Meijer Renewable Energy Strategy

Client:

Meijer Inc.

Master's Project Final Report
April 2018

A project submitted in partial fulfillment of the degree of Master of Science (School for Environment and Sustainability)

University of Michigan
School for Environment and Sustainability

Student Team: Chun Yin Anson Chang, Xiaodan Zhou, Geoffrey Murray
Advisors: Professor Greg Keoleian
Michael Elchinger, National Renewable Energy Laboratory

Abstract

As one of the largest energy consumers in the Midwest, Meijer is seeking opportunities to decrease its fossil fuel based electricity consumption. The SEAS MS project team worked to identify and evaluate opportunities to expand Meijer's renewable energy portfolio by understanding the current state of energy consumption, benchmarking Meijer with their competition, and developing a tailored renewable energy strategy to meet Meijer's sustainability goals. The scope of this project included understanding the baseline of Meijer's electricity consumption, evaluating on-site generation opportunities, evaluating off-site procurement opportunities, and developing a pre-development guide tool to be used to analyze specific projects before making investments into project development. The project resulted in a per year prioritization list that considered the economic benefit of potential projects at every store site given annual budgetary constraints and project NPVs, an analysis of off-site Power Purchase Agreement opportunities, a comprehensive renewable energy strategy for on-site and off-site renewable energy generation, and an excel based pre-development guide to further analyze specific projects.

Executive Summary

The School for Environment and Sustainability (SEAS) team worked with Meijer, Inc. to continue the work of improving energy sustainability at Meijer. The 2014 SNRE team that previously worked with Meijer identified energy consumption as the sustainability category with the greatest environmental impacts (SNRE Team 2015). Sustainable energy has two key components: Energy Efficiency and Renewable Energy. In 2017, Meijer tasked the SEAS team to evaluate opportunities to expand the renewable energy portfolio by understanding the current energy consumption, benchmarking Meijer with competitors, and developing a tailored renewable energy strategy to meet Meijer's sustainability goals.

1 Motivations

Three major areas are identified to be the most substantial drivers for renewable energy development:

1) Reduce Carbon Footprint

Meijer has seen success with their energy efficiency improvement. Although Meijer added new facilities that accounted for a 4.4% increase in total square footage from 2014 to 2015, the company's total carbon emissions decreased by 0.1% (Skill 2016). However, even further projected expansion creates a need for energy transition to further control and reduce carbon emissions.

2) Enhance Cost Resiliency

In 2015, coal and natural gas made up 77.6% Meijer's electricity sources. According to the forecast from Bloomberg New Energy Finance, the coal and natural gas prices are projected to increase 45% and 52% respectively by 2040 (Sopher 2015). Meijer will be expected to experience an increase in electricity price if they remain the energy profile unchanged. To diversify the risk of electricity costs, Meijer could explore other energy sources.

3) Align with Industry Leaders

From benchmarking results, Target and Walmart have been leading renewable energy development in the grocery retail industry with 147.5 MW and 145 MW installed solar capacity in 2016, respectively (Mearian 2015). Both retailers recognized that renewable energy is good for the community and envision it as a key for efficient and sustainable company expansion to meet the rising retail demand (Walmart 2014). In 2015, only 2% of the energy consumed by Meijer was generated from renewable energy. Accordingly, Meijer decided to explore renewable energy for current stores and future stores.

2 Project Objective

As the ultimate mission of the project is to develop an applicable and realistic renewable energy strategy for Meijer, three objectives are proposed:

1) To help Meijer understand their renewable energy usage potential and to propose an appropriate renewable energy goal.
2) To establish a renewable energy strategy for Meijer including a priority list of areas with opportunity for deployment.
3) To create a guideline for validating selected projects before going into actual development.

3 Strategy Development

1) Project Fundamentals

Project fundamentals is the analysis of identifying the need to consider renewable energy at Meijer and understanding the potential using the BEPTC framework from NREL. This framework considers the Baseline, Economic, Policy, and Technology aspects of renewable energy to develop stakeholder motivation and reach Consensus to invest.

2) On-site Generation

The on-site generation analysis is used to develop a priority list of potential on-site roof and ground solar projects at Meijer's 226 stores and 10 distribution centers as of 2016. This analysis used the System Advisor Model from NREL to evaluate the energy and financial performance of potential projects at every site. The proposed budget creates an investment window from 2019 to 2035.

3) Off-site Procurement

The off-site generation analysis is used to develop the insights necessary to make an informed investment in large utility scale wind projects. This analysis, which leverages resources and data from Bloomberg New Energy Finance and the Business Renewable Center, includes potential wind PPA (Power Purchase Agreement) options, cost and benefit analysis, and a PPA investment recommendation.

4) Pre-Development Guide

The pre-development guide is a constructed Excel based tool that will help validate chosen projects from both on-site and off-site generation strategies by identifying and evaluating potential developmental problems through the SROPTTC framework developed by NREL. This framework defines the potential problems in the subjects of Site, Resource, Off-take, Permits, Technology, Team, and Capital.

4 Renewable Energy Goal

The SEAS team is proposing a renewable energy goal. The goal is considered sensitive to Meijer and cannot be made available to the public at this moment. This goal was set using a resource and finance assessment of potential on-site and off-site projects based on the principles of innovation, feasibility, and tractability. Projects under this renewable energy goal are all cost-competitive and impactful in reducing carbon footprint. While the goal cannot be made public at this time, we can say that it is made up of 20% of on-site solar generation and 80% off-site wind procurement.

5 Impact of the Goal

1) Energy Cost

Upon completion of all on-site solar projects, a significant portion of Meijer’s electricity costs will be displaced. Also, by contracting a virtual wind PPA contract, Meijer is expected to hedge the price of a certain portion of their electricity consumption, mitigating the risk of increasing electricity prices to Meijer’s operations.

2) Carbon Footprint

This strategy and investment into renewable energy will generate enough renewable energy annually to significantly reduce CO_2 emissions from Meijer’s carbon footprint.

Acknowledgement

The team would like to acknowledge certain people who have contributed to the project thus far. Michael Elchinger from NREL has volunteered his time to help educate the team on renewable energy topics and provide advice on ways to approach the project. Professor Greg Keoleian has served as the faculty advisor for this project and has helped the team with scoping. The Meijer Sustainability and Engineering Team, to include Erik Petrovskis, Greg Serkaian, Jason Flanigan, and Diana Bach, has provided the team the ability to work on a meaningful client facing renewable energy project that has the potential to affect the electricity demand across the Midwest. Thank you for your continued support.

Abbreviation Table

BEPTC	Baseline, Economic, Policy, Technology, Consensus
BNEF	Bloomberg New Energy Finance
BRC	Business Renewables Center at Rocky Mountain Institute
BTU	British Thermal Unit
CEO	Chief Executive Officer
EIA	Energy Information Administration
FERC	Federal Energy Regulatory Commission
FY	Fiscal Year
GHG	Greenhouse Gas
IPP	Independent Power Producer
ISO	Independent System Operator
ITC	Investment Tax Credit
LCOE	Levelized Cost of Energy
LEED	Leadership in Energy and Environmental Design
MISO	Midcontinent Independent System Operator
MS	Master of Science
NPV	Net Present Value
NREL	National Renewable Energy Laboratory
PPA	Power Purchase Agreement
PTC	Production Tax Credit
REC	Renewable Energy Credit
RILA	Retail Industry Leaders Association
RMI	Rocky Mountain Institute
RTO	Regional Transmission Operator
SAM	System Advisor Model
SEAS	School for Environment and Sustainability
SNRE	School of Natural Resources and Environment
SROPTTC	Site, Resource, Offtake, Permits, Technology, Team, Capital
TWh	Terawatt Hour
VPPA	Virtual Power Purchase Agreement

Team Composition

Geoff Murray

Geoff is earning a MS in Sustainable Systems from the School for Environment and Sustainability and a MBA from the Ross School of Business. Prior to attending the University of Michigan, Geoff served in the Army for eight years as an officer in the Field Artillery branch. His education has been focused on energy sustainability and business strategy with the goal of becoming a business leader that drives positive sustainability change.

Chun Yin Anson Chang

Anson is a MS student at the School for Environment and Sustainability and he is also earning a graduate certificate in Data Science. Before attending the University of Michigan, Anson worked for two years in the manufacture and certification industries. He is focusing on taking an interdisciplinary approach to facilitate the development of sustainable energy especially at the corporate level with the business experience and energy knowledge he has.

Xiaodan Zhou

Xiaodan is a MS student at the School for Environment and Sustainability, focusing on Sustainable Systems. Before attending the University of Michigan, Xiaodan earned a BS in Environmental Science at Peking University and worked as intern in Natural Resource Defense Council. Through her experience, she has developed applicable skills including systems thinking and statistical data analysis. She has a strong interest in renewable energy strategy issues.

Table of Content

Figures

Tables

Appendices

Chapter 1 Background

Meijer Inc. is a multi-billion-dollar private retail company that provides comprehensive retail services in the Midwest. Owning over 200 stores, 10 distribution centers, six food manufacturing plants, gas stations, pharmacies, and a corporate headquarters, Meijer provides services in six states: Michigan, Ohio, Kentucky, Indiana, Illinois and Wisconsin. Meijer's stores service a large customer population by providing products including grocery, electronics, household essentials, toys, clothing, home appliances, pet care, and much more.

1 Meijer's Core Values and Sustainability

Meijer is a company that strives to be a good community member, since it is serving the communities in which it operates. They pursue sustainability initiates across numerous environmental functions to include clean energy, better products, waste reduction, and green buildings. Meijer's concern and commitment for sustainability align with their core values:

1) Customers

Many customers are now interested in retail companies that operate with reduced environmental impact. Caring about customers requires that Meijer also cares about protecting the environment that their customers live in and depend on.

2) Competition

Many of Meijer's competitors are pursuing sustainability initiatives. Meijer has a passion to compete and to conquer sustainability challenges that face the retail industry. Additionally, by reducing expenses for energy use, Meijer can cut costs and pass those savings onto their customers.

3) Family

As a family oriented company, Meijer cares about strengthening the communities it serves and providing for the success of future generations. Reducing carbon emissions helps Meijer serve its communities and protect the environment for the future.

4) Freshness

Meijer focuses on providing fresh food to their customers. Sourcing produce from local farms provides customers with the freshest product and avoids adding to their carbon footprints and costs from long-distance transportation.

5) Safety and Health

Meijer cares about providing a safe and healthy environment for their customers and employees. Reducing air emissions from traditional fuels helps keep the communities Meijer serves clean and healthy.

2 Meijer’s Motivations

Meijer has placed an increased emphasis on improving energy sustainability. Meijer has taken actions to reduce the environmental impacts caused by their energy consumption in their facilities through their belief in ‘green living’, which means incorporating eco-friendly initiatives to reduce environmental impact. In 2014, Meijer initiated a SNRE MS project to analyze Meijer’s environmental footprint. One of the conclusions of that analysis was that Meijer’s energy consumption had the highest environmental impact, followed by air emissions, waste, and recycling. To offset the impact from energy consumption, Meijer has invested in energy efficiency initiatives. All new Meijer stores are built under Leadership in Energy and Environmental Design (LEED) program guidelines and principles. Additionally, high efficiency motors and improved ventilation equipment have been incorporated in all stores.

In addition to the core values, the economic consideration is another driver for Meijer’s renewable energy strategy. As the price of renewable energy is decreasing, the cost for renewable energy investments is getting smaller with a shorter payback period and higher NPV. Meijer’s reputation would also benefit from the advantages of being recognized as a sustainable company. Benefits would include improvement to brand recognition, differentiation from competition, and increased employee morale.

The new sustainability initiative Meijer is pursuing with this SEAS MS project team is developing a companywide renewable energy strategy for their facilities. In this project, Meijer is seeking to identify and evaluate opportunities to expand the renewable energy portfolio by understanding the current state of energy consumption, benchmarking Meijer with their competition, and developing a tailored renewable energy strategy that meets their sustainability goals.

3 Meijer’s Challenge

Given declining fossil fuel energy resources and increasing public concern for greenhouse gas emissions, Meijer is becoming more interested in considering renewable energy due to the large amount of primary and secondary energy consumed by Meijer’s facilities every year. In FY2015, the total energy consumption for all facilities was 6.3 trillion BTU (Skill 2016). According to Figure 1, there is an increasing trend of total annual energy consumption, mostly due to the expansion of Meijer stores in the market. Breaking down the secondary energy into the primary sources, Figure 2 (a) shows that fossil fuels account for 76.6% of Meijer’s electricity sources, while renewable energy only accounts for 3.1% (Skill 2016). Though the energy portfolio differs slightly in each state, fossil fuels are the primary sources for electricity. According to Figure 2 (b), stores account for the greatest proportion of electricity use (86%), followed by distribution centers (11%), and 6% by other facilitates (Skill 2016). This means that their biggest opportunity is with potentially displacing a portion of grid electricity at their stores with renewable energy projects.

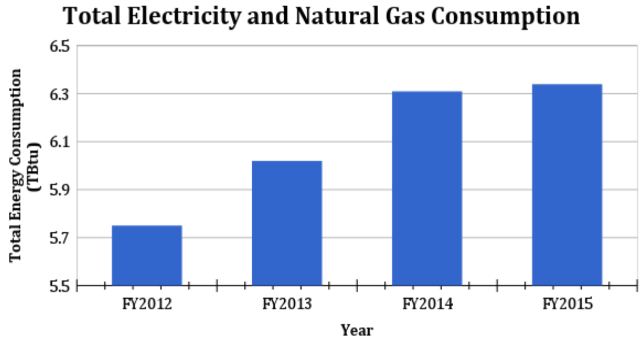
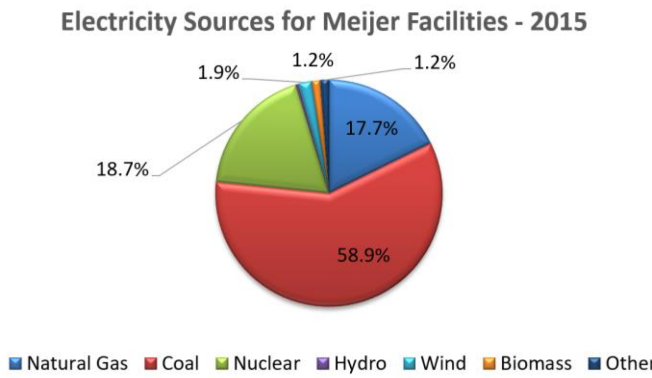
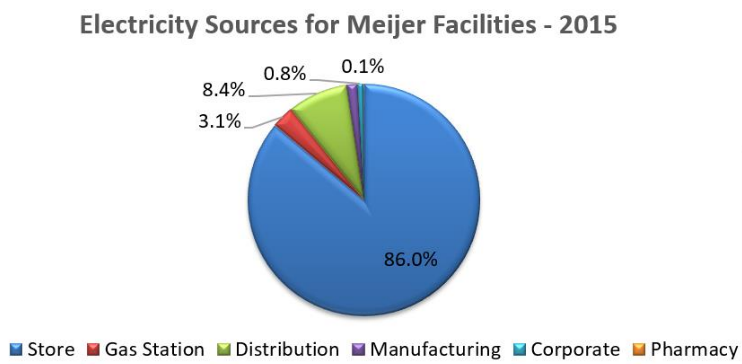


Figure 1 Meijer's total energy consumption for FY2012 to FY2015 (Skill 2016)



(a) Total electricity breakdown



(b) Total electricity use by facility type

Figure 2 FY2015 electricity breakdown and energy use by facility type

According to the 2016 RILA Retail Energy Management Report (Retail Industry Leaders Association 2016), Meijer is at “initiating level” of “energy storage, generation or demand response” while the peer average is at the “exceling level”. Meijer is behind its peers in that category. This is because Meijer has minimal energy storage, generation, or demand response programs in place, which makes renewable energy one of the largest opportunities for Meijer to catch up to peers. The potential to enhance renewable energy proportion for Meijer is high, and this project will analyze the different options available to Meijer and provide recommendations on how to implement.

4 Project Objectives

As the target audience of the project is Meijer's leadership, sustainability, and engineering teams, three objectives are proposed to satisfy their needs:

1) To help Meijer understand their renewable energy usage potential and to propose an appropriate renewable energy goal.
2) To establish a renewable energy procurement strategy for Meijer including a priority list of areas with opportunity for deployment.
3) To create a guideline for validating the selected projects before going into actual development.

5 Project Scope

5.1 BEPTC: Project Fundamentals

Investing in renewable energy is a significant decision for a company. Before a large-scale strategy can be developed an assessment of the renewable energy potential and the motivation of the company must be determined. As a result, an analysis of the fundamentals must be conducted to gain stakeholder motivation and consensus. Stakeholders must be shown proof that there is even an opportunity and that renewable energy should be the solution to that opportunity.

BEPTC (**B**aseline, **E**conomic, **P**olicy, **T**echnology, and **C**onsensus), developed by the National Renewable Energy Laboratory (NREL), is a framework for analyzing project fundamentals in the renewable energy sector. Using this framework, the analysis looks at Meijer's current energy situation, the local renewable energy policy and market situation, and the resource and technology availability in Meijer's regions. This information provides the fundamentals needed to gain stakeholder motivation for investing in renewable energy and the fundamentals from which to base a strategy.

5.2 On-site Generation Strategy

One promising approach to expand Meijer's renewable energy portfolio is to replace traditional electricity with renewable solar energy generated by on-site solar projects. In an on-site solar project, Meijer purchases and installs solar panels on Meijer's available land. The stores or distribution centers nearby are partially powered by solar installations and reduce electric consumption from the grid. Meijer has the option to invest in solar projects at any of its 236 locations. Due to budget constraints, a strategy is needed to prioritize solar project options based on the strength of each project's economic and energy performances.

The on-site strategy covers potential solar projects at Meijer's 226 stores and 10 distribution centers with an investment window based on the proposed budget. Project performances are modeled and analyzed using the System Advisor Model (SAM), a software program developed by National Renewable Energy Laboratory (NREL). Projects are ranked based on their economic performance, which is defined by net present value. A strategy is developed based on this ranking and Meijer's budget.

5.3 Off-site Generation Strategy

The biggest opportunity to increase Meijer's renewable energy portfolio is by identifying and investing in opportunities off-site because of the scalability benefit while minimizing the up-front capital cost. Third party renewable energy developers build large utility scale renewable energy projects in areas that are rich with renewable energy resources and have favorable policies. These developers need corporate buyers to provide a steady stream of income for the electricity. More and more corporate buyers are working with developers to enter into these types of agreements, as it is a way for non-energy companies who are heavy electricity consumers to decrease their carbon footprint and hedge against volatile electricity prices.

The mechanism for Meijer to invest in off-site generation is called the power purchase agreement (PPA) and is the focus of the off-site generation strategy. The analysis for off-site generation includes descriptions of the different types of PPAs, list of potential benefits to Meijer, calculations for the expected price from the developer based on historical PPAs, analysis of trends of the wholesale electricity market, and examples of the use of PPAs from other corporate buyers. The analysis initially considered both solar and wind resources, but wind was identified as the more economical option in the Midwest and the focus of this analysis.

5.4 Pre-Development Guide

The on-site and off-site generation strategies have helped to choose suitable store locations and projects with appropriate size to maximize the benefits. However, potential developmental problems beyond the scope of this strategy analysis may arise that could make individual projects infeasible. The pre-development guide covers a comprehensive framework based on the Developing Renewable Energy Projects Larger Than 10 MWs at Federal Facilities white paper from U.S. Department of Energy (US DOE 2013), which identifies potential problems that might become obstacles to the projects. Ultimately, the guide is designed to equip the decision-maker with necessary knowledge on a specific project before moving onto the development stage and soliciting work from developers.

The pre-development guide is in excel format and is divided into an on-site store specific part and an off-site project specific part and uses the SROPTTC framework from NREL as the foundation. The questions for the on-site part are categorized into Site, Resources, Permit, Technology, Team and Capital. The questions for the off-site part are developed based on Off-take, which is the remaining section from SROPTTC. Responsible stakeholders at Meijer will be assigned specific questions to which they are accountable for answering and analyzing. After evaluating the impacts and potential mitigation methods for each question, they will rate the seriousness of the problem. The overall rating of the project will become an indicator of whether the chosen project is feasible and realistic.

Chapter 2 Project Fundamentals

Before considering an individual project, it is important to analyze the fundamental characteristics that set the conditions for a successful project and help in the setting the framework for developing project support and motivation. The BEPTC (Baseline, Economic, Policy, Technology, and Consensus) framework was developed by NREL and is employed as a framework and tool to understand the current conditions and potential for economic, environmental, and social benefits from incorporating renewable energy into operations to gain stakeholder motivation and consensus (US DOE 2012). Once all project motivations are established and communicated through the BEPTC framework, a renewable energy strategy can be constructed and used to confidently select specific renewable energy projects for investment.

1 Baseline

Baseline is used to identify the fundamental reasons of why a renewable energy project is necessary by conducting an objective analysis of the energy baseline. This includes analyzing current use patterns and understanding the resources that make up the energy portfolio.

According to the 2015 energy chart (Figure 2), 86% of Meijer's electricity was consumed at the store level. Meijer's electricity utilities have been increasing the proportion of natural gas in the grid mix up to 17.7% in 2015 (Skill 2016), which has reduced a lot of greenhouse gas emissions. However, natural gas still poses environmental problems since it is still a fossil-based fuel. Research has also shown that the leakage of methane from transporting natural gas is 31 times (University of Princeton 2014) more potent than carbon dioxide. Therefore, the better option to reduce greenhouse gas emissions is to displace the grid electricity with renewable energy generation.

