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Asset Price Deflator Research for OEB

Calculation of power distributor TFP trends is sensitive to the way that capital costs and quantities are treated, since distribution technology is capital-intensive. The abundant data on utility capital cost in North America facilitate monetary approaches to capital quantity measurement which require deflation of the asset (aka "plant") values that utilities report. Asset price deflators can have an important impact on calculated capital quantity and TFP trends.

In our prior cost research for the OEB, PEG has used the Electric Utility Construction Price Index ("EUCPI") for distribution systems (CANSIM Table 327-0011) to deflate the value of Ontario power distributor assets. Since this index is no longer calculated, and PSE used an alternative American deflator in its evidence, PEG has in this proceeding explored the best methodology for deriving an asset price deflator to replace the EUCPI. This attachment discusses PEG's asset price deflator research for the OEB.

EUCPI

EUCPIs were developed and then calculated by Statistics Canada from 1961 to 2014 to measure trends in electric utility construction prices. To create the EUCPIs, Statistics Canada estimated costs of electric utility construction projects and developed cost share weights. According to an OECD report, the weights for different EUCPI sub-indexes were derived from the tracked costs of 100 to 200 items used in construction projects from 1965 to 1973.[1] Statistics Canada used product, labor, and financing price indexes to measure the price growth of these items. Specifically, they used Canadian Industrial Product Price Indexes; Non-Residential Building Construction Price Indexes; Surveys of Employment Payroll and Hours; Construction Union Wage Rate Indexes; and U.S. Bureau of Labor Statistics' ("BLS") Product Price Indexes ("PPIs"). Additional data and financing information were gathered from the Bank of Canada.

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[1] Kincannon and Franchet (1997). *Source and Methods Construction Price Indices*, pg. 44.

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The price subindexes were combined with the base year weights to create summary fixed-weight price indexes for distribution systems, transmission, and substations.[2] Sub-indexes were created within these categories for important asset categories such as transformers and power lines.

Details of the construction of the summary distribution system EUCPI are presented in Table 14-1. It can be seen that the cost categories considered included various direct costs like those for materials (e.g., poles, conductors, and street lights), distribution equipment (e.g., line transformers), labor, and construction equipment, as well as indirect (e.g., engineering and administrative) construction costs.

The growth rates of the distribution systems EUCPI and several sub-indexes are displayed in Table 14-2. Inspecting the results for the summary distribution systems EUCPI, it can be seen that the average annual growth rate (aka trend) for the full sample period, 1962 to 2014, was 4.1 percent. Trends in some sub-periods varied greatly from the long-term trend. Inflation was especially rapid from 1973 to 1982, spurred by two oil price shocks, averaging 10.1 percent annual growth. Following a period of more normal inflation from 1983 to 2001, inflation slowed further in the 2002 to 2014 period, averaging only 1.6 percent.

PSE does not recommend using the *Distribution Systems* EUCPI for Hydro One in part because it is unclear as to whether it includes financing costs. The Handy-Whitman Index that PSE instead uses does not include such costs. However, incorporation of financing costs has little effect on the trends in summary EUCPIs. We calculated transmission and substation EUCPIs with and without interest included. As can be seen in Table 14-3, which compares growth rates of these two indexes, inclusion of financial costs lowered annual average growth by only 14 basis points for transmission and 15 basis points for substations over the period from 1972 to 2014. The difference was only 6 basis points for both categories between 1998 and 2014.

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[2] The distribution systems EUCPI does not include substations.

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Table 14-1

Details of the Electric Utility Distribution Systems Construction Price Index

Major components and items	Description of Index Item	Weights			Sources	CANSIM Vector
		100.01				v735224
Total direct costs		84.65				v735225
Materials			25.65			v735226
Poles, towers and fixtures			12.77			v735227
Poles - wooden	Western Cedar 35' to 45'.			8.20	IPPI - Preserved or Treated Wood	v735228
Crossarms	B.C. fir 3 3/4" x 4 3/4" length, 6" to 11' drilled, treated and untreated			1.38	IPPI - Preserved or Treated Wood	v735229
Hardware	Pole Line Hardware			2.17	IPPI - Pole line hardware	v735230
Insulators	Porcelain, pin, horizontal and vertical line, post type.			1.02	IPPI - Porcelain Insulator Fittings, secure	v735230
Overhead conductors			7.65			
Aluminum cable, steel reinforced	Aluminum cable steel. Reinforced			3.31	IPPI - Aluminum wire & cable, incl ACSR	V735232
Aluminum and triplex	Aluminum (wires, waterproof, all others). & Triplex service cable			3.22	IPPI -Other insulated wire & cable	V735232
Copper conductor	Copper conductor			1.12	IPPI - Copper wire & cable, not insulated	v735233
Street lighting systems and water heaters			5.23			v735234
Luminaires and water heaters			3.40			v735235
HPS & MV fixtures for street lighting.	HPS & MV fixtures, 400, 250 watts for street lighting.			0.59	IPPI - Street lighting fixtures	
Water heaters	Water heaters, automatic, electric storage			2.80	IPPI - Water heaters electric (secure)	
Conductors	Power cables			0.27	IPPI - Wires & cables, over 1000 volts	v735236
Poles, metal and concrete			1.56			v735237
Concrete poles						
3,000 psi ready mix concrete.	3,000 psi ready mix concrete.			0.13	IPPI -Ready mix concrete	
Bars-reinforcing for concrete.	Bars-reinforcing for concrete.			0.10	IPPI - Conc. reinforcing bars/non fabricated	
Aluminum pole fixtures.	Aluminum pole fixtures.			0.05	IPPI -casting & extruding aluminum, industry	
Concrete product employees weekly earnings	Concrete product employees weekly earnings			0.24	SEPH - Concrete product employees weekly earnings incl O/T	
Metal, steel poles						
Carbon steel strip. unfrabricated hot rolled.	Carbon steel strip. unfrabricated hot rolled.			0.10	IPPI- Plates, sheets & strips, H.R., carbon steel	
Steel sheet and strip. Galvanized.	Steel sheet and strip. Galvanized.			0.11	IPPI - Sheet & strip steel, coated, Tin or zinc	
Paint, ready-mix, exterior.	Paint, ready-mix, exterior.			0.03	IPPI - Paints & enamels industrial	
Hardware, all metal bolts, nuts, etc	Hardware, all metal bolts, nuts, etc			0.03	IPPI - Bolts, nuts, screws, fastnings	
Labour, average hourly earnings - Canada.	Labour, average hourly earnings - Canada.			0.24	S.I.C. 300-309 Labour Division. Statistics Canada Cat # 72-002	
Metal, aluminum poles						
Aluminum, structural shapes and extrusions.	Aluminum, structural shapes and extrusions.			0.35	IPPI - Aluminum, structural shapes and extrusions.	
Hardware, all metal bolts. Nuts, etc	Hardware, all metal bolts. Nuts, etc			0.03	IPPI - Bolts, nuts, screws, fastnings	
Labour, Average hourly earnings - Canada	Labour, Average hourly earnings - Canada			0.14	S.I.C. 300-309 labour div. Statistics Canada, cat 72-002	
Distribution systems equipment			19.67			v735238
Transformers	Distribution transformers liquid single phase, up to 167 kva		14.91		IPPI - Power & Distribution Transformers	v735239
Meters and enclosed safety switches	Watt hour meters, clock type, single phase, 240 volts		4.76		IPPI - Elec. quantity measuring instruments and enclosed safety switches	v735240
Labour	Basic wage rates for linemen, groundmen, equipment oper, and labourers from major utilities and construction associations	34.11			Wage rate indexes (basic) plus utility rates	v735241
Construction equipment		5.22				v735242
Equipment , Trucks			2.51			v735243
Medium Trucks	Medium Trucks, 10,000 - 19.000 lb			1.00	IPPI - Trucks, chassis, tractors, commercial	
Heavy trucks	Heavy trucks, 19,501 - 33,000 lbs			1.50	IPPI - Trucks, chassis, tractors, commercial	
Operating expenses			2.71			v735244
Mechanics	Garage Maintenance Mechanics			0.68	SEPH series	v735245
Other operating expenses			2.03			v735246
Motor gasoline, unleaded	Motor gasoline, unleaded			0.66	IPPI - Motor gasoline, regular unleaded	
Lubricating oils	Lubricating Oil. autos, all grades			0.05	IPPI - Lubricating oil & greases	
Tires	Truck and Bus tires 12x22			0.98	IPPI - Highway type, truck & bus tires	
Motor vehicle parts	Motor vehicle parts and accessories			0.34	IPPI - Motor vehicle parts and accessories industries	
Construction indirects		15.36				v735247
Engineering	Engineers salaries including overtime		4.33		Labour Division, Survey of Employment Payroll and Hours, (SEPH), Electric Power Utilities, Salaried workers incl O/T	v735248
Administration and overheads			11.03		Administration index used from EUCPI steam electric plant model	v735249
Administration	Engineers salaries including region, Canada, elect utilities, incl overtime, all employees			10.17	Labour Division, Survey of Employment, Canada Catalog 72-002	
Overheads	Telephone & postage services			0.41	Consumer price index (CPI)	
Office furniture & equipment	Office furniture & equipment			0.45	MEPI-Office furniture & visible record	

Legend

SEPH	Survey of Employment, Payrolls and Hours
IPPI	Industrial Product Price Index
CUWRI	Construction Union Wage Rate Index
MEPI	Machinery and Equipment Price Index
CPI	Consumer Price Index
BLS	Bureau of Labour Statistics

Source: Jennifer Winters, Chief Construction Division Statistics Canada

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Table 14-2
Growth Rates of the Distribution Systems EUCPI and Subindexes

Year	Distribution Systems	Total Direct Costs	All Materials	Poles, Towers and Fixtures	Wooden poles	Crossarms	Hardware and Insulators	Overhead Conductors	Street Lighting Systems and Water Heaters	Transformers	Meters and Switches	Labour	Construction Equipment	Construction Indirects
1962	1.6%			3.1%	4.1%	11.0%	0.8%	-1.3%		0.6%	0.0%	4.5%	-1.5%	
1963	0.5%			3.6%	4.0%	3.7%	2.4%	0.0%		-6.0%	-3.8%	4.3%	1.0%	
1964	2.1%			0.0%	-1.3%	9.5%	0.0%	-0.4%		2.5%	2.5%	3.3%	1.0%	
1965	2.0%			7.3%	12.4%	0.0%	0.8%	5.3%		-4.0%	0.0%	4.8%	0.5%	
1966	4.9%			5.8%	7.8%	1.6%	2.3%	5.4%		6.4%	2.5%	4.5%	1.9%	
1967	3.8%			0.0%	-4.4%	2.4%	5.6%	3.4%		-7.1%	0.6%	11.2%	5.1%	7.3%
1968	-0.9%			-2.6%	-5.2%	3.9%	1.1%	-4.5%		-8.0%	0.0%	7.0%	2.2%	7.4%
1969	4.1%			5.6%	5.7%	12.9%	4.2%	1.1%		0.0%	0.0%	7.7%	3.5%	7.5%
1970	7.3%			10.8%	8.6%	23.2%	11.3%	4.4%		5.7%	1.5%	7.7%	5.8%	8.0%
1971	3.7%			0.0%	2.5%	-4.9%	-2.2%	0.4%		5.7%	0.0%	7.1%	5.1%	7.8%
1972	4.3%	3.8%	0.7%	3.9%	4.4%	2.2%	3.7%	1.8%	-0.7%	-0.6%	0.0%	8.5%	3.4%	9.0%
1973	8.8%	9.0%	8.3%	21.5%	24.9%	43.6%	9.7%	7.8%	9.4%	1.2%	-0.3%	12.3%	3.7%	6.3%
1974	18.5%	20.2%	26.0%	35.1%	40.0%	16.0%	30.0%	29.1%	17.3%	26.9%	7.0%	9.2%	13.7%	11.5%
1975	11.6%	10.9%	7.7%	8.6%	10.9%	-28.0%	12.9%	1.9%	12.1%	8.5%	7.8%	17.1%	8.4%	14.1%
1976	5.6%	4.9%	-0.4%	2.0%	-2.7%		10.1%	5.2%	8.4%	-10.4%	2.1%	13.5%	11.7%	9.8%
1977	6.4%	6.3%	2.6%	1.1%	1.1%		3.8%	5.8%	2.4%	1.2%	7.1%	10.7%	10.2%	8.4%
1978	7.1%	7.2%	7.4%	10.8%	11.1%		9.6%	6.1%	5.6%	5.0%	9.9%	6.5%	10.9%	6.8%
1979	12.7%	13.3%	18.1%	18.8%	22.7%		6.0%	24.4%	7.4%	22.4%	4.2%	6.1%	11.5%	8.2%
1980	13.1%	13.4%	15.8%	12.6%	17.2%	14.3%	0.8%	23.7%	4.9%	20.3%	10.1%	9.3%	13.0%	10.4%
1981	8.6%	8.5%	6.0%	8.3%	7.9%	3.0%	10.9%	3.1%	7.1%	3.9%	12.5%	10.8%	18.2%	11.1%
1982	8.9%	8.3%	6.3%	5.6%	5.2%	6.1%	6.3%	2.4%	4.6%	8.1%	11.3%	11.5%	10.4%	12.1%
1983	4.1%	3.3%	-1.0%	0.6%	0.7%	-6.9%	2.5%	-0.6%	2.8%	-6.3%	8.0%	9.6%	4.9%	7.6%
1984	4.3%	4.1%	4.8%	1.5%	2.2%	-2.0%	0.9%	6.4%	6.4%	5.1%	7.8%	3.6%	3.1%	5.4%
1985	5.0%	5.3%	6.6%	4.1%	5.6%	3.4%	0.3%	-4.5%	6.1%	16.2%	2.0%	3.2%	4.5%	4.4%
1986	2.3%	2.1%	2.2%	2.4%	1.8%	2.0%	3.7%	5.8%	2.7%	0.2%	3.0%	2.6%	-2.8%	3.2%
1987	3.0%	2.8%	2.8%	-1.1%	-2.3%	-1.2%	1.5%	14.5%	2.0%	-0.9%	5.0%	3.4%	1.0%	3.8%
1988	5.9%	6.3%	8.6%	-2.2%	-4.9%	4.3%	1.7%	23.7%	3.8%	11.5%	1.3%	3.5%	-2.0%	4.3%
1989	3.8%	3.9%	3.2%	8.2%	8.2%	25.0%	3.0%	1.6%	4.0%	-0.5%	4.9%	5.1%	2.6%	3.2%
1990	3.1%	2.6%	1.8%	8.3%	7.3%	19.2%	5.6%	-11.1%	-0.6%	4.4%	5.1%	3.7%	5.6%	5.8%
1991	-0.8%	-2.0%	-8.2%	-1.3%	3.3%	-7.4%	-10.0%	-16.2%	-12.2%	-10.0%	-2.1%	6.0%	2.2%	6.4%
1992	2.3%	2.1%	1.5%	0.0%	-0.5%	0.7%	0.8%	-2.5%	-3.5%	6.1%	3.0%	3.1%	0.6%	3.3%
1993	2.5%	2.5%	2.1%	5.1%	6.7%	6.7%	0.1%	1.2%	0.6%	0.8%	0.9%	2.7%	4.7%	2.3%
1994	5.4%	6.2%	9.7%	13.3%	17.2%	17.2%	0.1%	7.7%	4.9%	11.7%	1.3%	1.5%	5.7%	1.0%
1995	7.6%	8.4%	13.0%	7.1%	8.7%	8.7%	0.1%	-6.1%	8.9%	20.4%	1.7%	1.7%	8.0%	2.1%
1996	-0.1%	-0.4%	-1.6%	4.8%	5.6%	5.6%	1.2%	19.8%	0.2%	-7.3%	0.7%	0.5%	4.4%	2.2%
1997	1.2%	0.9%	-0.9%	0.7%	-0.3%	-0.3%	4.9%	0.6%	1.5%	-4.6%	1.9%	3.2%	3.2%	2.9%
1998	4.0%	3.1%	0.3%	3.2%	2.4%	2.4%	6.4%	-6.2%	1.2%	0.0%	2.8%	6.6%	6.2%	8.9%
1999	2.7%	2.4%	0.5%	1.0%	1.1%	1.1%	0.5%	-6.9%	1.0%	2.5%	3.1%	5.0%	2.4%	4.4%
2000	2.0%	2.4%	2.0%	1.1%	1.3%	1.3%	0.0%	1.6%	2.1%	3.6%	0.4%	4.1%	-4.5%	-0.2%
2001	0.7%	0.5%	-0.7%	0.1%	0.2%	0.2%	0.1%	-1.3%	1.3%	-2.7%	1.9%	1.5%	4.8%	1.7%
2002	0.7%	0.6%	-0.1%	0.0%	0.0%	0.0%	-0.2%	1.7%	1.8%	-2.3%	2.8%	1.2%	2.4%	0.8%
2003	0.1%	0.2%	0.2%	0.3%	0.4%	0.4%	0.1%	-4.4%	4.0%	0.3%	1.7%	0.3%	0.0%	-0.7%
2004	0.4%	0.3%	3.6%	2.0%	2.2%	2.2%	0.7%	11.6%	6.8%	1.1%	0.7%	-4.2%	1.7%	0.7%
2005	1.9%	2.2%	4.2%	0.0%	0.1%	0.1%	-0.4%	4.0%	10.6%	7.3%	-1.1%	-1.5%	6.3%	0.4%
2006	6.4%	7.2%	11.5%	3.6%	3.4%	3.4%	4.7%	16.7%	-0.1%	22.4%	1.3%	1.7%	1.4%	1.7%
2007	4.4%	4.4%	6.3%	4.3%	5.3%	5.3%	0.4%	3.7%	2.9%	11.2%	0.0%	2.2%	0.0%	4.3%
2008	1.0%	0.8%	1.6%	1.7%	1.4%	1.4%	3.1%	-4.6%	2.7%	4.1%	-1.4%	-2.0%	8.3%	2.1%
2009	0.5%	-0.8%	-0.1%	2.4%	1.9%	1.9%	4.1%	-7.1%	-0.4%	-0.2%	5.7%	-0.4%	-8.8%	8.1%
2010	2.6%	2.9%	1.2%	0.4%	0.1%	0.1%	2.1%	5.7%	-1.3%	0.7%	1.9%	5.8%	2.7%	0.8%
2011	3.2%	2.7%	0.8%	0.8%	0.1%	0.1%	3.5%	1.9%	1.0%	0.8%	-1.4%	6.2%	1.7%	5.2%
2012	0.9%	0.8%	0.0%	0.1%	0.1%	0.1%	-0.1%	0.5%	1.2%	-0.2%	-2.0%	2.5%	-1.8%	1.2%
2013	-0.8%	-0.7%	0.9%	0.9%	0.4%	0.4%	3.0%	3.4%	-0.1%	0.0%	1.3%	-3.5%	0.5%	-1.2%
2014	0.1%	-0.8%	0.3%	1.3%	1.1%	1.1%	2.1%	-1.6%	0.4%	0.5%	-1.4%	-2.3%	-0.9%	4.7%

