## Control Energy solutions

### Services
- Mechatronic Support
  - Machine optimization
- Mechatronic Support
  - Machine analysis

### Software
- SIZER
- STARTER

### Functions
- Ctrl-E Profiles
  - SINUMERIK Operate
  - Energy recovery
  - Reactive power compensation
  - Dynamic energy management in the DC-link
  - Energy buffering in the DC-link
  - Automatic flux reduction for asynchronous spindle motors

### Components
- Control Cabinets from Siemens
- Condition Monitoring
- Machine retrofit
- Productivity improvement

### APC Support
- SINUMERIK Integrate: Analyze My Condition
- NX CAM / SINUMERIK process chain

### Virtual Machine
- SinuTrain for SINUMERIK Operate

### SIZER
- Virtual Machine
- SIZER STARTER

### SIZER
- Virtual Machine
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### Software
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- Productivity improvement

### Plant/machine design
- Production planning
- Installation
- Production/manufacturing
- Standby

### Machine tool builder’s perspective

### Machine user’s perspective
SINUMERIK Control Energy

- The SINUMERIK Ctrl-Energy solution matrix
- Components
  - Functions
  - Software
  - Services

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The challenge:
- High-efficiency drive systems for use in demanding motion control applications with high requirements placed on the power density, dynamic performance and precision

The solution:
- SINAMICS S120 drive system in single-axis/multi-axis version with intelligent hardware design, state-of-the-art semiconductor technology and a multiple of software functions to achieve maximum energy efficiency

The customer advantages:
- Extremely high efficiency of up to 99% using a multi-axis concept based on common DC link
- Compact drive design with different cooling types

The energy saving potential:
The challenge:
- High-efficiency motors for use in all types of rotating and linear motion control axes with high demands placed on the power density, dynamic performance and precision

The solution:
- SIMOTICS servo, main, linear and torque motors in synchronous or induction versions as complete or built-in motor with a high copper space factor and with different cooling types
- Optimized for operation with SINAMICS frequency converters

The customer advantages:
- High-efficiency up to 97%
- Compact motor design
- Efficient integration into the machine

The energy saving potential:
- SIMOTICS S 1FK7/1FT7 optional with gearbox
- SIMOTICS M 1PH8
- SIMOTICS L 1FN3/1FN6
- SIMOTICS T 1FW3/1FW6
Weiss motor spindles

The challenge:
The mechanical design of the spindle unit with the according supply units provides a substantial energy saving potential.

The solution:
Weiss built-in and hybrid motor spindles for different kinds of machining technologies

The benefits:
✓ Grease re-lubrication without oil/air lubrication unit
✓ Brush sealing without sealing air and compressor unit
✓ Electrical tool release unit without hydraulic and pump unit

The energy saving potential:

Example: general saving of compressed air supply

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<thead>
<tr>
<th>Main time</th>
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<tr>
<td>Downtime</td>
<td>Auxiliary components</td>
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</table>

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The challenge:
- Reduction of the energy usage in basic performance applications such as pumps/fans/compressors, conveyor technology applications and auxiliaries

The solution:
- SIMOTICS GP/SD 1LE1 low-voltage motors for line operation (fixed speed) or frequency converter operation (variable-speed) with innovative rotor design with a high conductivity in IE2, IE3 and NEMA versions

The customer advantages:
- Highest IE3 efficiency class with an efficiency of up to 97%
- For fixed speeds, energy savings of up to 10% and for variable-speed operation, up to 70%
- Excellent starting behavior
- In compliance with all of the legal stipulations and efficiency class is worldwide

The energy saving potential:
The challenge:
- Applications, for example pumps, fans and compressors, efficiently operating conveyor technology in the partial load range

The solution:
- SINAMICS G frequency converters for variable-speed operation of low-voltage motors and geared motors

The customer advantages:
- High-efficiency up to 98%
- Up to 70% energy saving for pump applications with frequency converters
- Lower energy consumption of auxiliaries when operated with variable speed
- Lower amount of heat generated in the machine (lower temperature rise)

The energy saving potential:
- Up to 70% energy saving potential

Components:
- Single-axis drive system
- SIMOTICS GP/SD 1LE1
- SIMOGEAR bevel, parallel shaft, helical geared motors

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<th>Services</th>
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SINUMERIK Control Energy

- The SINUMERIK Ctrl-Energy solution matrix
- Components
  - Functions
  - Software
  - Services

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**The challenge:**
Especially with large scale production, the cutting strategy influences the energy consumption of the machine significantly.

