Power Management Solutions
Exploring Hidden Cost Opportunities

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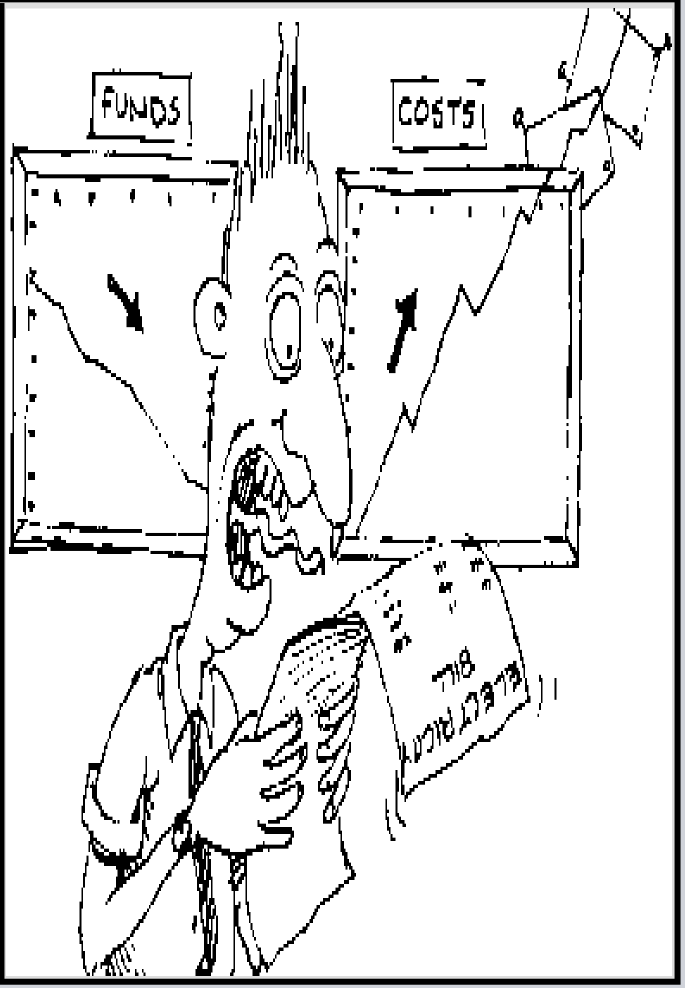
Agenda

- Introduction to power quality
- Financial implications of power management
- Regulatory and standardisation issues
- Application hints
- Examples
- Voltage optimisation – fact or fiction
- Power management implementations
- Joint Q&A session



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Introduction To "Power Quality"

- Users are increasingly experiencing increased costs caused by "poor power quality" – often without realising!

- Power quality issues can also put the facility at risk of spurious down time and systems failures – with their attendant costs

- Correcting power quality issues can..
  - Reduce direct energy costs
  - Improve system reliability
  - Reduce lost productivity caused by systems failure
  - Eliminate the risk of contravening UK regulations

- Typical remedial measures often provide payback within 1 – 2 years with ongoing savings thereafter.

- Rigorous assessment and design is essential.....

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Sources Of Power Quality Issues

Disturbances from the supply

- Network Switching
- Storms (Lightning)
- Repairs
- Neighbouring loads
- Interruptions
- Spikes & Swells
- Notches & Sags
- Flicker

Disturbances from Loads

- Drives & motors
- UPS
- Generators
- Office Equipment
- Capacitors
- Harmonics
- Poor power factor
- Flicker
- Voltage collapse
- Resonance

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Introduction To "Power Quality"

Harmonics
50Hz - 2.5kHz

- Extra Heating in Cables
- Reduced Efficiency in Motors and Transformers
- Nuisance Tripping of Breakers
- Random Microprocessor faults
- Injection into the Electricity Network
- Reduced life of equipment especially lighting
- Incorrect Power Readings

Transients

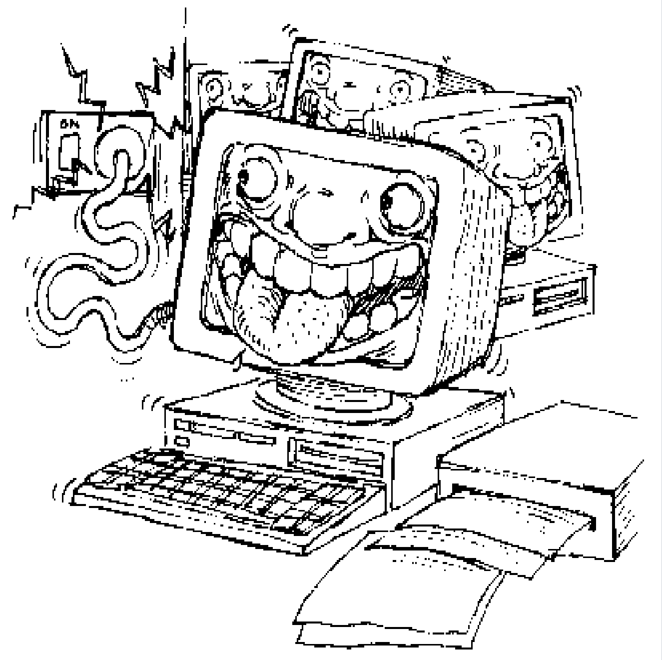
- Effects of Lightning Strikes
- Switch Large Motors/ capacitors causing spikes
- Destroying Sensitive Components
- Data Loss
- Fire Risk

