TOSHIBA

TOSHIBA INTERNATIONAL CORPORATION

Adjustable Speed Drive

Energy Applications

Douglas Reichardt –Toshiba St. Louis

Industries and Applications

Industries Served:

- Chemical
- City Municipality
- Coal Mine
- Food
- Industrial Marine
- Irrigation
- Paper
- Petroleum
- Power Plant
- Water/Wastewater

Applications (Pumps):

- Bilge
- Disc Flow
- Grinder
- Mixed-Flow Impeller
- Recessed Impeller
- Slurry
- Vertical Multi-Stage
- Vertical Turbine
- Water

Objectives

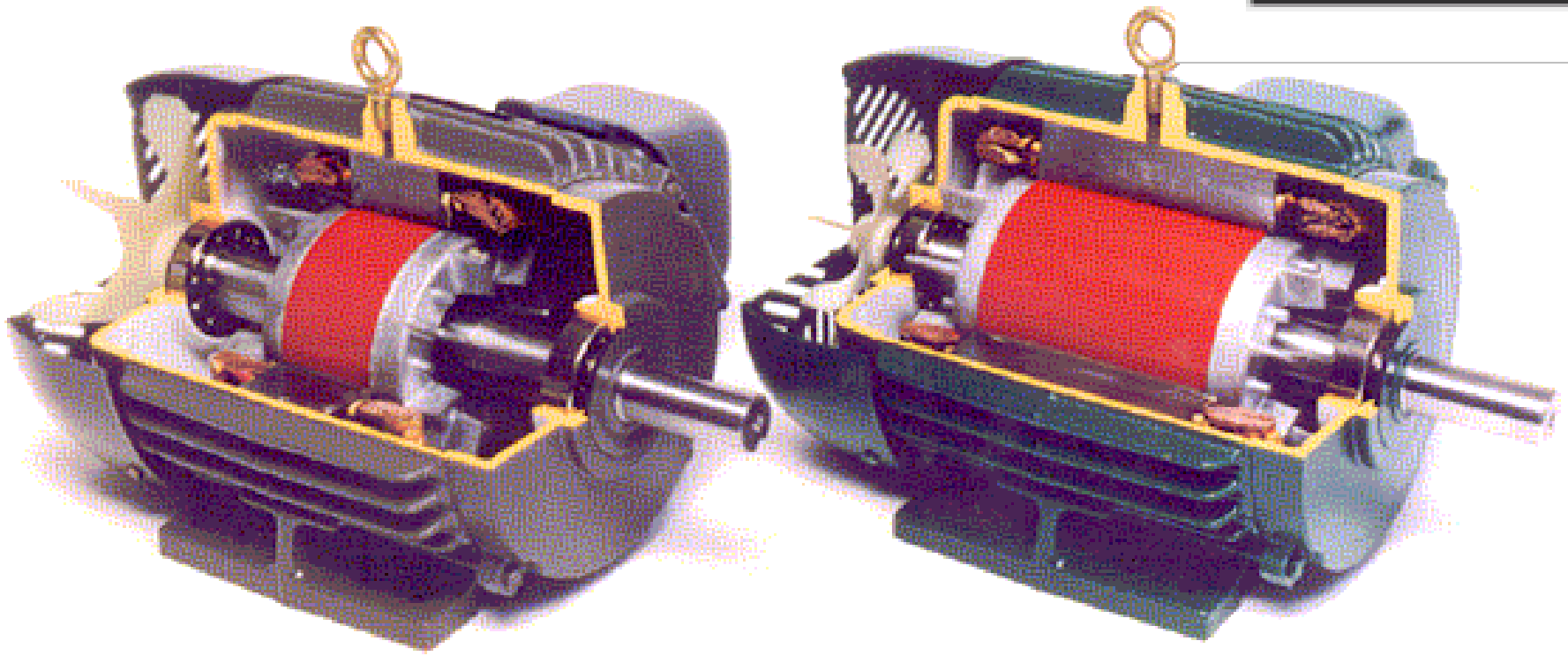
Motor design and applications

- Understand the limitations of AC Motors and different starting methods
- Relate the requirements of an induction motor to an ASDs design