Meijer has considered renewable energy potential since 2009. There were 9 projects proposed before 2017 but only two of them were executed (Table 1). The lack of a collective strategy made individual projects hard to implement. A companywide renewable energy plan will help to solidify the project motivations, make projects more feasible, and get stakeholders' approval more easily.

Table 1 Meijer's renewable energy project history

Project Year	Resources	Location	Status
2009	Solar; Wind	Executed (MI); Potential (MI)	2 Projects Executed; 1 Project Proposed
2010	Solar; Wind	Potential (OH)	2 Projects Proposed
2011	Wind	Potential (West MI, OH, IN)	3 Projects Proposed
2017	Solar	Potential (IN)	1 Project Proposed

According to a recent report from Advanced Energy Economy, 71 of the Fortune 100 companies and nearly half of the Fortune 500 companies have adopted renewable energy or sustainability goals (Belcher and Sunkara 2017) as part of their operations. Companies employ different ways to frame their renewable energy goal. In the retail market, there are four common ways of goal proposition: 1) Percentage of renewable energy; 2) Number of projects/ properties; 3) Number of installed solar panels, and 4) Carbon dioxide reduction.

Table 2 shows the current use and renewable energy goals in the retail grocery industry as reported by Meijer's major competitors. The information is an important benchmark for developing Meijer's renewable energy goal. Different corporations have their own strategies and their own ways of framing their goal. For example, by setting the goal as the number of projects or buildings, there will not be a system size constraint; by framing the goal as carbon dioxide reduction, the actual environmental impact from the renewable energy transition can be highlighted. The proposed goal must be communicated with stakeholders to ensure it is in alignment with the corporation's direction and meets customer expectation.

Table 2 Renewable energy benchmarking results in the retail grocery industry

Competitors	Current Use	Renewable Goal	Impact	Comments
Walmart (Walmart 2014; Ozment 2014; Walmart 2016)	470 on-site & off-site projects	100% renewable energy by 2020	Avoided 3 million metric tons of GHGs	Not just RECs
Target (Target 2017, 2015)	350 buildings with rooftop solar	500 buildings with rooftop solar by 2020	Offset 15-40% of each building's energy consumption	No system size limit on projects; No unbundled RECs
Aldi (Aldi 2015)	4 DCs and 28 stores with on-site projects	Reduce 30% GHGs emissions by 2020	Avoided 2.7 million pounds of coal burned in 2015	On-site solar as priority
Whole Food Markets (WholeFoods 2006, 2016)	100% RECs, 25 properties with on-site solar	84 stores and DC with on-site solar	Each on-site solar project avoided 1650 tons of CO2 over 20 years	Has purchased 100% RECs since 2006
Kroger (Kroger 2014)	2 wind turbines and 7 on-site solar projects	Reduce 40% cumulative consumption by 2020	Saved 1.6 billion kWh	On-site wind turbine, food power
Trader Joe's (Whitten 2016)	253 kW rooftop solar 3rd party PPA project	No published goal	-	3rd party PPA with Regency who sells 100% power to Trader Joe's

Figure 3 shows the number of renewable energy project per 100 stores for Meijer and their major competitors as of 2016. Target leads the retail market with 147.5 MW of on-site solar installation, and Walmart is the second with 145 MW (Lazard Inc 2017). Meijer has the potential significantly improve the above index by strategically investing in more medium size on-site projects.

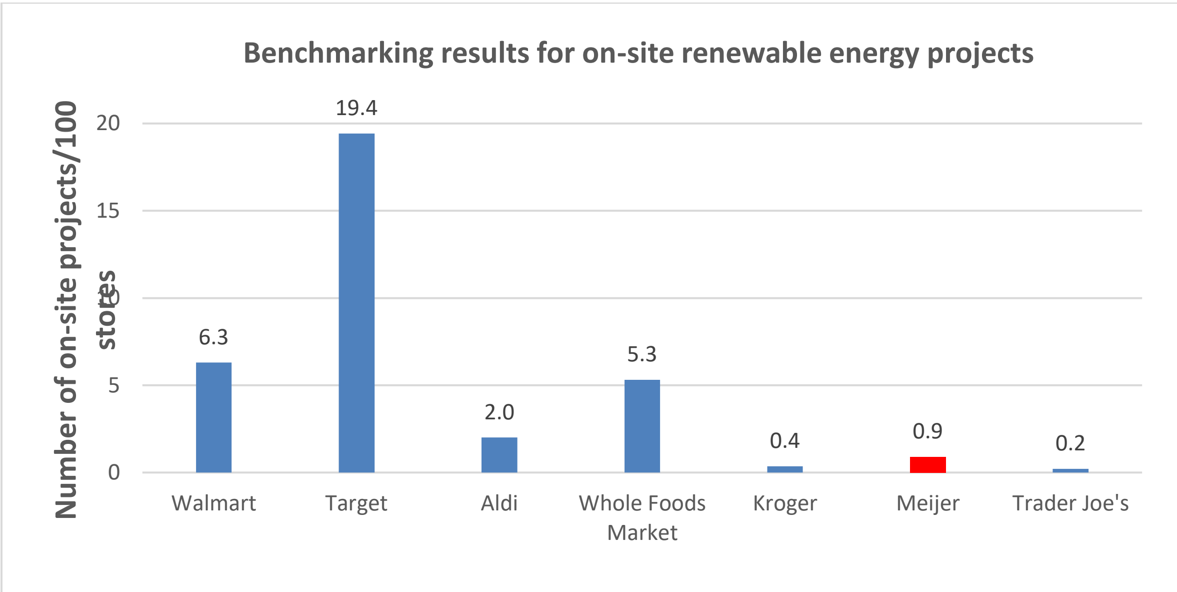


Figure 3 Chart showing the number of renewable energy on-site projects per 100 stores in the retail grocery industry

2 Economic

The purpose of the economic portion of the BEPTC framework is to understand the fundamental energy economics of Meijer's current energy use and potential renewable energy alternatives. This is done by understanding the total cost of current use, LCOE and total costs of renewable energy options, and other relevant economic benefits such as tax credits.

To compare the cost of electricity for the different electricity sources according to industry standard, the levelized cost of energy (LCOE) is used. LCOE is defined as the net present value of the unit-electricity cost over the lifetime of the generation infrastructure. Renewable sources often have minimal operational costs but very large up-front capital costs. A lifetime cost comparison can therefore determine whether renewable electricity has a cost advantage in the long run.

According to Meijer's historical electricity price chart in Figure 4, Meijer has experienced an increase in companywide electricity price from $.075/kWh in 2009 to $.081/kWh in 2016. Although there were many reasons that can lead to the increase in electricity price, the increase in the price of fossil fuel was one of the major reasons. From the Bloomberg LCOE forecast in Figure 5, LCOE of coal and natural gas are forecasted to increase by 45% and 52% respectively from 2015 to 2040. While the LCOE of large-scale solar PV and wind are expected to decrease by 35% and 23% respectively in the same time window. If Meijer current energy portfolio remains unchanged, they are expected to experience the impact from the increase in fossil fuel price which will lead to a further increase in electricity price. On the other hand, the decrease in the price of renewable energy is opening an opportunity for Meijer to displace the grid electricity and reduce the impact from fossil fuel.

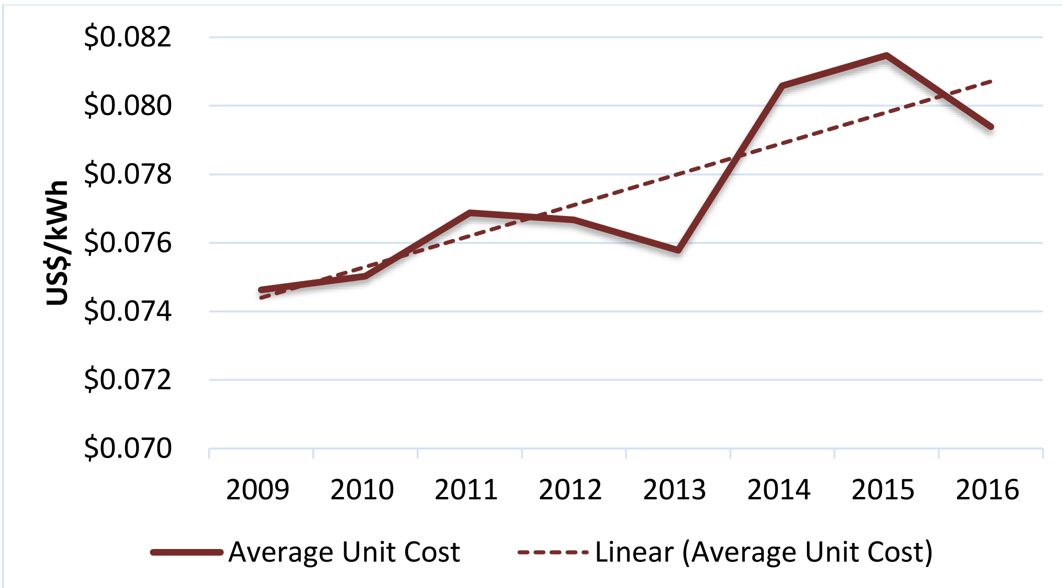


Figure 4 Meijer's historical electricity unit price

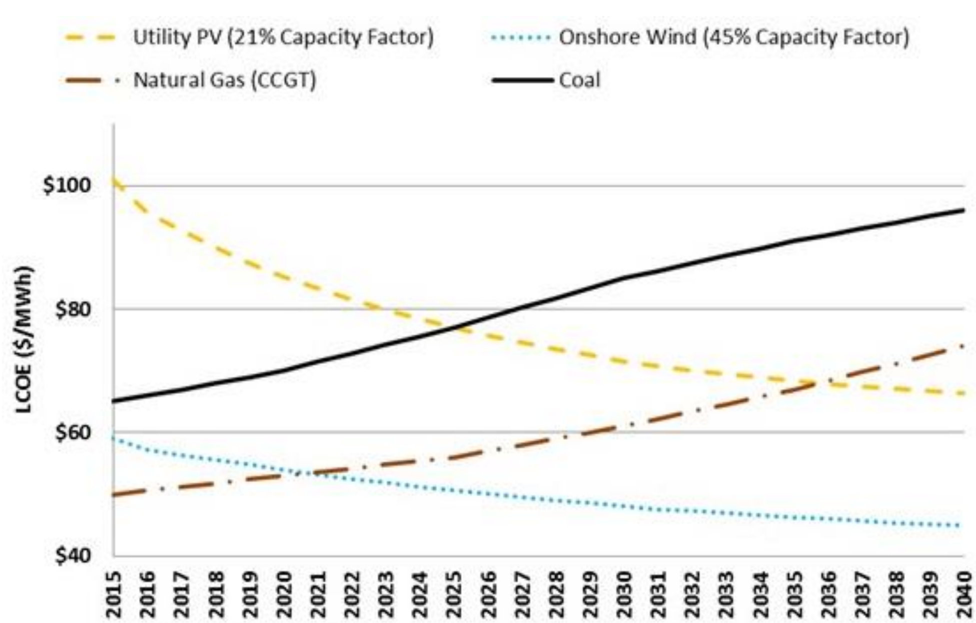


Figure 5 Chart showing the LCOE forecast from Bloomberg New Energy Finance

A closer look at the distribution of 2016 electricity price per store (Figure 6) shows approximately 20 stores skew to the high end (>$0.09/kWh) and 10 are even higher than $0.10/kWh. Those stores, particularly in Wisconsin and some parts of Michigan, provide an attractive economic environment for the development of on-site solar to reduce the exceptionally high electricity cost. Meijer could strategically leverage the electric utility data they possess to develop a renewable energy integration plan to improve the cost performance, stabilize the electricity cost, and achieve a lower average price in the future.

Meijer's 25-year levelized electricity price with 2016 as baseline was $107.6/MWh, while commercial rooftop solar has decreased from $300/MWh in 2010 to $140/MWh in 2016 as shown in Figure 7. Commercial solar LCOE is expected to decrease even further due to the cost reduction of solar panel manufacturing, improvements in solar cell efficiency, and reductions in soft costs. Therefore, we expect the cost of commercial solar to become increasingly cost-competitive with Meijer's electricity price in the next decade. In fact, some of the stores with higher electricity prices could already benefit from installing rooftop solar. By displacing a portion of the source of electricity from natural gas to renewables, the electricity price can be stabilized or even reduced.

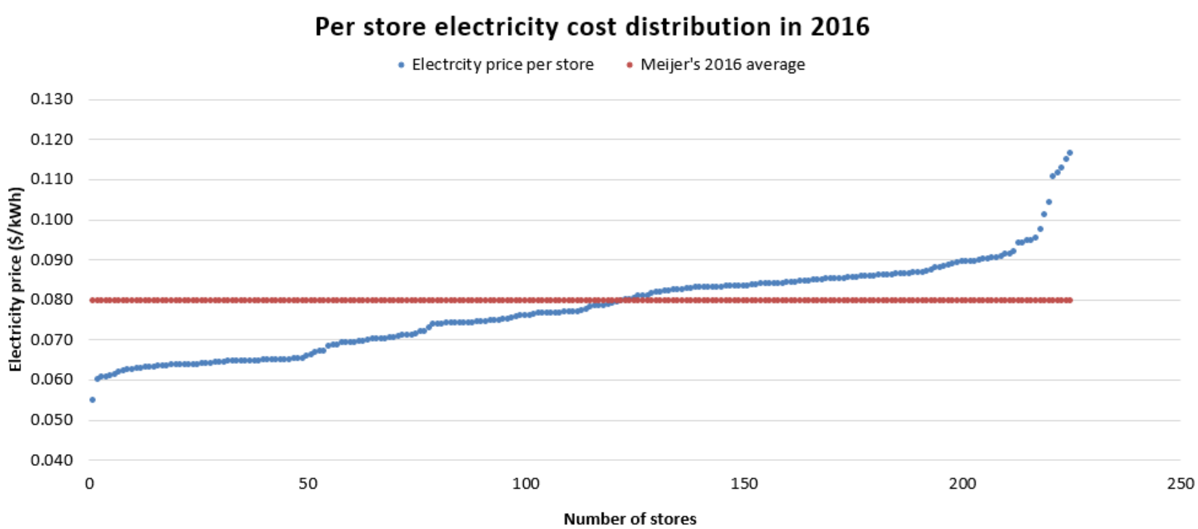
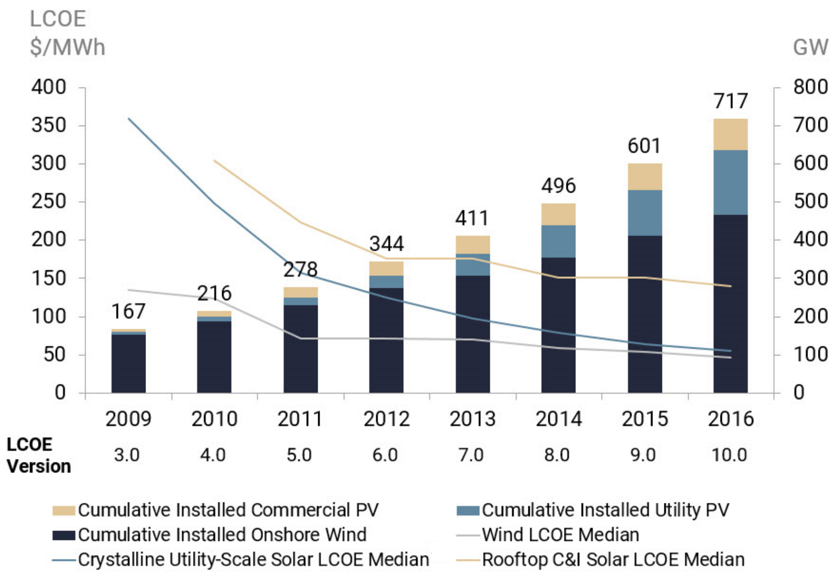


Figure 6 Chart showing the distribution electricity price among 241 Meijer's stores



Note: The LCOE above is an annual average and it varies by location based on resources and local cost.

Figure 7 Chart showing the trend for wind and solar levelized electricity cost (LCOE) (Lazard Inc 2017)

3 Policy

Federal, state, and local incentives that make renewable energy projects economically more attractive are the focus of the Policy analysis. There are also regulatory policies that may be a barrier to a successful project.

There are several important policies that create the desired investment environment for renewable energy projects. The Investment Tax Credit (ITC) is currently a 30% federal tax credit claimed against the tax liability of investors in solar energy property (Solar Energy Industries Association, n.d.). The Production Tax Credit (PTC) is a per-kilowatt-hour tax (kWh) credit for electricity generated using qualified energy resources, with wind being the most prominent (Department of Energy, n.d.). The Modified Accelerated Cost Recovery System (MACRS) is a method of depreciation in which a qualifying solar energy investments in certain tangible property are recovered, for tax purposes, over a period of five years through annual deductions (Solar Energy Industries Association, n.d.). Net Metering allows commercial solar customers who generate their own electricity from solar power to sell electricity they do not use back into the grid for the market retail rate (Solar Energy Industries Association, n.d.).

Table 3 Federal incentive timeline

Type	2019	2020	2021	2022
Investment Tax Credit (ITC)	30%	26%	22%	10%
Production Tax Credit (PTC)	\$0.0096/kWh	\$0.0096/kWh	\$0.0096/kWh	\$0.0096/kWh
Modified Accelerated Cost Recovery System (MACRS)	30% bonus	0% bonus	0% bonus	0% bonus

Table 4 State and local incentive summary

Level	Type	Description
State/ Local Incentives	Net Metering	No trade limit in OH
	Direct Subsidy	Up to 75% project cost in IL
	Tax Exemption	Up to 100% sales tax incentive in WI, KY
	RECs Market	Utility purchasing in IL, OH
	Production Based Incentive	\$0.199/kWh in MI

Detail analysis: Please refer to the "Policy" excel spreadsheet

From the federal incentive timeline table in Table 3, those major incentives and bonuses will start to phase out after 2019. If Meijer want to maximize the incentive benefit, they can consider piloting some top ranked projects in 2019. In another word, the earlier and the more projects Meijer can develop, the higher the incentive benefit will be.

4 Technology

The technology part of the framework covers resource assessments that characterize the renewable resource, assess commercial technologies and reliability, and establish the most straightforward project motivations.

Sunlight striking the earth's surface in just one hour delivers enough energy to power the world economy for an entire year (L. R. Brown 2015). Today, the top three new U.S. power sources: wind, natural gas and solar, make up 90% of new generating capacity and are delivering cleaner and cheaper power to consumers (C. Brown 2017). Renewable resources offer the potential to improve energy security by diversifying the energy mix and strengthening the reliability of the power grid.

Figure 8 shows that in the Midwest, there is a medium level of resource abundance for both solar (~4.5 kWh/m^2/Day) and wind (~6.5m/s) relative to the rest of the country. The Midwest does not have as much sunshine as California (about 45% less) or as much wind as Texas (about 25% more), but the resource density is not the only factor to justify the economic feasibility of the renewable technology as further analysis will show. However, the variability of resources is large, and the resolution of the map matters to identify areas with high renewable resources. For an example, different altitudes within the same region and various distances to the lake will lead to a significant change in resource abundance. For that reason, DTE has explored potentially successful projects in the thumb area and upper peninsula in Michigan (Anders 2012). Meijer can leverage its geographic presence across the Midwest to explore the potential in various locations.

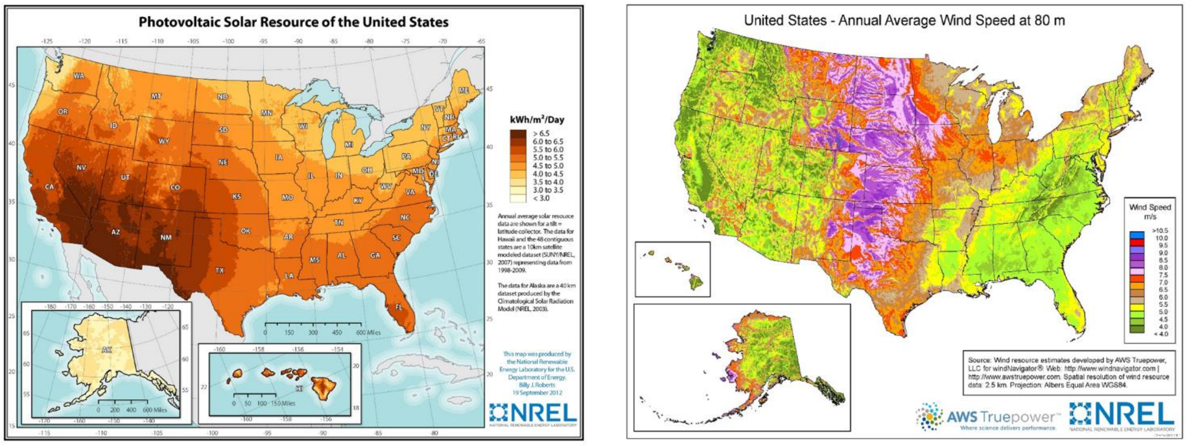


Figure 8 Maps showing national solar insolation and wind speed at 80 m (National Renewable Energy Laboratory 2010)

The 2017 solar report card, which analyzes the performance of a 5 KW solar system across various states within the United States (Table 5), shows how the combination of electricity price, state incentive, and RPS (Renewable Portfolio Standard)[1] to create an economically appealing environment for solar power development. In general, the higher the electricity price, the more the state incentive; the more aggressive the RPS, the better the state will be suitable for solar. Illinois and Wisconsin are currently ranked the top two among the six states in which Meijer is located. As Meijer plans to expand west, it is worth considering capturing the benefit from the solar early in the planning stage.

