A sustainable transport solution for a Slovenia town

Matjaž Knez[1], Ali Naci Celik[2] and Tariq Muneer[3]
[1]Faculty of Logistics, University of Maribor, Mariborska c. 7, 3000 Celje, Slovenia
[2]Faculty of Engineering and Architecture, Abant Izzet Baysal University, Golkoy Campus, 14280, Bolu, Turkey; [3]Transport Research Institute, Edinburgh Napier University, Merchiston Campus, Edinburgh EH10 5DT, UK

Abstract

Authorities in Slovenia and other EU member states are confronted with problems of city transportation. Fossil-fuel-based transport poses two chief problems—local and global pollution, and dwindling supplies and ever-increasing costs. An elegant solution is to gradually replace the present automobile fleet with electric vehicles (EVs). This article explores the economics and practical viability of the provision of solar electricity for the charging of EVs by installation of economical available Photovoltaic modules. A steep decline in the module, inverter and installation costs is reported herein. Present estimates indicate that for the prevailing solar climate of Celje—a medium-sized Slovenian town—the cost would be only 2 euros and 11 cents per kWh of generated solar electricity.

Keywords: electric vehicles; energy sustainability; Slovenia; solar photovoltaic; sustainable transport; urban transportation

*Corresponding author.
t.muneer@napier.ac.uk

1 INTRODUCTION

Due to contemporary way of life and the ubiquitous economic growth, the environment is increasingly getting polluted. Global climate changes call for an immediate global action through international cooperation of all countries. According to the European environment agency, the transport sector is the fastest growing user of energy and hence the fastest growing producer of greenhouse gases in all EU states.

Slovenia joined the EU in the year 2004 and has attempted to integrate itself within the Union in an enthusiastic manner. Today, city authorities in Slovenia and other EU member states are confronted with problems of city transportation in order to introduce the concept of green cities. These problems include an overpopulation of automobiles in city centres—leading to gird locks, pollution, smog, accidents etc. In order to reduce the damage, inflicted on city environments, transport change and change in the attitude of people and companies is needed. City authorities can influence the implementation of better management of transport in three ways [1, 2]:

- Regulations and taxes,
- Co-funded infrastructure development and environmentally friendly vehicles and
- Change of transport regime

Michaelis [3] asserts that the level of CO_2 emissions in city transport can be reduced in three different ways: (1) by using more efficient, environmentally friendly transport technologies, (2) by altering peoples' travel habits and (3) to change transport policy of city authorities regarding city-centre transport management.

Traffic jam in city centres is continuously increasing despite various measures due to rapidly increasing transport demands. The evolution and development of urban logistics in the past decade has only decreased the situation, partly also due to increased use of motor vehicles. In order to reduce negative impacts on the environment, different economic instruments have been implemented such as environmental taxes whereby the polluter pays. An important instrument is also the implementation of reducing payments or taxes or exemption from such taxes due to investments in environmental protection. Environmental technology or green technology is the power of environmental science, to protect the nature and to reduce the impacts caused by mankind. In this article, a clean energy

solution has been proposed by means of propulsion of electric automobiles utilizing solar energy.

2 BRIEF REVIEW OF TRANSPORT-RELATED EUROPEAN BEST PRACTICE

Early in 2002, Copenhagen started with the implementation of the so-called City Goods Ordinance scheme in the medieval city centre regarding the use and the capacity of motor vehicles [4]. The aim of this endeavour was reduce the impact of transport of goods has on the environment and to improve the accessibility of narrow medieval streets, by reducing the number of vans and all vehicles, which are driving into towns. The first half of the year concentrated on restricting the tours of vans and lorries to those with acquired certificates. The fine for those without such a certificate amounted to €68. According to the survey, the residents mostly approved of the scheme. Four larger Swedish cities introduced the so-called environmental zones within city centres with the objective to improve air quality and reduce noise pollution [5]. This programme refers to buses and lorries whose weight exceeds 3.5 tonnes. The key requirement for entering the environmental zone was that no diesel vehicle be older than 8 years. Older vehicles may enter the zone provided they have undergone emission tests or they can be entirely banned from entering the city centre. Following the Swedish example, Great Britain [6] implemented improvements regarding emission reduction by introducing the so-called low emission zone. It is a precisely defined area which may only be accessed with specific vehicles that meet the set requirements or standards. The main aim of this measure is to reduce traffic impact on the environment and hence increase air quality and encourage the use of cleaner or greener vehicles in city centres or areas with high level of pollution. Although it is not necessary that the number of vehicles in these areas will decrease as a result, and the number of cleaner vehicles with fewer emissions will increase.