**The solution:**
Ctrl-E Analysis function to measures and analyze the energy consumption of the machine

**The benefits:**
- Easy energy optimization of cutting processes (determination of energy per part)
- Easy energy optimization during the machine design engineering phase

**The energy saving potential:**
- Main time
- Main drive
- Auxiliary components

Press Ctrl + E for operation

Energy consumption of the complete machine

Energy consumption of the drive system

<table>
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</tbody>
</table>
The challenge:
Especially in JobShops, machines are not used permanently. During downtimes auxiliary components such as hydraulic aggregates waste energy. This waste of energy shall be reduced.

The solution:
Ctrl-E Profiles function with a predefined commissioning platform for the management and operation of machine standby modes

The benefits:
- Less energy wastage during machine standby
- Easy operation by key-combination Ctrl + E
- Minimization of commissioning efforts

The energy saving potential:

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<tr>
<td>Plant/machine</td>
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</table>

Press Ctrl + E for operation

Profile management
- Condition tracking
- Timer management
- Message generation
- Operation

Control interface
- PLC-interface for auxiliary component control
- PLC-interface for plant control

Components: Main time, Main drive, Downtime, Auxiliary components
Functions: Profile management, Condition tracking, Timer management, Message generation, Operation
Software: Ctrl-E Profiles
Services: Plant/machine design, Installation, Production/manufacturing, Standby, Plant/machine retrofit

Plant/machine in operation

UP TO 90% ENERGY-SAVING POTENTIAL
The challenge:
Setting up the machine for the production, e.g. determination of work-offsets or tool geometries, occupies the machine which leads to a lower machine utilization and therewith to an unnecessary energy wastage.

The solution:
Graphical interactive user-interface SINUMERIK Operate with its state of the art Animated Elements input help, featuring short movie sequences, for most intuitive machine operation.

The benefits:
✓ Less energy wastage during unproductive machine setup procedures

The energy saving potential:

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<th>Downtime</th>
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<tr>
<td>UP TO 10% ENERGY SAVING POTENTIAL</td>
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</table>
The challenge:
- Feedback the energy generated in the drive system, e.g. when braking, back into the line supply in compliance with the grid codes.

The solution:
- SINAMICS G and S frequency converters with energy recovery.

The benefits:
- ✓ No energy loss thanks to energy recovery
- ✓ No undesirable heat generated in the area around the machines
- ✓ External components can be eliminated (e.g. braking resistors, line reactors)
- ✓ Lower cooling costs and control cabinet envelope dimensions
- ✓ Up to 80% energy saving per process cycle at the machine when using SINAMICS G120–PM250 capable of energy recovery when compared to pulsed resistors

The energy saving potential:

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<th>Component</th>
<th>Energy Saving Potential</th>
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<td>Main time</td>
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<td>Main drive</td>
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<td>Downtime</td>
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</tr>
<tr>
<td>Auxiliary</td>
<td>✓</td>
</tr>
</tbody>
</table>

PM250 = Power-Module 250          SLM=Smart-Line-Module          ALM=Active-Line-Module
Reactive power compensation

The challenge:
- Reduce the capacitive and/or inductive reactive power in the machine
- Reduce the amount of expensive reactive power compensation systems

The solution:
- SINAMICS S120 with Active Line Modules (ALM) automatically compensates the reactive power of the complete machine up to a $\cos \phi = 1$

The customer advantages:
- Up to 100% cost saving of the reactive power drawn by the drive train
- The line supply is not loaded with reactive power
- No phase offsets
- Cost savings for stationary reactive power compensation systems depending on the system configuration

The energy saving potential:
- Main time: ✔
- Main drive: ✔
- Downtime: ✔
- Auxiliary components: ✔
Dynamic energy management in the DC link

The challenge:
- Provide the regenerated energy to other drives/loads.

The solution:
- SINAMICS S120 with a common DC link for energy exchange between the drive modules.

The benefits:
- Efficient use of energy in the complete DC link through dynamic energy management
- Efficient engineering/configuring of the infeed modules depending on the particular load cycle

The energy saving potential:
- Example: Energy saving of up to 80% for a winder application when compared to a conventional solution with converter and braking resistor

Example: Energy saving of up to 80% for a winder application when compared to a conventional solution with converter and braking resistor
The challenge:
• For dynamic reversing operations in single-axis and multi-axis systems, the kinetic energy available in the system should be reused.

The solution:
• SINAMICS S120: Energy equalization through the common DC link
• Additional capacitor module connected to the DC link as energy storage device
• Only the excess energy is fed back into the line supply

The customer advantages:
✓ Crane applications, servo presses with additional savings of up to 10% when compared to previous solutions based on ALM.
✓ Lower power peaks at the line supply and optimized power costs
✓ Minimization of energy losses through energy buffering
✓ Brief line supply dips/failures are buffered

The energy saving potential:

<table>
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<td>Main time</td>
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<tr>
<td>Auxiliary components</td>
<td>✔</td>
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</table>

Energy saving potential: Up to 10%
## ECO mode / automatic flux reduction for induction motors

**The challenge:**
- Machines with reduced torque and less dynamic performance do not require the high motor torque over the complete operating range.

