The Economic Club of New York

The 2023 ECNY Innovation and Social Impact Challenge

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To honor the Club's 115th anniversary, The Economic Club of New York launched the **Innovation and Social Impact Challenge**, which has contributed to the creation of our research division and aligns with the Club's mission to be a catalyst for thought and innovation and leverages our platforms to introduce content into the mainstream business and economic communities. These ideas or concepts can benefit not just New York or the U.S., but the broader community and humankind.

In its second year, the themes of the 2023 Challenge were: **Artificial Intelligence, Climate Change, Geopolitical Relations, and/or Corporate Governance**.

This Challenge was presented to our Class of 2023 Fellows. With six entries submitted by teams or individuals, the winners were:

- 1st Place: "NIMBYism to YIMBYism: Rethinking the Economics of Large-Scale Transmission Projects*"*
    - Authors: Daniel Corbett [Aterian Investment Partners], Nicholas Martin [Rudin Management Company], Ryan Nowicki [State Street Global Advisors], Tope Odusanya [Houlihan Lokey] & Salome Saliashvili [Inspiration Mobility]
- 2nd Place: *"Leveraging AI Software to Analyze Municipal Finance and Increase Accountability"*
    - Author: Lisa Phan [Wells Fargo]

Each applicant/team submitted a white paper and presented the work to an impartial panel of judges, who selected the winners**.** These are the winning white papers. The authors own the idea and content, but by participating in the Challenge, the applicants consent to publication on the Club's website. The submission of this work and the presentation of the award does not represent an endorsement of any idea or innovation by the Club; instead, our goal is to facilitate innovative thinking across economic, social, and/or political issues facing society. As a reflection of the Club's mission, the goal is to bring forward work to "be a catalyst for thought and innovation" and leverages our platforms to share innovative and beneficial concepts and ideas.

The 2023 Challenge was generously sponsored by: Phenix Bio

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Please contact Club President & CEO, Barbara Van Allen at officeofthepresident@econclubny.org for more information the white paper, their authors, or the annual Innovation Challenge.

The Economic Club of New York

First Place Winning Entry

NIMBYism to YIMBYism:

Rethinking the Economics of Large-Scale Transmission Projects

September 18, 2023

Daniel Corbett, Nick Martin, Ryan Nowicki, Tope Odusanya, Salome Saliashvili

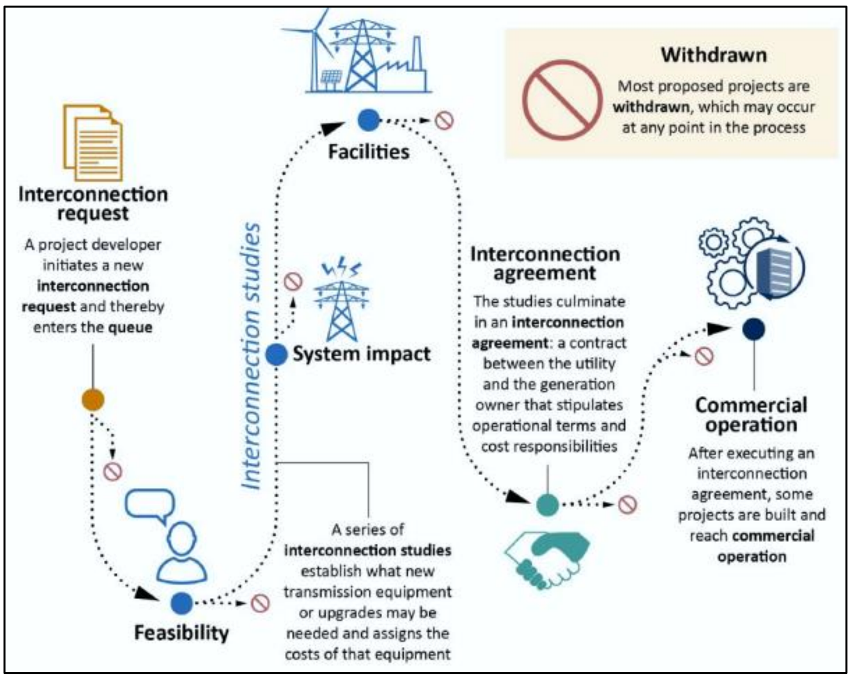
Transmission: A Critical Inflection Point for the Clean Energy Transition

By 2050, energy demand is forecasted to necessitate a 2x to 3x[i] increase in the current U.S. generation capacity of 1,300 GW[ii]. While scaling generation assets is critical, the last twenty years have demonstrated that the largest obstacle to grid development in is transmission – a complex, multi-stakeholder coordination effort that involves connecting generation assets to grids and the demand centers across the country.

This paper quantifies the holdup value of community opposition, also known as Not In My Back Yarders ("NIMBY" or "NIMBYs"), to transmission projects. A two-step revenue share model is proposed and applied to an illustrative project utilizing publicly available project financials. The model results in an approximate 400bps increase in returns and up to three years in reduced timeline to commercial operation date.