EMC
1kHz - 500MHz

- Malfunction of electronic equipment
- False tripping
- Electronic component failures
- Corruption of data

Voltage

- Increased Energy Use
- Reduced Equipment Life
- Blackouts/ Brownouts causing plant stoppage
- Notching causing equipement faults
- Flickering lights from Rapid Loads



Power Factor

- Excess reactive power charges
- Increased cable losses
- Higher transformer losses
- Increases maximum demand
- Higher availability charges

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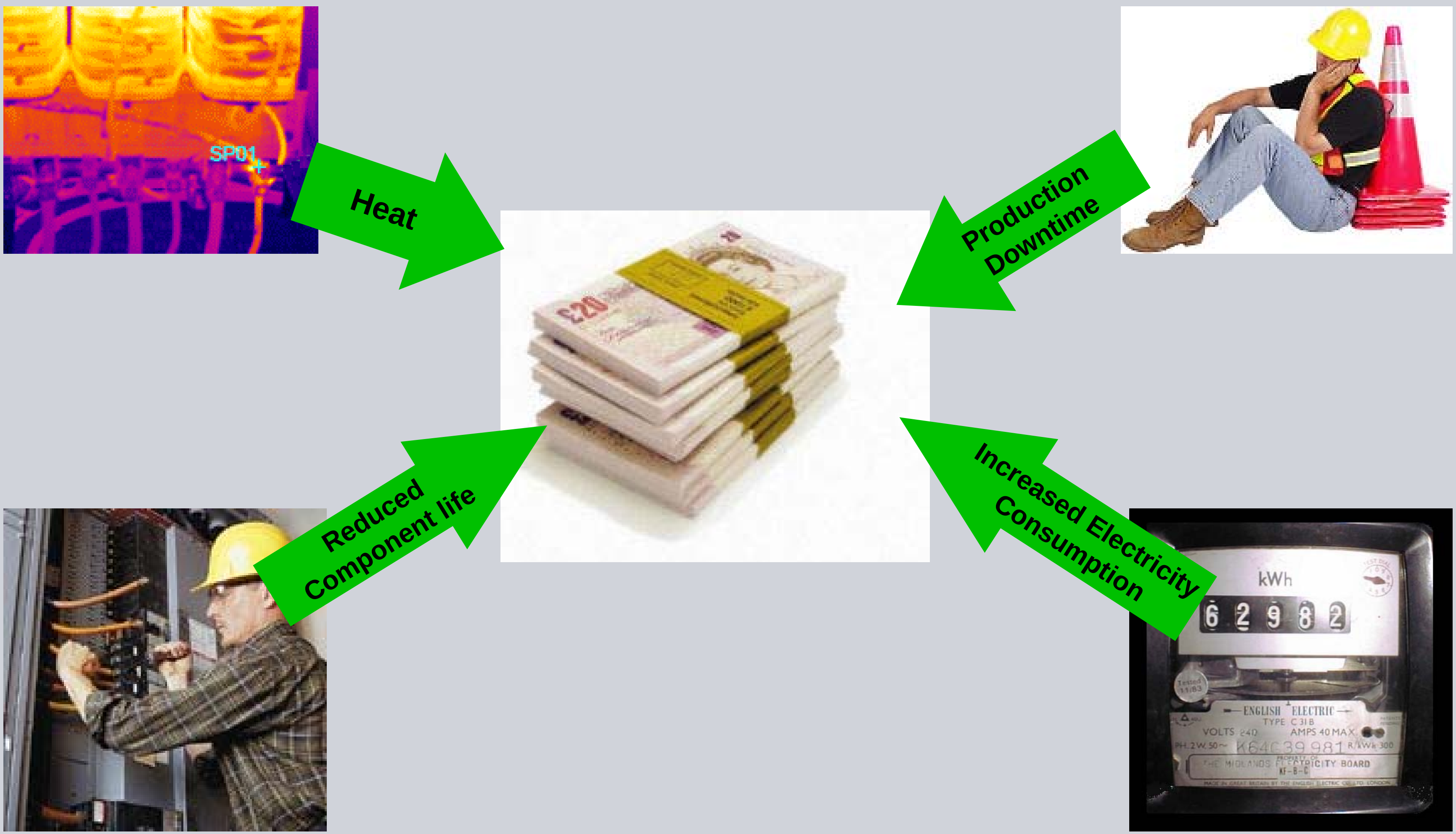
Hidden costs of Power Quality