The 2017 wind report card (Table 6) shows the projects currently online and the number of manufacturing facilities that justify wind development potential in the six states. Illinois, ranked 6th, is one of the top wind performers in the nation. The large installed capacity currently in the state will provide an economy of scale, which lowers the PPA price. As a result, it is an integration option that will be analyzed later as a potential big energy saver for Meijer's stores.

[1] RPS (Renewable Portfolio Standard)[1] is a set of regulations that aims to improve the renewable energy production in each state and help to set the state renewable energy goal.

Table 5 Solar report card 2017 (Solarpowerrocks 2012)

State	State rank within US	5 kW payback (years)	IRR	RPS	Electricity Price	Net metering performance
Illinois	18	13	7.40%	25% by 2025	$0.12/kWh	B
Wisconsin	19	12	8.10%	10% by 2015	$0.14/kWh	D
Ohio	20	15	5.20%	12.5% by 2026	$0.12/kWh	A
Indiana	27	18	3.50%	10% by 2025 (voluntary)	$0.11/kWh	B
Michigan	36	15	5.50%	10% by 2015& 1100MW	$0.15/kWh	B
Kentucky	42	17	4.90%	none	$0.10/kWh	B

Table 6 Wind report card 2017 (American Wind Energy Association 2011)

State	Installed capacity (MW)	Rank	Wind generation %	Wind projects online
Illinois	4,026	6	5.70	47
Wisconsin	648	25	2.30	17
Ohio	545	26	1.10	34
Indiana	1,897	12	4.80	15
Michigan	1,760	14	4.16	25
Kentucky	0	-	0	0

Another important factor to consider for the implementation of renewable energy will be the integration options, as seen in Table 7. Generally, there are five major types of renewable energy integration options. They are divided into behind and in front of the meter incorporation, which usually corresponds to on-site and off-site procurement. The major differences to be considered include ownership, up-front cost, and annual cost. These options will be modeled to find the best option for every Meijer store from the economic perspective.

Table 7 Renewable energy integration options

Integration methods	Behind/ In front of meter	Ownership	Up-front cost	Annual cost	Terms
On-site (Direct)	Behind	Meijer	Capital cost	O&M	Meijer owned
On-site (3rd party)	Behind	3rd party	None	PPA price	Up to 10 years
PPA (Physical)	Behind	3rd party	None	PPA price	Up to 25 years
PPA (Virtual)	In front	3rd Party	None	PPA price	Up to 25 years
Green Power Purchasing	In front	3rd party	None	Premium	Up to 25 years
RECs	In front	Meijer	REC price	REC price	Meijer owned

5 Consensus

Identifying all project fundamentals, reaching a common understanding and unifying a purpose will be substantial to move the project from paper to development. These fundamentals are communicated among stakeholders until a consensus is built. In this project, we developed two different strategic integration systems to involve necessary stakeholders. The first is the on-site generation strategy, which focuses on on-site solar deployment at Meijer's locations. The second, is the off-site procurement strategy, which focuses on off-site wind PPA development. These two strategies are the detailed analysis and research findings elaborated from those project fundamentals, which will give a roadmap to reach the final renewable energy goal at Meijer. To facilitate the effective communication and avoid potential developmental failure, the team developed a pre-development guide to conduct the feasibility assessment of specific projects.

With project motivations established and defined through BEPTC, there are clear reasons to pursue the development of renewable energy projects at Meijer and allocate the necessary support and resources to undertake this effort.

Chapter 3 On-site Generation Strategy

One promising approach to expanding Meijer's renewable energy portfolio is to replace traditional electricity with renewable solar energy generated by on-site solar projects. In an on-site solar project, Meijer purchases and installs solar panels on Meijer's available land. The stores or distribution centers nearby are partially powered by this project and reduce electric consumption from the grid. Meijer has the options to invest in solar projects at any of their hundreds of locations. Due to budget constraints, a strategy is needed to prioritize solar project options based on projects' economic and energy performances.

The on-site strategy analysis covers potential solar projects at Meijer's 226 stores and 10 distribution centers through an assumed investment window for analysis from 2019 to 2035. All projects' performances are modeled and analyzed using the System Advisor Model (SAM), a software program developed by National Renewable Energy Laboratory (NREL). Projects are ranked based on their financial performance. A 17-year strategy is developed based on this ranking and the assumed Meijer's budget.

Although generation from wind is a common on-site generation method, it is not considered in the scope. An economically beneficial wind farm usually requires an area larger than Meijer's available vacant store lands. In addition, although there are some large outlot areas near distribution centers, they are reserved for potential business extension and not available for renewable energy development. Therefore, only solar energy is considered for Meijer's on-site renewable energy project since the panels can be installed on current infrastructure and some land at stores.

1 Introduction

The on-site solar project is becoming more popular in the retail industry in the past decade. It provides the opportunity for retailers to reduce the environmental impact without increasing cost. Meijer has passion for further sustainable efforts, which makes on-site solar a viable option.

In a commercial on-site solar project, Meijer pays for the project installation and operation and maintenance, but gains the benefit of powering nearby stores. The project cost is reduced when state and federal policy incentives are available. This kind of solar project has the potential to not only bring economic benefits to Meijer but expand Meijer's renewable energy portfolio.

The purpose of this analysis is to create a satisfying on-site project strategy composed of projects that can be implemented by Meijer from 2019 to 2035. The strategy building process includes 1) specifying and analyzing all project opportunities based on the budget constraint using the SAM model, 2) prioritizing all opportunities and establishing an on-site project "priority list" based on the projects' NPVs.

In addition, to provide some flexibility against the dynamic and unpredictable market environment, an on-site project "general list" is established by evaluating projects without budget constraints, and ranking projects by capital efficiency ($NPV/MW). The priority list ensures that Meijer can make use of all budgets to maximize the total NPV of solar projects, while the general list provides the flexibility against any changing conditions.

2 Methods

The overall procedure to establish the on-site project strategy includes four steps:

1) Project Opportunity Specification: specifying the project installation opportunities and project size by location and by year based on Meijer's budget and land availability, see 2.1.
2) Energy Performance Evaluation: evaluating projects' energy performance using SAM performance model based on project scales and other conditions, see 2.2.
3) Financial Performance Evaluation: evaluating projects' financial performances using SAM finance model based on the projects' energy performances and other conditions, see 2.3.
4) Project Prioritization: establishing the priority list based on the project NPV, and general list based on the projects' capital efficiencies, see 2.4.

2.1 Project Opportunity Specification

Meijer has opportunities to invest in solar projects at any of the 226 stores and 10 distribution centers. Specifying the project size at each location is the basis for single-project evaluation. At each location, the project size is determined mainly by the land availability (ground and roof) and budget availability in that year.

2.1.1 Annual Budget for Renewable Energy

A 17-year budget plan Table 8 is assumed for analysis to act as a base for this on-site strategy. The annual budget is a constraint for on-site project development. Such a budget-based analysis is a guiding light for Meijer's future investment for renewable energy.

Table 8 Assumed Meijer budget for renewable energy

Year	2019	2020	2021	2022	2023 and beyond
Budget ($/year)	500k	1.5M	2.5M	3.5M	4.5M

2.1.2 Land Availability for Renewable Energy

There are two types of land that are useful for the solar project: rooftop and outlot. Rooftop and outlot available at the same location are separated as two project opportunities. The process to estimate the land availability by location includes three steps:

1) Empty land size is measured at each location. The empty rooftop and outlot of stores are measured using Google Earth Software. The empty outlot of distribution centers is measured using Meijer's maps.
2) The percentage of land that can be used for solar projects is estimated. The percentage of land availability is 80% for rooftop based on discussion with the Meijer Real Estate Team. The

percentage for outlot is 56.5% and this is estimated by the Real Estate Team using 10 stores as test cases. The chosen 10 stores' outlot areas account for 30% of total outlot areas from 226 stores.

3) The land availability at each location is calculated using the percentage from above. Next, the system size is estimated using the factor of 0.25 MW/acre (Narasimhan 2015). The equations are:
   1. $Available\ rooftop\ area\ =\ Empty\ rooftop\ area\ *\ 80\% * 0.25\ MW/acre$
   2. $Available\ outlot\ area\ = (Outlot\ area\ B\ +\ Outlot\ area\ C\ +$ $Outlot\ area\ without\ maintenance\ ) * 56.5\%\ * 0.25\ MW/acre$

2.1.3 Project Size Estimation

For a solar project, the capacity is limited by the maximum capacity that can be supported either by available lands or by annual budget. In addition, the minimum project size is set to be 100 kW, following the industrial standard and Meijer's preference. As a result, any project with a size lower than 100 kW is eliminated from the evaluation.

2.2 Project Energy Performance Evaluation

SAM energy performance models perform calculations specific to each kind of renewable energy technology, including photovoltaic systems and wind farms. The performance model selected for Meijer is "Photovoltaic (PVWatts)". The Photovoltaic (PVWatts) performance model simplifies the complex photovoltaic system for users by making internal default assumptions about module and inverter characteristics. It only requires a few basic inputs to describe the system's nameplate capacity, array orientation and mounting type, and system losses. Therefore, this performance model provides appropriate and preliminary performance analysis before specifying the type of equipment to use in the system for Meijer's projects. Conditions influencing the energy performances includes location and weather (2.2.1), electric consumption (2.2.2) and photovoltaic system design (2.2.3).

2.2.1 Location and Weather

Location and weather are key physical factors affecting the solar radiation and therefore the performance of solar projects. Meijer's stores and distribution centers locates in six states (IL, IN, KY, MI, OH, WI). Such broad geographical distribution results in projects varying in weather and energy performance. Referring to these locations, the 2014 weather dataset is extracted from the National Solar Resource Database in SAM to represent the weather during the entire analysis period. With hourly precision, this dataset used by the performance model to calculate the quantity of electricity generated by the system in each hour, resulting in 8,760 hourly generation values in one year.

2.2.2 Electricity Consumption

Hourly electric consumption records for one year makes it possible to simulate the solar project generation as accurately as possible in SAM. However, among 226 stores, only 81 stores have the most complete hourly electric load record. The way to make up for the missing data of annual electricity consumption is to recognize the electricity consumption pattern. All stores are first classified into 27 groups by location and store size. Group members share some common electricity consumption patterns. Then in each group, the known data of stores are used to normalize unknown data. The classification result of 81 stores is visualized in **Appendix 1**. In this way, a complete one-year electricity consumption dataset is created as an input in SAM.

The classification result of 81 stores is visualized in Figure 9. The region represents the Meijer Region where Meijer's property is separated into six regions. As the figure shows, the annual electricity consumption varies by region and store size. Usually the larger the store, the higher the electricity demand. Also, the closer the store is to the lake, the flatter the demand peak - this is because of the lake effect reducing air conditioning demand during the summer. The solid patterns from the groups justify our classification and projection for absent data. In addition, this method is verified by discussions with Meijer and NREL experts. More details about this process and results are shown in Appendix 1.

As for the distribution centers, Meijer has only monthly electric consumption records and they are used in SAM model directly. Compared with hourly data, monthly data provide a less precise estimation in SAM. Additionally, it is hard to estimate the electricity growth rate for stores due to the continuous store remodeling and improvement in energy efficiency. Therefore, the electricity growth rate is assumed to be zero for the 25-year analysis period.

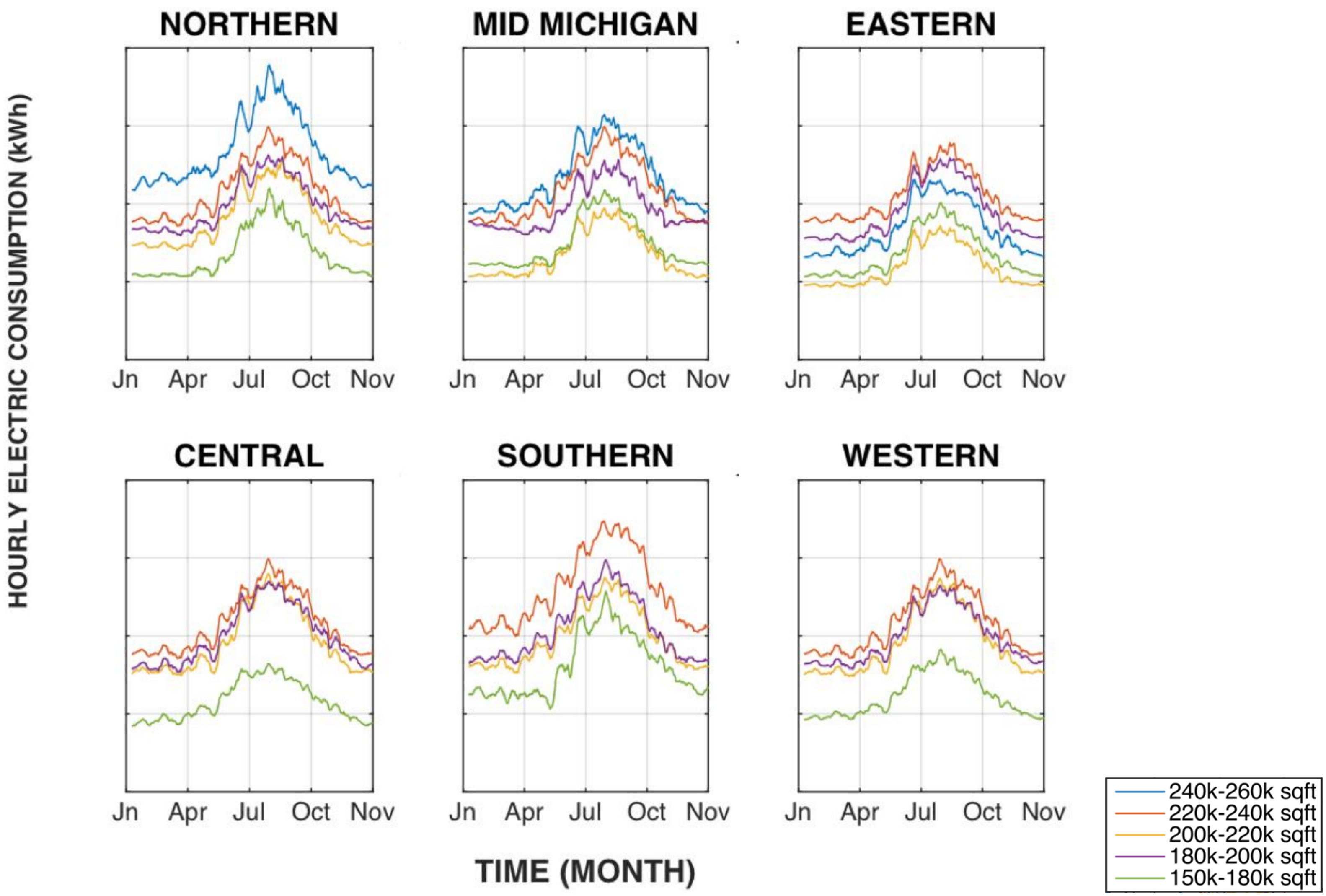
2.2.3 Photovoltaic System Design

The system parameters define the size of the system, the system losses, the array orientation, the performance degradation, and the system costs. NREL has designed a general system for the solar project. The settings are analyzed and then customized for Meijer's project. It is assumed that the photovoltaic systems run for 25 years, although in fact they work much longer if they are well operated and maintained. The degradation rate depends on the operation and maintenance as well, and it is assumed 0.5%/year following the SAM default. Some key parameter customizations are explained in Table 9, with other settings in Appendix 3.

Table 9 Photovoltaic system design parameters customized for Meijer

Setting	Value	Explanation
System Size (kWdc)	Vary by project	Based on the land availability and the proposed budget plan. See more explanation in 2.1 Project Opportunity Specification.
Tilt for roof project	15 degrees	Following the industrial standard to maximize the electricity generation
Tilt for ground project	Equals to the latitude value	Following the industrial standard to maximize the electricity generation
Battery bank	No battery	The battery is yet to be economic to consider commercially after performing analysis using SAM model
Total installed cost per capacity ($/Wdc)	1.91	Assumed for analysis. The escalation rate of cost is set zero due to the unpredictability

Figure 9 Meijer stores hourly electricity consumption pattern by region and stores size. (It shows a not absolute but universal trend that 1) the larger the store is, the higher the electricity demand is, and 2) the closer the store is to the lake, the flatter the peak demand is.)



2.3 Project Financial Performance Evaluation

SAM financial models represent a project's financial structure, including small-scale residential project, small-scale commercial project, and utility-scale project. The finance model used in Meijer’s projects is “Commercial (distributed)”. This model is designed for a commercial project that displaces purchases of power from the grid, and it allows finance through either a cash or loan payment. This model captures the value of electricity generated by the system, policy incentives, and the costs of installation, operation and maintenance, taxes, and debt. Therefore, it provides a comprehensive financial analysis for Meijer’s projects. Parameters influencing the financial performance includes energy performance (2.2), finance scenarios (2.3.1), background financial conditions (2.3.2), electricity rate (2.3.3), and policy incentives (2.3.4).

2.3.1 Finance Scenarios

Two scenarios, “cash-only” and “cash-loan”, are established, analyzed, and compared. In the cash-only scenario, Meijer pays all installation cost with cash. In the cash-loan scenario, Meijer pays 30% of the installation cost with cash up-front, and finances the remainder 70% with a loan. The loan period is 25 years and the interest rate for the 25-year loan is assumed to be 5%.

1) Cash-Only Scenario

The cash-only scenario provides a concrete project evaluation based on all constrains, including annual budget, land availability and policy incentives in different years. This model is used to create the priority list based on NPV ($) for Meijer.

2) Cash-Loan Scenario

The cash-loan scenario provides a general project evaluation based on 2019 conditions. Different from the former model, it is assumed that all vacant land will be used, and it is assumed that Meijer does not have a budget constraint for solar project. This model will create the general list ranked by capital efficiency ($NPV/MW). This general list is more applicable when Meijer takes loan into consideration or when other conditions change.

2.3.2 Background Financial Conditions

The cash-only and cash-loan scenarios share common background financial conditions as shown in Table 10. They are assumed fixed during the analysis period.

Table 10 Financial conditions in SAM

Assumed Parameters	Value
Inflation rate (%/year)	2.50
Assumed real discount rate (%/year)	3.41
Assumed nominal discount rate (%/year)	6.00
Assumed federal income tax rate (%/year)	28
Assumed state income tax rate (%/year)	7
Assumed sales tax of total cost (%)	5
Annual insurance rate of installed cost (%)	0.5

2.3.3 Electric Rates

Electricity rates and electricity load together determine the electricity bill. Among 226 stores, the electricity rate varies from 0.05 $/kWh to 0.13 $kWh, with an average of 0.08 $/kWh (2016). Stores with higher electricity rate will be more attractive options for the solar projects due to the biggest opportunity to offset their bill. Electricity rate consists of energy charge and demand charge. The former is based on Meijer's demand. The latter is based on the whole demand supported by the utility company. The utility charges customers more when the overall market demand is high because they need to ramp up peak power plants to meet the extra demand.

Energy charge is estimated by dividing monthly consumption by the monthly bill. The method assumes that electricity rate only varies by the month, not by hour. The demand charge rate is therefore assumed as zero in the model, but its value is implicitly represented in monthly average electricity rate. The nominal electricity price escalation rate is 2.5%/year (US EIA 2017).

2.3.4 Policy Incentives

Policies are elements that make some solar project more attractive by providing economic incentives. The incentive intensity varies by location and differentiates projects. The federal, state, and local incentive parameters are summarized in Table 11. The table reveals how policy influences Meijer solar projects' potential NPVs.

Table 11 Policy incentives by state

Incentives	MI	IL	IN	OH	WI	KY
Investment based incentive by state gov. ($)	30,000	-	-	-	-	-
Investment based incentive by state gov. (%)	20	-	-	-	12	-
Product based incentive by state gov. (%)	0.199	-	0.138	-	-	0.036
Sales tax value (%)	5	-	5	-	-	-
Property tax rate (%)	2	-	-	-	-	2
Capacity based incentive by state gov. (%)	-	0.25 (max. $500,000)	-	-0.007	-	-
Federal investment tax credits (%)	30 (2019), 26 (2020), 22 (2021), 10 (2022 and after)					
Federal 5-year Modified Accelerated Cost Recovery System (MACRS) income tax depreciation (% applied to the first five years)	20, 32, 19.2, 11.52, 11.52, 5.76					
State 5-year Modified Accelerated Cost Recovery System (MACRS) income tax depreciation (% applied to the first five years)	20, 32, 19.2, 11.52, 11.52, 5.76					

2.4 Project Prioritization

After being evaluated in the SAM model, all projects act as the basis to create the priority list. This is a budget-based process to extract projects from the whole project pool. Figure 10 shows the process to select projects in a year. This process is iterated for multiple times to create a multiple-year priority list. The key link is maximizing NPV each year by adding projects with higher NPV values and using up as much of the annual budget as possible.