Project delays are all but inevitable for transmission projects in the U.S. The grid ecosystem evolved as a disparate group of utilities, each serving specific geographic service areas, and therefore ill-equipped to coordinate projects that cross multiple jurisdictions or states. Today, 1,350 GW of generation, more than the total existing generation capacity in the U.S., is in an interconnection queue, waiting on approval from transmission system operators before being connected to the grid. Interconnection is a multi-step process, as detailed in Exhibit A below. Many grid connection requests are ultimately withdrawn, after the projects receive a revised projected cost estimate that are up to 2 - 10x original estimates[iii]. If the grid had sufficient capacity for the added generation, the projects in queue would have a clearer path to completion.

Exhibit A: Steps for interconnection approval[iv]



Transmission projects contend with many of the same project development challenges as generation assets, but with an added layer of crossing hundreds of miles of terrain with no clear benefit to the communities through which the line passes. Here rises the challenge of NIMBYism. We will detail two case studies to underscore this challenge.

Case Study: Champlain Hudson Power Express Project ("CHPE")

The CHPE is a ~$6 billion, 1,250 MW underground transmission line project 13+ years in the making. When complete, the 339-mile transmission line will provide 100% hydroelectric power to New York City, reducing the city's fossil fuel dependency from ~85% to ~40%. This project, pivotal to achieving New York's Climate Leadership and Community Protection Act goal of obtaining 70%+ of statewide electricity from renewable sources by 2030, will accelerate New York's path to a zero-emission grid[v]. The project will also have significant economic benefits for the state – decreasing electricity costs for New York City ratepayers by $17 billion over the first 25 years of operation and generating $1.4 billion of tax revenue across 73 municipalities.[vi]

The CHPE was first proposed to FERC in 2010 by Transmission Developers, Inc. ("TDI"), a Blackstone Energy Partners portfolio company. The project received all its required regulatory, environmental, and construction permits from the various state and federal regulatory agencies by 2014.

Despite the project having the requisite construction permitting in place, breaking ground has been delayed for nearly 10 years, due to opposition from the local / indigenous communities directly impacted by the transmission line construction. TDI and its Canadian partner, Hydro-Quebec, spent the better part of this 10-year time span partnering with 20+ New York State and Canadian agencies to negotiate monetary settlements for 36 individual municipalities and one indigenous community. The result: (i) a $40 million Green Economy Fund; (ii) a $117 million Environmental Trust Fund; and (iii) a Memorandum of Understanding, executed June 2021, that the Mohawk Council of Kahnawà:ke will share direct ownership of the transmission line, securing economic benefits for the community over a 40-year period.[vii,viii] In the end, the real cost of the community support was paid in time.

Case Study: New England Clean Energy Connect ("NECEC")

The New England Clean Energy Connect is a renewable project that did not face permitting challenges but rather NIMBY objections. The NECEC was initiated by the State of Massachusetts in 2018 to bring up to 1,200 MW annually of renewable energy – a combination of hydroelectric power and wind power – from Canada to the New England through a 145-mile transmission line in Maine[ix]. The permitting process began in 2017 and all necessary permits were secured by early 2021, with the project moving into the constructions phase. The project was suspended in November 2021 with 45% of the $1 billion budget spent and 85% of the line completed. The Maine Department of Environmental Protection ("MDEP") had suspended construction after the state referendum had voted 60% / 40% to stop the project.

NECEC challenged the legality of the referendum and in April 2023, the jury ruled in NECEC's favor. In May 2023, the MDEP lifted the suspension and construction restarted a few months later. The project is now expected to cost $1.5 billion[x].

The state referendum challenged the ecological impact of the transmission lines, and questioned the overall reduction in the greenhouse gas emissions that would result from the project. The financial benefits to Maine ratepayers would be realized through the $18 million of additional property tax revenues and the $6 million in community benefits payments spanning several funds including: the NECEC rate relief fund, the broadband fund, the heat pump fund, the electric vehicle fund, weatherization and household energy efficiency programs, an education grant fund, and the Franklin County host community benefits fund[xi]. While Maine residents would see improvements in their community, the majority of the savings would be realized by broader New England ratepayers, totaling $3.9 billion over the life of the project. Had the benefits been delivered more effectively to the Maine ratepayers, the referendum results may have been different.

Another way the development could have evaluated its options would have been to consider the $500 million project overrun as an avoidable amount which could be managed with more nuanced project development planning. Per the U.S. Census Bureau, the combined population of the counties through which the transmission line passes is 194,868, is $2,566 per resident.

Rethinking Transmission Economics: Private-Public Revenue Sharing

Transmission project execution hurdles faced by the stakeholders in the highlighted case studies reflect a broader trend: on average, transmission projects materially exceed their forecasted budget, and run significantly behind schedule. While this is consistent with the broader landscape for power and utility projects, where projects have been found to run 35% over budget and behind schedule by two years on average[xii], the problem is magnified for transmission projects in the U.S., where local governments in nearly every state have enacted laws to block projects with significant support from their local constituents.

