



**The Canadian**

***LCD***

***Market: 2001***

***An Independent White Paper Sponsored by:***



**Evans Research Corporation – January 2002**

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## Executive Summary

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The landscape of the Canadian monitor market is constantly in a state of change and 2001 was no exception. The market is certainly experiencing some major shifts, the most significant evolution is the **increase in popularity of liquid crystal display (LCD) technology.**

The Canadian monitor market is largely comprised of cathode ray tube (CRT) monitors and LCD products. **CRT products have traditionally represented the lion's share of the market, yet 2001 was a year where LCD products sharply increased unit shipments and overall monitor market share.**

**LCD** technology was introduced with notebook personal computers: **sleek, smooth compact, attractive, lightweight and functional.** Not only a space saver, **LCD units are easy on the eyes, environmentally friendly and energy efficient.**

While there are many attractive features of **LCD technology**, for businesses the most frequently asked question is **"How much will this cost?"** A breakdown of the related costs will be provided in this report, including:

- ◆ **Electrical Costs: Power Consumption / Environmental Concerns / Energy Costs**
- ◆ **Heat Dispersion: Cooling Costs**
- ◆ **Employee Benefit Costs**
- ◆ **Immediate Benefits**

Some key facts regarding LCD technology:

- ◆ **LCD units consume 33% less power than CRT monitors**
- ◆ **LCD units produce 37% less heat than CRT monitors**
- ◆ **LCD technology is best of class, including large, clear flat pictures with clear visibility and compact form factors**
- ◆ **LCD technology is more affordable than ever before**

In today's competitive business environment, business managers are faced with a plethora of issues. Strategic to the success of any business is the constant examination of productivity levels (and how to increase them) coupled with the need to continually reduce costs. This report looks at three Canadian examples where organizations made the switch to LCD technology from the older and more recognized CRT products. The current trends of the Canadian monitor market illustrate a definite pattern going forth, and that pattern focuses upon the *growth of the LCD market*. **Declining unit prices, lower radiation output, diminishing air conditioning charges, user-friendly technology and increasingly energy efficient units** all contribute to the success of the marketplace.

## Introduction

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The Canadian monitor market is in a state of evolution. The variety of monitor technologies available in the market is multiplying. Not just available, but increasingly affordable to the general consumer.

*LCD Technology:* The major advance in the marketplace in 2001 was the **dramatic price declines on liquid crystal display (LCD) units**. The attractive pricing certainly widens the market for the technology.

*Affordable* As such, monitor vendor LG Electronics (LGE) Canada commissioned Evans Research Corporation (ERC) to conduct an independent white paper on the Canadian LCD market.

*Compelling*

*Available*

Attractive features for LCD technology include:

**Low power consumption**  
**Low heat output**  
**Low radiation output**  
**Compact & light form factor**  
**Clear, bright & large viewing area**

**Low power consumption, heat output, radiation output and a large viewing area are all found in LCDs in comparison to standard CRT (cathode ray tube) units.** The combination of the five core features translates into a **low cost of ownership** for both the corporate and consumer user; an attractive feature as businesses aim to reduce costs and consumers strive to tighten pocketbooks.

This report will look at:

- ◆ The three main PC visual display options: CRT, LCD and Plasma
- ◆ The size of the monitor market (CRT & LCD combined)
- ◆ Major vendors and market share
- ◆ Benefits of LCD monitors
- ◆ Case study applications
- ◆ Success factors propelling acceptance of technology
- ◆ Future of the market.

LCD monitor technology has never been more compelling, nor has it ever been more affordable to implement these products into the current IT environment.

## Flat Panel Display (FPD) Technology

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*Types of Flat Monitors:* **Flat panel display (FPD) technology** refers to **monitors with a flat screen**. That is, a screen without a curve. Within the generalized term, there are several different types of technology: **liquid crystal display (LCD)**, **plasma display and flat cathode ray tube (CRT)**. The most distinguishable flat screen technology is liquid crystal display technology, which is currently gaining market share within the Canadian monitor market.

*Flat CRT's*

*LCD*

*Plasma Displays*

Since LCD's inception into the Canadian market, **each year concludes with more units shipped than the one previous**. Liquid crystal refers to the components of the actual display. The units can be either passive matrix<sup>1</sup> or active matrix. LCD is also referred to as a **Thin-Film Transitory Display, or TFT**, and it is comprised of pixels. Each active display has a transistor located in the middle of each pixel intersection. The current can be switched on and off for each pixel, resulting in a quick refresh time. A quick refresh time results in less eyestrain for the user and a clearer picture. LCD models are also thin and light compared to the bulky CRT models. LCD products are also available with touchscreen capabilities.

A monitor technology gaining popularity is **plasma display**. Plasma currently rests in the **high priced category**, catering towards a **specialty market**. Gas plasma technology, as with CRT, works on the premise of emitting light. The picture has extremely high quality and the units are thin. They are available in larger sizes, and remain expensive.

Another emerging technology emerging falls within the CRT category: **flat CRT** products. While this is becoming more and more prevalent, CRT products do not have the health and the environmental, nor the ownership cost benefits of LCD technology. The picture quality is also not quite as good. However, of the three types of FPDs, flat CRTs carry the least expensive price tag.

**This report is based upon LCD technology, focusing upon the abundant growth experienced by the products thus far, and the tremendous opportunities ahead.**

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<sup>1</sup> See Glossary for definition of terms.

## The Canadian LCD & CRT Monitor Market Forecast: 2000 - 2003

### Canadian Monitor Market

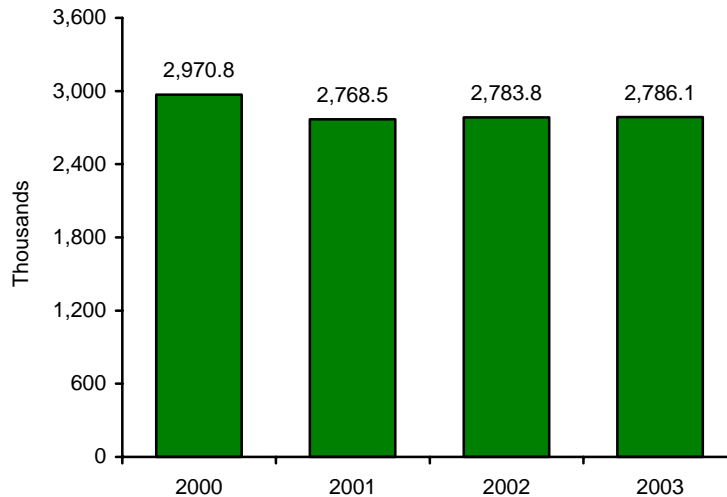
The Canadian monitor market is largely comprised of both CRT monitors and LCD units. **CRT products have traditionally represented the lion's share of the market.** While vendors continue to ship more CRTs versus LCDs, **2001 was a year where LCD products sharply increased unit shipments and overall monitor market share.**

### CRT (Cathode Ray Tube)

CRT monitors continue to dominate the overall display market in Canada. The total market (CRT and LCD products) is expected to conclude 2001 with approximately 2,768,500 units and \$941.1<sup>2</sup> million in revenues. Both numbers are down slightly from 2000.

### LCD (Liquid Crystal Displays)

**Exhibit 1: Total Monitor (CRT and LCD) Shipment Forecast<sup>3</sup>:  
2000 - 2003**



<sup>2</sup> Based upon average retail pricing.

<sup>3</sup> Preliminary data from Evans Research Corporation's *Segment Update Program – The Monitor Market in Canada*.

LCD units have been steadily increasing market share in the overall monitor market quarter over quarter, throughout the year. Look for continued increases over the next few years.