Three German cities [7] have implemented a law which forbids those vehicles which pollute the environment, to enter certain parts of city centres. These areas are labelled environmental zones. In Berlin, Hannover and Cologne drivers must equip their vehicles with special stickers as proof that the vehicles comply with the new environmental standards.

The European Commission recently unveiled a 'single European transport area' aimed at enforcing 'a profound shift in transport patterns for passengers' by 2050. Top of the EU's list to cut climate change emissions is a target of 'zero' for the number of petrol and diesel-driven cars and lorries in the EU's future cities. Siim Kallas, the EU transport commission, insisted that Brussels directives and new taxation of fuel would be used to force people out of their cars and onto 'alternative' means of transport. 'That actually means no more conventionally fuelled cars in our city centres' [8].

3 ELECTRIC VEHICLES—SUSTAINABLE SOLUTION FOR CITY CENTRES

The increasing concentration of population and wealth to cities is likely to continue-especially in the developing world [9]. With further global population increase and urbanization on the horizon congestion will exacerbate the negative impact of the manner in which the automobiles will be driven and on the overall energy consumption. It will not be possible to tackle global automotive energy consumption and green-house gas emissions effectively without a radical change in thinking with respect to urban transport [10]. For over a century, the automobile has offered affordable freedom of movement within urban areas. Currently, however, a typical automobile is larger and heavier than it needs to be to provide personal urban transport. On an average, it weighs 20 times as much as its driver, can travel over 450 km without refuelling and can attain speeds of over 160 kph. The average vehicle occupies 10 m^2 of road space for parking and is parked about 90% of the time [10]. Furthermore, the typical daily commuting distance in most European cities is <40 km.

Worldwide, 18 million barrels of oil is consumed each day by the automobile sector. Annually the vehicles emit 2.7 billion tonnes of CO_2 [11] and claim 1.2 million lives via accidents [12]. Within city centres, the average vehicular speeds hardly ever exceed 16 kph [13].

One solution to tackle the problem of congestion and pollution within city centres around the world is to use electricity powered, two-wheelers or ultra-compact four-wheelers. The ultra-compact cars weigh <450 kg and occupy less than two-third length of a conventional compact car [9].

The first electric car was built sometime between 1832 and 1839 by Robert Anderson in Scotland [14]. Breakthrough by Gaston Plante and Camille Faure increased battery energy storage capacity, which led to the commercialization of battery-electric cars in France and Great Britain in the 1880s. Battery-electric vehicles (EVs) were quiet, clean and simple to operate, but their batteries took a long time to recharge, were expensive to replace and had limited range [15]. Automobiles are quite inefficient with ~75% of the energy going into producing heat [16]. Research and development is being carried out into manufacturing affordable electric automobiles that offer an improved overall thermodynamic efficiency and, in this respect, the car manufacturer Nissan has announced plans to produce 50 000 Nissan 'Leaf' electric cars in the UK starting in 2013 with a global production of 200 000 units per year. At the same time, Chinese manufactured electric scooters are also increasingly making their entry in European cities with a typical scooter costing around €1200. Such scooters emit around 33 g CO_2/km if charged with fossil fuel electricity. The latter figure however drops to a significantly lower value of 1.3 g CO_2/km if solar energy is deployed to charge the scooter's lead acid batteries [17]. Within the UK market, the 'Charge' scooter company has

Table 1. *SWOT analysis for electric vehicles.*

Strengths	Weaknesses
• Eco-friendly	• Needs time to recharge
• Silent	• Lack of recharging infrastructure
• Low cost of ownership	• Batteries change is expensive
• Cheaper to run	
• Energy savings—achievable from regenerative braking system	
• Simpler mechanism	
Opportunities	**Threats**
• Governments subsidy for ownership	• Competition in form of electric hybrids, alternative fuel, hydrogen-powered cars
• No congestion charge	• Rise in cost of electricity
• Lower taxes	
• Increasing fossil fuel costs	

made available an 'S1' electric scooter that uses lithium-ion batteries and costs €2800. The 48-V, 40-Ah battery requires 4 h to add an 80% charge and can deliver a 55-km trip (Table 1).