Project cost and timelines are two key components of understanding the expected return profile of a developer. To date, most policymakers have attributed the lack of local support to lack of education, and argued that short, medium, and long-term benefits, like increased grid reliability and local job creation, are under advertised and/or misunderstood by local communities. As highlighted by the above case studies, the status quo is more nuanced, with communities demanding a more direct benefit for utilizing their territories for mega infrastructure projects. By directly sharing in the economics of the project, constituents would be more inclined to provide a strong and quicker buy-in.

To address this challenge, transmission project sponsors need to revise their approach to capital and cost allocation by offering local communities a meaningful stake in recurring project revenues. Understandably, most operators would hesitate to sacrifice any portion of future revenues and accept a lower project rate of return.[xiii] However, the typical costs[xiv] associated with failing to take this proactive approach, as demonstrated by the more than 50% budget overage[xv] caused by the two-year delay of the NECEC project due to community pushback[xvi], greatly exceeds[xvii] the costs associated with a community revenue-share model.

This model could be achieved through a two-step approach:

1. Allocate greater investment to one-time “easement” payments to local residents, symbolizing a meaningful “sign-on reward” for joining the constituent group and providing right-of-way approval for project construction; and

2. Offer a specific percentage of annual project revenues to the constituent group for a defined period, ideally aligning with the period of highest cost increases for ratepayers subsidizing the project. After this time expires, 100% of revenues would go to the transmission line operator.

Project Proposal: Powering the Finger Lakes Region Through Public-Private Revenue Sharing

To demonstrate the effectiveness and profitability of this model for transmission companies and local communities alike, our team – leveraging existing cost figures from a major US RTO[xviii] and census statistics from the State of New York Comptroller[xix] – created an economic model which supports a significant proposed transmission project in the Finger Lakes region of upstate New York. The project would facilitate the construction of a 130-mile transmission line to provide renewable electricity for 1.2 million people, including several Native American reservations communities, through:

1. Allocating $25 million to $75 million of one-time "easement" payments to communities; and

2. Offer 5% to 10% of the annual operating transmission revenue to the constituent group for 20 years.

<u>Financial Benefits</u>

To further underwrite the actionability of our proposed two-step "easement" payment and revenue sharing model, we compared three different Project Proposal scenarios against: (i) the current "Underwritten Outcome" – what transmission line developers underwrite today, ignoring community-driven delays, and (ii) "Today's Reality" – the actual, fully realized transmission line developer returns once community-driven construction date delays and associated cost increases are factored in. Exhibit B, along with select outputs in the appendix, summarizes the key assumptions and financial economic returns of the Project Proposal.

Exhibit B: Transmission Line Construction Returns Scenario Analysis

Key Project Assumptions ***($ in millions)***	
Generation Capacity (MW)	400
Hours in a Year	8,760
Annual Electricity Output (MWh)	3,504,000
Revenues ($/MWh)	$ 28.29
Operational Lifespan (Yrs.)	30
Annual O&M / Revenue Inflation	2.0%
Start Date	Dec-23

Project Team's Transmission Line Proposal vs. Today's Reality for Transmission Line Developers			
	Today's Reality	Prob. Wtd. Estimate	**Project Improvement**
Construction Length (Yrs.)	12 Yrs.	9 Yrs.	**3 Yrs.**
Unlevered FCF *($ in millions)*	$ 3,173	$ 3,226	**$ 53**
Unlevered Project IRR	9.84%	12.51%	**2.67%**

	Developer Returns - Underwritten vs. Reality				**Project Team Proposal Scenarios - Economic Sharing Model**					
	Underwritten Outcome		**Today's Reality**		**Scenario A | Downside**		**Scenario B | Base**		**Scenario C | Upside**	
Project Team Probability Wtd. Estimate					20.0%		60.0%		20.0%	
	$	Yrs.	$	Yrs.	$	Yrs.	$	Yrs.	$	Yrs.
Construction Prep Costs (Permitting, etc.)	$ (184)	5	$ (282)	9	$ (193)	9	$ (184)	6	$ (184)	5
Community Easement Payments	(10)	N/A	-	N/A	(75)	N/A	-	N/A	-	N/A
Construction Costs	(262)	3	(404)	3	(404)	3	(262)	3	(262)	3
Total Development Costs (a)	**$ (456)**	**8**	**$ (686)**	**12**	**$ (672)**	**12**	**$ (446)**	**9**	**$ (446)**	**8**
Gross Operational Revenue	$ 4,021	30	$ 4,021	30	$ 4,021	30	$ 4,021	30	$ 4,021	30
Less: O&M Costs ($6-$14 / kW-Yr.)	(162)	-	(162)	-	(162)	-	(162)	-	(162)	-
Less: Community Revenue Share	-	-	-	-	(86)	-	(171)	-	(109)	-
Net Operating Cash Flows (b)	**$ 3,859**	**30**	**$ 3,859**	**30**	**$ 3,773**	**30**	**$ 3,688**	**30**	**$ 3,751**	**30**
Unlevered FCF (b) - (a)	**$ 3,403**	**38**	**$ 3,173**	**42**	**$ 3,101**	**42**	**$ 3,242**	**39**	**$ 3,305**	**38**
Unlevered Project IRR		***14.36%***		***9.84%***		***9.52%***		***13.16%***		***13.88%***
Summary Stats / Assumptions:										
Community Easement Payment		$10		$0		$75		$0		$0
Annual Community Revenue Share (%)		–		–		5.0%		10.0%		10.0%
Community Revenue Share (Yrs.)		-		-		15		15		10
Total Development Lifespan (Yrs.)		8		12		12		9		8
Total Cost Overrun (vs. Underwritten)		$ -		$ (230)		$ (216)		$ 10		$ 10
Community-Driven Const. Cost Increase (%)		–		54.0%		–		–		–

Note: See appendix for additional support for the underlying transmission line development / construction cost data.

