

BLI Comparative Performance Evaluation

JULY 2015

Epson A3 Business Inkjet Devices versus Competing A3 Colour Laser Devices

Test Objective

Buyers Laboratory LLC (BLI) was commissioned by Seiko Epson Corporation (SEC) to conduct testing of two Epson inkjet devices (WorkForce Pro WF-R8590 DTWF and WF-8590 DWF) and five competing A3 laser devices. The lab evaluation included productivity, environmental impact, image quality, reliability, waste generation and user intervention testing and BLI compared the results for the Epson inkjet models with those for the laser devices. The laser models tested were the Konica Minolta bizhub C224e, Canon imageRUNNER ADVANCE C2225i and C5235i, Xerox WorkCentre 7225 and HP LaserJet Enterprise 700 Color MFP M775dn. All testing was conducted at BLI's European test facility in Wokingham, UK.

Tested Devices

Device	Connection	Printer PDL	Rated speed (PPM) Mono / Colour	
Epson WorkForce Pro WF-R8590 DTWF	Ethernet	PCL 6	22	21
Epson WorkForce Pro WF-8590 DWF	Ethernet	PCL 6	22	21
Konica Minolta bizhub C224e	Ethernet	PCL 6	22	22
Canon imageRUNNER ADVANCE C2225i	Ethernet	PCL 6	25	25
Canon imageRUNNER ADVANCE C5235i	Ethernet	PCL 6	35	30
Xerox WorkCentre 7225	Ethernet	PCL 6	25	25
HP LaserJet Enterprise 700 Color MFP M775dn	Ethernet	PCL 6	30	30

Tested Devices: Testing Matrix

Device	Image Quality	Environmental Impact (Power Consumption)	Waste Generation	Productivity	User Intervention
Epson WorkForce Pro WF-R8590 DTWF	X	X	X	X	X
Epson WorkForce Pro WF-8590 DWF	X	X		X	
Konica Minolta bizhub C224e	X	X	X	X	X
Canon imageRUNNER ADVANCE C2225i	X	X		X	
Canon imageRUNNER ADVANCE C5235i	X	X		X	
Xerox WorkCentre 7225	X	X		X	
HP LaserJet Enterprise 700 Color MFP M775dn	X	X		X	

Executive Summary

Designed to deliver image quality, productivity and affordability comparable to a workgroup laser device, Epson's A3 inkjet devices offer the traditional inkjet advantages of significantly lower power consumption, greater ease of maintenance and less waste. In BLI's rigorous lab evaluation, the Epson inkjet devices gave a very strong performance in virtually all areas of testing, delivering clear speed advantages in many areas, very good image quality (even in default mode and on plain paper) and impressively low energy consumption, to lend credence to their claims.

In first-page-out (FPOT), and first-set-out (FSOT) speed tests, the Epson WF-8590 DWF displayed a speed advantage for shorter job lengths in simplex and duplex compared with their test group laser rivals. In particular, the WF-8590 DWF proved to be the most productive device overall in both simplex and duplex modes in both the FSOT and FPOT tests. In the test for estimated saturated throughput (ESAT) speeds, the Epson device was competitive with three of the laser models in the simplex workflow but slower than the Canon C5235i and HP M775dn models—not surprising, given the laser models' much higher rated speeds, and these Canon and HP models were also stronger performers in the duplex workflow, with the Epson model averaging the slowest speed of 15.72 ipm (images per minute).

In BLI's business document workflow test, designed to test a device's ability to handle a typical mix of business documents printed in a multi-user environment, the WF-8590 DWF was again one of the most productive devices, delivering an FPOT time 31.8% faster than the nearest laser device. However, the Epson model's FSOT (First Set Out Time) was 16.8% slower than the fastest model in the group.

Using a selection of business test documents, BLI also conducted productivity performance testing on each device after being in sleep mode for five minutes. As would be expected of inkjet devices, which characteristically do not require as much warm up time as laser devices, the Epson model delivered much faster FSOT and FPOT times across the board when compared with the competitive laser models tested.

When evaluating image quality produced in default mode on standard plain paper, there were notable differences in character formation between the output produced by the inkjet and some of the competing laser devices. The best performers for text in default mode were the Canon C5235i and HP M775dn, which delivered very good and comparable text quality in simplex and duplex modes. In best mode, character definition with the Epson device was comparable in quality with the best laser output. All models delivered distinct fine lines and smooth circles in simplex; colour and black halftone fills were smooth and consistent across the full range with distinct transitions between all levels.

Results for photographic image testing conducted in default mode on standard plain paper were mixed: colours produced by the Epson inkjet model were comparable with most of the laser output, despite the fact that the Epson inkjet registered the lowest optical densities and smaller colour gamut sizes than those delivered by all but two of the laser models. Photographic images in duplex mode produced by the Epson inkjet matched the vibrant, saturated colours shown in the output from the Konica Minolta and Canon C5235i, whilst the HP and Xerox models had lower ratings (fair and good) in duplex as some graininess was visible in images. Fine detail in dark and light contrast areas was better maintained by the inkjet models. When printing on photo paper, the Epson inkjet delivered a colour gamut larger than two of the laser competitors, but smaller than the other three. Another strength of the Epson WF-8590 DWF is its impressively low mean Delta E drifts ranging from 0.7 to 1.0, versus a mean of 1.4 to 4.9 for laser models over a 250-page print run, supporting the argument that inkjet devices deliver superior colour consistency over time.

In an environmental evaluation—in which devices were tested using BLI's proprietary energy consumption test methods—the Epson WF-8590 DWF demonstrated impressive energy efficiency, offering by far the lowest projected weekday and annual energy consumption compared with the laser models in the test group. Its projected annual energy consumption is 41.6% lower than that used by its nearest laser rival (Canon C5235i), and 78.8% lower than that of the laser model with the highest projected energy rate overall (Xerox WC 7225). The WF-8590 DWF also delivered a superior environmental performance with the lowest energy consumed while in its active (Idle) state (but not in Sleep mode), and during five minutes of copying and printing; the noise emissions of the WF-8590 DWF were also the lowest on average of all models tested.

With their strong overall performance, the Epson inkjet models certainly proved capable of providing high quality, cost-conscious, productive and environmentally friendly printing.

Productivity

In BLI's first-set-out and first-page-out testing, using the multi-page PDF, Word and Excel test files as stipulated in the ISO 24734:2009 methodology, the Epson WF-8590 DWF displayed a significant speed advantage across all file types and all simplex and duplex workflows, overall. In the FSOT test in simplex mode, the Epson WorkForce Pro WF-8590 DWF was the most productive device, with an average time that was 30.4% faster when compared with the slowest device, the Xerox WorkCentre 7225. The Epson WorkForce Pro WF-8590 DWF also proved to be the most productive device overall in duplex mode in the FSOT test, with an average time that was 43.0% faster than the slowest laser model, the Konica Minolta bizhub C224e. In the FPOT test in simplex, the Epson device's average time was much faster than that of the slowest device, the Xerox WC 7225. In duplex mode in the FPOT test the Epson model's time of 11.88 seconds was 57.7% faster than the slowest model (Konica Minolta C224e).

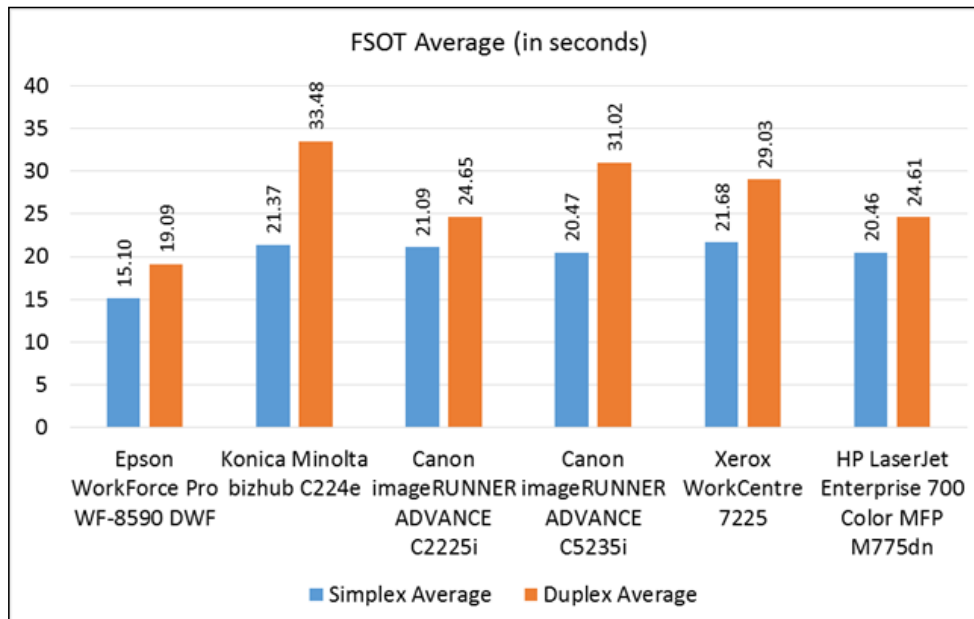
In the test for estimated saturated throughput (ESAT) speeds (a measure of speed that eliminates the impact of the first set), the Epson device was competitive with three of the laser models in the simplex workflow but slower than the Canon C5235i and HP M775dn models—as would be expected, given their higher rated speeds of 35/30 and 30 ppm versus 22/21 ppm for the Epson model, and these Canon and HP models were also stronger performers in the duplex workflow, with the Epson model providing the slowest average speed of the group.

