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better place

November 5, 2009

Via Email & Hard Copy
docket@energy.state.ca.us

California Energy Commission
Dockets Office, MS-4
Re: Docket No. 09-ALT-1
1516 Ninth Street
Sacramento, CA 95814-5512

RE: Docket number 09-ALT-1 Electric Drive Infrastructure Technical Workshop

Dear Sir/Madam,

Better Place would like to take this opportunity to thank the California Energy Commission (CEC) staff for their work in preparing the draft 2010-2011 AB118 Investment Plan and for this opportunity to offer our initial comments. Better Place strongly supports the CEC's commitment to electric vehicles (EVs) as reflected in its decision to allocate $46 million in incentives toward EV purchases and infrastructure in the 2008-2009 Investment Plan and in particular the $12 million for infrastructure. Electric vehicles powered by renewable energy offer the most cost-effective and environmentally responsible alternative to California's current transportation model.

As the CEC develops the 2010-2011 AB118 Investment Plan, Better Place recommends:

1) The inclusion of EV battery switch stations as eligible EV infrastructure option within the EV infrastructure category. This position was detailed in our correspondence of September 16;
2) The inclusion of EV management software and hardware as an option to provide "managed EV services" within the EV infrastructure category; and
3) Increasing the overall funding for EV infrastructure within the Investment Plan commensurate with the expected market entry of EVs in 2010-2012.

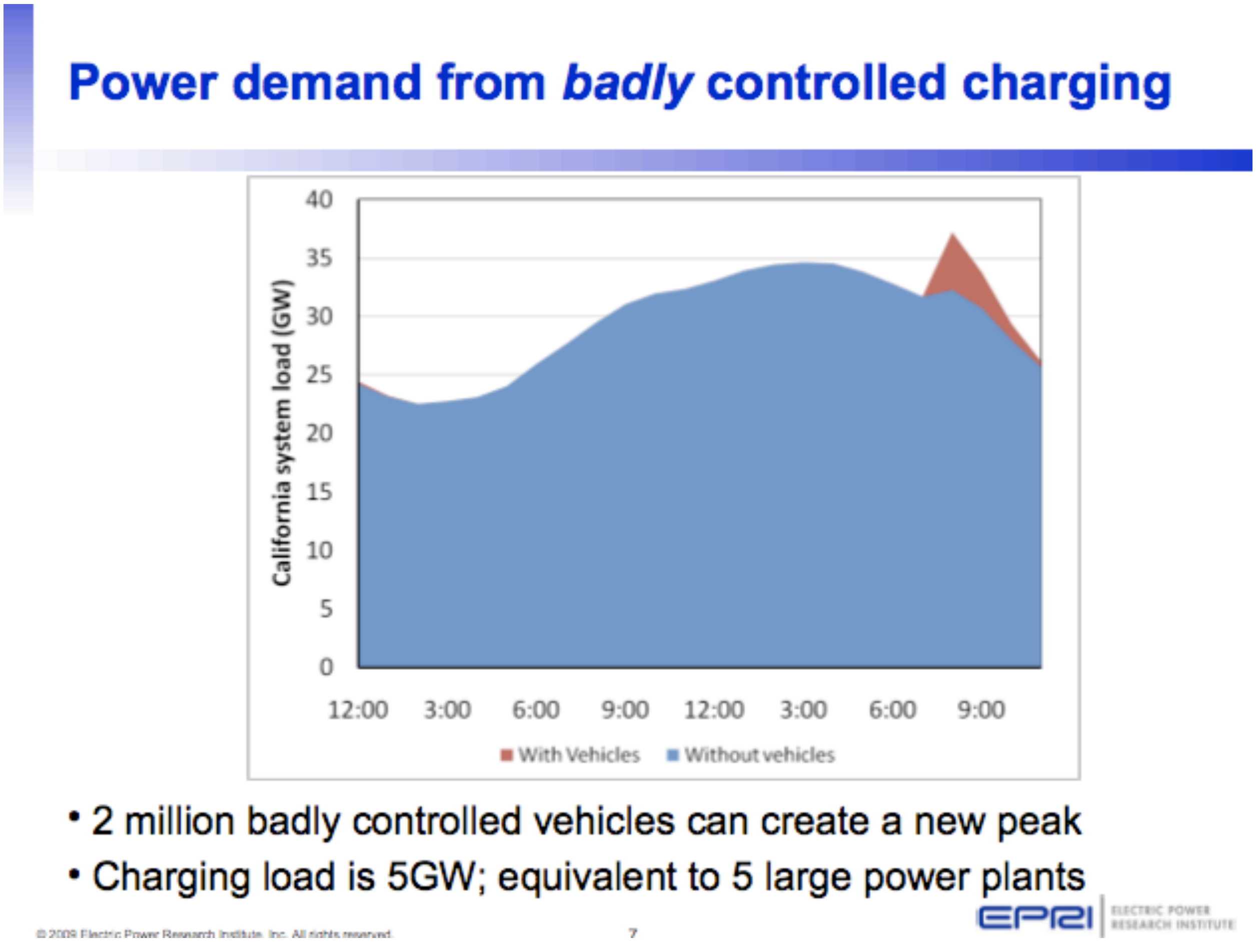
1. <u>Include Battery Switching as Eligible EV Infrastructure</u>

The rationale for battery switch stations was outlined in our correspondence of September 16. Since then, we have announced an agreement with Renault to facilitate the sale of more than 100,000 fully functional electric vehicles with switchable batteries for deployment in Israel and Denmark, our first two countries of launch, between 2011 and 2016. As an example of the positive impact switchable battery EV's have on accelerating mass adoption, over 50 major companies in Israel including IBM, CISCO and Nike, representing fleets of over 35,000 vehicles, have signed up to purchase these vehicles two years before the vehicles will arrive. It should also be noted that this single contract for 100,000 battery switchable EVs is approximately twenty times that of the total number of fixed battery EVs that were on California's roads during the last EV heyday of the 1990s and early 2000s. Finally, as detailed in our earlier correspondence, there are a number of major manufacturers like Mitsubishi Heavy Industries, Renault, and others that have all noted and are incorporating the benefits of battery switching, including California-based Tesla Motors.

2. Include EV Management Software and Hardware as Eligible EV Infrastructure

EV management software and hardware with the managed EV services they provide, are a necessary infrastructure component and the only means to both minimize negative impacts to the electrical grid, and to maximize the benefits EVs offer. These benefits include grid stability, demand response, renewable integration, ancillary services – all strategic priorities for the future while simultaneously providing a superior EV driver experience and minimizing cost. In essence, managed EV services aggregate and orchestrate the EVs to charge based on both the needs of the EV driver and those of the electrical grid. Of the three possible charging options, each discussed below, (uncontrolled charging, tariff directed charging and managed charging) only managed charging has the capability to both protect and enhance the grid, provide a superior EV driving experience and minimize costs to the EV owner/operator, utility and general public overall.