The project team prepared three unique scenarios (i.e., Downside, Base, and an Upside case) sensitizing different transmission line operations start dates, cost factors, community easement payment amounts, and revenue sharing payments. We further assigned probabilities to each proposed scenario (see Exhibit B above) to derive a blended, yet conservative, probability weighted outcome, and compared that outcome to the reality that transmission developers face today. As highlighted above, on average, construction length is reduced 3 years (12 years vs. 9 years), unlevered free cash flow is approximately $133 million higher, and unlevered IRR is approximately 3.5% higher, a 400bps increase compared to the reality today.

Community Benefits

The counties the above transmission line passes through, including several Native American reservations, have historically demonstrated a strong unwillingness to support energy-related projects. The developer must weigh the likelihood of a similar organized opposition to the current project under development. Our recommendation would be to proactively address the concerns of the communities and include the direct revenue sharing mechanism described above in order to provide a more accurate cost and timeline assessment to all the stakeholders.

Commerce & Regulatory-Related Tailwinds for Transmission Private-Public Revenue Sharing

Moving from theory to practice, there is evidence that community revenue sharing models providing attractive returns for project investors and local constituents alike. In 2022, FERC announced a landmark decision[xx] to approve transmission rates for the Morongo Band of Mission Indians, an indigenous community in Southern California and operator Southern California Edison[xxi]. The agreement facilitated the upgrade of a vital transmission link across Reservation lands, with constituents of the local community having the opportunity to participate in both the financing and revenues of the project.

The FERC ruling is symbolic of the private-public partnerships which will be critical to making meaningful progress toward unlocking the 1,350 GW of energy capacity[xxii] waiting to connect to the grid. Private-public partnerships will become increasingly financially attractive given the recently expanded authority of FERC's Backstop Siting Authority[xxiii], which effectively allows the agency to approve transmission projects hung up or rejected by state courts. Combined with the Department of Energy's license to expand the National Interest Electric Transmission Corridor[xxiv] under the Infrastructure Investment and Jobs Act[xxv], the regulatory bodies are looking to support mega infrastructure project development efforts, but in practice, the expanded federal power is meant to be used as a last resort. While community support will remain at the heart of successful projects, the new rulings have facilitated more constructive dialogue between RTO's, transmission project sponsors, and local communities.

Outside of the U.S., member states of the EU including Denmark[xxvi] and Germany[xxvii] have long supported community-owned energy cooperatives for renewables. Middelgrunden, a Denmark project that was the world largest offshore windfarm at the time of its construction in 2000, was co-funded, co-managed and co-owned by the people of Denmark. The success of Middelgrunden inspired numerous Danish energy cooperatives and in 2009, a law was passed that meant that at least 20% of any new wind farm had to be community owned. Today and several amendments later, several other provisions exist under Danish law including: i) a "loss of value scheme" mechanism that ensures payments are made to homeowners in the event of loss of property value following the erection of a wind turbine and ii) a local citizens sale provision under which an offer to purchase shares in wind developments must be made to residents living 4.5 km or less from the nearest turbine. If any shares are remaining, these must then be offered for sale to residents of the municipality in which the turbine is located (or with a coastline closest to the turbine)[xxviii]. Germany also introduced reforms in 2009 to ensure that more of the revenues of local wind farms went to the local municipality.

While these cooperatives have been found to reduce initial costs for ratepayers, their long-term consequences can include higher financial burdens on small communities which are unable to finance upgrades to the transmission lines. Our proposed solution solves for this unintended consequence by using a time-bound revenue sharing structure which would ensure that the private sponsor could pay for needed upgrades through the transmission lines lifetime, without any undue burden on ratepayers.

Delivering on a "Just" Energy Transition by Rethinking Transmission Line Economics

Solving for the myriad challenges faced by transmission projects requires a multi-lateral approach across diverse stakeholders with competing interests. Failing to proactively mitigate the risks associated with the holdup value of NIMBYism – as quantified by our project team's models – will prove fatal to achieving the stated climate goals of the U.S., which require clean energy deployment and construction to double in the coming years[xxix]. By implementing our team's proposed two-step approach, private sponsors maximize the social and economic opportunities of climate action – facilitating a "Just Transition"[xxx] for local communities and incentivizing policymakers to rethink how they can better participate in and subsidize such projects. Our pragmatic model recognizes the inherent hurdles faced by project sponsors, while introducing an economically sound plan for investors, bipartisan appeal for policymakers, and empowering local citizens and communities to think "Yes, I want that In My Backyard" ("YIMBYism").