First-Set-Out Test Results (seconds)

	FSOT Simplex				FSOT Duplex			
	PDF	Word	Excel	Average	PDF	Word	Excel	Average
Epson WorkForce Pro WF-8590 DWF	14.69	12.11	18.5	15.10	18.77	16.15	22.34	19.09
Konica Minolta bizhub C224e	20.33	19.94	23.83	21.37	32.08	32.36	36.01	33.48
Canon imageRUNNER ADVANCE C2225i	20.21	19.64	23.43	21.09	30.90	19.64	23.43	24.65
Canon imageRUNNER ADVANCE C5235i	19.58	19.00	22.84	20.47	27.35	27.10	38.62	31.02
Xerox WorkCentre 7225	20.72	20.18	24.14	21.68	27.90	26.88	32.31	29.03
HP LaserJet Enterprise 700 Color MFP M775dn	17.07	16.87	27.43	20.46	22.09	21.41	30.34	24.61

First-Set-Out Time (FSOT) is defined as the length of time (in seconds) the device takes to produce pages, measured from the initiation of the print job to the complete exit of the last page of the first test set. See www.iso.org and reference ISO standard 24734 for additional details.

Average First-Set-Out Test Results (seconds)

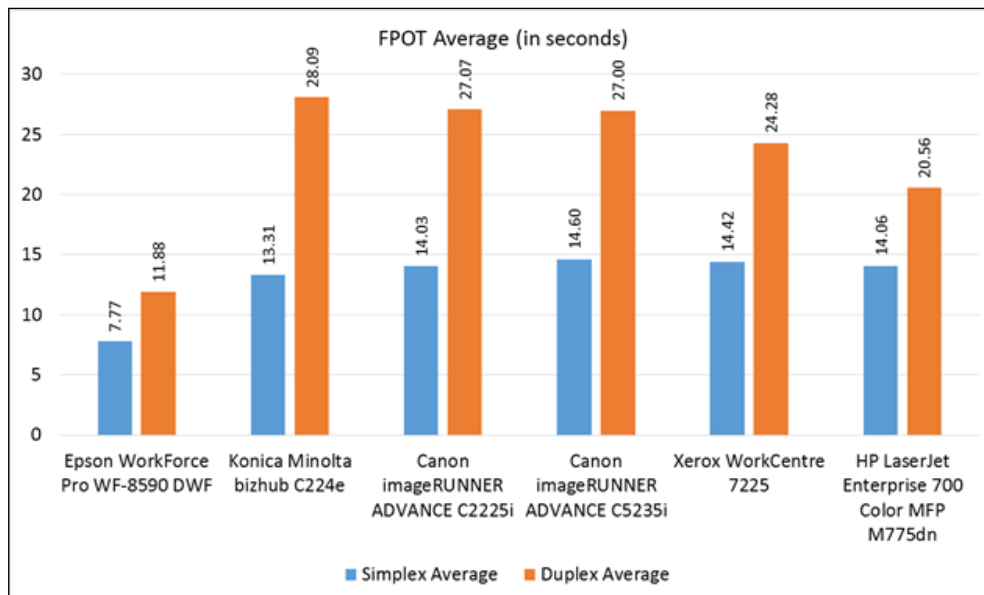


First-Page-Out Test Results (seconds)

	FSOT Simplex				FSOT Duplex			
	PDF	Word	Excel	Average	PDF	Word	Excel	Average
Epson WorkForce Pro WF-8590 DWF	7.17	5.84	10.30	7.77	11.57	9.65	14.43	11.88
Konica Minolta bizhub C224e	12.15	11.91	15.87	13.31	26.68	26.86	30.74	28.09
Canon imageRUNNER ADVANCE C2225i	13.10	12.62	16.38	14.03	26.10	25.68	29.45	27.07
Canon imageRUNNER ADVANCE C5235i	13.66	13.26	16.89	14.60	23.40	23.07	34.54	27.00
Xerox WorkCentre 7225	13.67	12.82	16.79	14.42	23.10	22.14	27.60	24.28
HP LaserJet Enterprise 700 Color MFP M775dn	11.19	10.65	20.34	14.06	18.08	17.30	26.31	20.56

First-Page-Out (FPOT) is defined as the length of time (in seconds) the device takes to produce a page measured from job release to the complete exit of the first page of the first test file.

Average First-Page-Out Test Results (seconds)

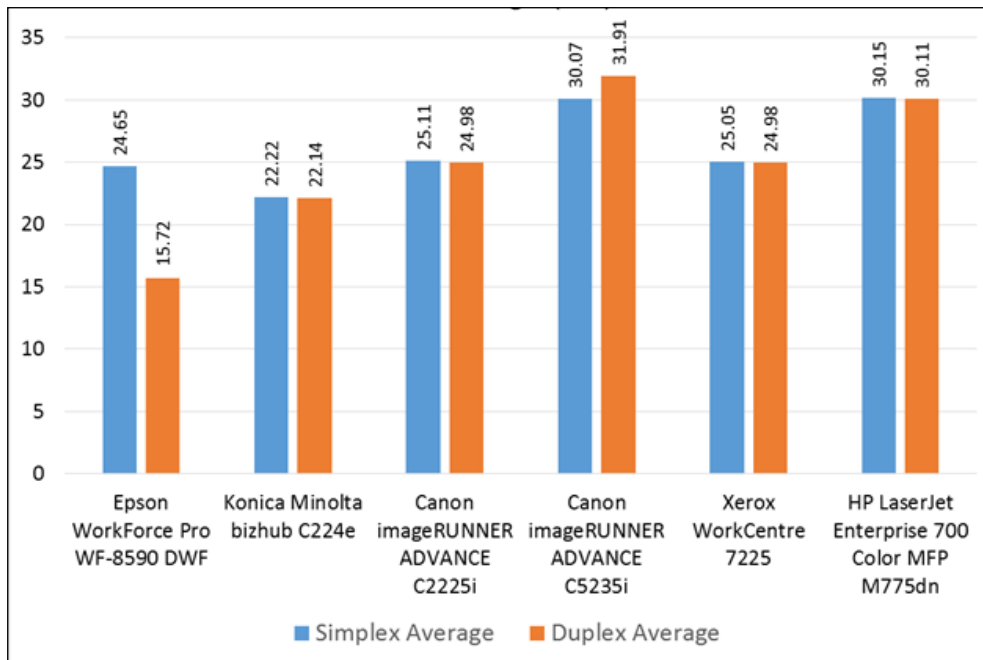


Estimated Saturated Throughput Test Results (images per minute)

	FSOT Simplex				FSOT Duplex			
	PDF	Word	Excel	Average	PDF	Word	Excel	Average
Epson WorkForce Pro WF-8590DWF	23.13	29.12	21.71	24.65	16.76	14.24	16.17	15.72
Konica Minolta bizhub C224e	22.28	22.18	22.21	22.22	22.15	22.23	22.02	22.14
Canon imageRUNNER ADVANCE C2225i	25.11	25.07	25.14	25.11	24.75	25.08	25.10	24.98
Canon imageRUNNER ADVANCE C5235i	30.07	30.04	30.11	30.07	31.91	31.90	31.91	31.91
Xerox WorkCentre 7225	25.00	25.07	25.08	25.05	24.92	25.03	24.97	24.98
HP LaserJet Enterprise 700 Color MFP M775dn	30.06	30.36	30.05	30.15	30.05	30.15	30.13	30.11

Estimated Saturated Throughput (ESAT) is defined as the rate at which a device produces pages, measured from the complete exit of the last page of the first test set through to the complete exit of the last page of the last test set. ESAT is expressed in images per minute (ipm). See www.iso.org and reference ISO standard 24734 for additional details.