Average Annual Growth Rates

1962 - 2014	4.1%	NA	NA	4.5%	4.8%	NA	3.3%	3.5%	NA	3.4%	2.6%	4.8%	3.9%	NA
1962 - 1972	3.0%	NA	NA	3.4%	3.5%	6.0%	2.7%	1.4%	NA	-0.4%	0.3%	6.4%	2.6%	NA
1973 - 1982	10.1%	10.2%	9.8%	12.4%	13.5%	NA	10.0%	10.9%	7.9%	8.7%	7.2%	10.7%	11.2%	9.9%
1983 - 2001	3.1%	3.0%	2.5%	3.0%	3.4%	4.2%	1.2%	1.4%	1.7%	2.6%	2.8%	3.7%	2.9%	3.8%
1983 - 2014	2.5%	2.4%	2.4%	2.3%	2.5%	3.0%	1.5%	1.8%	2.0%	3.0%	1.9%	2.4%	2.1%	3.1%
2002 - 2014	1.6%	1.5%	2.3%	1.4%	1.3%	1.3%	1.8%	2.4%	2.3%	3.5%	0.6%	0.5%	1.0%	2.2%

Notes

[1] All growth rates are computed logarithmically. For example, growth rate of X = ln(X_t/X_{t-1})

[2] Electric Utility Construction Price Index (Statistics Canada, Table 327-0011)

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Table 14-3
Comparison of EUCPI Growth Rates with and without Financial Costs[1,2]

Year	Transmission Line Systems				Substations			
	Interest Included		Interest Excluded		Interest Included		Interest Excluded	
	Level	Growth Rate	Level	Growth Rate	Level	Growth Rate	Level	Growth Rate
1972	27.3	4.5%	26.1	4.3%	27.8	3.3%	26.6	3.4%
1973	29.3	7.1%	28.1	7.4%	29.7	6.6%	28.4	6.5%
1974	35.5	19.2%	34.1	19.4%	36.3	20.1%	34.9	20.6%
1975	41.6	15.9%	40.3	16.7%	42.5	15.8%	41.1	16.4%
1976	44.6	7.0%	43.3	7.2%	45.5	6.8%	44.1	7.0%
1977	47.0	5.2%	45.8	5.6%	47.3	3.9%	46.1	4.4%
1978	50.6	7.4%	49.5	7.8%	50.9	7.3%	49.8	7.7%
1979	56.5	11.0%	55.4	11.3%	56.0	9.5%	54.8	9.6%
1980	63.3	11.4%	61.8	10.9%	62.2	10.5%	60.6	10.1%
1981	69.7	9.6%	67.6	9.0%	68.0	8.9%	65.8	8.2%
1982	75.1	7.5%	73.4	8.2%	74.5	9.1%	72.6	9.8%
1983	77.0	2.5%	75.8	3.2%	75.8	1.7%	74.5	2.6%
1984	80.6	4.6%	79.4	4.6%	79.1	4.3%	77.8	4.3%
1985	81.6	1.2%	80.8	1.7%	80.2	1.4%	79.3	1.9%
1986	84.0	2.9%	83.6	3.4%	83.0	3.4%	82.5	4.0%
1987	89.2	6.0%	88.8	6.0%	89.2	7.2%	88.8	7.4%
1988	96.5	7.9%	96.1	7.9%	96.0	7.3%	95.6	7.4%
1989	102.6	6.1%	102.4	6.3%	103.6	7.6%	103.5	7.9%
1990	104.0	1.4%	103.6	1.2%	104.3	0.7%	104.0	0.5%
1991	100.4	-3.5%	100.2	-3.3%	99.9	-4.3%	99.8	-4.1%
1992	100.0	-0.4%	100.0	-0.2%	100.0	0.1%	100.0	0.2%
1993	103.0	3.0%	103.3	3.2%	103.0	3.0%	103.2	3.1%
1994	108.1	4.8%	108.2	4.6%	107.9	4.6%	108.0	4.5%
1995	112.8	4.3%	113.0	4.3%	111.8	3.6%	112.0	3.6%
1996	113.5	0.6%	114.0	0.9%	111.8	0.0%	112.2	0.2%
1997	115.7	1.9%	116.5	2.2%	113.7	1.7%	114.6	2.1%
1998	121.0	4.5%	122.1	4.7%	119.4	4.9%	120.5	5.0%
1999	122.2	1.0%	123.3	1.0%	120.6	1.0%	121.6	0.9%
2000	124.7	2.0%	125.8	2.0%	122.5	1.6%	123.5	1.6%
2001	127.0	1.8%	128.1	1.8%	125.4	2.3%	126.5	2.4%
2002	129.2	1.7%	130.4	1.8%	127.8	1.9%	129.0	2.0%
2003	126.4	-2.2%	127.7	-2.1%	124.0	-3.0%	125.2	-3.0%
2004	129.0	2.0%	130.4	2.1%	125.4	1.1%	126.8	1.3%
2005	130.9	1.5%	132.6	1.7%	127.7	1.8%	129.2	1.9%
2006	136.2	4.0%	137.9	3.9%	132.6	3.8%	134.3	3.9%
2007	142.6	4.6%	144.4	4.6%	139.5	5.1%	141.3	5.1%
2008	148.8	4.3%	150.9	4.4%	147.5	5.6%	149.4	5.6%
2009	149.7	0.6%	151.9	0.7%	149.5	1.3%	151.5	1.4%
2010	150.5	0.5%	152.8	0.6%	149.3	-0.1%	151.4	-0.1%
2011	154.0	2.3%	156.5	2.4%	151.8	1.7%	154.1	1.8%
2012	154.4	0.3%	157.3	0.5%	152.4	0.4%	155.2	0.7%
2013	154.6	0.1%	157.4	0.1%	153.6	0.8%	156.2	0.6%
2014	158.7	2.6%	161.5	2.6%	159.0	3.5%	161.7	3.5%

Annual Average

1972-2014		4.20%		4.34%		4.13%		4.28%
1998-2014		1.86%		1.92%		1.97%		2.03%

Notes

[1] All growth rates are computed logarithmically. For example, growth rate of $X = \ln(X_t/X_{t-1})$

[2] Electric Utility Construction Price Index (Statistics Canada, Table 327-0011)

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While we do not believe inclusion of financing costs is a significant concern, there are several problems with the EUCPIs. In response to our inquiries, Statistics Canada confirmed that many of the models have not been updated since the 1970s, leading the EUCPI to be discontinued "until such time as we [Statistics Canada] could acquire new and updated electric utility models."[3] Cost shares can change materially over the years. With technological change, for example, the weight for meters is likely much higher than in the past.

Another concern we have about the EUCPI is the recent slow growth of the labor price sub-index. Statistics Canada provided PEG with additional information on the weights and indexes that were used to construct the EUCPI. Table 14-1 indicates that *labor* prices are sourced from "wage rate indexes (basic) plus utility rates." Similarly, the OECD report states that "labor costs data are obtained from surveys of employers as well as from information on collective wage agreements."[4] Statistics Canada stated in commentary on the EUCPI methodology that "basic union wage rates are used for construction trades. Data from the survey on employment, earnings and hours (SEPH) on average weekly earnings ("AWE") (including overtime) for salaried employees are used for engineers, technicians, clerks and draftsmen."[5]

We compare the EUCPI labor price subindex to other labor price indexes, including the AWE, average hourly earnings ("AHE"), and the construction union wage rate index in Table 14-4. It can be seen that trends in the labor price indexes were broadly similar through 2001, after which the EUCPI labor price subindex grew much more slowly than all of the other indexes and declined in several years. No negative growth rates were reported for this sub-index before 2000.

Another concern with the EUCPI lies in how some asset prices are tracked. Metering is an example. Installation of advanced metering infrastructure began during the mid-2000s and has been widespread in some provinces, including Ontario and Quebec. However, the EUCPI tracked "watt hour

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[3] Conversation with Jennifer Winters, Statistics Canada Construction Prices Division

[4] Kincannon and Franchet, *op. cit.*, pg. 44.

[5] *Capital Expenditure Price Statistics* 62-007-X (October 2013), pg. 90.

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Table 14-4

Canadian Labour Price Indexes[1]

| | EUCPI[2] | Construction Union Wage Rate Index[3] | | SEPH Average Weekly Earnings Index[4] | | | |
| | Canada | Canada | Ontario | Canada | | Ontario | |
	Distribution Systems Labour	Composite	Composite	AHE Fixed Utilities[4]	AWE Non-Fixed Electric Power GTD[5]	AHE Fixed Utilities[4,6]	Non-Fixed Electric Power GTD[5]
1962	4.5%						
1963	4.3%						
1964	3.3%						
1965	4.8%						
1966	4.5%						
1967	11.2%						
1968	7.0%						
1969	7.7%						
1970	7.7%						
1971	7.1%						
1972	8.5%	9.6%					
1973	12.3%	9.2%					
1974	9.2%	9.3%					
1975	17.1%	13.0%					
1976	13.5%	13.5%					
1977	10.7%	10.7%					
1978	6.5%	6.2%					
1979	6.1%	5.8%					
1980	9.3%	7.7%					
1981	10.8%	8.7%					
1982	11.5%	8.8%	7.5%				
1983	9.6%	11.5%	12.2%				
1984	3.6%	3.2%	3.0%				
1985	3.2%	2.1%	2.7%				
1986	2.6%	2.5%	3.5%				
1987	3.4%	2.3%	3.7%				
1988	3.5%	3.3%	4.8%				
1989	5.1%	4.1%	5.7%				
1990	3.7%	5.1%	6.1%				
1991	6.0%	5.3%	6.9%				
1992	3.1%	3.8%	2.7%				
1993	2.7%	1.9%	1.8%				
1994	1.5%	1.6%	2.6%				
1995	1.7%	1.1%	1.3%				
1996	0.5%	0.4%	0.1%				
1997	3.2%	1.4%	1.4%				
1998	6.6%	1.0%	0.7%				
1999	5.0%	1.0%	0.5%				
2000	4.1%	1.9%	1.2%				
2001	1.5%	1.6%	1.7%				
2002	1.2%	2.8%	2.4%	5.1%	5.8%	4.8%	5.8%
2003	0.3%	2.2%	2.2%	5.1%	3.6%	7.3%	5.3%
2004	-4.2%	1.4%	2.0%	1.8%	0.4%	1.8%	-0.5%
2005	-1.5%	1.9%	2.2%	1.8%	3.5%	2.0%	3.6%
2006	1.7%	2.9%	2.0%	2.1%	3.0%	1.9%	1.6%
2007	2.2%	3.0%	1.9%	5.4%	4.5%	4.9%	5.0%
2008	-2.0%	4.6%	3.3%	1.3%	0.5%	-1.4%	-4.0%
2009	-0.4%	3.8%	3.0%	5.6%	3.8%	4.9%	6.1%
2010	5.8%	2.9%	1.9%	3.1%	4.3%	4.7%	-0.4%
2011	6.2%	2.2%	1.8%	1.5%	5.4%	-6.1%	3.5%
2012	2.5%	2.2%	2.2%	2.8%	0.1%	5.5%	0.4%
2013	-3.5%	2.1%	1.8%	-0.4%	-1.1%	2.3%	1.1%
2014	-2.3%	2.3%	2.2%	4.9%	9.0%	7.0%	10.6%
2015	na	2.2%	2.3%	-2.6%	-0.4%	-3.7%	-0.6%
2016	na	1.5%	1.6%	1.8%	-3.0%	-0.6%	-6.4%
2017	na	1.1%	1.5%	6.1%	7.3%	4.3%	5.1%
Average Annual Growth Rates							
1962 - 2014	4.8%	NA	NA	NA	NA	NA	NA
1962 - 1972	6.4%	NA	NA	NA	NA	NA	NA
1973 - 1982	10.7%	9.3%	NA	NA	NA	NA	NA
1983 - 2014	2.4%	2.8%	2.9%	NA	NA	NA	NA
1983 - 2001	3.7%	2.9%	3.3%	NA	NA	NA	NA
2002 - 2014	0.5%	2.7%	2.2%	3.1%	3.3%	3.0%	2.9%
2009 - 2014	1.4%	2.6%	2.2%	2.9%	3.6%	3.1%	3.6%

Notes

[1] All growth rates are computed logarithmically. For example, growth rate of X = ln(X_t/X_{t-1})

[2] Electric Utility Construction Price Index (Statistics Canada, Table 327-0011)

[3] Construction Union Wage Rate Index, basic construction wage rate indexes (Statistics Canada, Table 327-0045)

[4] Fixed weighted index of average hourly earnings for all employees (Statistics Canada, Table 281-0039).