ASD Applications

- Different applications for drives and why they are used
- Energy savings using ASDs
- Some of the concerns with using ASDs and how to avoid issues

NEMA Premium™



Standard

Toshiba EQP Global SD

Energy Independence and Security Act of 2007

Limitation with Full Voltage Starters

Where:

A = Maximum number of starts per hour.

B = Maximum product of starts per hour times load Wk^2.

C = Minimum rest or off time in seconds between starts.

Example:

25 hp, 4 pole, load Wk^2 = 50

From Table, A = 8.8,

B = 122. Starts per hour =122/50

= 2.44 Starts per hour

HP	2 Pole			4 Pole			6 Pole		
	A	B	C	A	B	C	A	B	C
5	8.1	5.7	83	16.3	27	42	18.4	71	37
7.5	7	8.3	88	13.9	39	44	15.8	104	39
10	6.2	11	92	12.5	51	46	14.2	137	41
15	5.4	16	100	10.7	75	50	12.1	200	44
20	4.8	21	110	9.6	99	55	10.9	262	48
25	4.4	26	115	8.8	122	58	10	324	51

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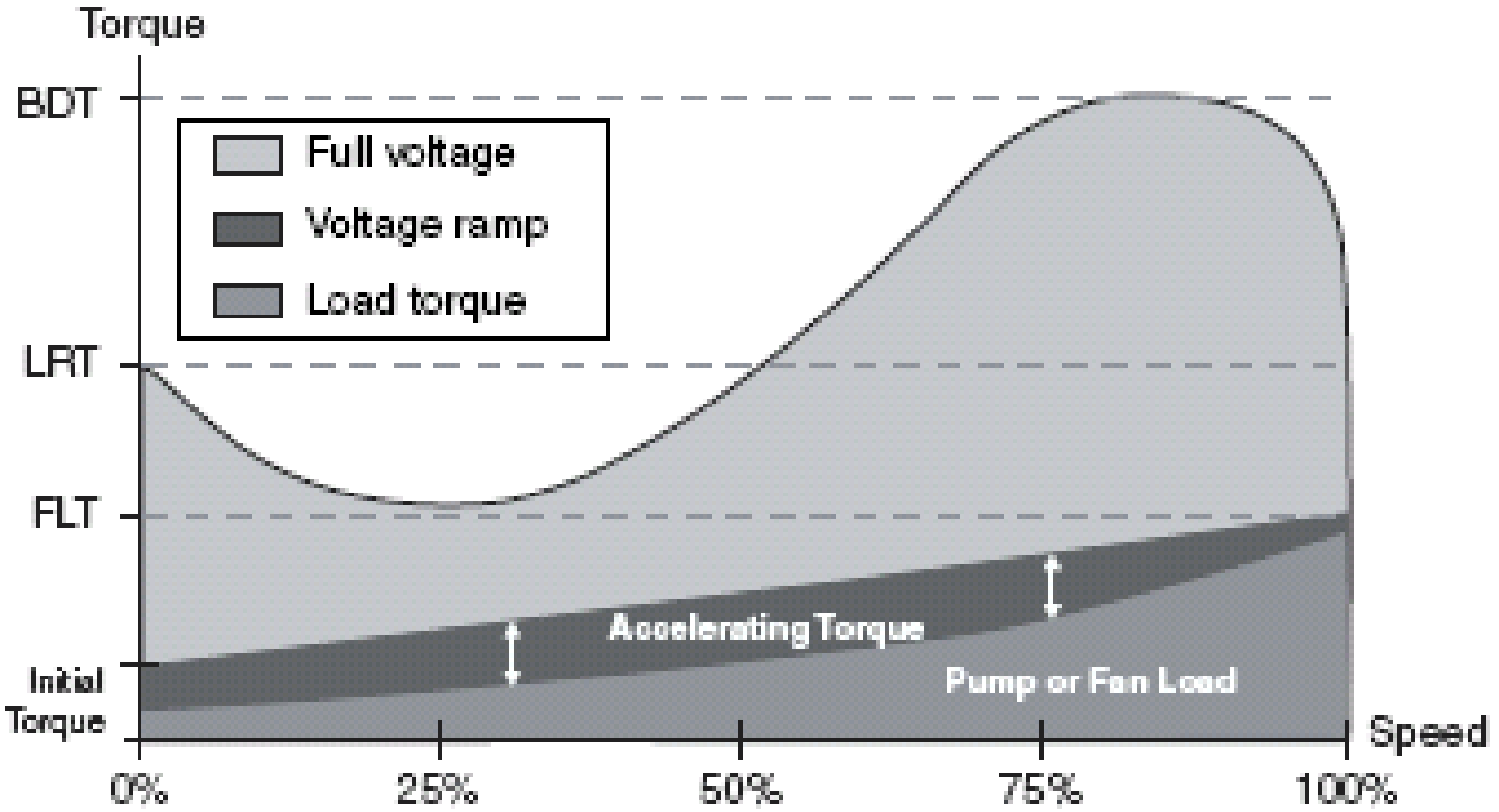
Reduced Voltage Solid State Starter Speed Torque Curve (No Energy Savings)



