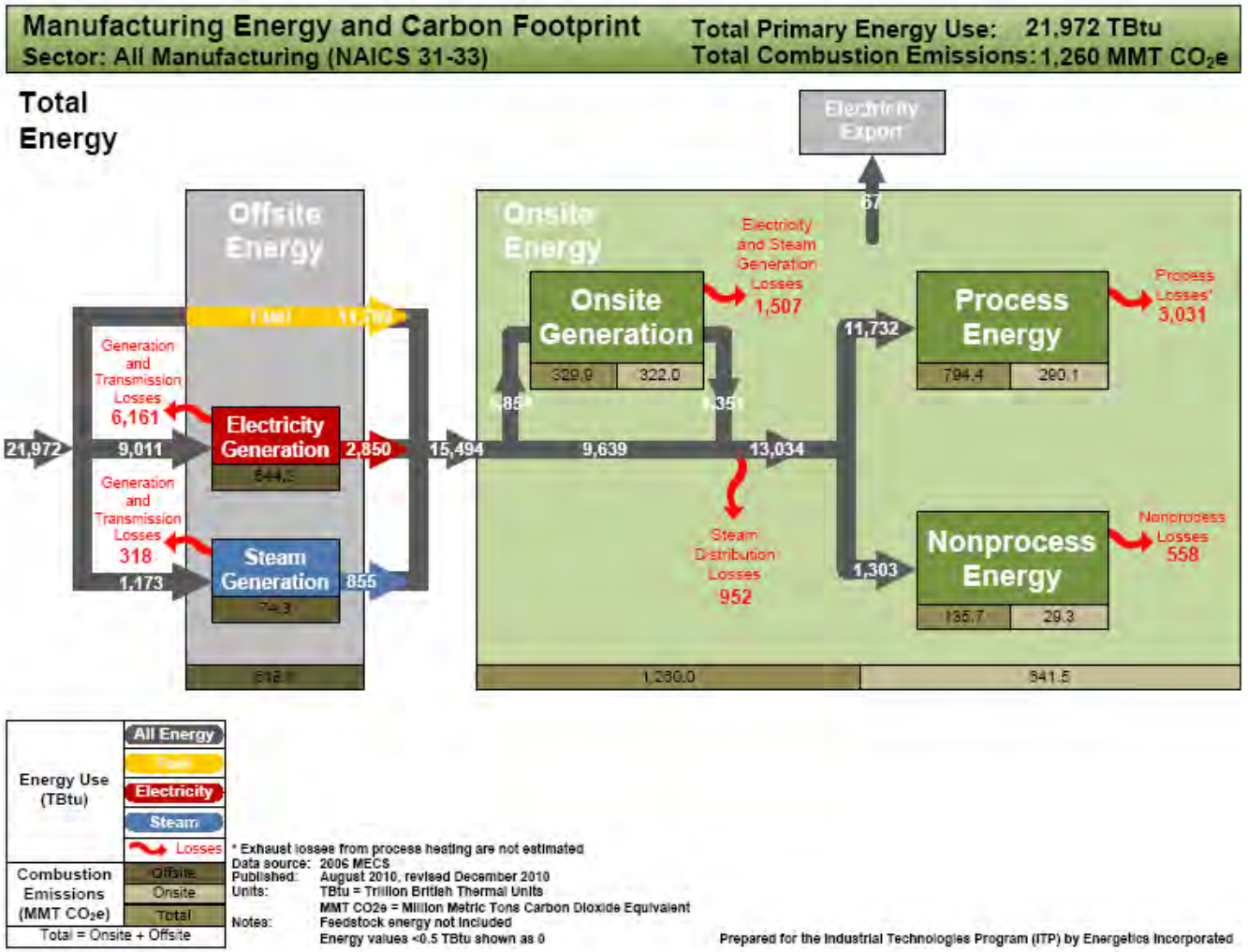
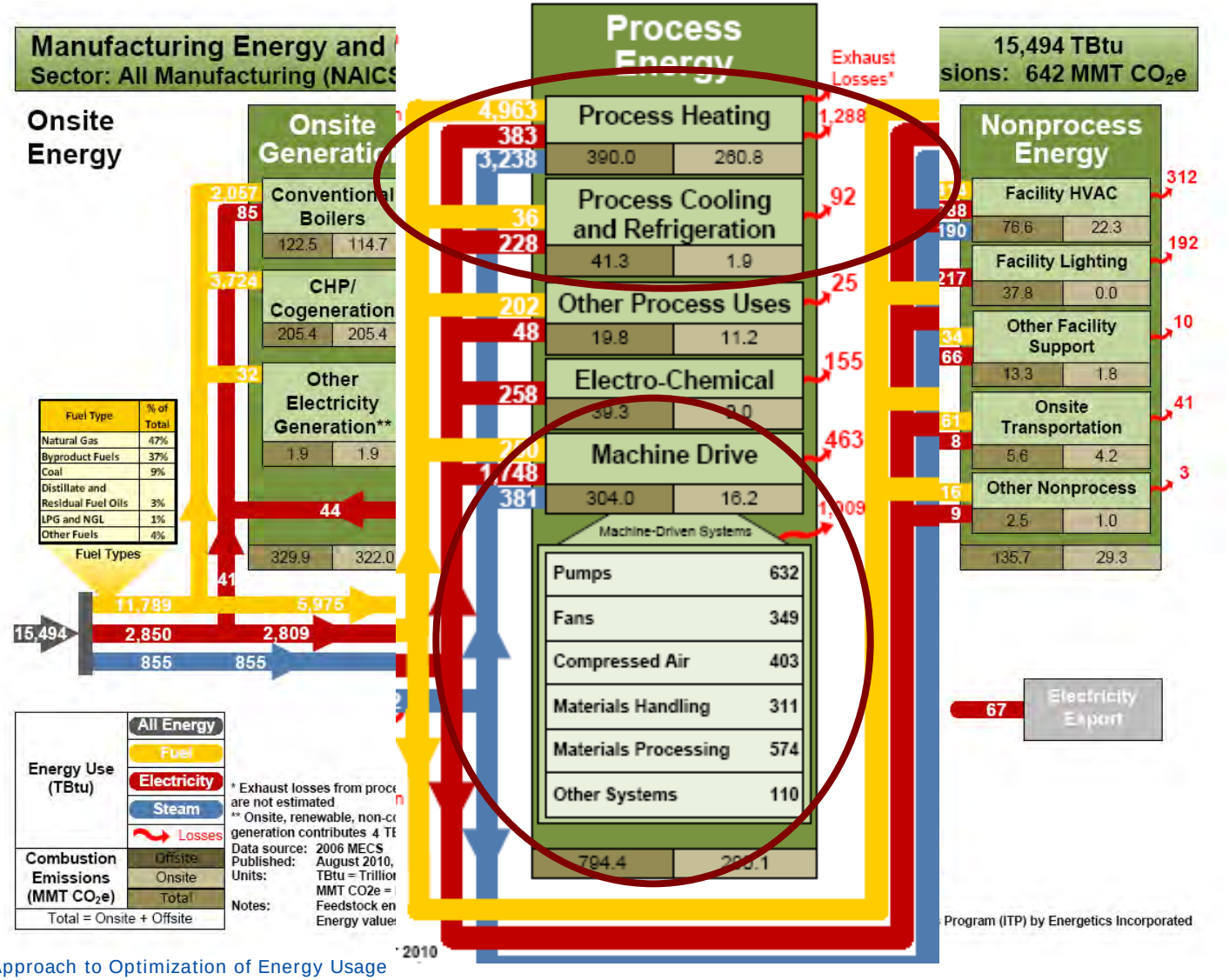
