EXHIBIT M:

Greenhouse Gas

Assessment

Nutmeg Solar Project

Enfield, Connecticut

Life Cycle Greenhouse Gas Assessment: Nutmeg Solar project

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Project Summary

The primary objective of this analysis was to determine the potential change in greenhouse gas (GHG) emissions to the atmosphere (in tonnes of CO_2e) that could result from the proposed Nutmeg Solar, LLC Project located in Enfield, Connecticut to be developed by NextEra Energy Resources (NEER). The proposed site for the solar installation is comprised of 26 acres of tobacco field, 10 acres of pumpkin and squash, and 95.3 acres of forest (89.9 acres of forest plus 5.4 acres of selective trimming) that has been previously cleared. The forest is not projected to be managed as a working forest at the time of this project.

The Nutmeg Solar project is being proposed as a means to add electricity generation capacity to the state's electricity grid from a renewable source, rather than adding generation capacity via conventional feedstocks such as natural gas. As such, the primary focus of this analysis was to model these two alternative means of adding capacity to determine the relative life cycle GHG emissions of each option and to quantify the potential GHG emission benefits of the Nutmeg Solar project.

To calculate the potential GHG benefits of this solar installation, we quantified the change in GHG emissions over the study period associated with: 1) leaving the existing agricultural land and forest at the site and adding conventional natural gas-based electricity generation capacity (using a combustion turbine) equivalent to the proposed project (baseline scenario); and 2) converting the agricultural land and forest to a solar panel installation to supply additional generation capacity (solar installation scenario). The difference between these two values is an estimate of the GHG reduction that the project can expect to achieve. The study period for this analysis was 20 years, which is the expected minimum service life of the solar installation.

The life cycle GHG emissions calculations for both scenarios were modeled in SimaPro LCA software (www.pre.nl) and the results were calculated using the 2013 IPCC 100 year Global Warming Potential method (IPCC, 2013). Details of the life cycle inventory (LCI) are summarized briefly in this report.

Solar Installation Scenario

Scenario Description

Under the solar installation scenario, it was assumed that 26 acres of tobacco field, 10 acres of squash and pumpkin field, and 95.3 acres of forest (5.4 acres of selective trimming plus 89.9 acres of forest) were cleared from the project site and that a 19.99 MW solar electricity generation array was installed for a 20-year period. It was estimated that the 19.99 MW solar array could produce approximately 39,000 MWh/year in year 1, with a reduction in energy output of 0.5% per year over the 20-year study period resulting in a total of 744,038 MWh over the life of the project (Knapp, 2017).

A portion of the wood biomass harvested from the forested area was assumed to be chipped into mulch (about 17%) and the remaining (about 83%) was assumed to be converted into firewood and burned.

As a result of the change in land use, from tobacco, squash and pumpkin fields to a solar installation, it is believed that the same volume of pumpkin and squash will be grown at an alternative site to meet the demand in the surrounding area of Connecticut. Since pumpkin and squash are bulky to transport, it is likely that an existing, nearby, unplanted farm will be used as the alternative site. The unplanted fallow land is assumed to have a vegetation cover comprising mostly of grasses. Due to declining demand for tobacco products, and a steady decrease of tobacco grown in the area (Laplante, 2018), it was assumed that the volume of tobacco grown on the Nutmeg site would be eliminated.

Scope of the GHG Emissions Assessment

The scope of the GHG emissions assessment for the solar installation scenario included the life cycle emissions associated with the solar technology, as well as the implications of changes to carbon stocks as a result of the land use change.

For the solar installation scenario, we quantified the following over the study period:

- Life cycle GHG emissions of manufacturing, transporting, installing, maintaining, and decommissioning key solar installation components, including the solar panels, inverters, and other infrastructure (e.g. mounting racks, wiring, mounting pads, etc.)
- Carbon emissions from harvested crop and forest biomass (including above-ground carbon, live below-ground carbon, and soil organic carbon)
- Carbon no longer sequestered from the atmosphere due to loss of crops and forest
- Life cycle GHG emissions associated with mechanical harvesting activities during site clearing
- Land use change due to displaced squash and pumpkin crops

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- Carbon emissions of transforming cleared trees into wood chips and firewood
- Carbon sequestration by approximately 208 trees and 1330 shrubs to be planted at the site

Life Cycle Inventory (LCI)

The LCI for the solar installation scenario is summarized in Table 1. More detailed raw data and calculations are provided in the accompanying spreadsheet (Appendix A).

