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How We Built the ICE U.S. Carbon Neutral Power Index

May 2023

Index Structure Strategy

On January 18, Intercontinental Exchange ("ICE") launched the first index that tracks the broad U.S. electricity market, the ICE U.S. Carbon Neutral Power Index ("ICECNPIT)[1]. The ICECNPIT has features that distinguish it from other commodity indexes. It uses a 12-month calendar strip of futures to price the index rather than the prompt month future. It combines calendar strips from multiple U.S. power pools rather than a national price quoted from a delivery location, and it includes carbon allowance futures to achieve a net-zero carbon footprint.

Unlike other commodities, electricity (power) cannot be stored, which means there are no inventories to mitigate or exacerbate short term changes in demand. The primary drivers of power market prices are not the economy, but the weather and regional market supply and demand, which change month to month and differ by region.

A strategy for structuring any index must answer three questions:

- **Is the index important?** With an annual notional dollar value of consumption on a par with gasoline, power is a major commodity today and for the future as the U.S. evolves toward a fully renewable grid. Electricity is the second-largest contributor to the energy sub-index of CPI and exhibits the strongest correlation to year-over-year changes in CPI due to its importance as an input cost at every stage of the industrial manufacturing and service economy. The ICECNPIT is the only index to provide direct exposure to electricity prices and the only commodity index with a net-zero carbon footprint.
- **Is the index useful?** ICECNPIT provides (i) direct exposure to power prices, (ii) a better inflation hedge than carbon intensive commodities, (iii) better diversification than equities, fixed income, or other commodities due to the weak links between the economy and power prices, and (iv) greater returns per unit of risk for portfolios that include power than for portfolios that don't.
- **Is the index robust?** A robust index (i) accurately represents the change in value of the asset class over time; (ii) has sufficient market capacity to accommodate meaningful volumes of investment; (iii) is structurally compatible as a candidate for combination with other index products; and (iv) captures any structural profitability inherent in the asset while minimizing volatility.

Qualities of Robust Indexes	ICECNPIT Solution
Accurately Represents Asset Value	• Combines calendar strips of 6 major ISOs with carbon allowance futures
Capacity for Sizable Investments	• $1 billion invested in the index represents 2% of market open interest
Compatible with Other Index Products	• Rolls and rebalancing structured for compatibility with other indexes
Structural Stability	• 12-month rolling index tenor minimizes volatility of prompt month and captures roll yield from backwardated futures curve

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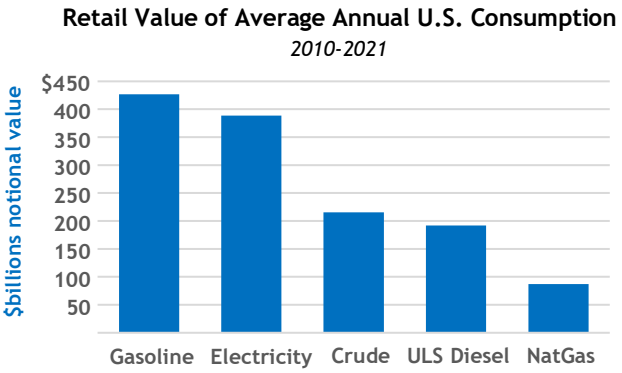
Important: The Preeminence of Power

Power is the second most consumed commodity after gasoline in the U.S. Since 2010 annual consumption has averaged just under $400 billion on a retail notional dollar basis, but despite its importance, power is not included in any ETF, mutual fund, or other publicly available investment product. It is not a component in the ICE BofAML Commodity Index (MLCXTR), the Bloomberg Commodity Index (BCOMTR), the S&P GSCI Total Return Index (SPGSCITR), or any other index.



As renewable generation continues to displace an increasing share of the U.S. power grid and electric vehicles (EVs) take a meaningful share of the U.S. auto market, the importance of power in the evolution of the U.S. economy will continue to grow at the expense of other energy sources. Furthermore, the commitment of the U.S. to an 85% renewable grid by 2030 will require more than double the number of renewable generation facilities than are currently under development and will cost over $1 trillion in new capital investment.

March 2023	% Energy CPI	% CPI	LTM Δ%	Contribution to Δ% CPI
Motor Fuel	51.2%	3.58%	**-14.2%**	**-0.48%**
Electricity	36.7%	2.57%	10.2%	0.26%
Utility Gas Services	12.1%	0.85%	5.5%	0.05%
Energy CPI Subindex	100.0%	7.00%	**-6.4%**	**-0.45%**
CPI			4.98%	4.98%

Investors have few tools for hedging inflation from rising electricity prices. The important role of power in the economy makes it a significant contributor to CPI. It is the second largest component in the Energy CPI Subindex and contributes more than a third of what the subindex adds to CPI. For the 12 months ended March 31, 2023, electricity accounted for 2.57% of the CPI[2] and on 10.2% year-over-year inflation contributed 26 basis points to the 4.98% change in the CPI over the same period. At the same time, motor fuel including gasoline lowered the CPI by 48 basis points.