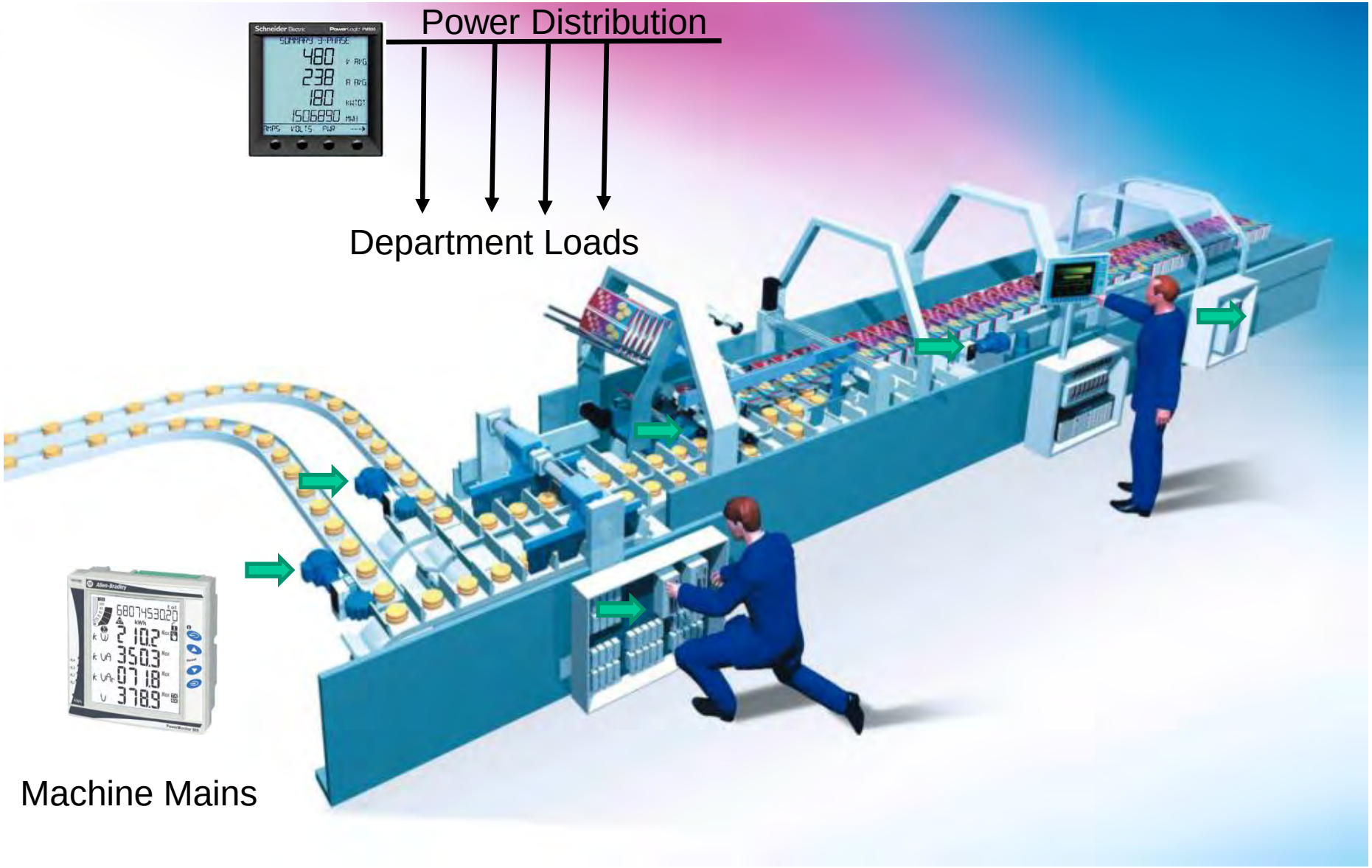