**Exhibit 2: CRT vs. LCD Monitor Shipment<sup>4</sup> Percentages:  
Q1 2001 - Q3 2001**

*LCD units are gaining ground, quarter by quarter, on the CRT segment.*

<i>Percentages</i>	<b>Q1 2001</b>	<b>Q2 2001</b>	<b>Q3 2001</b>	<b>YTD<sup>5</sup> Q3 2001</b>
<b>CRT Units</b>	97.6%	95.1%	93.5%	95.5%
<b>LCD Units</b>	2.4%	4.9%	6.5%	4.5%
<b>Total</b>	100.0%	100.0%	100.0%	100.0%

As found overall in the IT industry in Canada, forecasted growth for the monitor market is flat. Monitor shipments will mirror the desktop PC market in that regard<sup>6</sup>.

<sup>4</sup> Please note that some totals may not add to 100%, due to rounding.

<sup>5</sup> YTD stands for Year to date

<sup>6</sup> Canadian Desktop PC market comments from Evans Research Corporation's *Segment Update Program: The PC Market in Canada*.

## A Comparison of CRT, LCD and Plasma Display Technologies

A comparison of the key differentiators between CRT, LCD and Plasma Display technology is listed below:

	<b>CRT Technology</b>	<b>LCD Technology</b>	<b>Plasma Display</b>
<b>Definitions</b>	<ul style="list-style-type: none"> <li>◆ A cathode ray tube (CRT) is a specialized vacuum tube in which images are produced when an electron beam strikes a phosphorescent surface.</li> <li>◆ CRT colour monitors have three electron guns, one red, one green and one blue, which combined produce three overlapping images.</li> </ul>	<ul style="list-style-type: none"> <li>◆ LCD (liquid crystal display) technology is comprised of either a passive matrix or an active matrix display grid. The current in an active matrix display can be switched on and off frequently (quick screen refresh time) Some passive matrix-LCDs have dual scanning capability (double the scan capability in same amount of time as the original technology).</li> </ul>	<ul style="list-style-type: none"> <li>◆ A plasma display is a computer video display in which each pixel on the screen is illuminated by a tiny bit of plasma or charged gas. Plasma displays are thinner than CRTs and brighter than LCDs. Sometimes marketed as "thin-panel" displays; plasma units can be used to display either analog video signals or modes of digital computer input.</li> </ul>
<b>Physical Size</b>	<ul style="list-style-type: none"> <li>◆ Bulky and heavy, due to tube.</li> </ul>	<ul style="list-style-type: none"> <li>◆ Compact and lightweight.</li> <li>◆ Very thin screen. Ensures maximum space efficiency.</li> <li>◆ Able to adjust screen for vertical or horizontal viewing (in most cases)</li> </ul>	<ul style="list-style-type: none"> <li>◆ Thin and compact. Some models are only 3-inches wide and are most commonly used as televisions</li> </ul>
<b>Display Size</b>	<ul style="list-style-type: none"> <li>◆ A 17-inch CRT has the viewing area of approximately 16-inches (325.4 * 244.1 mm)<sup>7</sup></li> <li>◆ Weight – 22.5 kg Gross</li> </ul>	<ul style="list-style-type: none"> <li>◆ A 15-inch LCD typically has a comparable viewing size of a 17-inch CRT unit (307 * 230 mm)<sup>8</sup></li> <li>◆ Weight – 7.1 kg Gross</li> </ul>	<ul style="list-style-type: none"> <li>◆ Larger than both CRTs and LCDs</li> <li>◆ Ranges from 40 to 61-inches, at time of report</li> </ul>
<b>Colours</b>	<ul style="list-style-type: none"> <li>◆ Many are capable of unlimited colours</li> </ul>	<ul style="list-style-type: none"> <li>◆ Many are capable of unlimited colours</li> </ul>	<ul style="list-style-type: none"> <li>◆ Unlimited Colours</li> </ul>
<b>Resolution</b>	<ul style="list-style-type: none"> <li>◆ CRT monitors are capable of running multiple resolutions.</li> <li>◆ Maximum – 1280 * 1024 60Hz</li> </ul>	<ul style="list-style-type: none"> <li>◆ LCD monitors will work well in one resolution – reducing eyestrain – but many offer multiple settings.</li> <li>◆ Maximum 1024 * 768, with 13 Preset modes, 10 user modes</li> </ul>	<ul style="list-style-type: none"> <li>◆ High Resolution</li> </ul>
<b>Brightness</b>	<ul style="list-style-type: none"> <li>◆ A non-issue</li> </ul>	<ul style="list-style-type: none"> <li>◆ LCD monitors are backlit and have different levels of brightness.</li> <li>◆ 250 cd/mz (typical) &amp; 200 cd/mz (minimum)</li> </ul>	<ul style="list-style-type: none"> <li>◆ Different levels of brightness, examples include 200cd/m2 and 370cd/m2</li> </ul>
<b>Viewing Angle</b>	<ul style="list-style-type: none"> <li>◆ Sports a wide viewing angle, especially horizontally.</li> </ul>	<ul style="list-style-type: none"> <li>◆ Horizontal is +/- 60 degrees. Vertically is +/- 45 degrees.</li> <li>◆ An issue constantly being addressed.</li> </ul>	<ul style="list-style-type: none"> <li>◆ Wide angle</li> </ul>
<b>Radiation Controls</b>	<ul style="list-style-type: none"> <li>◆ Low Radiation – MPR II, TCO-99</li> </ul>	<ul style="list-style-type: none"> <li>◆ Low Radiation</li> <li>◆ TCO-99 compliant (Industry standard)</li> </ul>	<ul style="list-style-type: none"> <li>◆ Does not emit radiation, due to gas plasma technology</li> </ul>
<b>Power Consumption</b>	<ul style="list-style-type: none"> <li>◆ High levels</li> <li>◆ 105 Watts (W) – Normal Setting, 15 W Standby and Suspend modes, 3 W off</li> </ul>	<ul style="list-style-type: none"> <li>◆ Lower levels, resulting in lower energy costs both for air conditioning and initial expenses</li> <li>◆ 36 W On, 3 W Suspend, Standby and Off positions</li> </ul>	<ul style="list-style-type: none"> <li>◆ Low levels, due to the technology used.</li> </ul>
<b>Prices</b>	<ul style="list-style-type: none"> <li>◆ Lowest price of all monitor technologies. An example of pricing includes a 17-inch model available at approximately \$300.</li> </ul>	<ul style="list-style-type: none"> <li>◆ Moderately priced. A 15-inch model for approximately \$600</li> </ul>	<ul style="list-style-type: none"> <li>◆ Premium pricing. A 42-inch model had a suggested list of \$7,995 US in Q4-01.</li> </ul>

<sup>7</sup> The 17-inch CRT referenced is LGE's Flatron ® 775FT

<sup>8</sup> The 15.1-inch LCD unit referenced is LGE's Flatron ® 563LS

## Historical Perspective of Monitor Technologies

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*Televisions = CRT* Initially there was the television screen. Using **cathode ray tube** technology, an electron beam projected images on to a phosphorescent surface, resulting in a picture. Then came the personal computer.

*Notebooks = LCD* Initially monochrome (one colour) CRT monitors were available. “Black and white”, (or black/green or amber/black) were the initial products. Then colour monitors were introduced. The monochrome or single colour products use one electron gun and fire individual beams of colour at the screen to form a single image. Colour CRTs use three guns - one blue, one red and one green – to fire three individual colour beams. Using these three colours an almost infinite variety of colours can be reproduced on the screen.

*Restaurant Kiosks  
= LCD  
Touchscreen*

*DVD's = Plasma  
Display Technology*

The replacement cycle for monitors shifts from one size to the next as prices decline for larger screens. For example, in 1998 the 15-inch segment was the most popular. Average unit prices were approximately \$291<sup>9</sup>. As prices declined on the larger 17-inch products, users replaced 15-inch models with the 17-inch. In 2001, the 17-inch segment represents the lion’s share of all display sales and has an average retail price of \$227. Also in 2001, prices began to decline for 15-inch LCDs and 19-inch CRTs. As a result, unit shipments are increasing for both of the newer products.

