

# Power Compensation

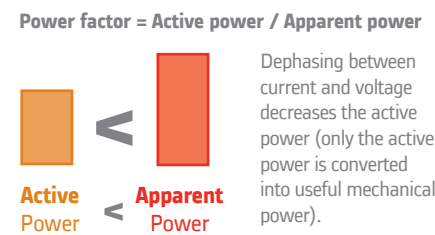
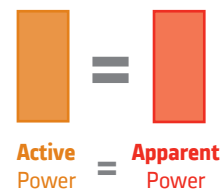
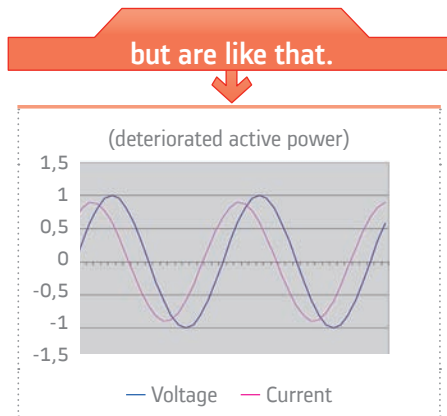
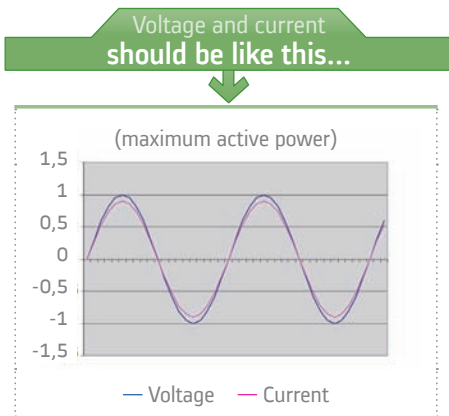
## Why do we need Power Compensation ?



### Power factor correction

Connected equipment (transformers, motors, air-conditioning, refrigerators, etc.) cause a phase angle between current and voltage. When the current is phase-shifted, it takes more current to deliver the same amount of active power.

« Power Quality saves money »



**Impact of reactive power**

- Transmission equipment has to be sized for the apparent power, yet only active power is useful
- Increased losses in the network
- You pay for apparent power but use active power (higher electricity bill)
- Penalty fees to customers with a low power factor (example < 0.95)

**Who**

- Power consumers, network operators, power supplier, power industry, hospitals, offices, public buildings, factories

**Solution**

- The power factor of a facility can be improved by installing capacitor banks

**Customer Benefits**

- Money Savings
- More power
- Less CO<sub>2</sub>
- A range of products based on field-proven experience

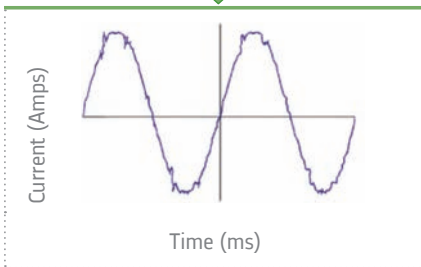
# Why do we need Power Compensation?

## Harmonic filtering

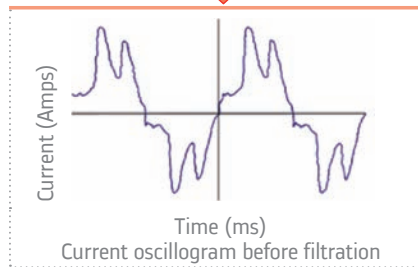
Variable speed drives (process industries, lifts, air conditioning pumps, etc.),

uninterruptible power supplies for computers, electronic equipment, etc. distort the current (introduce harmonics).

Current  
should be like this...



but is like that.