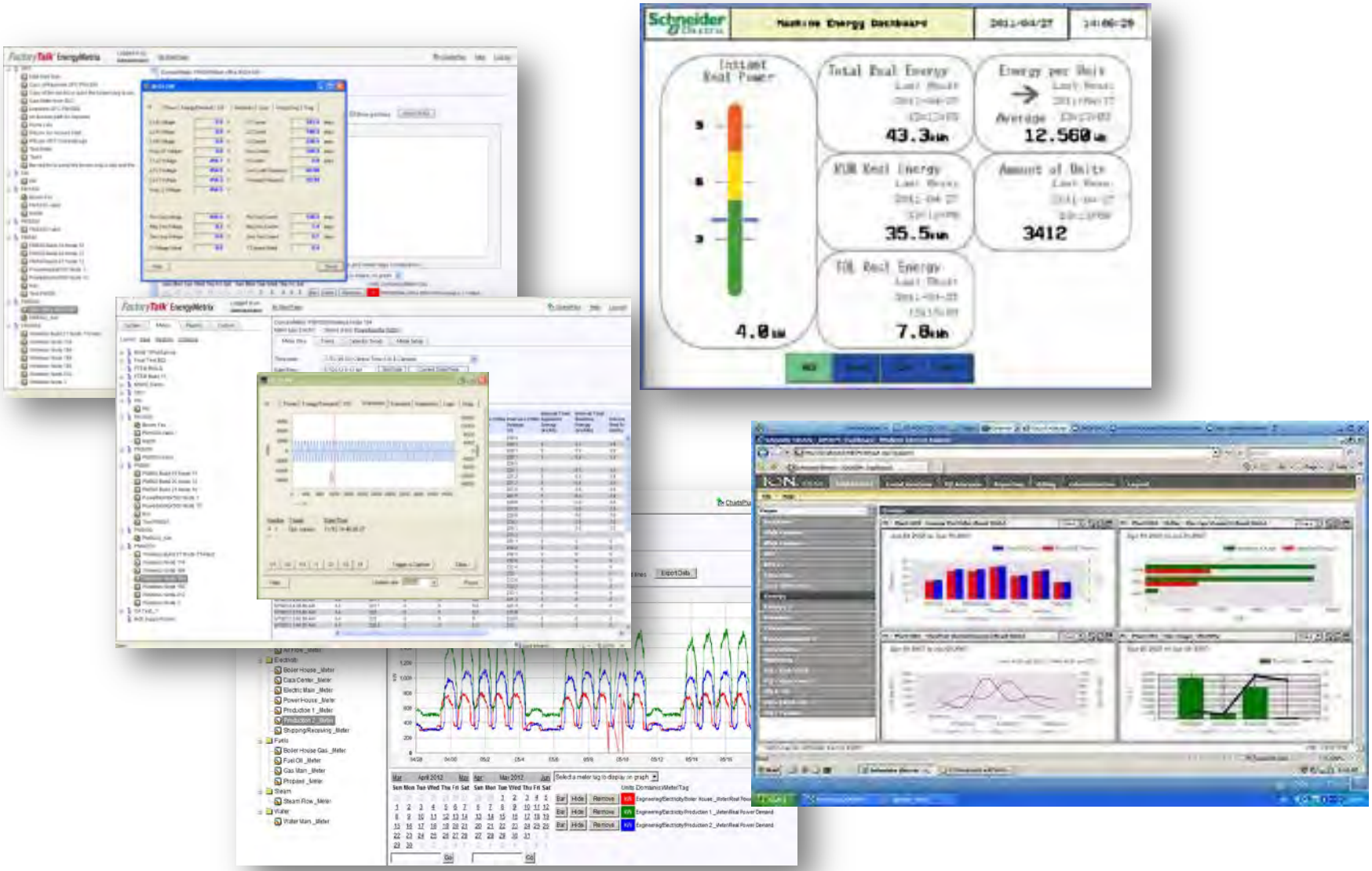
The mfg. energy opportunity