Uncontrolled Charging and Tariff Directed Charging – Charging is either not controlled and commences immediately upon plugging in or is directed by an electricity tariff (charging is directed based on a fixed pricing schedule). Both of these charging protocols are not sufficient to protect the grid. For example, in uncontrolled charging, a typical EV driver driving 40 miles a day (including commuting and errands), would tend to plug in upon arrival at home, typically between 4 and 7pm. Without EV management software, charging would begin immediately, at peak, and when done in mass or even on the order of ten EVs on a local electrical distribution network, this scenario has the potential to stress the electrical grid, leading to brownouts and blackouts. The California Public Utilities Commission is and has been aware of this issue and has required the Investor Owned Utilities (IOUs) and encouraged the municipality owned utilities to provide tariff directed charging in the form of time of use electrical rates (TOU) for EVs . Unfortunately, as illustrated by the following chart from Electric Power Research Institute (EPRI), once EVs are adopted in mass, tariff directed charging may lead to new peaks on the electrical grid.



Managed EV charging - Vehicle charging is controlled externally (rate and time) based on a large number of variables including other EVs on the network, their location, energy required, charge rate, current and future electricity supply (including generation, transmission and distribution impacts) grid stability, renewable energy integration, utility ancillary services, etc for the benefit of EV owner/operator, utility and general public overall. Using the above example, under a managed services scenario, the individual would still plug-in upon arriving home. The system, realizing that the EV had sixty miles of range (with a maximum one hundred mile range) and based on the historic knowledge of the individual's driving pattern, would then hold charging until midnight. It would use the vehicle from midnight to 2 am to perform ancillary services before going into full charging mode between 2 and 4 am to "harvest" wind-generated energy that would otherwise have been lost. At 4 am the vehicle would be fully charged, ready for use and a signal relaying same would have been sent to the driver's cell phone.

The Israel Electric Corporation has explored the issue of uncontrolled charging, controlled charging via a TOU rate and charging via managed EV services and produced the attached report. In summary, both the uncontrolled and TOU driven charging regime required additional generation, transmission and distribution to serve the EV load. Under the managed EV services scenario the need for additional generation and transmission was eliminated and the need for additional distribution was substantially reduced.

This has been likewise confirmed by NREL for plug-in hybrids in their Technical Report NREL/TP-550-46345, August 2009, "Field Testing Plug-in Hybrid Electric Vehicles with Charge Control Technology in the Xcel Energy Territory."

Given the above issues associated with EV charging, and the economic and environmental benefits of managed EV services, Better Place deems that it is appropriate to include the managed EV services hardware and software as a component of EV infrastructure within the AB 118 Investment Plan. It is the only way to fully utilize all the opportunities EVs provide including performing demand response, stabilizing the grid, increasing renewable energy penetration while simultaneously reducing our petroleum use and carbon footprint.

3. Increase funding for EV infrastructure within the Investment Plan Commensurate with the Expected Market Entry of EVs in 2010-2012

Given the number of EV models coming to the California market, the current EV infrastructure funding level is insufficient and should be increased. As the CEC is aware, in the last six months, there has been a large number of announcements related to EVs (both from OEMs regarding EV models and makes and from countries and regions allocating large sums for infrastructure funding). These announcements indicate how quickly the EV market is expanding. As such, California not only risks being unprepared, which may delay or worse, be the chasm that prevents the mass adoption of EVs but also sends a negative signal to EV support companies considering relocating or expanding in California. To avoid these potential pitfalls, California should increase the EV infrastructure funding within the AB118 Investment Plan.

OEM EV Announcements - EVs dominated the vehicle lineup at both the September Frankfurt Motor Show and October Tokyo Auto Show. "The electric car will account for 10 percent of the global market in 10 years," Carlos Ghosn, head of Renault-Nissan, told the BBC at the Frankfurt Motor Show. "…It is time for zero emission motoring." The sheer number of EV models displayed at these shows demonstrates the reality that EVs are coming. By increasing funding, California sends a strong signal not only that we want these vehicles to land in California first and but that we are preparing for the mass adoption of EVs.

EV Infrastructure Investments - Counties and regions are committing funds to install EV infrastructure to attract the initial limited supply of vehicles, to enable the potential for mass EV adoption, and create the support industries associated with EVs require. California, with our history of embracing clean/ green tech, should do likewise. For example, France announced in early October that they will spend approximately $2.2 billion to install a network of EV charging stations across the country. In addition, they are requiring the installation of charging stations in office parking lots by 2015, and new apartment blocks with parking lots will have to include charging stations beginning in 2012. This is part of a broad initiative to encourage the development of clean vehicle technology and battery manufacturing in the country. California should likewise provide a similar level of support for EVs.

In summary, we recommend that in the 2010-2011 AB118 Investment Plan, the CEC include battery switch stations, software and hardware to provide managed EV services plus increase the overall funding for EV infrastructure. Inclusion of these technologies and increasing the EV infrastructure funding will in turn increase the EV allocation to California, attract EV support industries plus dramatically increase both EV adoption and utilization rates while furthering the CEC's long-term goals of reducing California's greenhouse gas emissions and petroleum dependence.

Should you have any questions, please do not hesitate to contact Sven Thesen at (415) 225-7645 or myself.

Cordially,

Jason Wolf

Head of Better Place California

CC:

Leslie Baroody, CEC lbaroody@energy.state.ca.us

Peter Ward, CEC pward@energy.state.ca.us

Israel Electric Corporation Ltd.
Engineering Projects Division
Business Development Unit

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No. 2008-1095

Feasibility Study for the Better Place Company's Electric Car Project

Prepared by:

Ilan Avraham – Dan District

Sanda Harel – System Administrator

Daniel Kotek – Planning, Development and Technology Division

Sagiv Ben-Arie – The Business Development Unit

Israel Electric Corporation Ltd.
Engineering Projects Division
Business Development Unit

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Israel Electric Corporation Ltd.
Engineering Projects Division
Business Development Unit

Executive Summary

We examined the impact of the electric car project on the Israel Electric Corporation's electricity generation, transmission, transformation and distribution systems in 2011, 2015 and 2020, respectively. The impact was examined vis-à-vis three theoretical scenarios defined by the Better Place Company.

1. <u>Random charging and random consumer behavior scenario</u>
   In this scenario, no centralized entity exists that controls the times at which the charging is performed, and in effect, the charging of a car begins the moment the owner connects it to a power source, and continues until the battery finishes charging (at which point trickle charging continues with a very low current) or disconnection of the car from the power source, whichever is first. Under this scenario, most of the battery charging is expected at two main times: upon the arrival of the car at the owner's workplace in the morning, and upon the arrival of the car at the owner's place of residence.

2. <u>Random charging and rational consumer behavior scenario</u>
   In this scenario too, no centralized entity exists that physically controls the times that charging is performed. However, economic incentives exist in the form of tariffs. 30% of car owners will adjust the time they charge their cars to the cheaper tariffs while 70% of car owners will charge their cars immediately after parking.

3. <u>Controlled charging scenario</u>:
   In this scenario, an optimal battery charging plan exists for each car that takes into account the state of the battery, the expected journey length until the next charging spot, and the state of the local and national electrical system.

It is emphasized here that no feasibility check was conducted on the scenarios, nor was any assessment made of the motives in customer behavior characteristics, nor were the "tools" or measures dealt with that could ensure some or other behavior on their part, and which constitute an essential condition for the implementation of scenario 3.

<u>Results</u>
In the area of electricity generation, the first scenario will necessitate the setting up of seven new generation units with an overall power output of 2,345 Megawatts by 2020. The second scenario will necessitate the setting up of six new generation units with an overall power output of 1,770 Megawatts until that year. The third scenario will not require the setting up of any new generation units.