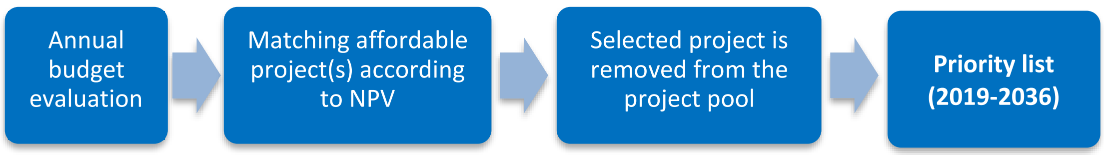


Figure 10 the project prioritization workflow

3 Results and Recommendation

3.1 Store Case Analysis

A store case analysis will help Meijer deepen their understanding about 1) a solar project's influence on the present energy consumption portfolio, 2) the economic benefits brought by the solar project to Meijer, and 3) the financial difference between the cash-only and the cash-loan scenarios. This section will first introduce the store solar project using the cash-only scenario. Then it will be compared with the same project using the cash-loan scenario.

Store XXX (actual store number and location are sensitive and not available to the public) roof project is the example case. Store XXX can support a 780kW solar project if using up available rooftop 3.57-acre rooftop). This store ranks first on the priority list and ranks top 10 in the general list. In the case analysis below, it is assumed that the solar project is installed in 2020 and last for 25 years.

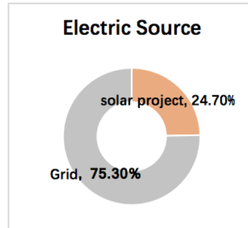
3.1.1 Energy Performance

Since the energy performance is independent of the financial performance, the projects using cash or loan have the same energy performance. Store XXX has a typical annual electricity load of 5,308 MWh, with the fluctuating demand ranging from 369 to 547 MWh/month. Some facts about store XXX solar project energy performance are shown in Figure 11, and below are some insights.

1) The solar project produces 1,308 MWh annually and makes up for 24.7% of the electric source for the store.
2) The energy from the solar project is especially beneficial at peak hours. Using July 1^{st} as an example, the solar project has a peak production at 12:00 and satisfies 75% of the electricity demand at 12:00-14:00.
3) The electricity production of solar panels varies with seasonal weather. For store XXX, the monthly electricity production ranges from 79 to 137 MWh/month, with the peak during May and lowest production during December.
4) The hourly electricity production of solar panel varies a lot during the day, ranging from 0 to 595 kWh.

5) This store case analysis reveals that an on-site solar project is physically an excellent choice for store XXX to support as much as 24.7% of the store electricity demand. In addition, it reduces electricity demand significantly from the grid especially at peak hours.

Metrics	Value	Unit
Capacity	780.601	kW
Store total Elctric Consumption	5,308,269	kWh
Annual energy production	1,308,122	kWh
Capacity factor	19.1	%
Energy yield	1,676	kWh/kW



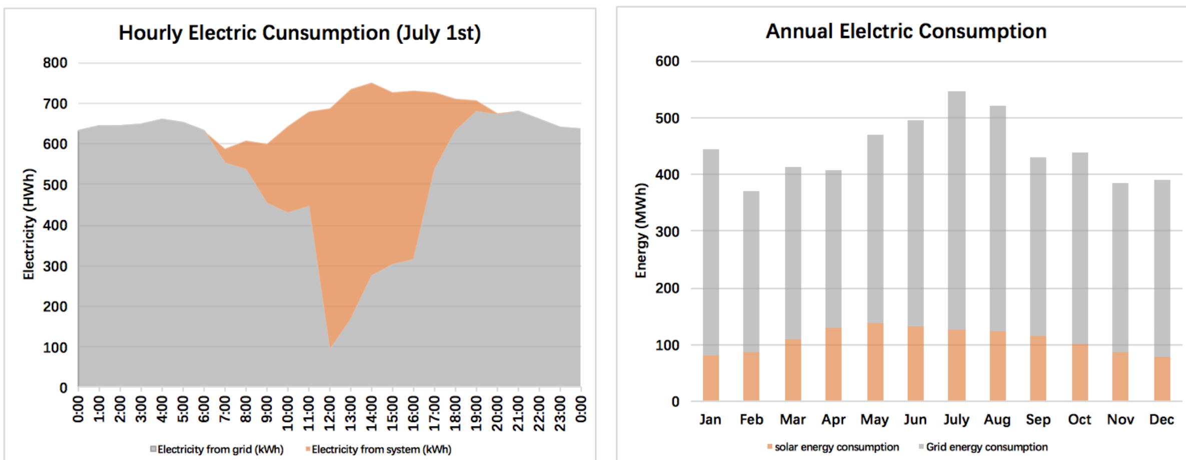


Figure 11 Store XXX solar project energy performance dashboard (year 1)

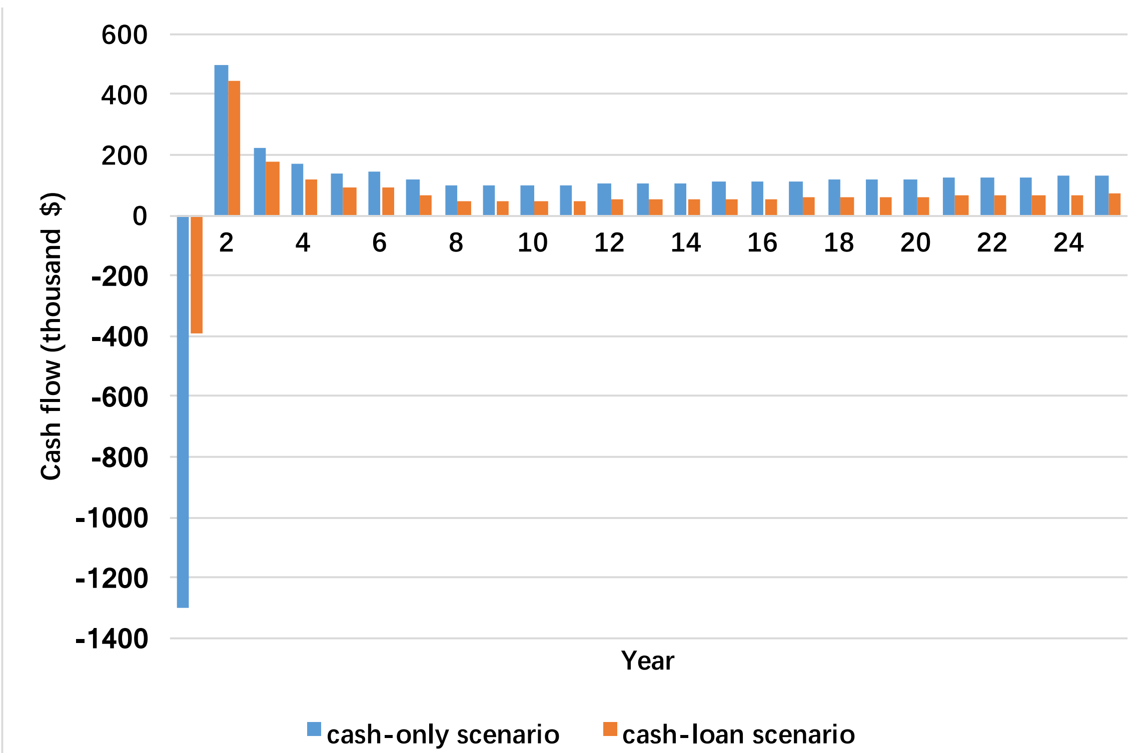
3.1.2 Finance Performance

Some facts about the financial performance of both the cash-only and the cash-loan scenarios are shown in Table 12. The cash-only project has a NPV of $683k. In contrast, the cash-loan project has a NPV of $906k, 33% much higher than the former. This is because Meijer owns the equity at a nominal interest rate of 6% while has the debt at the rate of 5%. Therefore, the project with a loan can generate a higher NPV for Meijer. This is an attractive incentive that Meijer may want to consider in the future. Exploiting the loan opportunity, the project Meijer invests in will be more valuable. The payback period for both finance models is 6.1 year. Payback period is a metric to evaluate the project value rather than the loan value. The cash flow of a project provides a better way to understand how using a loan makes a difference in a solar project case. As Table 12 shows, the loan diverges the cash flow in two aspects: 1) with the assumption of 70% loan for initial cost, the year zero payment is much lower, 2) paying the loan annually decreases the cash flow in the following 25 years. When considering the value of time, it is economically reasonable to get a loan and pay it back in the future.

Table 12 Store XXX rooftop solar project financial performance dashboard

Metric	cash-only	cash-loan	Unit
Net present value	682,982	906,387	$
Payback period	6.1	6.1	years
Levelized COE (nominal)	5.48	4.08	¢/kWh
Levelized COE (real)	4.24	3.16	¢/kWh
Net capital cost	1,296,031	1,296,031	$
Equity	1,296,031	388,809	$
Debt	0	907,222	$
Federal and State incentives	377,280	377,280	$
Electricity bill without solar project	742,146	742,146	$/yr
Electricity bill with solar project	591,531	591,531	$/yr
Net savings with solar project	150,615	150,615	$/yr

Figure 12 Store XXX rooftop solar project 25-year cash flow



The nominal levelized cost of electricity (LCOE) is 5.48¢/kWh from Table 12. The solar energy production offsets the annual electricity bill by $151,000, which is equivalent to 20% of the bill. Among the offsetting, a solar project may benefit from 1) energy bill saving, 2) investment-, capacity-, performance-based incentives, and 3) production-, investment-based tax credits. These incentives and tax credits vary by state and by project. In the store XXX case, the cash flow is decomposed into four components in Figure 13. It's clear that the major component of benefit is the energy bill savings, followed by the federal incentives, especially the 5-year MACRS. The state incentives are relatively minimal in the case. Additionally, the operation cost is stable from year to year.

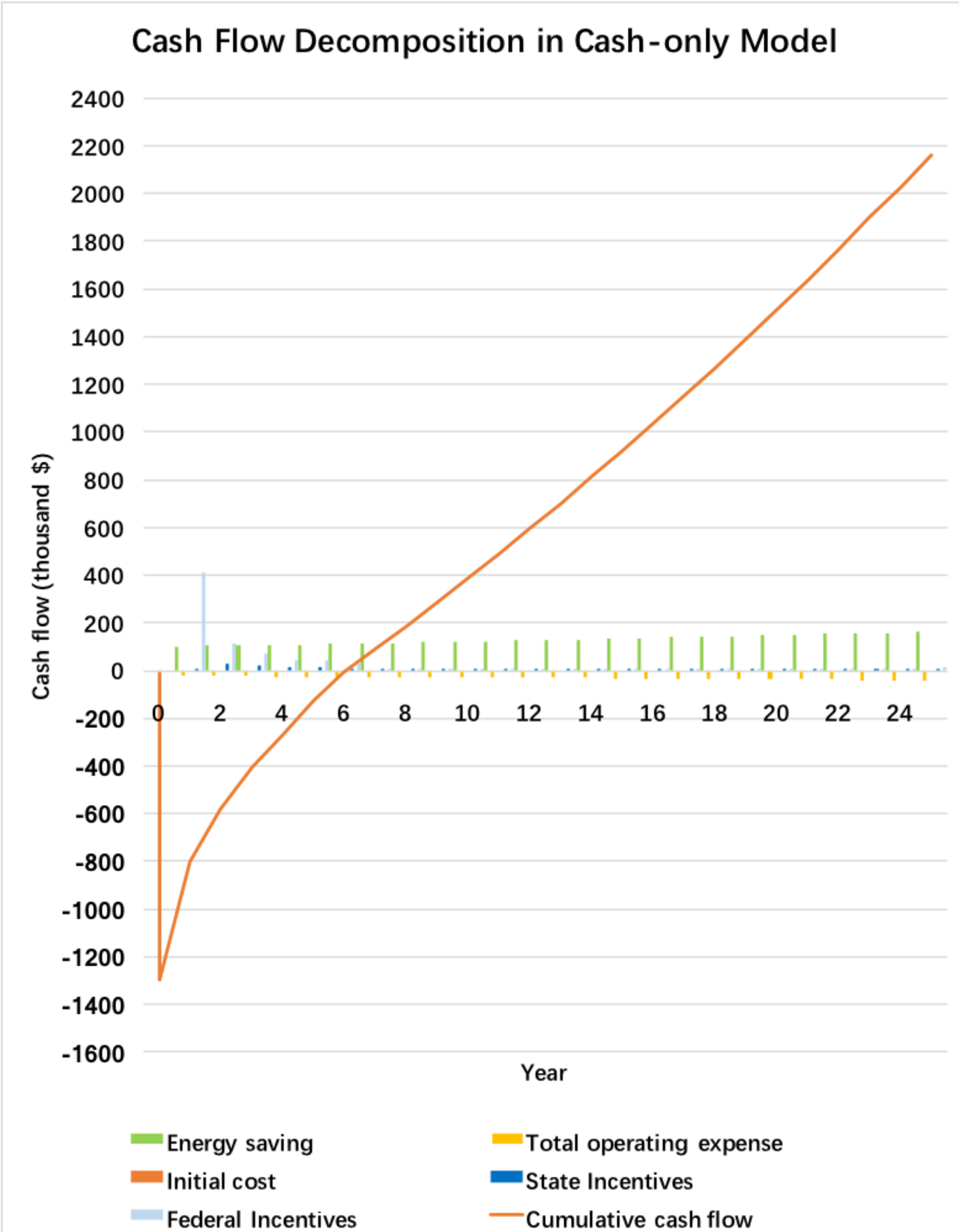


Figure 13 Store XXX rooftop solar project 25-year cash flow decomposition in cash-only scenario

3.2 Priority List and Impact

If all projects are executed, Meijer will save millions of dollars annually from their energy bill over 25 years with a production degradation rate of 0.5%. In addition to the energy bill savings, CO_2 emissions from Meijer's carbon footprint will be reduced by thousands of metric tons annually (US EPA 2017a).

On-site solar projects also bring non-economic benefits to Meijer as well. First, Meijer's customers will learn and appreciate Meijer's action and contribution to the community. This will help build customer loyalty to Meijer. Second, Meijer will be able to catch up with other leading retailers like Walmart, Whole Foods, and Kroger in on-site renewable energy generation. Meijer will develop leadership in renewable energy and build a sustainable retailing brand.

The priority list strictly follows the budget plan and financing preference and makes use of all accessible information from Meijer. Therefore, it provides an accurate solar project energy and financial performance estimation and overall impact prediction. However, the application of the list is limited when the budget or policy incentives change. In this situation, the general list will be useful.

3.3 General List and Impact

The general list is created by ranking all projects with positive NPVs by capital efficiency based on the year 2019 scenario. It is assumed that there is no budget limitation and all empty land is available. There are hundreds of positive-NPV projects ranging across 233 stores and distribution centers that could be implemented by Meijer. Ideally, Meijer would have the potential to implement all projects, which would provide and even further the installed capacity and potential impact.

However, it is worth noting that there are in fact many limiting factors with this analysis. For example, the assumption that all land is available is uncertain. The 2019 scenario has high policy incentives, yet the incentive is different once the project is conducted after 2019. Therefore, the general list is neither a long-standing outlook of the future nor a prediction. Instead, it provides a project comparison based on capital efficiency, where the ranking is insensitive to the changing conditions, including budget, incentives, and land availability, etc. Although it does not provide as accurate of an estimation as the priority list, it does provide reliable ranks between projects.

For example, there are many elements that may affect Meijer's action in the future. If solar tariff increases the installation cost and disables the priority list's function, Meijer can refer to the general list and select new projects quickly.

3.4 Implementation Recommendations

1) Based on the analysis above, the loan should be considered by Meijer since it can significantly increase the projects NPV and make use of the time value of money. In addition, the loan will free Meijer from the constraint of budget, which will allow Meijer to conduct more projects faster.

2) When using the priority list, Meijer should be cautious that at not all projects are feasible. The priority list ranks the projects based on their financials, but it does not consider potential obstacles in the development phase. Identified projects must go through pre-development analysis to understand their true feasibility and benefit to Meijer. The pre-development guide discussed in Chapter 5 facilitates that step. If there are patterns of pre-development issues, Meijer can turn to the general list and still select economically effective projects.
3) Meijer has decided to act in the renewable energy field potentially for the long term and should invest in better energy dataset storage and management as it is serving an important role in renewable energy project analysis. Meijer should start tracking the hourly electric rate data and improve the degree of completion of hourly electric load data. With accurate peak hour and non-peak hour price data, Meijer can better understand the function of solar projects in their operations. By making use of this data and the SAM model tool, Meijer will be able to conduct a high-quality evaluation of more future solar projects.
4) Meijer should pay close attention to advances in solar energy technology development since the priority list is based on current technology. Meijer should keep an eye on solar panel and battery development. This will prepare Meijer to act quickly once more advanced technology is feasible in the market.
5) This research does not include an analysis on third-party on-site ownership projects, but it should be considered by Meijer. In a third-party ownership scenario, the property owner makes an agreement with a third party who installs, operates, and owns the system. The system reduces Meijer’s electricity bill, and Meijer makes payments to the third-party owner for the system. Since the value of the third-party project is to be evaluated, it deserves further analysis and consideration.

Chapter 4 Off-Site Procurement Strategy

1 Introduction

1.1 Background

Meijer consumes well over one terawatt–hour (TWh) of electricity and spends over $90 million dollars in electricity consumption per year in its retail stores alone. This makes energy one of Meijer's largest operating expenses (Skill 2016). Additionally, the greenhouse gas emissions (GHG) from the consumption of over one TWh of electricity per year is the biggest driver in Meijer's carbon footprint (Skill 2016). As one of the largest consumers of energy in the Midwest, Meijer has vested interest in identifying and implementing strategies for incorporating renewable energy into its energy portfolio at large scale and in a timely manner.

Generally, there are three methods to meet renewable energy goals: Renewable Energy Certificates (RECs), On-Site Generation, and Power Purchase Agreements (PPAs). All three offer unique benefits and should be considered in the larger corporate strategy. However, since Meijer consumes such a large amount of electricity, it makes both economic and environmental sense to consider options that allow it to offset electricity consumption at a scalable portion. PPAs offer the benefit of scalability while minimizing up-front initial capital costs. PPAs are a tool used by numerous companies, typically large electricity consumers, to meet environmental goals while price hedging against the volatile electricity market. Since Meijer is a large electricity consumer and in the grocery industry, the volatility of electricity prices is a threat to its profitability since that volatility cannot be passed to Meijer's customers and is a part of their costs. As a result, Meijer should consider a hedge by investing in PPAs and renewable energy.

1.2 PPA Overview

A PPA is usually a long-term contract between a renewable energy developer and a buyer (in this case Meijer) where the developer agrees to own and maintain the renewable energy project and sell the physical energy and the RECs associated with that generation on a per kilowatt-hour (KWh) basis to the buyer who agrees to a long-term contract (typically about 20 years) on a fixed rate structure. There are numerous benefits of a PPA to Meijer. First, Meijer would not be responsible for the capital expenditure typically associated with a renewable energy project since the developer covers those costs, and Meijer would pay for the energy on a per KWh basis. Second, Meijer would not have to invest in the necessary know-how of energy project finance management and owning and maintaining the equipment. Third, PPAs give Meijer the best opportunity to scale to the necessary size to properly take advantage of the optimal economies of scale.

1.3 Types of Power Purchase Agreements (PPA)

A PPA is an agreement between a generator and seller of electricity and a buyer of that electricity. The seller and the buyer typically agree upon a set price for the electricity generated from an energy project, in this case renewable energy, over a long period of time. The seller enters a PPA to ensure a fixed stream of revenue over the length of their project. The buyer, typically a large consumer or provider of electricity, enters into a PPA to lock-in energy prices to hedge against the volatile electricity market and to meet energy portfolio requirements and goals. There are various types of PPAs. The listed types were identified and defined by BRC in their Deal Structure Primer as the most commonly seen in the market, although there are numerous ways to creatively enter into a PPA (Business Renewables Center, n.d.).

1.3.1 Virtual PPA (VPPA)

The virtual PPA (VPPA) is the recommended structure for Meijer, which will be explained in Results and Recommendation section. From Meijer's perspective, this agreement is merely a financial transaction as Meijer never physically takes ownership of the electricity. The electricity generated from the wind farm is sold into the wholesale electricity market. Meijer would pay the developer a fixed price for the electricity generated on a per kilowatt hour basis. In exchange, Meijer would receive the market rate determined by the wholesale electricity market and the Renewable Energy Credits (RECs) from the electricity generated.

1.3.2 Physical PPA

The physical PPA is similar to the structure of a VPPA. The biggest difference is that in a physical PPA the off-taker takes ownership of the generated electricity and is responsible for selling it. This structure is the preferred structure of utilities or corporations where electricity is a part of their core business model.

1.3.3 Direct Investment

Direct investment is defined as becoming an equity owner or partner in the project. There are two types of direct investments. The first is sponsor equity. Sponsor equity is defined as becoming a traditional equity owner in the project. The corporation carries the responsibility and risk of financing and operating in exchange for rights to the money and benefits generated from the project. The other type of direct investment is tax equity. Renewable energy projects are often eligible for the Production Tax Credit (PTC) or the Investment Tax Credit (ITC). However, often developers do not have a large enough tax liability to take full advantage of these credits and will look for an entity who pays more in taxes. As a result, the developer will partner with and pass the tax benefits to that entity who can use the credits in exchange for an investment into the project.