Useful: A Swiss Army Knife of Indexes

Any commodity index provides investors with a tool for expressing their view on the direction of prices of the underlying asset. With the launch of the ICECNPIT investors now have for the first time the opportunity to express a view on U.S. electricity prices. But there is no commodity index, nor any other index for that matter, that provides both the inflation hedge and the effective diversification of ICECNPIT. It is the proverbial Swiss army knife of indexes.

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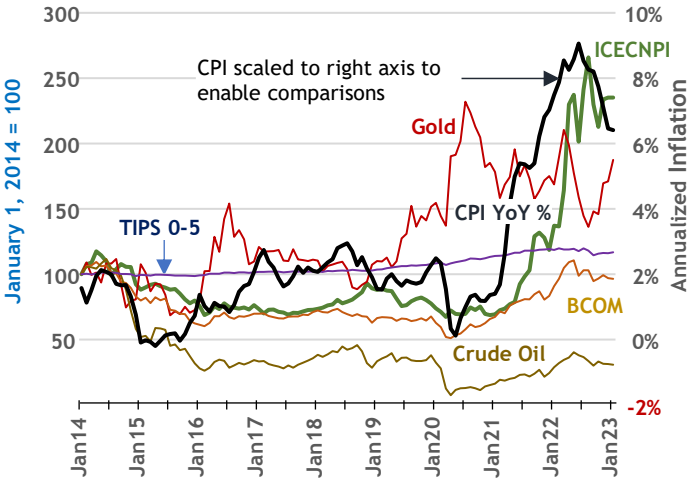
Traditional commodity futures such as gold, oil, the Bloomberg Commodity Index (BCOM), and TIPS have historically been the most common tools for hedging inflation, and the most scalable, despite research that whatever hedge they provide is neither stable nor persistent[3].

As a proxy for inflation, however, electricity tracks inflation more closely than other commodities. Since 2014, the CPI All Consumers Electricity Index has tracked the CPI with a correlation of over 85%, which explains the 80% correlation of the ICECNPIT with the CPI over the same period. A comparison of CPI with ICECNPIT and common commodity indexes shows that the other indexes generally follow the trend of inflation, but with significantly greater tracking error. The ICECNPIT provides both direct exposure to rising electricity prices and a better inflation hedge than existing carbon intensive commodities.

CPI versus ICECNPI and Selected Commodity Indexes

January 1, 2014 - January 31, 2023



As real non-financial assets, commodities are subject to physical forces of supply and demand independent of financial markets that provide diversification to portfolios in addition to whatever hedge they may provide for inflation. Commodities in a diversified portfolio over time increase returns, reduce risk, and provide exposure to different industrial sectors and to different regions of the global economy[4].

The contribution from any asset to a portfolio comes from its returns, the variability of its returns, and the correlation of those returns with returns of other assets in the portfolio. The primary drivers of power market prices are not the economy, but regional available generation capacity, demand, and the weather, which means power markets exhibit the weakest correlations with every major asset class—equities, fixed income, and other commodities.

ICECNPIT Correlation Matrix

January 1, 2018 - March 31, 2023

	ICECNPI	MLCX	MLCXEN	S&P	IG Bonds	5 yr TIPS	Gold	Crude	NatGas
ICECNPI	1.00	0.22	0.20	0.09	(0.02)	0.08	0.04	0.11	0.80
MLCX	0.22	1.00	0.97	0.33	(0.09)	0.34	0.21	0.89	0.22
MLCX Energy	0.20	0.97	1.00	0.34	(0.10)	0.32	0.13	0.94	0.22
S&P	0.09	0.33	0.34	1.00	(0.01)	0.14	0.09	0.29	0.12
IG Bonds	(0.02)	(0.09)	(0.10)	(0.01)	1.00	0.58	0.32	(0.08)	(0.01)
5 yr TIPS	0.08	0.34	0.32	0.14	0.58	1.00	0.38	0.29	0.08
Gold	0.04	0.21	0.13	0.09	0.32	0.38	1.00	0.13	0.02
Crude Oil	0.11	0.89	0.94	0.29	(0.08)	0.29	0.13	1.00	0.12
NatGas	0.80	0.22	0.22	0.12	(0.01)	0.08	0.02	0.12	1.00