In the area of transmission and transformation, the first scenario will necessitate the setting up of a new 400/161 kV switching station, 10 new substations and another 18 transformers in existing substations by 2020. The second scenario will necessitate the setting up of a new 400/161 kV switching station, seven new substations and another 13 transformers in existing substations by that year. The third scenario will not require the setting up of any new infrastructures whatsoever.

In the area of distribution, all the scenarios will necessitate additional infrastructure comprising distribution transformers and medium and low voltage cables on a large scale, to the point of doubling the Israel Electric Corporation's expected pace of work. However, the quantities of infrastructures in the third scenario are significant less than those in the first and second scenario. Thus, for example, in 2020, the first scenario will require 2,158 km of medium voltage cables compared with 1,581 km required in the second scenario, and compared with only 287 km required in the third scenario in the same year.

Conclusion

The project will require the extensive addition of electricity distribution infrastructure in all cases. The more random the charging and the more random the customer behavior, the greater the scale of the investments required in the generation, transmission/transformation and distribution segments.

I. Background

1. Better Place approached the Israel Electric Corporation (IEC) with a request to conduct a feasibility study for the electric car project in terms of the project's impact on the electricity supply chain. Specifically, the IEC was asked to assess the following issues (from the application document dated July 28, 2008 enclosed in Appendix A):
   a. What would the impact of the electric car be on the distribution and delivery systems?
   b. What would the impact of the electric car be on the energy generation system?

2. As a result of this request, a process was set in motion to define the characteristics of the study, receipt and assessment of the data and their validation against IEC data, analysis and drawing of conclusions.

II. Study execution principles

1. The study was executed subject to the data and scenarios supplied by Better Place. **This document does not constitute confirmation/recognition by the IEC that the data/scenarios are indeed those that will effectively be implemented in practice**. Moreover, other data/scenarios would have different implications for the different aspects and segments of the electricity supply chain.

2. The study is a preliminary one confined to specific issues, based on theoretical data, and before the execution of a pilot in the field.

3. The study's methodology, and the method of execution were based on the principle of a comparison between two key variables: the power outputs expected to be required from the Better Place project on the one hand, and the energy generation, transmission, transformation and distribution capacities reflecting the forecast demand trends (without the project's impact) on the other hand - while all of these variables are subjected to several scenarios.

4. The result of the methodology is that for every comparative section, based on a common denominator, we will be able to formulate the scale of the project's inputs versus the scales and characteristics of the expected electricity supply chain and consequently to quantify the answers to the questions at the heart of the study.

5. Variable A: the power outputs expected to be required were calculated on the basis of data transferred by Better Place to the IEC, broken down according to points in time in the project's development, charging behavior characteristics, and technical data about the charging power outputs and efficiency, quantities of cars charged, and the charging location. All this data, as well and as the points in time and charging characteristics that form the basis for the calculations for variable A mentioned above, come under the sole responsibility of Better Place.

6. Variable B: the IEC capacities were based on the development plans approved by the IEC, at the time of the writing of this study, in the areas of energy generation, transmission and transformation at the points in time corresponding to those defined by Better Place. The IEC's distribution capacities were based on existing characteristics and criteria of the ratio of power generation to transmission to transformation and to distribution. That is, the underlying assumption for distribution was based on maintaining the ratios of the power outputs, transformation, distribution and supporting infrastructure throughout the electricity supply chain, as they exist today.

7. The above logic also gives rise to the method of the study's execution, the work and its chronology:
   - Calculations of the power outputs expected to be required by Better Place broken down according to three points in time representing the scale of the project's market penetration and three different charging characteristics.

- After the formulation of Variable A and all its characteristics, and quantification of its inputs, they were examined in relation to the components of Variable B.
- An analysis of the comparison's findings led to the study's conclusions presented below.

III. Underlying Assumptions, Explanations and Clarifications

1. For the purposes of the study, we assumed that a fixed ratio would be maintained between the density of IEC customers, the density of the distribution network and the density of the energy consumption.

2. The study assumes that the nature of the curve for existing demand, without the impact of the electric car, according to the seasons of the year, the time of day, and weekdays versus weekends/public holidays, would be maintained.

3. The study is based on Better Place's forecast for the extent of the project's market penetration at the following points in time: 2011, 2015 and 2020. Any change in the scale of penetration at these points in time will naturally change the significance of the project's influence on all the components of the electricity supply chain.

4. The study focuses on the electricity supply chain infrastructure issues and capacities, and does not express any assessment about the implications or about Better Place's commercial, business or operational intentions. It also does not deal with commercial/ tariff aspects on the IEC side.

5. It must be assumed that there will be changes in the system of tariff incentive tools and in the arrangements for regulating the loads that exist today, in terms of new customer sector exposure and in terms of adding of tools or greater use of existing tools. In this regard, apart from the fact that the study does not deal with the tariff aspect, it also ignores the fact the possibility that if changes are made to the tariff system, they will also affect the existing demand patterns.

6. The study is based on three battery charging behavior characteristics (scenarios) formulated by Better Place, and also on a fixed ratio between battery charging at charging spots and battery exchange stations. In this context, it is important to point out that:
   a. These specific behavior characteristics were formulated by Better Place, and the IEC has no assessment as to the extent of their validity, nor is it the IEC's role to assess their feasibility.
   b. According to Better Place's instructions, no sensitivities were calculated in respect of these scenarios.

c. The differences between the charging behavior characteristics, according to Better Place, derive from the degree of the guiding hand and the savings driving customer behavior (see the protocol of August 18, 2008 in Appendix B):

- Random charging and random consumer behavior scenario.
- Random charging and rational consumer behavior scenario.
- Controlled charging scenario.

However, the study does not assess the motives for the customers' behavior characteristics and does not address "tools" or measures liable to contribute to this or that behavior on their part. The study's conclusions address the scenarios presented by Better Place, but this in no way constitutes justification and/or a recommendation and/or assessment in regard to the use of these or other measures to steer customer behavior. It is not within the scope of this feasibility study in particular, or of the IEC in general, to assess whether this or that customer behavior is driven by tariff incentives and/or by a service model managed or provided by this or that entity.

IV. Work Method

1. On July 30 2008, August 18, 2008 and September 1, 2008 (see appendixes B, C and D, respectively), Better Place transferred to the IEC the data constituting Variable A: the characteristics of the power outputs expected to be required by the project, according to a breakdown by specific points in time and by scenarios.

2. The data was used as the basis for calculations of the power outputs required according to the various breakdowns, and additional clarifications were required.

3. A coordination meeting was held with Better Place representatives to obtain Better Place's approval for the calculation framework used by the team as the basis for calculating the power output required from the Better Place project. The approval was given (a summary of the meeting is presented in Appendix E).

4. The implications of Variable A in respect of Variable B were analyzed in the following areas: generation, transmission, transformation and distribution.

V. The Power Outputs and Energies Expected to be Required by the Better Place Project

1. The underlying assumptions are based on data received from Better Place and on additional estimates[1] (for the quantitative primary data, see Appendix F).
2. Required power outputs according to the scenarios[2] (for details, see Appendix G).