The main goal of this work is to review the energetic and environmental impact of the transportation sector in Slovenia, assess the propulsion energy requirement of automobiles for a small town's fleet and then determine the benefits of replacing a proportion of the conventional fleet with EVs.

4 SLOVENIA AND ITS GEOGRAPHY

Slovenia is a central European country which borders the Adriatic Sea through a small coastal strip. Koper is the main port of the country. The terrain consists of an alpine mountain region adjacent to Italy and Austria and mixed mountains and valleys with numerous rivers to the east. Despite its small size, this eastern Alpine country controls some of Europe's major transit routes. The country is crossed by two TEN-T corridors: Corridor V (Venice–Trieste/Koper–Ljubljana–Budapest–Kiev) and corridor X (Salzburg–Ljubljana–Zagreb–Belgrade–Thessaloniki).

Slovenia's GDP per capita is 84% of the EU27 average [18]. It was the first new member of the European Union to adopt Euro as a currency in January 2007, and it has been a member of the Organisation for Economic Co-operation and Development since 2010 [19]. Figure 1 shows the location of the candidate conurbation (Celje) chosen for this study. Celje is a typical Central European town and the third largest town in Slovenia. It is located at the junction of the motorway and railroad of V. and X. corridor, on halfway between the major transport nodes Ljubljana and Maribor, which raises the Celje in a very favourable position of communications traffic (see Figure 2). The city centre is very accessible by many roads. Through the town run some important road links, which further increases pressures on the environment.

4.1 The energy budget

According to energy statistics for 2010, the production of primary energy in Slovenia increased by 2% compared with the previous years. The increase was mostly influenced by an 8%

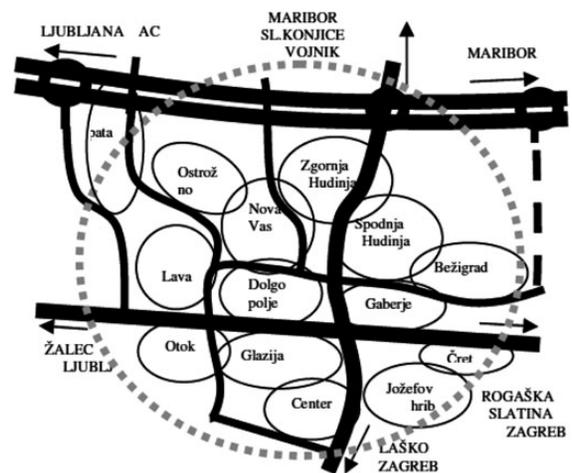**Figure 1.** *The position of Celje within Slovenia.*

Figure 2. *Micro location of town Celje with settlements.*

increase in renewable energy sources production out of which the production of biogas increased the most, namely by 80%. Total energy primary supply, which besides primary energy production includes also import and export of energy increased by 3%. The increase was influenced mostly by the increase in supply of renewable energy sources by 10% and supply of natural gas by 4% [20]. Supply with petroleum products also decreased in 2010, compared with the previous year by 2%. Energy dependency of Slovenia in 2010 was 50%. In 2010, the gross production of electricity was 16 433 GWh. Most electricity was produced in thermal power plants (37%), followed by the nuclear (34%) and hydro power plants (29%).

5 RESEARCH METHODOLOGY

This study is divided into four sections. First, we calculate the average mileage of Slovene cars and energy consumption of EVs, and then the CO_2 emissions of passenger cars in Celje are presented. The third and fourth sections, respectively, present calculation of solar energy availability and the required recharging capacities for proposed EV fleet.
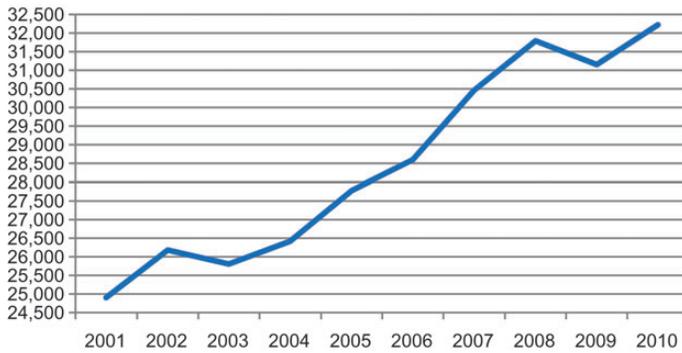
Figure 3. *Number of vehicles registered in Celje from 2001 to 2010.*

In 2010, Celje had registered 32 214 road vehicles [21, 22]. Figure 3 shows the very significant increase in the automobile population, primarily resulting from the membership of Slovenia in EU.