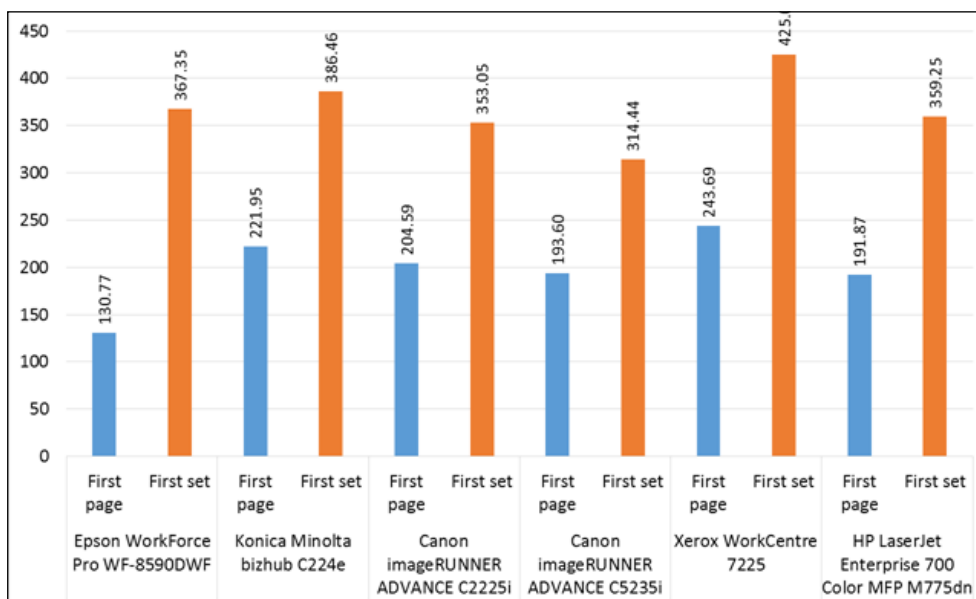
Estimated Saturated Throughput Test Results (images per minute)



Business Document Workflow FPOT and FSOT Test Results

In BLI's business document workflow test, 12 separate file types of varying lengths—designed to reflect a typical mix of business documents printed in a multi-user environment—were sent to print when the devices were in Idle mode, with the time from job release to final page out recorded. The chart below documents the total time for all test files by first-page-out and first-set-out.

Total FPOT and FSOT Results (From Idle Mode, in seconds)



The Epson WF-8590 DWF outclassed all the A3 laser competitors, proving to be the more productive device in terms of the FPOT (First Page Out Times) from idle state evaluation with all FPOT times aggregated, where its time of 130.77 seconds was 31.8% faster than the nearest (HP M775dn) laser model. However, when evaluating the overall FSOT (First Set Out Times) for the entire business document test suite, the Epson WF-8590 DWF proved to be the third slowest performer

overall, with a total time of 367.35 seconds, 16.8% slower than the fastest Canon C5235i model. This is not surprising when you consider that five out of six laser competitors have a higher (or much higher) rated speed in colour, putting the Epson model at a disadvantage when printing graphics-intensive documents like the PowerPoint presentation.

FPOT Times per Test File (from Idle Mode, in seconds)

		Epson WorkForce Pro WF-8590 DWF	Konica Minolta bizhub C224e	Canon imageRUNNER ADVANCE C2225i	Canon imageRUNNER ADVANCE C5235i	Xerox WorkCentre 7225	HP LaserJet Enterprise 700 Color MFP M775dn
Document name	file type	First page	First page	First page	First page	First page	First page
ISO 24734 (PDF file)	.pdf	7.17	12.15	13.1	13.66	13.67	11.19
BLI Test document	.docx	6.44	11	11.95	12.38	8.5	10.85
www.CNN.com (home page)	.html	8.44	14.03	14.18	14.34	15.97	12.92
Government tax form	.pdf	7.94	11.84	12.75	13.38	13.47	11.63
Press release	.docx	6.31	11.66	12.51	12.94	13.13	10.55
Powerpoint presentation	.pptx	17.86	17.75	17.28	17.02	27.22	20
Excel spreadsheet	.xlsx	7.31	16.63	13.35	14.08	14.25	13.42
Hi-Res product brochure	.pdf	9.95	17.1	17.59	18.28	22.41	20.47
Letter with Hi-Res image	.docx	11.56	18.75	19.66	15.14	30.57	12.5
Government tax form (300dpi scan)	.tiff	18.88	19.18	17.68	16.68	26.48	19.99
Booklet*	.pdf	19.44	48.61	35.57	27.63	35.3	28.13
Multipage 4 into 1 (16 page document)**	.pdf	9.47	23.25	18.97	18.07	22.72	20.22
Total time for all test files.		130.77	221.95	204.59	193.60	243.69	191.87

FSOT Times per Test File (from Idle Mode, in seconds)

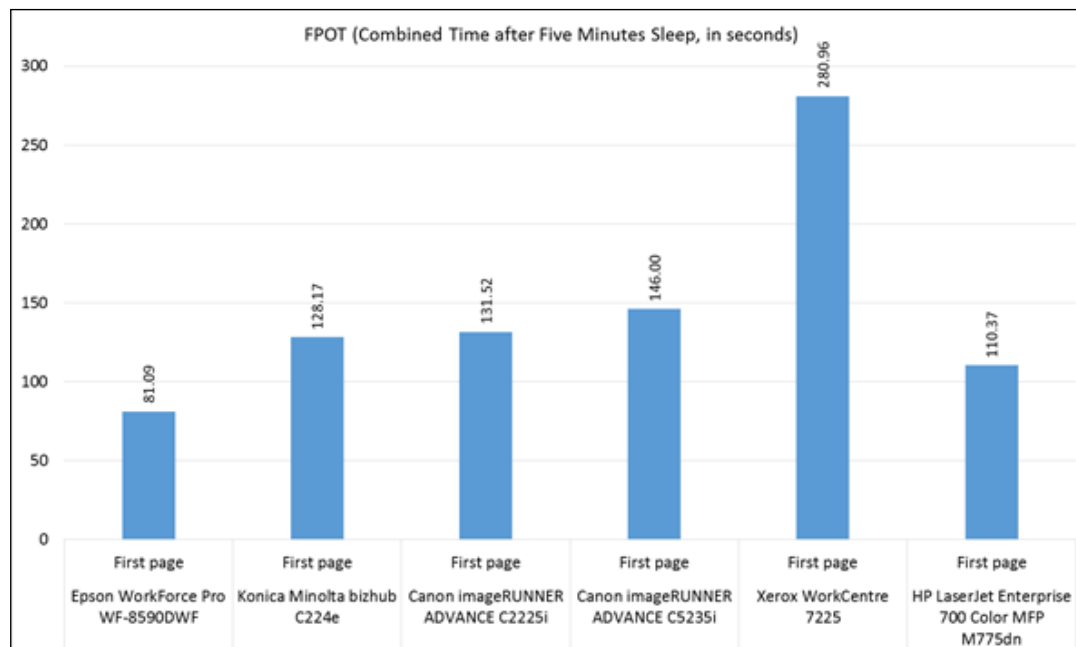
	Idle mode		Epson WorkForce Pro WF-8590 DWF	Konica Minolta bizhub C224e	Canon imageRUNNER ADVANCE C2225i	Canon imageRUNNER ADVANCE C5235i	Xerox WorkCentre 7225	HP LaserJet Enterprise 700 Color MFP M775dn
Test File	No. of pages	file type	First set	First set	First set	First set	First set	First set
ISO 24734 (PDF file)	4	.pdf	14.69	20.33	20.21	19.58	20.72	17.07
BLI Test document	1	.docx	6.44	11	11.95	12.38	8.5	10.85
www.CNN.com (home page)	2	.html	12.37	16.66	16.68	16.23	18.28	14.87
Government tax form	6	.pdf	25.44	25.31	24.72	23.35	25.76	21.66
Press release	3	.docx	11.27	17.09	17.26	16.91	17.91	14.62
PowerPoint presentation	22	.pptx	89.75	74.56	67.39	58.94	102.08	61.93
Excel spreadsheet	5	.xlsx	17.94	24.7	22.99	21.94	24.03	21.37
Hi-Res product brochure	12	.pdf	56.59	46.84	43.87	40.03	52.38	54.72
Letter with Hi-Res image	2	.docx	14.16	21.31	22.16	17.07	32.99	14.93
Government tax form (300dpi scan)	6	.tiff	50.66	32.58	29.64	26.57	42.66	40.03
Booklet	16	.pdf	48.5	64.93	49.96	37.37	49.79	50.9
Multipage 4 in to 1 (16 page document)	4	.pdf	19.54	31.15	26.22	24.07	29.97	36.3
Total for all test files			367.35	386.46	353.05	314.44	425.07	359.25

Using a selection of typical business test documents (six files, totalling 41 pages), BLI conducted productivity performance testing on each device after being in Sleep mode for five minutes. This was a very strong showing from the Epson inkjet model: as inkjet devices typically do not require as much warm up time as laser devices, the Epson WF-8590 DWF displayed much faster FPOT, in particular, and FSOT times across the board when compared with the competitive laser group average. Its FPOT combined time is 26.5% faster than the nearest laser device (HP MFP M775dn).