2011	Scenario 1 (Megawatt)	Scenario 2 (Megawatt)	Scenario 3 (Megawatt)
Week days 08:00-13:00 and 15:00-20:00	24.6	17.3	
Weekend 10 hours per day	15.4	10.8	
Off-peak 3,420 hours per year	(+) 2.6	7 (+) 2.6	23.5 (+) 2.6

2015	Scenario 1 (Megawatt)	Scenario 2 (Megawatt)	Scenario 3 (Megawatt)
Week days 08:00-13:00 and 15:00-20:00	246	173	
Weekend 10 hours per day	154	108	
Off-peak 3,420 hours per year	(+) 26	70 (+) 26	235 (+) 26

2020	Scenario 1 (Megawatt)	Scenario 2 (Megawatt)	Scenario 3 (Megawatt)
Week days 08:00-13:00 and 15:00-20:00	2,460	1,730	
Weekend 10 hours per day	1,540	1,080	
Off-peak 3,420 hours per year	(+) 260	700 (+) 260	2,350 (+) 260

The (+) sign refers to the power output of the battery exchange stations. Without the sign, the figure represents the power output at the charging spots.

3. The energies required (for details, see Appendix G):

Year	Total energy (thousands of Megawatt)
2011	89
2015	890
2020	8,900

[1] The mentioned estimates were approved by Better Place. See Appendix D
[2] See section III 6. above.

VI. Examination of the profile of the power output expected to be required versus the expected capacities of the electricity supply chain

1. Underlying assumptions for the demand forecast

The long range demand forecast prepared by the Statistics and Market Research Department in the Finance & Economics Division is based on the most highly probable scenario: a scenario involving basic economic development and an average summer.

2. Underlying assumptions for the energy generation segment

An energy generation development system plan from August 2008 that includes the emergency plan up until the year 2013 as well as large energy generation units of private energy producers who have a conditional license.

3. Underlying assumptions for the transmission/ transformation segment

The RE-1050 delivery and transformation system development plan of January 2008 with the addition of transformation projects according to the forecast needs broken down according to feed areas.

4. Underlying assumptions for the distribution segment

a. Ratio of the number of cars to the number of charging outlets (sockets).

At the start of the project, that is, until 2015, the ratio will stand at 1:2, falling later in the implementation to a ratio of 1:1.4.

b. Road infrastructure
36 outlets will be fitted along 100 meters of road on both sides of the road, and for them, 250 meters of cable need to be laid on average (including a feed from a feed source). The conversion factor is 6.94 meters per outlet.

c. Infrastructure in a public parking lot

A parking lot has on average 250 outlets. The feed will come from an indoor transformation station, requiring the laying of 200 meters of cable on average (infrastructure in the parking lot area will be laid by the customer). The conversion factor is 0.8 meters per outlet.

d. Infrastructure in a private parking space
The assumption is that 10 charging outlets will be fitted in an average residential building containing 10 apartments. Adapting the size of the connections and the infrastructure is predicted to be as follows:

Scenario 1
Feed cables will need to be replaced / added in about 50% of buildings. In addition, the assumption is made that the electricity infrastructure outside the meter terminals will be laid by the customer. The average length of a feed cable for a house mains connection (service point) is 70 meters. The conversion factor is 3.5 meters per outlet.

Scenario 2
Feed cables will need to be replaced/ added in about 35% of buildings. In addition, the assumption is made that the electricity infrastructure outside the meter terminals will be laid by the customer. The average length of a feed cable for a house mains connection (service point) is 70 meters. The conversion coefficient is 2.5 meters per outlet.

Scenario 3
Feed cables will need to be replaced/ added in about 20% of buildings. In addition, the assumption is made that the electricity infrastructure outside the meter terminals will be laid by the customer. The average length of a feed cable for a house mains connection (service point) is 70 meters. The conversion factor is 1.4 meters per outlet.

e. The transformation ratio between the transmission system and distribution system will be maintained.[3]

f. For each additional transformer in a substation, eight medium voltage (hereinafter MV) infrastructure outputs were calculated, each with an average length of 3.5 km.

g. Connection of each distribution transformer requires 0.2 km of MV cable and 0.5 km of low voltage (hereinafter LV) cable up to the feed point of the Better Place infrastructure.

h. The addition of a distribution transformer will be required to feed the charging stations as well as the public parking lots (see Appendix H).

i. The addition of a distribution transformer will be required depending on the nature of the local infrastructure, the local power output required in the parking area, etc. As a result, the uncertainty factor in this field is high. The assumption is that about half of the additional power output required will give rise to the need for new distribution transformers.

j. For detailed data, see Appendix H.

[3] The ratio is based on data from the end of 2007: 363 transformers in substations and 44,308 distribution transformers – 1:122.

5. Impacts on the energy systems according to scenario [4]

Additional energy generation infrastructure

Year	Scenario 1	Scenario 2	Scenario 3
2011	--	--	--
2015	--	--	--
2020	6 CCGTs with a power output of 365 Megawatts each 1 GT with a power output of 155 Megawatts	4 CCGTs with a power output of 365 Megawatts each 2 GTs with a power output of 155 Megawatts each	0 CCGTs 0 GTs

CCGT = combined cycle gas turbine
GT = gas turbines

Additional transmission/ transformation infrastructure

Year	Scenario 1	Scenario 2	Scenario 3
2011	--	--	--
2015	--	--	--
2020	10 substations (of 2 transformers) 18 transformers 1 switching station 400/161 KV	7 substations (of 2 transformers) 13 transformers 1 switching station 400/161 KV	0 substations 0 transformers 0 switching stations

Switching station = 400/161 KV switching station that connects a 400 KV system to a 161 KV system.

Additional distribution infrastructure

Year	Component			
		1	**2**	**3**
2011	Distribution transformer MV cables (km) LV cables (km)	314 63 157	304 61 131	284 57 97
2015	Distribution transformer MV cables (km) LV cables (km)	1,173 235 1,358	1,073 215 1,100	893 179 775
2020	Distribution transformer MV cables (km) LV cables (km)	5,469 2,158 10,141	4,127 1,581 8,000	1,433 287 4,943

[4] See section III 6. above

VII. Summary

1. Scale of the infrastructures required

If the Better Place project is implemented, it shall necessitate additional infrastructure on a very extensive scale in the distribution segment, in direct relation to the extent of the randomness of the charging. The greater the randomness of the car charging pattern, the greater the probability of providing an early solution also in the transformation/ transmission and energy generation segments.

2. The quality of the electricity

Batteries are charged with direct current using a rectifier. The rectifier constitutes a non-linear load liable to harm the quality of the electricity supplied to other customers. The problem can be dealt with if certain rectifier features are ensured by the application of standards or appropriate technical measures. Better Place must be asked to provide data about the rectifiers the company plans to use. The IEC will examine the rectifiers and define parameters that will apply to Better Place in order to ensure that harm to the quality of the electricity supplied to customers is minimal.

3. Impact on the fuel basket

In view of the fact that the fuel basket its planned for a five-year period, there is no certainty whatsoever about the period 2015 to 2020. One can surmise that in scenarios 1 and 2 which require additional energy generation units in the form of combined cycle energy generation units and gas turbines, the IEC will need to purchase additional quantities of gas.

In the scenario that does not require any additional energy generation units, the all the energy generation required to meet the need for the expected power outputs of the Better Place project will be generated from coal.