Appendix – Transmission Line Project Cost Support Exhibits

Estimated Transmission Line Project Costs (pre-inflation)		
Cost Category	**Cost Sub-Category**	**Total**
Transmission Line Construction	- Material	$ 40,920,726.00
	- Installation	$ 61,381,572.00
	- Hardware	$ 9,148,020.00
	- Foundation	$ 31,690,596.00
	- Reconductor	$ 84,000,000.00
Land Costs	- Fees Associated with State Commission Board for construction approval - public outreach, open houses	$20,000,000
	- Right of Way	$ 22,835,880.00
	- Acquisition	$ 46,522,800.00
	- Regulatory & Permitting	$ 32,371,200.00
	- One-time environmental impact fee	$ 17,443,539.70
Administrative & General Overhead		$20,000,000
Project Management		$ 20,000,000.00
Taxes and Duties		$ 30,000,000.00
Total Project Cost		**$ 436,314,333.70**

Project Timeline & Scope	
Phase	**Year**
Project Planning & Initial Stakeholder Engagement	2024 (Year 1)
Routing, Public Engagement and Permitting	2025 (Year 2)
Permitting, Engineering, Environmental Surveys, Real Estate & Public Engagement	2026-2028 (Years 3-5)
Construction	2029-2032 (Years 6-8)
In-Service Launch	2033
Project Assumptions	
Transmission Line Type & Voltage	Steel Pole Double-Circuit 345 Kv
Structure Type	Tangent Structure
Transmission Line Coverage	150 Miles
Distance between Steel Poles (Flat Terrain)	500 meters
Total Steel Poles Required	483
Material Cost Per Pole	$ 84,722.00
Installation Cost Per Pole	$ 127,084.00
Hardware Cost Per Pole	$ 18,940.00
Foundation Cost Per Pole	$ 65,612.00
Acquisition Cost Per Acre	$ 12,923.00
Regulatory & Permitting Cost per Acre	$ 8,992.00
Right of Way Costs per Acre -Pasture (60% of Route)	$ 3,485.00
Right of Way Costs per Acre -Crop (30% of Route)	$ 8,426.00
Right of Way Costs per Acre -Suburban & Urban (10% of Route)	$ 17,245.00
Reconductor Per Circuit Per Mile	$ 560,000.00
Number of Constituents Recieving "Signing Bonus"	50,000.00

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The Economic Club of New York

Second Place Winning Entry

Lisa Phan

18 September 2023

Leveraging AI Software to Analyze Municipal Finance and Increase Accountability

Introduction

Corporate governance is a hot topic, one that politicians, media, and the general public discuss *ad nauseum* with the presumption that corporations will be bad actors without oversight, harming the American public. Public company CEOs are regularly brought in front of U.S. Congress to testify on moral hazards ranging from controversial investments to questionable business practices. While intense scrutiny on a handful of name brand companies makes for captivating television, when considering the total economic impact to the general public, the actor that does not get much airtime is municipalities.

Municipalities affect every aspect of American life—attending school, driving on highways, turning on the tap, and paying taxes at the cash register all involve a municipal authority who is likely also a municipal debt issuer. Encouraging more accountability and transparency in municipal finance should therefore have a significant impact on the lives of Americans.

One may be surprised to learn that municipalities are currently undergoing a crisis of transparency. Not only is the quality of municipal financial reporting oftentimes lacking, but a supposed lack of accountants has driven increased lateness in financial reporting, sometimes by more than a year, and loose covenants in debt documents allow the practice to continue (Braun). Could AI help better increase transparency and accountability at municipalities?

Background on Municipal Finance

There are $4T municipal bonds outstanding with individual investors directly owning 45% of the market, in addition to indirect ownership through ETFs and mutual funds ("Trends"). Not only are the American public direct payers of municipal debt, they are also direct beneficiaries and owners of said debt. Unlike public companies, municipal issuers are not directly subject to federal or SEC rulemaking regarding disclosure ("Investor"). SEC Rule 15c2-12 obligates underwriters to require municipal bond issuers to provide continuing financial disclosure; however, the rule does not govern timeliness or level of detail provided, leading to frequently delayed financial reports that may be over a year old ("Preliminary").

Not only are disclosures lacking, but the dataset is large—there are around 40,000 municipal issuers and close to a million different bonds outstanding (Ivanov). With credit work on individual issuers requiring a heavy lift, investors may have to rely on rating agencies to track credit quality and report on sector risks like the COVID-19 impact to non-profit hospitals. However, rating agencies too are reliant on the infrequent financial disclosures of municipalities, credit analysts can only analyze numbers so fast, and their focus is on financial performance, not necessarily other measures of accountability and governance.

Applicability of Artificial Intelligence (AI)

AI excels at problems involving large datasets, uncertain inputs and outputs, and a need to automate repetitive tasks like updating models, making it a promising tool to supplement municipal analysis.