Energy Flows in Manufacturing



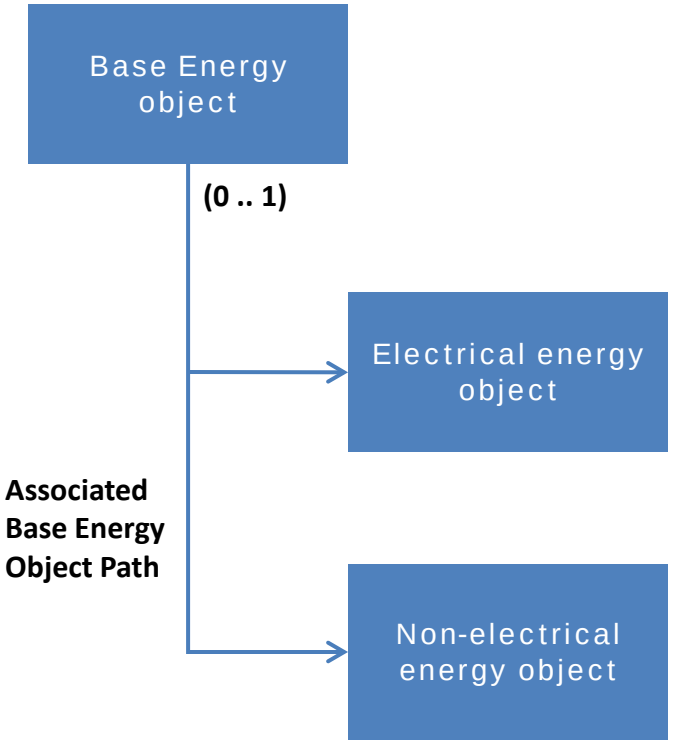




Base Energy Object

Energy Supervisor

- Capabilities
- Accuracy
- Paths
  - To Subordinate Objects
  - To Aggregated Objects
- Reports energy and/or power
- Standardized reporting units (kWh/kW)
  - 1 kWh = 3600 Joules



Energy Reporting Methods

Odometer: Energy expressed as a 5-integer array

- Widely used, combines precision with wide range

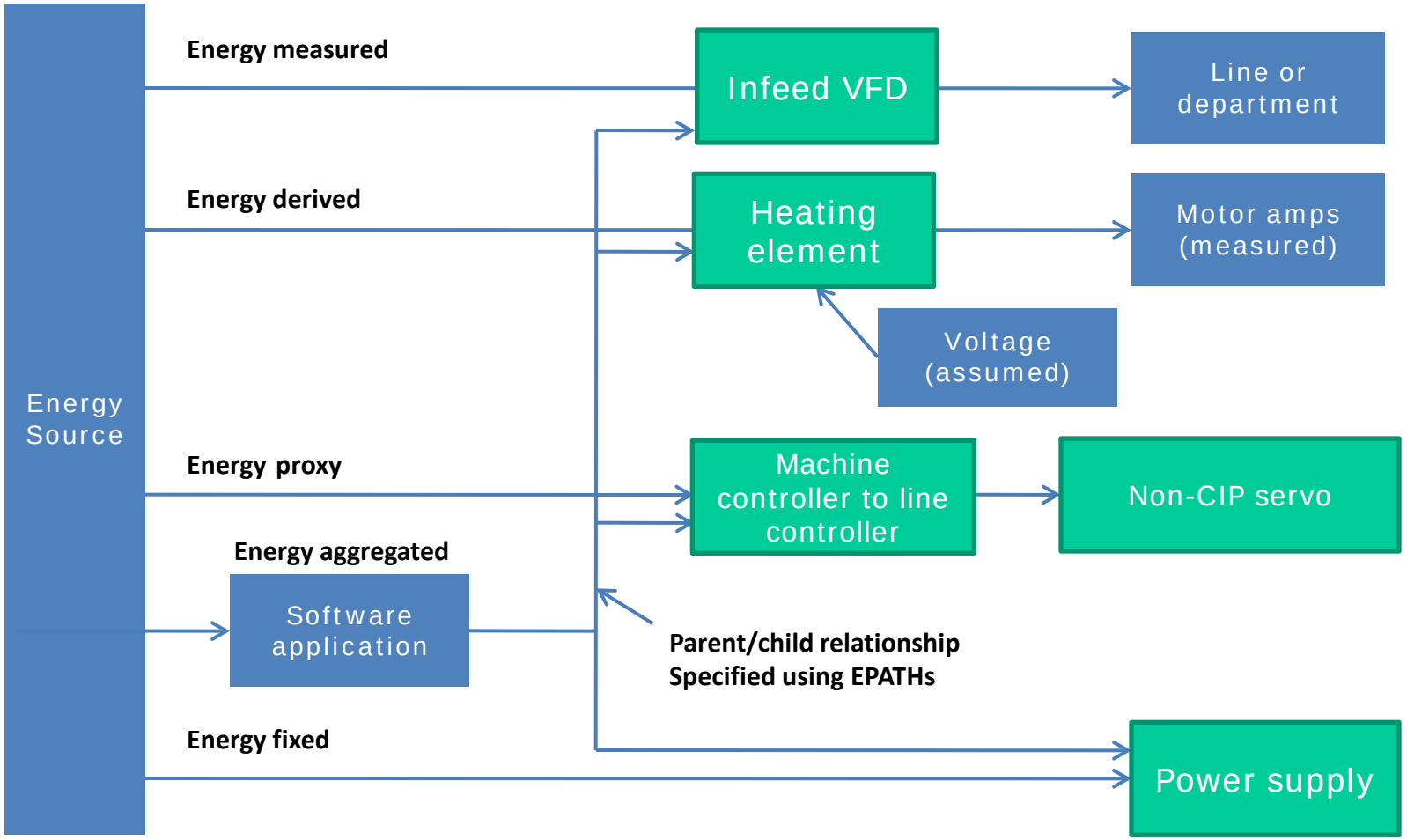
Array[4]	Array[3]	Array[2]	Array[1]	Array[0]
Terawatt-hours ($kWH \times 10^{9}$)	Gigawatt-hours ($kWH \times 10^{6}$)	Megawatt-hours ($kWH \times 10^{3}$)	Kilowatt-hours (kWH)	Watt-hours ($kWH \times 10^{-3}$)

- Three energy buckets
  - Consumed, generated, total
  - Values eventually roll over to zero and start over

Power: expressed as a REAL (floating point) value

- Positive = energy consumed
- Negative = energy generated

Energy Capabilities Examples



Modbus Integration

Modbus energy information

Translator maps to Energy Object

Recommendations to place energy / power info in specified registers

- Energy/power info contained in proprietary files (FC 20, 21) problematic to map to Energy Object