FPOT Times per Test File (From Five Minutes Sleep, in seconds)

	From 5 Minute sleep	Epson WorkForce Pro WF-8590 DWF	Konica Minolta bizhub C224e	Canon imageRUNNER ADVANCE C2225i	Canon imageRUNNER ADVANCE C5235i	Xerox WorkCentre 7225	HP LaserJet Enterprise 700 Color MFP M775dn
Test File	File type	First page	First page	First page	First page	First page	First page
ISO 24734 (PDF file)	.pdf	11.10	20.05	24.94	25.87	43.38	14.90
Government tax form	.pdf	11.63	17.03	18.41	20.56	43.91	16.07
Press release	.docx	10.40	17.02	24.45	20.28	44.22	14.74
Powerpoint presentation	.pptx	16.37	22.59	21.87	24.53	51.69	18.14
Letter with Hi-Res image	.docx	19.92	23.49	19.12	26.59	53.16	16.63
Multipage 4 in to 1 (16 page document)	.pdf	11.67	27.99	22.73	28.17	44.6	29.89
Total for all test files		81.09	128.17	131.52	146.00	280.96	110.37

FPOT Combined Time for Entire Test Suite (From Sleep Mode, in seconds)



FSOT Times per Test File (From Five Minutes Sleep, in seconds)

	5 Minute sleep		Epson WorkForce Pro WF-8590 DWF	Konica Minolta bizhub C224e	Canon imageRUNNER ADVANCE C2225i	Canon imageRUNNER ADVANCE C5235i	Xerox WorkCentre 7225	HP LaserJet Enterprise 700 Color MFP M775dn
Test File	No. of pages	File type	First set	First set	First set	First set	First set	First set
ISO 24734 (PDF file)	4	.pdf	18.15	28.30	32.12	31.87	50.69	20.97
Government tax form	6	.pdf	29.28	30.36	30.41	30.42	56.20	26.09
Press release	3	.docx	15.28	22.59	29.30	24.14	48.97	18.84
Powerpoint presentation	22	.pptx	87.27	79.53	71.97	66.39	128.41	72.06
Letter with Hi-Res image	2	.docx	16.24	26.46	21.79	28.44	55.62	19.48
Multipage 4 in to 1 (16 page document)	4	.pdf	23.24	36.13	30.16	34.17	52.03	45.43
Total time for all test files.	41		189.46	223.37	215.75	215.43	391.92	202.87

FSOT Combined Time for Entire Test Suite (From Sleep Mode, in seconds)

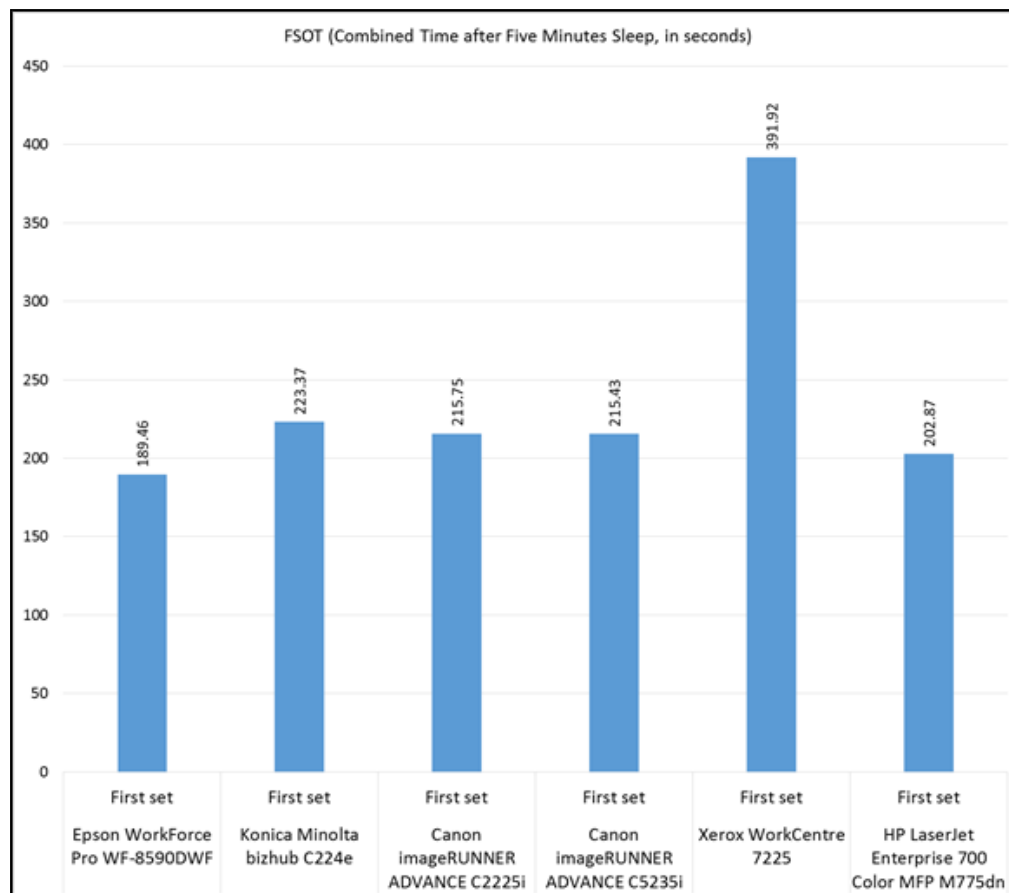


Image Quality

Test Description: Using a range of BLI and industry-standard test targets, image quality was assessed from a variety of perspectives including optical density, photographic image reproduction, consistency of duplex output and colour consistency. All tests were conducted in default quality mode (for laser devices) and draft, default and best modes (for the Epson inkjet device) using 80gsm multipurpose office paper. Colour gamut evaluation was performed using 80gsm multipurpose office paper and photo paper (190gsm glossy photo paper for inkjets and 200gsm photo colour paper for lasers).

Text and Fine Line Reproduction

In BLI's text reproduction evaluation, there was a notable difference between output produced by the inkjet devices and some of the competing laser models. The best performers in default mode were the Canon C5235i and HP M775dn, which delivered very good text quality in simplex and duplex modes—serif and sans serif fonts on plain 80gsm media were legible down to the smallest 3-pt. font size, with no breakup across the board—closely followed by the Konica Minolta C224e whose fonts were legible down to 4-pt. sizes. In default mode the Epson WF-8590 DWF delivered fonts that were fully legible at the 6-pt. size for Times serif fonts, and 4-pt. size for Arial sans serif fonts. Similar results were evident in output from the Canon C2225i and Xerox 7225 models. As expected, the Epson device's fonts were slightly less distinct in draft mode, whilst in best mode, character definition was much improved with all fonts legible down to 3-pt. level (comparable in quality with the best laser output).

Fine lines produced by four of the laser models (both Canon models, plus HP and Konica Minolta) remained distinct down to the 0.1-pt. level in default mode. The Epson needs its best mode to achieve the same results; in draft and default modes, fine lines delivered by the Epson model were rated fair and were only distinct at the 0.25-pt. level, a similar result as with the Xerox 7225. Circles were smooth and rated good or very good with the laser devices (except for Xerox) and remained distinct to the 0.1-pt level—a level of quality attained by the Epson inkjet devices only in best mode. In default mode, all devices (except for Xerox and Epson) produced the 1 x 1 pixel grid with no quality issues; as expected in draft mode where less ink is laid down, the Epson model delivered 2 x 2 pixel grids that were rated poor. The laser models were capable of producing white-on-black fine lines down to the 0.1-pt level and rated good to very good. With the Xerox 7225 and the Epson inkjet device, white-on-black fine lines were visible down to the 0.25-pt. level.