5.1 Calculating the mileage and energy consumption of EVs in Slovenia

In the first step, we calculate the mileage of all vehicles. At the end of 2010, Slovenia had 1 061 646 registered passenger cars, or 518 vehicles per 1000 inhabitants [22]. The total vehicle mileage (MGE) was thus obtained as,

$$\text{MGE} = N \times D = 23\,356\,212\,000 \text{ vehicle-km/year} \quad (1)$$

where Q is the amount of gasoline consumption in litres and FC is average fuel consumption of European cars, which is around 6.5l/100 km [23]. For the purposes of transport, Slovenia spent 651 690 000 kg of gasoline in year 2008 (leaded and unleaded) [24]. For calculation purposes, we have taken into account the petrol density of gasoline, which is 760 g/m^3 and thus get Q in litres, which in our case is 857 486 842 litres of gasoline. We can also calculate the average mileage of each car which comes out as 47 km/day-vehicle.

According to the study prepared by MIT Electric Vehicle Team [25], EV consumes 200–300 Wh for a mile on average. In this study, a figure of 200 Wh/km was used, i.e. if all of the above cars in Slovenia were converted to EVs, they would consume 3654 GWh/year. The energy consumed by one electric car would approximately be 3.4 MWh/year or 9.3 kWh/day.

5.2 CO$_2$ emissions associated with passenger cars in Celje

CO$_2$ emissions of new vehicles registered, respectively, in the years 2008, 2009 and 2010 have shown a decreasing trend of 159, 156 and 145 g/km. For calculation purposes, we considered the number of cars within Celje, amounting to 32 000 and the average value of CO$_2$ emissions of cars as 153.3 g/km. This translated to a figure of 84 060 tonnes of CO$_2$ per annum or 230 tonnes/day.

Table 2. *State subsidy for the purchase of electric vehicles for some of the EU member states [Source: [32]].*

	Subsidy (k€)
Germany	0.38
France	5.000
Norway	17.524
UK	6.400
Austria	2.571
Denmark	20.588
The Netherlands	4.936
Spain	6.500
Sweden	0.470
Slovenia	**5.000**
Italy	1.200
Portugal	9.442
Belgium	10.907
Czech Republic	0.271
Ireland	5.000
Romania	3.700

5.3 Solar recharging

The two factors that will bring about a significant change in the present day unsustainable aspect of transport sector are market inducements for the introduction of EVs and a sustainable supply of electricity for charging them. In this respect, a brief review of the policy of the Slovenian government is presented. Firstly, the introduction of EVs is being encouraged by a subsidy offer of €5000. Table 2 shows the EV subsidy figures for other EU countries.

Secondly, the relevant legislation affecting renewable energy sources (RES)-E in Slovenia makes it incumbent on the energy network operators to purchase electricity from 'qualified producers' either for fixed feed-in or for premium feed-in tariffs. The network operator and the qualified producer sign a Purchase Agreement covering the purchase of electricity from the qualified producer for a period of 10 years.

Slovenia measures only 20 256 km^2, but, in spite of this, we can divide its territory into three climate types: sub-Mediterranean, temperate-continental and mountainous [26]. However, the quantity of energy received due to solar radiation is influenced more by various relief positions than by the different climate types. Average solar radiation in Slovenia is more than 1000 kWh/m^2-annum. The 10-year average of the measured (1993–2003) annual global radiation was between 1053 and 1389 kWh/m^2 (Figure 4). Half of Slovenia receives between 1153 and 1261 kWh/m^2.

The construction of solar power plants in Slovenia has shown an extremely rapid growth. In a few years, Slovenia has installed more than 1390 plants that were connected to the grid. Total power plants at the end of 2011 were more than 90 MW. In 2012, Slovenia's electricity generation was more than 130 MWh from solar energy.