[5] Average weekly earnings, including overtime, for all employees in current dollars (Statistics Canada, Table 281-0026).

[6] We replaced the missing Ontario 2009 fixed utilities average weekly earnings value with the simple average of 2008 and 2010.

PEG

Pacific Economics Group Research, LLC

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meters, clock type, single phase, 240 volts" which will not pick up AMI price trends.[6] As shown in Table 14-2, the sub-index for Meters and Switches averaged only 0.6 percent annual growth from 2002 to 2014. Historically, meters were replaced after failures, but the AMI initiative involved massive quick replacements.

We conclude from this review that the EUCPI produced reliable results only through 2001. Alternative asset price deflators can be usefully appraised by their ability to track the EUCPI during this period. Trends in alternative asset price deflators are compared to the trends in the EUCPIs for distribution systems and substations in Table 14-5.

Flows and Stocks of Fixed Non-Residential Capital

One promising alternative asset price deflator for Canada can be calculated from the Flows and Stocks of Fixed Non-Residential Capital (CANSIM Table 031-0005) dataset. This is part of the Stock and Consumption of Fixed Capital ("SCFC") program. This program uses monetary methods to measure trends in the quantities of capital assets in various sectors of the economy, including the utilities sector. Recall that monetary methods require deflation of asset value data. Calculations are available for Ontario as well as Canada.

Statistics Canada generates this dataset by gathering investment data from the Annual Capital Repair and Expenditures Survey ("CES"). This survey tracks actual investment expenditures, investment intentions, and the service lives of assets. Additional surveys are utilized to supplement the CES.[7] After the investment value data are gathered, Statistics Canada deflates values to constant 2007 dollars

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[6] See Table 14-1.

[7] Specifically, investment data are also gathered from the Building Permits Survey, CMHC Starts and Completions Survey, Quarterly Survey of Capital Expenditures – Oil and Gas Activities, Annual Survey of Research and Development in Canadian Industry, Employment Indicators, and Imports/Exports *About the Stock and Consumption of Fixed Capital Program* (February 2016).

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Table 14-5
Alternative Utility Asset Deflators[1]

	EUCPIs[2]		Implicit Capital Stock Deflators					GFCF Implicit Price Indexes[6]		Handy-Whitman Index	
			Current Methodology[3]		Historic Methodology[4]					Total Distribution Plant[7]	
			Canada	Ontario	Canada		Ontario	Canada	Ontario		
Year	Distribution Systems	Substations	Utilities		Utilities	Electric GTD Assets[5]	Utilities	Non-Residential Structures, Machinery and Equipment	Non-Residential Structures, Machinery and Equipment	North Atlantic Region	NA Region with PPP Adjustment
1962	1.6%	4.6%	1.9%	2.2%	1.9%	2.1%	2.3%			1.7%	1.0%
1963	0.5%	2.4%	2.3%	2.0%	2.4%	2.2%	2.3%			0.0%	0.7%
1964	2.1%	4.7%	3.2%	3.3%	3.2%	3.2%	3.1%			3.4%	4.4%
1965	2.0%	4.9%	5.6%	6.0%	5.6%	5.6%	5.8%			3.3%	4.0%
1966	4.9%	3.9%	5.4%	4.6%	5.1%	5.0%	4.5%			3.2%	4.6%
1967	3.8%	-1.3%	4.1%	4.0%	3.6%	3.4%	3.3%			4.6%	6.1%
1968	-0.9%	-3.0%	0.9%	0.8%	0.9%	0.7%	0.5%			4.4%	3.2%
1969	4.1%	2.2%	4.8%	3.9%	4.7%	4.4%	4.0%			5.6%	4.9%
1970	7.3%	9.8%	5.5%	6.2%	5.8%	5.9%	6.3%			9.0%	4.7%
1971	3.7%	5.0%	5.1%	5.0%	5.0%	4.9%	5.1%			7.1%	6.9%
1972	4.3%	3.3%	5.6%	4.5%	5.5%	5.4%	4.4%			5.6%	7.1%
1973	8.8%	6.6%	7.2%	6.7%	7.1%	7.0%	6.5%			8.3%	12.3%
1974	18.5%	20.1%	17.2%	17.0%	17.5%	17.5%	17.1%			16.6%	22.1%
1975	11.6%	15.8%	14.7%	15.2%	14.6%	14.6%	15.1%			14.2%	15.5%
1976	5.6%	6.8%	7.2%	6.3%	7.2%	7.0%	6.3%			4.3%	8.0%
1977	6.4%	3.9%	6.7%	6.5%	6.6%	6.6%	6.5%			4.8%	5.4%
1978	7.1%	7.3%	8.3%	8.3%	8.3%	8.5%	8.4%			4.6%	4.2%
1979	12.7%	9.5%	10.1%	10.1%	10.0%	10.2%	9.8%			10.3%	11.9%
1980	13.1%	10.5%	10.3%	10.3%	10.4%	10.5%	10.3%			7.2%	8.2%
1981	8.6%	8.9%	11.0%	11.0%	11.1%	11.1%	11.2%			8.3%	9.6%
1982	8.9%	9.1%	7.4%	7.6%	7.6%	7.3%	7.9%	7.3%	7.2%	6.2%	8.6%
1983	4.1%	1.7%	3.5%	3.1%	3.4%	3.2%	3.1%	0.8%	-0.6%	3.7%	5.4%
1984	4.3%	4.3%	3.5%	3.7%	3.5%	3.6%	3.7%	1.9%	0.8%	2.7%	2.6%
1985	5.0%	1.4%	3.2%	3.4%	3.4%	3.5%	3.5%	2.2%	-1.0%	2.2%	2.3%
1986	2.3%	3.4%	4.2%	5.3%	4.1%	4.2%	4.9%	1.4%	-0.3%	1.3%	2.3%
1987	3.0%	7.2%	2.9%	2.4%	2.8%	2.9%	2.3%	1.1%	2.4%	0.8%	3.0%
1988	5.9%	7.3%	3.7%	2.9%	3.6%	3.3%	2.8%	1.7%	1.8%	7.2%	8.1%
1989	3.8%	7.6%	2.8%	2.9%	2.8%	2.6%	2.9%	2.3%	2.3%	5.8%	6.5%
1990	3.1%	0.7%	4.5%	4.2%	4.5%	4.4%	4.1%	2.0%	1.2%	2.7%	2.4%
1991	-0.8%	-4.3%	-1.0%	-1.2%	-1.1%	-1.6%	-1.2%	-3.6%	-4.0%	2.6%	2.3%
1992	2.3%	0.1%	-0.8%	-0.4%	-0.7%	-1.2%	-0.3%	0.8%	-4.0%	1.2%	0.4%
1993	2.5%	3.0%	0.3%	-1.5%	0.5%	0.5%	-1.1%	1.9%	2.4%	2.6%	1.6%
1994	5.4%	4.6%	3.8%	3.8%	3.8%	3.8%	3.8%	3.7%	3.7%	3.1%	2.4%
1995	7.6%	3.6%	1.7%	2.0%	1.9%	2.1%	2.2%	1.1%	0.3%	3.0%	3.1%
1996	-0.1%	0.0%	3.0%	2.8%	3.1%	3.0%	3.0%	0.7%	-1.3%	1.6%	1.6%
1997	1.2%	1.7%	3.7%	5.5%	3.3%	3.2%	4.8%	1.3%	0.3%	1.5%	1.0%
1998	4.0%	4.9%	3.3%	3.5%	3.5%	3.8%	3.7%	2.3%	2.2%	2.3%	1.0%
1999	2.7%	1.0%	0.9%	1.2%	1.0%	1.1%	1.3%	-1.3%	-2.8%	0.7%	1.1%
2000	2.0%	1.6%	2.0%	2.4%	2.0%	2.0%	2.5%	0.4%	-1.0%	2.6%	5.6%
2001	0.7%	2.3%	2.2%	1.4%	2.2%	2.4%	1.5%	1.0%	1.5%	2.9%	2.3%
2002	0.7%	1.9%	0.6%	-0.3%	0.7%	0.8%	0.0%	1.3%	0.1%	3.2%	4.0%
2003	0.1%	-3.0%	-0.8%	0.0%	-1.2%	-1.6%	-0.9%	-3.6%	-3.7%	2.0%	1.7%
2004	0.4%	1.1%	3.3%	2.9%	3.0%	2.7%	2.7%	0.3%	-1.3%	6.3%	6.8%
2005	1.9%	1.8%	2.9%	1.4%	2.8%	2.5%	1.2%	0.5%	-2.3%	8.0%	6.4%
2006	6.4%	3.8%	3.7%	1.4%	3.5%	3.4%	1.2%	1.6%	-1.5%	10.1%	9.6%
2007	4.4%	5.1%	3.8%	2.8%	3.8%	3.7%	2.7%	1.4%	-0.9%	10.7%	11.3%
2008	1.0%	5.6%	6.2%	6.4%	4.7%	4.8%	4.0%	3.3%	2.6%	8.9%	10.6%
2009	0.5%	1.3%	2.9%	4.3%	3.7%	3.9%	4.4%	3.1%	3.4%	2.7%	0.1%
2010	2.6%	-0.1%	1.0%	1.1%	2.3%	1.9%	1.5%	-2.5%	-5.0%	3.5%	4.8%
2011	3.2%	1.7%	2.4%	1.6%	2.6%	2.5%	2.0%	1.1%	-0.8%	4.8%	6.4%
2012	0.9%	0.4%	2.7%	1.2%	2.9%	2.8%	2.8%	2.2%	1.4%	4.3%	4.7%
2013	-0.8%	0.8%	2.8%	3.1%	2.9%	2.8%	2.7%	1.3%	0.8%	3.3%	0.9%
2014	0.1%	3.5%	2.5%	2.9%	na	na	na	3.7%	3.6%	2.9%	4.3%
2015	na	na	2.6%	3.4%	na	na	na	3.6%	5.8%	2.1%	3.3%
Annual Average Growth											
1962 - 2013	**4.1%**	**4.0%**	**4.3%**	**4.1%**	**4.3%**	**4.2%**	**4.1%**	**NA**	**NA**	**4.8%**	**5.3%**
1962 - 1972	**3.0%**	**3.3%**	**4.0%**	**3.9%**	**4.0%**	**3.9%**	**3.8%**	**NA**	**NA**	**4.4%**	**4.3%**
1962 - 2001	**4.8%**	**4.7%**	**4.8%**	**4.7%**	**4.8%**	**4.7%**	**4.7%**	**NA**	**NA**	**4.6%**	**5.2%**
1973 - 1982	**10.1%**	**9.9%**	**10.0%**	**9.9%**	**10.0%**	**10.0%**	**9.9%**	**NA**	**NA**	**8.5%**	**10.6%**
1983 - 2001	**3.1%**	**2.7%**	**2.7%**	**2.5%**	**2.5%**	**2.5%**	**2.5%**	**1.1%**	**0.2%**	**2.7%**	**2.9%**
1983 - 2013	**2.6%**	**2.3%**	**2.7%**	**2.4%**	**2.5%**	**2.5%**	**2.3%**	**1.0%**	**-0.1%**	**3.8%**	**3.9%**
2002 - 2013	**1.8%**	**1.7%**	**2.6%**	**2.1%**	**2.6%**	**2.5%**	**2.0%**	**0.8%**	**-0.6%**	**5.7%**	**5.6%**

Notes
[1] All growth rates are computed logarithmically. For example, growth rate of X = ln(X_t/X_{t-1})
[2] Electric Utility Construction Price Index (Statistics Canada, Table 327-0011)
[3] Flows and Stocks of Fixed Non-Residential Capital (Statistics Canada, Table 031-0005)
[4] Flows and Stocks of Fixed Non-Residential Capital (Statistics Canada, Table 031-0002)
[5] Electric GTD stands for Electric Generation, Transmission and Distribution
[6] Gross Fixed Capital Formation Implicit Price Indexes, Gross Domestic Product, Provincial and Territorial (Statistics Canada, Table 384-0039)
[7] The columns labeled adjusted growth rate were converted to Canadian growth rates using purchasing price parity.

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utilizing price deflators appropriate for the asset's broader classification. For the current program, price indexes for imports, Canadian products, and labor are used.[8]

After asset values are deflated to constant dollars, depreciation is determined, and net stocks are calculated. Net stock is the level of net stock from the previous year, plus new investment, less depreciation. Once net stock has been calculated for the current year, assets are re-inflated using the same price indexes utilized for deflation. Statistics Canada reports these results for the utilities sector of the economy in the following categories: machinery and equipment, engineering construction, non-residential buildings, and intellectual property products. The sum of these capital asset quantities is also published as total non-residential capital in the utilities sector.

Statistics Canada reports capital stocks in current, constant and chained-fisher dollars. It is from these values that the *implicit* asset prices can be derived. Therefore, when the current dollar levels are divided by constant dollar levels, the quantity component cancels out leaving the ratio of the prices in the two years, which is the price deflator. By applying this methodology to a time series, it is possible to generate an implicit capital stock deflator ("ICSD").

Attached to the Stock and Consumption of Fixed Non-Residential Capital program's description page is a publication titled *Investment Flows and Capital Stocks Methodology*. This document discusses the deflation of asset categories in some detail. We found some contradictions between this report and other Statistics Canada publications. When we asked Statistics Canada about these discrepancies, they stated that the *Investment Flows and Capital Stocks Methodology* document is outdated, and that they do not have a publicly available methodological document to replace it. However, Statistics Canada informed us that an older Flows and Stocks of Fixed Non-Residential Capital (CANSIM Table 031-0002) dataset, which was disseminated through 2013, utilized the older methodology.

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[8] Specifically, the New Housing Price Index; Machinery and Equipment Price Index; Industrial Product Price Index; Construction Price Indexes; Commercial Software Price Index; Import Price Indexes; and Average Weekly Earnings. *About the Stock and Consumption of Fixed Capital Program* (February 2016).

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When we compared our ICSDs for the utilities sector between both datasets in Table 14-5, we observed similar growth rates. Therefore, we believe that the methodologies are similar and offer a brief discussion of the previous deflation methodology.[9] Engineering construction and machinery and equipment average over 95 percent of the assets over the full sample period (93% more recently) in the utilities sector, so we focus on these categories. For engineering construction assets, indexes that measure prices of sold construction projects and assets were used. They were weighted using data from Statistics Canada's publications: *Construction in Canada* from 1971 to 1991 and *Capital Expenditures by Type of Asset* after 1991. Previously, weighted averages of construction input price indexes were used to deflate engineering construction assets. Statistics Canada began to switch to selling price indexes in 1971 and only used selling price indexes after 1980.