What Is an Inverter Duty Motor?

Any 3 phase motor will work with an inverter (ASD), does that mean that it is inverter duty?

1) An inverter duty motor should meet NEMA MG1 Part 31 for inverter duty wire withstand ratings for peak voltage spikes.

2) An inverter duty motor should have a speed range listed for VT and CT on the nameplate. Some motor manufacturers are only 2:1 of 4:1.- A separate powered blower may be required on one manufacturer's motor, but not on another.

3) An inverter duty motor should have insulated bearings on both ends, especially on large 400 frame motors and larger. Smaller HP motors are less common to have these issues.

4) Try to match motor and drive manufacturers when possible for packaged warranties, especially when they cover bearings.

Adjustable Speed Drive Facts

ASD's offer two economic benefits to end users

- Enhanced production process control
- Energy savings by matching motor speed with load

Fans & pumps are excellent retrofit candidates

- These represent 18-25% of total installed base

More ASD Facts

ASD's can match the speed of an AC motor to the requirements of a fluctuating load

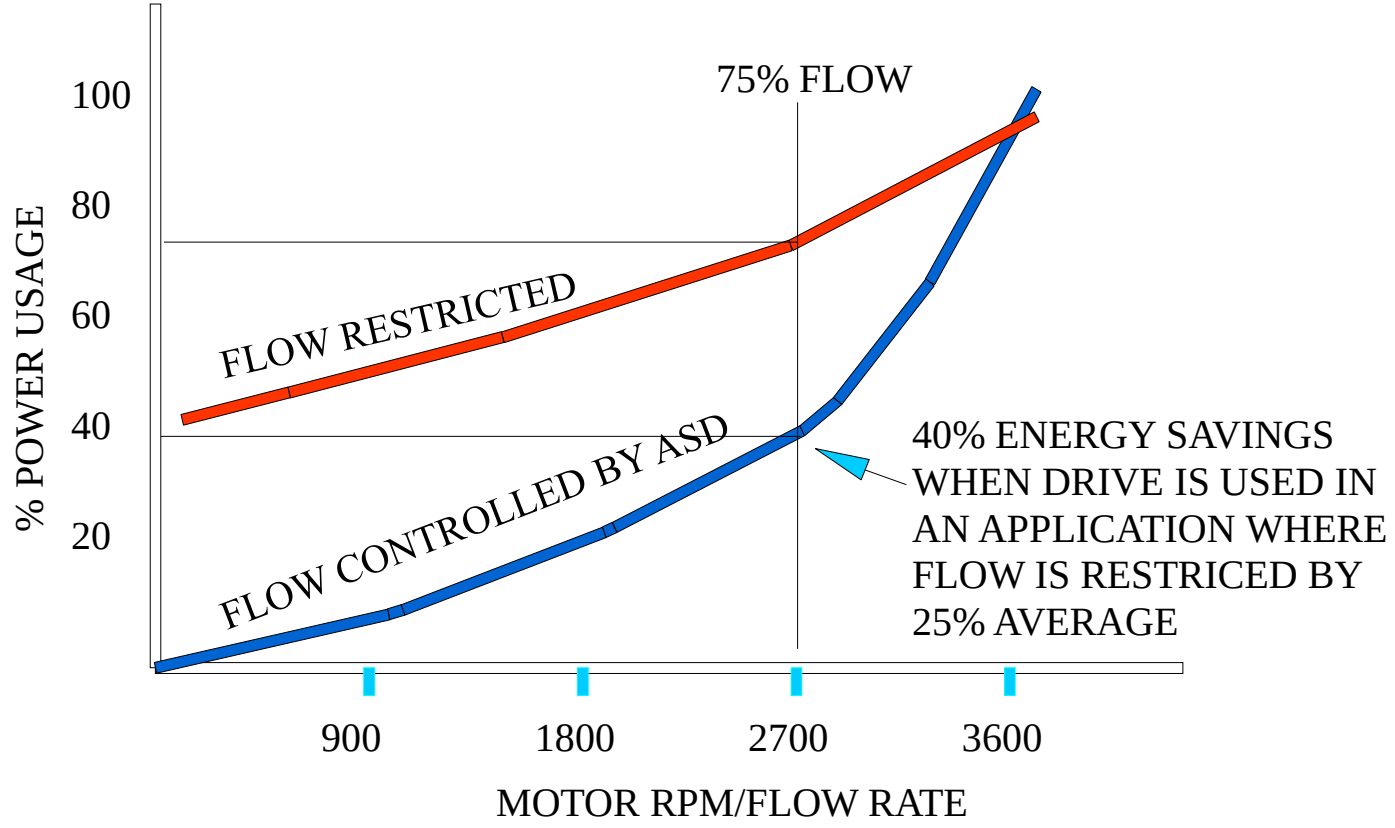
For centrifugal loads (most applications) power consumption is equal to the cube of the speed

- (Affinity Laws)

The savings available for matching system requirements is very high

Affinity Laws

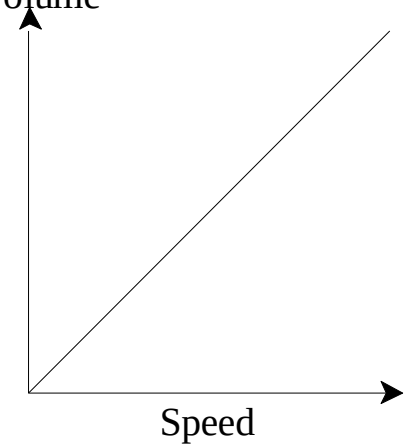
As the speed of a centrifugal load decreases, the horsepower requirement will decrease with the cube of the speed while flow is proportional to speed.



AFFINITY LAWS

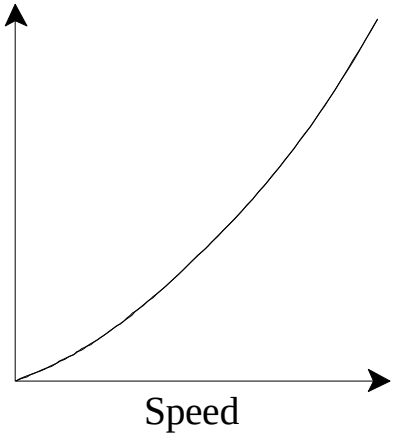
Centrifugal Loads [Fans, Pumps (no static head), etc.]