Table 1: Life cycle inventory data sources for modeling the solar installation scenario.

Life Cycle Stage	Data Source	Notes
Manufacturing of solar panels	Ecoinvent 3.3 Database (Wernet, 2016)	Scaled up the Ecoinvent values from an open-ground solar installation with a lower capacity.
Manufacturing of inverters	Ecoinvent 3.3 Database (Wernet, 2016)	Scaled up the Ecoinvent values from an open-ground solar installation with a lower capacity.
Manufacturing of mounting systems	Ecoinvent 3.3 Database (Wernet, 2016)	Scaled up the Ecoinvent values from an open-ground solar installation with a lower capacity.
Manufacturing of fuse box, electric cables and electric meters	Ecoinvent 3.3 Database (Wernet, 2016)	Scaled up the Ecoinvent values from an open-ground solar installation with a lower capacity.
Installation of solar panels and infrastructure at the site	Ecoinvent 3.3 Database (Wernet, 2016)	Scaled up the Ecoinvent values from an open-ground solar installation with a lower capacity.
Maintenance (replacement of inverters once during service life)	Ecoinvent 3.3 Database (Wernet, 2016)	Scaled up the Ecoinvent values from an open-ground solar installation with a lower capacity.
Disposal of solar panels and infrastructure at end of life	Ecoinvent 3.3 Database (Wernet, 2016)	Scaled up the Ecoinvent values from an open-ground solar installation with a lower capacity.
Sequestration of forest carbon at the project site	(USFS, 2016)	Average carbon sequestration of Connecticut forests on an annual basis scaled to 95.3 acres
Below-ground forest carbon stock	(USFS, 2016)	Average of live below-ground carbon content and soil organic carbon content of Connecticut forests scaled to 95.3 acres
Above-ground forest carbon stock	(USFS, 2016)	Average above-ground carbon content of Connecticut forests scaled to 95.3 acres
Harvesting of trees during site clearing	Ecoinvent 3.3 Database (Wernet, 2016)	Modified USLCI process: *Roundwood {GLO}| harvest, primary forest | Alloc Rec, U*
Conversion of wood into firewood and burning	(Crawford, 2008)	Average CO_2 emissions from burning firewood
Wood chipper to transform cleared trees into mulch	Ecoinvent 3.3 Database (Wernet, 2016)	Wood chipping, chipper, mobile, diesel, at forest road {GLO}| market for | Alloc Rec, U

Carbon sequestration by 208 trees and 1330 shrubs at the site	(U.S. Department of Energy, 1998); (Gratani, 2013)	Carbon sequestration based on annual sequestration rate for urban trees obtained from USDOE, 1998. Annual carbon sequestration by shrubs obtained from Gratani et al., 2012.
Land use change impact from growing pumpkin and squash on nearby fallow land	(A.J. Franzluebbers, 2001); (Jones, 2004)	Based on soil carbon sequestration rate of Bermuda grass (following long term cropping) and perennial grasslands.
Land use change impact from growing pumpkin and squash on nearby fallow land	(Immaculada Oliveras, 2013); (Bethany A. Bradley, 2006)	Based on above ground biomass for grasslands.

Baseline Scenario

Scenario Description

Under the baseline scenario, it was assumed that additional electricity generation capacity is added to the state grid by increasing natural gas generation over the 20-year study period by 744,038 MWh (equivalent to the total output of the solar installation scenario). Retirement of fossil fue-based generators and growth of renewables is expected in the future but is not captured in this analysis.

It was assumed that the forest, pumpkin and squash crops on the proposed Nutmeg Solar site were left as they are, and that there will be no forest or agricultural management plan for the site during the 20-year study period. Due to declining demand to tobacco products, and a decrease of tobacco grown in the area (Laplante, 2018), it was assumed that the volume of tobacco grown on the Nutmeg site would be eliminated. Sequestration by the forest and crops were not considered, as they are included as emissions in the solar scenario.

Life Cycle Inventory

The life cycle inventory data for natural gas are obtained from the DataSmart library (LTS, 2016), that includes the most up-to-date and detailed LCI data on natural gas production in the U.S. These data include all the production steps from natural gas extraction and processing to combustion in power plant (simple cycle combustion turbine). GHG emissions for combustion in a power plant are based on EPA's emission factors (EPA, 2016) and the upstream extraction and processing data is based on published sources, such as Skone et al., 2011 and Clark et al., 2011. These data include a conventional and shale gas mix of 54% and 46%, respectively (U.S.EIA, 2015). Sensitivity of the results to this data source is tested by considering harmonized median values provided by the National Renewable Energy Laboratory's (NREL) (O'Donoughue et al., 2014).