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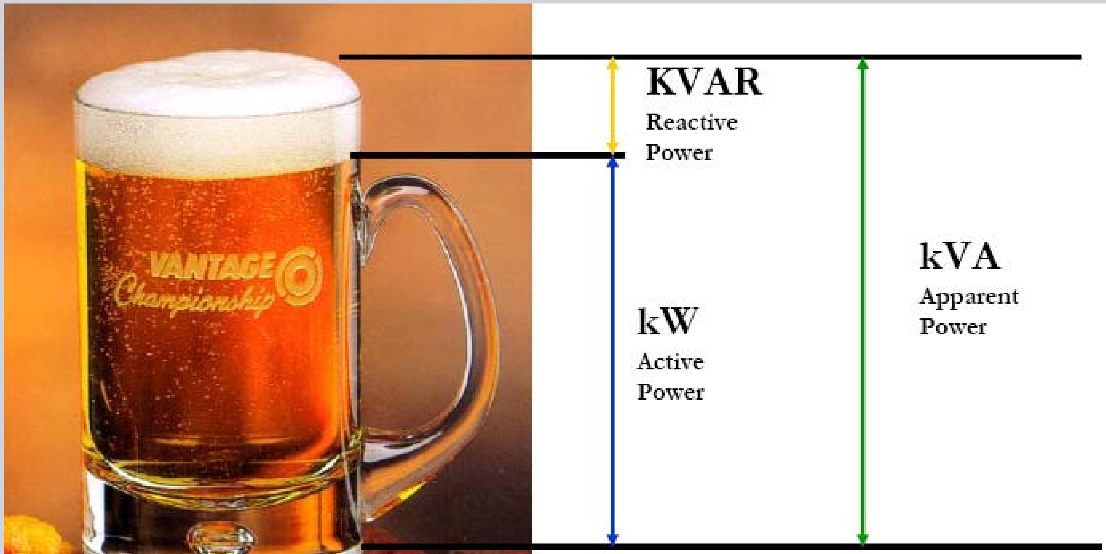
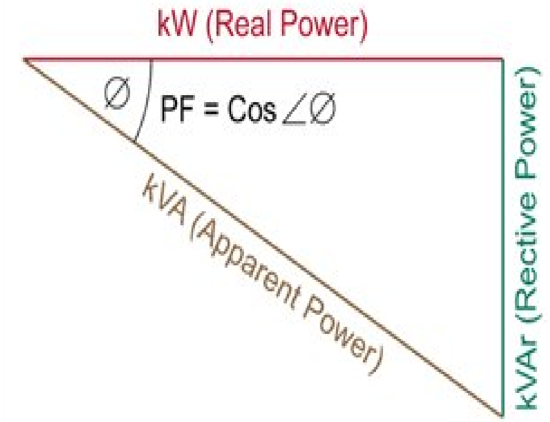
Power Factor



$$PF = \frac{kW}{kVA}$$

$$\text{Power Factor (pf)} = \frac{\text{kW (Real Power)}}{\text{kVA (Total Power)}}$$



- Power factor is a measure of how effectively the input current translates into active power (kW)
- The supply and distribution equipment must be sized for the total (apparent) rating
- low power factors waste energy, attract additional charges and waste equipment ratings
- Many sites have neglected power factor correction in recent years

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Power Factor

- Most regional companies now charge for "power factor" (Reactive power charges)
- The benchmark is 0.95 lagging

- Typical paybacks for upgrading site power factor correction is around 1 to 2 years
- Power factor correction (pfc) is a simple cost effective solution
- PFC also increases the effective capacity of supply transformers, cables etc

Notes:

- For many applications, "detuned" capacitors are required – wherever an abundance of electronic equipment is installed (computers, variable speed drives, electronic lighting systems etc.
- Correctly detuned pfc will provide many years of trouble free operation
- Detuned pfc can be used to give a small reduction of power frequency harmonics
- Active power factor correction is a good technical solution - although expensive!

Distributor	Charge?
CE Electric UK	Never charge ?
Central Networks A company of e.on	Charge up to 0.95 p.f.
EDF ENERGY	Charge in two bands to 0.95pf
Northern Ireland Electricity	Charge during winter months
Scottish and Southern Energy	Charge up to 0.95 p.f.
ScottishPower	Charge up to 0.95 p.f.
United Utilities	Charge up to 0.95 p.f.
WESTERN POWER DISTRIBUTION	Sometimes charge

Power Factor – Example

A facility in the South East of England purchases their electricity from Southern Electric, but is connected to the local EDF network.

• The facility has a Maximum Demand (M.D.) of 3, 500kVA and is currently operating with a Power Factor of **0.79**. Installing a 1, 500 kVAr PFC bank increased the power factor to 0.97, saved the company 670 kVA, and 217, 110 kVArh units per month. Based on their current tariff they realised over **£16k p.a.** total savings:

Reactive Power charge

(charged at 0.62p per kVArh excess) - Saving 217, 110 kVArh x 0.0062 x 12 months

= £16, 145 p.a.

Total cost of equipment including installation

Totalled c. £20, 000

Payback Time = c. 14 months

Furthermore*, increasing the pf from 0.79 to 0.97 yielded an increasing available power of an* ***additional 630kW*** *– based on the existing installed assets. This meant the client was able to defer the cost of new transformers and supplies necessary to meet the site requirements for increased power demand.*

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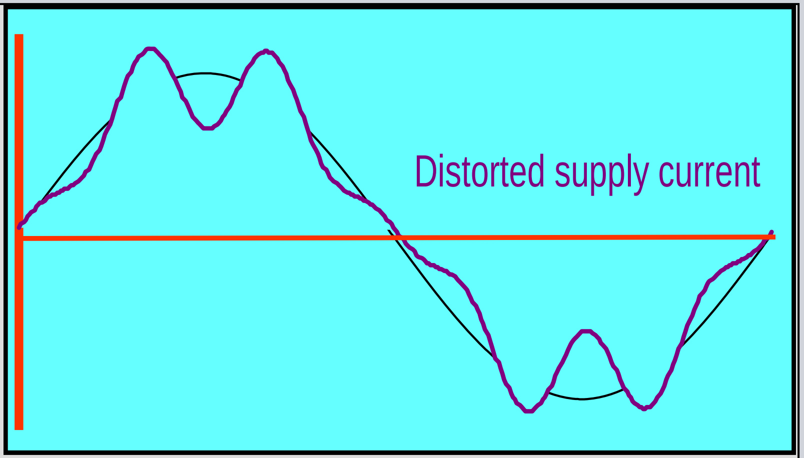
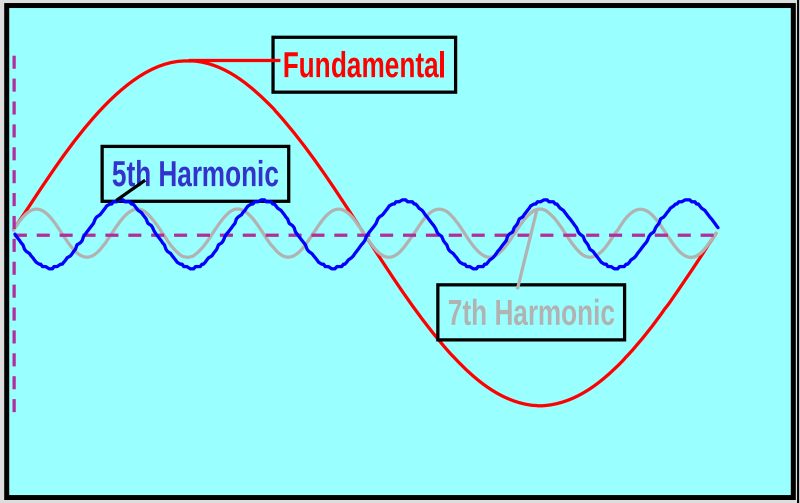
Power Frequency Harmonics