Recently, ChatGPT has shone a light on the power of Large Language Models and Generative AI, which involves training an algorithm to process natural language and create new content based on user prompts (Mandani). While ChatGPT can answer a variety of useful requests, from drafting Python code to generate a chart showing revenue trends to writing a poem about profit margins, when it comes to more specific analysis, the software falls short. For example, given a basic query of "Did NYC's budget for public schools grow last year?", the chatbot responded with an unhelpful:

> I'm sorry, but I don't have access to real-time financial data. The budget for public schools in New York City can change from year to year. To find the most current information on NYC's spending on public schools, I recommend checking the official website of the New York City Department of Education or consulting recent news reports and budget documents.
>
> Source: ChatGPT, personal communication, Sept. 2023

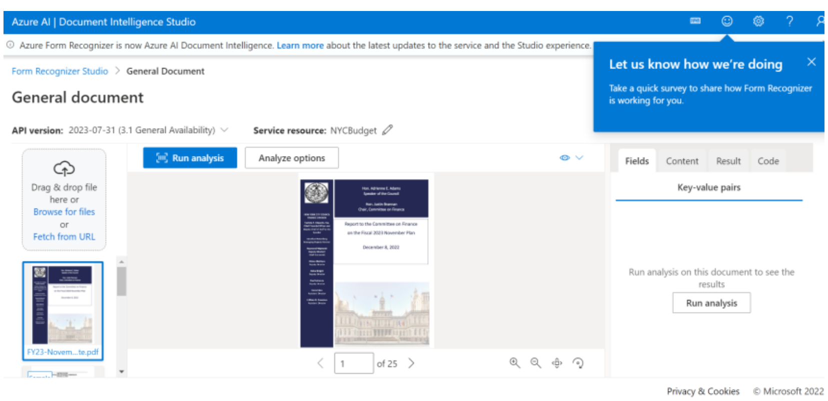
Fortunately, ChatGPT is but one of the many AI applications available in the market right now. Importantly, one does not need to be a computer scientist to use these applications as many like ChatGPT are "off-the-shelf" solutions. There exists a plethora of companies developing new algorithms every day, including a software company that every financial analyst is already familiar with—Microsoft.

Example of AI Use Case in Municipal Analysis

While Microsoft's Azure AI does not have an application called "Analyze Financial Statements", it does contain a multitude of "off-the-shelf" solutions that could help a municipal analyst more quickly analyze municipal disclosures, showcasing that a systematic usage of AI software can supplement traditional financial analysis.

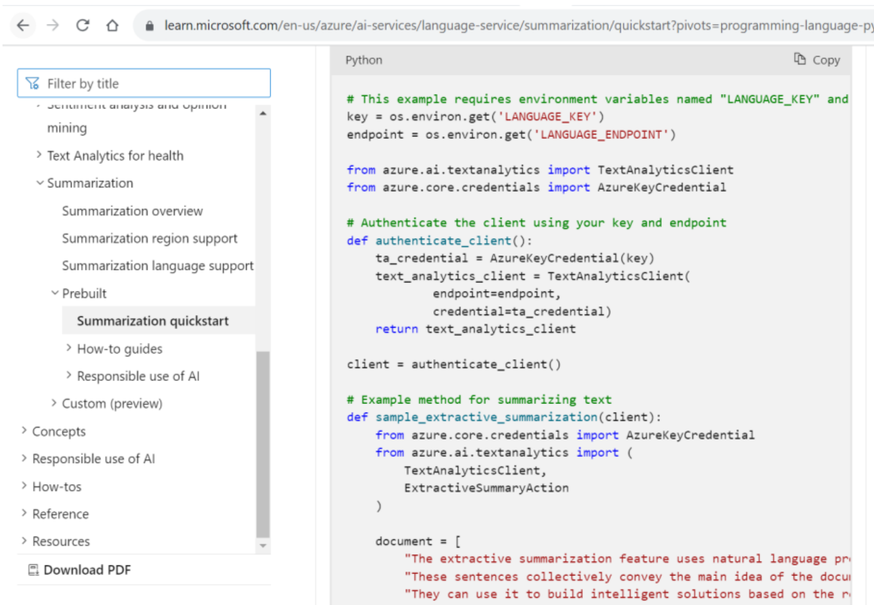
The first step to analyzing municipal disclosure is to extract information from existing documents, and the second step is to have a tool that can comprehend the data. Microsoft Azure AI has two products that do just that, Document Intelligence and Language Service. By copying and pasting simple code that calls upon these tools and referencing a source document, the AI software can highlight key words, extract tables and data for analysis, and summarize text.