Machinery and equipment assets were deflated differently. Asset class and industry weights were derived from Statistics Canada's input-output model. It is worth noting that there was a three-year lag before weights could be revised to reflect the latest input-output models.[10] After the weights were determined, for all goods other than computers and software, the associated product price indexes from Statistics Canada's Price Division were used.[11]

We have identified several reasons for the differences in results between the two ICSD methodologies. The old report states that indexes of Paasche form were used for Machinery and Equipment, but the more recent Flows and Stocks dataset uses indexes of Laspeyres form.[12] Furthermore, in our correspondence with the National Economic Accounts Division of Statistics Canada, they stated that the Machinery and Equipment category incorporates import price indexes, something

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[9] This discussion is based on Statistics Canada's *Investment Flows and Capital Stocks Methodology* (2001).

[10] Prior to 1961, weights were chained to later years using the average over 1961 to 1963 of the ratio of fixed to current price indexes.

[11] Price indexes for computers and software come from the System of National Accounts. *Investment Flows and Capital Stocks Methodology* (2001).

[12] *Canadian System of Macroeconomic Accounts: Chapter 7 Price and Volume Measures* (November 2016)

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that the old methodological publication makes no reference to. Further change may have resulted from adjustments in how assets and price indexes are matched.

A current methodology statement is not published for the SCFC, so we cannot explicitly state how it is different from the EUCPI in terms of weighting. However, the SCFC uses prices indexes of both the Paasche and Laspeyres forms, instead of fixed year weights. Moreover, given the recent updates to the SCFC, the base year is likely more recent than 1973. Therefore, capital assets are likely paired with price indexes and weights that are more in line with current construction practices and technology.

Since there are differences in what the EUCPI and this ICSD are measuring, it is worth comparing them to determine whether this alternative is a good substitute. As we have seen, the utility sector ICSD is easy to calculate, and the program is reviewed regularly, but it has the drawback of having a higher level of aggregation than indexes specific to electric utilities. It includes asset prices for electric power generation, distribution, and transmission; natural gas distribution; water, sewage and other systems.[13]

Prior to 2014, in CANSIM Table 031-0002, the utilities sector was itemized at the four-digit level, and electric power generation, distribution, and transmission was given its own category. Between 2002 and 2013, electric power generation, distribution, and transmission averaged approximately 80 percent of total utility assets valued in constant dollars. We compared the growth rates for the deflator of utilities with the current methodology with the deflator for electric power generation, distribution and transmission using the historic methodology in Table 14-5. For Canada as a whole, we found that the deflator for utilities averaged 4.3% percent annual growth from 1962 to 2013; over the same period, electric power generation, distribution and transmission averaged 4.2%. While the utilities-sector ICSD picks up some additional information that we do not want, it historically tracked the Electric Power Generation, Distribution and Transmission price deflator fairly closely.

Next, we compared these deflators to the EUCPI (also in Table 14-5). As we previously mentioned, the credibility of the EUCPI is dubious in recent years. The labor price growth rate slows inexplicably compared to other wage metrics after 2000. There have also been significant technological

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[13] Gas transmission is excluded.

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improvements to meters, switchboards, and undergrounding construction processes which likely contributed as well. Since the EUCPI was based on 1970s projects, these items might be improperly weighted or, as is the case with meters, utilize a price index that does not track current construction practices. Therefore, we looked at the period from 1962 to 2001 for all of Canada. We observed growth rates of 4.8 percent for both the EUCPI and the utilities sector ICSD using the current methodology. We also compared the same datasets for the shorter epochs spanning 1962 to 1972, 1973 to 1982, and 1983 to 2001. From 1962 to 1972, the EUCPI averaged 100 basis points less annual growth than the Utilities ICSD. However, the EUCPI models were not constructed until 1973 at the earliest, which may be causing this discrepancy. During the hyper-inflation period of 1973 to 1982, average growth was only 10 basis points higher annually for the EUCPI. This gap broadened slightly to 40 basis points between 1983 to 2001, but the indexes still tracked closely. Note also that, since 2001, utilities-sector ICSD growth has been a little slower for Ontario than for Canada as a whole.

Gross Fixed Capital Formation Indexes

We also considered implicit price indexes for gross fixed capital formation ("GFCF") (CANSIM Table 384-0039). Hydro-Quebec Distribution proposed one of these indexes as an RCI inflation measure in a recent IRM proceeding. The Statistics Canada GFCF program measures the "level of producer's acquisitions, less disposal of fixed assets … plus certain specified expenditure on services that adds to the value of non-produced assets (such as transfer fees)."[14] On the national level, it measures new investment in fixed capital throughout the Canadian economy and is an account used to calculate GDP via expenditures. The associated indexes can be used to derive real GDP from nominal GDP. For Canada as a whole, the price indexes implicit within GFCF can be derived from the GFCF estimates in CANSIM Table 380-0068 by dividing GFCF in seasonally adjusted current prices by GFCF in seasonally adjusted chained Fisher dollars, then multiplying by 100. Thus, these asset prices are implicit chained Fisher indexes.

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[14] Statistics Canada, *Methodological Guide: Canadian System of Macroeconomics Accounts* (13-607-X) (May 2016).

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Beyond differences in derivation, there are several differences between these indexes and the ones calculated from the Stock and Consumption of Fixed Capital program. The overall methodology for the calculation of price indexes is similar, but "the constant dollar price values and chained prices for the investment within the SCFC and the GFCF will vary as deflation within the SCFC starts at a more detailed level, therefore, once aggregation is completed, the total may differ."[15] GFCF indexes are thus calculated starting from a less itemized level. It is not possible to get an implicit price index for just the Utilities sector. There are no indexes that include just total non-residential capital. Therefore, we must choose between business gross fixed capital formation, which also includes residential structures, and non-residential structures, machinery and equipment, which excludes intellectual property products.

The GFCF indexes were not published prior to 1981, so we compare them to the EUCPI in more recent years. Looking at Table 14-5, we observe that between 1983 and 2001 the GFCF Non-Residential index averaged 1.1 percent annual growth for Canada, compared to 3.1 percent growth for the distribution systems EUCPI. In the more recent epoch, from 2002 to 2013, the GFCF Non-Residential index had only a 0.8 percent growth trend, while the EUCPI had 1.8 percent annual growth. It is our view that the EUCPI grew too slowly in the final years of its publication, so the gap using the GFCF implicit price deflator is likely even wider. Therefore, GFCF implicit price indexes do a worse job of tracking the EUCPI and offer fewer details than the utility-sector ICSD and, so they are less appropriate than ICSDs.

HWI

Handy-Whitman Electric Utility Construction Cost Indexes (HWIs) are calculated and marketed by Whitman, Requardt, and Associates (WRA). Summary HWIs are available for transmission, distribution, and various kinds of generation plant for six geographic regions across the contiguous United States. The two Handy Whitman regions adjacent to Ontario are the North Atlantic and North Central states. Each summary index averages trends in various subindexes. In the case of power distribution, for example, there are subindexes for station equipment, underground conductors and

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[15] Statistics Canada, *About the Stock and Consumption of Fixed Capital Program* (February 2016).

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devices, etc. Like the EUCPIs, the HWIs have been constructed with weights for various labor, materials, equipment, and other costs based on historic projects. Price data on these items are gathered from sources like the *Engineering News-Record*, the Construction Labor Research Council, and major manufacturers and utilities.[16]

In their research on the TFP trend of Hydro One, PSE derived the asset price deflator using the HWI of Total Power Distribution Plant in the North Atlantic states. To convert the HWI to Canadian prices, PSE used U.S.-Canadian purchasing power parities ("PPPs") from the OECD. PSE applied this adjustment to Hydro One in every year in the sample period. For the other Ontario distributors studied, PSE instead used the published values of the distribution systems EUCPI, except in 2015 where they estimated the construction price inflation using the growth rate in the North Atlantic total power distribution plant HWI.

We have some concerns about using HWIs for Canadian benchmarking. A big concern is that we believe the HWIs are constructed using fixed 1973 weights. HWIs have therefore not been updated in nearly 45 years to reflect current cost shares. Similarly, it is possible that the subindexes that compose the HWI are flawed if they are based on 1973 projects. Recall that Statistics Canada specifically discontinued the EUCPI in the past because they believed that indexes derived from projects completed in the 1970s do not accurately model current construction practices.

HONI presents a table in interrogatory HONI-19 that shows that the construction cost trend of power distribution in the North Atlantic region was considerably more rapid than that of power transmission and several kinds of generation from 2003 to 2015. This raises concern that an asset price index designed to track *all* electric utility assets will not track trends in prices of *distribution* assets well. However,

- Hydro One's table excludes the HWI for other production plant, which grew briskly over the 2003-2015 period.

- Hydro One's table also excludes any *summary* HWI for the electric utility sector.

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[16] Whitman, Requardt, and Associates, *The Handy-Whitman Index of Public Utility Construction Costs* (2017).

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- Hydro One's table focusses on a period when copper prices grew briskly. While sensitivity to copper price trends is a desirable feature of an asset price deflator for power distribution, comparably large copper price runup is unlikely to occur in the next five years.

- The asset price index is also used for the benchmark year adjustment. Hence, 2003-2015 is not the only period where the trend in the asset price deflator matters.

Tables 14-6a and 6b provide a more complete set of HWIs for the North Atlantic and North Central regions from 1950 to 2015. Please note the following.

- Over the 2002-2015 period, the growth trend of the summary HWI for total plant-all stream and hydro generation differed from that power distribution by only 90 basis points in the North-Atlantic region and by 100 basis points in the North Central region.[17]

- Over the full 1962-2015 period that matters in research on Hydro One, the trends in the HWI for distribution and a summary HWI for the North Atlantic region were the same in both the North Atlantic and North Central regions.

Tables 14-7a and 7b display the growth rates of the HWI subindexes for the various kinds of distribution assets in the American North Atlantic and North Central regions. Please note the following.

- From 2002 to 2015, the brisk growth in the summary distribution indexes was due chiefly to brisk growth in just a few subindexes

  - Station equipment (5.0% in North Atlantic region)
  - Underground conductors and devices (6.0%)
  - Line transformers (8.8%)

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[17] We do not know whether this summary HWI included other power plant.

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Table 14-6a
North Atlantic Handy-Whitman Summary Growth Trends[1,2]

Year	Total Plant All Steam & Hydro	Total Steam Production	Total Nuclear Production	Total Hydraulic Production	Total Other Production	Total Transmission	Total Distribution
1950	5.1%	2.5%	na	5.9%	na	7.4%	5.0%
1951	7.2%	9.5%	na	2.8%	na	9.1%	7.1%
1952	2.3%	0.0%	na	5.4%	na	4.3%	2.2%
1953	6.6%	4.4%	na	5.1%	na	4.1%	6.5%
1954	2.1%	4.3%	na	2.5%	na	2.0%	2.1%
1955	2.1%	2.1%	na	4.8%	na	3.8%	2.0%
1956	9.7%	13.4%	na	8.9%	na	7.3%	5.8%
1957	5.4%	8.6%	na	6.2%	na	1.7%	1.9%
1958	1.7%	3.2%	na	3.9%	na	3.4%	3.6%
1959	1.7%	1.6%	na	3.8%	na	0.0%	0.0%
1960	0.0%	0.0%	na	1.8%	na	0.0%	1.8%
1961	0.0%	-3.2%	na	0.0%	na	-3.4%	0.0%
1962	0.0%	0.0%	na	1.8%	na	0.0%	1.7%
1963	1.7%	0.0%	na	1.8%	na	0.0%	0.0%
1964	1.7%	1.6%	na	3.4%	na	5.0%	3.4%
1965	3.2%	1.6%	na	1.7%	1.4%	4.8%	3.3%
1966	3.1%	3.1%	3.1%	4.9%	2.7%	3.1%	3.2%
1967	4.5%	3.0%	4.4%	3.1%	9.0%	5.9%	4.6%
1968	2.9%	2.9%	2.9%	4.5%	6.0%	2.8%	4.4%
1969	5.6%	5.6%	5.5%	7.1%	2.3%	5.4%	5.6%
1970	9.0%	6.5%	7.7%	7.9%	5.5%	7.6%	9.0%
1971	7.1%	9.6%	8.3%	8.5%	4.2%	7.1%	7.1%
1972	6.7%	8.8%	7.7%	8.9%	2.0%	4.4%	5.6%
1973	7.3%	5.1%	5.1%	6.2%	1.0%	8.3%	8.3%
1974	16.6%	16.6%	12.2%	14.0%	8.6%	19.9%	16.6%
1975	14.9%	14.2%	11.7%	10.7%	19.9%	13.8%	14.2%
1976	5.0%	5.7%	6.8%	5.3%	9.3%	4.9%	4.3%
1977	5.4%	7.4%	7.1%	5.8%	8.5%	5.9%	4.8%
1978	5.8%	7.5%	6.0%	6.8%	4.3%	3.2%	4.6%
1979	9.5%	9.7%	9.2%	10.5%	7.5%	8.3%	10.3%
1980	8.7%	8.3%	8.5%	9.0%	7.5%	10.3%	7.2%
1981	8.0%	8.6%	8.3%	6.8%	8.9%	7.4%	8.3%
1982	5.6%	5.4%	7.7%	4.4%	7.7%	5.6%	6.2%
1983	3.6%	3.4%	4.5%	4.2%	3.0%	3.1%	3.7%
1984	3.9%	4.1%	3.5%	5.4%	1.7%	2.6%	2.7%
1985	2.1%	3.2%	2.9%	3.4%	1.7%	2.5%	2.2%
1986	1.6%	1.6%	0.8%	2.5%	1.6%	2.1%	1.3%
1987	2.0%	2.7%	3.2%	2.0%	6.7%	1.2%	0.8%
1988	7.6%	7.2%	6.2%	5.5%	18.9%	10.3%	7.3%
1989	4.7%	4.4%	4.7%	3.0%	4.9%	4.3%	5.7%
1990	3.4%	2.6%	2.5%	0.7%	2.1%	5.8%	3.3%
1991	3.0%	2.2%	2.7%	3.3%	2.3%	3.6%	3.5%
1992	1.0%	2.2%	1.7%	1.8%	1.1%	0.3%	-0.3%
1993	2.9%	3.7%	3.3%	3.8%	2.2%	3.1%	2.4%
1994	3.7%	3.5%	3.5%	4.0%	-2.2%	4.5%	3.3%
1995	3.6%	3.4%	4.0%	3.2%	2.2%	4.0%	2.9%
1996	1.2%	1.4%	0.9%	1.2%	3.5%	0.8%	1.9%
1997	2.3%	3.3%	2.9%	3.0%	0.3%	2.2%	1.2%
1998	2.2%	2.1%	1.7%	1.5%	3.1%	3.0%	2.4%
1999	1.1%	1.6%	1.7%	-0.3%	4.0%	0.3%	0.6%
2000	4.8%	6.5%	5.7%	3.2%	8.5%	5.4%	2.9%
2001	2.3%	2.4%	2.6%	2.3%	-4.7%	2.2%	2.3%
2002	3.3%	3.0%	3.0%	2.2%	4.0%	1.9%	3.9%
2003	0.7%	0.7%	1.0%	0.3%	1.6%	0.0%	1.3%
2004	6.2%	5.3%	4.8%	5.1%	0.7%	9.0%	6.5%
2005	6.5%	5.8%	6.8%	5.3%	0.7%	6.6%	7.3%
2006	7.1%	4.4%	4.7%	3.2%	4.6%	7.3%	10.0%
2007	7.6%	5.8%	4.5%	7.6%	14.2%	7.5%	9.7%
2008	9.4%	8.8%	8.4%	7.5%	12.6%	10.9%	10.0%
2009	-0.7%	-3.1%	-2.6%	-1.2%	8.0%	-3.1%	2.6%
2010	4.4%	4.4%	4.6%	3.5%	4.8%	4.5%	4.3%
2011	4.6%	4.4%	4.4%	3.2%	2.4%	4.7%	5.1%
2012	3.1%	2.2%	2.4%	1.2%	8.5%	1.9%	4.5%
2013	2.1%	1.2%	1.3%	0.8%	2.3%	1.2%	3.2%
2014	2.8%	2.9%	2.8%	2.1%	4.3%	2.4%	2.7%
2015	2.7%	4.1%	-9.5%	3.0%	2.8%	1.7%	2.1%

Annual Average Growth Rate

1950 - 2015	4.4%	4.4%	NA	4.3%	NA	4.4%	4.4%
1962 - 2015	4.6%	4.5%	NA	4.3%	NA	4.7%	4.7%
1950 - 1972	3.3%	3.0%	NA	4.2%	NA	3.1%	3.6%
1973 - 1981	9.0%	9.2%	8.3%	8.3%	8.4%	9.1%	8.7%
1982 - 2001	3.1%	3.3%	3.3%	2.9%	3.4%	3.3%	2.8%
2002 - 2015	4.3%	3.6%	2.6%	3.1%	5.1%	4.1%	5.2%

Notes

[1] All growth rates are computed logarithmically. For example, growth rate of X = $\ln(X_t/X_{t-1})$

[2] *The Handy Whitman Index of Public Utility Construction Costs*, Whitman, Requart and Associates (2017). Growth rates are calculated from annual index numbers prior to 1988, and from July index values from 1988 to the present.