### **Price Comparison<sup>10</sup> (MSRP – December 2001):**

17-inch CRT - \$229 - \$369  
19-inch CRT - \$369-\$549  
15-inch LCD – \$599

A technological advancement in the CRT market includes switching from a curved to a flat screen. Improved visual clarity and a larger viewable area are two key reasons for this transition.

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<sup>9</sup> Prices are based upon average retail pricing, from ERC’s *Segment Update Program – The Monitor Market in Canada*.

<sup>10</sup> LG Electronics’ product price ranges

**LCD** technology was introduced with notebook personal computers: sleek, smooth compact, attractive and functional. Not only a space saver, LCD units are **easy on the eyes, environmentally friendly and energy efficient**. However, with a price tag of approximately \$1,500 for a 15-inch unit, LCDs were not competitive with CRT monitors. As manufacturing techniques were improved, prices started to decline. As the lower prices stimulated demand, additional vendors entered the market. This increase in competition pushed prices even lower.

The above mentioned market factors are why LCD units are gaining ground against the ever-popular CRT models, and why 2001 is the initial year of substantial growth for LCD products. PC users had the choice to trade their 17-inch CRT model for either a 19-inch CRT or switch to a 15-inch LCD model. A 15-inch LCD has a comparable viewing space to a 17-inch CRT, and has a smaller footprint, thereby taking up smaller desktop real estate.

**Plasma display devices** remain specialty products at this time due to their **high price point**. Prices are declining slightly, but plasma products remain a specialty item. Screens are large (40-62-inch) and expensive, with average retail prices in the thousands<sup>11</sup>, instead of the hundreds.

These screens can be used for both television viewing and for computing experiences. Plasma displays are gaining recognition through the popularity of DVD units and are often used to highlight the benefits of the DVD experience in retail locations.

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<sup>11</sup> A sample price reduction witnessed in December 2001 includes NEC Technologies reducing the price of its PlasmaSync® 61MP1 from \$27,995 US (SRP) to \$19,995 US (unit is 61-inches).

## The Liquid Crystal Display (LCD) Monitor Market in Canada

The **liquid crystal display (LCD)** market in Canada represents approximately 5%<sup>12</sup> of total monitor shipments, however it is currently experiencing tremendous growth. With **2001 forecasted growth to finish at 269% over 2000 totals**, look for LCD units to gain overall market share over the course of the next few years.

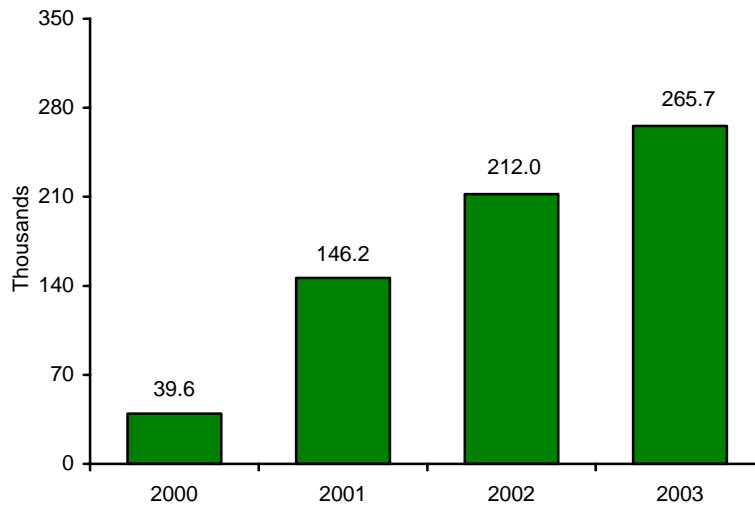
*Total 2001 forecasted growth is expected to finish 269% higher than 2000.*

The products have many selling points, including a **price tag that fell over the course of 2001**. Other points include **strong inventory levels, a large and clear viewing area, low radiation output, low heat output and an attractive cost of ownership**.

Selling features combined with aggressive sales efforts on behalf of the vendors and reseller community will help to propel the market.

**Exhibit 3: Liquid Crystal Display Shipments: 2000 – 2003**

*Look for liquid crystal displays to gain overall market share over the course of the next few years.*



Prior to 2001, liquid crystal display shipments were sporadic across the product segments. As is the case with most new products, users had to familiarize themselves with the technology.

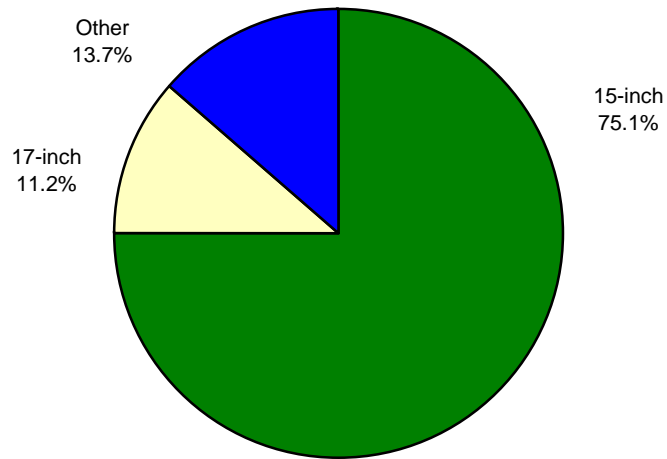
Initially, the 14-inch products received attention. Both pricing and availability were attractive for the smaller segments.

<sup>12</sup> Taken from ERC's *Segment Update Program – The Monitor Market in Canada*.

Then, the 15-inch LCD segment experienced a surge in popularity. Not only do they share the same viewing size as the popular 17-inch CRT models, but also it is characteristic of PC users to shift to the next largest display technology.

Also in 2001, manufacturing and supply costs declined on LCD units. While it appears that Canadian prices have settled, as of the end of 2001 unit prices do appear to be on the rise in Asia and in the United States. As demand increases, supply might tighten, resulting in price increases.

**Exhibit 4: Liquid Crystal Display Market by Monitor Size:  
Year-to-Date Q3 2001**



The success of the LCD market is primarily propelled by the 15-inch product segment, which comprises approximately 75 % of the total market. Robust 15-inch shipments are expected throughout the next 18 months.

Traditionally, **LCD units have been popular** in areas such as the financial markets (i.e. trading floors) **where a high value is placed on floor and desk space.** Segments that pay significant attention to the **image** are also attracted to the LCD product line – such as in an advertising atmosphere: where the image of the corporation is presented directly to the clients.

Lower prices and the environmental benefits of the product do raise the profile of the technology.

Due to higher price point, the larger 17-inch and 18-inch products are found in niche environments.