- Caused by all "non linear" equipment (especially electronics) – such as:
  - Televisions & domestic equipment
  - Computer equipment
  - DC & a.c. drives
  - Industrial controls
  - Transformers and rotating machines
- Prevalent across industry and commerce
- Create both practical & regulatory issues
- Can be an opportunity to reduce costs
- Consider as part of a systematic approach





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Power Frequency Harmonics

- Harmonics are just multiples of the mains frequency (50Hz in the UK)
- Electrical equipment causes multiple frequency harmonics to be generated
- There are regulations which limit the “harmonics” that a user is allowed to generate back on to the supply (ER G5/4-1)
- Excess harmonics can cause practical problems - Including:
    - Overheating of transformers and cables
    - Excess neutral currents in buildings
    - Spurious tripping of equipment
    - Reduced lifetime of connected products
    - Problems with lighting systems
    - Limits on capacity of standby generators and UPS systems
- Standard solutions exist:
    - Active harmonic filters
    - Low harmonic products (e..g. active front end VSDs)
    - Power factor correction – detuned! - (for small problems where pfc allows)
    - Phase shifting transformers
- Electricity companies can disconnect users who contravene regulation “ER G5/4-1”

Voltage Optimisation

• Based on the fact that many (most?) installations in the UK are supplied with ‘excess’ voltage levels.

• EU Voltage harmonisation based on 400V but most UK distribution still based on 415V (433V) supply.

• Higher voltage leads to higher energy consumption, reduced equipment lifetime and higher breakdown rate

• Correct voltage optimisation and conditioning can reduce cost, minimise maintenance and improve system reliability.

• Benefits are often “oversold” – but can be a very good solution in some cases.

Notes:

- Check suitability for voltage optimisation
- What about tapping down the main supply transformer
- Consider installation issues
- Savings are very dependent on the load types!!!

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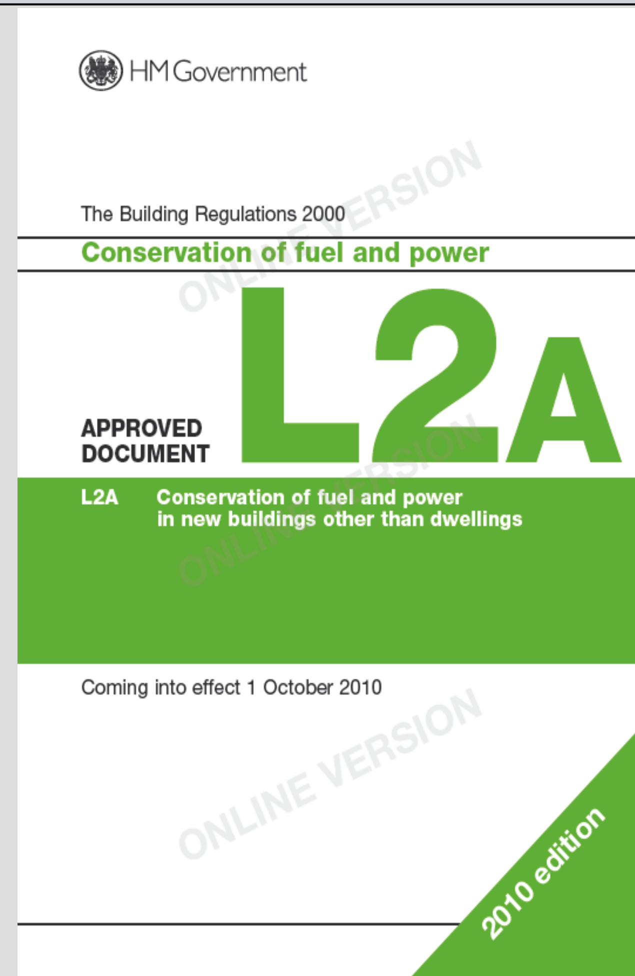
Power Management Solutions

Integration of metering systems, intelligent software – aM&T, can provide:

- Accurate analysis of historical consumption data
- Trending
- Benchmarking
- Energy management analysis tools such as regression etc
- Compliance with building regulations metering requirements

Active power management can provide:

- Intelligent load shedding for demand reduction
- Tariff management – e.g. Triads and maximum demand
- Integration of standby generator control
- innovative energy reduction topologies with real time harmonic compensation



Other issues

• **Flicker** - fast changes electrical loads (e.g. arc welding, DC drives) can cause a problem known as “flicker” – the limits for this are specified in regulation “P28”. A number of companies have been instructed to carry out remedial work or be disconnected. Corrected by high speed reactive compensation.