The efficiency of solar modules that are available on the market ranges between 8 and 20%. In our study, electric characteristics of mono-crystalline silicon photovoltaic modules produced by Bisol Company of Slovenia were used. An average module efficiency of 14% was used.

5.4 Economics of solar recharging for EVs in Celje

One of the options to reduce CO_2 emissions is the integration of EVs as far as possible, but only if the EV's would be charged from environmentally friendly sources of energy.

Distribution of electricity in Celje is carried by Elektro Celje Company. Electricity production is still dominated by conventional sources (63%) and 37% from renewable energy sources [27]. The present Carbon footprint for Solvenian electricity is 0.44–0.66 kg CO_2/kWh [28] (Figure 5).

As predicted by a study conducted by Purgar [29], EVs can reach a market share of 10% by 2020. The required electricity that needs to be produced from photovoltaic (PV) panels to empower the 3200 EVs for Celje's roads by 2020 is shown in Table 3.

Figure 6a and b shows the historical price drop of PV module costs and the total system cost. The projected PV system prices are based on forecasted lower cost limits and upper efficiency limits for modules, as well as the range of non-module cost improvements. It is also assumed that, over time, competition and industry growth will reduce installer overhead and margins, what may result in lower prices [30].

In Celje, there are about 9000 residential buildings and if just one half of them could be suitable for PV modules installations, it means that at least 3 kW systems could be installed on 4500

homes. This could mean the sum of about 112 000 m^2 of PV modules would generate 14 MW peak power which may be used for charging the battery bank for two- or four-wheel EVs.

The price of the electricity generated by a solar PV system (C_{PV}, €/kWh) is the ratio between annual payment to offset PV installation financing loan and the total annual amount of energy produced (E_{an}). Capital costs can be decomposed in investment: panels (I_p), inverter (I_i), installation (I_l) and annual maintenance, M. Note that the replacement costs of the inverter, which has a shorter lifetime than the panels, have to be taken into account. We thus have the basic set of equations that lead to financing costs,

Annual payment to offset PV installation financing loan,

$$A = P \cdot F_i (1 + F_i)^n / [(1 + F_i)^n - 1] \tag{3a}$$

where P is the capital costs associated with erection and life-time maintenance of the PV plant and n is the payback period, assumed to be 25 years for the present study (life of PV modules).

For a unit square metre of PV module area that has a nominal efficiency of η (expressed as a fraction),

$$P, € = 1000 \, h(I_p + I_l + [L_p / L_i] \cdot I_i + n \cdot M) \tag{3b}$$

Note that Tables 4 and 5, respectively, provide a further explanation for above-used symbols and the present cost of fossil-nuclear powered electricity. The estimation of the annual-averaged energy generated per square metre of PV module area, E_{an} ought to include the decline of cell efficiency with time (d) and the energy generated per peak Watt installed capacity of the PV modules per year, i.e. kWh/kWp-year. It may easily be shown that
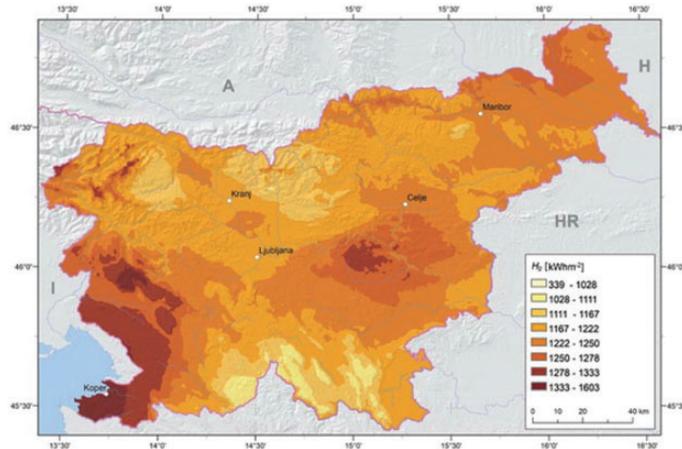
$$E_{an} = 0.5 \, h \, [F_0 + F_{25}] G_b \tag{3c}$$