1.3.4 Green Tariffs and Green Power Purchasing

Corporations or any other type of consumers can work with their utility company to ensure a higher proportion of their electricity consumption is from renewable energy. Through green tariffs and green power purchasing, the consumer pays their utility company a premium to purchase electricity from renewable energy sources and supply it directly to them. The consumer pays a premium for their electricity, but the utility is responsible for the generation and distribution of the renewable electricity.

1.3.5 Renewable Energy Credit (REC) Purchasing

Once electricity is generated, it is essentially interchangeable with other generated electricity. Regardless of the energy source, the electricity will be transmitted into the grid. RECs are the tags assigned to electricity generated from renewable sources to provide proof that a certain quantity of electricity was from a renewable source. RECs have monetary value, are tradable, and serve as a way to receive credit for using renewable electricity. An entity interested in making a portion of its electricity portfolio renewable could pay the market price for a REC and retire it to claim that it offset its electricity use with the renewable electricity.

1.4 Company Examples of PPA Use

In addition to the numerous benefits of PPAs, corporations have increasingly decided to use virtual PPAs as their primary mechanisms to meet their increasingly ambitious renewable energy goals. Google was the early adopter in corporate renewable energy procurement and has signed 20 PPAs since 2010 totaling over 2.6 GW of renewable energy. As a result, Google announced that it will meet its 100% renewable energy purchasing goal by the end of 2017 (Google 2016). Other companies are following suit such as Amazon who will be powered by 50% renewable energy by the end of 2017. Walmart, another ambitious renewable energy company stated in a report describing their approach to renewable energy that “to date, we have found the PPA to be a highly effective model for Walmart to leverage our scale and buying power to accelerate renewables.” (Walmart 2014) Companies with high energy demand and a strong desire for setting and meeting ambitious renewable energy goals use PPAs as their primary mechanism for procurement.

1.5 Regulated v. Deregulated Markets

Electricity is a public utility and as a result its market is heavily influenced by state and federal policy. Public regulatory policies vary from state to state and decide to what degree electricity can be generated and sold outside of a region’s electricity provider, which is typically a regulated monopoly utility company. Variance in regulatory policies occur because there is a tradeoff between utility companies providing affordable electricity prices to the entire community and private entities wanting to generate, use, and sell their own electricity. BRC classifies the level of deregulation of an electricity market into two levels: wholesale level and retail level (Business Renewables Center, n.d.). Meijer must consider the level of regulation in potential wind farm locations as it will legally constrain their options for off-site renewable energy generation.

1.5.1 Wholesale Deregulated Market

Electricity wholesale refers to generating and selling electricity on the wholesale market. A region that is deregulated at the wholesale level means that an entity other than the local utility may own and operate electricity generating assets in that region and sell that electricity into the wholesale market. The entities that generate and sell the electricity are referred to as independent power producers (IPPs). The wholesale market is governed by the Federal Energy Regulatory Commission (FERC) and managed by independent system operators (ISOs) and regional transmission operators (RTOs). If the electricity market is deregulated only at the wholesale level, the IPPs cannot sell the electricity directly to end consumers in that region. Deregulation at the wholesale level essentially allows the IPP to use the transmission infrastructure to sell the electricity through the ISOs and RTOs.

1.5.2 Retail Deregulated Market

Electricity retail refers to electricity consumers' ability to decide where their electricity is supplied from, or essentially shop for their electricity. A region that is deregulated at the retail level allows suppliers other than the local utility to sell electricity in that region. This creates competition for the local utility company as consumers can decide on the electricity source that best meets their needs, which could include self-generated, better priced, or lower emitting energy sources. Although an electricity market may be deregulated at the wholesale level but not the retail level, an electricity market would not be deregulated at the retail level but not the wholesale level. It can be implied that an electricity market that is deregulated at the retail level is also deregulated at the wholesale level since if the electricity is supplied from a non-utility, it was likely generated by a non-utility.

1.5.3 Regulated Market

A regulated market is one that is not deregulated. Regulated markets are the least attractive for entities looking at renewable energy options as the utility company holds a regulated monopoly on the entire electricity value chain. The utility company must be heavily involved in any energy project within their jurisdiction and holds a great deal of negotiating power as a result. In regulated markets, companies can request to have their electricity supplied from alternative sources through green tariffs and green power purchasing, but they will likely pay a premium for that right.

2 Methods

The focus of this analysis is on providing Meijer leadership the necessary information to 1) deepen understanding of which PPA business model is the most appropriate for Meijer, 2) understand how Meijer could benefit both economically and non-economically, and 3) make a decision on investing in a PPA. The analysis is focused primarily on the wind PPA as the wind resource is more commonly used in the Midwest for utility sized projects. The economic analysis focuses on providing educated estimates on various price points within the value chain of a PPA. The non-economic analysis focuses on the identification of positive externalities both internally and externally to Meijer. The items identified in the non-economic analysis provide value both to the environment and to Meijer but do not necessarily have a dollar value assigned to them. Although not directly affecting Meijer's bottom line, these externalities are worth factoring into the value of a potential PPA to Meijer.

2.1 PPA Model Type Determination Metrics

Data regarding the pros and cons of PPA types is collected by general literature research and research on the BRC Portal, a part of the RMI. As described earlier, there are several models for off-site procurement in which Meijer can consider. When deciding the model, there are three key attributes and metrics for Meijer to consider: 1) Implementation Feasibility, 2) Market Regulation, and 3) Renewable Energy Additionality.

2.1.1 Implementation Feasibility

Although electricity is a large percentage of Meijer's costs, Meijer is a retail store company and energy procurement is not part of its core business. Meijer must consider the amount of resources and effort it wants to allocate to energy procurement. The different types of PPA model options vary in the amount of direct management Meijer would need to provide. Physical PPAs and directly investing into an energy project would require more energy project finance resources and know-how in their management. VPPAs and green purchasing from the local utilities require minimal management know-how and are closer to financial agreements that may be better suited for Meijer. Each model's implementation feasibility for Meijer is analyzed by expected energy project finance know-how expected to be needed, as outlined in Table 13.

Table 13 Needed energy project know-how for PPA models

PPA Models	Needed Energy Project Know-How
Physical PPA	High
Virtual PPA	Low
Direct Investment	High
Green Tariffs and Green Power Purchasing	Low
RECs	Low

2.1.2 Market Regulation

Meijer must consider the level of deregulation in the states in which it operates and the amount of resources and effort they want to allocate to the activity of energy procurement. The level of deregulation will legally limit Meijer's options regarding PPAs. Each state must be determined to be either deregulated at the retail level, deregulated at the wholesale level, or regulated. The level of deregulation will drive which model options are available in each state. Table 14 shows each state's level of regulation and the PPA models that would be available. This was determined by looking at which states had electricity retail choice programs, as shown in Appendix 4 provided by the EIA, and which states were covered by a system operator, as shown in Appendix 6 also provided by EIA. Appendix 5 shows that even within states that have retail choice programs, there may be additional constraints on the scale in which a state's electricity may be supplied by a non-utility, as is the case within Michigan where it is capped at 10%.

Table 14 Models available in each state

State	Deregulation Level	Models Potentially Available*
Illinois	Retail Level	Physical PPA, VPPA, Direct Investment, Green Purchasing, RECs
Indiana	Wholesale Level	VPPA, Direct Investment, Green Purchase, RECs
Ohio	Retail Level	Physical PPA, VPPA, Direct Investment, Green Purchasing, RECs
Michigan	Retail Level	Physical PPA, VPPA, Direct Investment, Green Purchasing, RECs
Wisconsin	Wholesale Level	VPPA, Direct Investment, Green Purchasing, RECs
Kentucky	Wholesale Level	VPPA, Direct Investment, Green Purchasing, RECs

*Additional restrictions may still be applied by the state or utility

2.1.3 Renewable Energy Additionality

Meijer's reasons for wanting to invest in renewable energy are driven by sustainability impact and the economics of creating alternative electricity sources for its business. As a result, Meijer will prefer models that generate additional renewable energy (additionality). Models that do not generate additional renewable energy are not preferred due to the lack of actual sustainability impact and the economics of merely paying a premium for electricity to make the claim that it was from a renewable source.

2.2 Economic Impact Analysis

The most predictive price point is the PPA price rate of electricity from a developer to a buyer in a virtual PPA. These price rates provide Meijer a basis from where to start when working with a developer. It not only answers the question of what is a realistic price, but it also identifies the ideal project size to maximize economies of scale and which states have historically lower prices. This analysis is constrained based on the limited number of publicly available PPA contracts and the fact that many of the available contracts are examples of utility company as buyers. The Wholesale Price is harder to predict since it is driven by macroeconomic trends and is market based. The analysis identifies an average price with a great deal of variance.

2.2.1 PPA Price Rate Analysis

The purpose of this analysis is to estimate the PPA price by state to help Meijer predict the price they may be able to negotiate from a developer. Step 1 is data gathering and separating the dataset by state. Step 2 is analyzing the yearly data to identify an appropriate prediction method given the trends of the data. Step 3 is applying the identified prediction method to determine a predicted price for each state.

Step 1 - Data Gathering: The data set used in this analysis comes from Bloomberg New Energy Finance (BNEF). It consists of 50 historic wind PPAs from the states in which Meijer operates (Illinois, Indiana, Wisconsin, Michigan, Kentucky, and Ohio). However, there is no data on PPAs in Kentucky, and Wisconsin had only one, which is from 2008. Relevant data consist of information such as owner, buyer, project size, state, contract duration, and contract date.

Step 2 - Yearly Data Analysis: Generally, a larger sample size is better for determining an average price. However, since this analysis is determining the best estimated price for 2017, the fact that the data ranges from 2008-2016 means that it could be sensitive to the change in prices over time. This is especially relevant in a field such as renewable energy where advances in technology could be driving down the costs. In fact, Lazard reported that the Levelized Cost of Energy (LCOE) from Wind has decreased 61% from 2009 to 2015 (Lazard Inc 2015). As a result, an analysis of the trend in wind energy price over time must be completed to determine if more recent projects should be weighted heavier.

Step 3 - Determining the Best Price for Each State: The analysis from step 2 shows that PPA prices had been decreasing over the time span of the data set. This is shown in Appendix 7 where the PPA prices have clearly decreased from 2008 to 2016. The overall trendline shows a decrease of over 50% from 2008 to 2016. Because of this decrease in prices over the range of the dataset, a weighted average calculation is identified as an appropriate approach to place emphasis on more recent projects that better represent prices in 2017.

Projects dated before 2011 are not considered, and projects from 2011 to 2016 are weighted with the more recent having heavier weights. The weights are displayed in Table 15.

Table 15 Weight multiplier for each year

Year	Weight Multiplier
2011	x1
2012	x2
2013	x3
2014	x4
2015	x5
2016	x6

The price of a project is multiplied with its respective weight multiple. The sum of the multiplied prices is then divided by the sum of the weight multiples to give an average price weighted more heavily to the more recent projects. This calculation is done for each state. The result is the price Meijer should use as its basis for larger scale virtual PPAs.

2.2.2 Wholesale Price Rate Analysis

Data Gathering: The data set used in this analysis comes from EIA. It consists of daily wholesale electricity market transactions in the years from 2006 to 2017 in the Midcontinent Independent System Operator (MISO) Indiana Hub. It includes relevant data such as the daily volume (MWh), the daily weighted average of price ($/MWh), the daily revenue ($), and the daily range of prices.

Yearly Data Analysis: Unlike the PPA price from the developer which is fixed, the wholesale electricity price is extremely volatile, meaning that it can fluctuate over time and is hard to predict. Also unlike the PPA price, the wholesale electricity price will not vary as much from state to state. The analysis looks at the average price over the duration of the data set and the degree of its variance. The average price provides a long-term view of the expected revenue of the project, and the variance shows how much the benefit will vary from year to year.

Wholesale Electricity and Utility Electricity Comparison: Since the true economic value of a PPA is its use as a cross-hedge against the volatility of the electric prices Meijer pays to its utility companies, the correlation between wholesale electricity and utility electricity prices is important to note. The concept of a cross-hedge is shown in

Appendix 8, which compares various electricity price scenarios. This comparison analyzes the correlation between the wholesale electricity prices and the utility electricity price over a three-year period. The utility electricity price is based on the prices at one of Meijer's stores. Data from a single store is used opposed to Meijer as a whole because a single store better captures the variability of electricity prices over time by maintaining a constant electricity demand boundary.

2.3 Non-Economic Impact Analysis

Besides economic benefits of entering a PPA, there are also other sustainability benefits which are more difficult to monetize. This analysis explores those benefits from two areas. The first is internal to Meijer, meaning benefits that affect operations at Meijer but are not necessarily customer facing. The second is external to Meijer, meaning benefits that affect the local community and the customer facing brand image of Meijer. Through its relationships with other corporate PPA buyers, the Business Renewables Center (BRC) of the Rocky Mountain Institute (RMI) conducted interviews with those buyers to identify common themes. This analysis outlines the findings from those interviews ((Business Renewables Center, n.d.).

3 Results and Recommendations

3.1 Model Type Identification

Based on the results shown in Table 16, the VPPA is the model that best fits Meijer's objectives for the following reasons:

Table 16 PPA model metric scoring

PPA Models	Implementation Feasibility	Renewable Energy Additionality	Market Regulation Level
Physical PPA	Not Feasible	Yes	Regulated in 3 states
Virtual PPA	Feasible	Yes	Regulated in 0 states
Direct Investment	Not Feasible	Yes	Regulated in 0 states
Green Tariffs and Green Power Purchasing	Feasible	No	Regulated in 0 states
RECs	Feasible	No	Regulated in 0 states

Reason 1: It can be used in states that are deregulated either at the retail level or the wholesale level. This allows Meijer to explore potential PPAs in any of the six states in which they operate or any state that is deregulated.

Reason 2: It has relatively minimal energy project operational know-how required to implement compared to other models. From Meijer's perspective, it is purely a long-term financial agreement with the benefits of incorporating renewable energy.

Reason 3: It provides a cross-hedge against volatile electricity prices. Other models that have minimal required know-how, such as green purchasing and RECs, are structured so that Meijer would just pay a premium in addition to its set electricity rates. The wholesale electricity

market has some correlation to the changes in the electricity rates from the utilities, which results in a cross-hedge type effect. The benefits of a cross-hedge to Meijer are shown in

Appendix 8, which shows that the net electricity price remains constant in conditions of low, medium, and high electricity price scenarios.

Reason 4: The VPPA would directly result in additional renewable electricity being added into the grid. Some of the other models are not as direct. For an example, the REC is not directly adding new renewable electricity as it represents electricity that has already been generated.

3.2 PPA Price

The prices for the states in which Meijer operates range from $30.61-43.10/MWh as shown in Table 10. Kentucky and Wisconsin are left off the list due to not having PPA contract data likely due to either resource or policy constraints. In many situations, these prices are less than half of the price Meijer pays the utility company at each store. These prices represent the price from the developer and do not consider additional costs associated with either using the electricity or selling it into the wholesale market or the grid. Although Meijer should shop for competitive PPA contracts across all states of operations, the price data in Table 17 shows that Illinois historically has the most price competitive opportunities. This is likely related to wind resource availability and more deregulated policies.

Table 17 Estimated PPA price in each state

State	**Estimated PPA Price**
Illinois	$30.61/MWh
Indiana	$32.02/MWh
Ohio	$40.54/MWh
Michigan	$43.10/MWh

3.3 Wholesale Price

The average wholesale price for all electricity bought on the MISO Indiana Hub market from 2006 to 2017 is $52.20/MWh. Trades during this period range from $21.00/MWh to $305.25/MWh, which is an extreme amount of variability. Figure 14 shows the daily average wholesale price over the span of the data set and explicitly shows the degree of the variability.

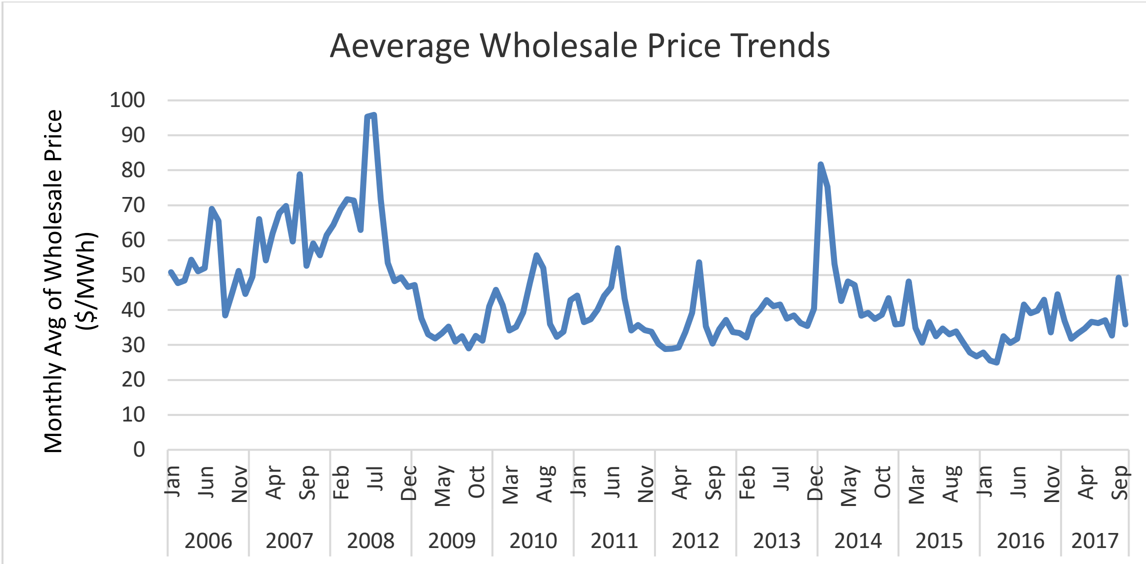


Figure 14 MISO average wholesale price trends

3.4 Overall Economic Benefits

The correlation coefficient between the whole electricity market rates and the electricity rates at a Meijer store over a three-year period is 0.36. As explained previously, a single store is used due to the capability to limit variables that could affect electricity prices other than general trends such as increase in electricity demand due to expansion. This indicates a weak to moderate positive linear relationship between the two. Although not a perfect cross-hedge, selling on the wholesale electricity market would offset risk to changes in electricity prices at this store to some degree. The relationship between changes in the wholesale electricity market and the rates which Meijer pays can be seen in Figure 15 and Figure 16. Figure 15 shows that during periods of time when Meijer's electricity prices spiked, the wholesale market also increased but did not respond as drastically. If periods of unusual spikes in prices are removed, a stronger positive correlation between the wholesale electricity market and Meijer's electricity prices is apparent in Figure 15 and Figure 16. Since there is a positive correlation between Meijer's electricity prices and the prices on the wholesale electricity market, investing in a virtual PPA is proven to be a hedge against electricity prices since Meijer would now also be a seller of electricity generated from the PPA.