**The solution:**
- For SINAMICS G converters, the ECO mode in V/f operation reduces motor losses by automatically adapting the magnetic motor flux.
- For SINAMICS S converters in the SERVO mode, the flux-generating current is automatically adapted when the induction motor is in the partial load range.

**The benefits:**
- Less energy wastage during stable speed of the machine in the partial-load operating range.
- Reduction of ohmic losses and therefore the associated thermal motor losses.
- High accuracy due to less heat input into the machine tool (less thermal expansion).

**The energy saving potential:**

<table>
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**ECO mode in V/f operation**

- G120D
- G120C
- G120P

**Flux reduction in SERVO operation**

- S120 Compact
- S120 COMBI
- S140

The ECO mode is deactivated for setpoint changes or when a converter DC link voltage is outside the nominal tolerance range.
SINUMERIK Control Energy

- The SINUMERIK Ctrl-Energy solution matrix
- Components
- Functions
- **Software**
- Services
The challenge:
- Energy-efficient and load-cycle dependent configuration of a plant/machine

The solution:
- SIZER calculates the complete drive train (line components, motor, drive, control)
- An energy usage calculation and optimization is performed, based on the mechanical properties as well as the machine load cycle

The customer advantages:
- Optimum drive configuration
- Load-dependent calculation of the energy usage
- Automatic calculation of the drive alternatives with the most favorable energy balance (efficiency) for the application

The energy saving potential:
- Up to 10% energy saving potential

Please click the picture for animation!
The challenge:
- Configuring and commissioning all Siemens drives with an intelligent tool which can be intuitively used to create energy-efficient solutions

The solution:
- The STARTER software allows SINAMICS drives to be commissioned in a navigated fashion
- The STARTER tool is available either as an autonomous PC application or via “Drive ES Basic”, integrated in the SIMATIC STEP 7 in conformance with TIA

The customer advantages:
- First commissioning using a wizard and graphic screen forms
- Fine tuning and individual settings using the expert list
- Simplification of commissioning using solution-oriented dialog prompting
- Reduction of the manual optimizing time & costs through self-optimizing functions
- Test and diagnostic functions are provided for support

The energy saving potential:
Virtual Machine

**The challenge:**
Avoid stand-still of the machine tool due to programming of part programs on the HMI. Reduce stand-still of the machine tool during the set-up process.

**The solution:**
PC-Software system “Virtual Machine” with original SINUMERIK CNC kernel and original SINUMERIK Operate CNC user interface

**The benefits:**
- Complete verification of NC programs on PC
- Acceleration of set-up process due to visualization
- Accurate prediction of machining times
- Optimization of machining process without stand-still

**The energy saving potential:**
- Up to 10% energy saving potential
**The challenge:**
CNC-training of new employees and the preparation and optimization of CNC-parts programs occupies the machine which leads to a lower machine utilization and therewith to an unnecessary energy wastage.

**The solution:**
SinuTrain for SINUMERIK Operate: comfortable machine identical SINUMERIK operation and CNC-programming offline on a PC

**The benefits:**
- No energy wastage due to easy offline CNC-learning
- No energy wastage due to offline preparation and testing of CNC-programs

**The energy saving potential:**

<table>
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Source: INEX-Werke GmbH & Co KG, Hahn & Tausky
The challenge:
Operation media of machine tools cause costs and energy consumption. The use of operation media in non-productive periods shall be minimized plant wide.

The benefits:
- Detection of increased consumption rates
- Threshold control and messaging
- Operator independent machine de-activation (standby) in non-productive periods
- Record of media consumption per part, order, shift, …
- No machine PLC modifications necessary

The solution:
Sinumerik Integrate Analyze My Condition combined with a server system to configure logic-based conditions for machine stand-by for the whole machine park

The energy saving potential:
**NX CAM / SINUMERIK process chain**

**The challenge:**
An inefficient process chain of CAM, post processor and CNC leads into prolonged machining times and therewith to a higher energy consumption.

**The solution:**
NX CAM with perfectly optimized post processor for SINUMERIK controllers

**The benefits:**
- Shorter machining time due to optimized process chain
- Free of charge NC CAM post processor for every registered machine with a SINUMERIK CNC

**The energy saving potential:**
- **Main time:** ✓
- **Main drive:**
- **Auxiliary components:**

UP TO 2% ENERGY SAVING POTENTIAL

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**NX CAM + SINUMERIK**

**Post processor optimized for SINUMERIK CNC command set**

**Shortest machining time leads to minimum of energy consumption**

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**Components**
- **Plant/machine design**
- **Production planning**
- **Installation**
- **Production/manufacturing**
- **Standby**
- **Plant/machine retrofit**

**Plant/machine in operation**
SINUMERIK Control Energy

- The SINUMERIK Ctrl-Energy solution matrix
- Components
- Functions
- Software
- Services
The challenge:
- Detailed understanding of the energy usage of an existing machine in different operating states (usage modes).
- Apply the knowledge in the development of new machines with lower energy usage.