• **Voltages surges** or dips can cause equipment outages or failures. Consider correct transient protection.

• **Excessive frequency variations** will also cause practical problems, nuisance tripping, speed variation of motors etc

• **EMC** – Electromagnetic compatibility (high frequency disturbances). Good basic equipment designs now but requires effective grounding and shielding techniques. Use correct EMC filtering selected for the environment.

Site Surveys – Starting Point For Power Solutions

- Potential issues can be quickly and effectively identified by a professional site survey

- For regulatory purposes (ER G5/4-1), such surveys must be of 7 days duration and must be done in accordance with prescribed methodology using “compliant” instrumentation.

- Where local practical issues are suspected, “spot measurements” may be taken over a time period that covers typical operation of the building or plant

- A comprehensive report is provided which includes tabular and graphical results and also covers key recommendations and conclusions

- The survey provides a baseline for the optimisation of any necessary remedial measures and allows Siemens to guarantee the solution

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Thank You

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Q&A

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Q&A – Power Management Solutions

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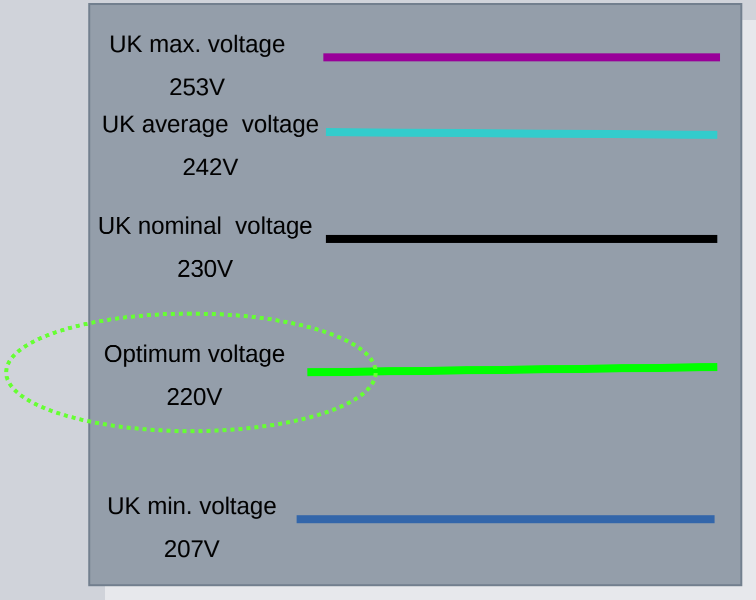
What are (not) Voltage Optimisers

- NOT substitute for full power factor correction equipment. De-tuned required for certain applications
- NOT a full harmonic filter solution to satisfy G5/4-1
- They ARE effective way of optimising your local supply voltage



"A 230V linear appliance used on a 240V supply will take 4.3% more current and will ***consume almost 9% more energy …"****and"****…only achieve 55% of its rated life"***

Source: Extracts from IEE 16th edition guide BS7671

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Potential Savings

Dependant on:

- Site voltage
- Equipment used; type and percentage of lighting loads, HE lights,

  (Smaller savings with high frequency electronic ballasts but larger savings with traditional discharge lighting / incandescent)

- Proportion of fixed/variable speed motors etc…

  (bigger savings where lightly loaded. No savings if heavily loaded)

- Load conditions of motor-driven equipment, i.e. flow-rates / usage etc.

➡ ALWAYS Site specific – A full survey is vital to make the correct recommendations

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Savings Model – Reported Examples

- The actual savings achieved will therefore be site specific and will depend on use. Actual examples of reported savings achieved with voltage optimisation are:
  - 17.7% - Textile manufacturer
  - 18,5% - Hotel
  - 8.6% - Hotel
  - 11.5% - Office
  - 16.3% - Office
  - 22.1% - Office
  - 12.5% - Printing company
  - 12.0% - Automotive component manufacturing
  - 11.7% - Office/Data centre
  - 17.0% - Swimming pool
  - 12.9% - Warehouse

Average payback time is 2.8 years

Note – it is understood that the sites were not otherwise advanced with energy saving measures. Siemens has a very conservative approach to potential savings

