FAIRFAX COUNTY PLANNING COMMISSION
ENVIRONMENT COMMITTEE
THURSDAY, OCTOBER 4, 2012

COMMITTEE MEMBERS PRESENT:
Frank A. de la Fe, Hunter Mill District
Jay P. Donahue, Dranesville District
Earl L. Flanagan, Mount Vernon District
James R. Hart, At-Large, Chairman
Kenneth A. Lawrence, Providence District

COMMITTEE MEMBERS ABSENT:
Walter L. Alcorn, At-Large
Timothy J. Sargeant, At-Large

OTHER COMMISSIONERS PRESENT:
Ellen J. Hurley, Braddock District
James T. Migliaccio, Lee District

FAIRFAX COUNTY STAFF PRESENT:
Pamela G. Nee, Chief, Environment and Development Review Branch (EDRB), Planning Division (PD), Department of Planning and Zoning (DPZ)
Noel H. Kaplan, Senior Environmental Planner, EDRB, PD, DPZ
Maya P. Dhavale, Planner III, EDRB, PD, DPZ
Ellen N. Eggerton, Green Building Ombudsman, Land Development Services Division, Department of Public Works and Environmental Services
Dawn M. Ashbacher, Assistant Director, Planning Commission Office
Kara A. DeArrastia, Clerk to the Planning Commission

OTHERS PRESENT:
Inda Stagg, Senior Land Use Planner, Walsh, Colucci, Lubeley, Emrich & Walsh, PC

ATTACHMENTS:
A. "Prototype Proffer – New Construction, no enforcement mechanism" document
B. "Discussion of Implementation of Green Building Policy" document, dated July 19, 2012
C. "Electric vehicle charging infrastructure recommendations to Fairfax County: Task 5 of sustainability study under Proffer Number 9, RZ 2008-PR-011, dated July 19, 2011" report

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Chairman James R. Hart called the meeting to order at 6:57 p.m., in the Board Conference Room, 12000 Government Center Parkway, Fairfax, Virginia 22035.

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PROTOTYPE PROFFER – NEW CONSTRUCTION, NO ENFORCEMENT MECHANISM

Maya Dhavale, Planner III, Environment and Development Review Branch (EDRB), Planning Division (PD), Department of Planning and Zoning (DPZ), reviewed the “Prototype Proffer – New Construction [NC], no enforcement mechanism” document, as shown in Attachment A. She noted that this proffer language could be used in situations where an applicant wanted to attain LEED certification for a development proposal located outside an area of expectation for a green building commitment, but was not willing to post an escrow, the primary enforcement mechanism available to the County at this time.

In response to questions from Commissioner Hurley, Ms. Dhavale said the prototype proffer language could apply to the Cardinal Forest TD Bank application (SE 2011-BR-016). She noted that the submission of documentation to the EDRB demonstrating the status of attainment of LEED certification could denote that the applicant had attempted certification but had failed. She explained that if an applicant’s project failed to attain LEED certification, the applicant could still register with the U.S. Green Building Council (USGBC) to access the LEED Online system at a cost of approximately $1,000 depending upon the applicant’s membership to the USGBC. She indicated that the LEED Online system was a suite of tools designed to assist in the incorporation of green building techniques into a building.

Replying to questions from Commissioner Flanagan, Ms. Dhavale said an applicant’s commitment to LEED certification was not a criterion for acceptance of a zoning application and staff often received more information about the development project during the application review process. She stated that the County encouraged all applicants to commit to LEED certification or equivalent program with independent third party certification. She indicated that the prototype proffer would go into effect after the application had been approved by the Board of Supervisors and during the site plan/building plan review process.

Inda Stagg, Senior Land Use Planner, Walsh, Colucci, Lubeley, Emrich & Walsh, PC, suggested changing all occurrences of “will” in the first and third paragraphs of the prototype proffer language to “should” and removing “attainment of” from the phrase, “demonstrating the status of attainment of LEED certification,” in the last sentence of the third paragraph. Chairman Hart commented that the intention of this language was to ensure that the applicant reported to the EDRB whether LEED certification was attained. Ms. Dhavale agreed with this statement, pointing out that this prototype proffer contained standard language staff currently provided to applicants in applicable situations. She explained that the use of the word “will” was important because it provided the only assurance to the County that the applicant was even trying to attain LEED certification. She noted that staff generally asked applicants to pursue a few credits above the minimum necessary for LEED certification to allow for some flexibility.

Responding to a comment by Ms. Stagg, Chairman Hart said the applicant had to report the status of attainment of LEED certification to the EDRB prior to release of the bond for the development project, although certification did not actually have to be attained.

Ellen Eggerton, Green Building Ombudsman, Land Development Services Division, Department of Public Works and Environmental Services (DPWES), pointed out that "will" was enforceable but "should" was not.

Answering a question from Ms. Eggerton, Ms. Dhavale noted that the release of the final construction bond for the project was the last legal point in the zoning/development process where the County could tie this proffered commitment.

Chairman Hart reminded everyone that proffers were voluntary commitments by an applicant; therefore, the County did not dictate such commitments.

Ms. Eggerton said green building certification was not required as part of the site plan, building plan, or building permit processes. She explained, however, that both residential and commercial development projects that were designed to attain LEED Silver or higher certification would be eligible for shorter waiting times during these review processes.

Commissioner Flanagan suggested that staff ask applicants to provide a statement indicating whether they intend to pursue LEED certification. Ms. Eggerton replied that applicants usually constructed their projects in conformance with the minimum Virginia Uniform Statewide Building Code (VUSBC) and did not gain any advantage in committing to incorporate green building elements into their project. She added that the green building measures beyond the minimum VUSBC would need to have an enforcement mechanism.

Chairman Hart pointed out that unless the Board of Supervisors changed its policy, the County would continue to expect commitments to a green building escrow inside an area with an expectation for such a commitment. He said this prototype proffer currently only applied to a small subset of applications wherein the applicant offered a green building commitment for a project that was located outside an area with an expectation for such a commitment.

In reply to questions from Commissioner Lawrence, Ms. Dhavale noted that the scorecard of specific credits within the most current version of the LEED rating system was available online. She explained that the certification statements confirming that the items on the list would meet at least the minimum number of credits necessary to attain LEED certification indicated that those were the items chosen for the project and the applicant anticipated obtaining LEED certification.

Ms. Eggerton pointed out that some of the credits in the LEED program applied to design- or construction-related elements that were already required by the County or by minimum code.

Commissioner Lawrence commented that the list of specific green building elements the applicant intended to incorporate into the design and construction of its project would demonstrate that the project was anticipated to attain a sufficient number of credits for LEED certification. Ms. Dhavale concurred with this statement.

Commissioner Lawrence indicated that the next step in this process was that the Chief of the EDRB would review the project status and monitor the progress of all documents submitted by the project team. He noted that the third step was that the USGBC would perform a preliminary review of design-oriented credits in the LEED program and the associated documentation would demonstrate whether the project was anticipated to attain LEED certification. He said the fourth and final step was the outcome of the review and inspection process and determination of whether the project could attain LEED certification.

In response to questions from Commissioner Lawrence, Ms. Dhavale pointed out that as depicted in the third paragraph of the prototype proffer; the USGBC only reviewed the design-oriented credits in the LEED program prior to building plan approval. She explained that if the applicant chose not to pursue the construction-related credits as identified on the list provided as part of the site plan and building plan submissions, the project would fail to attain LEED certification. She said that in this case, the USGBC would inform the applicant that the project had failed to meet the minimum number of credits necessary for LEED certification.

Commissioner Lawrence expressed support for the prototype proffer language.

Replying to questions by Commissioner Hurley, Ms. Dhavale explained that:

- this prototype proffer was aimed solely at applicants who wanted to pursue LEED certification but did not want to post a green building escrow;

- “the status of attainment of LEED certification” would be demonstrated by a letter from the USGBC notifying the applicant whether the project attained LEED certification, which was the final outcome of this proffered commitment;

- the County would not impose a penalty if an applicant failed to attain LEED certification of a project;

- the use of the word “will” rather than the word “should” in the proffer language provided assurance to the EDRB that the applicant was attempting to pursue LEED certification for the project, given the fact that there was no enforcement mechanism; and

- the prototype proffer represented standard proffer language already in use by applicants.

