ENERGY EFFICIENCY IN FLOUR MILLS
Main Cost Factors in the Flour Mill

- Raw Material (Wheat)
- Electricity
- Water, Distribution, Marketing, etc
- Labor Cost (Staff)
Main Cost Factors of Flour Mill

The largest operating cost is raw material. Then, the electricity cost in running of the flour mill.

- Raw Material: 78%
- Electricity Cost: 3-4%

Electricity Price is changing country to country.
Electricity consumption (Billion KWH)

As a demand is increasing faster than the supply.

Today = Almost 20 billion Megawatt

|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|

Source: CIA World Factbook
Electric usage is increasing simultaneously with grain demand and electricity cost is increasing too. For that reason energy efficiency is getting more crucial.
Developing countries will need more electricity to produce flour. For that reason energy efficiency is critical for millers especially in these countries.
Total Electricity Consumption of All Flour Mills in the World versus Total World electricity Consumption

19.540 billion KWH

37.5 billion KWH

0.2%

We did not consider Maize and Rice in this study.
Energy Efficiency Analysis can be divided into 3 categories:

1. Operational
2. Product Quality and Environment
3. Maintenance and Control
Operational Solutions for Energy Efficiency

- Electro-mechanical solutions
- Technological solutions
Some of Electro-Mechanical Solutions for Higher Energy Efficiency

- High Efficiency Motor
- Variable Speed Drives (Inverter)
- Single Motor in Double Deck Roller Mill
Some Technological Solutions for Higher Energy Efficiency

- Optimization of flow chart with good diagramme and high quality and reliable machines – no need more machines. Efficient designing of pneumatic conveying and aspiration.

- High standard parts of the machines- bearings, rolls, belts and high quality electrical parts

- Maximize the efficiency of the operations, working full capacity all the time. For that you need high quality and reliable machines.
1) New and special energy efficiency motors IEC NORM IE3 
   PREMIUM EFFICIENCY MOTORS (this motors have even higher 
   efficiency than FF1 type motors)

2) Single motors in two passages in double deck roller mills

3) Inverter to drive blower

4) Variable frequency drive on high pressure fan motors and 
   compressors
Product Quality and Climatic Effect on Energy Efficiency

Product Quality

- Wheat Quality
- Impurities Ratio
- Optimum capacity utilization

Climatic

- Temperature
- Altitude

( High temp. or high altitude means less density of air means need more volume of air )
Maintanance and Control on Energy Efficiency

- Regular maintenance and cleaning
- General vibration control (mechanical balance application)
- Proper alignment in the machines
- On time Lubrication to minimize friction loss
- Periodic Belts changing
- Parallelism of the pulleys to each other
- Tension of the belts
- Leak prevention
The cost breakdown of operating the mill and the electricity costs are shown in the graph.

- **Electricity**: 36%
- **Labor**: 20%
- **Packing**: 15%
- **Purchasing**: 14%
- **Maintenance**: 8%
- **Quality Control**: 3%
## Energy Consumption in the mill sections

<table>
<thead>
<tr>
<th>UNITS</th>
<th>ELECTRICITY</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTAKE SECTION</td>
<td></td>
<td>0.4%</td>
</tr>
<tr>
<td>CLEANING SECTION</td>
<td></td>
<td>7.7%</td>
</tr>
<tr>
<td>SECOND CLEANING SECTION</td>
<td></td>
<td>3.0%</td>
</tr>
<tr>
<td>MILLING SECTION</td>
<td></td>
<td>10.8%</td>
</tr>
<tr>
<td>Roller Mill</td>
<td></td>
<td>49.6%</td>
</tr>
<tr>
<td>P. Fan</td>
<td></td>
<td>17.1%</td>
</tr>
<tr>
<td>FLOUR PACKING SECTION</td>
<td></td>
<td>10.5%</td>
</tr>
<tr>
<td>BRAN PACKING SECTION</td>
<td></td>
<td>1.0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.0%</strong></td>
<td></td>
</tr>
</tbody>
</table>