The colour and black halftone fills produced by all models in default mode were smooth and consistent across the 10% to 100% dot-fill levels, with distinct transitions between all levels, and displayed no mottling. In draft and default modes, the Epson device's greyscale coverage was only rated fair and lacked definition at the lighter end of the range. However, colour halftone coverage was still rated good and was clear and distinct across the full range. In best mode, colour and black halftone quality was, as expected, notably enhanced and was rated very good.

Subjective Image Quality Analysis

BLI analysts noted that when tested on 80gsm plain paper in default settings, there were only subtle differences between the images produced by the Epson inkjet model compared with images from the laser devices. Quality was very good across the board, except for the Xerox and the Canon C2225i models which were rated good. Photographic images in duplex mode produced by the Epson inkjet matched the vibrant, saturated colours shown in the output from the Konica Minolta and Canon C5235i, whilst the HP and Xerox models had lower ratings (fair and good) in duplex. The Epson WF-8590 DWF inkjet delivered smoother gradations between dark and light areas over most of its laser rivals—by comparison, output from the Canon C2225i and the HP model exhibited some graininess and poor transitions from light to dark areas. When tested in draft mode, images produced by the Epson inkjet device were predictably inferior, with pale, 'washed-out' colours and lower definition. Image quality delivered in best mode was on a par with that produced in default mode: very good across the board.

Solid Density

In BLI's evaluation, the laser devices delivered considerably higher average black and colour optical densities in default mode when printing on 80gsm plain paper compared with those from the Epson inkjet device. Although the Xerox 7225 had the highest optical densities for magenta and black (in both simplex and duplex), it had the lowest densities of the laser models for cyan and yellow.

Average Density in Simplex and Duplex (Default mode)

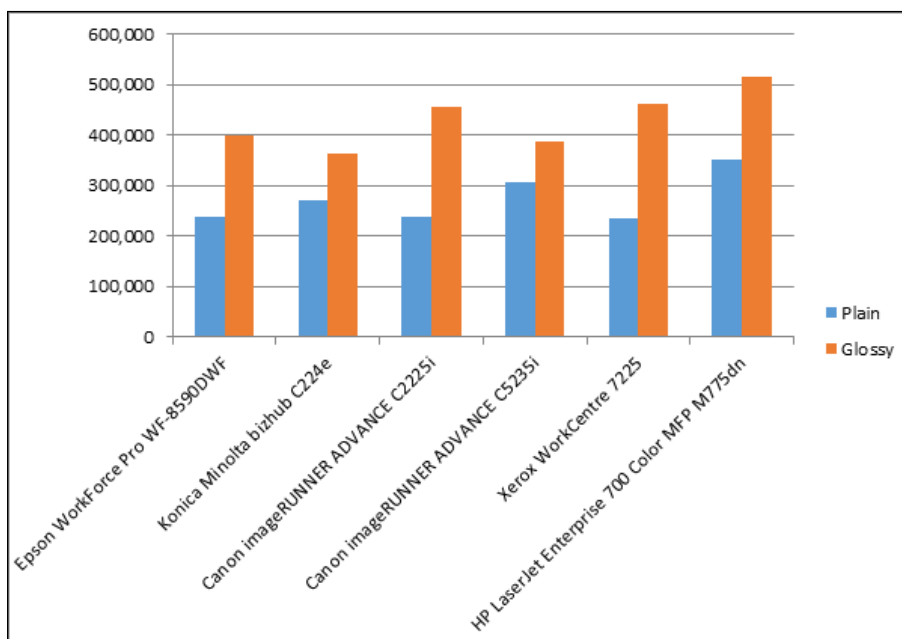
Device	Simplex				Duplex			
	Cyan Average	Magenta Average	Yellow Average	Black Average	Cyan Average	Magenta Average	Yellow Average	Black Average
Epson WorkForce Pro WF-8590 DWF	0.75	0.86	0.60	1.01	0.75	0.87	0.59	1.01
Konica Minolta bizhub C224e	1.13	1.09	0.78	1.39	1.11	1.04	0.77	1.39
Canon imageRUNNER ADVANCE C2225i	0.95	1.07	0.88	1.25	0.95	1.13	0.95	1.29
Canon imageRUNNER ADVANCE C5235i	1.00	1.19	0.84	1.40	0.99	1.17	0.81	1.36
Xerox WorkCentre 7225	0.93	1.29	0.64	1.44	0.90	1.23	0.63	1.46
HP LaserJet Enterprise 700 Color MFP M775dn	1.34	1.21	0.85	1.27	1.36	1.20	0.85	1.26

Colour Gamut

	80 gsm plain paper	100gsm glossy photo paper
Epson WorkForce Pro WF-8590 DWF	238,323	399,864
Konica Minolta bizhub C224e	269,611	362,539
Canon imageRUNNER ADVANCE C2225i	237,638	457,107
Canon imageRUNNER ADVANCE C5235i	306,420	386,059
Xerox WorkCentre 7225	235,294	461,115
HP LaserJet Enterprise 700 Color MFP M775dn	350,360	516,079

Using a 300-patch profile, an EFI ES-1000 colour spectrophotometer and Chromix ColorThink Pro v3.0 software, BLI assessed the CIE colour gamut volume at the start and end of the test. The tests were conducted on 80gsm multi-purpose uncoated office paper and compatible glossy photo paper. When printing on standard office paper, the Epson model's colour gamut was higher than that of the Canon C2225i and Xerox 7225 devices, but was a long way short of the HP M775 and Canon C5235i models. When printing on 100-gsm glossy photo media, the Epson delivered a creditable CIE volume of 399,864—higher than the colour gamut achieved by the Konica Minolta C224e and the Canon C5235i, but much lower than the impressive 516,079 achieved by the HP M775 model.

Colour Gamut on Plain and Glossy Paper

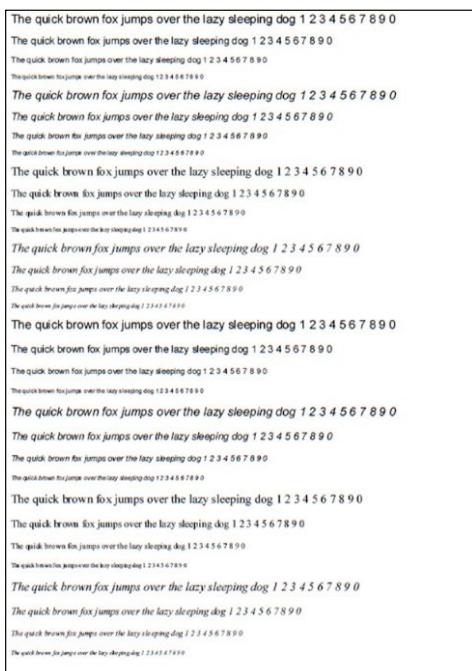


Consistency of Duplex Output

BLI analysts observed there was broadly the same level of consistency and quality in text and fine lines produced in duplex workflows across all tested laser and inkjet devices, when compared with simplex output. As noted above, the HP and Xerox models had lower ratings (fair and good) in duplex for photographic images, as there was some graininess visible in duplex output, but this was the only difference between simplex and duplex output across the models tested.

There was negligible difference in inkjet and laser models' duplex density readings compared with simplex densities, with the Epson inkjet, as predicted, yielding a lower density average in duplex compared with the laser models. There was an increase in magenta and yellow duplex solid densities for the Canon C2225i model, but all other models had very similar duplex results.

BLI's duplex test target



In order to assess the effect of showthrough caused by printing in duplex, BLI printed its proprietary test target (above) on both sides of 80gsm plain paper on all tested devices.

The output from the laser devices was very good; there was minimal showthrough on the standard office media. The Epson WF-8590 DWF inkjet exhibited enough showthrough on its duplex output to be judged acceptable for general office use, as readability was not affected, but it would not be considered suitable for external consumption.