Commissioner Migliaccio and Ms. Dhavale discussed Development Condition Number 13 for the Burgundy Farm Country Day School, Inc. application (SEA 93-L-014-02), scheduled to be heard by the Planning Commission on Thursday, October 11, 2012. This condition required that the applicant submit a scorecard of specific credits within the most current version of the LEED®-NC rating system that was available at the project’s registration, or other LEED rating system determined to be applicable to the renovated Loft building by the USGBC. A professional engineer or architect was also required to provide certification statements confirming that the items on the scorecard had met a range of LEED credits that was no less than the minimum necessary to attain LEED certification. Prior to issuance of the Non-Residential

Use Permit (Non-RUP), certification of compliance with this commitment must be submitted to the EDRB. This project was located outside an area of expectation for a green building commitment. Given that the Loft building was not planned for construction until Phase II of III of the project, the applicant was not yet certain of the design specifics for this building. Commissioner Migliaccio expressed concern that if the applicant decided not to pursue or had failed to attain LEED certification for the Loft building, this development condition would delay issuance of the Non-RUP. Ms. Dhavale replied that in this case, the applicant would need to file another Special Exception Amendment application to amend the development condition.

Commissioner de la Fe pointed out that development conditions must be based on Zoning Ordinance requirements, but proffers were completely different and could not be treated the same.

Answering questions from Commissioner Lawrence, Ms. Dhavale noted that the prototype proffer language could also apply to other independent third party certification programs that staff considered the equivalent of LEED. She stated that the County recognized that LEED was the accepted independent third party verified system most commonly used for office development. She said she was uncertain whether the Green Globes rating system was still a self-verified system based on a questionnaire because the materials were only available online to people whose projects were registered.

Commissioner Flanagan recommended revising the beginning of the first paragraph to read, “The applicant, who is requesting LEED certification, will include…” because it would provide clarification regarding the applicant.

Commissioner Donahue said he recalled asking staff to consult the County Attorney’s Office on the issue of enforcing an applicant’s voluntary commitment to attain green building certification in a development condition. He pointed out that Development Condition Number 17 for the recently-approved Chesterbrook Plaza TD Bank application (SE 2012-DR-003) required that the site and building plans include a list of specific credits within the most current version of the LEED®-CI rating system, or other LEED rating system determined to be applicable to the financial institution by the USGBC.

Chairman Hart explained that the Board of Supervisors, in approving a Special Exception application, and the Board of Zoning Appeals, in approving a Special Permit application, had the ability to impose development conditions on the applicant to ensure that the use would be harmonious with and would not adversely affect the use or development of neighboring properties. He questioned how the County could enforce a commitment to attain green building certification when it was not explicitly required by the Zoning Ordinance, and requested that staff consult the County Attorney’s Office regarding this question.

Chairman Hart recommended adding a disclaimer to this prototype proffer that explicitly stated that it was only germane to situations where the development project was located outside an area of expectation for a green building commitment, the applicant was committing to attain LEED certification, and the applicant was opposed to posting a green building escrow. Ms. Dhavale responded that staff maintained a library of proffers that were separated into specific categories of applicability. She noted that when staff provided prototype proffer language to a particular applicant, there was always concern that such language might be used for another application.

Responding to a question from Chairman Hart, Ms. Dhavale said staff did not need the Committee's endorsement to use this prototype proffer. She stated that staff wanted to share a potential solution for expressing an applicant's intention to attain LEED certification in writing without the imposition of a penalty for expressing that commitment.

In reply to a question from Commissioner Flanagan, Ms. Dhavale stated that staff asked for a green building escrow because if an applicant simply proffered to attain green building certification but was unsuccessful, the applicant would need to file a Proffered Condition Amendment (PCA). She said this prototype proffer was used because it simply ensured that the applicant would provide documentation to the EDRB demonstrating the status of attainment of LEED certification for each building on the property. She explained that in cases where there was not an expectation for a green building commitment, applicants who were concerned that their project might not attain certification were advised by staff to not explicitly state such a commitment in a proffer to prevent them from having to file a PCA application in the future. She noted that in situations where an applicant was willing and able to attain green building certification, such a commitment needed to be reflected in a proffer.

Chairman Hart requested that staff consult the County Attorney's Office regarding the legality of Development Condition Number 13 for the Burgundy Farm Country Day School application. Ms. Dhavale agreed to this request.

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IMPLEMENTATION/GEOGRAPHIC ISSUES

Ms. Dhavale indicated that the following outstanding issue still needed to be discussed by the Committee: Was it appropriate to retain the geographic distinctions established at the beginning of Policy b, "Within the Tysons Corner Urban Center, Suburban Centers, Community Business Centers, Industrial Areas, and Transit Station Areas as identified on the Concept Map for Future Development"? She said the "Discussion of Implementation of Green Building Policy" document, dated July 19, 2012, as shown in Attachment B, had outlined some options on how to address this issue. Ms. Dhavale noted that the Pohanka Stonecroft LLC applications for an auto dealership (RZ 2011-SU-024 and SE 2011-SU-009) had raised a concern about equitability. She explained that Pohanka had expressed concern that a project involving a Bill Page auto dealership (PCA 2009-MA-011 and SEA 95-M-039-02) was not being held to the same expectation for green building certification because it was located outside an area subject to such an expectation. She stated that one potential solution to this concern would be to remove the geographic differentiation from Policy b, thereby establishing consistent recommendations that would apply to all uses meeting the bulleted criteria under this policy, regardless of the location.

In response to a question from Chairman Hart, Ms. Dhavale said the geographic areas of expectation could remain in the Green Building Policy strawman proposal so that this issue could receive public feedback prior to making a decision on whether to remove this language. However, she said staff and Commissioners would benefit from a discussion as to how to define expectation for commitments based on uses, not geography.

Commissioner de la Fe suggested revising the policy to have no areas of expectation, only encouragement of green building certification of projects throughout the County. He expressed concern about defining the uses for which green building certification would be considered reasonably applicable or workable.

Answering a question from Chairman Hart, Ms. Dhavale said staff sought to address equitability concerns regarding the geographic distinctions. She noted that when the Green Building Policy was initially adopted in December 2007, the designation of geographic areas of expectation for a green building commitment was considered a pilot program to assess its efficacy and decide whether to remove them altogether or to expand the areas. Ms. Dhavale pointed out that the majority of development in the County was occurring in the identified growth centers, leaving aside the expectation Countywide that zoning proposals for residential development that seek development at or above the mid-point of the Plan density range incorporate green building practices. She said she was also concerned that identifying uses for which green building certification would be considered appropriate could cause disagreement in the development community.

Noel Kaplan, Senior Environmental Planner, EDRB, PD, DPZ, explained that another option was to examine the four bullet points under Policy b that triggered the expectation for a green building commitment located in a growth center that sought at least one of the following:

- Development in accordance with Comprehensive Plan Options;
- Development involving a change in use from what would be allowed as a permitted use under existing zoning;
- Development at the Overlay Level; or
- Development at the high end of planned density/intensity ranges. For nonresidential development, consider the upper 40 percent of the range between by-right development potential and the maximum Plan intensity to constitute the high end of the range.

Mr. Kaplan said the Committee could determine whether those bulleted criteria made sense if applied Countywide rather than specific geographic locations, or whether certain criteria needed to be refined and narrowed to focus on particular categories of circumstance that should have an expectation. He added that difficult/complex cases could be evaluated on a case-by-case basis.

Commissioner Flanagan said he thought that the optional approach described by Mr. Kaplan would be worth pursuing. He then asked how this might affect redevelopment projects within areas, such as the Richmond Highway Corridor, subject to this expectation. In response, Mr. Kaplan explained that the concern was that a zoning proposal for a particular use, such as a drive-through bank located within an area of expectation, was that the proposal would be treated differently from a proposal for another drive-through bank that was located outside such an area simply because of its location. He indicated that this geographic differentiation had raised the concern of equitability. Mr. Kaplan said the question was whether it was appropriate for a policy to make that distinction or to remove it, thereby expanding the policy's reach Countywide. He noted that if the geographic distinctions were removed, the Committee would need to determine how to draft this policy in a way that was reasonable and specifically focused on the kinds of uses or circumstances for which expectation for a green building commitment should be applied.

Replying to questions from Commissioner Hurley, Ms. Dhavale stated that any nonresidential construction within the Tysons Corner Urban Center was expected to attain certification at the LEED Silver level, in accordance with the Tysons Comprehensive Plan. She said staff was not suggesting that this expectation apply Countywide, and the Green Building Policy simply identified Tysons as one of the areas of geographic expectation. She noted that the Green Building Policy discussed how such practices could be applied to development and redevelopment projects throughout the County. She added that the issue currently under discussion was as follows: Should there be defined areas of expectation for a green building commitment within the County, or should such expectation be based on certain uses or circumstances throughout the County?

In response to questions from Commissioner Lawrence, Ms. Dhavale confirmed that businesses, such as banks, fast food restaurants, gas stations, and hotels, could enroll in the LEED Volume Certification Program to define a prototype by choosing a set of prerequisites and credits that were common to all the projects they planned to certify. She cited PNC Financial Services Group and Marriott Hotels as enrollees in this program. Ms. Dhavale indicated that if a zoning applicant was enrolled in this program, staff would ask if the project would be built to the pre-certified prototype to encourage such commitment. However, she said staff could not suggest that an applicant join this program because it was a private business decision.