Do improvement in these areas.
<table>
<thead>
<tr>
<th>Motor Type</th>
<th>Efficiency Level</th>
<th>Motor Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>IE1 motor</td>
<td>Normal Motor</td>
<td>89.9%</td>
</tr>
<tr>
<td>IE2 motor</td>
<td>High Efficiency 2</td>
<td>91.6%</td>
</tr>
<tr>
<td>IE3 motor</td>
<td>High Efficiency 3</td>
<td>93.0%</td>
</tr>
</tbody>
</table>
### Effect of High Efficiency Motors

<table>
<thead>
<tr>
<th>Power (KW)</th>
<th>IEC IE1 - standard</th>
<th>IEC IE3</th>
<th>DIFF %</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>88,50%</td>
<td>91,50%</td>
<td>3,0%</td>
</tr>
<tr>
<td>25</td>
<td>90,00%</td>
<td>93,50%</td>
<td>3,5%</td>
</tr>
<tr>
<td>50</td>
<td>92,50%</td>
<td>94,20%</td>
<td>1,7%</td>
</tr>
<tr>
<td>75</td>
<td>92,70%</td>
<td>95,00%</td>
<td>2,3%</td>
</tr>
<tr>
<td>100</td>
<td>93,00%</td>
<td>95,50%</td>
<td>2,5%</td>
</tr>
<tr>
<td>150</td>
<td>94,00%</td>
<td>96,00%</td>
<td>2,0%</td>
</tr>
</tbody>
</table>

The table above illustrates the efficiency differences between IEC IE1-standard and IEC IE3 motors at various power levels. The diagram on the right side shows the efficiency curves for different motor standards, providing a visual representation of the performance improvement.
A **variable-frequency drive (VFD)** (also termed **adjustable-frequency drive**, **variable-speed drive**, **AC drive**, **micro drive** or **inverter drive**) is a type of adjustable speed drive used in electro mechanical drive systems to control AC motor speed and torque by varying motor input frequency and voltage.
Variable Speed Drives

If the VSD is used in a fan control application savings of up to 50% are possible. For example a fan running at 80% speed only uses 50% of the energy, compared to one running at full speed.

Source: RS component

Figure 1: Energy Savings with Speed Control
Variable Speed Drives

Total air moved \((L)\) depends on the speed \((n)\)
\[
m3/sec \quad L = f(n)
\]

Static pressure \((P)\) is proportional to the square of the speed \((n^2)\)
\[
\text{New/m}^2 \quad P = f(n^2)
\]

Required power \((N)\) is proportional to the cube of the speed \((n^3)\)
\[
\text{watt} \quad N = f(n^3)
\]

Summary, when 20% of the air is reduced, the fan speed is decreased at the same rate and the force used is reduced by 50%. \((0.8 \times 0.8 \times 0.8)\)

If the VSD is used in a fan control application savings of up to 50% are possible.
For example a fan running at 80% speed only uses 50% of the energy, compared to one running at full speed.
Effect of Inverter (Variable Speed Drives)

- $N(W)$
- $N_n$
- $N_i (N_n \times 0.8)$
- $Q(m^3/s)$
### The Effect of Efficiency Motor and Inverter

<table>
<thead>
<tr>
<th>NUMBER OF MOTORS</th>
<th>TOTAL KW</th>
<th>HIGH EFFICIENCY</th>
<th>% DIFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>280</td>
<td><strong>2483,12</strong></td>
<td>2430,0</td>
</tr>
<tr>
<td>0-10 KW</td>
<td>177</td>
<td>489,02</td>
<td>474,3</td>
</tr>
<tr>
<td>10-25 KW</td>
<td>94</td>
<td>1456,28</td>
<td>1424,2</td>
</tr>
<tr>
<td>25-50 KW</td>
<td>6</td>
<td>204,82</td>
<td>202,8</td>
</tr>
<tr>
<td>50 KW +</td>
<td>3</td>
<td>333</td>
<td>328,7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NUMBER OF BLOWER</th>
<th>TOTAL KW</th>
<th>AFTER INVERTER</th>
<th>% DIFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>75 Kw</td>
<td>1</td>
<td>75</td>
<td>71,25</td>
</tr>
<tr>
<td>30 kw</td>
<td>1</td>
<td>30</td>
<td>28,5</td>
</tr>
<tr>
<td>45 kw</td>
<td>1</td>
<td>45</td>
<td>42,75</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PNEUMATIC FAN</th>
<th>TOTAL KW</th>
<th>AFTER INVERTER</th>
<th>% DIFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>132</td>
<td>2</td>
<td>264</td>
<td>237,6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TOTAL BLOWER AND P.FAN</th>
<th>TOTAL KW</th>
<th>AFTER INVERTER</th>
<th>% DIFF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>414</td>
<td>380,1</td>
<td>-8,2%</td>
</tr>
</tbody>
</table>