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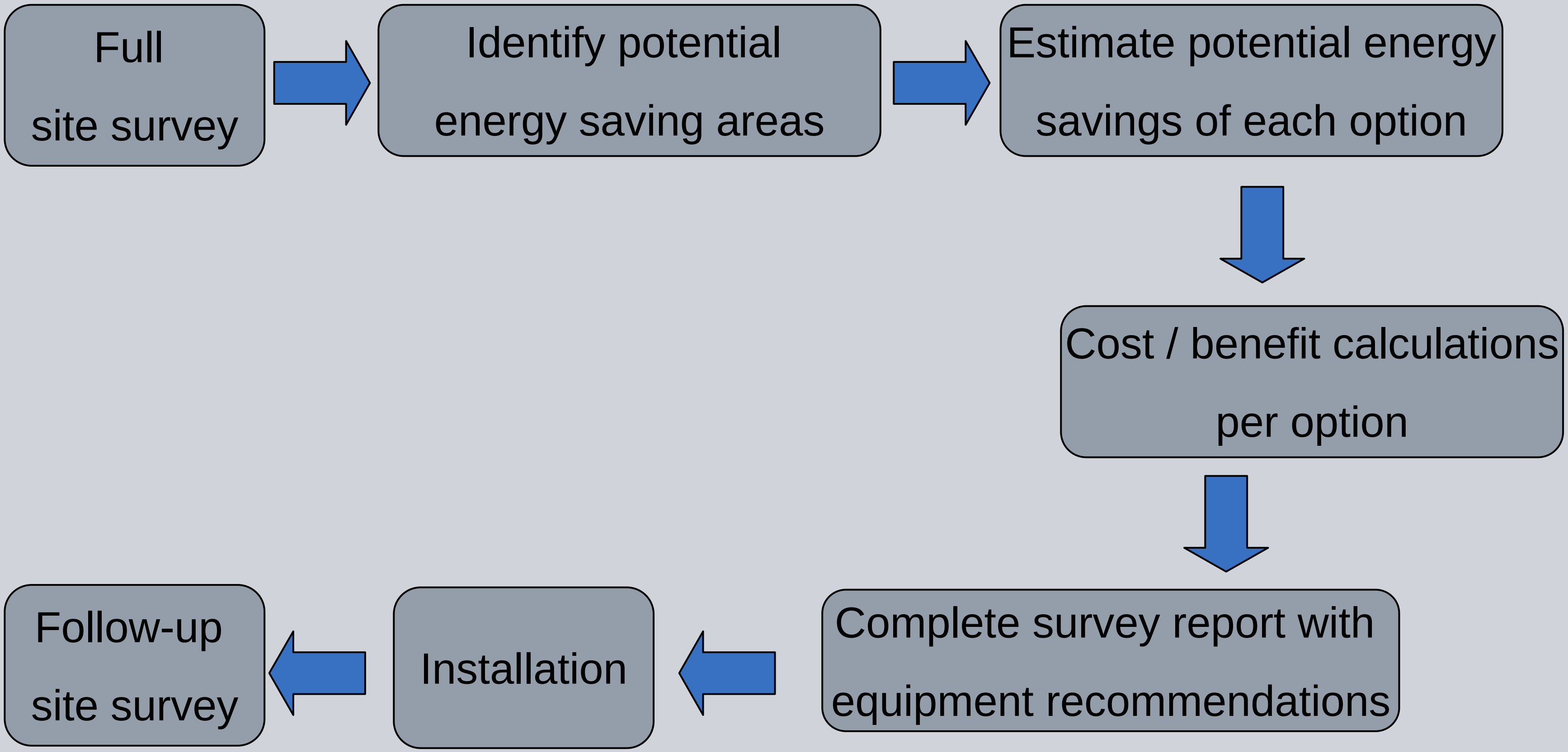
Process Involved



- To confirm actual results

Effective metering strategy

Granularity via AMR & aM&T

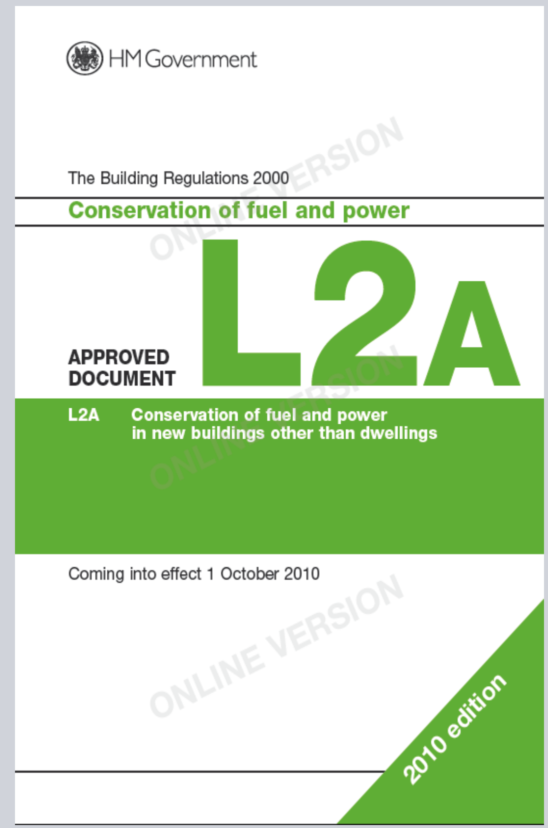
Automatic Meter Reading, Automatic Monitoring & Targeting is consistently regarded by experts as the optimum way to holistically reduce energy expenditure within an industrial process or commercial building.

Part L

Design guidelines offers suggested energy values for metering, and detail on how best to collect the data.

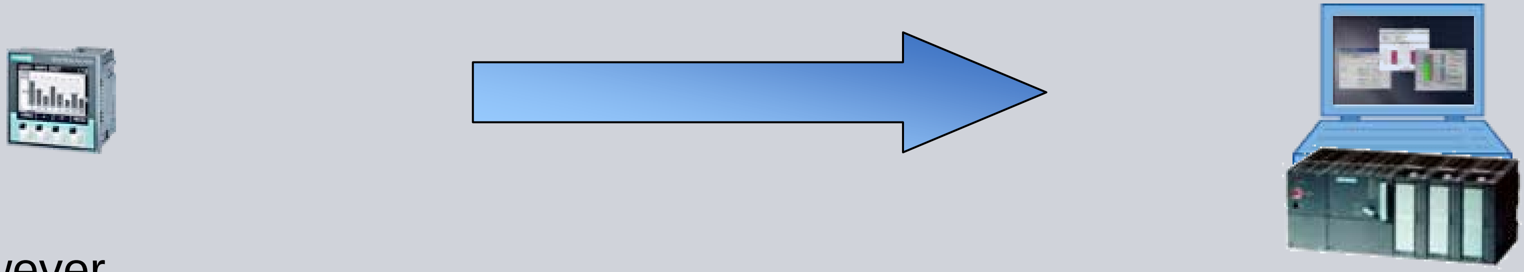
CRC

Deploying an AMR system and strategy is considered as “Early Action Metric”.