VIII Operative Implications

A comprehensive view of the whole set of implications expected from the Better Place project, including all of the scenarios, and in every outline, points to the need for an infrastructure solution on an extensive scale beyond the trends that would expected without the project.
It is not within the realm of this document to specify the operative ramifications; however, considering that the infrastructure activity on the scales specified above require extensive, lengthy and costly planning, statutory and execution preparations, we deem it appropriate to raise the issue and to establish the necessity to act early enough to formulate appropriate responses.

In concrete terms:

- If additional energy generation, transmission and transformation are required, this will naturally have wide-ranging ramifications – **basic planning processes, statutory procedures, procurement, and setup- which shall require at least five years.**
- Adding more distribution requires the opening of purchase orders in the IEC and the start of deployment of infrastructures as early as possible, including all the infrastructures required in the streets for the project. This is due to the fact that the said process requires special preparations and is subject to external constraints, the main ones being the ability of the municipalities and local authorities to take on a large amount of infrastructure works in a short period of time. In the IEC's assessment, the existing pace of work must be at least doubled for laying the low-voltage infrastructures in towns from 2010 in order to achieve the desired deployment of infrastructures by 2020. In addition, in our assessment, in order to bring the aforementioned project to fruition, the IEC shall be required, among other things, to set up more than 10,000 distribution cells in public areas. Efforts must be made with the authorities to bring them on board and to make it easier to obtain approvals and to find alternative solutions for stationing the said installations on the one hand, and on the other, to get fast track approval for works connected with the project.

IX Accompanying Implications

1. The study is a preliminary and general feasibility study. To reach and make a more precise assessment, feasibility studies will be required in the future based on the project's actual data accumulated during its implementation, and not only based on data estimates.

2. The scale of the accelerated growth expected by Better Place over the period 2015 to 2020 requires a much more detailed focus in the future.

3. If the project is brought to fruition, it will have implications for the maintenance system of all the components in the energy supply chain. It will increase overall demand on the one hand, and divert demand to off-peak times on the other. It will also reduce the range of operation and the flexibility that enable execution of maintenance works with minimum effect on the electricity supply.

4. In terms of providing commercial, operational and maintenance service, the Better Place project means an additional 2.8 million energy supply points over and above the expected growth trend if the project were not implemented. Therefore, one cannot ignore the fact that the system of services for the distribution segment, including all its components, is expected to grow significantly in terms of the scale of the requirements: from the setting up of infrastructures and connections, to operation and maintenance, and culminating in the provision of a commercial/service solution. For example: collection [of fees], technical inspections, the impact of the additional loads on the lifespan of the existing electrical systems/ less land reserves for the IEC on sidewalks so that infrastructure can be laid for Better Place, liable to make IEC infrastructure works more expensive because of the need to execute them in the road instead of on the sidewalk at much higher reconstruction costs.

5. One of the implications of the nominal power output alternatives of 16 Amps or 32 Amps at the charging spots relates to the reciprocal compensation mechanism between load and infrastructure at the LV/ house-mains connection level. That is, as the nominal charging power output increases, so does the probability of the need to enlarge the connection feed infrastructure that feeds the charging spots.

Israel Electric Corporation Ltd.
Engineering Projects Division
Business Development Unit

Appendix A

Attn:
Mr. Yasha Hain
Manager, Engineering Projects
IEC

re: Feasibility study for the electric car project in Israel

The Better Place Company is promoting the electric car project in Israel.

Following the request of the Director General of the Ministry of National Infrastructures, we wish to order a feasibility study for execution of the project. The study must answer two key questions:

a. What will the impact of the electric car be on the distribution and delivery systems?
We will want to clarify the following points:
- What will the impact be on the quality of the electricity (harmonics, etc.)?
- What additional investment will be required, if any, to set up the distribution and transformation networks, etc.?
- If there is a need for additional IEC infrastructures, is there any constraint on the part of the company for setting these up?
- Is an impact expected at any stage on the delivery system (for example: addition or expansion of substations, transmission lines, etc.)?

b. What will the impact of the electric car be on the energy generation system?
We will want to clarify the following points:
- Will additional energy generation units be required?
- What will the impact be on the composition of the basket of fuels used to generate electricity in general, and on the quantities of natural gas that will be required, specifically?

We would like to receive the answers to these questions such that they are spread over the time axis and as a function of several car charging work regimes.

It is evident to us that in order to answer these questions, considerable data will be required (such as: the expected rate of penetration of electric cars in Israel, a profile of their electrical consumption according to time-of-day, etc.), and we will be happy to meet with you to clarify the issues.

I request a preliminary cost estimate for the execution of the feasibility study and an estimate of how long the study will take to complete.

Yours sincerely
Moshe Kaplinsky
CEO, Better Place Israel
cc:

Mr. Hezi Kugler, Director General, Ministry of National Infrastructures

Appendix B

Technical Specification and Deployment Forecast for the Electric Vehicle Project

The vehicle and the battery:

Subject	**Measurement Unit**	**Estimate**
Vehicle – General		
Weight (including battery)	Kg	1,300-1,500
Electric engine power output	Kilowatt	70 (about 100 hp)
Energy consumption:		
Basic journey	kWh/ km	0.10
Combination journey (with air-conditioner)	kWh/ km	0.2
Average journey range:		
Basic journey	Km	200
Combination journey	Km	100
Battery		
Weight	Kg	250-270
Size	Liters	250
Estimated lifetime	Charging cycles	2,000
Time it takes for normal full charging	Hours	3-6
Time it takes to exchange a battery at a station	Minutes	3-5

Charging spots

Subject	**Measurement Unit**	**Estimate**
Electricity:		
Nominal current	Ampere	16/ 32
Electrical power	Volt	230
Connection to control center		By AutOS
Possibility of disconnection by remote control		By AutOS
Possibility of load balancing		By AutOS
Protection against electrocution		Yes
Automatic disconnection during a fault/ damage		Yes

Battery exchange stations

Year	Number of stations	Number of lanes	Demand for Electricity in Megawatts
2011	100	100	100

2015	150	300	300
2020 onwards	150	300	300

Forecast of vehicles, [charging] spots and demand for electricity:

Year	Forecast number of vehicles	Total mileage in electric vehicles in millions of km	Number of charging spots nationwide	Total annual electricity consumption Millions of kWh	Average daily electricity consumption Millions of kWh
2008	5	Experimental stage	Negligible	Negligible	Negligible
2009	50	Experimental stage	500	Negligible	Negligible
2010	500	8.3	10,000	1.66	Negligible
2011	20,000	332	100,000	66.4	0.18
2015	200,000	3,320	1,000,000	664	1.82
2020	2,000,000	33,200	2,000,000	6,640	18.2

Israel Electric Corporation Ltd.
Engineering Projects Division
Business Development Unit

Appendix C

August 18, 2008

Attn:
Mr. Yakov (Yasha) Hain
VP, Engineering Projects
IEC

re: Data for the Feasibility Study for the Electric Car Project in Israel

Further to the meeting held on August 6, 2008, enclosed are the details that we were asked to supplement over and above the specification that we attached to our previous request:

a. Charging Spots
We want to examine three scenarios:

1. Random charging and random consumer behavior scenario:
Under this scenario, no centralized entity exists that controls the times of the charging, and in effect, charging of a car begins the moment the owner connects it to a power source and continues until the battery finishes charging (at which point float charging continues under a very low current) or disconnection of the car from the power source, whichever is first.