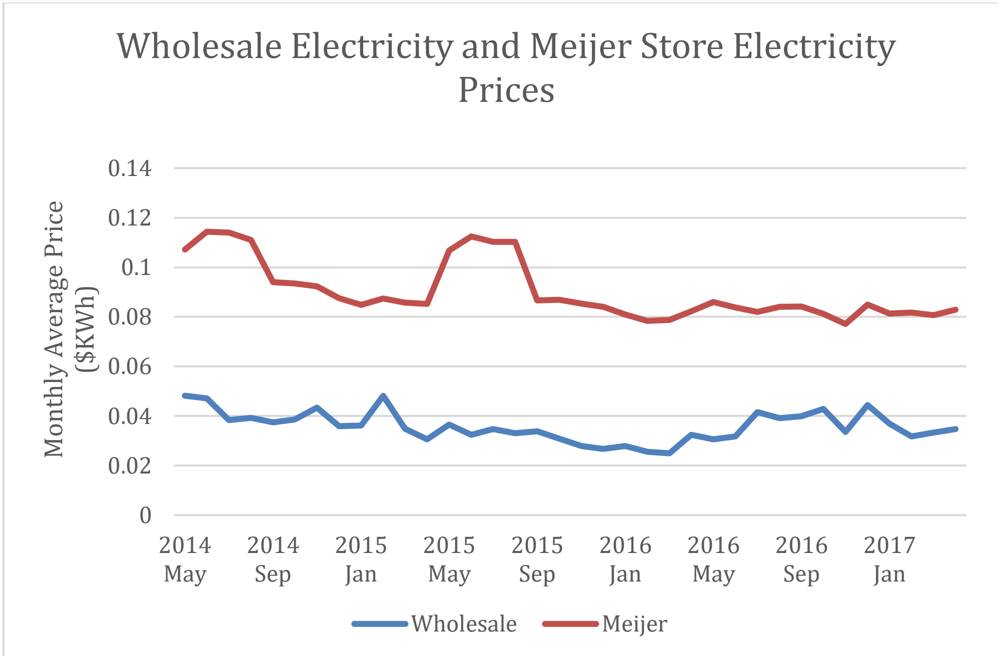


Figure 15 Wholesale and Meijer electricity prices over time

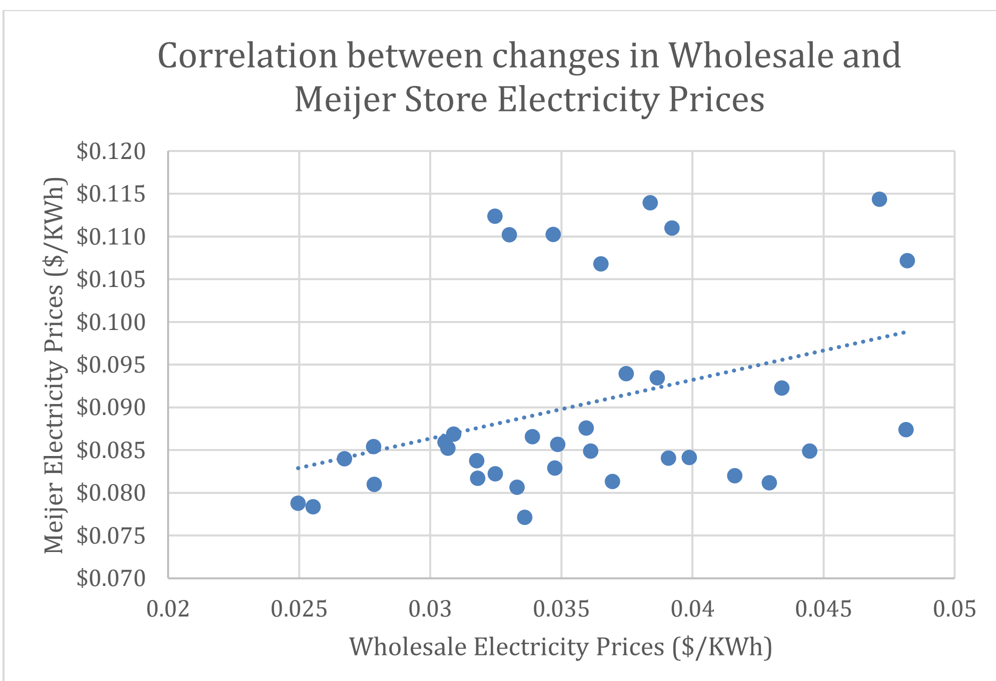


Figure 16 Wholesale electricity prices vs. Meijer electricity prices

3.5 Non-Economic Benefits

3.5.1 Internal Benefits

BRC reports that companies that invest in renewable energy and more specifically PPAs found internal benefits not necessarily directly related to the economics of the contract. For an example, companies report a boost in employee morale and attracting new employees. Employees feel pride in the fact that their employer is extending beyond selling consumer products and contributing to the health of the planet. The sustainability departments also specifically report positive feedback from the projects. The PPA allows the company to quickly scale to set and meet ambitious sustainability related goals compared to other sustainability related ventures. As a result, it drives internal communication and support within and to the sustainability department. This heightened awareness could drive support for other sustainability initiatives.

3.5.2 External Benefits

In addition to internal benefits to Meijer, BRC also reports that companies listed several external benefits not necessarily directly related to the economics of the contract. The first benefit is to the local community. Renewable energy obviously has health benefits related to generating cleaner electricity from which the local community and beyond will benefit. However, renewable energy also adds jobs and employment into the area where the project is located. Improving health and creating jobs are obviously positive externalities. Companies also list benefits to their brand, which serves as a marketing benefit. Renewable energy is generally thought positively upon, and customers have a positive perception of companies that participate in renewable energy generation. These companies are perceived to be leaders in innovation and environmental improvements. This would be especially beneficial to Meijer since they are a business to consumer company.

3.6 PPA Case Study

An example PPA will help illustrate the benefits and the financials of the project. Virtual PPAs generally range in capacity from 50-200 MW, but a 100 MW project will be used as the assumption for this case. Necessary assumptions include wholesale price assumptions, PPA price assumptions, and project assumptions. See Table 18 for the complete list of assumptions. As shown previously, electricity prices are extremely volatile and as a result make modeling difficult to project. To account for this volatility, a Monte Carlo simulation was run with five thousand iterations to determine the mean NPVs and standard deviations of various length projects. The independent variable that was manipulated by the simulation was the wholesale electricity price, and the probability distributions were based on the mean and standard deviation of the daily average MISO wholesale electricity prices from the same dataset as Figure 14. An important variable that Meijer can control is the PPA price that they negotiate with the developer. NPVs for various PPA price and project length scenarios are shown using a sensitivity analysis.

Table 18 Virtual PPA Example Assumptions

Whole Sale Price Assumptions		
First Year Whole Sale Price	44.52	$/MWh
Whole Sale Price Escalation	2%	/year
PPA Price Assumptions		
First Year PPA Price	40	$/MWh
PPA Price Escalation	2%	/year
Project Assumptions		
Project Size	100	MW
Capacity Factor	45%	
Degradation	0%	/year
Assumed Discount Rate	5%	
Project Length	15	years
Monte Carlo and Sensitivity Analysis Assumptions		
Mean Wholesale Price	44.52	$/MWh
Stand Dev	17.32	$/MWh

For a 100 MW project in the Midwest, Meijer would expect an annual output of about 394 GWh of electricity, which equates to approximately 30% of Meijer's total annual electricity consumption. This electricity generated would be sold in the MISO wholesale market, which would act as a cross-hedge to 30% of Meijer's energy consumption and costs and decrease the overall risk of increasing electricity prices to Meijer's operations. The financial model using the Monte Carlo simulation shows that the expected NPV of this project would be over $20 million with a standard deviation of just over $18 million. The NPV along with the standard deviation shows that the project would likely be a profitable venture for Meijer but with a great deal of uncertainty. Fortunately, if the project ends up not being profitable, it is likely due to sustained low electricity prices, which also benefits Meijer's operations. Figure 17 shows the NPVs and the standard deviations of the case example given project lengths ranging from 5-25 years. A sensitivity analysis of how the NPVs change given different negotiated PPA prices is shown in Table 19. This shows the importance of negotiating favorable PPA prices ($40/MWh and lower). These prices are feasible to obtain based on the PPA price analysis conducted earlier.

In addition to the economic benefits, this PPA would also have environmental benefits. The grid produces about 800 grams of CO_2 per KWh generated (Barnard 2017). Meijer would be essentially displacing 394 GWh of grid produced electricity per year with renewable electricity. This equates to approximately 297,000 metric tons of carbon reduced, or the equivalent of over 325 million pounds of coal burned per year. In terms of greenhouse gas emissions, it would be the equivalent of reducing automotive miles driven by about 730 million miles per year (US EPA 2017a). The EPA values the social cost of carbon as $41 per ton. The societal benefit of this PPA would be over $12 million per year. As a result, there are significant externalities to entering a PPA. Additionally, Meijer could leverage these positive externalities to boost the company's image for marketing and employee morale.

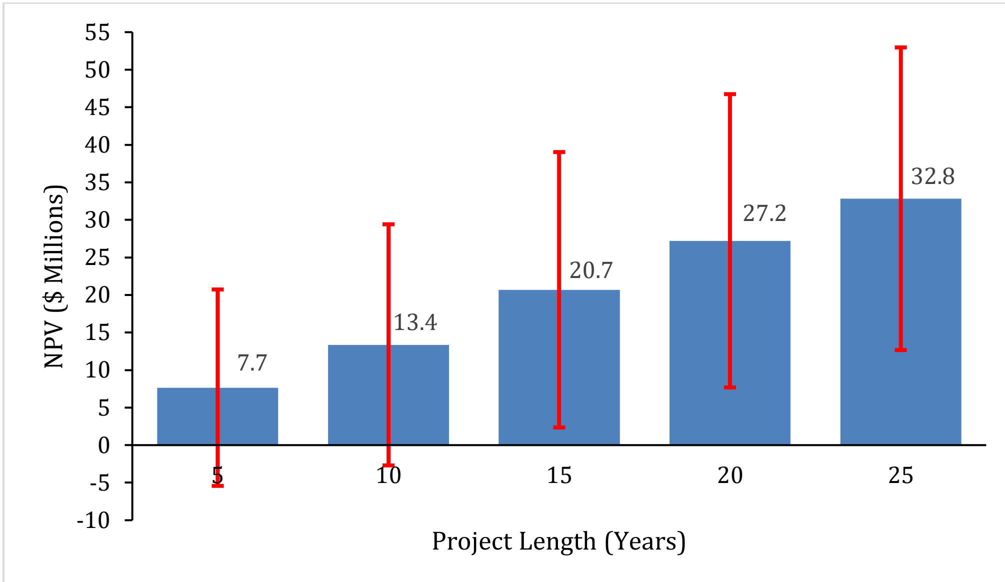


Figure 17 NPVs with STDevs for 100MW Virtual PPAs (PPA Price of $40/MWh)

Table 19 Sensitivity Analysis of PPA price and length on NPV

		5 Year VPPA		10 Year VPPA		15 Year VPPA		20 Year VPPA		25 Year VPPA	
		NPV	ST Dev	NPV	ST Dev	NPV	ST Dev	NPV	ST Dev	NPV	ST Dev
PPA Price ($/MWh)	30	$25,707,643	$13,365,966	$43,730,056	$16,439,334	$64,624,060	$18,378,675	$82,734,008	$19,527,834	$98,455,086	$20,266,362
	35	$16,689,988	$13,113,796	$28,547,605	$16,247,980	$42,959,892	$18,457,069	$55,186,623	$19,723,825	$65,645,183	$20,396,307
	40	$7,650,817	$13,078,645	$13,354,467	$16,057,143	$20,690,316	$18,336,364	$27,210,086	$19,533,624	$32,813,331	$20,150,332
	45	($797,336)	$13,187,629	($1,447,589)	$16,308,113	($858,339)	$18,598,254	($441,756)	$19,697,974	($89,796)	$20,293,189
	50	($9,878,291)	$13,022,316	($16,623,067)	$16,174,073	($22,881,972)	$18,359,212	($28,366,767)	$19,573,236	($33,128,307)	$20,316,481

3.7 VPPA Risks

The VPPA has numerous risks associated with it to the off-taker. Meijer must understand these risks and take the necessary mitigation measures. Table 20 shows the primary market risks associated with the VPPA to the off-taker and ways for Meijer to mitigate those risks as identified by the BRC (Business Renewables Center, n.d.).

Table 20 VPPA Risks and Mitigation

Risk Type	Description	Mitigation
Price Risk	Wholesale market price drops below PPA Price, creating PPA loss	1 - Accept risk with justification of price hedging concept 2 - Negotiate a price floor with developer
Basis Risk	Wholesale market fluctuates differently than the utility electric prices due to different geographies or timing	1 – Plan for long term correlation (annual/monthly correlation) rather than short term (daily/weekly)
Congestion Risk	Physical limitations of transmission lines constrain the amount of electricity that can be transmitted	1 – Typically a risk accepted by the power producer 2 – Negotiate a wholesale market floor at which the producer must stop generating
Curtailment Risk	Grid operator forces the wind farm to stop generating or generate less typically due to supply for exceeding demand	1 – Negotiate that producer gets no payment upon curtailment 2 – Share the risk by allowing the seller a set number of curtailment hours
Market Changes	Wholesale market faces structural changes likely due to regulation changes or shifts of geographic coverages	1 – Include a contractual clause that upon market changes, buyer and producer meet to renegotiate
Credit Risk	Producer or other buyer partners cannot fulfill their financial obligations	1 – Seller provides an unlimited liability parent guaranty to financially back the PPA

3.8 Implementation Strategy

1) Build Team: The first step is to identify internal stakeholders and build the appropriate team. A PPA is a long term multi-million-dollar investment that will displace a large portion of Meijer's electricity with renewable electricity. All appropriate internal stakeholders needed to make such a deal take place will need to be represented and must have the appropriate understanding and skill set.
2) Learn: There may be a learning curve in fully understanding a PPA. Senior leadership may not be familiar with the benefits of a PPA, and the team structuring the deal may not be

familiar with the numerous intricacies. Appropriate time may be needed to build the knowledge base. Consider hiring external help for the first project.

3) Network: Through organizations such as the BRC, Meijer can connect with potential developers and other potential off-takers. This will help bridge any level knowledge gap as organizations are generally willing to share lessons learned. Meijer can also meet future potential developers and partners to help build that relationship.
4) Confirm and Commit to Goals: Once the team becomes more familiar with PPAs, Meijer should reconfirm renewable energy goals set previously and commit to obtaining those goals. Meijer will need to identify the level of risk it is willing to accept, the value it places on the non-economic benefits and externalities, and the value of hedging electricity prices. If goals change, Meijer may decide to adjust its renewable energy strategy to additional or less on-site or off-site options.
5) Identify Best PPA Model(s): This report recommends the VPPA for Meijer, but other models could be viable options for Meijer. If Meijer is willing to pay a premium above its utility electricity rates, green purchasing options from its utility companies could be viable options. Additionally, in states that are deregulated at the retail level, Meijer could decide to use a physical PPA if they are willing to take ownership of the electricity.
6) Shop for Potential PPAs: As a potential buyer in a PPA, Meijer can shop for projects from numerous different developers. Meijer should identify projects that have favorable PPA prices. If the terms are not sufficient, Meijer should explore other options.
7) Build Financial Model and Understand Threshold for Investment: A financial model will be necessary to project cash flows and NPV. As shown previously, the wholesale electricity market is very volatile. That volatility should be considered. The benefits of the PPA will need to be sufficiently communicated to the decision maker at Meijer, and hence, specific metrics and thresholds for investments should be identified beforehand.
8) Negotiate PPA Terms: Contract negotiation is important since a PPA could span over decades. Meijer's legal team will need to be actively involved. Items such as selling of the electricity and handling of the RECs can be negotiated.
9) Gain Approval and Finalize Deal: After the contract has been negotiated, Meijer will need final approval from various stakeholders. They should also figure out how they want to internally treat the revenue from the PPA and externally how to properly promote the deal to the public. Once the project is underway, Meijer should verify that it is being run in accordance to the terms of the contract.

Chapter 5 Pre-Development Guide

1 Introduction

From the on-site and off-site generation strategies, the project selection priority is well-established quantitatively. Projects are ranked according to economic attractiveness to maximize the overall benefits. However, some qualitative measures that require additional site-specific analysis have not been considered and could lead to developmental barriers. These potential barriers could prevent the project from being developed or reduce the overall benefits. To reduce the chance of unnecessary development costs or investments into initial site identification expenses, a pre-development guide is proposed.

1.1 Objective

The intent of the pre-development guide is to validate the chosen projects from the on-site and off-site generation strategies. By going through a pre-development checklist, potential problems can be identified earlier and help avoid Meijer investing in the early stages of a project that may not be able to be completed. Additionally, the project manager will be equipped with the necessary knowledge to efficiently facilitate the development.

1.2 Overview

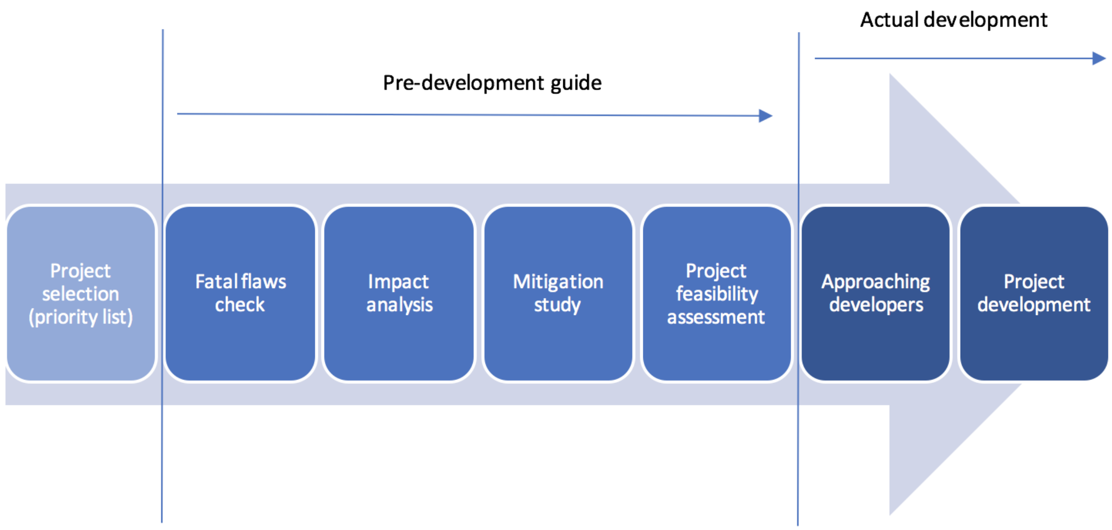


Figure 18 Overview of the Pre-Development Guide

After a project is chosen from either the on-site or off-site generation strategy, it will go through the pre-development guide to be validated as shown in Figure 18. A list of 82 questions is proposed for the on-site pre-development guide and a list of 36 questions is proposed for the off-site guide to form the fundamental check-lists for project validation. The questions are categorized into seven categories using the NREL SROPTTC framework (Site, Resources, Off-take, Permit, Technology, Team, and Capital) (Springer 2013) for renewable project development. The questions were developed based on the Large-Scale Renewable Energy Guide, written by the U.S. Department of Energy (US DOE 2013).

The checklist for the selected project will be circulated at Meijer to various stakeholders. The stakeholders will answer the questions related to their sector of expertise. Then they will decide if the problem exists for this particular project. If problems are identified on a project, the responsible stakeholder will evaluate the impact of the problems accordingly. There are six types of impacts considered in the guide (Cost, Time, Capacity, Engineering Obstacles, Soft Value and Return on Investment). The stakeholders will propose the potential mitigation method from their experience and decide if the project is still feasible to execute given the potential cost of the solution and potential degrade of the project due to the problem. The impact evaluation and mitigation will be iterative until the best remedial measure has been found. After completing the validation process, the accountable person will give a rating to the question of either Green, Yellow, or Red according to the seriousness of the problem, with Red being insurmountable.

The validation exercise will continue until all the questions are addressed. An overall rating will be determined, which will serve as an indicator of whether the project is practical to develop. Only by considering both the quantitative economic metrics and the qualitative developmental issues, can a project be approved for further investment to transition from idea to reality.

2 Development Process

There are several elements to consider when building up the pre-development guide from the user's perspective, as shown in Figure 19. In conducting the fatal flaws check, the first step will be to decide which questions best identify potential problems. After structuring the questions, the next step is to identify the appropriate stakeholder to assign accountability for the analysis.

Finally, to understand project feasibility, a grading system is necessary at the end of the evaluation.

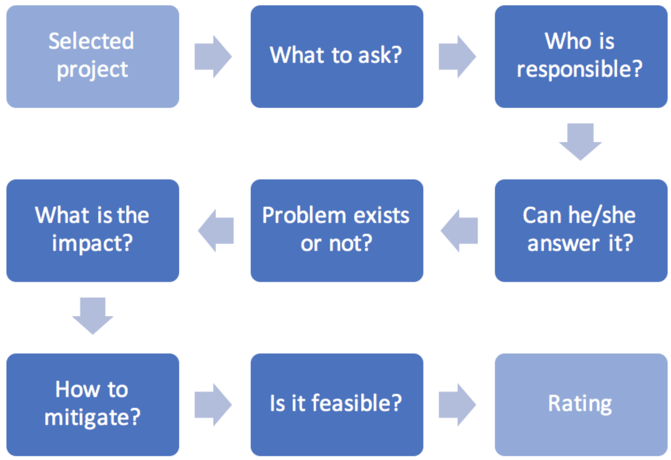


Figure 19 Development process for the Pre-development guide

2.1 Framework

The pre-development guide is created using the SROPTTC framework developed by NREL which highlights the development processes and activities each renewable energy project should undergo. A well-established, repeatable, and disciplined process for project development that is consistent with professional commercial practices is necessary for the success of any renewable energy project. The SROPTTC framework (Table 21) consists of seven essential areas that guide the creation of questions - **S**ite, **R**esource, **O**ff-take, **P**ermits, **T**echnology, **T**eam, and **C**apital.

Table 21 SROPTTC framework (US DOE 2013)

Elements	Description
Site	The site category is focused on obtaining the legal access to a location with appropriate characteristics for a renewable energy project, which is necessary to start the development process. A well-established site control can help Meijer recover the investment cost made during the development process. It is also a key ingredient to project feasibility as it helps to warrant the investments required to fully develop other elements.
Resources	The resources category is focused on the renewable resource. Developing the understanding of the quality and quantity of the resource potential at a site using general characterization, mapping, and refined engineering data can help to forecast the electricity output. It also helps to qualify the project and provides confidence for investment.
Off-take	The off-take category, mostly relevant in PPAs, is focused on everything necessary to achieve a long-term contract with the developer to purchase or sell the output of a renewable energy project and get the benefit. A successful off-take agreement consists both economic and regulatory factors. Electricity selling, ancillary services, and RECs are economic examples of revenue streams that connect different roles in the electricity market to the off-taker. State laws, RPS, and incentives are the regulatory considerations for setting up the agreement. Reviewing these at an earlier stage can improve the chance of accomplishing the most beneficial contract terms for Meijer.
Permit	The permit category is focused on identifying the required permitting before construction begins. It includes many potential approvals, permitting actions, or processes that may stop the project if not achieved. The scope ranges include local, state, and federal levels.
Technology	The technology category is focused on addressing the selected technology for the project and the process of designing and engineering all necessary facilities. It includes risk evaluation, performance assessment, and equipment procuring considerations in both short and long-term timeframes.
Team	The team category is focused on forming the project team tasked with executing the renewable energy project. The expertise of many professionals will be required at different points in the project. A team member is defined as the stakeholder who has a key role in contributing to the success of the project.
Capital	The capital category is focused on how to transit the financial resources to the project smoothly and successfully but not the funding itself. At this stage, all categories of development are completed and the unknowns are eliminated. The investment is likely to be approved for the project, so this category emphasizes the cash flow.