It was the consensus of the Committee that it was comfortable with staff exploring the bulleted criteria under Policy b as an option to be included for future consideration.

Chairman Hart announced that the Committee would next meet on Thursday, November 29, 2012, at 7:00 p.m. in the Board Conference Room, to complete the review of the Green Building Policy strawman document. Ms. Dhavale noted that staff would prepare a second strawman, detailing potential changes to the Policy language that reflected the Committee's discussion and recommendations thus far, and develop options for language to address the issue of equity across geography in regards to uses or circumstances for presentation to the Committee at its meeting on November 29.

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MITRE ELECTRIC VEHICLE CHARGING INFRASTRUCTURE REPORT

Mr. Kaplan stated that the MITRE Corporation had prepared a report offering a series of policy recommendations to the County regarding consideration of electric vehicle charging infrastructure in the review of development proposals, largely focusing on Tysons, as shown in Attachment C. He added that MITRE was almost finished with preparing a second report offering a series of policy recommendations to the County regarding innovative building energy concepts. He noted that the Board of Supervisors had referred the electric vehicle-charging infrastructure report to the Planning Commission for its review and recommendation. Mr. Kaplan indicated that he could invite County staff members who have been involved in electric vehicle issues and possibly MITRE representatives to the meeting on November 29, to provide an overview of electric vehicle charging concepts and the MITRE report. He added that there was no deadline for making a recommendation on this issue to the Board of Supervisors.

Chairman Hart said the purpose of the next Committee meeting should be primarily devoted to reviewing the updated version of the Green Building Policy strawman and voting to make a recommendation to the Planning Commission. He noted that also at this meeting, the Committee might benefit from receiving a brief overview from staff on a proposed timeline for the Committee's review of the MITRE report. In addition, he anticipated that the meetings following November 29 would focus on developing policy guidance regarding pursuit of commitments to the provision of electric vehicle supply equipment through the zoning process through either proposed Policy Plan language, prototype proffer language, or other form of guidance.

Mr. Kaplan noted that he would draft a possible approach for the Committee's review and present it at the next meeting.

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SOLID WASTE COLLECTION/MANAGEMENT AND RECYCLING

Chairman Hart asked whether the Committee would return to its discussion on solid waste collection/management and recycling. (*Note: The Committee had received a presentation on this topic from DPWES staff on March 10, 2011.*) Ms. Dhavale replied that solid waste and recycling management practices had been discussed as part of the Committee's review of the Green Building Policy strawman document. She said she recognized that this topic had generated much discussion and interest, but did not necessarily require any action. Chairman Hart suggested scheduling another Committee meeting to further discuss this issue.

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The meeting was adjourned at 8:06 p.m.
James R. Hart, Chairman

An audio recording of this meeting is available in the Planning Commission Office, 12000 Government Center Parkway, Suite 330, Fairfax, Virginia 22035.

Minutes by: Kara A. DeArrastia

Approved: January 10, 2013

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Kara A. DeArrastia, Clerk to the
Fairfax County Planning Commission

Prototype Proffer – NC, no enforcement mechanism

The applicant will include, as part of the site plan submission and building plan submission, a list of specific credits within the most current version of the U.S. Green Building Council's Leadership in Energy and Environmental Design—New Construction (LEED®-NC) rating system, or other LEED rating system determined to be applicable to the building(s) by the U.S. Green Building Council (USGBC), that the applicant anticipates attaining. A LEED-accredited professional who is also a professional engineer or licensed architect will provide certification statements at both the time of site plan review and the time of building plan review confirming that the items on the list will meet at least the minimum number of credits necessary to attain LEED certification of the project.

In addition, prior to site plan approval, the applicant will designate the Chief of the Environment and Development Review Branch of the Department of Planning and Zoning as a team member in the USGBC's LEED Online system. This team member will have privileges to review the project status and monitor the progress of all documents submitted by the project team, but will not be assigned responsibility for any LEED credits and will not be provided with the authority to modify any documentation or paperwork.

Prior to building plan approval for any building to be constructed, the applicant will submit documentation, to the Environment and Development Review Branch of DPZ, regarding the U.S. Green Building Council's preliminary review of design-oriented credits in the LEED program. This documentation will demonstrate that the building is anticipated to attain a sufficient number of design-related credits that, along with the anticipated construction-related credits, will be sufficient to attain LEED certification. Prior to release of the bond for the project, the applicant shall provide documentation to the Environment and Development Review Branch of DPZ demonstrating the status of attainment of LEED certification from the U.S. Green Building Council for each building on the property.

Planning Commission Environment Committee meeting, July 19, 2012
Discussion of Implementation of Green Building Policy

At the May 31, 2012 meeting, the Planning Commission's Environment Committee discussed the implementation of the green building policy, specifically how to craft and enforce a soft commitment for an application outside the areas within which Policy b establishes an expectation for green building certification through LEED or an equivalent program. As staff sought to address these questions, other questions concerning the implementation of the policy arose, specifically relating to the geographic distinction established within Policy b. Staff would like to discuss the following questions to have further clarification; the outcomes of this discussion may result in additional revisions to the draft strawman.

1. Is it appropriate to retain the geographic distinctions established in Policy b? The direction from the Environment Committee was to establish guidance for soft commitments that could apply outside of the specific areas linked to green building certification in Policy b. During the May 31 discussion, there was particular concern raised regarding uses for which green building certification may not be reasonably applicable/workable. Staff's consideration of this concern has caused it to ask what the appropriate approach should be for such uses **within** the areas identified in Policy b, and this question, along with recent case experience where equitability concerns were raised regarding Policy b's geographic distinctions, have, in turn, raised a broader question as to whether these geographic distinctions should be retained. There may be a number of options available to address this question, including:
    a. Remove the geographic distinctions in Policy b, thereby expanding its reach countywide.
    b. Revise the policy to have no areas of expectation, only encouragement throughout the County.
    c. Define expectation for commitments based on uses, not geography (Option a with a focus on particular uses).
    d. Delete the "change in use" bullet (the second bullet within Policy b), perhaps in conjunction with Option a.
    e. Retain the existing policy, including the geographic distinctions, and address difficult/complex cases on a case-by-case basis.
    f. Other options from the Environment Committee?

2. Framework for soft commitments for applications outside of the areas of expectation

3. How to handle applications inside the area of expectation that are unwilling/unable to commit to formal certification?

Attachment C

MITRE

Electric vehicle charging infrastructure recommendations to Fairfax County

Task 5 of sustainability study under Proffer #9, RZ 2008-PR-011

July 19, 2011

Approved for Public Release: 11-2916. Distribution Unlimited.

Executive Summary

Plug-in vehicles feature prominently in the vision for a livable, sustainable Tysons Corner. They promise cleaner, quieter transportation that is less dependent on the political stability of other parts of the world, but they come at the price of being a fundamentally different way of powering the automobile fleet. Charging will largely be done over long periods of time at distributed locations, rather than at particular fueling stations. As Tysons Corner evolves from a suburban office park to an urban center, the evolution to an electric automotive fleet will affect urban layout, building design, and utility services.

Fairfax County is attempting to determine the effects of widespread plug-in vehicle adoption on infrastructure requirements and to determine design approaches that can be considered through the county's zoning process to encourage appropriate investment. MITRE, in support of the County's sustainability objectives, has considered the problem under Proffer #9, RZ 2008-PR-011. This document is the result.

We present a background for plug-in vehicles, charging stations, and other estimates of plug-in vehicle market penetration. We emphasize the impossibility of a demonstrably accurate estimate of market penetration, the fact that vehicle charging will be done primarily at home, and that modifications to initial parking area construction can reduce the overall cost and risk of installing charging stations. Four primary recommendations result:

1. The County should strongly encourage developers to include the conduit infrastructure – space, conduit banks, conduit, and access points – for relatively easy and inexpensive installation of charging stations in the future. The County should encourage, but place less emphasis on the full installation of electric vehicle supply equipment (EVSE) – the transformers, switches, wiring, and charging stations themselves – at the time of initial construction given the uncertainties surrounding electric charging station demand.
2. The fraction of parking slots for which the infrastructure should be included should represent a fully plug-in fleet for the groups of users that would use charging infrastructure at the facility. This means all parking spaces for a residential building (single- or multi-family). At commercial and retail facilities, this means the fraction of vehicles that arrive from locations geographically situated to require a charge before the return trip.
3. The County can most appropriately seed charging station supply by negotiating for the installation of full charging stations at the lowest expected adoption rate in the near future. Any supply seeding is best done at apartment buildings and should be limited to a maximum of 2% of all parking spaces.
4. The County should coordinate with its peer jurisdictions to encourage charging station manufacturers to form a standard defining the connection of the charging station to the facility in which it is installed. The standard should define both the electrical connection and physical mount with the purpose of making it possible to move charging stations to a new facility relatively easily and quickly.