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Table 14-6b
North Central Handy-Whitman Summary Growth Trends[1,2]

Year	Total Plant All Steam & Hydro	Total Steam Production	Total Nuclear Production	Total Hydraulic Production	Total Other Production	Total Transmission	Total Distribution
1950	2.5%	2.5%	na	2.9%	na	5.0%	2.5%
1951	9.5%	9.5%	na	8.2%	na	11.5%	9.3%
1952	4.4%	2.2%	na	5.1%	na	2.2%	4.3%
1953	6.3%	4.3%	na	7.2%	na	6.2%	6.2%
1954	2.0%	4.2%	na	2.3%	na	2.0%	2.0%
1955	2.0%	4.0%	na	4.4%	na	3.8%	1.9%
1956	9.4%	11.1%	na	8.3%	na	7.3%	5.6%
1957	5.2%	8.4%	na	5.8%	na	1.7%	3.6%
1958	3.3%	4.7%	na	3.7%	na	3.4%	0.0%
1959	1.6%	1.5%	na	3.6%	na	0.0%	3.4%
1960	-1.6%	-1.5%	na	1.7%	na	0.0%	0.0%
1961	0.0%	-3.1%	na	0.0%	na	-3.4%	0.0%
1962	0.0%	0.0%	na	1.7%	na	0.0%	0.0%
1963	0.0%	0.0%	na	1.7%	na	0.0%	0.0%
1964	1.6%	3.1%	na	1.7%	na	3.4%	3.3%
1965	3.2%	1.5%	na	1.6%	1.4%	4.9%	3.2%
1966	3.1%	3.0%	1.5%	3.2%	2.7%	4.7%	3.1%
1967	4.4%	2.9%	4.4%	4.6%	10.1%	4.4%	4.5%
1968	4.3%	2.8%	2.8%	4.4%	4.7%	4.3%	4.3%
1969	6.7%	5.4%	6.7%	6.9%	3.4%	8.0%	9.4%
1970	8.7%	6.4%	7.5%	6.5%	4.3%	8.6%	8.6%
1971	6.9%	9.4%	8.1%	8.4%	4.2%	6.8%	6.8%
1972	5.4%	6.5%	5.4%	7.7%	1.0%	3.2%	4.3%
1973	5.1%	5.1%	5.1%	6.2%	1.0%	6.2%	5.1%
1974	17.4%	16.6%	13.1%	14.8%	6.8%	19.9%	17.4%
1975	14.8%	14.2%	11.6%	11.4%	21.0%	15.9%	14.8%
1976	5.6%	6.4%	6.8%	3.8%	10.1%	4.8%	4.3%
1977	6.6%	6.7%	7.0%	5.8%	9.8%	6.5%	6.7%
1978	5.6%	8.1%	7.8%	8.7%	3.1%	3.7%	5.1%
1979	9.3%	10.2%	9.0%	10.3%	8.1%	8.1%	9.4%
1980	9.0%	8.7%	8.8%	9.9%	7.0%	9.5%	7.0%
1981	8.2%	8.5%	9.1%	7.6%	9.4%	8.7%	10.0%
1982	5.4%	4.4%	7.0%	3.8%	7.7%	6.7%	6.0%
1983	3.0%	3.4%	3.5%	3.7%	2.6%	2.6%	2.2%
1984	2.9%	3.7%	2.6%	3.5%	1.3%	0.8%	1.3%
1985	2.1%	2.8%	2.1%	3.0%	1.3%	1.7%	1.3%
1986	1.2%	1.6%	1.2%	2.1%	1.6%	1.2%	1.3%
1987	2.0%	2.7%	3.6%	2.9%	7.5%	1.2%	0.8%
1988	7.6%	6.9%	5.7%	4.7%	19.2%	11.7%	6.1%
1989	3.6%	3.4%	4.0%	1.9%	4.6%	3.2%	4.6%
1990	3.1%	2.7%	1.8%	1.1%	2.1%	5.1%	3.7%
1991	1.7%	1.0%	1.4%	1.1%	1.7%	2.3%	1.8%
1992	0.7%	1.9%	2.1%	1.5%	1.1%	-0.6%	0.4%
1993	2.6%	3.2%	2.3%	3.9%	2.0%	2.6%	1.4%
1994	4.4%	4.3%	4.2%	3.8%	-2.5%	5.2%	3.8%
1995	3.7%	3.2%	3.7%	2.6%	1.7%	4.7%	3.6%
1996	2.1%	2.6%	1.5%	2.9%	4.1%	1.7%	1.3%
1997	2.0%	2.5%	3.0%	2.8%	0.0%	1.7%	1.6%
1998	2.3%	2.2%	1.7%	2.1%	2.9%	3.3%	2.2%
1999	0.8%	1.9%	1.7%	2.1%	4.4%	-1.3%	0.0%
2000	4.9%	5.4%	4.7%	3.2%	8.4%	6.3%	3.0%
2001	3.1%	3.2%	2.9%	2.0%	-5.2%	3.3%	3.2%
2002	3.0%	3.3%	3.3%	1.9%	4.0%	1.7%	3.7%
2003	2.0%	1.9%	2.5%	1.4%	2.3%	1.0%	2.7%
2004	5.7%	4.5%	4.1%	4.3%	-0.5%	8.5%	5.8%
2005	5.8%	5.3%	6.2%	4.1%	-0.5%	6.6%	6.4%
2006	7.1%	4.5%	4.8%	4.2%	4.7%	8.5%	11.1%
2007	6.7%	5.4%	3.8%	5.8%	14.8%	7.3%	8.4%
2008	9.2%	8.1%	8.1%	6.4%	13.1%	10.5%	10.3%
2009	-3.0%	-3.9%	-3.8%	-2.1%	8.3%	-6.5%	0.9%
2010	4.2%	4.1%	4.2%	3.0%	4.9%	4.6%	4.1%
2011	4.7%	4.2%	4.6%	2.7%	2.0%	4.9%	5.0%
2012	1.9%	2.3%	2.0%	2.4%	9.0%	0.5%	2.5%
2013	2.2%	1.3%	1.2%	1.4%	2.3%	2.0%	3.4%
2014	2.3%	2.5%	2.6%	2.1%	4.1%	2.1%	2.5%
2015	3.2%	4.3%	5.9%	3.8%	2.9%	1.7%	2.2%

Annual Average Growth Rate							
1950 - 2015	4.3%	4.3%	NA	4.2%	NA	4.4%	4.3%
1962 - 2015	4.5%	4.4%	NA	4.1%	NA	4.6%	4.6%
1950 - 1972	3.2%	2.8%	NA	3.8%	NA	3.2%	3.4%
1973 - 1981	9.1%	9.4%	8.7%	8.7%	8.5%	9.2%	8.9%
1982 - 2001	3.0%	3.1%	3.0%	2.7%	3.3%	3.2%	2.5%
2002 - 2015	3.9%	3.4%	3.5%	2.9%	5.1%	3.8%	4.9%

Notes

[1]All growth rates are computed logarithmically. For example, growth rate of X = ln(X$_t$/X$_{t-1}$)

[2]*The Handy Whitman Index of Public Utility Construction Costs*, Whitman, Requart and Associates (2017). Growth rates are calculated from annual index numbers prior to 1988, and from July index values from 1988 to the present.

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Filed: 2018-05-11
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Table 14-7a

North Atlantic Handy-Whitman Distribution and Transmission Growth Trends[1,2]