2.2 Platform

To create an applicable and realistic platform for the pre-development tool, convenience, efficiency, and user-friendliness are considered. As the guide will be circulated around Meijer for various stakeholders to fill out, an electronic version is preferred than a paper copy. Besides, excel format is suggested because the formula function can help to provide necessary follow-up, extra-guidance and statistic results. Excel is also preferred than other programming languages because of the user-friendliness in a business environment. Therefore, an excel based pre-development guide is proposed.

2.3 Metrics

Table 22 Metrics of the Pre-development guide

Metric	Description
Site Attributes	The site attribute is specific to the "Site" section from the on-site pre-development guide. It defines the categories of 25 questions and groups them accordingly. A sub-classification here is helpful because the question variation is large for "Site". It includes access, physical characteristic, and technical interconnection issues.
Accountability	The accountability section assigns accountability of the questions to the appropriate stakeholders. It also helps to provide a contact when a specific issue must be reviewed in the future during the development stage.
Check List	**On-site**
	The on-site checklist provides all of the necessary questions to evaluate a specific chosen store for on-site solar power development. There are 82 questions proposed based on six areas from SROPTTC (Site, Resources, Permit, Technology, Team, and Capital) that validate the site from the different necessary perspectives.
	Off-site
	The off-site checklist focuses on questioning everything necessary to achieve a long-term and off-site contract in wind power procurement. There are 36 questions proposed based on only one area from SROPTTC (Off-take) that represents all essential knowledge to create a virtual power purchase agreement.
Status	The status represents the progress and capability of the accountable person in answering the question. When the stakeholder receives the guide, he/she may not be able to answer certain questions immediately. He/she may have to conduct further research or identify another person who has the answer. Therefore, under the status column, "Completed" and "Pending" are available options.
Y/N	The Y/N section provides the area for a responsible stakeholder to decide if the problem exists in this project. Under the Y/N column, "Y", and "N" are available to choose.

Impact	If the problem exists in a project, the decision maker will evaluate the impact associated. There are six impacts (Cost, Time, Capacity, Engineering Obstacles, Soft Value, and Return of Interest) proposed, which provide a holistic review from Meijer's perspective on an engineering project. A high-level direction of impact (Increase, Unchanged, or Decrease) will be assigned by the stakeholders to facilitate their thought process in giving an overall rating on the problem. The impact section also provides a value in reviewing during the development stage.
Mitigation Method	The mitigation section provides the area for a responsible stakeholder to think about any possible mitigation methods towards the problem. The completed impact evaluation will provide a direction for the stakeholder to consider the remedial measure with respect to the problem. The exercise between impact evaluation and mitigation development is expected to be an iterative loop to facilitate the judgment of the rating.
Feasibility	The feasibility section aims to verify if the mitigation method proposed by the stakeholder is feasible and realistic to be carried out. Sometimes the mitigation measure may involve a large extra cost and lengthen the development process. Under the feasibility column, "High", and "Low" are available to choose.
Rating	**Green (G)**
	The green rating represents the project is good to go with that problem on the checklist. The stakeholder will choose "G" under two scenarios:
	The problem does not exist in this project.
	After the impact and mitigation exercise, he/ she thinks the issue is unimportant and it can be easily solved without incurring significant additional cost and effort.
	Yellow (Y)
	The yellow rating represents the problem is serious but still solvable. After the impact evaluation and feasibility exercise, if the stakeholder thinks the remedial measure will further increase the impact considered (e.g. Cost and Time), he/ she will give a "Y". The decision maker must be careful that he/ she is willing to afford the extra cost, labor, or time.
	Red (R)
	The red rating represents the problem is unsolvable and will directly shut down the development. The stakeholder will choose "R" under two scenarios:
	The problem does not have any mitigation measures
	After the impact and mitigation exercise, he/ she thinks the solution will involve an extra unaffordable cost, labor, or unacceptable delay.

2.4 Impact

To better understand the potential impact towards the project, an example is used for illustration. We assume that an on-site solar project with a high net present value (NPV) on the outlot area of a Meijer store is identified to have a wetland.

Table 23 Impact

Impact	Direction	Description
Cost	Increase/ Unchanged/ Decrease	The impact on cost is defined as the potential changes in initial capital cost, operation, and maintenance cost in developing a renewable energy project. E.g. To develop a ground solar system on a wetland, a mitigation plan during and after construction is necessary. Extra permission application and the employment of light machinery instead of heavy will increase the capital cost of the project.
Time		The impact on time is defined as the potential changes on the overall time required to commission the project. E.g. For a wetland solar project, the mitigation required will increase the permit application and approval time, construction time, and maintenance time.
Capacity		The impact on capacity is defined as the potential changes on the renewable energy system size in watt. E.g. In order to maintain healthy vegetation on the wetland, the space of panels has to be larger than the traditional ground solar system for the hydrology to best fit natural conditions (Mason et al. 2016). Within a limited available area, the overall system capacity will thus be reduced.
Engineering Obstacles		The impact on engineering obstacles is defined as the changes in technical complexity in logistic, construction, and operation of the renewable infrastructure. E.g. For a wetland solar project, the equipment logistic will become more complicated due to the physical nature of the area. Also, the employment of heavy machines like dozers and cranes will be limited for minimizing the damages to the wetland. These will increase the engineering difficulty to put the system in place and function properly.
Soft Value		The impact on soft value is defined as the changes in the satisfaction and relationship between Meijer

		and various stakeholders. It includes business partners, employees, and customers. E.g. For a wetland solar project, it can improve Meijer's image in committing in sustainability but at the same time, it will lead to damage to a valuable natural habitat. Therefore, the overall change in soft value is assumed to be unchanged.
Return on Investment (ROI)		The return on investment (ROI) is defined as a performance measure to evaluate the efficiency of an investment in the renewable energy project. It is calculated by dividing the benefits by the cost. E.g. For a wetland project, the cost will be increased. At the same time, the benefit from the system per acre will be less because of the reduced capacity. Therefore, the return of investment will be lower compared with the traditional ground solar project.

2.5 Reviewing

The pre-development guide is designed according to the preference of the actual user at Meijer. Therefore, obtaining feedback from relevant stakeholders to this project and the actual user is important to finishing and publishing. The guide is circulated to the project advisor Prof. Greg Keoleian, the project partner Michael Elchinger from NREL, and the project manager Jason Flanigan from Meijer to get varying opinions on the improvement for metrics, content, and format. The review will help to make the finalized guide more readable, consistent, and applicable.

2.6 Formatting

The pre-development guide is designed to be an excel based tool. There are nine tabs for the on-site guide and three tabs for the off-site guide. The common tabs for both are the Introduction and the Summary Dashboard. The Introduction will be a general user guide with a demonstration to navigate various stakeholders to fill the tool. The Summary Dashboard consists of a summary table on the percentage of "G", "Y", and "R" and the progress of each section and the project as a whole. There is also a table to show all the "R" problems for further review among stakeholders and as a reference for the decision maker.

For the on-site pre-development guide, there are six tabs that consist of the checklists in Site, Permit, Resource, Team, Technology, and Capital respectively according to the SPROTTC framework. There is also an extra Follow-up tab to show all of the pending problems. If a question from the checklist is answered with "Pending" under the Status column, it will appear in the Follow-up tab for the sake of convenience that the stakeholder can come back to later.

For the off-site pre-development guide, there is an “Off-take” tab which is the checklist for virtual PPA project according to SPROTTC framework.

3 Results

3.1 Description

Table 24 The actual table of the Pre-development guide

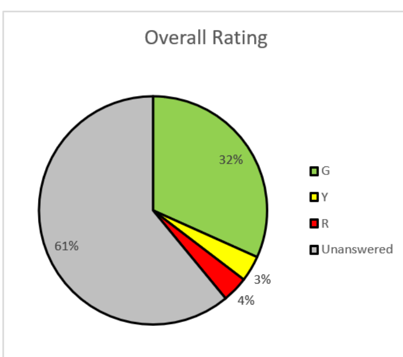
Accountability	Check List	Status	Y/N	Impact						Mitigation Method	Feasibility	Rating
				Cost	Time	Capacity	Engineering Obstacles	Soft Value	ROI			
Mapping team	E.g. Is there any wetland in the outlot area?	Answerable	Y	Increase	Increase	Decrease	Increase	Unchanged	Decrease	Extra permission is required; Construction mitigation plan has to be approved; Post-decommission restoration plan has to be approved	Low	Y

The checklist is shown in Table 24. with a completed demonstration of wetland solar problem. A yellow rating is being graded on this question. It contains all the necessary information for review in the future during development if the project manager decides to return to it.

Table 25 Summary Dashboard table

Summary Dashboard					
	Progress (%)	G	Y	R	Unanswered
Site	48%	10	1	1	13
Permit	86%	5	1	0	1
Resource	6%	0	0	1	15
Team	100%	8	0	0	0
Capital	0%	0	0	0	9
Technology	29%	3	1	1	12
Overal Evaluation	-	26	3	3	50
Overal Rating	**39.02%**	**32%**	**4%**	**4%**	**61%**

Overall Answered Rating	G	Y	R
Overall Answered Rating	**81%**	**9%**	**9%**



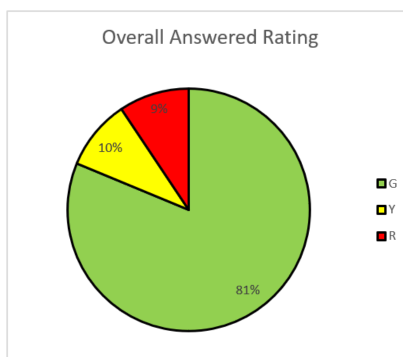


Figure 20 Rating in pie chart

The summary dashboard is shown in Table 25 with a demonstration. The focus is on the percentage of progress and each of the three ratings. It provides a quick reference for the decision maker. The pie charts in Figure 20 are a quick indicator of the project feasibility. A high quality and feasible project should consist of almost all “G”s, with a minimal amount of “Y”s and no “R”s.

3.2 User guide

In each section, the accountable stakeholder will complete the tool from left to right. If the accountable person can answer the question immediately, then a "Completed" will be added in Status column. If more research is needed, “Pending” will be chosen. If the project has the problem asked, a Y will be completed in the "Y/N" block and the person will proceed to the left column. If not, proceed to the next question.

For a "Y" question, the stakeholder will evaluate the impact (Increase/unchanged/decrease) on six major elements (Cost, Time, Capacity, Engineering Obstacles, Soft Value and Return of Interest). The user will then proceed to look for mitigation measures and evaluate the feasibility of the identified mitigation solution. Finally, there is a rating column for evaluating the seriousness of the problem. Green (G) represents unimportant, Yellow(Y) represents a serious but solvable issue, and Red(R) represents a problem that will halt the project directly. After completing the guide for a project, the user may return to the summary dashboard to view the overall score of the project for making a to-go or not-to-go decision.

3.3 Recommendation

The pre-development guide is designed to use before the actual development stage of the project takes place. The team recommends picking a few high-quality projects from the priority list for using the guide the first time and reserve about a month for completion. Relevant stakeholders can evaluate multiple projects at once to facilitate the project validation process. Initial ratings from the first-round results can be a benchmark on project quality and feasibility. The ultimate decision maker at Meijer will then be able to choose a highly economic and feasible project according to the overall rating to take to a developer and make the renewable energy project successful.

There is flexibility for future improvement on the pre-development guide. After the completion of the first round of renewable energy projects at Meijer, the team members who are accountable for different SPROTTC sections in the guide will better understand what questions are critical to the project and adjust accordingly. The quantity of questions may be too large (82 for On-site and 32 for Off-site), which will take a large portion of time to complete. Additionally, there may be more questions for Meijer to add that may be identified after the first iteration. The pre-development guide can be a live document that can be edited for improvements to make it more efficient, applicable, and realistic.

Chapter 6 Conclusions

Renewable energy is not new at Meijer, the first project was completed in 2009. However, without a holistic strategy and systematic approach to renewable energy integration, individual projects are difficult to launch. Therefore, the SEAS team was tasked with establishing a renewable energy strategy, proposing an appropriate goal, and creating a pre-development guide. The following is a summary of key findings and recommendations.

1 Meijer's Renewable Energy Motivation

1) Reduce Carbon Footprint

Meijer has seen success with their energy efficiency improvement. Although Meijer added new facilities that accounted for a 4.4% increase in total square footage from 2014 to 2015, the total carbon emissions decreased by 0.1% (Skill 2016). However, even further projected expansion creates a need for energy transition to further control and reduce carbon emissions.

2) Enhance Cost Resiliency

In 2015, natural gas made up 42% of Meijer's energy portfolio. According to EIA forecasts, the natural gas price is projected to increase 35% by 2030 (US EIA 2018) and Meijer will be expected to experience an increase in electricity prices with such a large portion of natural gas in their portfolio. To diversify the risk of electricity costs, Meijer should explore other energy sources.

3) Align with Industry Leaders

From benchmarking results, Target and Walmart have been leading the renewable energy development in the grocery retail industry with 147.5MW and 145MW installed solar capacity in 2016 respectively (Mearian 2015). Both retailers recognized that renewable energy is good for the community and envision it as a key for efficient and sustainable company expansion to meet the rising retail demand (Walmart 2014). In 2015, only 2% of the energy consumed by Meijer was generated from renewable energy. Accordingly, Meijer decided to explore renewable energy for current stores, in remodeling, and with future expansions.

2 Meijer's Renewable Energy Goal

The SEAS team is proposing a renewable energy goal to Meijer consisting of 20% on-site solar generation and 80% off-site wind procurement. The exact goal is sensitive to Meijer and not available to the public at this time.

The renewable energy goal is proposed based on three major elements:

1) Innovation

Innovation in technology and finance will help to diversify the renewable portfolio and maximize the benefit to Meijer. On-site solar generation provides a unique value of reducing the electrical load at the installed location and offers marketing benefits around environmental claims. Off-site wind procurement helps to increase the renewable capacity without the physical constraints at its properties. It also has the value of hedging long-term electricity cost.

2) Feasibility

The goal comprises of a series of on-site solar projects and a single virtual wind PPA project. The on-site priority list is optimized according to Meijer's budget, which will be more susceptible to potential changes. However, the PPA project provides project size flexibility, which can compensate any loss of installed capacity from unchosen on-site solar projects.

3) Tractability

The proposed goal is based on Meijer's budget with no financing to minimize the risk and to be a tractable investor as a private company. From the cash-only on-site analysis model, on-site solar would be installed over the course of 17 years. If finance is considered, the total installed capacity would be increased due to the time value of money and the ability to invest in more projects faster. From the off-site analysis model, PPAs can range up to 200 MW in the commercial market. Bigger projects provide more benefits as factors related to economies of scale potentially help the developer reduce costs.

3 Overall Impact

1) Energy Cost

Upon completion of all on-site solar projects, the projects are expected to generate thousands of MWhs of electricity and save Meijer millions of dollars over a 25-year period. Also, by contracting a virtual wind PPA contract, Meijer is expected to hedge a large portion of their electricity costs, mitigating the risk of increasing electricity prices to Meijer's operations. The exact numbers have been redacted.

2) Carbon Footprint

This strategy and investment into renewable energy will reduce CO2 emissions by thousands of metric tons, reducing Meijer's carbon footprint. The exact numbers have been redacted.

3) Social Impact

Meijer will directly and indirectly help to advance the whole renewable industry with such a large investment in renewable energy suggested by the goal. It not only creates a healthy and positive outlook for the whole renewable sector in the retail industry, but it also has an intangible impact on job creations and community cohesion.

4) Branding

The addition of renewable energy and accomplishing a renewable energy goal is an impressive achievement and will further support Meijer's core value of committing to the community. The tangible health benefit and intangible green image will improve the shopping satisfaction for customers and working atmosphere for employees.

4 Additional Recommendations

1) On-site Generation Strategy

The by-year on-site solar priority list is built based on the assumed budget, finance, and policy. Therefore, the SEAS team also provides a general priority list as well in case any potential changes happen in the future. It emphasizes the site ranking to provide a more resilient strategy in site selection.

2) Off-site Procurement Strategy

Meijer is recommended to join BRC and explore potential partners to build a larger off-site project to maximize the benefit from the economics of scale. The electricity price hedge benefit can then be enlarged to virtually the entire company's electricity use.

3) Pre-development Guide

The pre-development guide provides the opportunity to conduct a feasibility assessment to every selected project to ensure the priority list is applicable and realistic. However, the SEAS team understands a large number of questions will take time for analysis. Therefore, we recommend for future renewable team at Meijer to continuously improve the guide through hands-on development experience. We expect the exercise will provide a more critical, flexible, and efficient guide to better address Meijer's needs.

4) Technology Options

On-site solar and off-site wind technologies are being considered in this project because of the current technology maturity and resource distribution. Nevertheless, other options are also recommended to be considered in the future due to rapid growth under policy facilitation and technology advancement. Solar storage, fuel cells, and biomass will become more economical in the commercial scale soon. Diversifying the renewable portfolio not only includes the benefit of energy resiliency to market and policy changes but also the captures various available incentives.

5) Investment Options

Direct ownership is being considered for on-site solar generations. The major benefit is that Meijer will be able to capture a bigger portion of each investment. Meijer is also recommended to consider on-site 3rd party ownership through PPA because of the following reasons:

a) The equipment would belong to the 3rd party, which would reduce the capital investment. Meijer would be able to invest in more projects and take advantage of the current incentives, which may not always be available.
b) The 3rd party will provide technical expertise for operation and maintenance services.
c) Having multiple projects with a single 3rd party provider can include benefits related to economics of scale and lower individual PPA prices.

6) Next Steps

Meijer is recommended to invest in renewable energy projects through strategic steps after completion of this project done by the SEAS team.

a) Refine the strategy through establishing new consensus among internal stakeholders after attending the presentations and reading this report.
b) Develop renewable energy business connections with external partners and organizations to obtain the actual market data and quotations and establish deals.
c) Pilot some top ranked projects in 2019, for example #XXX, to maximize the incentive benefits since the incentive will phase down after 2019.
d) Commit to the renewable energy goal through publishing it to create the accountability and positive reception for driving the success.
e) Revisit the strategy regularly to address the market and policy changes in the renewable energy industry.

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Appendices

Appendix 1 Stores' hourly electricity consumption analysis

The process to create complete one-year electricity consumption records for 224 stores are shown in Figure 21. Some visualized medium results are visualized as well to deepen understanding. Figure 22 shows the 81 stores' complete data by Meijer Region (Appendix 2) and store sizes, 90% of which are raw data. Each curve represents one stores. Figure 23 shows 226 stores' electricity load by Meijer Region and store size, 145 of which is estimated. Each curve represents one stores.