The objective is to prepare Tysons Corner for widespread plug-in adoption, but to do so as inexpensively as possible so as to encourage the desired population and job growth that will sustain Tysons Corner as a livable urban center.

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1 Introduction

MITRE fully supports Fairfax County's sustainability objectives for Tysons Corner. As part of Proffer #9, RZ 2008-PR-011, we are conducting an analysis of emerging building, automotive, and energy technologies – specifically, how they may affect future Tysons Corner development and how they can best be harnessed to aid the transformation of Tysons Corner in to a sustainable, livable urban center.

This document concerns plug-in vehicles and plug-in vehicle charging infrastructure. It satisfies Task 5 of the study that MITRE is performing per the aforementioned proffer commitment. The specific components of Task 5 are:

> "Describe the following as they relate to the establishment of electric vehicle charging stations:
>
> a. Guidance regarding the anticipated future need for electric vehicle charging stations in Tysons Corner, including an estimate of the number of charging facilities that may be needed in the future and concentrations relating to broad land use categories (e.g., number of multifamily dwelling units per charging station; office and retail square footage per charging station)
>
> b. Guidance regarding impacts to infrastructure in Tysons Corner that would occur as a result of full implementation of electric vehicle charging stations in Tysons Corner per 5.a above
>
> c. A general overview (not site-specific details) of infrastructure (including voltage requirements and amperage reserves) and site design elements that would be necessary for the establishment of electric vehicle charging stations at typical redevelopment sites in Tysons Corner (including design accommodations that could be made for the possible future establishment of charging stations on sites)."

MITRE's response to this guidance is a series of building construction recommendations that would, if implemented, lower the overall cost for future installation of a full plug-in vehicle charging infrastructure. We show the course of reasoning from which they were derived. We first provide some background information to set the context of the discussion. Population and employment forecasts for Tysons Corner are referenced. We note the various types of plug-in vehicles, and we discuss multiple other studies that have attempted to estimate future plug-in vehicle market penetration. An overview of the current state of charging technology concludes the background review. From the background section, we move into the discussion of recommendations. We make explicit our underlying assumptions and then present their consequences on Tysons Corner charging infrastructure. Finally, we present specific recommendations to the County.

We have excluded from this document a discussion of the effects that plug-in vehicle adoption will have on the electrical grid in general. That analysis is best done in conjunction with the other part of the proffer study on general energy use and system level effect.

2 Background

2.1 Demographics

2.1.1 Fairfax County

Fairfax County currently is home to more than 1 million people and 580k jobs (Fairfax, 2011).

Figure 1 shows the Mid-Atlantic area centered in Tysons Corner. The concentric rings show driving distances (not straight-line distances) from Tysons Corner and are spaced twenty miles apart. Each ring shows estimates of both resident population and the source of commuters into Tysons Corner. The figure shows the data on a map. Table 1 summarizes the data.

Table 1: Total resident and Fairfax County commuter populations living within given distance from middle of Tysons Corner

Driving distance from Tysons Corner	Resident population (millions)	Inbound Fairfax commuters (x100k)	Percent of inbound Fairfax commuters
< 20 miles	3	367	67%
20 – 40 miles	5.4	496	91%
40 – 60 miles	8	526	97%
60 – 80 miles	9.1	539	99%
80 – 100 miles	10.4	540	99%
> 100 miles		545	100%

Sources: Total population – US Census, 2010; Commuters – AASHTO, 2011; Driving distances – ESRI Network Analyst.

Two points should be noted about the commuter data. First, the total number of commuters in this table does not match the current 580k jobs because it is a result of statistical sampling done 2006 through 2008. We assume for the sake of this study, that even as the number of commuters increases, the geographic distribution of their homes remains constant. Also, we assume that the geographic distribution of commuters' homes is the same for Tysons as for the entirety of Fairfax. Second, the data is a total count of workers traveling within and to Fairfax County for work. There is no attempt to determine the frequency of those trips.

2.1.2 Plan for Tysons Corner Urban Center

Focusing more specifically on Tysons Corner itself, the 2007 Fairfax County Comprehensive Plan, with the 2010 Tysons Corner Urban Center Amendment, plans a more livable area with a sustainable integration of work, play, and home. The plan provides, "… a framework for growth beyond 2030." 17,000 people currently live in Tysons Corner, but studies upon which the amendment are based estimate 31,000 residents in 2020 and up to 86,000 by 2050. Likewise, there are currently 105k jobs in Tysons Corner. In 2020, a forecast suggests that this number may be as high as 140k and by 2050, 210k. The Comprehensive Plan for Tysons Corner indicates goals of 100,000 residents and 200,000 jobs by 2050 (George Mason, 2008).

The recommendations below are made in the context of these projections and in the context of constructing buildings that will stand for the next forty years or more.

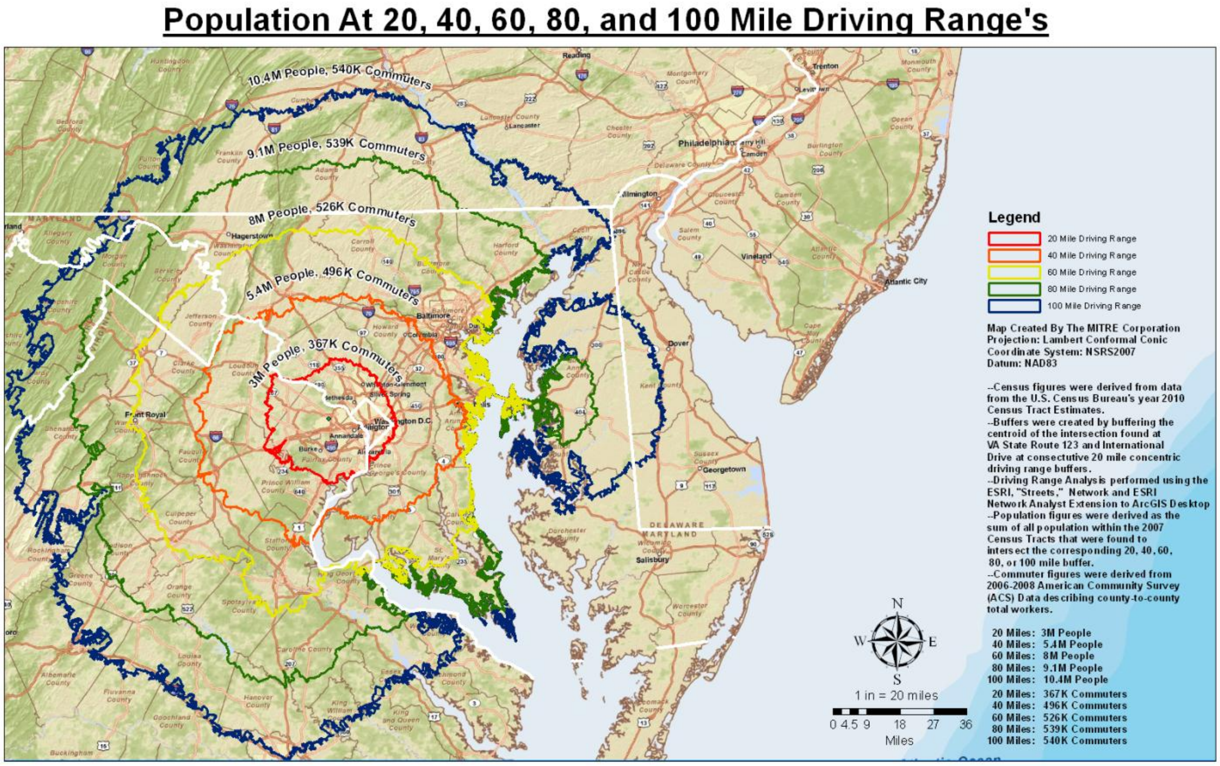

Figure 1: Driving distances from Tysons Corner

2.2 Battery electric and plug-in hybrid vehicles

2.2.1 Models

We consider two types of vehicles in this document: battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV). As its name implies, a BEV's sole power source is its on-board battery. The Nissan LEAF is the current most visible mass market BEV with a nominal range of 100 miles, although some estimates place a more realistic expected range at 80 miles. A PHEV has both a battery and an internal combustion engine. It operates on a combination of electric and gas or diesel power in a proportion determined by its electronic control system in response to such factors as power demand, temperature and state of charge of the battery. During the first portion of a trip, the battery, which has been charged from the grid prior to the trip, bears a greater burden for moving the vehicle. When the battery charge is used down to a predetermined level, the car automatically reverts to a "charge sustaining" mode and continues to operate just like a non-plug-in hybrid. In this mode, the battery's electrical charge is alternately used for propulsion and replenished by engine power (directly or through regenerative braking) and is "sustained" in a relatively narrow range. The Chevy Volt, the currently most visible example of a PHEV, is designed in such a way as to use only battery power (no engine power) during the "charge-depleting" portion of the trip. Both BEVs and PHEVs, of course, plug into the electrical grid for the bulk of their charge.