Flow
Volume



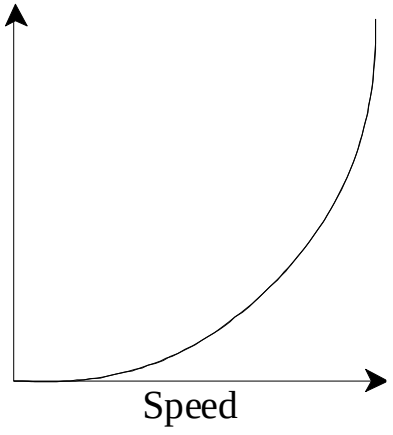
$$\frac{Q_2}{Q_1} = \frac{N_2}{N_1}$$

Pressure
(Head)



$$\frac{P_2}{P_1} = \left(\frac{N_2}{N_1}\right)^2$$

Power



$$\frac{HP_2}{HP_1} = \left(\frac{N_2}{N_1}\right)^3$$

Where: N = Fan or Pump Speed

Q = Flow (CFM)

P = Pressure (Static inches of water or feet of head)

HP = Horsepower

Numeric Description of the Affinity Laws

Speed	Flow	Required Power
100%	100%	100%
90%	90%	73%
80%	80%	50%
70%	70%	34%
60%	60%	22%
50%	50%	13%
40%	40%	6%
30%	30%	3%

Loads and Load Characteristics

Three Basic Types of Loads

- Constant Torque
  - The load is essentially the same throughout the speed range.
- Variable Torque
  - The load requirements increase with an increase in speed
- Constant Horsepower
  - The load decreases as speed increases

Loads and Load Characteristics

Constant Torque Loads

- the torque requirement is the same regardless of speed
- horsepower increases linearly with speed
- Lifting Equipment, Conveyors, Rolling Mills, Extruders, and Planers are examples of constant torque loads.

Torque = Constant

Hp = Speed

Loads and Load Characteristics

Variable Torque Loads

- the torque requirement increases as the square of the speed
- the horsepower requirement increases with the cube of the speed
- Fans, Blowers, Centrifugal Pumps, and Centrifuges are examples of this type of equipment

Torque = Speed Squared (N^2)

HP = Speed Cubed (N^3)

Loads and Load Characteristics

Constant Horsepower

- Torque requirements decrease by the inverse of the increase in speed
- Horsepower requirements are constant regardless of speed
- Winders, Rotary Cutting Equipment, De-reelers, and Lathes are examples of constant horsepower equipment

Torque = Speed Squared (N^2)