Under this scenario, most of the charging is expected, on weekdays, at two main times:

a. Upon the arrival of the car at the owner's workplace in the morning.

b. Upon the arrival of the car at the owner's place of residence.

In this scenario, it is assumed that the average car between two charging executes a journey that discharges a third of the battery.
The picture on weekends is more complicated. It can be assumed that 20% of the cars - those cars belonging to the religious population - do not travel at all, and hence will already charge to the full on Friday. The average journey between two charging discharges 40% of the battery.

On the eve of religious public holidays involving considerable travel (the Jewish New Year and the Passover) the average journey between two charging discharges 50% of the battery.

2. Random charging and rational consumer behavior scenario:
As in the previous scenario, no centralized entity exists that physically controls the times of the charging. However, economic incentives exist in the form of tariffs (Load & Time tariff or a specially designated tariff for electric cars). The impact of the economic incentive can be demonstrated by a car arriving home in January at 19:00. A non-rational consumer will connect the car to a power source after parking, at peak rates, and pay 99.93 agoras per kWh. A rational consumer will start the charging at 22:00, and until 23:00 pay 60.66 agoras per kWh. From 23:00 onwards, the consumer will pay 23.12 agoras per kWh.

The assumption is that 30% of car owners will adjust the time they charge their car to the cheaper tariffs while 70% of car owners will charge their cars immediately after parking. The same battery discharging percentages assumed in the previous scenario are assumed in this scenario too.

3. Controlled charging scenario:
In this scenario, an optimal charging plan exists for each car that takes into account the state of the battery (full, empty, partially charged) the expected journey length until the next charging spot (if this information is known or can be estimated), and the state of the local and national electrical system.

It can be assumed in this scenario that the entire fleet of electric cars will join one or more of the present ("Hashalat Teder" or "Pisga Nayedet" tariff) or future [electricity] demand management arrangements.

We estimate that in the first and second scenario, electric cars are expected to contribute greatly to peak demand, while in the third scenario their contribution to peak demand is expected to be marginal.

The deployment mix expected at the charging spots
The charging spot deployment mix might vary dramatically from one area to another. Thus, for example, the mix in an area of many old buildings that don't have parking is expected to differ from the mix in an area of many new buildings that have parking spaces as part of the structures. Consequently, the mix below is a mix based on the national average:

1. Public parking lots and parking lots at the workplace:	40%
2. Private parking and private parking lots:	50%
3. Streets:	10%

Density of charging spots in the street
Better Place aims to achieve a situation whereby there are two charging spots for every electric car: a charging spot close to the car owner's home, and another spot close to the car owner's workplace. To turn this into reality, Better Place will strive to ultimately set up a charging spot next to every legal parking space in Israel.

Assuming the average length of a parking space to be 5.5 meters, the parking spot density would be 0.36 charging spots per meter of street (or 36 charging spots per 100 meters of street) that has parking spaces on both sides; else, any alternative involving the deployment of charging spots in the street that fits the business/ infrastructure model and local conditions.

b. Battery exchange stations
The deployment of battery exchange stations shall be as follows:

By 2011, 100 single lane stations will be set up that will consume 600 to 750 kilowatt each; by 2015, the number of stations will expand to 150, some with a single lane, and some with a greater number of lanes. The size of the electrical connection shall be accordingly.

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Engineering Projects Division
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The battery exchange stations are designed mainly for those traveling a distance of more than 160 km, and the vast majority will be located in outlying areas, not in urban areas. We estimate that the location of the battery exchange stations, broken down according to IEC districts, will be as follows:

Northern District:	35%
Haifa District	5%
Jerusalem District:	5%
Dan District:	10%
Southern District:	45%

We believe that battery exchange stations will consume their maximum load on weekends and on public holidays when the masses make long journeys. Very high loads can be expected on the intermediate days of the Passover and Sukkoth, when the religious population also tends to make journeys. On normal workdays, the peak loads will be approximately 70% of the connection size.

c. <u>The percentage of loss during charging</u>
We will plan the energy loss in the electrical cables and in the charging infrastructure such that it does not exceed 3%. To the extent that we shall have additional data in this regard, we shall update the IEC accordingly.

We hope that this information will assist you in preparing the feasibility study, and we will help by transferring any additional data or estimate that shall be asked of us.

Yours sincerely
Moshe Kaplinsky
CEO, Better Place Israel

Israel Electric Corporation Ltd.
Engineering Projects Division
Business Development Unit

Appendix D

September 1, 2008

Attn:
Mr. Yakov (Yasha) Hain
VP, Engineering Projects

re: Data for the Feasibility Study for the Electric Car Project in Israel – Supplementary Information

Further to our letter to you of August 18, 2008, I would like to clarify the issue of the electric car's energy consumption.

The figures of 0.1 kWh/km (for a basic journey) and 0.2 kWh/km (for a combination journey) contained in the specification transferred to you, refer to the energy measurement taken at the battery output at the input to the electric engine.

Naturally, the energy consumed from the electricity grid is higher than the values indicated, because of the efficiency of the components that come before the engine: the battery, the rectifier (charger) and the electricity network between the IEC meter and the charging spots. Needless to say, the electricity grid owned by the IEC, from the power plant to the meter, also has efficiency that must be taken into account.

The battery efficiency
The battery efficiency, that is, the ratio between energy during discharge to the energy while being charged, depends to a large degree upon the battery type and upon the charging regime (fast charging is generally less efficient). Efficiency of 80% should be assumed.

The rectifier (charger) efficiency
It can be assumed that the efficiency of modern rectifiers is no less than 94%.

The efficiency of the electricity grid between the IEC meter and the charging spots
Because of the relatively short distances between an IEC meter and the charging spots, it can be assumed that the efficiency of the electricity grid between the IEC meter and the charging spots will not fall below 99%.

Therefore, the overall efficiency between the Better Place meter and the electric car engine is approximately 75%. The energy consumption on the Better Place meter will therefore vary between 0.13 kWh/km (for a basic journey) and 0 .27 kWh/km (for a combination journey).

Yours sincerely

Dr. Dan Weinstock

cc:
Ziva Patir, Pini Lieberman, Omer Sela – Better Place
Sagiv Ben Arie – the IEC

Appendix E

The Israel Electric Corporation Ltd.
Dan District
Planning Department

September 10, 2008
Our Reference: 861/332/08

Protocol from the meeting held on September 9, 2008

re: Feasibility study for Better Place in respect of the Electric Car in Israel

Participants: from the IEC: A. Avraham, S. Harel, Dr. D. Kotek, S. Ben Arie
Better Place representatives: Ms. Z. Patir, Dr. D. Weinstock

1. The aims of the meeting:

a. Receipt of approval from Better Place for the underlying assumptions that the team used as a basis for calculating the power output required from the Better Place project.

b. Clarification and coordination of positions on several issues that the IEC team saw fit to obtain clarifications on.