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ICECNPIT provides better diversification than energy or commodity indexes, exhibiting lower correlations with every other asset class, but most importantly with the S&P 500 and U.S. investment grade bonds. In an historical back test from January 1, 2014 through March 31, 2022, ICECNPIT delivered better returns at lower risk, as measured by Sharpe ratios, than the ICE BofA Commodity Index (MLCXTR), the energy subindex (MCLXENTR) of the MLCX, crude oil, and natural gas. Only gold delivered a marginally higher Sharpe ratio over the same period. The correlation between ICECNPIT and any major asset classes is 0.22 or less.

Commodity Index Risk Metrics
January 1, 2014 - March 31, 2023

Parameters	ICECNPI	MLCX	MLCXEN	Gold	Crude	NatGas
Annual Returns	6.5%	0.3%	-3.1%	5.5%	-10.2%	-23.8%
Annualized Volatility	20.0%	22.0%	34.0%	14.8%	43.6%	49.9%
Sharpe Ratios	0.32	0.01	-0.09	0.37	-0.23	-0.48

Efficient frontier analysis demonstrates the usefulness of the ICECNPIT in portfolio construction. Assets are allocated by their volatilities for the minimum variance portfolio and by their returns divided by their volatilities (Sharpe ratio) for the optimal portfolio. In an optimization of a diversified portfolio of equities, bonds, and commodities over the 2014-2023 back test period, the risk, return, and correlation profile of ICECNPIT places the portfolio with the maximum allocation of 5% to ICECNPIT on efficient frontier with the highest return per unit of risk.

Power belongs in an optimized portfolio. A portfolio with power will deliver better overall returns with less risk and better risk adjusted results than a portfolio without power.

ICECNPIT in a Diversified Portfolio
January 1, 2014 - March 31, 2023

Parameters	SPX	IG Bonds	MLCX	ICECNPI
Annual Returns	11.1%	1.7%	0.3%	6.5%
Annualized Volatility	18.1%	4.3%	22.0%	20.0%
Minimum Weight	55.0%	30.0%	0.0%	0.0%
Maximum Weight	65.0%	60.0%	15.0%	5.0%

			weights			
Efficient Frontier	Portfolio Returns	Portfolio Volatility	SPX	IG Bonds	MLCX	ICECNPI
Minimum Variance Portfolio	6.87%	9.99%	55.0%	45.0%	0.0%	0.0%
Maximum Return Portfolio	8.05%	11.84%	65.0%	30.0%	0.0%	5.0%
Optimal Portfolio	8.05%	11.84%	65.0%	30.0%	0.0%	5.0%

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Robust: An Index Built to Meet the Need

Selection of Power Hubs

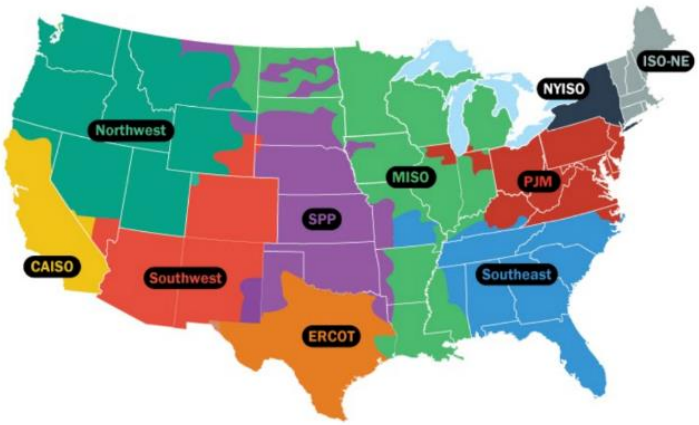
The ICECNPIT provides investors with a transparent, rules-based approach to investing in a diversified portfolio of electricity and carbon allowance futures contracts representing the U.S. domestic market for power in a carbon neutral format. The index was designed to create an accurate and stable benchmark of the change in value over time of the U.S. power market and to support a liquid and scalable market for investible products.

The design process selected six major power trading hubs as a proxy for the U.S. power market, based on diversity in geography representative of the broader U.S. market and on the depth of market liquidity for trading futures contracts. They are, in order of their weight in the index, PJM-W (Pennsylvania, New Jersey, Maryland); MISO (MidWest); ERCOT-N (Texas); CAISO (California); NY-G (New York); and ISO-NE (New England).