A comparison of the two prominent LCD monitor sizes illustrates the changes in average unit prices throughout the past year:

**Exhibit 5: 15.x-inch LCD Average Unit Price Quarterly Summary<sup>13</sup>:  
Q3 2000 – Q3 2001**

<i>LCD Units</i>	<b>Q3 00</b>	<b>Q4 00</b>	<b>Q1 01</b>	<b>Q2 01</b>	<b>Q3 01</b>
<b>15.x-inch Average Price</b>	\$1,073	\$1,137	\$914	\$702	\$663
<b>% Change</b>	-23%	+6%	-20%	-23%	-6%
<b>17.x-inch Average Price</b>	\$2,750	\$1,594	\$2,037	\$1,472	\$1,224
<b>% Change</b>	-47%	-42%	+28%	-28%	-17%

<sup>13</sup> Taken from ERC's *Segment Update Program – The Monitor Market in Canada.*

## Key Factors for LCD Growth in the Canadian Market

Multiple factors came into play in 2001 to propel the growth of the LCD segment:

Compelling Factors	LCD Technology
<b>Supply</b>	<ul style="list-style-type: none"> <li>◆ Vendors and manufacturers had access to <b>high inventory of liquid crystal displays since the beginning of 2001</b>. Towards the end of the year, inventory levels began to decline – a combination of higher demand and robust competition.</li> </ul>
<b>Technology</b>	<ul style="list-style-type: none"> <li>◆ Vendors and manufacturers addressed technological issues prior to 2001 to improve the units: i.e. <b>Expanded Viewing Areas / Increase in Brightness / High Resolution</b></li> </ul>
<b>User Knowledge &amp; Confidence</b>	<ul style="list-style-type: none"> <li>◆ Users, both corporate and consumer, are increasingly familiar with the benefits of LCD technology. The <b>pros of the products are compelling reasons to evaluate and strongly consider implementing the units</b>.</li> </ul>
<b>Environmental Concerns</b>	<ul style="list-style-type: none"> <li>◆ When compared to CRT models, LCD monitors are more environmentally friendly. <b>Tighter radiation controls and lower power consumption levels</b> contribute to the “greenness” of the products.</li> </ul>
<b>Prices</b>	<ul style="list-style-type: none"> <li>◆ <b>Average unit prices declined in 2001</b> (a combination of strong inventory levels and aggressive competition) thereby expanding marketplace presence.</li> </ul>
<b>Cost of Ownership</b>	<ul style="list-style-type: none"> <li>◆ Although the LCD units carry a higher unit price than those found in the CRT segments, <b>LCD products cost less to operate</b>. As such, LCD units help to lower the operating costs of both corporations and of consumers, by <b>lowering requirements for air conditioning, space and energy</b>.</li> </ul>

## LCD Cost of Ownership

There are many attractive features of LCD technology. For businesses the most frequently asked question is “**How much will this cost?**” A breakdown of the related costs are provided below:

- ◆ **Electrical Costs**
  - Power Consumption / Environmental Concerns / Energy Costs**
- ◆ **Heat Dispersion**
  - Cooling Costs**
- ◆ **Employee Benefit Costs**
- ◆ **Immediate Benefits**

### **Electrical Costs**

A quick glance at LCD specification sheets outlines low power consumption ratings and the low radiation output levels. A comparison between CRT and LCD technology is provided in this section, with a comparative snapshot of energy rates across the country.

#### *Power Consumption*

LCD units require less power than CRT units: an extremely attractive feature of the technology. A comparison of the two technologies is provided below. A 17-inch CRT unit (LGE Flatron® 775FT) and a 15-inch LCD unit (LGE Flatron® 563LS) are used for this examination.

**Exhibit 6: Total Number of KiloWatts Consumed per Hour (kWh):  
17-inch CRT vs. 15-inch LCD Unit**

<i>Total Number of KiloWatts Consumed per Hour (kWh)</i>	<b>17-inch CRT</b>	<b>15-inch LCD</b>	<b>Variances</b>
<b>On</b>	0.105 kWh	0.036 kWh	0.069 kWh
<b>Standby/Suspend</b>	0.015 kWh	0.003 kWh	0.012 kWh
<b>Off</b>	0.003 kWh	0.003 kWh	N/A

To look at the data in a business setting, some **assumptions** were made regarding the usage of the monitors:

- ◆ The unit is **on** 5 hours per day, 5 days per week and 50 weeks per year. (Total = 1,250 hours)
- ◆ The unit is on **standby/suspend** 4 hours per day, 5 days per week and 50 weeks per year. (Total = 1,000 hours)
- ◆ The unit is **off** 15 hours per day, 5 days per week and 50 weeks per year. (Total = 3,750 hours)
- ◆ The unit is **off** 24 hours per day, 2 days per week and 2 weeks per year. (Total = 96 hours)

**Exhibit 7: Total Number of kWh Consumed per Year: 17-inch CRT vs. 15-inch LCD Unit**

<i><b>Total Number of kWh Consumed per Year</b></i>	<b>17-inch CRT</b>	<b>15-inch LCD</b>	<b>Variances</b>
On	131.250 kWh	45.000 kWh	86.25 kWh
Standby/Suspend	15.000 kWh	3.000 kWh	12.000 kWh
Off	11.538 kWh	11.538 kWh	N / A
<b>Total</b>	<b>157.788 kWh</b>	<b>59.538 kWh</b>	<b>98.250 kWh</b>

**Bottom Line**

- ◆ LCD units consume 38% less power than CRT monitors.

*Environmental Concerns*

To address environmental concerns, LCD monitor manufacturers conform to measurement and emission guidelines<sup>14</sup>. Emerging from Sweden, MPR II<sup>15</sup> outlines limits on electromagnetic field (EMF) emissions in the extremely low frequency (ELF) and very low frequency (VLF) ranges, as well as in the electrostatic field. More restrictive and recent standards TCO-95 and TCO-99<sup>16</sup> address the entire computer system and include guidelines for energy consumption, screen flicker, luminance and keyboard use.

MPR II measurements are taken approximately 50 centimeters (cm) from the monitor screen, at three levels of 16 points each.

TCO measurements are taken at a distance of 30 cm in front of the screen and at 50 cm around the screen. Band II magnetic fields and static fields are both measured at 50 cm from the front of screen

<sup>14</sup> LG Electronic’s Flatron ® products conform to these standards

<sup>15</sup> MPR II was established by the Swedish Government

<sup>16</sup>TCO refers to the Swedish Confederation of Professional Employees.

Emission limits prescribed by MPR II and TCO are as follows<sup>17</sup>:

<b>Electric Fields</b>	<b>MPR II</b>	<b>TCO</b>
<b>Frequency Range</b>		
<b>Static Field</b>	+/- 500 V	+/- 500 V
ELF 5 Hz – 2 KHz (Band I)	< / = 25 V / m	< / = 10 V/m
VLF 2 KHz – 400 KHz (Band II)	< / = 2.5 V/m	< / = 1 V/m
Above 400 KHz	none	none
<b>Magnetic Fields</b>	<b>MPR II</b>	<b>TCO</b>
ELF 5 Hz – 2 KHz (Band I)	< / = 2.5 mG	< / = 2.0 mG
VLF 2 KHz – 400 KHz (Band II)	< / = .25 mG	< / = .25 mG
Above 400 KHz	none	none

Another significant component is the disposal methods of computing display units. CRT units contain mercury, which can seep into our soil and water through inappropriate disposal methods.

**Bottom Line**

- ◆ Less financial commitment regarding the disposal of CRT units.

<sup>17</sup> Taken from [www.noradcorp.com/swedish](http://www.noradcorp.com/swedish) (Field Management Services)

*Energy Costs*

A snapshot of energy costs across Canada<sup>18</sup>:

<b>Province</b>	<b>Energy Cost</b>
British Columbia <sup>19</sup>	\$ 0.04560 / kWh
Alberta <sup>20</sup>	\$ 0.06985 / kWh
Ontario <sup>21</sup>	\$ 0.05790 / kWh
Quebec <sup>22</sup>	\$ 0.05575 / kWh
Yukon <sup>23</sup>	\$0.10900 / kWh

By combining the above table with the monitor consumption data, we are able to see the financial benefit of LCD technology:

**Exhibit 8: Annual Operating Costs for a 17-inch CRT Unit**

<i>Annual Operating Costs for a 17-inch CRT Unit</i>	<b>Individual Unit</b>	<b>10 Units</b>	<b>50 Units</b>
<b>British Columbia</b>	\$ 7.20	\$ 72.00	\$ 360.00
<b>Alberta</b>	\$ 11.02	\$ 110.20	\$ 551.00
<b>Ontario</b>	\$ 9.14	\$ 91.40	\$ 457.00
<b>Quebec</b>	\$ 8.80	\$ 88.00	\$ 440.00
<b>Yukon Territory</b>	\$ 17.20	\$ 172.00	\$ 860.00

<sup>18</sup> Please note these rates are provided as a guideline only. Check your local provider for current rates.