Figure 4. *Annual global solar radiation on a horizontal surface for Slovenia.*

Table 3. *Electrical energy needed for propulsion of EVs.*

Energy demand, MWh	Per day	Per month	Per year
	29.80	907	10 800

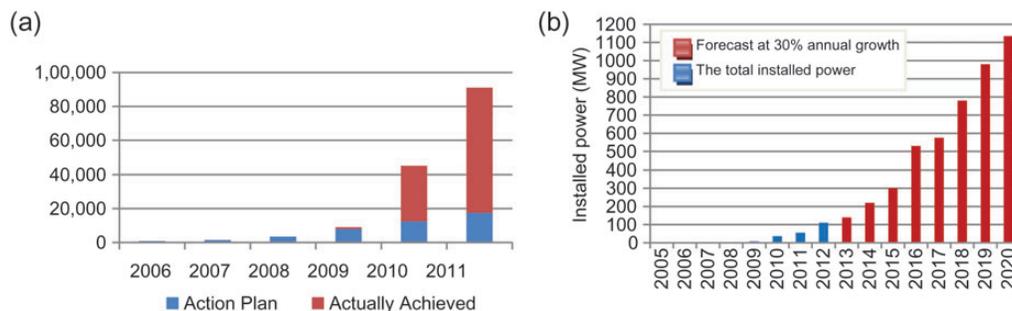**Figure 5.** *Slovenian constructions of solar power plants (a) and the forecast for 2020 (b).*
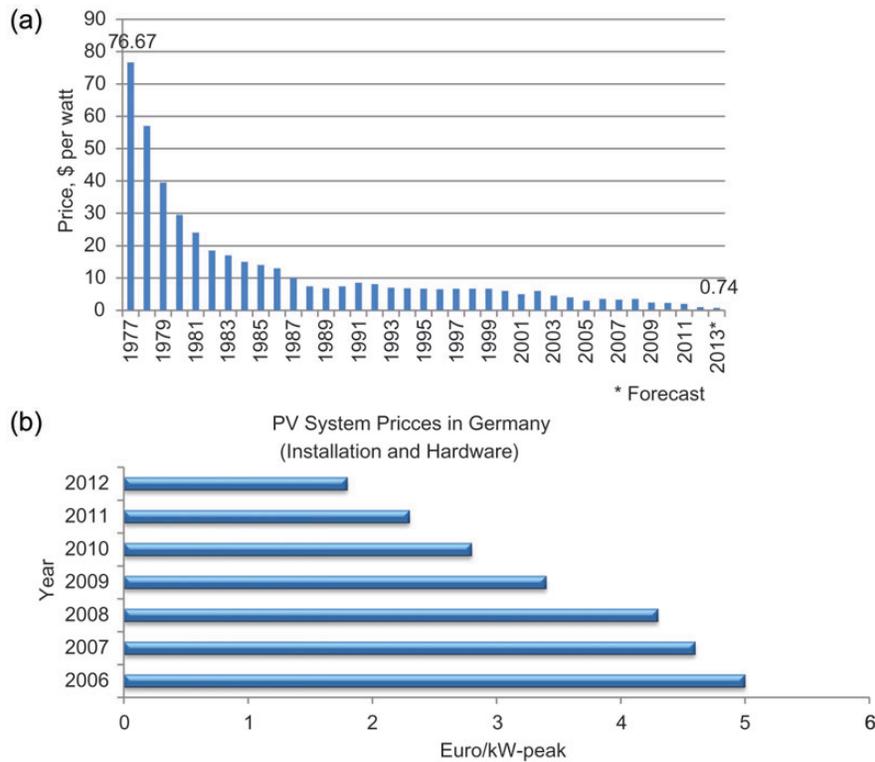
Figure 6. *(a) The decreasing cost of crystalline silicon photovoltaic cells (Source: [31]). (b) The decreasing cost of complete PV electricity systems [30].*

Table 4. *Parameters used for the cost equation.*

Investment cost for PV panels	I_p	0.6 €/Wp
Investment cost for inverter	I_i	0.2 €/Wp
Investment cost for installation	I_l	0.8 €/Wp
Lifetime for PV panels	L_p	25 years
Inverter lifetime	L_i	10 years
Maintenance costs	M	0.02€/Wp/year
Interest rate	F_i	4%/year

where G_β is the annual-averaged global irradiation (kWh/m^2) in the plane of (inclined) PV modules. F_0 and F_{25} in equation (3c) are usually provided by module manufacturers and a typical set of values indicate a 97% performance (F_0) for new modules that linearly drops to a figure of 80.2% (F_{25}) after a 25-year use.