Colour Delta E Drift Summary over 250-page print run

	Delta E - Colour drift									
	50		100		150		200		250	
	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak	Mean	Peak
Epson WorkForce Pro WF-8590 DWF	0.8	1.9	0.9	1.8	0.7	1.5	0.7	2.2	1.0	2.5
Konica Minolta bizhub C224e	1.4	3.5	2.0	5.2	2.2	4.9	2.5	4.8	2.7	5.7
Canon imageRUNNER ADVANCE C2225i	3.3	7.5	2.9	7.1	2.7	5.9	3.3	8.2	3.5	8.9
Canon imageRUNNER ADVANCE C5235i	1.5	3.4	2.2	5.5	2.4	5.4	2.8	6.4	2.9	6.6
Xerox WorkCentre 7225	1.7	6.5	2.0	3.9	4.6	7.5	4.8	8.1	4.9	8.4
HP LaserJet Enterprise 700 Color MFP M775dn	1.4	3.6	1.6	3.8	1.6	3.8	1.7	4.3	1.7	5.3

During BLI's colour drift analysis, in which a FOGRA39 media wedge is submitted for print and then measured for colour consistency using EFI Color Verifier software, the Epson inkjet device delivered impressively low mean Delta E drifts that ranged from 0.7 to 1.0, versus the 1.4 to 4.9 from the laser models. In terms of colour variance, the Epson WF-8590 DWF's colour variance remained largely stable, with a peak of just 2.5 over the final 200- to 250-page test phase. The laser devices showed more colour variance over the course of the test, with the Canon C2225i and Xerox WorkCentre 7225 showing the greatest colour variance, with the highest peak Delta E readings of 8.9 and 8.4, respectively, which would be discernible by the unaided eye. These results support the argument that inkjet devices deliver superior colour consistency over time compared with laser devices.

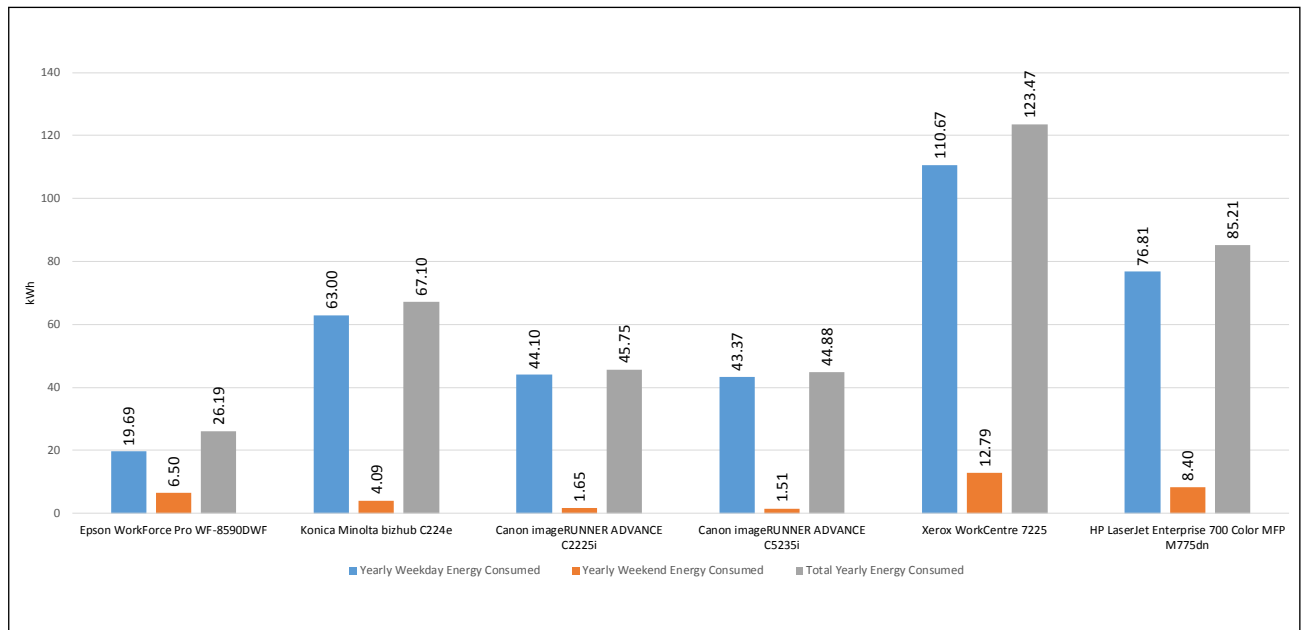
Environmental Testing

Energy Consumption

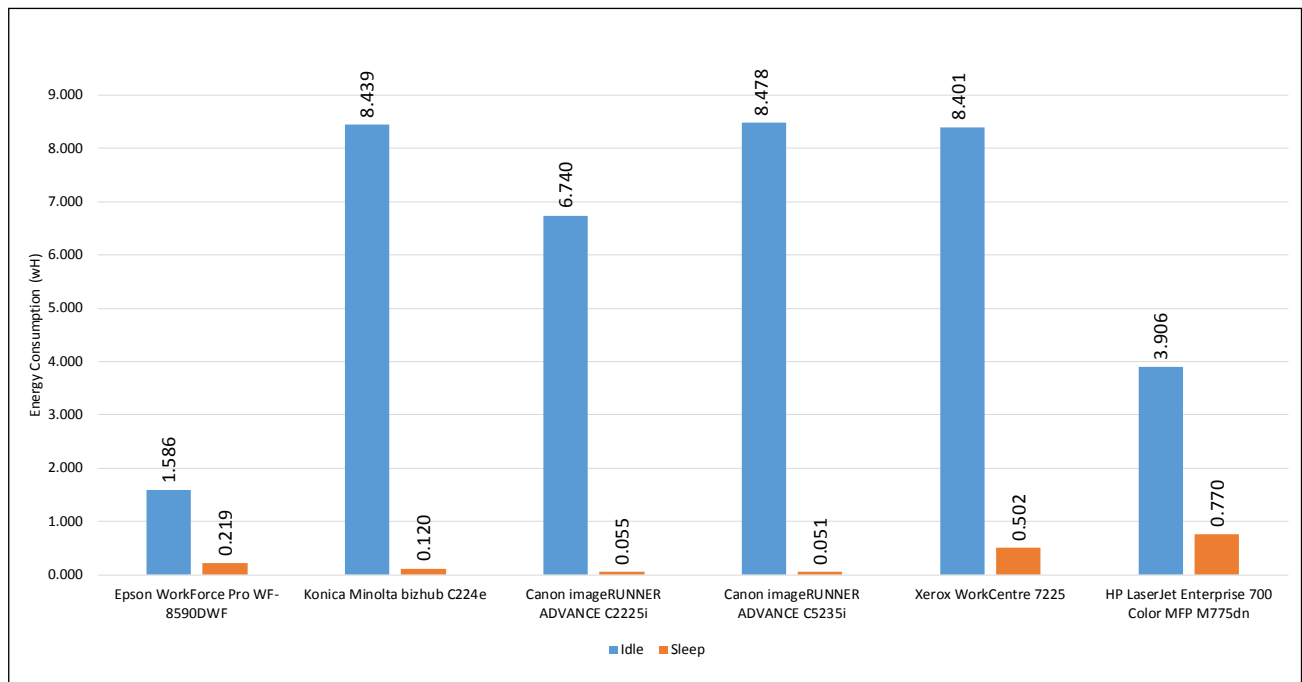
In BLI's environmental evaluation, devices were tested in default mode and in both simplex and duplex modes, following BLI's proprietary standard energy consumption test methods. Total yearly energy consumption is calculated based on the total energy used during a typical workday, plus overnight and weekend sleep energy. Energy measurements were recorded using a Yokogawa WT210 energy meter.

The Epson WF-8590 DWF delivered an impressive vindication of the claims made for the energy efficiency of inkjet models, offering by far the lowest overall projected weekday and annual energy consumption compared with its laser competitors. It had an estimated annual energy consumption of just 26.1894 kWh—41.6% lower than that yielded by its nearest laser rival (Canon C5235i), and 78.8% lower than that of the laser model with the highest projected energy rate overall (Xerox WC 7225).

Projected Weekday, Weekend and Yearly Energy Consumption (kWh)



Energy Consumption during Five Minutes in Idle and Sleep Modes (wH)



During five minutes in Sleep mode, all devices in the test group displayed low energy consumption, with Epson almost matching the ultra-low Sleep mode consumption of the Konica Minolta and both Canon models. When remaining in active ready (Idle) state, the energy consumed by the Epson inkjet device is far lower compared with the results from the laser models in the test group. The WF-8590 DWF consumed 81.3% less energy in Idle mode compared with the Canon C5235i which had the highest energy consumption rate during five minutes in its active state (1.586 wH versus 8.478 wH).