Monitoring or management

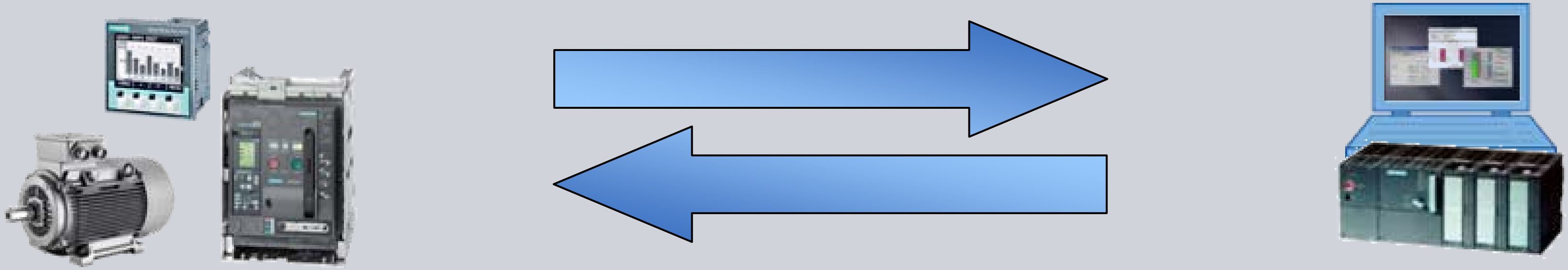
AMR Automatic meter reading is a passive simplex (half duplex) system, but will still identify areas for energy saving, and qualify as a CRC benefit.



However…

A dynamic management system is based on duplex communications, thus adding a layer of control, therefore the following is possible:

- Load shedding as a result of (excessive) peak loading.
- Switching in additional energy sources based on historical / system data.
- Minimal system downtime as a result of tripped devices (overload avoidance).



Options for energy management

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Automation Based

- Locally Embedded
- Utilising existing installed automation architecture
- Desire to correlate Process & Energy data
- SCADA & integration into ERP
- One off procurement costs (amortisation)

PC Based

- Locally Embedded
- Wide ranging connectivity options simple copper cable, Fieldbus to Ethernet
- BMS Integration possibilities
- One off procurement costs (amortisation)

Host / Managed

- Internet structure
- Discrete managed reports
- (Possibly) lower procurement costs
- Vendors are generally “niche” energy specialists
- Subscription fees for system and possibly metering components

Each scheme has both it’s merits and a position within the market place

SIEMENS has a solution for each requirement

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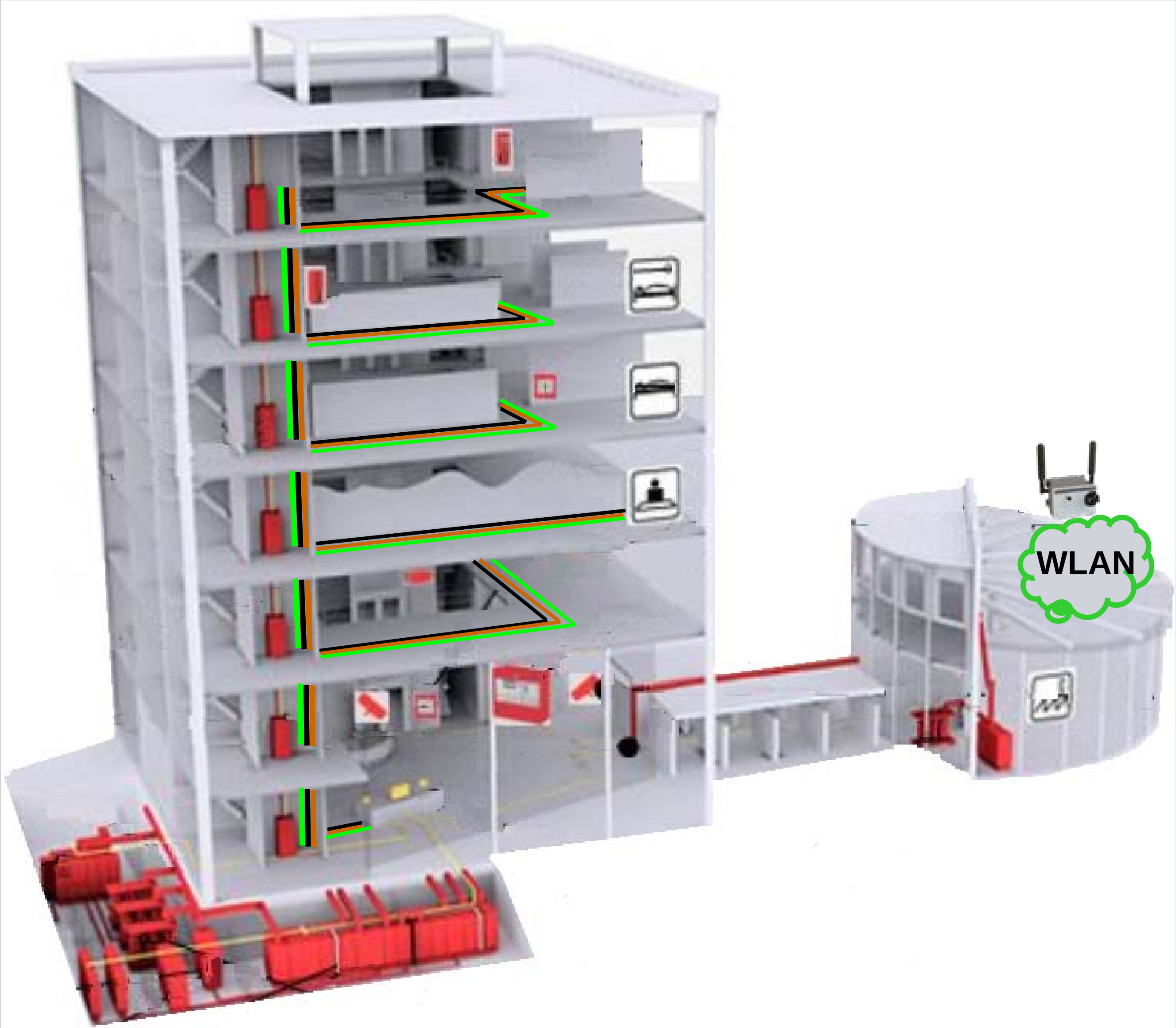
Architecture For Energy Management (Building)