Results

Solar Installation Scenario Results

The results of the GHG emissions assessment for the solar installation scenario are summarized in Table 2 and Figure 1. These results show total GHG emissions across the full 20-year life of the project expressed in tonnes of CO_2e.

Table 2: Life cycle greenhouse gas emissions for the solar installation scenario for generation of 744,038 MWh of electricity over 20 years, including contribution analysis for the key sources of GHG emissions in the project life cycle

Life Cycle Stage	GHG Emissions (MT CO_2e)
Solar Panels and Infrastructure	134,152
Wood Chips	6121
Wood Products (Firewood)	24,205
Lost Forest Carbon (below ground & annual sequestration)	13,739
Land clearing & wood chipping	288
Carbon sequestration, planted trees and shrubs	-672
Total Life Cycle Emissions	**177,859**

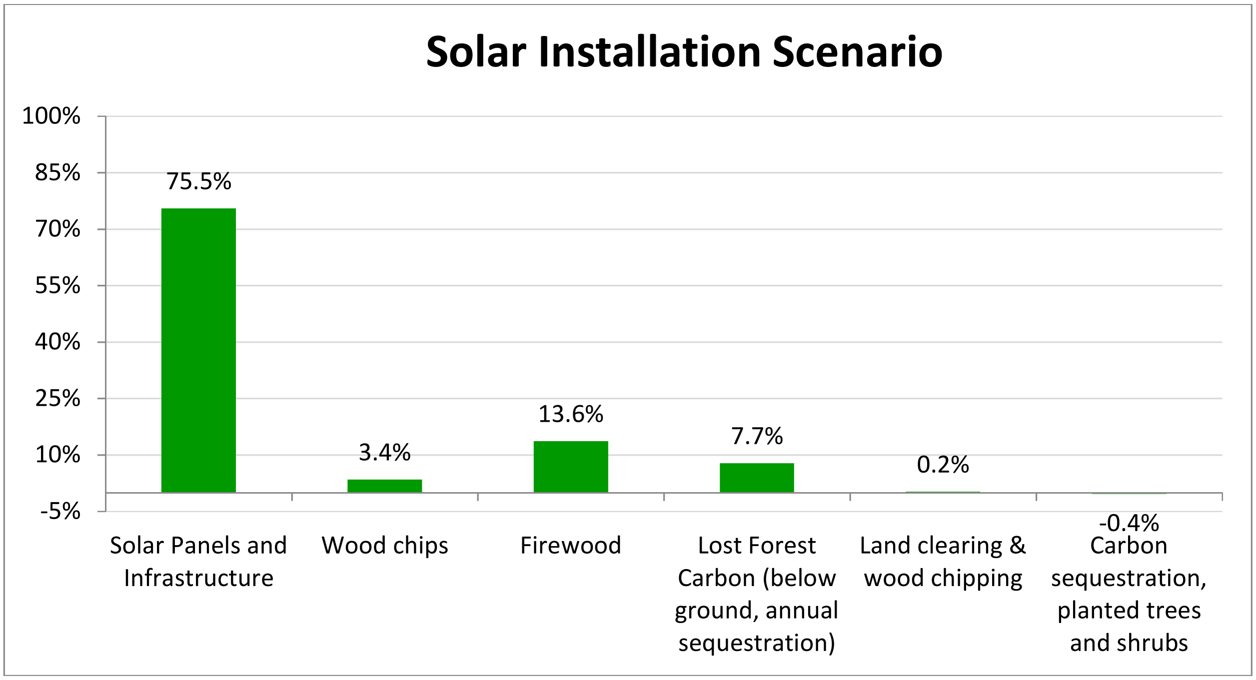

Figure 1: Life Cycle GHG Emissions for Solar Installation Scenario per 744,038 MWh

Total GHG emissions for generating 744,038 MWh of electricity from the solar installation scenario over the 20-year study period are approximately 177,859 MT of CO_2e. The primary sources of emissions are the manufacturing, installation, maintenance, and disposal of the solar panels and the related infrastructure, accounting for about 76% of the life cycle GHG emissions. Among these, manufacturing of the panels is the main contributor to the total GHG emissions. The emissions associated with transformation of cleared trees into firewood are the second largest contributor to total GHG emissions at about 14%.

Baseline Scenario Results

The results of the GHG emissions assessment for the baseline scenario are outlined in Table 3.