<sup>19</sup> Rates are for Vancouver and are from May 2000.

<sup>20</sup> Rate presented is an average of January and September 2001. Alberta does offer a rebate on electrical costs, which has not been factored into the equation.

<sup>21</sup> OnSource @ 3-year Best of 3 Electrical Price, good until 16 December 2001.

<sup>22</sup> Hydro Quebec Rate, Business Rate – Small Power. An average rate is presented as Hydro Quebec offers a tiered charge.

<sup>23</sup> Rate is for Electricity as of 31 October 1996.

These charges are estimates only and are entirely dependent upon the charges of a local carrier.

**Exhibit 9: Annual Operating Costs for a 15-inch LCD Unit**

<i>Annual Operating Costs for a 15-inch LCD Unit</i>	<b>Individual Unit</b>	<b>10 Units</b>	<b>50 Units</b>
<b>British Columbia</b>	\$ 2.72	\$ 27.20	\$ 136.00
<b>Alberta</b>	\$ 4.16	\$ 41.60	\$ 208.00
<b>Ontario</b>	\$ 3.45	\$ 34.50	\$ 172.50
<b>Quebec</b>	\$ 3.32	\$ 33.20	\$ 166.00
<b>Yukon Territory</b>	\$ 6.49	\$ 64.90	\$ 324.50

***Heat Dispersion / Cooling Costs***

BTU (British thermal unit) is the standard method of measuring the amount of energy required to alter the temperature of one pound of water by one degree Fahrenheit at 39 degrees Fahrenheit (the temperature water is most dense). This is a useful measure for determining how your computer monitor raises the temperature of an office. Listed below are the BTU conversions for the monitors from the above chart. Further below are sample energy rates from across the country to help determine energy measurements across Canada.

- ◆ Multiply the BTU by the number of monitors installed
- ◆ Multiply that number by the size of the room

**Exhibit 10: A Comparison of Kilo Watts & BTUs Consumed per Year:  
17-inch CRT vs. 15-inch LCD**

<i>A Comparison of Kilo Watts &amp; BTUs Consumed per Year</i>	<b>17-inch CRT</b>	<b>BTU Conversion</b>	<b>15-inch LCD</b>	<b>BTU Conversion</b>	<b>LCD BTU Benefit</b>
On	131.250 kWh	485,625	45.000 kWh	166,500	(319,125 kWh)
Standby/Suspend	15.000 kWh	55,500	3.000 kWh	11,100	(44,400 kWh)
Off	11.538 kWh	42,691	11.538 kWh	42,691	-
<b>Total</b>	<b>157.788 kWh</b>	<b>583,816</b>	<b>59.538 kWh</b>	<b>220,291</b>	<b>(363,525 kWh)</b>

The annual requirement of **583,816 BTU's** will maintain the room temperature with **one 17-inch CRT** monitor. Only **220,291 BTUs** are required for **one 15-inch LCD unit**.

**Assume 10 units per room:**

- ◆ 17-inch CRT – 5,838,160 BTUs
- ◆ 15-inch LCD – 2,202,910 BTUs
- ◆ Variance – 3,635,250 BTUs (in favour of the LCD model)

**Assume 50 units per room:**

- ◆ 17-inch CRT – 29,190,800 BTUs
- ◆ 15-inch LCD – 11,014,550 BTUs
- ◆ Variance – 18,176,250 BTUs (in favour of the LCD model)

**Bottom Line**

- ◆ LCD units produce 37% less heat than CRT monitors

## **Employee Benefit Costs**

In order to provide a healthy and comfortable working environment, today's manager has choices available: ergonomically designed furniture, environmentally friendly office equipment and LCD technology. LCD units provide greater desk space and reduced eyestrain compared to CRT monitors.

### *Health Benefits*

*Users of LCD technology report a lack of eyestrain, headaches, and managers report higher productivity.*

Polls have been taken in offices across the country concerning the health problems associated with CRT use. These problems included eyestrain, headaches and decreased productivity due to frequent breaks. When users switch to LCD units, they report a significant decrease in these problems, particularly when they use LCD units for the majority of the day. **Improved picture quality, larger viewing area and diminished flicker rates** (compared to CRT models) all take credit for **reduced eyestrain and less frequent headaches**. It is suspected that the lesser radiation levels also contribute to the reduction of headaches.

#### **Bottom Line**

- ◆ **Users** – Less eyestrain and headaches result in productivity increases.
- ◆ **Managers** – Happy, healthy and more productive employees.

### *Technological Benefits*

*Top  
technology at  
an  
attractive price  
point.*

As IT products mature, technology improves with each version. The LCD segment certainly follows this historic pattern. In 1998<sup>24</sup>, LCD vendors shipped approximately 4,000 units. Over 49% of the shipments belonged to the sub-13-inch and in the 14-inch segments. Now the total LCD market accounts for 146,200 units per year, and only a handful of units are found in the sub-15-inch segment. The segment is not separated in the reports.

#### **Key technological benefits provided with LCD technology include:**

- ◆ **Flat screen products**
- ◆ **Expanded viewing area**
- ◆ **Pixel clarity**
- ◆ **Wide range of colours**

#### **Bottom Line**

- ◆ Top technology, including a large, clear flat picture with unlimited colours, at an attractive price point

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<sup>24</sup> Evans Research Corporation's *Segment Update Program – The Monitor Market in Canada*

**Immediate Benefits**

*Supply & Pricing*

Due to advancements in manufacturing techniques and the strong availability of components, display manufacturers have been able to supply plentiful product for the Canadian market. Coincidentally the number of vendors within the marketplace increased.

*LCD  
Technology is  
more affordable  
than ever  
before.*

As in any industry, **enhanced competition helps to lower individual prices.** Another market dynamic occurring at the same time was the expansion of the number of styles available. The combination of these forces improved the market conditions for the purchaser – both commercial and consumer.

At the beginning of 1999<sup>25</sup>, approximately 14 vendors competed in the Canadian LCD market. At the end of 2000 that number had increased to approximately 20. By the end of the third quarter of 2001, there were approximately 25 vendors competing. Twenty-five vendors helped the average retail price to decline: from \$1,243 (15-inch) in fourth quarter 2000 to \$599 in fourth quarter 2001.

The table below illustrates the annual decline of the average retail price for the 15-inch LCD unit:

**Exhibit 11: 15.x-inch LCD Average Retail Unit Prices by Year<sup>26</sup>:  
1999 – 2001**

<i>Average Unit Price</i>	<b>1999</b>	<b>2000</b>	<b>2001</b>
<b>Annual</b>	\$3,537	\$1,455	\$776

Although the technology has experienced a dramatic price reduction, as demand begins to exceed supply, look for prices to rise. Manufacturers have indicated that demand might soon surpass supply, which will result in a natural increase of unit prices.

**Bottom Line**

- ◆ LCD Technology is more affordable than ever before.

<sup>25</sup> ERC's *Segment Update Program – The Monitor Market in Canada*

<sup>26</sup> Taken from ERC's *Segment Update Program – The Monitor Market in Canada*

*Product Design*

*LCD units are sleek, smooth, compact, attractive and functional.*

As technology advances, **additions will be made to LCD units, thereby further enhancing the computing experience.** One accessory already attached to the monitor is the active USB port, enabling the user to add a peripheral device, such as a zip drive, to the computer via the monitor, instead of fussing with cables under the desk.

A major component of product design when comparing CRT and LCD units is **form factor.** CRT monitors are bulky, heavy objects that consume a lot of desk space, whereas LCD units are light and compact.