Throughout this document the terms *electric vehicle* or *plug-in vehicle* will refer to both PHEV and BEV without distinction. If we need to differentiate between the two, the appropriate acronym is employed.

2.2.2 Adoption

2.2.2.1 Market forces

Estimates of plug-in vehicle market penetration are highly varied, but do cite common factors both pushing and hindering adoption. As we show in the following, each factor includes significant estimates and guesses. We present the list to emphasize the lesson that estimating future electric car adoption is an inexact art and that any such estimate is likely wrong.

2.2.2.1.1 Encouraging adoption

Factors encouraging adoption can generally be boiled down to two: financial and convenience. More altruistic mechanisms certainly exist, but they are not widespread enough to greatly affect aggregate market penetration of plug-in vehicles.

Financial encouragement for electric adoption comes in the form of rising gasoline prices. Average gasoline price has more than doubled in real terms since the late 1990s (US EIA, 2011). As world demand increases, this general upward trend for gasoline will likely continue. This trend will be exacerbated in the face of any future turmoil in oil producing countries. US electricity prices over the same term have not seen the same increases (US EIA, 2011), and locally, if a vehicle is charged at night using time-of-day pricing, even at current prices, gasoline can be an order of magnitude more expensive per mile than electricity delivered from the grid (Dominion, 2011).

Financial encouragement also derives from government policy. At a national level, tax rebates have been offered for the purchase of hybrid vehicles. Should this become a national priority, similar such programs will again be offered. In time, should greenhouse gas regulation come to pass, plug-in vehicles will likely have additional fuel cost advantage over traditional vehicles as greenhouse gas intensity of grid generation is less than that of distributed gasoline-burning engines (EPRI, 2007).

Convenience comes also in the form of government policy. Locally, high occupancy vehicle (HOV) exemptions for hybrids have been a primary force for their adoption by commuters seeking to bypass heavy traffic without the hassle of finding and coordinating with other passengers.

2.2.2.1.2 Discouraging adoption

Factors discouraging adoption are many. We begin with concerns closest to the driver and proceed to more general constraints.

The first concern is general to all new technologies, not specifically those of plug-in vehicles. PHEV and BEV are new to the mass market, and as with the introduction of any new technology, early adopters will have to demonstrate the technologies' fitness before general adoption will begin.

The most obvious car-specific concern is vehicle range. BEVs cannot be driven beyond charging station range. PHEVs can but upon the switch to gasoline, lose the price per mile advantage over a traditional hybrid. Thus the economic benefit of PHEVs is only apparent if they remain close to charging infrastructure.

Vehicle initial cost is the next inhibitor. Include the cost of a charging station and its installation in the home, and plug-in vehicles require a larger up-front investment for the buyer than do internal combustion vehicles. Adoption will only become widespread if the ownership costs of such vehicles (fuel, maintenance, government levies) generally decrease to the point that the return on investment offsets the larger up-front cost.

This initial cost disadvantage for plug-in vehicles will likely fall over time as automakers increase investments in research and development. The ability and willingness of automakers to make such investments, however, depends heavily on the general economic climate, the rate of adoption, and targeted government subsidies, each of which presents its own difficult estimation problem.

A subset of the cost disadvantage is specific to a collection of difficulties in the battery supply chain that limit production. Currently battery manufacturing is constrained by simple production under-capacity, raw material availability, and technical immaturity.

Finally, the electrical grid itself is likely not suitable for large-scale adoption of electric cars. While not a constraint in the near term where numbers will be limited, the grid will require large investments over time to respond to the increased overall demand and the specific use patterns of the electric fleet. This investment will be passed along to the consumer, and if it is specifically passed to electric car owners, plug-in vehicles will lose a degree of their fuel cost advantage.

2.2.2.2 Estimates

Having presented some of the forces affecting plug-in vehicle adoption, we present three studies – one sponsored out of the Department of Energy (referenced as 'Sentech' below), one from the National Academy of Sciences, and one from an electricity industry group – that estimated the future US plug-in fleet. Each ignores the possibility of revolutionary technology, geopolitical upheaval, or large domestic political shifts. Even without such large market distorting events, we see that each presents a collection of highly variant alternatives.

Noticeably absent are any assessments by the automakers themselves. Such analyses would be proprietary and closely held, but the vastly different approaches the automakers themselves are taking with fleet electrification shows that not even they have a handle on what the market is going to look like in the coming decades. GM entered the EV market in the 1990s with the EV1, but discontinued the model. Non-plug-in hybrids first emerged in the late 1990s. Toyota made the explicit early decision not to include a plug on the Prius, but has reconsidered the decision for future models due to this year's introduction of GM's PHEV Volt. Nissan is skipping hybrid technology altogether with its EV Leaf this year.

The point here is that automotive market experts and even the automakers themselves are uncertain as to what the future holds for plug-in vehicles. The County, therefore, cannot expect to develop a good estimate of plug-in vehicle market penetration, and, as such, it should adopt a posture that does not hinge on a particular estimate.

To provide context for these studies, sales of new passenger vehicles in the US totaled roughly 17 million units annually from 2000 through 2007. With the general economic downturn, that total fell to 13.5 million in 2008 and 10.6 million in 2009 (Census, 2011). Roughly 250 million such vehicles are currently registered in the US (Census, 2011).

Figure 2 summarizes our source studies.

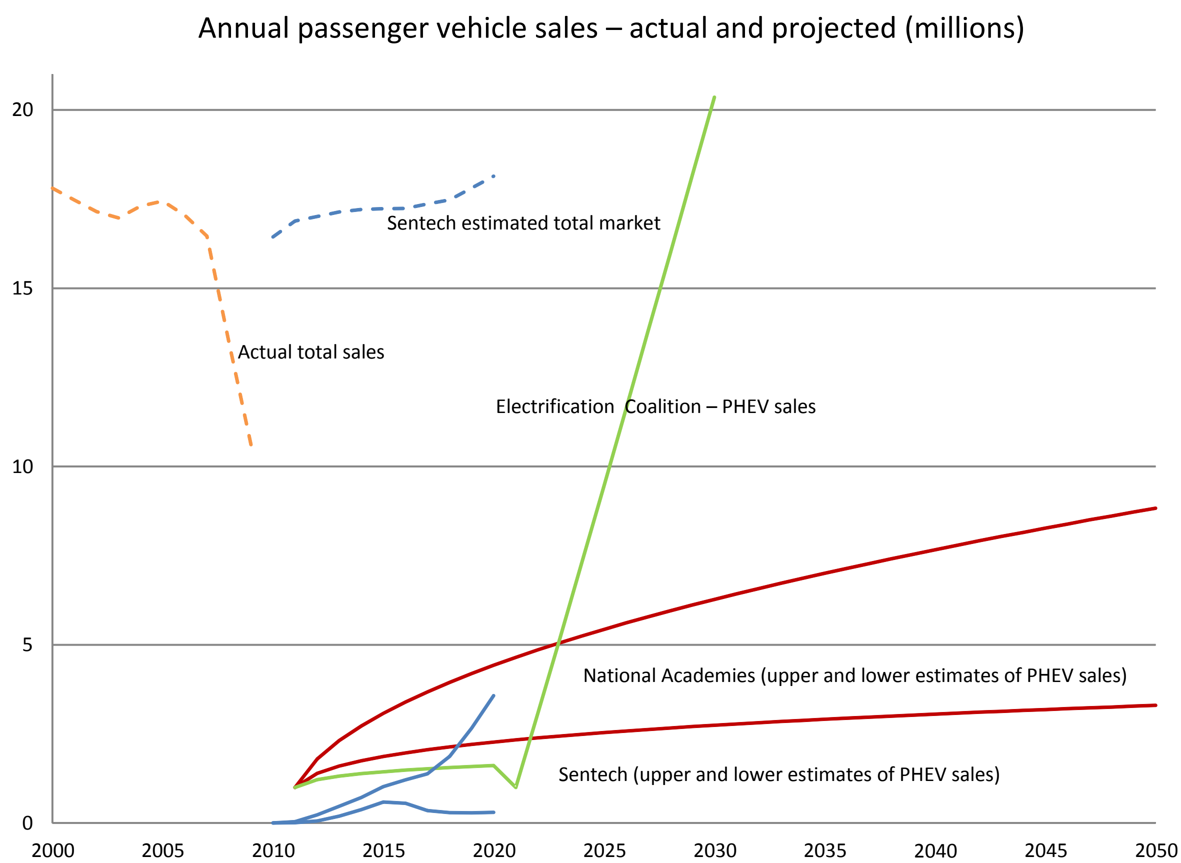

Figure 2: Annual passenger vehicle sales – actual and projected (millions)
Sources: US Census, 2011; Sentech, 2010; derived and estimated from National Research Council, 2010; derived and estimated from Electrification Coalition, 2009.