Table 3: Life cycle greenhouse gas emissions for the baseline scenario for generation of 744,038 MWh of electricity over 20 years using average U.S. natural gas

Life Cycle Stage	GHG Emissions ($MT\ CO_2e$)
Natural gas electricity (US/46% shale gas)	1,273,861
Total Life Cycle Emissions	**1,273,861**

Results of the GHG emissions assessment for adding natural gas electricity generation capacity to the ISO-NE grid show that this would result in 1,273,861 tonnes of CO_2e over 20 years.

Comparative Results

Solar Installation Scenario vs. Baseline Scenario

The primary objective of this analysis was to quantify the relative life cycle GHG emissions for adding 744,038 MWh of electricity generation capacity by either the solar installation scenario or the baseline scenario using natural gas. Results of the screening analysis (Figure 2) indicate that significant reductions of nearly 90% in GHG emissions could be achieved by pursuing the solar installation scenario.

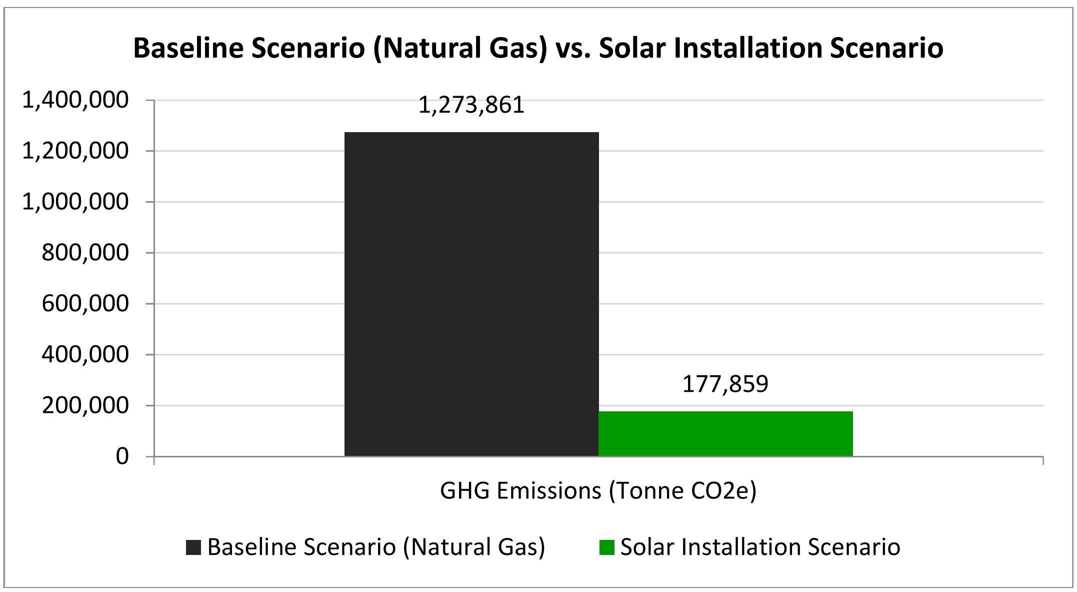

Figure 2: Life Cycle GHG Emissions for Baseline Scenario (Natural Gas) vs. Solar Installation Scenario per 744,038 MWh

Sensitivity to natural gas data

The DataSmart process for natural gas electricity generation, using a 46% shale gas feedstock mix, gives a result of 750 g CO2e/kWh. To test the sensitivity of the results to this data source, we considered the NREL's harmonized median life cycle GHG values of 670 g CO_2e/kWh for a combustion turbine and 450 g CO_2e/kWh for a combined-cycle turbine (O'Donoughue et al., 2014). The results with the median harmonized values for combustion turbine show that per 744,038 MWh, life cycle GHG emissions are 1,085,400 MT CO_2e. These values are about 15% lower than the DataSmart values for natural gas. When these harmonized values are compared with the solar installation scenario, we find that the solar scenario still has about 86% lower GHG impacts.

With the harmonized median GHG value of 450 g CO_2e/kWh for a combined-cycle turbine, we find that per 744,038 MWh, the GHG emissions are 729,000 MT CO_2e. These values are about 43% lower than the DataSmart values for natural gas. When these harmonized values are compared with the solar installation scenario, we find that the solar scenario still has about 79% lower GHG impacts.

Conclusions

Results of the screening life cycle GHG assessment of the Nutmeg Solar installation indicate that substantial GHG emissions reductions of 79-90% could be achieved over the 20-year study period relative to adding natural gas generation capacity.