2. The following was agreed:

a. **The market segment of mass transit vehicles/ taxis** – the present study will not address the aforesaid segment in which charging is essential without regard for the time of day – this, because in the estimation of Better Place representatives, they constitute only a few percent.

b. **Number of charging spots in streets**: IEC representatives think that in respect of Better Place's statement of striving to achieve a charging outlet at every free parking space, the figure of 10% of all charging spots being in the street is low and that the aforesaid figure needs to be re-examined.
Better Place's estimate of the percentage of charging spots dispersed in the streets remains the same at 10% of all charging spots. That said, Better Place representatives will examine the figure again.

c. **<u>Ratio between the number of cars and the number of charging outlets</u>**: in the first part of the project, that is, until 2015, the ratio will remain at 1:2, and during the implementation will decline to a ratio of 1:1.4.

d. **<u>The geographic deployment mix of charging spots</u>**: the underlying assumption about the direct relationship between the IEC customer density, the grid density and the electric car energy consumption density was accepted.

e. **<u>The kWh / km ratio</u>** on which the study is based stands at 0.2.

3. From this it transpires that the data appearing in the draft of September 1, 2008 are agreed and will be transferred by the team members to the Planning, Development and Technology Division for examination and comparison with existing development plans.

4. <u>Additional Issues</u>:

a. **<u>Electricity quality</u>**: in the present study, the guiding principal required will be defined without providing technical details. Reference will be made to the need for formulation of a binding standard and Better Place's compliance with it. The IEC will help Better Place examine the technical engineering implications and formulate a recommendation for the establishment of relevant standards.

b. **<u>Establishment of standards for future building construction tailored to the realm of electric cars</u>**: the IEC will help by providing Better Place with advice. The contact in this realm at the IEC is Mr. S. Ben Arie.

c. **<u>The proceedings between 2015 and 2020</u>**: the short time frame between 2015 and 2020 on the one hand, and fast growth of the Better Place project on the other, necessitate a more detailed analysis of the proceedings over those years in order to adapt the IEC's execution and development plans accordingly. It was agreed that the issue would be examined jointly by the IEC and Better Place.

5. <u>The efficiency of the charging system</u>: Better Place representatives confirmed that the charging system has an efficiency of 75%.

Yours sincerely

A. Avraham

cc:
Y. Hain
Those in attendance
Better Place file.

Appendix F

Quantitative basic data:

Specific energy consumption	0.27 kWh/ km
Charging/ discharging cycle efficiency	75%
Battery charging time	3 to 6 hours
Car annual travel distance range	16,500 km
Battery exchange stations	In 2011: 100 stations In 2015: 150 stations In 2020: 150 stations
Number of electric cars	20,000 in 2011 200,000 in 2015 2,000,000 in 2020
Annual energy consumption	20,000×16,500×0.27=89.1 million kWh in 2011 200,000×16,500×0.27=891 million kWh in 2015 2,000,000×16,500×0.27=8,910 million kWh in 2020
Off-peak tariff[5]	3,240 hours a year
Mix of charging spots	Public parking lots including workplaces: 40% Private parking spaces and private parking lots: 50% Streets: 10%

The ratio between the number of electric cars and the number of charging outlets will initially (until 2015) be 1:2, declining during the implementation to a ratio of 1:1.4 in 2020.

[5] "Off-peak tariff": represents here the total off-peak demand. The tariff mechanism itself, as aforesaid, is not relevant to this discussion, and might even change with time and/or adopt new tariff tools.

Appendix G

1. Random charging and random consumer behavior scenario[6]

Charging of batteries in the morning and afternoon hours. Charging at charging spots: 90%. Charging at battery exchange stations: 10%. Morning charging from 08:00 to 13:00. Afternoon charging from 15:00 to 20:00. Total charging time: 10 hours. The assumption is made that the charging power output is uniform at all times. 80% of the energy used on weekdays; the rest on the weekend.

Power output during charging on weekdays:

In 2011: $0.9 \times 0.8 \times \dfrac{89.1 \times 10^6}{52 \times 5 \times 10}$ Megawatt

In 2015: $0.9 \times 0.8 \times \dfrac{891 \times 10^6}{52 \times 5 \times 10}$ Megawatt

In 2020: $0.9 \times 0.8 \times \dfrac{8{,}910 \times 10^6}{52 \times 5 \times 10}$ Megawatt

Charging power output on weekends:

In 2011: $0.9 \times 0.2 \times \dfrac{89.1 \times 10^6}{52 \times 2 \times 10}$ Megawatt

In 2015: $0.9 \times 0.2 \times \dfrac{891 \times 10^6}{52 \times 2 \times 10}$ Megawatt

In 2020: $0.9 \times 0.2 \times \dfrac{8{,}910 \times 10^6}{52 \times 2 \times 10}$ Megawatt

[6] See section III 6. above.

Charging power output at battery exchange stations during off-peak hours (3,420 hours per year):

In 2011: $\dfrac{0.1 \times 89.1 \times 10^6}{3{,}420}$ = 2.6 Megawatt

In 2015: $\dfrac{0.1 \times 891 \times 10^6}{3{,}420}$ = 26 Megawatt

In 2020: $\dfrac{0.1 \times 8{,}910 \times 10^6}{3{,}420}$ = 260 Megawatt

2. Random charging and rational consumer behavior scenario[7]

30% of car owners will adjust the time they charge their batteries to the cheaper rates, and 70% will charge their batteries as in scenario 1.

Power output during charging on weekday mornings 08:00 to 13:00 and afternoons 15:00 to 20:00:

In 2011: $0.9 \times 0.8 \times \dfrac{0.7 \times 89.1 \times 10^6}{52 \times 5 \times 10}$ Megawatt

In 2015: $0.9 \times 0.8 \times \dfrac{0.7 \times 891 \times 10^6}{52 \times 5 \times 10}$ Megawatt

In 2020: $0.9 \times 0.8 \times \dfrac{0.7 \times 8{,}910 \times 10^6}{52 \times 5 \times 10}$ Megawatt

[7] See section III 6. above.

<u>The charging power output on weekends</u>:

In 2011: $0.9 \times 0.2 \times \dfrac{0.7 \times 89.1 \times 10^6}{52 \times 2 \times 10}$ Megawatt

In 2015: $0.9 \times 0.2 \times \dfrac{0.7 \times 891 \times 10^6}{52 \times 2 \times 10}$ Megawatt

In 2020: $0.9 \times 0.2 \times \dfrac{0.7 \times 8{,}910 \times 10^6}{52 \times 2 \times 10}$ Megawatt

<u>Power output during charging on weekdays at off-peak times</u>:

In 2011: $0.9 \times \dfrac{0.3 \times 89.1 \times 10^6}{3{,}420}$ Megawatt

In 2015: $0.9 \times \dfrac{0.3 \times 891 \times 10^6}{3{,}420}$ Megawatt

In 2020: $0.9 \times \dfrac{0.3 \times 8{,}910 \times 10^6}{3{,}420}$ Megawatt

The charging power output at battery exchange stations during off-peak hours (3,420 hours per year) – identical to scenario 1:

In 2011: $\frac{0.1 \times 89.1 \times 10^6}{3{,}420} = 2.6$ Megawatt

In 2015: $\frac{0.1 \times 891 \times 10^6}{3{,}420} = 26$ Megawatt

In 2020: $\frac{0.1 \times 8{,}910 \times 10^6}{3{,}420} = 260$ Megawatt

3. Controlled charging scenario[8]

Power output during charging on weekdays

In 2011: $0.9 \times \frac{89.1 \times 10^6}{3{,}420}$ Megawatt

In 2015: $0.9 \times \frac{891 \times 10^6}{3{,}420}$ Megawatt

In 2020: $0.9 \times \frac{8{,}910 \times 10^6}{3{,}420}$) Megawatt

Charging power output at battery exchange stations during off-peak hours (3,420 hours per year) – identical to scenario 1:

In 2011: $\frac{0.1 \times 89.1 \times 10^6}{3{,}420} = 2.6$ Megawatt

In 2015: $\frac{0.1 \times 891 \times 10^6}{3{,}420} = 26$ Megawatt

In 2020: $\frac{0.1 \times 8{,}910 \times 10^6}{3{,}420} = 260$ Megawatt

[8] See section III 6. above.