The various studies estimate PHEVs to represent anywhere between 2 and 20% of 2020 sales, with estimates diverging dramatically afterwards. The point of showing the disparity between (and even within each of) the studies is to demonstrate the difficulty – if not impossibility – of Fairfax generating an estimate of plug-in vehicle adoption good enough to proceed with large scale installation of charging infrastructure. Instead, as we recommend below, the County should strongly encourage the development of infrastructure that allows for the minimum of retrofit costs and, therefore, the lowest long-term cost of fleet electrification and necessary charging station availability.

2.3 Charging stations

Charging stations constitute the plug-in vehicle's connection point to the grid. Table 2 shows a summary of the three general classes of charging stations (Virginia Clean Cities, 2010).

Level of Charging	Level 1	Level 2	DC Fast Charge (Level 3)
Voltage	120 VAC	240 VAC	480 VAC (off board charger provides AC to DC conversion)
Amperage	15 - 20 Amp	40 - 80 Amp	85 Amp
Instantaneous Demand	1.2 - 1.6 kW	3.3 - 7.7 kW	60 kW
Charge Time			
PHEV 40 Vehicle	5 - 13 hours	2.5 - 5 hours	N/A
EV100 Vehicle	8 - 15 hours	3 - 5 hours	15 to 30 minutes

Table 2: Charging station summary

Level 1 can be as simple as a standard three-prong plug into a standard wall socket (Level 1 EVSE does exist to improve safety and improve grid integration, but it does not improve charging speed). The time required to fully charge a vehicle at Level 1 makes it an impractical general solution.

Level 2 is the answer to this impracticality. There is a defined standard (Society of Automotive Engineers J1772), and mass produced plug-in vehicles have sockets to fit. Despite their high current rating, the power demand shown is indicative of practical use where less current is used to improve longevity of the battery itself (not the individual charge). Level 2 is the assumed primary mechanism for most charging as it strikes a balance between practical speed and battery protection. It is intended for installation in the home and at other locations where the car is expected to sit unused for a number of hours at a time.

Level 3 is not yet standard, though multiple competing standards have emerged. It is the closest analogy to the current gasoline pump. Multiple rapid charges, however, negatively affect the longevity of current batteries, and so such chargers are assumed to be of use primarily in emergencies (Burke, et al, 2007; Hybrid Cars, 2010).

2.4 Construction costs

Construction costs serve as the final bit of input data for the analysis. Cost estimates for the parking structures help frame the analysis. The estimates are drawn from industry standard resources (RS Means CostWorks) and from private historical databases belonging to builders MITRE uses for our own construction efforts. They include design, construction, and labor. They do not include the cost of the land itself.

Table 3: Per parking space new construction estimated costs

	Estimated per space new construction cost
Below grade garage	$33-38k
Above grade garage	$12-17k
Surface lot	2.5-3.5k

With regards to the installation of plug-in vehicle charging infrastructure, the intent is to minimize the overall cost of establishing adequate charging supply. EVSE can be fully installed during initial construction, but if the demand never makes full use of that charging supply, money is wasted. EVSE can also be retrofitted into a building later when demand emerges, but retrofit is more expensive than is inclusion during initial construction. The per space construction costs (Table 3) must be borne regardless of whether EVSE is considered during initial construction or whether it is to be delayed for retrofit. The analysis thus turns on the difference between installation during initial construction and installation as part of a retrofit.

It turns out that conduit installation drives the higher costs of retrofit. It is far cheaper to embed conduit during initial construction than it is to drill through concrete (in a garage) or dig a tunnel and resurface asphalt (in a surface lot). The cost of installing transformers, switches, cable, and the charging stations themselves are equivalent whether they are being done during initial construction or as part of a retrofit. So, since we are considering the difference between initial construction and retrofit, we focus on the additional per space cost imposed by conduit installation.

Table 4 shows the estimates of the costs incurred during initial construction and during retrofit. Again, we rely on a mix of industry standard sources (RS Means) and the private historical databases of contractors with whom we have relationships.

Table 4: Additional per space estimated cost of EVSE conduit installation during…

	Initial construction	Retrofit
Surface lots	$1800	$2900
Garage	$400	$1200

The differences between garage and surface lot installation are a consequence of the fact that the conduits must be buried in a surface lot installation. In the garage, the conduit can be attached to the ceilings or wall.

3 Assumptions

This analysis rests on the fundamental assumption that plug-in vehicles will become widespread only if they become as convenient and economical as other non-plug-in vehicles (internal combustion and traditional hybrids). Likewise, plug-in vehicle charging infrastructure will only emerge where and when profit can be derived (after all, we couldn't put gasoline in our cars if we didn't put dollars into someone's pocket in the process). This simple notion leads to a number of consequences that affect the recommendations.

We further assume that plug-in vehicle owners will have the ability to fully charge their vehicles at home. Without that ability, the owner would be utterly reliant on an infrastructure that currently does not exist and will emerge in some currently unknown form. We accept our infrastructure dependence with internal combustion engines because most areas are saturated with gas stations and because the time to fill a car for a range of multiple hundreds of miles is minimal. These conditions are not satisfied for the plug-in fleet, and so home charging is a must.

3.1.1 Charging is done at home

With the assumption that the plug-in vehicle owner will spend the money to establish a charging capability at home, the question is how much he will rely on commercial charging stations.

If we consider only convenience, even a Level 3 charging station will likely require 30 minutes to fill an EV100. It is unreasonable to assume plug-in vehicle drivers will line up to fill the batteries before the commute home every day. Additionally, Level 3 rapid charging reduces the battery's useful lifespan (Burke, et al, 2007; Hybrid Cars, 2010). So between the impracticality of the charger and the wear it induces on the battery, we conclude that Level 3 charging (at least in the context of Fairfax County) will be an emergency activity for only a small fraction of plug-in vehicles in the near future.

So we turn to Level 2 charging, where we accept longer charging times and charge where we spend most of our time: at home and at work. Cost considerations push the driver to charge at home in this case. If charging stations become widespread, Dominion will impose time-of-day pricing on the charging station owners (Dominion, 2011). This helps to control peak demand, and it prevents a political fight over raising other rates to provide flat-rate pricing on charging stations. Since most drivers are away from home during the day when wholesale electricity prices are higher, the electricity they use away from home is more expensive.

While the electricity consumed away from home is itself generally more expensive, the fact that the charging station is owned by a for-profit entity – remember, money has to be made – also increases the cost of away-from-home charging. The charging model may simply be the price of electricity plus some fee (now that electricity resale is legal in Virginia for this application) (Virginia, 2011). It may also be in the form of a per session fee, a per minute fee (to absorb the opportunity cost of a car blocking the station but not charging), or an access rights model. In any of these cases, the charging station owner passes along the cost of electricity and then turns a profit for himself. Indeed, home charging is the cheapest charging.

3.1.2 Geography and drivers for focus

We now return to the map in Figure 1 **Error! Reference source not found.**to consider the effects of the home charging predominance.

All PHEV and BEV drivers who live in Tysons Corner will primarily charge their vehicles in Tysons Corner at night. The majority of people living in Tysons Corner will reside in large multi-family buildings and, therefore, do not have the individual option to install their own charging station if the building has not already either provided a charging station or the infrastructure into which a charging station can easily be installed. Thus, the County should put particular focus on residential buildings. If charging stations are not available to allow owners to charge their vehicles overnight, they cannot purchase plug-in vehicle, nor can people who already own plug-in vehicles tenant the building. This both slows new adoption of plug-in vehicles and potentially makes the area less attractive to people moving here from locations with better charging resource availability.

Moving outside of Tysons Corner itself, non-residential charging stations encourage PHEV adoption, but they are not sufficient. They make the commute less expensive – electric-only retains a price advantage over gasoline-augmented operations here in Tysons Corner even with a profit-making charging station on a hot summer afternoon (PJM, 2011; EcoWorld, 2006; Toyota,

2011) – and, therefore, build the case for plug-in vehicles, but they are not a necessary condition since the vehicle can continue with its internal combustion engine.

The savings are a function of the electric-only range of the PHEV (the pluggable Prius will be a PHEV12; the Chevy Volt at PHEV40) and the commute distance. The outer extreme of this case is represented by the 20-mile (40-mile return commute) ring which includes all of Fairfax, Arlington, Alexandria, and the District and contains about 65% of the Tysons Corner workforce (we do not have data granularity to estimate the fraction of the Tysons Corner workforce within the 6-mile ring). For commutes less than half of the electric-only range, the non-residential chargers in Tysons are of no use; the charging is done at home. For commutes longer than half of the all-electric range, the non-residential charging stations simply reduce the operating costs of PHEV.