Power pool contracts in the index are weighted by the 3-year average annual power consumption for each region and adjusted by sufficient CCAs (California Carbon Allowances) and RGGIs (Regional Greenhouse Gas Initiatives) to ensure a zero-carbon footprint for the index. The index is rebalanced annually using the same calculation for weighting exposure to each hub.

ICECNPIT Index Components[5]

Index Weights & 3-Year Average Loads



ISO	% ICECNPIT	3-yr avg MW daily load
PJM-W	28.5%	88,481
MISO	24.4%	75,975
ERCOT-N	14.2%	44,037
CAISO	8.1%	25,052
NY-G	5.6%	17,412
ISO-NE	4.3%	13,344
CCA & RGGI	15.0%	

The broad geographical dispersion of the regional hubs offsets volatility of the individual components and contributes to the overall stability of the index. Weather patterns occur at different times with different conditions across the U.S. New York and New England may have the same weather with an hour or two delay while Texas and California are experiencing completely different conditions.

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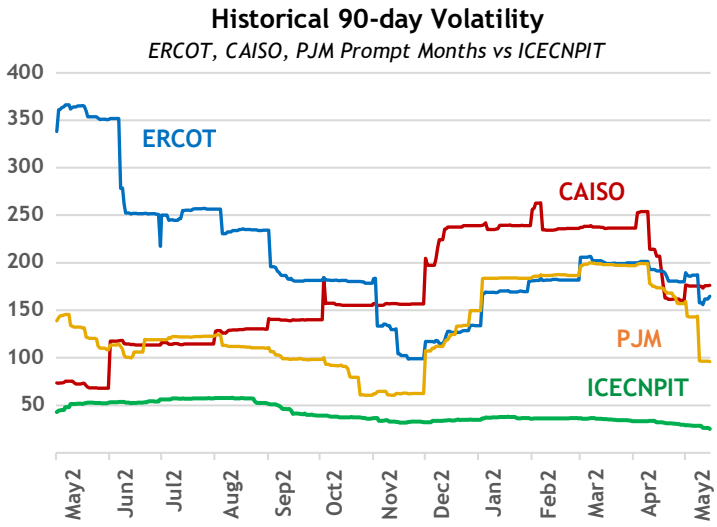
Significant differences also appear in hourly demand, seasonal demand, and types of generating facilities. Peak and minimum power loads and prices rarely, if ever, occur on the same dates at the same time in regions a thousand miles apart due to seasonal weather changes and hours of peak industrial and residential demand that are set by the scale of manufacturing and commercial activities in the local economy. Offshore wind is only available in certain regions; solar is more economic in the South and West than in other parts of the country; and renewable power is difficult to implement in urban environments. Renewables as a percentage of generation capacity in the U.S. ranges from 17% in PJM to 61% in California.

The ICECNPIT combines the 6 ISO power pools and carbon allowances in a package that broadly reflects the diverse geography, demand, and physical grid of the U.S. power market. It also offers a large and scalable platform for investible products. A $1 billion investment in an instrument that tracks the ICECNIPT represents less than 0.25% of the open interest for the 6 power pools in the index.

Importance of 12-Month Tenor Structure

Spot market power prices are among the most volatile of any asset. Short-dated electricity contracts are seasonal and profoundly affected by vagaries of weather, short-term demand, transmission constraints, unit outages, marginal fuel costs, and myriad other factors. The effect of changes in any of them is mitigated as they propagate through the term structure of the futures curve with significantly less impact on longer-dated contracts.



Unlike other commodity indexes that use a prompt-month-to-prompt-month roll structure, the ICECNPIT uses a 12-month calendar strip of electricity and carbon allowance futures that rolls the electricity prompt month to month 13 over 15 business days and the carbon allowance futures over 3 months. A comparison of the 90-day implied volatilities of the ERCOT, CAISO, and PJM-West prompt month indexes with the implied volatility of ICECNPIT shows that 12-month tenor structure reduced volatility in this example by an average of 70%. The 12-month tenor and rolling technique mitigates the volatility of shorter-dated contracts in the futures curve and provides a more broadly representative measure of electricity consumption and market value in the U.S. economy.