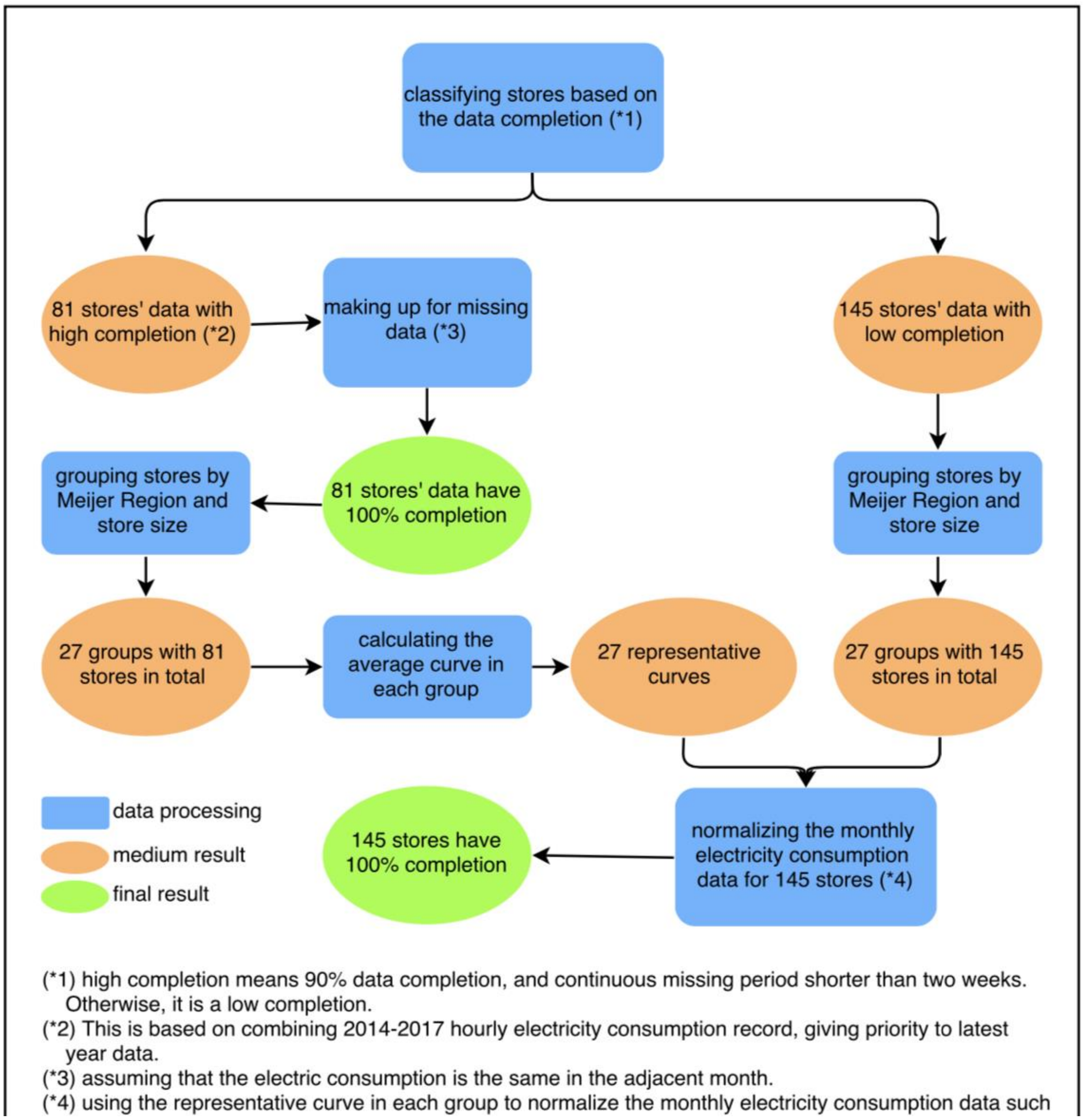


Figure 21 Stores' hourly electricity consumption analysis workflow

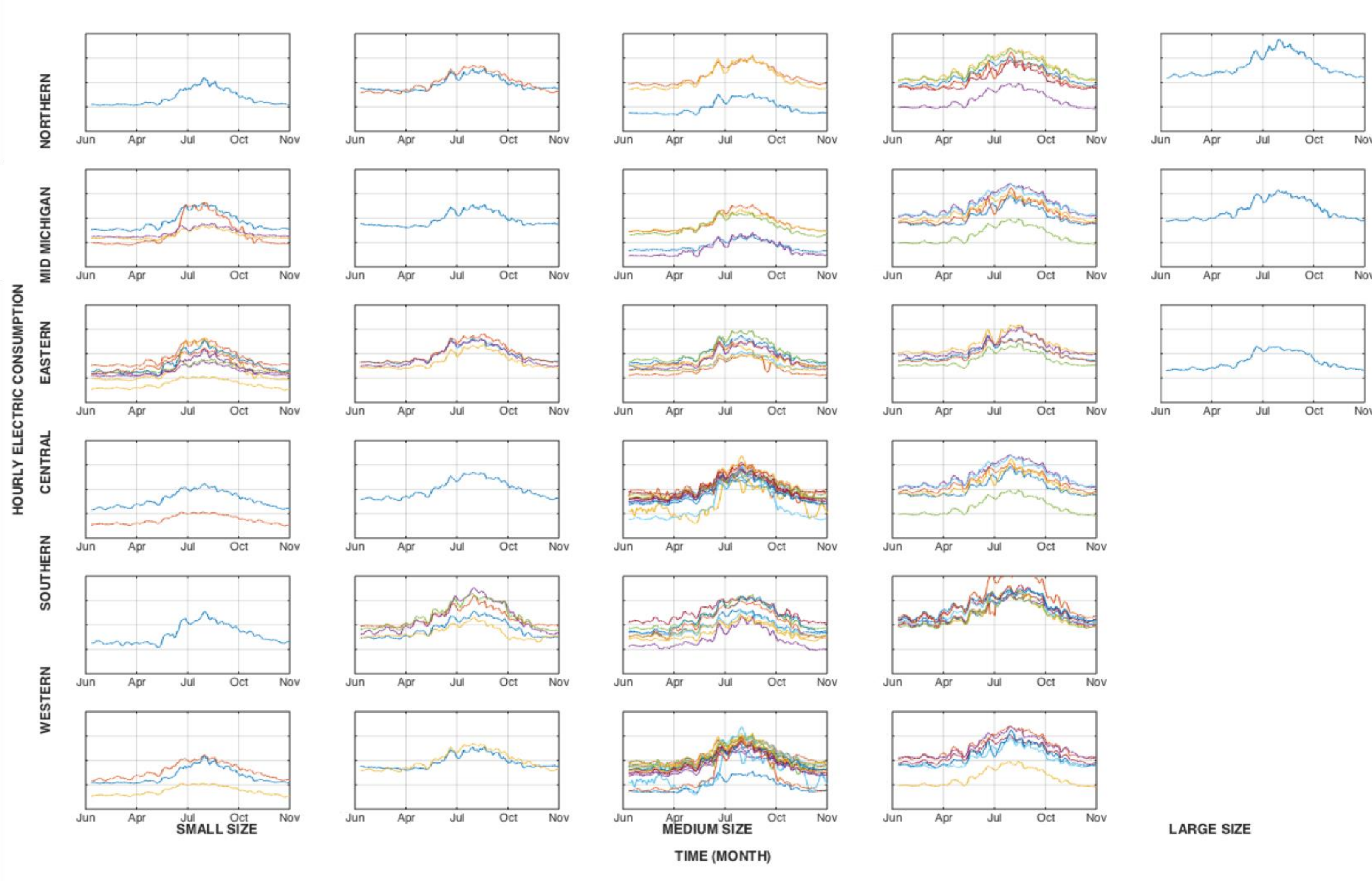


Figure 22 82 stores' complete annual electricity consumption

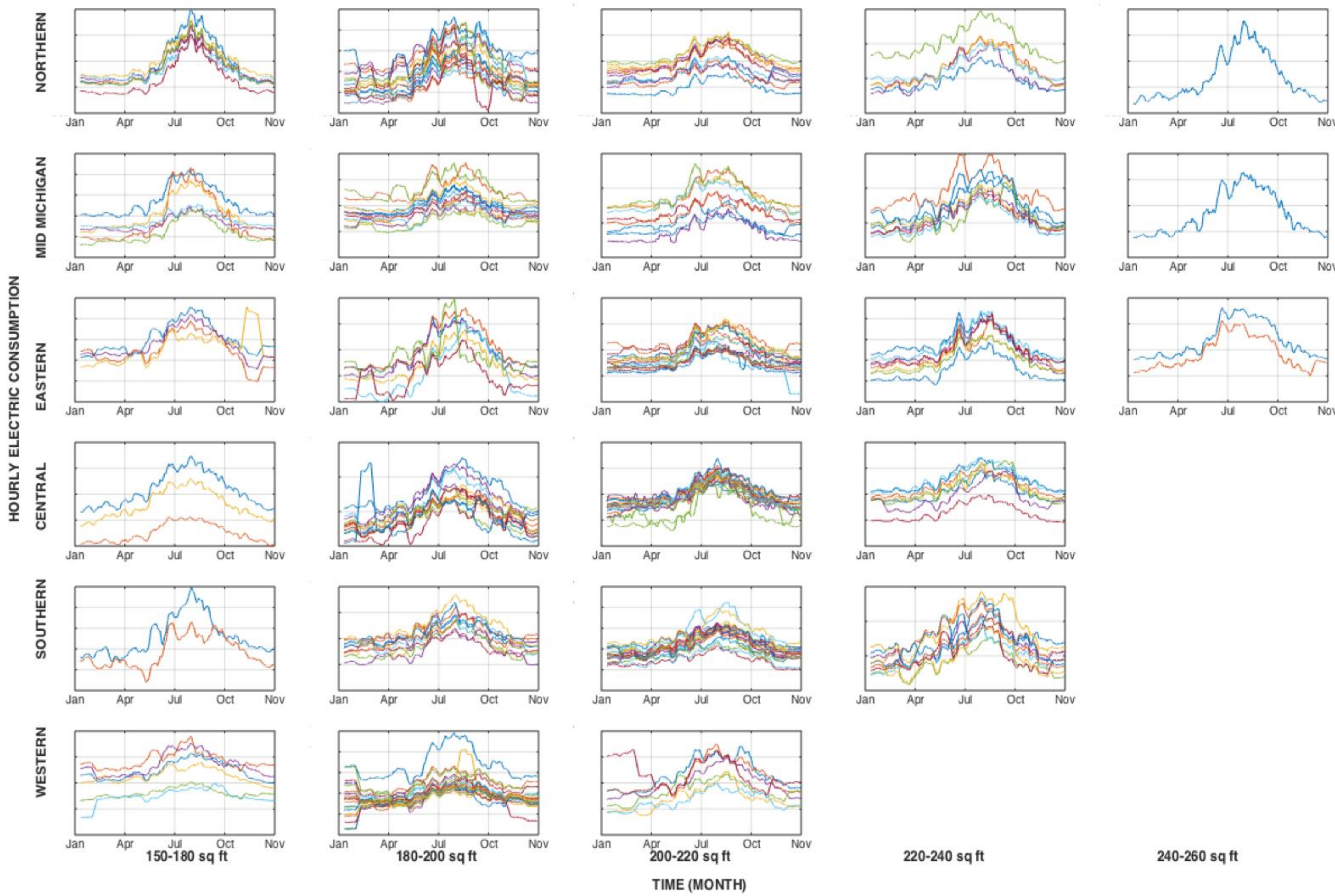
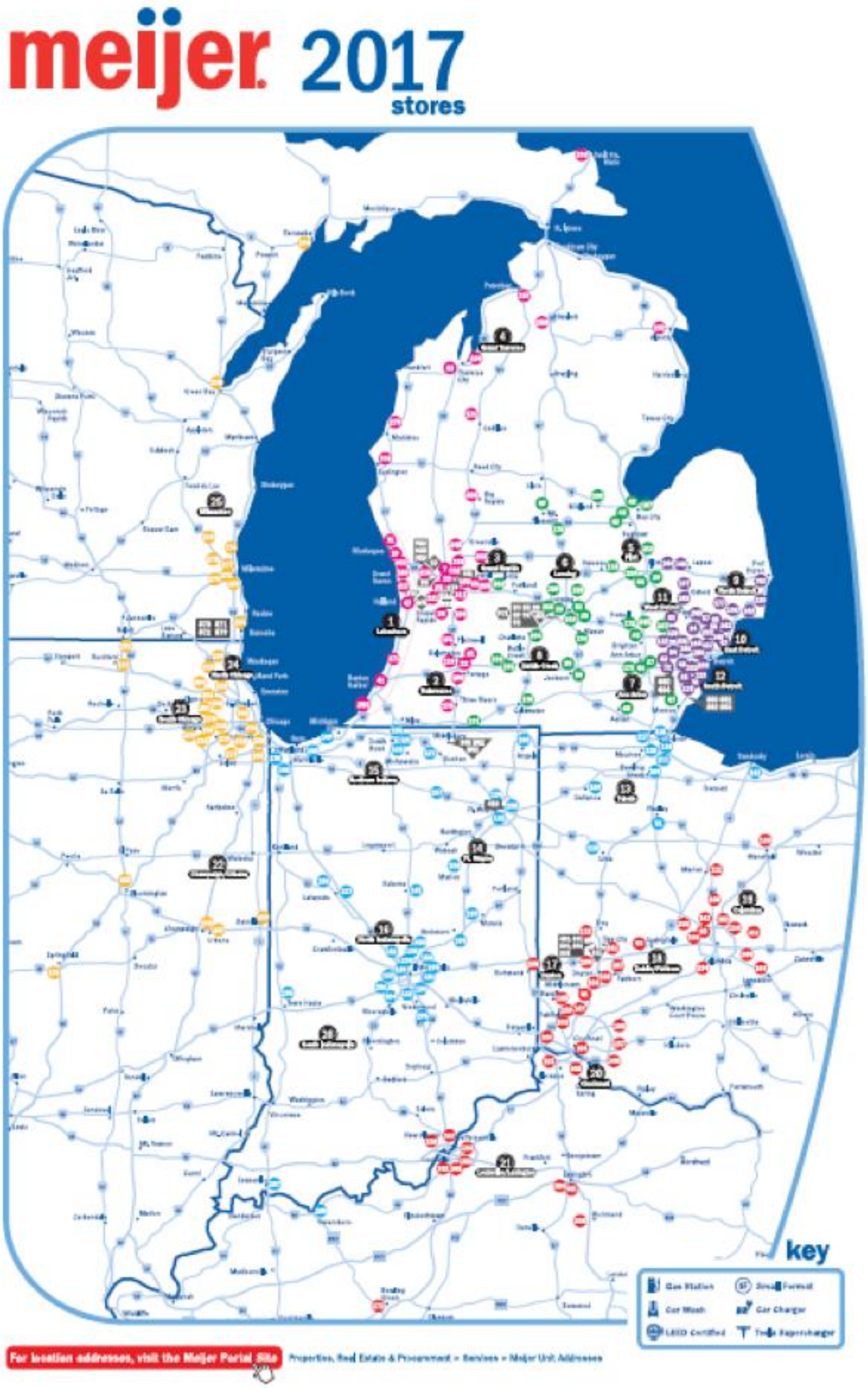


Figure 23 226 stores' complete annual electricity consumption

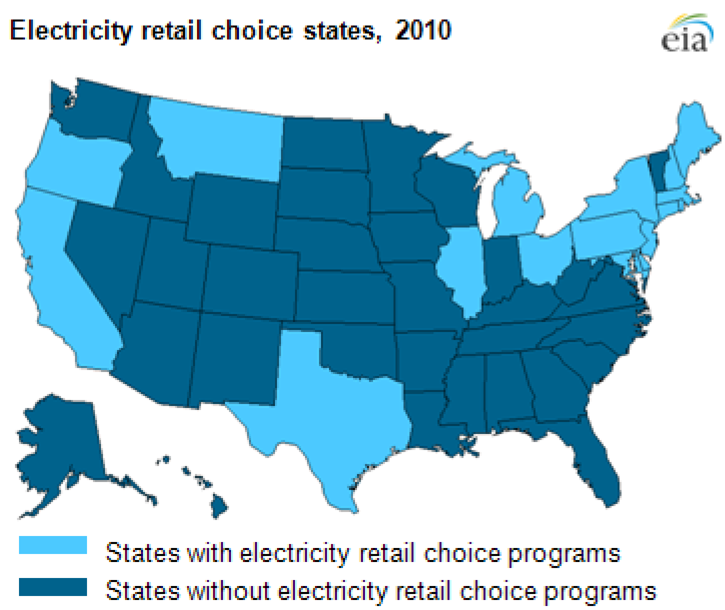
Appendix 2 Meijer Region and store locations



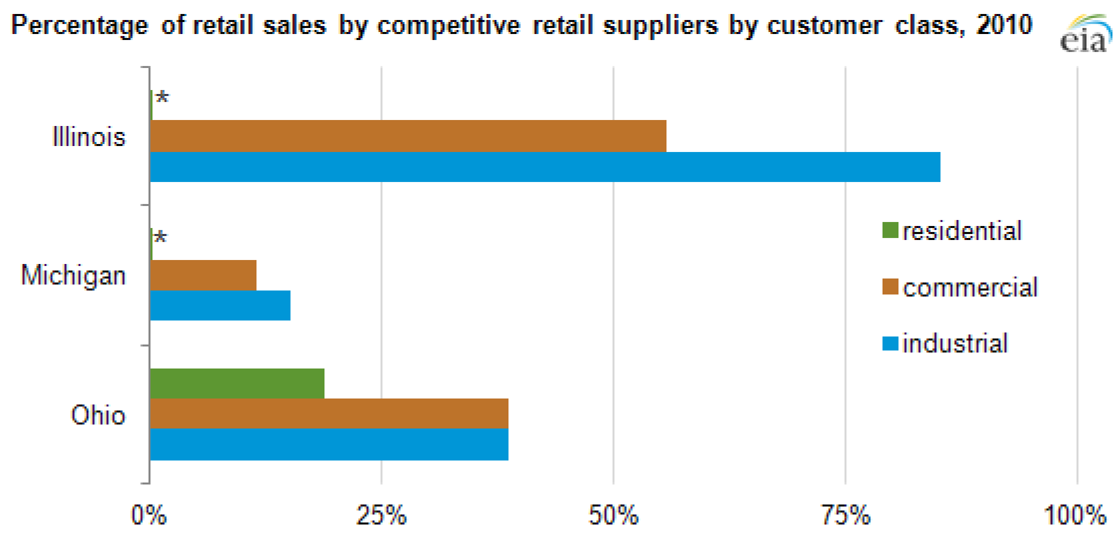
Appendix 3 Photovoltaic system design parameters designed by NREL

parameter	value
Module type	Standard
DC to AC ratio	1.2
Inverter efficiency (%)	96
Array type	Fixed open rack
Total system losses	14.08%
Degradation rate applying to the system's total annual AC output (%/year)	0.5

Appendix 4 Electricity retail choice states in US (US EIA 2012)



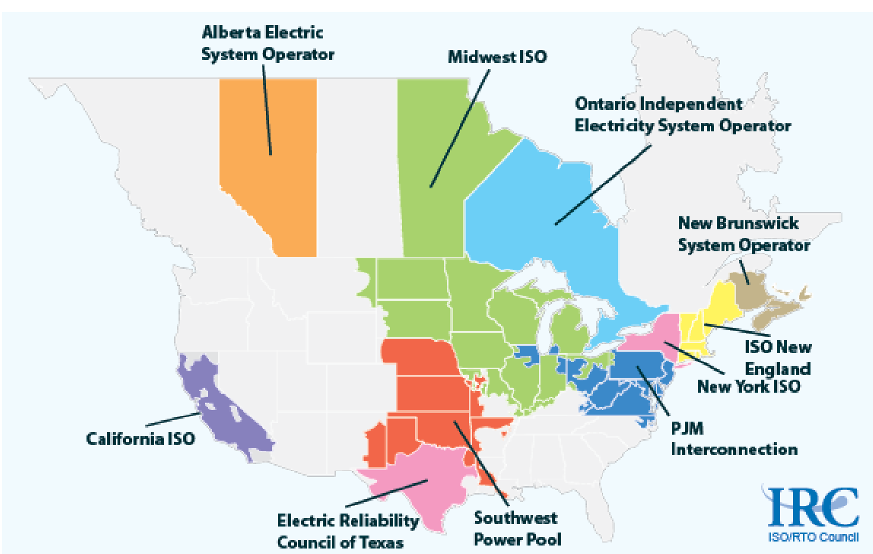
Appendix 5 Electricity retail sales in Midwest by customer class (US EIA 2010)



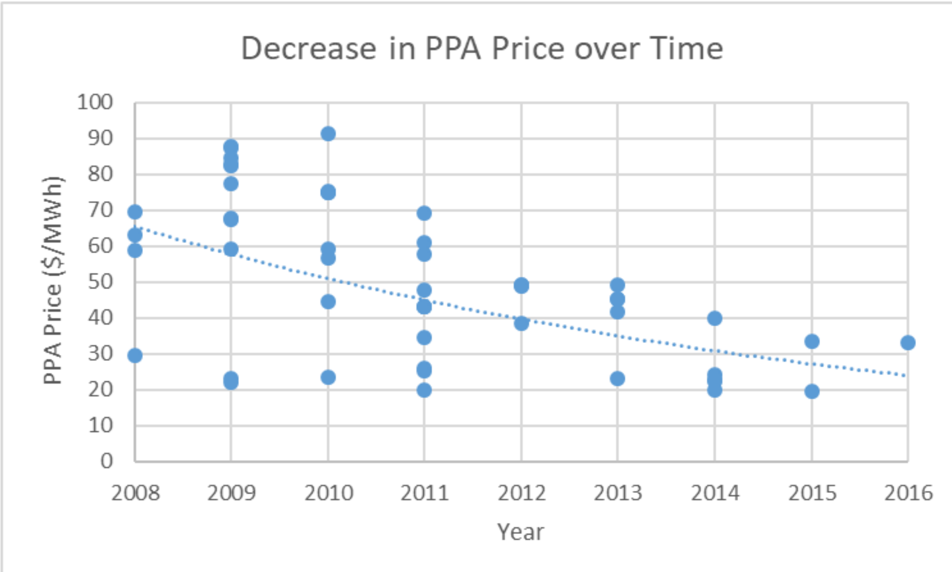
Source: U.S. Energy Information Administration.
Note: *Denotes less than 1% of sales in a customer class.

Midwestern States: Only three states in the Midwest have adopted retail choice programs. Illinois' industrial and commercial participation rates are among the highest in the country, at 85% and 56%, respectively. Ohio's residential sector participation rate at 19% is the third highest in the country after Connecticut and Texas (US EIA 2012).

Appendix 6 ISO/RTO map of US (US EIA 2012)



Appendix 7 Change in PPA price over time in states in which Meijer operates



Appendix 8 Electricity price hedging illustration table

	Electricity Price Scenarios			
	Low	**Medium**	**High**	
PPA Price ($/MWh)	$40	$40	$40	*Meijer pays to developer
Wholesale Price ($/MWh)	$20	$40	$60	*Meijer sells to market
PPA Net (Gain)/Loss	$20	$0	($20)	
Utility Energy Price ($/MWh)	$80	$100	$120	*Meijer pays utility
Net Price ($/MWh)	$100	$100	$100	

*Table based on BRC's illustration of the concept of cross-hedging electricity prices. It is for illustrative purposes only and the numbers are not based on actual data