The solution:
- Siemens Mechatronic Support expert service for the measurement, the interpretation and support/optimization of the energy consumption of a specific machine.

The customer advantages:
- Identification of the relevant energy consumers in the machine.
- Discuss the results with Siemens experts and realize the energy saving potential.

The energy saving potential:

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Example: reducing the moved mass of the drive train by 30% resulted in an associated energy saving of 10%.
The challenge:
- Realize high jerk and acceleration values in order to achieve a higher productivity and therefore an improved “energy consumption per unit” parameter

The solution:
- Siemens Mechatronic Support expert service for simulation and optimization of new machines regarding the stiffness and reduction of moved masses

The customer advantages:
- Machines with a high dynamic performance with low energy usage per unit produced
- Increased machine productivity

The energy saving potential:

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**The challenge:**
Based on process monitoring system, productivity of the process and therewith the energy efficiency can be enhanced. This process monitoring systems have to be adapted to the specific machine tool.

**The solution:**
SINUMERIK Manufacturing Excellence expert service for installation and set-up of SINUMERIK Integrate In-Condition server based process monitoring system

**The benefits:**
- Maximum process efficiency by expert service
- Shortest commissioning times
- Manufacturer-independent installation

**The energy saving potential:**
- Up to 10% energy saving potential

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**Machine retrofit**

**The challenge:**
Assurance of the availability and efficiency of older machine tools in production.

**The solution:**
Siemens expert service for modernization of the automation systems of older machine tools combined with possibility to apply Sinumerik Ctrl-Energy for improved energy efficiency.

**The benefits:**
- Extension of the life of the machine tool
- Significant cost savings by latest efficient and profitable technology.
- High level of availability ensures competitiveness

**The energy saving potential:**

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**Benefit of Retrofit**

- Investment costs
- Operational costs
- Unit costs

**Plant/machine retrofit**

- Plant/machine in operation
- Production planning
- Installation
- Production/manufacturing
- Standby

**UP TO 10% ENERGY SAVING POTENTIAL**
The solution:
- Siemens control cabinets are designed, manufactured and certified according to a holistic and integrated system optimization approach, for specific applications according to electrical, thermal, mechanical and energy-efficient perspectives, taking into account the applicable engineering/installation guidelines.

The customer advantages:
- Lower energy consumption, commissioning and climate control costs through an optimized control cabinet design.
- Increased availability of plants and machines.
- Longer lifetime of the installed electronic components.
- Range of services: Visual control cabinet assessment and certification on site.

The energy saving potential:

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Control cabinets from Siemens
Productivity improvement

**The challenge:**
Improvement in the productivity of older machine tools with Sinumerik 840D or 840C. Preferably these machine tools are under high utilization, or with long runtimes and are running at high hourly machine rates.

**The solution:**
Siemens expert service for reduction of the machining time per unit and thus reduction of the energy consumption per work-piece.

**The benefits:**
- Permanent improvement at short amortization times
- Security for the customer through performance contracting (merit pricing model)
- Professional project planning for minimum production stop

**The energy saving potential:**

<table>
<thead>
<tr>
<th>Component</th>
<th>Before</th>
<th>After</th>
<th>Cycle time saving</th>
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<tbody>
<tr>
<td>Main time</td>
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<td>Downtime</td>
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<td>Main drive</td>
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<tr>
<td>Auxiliary comp.</td>
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**Cycle time**

- Before: 100%
- After: 84%

- Tool change
- Finishing
- Roughing
The challenge:
- How are the plants and machines operated by the user?
- How is the specific energy usage of his plant, line or machine made transparent to the user?
- Which measuring equipment is required?
- How are the determined data evaluated from energy efficiency perspectives?

The solution:
- The “Focus APC EE” analyzes machines, lines and plants including the evaluation of the data that has been collected and draws up specific recommendations for action to be taken.

The customer advantages:
- Investment for measuring equipment is not necessary
- Identification of the energy consumers
- Specific catalog of measures to optimize the energy usage

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<td>Plant/machine in operation</td>
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</table>

Percentage distribution of the energy types:
- Load profile characteristics: 36% (electricity), 26% (gas), 26% (oil), 2% (hot water), 5% (water), 3% (condensate), 2% (potable water), 0% (wastewater).

Process analyses:
- Energy flow diagram (Sankey).

Load profile characteristics:
- Time (s)

Energy saving potential:
- Main time ✔
- Downtime ✔
- Main drive ✔
- Auxiliary components ✔
Thank you for your attention!

Industry Sector, Motion Control

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