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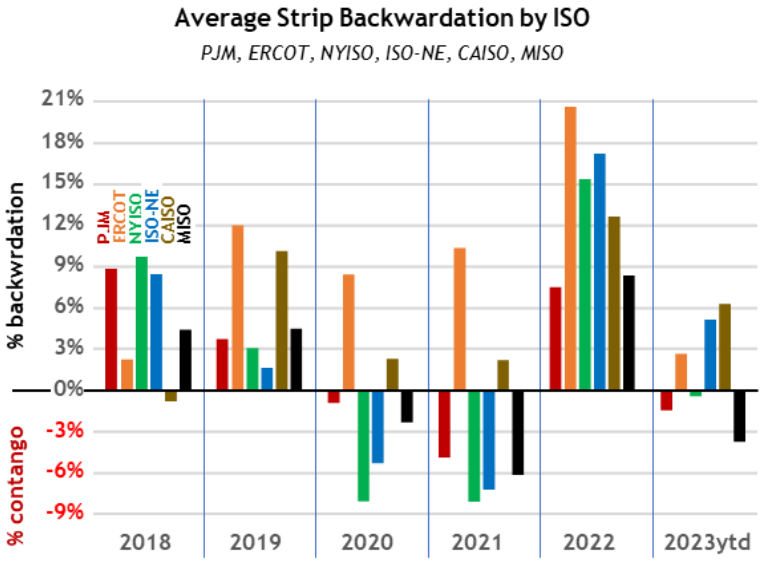
The structure also enables ICECNPIT to capture value from backwardation in power markets. Backwardation occurs in futures markets when the prompt contract price, or spot price, is higher than the future month's price.

There are three main sources of yield in the ICECNPIT. They are (i) spot yield, which is the change in the current price of the underlying power futures; (ii) roll yield, which is the difference between the prompt, expiring future in the index and the longer dated futures—backwardated if lower, contango if higher; and (iii) collateral yield, which is the interest earned on the collateral supporting the futures position, usually 3-month U.S. Treasuries.



Since 2018 dislocation between physical power market fundamentals and long-term financial markets has created persistent backwardation in prompt month power prices across the 6 power pools in the index, and this is expected to continue for the foreseeable future. The reason for this is that traditional purchasers of physical power bid up the front months of the power futures curve to ensure pricing and security of supply, while financial intermediaries sell longer-term futures to provide the hedges required for funding the construction of renewable generation facilities. This creates an arbitrage between shorter-dated contracts subject to constraints of physical supply and demand and the demand for the longer-dated financial contracts required for hedges, which creates profits for buyers when the longer-dated contracts roll up the backwardated curve as they mature.

How the Rolls Work

The ICECNPIT Index consists of 74 individual futures contracts: 72 electricity futures in six 12-month calendar strips from six ISOs and two carbon allowance futures. In addition, the major ISOs in the index all have sub-hubs, which are additional locations inside the ISO with shared transmission lines and exchange-traded futures that are liquid and trade in tight correlations with futures of the main hub.

While the ICECNPIT mechanically rolls from month 1 to month 13 over a 15-day window, flexibility exists to roll pro-rata into a quarterly 3-month strip that contains month 13 instead of rolling from month 1 to 13 directly, and then to work out of the quarterly strip into month 13 as market factors permit.

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The permutations of different trading strategies create infinite flexibility for experienced traders to track the ICECNPIT, flexibility to counter front-running by market participant before the rolls, flexibility to minimize market disruptions from rolls of large notional values of futures in short market windows that artificially depress market prices, and flexibility to amortize transaction costs of execution fees, bid/ask spreads, and administration costs over 24 to 28 different commodity futures each month.

Roll Policies of Selected Commodity Indexes

Ticker	ICECNPIT	MLCXTR	BCOMTR	GSCI	CSIX	PDBC
Fund	ICE US Carbon Neutral Power Index	ICE BofA Commodity Index	Bloomberg Commodity Index	S&P GSCI Total Return Index	Credit Suisse Commodity Benchmark Total Retirn Index	Invesco Optimum Yield Diversified Commodity Index
AUM ($billions)		$1	$800	$700	$50	$6
Contracts	74	24	23	24	28	14
Contracts rolled monthly	6, 8 with carbon rolls	24	23	24	28	14
Roll Window	15 days power 90 days carbon	15 Days	5 Days	5 Days	5 Days	5 Days

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[2] Consumer Price Index News Release, U.S. Bureau of Labor Statistics, May 10, 2023. https://www.bls.gov/news.release/archives/cpi_05102023.htm

[3] Futerman, A.G. & Sarjanovic, I.A, Commodities as an Asset Class: Essays on Inflation, Palgrave Macmillan, Chaim, Switzerland, 2022, pp. 50-56.

[4] Jensen, Gerald R., Robert R. Jhonson, and Jeffrey M. Mercer. 2000. Efficient use of commodity futures in diversified portfolios. *The Journal of Futures Markets* 20: 489–506.

[5] ICE data for 3-year average loads. Map from https://elpc.org/blog/bridging-gaps-in-the-grid/.