A quick comparison of unit weights of the two segments is provided below:

**Exhibit 12: Comparison of CRT & LCD Unit Weights by Size:**

<b>CRT Models</b>	<b>Weight</b>	<b>LCD Models</b>	<b>Weight</b>
<b>Flatron ® 775FT 17-inch</b>	19.2 kg Net, 22.5 kg Gross	<b>Flatron ® 563LS 15.1-inch</b>	5.2 kg Net, 7.1 kg Gross
<b>Flatron ® 995FT 19-inch</b>	26.5 kg Net 28.4 kg Gross	<b>Flatron ® 885LE 18.1-inch</b>	8.9 kg Net, 12.3 kg Gross
<b>StudioWorks ® 221U 21-inch</b>	30 kg Gross	<b>Flatron ® 295LM 22-inch</b>	11.3 kg Net, 17.4 kg Gross

**Bottom Line**

- ◆ Desks do not have to be large if LCD units are installed. As a result, more desks can be placed in a given area, thereby increasing employee head count.
- ◆ If the same number of desks is utilized, users have more available space on the actual desktop.

**Summary of Power Consumption and Power Usage – Cost of Ownership**

While each business location will have a set of unique variables regarding the computing experience, LCD units are more efficient in the areas of power consumption, cooling levels, employee health and office space, putting LCD units well ahead of the CRT offerings.

**Exhibit 13: Total Number of Kilo Watt Hours Consumed per Year:  
17-inch CRT vs. 15-inch LCD Units**

<i>Total Number of KiloWattHours Consumed per Year</i>	<b>17-inch CRT</b>	<b>15-inch LCD</b>
On	131.250 kWh	45.000 kWh
Standby/Suspend	15.000 kWh	3.000 kWh
Off	11.538 kWh	11.538 kWh
<b>Total</b>	<b>157.788 kWh</b>	<b>59.538 kWh</b>

**Exhibit 14: Annual Operating Costs of an Individual Unit:  
17-inch CRT vs. 15-inch LCD Units**

<i>Annual Operating Costs of an Individual Unit</i>	<b>17-inch CRT</b>	<b>15-inch LCD</b>
<b>British Columbia</b>	\$ 7.20	\$ 2.72
<b>Alberta</b>	\$ 11.02	\$ 4.16
<b>Ontario</b>	\$ 9.14	\$ 3.45
<b>Quebec</b>	\$ 8.80	\$ 3.32
<b>Yukon Territory</b>	\$ 17.20	\$ 6.49

**Exhibit 15: A Comparison of Kilo Watts & BTUs Consumed per Year:  
17-inch CRT vs. 15-inch LCD**

<i>A Comparison of Kilo Watts &amp; BTUs Consumed per Year</i>	<b>17-inch CRT</b>	<b>BTU Conversion</b>	<b>15-inch LCD</b>	<b>BTU Conversion</b>	<b>LCD BTU Benefit</b>
On	131.250 kWh	485,625	45.000 kWh	166,500	(319,125 kWh)
Standby/Suspend	15.000 kWh	55,500	3.000 kWh	11,100	(44,400 kWh)
Off	11.538 kWh	42,691	11.538 kWh	42,691	-
<b>Total</b>	<b>157.788 kWh</b>	<b>583,816</b>	<b>59.538 kWh</b>	<b>220,291</b>	<b>(363,525 kWh)</b>

## LCD Technology Case Studies: Adoption of LCD Technology in Canadian Businesses

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In today's competitive business environment, business managers are faced with a plethora of issues. Strategic to the success of any business is the constant examination of productivity levels (and how to increase them) coupled with the need to continually reduce costs. As information technology becomes increasingly more important in our lives, the more significant a business tool it becomes. As such, it is an area requiring continual assessment. When faced with either upgrading computer systems, or upgrading components, many issues fall into place. A common practice is to upgrade the component, as witnessed in the growth of the LCD market.

This report looks at a couple of Canadian examples where organizations made the switch to LCD technology from the older and more recognized CRT products. Their stories are below:

### **Grant MacEwan College, Edmonton Alberta**

*The switch to LCD units helped to eliminate the discomfort, resulting in higher productivity and less break time.*

*- Peter Brown,  
Grant MacEwan College*

As one of the early adopters of LCD technology, **Grant MacEwan College** recognized quickly the benefits of LCD technology. Initially motivated by reducing the eyestrain of their administrative staff, the multiple benefits of the equipment has resulted in two laboratories of monitors and the decision to continue purchasing the technology. Gradually the switch from CRT to LCD is being made. Approximately 80 units have been currently been installed including two computer/engineering laboratories and the administrative staff of the Arts & Science department.

One of the initial motivating factors for the conversion was the possibility of reducing the **eyestrain** common with the bulky CRT units. The low flicker rate of the technology, combined with brightness and increased viewing angle, aided in improving the viewing experience. The administrative employees of the Arts & Science departments use computers as a mainstay of their positions and were previously suffering from sore eyes. The switch to LCD units helped to eliminate the discomfort, resulting in higher productivity and less break time.

The second benefit of the displays in this environment was their **compact size**, and the lack of room taken up on a desk. In the rooms that house the administrative staff, space was at a premium, and the compact displays enabled users to make better

*One student actually remarked that they “will never work on such good equipment again at university” when they were finished their studies at the College.*

*Grant MacEwan College wants to present themselves as being a school that operates with a professional air.*

*One quick look at the specification sheets, listing the watt usage, and quick comparison of LCD and CRT products, and the school was sold.*

use of their space, increasing overall employee satisfaction. They are now at a point where **“You couldn’t come in and take one away”**, according to Peter Brown, the Department Head of the Arts & Science Faculty at the college. You could, however, add one to the product mix. Which is something they will be doing over the next few years. In fact, the faculty no longer purchases CRT products, preferring the compact LCD units.

One of the other major benefits as experienced by the college, is the **environmentally friendly aspect of reduced heat emissions from the units**. Prior to installing the 15-inch LCD models, the heat emissions generated from the 17-inch CRT models were noticeable. Around the same time, Mr. Brown was looking to expand the number of laboratories the college had. Two classrooms were available. Instead of installing the rooms with the then-standard CRT models, the department opted for the “cooler” LCD models. By installing LCD units, an important key benefit was achieved. The rooms did not require the installation of a costly air conditioning system. Therefore, 30 personal computers and 30 LCD units were installed per room, and additional air conditioning was not. So far, there has not been a need to add the cooling system.

In an education setting, it is important to prevent students from walking behind each other to access their desks and seats. Quick and easy access to desks is preferred, especially with the Canadian winters and full knapsacks. The **thin displays reduced the need for large desk spaces**, which in turn freed up room for extra aisles. Now the students can access their desks easily without inconveniencing others. While this perhaps seems like a small issue, on a day-to-day practice it is extremely beneficial, and also contributes to the overall improved environment.

One key issue for the school is presenting an image of professionalism. Competing with universities, **Grant MacEwan College** aims to present an expert classy environment, through professors, available courses, buildings, IT equipment and web presence. The high-resolution LCD monitors certainly help to support this standard.

While a cost-benefit analysis has not been conducted to Mr. Brown’s knowledge, the accounting department, although initially curious about the large investment, no longer questions his IT purchasing decisions. (An important item to note is that the original purchase occurred about a year and a half ago, while the prices were still

quite high. Each display cost approximately \$1,500.) One quick look at the specification sheets, listing the watt usage and quick comparison of LCD and CRT products and the school was sold on the technology.

*Grant MacEwan College* is extremely proud of the results of their LCD units, and will remain loyal to the technology in the near future.

### ***Bio Mira Research, Edmonton Alberta***

*A clear display was and is critical to improving their business practices. A small footprint was crucial for improving the cramped work environment.*

A biotechnological corporation, researching cancer in Edmonton, Alberta, ***Bio Mira Research*** was extremely interested in finding display products to help improve their visual experience. A clear display was and is critical to improving their business practices. A small footprint was crucial for improving the cramped work environment. The decision to switch to LCD technology was made.