Turning now to all-electric vehicles, the 40-mile and 80-mile rings are of interest. The 40-mile ring is the effective half range of an EV100. EV100 owners inside this ring will require little in the way of charging infrastructure in Tysons. They will charge at home. Roughly 90% of Fairfax's workforce resides within this ring.

At the 80-mile ring (and this may be generous), we reach the effective outer range of the EV100 vehicles. A commuter originating between the 40-mile and the 80-mile rings (roughly 8% of the current workforce) will require charging resources to return home. Outside the 80-mile ring, the trip will not be attempted, and the County can safely ignore such drivers.

In summary, the Tysons Corner charging stations service distinct groups for distinct purposes;

- PHEV and EV ownership within Tysons Corner is made feasible with residential charging. There can be no plug-in ownership without home charging.
- Charging stations available to non-residents make the commute cheaper for PHEV drivers who come from further than half of their all-electric ranges. PHEV owners from inside this distance are unaffected by Tysons Corner charging infrastructure since they can fully charge at home.
- Commutes to Tysons Corner are made feasible for EV owners who live between 40 and 80 miles away. Otherwise outside EV owners are relatively unaffected by Tysons Corner charging infrastructure.

3.1.3 Technology evolution

These rings represent the state of 2011 technology, but a building shell is likely to be used for 40 to 50 years, so what happens as technology improves?

In general, improved battery and charging station technology will increase overall demand for plug-in vehicles and, therefore, charging infrastructure. An inspection of the rings, however, reveals consequences for Tysons Corner in particular.

Within Tysons Corner itself, improved technology will increase the fraction of resident vehicles that require home charging, and, any new residential building should assume that a large fraction of the resident fleet will be electric in the coming decades.

In thinking about the population commuting into Tysons, we consider the cases of charging speed and battery capacity independently.

If battery capacity improves, the rings move further out, but the effect on aggregate demand is indeterminate. Drivers from more densely populated inner rings that would have previously used commercial charging stations no longer require that capability to return home. At the same time, plug-in drivers from less densely populated outer regions are newly within range of Tysons. This would indicate a net reduction in demand, but it must be assumed that as technology improves, the total fraction of vehicles that are plug-in will increase.

If charging speed improves then quick charge stations become more feasible, and the infrastructure begins to resemble more that of the current gasoline infrastructure. This may reduce demand for Level 2-style stations at office and retail locations, but it will not affect demand for home charging as home charging will still be the cheapest, most convenient charge mechanism.

If replaceable batteries become more prevalent, then some hybrid of home charging and swap stations will likely emerge. Home charging infrastructure is still required, but the fewer charging stations are required at offices and at retail location. To date, however, no vehicle on the market or proposed for the near future market features such batteries.

4 Policy recommendations

The County's development requirements and expectations must balance with the County's other objectives. The county wants to attract business and residents, so the costs it imposes cannot be too high. The county may want to enable and encourage the electrification of region's automotive fleet, so the charging infrastructure it requires should not lag or inhibit demand.

Here, we attempt to strike a balance between these objectives and recommend a course of action for the County. Having described the environment in which these decisions are made and described the assumptions underpinning our analysis, we present our policy recommendations here. We propose a long term, sustainable course; a plan for the short term; and recommendations for data collection, which will aid future market analysis of charging station demand.

4.1 Long-term recommendation

4.1.1 General

As we saw in the background sections above, considerable uncertainty exists regarding the adoption of plug-in vehicles. This uncertainty induces large financial risks for anyone installing and operating a commercial charging station. If demand is lower than expected, the charging station is a wasted investment. If demand is higher than originally expected and if the infrastructure into which additional charging capacity would be installed is constrained, then there exists a retardant on plug-in vehicle adoption. This uncertainty also induces political risk for the County. If it undertakes any strategy that depends on some assumption of adoption, a critic can always find a competing study arguing for more or less charging structure.

The best long-term policy response then is one that does not require the County, a resident, or a developer to estimate vehicle adoption or charging station demand. Here, we propose recommendations for initial building construction that are intended to reduce the risk associated with uncertain charging station demand.

The proposed building recommendations are intended to reduce the overall cost of electrifying a parking area with Level 2 charging stations, while allowing the owner or third-party to match demand with investment over time by installing charging stations at minimal cost in the future. In the long-term case, profits can be earned with commercial charging stations. The objective of minimizing future installation costs is to increase the quantity and reduce the price at which supply and demand are equivalent.

Initial parking area construction satisfying three conditions is relatively inexpensive and serves as a basis for future installation at least expense. The following conditions are thus recommended:

- A newly constructed facility should have the physical space to allow the installation of enough transformer capacity to enable intended operations as well as allow electrification of the parking area. The transformer capacity to fully electrify the lot, however, need not necessarily be installed during initial construction. Full installation can occur as demand emerges in the future.
- The building's electrical room should have enough physical space to allow the future installation of a switchboard (with the capacity for sub-metering) for the charging stations. Again, the full switchboard need not be installed immediately.
- Initial parking area construction should include the conduit bank and conduit between the facility's electrical room and the spaces allotted for possible future electrification. An access point (junction box or hand hole) at each possible future charging station location is recommended. Access points (manholes, hand holes, and junction boxes) to draw cable from the electrical room to the charging stations are recommended as well.

The recommendations are a hedge against the uncertainty of charging station demand. The installation of conduit and access points are the primary drivers of difference between the cost of installing a charging station during initial construction and installing one in which the whole of the system is retrofit into a facility. The intent of the recommendation is that of insurance. If the cost is low enough, even if the lot is never electrified, the lost investment is bearable, but if large demand for charging stations indeed emerges, the recommendations greatly reduce the cost of servicing that demand.

4.1.2 Building class specifics

The transformer space and empty conduits are relatively small investments during initial construction, but they are not zero. Here, we consider the various classes of buildings and offer bounds on the fraction of parking spaces that should be designated for future charging station installation. In a previous section, we noted the three classes of plug-in vehicle drivers who will use the Tysons Corner charging infrastructure: Tysons Corner residents, PHEV drivers who live further than half of their all-electric ranges from Tysons Corner, and EV owners who live between 40 and 80 miles from Tysons Corner. They define the need.

4.1.2.1 Residential

It is with the development of residential buildings that the County should be most aggressive in negotiating for commitments from developers. Plug-in vehicles require home charging. If home charging is not available, there will be no plug-in vehicles.

Given the uncertainty of future demand, for residential development, we propose that the transformer space, switch space, and conduit recommendations in the previous section apply to all newly constructed parking spaces. The objective is to allow an inexpensive, full migration to a plug-in fleet within the lifespan of the parking area. In Tysons Corner specifically, since most parking will be in garages – and likely underground garages at that – the cost of this conduit infrastructure is a tiny fraction of total cost, and its initial inclusion is roughly 30% of the costs of retrofit (see Table 4).

Though this analysis is focused specifically on Tysons Corner, we strongly recommend that all residential development (single family homes, townhouses, condominiums, and apartments) in broader Fairfax be subject to this guidance on conduit and space. Because of the dependence on home charging, we have to assume that long-term homeowners will constitute the bulk plug-in vehicle buyers as they have the stability to assume access to home charging for the whole of the vehicle's lifespan. Apartment dwellers may be less inclined to purchase plug-ins because they are generally more transient. The availability of a charging station at the next home is unknown, and without home charging a plug-in becomes impractical. Thus, the payoff for the policy is likely to be highest in developments where the owners are the occupants.

In the house, townhouse, and condominium markets, the developer, by definition, is not the long-term owner of the residence, and so he has the incentive to respond only to current market pressure. The installation of conduit during initial construction is an insurance policy against possible future market forces. Though the developer's cost of initial installation is a larger fraction of the overall construction cost for most home applications – presumably such costs are more in line with surface lot installation – the existence of such conduit greatly affects future adoption rates of plug-in vehicles since any retrofit costs implied by the purchase of a plug-in vehicle will depress demand. Such conduit is not yet a selling point for homes in the region, however, and so it is not yet a commonly-offered feature. Thus, to minimize hurdles to widespread adoption, the County is wise to strongly encourage the inclusion of conduit for all residential development across the county.

4.1.2.2 Commercial office buildings

For commercial office buildings, we recommend the transformer, switch, and conduit recommendations apply to 35% of newly constructed spaces – the fraction of spaces equivalent to the fraction of vehicles that arrive into Tysons from outside 20 miles. This would allow the full adoption of plug-in in the fleet arriving from outside the 20 mile ring (inside of which the Tysons charging infrastructure largely unnecessary). As zoning ordinances are modified in coming years – presumably, with the arrival of Metro, reducing the number of spaces required for an office building – this fraction would rise on the newer, smaller lots since more of the incoming vehicular traffic would be from outlying areas not served by Metro.