Modbus Integration SIG currently working on mapping methods


ODVA™
FactoryTalk EnergyMetrix
Reports
Meter Setup
Monthly Utility (Energy) Usage in
Monthly Utility (Energy) Cost Allocation
Schneider Electric
PowerLogic SCADA
Real Power

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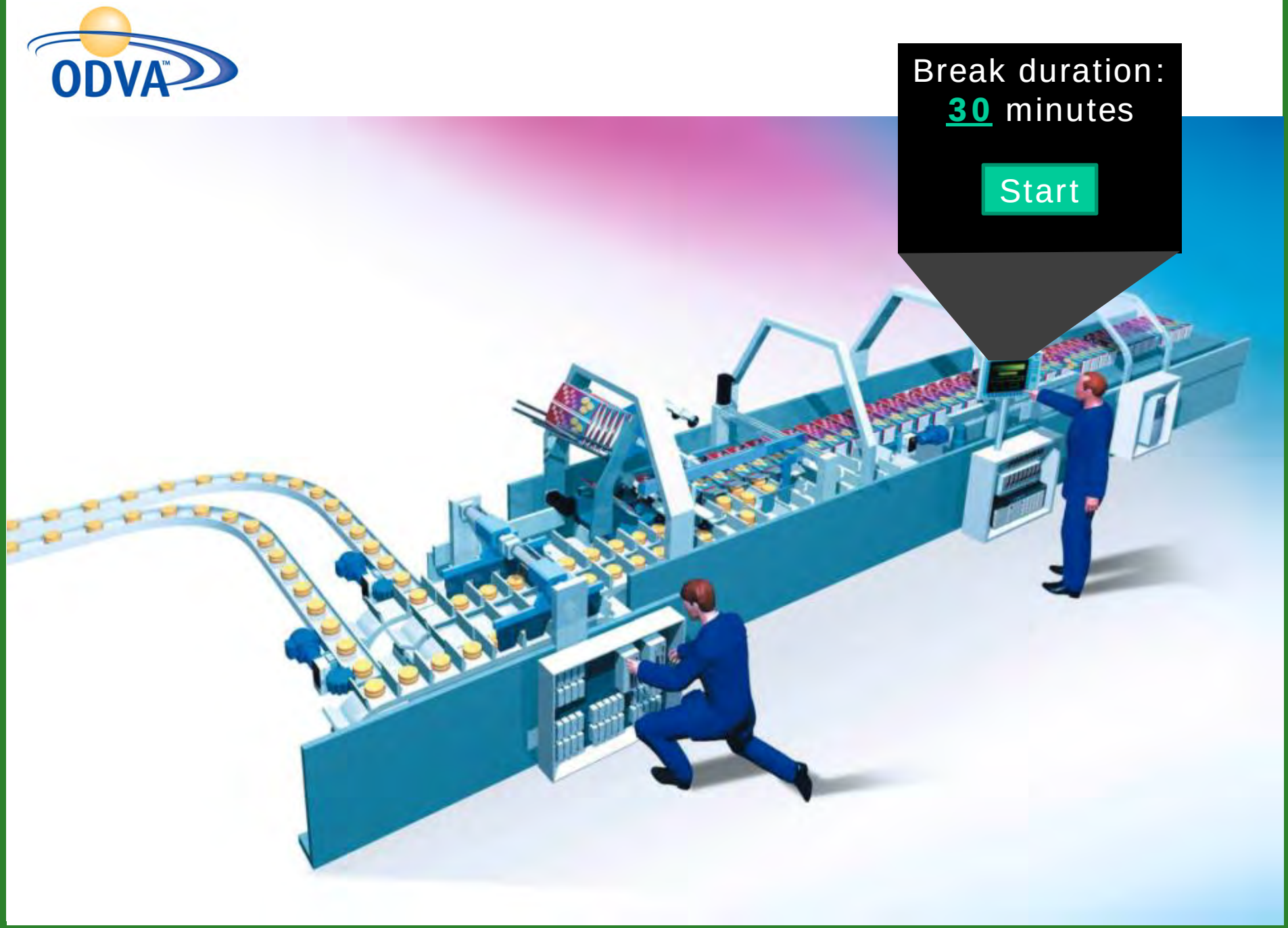