So the search for the economically viable product began. Working with a local reseller, ***Bio Mira*** was introduced to two of *LG Electronics*' LCD products: the Flatron ® 563LS and the Flatron ® 577LM (which allows for screen rotation). In addition to the clear display and the small footprint, the LCD technology offered a compact (small and light) form factor, an attractive power consumption rating, low radiation and reduced eyestrain. Although the radiation output levels and health benefits are certainly added features for ***Bio Mira***, they were not prime motivational factors for switching to the technology.

***Bio Mira*** intends to spend the next couple of years switching existing CRT monitors over to LCD technology.

## ***Regional Psychiatric Centre of Saskatoon, Saskatoon, Saskatchewan***

*It was the promise of increased desk space that motivated the purchase.*

Initially motivated by the lack of available space on the secretarial and clerical desktops, the ***Regional Psychiatric Centre of Saskatoon*** began a systematic replacement of CRT monitors with LCD units in 2000. It is a gradual process, due to the number of desks and the organization's reliance upon funding. Preliminary results have all been positive. The installers, purchasers and users of the equipment have only confident comments on the technology.

***“Everybody loves them.”***

*Jake Pedrosa, Regional Psychiatric Centre of Saskatoon, when questioned regarding LCD monitors.*

When pressed regarding the other key benefits of the units, Jake Pedrosa of the ***Regional Psychiatric Centre of Saskatoon*** admitted that the real advantage surrounding the LCD units was the compact design. Yes, the lack of eyestrain was wonderful, and yes, everyone loved the fact that their eyes were not tired at the end of the day, but really it was the promise of increased desk space that motivated the purchase. A cost analysis was conducted, to highlight the benefits of the expenditure to the management committee, and was passed quickly. The low power consumption qualities of the units were definitely a bonus.

The conversion began with senior secretaries and with financial clerks. It is a tiered installation and will continue in 2002.

## **Future Dynamics of the Liquid Crystal Display Market**

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The current trends of the Canadian monitor market illustrate a definite pattern going forth, and that pattern focuses upon the *growth of the LCD market*. **Declining unit prices, lower radiation output, diminishing air conditioning charges, user-friendly technology and increasingly energy efficient units** will all contribute to the success of the marketplace.

The Canadian desktop PC market<sup>27</sup> represents approximately \$3.8 billion annually. The Canadian CRT<sup>28</sup> market represents \$747 million annually. Both are experiencing declines in average unit prices and units shipped. While the LCD market only represents \$160 million annually, the **Canadian LCD market is on a tremendous growth curve** and will continue the upswing over the next few years. The desktop PC market is fueled by the girth of the commercial market and is experiencing declines of approximately 1 percent each year. The consumer market is experiencing flat unit shipments, year over year. **The LCD market is expected to finish 2001 with a unit growth of 269% over 2000.** One of the characteristics of the overall high tech market is that **PC users are upgrading components versus the entire system**. As prices decline on LCD units, the future looks rosy for the consumer/SOHO marketplace. And **cutting costs remains a mission critical issue of businesses today**. While a lower unit price is attractive, IT purchasers are looking at the total picture, and focus on an aggressive unit price, but also the long term operating savings of the item.

As consumers look for viable computing display possibilities and corporate users search for a quality total solution, **LCD units gain popularity**. **High quality and a better viewing experience** are attractive features when looking to upgrade display components. Also when comparing the total costs of the units, **LCD units** clearly finish ahead of the competition as **operating costs are lower than CRT models**.

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<sup>27</sup> Based upon average retail prices, and ERC's *Segment Update Program – The PC Market in Canada*.

<sup>28</sup> Based upon average retail prices, and ERC's *Segment Update Program – The Monitor Market in Canada*.

## **Methodology**

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The methodology employed for this project is two fold, and encompasses both qualitative and quantitative issues.

### ***Quantitative Issues***

The overall snapshot of the Canadian monitor market was created utilizing ERC's report findings within the *Segment Update Program – The Monitor Market in Canada*, which employs a similar methodology as found in most other ERC vendor-tracking reports. Quarterly questionnaires are distributed to all of the major players in the Canadian market. Data is collected over the course of several weeks at which point a data sheet is prepared with all vendor estimates for the quarter. In situations where vendor information is unavailable, ERC estimates are formulated. These estimates and the collected vendor estimates are then sent to industry contacts for comments.

Presenting the business case for liquid crystal technology, cost of ownership benefits were examined. Energy output and input, radiation levels, in conjunction with product information such as viewing angles and required desktop space were all explored. The power consumption of units was inspected, in conjunction with the conversion to British Thermal Units (BTU), which represents the increase in heat generated by the unit. Cross-country energy costs were compared with reference to cost of room air conditioning declining charges due to the lower BTU output of the LCD products, as compared to the CRTs.

Examples are presented, as are the product energy usage tables, thereby enabling the reader to check the conversion rates based upon individual situations.

### ***Qualitative Issues***

ERC conducted personal interviews with corporate clients of LCD technology who had implemented the displays in mission-critical environments. During the interviews, interviewees were asked to explain key reasons for switching to LCD technology and key benefits of the change. Those comments are presented in this report.

Comments obtained in these interviews were extremely helpful in understanding the key benefits of LCD technology. Throughout the report, direct quotations from the interviewees are presented to enhance the reader's understanding of the technological benefits of the products.

## Glossary<sup>29</sup>

Term	Definition
<b>British Thermal Unit (BTU)</b>	<ul style="list-style-type: none"> <li>◆ Refers to the amount of energy required to change the temperature of one pound of water one degree Fahrenheit. (The amount of energy generated by your monitor that would raise the temperature of the room up or down one degree.)</li> </ul>
<b>Cathode Ray Tube (CRT)</b>	<ul style="list-style-type: none"> <li>◆ A cathode ray tube is a specialized vacuum tube in which images are produced when an electron beam strikes a phosphorescent surface. The CRT in a computer display is similar to the "picture tube" in a television receiver.</li> <li>◆ A cathode ray tube consists of several basic components. The electron gun generates a narrow beam of electrons. Anodes accelerate the electrons. Deflecting coils produce an extremely low frequency (ELF) electromagnetic field that allows for constant adjustment of the direction of the electron beam. There are two sets of deflecting coils: horizontal and vertical. The intensity of the beam can be varied. The electron beam produces a tiny, bright visible spot when it strikes the phosphor-coated screen.</li> <li>◆ To produce an image on the screen, complex signals are applied to the deflecting coils and to the apparatus that controls the intensity of the electron beam. This causes the spot to race across the screen from right to left and from top to bottom, in a sequence of horizontal lines called the raster.</li> <li>◆ Colour CRTs have three electron guns, one red (R), green (G) and one blue (B), and produces three overlapping images: called the RGB colour model.</li> <li>◆ In computer systems, there are several display modes, or sets of specifications according to which the CRT operates. The most common specification for CRT displays is known as SVGA (Super Video Graphics Array).</li> </ul>
<b>Contrast Ratio</b>	<ul style="list-style-type: none"> <li>◆ The ratio of light intensity between the brightest white and the darkest black, that can be produced. A major determinant of perceived picture quality. The higher the contrast ratio, the sharper the image.</li> </ul>
<b>Dot Pitch</b>	<ul style="list-style-type: none"> <li>◆ Dot pitch refers to the space between adjacent phosphor dots of like colour on the screen. The closer the dots, the finer the dot pitch, resulting in more colours produced in a smaller area and therefore a higher resolution.</li> </ul>
<b>DVD Technology</b>	<ul style="list-style-type: none"> <li>◆ DVD (digital versatile disc) refers to optical disc technology. A DVD holds 4.7 gigabyte of information on one of its two sides, or enough for a 133-minute movie. With two layers on each of its two sides, it will hold up to 17 gigabytes of video, audio, or other information.</li> </ul>
<b>ELF</b>	<ul style="list-style-type: none"> <li>◆ ELF (extremely low frequency) refers to an electromagnetic field having a frequency much lower than the frequencies of signals typically used in communications.</li> <li>◆ The measurement range is 0.3 – 3.0 KHz.</li> <li>◆ ELF fields have become a concern in applications where CRT displays are used. CRT displays generate electromagnetic fields because of the strong, fluctuating currents in the electron-beam deflecting coils. The frequencies of these fields are on the order of a few kilohertz or less. Some studies suggest that ELF fields might have detrimental health effects on humans exposed to them for long periods of time, varying from increased risk of cancer to premature births and miscarriages.</li> </ul>
<b>Electromagnetic Emissions</b>	<ul style="list-style-type: none"> <li>◆ Does not apply to LCD units.</li> <li>◆ CRT monitors should comply with TCO or MPRII standards. Manufacturers can comply by installing shielding structures within the monitors.</li> </ul>
<b>Ergonomics</b>	<ul style="list-style-type: none"> <li>◆ Refers to the features that distinguish a monitor as being user friendly, healthy and easy top use. (MPR-II, tilt and swivel base, non-glare screens, etc...)</li> </ul>
<b>Flicker</b>	<ul style="list-style-type: none"> <li>◆ The issue of flicker is subjective, but it is a condition found in monitors with low refresh rates, interlaced scan and occasionally in certain lighting conditions.</li> </ul>