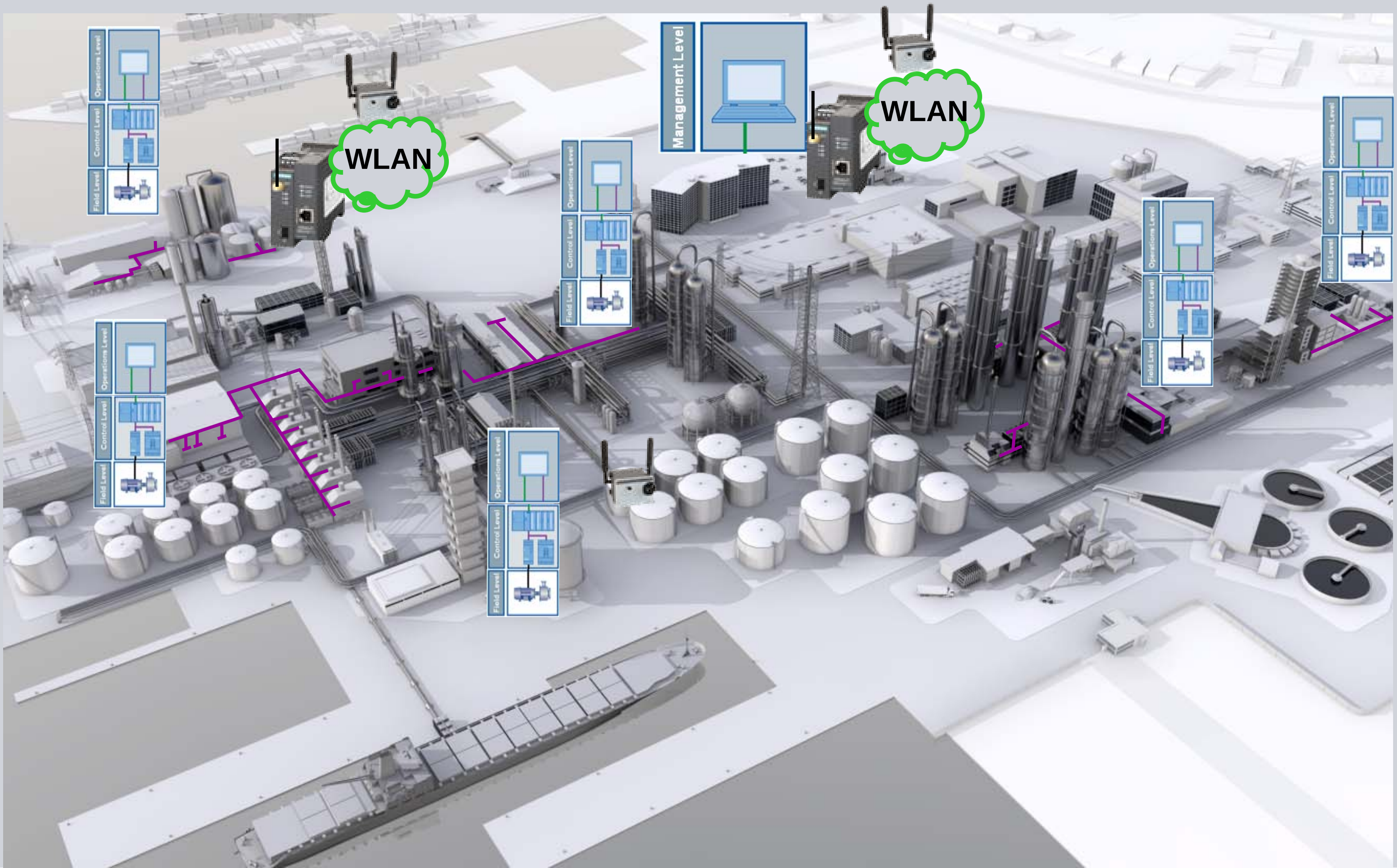
Copper Cable

Fieldbus

Ethernet



Architecture For Energy Management (Process)



Q&A – Power Management Solutions

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