Break duration:
30 minutes
Start

Phase 2a
Power Management

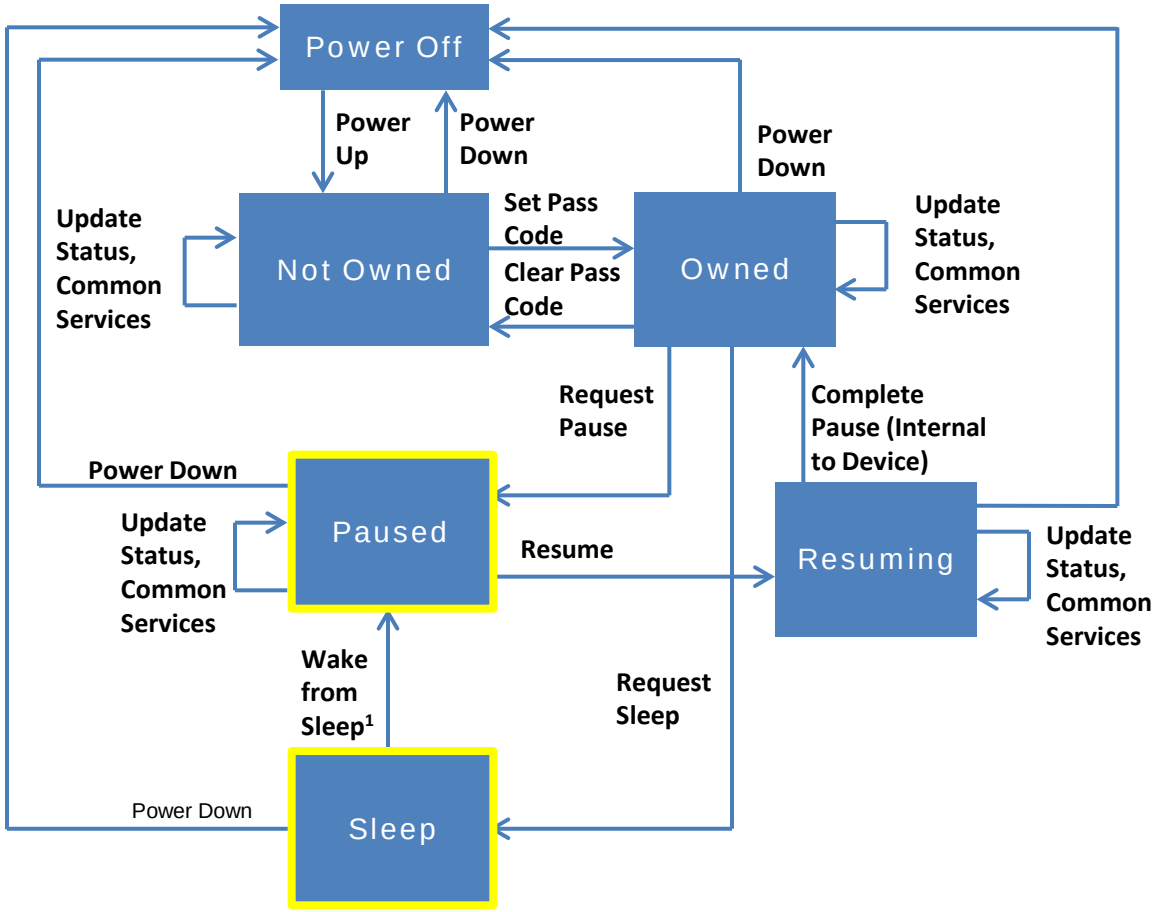
Management activities to save energy include:

- Directing devices to go to known low power consumption **pause states** during idle periods.
- Directing devices to go into **sleep states**
  - Where even the device's communications hardware is sent to its lowest possible energy consumption state for extended periods of time

The specification defines:

- The Power Management Object
  - Controls entry into and exit from energy saving pause states
- EtherNet/IP specific sleep mechanism
  - Controls entry into and exit from sleep states