Appendix H

Table 1.1: Forecast of cars, number of charging outlets and length of LV cables in scenario 1

ear	Forecast number of cars	Number of charging outlets (sockets) nationwide	Number of charging outlets nationwide			Length of cables in km			Total length of cables in km
			Public parking lot and workplaces 40%	Private parking lots 50%	Street parking 10%	Public parking lot and workplaces	Private parking lots	Street parking	
008	5	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
009	50	100	40	50	10	0.032	0.175	0.1	0.3
010	500	1,000	400	500	100	0.32	1.75	0.7	2.8
011	20,000	40,000	16,000	20,000	4,000	12.8	70	27.8	111
015	200,000	400,000	160,000	200,000	40,000	128	700	277.8	1,105
020	2,000,000	2,800,000	1,120,000	1,400,000	280,000	896	4,900	1,944	7,740

Table 1.2: Forecast of cars, number of charging outlets and length of LV cables in scenario 2

Year	Forecast number of cars	Number of charging outlets (sockets) nationwide	Number of charging outlets nationwide			Length of cables in km			Total length of cables in km
			Public parking lot and workplaces 40%	Private parking lots 50%	Street parking 10%	Public parking lot and workplaces	Private parking lots	Street parking	
2008	5	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
2009	50	100	40	50	10	0.032	0.1225	0.1	0.2
2010	500	1,000	400	500	100	0.32	1.225	0.7	2.2
2011	20,000	40,000	16,000	20,000	4,000	12.8	49	27.8	90
2015	200,000	400,000	160,000	200,000	40,000	128	490	277.8	896
2020	2,000,000	2,800,000	1,120,000	1,400,000	280,000	896	3,430	1,944	6,270

Table 1.3: Forecast of cars, number of charging outlets and length of LV cables in scenario 3

Year	Forecast number of cars	Number of charging outlets (sockets) nationwide	Number of charging outlets nationwide			Length of cables in km			Total length of cables in km
			Public parking lot and workplaces 40%	Private parking lots 50%	Street parking 10%	Public parking lot and workplaces	Private parking lots	Street parking	
2008	5	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
2009	50	100	40	50	10	0.032	0.07	0.1	0.2
2010	500	1,000	400	500	100	0.32	0.7	0.7	1.7
2011	20,000	40,000	16,000	20,000	4,000	12.8	28	28	68.6
2015	200,000	400,000	160,000	200,000	40,000	128	280	278	686
2020	2,000,000	2,800,000	1,120,000	1,400,000	280,000	896	1,960	1,944	4,800

Table 2: Charging stations in the all scenarios (assumptions: electricity room adjacent to the IEC transformer room. Each transformer requires 200 meters of MV cable and 100 meters of LV cable)

Year	Number of stations	Power output in Megawatt	Number of distribution transformers (630 kVA)	MV cables (km)	MV cables (km)
2011	100 Single lane	100	278	56	28
2015	150 Multi-lane	300	833	167	83
2020	150 Multi-lane	300	833	167	83

The addition of transformation in the distribution and translation of that into additional cables: for every transformer at a substation (45 MVA), 122 distribution transformers (630 kVA) are installed; for every distribution transformer, approximately 200 meters of MV cable and 500 meters of LV cable are required up to the first electrical junction that feeds the Better Place infrastructure.

Table 3.1: Scenario 1

Year	Number of additional transformers in a substation	Number of distribution transformers (630 kVA)	MV cables (km)	LV cables (km)
2011	0	0	0	0
2015	0	0	0	0
2020	38	4,636	927	2,318

Table 3.2: Scenario 2

Year	Number of additional transformers in a substation	Number of distribution transformers (630 kVA)	MV cables (km)	LV cables (km)
2011	0	0	0	0
2015	0	0	0	0
2020	27	3,294	659	1,647

Table 3.3: Scenario 3

Year	Number of additional transformers in a substation	Number of distribution transformers (630 kVA)	MV cables (km)	LV cables (km)
2011	0	0	0	0
2015	0	0	0	0
2020	0	0	0	0

The addition of medium voltage cables for the outputs from a substation to the first distribution transformer (based on 8 outputs from a substation per transformer with a length of 3.5 km per output)

Table 4.1: Scenario 1

Year	Number of additional transformers in a substation	Number of outputs per transformer	MV cables per output (km)	Total MV cables (km)
2011	0	8	3.5	0
2015	0	8	3.5	0
2020	38	8	3.5	1,064

Table 4.2: Scenario 2

Year	Number of additional transformers in a substation	Number of outputs per transformer	MV cables per output (km)	Total MV cables (km)
2011	0	8	3.5	0
2015	0	8	3.5	0
2020	27	8	3.5	756

Table 4.3: Scenario 3

Year	Number of additional transformers in a substation	Number of outputs per transformer	MV cables per output (km)	Total MV cables (km)
2011	0	8	3.5	0
2015	0	8	3.5	0
2020	0	8	3.5	0

Table 5: Addition of transformers in scenario 3. Additional transformation for large public parking lots that cannot be supplied with electricity from the existing system (new enlarged connection for off-peak hours)

Year	Number of distribution transformers (630 kVA)	MV cables (km)	LV cables (km)
2011	6	1	1
2015	60	12	6
2020	60	120	60

Table 6.1: Total distribution transformers (630 kVA), medium and low voltage cables in scenario 1
Note: we assumed an addition of 36 transformers in 2011 and 340 transformers in 2015 (together with a set of cables per transformer), in order to provide a solution for the additional load on the existing infrastructure.

Year	**Number of distribution transformers (630 kVA)**	**MV cables (km)**	**LV cables (km)**
2011	314	63	157
2015	1,173	235	1,358
2020	5,469	2,158	10,141

Table 6.2: Total distribution transformers (630 kVA), medium and low voltage cables in scenario 2
Note: we assumed an addition of 26 transformers in 2011 and 240 transformers in 2015 (together with a set of cables per transformer), in order to provide a solution for the additional load on the existing infrastructure.

Year	**Number of distribution transformers (630 kVA)**	**MV cables (km)**	**LV cables (km)**
2011	304	61	131
2015	1,073	215	1,100
2020	4,127	1,581	8,000

Table 6.3: Total distribution transformers (630 kVA), medium and low voltage cables in scenario 3

Year	**Number of distribution transformers (630 kVA)**	**MV cables (km)**	**LV cables (km)**
2011	284	57	97
2015	893	179	775
2020	1,433	287	4,943