The cost equation thus becomes

$$C_{PV}, €/kWh = A/E_{an} \quad (3d)$$

Using data of Table 4 and using equations (3a) through (3d), we thus obtain for 1 m^2 of PV module area: $P = 364.8$, $A = 23.35$, $E_{an} = 168.34$ and $C_{pv} = 0.139$. Note that, in the above calculations, a value of solar irradiation of 1250 kWh/m^2-year for Celje and an efficiency of 15.2% for mono-crystalline PV modules was used.

The above estimate of solar electricity (13 euros and 9 cents per kWh) may be compared with the present cost of 14 euros and 74 cents per kWh for fossil-nuclear fuel electricity that is available in Celje.

Table 5. *Electricity prices for households (EUR/100 kWh), Slovenia, second half of 2011.*

Consumer group (annual consumption band)	Price, all taxes included
DA (<1000 kWh)	22.52
DB (1000 < 2500 kWh)	17.02
DC (2500 < 5000 kWh)	14.92
DD (5000 < 15 000 kWh)	13.61
DE (≥15 000 kWh)	12.49
SLOVENIA, average	14.74

Source: SURS [33].

6 CONCLUSIONS

The present study encompassed the following four tasks:

- Estimate the average mileage of Slovene cars.
- Obtain the corresponding CO_2 emissions of passenger cars in Celje, a medium-sized town.
- Compute the energy requirements of EVs.
- Calculate the available solar energy and the required recharging economics for the proposed EVs.

It was shown that, within Slovenia, there is a strong and robust uptake of solar PV plants with actual installations exceeding the planned capacities by a factor of 6. Furthermore, it was noted that the price of PV modules within the past 36 years has dropped by a

factor of 104. The present analysis indicates that price of solar electricity that is presently obtainable is 13 euros and 9 cents per kWh. This compares quite favourably with the present cost of 14 euros and 74 cents per kWh for fossil-nuclear fuel electricity that is available in Celje.

REFERENCES

[1] Knez M. *Business of Logistics Companies—Material for Tutorials*. Celje, University of Maribor, Faculty of logistics, 2008.

[2] Portal. *Urban Freight Transport and Logistics in the Cities*. Portal, Courseware on the Market. The Results of a Research Project Funded by the EU on Urban Transport, 2003. http://www.eu-portal.net/material/download area/kt8_wm_sl.pdf (25 April 2012, date last accessed).

[3] Michaelis L. *Cars, Congestion, CO$_2$ and Choice. Organisation for Economic Cooperation and Development*. The OECD Observer; August 1995; 195; ProQuest European Business, 1995, p. 25.

[4] DGET. *Case Study: City Goods Ordinance (City Gods Ordningen)*. Directorate—General for Energy and Transport, 2002. http://www.managenergy.net/products/R950.htm (18 April 2012, date last accessed).

[5] Dieselnet. 1996. Sweden: Environmental Zones Program. http://www.dieselnet.com/standards/se/zones.php (10 April 2012, date last accessed).

[6] Transport for London. About the LEZ. 2008. http://www.tfl.gov.uk/roadusers/lez/2021.aspx (24 April 2012, date last accessed).

[7] PR Newswire Europe Ltd. 2008. Environmental Zones in Germany: Foreign Visitors Can Now Obtain Environmental Badges for Their Cars and Trucks Online at www.green-zones.eu. Without a Badge You Will Be Liable for a Fine! http://www.prnewswire.co.uk/cgi/news/release?id=216145 (14 April 2012, date last accessed).

[8] Waterfield B. EU to ban cars from cities by 2050. *The Telegraph*, 2011. 28 March 2011. http://www.telegraph.co.uk/motoring/news/8411336/EU-to-ban-cars-from-cities-by-2050.html (14 May 2012, date last accessed).

[9] Muneer T, Celik AN, Caliskan N. *Sustainable Transport Solution for A Medium-Sized Town in Turkey—A Case Study*. Sustainable Cities and Society, 2011. V. 1, p. 29–37.

[10] Mitchell WJ, Borroni-Bird CE, Burns LD. *Reinventing the Automobile*, 1st edn. The MIT Press, 2010.

[11] IEA. *International Energy Agency (IEA), 2010. World Energy Outlook 2008*. 2010. http://www.iea.org/Textbase/npsum/WEO2008SUM.pdf (18 May 2012, date last accessed).