4.1.2.3 Retail

Most retail activities are substitutable across the Mid-Atlantic region, and so we have to guess that most retail customers in Tysons Corner live within a short radius. However, since retail is fundamentally about attracting customers to a particular destination and since the higher prices of plug-in vehicles imply relatively affluent buyers, retail developers have the incentive to make an adequate number of charging stations available. We thus assume that retail development will require the least nudge from the County to provision for charging stations.

Should the County find itself in the position of having to provide that nudge, we recommend the same guidelines as those for office buildings with conduit infrastructure being encouraged for the fraction of vehicles coming from outside a 20-mile radius. That fraction of traffic, however, is unknown and certainly not presented in the Census resources from which we can determine work commuting patterns. Thus, the county is wise to work with its retail base to determine the source of the populations inbound for retail.

4.1.2.4 Hotels

Hotels offer the logistical opportunity for a Level 2 charge. We do not have any data describing the mix of vehicles that park in Tysons Corner hotels, so instead, we recommend that the County work with hotels in the region to determine need, with the need for conduit installation being primarily defined by the rental car population in a hotel's garage.

4.1.3 Charging station standards

The definition of a standard connection point for the charging station to the vehicle (SAE J1772) has been a necessary step towards the widespread adoption of plug-in vehicles. Without the standard connection point, drivers of the various plug-in models would have to carry around various connectors and adaptors in hopes of accessing charging resources more potent than a standard wall outlet.

We propose that the County coordinate with peer jurisdictions, which are also looking to ease the widespread adoption of plug-in vehicles, in an attempt to force a standard connection point for the charging station itself to the facility into which it is to be installed. The connection point is both the electrical connection and the piece by which the station is physically mounted to the wall, ground, or ceiling. The first and most obvious purpose is simply to reduce the overall cost of installation.

The second purpose of a standard mount is to allow for easy movement of charging station to a new location. We see the standard mount allowing multiple business models that reduce the risk associated with uncertain charging station demand. A third party vendor may manage a fleet of charging stations that it deploys and adjusts to service demand for multiple facilities. An apartment management company may rather provide a connection point and allow plug-in drivers to attach their own (sub-metered) charging stations, so that it does not have to deal with the risk of too many or too few charging stations. In both cases, the facility owner eliminates his need to monitor and respond to developments in the plug-in vehicle marketplace, and the flexibility afforded by a quick, easy installation ensures that supply is more responsive to demand.

From a driver's perspective, the standard mount also reduces risk. As the standard mount becomes more widespread, a plug-in owner knows he can take his charging station with him should he decide to find to a new home, and he knows he can sell his charging station to another plug-in owner should he no longer need the station or upgrade the station. Because the risk of vehicle ownership is potentially decreased, demand for plug-ins is potentially increased.

The definition of such a standard is certainly not the responsibility of Fairfax or any local jurisdiction. The point in making the recommendation here is that Fairfax is in a position with its peer jurisdictions to encourage the charging station vendors to proceed along this path.

4.2 Short term

4.2.1 Charging stations – seeding supply

Plug-in vehicle adoption has always been considered a 'chicken and egg' problem with cars not being purchased because charging stations are not available and charging stations not being installed because of inadequate numbers of plug-in vehicles. Thus, the County may recommend implementation of a handful of charging stations at each new building site and proffers that deliver charging stations to public areas.

Above, we see that residential charging is the key to widespread plug-in vehicle adoption, and we reasoned that plug-ins are more likely (in the near term) to be purchased by people who own their own homes and intend to stay there for the lifespan of the car. If the County wishes to speed adoption by apartment dwellers inside Tysons Corner, it may recommend the installation of charging stations at new apartment developments. If so, we recommend that the number of full stations be equivalent to the lowest estimate of market penetration for plug-ins (see 2.2.2.2). The region may have a higher rate of hybrid adoption over the recent years, but that margin will be swamped by the broader trends which drive nationwide adoption. In the lowest estimate presented above, plug-ins are estimated to constitute less than 2% of cumulative sales, and so we recommend that the upper-bound of any County negotiation for fully installed charging stations be limited to 2% of the parking spaces at an apartment building in Fairfax. This is in addition to the strong recommendation for the conduit infrastructure.

For office and retail buildings, we have recommended the County pursue commitments to the provision of infrastructure that would allow for inexpensive charging station installation in the future. We do not, however, recommend any expectation for full station installation. Plug-in vehicle adoption will be a function of home charging capacity; charging availability at work or retail locations alone is not sufficient to allow adoption. Luckily, if we return to the map and the concentric rings, office and retail charging is only a necessity for BEV drivers who live between 40 and 80 miles from Tysons Corner (and only 8% of inbound Fairfax commuters live at that distance). For PHEV drivers who live more than half of their all-electric range from Tysons Corner, the charging stations would indeed reduce commuting costs, but we cannot believe that a prospective PHEV owner would purchase such a vehicle while being dependent on cheap workplace charging to make the economic case for purchase. Any proffer for provisioning charging stations thus supports a very small fraction of inbound commuters (BEV owners from 40 to 80 miles away) or a group of drivers who would have purchased their vehicles anyway (PHEV owners). The lesson is that for office and retail development, developers may be able to better benefit the community with proffers that include improvements other than the provisioning of a large number of charging stations.

4.2.2 County procedures

The County itself can continue to support plug-in adoption by continuing to maintain its current easy, efficient process for permitting electrical installations at existing facilities. Plug-in buyers need this process to make the installation of charging stations at home to remain as easy as it is. If the process is slowed, then adoption of plug-in vehicles will also be slowed.

4.3 Data generation and monitoring

A primary purpose of the recommendations would be to allow charging station deployment to coincide with charging station demand. This would allow the business justification for commercial charging capacity to emerge and, therefore, would make plug-in vehicle ownership more convenient (and feasible for a larger population). To speed the development of the business case, the County (to the extent possible within in the bounds of privacy concerns, proprietary competitive data, and simple data gathering feasibility) is wise to develop the mechanisms to gather and monitor data describing:

- A more precise understanding of the Fairfax work population and where it lives within Fairfax and within the nearby counties;
- The other inbound population of Tysons Corner and where it lives;
- Use patterns for charging stations as they are installed in Tysons Corner. Who uses them? When are they used? On what sorts of vehicles?
- PHEV and BEV registrations for Tysons Corner and the jurisdictions within 100 miles of the area.

With a good handle on this information, the County would be better positioned to respond to changes and trends in the emerging markets of commercial charging stations and plug-in vehicles. Potential charging business owners would be better able to gauge demand. And Dominion would be better able to understand its supply requirements.

5 Conclusion

We close with an emphasis on two points. First, no demonstrably accurate estimate of plug-in vehicle market penetration is possible. And second, when plug-in vehicles do arrive to market in large numbers, their owners will completely rely on, will prefer, and will predominantly charge them overnight at home.

These two points naturally lead to the recommendations

1. Developers should be strongly encouraged to include the space, conduit banks, conduit, and access points for easy and inexpensive installation of charging infrastructure in the future. They should not be asked to install the transformers, switches, wiring, or charging stations themselves, however.
2. The fraction of parking slots for which the infrastructure should be included should represent a fully plug-in fleet for the groups of users that would use charging infrastructure at the facility. This means all slots in a residential building. At commercial and retail facilities, this means the fraction of vehicles that arrive from locations geographically situated to require a charge before the return trip.
3. The County can most appropriately seed charging station supply by negotiating for the installation of full charging stations at the lowest expected adoption rate in the near future. Any supply seeding is most efficiently done at apartment buildings and should be limited to a maximum of 2% of all parking spaces.
4. The County should coordinate with its peer jurisdictions to encourage charging station manufactures to form a standard defining the connection of the charging station to the

facility in which it is installed. The standard should define both the electrical connection and physical mount with the purpose of making it possible to move charging stations to a new facility relatively easily and quickly.

The overall points are that transformer space and conduits are more expensive to retrofit into a facility than to include during initial construction. Their inclusion at the outset would allow the cheapest possible overall cost of installing a full charging infrastructure, and their inclusion in such quantity would be a low-cost insurance policy against the inability to estimate plug-in vehicle market penetration rates over the expected life spans of newly constructed buildings.

The County thus would ensure that development in Tysons Corner would remain an attractive investment and that the area would be fully prepared for whatever occurs with plug-in vehicle adoption.

6 Acronyms

BEV	Battery Electric Vehicle
BEV100	Battery Electric Vehicle with 100-mile range
EV	Electric Vehicle
EV100	Electric Vehicle with 100-mile range
EVSE	Electric Vehicle Supply Equipment
PHEV	Plug-in Hybrid Electric Vehicle
PHEV12	Plug-in Hybrid Electric Vehicle with a charge-depleting range of 12 miles
PHEV40	Plug-in Hybrid Electric Vehicle with a charge-depleting range of 40 miles

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