Energy Consumed during Five Minutes Copying/Printing (wH)

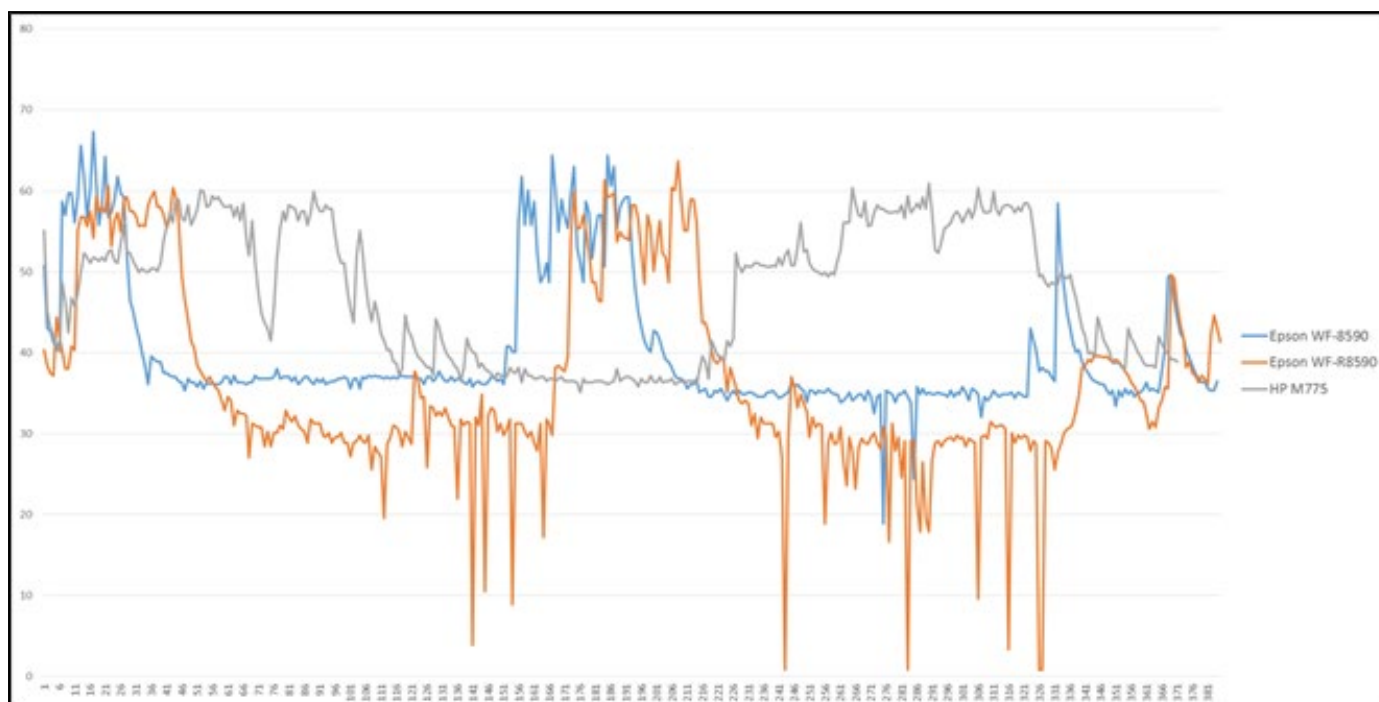
Device	Five minutes copying				Five minutes printing			
	Mono simplex	Colour simplex	Mono duplex	Colour duplex	Mono simplex	Colour simplex	Mono duplex	Colour duplex
Epson WorkForce Pro WF-8590 DWF	2.859	2.615	2.949	2.771	3.164	3.143	2.275	2.284
Konica Minolta bizhub C224e	37.402	40.035	36.942	40.493	38.603	41.883	33.273	35.134
Canon imageRUNNER ADVANCE C2225i	34.633	38.405	34.234	34.411	40.148	37.605	36.67	39.173
Canon imageRUNNER ADVANCE C5235i	48.503	48.42	52.401	51.699	55.292	51.794	51.568	52.004
Xerox WorkCentre 7225	31.769	32.488	27.831	29.085	30.571	33.788	29.952	30.789
HP LaserJet Enterprise 700 Color MFP M775dn	42.487	41.332	38.431	36.389	43.109	42.762	38.932	36.993

Noise Generation in Decibels

In accordance with BLI standard methodology, all devices were tested for noise emissions over a range of typical office activities for a period of three minutes. A four-page ISO test document was sent to print in simplex mode and then the device was left in idle state for one minute; the same job was sent as a duplex job and the device spent one more minute in idle state, after which the test was repeated for the duration of the three minute period. Noise emissions were measured using an Extech sound level datalogger.

	Epson WorkForce Pro WF-8590 DWF	Epson WorkForce Pro WF-R8590 DTWF	Canon imageRUNNER ADVANCE C2225i	Canon imageRUNNER ADVANCE C5235i	HP LaserJet Enterprise 700 Color MFP M775dn	Konica Minolta bizhub C224e	Xerox WorkCentre 7225
Minimum (dBA)	17.9	0.8	17.9	0.8	35.1	34.9	31.0
Maximum (dBA)	55.6	63.7	55.6	60.1	60.9	56.6	58.9
Average (dBA)	40.12	36.55	40.85	37.33	47.48	44.55	42.00

The Epson WF-R8590 DTWF produced the lowest average noise emissions (36.55 dBA) overall, followed by the Canon C5235i (37.33 dBA) and Epson's sister model the WF-8590 DWF (40.12 dBA). The HP LaserJet Enterprise 700 Color MFP M775dn registered the highest average (47.48 dBA), however the highest peak noise emissions were delivered by the Epson RIPS inkjet device. BLI analysts observed the Epson devices were capable of entering sleep mode at a faster rate than the laser models which helped with noise reduction. The inkjets also tended to have longer quiet periods but would typically emit a sharp noise (reflected in their higher peak noise emission results) upon completing a print job, which BLI technicians attribute to the inkjet finishing process whereby the printhead is wiped and returns to its starting position.



Noise emissions recorded for the duration of the three-minute test for three devices: two Epson inkjets which delivered low noise emission averages and an HP laser model which delivered the highest average noise emissions, overall. In between print jobs, the devices were sent to sleep for a duration of one minute; the inkjets clearly fall into sleep mode at a faster rate, compared to the HP device, and exhibited longer quiet periods.

Space Requirements

	Length (cm)	Width (cm)	Height (cm)	Total volume (M ³)
Epson WorkForce Pro WF-R8590 DTWF	120	110	147	1.940
Epson WorkForce Pro WF-8590 DWF	120	70	147	1.235
Konica Minolta bizhub C224e	110	110	157	1.900
Canon imageRUNNER ADVANCE C2225i	120	100	155	1.860
Canon imageRUNNER ADVANCE C5235i	120	100	155	1.860
Xerox WorkCentre 7225	110	90	146	1.445
HP LaserJet Enterprise 700 Color MFP M775dn	115	90	93	0.963

When evaluating the maximum space requirements for operation and maintenance tasks (e.g., access to misfeed areas and the replacement of consumables) there was little to distinguish between most of the test models. However, the Epson WF-R8590 DTWF RIPS model with its large-sized ink cartridge side panels clearly requires more desk space than the rest, though it's comparable with the two Canon models and the Konica Minolta C224e. The non-RIPS Epson model is (along with the HP model) among the most compact devices, and requires very little space for cartridge replacement compared with its laser competitors, some of which require the removal of the drum unit.