Figure 1. Snapshot of Microsoft Azure Document Intelligence



Source: Microsoft

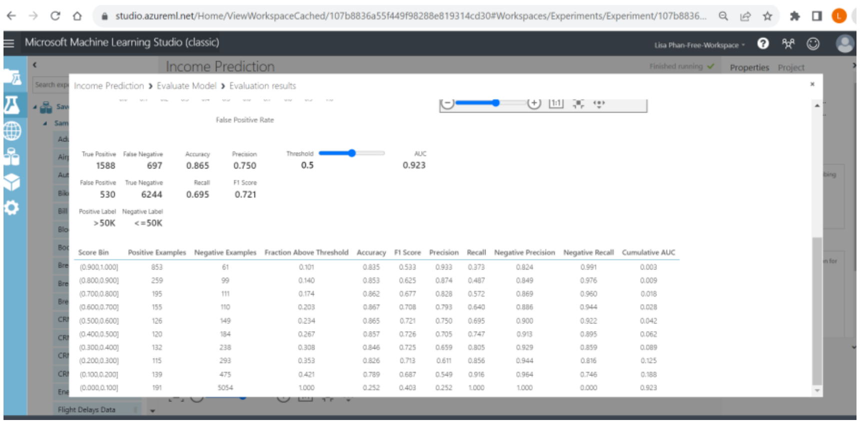
Figure 2. Sample Code in Microsoft Azure Language Service



Source: Microsoft

AI is helpful not only for data extraction and quickly understanding what happened in the past, but it can also be used for trend forecasts through predictive analytics. For this, Microsoft has a tool called Microsoft Machine Learning Studio whereby a user can upload a dataset to train the model, then the model can tell the user the probability of something happening. For example, the user can input a dataset of revenue, profit, and debt outstanding for municipal issuers along with their credit ratings. The Machine Learning software can learn to predict ratings given those inputs.

Figure 3. Sample Output in Microsoft Machine Learning Studio



Source: Microsoft

Exploring Data Beyond Issuer Financial Disclosure

The use case above demonstrates the usefulness of AI software for navigating and comprehending large datasets of municipal financial disclosures. However, if the quality of the inputs is lacking, the quality of the outputs may also lack. Such is the case with current municipal disclosure, which as discussed is oftentimes vague and delayed.

This is also a problem that AI may help solve. As Bloomberg News reported, even traditional municipal analysts are turning to nontraditional solutions for the problem of vague and delayed disclosures, including flying drones over cities and looking at insurance premiums to infer municipal performance (Mysak). Finding potential correlation and patterns in a sea of unstructured data is exactly the expertise of Machine Learning, and where it can add significant value when exploring data outside of issuer disclosures (Baheti).

A subset of Artificial Intelligence, Machine Learning develops an algorithm to identify patterns in a dataset, learns, and improves ("Artificial"). Machine Learning is the backbone of AI programs like ChatGPT. There are a few general categories of Machine Learning: Classification (e.g., labeling images), Regression (e.g., solving for a linear relationship between inputs and outputs), Clustering (e.g., labeling groups based on shared characteristics), Association (e.g., finding words that often get used together), and Dimensionality Reduction (e.g., discovering relevant variables) (Ravi).

The former two categories are examples of supervised learning, requiring a human expert to train the Machine Learning algorithm with a set of inputs and outputs that have a known relationship. In the Microsoft Azure Machine Learning Studio example above, the municipal analyst, using expert judgment and knowledge of rating agencies' quantitative grids, feeds the algorithm issuers' financial results and their corresponding credit ratings. The municipal analyst knows that these metrics surely drive the credit ratings, at least partially. The algorithm solves for a formulaic relationship using the training data set, and the derived formula helps it predict outcomes when given inputs going forward. As the algorithm sees new data and learns whether the prediction is right or wrong, it refines the formula and can become more accurate over time.

While predicting credit ratings can be helpful for debt investors and gives stakeholders an idea of the municipalities' financial health, there are other measurements that matter to the American public. These may include evaluating Environmental, Social, and Governance (ESG) performance, tracking the progress of construction and capital spending, holding public officials accountable for campaign promises, and evaluating the efficacy of public spending on social programs. Unlike predicting credit ratings where there are clear inputs and outputs, these topics are ambiguous and difficult to measure.

This is also where Machine Learning can also help, using Clustering and Dimensionality Reduction, forms of unsupervised learning. Unsupervised learning involves situations where there is only input data and the user does not know exactly which input data are relevant (Ravi). However, it is not completely unsupervised as it still relies on a human to come up with a hypothesis, input the hypothetical input data, and interpret the results.