Year	Total Transmission	Total Distribution	Station Equipment	Poles, Towers & Fixtures	Overhead Conductors and Devices	Underground Conduit	Undeground Conductors and Devices	Line Transformers	Pad-Mounted Transformers	Services-Overhead	Services-Underground	Meters Installed	Street Lighting-Overhead	Mast Arms & Luminaries Installed	Street Lighting Underground
1950	7.4%	5.0%	4.1%	3.1%	6.1%	5.7%	5.8%	4.5%	0.0%	6.5%	2.6%	0.0%	4.7%	na	-2.4%
1951	9.1%	7.1%	9.5%	5.9%	8.5%	5.4%	20.4%	12.4%	0.0%	9.0%	12.1%	0.0%	8.7%	na	9.1%
1952	4.3%	2.2%	1.8%	2.8%	5.3%	2.6%	3.0%	0.0%	0.0%	5.6%	2.2%	0.0%	4.1%	na	0.0%
1953	4.1%	6.5%	5.2%	5.4%	2.5%	2.5%	0.0%	5.7%	0.0%	5.3%	0.0%	4.2%	2.0%	na	2.2%
1954	2.0%	2.1%	3.3%	2.6%	4.9%	4.9%	1.5%	2.7%	0.0%	0.0%	-2.2%	1.4%	5.7%	na	8.2%
1955	3.8%	2.0%	1.6%	2.5%	6.9%	2.4%	4.3%	0.0%	0.0%	7.4%	0.0%	-4.1%	0.0%	na	3.8%
1956	7.3%	5.8%	9.2%	9.5%	8.5%	6.7%	-1.4%	2.6%	0.0%	6.9%	4.4%	4.1%	5.4%	11.6%	1.9%
1957	1.7%	1.9%	5.7%	4.4%	0.0%	4.3%	-13.8%	5.1%	0.0%	-4.5%	-2.2%	5.3%	8.4%	9.0%	-9.7%
1958	3.4%	3.6%	2.7%	2.2%	-2.1%	4.1%	0.0%	-2.5%	0.0%	0.0%	-4.5%	2.5%	4.7%	0.0%	21.9%
1959	0.0%	0.0%	0.0%	2.1%	4.1%	3.9%	3.2%	-3.4%	0.0%	4.5%	2.3%	2.5%	0.0%	-5.9%	0.0%
1960	0.0%	1.8%	-2.7%	4.1%	2.0%	3.8%	1.6%	-1.8%	-3.0%	4.3%	-4.7%	1.2%	-1.6%	0.0%	1.6%
1961	-3.4%	0.0%	-7.2%	0.0%	0.0%	1.8%	-1.6%	-3.6%	-4.1%	0.0%	0.0%	-1.2%	0.0%	0.0%	-3.3%
1962	0.0%	1.7%	1.5%	3.9%	3.8%	3.6%	0.0%	-9.7%	-1.1%	2.1%	6.9%	0.0%	0.0%	-1.5%	0.0%
1963	0.0%	0.0%	-3.0%	1.9%	1.9%	1.7%	1.6%	-5.2%	1.1%	2.1%	2.2%	0.0%	1.6%	0.0%	1.7%
1964	5.0%	3.4%	3.0%	1.9%	3.6%	3.4%	7.5%	0.0%	-5.4%	4.0%	4.3%	0.0%	1.5%	3.0%	0.0%
1965	4.8%	3.3%	2.9%	5.4%	5.2%	1.7%	8.3%	2.1%	0.0%	5.7%	8.0%	0.0%	1.5%	1.5%	1.6%
1966	3.1%	3.2%	1.4%	3.4%	3.3%	1.6%	1.3%	0.0%	3.3%	5.4%	9.2%	0.0%	1.5%	5.7%	7.8%
1967	5.9%	4.6%	6.8%	3.3%	6.4%	3.2%	2.6%	3.1%	3.2%	6.8%	5.1%	1.2%	5.7%	-1.4%	9.9%
1968	2.8%	4.4%	6.4%	3.2%	4.5%	3.1%	-5.3%	5.0%	2.1%	4.8%	6.5%	3.6%	2.7%	0.0%	-4.1%
1969	5.4%	5.6%	2.4%	7.6%	8.5%	5.9%	7.8%	-4.0%	-4.2%	9.0%	6.1%	3.4%	6.5%	5.5%	5.5%
1970	7.6%	9.0%	4.7%	8.5%	13.9%	10.8%	6.1%	1.0%	1.1%	14.6%	7.1%	4.4%	8.5%	16.0%	13.7%
1971	7.1%	7.1%	2.3%	9.0%	9.0%	10.9%	1.2%	1.0%	2.1%	9.4%	5.3%	5.2%	5.7%	5.5%	6.7%
1972	4.4%	5.6%	3.3%	7.1%	3.2%	7.7%	12.0%	-2.0%	2.0%	6.5%	11.1%	1.0%	5.3%	3.2%	5.3%
1973	8.3%	8.3%	8.3%	13.9%	4.1%	6.2%	3.0%	1.0%	1.0%	5.1%	15.1%	1.0%	4.1%	4.1%	3.0%
1974	19.9%	16.6%	19.9%	20.7%	14.0%	10.4%	22.3%	8.6%	3.0%	7.7%	14.0%	6.8%	19.1%	15.7%	18.2%
1975	13.8%	14.2%	13.0%	14.4%	21.8%	8.6%	3.1%	17.6%	1.9%	10.5%	-7.2%	14.7%	19.5%	15.8%	20.3%
1976	4.9%	4.3%	3.5%	0.7%	12.5%	4.8%	3.1%	3.0%	1.9%	6.5%	4.6%	7.0%	5.3%	9.7%	6.6%
1977	5.9%	4.8%	7.4%	3.4%	5.4%	6.1%	5.8%	7.9%	9.8%	6.1%	3.5%	3.7%	6.3%	8.9%	6.8%
1978	3.2%	4.6%	5.6%	5.9%	-3.6%	6.5%	4.8%	6.0%	9.7%	6.4%	6.7%	2.9%	8.7%	7.6%	8.6%
1979	8.3%	10.3%	5.9%	11.4%	7.6%	9.3%	20.7%	5.7%	5.2%	8.6%	7.8%	2.8%	10.5%	9.1%	10.9%
1980	10.3%	7.2%	8.3%	8.2%	10.1%	6.7%	12.4%	0.0%	13.6%	10.2%	17.7%	-1.4%	8.2%	10.7%	7.6%
1981	7.4%	8.3%	7.6%	8.0%	7.8%	6.3%	1.0%	15.3%	15.9%	6.1%	9.5%	10.5%	9.2%	10.9%	8.3%
1982	5.6%	6.2%	8.0%	6.5%	5.5%	5.9%	-0.5%	8.1%	0.0%	6.3%	0.6%	15.6%	6.9%	5.6%	8.0%
1983	3.1%	3.7%	1.8%	2.7%	6.9%	7.6%	1.9%	1.9%	1.6%	4.0%	10.7%	7.2%	1.2%	3.1%	0.8%
1984	2.6%	2.7%	2.2%	3.9%	2.9%	6.1%	0.9%	1.4%	9.7%	9.3%	3.5%	1.5%	5.3%	7.3%	5.2%
1985	2.5%	2.2%	2.2%	2.9%	0.8%	2.7%	3.2%	0.9%	1.4%	0.4%	-8.2%	1.5%	4.3%	4.1%	3.9%
1986	2.1%	1.3%	1.3%	2.0%	0.8%	2.2%	4.9%	0.9%	3.8%	0.4%	-2.7%	2.4%	-0.4%	-2.4%	0.3%
1987	1.2%	0.8%	2.9%	0.4%	-0.8%	2.2%	1.7%	-0.9%	9.7%	1.7%	6.4%	0.0%	-4.3%	-3.5%	-5.0%
1988	10.3%	7.3%	9.7%	6.2%	21.8%	7.4%	1.7%	0.0%	10.7%	11.0%	0.5%	-4.3%	2.6%	1.4%	2.5%
1989	4.3%	5.7%	7.5%	4.1%	1.6%	11.6%	7.6%	5.0%	5.8%	6.4%	14.2%	-6.6%	3.9%	5.8%	3.5%
1990	5.8%	3.3%	7.0%	3.6%	2.2%	-0.7%	4.9%	2.2%	0.7%	0.4%	5.6%	0.5%	3.1%	3.0%	3.4%
1991	3.6%	3.5%	1.0%	6.4%	6.6%	0.7%	4.7%	0.4%	5.5%	3.9%	-6.5%	11.8%	4.6%	4.7%	4.2%
1992	0.3%	-0.3%	0.6%	5.1%	-8.5%	0.7%	0.0%	2.6%	-1.0%	-2.5%	-1.3%	-4.8%	2.5%	3.3%	2.2%
1993	3.1%	2.4%	1.3%	2.5%	5.2%	3.1%	2.1%	0.0%	3.3%	3.8%	1.8%	4.3%	4.9%	3.2%	5.5%
1994	4.5%	3.3%	3.4%	6.8%	4.1%	4.3%	1.0%	2.9%	1.0%	4.4%	5.2%	-6.3%	5.2%	7.0%	4.3%
1995	4.0%	2.9%	5.3%	2.8%	7.7%	1.9%	4.7%	-3.3%	0.6%	4.8%	2.9%	-2.0%	3.9%	2.1%	3.9%
1996	0.8%	1.9%	-0.9%	2.2%	1.6%	1.6%	1.9%	0.8%	3.8%	1.2%	0.0%	3.5%	5.0%	7.1%	5.0%
1997	2.2%	1.2%	1.7%	3.5%	1.8%	2.8%	0.6%	-4.7%	0.9%	1.8%	2.0%	8.5%	2.0%	1.7%	2.1%
1998	3.0%	2.4%	4.2%	1.3%	3.5%	2.4%	1.9%	1.3%	0.6%	1.5%	-2.4%	0.9%	0.8%	-0.7%	1.0%
1999	0.3%	0.6%	1.3%	1.8%	-3.5%	2.9%	3.1%	0.4%	0.9%	1.2%	-0.4%	-3.6%	2.0%	1.0%	2.2%
2000	5.4%	2.9%	1.3%	1.8%	8.1%	3.7%	1.2%	0.9%	0.9%	2.9%	5.6%	-1.4%	1.7%	1.2%	2.2%
2001	2.2%	2.3%	2.1%	2.2%	2.8%	3.0%	-1.5%	3.8%	5.8%	2.0%	-0.4%	12.4%	2.6%	1.7%	3.1%
2002	1.9%	3.9%	1.0%	4.1%	2.7%	5.5%	3.0%	4.0%	3.6%	3.3%	5.3%	13.9%	6.2%	2.8%	6.8%
2003	0.0%	1.3%	1.3%	1.4%	2.0%	-0.3%	0.6%	2.0%	-1.4%	1.6%	0.4%	3.5%	5.2%	2.0%	6.3%
2004	9.0%	6.5%	11.2%	3.4%	6.8%	4.3%	6.5%	4.5%	24.1%	6.0%	2.9%	12.4%	2.5%	2.6%	2.0%
2005	6.6%	7.3%	6.4%	5.8%	9.8%	7.3%	10.9%	7.1%	16.7%	7.1%	8.9%	-3.1%	6.0%	9.3%	5.3%
2006	7.3%	10.0%	8.2%	3.9%	11.3%	5.6%	7.8%	23.5%	18.4%	5.0%	22.8%	2.5%	14.9%	10.5%	16.3%
2007	7.5%	9.7%	10.9%	4.9%	8.1%	5.5%	18.4%	14.2%	22.8%	6.7%	-4.6%	3.9%	5.8%	5.7%	6.4%
2008	10.9%	10.0%	7.9%	5.4%	13.1%	6.3%	12.6%	19.3%	-7.6%	6.3%	-0.5%	1.5%	6.7%	0.2%	8.1%
2009	-3.1%	2.6%	3.0%	3.8%	-14.0%	4.3%	9.1%	9.3%	-12.5%	-3.8%	-5.7%	1.5%	11.1%	18.2%	10.5%
2010	4.5%	4.3%	5.7%	2.9%	11.1%	0.9%	-5.0%	9.2%	-2.1%	7.3%	8.1%	4.5%	-3.2%	3.7%	-5.2%
2011	4.7%	5.1%	4.6%	1.2%	7.2%	3.0%	7.7%	4.9%	8.6%	7.8%	14.3%	-2.2%	4.8%	2.7%	5.4%
2012	1.9%	4.5%	4.0%	3.8%	-0.9%	4.3%	9.3%	5.8%	0.8%	0.0%	10.6%	1.1%	4.3%	6.1%	3.9%
2013	1.9%	3.2%	2.3%	1.1%	4.6%	-0.2%	2.0%	8.2%	-2.8%	1.4%	1.9%	1.9%	0.2%	0.0%	0.2%
2014	2.4%	2.7%	2.9%	0.6%	3.7%	2.7%	1.2%	7.2%	-1.7%	4.2%	-9.0%	2.2%	-4.4%	-10.1%	-3.3%
2015	1.7%	2.1%	0.9%	0.8%	2.2%	1.8%	0.5%	4.0%	2.7%	2.9%	4.6%	1.1%	2.0%	2.2%	2.3%

Annual Average Growth Rate

	Total Transmission	Total Distribution	Station Equipment	Poles, Towers & Fixtures	Overhead Conductors and Devices	Underground Conduit	Undeground Conductors and Devices	Line Transformers	Pad-Mounted Transformers	Services-Overhead	Services-Underground	Meters Installed	Street Lighting-Overhead	Mast Arms & Luminaries Installed	Street Lighting Underground
1950 - 2015	4.4%	4.4%	4.2%	4.5%	5.0%	4.4%	4.1%	3.4%	2.9%	4.6%	3.8%	2.6%	4.4%	NA	4.5%
1962 - 2015	4.7%	4.7%	4.5%	4.7%	5.2%	4.5%	4.6%	3.8%	3.7%	4.8%	4.5%	2.8%	4.7%	4.5%	4.8%
1950 - 1972	3.7%	3.7%	2.8%	4.3%	4.8%	4.4%	2.9%	0.6%	-0.1%	5.0%	3.6%	1.5%	3.6%	NA	3.5%
1973 - 1981	9.1%	8.7%	8.8%	9.6%	8.9%	7.2%	8.5%	7.2%	6.9%	7.5%	8.0%	5.3%	10.1%	10.3%	10.0%
1982 - 2001	3.3%	2.8%	3.2%	3.4%	3.6%	3.6%	2.3%	1.2%	3.3%	3.2%	1.9%	2.0%	2.9%	2.8%	2.9%
2002 - 2015	4.1%	5.2%	5.0%	3.1%	4.8%	3.7%	6.0%	8.8%	5.0%	4.0%	4.3%	3.2%	4.4%	4.0%	4.7%

Notes

[1] All growth rates are computed logarithmically. For example, growth rate of X = ln(X_t/X_{t-1})

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Filed: 2018-05-11
EB-2017-0049
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Tab 8
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Table 14-7b

North Central Handy-Whitman Distribution and Transmission Growth Trends[1,2]