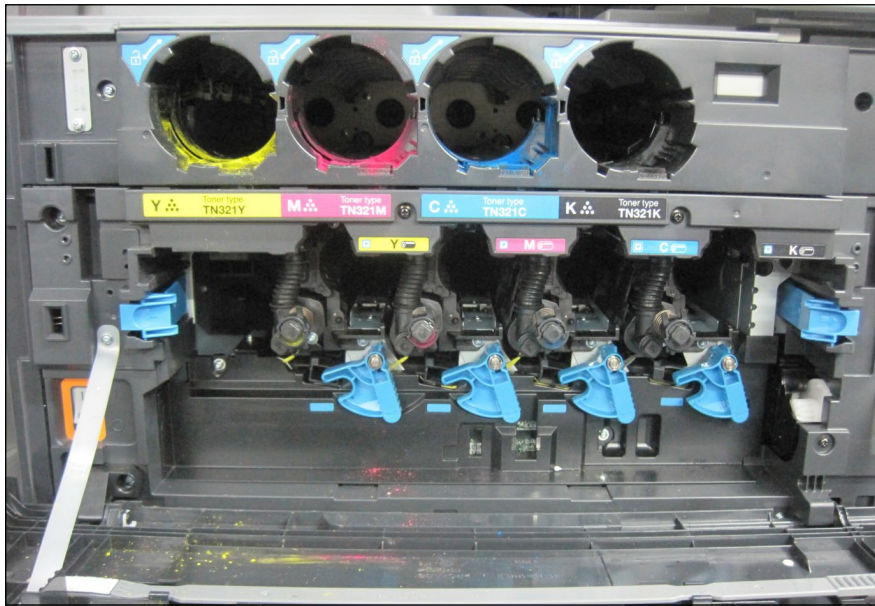
Consumable Replacement



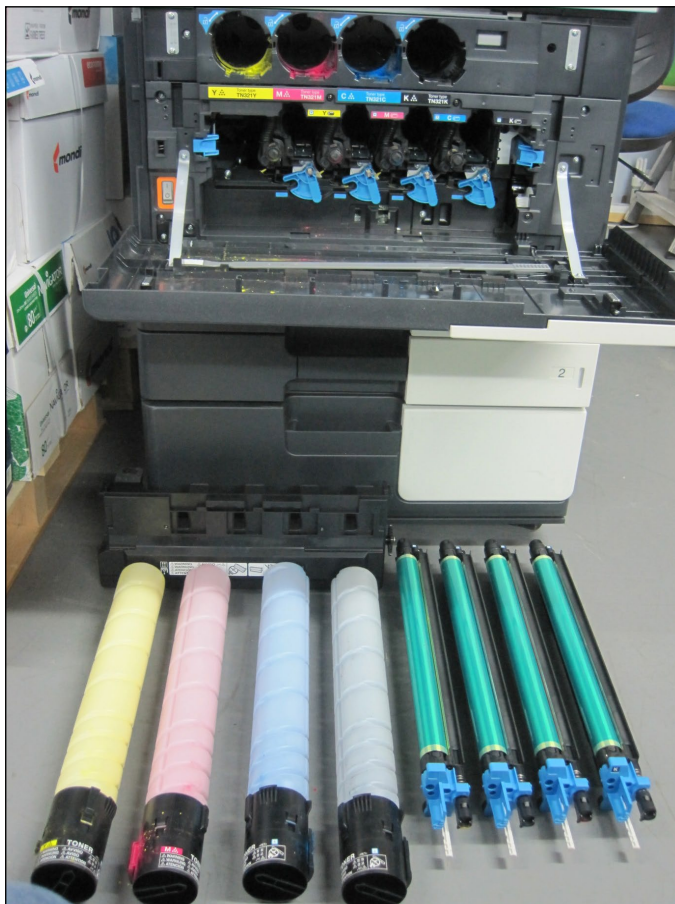
Epson WorkForce Pro WF-8590 DWF: replacing ink cartridges is an extremely quick, easy and clean process. Users open the front cover and then push in the empty cartridge to release it (it's spring-loaded). Slots are colour-coded and cartridges are “keyed”, making the process foolproof.



Epson WorkForce Pro WF-R8590 DTWF: replacing ink cartridge bags is a very clean and straightforward process. Users open the side panel covers and push in the button on the cartridge holder to release the bag. Slots are clearly colour-coded and keyed. New cartridge bags slide easily into place and can be quickly clipped into position in a one-handed operation.



Replacing toner containers and waste containers on the Konica Minolta bizhub C224e is also straightforward, although some toner contamination is almost inevitable after cartridges have been removed, as shown above.



Konica Minolta bizhub C224e after toner cartridges and waste containers have been removed.

Reliability, Waste Generation, User Intervention and Cost of Ownership Evaluation

Reliability

During this test over 65,000 impressions, the Epson WorkForce Pro WF-R8590 DTWF experienced just one misfeed, while the Konica Minolta bizhub C224e produced a faultless reliability performance, experiencing no misfeed and no component failures, nor did it experience any image quality issues.

Model	Total Misfeeds	Misfeed Rate	Service Calls	Other issues	TOTAL
Epson WorkForce Pro WF-R8590 DTWF	1	Not Applicable	0	0	0
Konica Minolta bizhub C224e	0	Not Applicable	0	0	0

Waste Generation

To assess the comparative amount of waste material generated over the course of a 65,000-impression run, BLI assessed all consumables waste including toner/ink cartridges, imaging units, waste toner bottles, and any maintenance kit items required, with all items being retained, weighed and photographed. All toner/ink cartridges were run to exhaustion or until image quality was deemed to have dropped below an acceptable standard for external usage. There was much less waste incurred by the Epson WF-R8590 DTWF in this test, not surprising given the RIPS cartridge packs' rated yield of 75,000. The Epson WF-R8590 DTWF not only used far fewer cartridges than the Konica Minolta model to print 65,000 pages (resulting in fewer interruptions to workflow to change supplies), but also produced significantly low amounts of consumables and packaging waste over the test when compared to that of the Konica Minolta device—in fact, as much as 91.2% less by weight. The total weight of all cartridges, maintenance kits and cartridge packaging required to print 65,000 pages was just 529.8 grams for the Epson device, compared with 6,001.8 grams for the Konica Minolta model.

Total Supplies and Consumables Waste Generated (in grams)

Model	Consumables and packaging waste (16,250 pages)	Consumables and packaging waste (32,500 pages)	Consumables and packaging waste (48,750 pages)	Consumables and packaging waste (65,000 pages)
Epson WorkForce Pro WF-R8590 DTWF	0	0	0	529.8
Konica Minolta bizhub C224e	0	282.0	2,768.1	6,001.8



Waste after 65,000 impressions. Epson WF-R8590 DTWF consumables (left) vs. Konica Minolta bizhub C224e consumables (right).

User Interventions

	Epson WorkForce Pro WF-R8590 DTWF	Konica Minolta bizhub C224e	% Time saving
Toner/Ink Cartridge Replacement	0	5	
Time per change	30 seconds	30 seconds	
Waste boxes	1	1	
Time per change	30 seconds	30 seconds	
Total Consumable Replacement Time	30 seconds	3 minutes	83.3% (Epson advantage)
Printhead Cleaning Cycles	3 (2 minutes per cycle)	0	
Total Printhead Cleaning Time*	6 minutes	NA	
Total User Intervention Time	6 minutes, 30 seconds	3 minutes	53.8% (Konica Minolta advantage)

Note: this does not include operator time required to attend to the device, determine supplies out, order/obtain supplies, return to the device, all of which will add further time per intervention.

* During testing, the WF-R8590 DTWF experienced intermittent image quality issues, when the device started creating output exhibiting slight streaking on the pages. BLI technicians conducted a printhead cleaning cycle each time, which eliminated the image quality issues. The Konica Minolta model did not require any cleaning cycles to maintain print quality.

In terms of replacing consumables over 65,000 impressions, Epson is the clear winner, saving users 2 minutes 30 seconds compared to the bizhub C224e. However, once you factor in the cleaning cycles required to maintain print quality on the Epson device, the Konica Minolta bizhub C224e holds the advantage, saving 3 minutes 30 seconds of worker time over 65,000 impressions, compared to the Epson WF-R8590 DTWF, mostly due to the number of printhead cleaning cycles required by the inkjet device.

Drying Time due to Inactivity

In BLI's evaluation to determine the impact on the Epson inkjet devices when left inactive for prolonged periods of time, the Epson inkjet devices were left powered off for one month, two months, three months and six months. At the end of each stage, the devices were switched on and a print job was sent, with the results assessed to determine if there were any issues which may require an automatic or manual cleaning cycle to resolve. At the one-, two- and three-month mark, there were no issues observed by BLI's technicians with the WF-8590 DWF, nor were there any problems with nozzle clogging.

Not surprisingly, however, at the three-month mark with the WF-R8590 DTWF, and at the six-month mark with both inkjet models, they failed to print in black on BLI's test chart due to nozzle-clogging issues. This was easily rectified by initiating a single head cleaning cycle, taking 5 minutes, 17 seconds with both models.

Test Conditions

Test Environment

Testing was conducted in BLI's European test lab, in an atmospherically controlled environment monitored by a 24/7 Dickson Temperature/RH chart recorder, ensuring that typical office conditions were maintained. All paper used in testing was allowed to acclimatize inside the facility for a minimum of 12 hours before being used.

Test Equipment

BLI's dedicated test network in Europe, consisting of Windows 2008 servers, Windows 7 workstations, 10/100/1000BaseTX network switches and CAT5e/6 cabling.

Test Procedures

The test methods and procedures employed by BLI in its lab testing include BLI's proprietary procedures and industry-standard test procedures. In addition to a number of proprietary test documents, BLI uses industry standard files including an IT8 test file and an ASTM monochrome test document for evaluating black image quality. In addition to a visual observation, colour print quality and gamut size are evaluated using a profile software tool from Colour Confidence that was read using an EFI ES-1000 colour spectrophotometer and analysed using Chromix ColorThink Pro 3.0 software. Density of black and colour output was measured using an X-Rite 508 densitometer. Image quality is tested using Units are tested for compatibility on Windows 7 with Microsoft Office Suite 2010, as well as Adobe Acrobat Reader 10.0.

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