Power Management Object States

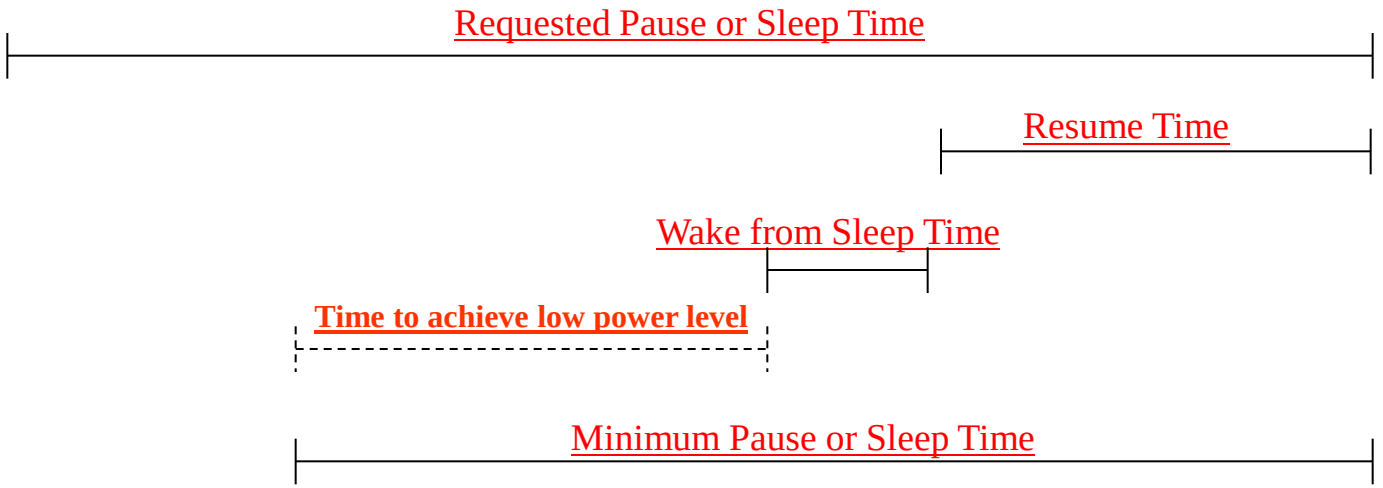


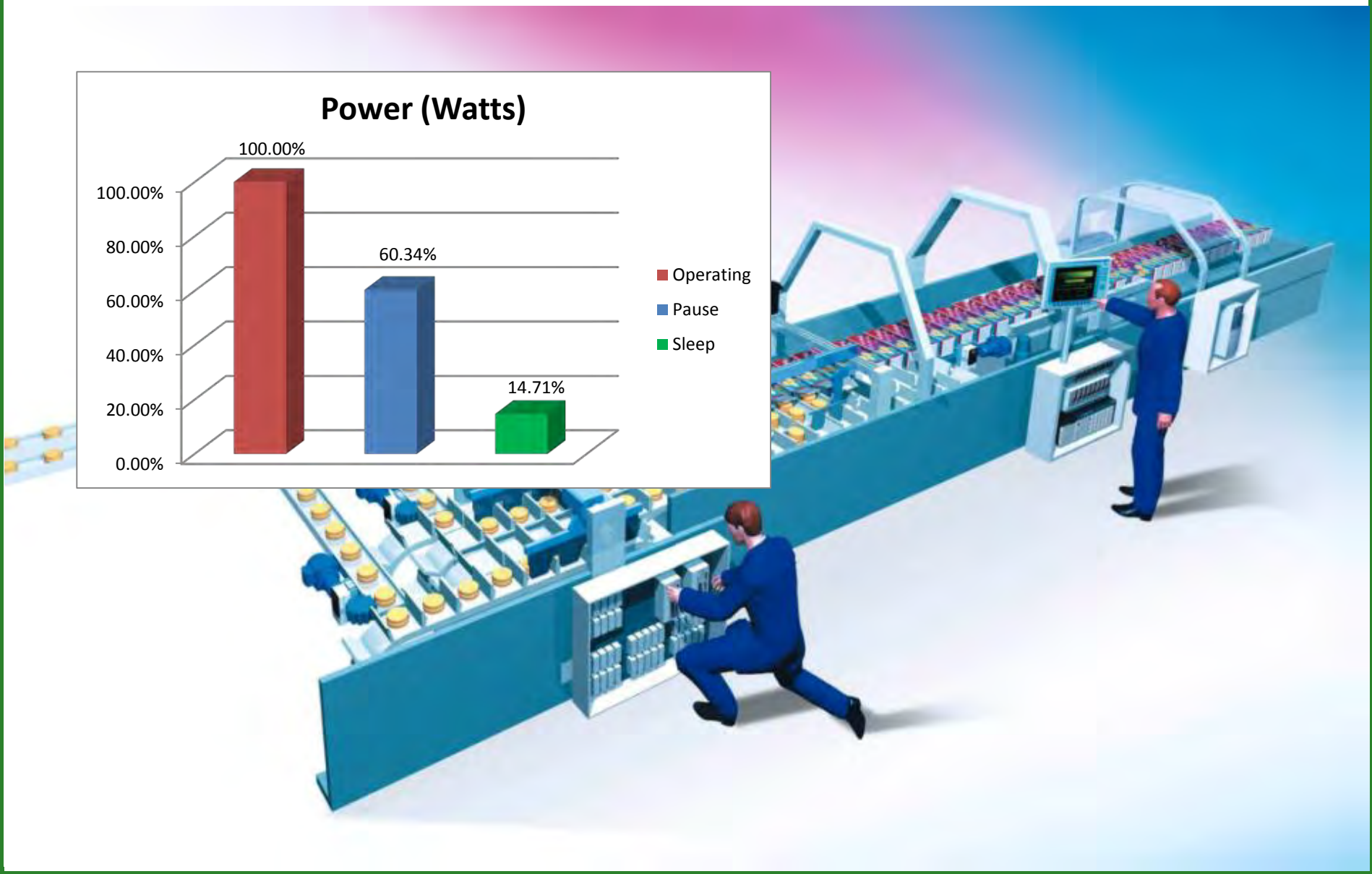
1 Adaptation-specific Wake from Deep Sleep mechanism (example: Ethernet Magic Packet)

Timing Relationships

The Power Management object includes a number of time elements.

- **Requested Pause or Sleep Time** – the time requested by a client issuing a Pause or Sleep; indicated the time until the server may be expected to have returned to a fully operational condition.
- **Resume Time** – the time required for a server to transition from the Paused state, through the Resuming state into the Owned state.
- **Wake from Sleep Time** – the time required for a server that supports the Sleeping state to transition from the Sleeping state to the Paused state.
- **Minimum Pause or Sleep Time** – the time required for a server to enter into and exit from an energy saving mode. This time includes the Wake from Sleep Time and Resume Time, as applicable, in addition to a time required to attain the agreed power usage level.




Power (Watts)
100.00%
60.34%
14.71%
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Operating
Pause
Sleep