### Impact of harmonics on transmission / distribution equipment

- Additional losses (paid for by the end user)
- Heating in power cables
- Audible noise (transformers)

### Impact of harmonics on equipment connected

- Decreased machine efficiency and lifetime
- Costly process shutdowns
- Disturbed electronic equipment (computers, telephones)

### Who

- Power consumers, network operators, power supplier, power industry

### Solution

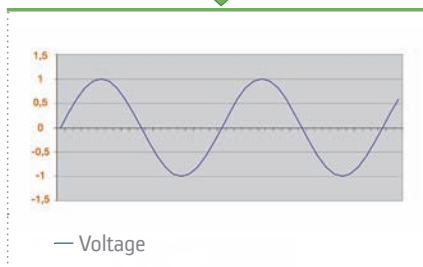
- Harmonics can be filtered through a combination of reactors and capacitors (passive filtering) or by injecting the exact opposite of the harmonics detected (active filter) into the network



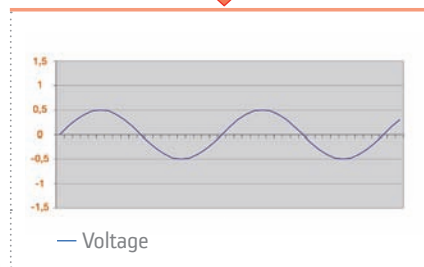
## Series Compensation

Long overhead lines cause the voltage to drop along the line. More current is needed to deliver the same power.

Voltage  
should be like this...



but is like that.



### Impact

- Decreased useful power
- Additional losses (network power losses are proportional to the square of the current)
- Reduced transmission capacity of the overhead line

### Who

- Transmission utilities

### Solution

- Voltage could be increased with the help of capacitor banks connected in series



### Main Advantages

- Today, Alstom Grid is the only international company to provide both air-core reactors and capacitors, the key elements for medium and high voltage reactive power compensation solutions
- We analyze the electrical installation of our customers (industries or utilities) to propose and supply the most suitable compensation solution
- Complete solutions have been designed and manufactured by our Tampere (Finland) unit for more than 50 years (Nokian Capacitors factory acquired by Alstom Grid in January 2008). We currently carry out this activity also in Brazil, Mexico and China

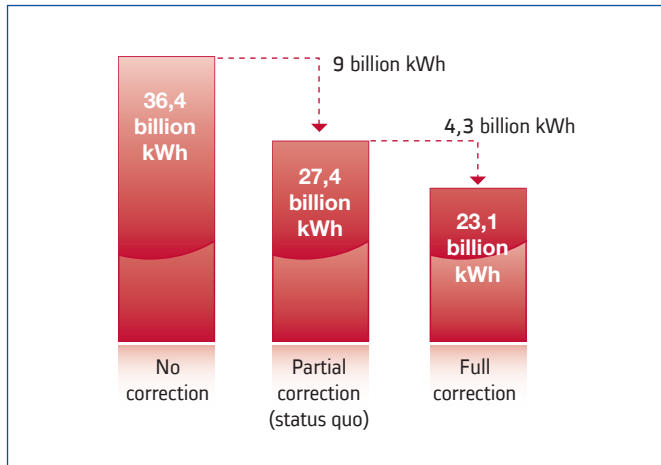


## « Power Quality saves money »

### Benefits of power factor correction

#### German example

By decreasing the electrical losses in the transmission and distribution networks, and hence reducing the emissions of CO<sub>2</sub>, this technology is making an active contribution to reducing global warming.



Current-dependent network losses (1999 values)

### Benefits of power factor correction

- Power factor correction reduced network losses in Germany in 1999 by 9 billion kWh (5.1 million ton of CO<sub>2</sub>)
- With the maximum possible use of power factor correction, there is the potential for a further reduction in network losses of 4.3 billion kWh
- An additional improvement can be obtained by harmonic filtering, avoiding harmonic currents flowing in the network

Source: German electrical and electronic manufacturers' association – September 2003

### Power Compensation brings

#### Economic benefits

- Saving the costs of reactive power
- Additional savings through reduced active power losses
- Reduction in investment cost



Return on investment is generally below 18 months.

#### Environmental benefits

- **Reduced CO<sub>2</sub> emissions**  
Customers see environmental benefits through energy savings and more efficient power systems



By saving millions of tons of CO<sub>2</sub>, power compensation makes an active contribution to protecting the environment