Year	Total Transmission	Total Distribution	Station Equipment	Poles, Towers & Fixtures	Overhead Conductors and Devices	Underground Conduit	Undeground Conductors and Devices	Line Transformers	Pad-Mounted Transformers	Services-Overhead	Services-Underground	Meters Installed	Street Lighting-Overhead	Mast Arms & Luminaries Installed	Street Lighting Underground
1950	5.0%	2.5%	5.9%	6.1%	6.3%	5.7%	5.8%	5.6%	0.0%	6.9%	5.4%	0.0%	4.7%	na	0.0%
1951	11.5%	9.3%	9.2%	5.7%	11.4%	5.4%	21.9%	11.3%	0.0%	15.4%	14.7%	0.0%	10.8%	na	9.1%
1952	2.2%	4.3%	3.4%	5.4%	5.3%	5.1%	3.0%	1.0%	0.0%	5.6%	-2.3%	-1.4%	2.0%	na	2.2%
1953	6.2%	6.2%	5.0%	5.1%	5.0%	2.5%	-1.5%	5.6%	0.0%	5.3%	0.0%	4.2%	2.0%	na	0.0%
1954	2.0%	2.0%	3.2%	2.5%	2.4%	4.8%	2.9%	1.8%	0.0%	2.5%	2.3%	2.7%	5.7%	na	10.1%
1955	3.8%	1.9%	3.1%	2.4%	9.1%	4.5%	4.3%	0.0%	0.0%	7.2%	0.0%	-4.1%	1.8%	na	3.8%
1956	7.3%	5.6%	8.7%	6.9%	8.3%	4.3%	-1.4%	2.6%	0.0%	6.7%	4.4%	4.1%	5.3%	9.7%	1.8%
1957	1.7%	3.6%	5.4%	6.5%	-2.0%	4.2%	-13.6%	5.9%	0.0%	-4.4%	-2.2%	5.2%	6.7%	8.8%	7.0%
1958	3.4%	0.0%	2.6%	2.1%	0.0%	4.0%	-1.6%	-2.5%	0.0%	0.0%	-4.5%	2.5%	6.3%	1.4%	5.0%
1959	0.0%	3.4%	1.3%	0.0%	2.0%	1.9%	4.8%	-4.3%	0.0%	4.4%	2.3%	2.4%	-1.5%	-7.2%	0.0%
1960	0.0%	0.0%	-2.6%	4.0%	2.0%	3.8%	1.6%	-0.9%	-2.0%	4.3%	-4.7%	1.2%	0.0%	1.5%	1.6%
1961	-3.4%	0.0%	-8.1%	1.9%	1.9%	3.6%	-1.6%	-3.6%	-5.1%	2.1%	2.4%	-1.2%	0.0%	-1.5%	-1.6%
1962	0.0%	0.0%	1.4%	1.9%	3.8%	1.8%	0.0%	-8.6%	-1.0%	2.0%	4.5%	0.0%	0.0%	-1.5%	-1.6%
1963	0.0%	0.0%	-2.8%	1.9%	0.0%	3.4%	1.6%	-7.3%	1.0%	0.0%	2.2%	0.0%	1.5%	1.5%	1.6%
1964	3.4%	3.3%	2.8%	1.8%	3.6%	1.7%	7.4%	0.0%	-4.3%	3.9%	4.3%	0.0%	1.5%	1.5%	0.0%
1965	4.9%	3.2%	1.4%	3.6%	5.2%	1.7%	6.9%	2.1%	-1.1%	5.6%	8.0%	0.0%	0.0%	1.5%	0.0%
1966	4.7%	3.1%	2.7%	3.4%	3.3%	1.6%	1.3%	1.0%	3.2%	3.6%	7.4%	0.0%	2.9%	5.6%	7.8%
1967	4.4%	4.5%	3.9%	3.3%	6.4%	3.2%	2.6%	4.1%	3.1%	6.8%	5.2%	1.2%	5.6%	-1.4%	11.3%
1968	4.3%	4.3%	3.8%	4.8%	6.0%	4.6%	-2.6%	3.0%	2.0%	6.4%	8.1%	3.5%	2.7%	1.4%	-5.5%
1969	8.0%	9.4%	7.1%	9.0%	13.5%	9.9%	8.8%	-2.0%	-2.0%	14.3%	11.8%	4.5%	8.9%	6.6%	8.1%
1970	8.6%	8.6%	4.5%	10.8%	11.9%	9.0%	5.8%	1.0%	0.0%	14.8%	8.0%	4.3%	9.3%	16.5%	15.6%
1971	6.8%	6.8%	1.1%	7.4%	9.6%	8.3%	0.0%	0.0%	2.0%	7.7%	3.8%	5.1%	4.3%	4.3%	6.5%
1972	3.2%	4.3%	2.2%	5.8%	1.0%	5.5%	11.8%	-2.0%	1.0%	3.1%	8.3%	1.0%	4.2%	2.1%	3.1%
1973	6.2%	5.1%	6.2%	11.7%	1.0%	7.3%	1.0%	0.0%	0.0%	3.0%	12.8%	-1.0%	2.0%	2.0%	1.0%
1974	19.9%	17.4%	19.9%	21.5%	14.8%	10.4%	22.3%	8.6%	3.9%	7.7%	14.0%	7.7%	19.9%	15.7%	18.2%
1975	15.9%	14.8%	14.5%	13.6%	20.9%	8.6%	3.1%	17.6%	1.0%	9.7%	-6.3%	13.8%	19.3%	16.5%	21.0%
1976	4.8%	4.3%	2.8%	0.0%	11.9%	4.0%	3.1%	3.0%	1.9%	6.5%	2.7%	7.0%	5.3%	9.0%	6.5%
1977	6.5%	6.7%	9.8%	5.5%	7.8%	7.6%	6.5%	7.9%	9.8%	9.0%	6.1%	5.1%	8.0%	10.7%	7.9%
1978	3.7%	5.1%	6.6%	7.1%	-2.3%	8.5%	6.1%	6.7%	10.5%	7.6%	6.6%	2.8%	9.0%	8.6%	9.5%
1979	8.1%	9.4%	5.7%	11.7%	6.8%	8.4%	20.3%	5.6%	5.2%	8.3%	8.4%	2.7%	10.3%	8.9%	10.6%
1980	9.5%	7.0%	7.5%	8.5%	9.9%	6.6%	12.2%	0.0%	14.2%	10.5%	16.8%	-1.4%	8.9%	10.4%	7.8%
1981	8.7%	10.0%	8.8%	9.2%	9.0%	7.3%	2.4%	15.8%	16.2%	7.5%	11.1%	11.0%	9.0%	11.9%	8.1%
1982	6.7%	6.0%	9.4%	5.4%	4.9%	6.3%	-1.4%	7.5%	-0.5%	5.0%	0.0%	15.3%	6.3%	5.1%	7.8%
1983	2.6%	2.2%	0.9%	1.7%	5.5%	6.4%	0.9%	1.4%	1.1%	2.4%	9.5%	6.6%	0.4%	1.9%	0.0%
1984	0.8%	1.3%	-0.4%	1.7%	0.8%	3.7%	-0.5%	0.9%	8.7%	6.5%	2.0%	0.5%	4.1%	6.5%	3.7%
1985	1.7%	1.3%	1.7%	1.7%	0.4%	1.4%	2.8%	0.9%	1.0%	-0.4%	-8.2%	1.0%	3.6%	4.1%	3.6%
1986	1.2%	1.3%	1.2%	2.1%	0.8%	1.8%	4.9%	0.5%	3.8%	0.9%	-3.3%	2.4%	0.0%	-2.7%	0.7%
1987	1.2%	0.8%	3.3%	1.2%	-0.4%	3.1%	2.2%	-0.5%	10.2%	2.6%	6.9%	0.0%	-4.3%	-3.5%	-5.0%
1988	11.7%	6.1%	9.9%	4.0%	19.4%	5.9%	-0.4%	-0.9%	10.4%	7.9%	-1.6%	-5.9%	1.1%	0.0%	1.1%
1989	3.2%	4.6%	8.7%	2.7%	1.0%	10.0%	7.8%	4.6%	5.5%	5.8%	14.6%	-7.3%	3.6%	5.9%	2.9%
1990	5.1%	3.7%	7.7%	3.7%	2.3%	-1.1%	4.7%	2.2%	0.4%	0.0%	5.7%	0.5%	2.8%	3.0%	3.1%
1991	2.3%	1.8%	0.0%	3.9%	4.7%	-3.0%	3.4%	0.0%	4.5%	1.1%	-8.9%	11.2%	3.0%	3.5%	2.7%
1992	-0.6%	0.4%	0.3%	6.1%	-8.0%	1.5%	0.4%	2.6%	-0.7%	-1.5%	-0.5%	-4.4%	3.3%	4.0%	2.9%
1993	2.6%	1.4%	0.0%	1.3%	3.6%	2.2%	1.1%	-0.4%	3.0%	2.2%	0.5%	3.9%	4.1%	2.4%	4.7%
1994	5.2%	3.8%	3.3%	7.5%	4.4%	4.7%	1.1%	3.0%	0.7%	4.3%	5.5%	-7.0%	5.7%	6.9%	4.8%
1995	4.7%	3.6%	6.0%	3.0%	8.5%	2.1%	5.2%	-3.4%	0.7%	5.5%	3.1%	-2.1%	4.3%	2.7%	4.3%
1996	1.7%	1.3%	-2.0%	2.6%	1.7%	2.4%	2.0%	0.9%	4.2%	1.7%	0.0%	3.6%	5.2%	7.3%	4.9%
1997	1.7%	1.6%	1.1%	3.9%	1.9%	3.6%	0.7%	-4.8%	0.9%	1.6%	2.5%	9.3%	2.4%	1.7%	2.6%
1998	3.3%	2.2%	5.2%	1.1%	3.5%	2.6%	1.6%	0.9%	0.9%	1.6%	-3.0%	0.5%	0.5%	-0.7%	0.8%
1999	-1.3%	0.0%	0.8%	1.3%	-4.3%	3.1%	2.6%	0.4%	0.6%	0.6%	-0.9%	-4.3%	1.5%	0.5%	1.8%
2000	6.3%	3.0%	0.8%	1.9%	9.2%	3.6%	1.9%	0.9%	0.9%	3.4%	6.3%	-1.5%	2.0%	1.5%	2.5%
2001	3.3%	3.2%	1.8%	3.6%	3.9%	4.1%	-0.9%	4.3%	6.5%	3.6%	0.4%	14.1%	3.4%	2.2%	3.6%
2002	1.7%	3.7%	-1.0%	4.0%	2.6%	6.1%	3.1%	4.1%	3.4%	3.2%	5.5%	13.9%	6.1%	2.8%	7.1%
2003	1.0%	2.7%	0.8%	2.9%	3.5%	1.6%	1.8%	2.4%	-0.8%	3.7%	1.5%	4.3%	6.4%	2.5%	7.3%
2004	8.5%	5.8%	6.3%	2.6%	5.7%	3.9%	5.5%	4.3%	24.1%	4.3%	1.9%	12.3%	1.9%	2.0%	1.6%
2005	6.6%	6.4%	12.1%	5.2%	9.0%	6.6%	10.5%	6.9%	16.9%	6.2%	8.2%	-4.2%	5.7%	9.1%	5.0%
2006	8.5%	11.1%	8.1%	4.9%	12.3%	6.6%	8.5%	24.3%	18.8%	6.3%	24.2%	3.2%	15.6%	11.2%	17.4%
2007	7.3%	8.4%	9.8%	3.5%	7.5%	3.7%	18.3%	14.2%	22.8%	5.5%	-5.5%	3.1%	5.4%	5.3%	5.7%
2008	10.5%	10.3%	7.0%	5.5%	13.6%	5.6%	13.1%	19.6%	-7.7%	7.0%	-0.6%	1.8%	6.9%	0.3%	8.4%
2009	-6.5%	0.9%	2.2%	2.4%	-15.6%	2.4%	8.7%	9.2%	-13.2%	-5.9%	-6.8%	0.6%	11.1%	18.3%	10.2%
2010	4.6%	4.1%	4.7%	1.3%	10.4%	-0.6%	-6.3%	8.8%	-2.9%	5.7%	6.8%	3.8%	-4.4%	3.2%	-6.5%
2011	4.9%	5.0%	3.8%	1.3%	7.5%	2.7%	8.3%	5.1%	8.9%	8.7%	15.3%	-2.6%	4.9%	2.7%	5.6%
2012	0.5%	2.5%	2.2%	1.8%	-3.1%	4.0%	8.2%	5.3%	0.3%	-3.3%	9.4%	-0.3%	3.4%	5.2%	3.2%
2013	2.0%	3.4%	0.9%	1.4%	4.7%	0.6%	2.0%	8.3%	-2.9%	1.2%	1.8%	1.8%	0.3%	0.0%	0.5%
2014	2.1%	2.5%	1.9%	-0.2%	3.4%	2.4%	0.8%	7.4%	-2.1%	3.8%	-10.4%	2.0%	-5.1%	-11.3%	-3.9%
2015	1.7%	2.2%	0.3%	0.5%	2.7%	1.3%	0.7%	4.2%	2.9%	3.8%	5.4%	1.4%	2.3%	2.5%	2.4%
Annual Average Growth Rate															
1950 - 2015	4.4%	4.3%	4.0%	4.4%	4.9%	4.3%	4.1%	3.4%	2.9%	4.5%	3.8%	2.4%	4.4%	NA	4.5%
1962 - 2015	4.6%	4.6%	4.2%	4.4%	5.0%	4.3%	4.5%	3.7%	3.7%	4.5%	4.3%	2.7%	4.6%	4.4%	4.7%
1950 - 1972	3.8%	3.8%	2.8%	4.4%	5.0%	4.4%	3.0%	0.6%	-0.1%	5.4%	3.9%	1.5%	3.7%	NA	3.7%
1973 - 1981	9.2%	8.9%	9.1%	9.9%	8.9%	7.6%	8.6%	7.2%	7.0%	7.8%	8.0%	5.3%	10.2%	10.4%	10.1%
1982 - 2001	3.2%	2.5%	3.0%	3.0%	3.2%	3.2%	2.0%	1.1%	3.1%	2.8%	1.5%	1.8%	2.6%	2.6%	2.7%
2002 - 2015	3.8%	4.9%	4.2%	2.6%	4.6%	3.3%	5.9%	8.9%	4.9%	3.6%	4.1%	2.9%	4.3%	3.9%	4.6%

Notes

[1] All growth rates are computed logarithmically. For example, growth rate of X = ln(X_t/X_{t-1})

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    o   Pad-mounted transformers (5.0%)

These are all assets with a high copper content.

- The longer-term trends in the various subindexes are more similar.

In Table 14-8, we compare the trends in some of the rapidly rising HWI power distribution sub-indexes in the North Atlantic region to trends in other available input prices. Looking at Producer Price Index data on transformers from the BLS, for example, we observed a 3.0 percent growth trend from 2002 to 2016. However, during this span in the HWI, we calculated 8.5 percent annual growth for the Line Transformers. This difference cannot be explained by rapidly growing labor costs. The BLS Employment Cost Index grew by only 2.5 percent in the Northeast Census region over the same period; nationally, the Employment Cost Index for utility workers increased 3.4 percent on average.

The growth trends of the HWIs for Overhead Conductors and Devices and Underground Conductors and Devices also display faster growth than their respective PPIs. Between 2002 and 2016, these HWIs averaged 4.7 and 5.4 percent growth, respectively. However, during the same span, the BLS PPIs for non-ferrous communication and energy wire, non-current-carrying wiring devices, and current-carrying wiring devices displayed growth trends of 4.3, 3.7 and 2.2 percent, respectively. We observe markedly faster growth from the HWIs compared to BLS PPIs.

The United States Bureau of Economic Analysis ("BEA") produces net capital stock datasets similar to the ones generated by Statistics Canada. [18] While we do not recommend utilizing the BEA's dataset to calculate an asset price deflator for Canadian TFP research, there are itemized price deflators for electric structures and electric transmission and distribution equipment which also offer a useful comparison to the distribution HWI.

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[18]In general, asset depreciation rates were developed by the BEA using the research of Hulten and Wykoff. See *Fixed Assets and Consumer Durable Goods in the United States, 1925-97* (2003).

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Table 14-8

How Handy Whitman Subindexes Compare to Alternative Price Indexes[1] (Growth Rates)

Year	Relevant BLS Producer Price Indexes					ECI		Select Handy-Whitman Sub-Indexes[8]			
	Steel Wire Drawing[3]	Communication and Energy Wire (non-ferrous)[4]	Non-Current-Carrying Wiring Device[5]	Current-Carrying Wiring Device[6]	Electric Power and Specialty Transformers[7]	Utilities[8]	All Industries in the Northeast[9]	Overhead Conductors and Devices	Underground Conductors and Devices	Line Transformers	Pad Mounted Transformers
	Growth Rate	Growth Rate	Growth Rate	Growth Rate	Growth Rate	Growth Rate	Growth Rate	Growth Rate	Growth Rate	Growth Rate	Growth Rate
1981		-4.4%	12.8%	na	12.7%						
1982		-2.6%	4.4%	5.0%	6.3%	na	na	5.5%	-0.5%	8.1%	0.0%
1983	-0.7%	-4.0%	2.7%	4.8%	1.9%	na	na	6.9%	1.9%	1.9%	1.6%
1984	1.7%	2.8%	8.1%	3.4%	0.7%	na	na	2.9%	0.9%	1.4%	9.7%
1985	1.0%	0.0%	2.6%	2.7%	1.8%	na	na	0.8%	3.2%	0.9%	1.4%
1986	-0.2%	0.3%	5.5%	2.7%	0.2%	na	na	0.8%	4.9%	0.9%	3.8%
1987	0.2%	1.2%	4.0%	1.0%	1.5%	na	na	-0.8%	1.7%	-0.9%	9.7%
1988	5.6%	17.8%	6.5%	2.8%	2.1%	na	na	18.6%	3.6%	1.7%	9.9%
1989	3.4%	9.5%	7.1%	2.8%	7.5%	na	na	4.5%	6.7%	4.1%	5.7%
1990	1.2%	-6.5%	2.1%	1.7%	5.3%	na	na	0.9%	4.4%	1.4%	2.2%
1991	-1.1%	-7.6%	0.9%	1.8%	2.9%	na	na	3.7%	3.3%	0.3%	3.8%
1992	0.9%	-1.2%	1.9%	1.5%	-0.5%	na	na	-2.3%	1.3%	2.1%	0.1%
1993	2.0%	-1.8%	3.6%	2.5%	-1.5%	na	na	4.6%	1.8%	0.8%	2.8%
1994	4.0%	3.1%	3.2%	0.8%	1.5%	na	na	4.2%	1.2%	2.0%	0.7%
1995	3.2%	5.4%	4.2%	2.5%	2.8%	na	na	6.4%	3.8%	-1.4%	0.6%
1996	-0.1%	-5.2%	3.1%	1.2%	0.7%	na	na	2.0%	2.2%	-1.8%	3.9%
1997	1.3%	-0.5%	3.3%	0.5%	-0.1%	na	na	2.3%	1.0%	-3.8%	1.8%
1998	1.5%	-5.2%	1.3%	-0.8%	0.9%	na	na	2.7%	1.9%	2.2%	0.7%
1999	-2.3%	-0.7%	-1.9%	-0.2%	1.2%	na	na	-2.3%	2.3%	0.5%	0.8%
2000	-0.5%	6.6%	0.6%	-0.5%	2.3%	na	na	5.7%	2.0%	0.4%	0.8%
2001	-1.6%	-5.1%	1.8%	-0.6%	-1.0%	na	na	4.5%	-0.1%	3.5%	4.8%
2002	0.0%	-2.9%	1.5%	-0.3%	-2.0%	4.5%	3.2%	2.7%	1.2%	3.6%	3.6%
2003	1.8%	4.5%	-0.5%	-0.5%	0.1%	3.9%	2.8%	2.3%	1.1%	1.2%	1.6%
2004	23.2%	9.0%	25.8%	2.0%	2.8%	5.6%	3.1%	6.7%	7.2%	5.1%	20.3%
2005	6.9%	16.8%	5.0%	4.2%	9.8%	5.1%	2.5%	10.1%	11.0%	10.4%	17.2%
2006	1.5%	32.6%	7.8%	7.9%	13.3%	9.8%	3.1%	11.0%	11.0%	21.7%	17.7%
2007	1.5%	6.2%	1.9%	5.9%	11.7%	-4.6%	3.3%	8.9%	15.6%	23.6%	15.1%
2008	24.0%	2.3%	8.4%	2.7%	10.5%	3.2%	2.9%	10.9%	12.5%	15.1%	-2.6%
2009	-12.7%	-17.5%	-4.3%	1.8%	-2.7%	2.8%	1.8%	-6.4%	6.5%	3.8%	-5.2%
2010	-1.0%	18.9%	2.6%	0.9%	5.9%	5.2%	1.9%	4.5%	-2.6%	8.4%	-3.7%
2011	6.0%	10.5%	4.6%	2.9%	3.1%	3.3%	1.7%	5.3%	7.6%	5.6%	5.9%
2012	0.3%	-0.3%	2.4%	4.3%	-0.6%	3.2%	1.6%	1.4%	7.0%	6.6%	2.6%
2013	-1.7%	-1.6%	0.7%	1.7%	-0.8%	1.6%	1.7%	4.3%	2.2%	8.0%	-1.9%
2014	-0.5%	-0.4%	0.7%	1.9%	0.2%	2.0%	2.1%	3.7%	1.7%	7.0%	-1.9%
2015	-3.1%	-4.2%	-0.3%	-0.5%	-4.7%	3.1%	2.6%	2.8%	0.3%	4.4%	2.6%
2016	-3.0%	-8.6%	-0.1%	-2.3%	-1.0%	2.6%	2.6%	2.3%	-1.9%	3.2%	-1.7%
Annual Average Growth											
1983 - 2016	1.8%	2.2%	3.4%	1.9%	2.2%	NA	NA	4.0%	3.8%	4.2%	3.9%
1983 - 2001	1.0%	0.5%	3.2%	1.6%	1.6%	NA	NA	3.5%	2.5%	0.9%	3.4%
2002 - 2016	2.9%	4.3%	3.7%	2.2%	3.0%	3.4%	2.5%	4.7%	5.4%	8.5%	4.6%
2009 - 2016	-2.0%	-0.4%	0.8%	1.3%	-0.1%	3.0%	2.0%	2.2%	2.6%	5.9%	-0.4%

Notes

[1] All growth rates are computed logarithmically. For example, growth rate of $X = \ln(X_t/X_{t-1})$

[2] The columns labeled adjusted were converted to Canadian dollars using purchasing price parity.