Horsepower = Constant

CT vs. VT

Speed Range

Starting/Running Torque

Inertia Accel/Decel Time

Horsepower/Voltage/**Current**

Harmonics

Distance

Environmental Considerations

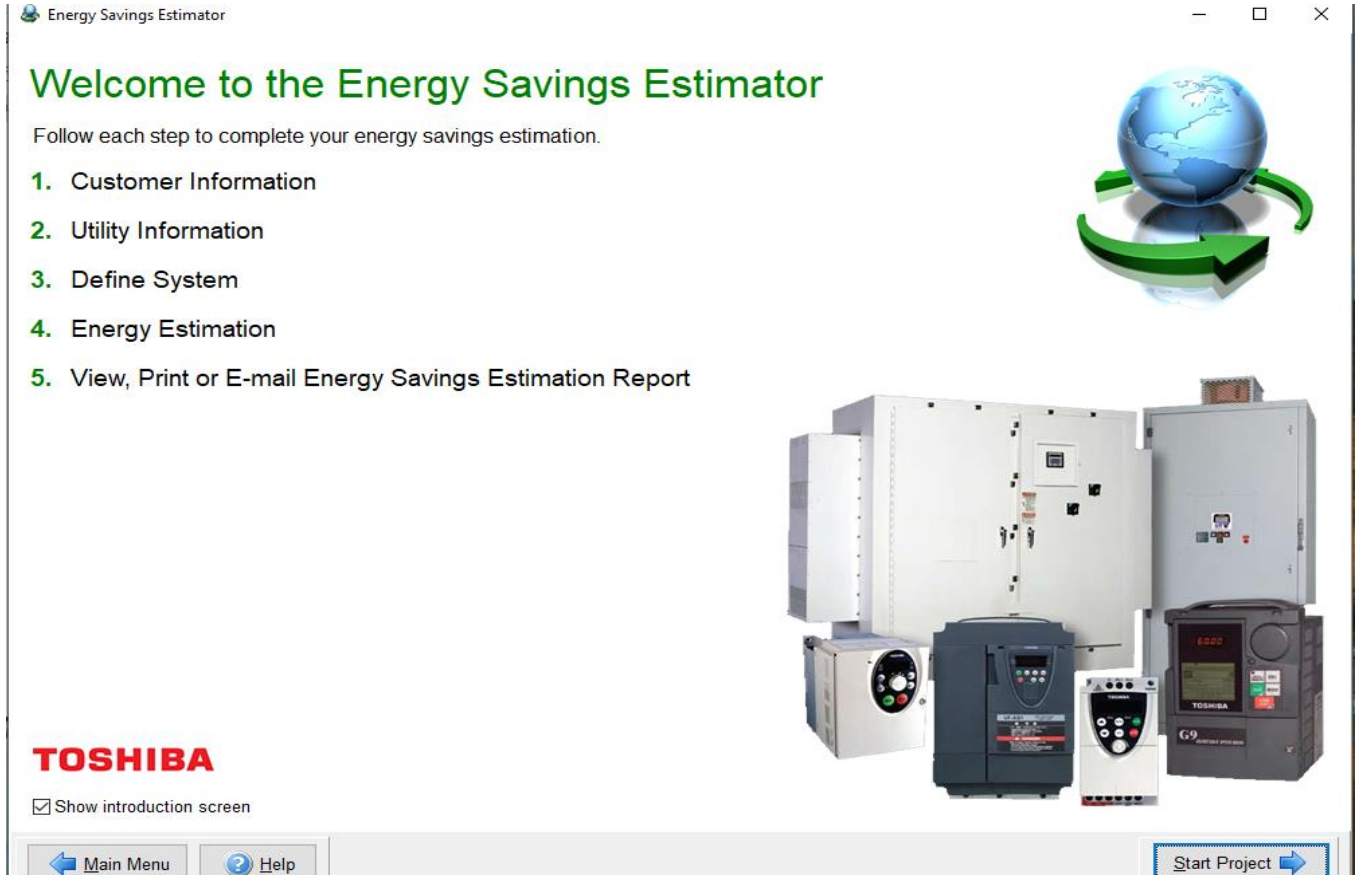
Speed Regulation

Input/Output Power Cables

Using reactors and filters

Device	Installation	Function
AC Line Reactor	Prior to drive	• Mitigate voltage surges • Reduce input voltage • Reduce drive harmonics • Improvement of power factor
Harmonic Filter	Prior to drive	• Reduces harmonic content of drive
DC Link Reactor	Across DC bus	• Reduces DC bus ripple • Adds system impedance
Output Load Reactor	Between drive and motor	• Mitigates output transients
dV/dt Long Lead Filter	Between drive and motor	• Reduces common mode voltage spikes that can damage motor • Reduces crosstalk between output leads • Used for lead lengths between 200-1500ft
Sinewave Filter	Between drive and motor	• Use with extended lead lengths • Tuned to drive carrier frequency

Energy Savings Software



Reduced Energy Consumption

Energy Savings

- Help reduce energy consumption when driving variable torque load.