<sup>29</sup> For standardization, these definitions are cited from [www.whatism.com](http://www.whatism.com).

<b>Footprint</b>	<ul style="list-style-type: none"> <li>◆ The amount of space a particular unit of hardware or software occupies.</li> </ul>
<b>Graphics Card</b>	<ul style="list-style-type: none"> <li>◆ An electronic board, which interfaces between the monitor and the computing device.</li> </ul>
<b>Liquid Crystal Display (LCD)</b>	<ul style="list-style-type: none"> <li>◆ A LCD is made with either a passive matrix or an active matrix display grid. The active matrix LCD is also known as a thin film transistor (TFT) display. The passive matrix LCD has a grid of conductors with pixels located at each intersection in the grid. A current is sent across two conductors on the grid to control the light for any pixel. An active matrix has a transistor located at each pixel intersection. The current in an active matrix display can be switched on and off more frequently, resulting in a quick screen refresh time.</li> <li>◆ Some passive matrix LCD's have dual scanning, meaning that they scan the grid twice with current in the same time that it took for one scan in the original technology.</li> </ul>
<b>Monitor</b>	<ul style="list-style-type: none"> <li>◆ A computer display and related parts packaged in a physical unit that is separate from other parts of the computer. The terms monitor and display are used interchangeably.</li> </ul>
<b>Passive Matrix Technology</b>	<ul style="list-style-type: none"> <li>◆ Displays pixel elements using a grid of intersecting vertical and horizontal wires. Images can appear blurry, or seemingly that it can't react fast enough to changes on the screen.</li> </ul>
<b>Pixel</b>	<ul style="list-style-type: none"> <li>◆ Short term for Picture Element, a pixel is a small dot or point that is illuminated on the monitor's screen. It is comprised of a triangular cluster of phosphor dots (one red, one green and one blue). The combination of pixels comprises a screen image. The more pixels, the higher the resolution.</li> </ul>
<b>Plasma Display</b>	<ul style="list-style-type: none"> <li>◆ A plasma display is a computer video display in which each pixel on the screen is illuminated by a tiny bit of plasma or charged gas. Plasma displays are thinner than cathode ray tube (CRT) displays and brighter than liquid crystal displays (LCD). Plasma displays are sometimes marketed as "thin-panel" displays and can be used to display either analog video signals or digital display modes.</li> </ul>
<b>Refresh Rate</b>	<ul style="list-style-type: none"> <li>◆ See Vertical Refresh Rate</li> </ul>
<b>Resolution</b>	<ul style="list-style-type: none"> <li>◆ The width and height of the illuminated portion of the screen. It is measured in pixels (i.e. – 1024*768 resolution is 1024 pixels horizontally by 768 pixels vertically). Higher resolution results in a sharper image and vibrant colours.</li> </ul>
<b>Scan Frequency</b>	<ul style="list-style-type: none"> <li>◆ Combined rate at which lines are re-drawn (refer horizontal synchronization) and screens are redrawn (vertical synchronization). Determines which video standards the monitor can work with.</li> </ul>
<b>Thin-Film Transistor (TFT)</b>	<ul style="list-style-type: none"> <li>◆ TFT technology has a transistor for each pixel, which means that the electrical current triggers pixel illumination, which can be smaller than CRT technology, and therefore can be switched on and off rapidly.</li> <li>◆ It is also known as active matrix display technology and is extremely responsive to change (as noted when the user moves the mouse around. The cursor image is responsive, and a catch-up time is not as noticeable as in earlier technologies.)</li> </ul>
<b>USB (Universal Serial Bus)</b>	<ul style="list-style-type: none"> <li>◆ Universal Serial Bus (USB) is a plug-and-play interface between a computer and add-on devices (such as audio players, joysticks, keyboards, telephones, scanners, and printers). With USB, a new device can be added to your computer without having to add an adapter card or having to turn the computer off.</li> </ul>
<b>Vertical Refresh Rates</b>	<ul style="list-style-type: none"> <li>◆ Refers to the number of repetitions per second. Also called a <i>Frequency rate</i> and is measured in Hertz (Hz). Higher refresh rates means less flicker, which helps to protect your eyes. The recommended refresh rate, by the International Ergonomics Standards Association, is a minimum of 70 Hz. Eyestrain is reduced at this frequency.</li> </ul>
<b>VLF</b>	<ul style="list-style-type: none"> <li>◆ VLF (Very Low Frequency: 3 – 30 KHz) refers to the frequency of the electromagnetic field. See also ELF.</li> </ul>

<b>VESA (Video Electronic Standards Association)</b>	<ul style="list-style-type: none"><li>◆ VESA stands for Video Display Standards Association and is based in Milpitas California.</li><li>◆ International trade association serving more than 150 companies (participate in the video display market). Website – <a href="http://www.vesa.org">www.vesa.org</a>.</li></ul>
<b>Watt (W)</b>	<ul style="list-style-type: none"><li>◆ The standard unit of power (or energy per unit time). It is the equivalent of one joule per second. A watt is used to specify the rate at which electrical energy is dissipated, or the rate at which electromagnetic energy is radiated, absorbed or dissipated.</li></ul>

## LG and Philips sign Definitive Agreement on Joint Venture



Amsterdam, June 11 2001: In Amsterdam today, Gerard Kleisterlee, President and Chief Executive Officer of Royal Philips Electronics (AEX: PHI, NYSE: PHG) and John Koo, Vice Chairman and CEO of LG Electronics (LG : KS 02610) signed a Definitive Agreement, through which the two companies will merge their respective cathode ray tube (CRT) businesses into a new joint venture company. The official presentation of the new company will be on July 5, in Hong Kong.

The 50-50 joint venture in display technology concerns all CRT activities including glass, and key components. With expected annual sales of nearly US\$ 6 billion and approximately 36,000 employees, the new company will have a global leadership position in the CRT market.

### Complementary Strengths and Synergy Potential

The merged entity is projected to benefit from the highly complementary strengths of the two companies:

- Philips' leadership in television tubes, and LG's leadership in monitor tubes;
- LG's geographical leadership in Asia, and Philips' strength in Europe, China, and the Americas;
- LG's industrial and manufacturing expertise and Philips' global marketing and technological innovation;
- Further benefits are expected in the areas of purchasing and research & development.

Under the terms of the agreement, LG and Philips will share equal control of the joint venture. The new company will be legally established in the Netherlands, with operational headquarters in Hong Kong. Philippe Combes, currently CEO of Philips Display Components, will lead the joint venture.

## Appendices

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[Overview Document](#)  
[Specification Sheet](#)