[3] PPI industry data for Steel wire drawing, not seasonally adjusted (U.S. Bureau of Labor Statistics)

[4] PPI industry data for Other communication and energy wire mfg-Power wire and cable, made from nonferrous metals (purchased wire), not seasonally adjusted (U.S. Bureau of Labor Statistics)

[5] PPI industry data for Noncurrent-carrying wiring device mfg, not seasonally adjusted (U.S. Bureau of Labor Statistics)

[6] PPI industry data for Current-carrying wiring device mfg, not seasonally adjusted (U.S. Bureau of Labor Statistics)

[7] PPI industry data for Electric power and specialty transformer mfg, not seasonally adjusted (U.S. Bureau of Labor Statistics)

[8] Wages and salaries for private industry workers, not seasonally adjusted, Employment Cost Index (U.S. Bureau of Labor Statistics)

[9] Wages and salaries for private industry workers, not seasonally adjusted, in the Northeast census region, Employment Cost Index (U.S. Bureau of Labor Statistics)

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The BEA creates capital stock datasets by first collecting information on capital expenditures. For electric services, investment data are gathered from several national agencies and surveys.[19] A description of the capital stocks methodology published in 2003 notes that: "the estimates of investment underlying the estimates of net stocks are developed to be conceptually and statistically consistent with the NIPA estimates of investment as well as with the classifications of the SIC."[20] According to the most recent BEA document on private fixed investment, HWIs are used to deflate the prices of electric structures, while producer and industrial product price indexes are used for electrical transmission, distribution and industrial apparatus.[21]

After collecting the necessary data, capital stocks are estimated using the perpetual inventory method.[22] Estimates of the value of capital stocks are published in terms of current cost and chain-type quantity indexes. Chain-type quantity indexes utilize the Fisher ideal index form, the geometric mean of price indexes of Laspeyres and Paasche form, to remove price effects. Therefore, we can calculate an implicit capital stock deflator by dividing the current cost index by the chained-quantity index.

In Table 14-9, we compare the growth rates of the implicit price deflators from electric structures and electrical transmission and distribution equipment to HWIs. Since they use the same price indexes, unsurprisingly, the implicit price deflator for electric structures tracks the HWIs fairly well. There is some divergence in the most recent period. The national average of the total distribution plant HWI had a 1.0 percent higher growth trend than electric structures between 2002 and 2016. However,

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[19] Specifically, the current methodology uses BEA's *National Income and Product Accounts*; the Department of Energy's *Electric Power Annual* and *Financial Statistics of Selected Investor-Owned Utilities*; the U.S. Department of Agriculture's *Farm Income Statistics, Rural Telephone Borrowers* and *Rural Electric Borrowers*; the Bureau of Census' *Annual Capital Expenditures Survey* and additional unpublished datasets from the Bureau of Census. *Fixed Assets and Consumer Durable Goods in the United States, 1925-97* (2003).

[20] *Ibid.*

[21] *Chapter 6: Private Fixed Investment* (November 2017).

[22] For a discussion of the perpetual inventory method, please refer to the Flows and Stocks of Fixed Non-Residential section of this report.

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Table 14-9

U.S. Capital Stock Deflator vs Handy-Whitman Indexes[1]

	Handy Whitman Indexes						BEA Capital Stock Deflator		
	Total Distribution Plant			Total Transmission Plant					
Year	National Average	North Atlantic	North Central Region	National Average	North Atlantic	North Central Region	Electric T&D Equipment	Electric Structures[2]	Average
Year	Growth Rate	Growth Rate	Growth Rate	Growth Rate	Growth Rate	Growth Rate	Growth Rate	Growth Rate	Growth Rate
1962	0.6%	1.7%	0.0%	0.6%	0.0%	0.0%	-1.1%	0.0%	-0.5%
1963	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	-2.7%	2.1%	-0.3%
1964	2.8%	3.4%	3.3%	3.7%	5.0%	3.4%	0.2%	3.6%	1.9%
1965	3.2%	3.3%	3.2%	4.9%	4.8%	4.9%	-0.1%	2.2%	1.0%
1966	3.4%	3.2%	3.1%	3.9%	3.1%	4.7%	3.6%	0.1%	1.8%
1967	4.7%	4.6%	4.5%	5.2%	5.9%	4.4%	5.1%	6.6%	5.9%
1968	4.3%	4.4%	4.3%	4.0%	2.8%	4.3%	3.0%	5.5%	4.3%
1969	6.5%	5.6%	9.4%	6.5%	5.4%	8.0%	0.0%	4.1%	2.0%
1970	7.8%	9.0%	8.6%	7.7%	7.6%	8.6%	4.2%	8.6%	6.4%
1971	6.6%	7.1%	6.8%	7.2%	7.1%	6.8%	0.6%	8.3%	4.4%
1972	5.0%	5.6%	4.3%	3.8%	4.4%	3.2%	-0.5%	4.3%	1.9%
1973	7.4%	8.3%	5.1%	7.4%	8.3%	6.2%	3.0%	13.6%	8.3%
1974	17.8%	16.6%	17.4%	20.4%	19.9%	19.9%	14.4%	18.1%	16.3%
1975	15.5%	14.2%	14.8%	16.1%	13.8%	15.9%	14.9%	9.2%	12.1%
1976	5.6%	4.3%	4.3%	6.4%	4.9%	4.8%	5.8%	7.5%	6.7%
1977	6.1%	4.8%	6.7%	6.1%	5.9%	6.5%	7.1%	4.1%	5.6%
1978	5.1%	4.6%	5.1%	3.0%	3.2%	3.7%	4.6%	8.4%	6.5%
1979	9.4%	10.3%	9.4%	8.2%	8.3%	8.1%	7.3%	10.4%	8.9%
1980	7.6%	7.2%	7.0%	10.2%	10.3%	9.5%	12.2%	8.8%	10.5%
1981	9.2%	8.3%	10.0%	7.8%	7.4%	8.7%	6.0%	6.5%	6.3%
1982	6.3%	6.2%	6.0%	5.1%	5.6%	6.7%	3.7%	4.1%	3.9%
1983	2.6%	3.7%	2.2%	2.6%	3.1%	2.6%	0.9%	2.3%	1.6%
1984	1.0%	2.7%	1.3%	0.8%	2.6%	0.8%	2.2%	1.9%	2.1%
1985	0.2%	2.2%	1.3%	1.0%	2.5%	1.7%	1.5%	1.0%	1.3%
1986	0.5%	1.3%	1.3%	0.8%	2.1%	1.2%	2.6%	0.8%	1.7%
1987	0.6%	0.8%	0.8%	0.5%	1.2%	1.2%	1.8%	3.6%	2.7%
1988	5.4%	7.2%	6.0%	9.3%	8.8%	9.8%	3.0%	5.9%	4.4%
1989	4.8%	5.8%	4.9%	4.9%	5.6%	4.9%	5.2%	3.7%	4.4%
1990	2.7%	2.7%	2.9%	3.7%	5.0%	3.9%	4.4%	1.3%	2.8%
1991	1.6%	2.6%	1.4%	1.7%	3.1%	1.9%	1.0%	0.9%	1.0%
1992	1.1%	1.2%	1.2%	0.9%	1.8%	1.1%	0.8%	2.4%	1.6%
1993	2.0%	2.6%	2.0%	3.4%	3.5%	3.2%	0.6%	3.9%	2.2%
1994	3.0%	3.1%	3.3%	4.6%	4.3%	4.9%	1.9%	3.4%	2.6%
1995	3.3%	3.0%	3.6%	4.4%	3.8%	4.6%	3.1%	3.3%	3.2%
1996	1.0%	1.6%	1.2%	1.8%	1.3%	1.7%	-0.5%	0.8%	0.2%
1997	0.7%	1.5%	1.4%	1.7%	2.3%	1.9%	-0.1%	3.0%	1.4%
1998	2.3%	2.3%	2.2%	2.5%	2.5%	2.4%	-0.2%	0.7%	0.3%
1999	0.3%	0.7%	0.3%	-0.8%	0.5%	-0.7%	1.1%	2.5%	1.8%
2000	2.3%	2.6%	2.5%	4.7%	4.3%	4.7%	0.9%	3.8%	2.4%
2001	3.2%	2.9%	3.5%	3.7%	3.3%	4.1%	-0.1%	2.8%	1.3%
2002	3.0%	3.2%	3.8%	1.5%	1.9%	2.2%	-1.2%	2.6%	0.7%
2003	2.0%	2.0%	2.8%	0.9%	0.8%	1.5%	0.3%	2.9%	1.6%
2004	6.2%	6.3%	5.6%	7.5%	7.6%	7.3%	2.0%	7.4%	4.7%
2005	7.6%	8.0%	7.7%	7.6%	7.5%	7.8%	3.1%	5.0%	4.1%
2006	10.5%	10.1%	10.6%	8.1%	7.3%	8.3%	5.3%	7.7%	6.5%
2007	10.5%	10.7%	10.1%	7.9%	8.1%	7.8%	4.1%	7.5%	5.8%
2008	9.0%	8.9%	8.8%	8.4%	9.3%	8.9%	3.1%	6.4%	4.7%
2009	2.1%	2.7%	1.3%	-2.3%	-0.2%	-2.7%	0.8%	-4.4%	-1.8%
2010	3.7%	3.5%	3.1%	2.4%	2.7%	1.9%	2.6%	5.9%	4.3%
2011	4.3%	4.8%	4.3%	3.3%	3.9%	3.6%	3.1%	4.6%	3.9%
2012	3.5%	4.3%	3.0%	1.5%	2.5%	1.6%	0.3%	2.2%	1.2%
2013	3.5%	3.3%	3.4%	1.8%	2.0%	2.0%	0.1%	1.5%	0.8%
2014	3.0%	2.9%	2.8%	1.7%	2.1%	1.9%	0.0%	3.4%	1.7%
2015	2.2%	2.1%	1.8%	2.0%	1.9%	1.7%	-1.8%	1.3%	-0.2%
2016	1.1%	1.2%	0.4%	1.6%	1.8%	1.2%	0.1%	2.9%	1.5%
Annual Average Growth									
1962 - 2016	4.5%	4.7%	4.5%	4.4%	4.6%	4.5%	2.6%	4.4%	3.5%
1962 - 1972	4.1%	4.4%	4.3%	4.3%	4.2%	4.4%	1.1%	4.1%	2.6%
1973 - 1982	9.0%	8.5%	8.6%	9.1%	8.8%	9.0%	7.9%	9.1%	8.5%
1983 - 2001	2.0%	2.7%	2.3%	2.8%	3.2%	2.9%	1.6%	2.5%	2.1%
1983 - 2016	3.3%	3.7%	3.3%	3.1%	3.6%	3.3%	1.5%	3.1%	2.3%
2002 - 2016	4.8%	4.9%	4.6%	3.6%	4.0%	3.7%	1.5%	3.8%	2.6%

Notes

[1] All growth rates are computed logarithmically. For example, growth rate of X = $\ln(X_t/X_{t-1})$

[2] "For annual, weighted average of Handy-Whitman construction cost indexes for electric light and power plants and for utility building."

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electric structures may encompass other, such as generation plant, types of construction that had slow growth rates.

The implicit price index for electric transmission and distribution equipment had a consistently slower trend than the distribution HWIs, and that this gap has increased over time. Between 1973 and 1982, the transmission and distribution plant HWI, averaged roughly 1.1 percent higher annual growth nationally. This difference decreased slightly between 1983 and 2001 but ballooned from 2002 to 2016. Compared to the BEA price deflator for equipment, the HWIs for distribution and transmission plant averaged 3.3 and 2.1 percent faster annual growth nationally, respectively. While there have been historical differences between these indexes, the HWIs are accelerating relative to the BEA indexes. The discrepancy in equipment growth rates challenges the credibility of the HWIs because HWIs are based on 1973 fixed weights, unlike the BEA's ICSDs which are derived from a more contemporary methodology.

Beyond the HWI's issues with tracking the BEA's corresponding implicit price indexes, Table 14-5 shows that from 1962 to 2001, PSE's adjusted HWI for the North Atlantic region did not track the EUCPI as closely as the utility sector ICSD. Between 2002 and 2013, the adjusted HWI grew much more rapidly than the utility sector ICSDs for Canada or Ontario.

Conclusion

Having reviewed the various options for measuring capital construction prices, we have concluded that Statistics Canada's ICSDs for the utilities sector are the best option for deflating the values of Ontario power distributor assets. This type of deflator is readily available, the methodology is updated regularly, and they tracked the EUCPI well in the years when it was most reliable. While the EUCPI provided a more granular level of detail, its discontinuation, archaic design, and implausible labor price trends make it a poor choice for use in the years of its calculation. It makes sense then to use the utilities-sector ICSDs for all years for which they are available.

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Appendix: Custom Index

We also considered creating a custom index to replace the EUCPI. There are a couple of sources from which we could derive weights. One option would be to use Statistics Canada's Supply, Use and Input-Output tables. These models measure the levels of inputs that an industry utilizes. Statistics Canada has used these accounts to weight the price indexes for *Machinery and Equipment* in the SCFC program. Similarly, we could use this dataset to construct weights for *Electric Power Generation, Distribution and Transmission* and/or *Electric Power Engineering Construction*. However, it appears that certain important intermediate goods are suppressed or grouped under broad value-added categories, thus determining accurate weights may not be doable.

An alternative would be to derive weights from capital additions reported by Ontario utilities as part of the RRR. We could then determine what percentage of construction costs are labor, material and equipment related using sources such as the *RS Means Heavy Construction Data*. If we wanted regional results, Ontario requires utilities to state what percentage of their capital expenditures are materials and labor. We would use their weights to create a mix of commodity indexes for each asset. By aggregating all assets, we would develop an index that is akin to the EUCPI. While this is an intriguing option, it is not feasible. To accurately derive weights, we would need cross-elasticities for all the input products that we are measuring, something which is not available. Additionally, the industrial product price indexes were reclassified in 2012, so most of the price indexes for electrical components do not go back further than 2010. Patching these indexes to earlier indexes would be time-consuming. Finally, this method would require that we make many assumptions about construction practices, so our result would be a rough approximation at best.