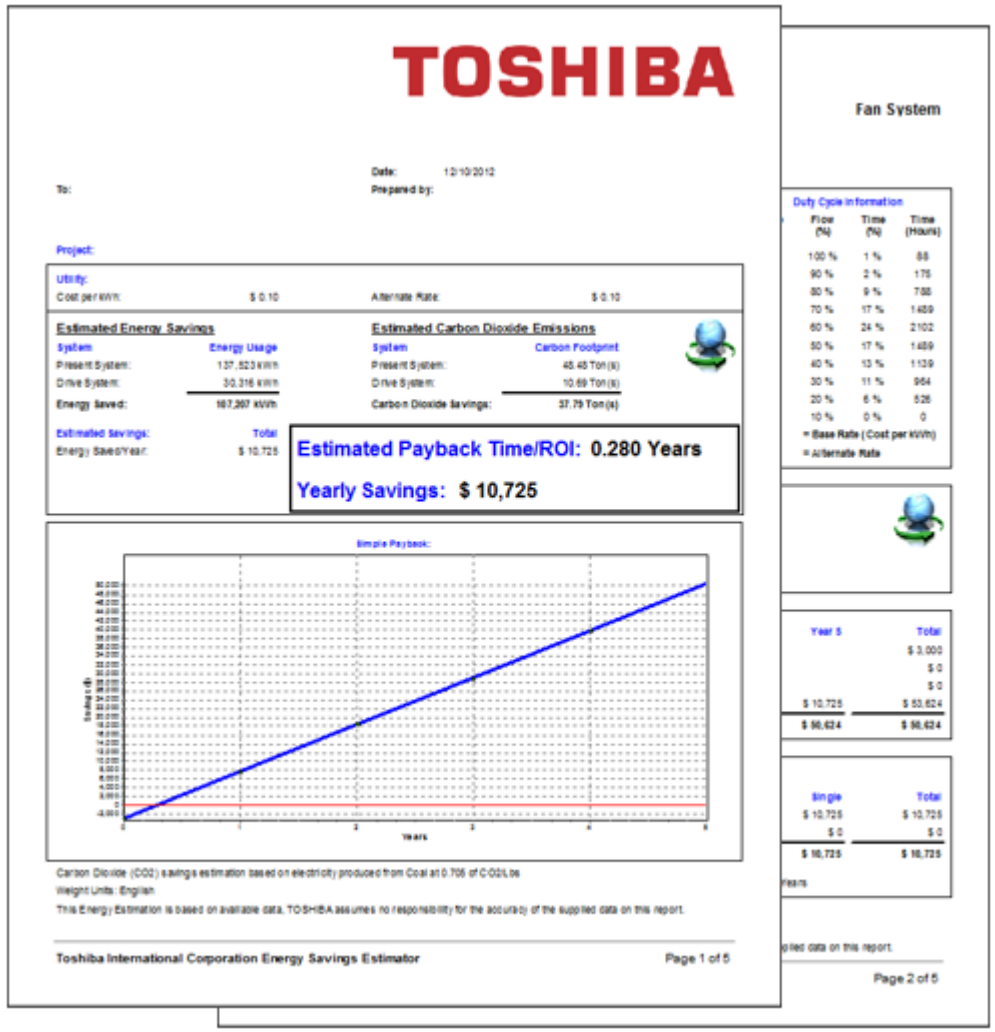
Energy Savings Tool

- Cost Savings Estimator
  - Easy
  - Simple 5 step process
  - Free

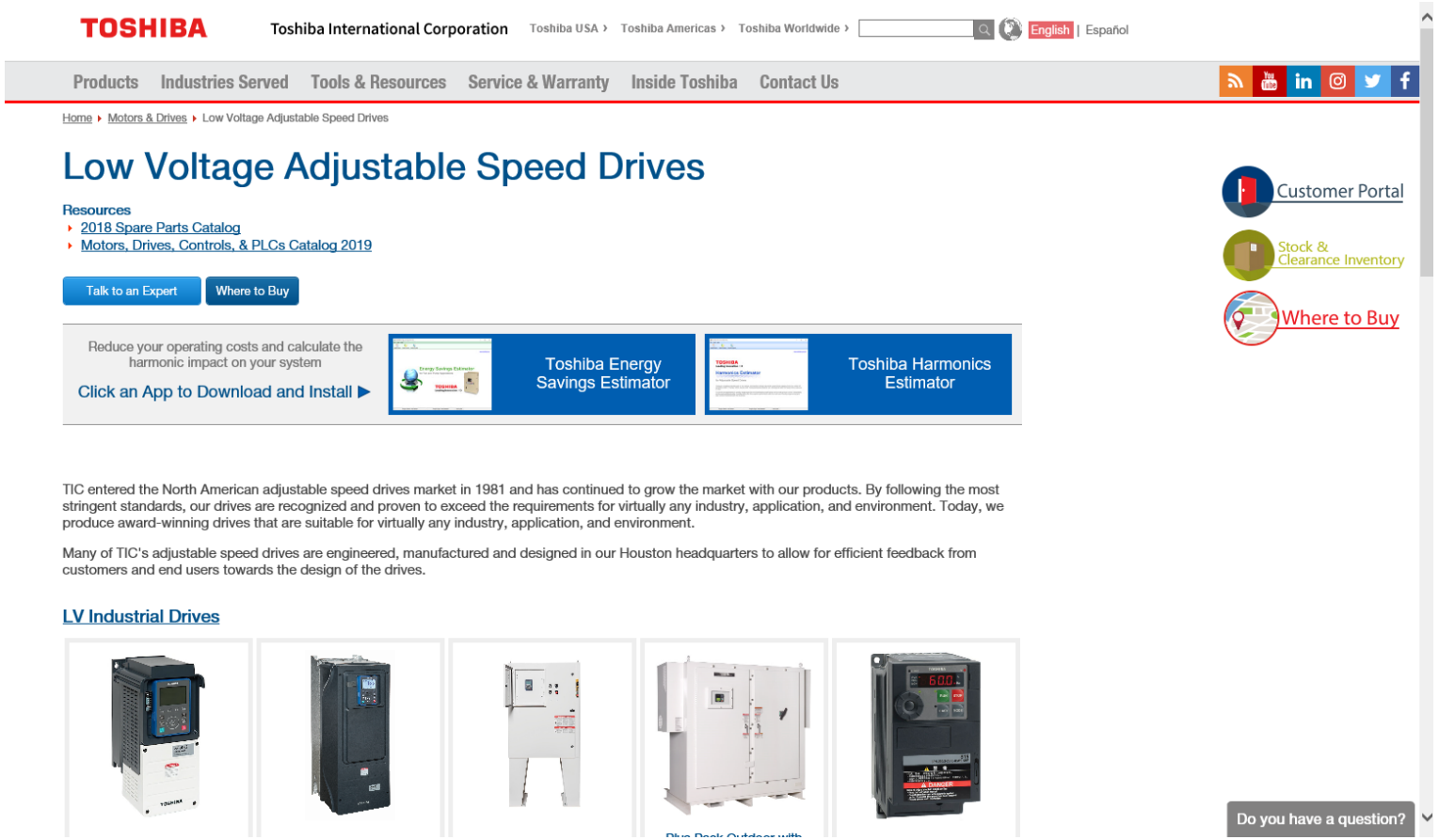
Energy Savings Estimator Report

Highlights ASD Energy Savings and Pollution Reduction Analysis

- Estimated Payback
- Yearly Savings
- Energy Savings
- Emission
- Comparisons
- And more



https://www.toshiba.com/tic/motors-drives/low-voltage-adjustable-speed-drives



Now available on-line

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