[12] WHO/World Bank. The world report on road transport injury prevention, Geneva, 2004.

[13] Kenworthy RJ, Laube FB. *An International Sourcebook of Automobile Dependence in Cities: 1960 = 90*. University Press of Colorado, 2000.

[14] PBS. *Timeline: History of the Electric Car*. 2010. http://www.pbs.org/now/shows/223/electric-car-timeline.html (18 May 2012, date last accessed).

[15] US Department of Transport. (2010). Bureau of Transport and Statistics, National Transport Statistics 2008. http://www.bts.gov/publications/national_transportation_statistics/2008/pdf/entire.pdf (9 May 2012, date last accessed).

[16] MacKay DJC. *Sustainable Energy-Without the Hot Air*. UIT, 2009.

[17] Muneer T, Clarke P, Cullinane K. The electric scooter as a means of green transport. *In Proceedings of the IMechE Conference on Low Carbon Vehicles, London*, 19–20 May 2009.

[18] Eurostat. '*GDP per Capita in PPS - GDP per Capita in Purchasing Power Standards (PPS) (EU-27L'100)*'. 2013. http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tec00114 (24 January 2014, date last accessed).

[19] ITC. *Basic Economic Data About Slovenia*. Embassy of the Republic of Slovenia Vienna, 2011. http://dunaj.veleposlanistvo.si/index.php?id=4035&L=1 (15 March 2012, date last accessed).

[20] SURS. *Annual Energy Statistics, Slovenia, 2010—Provisional Data*. 2011. http://www.stat.si/eng/novica_prikazi.aspx?id=3912 (20 April 2012, date last accessed).

[21] SURS. *Registered Road Motor Vehicles and Trailers, Slovenia, 2009—Final Data Statistical Office of the Republic of Slovenia*. 2010b. http://www.stat.si/eng/novica_prikazi.aspx?id=3150 (14 April 2012, date last accessed).

[22] SURS. *Registered Road Motor Vehicles and Trailers, Slovenia, 2010—Final Data*. 2011. http://www.stat.si/novica_prikazi.aspx?id=3940 (14 April 2012, date last accessed).

[23] GCC, Green Car Congress. *Fuel Consumption in Europe 47% Better Than US*. 2004. http://www.greencarcongress.com/2004/11/average_fuel_co.html (18 April 2012, date last accessed).

[24] MOP. *The Use of Biofuels in the Transport Sector in the Republic of Slovenia in 2008*. Ministry of Environment, 2009.

[25] MIT. *Fuel Economy Numbers for Electric Vehicles*, 2008. http://mit.edu/evt/summary_mpgge.pdf (20 April 2012, date last accessed).

[26] Ogrin D. *Climate Types in Slovenia*. 1996. Geografski vestnik 68. Ljubljana.

[27] Elektro Celje. *The Composition of the Primary Sources of Electricity*. 2011. http://www.elektro-celje.si/omrezje/284-sestava-primarnih-virov-el-energije (14 May 2012, date last accessed).

[28] Medved S. *Rational Use of Materials, Space and Energy*. Faculty of Mechanical Engineering, University of Ljubljana, 2003.

[29] Purgar Ž. 2012. Could Every Tenth Car Sold in 2020 Be Really Electric? Delo. 7 May 2012 http://www.delo.si/gospodarstvo/posel-in-denar/bo-vsak-deseti-prodani-avto-leta-2020-res-elektricni.html (5 May 2012, date last accessed).

[30] SunShot. SunShot Vision Study. U.S Department of Energy, 2012. February 2012. http://www1.eere.energy.gov/solar/pdfs/47927_chapter4.pdf (19 February 2013, date last accessed).

[31] The Economist. 2012. http://www.economist.com/blogs/graphicdetail/2012/12/daily-chart-19 (21 February 2013, date last accessed).

[32] Siol.net. *Slovenia Has Approved A Grant for the Purchase of Electric Vehicles*. 2011. http://www.siol.net/avtomoto/novice/2011/09/slovenski_trg_elektricnih_vozi.aspx (15 April 2012, date last accessed).

[33] SURS. *Statistical Information*. 2010a. http://www.stat.si/doc/statinf/03-SI-019-1001.pdf (20 April 2012, date last accessed).