600 Ton / day factory as reference
## BENEFIT of High Efficiency Motors

600 Ton / day factory as reference

<table>
<thead>
<tr>
<th>NUMBER OF MOTORS</th>
<th>TOTAL KW</th>
<th>YEARLY CONSUMPTION KWH</th>
<th>YEARLY COST USD</th>
<th>HIGH EFFICIENCY</th>
<th>YEARLY CONSUMPTION KWH</th>
<th>YEARLY COST USD</th>
<th>DIFFERENCE USD</th>
<th>PRICE DIF IE3-IE1</th>
<th>TOTAL DIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>280</td>
<td>2483.12</td>
<td></td>
<td>2430</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-10 KW</td>
<td>177</td>
<td>489.02</td>
<td>3.423.140</td>
<td>513.471</td>
<td>474.3</td>
<td>3.320.100</td>
<td>498.015</td>
<td>15.456</td>
<td>100</td>
</tr>
<tr>
<td>10-25 KW</td>
<td>94</td>
<td>1456.28</td>
<td>10.193.960</td>
<td>1.529.094</td>
<td>1405</td>
<td>9.835.000</td>
<td>1.475.250</td>
<td>53.844</td>
<td>125</td>
</tr>
<tr>
<td>25-50 KW</td>
<td>6</td>
<td>204.82</td>
<td>1.433.740</td>
<td>215.061</td>
<td>198</td>
<td>1.386.000</td>
<td>207.900</td>
<td>7.161</td>
<td>150</td>
</tr>
<tr>
<td>50 KW +</td>
<td>3</td>
<td>333</td>
<td>2.331.000</td>
<td>349.650</td>
<td>324</td>
<td>2.268.000</td>
<td>340.200</td>
<td>9.450</td>
<td>500</td>
</tr>
</tbody>
</table>

**BENEFIT IS ALMOST 86.000 USD**

**4,5 MONTHS RETURNING OF INVESTMENT**
This electrical consumption study is theoretical analysis. There could be +/- 5% differences in real consumption.
Conveying Equipment on Energy Efficiency

Bucket Elevators
Chain conveyors
Augers

- Prevent the friction
- On time preventive maintenance
- Don’t use when it is not required
- Using as full capacity
Preventive Maintenance

- Increased productivity
- Improved throughput
- High quality product
- Reduction in downtime
- Reduce costly replacements
- Reduce the need to repair
- Prevent damaged spouts

Preventative Maintenance = increased efficiency and energy efficiency

The Costs of Unplanned Maintenance
- Lost production
- Unbudgeted expense
- Unnecessary disruption
- Dependence on contractors
- Lost time
Periodic Maintenance

- Belts
- Pulleys
- Oil Changing
- Filter cleaning
- Spouting Control

Control for leakages and contamination.
In 2011, one mill in USA consumed 49 million KWh as total energy.

This Mill invested in having a wind turbine on their land. The project has the capacity to generate 50 Megawatts of electricity enough to supply approximately 12,000 household.
In 2011, one mill in USA consumed 49 million KWh as total energy.

The company installed solar panels at several of its facilities, including warehouse and the company’s headquarters. Studies have found that green roofs can reduce both summer cooling and winter energy needs by as much as 26 percent.
THANK YOU

Alapala