Using Machine Learning to Evaluate Municipalities

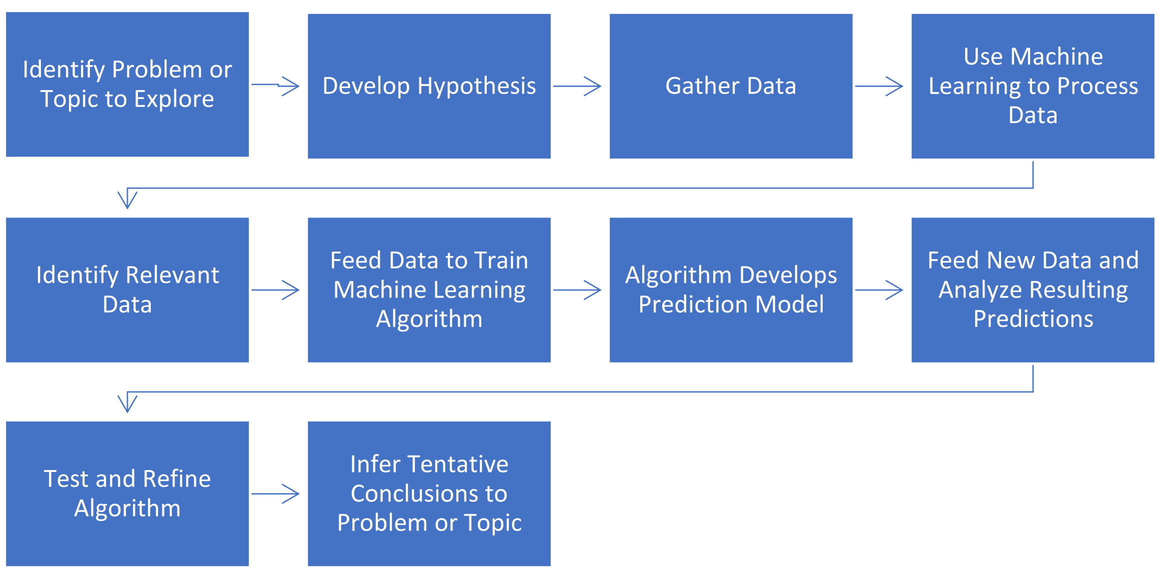
Take ESG as an example. Perhaps the analyst hypothesizes that determining whether one municipal electric utility is considered "environmental" compared to other utilities may have something to do with the average temperature in the area, how much natural gas the utility burns, the amount of electricity produced, how many customers the utility services, the average age of the power plants, and/or the average number of times the utility sends out announcements on social media about energy conservation. The analyst can collect a history of this data through the utilities' own disclosures, the National Weather Service website, popular social media sites, and/or other sources online like news articles.

With the large dataset in hand, the analyst can then use Python code to pull in statistical libraries that are used in unsupervised Machine Learning. For example, in Dimensionality Reduction, a popular statistical procedure used is Principal Component Analysis or PCA (Reddy). PCA's goal is to reduce the number of variables to those deemed important, at least from a statistical perspective in that those variables help explain the variance of a dataset. As PCA assumes correlation between variables, the analyst can first calculate correlation coefficients to determine if PCA is appropriate. After running the dataset through a PCA function, the analyst should have a relevant set of variables with which to train a Machine Learning algorithm.

There are free and publicly available Machine Learning libraries online, many of which are based on statistical procedures like Decision Tree structures, including XGBoost. XGBoost is a supervised Machine Learning algorithm that relies on an established set of inputs and outputs ("XGBoost"). Because of that, once again the human analyst must intervene and determine which electric utilities are considered "environmental" and which are not—perhaps the determination is subjective or perhaps the analyst relies on a third-party agency that ranks ESG. With these inputs, the Machine Learning algorithm can then be trained to predict or analyze whether other utilities should be classified as "environmental" or not based on their inputs.

While Machine Learning can be a useful tool in exploring vague topics, it still requires human intervention and reliance on potentially subjective or incorrect classifications.

Figure 4. Example Flow Chart of Machine Learning Technique



Limitations of AI

In the ESG example above, the trained Machine Learning algorithm could theoretically categorize all electric utilities as being "environmental" or not based on a handful of relevant inputs. Depending on the results of the PCA analysis, the relevant inputs might actually be sourced not from the vague and delayed issuer disclosure, but from a more reliable or detailed source. It seems that Machine Learning in this case could help the analyst bypass the problem of reliance on issuer data, evaluate municipalities on more metrics like ESG, and hold those municipalities accountable with these results!

However, as also described above, the implementation of AI, and Machine Learning in particular, is not as straightforward as typing into a ChatGPT box, "Is Utility X an environmental company?" and getting a 100% trustworthy answer of "Yes" or "No". The building blocks of much of AI software are statistical procedures, which rely on clean or pre-processed data sourced by a human, exposing them to potential biases and subjective classifications. Gathering relevant data can also be time-consuming and costly. While there exists automation libraries like Selenium and Beautiful Soup that crawl through websites and speed up the data collection process, some websites block such algorithms and human intervention is still required to parse through the collected data (Diaz).

Next Steps and Conclusion

Despite its limitations, AI can clearly add value and supplement traditional municipal analysis, whether it be simple tasks that save time like summarizing lengthy reports or more complex tasks that attempt to broaden analysis like identifying patterns in nontraditional data. The statistical processes that underlie AI have been around for some time, but the newly available “off-the-shelf” software is making these analytical processes more widely accessible to the American public, providing an additional tool to hold municipalities accountable. Beyond the ESG example discussed, there are still many other opaque topics that a municipal analyst can explore with AI, including tracking the progress of construction and capital spending, holding public officials accountable for campaign promises, and evaluating the efficacy of public spending on social programs. The last topic on that list is especially relevant amid the current migrant and homeless crises in America, problems that harm lives and consume tax dollars. While AI may not be able to provide an easy answer, it can help people find solutions, though likely also requiring creativity and patience. Behind every machine is a human operating it after all.

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