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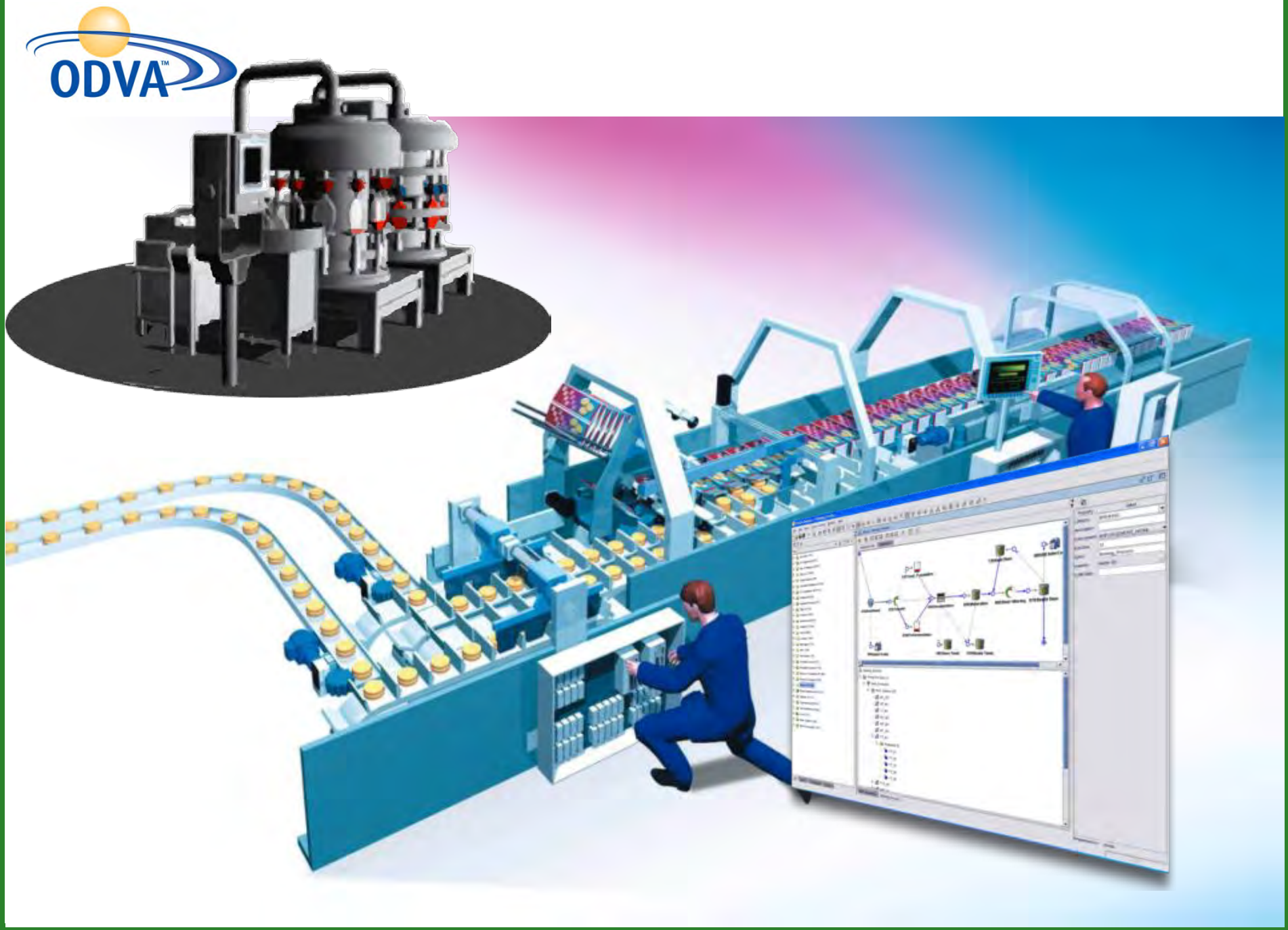
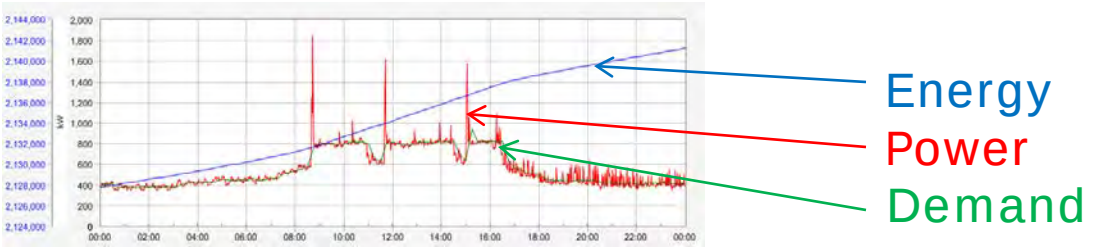

ODVA™

Phase 2b – Energy Management

Controlling Energy Demand

Demand

- Average rate of energy consumed per interval of time, in kilowatts



Demand charges

- Based on the highest interval demand in a month
  - $10 - $20 or more per kW
  - Depends on time of use (on-peak, off-peak)
- Demand is figured at the main utility meter
- Demand acknowledges equipment capability to absorb short-time overloads

Demand management

- Dynamically controlling loads to reduce energy demand

Phase 3
Smart Grid

Development of a standardized interface

- ODVA does not anticipate direct connection of devices to the Smart Grid
- Collaborating with other SDOs
  - ASHRAE/NEMA Facility Smart Grid Information Model

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Energy Can Be a Managed Resource

A "day in the life" of a manufacturing process shows how OEU and the ODVA energy technologies can be applied to balance risk, cost, and opportunity:

- Risk: no need to alter the operating process to get energy savings; can leverage installed base of CIP- and MODBUS-enabled devices by executing commands and collecting data over the existing communication cable; reduced dependence on customization and proprietary solutions
- Cost: lower implementation cost through elimination of custom code, fewer meters, etc.
- Opportunity: Lower cost of implementation means increased granularity of information, leading to more savings opportunities.

Benefits

To the End User and OEM

- More detailed energy info at very low cost
- Reduced integration costs
- Reduced operating costs through the application of this technology in automation and information processes

To the Vendor and OEM

- Integration of devices into the energy management functionality of automation systems
- Natural extension of CIP capabilities into a new and differentiable market space

Where is the Market Today?

- Much of the low fruit has been harvested without much intervention from automation
- Europe and Japan are ahead of the rest of the world in adopting these practices
- Global companies are starting to get the message and create top-down strategies, initially to create corporate good will
- Energy is slowly starting to become part of the total cost of ownership…and it won't be long before planning starting including energy on the manufacturing BOM

What are you seeing?

For more information

To learn more about ODVA's energy initiative, visit *www.odva.org* and click on *Optimization of Energy Usage*

To get involved in the ODVA Energy activities, contact ODVA at:

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