These significant reductions in GHG emissions can be achieved with the solar installation despite the proposed land use change for the 10 acres of pumpkin and squash field, and 95.3 acres of forest at the site, and despite annual reductions of 0.5% in energy output over the study period beyond year 1. Results of the assessment show that the potential GHG emissions associated with converting this agricultural land and forest to solar electricity production are orders of magnitude smaller than the life cycle GHG emissions associated with electricity from average U.S. natural gas generation. This is a result of the relatively small area of land to be cleared and the relatively low carbon sequestration potential of the site in its current condition.

Given the lost carbon dioxide sequestration over the life of the facility due to tree clearing and the carbon dioxide emitted from the manufacture of the solar equipment, the approximate payback period was calculated using regional weather data (NREL, 2017) and was found to be about seven years.

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APPENDIX A

Forest Carbon Calculations

Above-Ground Carbon

Amount:	**15533.9**	**MT CO2e**	
Above-ground carbon/acre Connecticut forest land:	163	MT CO2e/acre	*Source: USFS 2016*
Nutmeg Solar site acres to be cleared:	95.3	acres	*Source: Tetra Tech, Inc.*

Below-Ground Carbon

Amount:	**2763.7**	**MT CO2e**	
Total BGC and SOC per acre:	29.0	MT CO2e/acre	*Source: USFS 2016*
Nutmeg Solar site acres to be cleared:	95.3	acres	*Source: Tetra Tech, Inc.*

Tree Harvesting for Site Clearing (Solar Installation Scenario)

Amount:	**5,936**	**m3**	
SimaPro Process:	*Softwood logs with bark, harvested at medium intensity site, at mill, US PNW*		
Comment:	Process includes diesel consumption, use of lubricants for machinery, and transportation offsite		
Total volume of above-ground biomass, live trees	97,697,524	m3	*Source: USFS 2016*
Total area of Connecticut forest land	1,568,397	acres	*Source: USFS 2016*
Average Connecticut volume of live trees	62.29	m3/acre	
Nutmeg Solar site acres to be cleared:	95.3	acres	*Source: Tetra Tech, Inc.*

Lost Carbon Sequestration due to Site Clearing

Amount:	**3,160**	**MT CO2e**	
Annual carbon sequestration in Connecticut forest:	2,600,000	MT CO2e	*Source: Tomasso 2016, p15 (http://www.ct.gov/deep/lib/deep/climatechange/gc3_webinar_series/land_use_and_forestry.pdf)*
Total area of Connecticut forest land	1,568,397	acres	*Source: USFS 2016*
Carbon sequestration/ acre Connecticut forest land/ year	1.66	tons/acre/year	
Nutmeg Solar site acres to be cleared:	95.3	acres	*Source: Tetra Tech, Inc.*
Life of project	20	years	

Fallow Land Carbon Calculations

Above-Ground Carbon

Amount:	**68**	**MT CO2e**	
Above-ground carbon/acre grassland:	6.835	MT CO2e/acre	*Source: USFS 2016*
Nutmeg Solar site acres to be cleared:	10	acres	*Source: Tetra Tech, Inc.*

Lost Carbon Sequestration due to Site Clearing

Amount:	**164**	**MT CO2e**	
Carbon sequestration/ acre grassland/ year	0.82	tons/acre/year	*Source: Franzluebbers, 2001; Jones et al. 2004*
Nutmeg Solar site acres to be cleared:	10	acres	*Source: Tetra Tech, Inc.*
Life of project	20	years	

Site Planting Carbon Calculations

Carbon Sequestration from Planted Trees at Solar Site

Amount:	**108.992**	**MT CO2e**	
Carbon sequestration/tree/year	0.0262	tons/tree/year	*Source: USDOE (1998). U.S. Department of Energy. Energy Information Administration. Method for Calculating Carbon sequestration by Trees in Urban and Suburban settings.*
Nutmeg Solar number of trees to be planted	208	trees	*Source: Tetra Tech, Inc.*
Life of project	20	years	

Carbon Sequestration from Planted Shrubs at Solar Site

Amout:	**180.88**	**MT CO2e**	
Carbon sequestration/shrub/year	0.0068	tons/shrub/year	*Source: Gratani, L. V. (2013). Mediterranean shrublands carbon sequestration: environmental and economic benefits. Mitigation and Adaptation Strategies for Global Change.*
Nutmeg Solar number of shrubs to be planted	1330	shrubs	*Source: Tetra Tech, Inc.*
Life of project	20	years	